

LIST OF STANDARD TECHNICAL SPECIFICATIONS

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A-ITEM WISE TECHNICAL SPECIFICATION.			
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**Standard Specification
for
Earth Work and Back Filling
(A-1)**

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1 General

1.1 Scope

This specification covers earthwork in excavation in all kinds of soil including murrum, hard murrum, soft rock (without blasting), hard rock (without blasting), hard rock (with blasting, filling excavated earth in plinths, sand filling in plinths etc.

This specification, used in conjunction with the contract documents, Bill of quantities and drawings establishes the minimum requirements for excavation, filling and backfill within the limits of site boundary.

This specification also covers removal, hauling and proper utilisation or disposal of all excavated material and the shaping of excavations and preparation of empaved surfaces of excavations on the entire area in accordance with the lines, level grades, dimensions as specified herein and / or as shown in the drawings.

2 Regulations, Codes and Standards

The work of excavation, filling and backfill shall be in compliance with all applicable state/local laws and regulations.

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS: 3764	-	Safety Code for excavation work
IS: 4014	-	Safety Regulations for scaffolding work
IS: 4081	-	Safety Code for drilling and blasting operations
IS: 4138	-	Safety Code for working in compressed air
IS: 7923	-	Safety Code for working with construction machinery
IS: 2720	-	Methods of test for soils
IS: 1200	-	Method of measurement of building works.

3 Preparation of Area

Prior to the commencement of earthwork operations, areas to be excavated, or on which embankment is to be placed, shall be cleared, grubbed and scalped as required. Earthwork shall not start until an area has been prepared which is suitable to allow efficient and uninterrupted progress.

CONTRACTOR shall carry out the survey of the site before excavation and set properly all lines and establish levels.

Before excavation work begins the contractor shall check all underground utilities such as electrical cables, pipelines, tanks etc.

The CONTRACTOR shall not remove any tree without the prior permission of the Engineer-in-charge. Adjacent tree/shrubs subject to possible damage shall be properly marked and/or protected during construction.

The CONTRACTOR shall provide and maintain barricades, guard rails, fences and other protective devices necessary for prevention of injury to persons/property around all work areas and at other locations where such potential hazard exists.

The CONTRACTOR shall preserve all Bench marks, Boundary and reference pillars.

4 Weather Limitations

During the periods when weather conditions are such or have previously been such, as to preclude satisfactory execution of the work, earthwork operations shall be suspended or shall be limited to those activities which can be successfully executed under prevailing conditions. For this purpose excavation can be carried out in such area or depth where concrete will be poured immediately after the excavation has been completed. The CONTRACTOR may if he wishes cover the bottom of excavation with suitable material to keep off the frost/rain from affecting the exposed earth surface. The material for this purpose shall be furnished by the CONTRACTOR and removed by him immediately before pouring concrete at his cost.

5 Preservation of Property, Antiques and Relics

Excavating operation shall be conducted in such a manner that all properties, facilities, utilities and improvements on or near the project site, which are to remain in place, are not damaged.

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

Where circumstances require so the contractor shall furnish and install sheet-piling, cribbing, bulkheads, shores, bracing or other means as may be necessary to adequately support materials carrying such items or to support the items themselves and shall maintain such supports until they are no longer needed, at which time they shall be removed and disposed of.

6 Drainage

The CONTRACTOR shall take suitable precautions to prevent ingress of water into the excavated areas during construction. CONTRACTOR shall ensure positive drainage at all time or all areas affected by the work.

Areas to be fixed or to have the placement of dikes shall be drained of all surface water and such ground water as may impair the construction of embankment or areas fill. The area may be drained by well points and/or temporary ditches, sumps and pumps. Pumping and bailing from the interior of any foundation enclosure shall be done in such a manner as to prevent the possibility of movement of water through or alongside any concrete being placed.

Excavations shall be as dry as possible prior to and during placing concrete.

All water pumped or bailed out during de-watering of pits and trenches shall be disposed of suitably through properly laid channels or pipes by the CONTRACTOR at his own cost. Disposal of water shall be carried out in such way that no inconvenience or nuisance is caused to the work in progress in the area or to the other agencies working in the area or cause damage to property and structures nearby.

7 Classification

Earthwork shall be classified under any of the following categories:

7.1 Soft / Loose Soil

Generally any soil which yields to the ordinary application of pick and shovel or to phawra, rake or other ordinary digging; such as vegetable or organic soil, turf, gravel, sand, silt, loam, clay, peat etc. It shall also include embedded rock boulders not bigger than 1 metre in any dimension and not more than 200 mm in any of the other two dimensions.

7.2 Soft/Disintegrated Rock

This shall include rock, boulders, slag, moorum, chalk, laterite, slate etc. which could be excavated with picks, hammer crowbars, wedges etc. This shall also include rock boulders not bigger than 1 metre in any dimension and not more than 500 mm in any one of the other two dimensions.

7.3 Hard Rock

This shall include rock which cannot be easily excavated with pick-axes, hammer, crowbars and wedges but has to be either heated where blasting is prohibited or has to be blasted.

8 Earthwork in Excavation

All excavation operations shall be carried out in accordance with accepted practices within the lines and limits as indicated on the design drawings. All equipment and tools so employed shall be adequate and designed for the work to be performed and shall be in good condition and used by personnel experienced in such operation.

Excavation for foundations shall be carried to the depths required, to reach firm material. Care shall be taken to achieve an even, undisturbed bearing strata for concrete placement.

The CONTRACTOR shall prepare the grading in the vicinity of buildings and other structures, so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water which has accumulated in the excavated areas shall be removed promptly.

All suitable material removed from excavation shall be used for filling, grading or as may be directed by the Engineer-in-charge. All material used for fill shall be free from debris, organic or other objectionable material.

Excess materials from excavation not required for fill or backfill shall be disposed off as indicated on the drawings or as directed by the Engineer-in-charge. Wasted material shall be spread and levelled and or graded as directed by the Engineer-in-charge.

Should the excavation, through error, be carried beyond the depth shown on the drawings or called for herein, the CONTRACTOR shall fill up such extra depth at his own cost to the proper level with plain concrete of strength equivalent to design bearing capacity and provide the necessary materials, labour and equipment as required to correct such an error to the satisfaction of the Engineer-in-charge.

If the excavation is deeper than 2.0 M the sides of the trenches shall be made bigger by allowing steps on either side so as to make required slope in order to prevent the earth from falling in the pit. Necessary excavation scheme shall be submitted by the CONTRACTOR for the approval of Engineer-in-charge prior to start of work.

Side slopes, benching and/or shoring/shuttering for excavation work shall be as directed by the Engineer-in-charge and prior approval of the Engineer-in-charge shall be obtained for a suitable method of protection before the excavation work is commenced.

Every precaution shall be taken by the CONTRACTOR against slips and falls in the excavation. No extra payment will be made for removal of slips and for back filling the space with material approved by the Engineer-in-charge.

If in the opinion of the Engineer-in-charge there is a possibility of the nearby constructed work having been damaged or disturbed by such collapse, the work shall be laid bare at the expense of the CONTRACTOR for inspection. Any damage shall be made good by the CONTRACTOR at his own expense.

Should the bottom of any excavation appear to be soft unsound or unstable, the CONTRACTOR shall excavate the same to required depths and the extra depth shall be filled up by the CONTRACTOR with lean concrete and necessary approval shall be taken from the Engineer-in-charge.

Mechanical excavation other than in rock, shall be halted at least 5 cm above final inverted grade. The remainder of the excavation shall be shaped manually and graded to provide uniform bearing on compacted or undisturbed soil, immediately before concreting.

All the excavation surfaces and surfaces of backfill material against which concrete is to be placed shall be smooth and firm, true to line and level.

The CONTRACTOR shall protect all bench marks and reference pillars/lines including water gauges from damage or movement during work. In case of any damage, the CONTRACTOR shall have to restore the same to its original condition without any extra cost.

For excavation of drain work, the sides and the bottoms should be to the required slope, shape and gradient. The cutting shall be done from top to bottom. The final surface shall be neatly levelled and well compacted.

The excavated stacked earth shall be refilled in the trenches and sides of the foundation in the 150 mm layers in plinth and remaining shall be disposed off outside the refinery boundary.

9 Excavation of Rock

Should rock be encountered above contract levels, it shall be immediately brought to the notice of the Engineer-in-charge. When directed the rock surfaces shall be uncovered and CONTRACTOR shall submit a survey report indicated the levels of rock surface on a 3.0 M grid.

Blasting for rock excavation shall be carried out by persons skilled in such work and only with prior approval of Engineer-in-charge. It shall be performed in strict accordance with the requirements of Explosives Rules 1940, Indian Explosive act 1844 and other local and Governmental laws. The CONTRACTOR shall remain totally responsible for any accident arising out of blasting operations or driving storage and transport of blasting materials.

Excavations in rock shall be cut as close as practical to the lines required for the installation of the full thickness of floors, footings and trenches or as indicated on the construction drawings.

9.1 Blasting

Storing and Transport

Explosives shall be stored in clean, dry, well ventilated magazines to be built for the purpose by the CONTRACTOR at his own cost. Fuses and detonators shall be stored in separate magazines, detonators and explosives shall be transported separately to the blasting site.

Preparation of Blasting

Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal etc. Only the quantity of explosives required for a particular amount of firing to be done shall be brought to the site of work. All surplus explosive left after filling the holes shall be removed at least 600 m from the firing point.

A wooden stemming rod shall be used to push the cartridge into the shot-hole. Metal rod or rammer shall not be permitted on the site of the work. The charge shall be pressed firmly into the place and not rammed or pounded.

The explosive shall be fired by means of an electric detonator placed inside a cartridge and connected to the firing cable.

Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray currents and to keep the lead wires short circuited until ready to fire.

Drilling Rock for Blasting

The holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting shall be suitable for handling without any secondary blasting. The rock pieces so blasted shall be neatly stacked at allotted places.

Blasting Operations

Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of 300 metres radius from the firing point at least 15 minutes before the firing time by sounding a warning siren. The area shall be encircled by red flags.

All operations shall be carried out by competent and experienced licensed supervisors. The firing shall be conducted by a supervisor and the number of shots fired at one time shall not exceed the permissible limits. In case of misfires, the unexploded charge shall be carefully located after half an hour and shall be exploded by drilling a fresh hole along side of the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge. The workmen shall not return to the site of firing until at least half an hour after firing.

Controlled Blasting

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

In such cases short delay detonators shall be used for blasting purpose.

In areas where blasting is not permissible due to close proximity of sensitive structures/ installations, excavation by chiselling shall be carried out by the CONTRACTOR.

Blasting shall be carried out only with prior approval of Engineer-in-charge. CONTRACTOR shall strictly adhere to the provisions of the Explosives Rules 1940, Indian Explosives Act 1844 and other local and governmental laws and shall remain totally responsible for any accident arising out of blasting operations or during storage and transport or blasting materials.

10 Backfilling

Back filling material shall be approved by the Engineer-in-charge.

Back filling of excavations in trenches foundations and elsewhere shall consist of one of the following materials.

- (i) Excavated soil
- (ii) Murrum
- (iii) Sand
- (iv) Lean concrete

The compaction of filling shall be carried out as specified in the drawings or as directed by the Engineer-in-charge.

All operations for structural fill and backfill which will support footings and slabs shall be conducted in the dry with suitable on-site materials taken from excavated stock piles designated for such use.

Fill Classification

In accordance with the purpose for which it is used, fill shall be classified as follows :

Class I structural fill: used as support for equipment, storage tanks, structural tanks building foundations, floors, road pavements, parking areas, truck turnarounds and other paved areas.

Class II structural fill: used as backfill around foundations, and for the construction of dikes, parapets, barriers and embankments and also the areas where installations of equipments and structures are not planned.

Unless otherwise noted on the design drawings, the fill listed in paragraph 11.5.1 shall be placed and compacted as follows:

Class I structural fill shall be placed in uniform layers not exceeding 150 mm loose thickness. Each layer shall be compacted to a dry density equal to 95 percent of the dry density obtained by compaction using Standard Proctor Test.

Class II structural fill shall be placed in uniform layers not exceeding 200 mm loose thickness. Each layer shall be compacted to a dry density equal to 90 percent of the dry density obtained by compaction using Standard Proctor Test.

In no case shall backfill be placed adjacent to concrete structure before the concrete has attained sufficient strength, unless form work and bracings are left in place to securely resist the complete loading imposed by the backfill.

Back filling shall not start until the work has been inspected by the Engineer-in-charge and all form work has been removed and the excavation has been cleaned of trash and debris.

Piping shall be laid in trenches having proper depth and width. Before laying pipe, the bottom of the trench shall be tamped. The pipe shall be bedded in sand for the full length of the barrel with recesses to accommodate the joints where required. Any pipe which has its grade disturbed after laying shall be taken up and relaid. Under no circumstances shall pipe be laid in water. Pipe shall not be laid when the work as determined by the Engineer-in-charge at no cost to the Owner. After pipe has been laid and all joints sealed and tested, the trenches shall be back filled.

All trenches shall be carefully back filled to the required finish grade. Care shall be taken to avoid damaging pipe or electrical ducts. Backfill for trenches shall be carefully tamped in 150 mm layers to a height of 50 mm over the pipe and the balance of the back fill shall be placed and tamped in 200 mm layers. All trenches shall be filled and graded at ground elevation to allow for settlement.

11 Transportation of Earth / Waste Material

Surplus earth/soil from excavation/concrete debris/waste material shall be removed from refinery boundary to the area demarcated by the EPCC Contractor with prior approval of the Engineer-in-charge.

12 Sand / Moorum Filling

Sand/Moorum for filling shall be medium hard, strong, clean for free from dust, organic and deleterious material and shall be approved by the Engineer-in-charge.

Filling shall be caused out in layers not exceeding 200 mm and shall be compacted mechanically or by saturation to specified grade and level and to obtain 90% laboratory maximum dry density or as specified in Bill Of Quantities.

13 Shoring and Supports

The CONTRACTOR shall provide, timbering, sheet piling, bracing, anchoring and other supports as may be necessary to protect the excavated slopes, adjacent paving, structures, utilities, and to prevent personnel injuries and property damage.

Braced sheet piling shall be provided where deemed necessary. Shoring shall be installed so as not to interfere with the proper placement and compaction of back fill.

Shoring of excavation shall be removed only when excavation is safe from cave-in and as back filling progresses.

14 Line and Levels

It shall be the responsibility of the CONTRACTOR to set lines, levels, grade stakes, batter boards, bench marks and monuments at his own expense for his area of work as specified herein or as shown on the drawings.

The CONTRACTOR shall carefully protect all land monuments, survey points and property marks from disturbance or damage and shall not remove, cut or disturb them without written permission from the Engineer-in-charge.

15 Clean-up

At the conclusion of all fill and back fill operations, the CONTRACTOR shall clear away from the job site as well as from private and public roads, ditches and surrounding areas, all rubbish and construction materials and all CONTRACTOR's tools, equipment and other property, before the work is finally accepted.

16 Quality Assurance

The services of an independent testing and inspection laboratory shall be employed by the CONTRACTOR to secure samples of backfill and fill material, to perform screening tests on backfill and in place fill.

All excavations for foundations shall be approved by Engineer-in-charge prior to placing concrete.

**Standard Specification
for
Plain and Reinforced Cement Concrete
(A-2)**

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17 General

17.1 Scope

This specification, used in conjunction with contract documents, bill of quantities and/or drawing establishes the minimum requirements for the use of cement concrete for construction. Other material standards referred to herein for compliance shall be interpreted as an integral part of this specification.

Any special requirements as shown or noted in the drawings shall govern over the provision of this specification

18 Regulations, Codes and Standards

Manufacture, placing and compaction of concrete for construction shall be in compliance with all applicable federal, state, local laws and regulations.

18.1 Codes and Standards

Material

- | | | |
|-------------|---|--|
| IS :269 | - | Specification for ordinary, rapid hardening and low heat portland cement. |
| IS :455 | - | Specification for portland blast furnace slag cement |
| IS :1489 | - | Specification for portland pozzolona cement |
| IS :4031 | - | Methods of physical tests for hydraulic cement |
| IS :650 | - | Specification for standard sand for testing of cement. |
| IS :383 | - | Specification for coarse and fine aggregates from natural sources for concrete. |
| IS :2386 | - | Methods of test aggregates for (Part I to VII) concrete |
| IS :516 | - | Methods of test for strength of concrete |
| IS :1199 | - | Methods of sampling and analysis of concrete. |
| IS :2396(I) | - | Flakiness index of aggregates |
| IS :432 | - | Specification for mild steel and (Part I & II) medium tensile steel bars and hard drawn steel wire for concrete reinforcement. |
| IS :1139 | - | Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement. |
| IS :1566 | - | Specification for plain hard drawn steel wire fabric for concrete reinforcement. |
| IS :1786 | - | Specification for cold twisted steel bars for concrete reinforcement. |
| IS :4990 | - | Specification for plywood for concrete shuttering work. |
| IS :2645 | - | Specification for integral cement water proofing material. |
| IS :9103 | - | Specification for admixtures for concrete. |

Equipment

- | | | |
|----------|---|--|
| IS :1791 | - | Specification for batch type concrete mixer |
| IS :2505 | - | Specification for concrete vibrator immersion type. |
| IS :2772 | - | Specification for portable swing weighbatchers for concrete. |
| IS :2750 | - | Specification for steel scaffolding. |

Codes and Practices

- IS :456 - Code of practice for plain & reinforced concrete.
- IS :2751 - Code of Practices for welding of mild steel bars used for R.C.C. works.
- IS :2502 - Code of Practice for bending and fixing of bars for concrete reinforcement.
- IS : 4014 - Code of practice for steel tubular (Part I & II) scaffolding.

Construction Services

- IS :3696 - Safety code for scaffolding and ladders.

Measurement

- IS :1200 - Method of measurement of building works.

19 Materials

19.1 Cement

Ordinary portland cement shall conform to IS:269, portland blast furnace slag cement shall conform to IS:455. Use of Portland Pozzolana Cement shall be only with prior approval of the Engineer-in-charge.

19.2 Aggregates

Aggregates in general designates both fine and coarse inert materials used in the manufacture of concrete. The fine aggregate is aggregate which passes through 4.75 mm IS Sieve. Coarse aggregate is aggregate most of which is retained on 4.75 mm IS Sieve.

All aggregates shall conform to IS:383. Fine aggregate shall consist of natural sand, i.e, river or pit sand. Coarse aggregate shall consist of crushed gravel, natural gravel, crushed stone or combination thereof conforming to requirements of grading and physical properties called for. However, bank run gravel shall not be permitted for coarse aggregates.

The fineness modulus of sand should be between 2.2 - 3.2 for concrete works.

The maximum size of coarse aggregate shall be 38 mm except for slabs and walls less than 250 mm thick which shall have a maximum size of 19 mm.

Blast furnace slag and manufactured sand shall not be used as aggregates.

19.3 Water

Water used for both mixing and curing shall be free from injurious amounts of deleterious materials and shall be of potable quality conforming to clause 4.3 of IS : 456.

19.4 Brick Aggregates

The brickbats shall be new bricks well burnt, hard durables, broken to sizes and well graded. It shall be free from dust, earth and any other impurities.

19.5 Reinforcement

Reinforcement shall be of tested quality M.S. round rods conforming to IS:432, IRC wire mesh fabric conforming to IS:1566, mild steel and medium tensile steel deformed bars conforming to IS:1139 and cold twisted steel bars conforming to IS:1786 as shown in drawings.

All reinforcement shall be clean, free from grease, oil, paint, loose mill scale, loose rust, dust, bituminous material or any other material or substance that will destroy or reduce the bond.

16 SWG approved annealed wire shall be used for binding the reinforcement bars.

19.6 Water Stoppers

Metallic water stopper shall be fabricated from 22 gauge G.I. sheet of specified width and bent, folded to shape, soldered and fixed. The transverse joints of the sheets shall either be welded, brazed or overlapped. In case of overlapping of the stoppers the minimum overlap should be equal to width of such water stopper.

PVC and rubber water stops shall be either ribbed or serrated type having a minimum thickness of 6 mm. These can be of approved make, such as "PASK", "CALICO" or approved equivalent. They shall be accurately cut, fitted and integrally joined as per manufacturer's specifications.

19.7 Jointing/Sealing Materials

All joint fillers, sealing materials etc. used for joints in concrete shall be from approved standard manufacturer and shall conform to relevant IS codes. The extent, type, method of use and control shall be as per manufacturer's recommendation, subject to approval of the Engineer-in-charge.

19.8 Admixtures

Admixtures shall be used strictly in accordance with the manufacturer's instructions and shall conform to the relevant IS codes. Vendor's instruction shall be successfully incorporated in the trial mix. The extent, type, method of use and control shall be subject to approval of the Engineer-in-charge in all cases.

Integral water proofing compound shall conform to IS:2645

20 Storage of Materials

20.1 Cement

Cement shall be stored in a damp-proof hopper or in sealed bags in a weather proof shed, on a floor above ground and shall be used in the order of its delivery. Different types or brands of cement shall be stored separately. Not more than 12 bags shall be stacked in any tier.

20.2 Aggregates

Aggregates of different sizes shall be kept separately. Aggregates of similar grading but from different sources or different types shall not be stored together unless approved. All aggregates shall be stored in such a way that they are free from contact of deleterious matter.

20.3 Reinforcing Steel

Reinforcing steel members and wire mesh which are stored at the project site shall be above ground on platforms, skids or other supports.

Steel shall be protected from rain, moisture and kept free from dirt, oil or contaminant injuries.

20.4 Miscellaneous

All other materials shall be stored in a weather tight and dry place and be protected from open flame or sparks.

All packed materials shall be stored in their original unbroken package or container.

21 Concrete

Concrete shall be composed of portland cement, water fine and coarse aggregate and admixtures if any as approved by the Engineer-in-charge.

All concrete shall be manufactured and delivered in accordance with the requirements of IS:456-1978.

21.1 Grades of Concrete

Unless otherwise specified on drawings or called for in the schedule of quantities, the grade of concrete shall generally be as per Table - I.

Table – I

Grade	Specified characteristic compressive strength of 15 cm Cube at 28 days (N/MM ²)
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40

21.2 Concrete Mix

The concrete shall be either nominal mix concrete or design mix concrete as defined in IS:456. Unless otherwise specified or given in the schedule of quantities, all lean and structural concrete shall be nominal mix and design mix type respectively.

5.2.1 Nominal Mix Concrete

- 5.2.1.1 This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with the proportions of materials as specified in IS:456. The water cement ratio shall not exceed those specified in IS:456.
- 5.2.1.2 In case the quantity of water is required to be increased for better workability, the cement content shall also be proportionately increased so that water cement ratio as specified in IS:456 does not exceed.

5.2.2 Design Mix Concrete

- 5.2.2.1 The CONTRACTOR shall at his cost grade the aggregates and control the water - cement ratio, design and conduct the different trial mixes to required strength and workability and obtain Engineer-in-charge's approval for the same. Duly approved design mixes in accordance to IS:456 shall be used for construction.
- 5.2.2.2 The minimum cement content and maximum water cement ratio of concrete work shall conform to the requirements of durability of concrete consistent with the degree of exposure in accordance with IS:456-1978.
- 5.2.2.3 All concrete shall be machine mixed and no hand mixing shall be permitted. The concrete shall continuously agitated from mixing to pouring. The use of non-agitating equipment in transporting ready-mixed concrete or the use of partially hardened concrete is not allowed.
- 5.2.2.4 Where reinforcement is too closely spaced for the maximum size of aggregate in a range, the largest suitable range will be used with the approval of the Engineer-in-charge.
- 5.2.2.5 The details of the tests for design mix together with the grading analysis and mix design calculation shall have to be approved by the Engineer-in-charge before the start of concreting. No concrete shall be placed on site before the approval of mix design by the Engineer-in-charge. However, this does not absolve the CONTRACTOR of his responsibility regarding achievement of prescribed strength of the mix. If during the execution of the work cube tests show lower strength than the required one, changes will have to be made in the source, grading of the aggregates, water content of the mix etc. Engineer-in-charge may instruct for fresh trial mixes which shall be carried out and tested by the CONTRACTOR at his own cost.

21.3 Mixing / Batching

Except where nominal mix concrete as defined in IS:456 is permitted to be used by the Engineer-in-charge, all components of concrete shall be proportioned by weight using weigh batchers for each grade of concrete. Water should be either measured by volume in calibrated tanks or weighed. Any admixture that may be added, shall be measured by volume or weight as per manufacturer's instructions. Mixing shall be carried out in mechanical mixers and preferable in a batch mixing plant. Batching plant where used shall conform to IS:4925-1968. Batchers shall not exceed the capacity which can be mixed efficiently as determined by the mixer efficiency test and peripheral speed shall conform to the manufacturer's recommended rate which shall not vary more than + 10%. Mixing shall continue until the mass is uniform in color and consistency but in no case shall the minimum mixing time shall be less than 1.5 minutes. Net minimum mixing time shall be measured from the time where all ingredients including water is in the mixer. Mixers shall be operated by trained operators and excessive mixing shall be avoided. Weigh batchers shall be placed level during use and hoppers shall be loaded evenly.

The mixers shall be maintained in satisfactory operating condition and mixer drums shall be kept free of hardened concrete. Mixer blades shall be replaced when worked down more than (10%) of their depth. Should any mixer at any time produced unsatisfactory results, its use shall be discontinued until it is repaired.

Mixing Time

Mixing time shall be as indicated in the following table. Time shall start when all solid materials are in the mixing drum, provided that all of the mixing water shall be introduced before one fourth of the mixing time has elapsed. Engineer-in-charge may however, direct change in mixing time, if he in his opinion considers such change is necessary.

<u>Capacity of Mixer</u>	<u>Min. Mixing time for Stationary mixer</u>
1 Cu. M. or less	1 1/2 Minutes
2 - 3 Cu. M	2 1/2 Minutes
4 Cu. M	3 Minutes

Stationary mixers shall have a suitable device to lock the discharge mechanism until the required mixing time has elapsed. Provision shall also be made to ensure that each batch is discharged completely before the mixer is recharged. The complete plant assembly shall include provisions to facilitate the inspection at all times. All records and charts for batching and mixing operations shall be prepared for batching and mixing operations shall be prepared as directed by the Engineer-in-charge.

Hand Mixing

Normally, hand mixing of concrete shall not be permitted. However, this may be allowed by the Engineer-in-charge in special cases such as far away, isolated placed. Ten percent (10%) extra cement shall have to be added to normal mixes when mixed by hand. It shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency.

21.4 Consistency

Consistency of concrete shall have to be controlled as per IS:456 and the slump tests shall be carried out by the CONTRACTOR in accordance with IS:1199.

The slump shall, in all cases, be as low as possible and shall fall within the values given in the following Table-2.

TABLE – 2

Type of Construction	Slump in Cm.	
	Max.	Min.
Reinforced foundation walls / Footings	7.5	2.5
Plain footing, caissons & Substructure walls.	7.5	2.5
Beams and reinforced walls	10.0	2.5
Slabs	7.5	2.5
Mass Concrete	5.0	2.5

At least one slump test shall be made for every compressive strength test carried out. More frequent tests shall be made if there is a distinct change in work conditions, if required by the Engineer-in-charge.

21.5 Workability

The concrete mix proportion so chosen, shall be such that the concrete is of adequate workability for the placing condition and can be properly compacted with the means available.

The suggested ranges of values of workability of concrete measured in accordance with IS:1199 are indicated in Table-3.

TABLE –3

Placing Conditions	Degree of Workability	Value of Workability
Concreting of shallow section with vibration	Very Low	20-10 seconds, Vee Bee time or 0.75 - 0.80, Compacting factor
Concreting of lightly reinforced sections with vibration	Low	10-5 seconds, Vee Bee time or .8 - 0.85, Compacting factor
Concreting of lightly reinforced sections without vibration, or Heavily reinforced sections with vibrations	Medium	5-2 seconds, Vee Bee time or 0.85 - 0.92, Compacting factor or 25-75 mm, slump for 20 mm aggregate
Concreting of heavily reinforced sections without vibrations	High	above 0.92, Compacting factor or 75-125 mm, slump for 20 mm* aggregate

* For smaller aggregate the values will be lower.

21.6 Work Tests

- 5.6.1 Over the full period of construction, the CONTRACTOR shall carry out work tests of concrete at his own cost. Sampling from fresh concrete shall be taken as per IS:1199 and cubes shall be made, cured and tested in accordance with IS:516. The number of specimen to be tested and their criteria for acceptance shall be according to IS:456. Frequency of work tests shall be as indicated below :

5.6.2 Frequency of Tests

5.6.2.1 Unless otherwise specified, for each grade of concrete, sets of test cube, each set consisting of three (3) twin specimens (i.e. total 6 nos.) shall be taken. Number of sets shall generally be calculated based on the types and corresponding volumes of work as indicated hereunder unless otherwise directed by the Engineer-in-charge:

Mass Concrete Foundations	:	For every 100 Cu. M of concrete placed, one set but not less than one set for each pouring of concrete.
Equipment and bldg. Column foundations	:	For every 50 Cu. m of concrete placed one set but not less than one set for each pouring of concrete
Frame & thin walled Structural components Columns, beams, slabs etc.	:	For every 30 Cu. m of concrete placed one set but not less than one set for each pouring of concrete

5.6.2.2 The test cubes shall be sampled in presence of the Engineer-in-charge/Owner's representative, who will also sign the record of testing in an agreed proforma.

5.6.2.3 For testing the cube specimens CONTRACTOR shall establish his own construction laboratory at site and the cost of testing of cubes shall be borne by him.

5.6.2.4 Supply of all required consumables, construction and erection materials including but not limited to gauges, welding, brazing, gasses and rods, electrodes, oxygen, acetylene, fuel, bolts, nuts and temporary support etc. For testing the cube specimens CONTRACTOR shall establish his own construction laboratory at site and the cost of testing of cubes shall be borne by him.

21.7 Standard Deviation

Standard deviation shall be calculated based on Clause 14.5 of IS:456.

21.8 Acceptance Criteria

5.8.1 The concrete shall be deemed to be accepted if it fulfills the requirements laid down in Clause 15 of IS:456.

5.8.2 If the concrete does not comply with Clause 15 of IS:456, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken up by the CONTRACTOR at his own cost. Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance. Concrete is liable to be rejected if it is porous or honey-combed ; its placing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified ; or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-charge.

22 Transportation Placing and Compaction of Concrete

Before any concrete is placed, the entire placing programme consisting of equipment, layout, proposed procedures and methods shall be submitted in writing to the Engineer-in-charge and no concrete shall be placed until his approval has been received. Engineer-in-charge approval for pouring concrete shall be considered as conveyed when the concrete pour card is signed.

22.1 Transportation of Concrete

Concrete shall be handled from mixer to the final place of deposit in a continuous manner and as rapidly as practicable. This should be done by means that will prevent segregation or flash set in the concrete during hot weather. During hot or cold weather concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may be adopted. At the time of placing concrete in very hot weather, care shall be taken to see that the temperature of wet concrete does not exceed 38degree C. Placing equipment and accessories shall be kept clean and

free of partially set grout and concrete. Suitable walk cradles shall be placed over the reinforcement when concrete is placed by manual transportation. All equipments used for transporting and placing of concrete shall be maintained in clean condition.

22.2 Placing

Concrete shall be placed within a maximum period of 25 minutes of its removal from mixer. No concrete shall be placed until the place of deposit has been inspected and approved by the Engineer-in-charge. In general, placing shall be direct, by transporting bucket. The concrete shall not be dropped from a height of over 1.5-m and it shall be carefully laid in position. Before placing the concrete, all formwork, embedments and reinforcement shall be checked for completeness, location, dimension, squareness and plumb. All chips and saw dust, debris, dirt shall be removed from the space to be occupied by concrete. During placing and compaction of concrete care shall be taken to ensure that there is no loss of liquid from concrete and no segregation of aggregates takes place. Where it is necessary to deposit concrete at level differences of more than 1.5 m, short chutes shall be used. In cases where chutes are impractical due to excessive drop upto the placing level, hoppers and sectional tubes (elephant trunks) shall be used. Concreting in open shall not be allowed during rains unless all precautions have been taken by the CONTRACTOR and permission has been given by the Engineer-in-charge.

To ensure bond and water tightness between old concrete surface and the concrete to be placed, the surface should be cleaned and roughened by initial green cuts by wire brushing or chipping. The initial green cutting may be done after 6 hours of placing concrete in order to facilitate the work. The loading of old slurry after thorough watering the old concrete surface removing all particles.

All soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. Storm water or water from the concrete which may accumulate on the surface of the bedding layer shall be removed by suitable means before start of placement. No concrete shall be placed on water covered surface.

22.3 Compaction

Each layer of concrete shall be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corners of the formwork with suitable type of equipment until the concrete has been consolidated to the maximum practicable density.

Concrete shall be compacted with mechanical vibrating equipment supplemented if necessary to obtain consolidation by hand spading and tamping. The vibrators shall be of Internal or Immersion type high frequency vibrators with speed not less than 7000 rpm when immersed in concrete. Concrete shall be placed in layers at least 300 mm deep in walls and approximately 450 mm in mass pours. Vibrators shall not penetrate more than 50 mm into the surface of previously placed layer but shall completely vibrate any concrete and specially those with higher slumps. Under no circumstances vibrators shall be attached to or allowed to touch reinforcement.

22.4 Embedments in concrete

All embedments shall be accurately set and rigidly fastened. Anchor bolts shall be set to template and firmly secured in vertical and horizontal line at required positions. Water stops shall be secured against displacement during the placing of concrete. The joints for G.I. sheet water stops shall be soldered water tight and those of PVC and rubber shall be joined by cementing with a bituminous cement against previously placed concrete.

Anchor holes and anchor bolts shall be protected by covering suitably with brickwork in lean cement mortar after thorough cleaning, unless otherwise approved by the Engineer-in-charge.

Before concreting the CONTRACTOR shall provide, fabricate and fix in proper position all metal inserts, anchor bolts, pipes etc., which are required to be embedded in concrete members as per relevant drawings and direction of the Engineer-in-charge.

Concreting shall not be started unless electrical conduits, pipes, fixtures etc. wherever required, are laid by concerned agency. The CONTRACTOR shall provide facilities and coordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-in-charge.

23 Construction Joints

When concreting work is to be interrupted, horizontal and vertical construction joints and bonding keys shall be located and shall conform in details to the requirements of the plans unless otherwise directed by the Engineer-in-charge. Construction joints shall be so located that they do not impair the strength of the structure. Method of forming all construction joints shall conform to the provisions of IS:456. Construction joints shall be provided as shown or described on the drawings. Where it is not described the joints shall be in accordance with the following :

- (i) In columns the joint shall be formed about 7 mm below the lowest soffit of the beams framing into it.
- (ii) Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and at the point of minimum shear.

In case of a beam intersecting a girder at the centre, the joints in the girder shall be offset a distance equal to twice the width of the beam and provision for shear transfer shall be made.

Before the fresh concrete is placed, the cement skin or any loose material of partially hardened concrete shall be thoroughly removed and cut back until solid face is exposed and surface made rough by any method as approved by the Engineer-in-charge. The rough surface shall be dried and coated with 1:1 freshly mixed cement sand slurry immediately before placing the new concrete.

24 Expansion Joints

Permanent expansion joints in structure shall be formed in the positions and to the shapes shown in the relevant drawings. Details of expansion joints shall be as shown in the drawing and all materials like bitumen impregnated fibre board, PVC water bar, aluminum foil etc. shall be of approved make and quality. CONTRACTOR shall ensure that all expansion joints are fully watertight.

25 Special Concreting

The placing of concrete underwater shall conform to IS:456 in all respects for the method employed. Special types of concrete shall be placed by methods most suitable for the particular conditions.

Grouting bases of machine, columns, foundation bolts etc.

Level Pads

For preparing the level pads, the top of the foundations concrete shall be chipped off to remove laitance formed on the concrete surface and all loose materials shall be thoroughly cleaned and surface to be wetted before grouting.

Grouting

Before placing the grout, the concrete surface shall be thoroughly cleaned, preferably with compressed air and the surface shall be thoroughly wetted with water for several hours. Grouting concrete shall be of grade M20 or more unless otherwise shown in the drawing with 6 mm down stone aggregates. Before placing the grout all free water shall be removed and the flat surface shall be coated with thin cement slurry.

The grout shall be carefully observed for initial settlement. If any settlement is observed, further grout is to be poured and compacted by rods.

For base plates having ribs underside the base plate, proper care is to be taken to ensure filling of the cavities between the ribs. In case of wide base plates or bed plates having ribs underside, it may be necessary to do pressure grouting as directed by the Engineer-in-charge.

Graving

The grout must not dry out after it is placed in position. The surface shall be kept moist with wet sacks for at least seven days.

Admixtures

If any admixtures is to be used with the grout, it shall be with prior approval of the Engineer-in-charge.

Non-Shrinking Grout

Non shrinking grout where required shall be used in accordance with the methods specified by the manufacturer. Material shall be as approved by the Engineer-in-charge.

The placement of grout shall be continuous so as to avoid "cold joints" under base plate and thoroughly worked under so as to eliminate air bubbles and voids. Rods or chains may be used to expedite this procedure.

Grout shall be placed so as to provide full and uniform bearing under all bearing surfaces.

Where forms are used for grouting, they shall remain in place for a period of 24 hours unless directed otherwise. All exposed grout with a thickness of 25 mm or more shall be sloped at about 45 degree unless otherwise noted.

25.1 Pre-cast Concrete Work

Following additional specification shall apply for Pre-cast Concrete Work.

Pre-cast concrete items shall have an absorption of not more than 6% by weight after immersion in water for 48 hours and if necessary to obtain this density, shall have an integral waterproofing admixture of a type approved by the Engineer-in-charge. Pre-cast items shall be cured for a period of no less than 24 hours in a water vat or any other specific method which is to be approved by the Engineer-in-charge and shall be aged under cover for a period of no less than 30 days prior to setting, unless otherwise approved by the Engineer-in-charge. Pre-cast concrete items shall be set, with faces plumb and true, in a full bed of mortar. The exterior joints shall be fitted solid and tooled. The pre-cast units shall have ends and joints at right angles to their faces. Ends, except where exposed shall be roughened for bond. The formwork and / or moulds for pre-cast concrete units shall be made of metal and true to shape and dimension of the finished product as indicated on the drawings. The moulds shall be close jointed and perfectly smooth with joints caulked to prevent leakage of cement slurry. The moulds shall be of rigid construction to prevent distortion and bulging of sides and shall be designed with suitable fastenings to allow them to be struck off without injury to the casing. The moulds shall generally be vibrated on a mechanically operated vibrator.

Marking of Units

All pre-cast members shall be marked in a manner approved by the Engineer-in-charge in a conspicuous place, with date of manufacturing and marking number. The upper part of the member shall be marked distinctly to ensure handling. Necessary lifting hooks shall be provided for handling as indicated in the drawing or as directed by the Engineer-in-charge, which shall not be less than 12 mm dia rounds.

25.2 Guniting Work

In addition to the relevant provisions of Clause 5.0 of this specification, following specifications shall be applicable for guniting work.

Reinforcement

Reinforcement mesh shall be electrically welded mesh fabric consisting of 8 gauge wire in both directions spaced at 150 mm centers. Dowels shall be 12 mm dia mild steel rounds 75 mm long spaced at 750 mm centers.

Proportion and Thickness

The mix of cement and sand shall be one part of cement to three parts of graded sand unless otherwise specified and water to be added just sufficient for hydration. Any quick setting admixture to be mixed shall be of approved quality. The thickness should be as shown on the drawings.

Preparation of Surface

The surface to be guniting shall be lightly chipped and thoroughly cleaned of any dirt by compressed air and all loose particles shall be removed and the surface shall be fully wetted.

Fixing Reinforcement

Necessary holes shall be drilled on the concrete surface at required intervals. The dowel bars shall be inserted in these holes and tied to the main reinforcement wherever possible. The dowels shall be grouted and the grout shall be allowed to set at least for 24 hours. After the grout has set, fabric tied to the dowels with 16 gauge annealed binding wires. The fabric reinforcement shall have a minimum lap of 2300 mm and an average cover of 20 mm from the existing concrete surface.

Workmanship

Water pressure shall be 1.06 kg/sq. cm. Gauge. Air pressure shall be 2.46 kg/sq. cm. For 30 m length of hose and shall be increased by 0.35 kg/sq.cm. gauge for every additional 15m length of lose or part thereof. Pressure gauge shall be indicated the specified pressure in the mixing chamber. The quantity of water added shall be regulated and water cement ratio shall be 0.25 to 0.30 by weight. The mixing shall be shot at right angles to the surface and all rebound materials shall be removed and shall not be reused. Loose sand deposits shall be removed. At the end of each day's work a thin edge shall be left. Where thickness of guniting is such that it has to be performed in more than one layer, a minimum of 5 hours shall be allowed between completion of one layer and starting of the next layer to reduce the undesirable effects of shrinkage.

Curing

Starting about six hours after completion of spraying, the surface shall be cured for a period of seven days by methods approved by the Engineer-in-charge

26 Curing

Curing of concrete shall be done in accordance with IS:456. Concrete shall be cured by keeping it continuously moist for at least first 78 days after placing except for high early strength concrete for which the time period for constant moistening shall be 3 days.

Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in-charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set and shall comply to manufacturer's specifications.

27 Finishing Of Concrete

On striking the formwork, pockets, blowholes, honey combing which may be formed due to segregation, improper vibration and any other reason whatsoever shall be brought to the notice of the Engineer-in-charge. The voids, if any, shall be properly keyed and reinforced, if necessary. The face shall be tightly formed and arranged for providing a head in concrete. The cavity shall be filled with the same concrete as used for the structure and thoroughly rodded or vibrated wherever possible. The filled hopper shall be left in place until shrinkage has taken place and the concrete, set sufficiently to stay in place. While still 'alive' the upper part of form hopper shall be removed and excess concrete struck off and finished with wooden flat or trowel to match existing concrete. Any fins or unsightly grout runs or bulges shall be removed from the surface, exposed to view. The rod holes shall be finished with cement or grouted to match the existing surface as closely as possible. No cement wash shall be used unless particularly called for in the drawings.

Defects like blow holes, honey combing, if required rectification, shall be corrected by necessary chipping and packing or grouting with concrete or cement mortar. If mortar is used it shall be 1:3 mix or as specified by the Engineer-in-charge. However if honey combing or blow holes are of such extent as being undesirable the Engineer-in-charge may reject the work totally and his decision shall be binding. No extra payments shall be made for rectifying the defects as stated above. All burns and even faces shall be rubbed smooth with the help of carorandum stone.

The surface or non-shuttered faces shall be equal to that of the rubbed down shuttered faces.

27.1 Concrete Slab Finishes

Concrete floor slabs shall be finished as hereinafter described and called for in drawings.

The dusting of wearing surface with dry material shall not permitted.

All slabs shall be dead level or sloped to exposed edges, to floor drains or to trenches, without water retaining pockets. Slabs shall be struck off true to the required elevations and prepared for finishing.

When 'Steel Trowel Finish' is called for in the drawings, concrete shall be vibrated and tamped to embed the coarse aggregate. The concrete shall then be screed, leveled and floated with straight edges while the surface is brought to the required elevation while the concrete is still green but sufficiently hardened to bear a man's weight without deep imprint. To produce a smooth hard surface and to provide a greater density and more wear resistance the concrete shall be steel trowled. The resulting smooth surface shall be slightly roughened to produce a non-slip finish when exposed to the weather.

When 'Wood Float Finish' is called for in the drawings, concrete shall be vibrated and tamped to embed the coarse aggregate. The concrete shall then be screeded, levelled and floated with straight edges until the surface is brought to the required elevation. While the concrete is still green but sufficiently hardened to bear a man's weight without deep imprint 6 mm maximum, it shall be wood floated to obtain a true even plane, to embed large aggregate just beneath the surface, to remove slight imperfections and to compact the concrete.

When 'Rough Slab Finish' is called for in the drawings, floors shall be finished by tamping the concrete with special tools to force the aggregate away from the surface and then screeding with straight edges.

Non-slip Finish: Concrete stair treads and slabs having a cement non-slip finish shall be evenly sprinkled with no less than $\frac{1}{4}$ pound of abrasive material over each 1.2 kg per sq. m., which has been screeded level, and finished with a wooden float.

When 'Broom Finish' is called for in the drawings, the floors shall be finished as previously specified for 'Monolithic Steel Trowel Finish' followed immediately after the final trowling by brooming. Broom finishing shall be done by drawing a broom over the surface without rearing the concrete and shall produce regular corrugations not over 3 mm deep. The strokes shall be square across the slab with adjacent strokes slightly overlapped. The finished surface shall be free of porous spots, irregularities, depressions and pockets or other defects that may be caused by disturbing particles of coarse aggregate embedded near the surface.

When 'Floor Hardened Finish' is called for in the drawings, floor slabs shall receive treatment with a chemical concrete hardening and dust proofing agent, applied in accordance with manufacturer's recommendations.

28 Load Test on Parts of Structure

The Engineer-in-charge may demand for a load test to be carried out on any structure if in his opinion such a test is required for any of the following reasons :

The work site made concrete test cube failing to attain the specified strength.

Suspected overloading during construction of the structure under review.

Shuttering being prematurely removed and not as per the specifications.

The concrete being improperly cured.

Load test shall be carried out as soon as possible after expiry of 28 days from the time of placing of concrete. The structure should be subjected to load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed.

The deflection due to imposed load only shall be recorded. If within 24 hours of removal of the imposed load, the structure does not recover at least 75 percent of deflection under superimposed loads, the test may be repeated after a lapse of 72 hours. If the result followed is same as the earlier one, the structure is deemed to be unacceptable.

If the maximum deflection in mm shown during 24 hours under load is less than $40 \times L \times L/D$ where L is the effective span in metres and D is the overall depth of the section in mm, it is not necessary to measure the recovery from deflected shape.

Other non destructive tests may be carried out, in which case acceptance criteria shall be agreed upon between the Engineer-in-charge and the CONTRACTOR and the tests shall be done under expert's guidance.

29 Tolerances

Tolerance is a specified permissible variation from lines, grades, or dimensions given in drawings or as permitted by Indian Standard considered.

30 Damp Proof Course (DPC)

The 14 mm thick damp proof course shall consist of plain cement concrete of grade M 15 or nominal mix concrete of 1:2:3 (1 cement : 2 coarse sand : 4 stone aggregate) with 10 mm and down graded aggregate, unless otherwise specified.

The DPC shall be laid at plinth level of brick walls, flush with the floor surface and shall not be carried across doorways.

Before laying the top surface of wall shall be thoroughly cleaned and watered. The DPC shall be laid in layers of 20 mm thickness retaining the edges by necessary formwork and shall be well tamped and trowelled to smooth finish. DPC should be kept wet for at least 3 days and after it has dried, two coats of hot bitumen of grade A 90 / S 90 conforming to IS:73 shall be applied over it at the rate of 1.7 kg / sq. m. and over this dry sand shall be sprinkled evenly.

31 Form Work

The term 'shuttering' shall include all centerings and formwork required to support the concrete during the process of laying, compacting and setting and all items such as blanking, lagging, walling, moulds, covers, cross-bearers, struts, props, bracing's etc. shall be covered by the term.

Shuttering shall be strong and rigidly constructed so that there shall not be any deformation under sight and pressure of wet concrete, constructional loads, wind and/or other forces. It shall be constructed in such a manner that it can be easily removed afterwards.

The shuttering shall have smooth and even surface and so constructed as to remain sufficiently rigid during the placing and compacting of concrete and sufficiently tight to prevent loss of liquid from concrete.

Steel Shuttering shall only be used for formwork.

Devices shall be provided in the shuttering for forming openings, holes, pockets, chases, recesses etc. wherever required. Cutting of holes etc. in the concrete after casting shall be avoided. Corner fillets shall be provided in the formwork to obtain chamfered edges to beams, columns etc. wherever required.

Shuttering shall conform to IS : 456. Forms shall be prefabricated standard or shop-built panels or built-in-place units, stiffened and braced. A smearing of oil shall be given on the faces of the shuttering in contact with the concrete. Care shall be taken so that oil does not come in contact with the reinforcements. Shuttering shall be clean from all dust and loose materials before applying oil over it.

Formwork with brick lining may be done for structures below ground level on earthface with prior permission of the Engineer-in-charge. In such case bricks shall be thoroughly wetted before placing concrete and brick lining may be left in position if so desired by the CONTRACTOR.

The shuttering shall be such that when it is removed the exposed concrete surface shall be smooth and even. If any unevenness is found, the CONTRACTOR shall chip the bulged portion of the concrete and plaster with 6 mm thick cement plaster (1:4) at his own cost after getting approval from the Engineer-in-charge.

The centering shall be true and rigid adequately braced both horizontally and diagonally. All floors and beam centering shall be crowned not less than 8 mm in all directions for every 5 m span.

Unless prior approval in writing has been received from the Engineer-in-charge all vertical wall forms may be constructed for the following minimum pressure. The pressures listed are intended as guide only and the CONTRACTOR shall ensure that the construction of the forms is adequate for all concrete.

Rate of pour in Cu. M per hour	Pressure Kg / Sq. m.	
	10 degree C	24 degree C
0.6	3600	2900
0.9	4000	3200
1.2	4400	3500
1.5	4600	3700

All horizontal forms shall be constructed for pressures from the dead load of the concrete and embodiments and a minimum live load of 200 kg/sq.m.

Inspection of Forms

Temporary openings shall be provided at the base of columns and other placed necessary to facilitate cleaning and inspection. Immediately before concrete is placed all forms shall be carefully inspected to ensure that they are properly places, sufficiently rigid and tight, thoroughly cleaned, properly treated and free from foreign material.

Supports

Form work shall be so designed that the side of beams and slabs can be removed without disturbing soffit forms and their supports. Props and supports shall allow accurate adjustment of the formwork to line and level and be capable of being removed in an approved sequence without injury to the concrete. Provision shall be made for removal of formwork without disturbing props required for hardening concrete.

Settings

Panels and units shall be set to true dimensional and alignment rigidly tight, walled and traced to prevent distortion and displacement during concreting. All joints shall be tight and close fittings to prevent leakage. At all construction joints, framework shall be tightly secured against previously cast or hardened concrete. When fixing formwork for beams and slabs tight fittings collars shall be provided around the heads of columns and the joints shall be made grout tight. Slip forms where used shall provide smooth even surface true to dimension and alignment and shall be free from off-sets, fins and bulges.

Ties

Standard form of ties, clamps, bolts etc. shall be of adequate strength. Spreaders either removable or embedded type shall be used to maintain the wall thickness. The material and position of any tie passing through the formwork shall be approved by the Engineer-in-charge. All tie members which will remain embedded in the concrete shall be fixed in a manner that will provide a minimum cover of 12 mm at both the ends. Provision shall be made for removal of a section of each rod at surface of the concrete to a depth of approximately 50 mm. All holes left by the removal of conical nuts or other removable fixtures embedded in the face of the concrete shall be filled with concrete or mortar as approved by the Engineer-in-charge. Provision shall be made for forming holes and chases for services and providing pipes, conduits and other fixtures as shown in the drawing and/ or directed by the Engineer-in-charge. Wire ties shall not be permitted where concrete surfaces will be exposed to weathering, at any point where discoloration will be objectionable and for liquid retaining structures. Wire ties will be permitted only upon approval of the Engineer-in-charge and when permitted shall be cut off flush with the face of the concrete or counter sunk, filled and finished as required by the Engineer-in-charge.

Chamfers and Fillets

All corners and angles shall be formed with 45 degree mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets unless otherwise detailed or specified shall be 25x50 mm. For heavier work chamfers or fillets may be 40x50 mm. Care should be exercised to ensure accurate moldings. Unit rates quoted shall include providing the chamfers as specified or as shown in the drawings.

Vertical construction joints on faces which will be exposed at the completion of the project shall be chamfered as above except where not permitted by the Engineer-in-charge.

Cleaning and Treating of Forms

All rubbish, particularly chipping, shavings and sawdust shall be removed from the interior of formwork before the concrete is placed and inside of the form work shall be wetted with water before commencing of concreting. Mould oil or other approved release agent shall be used to all panels. Care should be taken to prevent contact of release agent with reinforcement.

Reuse of Forms

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary repaired and re-oiled before resetting. Formwork shall not be used/reused if declared unfit or unserviceable by the Engineer-in-charge.

Removal of Forms

In determination of time for removal of forms, consideration shall be given to the location and character of the structures, the weather and other conditions including the setting and curing of the concrete and materials used in the mix.

The following table gives the minimum period for removing formwork for various concrete members when normal portland cement is used (and generally where temperatures are about 20 degree C). No work shall be loaded before a period of 21 days from casting. All formwork shall be removed without shock or vibration to the concrete.

		Minimum period for striking shuttering or forms
1	Walls, columns, vertical sides of beams and sides of foundations	24 to 48 hours or as may be decided by the Engineer-in-charge
2	Slabs (props left under)	3 days
3	Beam Soffits (-do-)	7 days
4	Removal of props under slabs :	
a)	Spanning upto 4.5 M	7 days
b)	Spanning over 4.5 M	14 days
5	Removal of props to beams	
a)	Spanning up to 6 M	14 days
b)	Spanning over 6 M	21 days

32 Exposed Concrete Work

32.1 Form Work

Other things remaining same as per Clause 15.0 except the formwork shall be plywood or steel only. Care shall be taken to arrange the shutters so that the joints between shutter boards correspond with the pattern indicated in the drawings. The shuttering boards shall be butting with each other in straight lines, the corners of the boards being truly at right angles. The joints between the boards shall cross in the two directions at right angles. Maximum care shall be taken to make formwork watertight. Burnt oil shall not be used. The CONTRACTOR shall be permitted reuse of shuttering brought new of the work for exposed concrete work as per the following tables. Such reuses shall be permitted only if forms are properly cared for, stored and repaired after each use.

However, Engineer-in-charge may in his absolute discretion order removal of any forms, he considers unfit for use in the work and order rejection of any form stored or created, he considers unfit for use.

32.2 Finishing

On striking the formwork the exposed surface shall be cleaned of extra mortar, grit etc. by carefully chipping or rubbing by carorandum stone. Uniform texture and smooth surface shall be ensured. In case of honey-comb, the same shall be immediately brought to the notice of the Engineer-in-charge. If it is allowed to be notified, concrete in the affected areas shall be carefully chipped off up to the depth of the concrete cover. The chipped off area shall be in rectangular shape enclosing the affected part, cement concrete grout of 1:1 ½:3 or as specified by the Engineer-in-charge shall be used to patch up the chipped off area carefully using metal trowel to rub along with finishing surface. The repaired patch shall be kept wet by covering with a place of gunny bag from 2 hours after the work for 14 days, ensuring gunny bag piece remaining wet throughout the period.

32.3 Cement Wash

If so desired by the Engineer-in-charge, the CONTRACTOR shall provide one coat of cement wash over the concrete surfaces of foundations, pipe racks, columns, walls etc. which are not covered. Cement used by the CONTRACTOR for providing cement wash shall be taken into account for material reconciliation. Cost of providing cement was deemed to have been included in the rate of various items of concreting in the schedule of rates.

33 Reinforcement

Workmanship shall conform to IS:2502. All reinforcement shall be free from loose mill scale, rust, oil, grease and paint. Reinforcement shall not be bent or straightened in a manner that will alter the composition of the materials. Bent bars for reinforcement shall be cold bent gradually by machine or other approved means without the use of heat to the shapes shown in the drawings except in case of bars larger than 28 mm diameter. In such case if approved by the Engineer-in-charge bars can be bent hot by heating the bar gradually. Bars bent hot shall not be heated beyond cherry red colour and after bending allowed to cool gradually without quenching. Bars which develop high strength due to cold working shall not be hot bent. Bars having cracks or splits on the bends shall be rejected. All bars shall be bent in accordance with the drawings and bends shall be made in accordance with the "Standard Bending Details for Reinforcement Steel" as issued by the Designer. In normal course bar bending schedules are to be developed by the CONTRACTOR and to be approved by the Engineer-in-charge. Such preparation of bar bending schedule is deemed to have been included in the rate for reinforcing item.

Bars shall be properly tagged for identification. Reinforcement bars shall be placed and maintained accurately in position as shown in the drawings. The correct cover to the reinforcement shall be maintained by use of pre-cast concrete blocks.

Only bars of full length shall be used as shown in the drawings. Splicing of the bars except where shown on the drawings will not be permitted without the written permission of the Engineer-in-charge. At a tension splice the minimum clear distance between bars shall be maintained. Splices in adjacent bars having tension shall be staggered. At a compression splice each pair of lapped bars may be in contact but minimum clear spacing between the splice and adjacent splice shall be that specified for adjacent single bars. In no case shall the clear distance between the bars may be less than the diameter of the bar nor less than one third size of the coarse aggregate. Reinforcement reduced in cross section shall not be used.

Bar protruding for future bonding shall be adequately protected from corrosion. In case, there is substantial delay in the work, the previously placed reinforcement left for future bonding shall be cleaned and wrapped.

Exposed portions of reinforcement bars must not be subjected to impact or rough handling and workmen should not be permitted to climb on bar extensions until the concrete has sufficient strength so that no movement of the bar in the concrete is possible.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care should be taken to ensure that at no time the radius of the bent less than 4 x bar diameters for plain mil steel or 6 x bar diameters for deformed bars. Care shall be taken when bending back bars to ensure that the concrete around bar is not damaged.

All intersections of longitudinal and transverse bars of stirrups and all laps shall be securely tied together

With approved binding wire. The binding wire shall be so placed that it touches all the four corners of the intersection and the two ends shall be looped with pliers and two ends shall be turned into the body of the concrete. Bars shall be tied with annealed iron wire at all intersections except where spacing is less than 300 mm in each direction, when alternate intersections shall be tied.

33.1 Welding

Welding joints for reinforcement shall not be used without the prior approval of the Engineer-in-charge. Where welding is permitted it must be at suitable staggered location. In all cases of important connections the tests shall be done at the cost of the CONTRACTOR to prove that the joints are of the full strength of bars connected. Welding shall be done in accordance with IS:2751 and special precautions shall be adopted for cold worked bars. Butt welding between the ends of a rod in line, whereby stress is transferred across the section may be adopted only for mild steel bars. In case of tack welding for fixing reinforcements in their position, no special precaution need to be taken.

Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances :

For effective depth 200 mm or less + 10 mm

For effective depth more than 200 mm + 15 mm

When specified diameter reinforcement is not available, CONTRACTOR shall use other diameter reinforcement on written approval from the Engineer-in-charge.

34 Quality Assurance Plan

The CONTRACTOR shall submit the quality assurance plan for the aforesaid item of works and shall take all necessary steps for compliance.

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35 General

35.1 Scope

This specification covers the requirement of all brick/stone/stone block/concrete block masonry in foundations, sub-structure and super structure as shown on the drawings and as specified herein.

All masonry work shall be true to line and levels as shown on the drawings and shall be tightly built against structural members after the structural concrete frame has been constructed.

36 Regulations, Codes and Standards

The masonry works shall be in compliance with all federal, state and local laws and regulations which are applicable.

The following Indian Standards codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

- IS :1127 - Recommendations for dimensions and workmanship of natural building stones for masonry code.
- IS :1129 - Recommendation for dressing of natural building stones.
- IS :1077 - Specification for common burnt clay building bricks.
- IS :1597 - Code of practice for construction of stone masonry.
- IS :2212 - Code of Practice for brickwork
- IS :2250 - Code of practice for preparation and use of masonry mortar.
- IS :2691 - Burnt clay facing bricks (with amendment no. 1)
- IS :3150 - Specification for hexagonal wire netting for general purposes.
- IS :2250 - Code of practice for preparation and use of masonry work
- IS :3495 - Method of test for burnt clay building bricks
- IS :1200 - Mode of measurement of brick work (part 3 & 4)

37 Materials

37.1 Bricks

Bricks used shall be of class 50 A or 50 B designation conforming to IS:1077. All bricks shall be hand or machine molded and of first class quality, sound, hard, well burnt, of regular and uniform size, shape and colour (generally deep red or copper), homogeneous in texture and free from flaws & cracks. They shall have plain rectangular faces with parallel sides and square straight and sharply defined arises. A fractured surface shall show a compact, fine grained uniform and dense texture free from lumps of lime, laminations, cracks, air holes, grits, soluble salts causing efflorescence, or other defects which may in any way impair the strength durability, appearance and usefulness of the brick. A clear metallic sound shall be emitted when two bricks are struck together. After 24 hours immersion in cold water, water absorption by weight shall not exceed 20% of the dry weight of the brick. They shall not break when thrown on ground on their flat surface in saturated condition from height of 1600 mm.

Good bricks locally available and conforming to above can also be used. The tolerance permitted in the accepted size of bricks shall be plus or minus 3 mm in any dimensions. Only bricks of one standards size shall be used on one work unless specifically permitted by the Engineer-in-charge. Each brick shall have the manufacturer's identification mark or initial mark clearly in the frog. Representative samples of full size bricks shall be submitted for approval before commencing the work.

The compressive strength of bricks shall be minimum of 50 kg per sq. cm. All bricks proposed to be used shall conform to the approved samples in all respects. Any brick found not up to the specification shall be removed from the site immediately by the CONTRACTOR at his own cost.

37.2 Wire Netting

Woven, hexagonal wire shall conform to type N3 of IS:3150 and shall be galvanised. The width shall suit the thickness of the wall.

37.3 Stones

The stones shall be of approved quality, free from decay and weathering. The stones shall be obtained from approved quarry. Building stone shall conform to IS:1127. A fresh fracture of stone should be bright, clean, and sharp without loose grains and free from any dull earthy appearance. The stones shall be properly dressed in conformity with IS: 1129 after quarrying.

Discolored or distorted stones with boulder skin or earthy or porous matter, or stones with round surface bedded. The crushing strength of the rubble for use in the stone masonry shall not be less than 150 kg/sq. cm. They shall be properly cleaned of dirt and dust. 70% of the stones used in masonry shall weight 20-30 kg each. The stones shall be hammer dressed on the face, the sides and the bed to enable them to come into close proximity with each other. The "brushing" on the face shall not project more than 20 mm on an exposed face and 15 mm on the face to be plastered.

37.4 Stone Blocks

Stone pieces for stone block masonry shall be the best of its kind, sound, hard, durable, free from flakes, cracks and skin and of quality approved by the Engineer-in-charge. No earthy or discolored, weathered or water worth stone shall be used. The width and thickness of the stone for stone block masonry shall be 100 - 150 mm only and the length shall not exceed 250 mm or as decided by the Engineer-in-charge. Water absorption shall not exceed 1.5 percent of the weight of dry stone and the specific gravity shall not be less than 2.50.

37.5 Cement

Ordinary Portland cement shall be used conforming to IS:269 (latest)

37.6 Sand

The sand used shall be natural sand from one approved source. The sand shall be hard, durable, clean and free from adherent coatings, mica, shale, organic matter and appreciable amount of clay,. The sand shall not contain impurities like iron pyrites, alkalis, salts, coal, mica, shell etc. Sand for masonry mortars shall have particle size grading conforming to IS:2116 (latest edition). The grading of sand for used in mortar for unreinforced and reinforced brick work shall be within the specified limited for respective works. The fineness modulus of sand for mortar in unreinforced brickwork shall be between 2.1 to 2.3. A sand whose grading falls outside the specified limited due to excess or deficiency of coarse or fine particles may be processed to comply with the standard by screening and blending.

37.7 Water

Water shall be clean and free from oil, acid, salt and other injurious materials, Water of soluble quality as per clause 4.3 of IS:456 shall be used.

38 Storage of Materials

38.1 Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded to minimise breakage and defacements. The supply of bricks shall be so arranged that at least three days requirements of bricks are available at site at any point of time. Bricks selected for use in different location of use in the work shall be stacked separately.

38.2 Cement & Sand

Cement and sand shall be stored as specified in clause 4.0 of specification for plain and reinforced concrete.

39 Mortar

Brick work shall be laid with specified mortar to be prepared in accordance with IS:2250. The mortar recommended shall be of following proportions unless mentioned otherwise in respective item of work in bill of quantities.

One cement and six sand for brickwork of thickness 230 mm.

One cement and four sand for brick piers, half brick walls, honey combed brickwork and hollow blocks. The cement and sand shall be mixed dry in specified proportion and then thoroughly mixed to prepare consistency. It shall be mixed in small quantity so as to be used up within 30 minutes. No left over materials shall be used.

40 Scaffolding

Scaffolding shall conform to IS:2212 and shall be designed to withstand the loads to ensure complete safety of workmen and materials.

The scaffolding should be double i.e. it shall have two sets of stands to avoid pullog holes. Where this is not possible the inner end of the horizontal scaffolding pole shall rest in a hole provided in the head course only. Only one header for each pole shall be left out. Such holes, however, shall not be allowed in pillars under one metre width or immediately near the skew backs or arches. Holes, if provided shall be filled in and made good by the CONTRACTOR to ensure that the surface does not give any unsightly appearance.

41 Reinforced Brick Work

Bricks : 50 A class bricks as per relevant clauses specified elsewhere in the tender document shall be used.

Mortar shall be with cement sand proportion 1:3 specified.

41.1 Reinforcement

Where hoop iron is to be used as reinforcement, it shall consists of hoops 25 mm wide 16 SWG or such other size provided at every fourth course or as may be specified. The hoop iron is to be punched at an intervals of 150 mm or so to form burrs on both sides or reinforcement to improve bond. The hoop iron shall be hooked with minimum of 230 mm hooks at all angles and junctions. At other end of wall 50 mm length of the hoop iron shall be bent up or down so as to take firm grip of the brickwork.

Where M.S. bars are used as reinforcement, they shall generally be not more than 10 mm in diameter except where specified otherwise. Where no mention is made in the drawing regarding diameter it shall be 2 nos. 6 mm dia. Commercial quality steel round M.S. rods provided at every fourth course or as specified in drawings, embedded inside the joint, one on each side at uniform distance from the face and shall have a side cover of 12 mm mortar. The reinforcing bars shall be tied together by 16 SWG black soft iron binding wire at 500 mm c/c. At ends of wall, the reinforcement shall be carried at least 150 mm into the adjoining walls. No reinforcing bars shall be provided in parapet or in partition walls wherever it is not specified in the drawings. Approval of the Engineer-in-charge is to be obtained before placing the reinforcement.

42 Cleaning

The CONTRACTOR shall carry out work in a clean manner as far as possible and shall remove excess materials and mortar droppings and rubbish daily. Where brickwork and stone necessary is to receive plaster, the joints shall be cleaned of excess mortar and raked to a depth of 12 mm and the surface shall be brushed clean.

43 Workmanship

The whole of the brickwork shall be carried out by the CONTRACTOR in an uniform manner according to the provisions of IS:2216. All the bricks shall be kept under water till they are completely soaked and used on the work on their becoming skin dry.

The CONTRACTOR shall set out and build all brickwork to the dimensions, thickness and height shown on the drawings. Brickwork shall be laid in English Bond unless otherwise specified. Half brick walls and casing to pipe, chases etc. shall be laid in stretcher bond. Half or cut bricks shall not be used except when needed to complete the bond.

The CONTRACTOR shall lay bricks in full mortar beds with shoved joints. The joints shall not exceed 10 mm in thickness and shall be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than a quarter of brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork shall be laid plumb true to line and level. No portion of brickwork shall be raised more than 1.0 M at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top most shall be wedged against reinforced concrete surface and the joint wall filled with mortar. The contractor shall flush up all joints thoroughly with mortar as the work proceeds.

Bricks shall be laid with frogs upward. While laying bricks shall be thoroughly bedded and flushed in mortar and tapped into position with a wooden mallet and the superfluous mortar removed. In all cases of returns, buttress, counter fort etc. are to be built up course by course carefully bound into the main walls.

At all angles forming the junction of any two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brickwork shall not be raised more than 14 courses per day.

All iron fixtures, pies, conduits, drains, sleeves, bolts, hold fasts of doors and window etc. which are required to be built in walls, shall be embedded in cement mortar or in cement concrete as specified, in their correct position as the work proceeds.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. New surface of unfinished work shall be cleaned and thoroughly watered before joining new work to it.

Walls having thickness less than a full brick length shall be reinforced as per the specifications.

43.1 Curing

Green work shall be protected from rain by suitable covering. Masonry work as it progresses shall be kept thoroughly well watered on all faces for at least 7 days after completion. Proper watering cans with nozzles must be used for this purpose. The top of masonry work shall be left flooded at the close of the day by forming fillet of mortar 40 mm high round the edges of the top course and filled with water. In case of fat lime mortar, curing shall commence two days after the laying of masonry and shall continue for seven days.

44 Casting of Blocks

A block of size specified in the drawing shall consist of small rubble stone (as per size specified) surrounded by lean cement concrete of 1:5:8 volume (1 cement, 5 natural sand and 8 aggregate). The maximum size of aggregate used for this concrete shall not exceed 20 mm and with minimum 40% of 10 mm down graded aggregate as approved by the Engineer-in-charge. The average compressive strength of such masonry blocks after 28 days shall not be less than 75 kg/sq. cm. In case the average compressive strength of the blocks at 28 days is not obtained with the mix given above, mix design shall be done jointly by the contractor and the Engineer-in-charge so as to get average compressive strength of 75 kg/sq. cm. at 28 days. The casting of the blocks shall be carried out on a concrete platform near the site. Concrete platform shall be constructed of approved size by the CONTRACTOR. Steel moulds for specific size of stone blocks shall be made and placed on the platform while casting. Thereafter the lean concrete of 1:5:8 mix shall be placed and compacted up to a height of about 50 mm into which 3 nos. of small stones shall be embedded and the same concrete mix duly placed and compacted. Each of the 3 stone pieces, one at the bottom and two at the top shall cover the whole length of the mould.

Wherever the same is not possible, not more than 2 pieces, will be permitted at the bottom of the mould which will eventually form the exposed face of the masonry and a total of 4 on the top which will form the inside face to be plastered.

It will be required to cast 1/2, 1/3, 1/4 & 3/4 block also for breaking joints in masonry. Mixing of the concrete shall be done with the concrete mixing of an approved type and size which shall ensure uniform distribution throughout mass. Compaction shall be done with vibrator or rodding and tamping etc.

After 24 hours of casting, the masonry blocks shall be taken to the curing tanks and shall be cured for at least 7 days and air dried for another 21 days before using in masonry work.

45 Uncoursed Random Rubble Masonry

Workmanship for stone masonry shall conform to IS:1597. No stone shall be less than 250 mm in thickness or less than 300 mm in each horizontal dimension. If the thickness be more than 300 mm the least horizontal dimension must be less than the thickness.

45.1 Dressing

The stones after being fully cleaned and wetted are to be set in the work as received from the quarry and without further dressing of any sort except that of knocking off weak corner and edges with the mason's hammer.

45.2 Bond and Laying

The stones shall be carefully laid so as to break joints by at least 75 mm and solidly bedded with close joints. No joint shall exceed 20 mm in thickness. Chips of stones and spalls shall be wedged into the work, wherever necessary, so as to avoid thick beds or joints or mortar. No dry work or hollow space shall be allowed in the masonry anywhere. Every stone whether large or small shall be set flush in mortar. Smaller stones used in filling being carefully selected to fit into the interstices between the larger ones roughly. The outside and inside faces of masonry in walls must be carried out in the same plane as the faces of the preceding length.

45.3 Face Stones

The face stones shall be laid as far as possible without pinnings in front and they shall be selected from the mass of quarry stone for greater size, good beds and uniform colour. They shall be laid so that they shall tail back and bond well into the work and shall not be of greater height than either the breadth or face or length of trial in the work.

45.4 Bond or header stone

At least one fifth of stones in the face shall be through stones evenly distributed throughout the wall. The through stones will fulfill all conditions of the face stone except as regards their length which must not be less than 450 mm and must run right through the wall when the wall is not more than 450 mm thick. In thicker walls a line of two or more through stones must be laid from face to back overlapping each other at least 150 mm. Through stones should not be in the same vertical plane in successive courses. For facility of checking they shall be marked and the marks shall be capable of being easily rubbed out. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq. m. of wall surface.

45.5 Quoins

The quoins shall be of selected stones neatly dressed to the required angle and shall be of the same height as the course in which they occur. They shall be formed of header stones from 220 mm to 450 mm long according to the height of the course and laid lengthwise alternatively along each face. They should be laid square on their beds which should be dressed to a depth of at least 100 mm. The corner of each quoin on each side to facilitate checking the vertical alignment.

45.6 Finishing

Stones shall be so laid that all joints are full of mortar. Where line mortar is used, the exposed faces of work shall be cement flush pointed, unless otherwise specified. When cement mortar is used, the joints may be flushed as the work proceeds. Where stonework is to receive plaster or to be pointed other than flush pointing, the joints shall be raked to a minimum depth of 12 mm to provide proper bond. Face joints shall vary from 12 mm to 25 mm thick, but not less than 12 mm. Joints shall be struck/flush and finished with CM 1:3 at the time of laying when plastering and pointing is not required. Joints shall be raked to a depth of 20 mm during construction, if walls are to be plastered or pointed. For the faces of walls which are not be plastered stone surfaces shall be cleared of mortar dropping to give uniform appearance. Any work in which mortar perishes shall be dismantled and rebuilt by the CONTRACTOR at his own expense.

45.7 Curing

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly wet for a minimum period of 7 days.

46 Coursed Random Rubble Masonry

The specification shall be same as clause 11.0 above excepting that the work shall be roughly leveled up to courses at internals varying from 300 to 900 mm

47 Coursed Rubble Masonry

47.1 Height of Courses

The stones after being cleaned and wetted shall be laid in horizontal courses of equal depth of not less than 150 mm and shall be set full in mortar.

47.2 Dressing

The joints between the two continuous face stones in the same course shall be truly vertical and the two stones shall be hammer or chisel dressed so as to give them rectangular block shape and keep them in proximity for at least 75 mm depth from the face of the wall. The beds of face stones shall also be hammer or chisel dressed for at least 75 mm depth from the face and side joints for at least 40 mm, such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The "Brushing" on the face shall not project more than 40 mm on exposed face.

47.3 Bond and Laying

All stones shall be wetted before use. The stones shall be laid in horizontal courses and each courses shall be of equal height. The height of each course shall not be less than 125 mm on exposed face.

The stones shall be laid on their boards face in the mortar and beaten into position with mallet care being taken that the mortar is well filled into the joint. Face stones shall be laid as alternate headers and stretchers. The vertical joint in each course must break joint at least 75 mm with those in the course above and below. No face stone shall be less in breadth than its height or shall tail into the work to a length less than its height and at least one third of the stones shall tail into the work for length no less than twice their height. No joint shall exceed 12 mm in thickness. The hearting of interior filling of wall shall consist of flat bedded stones carefully laid on their proper beds solidly bedded in mortar. The interior of wall shall not be filled up with spalls and/or chips. Spalls, chips may however be used to wedge into the mortar to avoid thick bed or joints of mortar, which should not exceed 10% of the quantity of stone masonry.

The masonry work shall be carried up regularly, but where breaks are unavoidable, the joints shall be raked back at an angle not exceeding 45 degrees. Teething shall not be allowed.

47.4 Face Stones

The face stones shall be squared on all joints and beds. No face stone shall be narrower or shorter than its depth. Its length tailing into the wall shall not be less than their height and at least one third of the face stones shall tail into the work for a length twice their height or in thick wall three times their height.

The width of the face stones in plan shall not be less than 150 mm for walls 400 mm thick, 200 mm for walls respectively. No stone less than 150 mm in height shall be used on the face.

47.5 Bond or header stones

Through stones for headers shall fulfill all the conditions of face stones, except as regards their length which must not be less than the width of the wall or 450 mm whichever is less. Through stones shall be inserted approximately 1.5 metre apart in every course. Other details shall be same as for bond or header stones for random rubble masonry.

47.6 Quions

The quions shall be of the same height as the course in which they occur, shall be formed of stones at least 0.5 m long, laid stretcher and header alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm.

47.7 Finishing

All bed joints shall be horizontal and all side joints vertical. All joints shall be full of mortar. Face joints shall not be more than 12 mm thick unless otherwise specified. The joint shall be either flush or struck with cement mortar 1:3 using wooden mould/template of minimum 12 mm depth for uniformity.

47.8 Curing

Same as random rubble masonry.

48 Quality Assurance

The CONTRACTOR shall submit the quality assurance plan for the above items of works and shall take all necessary steps for compliance.

The CONTRACTOR shall carry out any test on material as desired by the Engineer-in-charge in order to satisfy him regarding quality without any additional cost.

**Standard Specification
for
Structural Steel Work
(A-4)**

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49 General

49.1 Scope

This specification, used in conjunction with the contract document, Bill of Quantities and design drawings, establishes the minimum requirements for material, fabrication, galvanisation, assembly, tests / examination, transportation of welded and/or bolted of all types of structural steel works consisting of columns, beams, trusses, trestles, pipe rack, cable rack, monorails, stairs, ladder, hand railing etc. for general construction work of each individual module. This also includes preparation of fabrication drawing based on supplied design drawing.

50 Regulations, Codes and Standards

The work of structural steel shall be in compliance with all applicable state/local laws and regulations.

The following Indian Standard Codes unless otherwise specified herein shall be applicable in all cases. The latest revision of the codes shall be referred to.

IS:800	-	Code of practice for general construction in Steel
IS:2062	-	Weldable structural steel
IS:816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS:1363	-	Black Hexagonal Bolts, Nuts & Locknuts
IS:9595	-	Recommendation for metal arc welding of carbon manganese steel
IS:1367	-	Technical supply conditions for threaded fasteners
IS:8500	-	Weldable structural steel (Medium and High Strength qualities)
IS:3757	-	High strength friction grip bolts
IS:1161	-	Steel tubes for structural purposes.
IS:5369	-	General requirements for plain washers and lock washers.
IS:814	-	Covered electrodes for metal arc welding of Structural (Part - I&II) steel.
IS:5372	-	Taper washers for channels.
IS:5374	-	Taper washers for I - beams

51 Material

51.1 Structural Steel

All structural steel shall be of tested quality. The material of all Indian rolled section and plates shall conform to IS 2062 Grade - A.

Wherever the material is procured by the contractor, the contractor shall submit the test certificates conforming to the relevant standards of all steel materials used for fabrication. All structural steel shall be free from rust, scales, lamination, cracks, fissures and other surface defects.

Carbon steel pipes shall be as per IS:1161 grade YST-25. In case mild steel is available according to latest IS:2062, steel to grade A, B & C will be used as applicable.

51.2 Bolts and Nuts

Bolts and nuts shall conform to IS:1363 or IS:1364 as applicable and as shown in the drawing. Unless otherwise specified nuts and bolt heads shall be hexagonal. Property class of nuts and bolts shall be compatible. The contractor shall submit test certificates when called for. Wherever shown in the drawing, high strength friction grip bolts (HSFG bolts) and nuts conform to IS:3757 and IS:6623 respectively shall be used.

51.3 Washers

Plain washers shall be made of mild steel conforming to IS:5369 unless otherwise specified. At least one washer shall be supplied for each bolt and in case of special types of bolts more than one washer as needed for the purpose shall be supplied. Helical spring washer conforming to IS:6755 shall be provided for bolts carrying dynamic or fluctuating loads and those in direct tension. Tapered washers conforming to IS:5372 and IS:5374 shall be used for channels and beams respectively. Washers for high strength friction bolts shall conform to IS:6649.

51.4 Welding Consumables

Covered electrodes (for metal arc welding of structural steel) shall conform to IS:814.

Filler rods & wires for gas welding shall conform to IS:1278.

Base wire electrodes (in submerged arc welding of structural steel) shall conform to IS:7280. The combination of wire and flux shall comply with the requirement of IS:3613.

Filler rods and base electrodes (for gas shield arc welding of structural steel) shall conform to IS:6419.

52 Receipt & Storage of Materials

Each rolled section must be marked for identification and each lot should be accompanied by manufacturer's test certificate corresponding to chemical analysis and mechanical characteristics, if steel is supplied by the contractor.

All steel sections shall be checked, sorted out, and arranged according to the grades and qualities in stores as per the instructions of the Engineer-in-charge.

Structural sections and plates etc. with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards.

All materials shall be stored properly on skids, above the ground. It shall be kept clean and properly drained. Structural steel shall be so stored and handled that members are not subjected to excessive stresses and damage. Girders and beams shall be placed upright for storing. Long members shall be supported on closely spaced skids to prevent permanent set due to deflection.

Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room in compliance with IS:9595. Electrodes shall be perfectly dry and drawn from an electrode oven, if required.

Checking of quality of bolts of any kind and the storage of the same shall be made conforming to relevant standards.

Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's test certificates.

The CONTRACTOR may use alternative materials as compared to design specifications only with the written approval of the Engineer-in-charge.

Materials for which test certificates are not available or for which test results do not tally with relevant standard specifications, shall not be used and the contractor is liable to remove the same from the work site at his own cost.

53 Fabrication

In and erection drawings shall be prepared by the CONTRACTOR on the basis of "Approved for Construction" design drawings, issued to him. The CONTRACTOR shall submit six copies of fabrication and erection drawings conforming to IS:800 for the approval of the Engineer-in-charge.

Fabrication and erection drawings shall be thoroughly checked and signed by the CONTRACTOR'S own responsible engineer to ensure accuracy and correctness of the drawings. Unchecked and unsigned drawings shall not be used for the purpose proceeding with the work.

Fabrication and erection drawings (drawn to a scale large enough to convey the information clearly and adequately shall include the following :

Reference to design drawing number (along with revision number, if any) based on which fabrication drawings has been prepared.

Structural layout, elevation and sections (with distinct erection marking of all members).

Framing plans, member sizes, orientation and elevations.

Layout and detailing of rain water pipes and gutters showing all necessary level and connections wherever required.

Detailing of shop/field joints, connection, splices, for required strength and erection.

Location type, size and dimensions of welds and bolt

Shapes and sizes of edge preparation for welding.

Details of shop and field joints / welds

Bill of materials / D.O.D. Lists.

Quality of structural steel, plates etc., welding electrodes, bolts, nuts and washer to be used.

Erection assemblies identifying all transportable parts and sub-assemblies with special erection instructions, if required.

Method of erection and special precautions to be taken during erection as required.

The CONTRACTOR shall however ensure accuracy of the following and shall be solely responsible for the same.

- i) Provision for erection and erection clearance.
- ii) Marking of members.
- iii) Cut length of members.
- iv) Matching of joints and holes
- v) Provision kept in the member for other interconnected members.
- vi) Bill of materials / D.O.D. Lists.

Connections, splices and other details not shown on the design drawing shall be suitably designed and shown on the fabrication drawings.

CONTRACTOR shall incorporate all the revisions made in the design drawings during the course of execution of work in his fabrication drawings and resubmit the drawings.

53.1 Workmanship for Fabrication

General

Fabrication of structures shall be done strictly as per the "Approved for construction" fabrication drawings and in accordance with IS:800 , IS:9595 and other relevant IS codes and I.S.I. Hand book SP:6(1).

Tolerances for fabrication of steel structure shall be as per IS:7215

Templates

Templates used throughout the work shall be of steel or steel brushed in such cases as may be considered necessary by the Engineer-in-charge. Actual materials should be used as templates for drilling.

Straightening

All material shall be straight and if necessary shall be straightened and/or flattened by pressure unless required to be of curvilinear form and shall be free from twists.

Clearance

The erection clearance for cleated ends of members connecting steel to steel shall not be greater than 2 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed seatings or connections shall be developed.

Shearing, flame cutting and planning

Shearing or flame cutting may be used at the CONTRACTOR'S option. A mechanically controlled cutting torches shall be used for the flame cutting and that the resulting edge shall be reasonably clean and straight. Sheared members shall be free from distortion at sheared edges. For high tensile steel when flame cutting is adopted special care shall be take to remove the burn edges. When gas cutting is adopted, to 5 mm depending upon the thickness of the member. For this purpose cutting allowance shall be provided.

Chipped edges shall be ground to a neat finish and sharp corners and hammered rough faces shall be rounded off. Edge preparation for welding may be done by machine controlled flame cutting with edges free of burrs, clean and straight.

No electric metal are cutting shall be allowed. Unless clean square and true to shape, all frame cut edges shall be planned. Cold sawn ends if reasonably clean and flame cut ends of sections not inferior to sawn ends in appearance need not be planned except for butting ends.

Holing

Holes for rivets and bolts shall be drilled to conform to clause 10 of IS:7215. All holes shall be drilled to the required size or punched 3 mm less in diameter and reamed thereafter to the required size. Thickness of material for punching shall not be greater than 16 mm.

Holes in secondary members like purlins, runners etc. may be punched full size, provided the thickness of materials does not exceed 13 mm.

No holes shall be made by gas cutting process. Allowable variations in holes (out of roundness, eccentricity, plumb line deviation) shall be as per IS:800.

Assembly

All parts assembled for bolting shall be in close contact over the whole surface and all bearing stiffeners shall bear tightly at both top and bottom without being drawn or caulked. The component parts shall be so assembled that they are neither twisted nor otherwise damaged. Specified cambers, if any, shall be provided.

All parts of welded members shall be held firmly in position by mean of jigs or clamps while welding.

Trial assemblies shall be carried out at the fabrication stage to ensure accuracy of workmanship and these checks shall be witnessed by the Engineer-in-charge.

Bolting

All turned and fitted bolts shall be carefully turned and shall be parallel throughout the barrel. The following limits of tolerance shall be permitted upon the diameter of the barrels of turned bolts and holes which they are to fit.

	Barrel of Bolt	Hole
Low	- 0.13 mm	0.00 mm
High	0.00 mm	+ 0.13 mm

The barrel of each turned bolt shall be of such a length that is in full contact with the work throughout the screwed portion being made at least 1.6 mm less in diameter than the barrel or to suit the next smaller size of the metric screw thread. The barrel portion shall be joined to the thread portion by a 45-degree chamfer within thickness of washer. Unless otherwise specified, faces of heads and nuts bearing on steelwork shall be machined. All such bolts shall be provided with washers having a hole of 1.5 mm larger in diameter than the barrel of bolt and the thickness of not less than 6 mm so that the nut when tightened shall not bear on the unthreaded body of the bolt. In all cases, where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts bearing on the levelled surface.

53.2 Welding

The welding and welded work shall generally conform to IS:816 and IS:9595 unless otherwise specified. As much work as possible shall be welded at shops and the layout and sequence of operations shall be so arranged as to eliminate distortion and shrinkage stresses.

All electrodes shall be kept under dry conditions. Any electrodes damaged by moisture shall not be used unless it is guaranteed by the manufacture that when it is properly dried for use shall have no detrimental effect. Electrodes which have parts of flux coating broken away or otherwise damaged, shall be rejected. Any electrode older than six (6) months from the date of manufacture shall not be used.

The members to be assembled for welding shall be clean and dry on welding edges. Under no circumstances shall wet, greasy rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between member to be welded.

The edges shall be prepared as shown in drawings correctly to the shape, size and dimensions with an automatically controlled flame cutting torch and/or by grinding. Wherever, U-groove joint is required, the edges shall be prepared with an automatic flame cutting torch in two phases following a bash out with a gouging pass or by machining. The welding surfaces shall be smooth, uniform and free from fins, tears, notches or any other defect which may adversely affect welding.

Welding Procedure

The welding procedure shall be determined by a CONTRACTOR and approved by the Engineer-in-charge to suit the details of the joints as indicated on the drawings and the position at which welding has to be carried out. Welding procedure shall cover the following :

- i) Type and size of electrodes
- ii) Position of welding
- iii) Current and arc voltage
- iv) Length of run per electrode or (for automatic welding) speed of travel of electrode.
- v) Number of run in multipass welds and arrangement
- vi) Preparation of the parts
- vii) Welding sequence
- viii) Pre or post heating

The welding procedure shall be so arranged that the distortion and shrinkage stresses are reduced to a minimum and that the welds meet the requirements of quality specified.

Any weld found defective shall be cut by using either chipping hammer or gouging torch in such a manner that adjacent material is not injured in any way. The defects must be rectified according to IS:823 and as per the instruction of the Engineer-in-charge.

The welding seams shall be left to cool slowly. The CONTRACTOR shall not be allowed to cool the welds quickly by any other method.

For multipass welding, before welding the following layer the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing.

Fusion faces and surrounding surfaces

Fusion faces and the surrounding surfaces within 50 mm of welds shall be free from dirt, all mill scale, oil, paint or any substance which may affect the quality of welds or impede the quality / progress of welding. The surfaces to be welded shall be free from irregularities.

All mill scale within 50 mm of weld shall be removed either by pickling followed by thorough power wire brushing or by other approved methods before welding.

Edge preparation shall preferably be carried out by shearing, chipping, gas cutting or flame gouging. In general, no special edge preparations will be required for members under 8 mm thick. Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members.

Accuracy of fit-up

Parts to be fillet welded shall be brought into as close contact as possible and the gap due to faulty workmanship or incorrect fit up shall not exceed 1.5 mm. If larger separation occurs at any position, the size of fillet weld shall be increased at such positions by the amount of gap.

Ends of butt welded joints

The ends of butt joint shall be welded so as to provide full throat thickness. This may be done by the use of extension piece, cross runs or other approved means.

Weld face and reinforcement of butt welds

The weld face shall at all places be deposited proud the surface of the parent metal. Where a flush surface is required the surplus metal shall be dressed off.

Testing of butt welds

Butt welded joints are to be radiographically tested by the CONTRACTOR and shall be rectified by the CONTRACTOR if found defective by the Engineer-in-charge.

The minimum leg length of a fillet weld as deposited shall not be less than the specified size. In no case a concave weld profile shall be performed unless it is specially permitted. Where as concave weld is permitted resultant throat thickness shall be taken care of.

After making each run of welding all slag shall be thoroughly and properly removed and the surface is to be cleaned.

Quality of Welds

The weld metal as deposited including tack welds shall be free from cracks slag inclusion, porosity, cavity and other faults. Proper fusion of the parent metal should be there without undercutting or overlapping at the toes of the weld. The surface of the weld shall have a uniform contour with regular appearance.

Weather conditions

Welding shall not be done under extreme weather conditions which may have an adverse effect and the efficiency of weld might be deteriorated.

Qualification and testing of welders

Welding shall only be carried out by fully trained and experienced welders and approved by the Engineer-in-charge and the CONTRACTOR shall produce evidence to the effect that the welder have satisfactorily complete appropriate tests as described in IS:817. The Engineer-in-charge may at his discretion ask for periodic tests of the welders and/or the welds produced by them. Such tests shall be at the expense of the CONTRACTOR. The CONTRACTOR shall employ a competent superior to ensure the quality of workmanship, materials for welding as laid down in the specification.

Machining of Butting ends, Caps and Bases

Column splices and butt joints of struts and compression members shall be correctly machines and close butt over the whole section depending upon the contact area required for load transmission. In column caps and bases the ends of shaft shall be machined fitted with gussets, ribs etc., so that proper surface contact is achieved. In case any angle, channels are connected to column cap/base the thickness of such angles, channels shall not be reduced by more than 0.8 mm after machining.

53.3 Shop Assembly

The steelwork shall be temporarily shop assembled as necessary so that accuracy of fit may be checked before dispatch to site. The parts shall be shop assembled with a sufficient number of parallel drifts to bring and keep th part in place.

53.4 Erection Marking

Each fabricated member shall bear an erection mark, which will help to identify the member and its position in respect of the whole structure, to facilitate re-erection at site.

These erection marks shall be according to the markings incorporated in the shop detail and erection drawings.

The members shall be visibly marked with a weather proof light colored paint. For small members those are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle while the crates shall be marked directly.

53.5 Control in the Fabrication and Assembly of various structures

The Engineer-in-charge or his representative shall have free access at all reasonable times to the CONTRACTOR'S fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication being undertaken in accordance with drawings and specifications.

Technical approval of the steel structure in the shop by the Engineer-in-charge is mandatory.

The CONTRACTOR shall not limit the number and kinds of tests, final as well as the intermediate ones, or extra tests requested by the Engineer-in-charge.

The CONTRACTOR shall furnish necessary tool gauges instrument etc. and in addition technical and non-technical personnel for shop tests by Engineer-in-charge.

To ensure good quality of workmanship the CONTRACTOR shall control the fabrication and assembly of structures as per the procedure outlined below :

i) Steel Structures for Industrial Buildings

The CONTRACTOR shall from his end check the established process and instructions for steelwork. All welds shall be visually examined and measured for external dimensions by appropriate gauges. He shall also conduct selective examination of welds by ultrasonic or drilling methods, X-ray or gamma - ray depending upon the type of joint.

ii) Criteria for tests

The CONTRACTOR shall conduct tests in accordance with the following norms :

- a) Visual examination - 100 % of the welded joints.
- b) Ultrasonic or drilling method - one drill hole for 50 meters of welded joint and not less than 50 mm for each 50 metres of welded joint.
- c) X-ray or Gamma - ray examination - Two percent of the length of weld made by manual or semi- automatic machine and one percent of the weld if made by automatic welding machines (flux welding, shielded arc welding, electroslag automatic welding). However, specified important joints shall be tested beyond these general limits.

53.6 Tests

Visual Examination

The CONTRACTOR shall conduct visual examination and measurement of the external dimensions of the weld for all joints. Before examination, area close to weld on both sides of weld for a width not less than 20 mm shall be cleaned of slag and other impurities. Examination shall be done by a magnifying glass which has a magnification power of ten and measuring instrument which an accuracy of + 0.1 mm or by weld gauges. Also the following checks shall be carried out during visual examination :

- i) Correctness and shape of welding joints.
- ii) Incomplete penetration of weld metal.
- iii) Burns
- iv) Influx of slag
- v) Unwelded craters
- vi) Undercuts
- vii) Cracks in welded spot and heat affected zones
- viii) Porosity in welds
- ix) Displacement of welded element
- x) Compression in welded joints as a result of electrode impact while carrying out contact welding.

Mechanical Test

The CONTRACTOR shall carry out various mechanical test to determine weldability, the metal alloyability , nature of break, correct size and type of electrodes, degree of preheating and post heating treatment etc. The type, scope and sample of various mechanical tests shall be determined in agreement with the Engineer-in-charge, attained to satisfy the Engineer-in-charge that the correct type and size of electrode, pre-heating and post-heating treatment and weldability of different metal are being followed.

X-ray and Gamma-ray Examinations

X-ray and Gamma-ray tests shall be carried out by the CONTRACTOR to determine gas inclusion (blow-holes and hollows), slag inclusion, shallow welds and cracks.

Before conducting the test the weld joints shall be cleaned of slag and scales and visually examined. The welds shall be marked into separate portions depending upon the length to be photographed. The length shall be such as to ensure that there are no distortions and shall reveal and defect correctly. The length shall not be more than 0.75 times the focal distance. The width of the photograph will depend on the width of the welded joint plus 20 mm, on either side of the weld. The cassette with film shall be protected by sheet of lead or equivalent of proper thickness against incidental diffused and secondary radiation.

The direction of the ray with relation to the film shall be specified as follows :

Weld of butt joints without edge slopes and with edge processing shall be examined by a central ray directed at right angles to the weld.

In special cases examination of welds with included rays directed along edge slopes may be permitted by the Engineer-in-charge.

Lap joints shall be examined by directing rays at 45 degrees to the bottom plate. Welds in Tee-joint without edge preparation shall be examined by rays directed at 45 degrees to the bottom place on both the welds. Angle welds in lap and tee joints shall be examined by the rays from opposite direction. Weld in angle joints shall be checked directing ray along with bisector of the angle between the weld elements. Circulate welds of cylindrical and spherical products shall be examined along their full lengths by the ray source located inside the cylinder or sphere near the weld. The cassette with film shall be positioned along the full length of the weld on external surface. The length of the overlapping shall be 10 mm to 15 mm.

Ultrasonic Test

Ultrasonic test shall be conducted by the CONTRACTOR to detect gas inclusion (pores) slag inclusion, shallow welds, cracks, lamination and friability etc. Before starting ultrasonic test the weld joint shall be thoroughly cleaned of slag and other materials. Surface of the basic metal adjacent to the weld joint on both sides shall be mechanically cleaned by a grinder or metal brush to provide contact of the whole ultrasonic probe surface with surface of basic metal. The width of the clean surface shall be as directed by the Engineer-in-charge. The welded joint then shall be covered with a thin coat of transformer oil, turbine or machine oil to ensure acoustic contact. The joints so treated shall be marked and the marks shall be entered into documentation. Subsequent to this ultrasonic tests shall be carried out as directed by the Engineer-in-charge.

53.7 Tolerance in workmanship

The permissible tolerance in workmanship shall be as specified in drawings or shall conform to IS:7215.

53.8 Inspection and Testing of Fabrication

Unless directed otherwise, inspection shall be made at the place of manufacture prior to dispatch. Should any structure found not to comply with any of the provisions of this specification, it shall be liable for rejection. No structure or part of the structure, once rejected shall be re-submitted for inspection/test, except in cases where the Engineer-in-charge considers the defect as rectifiable.

Defects that may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the Engineer-in-charge. All gauges and templates necessary to satisfy the Engineer-in-charge shall be supplied by the CONTRACTOR. The Engineer-in-charge, may at his discretion, check the test results obtained at the CONTRACTOR'S works by independent test at the Government test house or elsewhere.

53.9 Marking, Packing and Despatch

Each piece shall be distinctly marked before delivery in accordance with the marking diagram and shall bear such other marks as will facilitate erection.

All projecting plates or bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be properly packed and all rivets, bolts, nuts, washers and small loose parts shall be packed separately in boxes so as to prevent damage or distortion during transit.

53.10 Storing and handling of materials

The fabricated materials on receipt at site shall be carefully unloaded, examined for defects, checked and sorted out for each building and stacked securely on skids above level ground, which should be clean and have proper drainage facility.

The CONTRACTOR shall unload the fabricated materials promptly on arrival, otherwise he will be responsible for demurrage charges, if any.

All members having damages like small bends or twists shall not be put in position unless the defects are rectified. Any serious bends or damage shall be reported at once to the Engineer-in-charge by the CONTRACTOR for instructions. The strengthening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury.

53.11 Setting out

One set of reference axes and one bench mark level shall be furnished to the CONTRACTOR. These shall be used for setting out of structures.

The CONTRACTOR shall assume full responsibility for correct setting out of all steel work and erecting it correctly as per alignment and levels shown in the drawings and plumbing of vertical members.

53.12 Erection

General

- i) The erection of structural steel work shall be carried out in accordance with IS:800 and in conformity with drawings and specifications.
- ii) The adequacy of all plant, equipment etc. used for erection shall be to the satisfaction of the Engineer-in-charge.

Scope of Work

For carrying out erection the CONTRACTOR shall provide all construction equipments, tools, tackles, consumables, materials including labour supervision

The CONTRACTOR shall take care of receiving, unloading, checking and moving into storage at site as outlined in general conditions and shall promote attendance to all insurance matters as necessary for all materials arriving at site.

Transporting from site storage, handling, rigging, assembling, bolting, welding and satisfactory erection of all fabricated materials in proper location according to the drawings or as directed by the Engineer-in-charge shall form a part of responsibility of the CONTRACTOR. The CONTRACTOR shall check centre lines, levels of all foundation blocks, line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer-in-charge. The correctness of the foundations before installing the fabricated structures on the foundation pockets.

The CONTRACTOR shall ensure the stability of the structure or part during erection until the final alignment, welding, bolting are carried out. Aligning, lining, leveling, bolting, welding, securely fixing the position shall be done to the satisfaction of the Engineer-in-charge.

Painting shall be done by the CONTRACTOR as per specification including supply of paint.

Supply of all required consumables, construction and erection materials including but not limited to gauges, welding, brazing, gasses and rods, electrodes, oxygen, acetylene, fuel, bolts, nuts and temporary support etc. as required to complete the erection shall be under the scope of the CONTRACTOR.

Erection shall also include the following work :

- i) Removal of bends, kinks, twists etc. for parts damaged in transport and handling
- ii) Cutting, grinding, filling, chipping, drilling etc. whatever required for preparation and finishing of site connections.
- iii) Re-fabrication of parts damaged beyond repair during transport and handling or wrongly fabricated.
- iv) Plug welding and re-drilling of holes which do not register and which can not be reamed for use.

Erection drawings shall be prepared by the CONTRACTOR and shall consist of line diagrams showing every member in position with respective erection mark.

All steelwork shall be erected with the marks in the same relative position as shown on the elevation or plan.

Any discrepancy between the drawings and the specification shall be brought immediately to the notice of the Engineer-in-charge for decision.

53.13 Assembly and Erection

Before starting the erection the CONTRACTOR shall submit to the Engineer-in-charge for his approval the method he proposes to follow and the number and type of equipment and temporary work he proposes to use for the erection. Adequate allowance and provision shall be made for lateral forces and wind loads.

The CONTRACTOR shall plumb and level all steelwork and shall thoroughly brace and brace the structures during erection to keep them plumb and rigid till completion. Erected parts of the structure shall be stable during all stages of erection and the structural elements should be strong enough to bear the erection load. Specific sequence of erection should be observed.

53.14 Erection Tolerances

Erection tolerances shall be as specified in drawings or shall conform to relevant IS standards.

53.15 Glazing

Unless otherwise specified, side glazing shall be of 6 mm thick rough cast wired glass with hexagonal or square mesh formed of 0.5 mm dia wires or as indicated in the bill of quantities. The materials shall be obtained from approved manufacturer. Glazing shall be fixed in M.S./Aluminium Tee astragals as shown in the drawings and/or as indicated in the bill of quantities with the polished face on the side exposed to the weather.

All glazing parts shall be securely fixed in their frame and shall be weatherproof. All glazing shall be flashed with the surrounding sheeting. Glass shall be fixed with putty, suitable for structural steelwork, glazing chips, neoprene gaskets etc. as per Indian Standard IS:1038 and IS:1081.

54 Quality Assurance Plan

The contractor shall prepare and submit the quality assurance plan to the Engineer-in-charge for his approval. Approved QAP shall be strictly followed.

**Standard Specification
for
Plastering
(A-5)**

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55 General

55.1 Scope

This specification used in conjunction with the contract document, Bill of quantities and drawings establishes the minimum requirement for plastering work.

This specification covers the requirement for furnishing and construction including curing of all cement plastering work on interior and exterior surfaces of concrete and masonry as shown on basic instruction drawings and as specified herein. This shall also include the work to be done to make the surface suitable for receiving the finishing items.

Before commencing the plastering work, the CONTRACTOR shall obtain the approval of the Engineer-in-charge regarding the scheduling of work to minimise damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other agencies engaged in the vicinity.

56 Regulations, Codes and Standards

The plastering works shall be in compliance with all federal, state and local laws and regulations which are applicable.

The following Indian Standards codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

Standards and recommended practices of the latest issues unless modified herein or called for in drawings.

IS :1661	-	Code of practice for cement and cement lime plaster finish on walls and ceilings.
IS :2394	-	Code of practice for application of lime plaster finish.
IS :1542	-	Specification for sand for plaster.
IS :269	-	Specification for ordinary, rapid hardening and low heat Portland cement
IS :1200	-	Method for measurement of building works.

57 Materials

57.1 Cement

Cement shall be ordinary Portland cement conforming to IS:269

57.2 Sand

The sand shall consist of natural sand from one approved source. The sand shall be hard, durable, clean and free from adherent coatings, mica, shale, organic matter and appreciable amount of clay. The sand shall not have deleterious impurities such as iron pyrites, alkalis, salts, coal, mica, shell etc. Sand for plaster shall have particle size grading conforming to IS:1542 latest edition.

57.3 Water

Water shall be clean and of portable quality conforming to clause 4.3 of IS:456.

57.4 Admixtures

Admixtures shall be used in strict accordance with the manufacturer's instructions and shall conform to the relevant IS codes. The extent, type, methods of use and control shall be subjected to approval of Engineer-in-charge in all cases.

57.5 Lime Neeru

Plastered surface shall be finished smooth by trowelling on the surface with neeru (lime cream). Fat lime of best quality shall be slaked and mixed with sufficient water to a thick paste and it shall then be passed through a fine sieve to remove all foreign matter and allowed to mellow under water for at least 1 days. The mixture shall be ground to fine paste and shall be applied with the help of steel trowel @ 2.2 kg / sq. m.

57.6 Wire Netting

Woven, hexagonal wire shall conform to type N3 of IS:3150 and shall be galvanized. The width shall suit the thickness of the wall.

58 Plastering

58.1 Preparation of background surface

The surface shall be cleaned off all dust, loose mortar droppings, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing or hacking for non-hard surfaces respectively. Projection on surfaces shall be tamed wherever necessary to get even surfaces. In case of block/stone masonry, raking of joints shall be carried out wherever necessary. The masonry shall be allowed to dry out for sufficient period before carrying out the plaster work. The masonry shall not be soaked but only damped evenly thereafter before applying the plaster.

58.2 Sequence of Operation

For external plaster, the plastering operations shall be started from the top floor and carried downwards. For internal plaster, the plastering may be started wherever the building frame, roofing and brickwork are ready.

The surfaces to be plastered, shall first be prepared as described in clause 4.1.0 .

The first underlay shall when be applied to ceilings. After the ceiling plaster is complete and scaffolding for the same removed, plastering on wall shall be started.

After a suitably time interval as detailed under various types of plaster in subsequent paras, depending upon the type mortar, the secondary layers if required shall be applied. After a further suitable time interval as detailed under various type of plaster in subsequent paras, the finishing coat shall be applied first to the ceiling and then to the walls.

Plastering of cornices, decorative features etc. shall be completed before the finishing coat is applied. Unless otherwise specified, corners and edges shall be rounded off to radius of 25mm. Such rounding off shall be completed along with the finishing coat to prevent any joint marks showing out later.

58.3 Plain Cement Plaster

4.3.1 Preparation of Mortars

The mortar of specified mix shall be used as per specifications of 'MORTAR' described in clause no. 5.0 of 'STD. SPECIFICATION FOR MASONRY WORK'.

4.3.2 Application of Plaster

4.3.2.1 One Layer Plaster Work

To ensure even, specified thickness, plaster of 150mm x 150 mm shall be first applied horizontally and vertically at not more than 2 metre interval over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical, horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc. shall be carried out with proper templates to the size required.

In suspending the work, the plaster shall be left, cut clean to line, both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area. Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

4.3.2.2 Two Layer Plaster Work

The first or underlay of the specified thickness shall be applied as described in clause no. 4.3.2.1. Before the first coats hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

The second layer shall be completed to the specified thickness in the same manner as for first layer.

58.4 Finish

Generally, the standard finish shall be used otherwise shown on drawings or directed by the Engineer-in-charge. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown in the drawings.

Neat Cement Finish

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

Rough-cast finish

The plaster shall be laid in two coats. The first coat shall consist of one part of cement and four parts of clean sharp sand. The thickness of the first coat shall be just sufficient to fill up all unevenness in the surface under treatment but shall not exceed 10 mm. The plaster shall be laid by throwing the mortar/by using a strong whipping motion on the prepared surface with a trowel in a uniform layer and pressed to form a good bond. The surface shall not be smoothened. The second coat shall consist of one part of cement and three parts of gravel or crushed stone of size 6 mm to 10 mm or as approved by the Engineer-in-charge. The thickness of this coat shall be 10 mm. The cement and aggregate shall be mixed dry in the proportion by volume as specified. Water shall be added to form a workable plastic mix. The second coat shall be applied while the first coat is still soft and plastic. The plastic mix shall be thrown on to the first coat by means of a plaster's trowel and left in the rough condition.

Scrap Finish

Ordinary plaster as described under clause 4.3 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer-in-charge.

Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under clause 4.3. Ornamental treatments in the form of horizontal or vertical rib texture, fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer-in-charge.

Sand Faced Plaster

Sand faced plaster shall be applied in two coats. The first coat or the base coat shall be approximately 12 mm thick and shall be splashed on to the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratchlines, to provide bond for the finishing coat. The second coat shall be 7 mm thick and shall be applied from top to bottom in one operation and without joints. The second coat shall be finished with sponge.

58.5 Curing

All plastered surfaces after laying, shall be watered for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and no susceptible to damage.

58.6 Scaffolding

CONTRACTOR shall supply, erect and afterwards remove all scaffolding, ladders and temporary platforms, required for all plastering work. The support or bracing's of any part of each scaffolding from or to any wall, still or window frame is strictly prohibited. All scaffolding must be strongly and safely built as an independent structure supported only by the floor or ground.

58.7 Acceptance Criteria

Plastering to masonry and concrete shall fully comply with the drawings, specifications and instructions of the Engineer-in-charge with respect to lines, levels, thickness, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

59 Quality Assurance Plan

The CONTRACTOR shall prepare and submit the quality assurance plan to the Engineer-in-charge for his approval. Approved QAP shall be strictly followed.

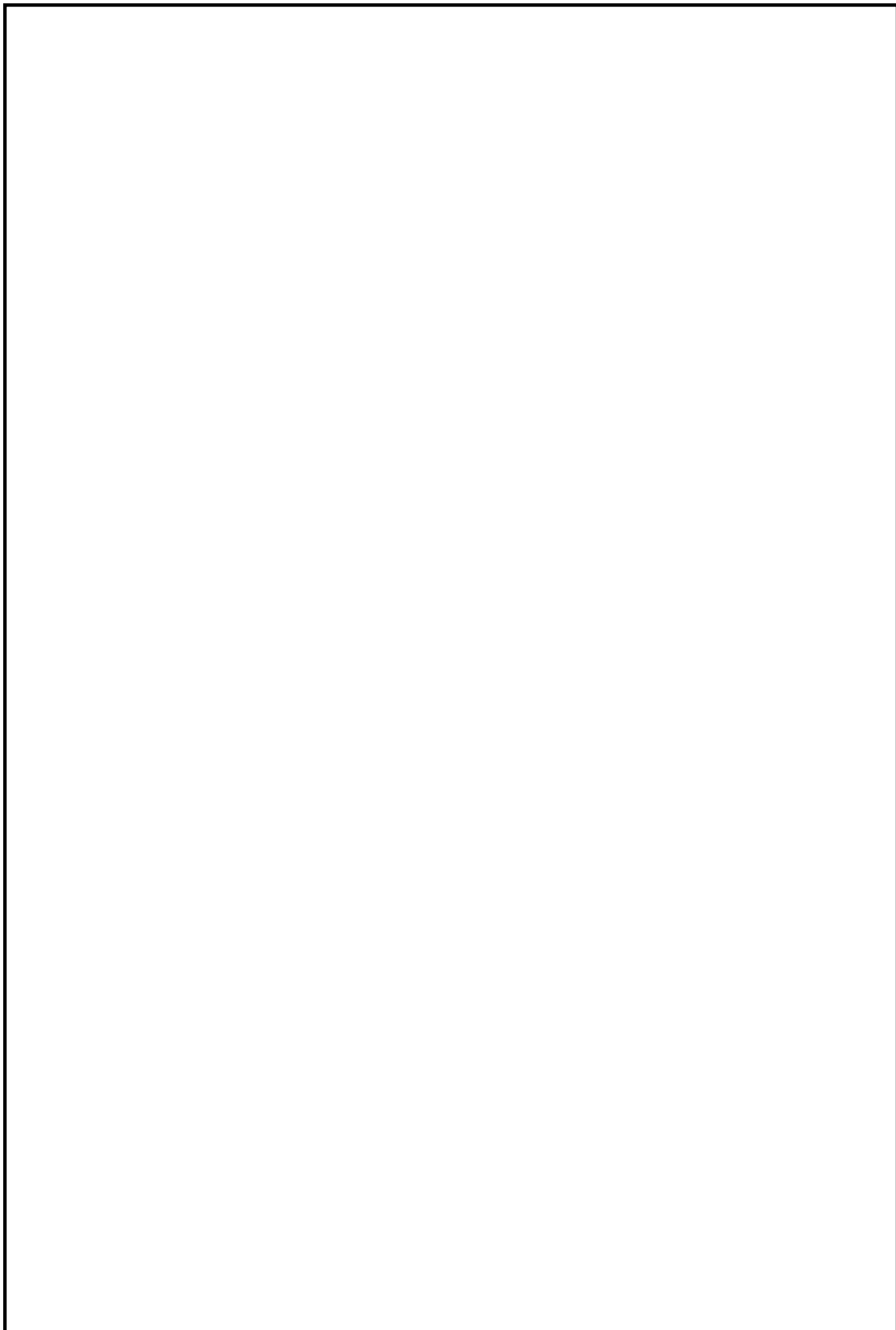


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60 General

60.1 Scope

This specification used in conjunction with the contract document, Bill of quantities and drawings establishes the minimum requirement for white washing and painting work excluding painting on structural steel work.

This specification covers the requirement for painting and white washing etc. of both interior and exterior surfaces of masonry, concrete, wood, rain water pipes, floor and roof drains, soil, waste and service water pipes as shown on the drawings, schedule or as directed by the Engineer-in-Charge.

The following specification describes the types of paint, mode of preparation of surface and mode of application.

Before commencing painting, the CONTRACTOR shall obtain the approval of the Engineer-in-Charge in writing regarding the schedule of work to minimise damage, disfiguration or staining by other trades or other installations.

61 Regulations, Codes and Standards

The painting works shall be in compliance with all federal, state and local laws and regulations which are applicable.

The following Indian Standards codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

- | | | |
|-----------------|---|---|
| IS: 2395 (I&II) | - | Code of practice for painting concrete, masonry and plaster surfaces. |
| IS: 239 | - | Distemper, dry colour as required |
| IS: 5410 | - | Specification for cement paint, colour as required. |
| IS: 428 | - | Distemper, oil emulsion, colour as required. |

62 Materials

62.1 General

All painting materials shall be obtained by the CONTRACTOR. The materials shall be of high grade and the products of well known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade. All materials shall be subject to inspection, analysis and approval of the Engineer-in-Charge. It is desired that materials of one manufacturer only shall be used. The shade shall not vary if the bulk supply is obtained to match the approved shade. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer-in-Charge.

All primer coats shall be compatible with the materials of the surface to be finished as well as with the finishing coats to be applied.

62.2 White Washing

White wash shall be prepared from a good quality fat lime. Lime shall be slaked with water to the consistency of a cream and allowed to remain under water for 2 days. It shall then be strained through a cloth and 2 kg of clean gum of approved make shall be added for every cubic metre of lime and indigo with 3 gm per kg of lime dissolved in water shall then be added and stirred well.

62.3 Cement Paint

External water proofing cement paint shall be from approved manufacturer like SNOWCEM or any other similar brand conforming to IS:5410.

62.4 Acrylic Emulsion Paint

The paint material shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any

deterioration in colour, or without showing flaking, blistering or peeling. Paints to be used for the various items of work should be approved make viz. BERGER, ASIAN, JENSON & NICKELSON, SHALIMAR etc.

62.5 Epoxy Paint

All catalyzed epoxy paints shall be cold cured, high building epoxy system, polyamide cured epoxy paint will consist of two packs.

The epoxy system shall consist of a base and hardener mixed in parts recommended by the manufacturer.

Mixing Time	:	5 Minutes
Pot Life	:	8 hours at 22 deg. C
Curing Time	:	Tough - 30/40 times Hard - 12 hours
Film thickness	:	1.5 ml/coat

Epoxy paint shall be of approved make viz BERGER, ASIAN, ICI etc.

62.6 Vinyl Paint

The paints shall be vinyl resin type. It is a ready mixed paint and can be thinned if necessary with vinyl thinner to achieve spraying viscosity.

62.7 Aluminium Paint

Aluminium paint supplied in two pack containers shall be mixed and applied as per manufacturer's recommendation/direction. The paint shall conform to IS:2339 and shall resist weathering.

62.8 Distemper

Distemper shall be of approved make. Water bound and oil bound distemper shall conform to the requirements of IS:427 and IS:428 respectively.

63 Material Storage

Work areas designated for storage and mixing of all painting materials shall be subject to approval of the Engineer-in-Charge. Painting materials shall be stockpiled in a neat manner to facilitate finding them and preventing loss or misuse. Painting waste shall be disposed off promptly in proper containers outside the building. No plumbing fixture or drainage system shall be used for protected from damage, disfigurement and stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the CONTRACTOR to prevent fire and including following provision:

- 1) Proper ventilation in the store
- 2) "No smoking" Board
- 3) Fire Extinguisher (portable type) within a very reasonable distance.
- 4) Closing the containers while in store
- 5) No naked flame.

64 Scaffolding

CONTRACTOR shall supply, erect and afterwards remove all scaffolding, ladders and temporary platforms, required for all painting work.

Tee support or bracing of any part of each scaffolding from or to any wall, sill or window frame is strictly prohibited. All scaffolding must be strongly and safely built as an independent structure supported only by the floor or ground. Painters shall take necessary precautionary measures during working like using safety belts etc. wherever necessary.

65 Preparation of Surface

Generally, all surfaces to be painted shall be wire brushed cleaned of oil grease and other foreign matters. If the surface is oily, a detergent wash shall be applied on surfaces where vinyl and epoxy paints are not

applied. The surfaces shall then be rubbed with emery paper and the dust removed thoroughly with clean cotton cloth. Special surfaces like concrete, plaster, etc. shall be , in addition treated differently as explained below. All the edges/corners/cracks shall be finished or rectified with necessary filler materials or chemicals as approved by the Engineer-in-Charge without any additional cost.

65.1 Concrete Surface

Air water jet at a pressure of 7 kg per sq. cm shall be forced through a nozzle having a tip with an orifice of 1.5 cm. If the pressure is not enough to open out air holes, the pressure shall be increased and all the laitance shall be allowed to dry for 48 hours. The pin holes exposed due to air water jet shall then be given a sack rub finish with cement fine sand and all excess cement shall be removed with clean cloth. Any imperfections, bulging notices in the concrete surfaces, shall be ground chipped and made good prior to sack rub finish.

65.2 Plaster Surfaces

The surface shall be wire brushed, rubbed with sand paper/emery paper clean and free of all oil, grease efflorescence, loose paint and other foreign and loose materials. Masonry/plaster cracks shall be cleaned patch filled with mortar similar to original surfaces and conforming texture. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the re-surfaced areas shall be treated with a coat of cement primer covering the area being treated and extending 150 mm all round such area. Surface with mildew or efflorescence shall be treated with an approved fungicide viz. ammonia wash consisting of 7 gms of copper carbonate dissolved in 8 ml. of liquid ammonia and diluted to one litre with water or 2.5 % Magnesium-Silica-Fluoride solutions and allowed to dry thoroughly before paint is applied.

Efflorescence shall be removed by scrubbing and treating the affected area with a solution of 30% strength muriatic acid in water (1:6) and washed fully with clean water and allowed to dry thoroughly.

65.3 Wooden Surfaces

Wooden surfaces shall be rubbed with a sand paper to give a smooth surface. No wood shall be painted or finished unless it is sufficiently dry. All sapwood, streaks and knots shall be sealed with knot sealer. The primer coat shall then be applied, afterwards, when dried, nails and knot holes shall be filled with putty, allowed to dry and sand papered smooth.

Wooden surfaces, except surfaces to be given natural finish, shall be primed and finished as specified in the painting schedule herein. Wooden items to be painted and in contact with or built into concrete, masonry units and mortar shall be back primed and given a coat of the specified first coat materials on all edges before installation. Glazing rabbets and heads in exterior sash and doors shall be primed prior to glazing. Edge of doors which have been trimmed during hanging and fitting shall immediately be given two coats of the specified first coat material.

Wooden surface to receive stained or natural finish shall be stained to the approved shade and lightly sanded. On softwood, a thin, penetrating coat of shellac shall be applied as a sealer before the stain is applied. Open grain wood shall be given the same treatment and, in addition , shall be given a coat of past wood fillers no less than eight (8) hours after the application of the stain. Each varnish coat shall be allowed to stand at least overnight to dry and lightly sanded prior to application of subsequent coat.

65.4 Preparation of Surface for Epoxy Paint

Concrete and plastered surfaces should be structurally sound, dry and cleaned off all dirt, dust, oils, grease, paint, curing compounds and other foreign materials. The ultimate adhesion of the protective coating is dependant upon a clean surface. Badly soiled concrete surfaces that are very dense and stick should be slightly roughened to provide a proper 'teeth' for the coating. All surfaces requiring painting shall be cleaned of all oil, grease and other foreign matter as directed by the Engineer-in-Charge. All concrete surfaces shall be sack rubbed prior to this cleaning operation.

Cleaning shall be high pressure water wash. Water shall be applied to the concrete/plaster surface by means of an air-nozzle using a tip with an orifice size of 1.5 mm. Water shall be potable. Water pressure connection to the pressure cleaning unit shall be at a minimum of 7 kg / sq. cm and the pressure will be increased if the cleaning is not satisfactory.

Work shall commence at the top of the walls working down, applying the spraying in a manner that will prevent surface water from the area being cleaned passing over previously cleaned areas. The nozzle shall be held approximately 300 mm from the surface at a slight angle perpendicular to the surface.

Sufficient time shall be spent on each area to remove all loose particles from the surface. Should any surface be oily, a detergent wash shall be applied before the water wash. The floor shall be thoroughly

rinsed with clean water after acid has stopped bubbling. All surface water shall be removed. The surface shall be allowed to dry out completely if necessary by force drying, before application of the protective coating.

66 Application of Paint

66.1 White Washing

One coat of white wash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. The second and the third coat application shall be done in similar way after each coat application dries up in case the Engineer-in-Charge feels that one or more coats are required the CONTRACTOR shall do so without any extra cost. No brush marks shall show on the finished surface. Use of sponge roller in application is preferred. The white wash shall be fast and should not come on hand when slightly rubbed by hand.

66.2 Water Proof Cement Paint

After surfaces preparation, as soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second and third coats shall be applied in a similar manner. The finished surface shall be kept moist by sprinkling with water for seven (7) days after painting.

66.3 Acrylic Emulsion Paint

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A small patch shall be painted to check alkali reaction. Painting shall be strictly as per manufacturer's specification.

66.4 Epoxy Paint

The paint has to be applied in accordance with the manufacturer's instructions in four to five coats to give a total dry film thickness of 6 to 8 mils or as directed by the Engineer-in-Charge. Before painting is commenced a sample panel shall be finished to the approval of the Engineer-in-Charge and finished work shall be as per this approved sample. No painting shall be done under dusty condition or when the temperature is lower than 18 degree C or while the system is curing. Precautions must be taken to provide adequate ventilation during application and curing of the paint system.

The solution shall be applied with pad of fine muslin cloth tied as per general practice. The pad shall be dipped into the solution and wrung with the fingers and be rubbed hard on the surface. In this way, first coat shall be given. After the previous coat is dried up, the successive coats shall be given in the same fashion. Surface shall have a uniform texture and high gloss. Dull polish if specified in the schedule shall be left dull.

66.5 Vinyl Paint

Vinyl painting on the concrete surface shall be done in accordance with the colour schedule. All vinyl resin painting shall be minimum five coat application consisting of one coat of primer paint and minimum four (4) seal coats of vinyl enamel applied in accordance with the specification and the manufacturer's instructions. The minimum total thickness of the dry film application shall be 6 mils (0.15 mm).

Paint shall not be applied to any surface which is likely to have a temperature of less than 10 degree C during painting or while the paint is drying. No painting shall be done under dusty conditions. The primer paint can be applied as soon as all surfaces are completely dry. The second vinyl coat shall be different in shade from the first. For subsequent vinyl coats, the color shall be as called for in the colour schedule. The vinyl coats shall not be applied until the wall surface has dried out.

All paints shall be applied in accordance with the manufacturer's instructions. Paint shall be spread evenly without runs, sags, brush marks or skips. Paint shall be well brushed on wall surfaces, edges and into all corners when brush application is essential. Each coat shall give complete coverage and must be dry and hard before the succeeding coat is applied.

Spray equipment shall be used and care shall be exercised during spraying operation to hold the nozzle sufficiently close to the surface being painted to avoid excessive evaporation of the volatile constituent and loss of materials into the air, or the bridging over of crevices and corners.

Spray equipment shall be equipped with mechanical agitators, pressure gauges and pressure regulators. Nozzles shall be of proper sizes. Floors, ceilings and adjacent equipment and piping shall be satisfactorily protected by drop clothes or other precautionary measures taken during spray and brush painting.

66.6 Aluminium Paint

The Aluminium paint shall be applied as per manufacturer's recommendation/directions. The number of coats specified in the item shall be applied after the paint film in the previous coat is dry and hard.

67 Mixing and Thinning

At the time of application, paint shall show no signs of hard settling, excessive skinning, livering or other deterioration. Paint shall be thoroughly stirred, strained and kept at a uniform consistency during application. Paints of different manufacturers shall not be mixed together. Where necessary to suit conditions for surface temperature, weather and method of application, packaged paint may be thinned immediately prior to application in accordance with the manufacturer's approved directions.

67.1 White Washing

The lime is brought to site in unslaked condition and after staking at site, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream 100 gms of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

67.2 Epoxy Paint

Epoxy is a two-pack system consisting of a base and a catalyst. These shall be mixed thoroughly in the specified proportion as detailed by the manufacturer. The mixing done by using an electrically operated mixing device, or rod. The paint shall be thinned if necessary to achieve a spraying viscosity of 100/120 secs. Viscosity is to be checked for every batch with standard viscosity cup known as ford cup no. 4 or cup no. 4 of IS:3944. Epoxy trowelling compound, consisting of base and catalyst, shall also be similarly mixed if necessary to form a semi solid paste, to a consistency for care of application with a putty blade (made of thin MS/GI/Copper Sheet)

67.3 Vinyl Paint

The vinyl paint shall be thinned if required with vinyl thinner to achieve spraying viscosity. Vinyl knifing compound which is also a one pack system may be thinned to such a consistence for ease of application with a putty blade.

68 Field Painting

All painting at site shall be designated field painting and shall consist of field priming and field painting to provide finish coating. The work shall be under close supervision of CONTRACTOR and surface preparation may be inspected and approved by the Engineer-in-Charge prior to application.

Adjacent areas to field painting shall be protected by the use of job cloths, or other approved precautionary measures shall be taken.

Painting shall be continuous and accomplished in an orderly manner so as to facilitate inspection. Surface of exposed members that will be in accessible after erection shall be cleaned and painted before erection.

Any defective paint changes in colour or incompatible paint with undercoat shall be scrapped off and repainted.

69 Coating Failures

If loose of adhesion due to flaking, blistering, cracking, lifting and wrinkling, lack of flexibility, soft film or failure are evident, CONTRACTOR shall remove all defective coatings, shall prepare the surface against as specified and shall repaint the surface in accordance with the painting schedule, as specified herein until satisfactory coatings have been obtained, the cost of additional painting required shall be at CONTRACTOR" expenses.

70 Cleaning

Cloth and cotton waste that might constitute a fire hazard shall be placed in close metal containers or destroyed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from site or destroyed in an approved manner. Paint spots, oil or stains upon adjacent surfaces shall be removed and the entire job left clean and acceptable.

71 Acceptance Criteria

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All epoxy vinyl painted surfaces shall be of uniform texture and high glossy finish.
- c) All stains, splashes and splatters of paints shall be removed from surrounding surfaces.

72 Quality Assurance Plan

The CONTRACTOR shall submit the quality assurance plan for the painting works for the approval of the Engineer-in-Charge. The painting job shall be carried out as per the approved plan.

**Standard Specification
for
Floor and Floor Finishes
(A-7)**

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General

72.1 Scope

This specification, used in conjunction with the contract document, Bill of Quantities and design drawings establishes the minimum requirements for floor and floor finish work. Reference to other material standards for compliance shall be interpreted as an integral part of this specification.

Any special requirement as shown or noted in the drawings shall be given preference over the provision of this specification.

73 Regulations, Codes and Standards

The flooring work shall be in compliance with all applicable federal, state local laws and regulations.

The following Indian Standard Codes unless otherwise specified herein shall be applicable. In all cases, the latest revisions of the codes shall be referred to :

IS:1443	-	Code of practice for laying and finishing of cement concrete flooring tiles
IS:2114	-	Code of practice for laying in situ terrazzo floor finish
IS:1077	-	Specification for common burnt clay building bricks.
IS:5491	-	Code of practice for laying of in-situ granolithic concrete flooring toppings.
IS:1237	-	Specification for cement concrete flooring tiles.
IS:4457	-	Specification for cement concrete flooring tiles.
IS:158	-	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali and heat resisting.
IS:4832	-	Specification for chemical resistant mortar.
IS:4441	-	Code of practice for use of silicate type chemical resistant mortar.
IS:4442	-	Code of practice for use of sulphur type chemical resistant mortar.
IS:383	-	Specification for coarse and fine aggregates.
IS:2571	-	Code of practice for laying in-situ cement concrete flooring.
IS:4443	-	Code of practice for use of resin type chemical resistant mortar.
IS:3461	-	Specification for PVC-Asbestos floor tiles.
IS:5318	-	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:1237	-	Specification for cement concrete flooring tiles.
IS:1443	-	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:455	-	Specification for Portland slag cement
IS:777	-	Specification for glazed earthenware tiles.
IS:269	-	Specification for ordinary Portland cement.

74 Material

74.1 Cement

Cement shall conform to IS:269 or IS:455.

74.2 Aggregate

The aggregates shall conform to IS:383 and shall be from approved source. Size of coarse aggregate shall be limited to 12 mm unless otherwise specified. Fine aggregate shall be from approved river or pit and also conform to IS:383

Rubble used for packing under floors, foundation etc. shall be hard, durable rock, free from veins, flaws and other defects. The size of the rubble shall be 100 mm – 150 mm unless otherwise specified. The quality of the rubble shall be got approved by the Engineer-in-Charge.

The aggregate used in mosaic flooring shall be marble aggregate of the following types :Calcite, Dolomites, Serpentine, travertine etc. The size of the aggregates shall be as approved in accordance with clause 5.2 of IS:2114 – 1962, marble powder used in the topping shall pass through IS Sieve 30.

74.3 Bricks

Bricks shall be class 50 B designation conforming to IS:1077.

74.4 Water

Water shall be clean and of potable quality conforming to IS:456.

74.5 Dividing Strip

Dividing strip shall be 2 mm thick and shall be of approved material (glass/Aluminium/PVC) and quality.

74.6 Colouring Pigment

Pigments, synthetic or otherwise, used for colouring shall have permanent non-fading colour and shall not contain material detrimental to concrete. The pigment shall be approved brand and tint shall be uniform. Pigments used for colouring cement shall conform to IS:2114.

74.7 Floor Hardener

It shall be best quality heavy duty metallic hardener – Ironite or approved equivalent.

74.8 Terrazzo Tiles

The terrazzo tiles (plain or coloured) shall conform to IS:1237 and shall be of approved colour and size. The type, quality, distribution and sizing of marble chips shall be approved by the Engineer-in-Charge.

74.9 Lime

Hydraulic lime shall conform to IS:712

74.10 Acid Proof Tiles

Acid proof unglazed ceramic tiles shall be of approved quality and shall conform to IS:4457 and be of different sized like 100 mm x 100 mm, 150 mm x 150 mm etc. with a thickness around 38 to 40 mm.

74.11 Bitumen Primer

Bitumen primer shall conform to IS:158, type II.

74.12 PVC (Vinyl) Tile

All PVC (Vinyl) tiles shall conform to IS:3461 and shall be of approved make like Bhor, Wonderfloor etc.

74.13 Adhesive

Rubber based adhesive of approved make and quality shall be used for fixing PVC tiles. Vitreous Tiles

Vitreous tiles shall conform to IS:777 and shall be of approved size and make e.g. Spartek, Johnson and Johnson, Somani etc. Thickness of the tile shall be generally 5 mm – 6 mm unless otherwise specified.

75 Workmanship

75.1 General

The CONTRACTOR shall furnish all material, labour, plant and equipments, tools and tackles etc. to complete the work as specified and/or shown in the drawings.

75.2 Soling for Sub-grade

All sub-grade shall be laid over the compacted soil.

The sub-grade shall be dressed to correct level and shall be rammed or rolled to proper consolidation.

75.2.1 Brick Flat Single Layer Soling

4.2.3.1 Bricks shall be placed on a thin cushion of sand on the consolidated sub-grade and the joint shall be broken. Joints shall be fully filled with dry sand and broomed.

75.2.2 Brick Flat Double Layer Soling

The first layer shall be same as that for brick flat single layer soling. The second layer of bricks shall be placed only after completing finishing of the first layer and the joints shall be fully filled with dry sand of approved quality and finally broomed. Both vertical and horizontal joints shall be broken.

75.2.3 Stone Boulder Soling

The sub-grade below the floor slab shall be minimum 230 mm thick stone boulder soling blinded with morrum unless otherwise specified in the drawings. Building paper shall be provided on top of sub-grade before casting the concrete floor slab.

The stone shall be placed absolutely close to each other and in layers only. The crevices between the stones shall be hand packed with stone ballast which shall be hammered into position so as to completely fill up crevices. No stone after packing shall move or tilt in any direction when walked over or pushed with hand. The same soling shall be adequately watered and raked with a power roller and then approved quality of morrum shall be laid over the rolled surface to a thickness of 25 mm and brushed into surface voids, watered and rammed. Spreading of morrum shall be done after obtaining Engineer-in-Charge's approval for soling.

75.3 Cement concrete flooring, skirting and Dado Granolithic Finish

Workmanship shall generally conform to IS:2571 – Code of practice for laying in situ concrete floors.

75.3.1 Surface Preparation

Before laying in situ concrete floor finish, the surface of the base concrete shall be thoroughly cleaned of loose materials, dirt and laitence by steel wire brushing. If the base concrete has hardened sufficiently the entire surface shall be roughened by chipping or hacking and to be cleaned. The surface then shall be soaked with water for 12 hours before laying the topping.

75.3.2 Laying of Floor

The entire floor where topping is to be laid shall be divided into uniform sized panel not exceeding 20 sq. m. in are with the help of Glass/PVC/Aluminium strip Thickness of the floor shall be 30—50 mm as specified in the drawings. The floor shall be laid in alternate panels.

A coat of cement slurry @ 2.75 kg/sq. m. shall be applied so as to get a good bond between the base concrete and the floor finish.

The mix shall be 1 part cement, 2 parts coarse sand and 4 parts graded stone aggregate and shall be prepared by volumes. The mix shall be prepared in a mixer and should be as stiff as possible consistent with workability. The slump of the mix shall not be more than 40 so as to prevent accumulation of excess water or laitence. The concrete shall be placed in position and leveled up and beaten with the wooden hammers until the slurry comes to the surface and all holes are filled up.

It shall then be finished by trowelling or floating. Finishing operation shall start shortly after compacting the concrete and shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled at the regular intervals so as to produce a uniform and hard surface. The final trowelling shall be done well before the concrete has become too hard but at such a time that sufficient pressure is required to make any impression on the surface. Trowelling with dry cement or with fine aggregate mix on the surface shall not be permitted.

As soon as the surface has hardened, it shall be kept continuously moist for at least fifteen days by impounding water on it.

For skirting and dado, the thickness shall be 15-20 mm and work shall be done on the vertical surfaces. Base layer shall be 12 mm thick P.C.C. 1:2:4 (1 cement, 2 sand; 4 graded stone aggregate of size 12 mm and down). Then it shall be finished with 6 mm thick plaster with CM 1:1.

75.3.3 Coloured cement concrete flooring

Where coloured finish is indicated, the pigment of approved colour shall be mixed with cement in the proportion of one part of pigment with three parts of cement.

The colouring material and cement shall first be mixed dry and special attention shall be paid to the mixing of colour which should be screened twice with a fine screen and again through fine muslin before use. Colour required for one room shall be mixed in one lot.

75.4 IPS Flooring with Floor Hardener Finish

The thickness of the IPS flooring shall be 50 mm and shall be laid in accordance with IS:5491.

The proportion of mix for cement concrete bedding shall be 1 part of cement, 2 parts of sand and 4 parts of granite chippings. The mix for the floor hardener shall be in accordance with the manufacturer's specification.

37 mm thick cement concrete bedding shall be laid as described in clause no. 4.3 above.

When granolithic finish is partially dried, approved floor hardener mix shall be applied on the granolithic finish in two or more coats and finished evenly with a trowel. Each coat shall be applied before previous coat dries.

As soon as the surface hardens, it shall be kept continuously moist for at least fifteen days by impounding water on it.

75.5 Pre-cast Terrazzo Tile Flooring

Terrazzo tiles can be plain or coloured and their type, quality, distribution and sizing of marble chips shall be approved by the Engineer-in-Charge. All tiles shall conform to IS:1237.

75.5.1 Surface Preparation

4.5.2.1 Before commencement of tiling work, all inside walls and ceilings shall be plastered, door frame, windows shall be fixed in place and all heavy work in the room shall be completed.

4.5.5.2 The surface of the base concrete shall be thoroughly scrapped, cleaned and washed to remove dirt, loose particles and laitence by scrubbing with a wire brush. The surface shall then be thoroughly cleaned and well wetted but without forming any water pools.

75.5.2 Bedding

Before laying of bed concrete, level pads shall be set up to indicate finished floor level on the clean damp surface of the base concrete and then setting mortar bed of thickness up to 20 mm shall be evenly spread. Proportion of setting mortar shall be cement mortar 1:6 (1 cement; 6 coarse sand) or lime mortar 1:2 (1 lime; 2 sand). Settings beds shall be screeded to a true plane or sloped to drains or leveled as shown.

Before laying the tiles shall be soaked in water for at least 20 minutes and then allowed to dry for about 10 minutes. It is necessary to have tiles damp, but not wet when they are laid.

75.5.3 Fixing and Laying

Workmanship for laying tiles shall conform to IS:1443.

When the bedding mortar acquires sufficient hardness to provide a fairly rigid cushion for the tiles, neat cement slurry of honey like consistency shall be spread @ 4.4 kg. of cement per sq. m. The tiles shall be fixed over this bed one at a time and gently tapped with wooden mallet to proper bedding and in level with the adjoining tiles. The joints shall be perfectly straight and shall not exceed 1.5 mm in width. The top surface of the tiles shall be laid true to plane with levels and/or slopes as indicated on the drawings. After the tiles have been laid, the surplus cement grout that may have come out of the joints, shall be cleaned off and finished with white cement or ordinary cement as specified. In areas adjoining walls, the tiles shall extend about 10 mm inside the plaster, skirting or dado as the case may be. Half tiles or pieces shall be avoided as far as possible. The day after the tiles have been fixed, the joints shall be refitted with cement paste or grout of the same shade as the colour of the tiles. Before the joints are filled, they shall be cleaned with wire brush or with points of a trowel and any loose cement, dirt or dust in the joints shall be removed.

75.5.4 Curing

4.5.4.1 The work shall be kept wet and protected for 7 days before starting the polishing. No one should be allowed to walk on the floor during the first 24 hours after it is laid. The traffic shall be allowed after completion of curing.

75.5.5 Polishing

4.5.5.1 Polishing shall commence only after the floor as well as the joints have dried out. The floor shall be polished by machine in three operations by expert trained polishers using carborandum stones of the following grit.

- | | | | |
|------------------------|---|------------|---|
| a) For first grinding | : | 24 to 60 | when the tiles are supplied ungrounded) |
| b) For second grinding | : | 120 to 150 | |
| c) For final grinding | : | 220 to 350 | |

Sufficient quantity of water shall always be continuously used during polishing to prevent scratching. After polishing, the floor shall be thoroughly washed clean and dried. When dry the floor shall be covered with oil free and dry saw dust. Prior to handing over of building, the saw dust shall be removed and floor shall be washed clean with dilute exilic acid solution and dried. Floor shall then be finally polished with wax and machine fitted with hessian felts until the floor shines.

75.5.6 Skirting and dado work

Skirting and dado shall be fixed only after laying the tiles on the floor. Where tiles are to be fixed on walls, the portion of the wall to be tiled shall be left unplastered.

For dado and skirting work, the vertical surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with about 12 mm thick 1:3 cement mortar. For this work the tiles as obtained from the factory shall be of the size required and practically fully 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. This shall be done from the bottom of the surface upwards. The joints shall be as close as possible and the work shall be truly vertical and flush. The tiles shall be fixed flush with the plaster or projected as specified by the Engineer-in-Charge. The junction of the plaster and the skirting or dado shall be neatly finished. The joints shall be filled with ordinary cement unless otherwise specified.

Skirting and dado shall be ground and polished just as for floor work but by machine suitable for the purpose. Otherwise skirting and dado may also be polished by hand by rubbing down with suitable polishing stones in three operations evenly and without scratching the surface. It shall then be thoroughly washed clean and dried as specified in clause 4.5.6.

75.6 Cast in Situ Terrazzo Flooring

Sample of the terrazzo / mosaic floor shall be approved by the Engineer-in-Charge. Workmanship for laying of cast in situ terrazzo floor shall conform to IS: 2114.

75.6.1 Surface Preparation

Before commencement of mosaic flooring work, all inside walls and ceilings shall be plastered, door frame, windows etc. shall be fixed in place and all heavy work in the room shall be completed.

The surface of the base shall be thoroughly cleaned of dirt, loose particles and laitance by scrubbing with wire brush, light chipping etc. It shall then be thoroughly swept, clean and well wetted down. The floor shall be divided into panels (not exceeding 2.5 sq. m. and the large dimension shall not exceed 2.0 M) by placing and fixing glass/Aluminium strips. The strip shall cover the full depth from base course to the top of the topping layer.

75.6.2 Preparation of Mix

4.6.2.1 The terrazzo shall be laid in two layers viz. under layer and topping layer.

4.6.2.2 The under layer of mosaic flooring shall be cement concrete of mix 1:2:4 (1 cement; 2 coarse sand ; 4 aggregate). The maximum size of aggregate shall not exceed 10 mm. Thickness of the under layer shall be 30 mm unless otherwise specified.

4.6.2.3 The mix of topping shall consist of cement and white cement (in approved proportion) with or without pigments, marble powder, marble aggregate and water. Cement and marble powder shall be mixed dry in the proportion of 3:1 by weight. The proportion of cement shall be inclusive of any pigment added to cement. For every part of cement and marble powder mix, proportion of marble aggregates by volume shall be as follows, depending upon the size of aggregates.

Size of the Marble aggregate	Proportion of aggregate to cement and marble powder mix.
For grade 00,0 & 1 (i.e. from 1 mm to 6 mm)	1 ¾ parts
For grade 2 & 3 (i.e. from 7 mm to 14 mm)	1 ½ parts
For grade 4 & 5 (i.e. from 15 mm to 25 mm)	1 ¼ parts

Complete quantities of cement and pigment required for one operation shall be mixed at the beginning of work and stored.

The thickness of terrazzo finish, that is the combined thickness of the under layer and the topping shall not be less than 40 mm. The thickness of the terrazzo topping shall not be less than 10 mm.

The mixing of materials is of utmost importance to obtain an uniform appearance. Mixing shall be carried out in a trough or tub. While mixing the aggregates, care shall be taken not to get the materials into a heap, as this would result in the coarsest chips falling to the edge of the heap and the cement coming to the center at the bottom. The materials shall be kept as far as possible in an even layer during mixing state, water shall be added in small quantities and materials shall be worked to make the mixture plastic so that the mix shall be capable of being moulded when squeezed in hand without water flowing out. The mix shall be used in the work within half an hour of addition of water.

75.6.3 Laying

The underlayer of cement concrete shall be laid in panels after preparation of surface as explained in clause 4.6.2. The underlayer shall be spread and leveled with a screeding board to leave slightly rough surface for forming key to terrazzo flooring.

Terrazzo topping mix prepared as per clause 4.6.2.3. & 4.6.2.5 shall be laid while the under layer is still plastic but has sufficiently hardened to prevent cement from rising to the surface, which is normally achieved between 18 to 24 hours after under layer is laid. A cement slurry of same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be placed on the screed bed and compacted thoroughly by tamping and trowelled to obtain a level surface. The surface shall then be rammed in order to consolidate the terrazzo, preferably with a piece of smooth marble stone of size 15 cm x 15 cm x 2.5 cm. This may be followed by trowelling. In trowelling pressure rather than rotary action shall be used to achieve a smooth surface.

75.6.4 Curing

4.6.4.1 After laying the terrazzo topping, the surface shall be left dry for air curing for a period of 12 to 18 hours depending upon temperature conditions. It shall then be cured by impounding water for a minimum period of seven days.

75.6.5 Grinding and Polishing

Machine grinding can start after seven days of laying the topping. The first grinding shall be done with carborundum stone of 60 grit size. The surface shall then be washed clean and grouted with neat cement grout of cream like consistency. It shall then be allowed to dry for 24 hours and wet cured for 4 days. The second grinding shall be done with 80 grit stone. After another surface grouting and wet curing as mentioned above, the third grinding with carborundum stone of 120 to 150 grit size shall be done. The surface then shall be grouted and wet cured again for four days. The last grinding shall be done with carborundum stone of 320 to 400 grit size and the surface then shall be washed clean and rubbed hard with felt and slightly moistened oxalic acid powder. Five grams of oxalic acid powder shall be used for one square metre of floor surface.

The floor shall be covered with oil free and dry saw dust. Prior to handing over of building to the purchaser, the saw dust shall be removed and the floor shall be washed clean with dilute oxalic acid solution and dried. Floor shall then be finally polished with machine fitted with hessian bobs of felts until the floor shines.

75.6.6 Terrazzo Skirting and dado

4.6.6.1 The height of the skirting/dado shall be as per the drawing. The under layer shall be 12-15 mm cement mortar of 1:3 proportion (1 cement, 3 coarse sand) and top 7-10 mm thick layer (shall be of approved marble chips in proportion 1:2 (1 cement, 2 marble chips). The skirting/dado shall be flush with the plaster or projected as specified by the Engineer-in-Charge.

The junction between the skirting / dado and the plaster shall be finished properly. The skirting/dado shall be hand polished.

75.7 Kotah Stone Flooring

Kotah stone can be rough, one side rough and one side polished or both side polished depending upon the nature of work. Stones shall be green in colour and free from natural defects. The quality, size and thickness (30-35 mm) of stone shall be approved by the Engineer-in-Charge.

75.7.1 Surface Preparation

Before commencement of Kotah stone flooring work, all inside walls and ceilings shall be plastered, door frames, windows shall be fixed in place and all heavy work in the room shall be completed.

The surface of the base concrete shall be thoroughly scrapped, cleaned and washed to remove dirt, loose particles and laitance by scrubbing, with a wire brush. The surface shall be thoroughly cleaned and well wetted but without forming any water pool.

75.7.2 Bedding

Before laying of bed concrete, level pads shall be set up to indicate finished floor level on the clean damp surface of the base concrete and then setting mortar bed of thickness approximately 37 mm thick shall be evenly spread. Proportion of setting mortar shall be either lime mortar 1:2 (1 lime; 2 sand) or cement mortar 1:6 (1 cement; 6 coarse sand). Setting beds shall be screeded to a true plane or sloped to drains or leveled as shown.

75.7.3 Laying and Fixing

Before laying the stone slabs over the bed of cement or lime mortar, they shall be thoroughly wetted with clean water. Neat cement shall be spread over the mortar bed and the slabs shall be placed one by one in approved pattern keeping in check the line and level of flooring. The slabs are then gently tapped with wooden mallet till it is firmly and properly bedded without any void. The joints should not be more than 2 mm thick and should be struck smooth.

75.7.4 Curing

The work shall be kept wet and protected for 7 days before starting the polishing. No one should be allowed to walk on the floor during the first 24 hours after it is laid. The traffic shall be allowed only after completion of curing.

75.7.5 Polishing

Polishing shall commence only after the floor as well as the joints have dried out. The floor shall be polished by machine in three operations by trained polishers using carborundum stones of approved grit sizes and then cleaned with oxalic acid. The CONTRACTOR shall also mop the floor with kerosene and water without any extra cost for at least 2-3 times daily for 7 days.

The other specification for polishing work shall remain same as described in Clause 4.5.6.

75.7.6 Skirting & Dado

The height of the skirting/dado shall be as per the drawing. The stones shall be pre-polished and machine cut and the edges shall be dressed by the fine true, straight and right angles to each other. The stones shall be fixed over cement mortar bed 1:4 (1 cement 4 coarse and). The joints shall be filled with ordinary cement. The joints in flooring shall be continued in the skirting/dado also. The joint between the top of skirting / dado and plaster shall be finished properly. The stones shall be hand and wax polished.

75.8 Vitreous Ceramic Tiles in Floor, Skirting and Dado

Ceramic tiles can be glazed, unglazed, coloured and their type, quality and size shall be approved by the Engineer-in-Charge. All tiles shall conform to IS:777.

75.8.1 Surface Preparation

Before commencement of tiling work, all inside walls and ceilings shall be plastered, door frame, windows shall be fixed in place and all heavy work in the room shall be completed.

The surface of the base concrete shall be thoroughly scrapped, cleaned and washed to remove dirt, loose particles, and laitence by scrubbing with a wire brush. The surface shall then be thoroughly and well wetted but without conforming any water pool

75.8.2 Bedding

Before laying of bed concrete or base plaster level pads shall be set up to indicate finished floor level. The tiles shall be submerged in water before laying.

Floor tiles shall be laid on 19 mm thick bedding comprising of cement sand mortar 1:3 (1 cement, 3 coarse sand).

Tiles for skirting and dado shall be fixed on a base of 12 mm thick cement sand mortar 1:3 (1 cement, 3 coarse sand).

75.8.3 Laying

Each tile shall be provided with neat cement slurry @ 3.0 kg/sq. m and glue (Araldite or approved equivalent) on the back side before laying and then shall be fixed to the bedding mortar with a wooden mallet. They shall be laid truly vertical on walls and truly horizontal on floors or to the slopes as directed. They shall be fixed as close as possible to the adjoining one and any difference in the thickness of tiles shall be evened out in the cushioning mortar so that all the tile faces are set in conformity with one another.

The tiles in dado shall be finished in such a way that, only the tile thickness projects over the finished plaster or as specified otherwise. Where full tiles are not possible, the same should be cut or sawn to the required size and their edges rubbed to ensure straight and true joints. Half tiles shall be provided at the corner of the floor or at the corner of walls and at bottom for dado work.

After the tiles are laid extra cement grout shall be removed. The joints shall be cleaned with wire brush and then the joint shall be floated with white or Grey cement as approved by the Engineer-in-Charge. The tiles shall be cured for at least seven days and cleaned.

75.9 Acid Resistant Flooring

Acid resistant tiles shall be of approved size, colour and make and conform to IS:4457.

75.9.1 Surface Preparation

Before commencement of tiling work, all inside walls and ceilings shall be plastered, door frame, windows shall be fixed in place and all heavy work in the room shall be completed.

The surface of the base concrete layer shall be thoroughly cleaned to remove dirt, loose particles etc.

75.9.2 Bedding and Laying

Two coats of bitumen primer shall be applied over the base concrete layer. Primer shall be of heavy grade, corrosion resistant and shall conform to IS:158, type 2.

The bitumastic impervious interliner of 12 mm – 15 mm thickness shall be applied over bitumen primer described above. It shall consist of a mixture of straight run bitumen of softening point 145 + 50 C and clean dry coarse quartz power free from lumps. This mixture at a temperature around 180 degree C or above shall be sufficiently plastic to be poured into place and compacted by wooden trowel or by other suitable means to provide a compact, lean tight resilient membrane. The specific gravity of mastic shall be approximately around 2 and penetration at 25 degree C (100 gms/5 mm) shall be above one.

For bedding, laying and jointing K-Silicate cement (two pack self hardening) conforming to IS:4832 part I shall be used. The bedding and jointing shall be at least 6 mm thick.

Furacin cement shall be used for jointing purpose and shall be self hardening (A two pack product conforming to IS:4832 (Part II)). In case of hydrofluoric acid service, carbon fillers shall be used. In case of concentrated sulphuric acid having temperature not exceeding 4 degree C sulphur cement conforming to IS:4832 (part III) shall be used.

75.10 PVC (Vinyl) Tiles Floor

PVC tiles flooring shall be approved size, colour, make and shall conform to IS:3461.

75.10.1 Surface Preparation

PVC tiles shall be laid on the leveled finished floor. If there are undulations in the floor, the same shall be made good by screed topping and should be finished with trowel to achieve the finish.

75.10.2 Laying and Fixing

PVC flooring shall be laid after the completion of plastering, painting and other decorative finishing work so as to avoid any accidental damage to the flooring. Prior to laying, the flooring tiles shall be brought to the temperature of the area in which it is to be laid by stacking in a suitable manner within the laying area for a period of 24 hours.

Where air conditioning is installed the flooring shall not be laid on the sub-floor until the conditioning units have been in operation for at least seven days. During this period the temperature shall neither fall below 20 degree C. These conditions shall be maintained during laying and for 48 hours thereafter.

Before commencing the laying operations, the sub-floor shall be cleaned with a dry cloth. PVC flooring shall not be laid on sub-floor unless it is perfectly dry. The dryness shall be tested in accordance with Appendix A of IS:5318.

The adhesive shall be applied by using a notched trowel to the sub-floor, and to the back side of the PVC tiles. When set sufficiently for laying the adhesive will be taken to the touch but will not mark the fingers. When the adhesive just tack face, the tiles shall be carefully placed in position from one end onwards slowly so that the air will be completely squeezed out between the tile and the background surface (care shall be taken not to slide the tile in position). It is preferable to start laying of tiles from the centre of the area. Care shall be taken to lay the tiles close to each other with minimum gap between the joints. After laying the tile in position it shall be pressed with suitable wooden roller (about 5 kg in weight). Any undulation noticed on the PVC surface shall be rectified by removing and relaying the tiles after thorough cleaning of the underside of the affected tiles. The adhesive applied earlier in such places shall be removed by using proper solvent and the surface shall be cleaned to remove the traces of solvent used.

Any adhesive which may squeeze up between the tiles shall be wiped off with a wet cloth before the adhesive is hardened. If, by chance, the adhesive dries up and removed with a solution of one part of commercial butyle acetate and three parts of turpentine oil.

Wherever, the edge of PVC tiles are exposed it shall be protected with metallic edge strip securely fastened to the sub-floor against damage of the material.

A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period the flooring shall not be put to any service.

76 Quality Assurance Plan

The CONTRACTOR shall submit the quality assurance plan for the flooring works for the approval of the Engineer-in-Charge. The approved QAP shall be strictly followed.

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77 General

77.1 Scope

This specification, used in conjunction with the contract document, Bill of Quantities and design drawings establishes the minimum requirements for doors and windows. The floors and windows shall be of approved make, quality and colour. Standard types of doors and windows shall be used to the extent possible. Non-standard doors and windows shall be used only where there is a specific requirement for such doors and windows.

78 Regulations, Codes and Standards

Door and Window works shall be in compliance with all applicable federal, state local laws and regulations. Provisions of the following Indian Standard Specifications (latest revisions) shall be applicable.

IS:1003 (Part I)	-	Timber panelled glazed door shutters
IS:1003 (Part II)	-	Timber panelled glazed windows and ventilation shutters.
IS:1038	-	Steel doors, windows and ventilators
IS:1081	-	Fixing and glazing of metal (Steel and Aluminium) doors, windows and ventilators
IS:1361	-	Steel windows for Industrial Building
IS:1826	-	Venation blinds for windows
IS:1948	-	Aluminium doors, windows and ventilators.
IS:2191 (Part I)	-	Wooden flush door shutters (Cellular and hollow core type) plywood face panels
IS:2191 (Part II)	-	Wooden flush door shutters (Cellular and hollow core type) particle board face panels.
IS:2202 (Part I)	-	Wooden flush door shutters (solid core type) plywood face panels.
IS:2202 (Part II)	-	Wooden flush door shutters (solid core type) particle board face panels.
IS:3614 (Part I)	-	Fire check doors, plate, metal covered and rolling type.
IS:4021	-	Timber door, windows and ventilator frames.
IS:4351	-	Steel door frames.
IS:4913	-	Selection, installation and maintenance of timber doors and windows.
IS:4962	-	Wooden side sliding doors.
IS:6248	-	Hot rolled steel sections for doors, windows and ventilators.
IS:6248	-	Metal rolling shutters and rolling grills
IS:7452	-	Hot rolled steel sections for doors, windows and ventilators.
IS:1200	-	Mode of Measurements

79 Steel Doors, Windows and Ventilators

79.1 General

The basic design of steel doors, windows, ventilators and fanlights shall conform generally to IS:1038 and IS:1361 respectively and also dimensionally to the details shown on the Drawings and materials and methods specified herein. Unless otherwise specified, couplings sections shall be of mild steel. Glazing clips shall be provided wherever pan sizes exceed 600 x 300 mm, and shall be of shape shown in IS:1038.

79.2 Scope of Work

The work covered in this specification consists of furnishing and installing steel doors. (hinged or sliding) steel windows, ventilators & fanlights, hollow metal pressed steel (HMPS) doors, fire proof doors, etc. Complete in strict accordance with this specification and the applicable drawings.

79.3 Shop Drawings

The CONTRACTOR if so directed shall submit three sets of shop drawings covering items of work of this specification. These drawings shall show all dimensions, details of construction and installation, relation to adjoining and related works where same requires cutting or close fitting and shall show all the reinforcement gauges of metal, nomenclature of various standard sections used, welding anchorage or holdfasts, positions of all fittings and fixtures etc. The various units shall be properly marked and their correct position shall be indicated. The marks and directions so indicated shall be painted on the fabricated members to facilitate erection at site. The work of fabrication shall be taken up only after the shop drawings are approved by the Engineer-in-Charge.

79.4 Steel windows, fanlights & ventilators

Steel windows for industrial buildings shall conform to IS:1361 unless specified otherwise. Frames shall show no warp or inferior workmanship. All openable windows shall be designed to open outside unless otherwise specified. Windows shall be designed for glazing on the outside of the frames. The hinges for side hung shutters shall be of projecting non-friction type and for top hung plain type unless otherwise specified. Weather bars shall be fitted to fabricated couplings section wherever required.

Steel windows with fixed louvers shall be with 16 gauge pressed steel guides for receiving glass louvers 5.50 mm thick, spaced at 50 mm c/c. In case of M.S. pressed steel louvers they shall be fabricated out of 16 gauge sheets bent to "Z" shape and shall be tack welded to frames. The necessary stiffening members shall be provided and in such cases the length of the louver shall not exceed 450 mm.

The openable steel windows shall have standard galvanised fly screen of 28 swg. And equivalent to IS sieve 100 in 16 gauges window frame sheet metal fixed inside of the frame by M. S. flat and screws to allow the screen being easily removed. Locking handle shall be provided to hold the shutter in closed position. Galvanising shall be hot dipped type and shall not be less than 0.50 kg/sq. m. of the area.

Any other approved flymesh shall be provided in place of Galvanised M. S. screws whenever called out.

79.5 Glazing

The glass used for the purpose of glazing shall be 4 mm thick clear sheet glass unless otherwise specified. The glass shall be fixed to the frames by means of glazing clips, and approved putty. The number of glazing clips shall be 4 minimum per panel. The glazing may also be done by means of pressed steel of Aluminium extruded beading screwed with countersunk screws to the frames. The glazing work shall conform to the specifications drawn out under clause 8.0.

79.6 Fixtures & Hardware

The windows and doors shall have following minimum hardware unless otherwise specified. The windows and doors shall have projecting type of hinges unless otherwise specified. Mild steel Holdfasts made out of M. S. Strips or rods shall be provided. The minimum no. of holdfasts for the frames shall be 6. However, as many holdfasts as required for fixing the frames firmly shall be provided. The handle and pegstays (one no. per shutter of windows) shall be provided. The doors shall have 3/2 no. of tower bolts depending upon double shuttered or single shuttered doors. Minimum fixtures such as aldrop and handles or latch and lock type of handles shall be provided, the fixtures so specified shall be cast brass copper oxidised unless

otherwise specified. The other hardware shall generally be in accordance with the specification detailed under heading "Finish Hardware". All the hardware shall be of approved make.

79.7 Installation / Erection

Frames shall be installed and fixed in masonry/concrete structures as shown on the drawings to plumb and true line, square in opening so that operation is easy and smooth. Parts such as hinges shall be cleaned off the construction waste and shall be greased prior to final painting.

79.8 Painting

The windows shall be painted with one coat of Red Oxide primer unless otherwise specified. The frames and shutters shall be painted with 2 coats of approved enamel paint when so specified.

80 Steel Rolling, Shutters and Rolling Grills

80.1 General

The rolling shutters or grills shall be fabricated according to drawings and shall conform to this specification IS:6248.

80.2 Materials and Fabrication

The materials for various integral parts of the rolling shutters shall be as shown below :

4.2.2.1 Curtain shall consist of interlocking corrugated laths or slats fabricated out of cold rolled steel strips conforming to IS:4030. The thickness fabricated out of steel sheets for the laths shall not be less than 0.9 mm for shutters up to 3.5 mm Width and shall not be less than 1.25 mm for shutters having width more than 3.50 meters. The bridge depth of the laths shall be 12 mm minimum ; so as to be strong enough to resist normal manual or wind pressure. Laths shall be made out of continuous single piece without any welded joint unless so permitted by the CONTRACTOR prior to fabrication. The water shedding surface shall be kept on the side exposed to atmosphere. When interlocked, the rolling centres of the laths shall be at 75 mm centres minimum ; unless otherwise specified. Each alternate lath section shall be fitted with malleable cast iron (conforming to IS:2108-1962) or mild steel clips securely riveted at either end thus preventing their lateral movement, and wearing of their edges against the guide channels.

4.2.2.2A fabricated Bottom Lock plate of riveted construction shall be made out of mild steel sheet of not less than 3.15 mm thickness (conforming to IS:513-1963) reinforced with mild steel angle of not less than 35 x 35 x 5 mm size at the bottom. It shall be interlocked with the bottom lath of the curtain, so as to have a firm contact against floor while the shutter is in closed position. The lock plate shall be fitted with sliding bolts (or flats) at either end to engage with suitable slits in the guide channels in a closed position. These bolts shall have a locking arrangement suitable for padlocks from inside and outside both. The lock plate shall also have pulling handles at both ends and both sides.

4.2.2.3The guide channels shall be of mild steel deep channels rolled, pressed or built up construction. Thickness of the construction shall not be less than 3.15 mm and the depth shall be adequate for easy movements of the curtain and also keep the ends within, under wind pressure of 200 kg/m². The gap should also be such as to prevent rattling of laths under wind pressure. The minimum depth of the channel shall be 60 mm for widths up to 3.50 metres and 75 mm for widths beyond 3.50 metres. The guide channels shall have minimum 3 nos. of M. S. Holdfasts or fixing plates, the maximum spacing of the same shall however not exceed 750 mm. Provision of M. S. stoppers at the maximum height shall be made on the guide channels.

4.2.2.4The bracket plates shall be fabricated out of mild steel sheets of minimum 3.15 mm thickness (conforming to IS:513-1963). However, the thickness shall be increased to 6 mm for gear operated shutters. The shape of the bracket plate shall be to suit the shape of the hood and shall be partially hexagonal in general. The edge shutting the wall shall be bent suitably at 90 degree to facilitate fixing of the plate to the wall.

In case of rolling shutters which are wider than 2.50 meters the bracket plates shall have M. S. angle of 30 x 50 x 6 mm or 65 x 65 x 6 mm welded to it for supporting the same on the wall. Since the bracket plate carries the full load of the rolling shutter, the fixing shall be done by bolts embedded in the lintel with proper anchorage.

4.2.2.5The roller shall consist of suspension shaft of heavy M. S. pipe conforming to IS:1161 and shall be of adequate diameter to have minimum deflection. It shall be of fabricated cage type housing the suspension shaft which shall be supported at intervals. The suspension shaft shall have helical wire spring and M. S. or

cast iron pulleys for counter balancing the weight of the curtain. The shaft shall have self aligning double row ball bearing 2 nos. minimum for shutters up to 2.50 meters width and more in case of window shutters. The spring shall be made from high tensile spring steel conforming to grade 2 of IS:4457 – 1967. The spring tension shall be made adjustable by providing suitable adjustment holes on the rims of the pulleys.

4.2.2.6 Hood covers shall be made of mild steel sheets not less than 0.90 mm thick, and shall be of shape indicated on drawings. These shall generally be hexagonal in part and follow the shape of the bracket plates. This shall be properly stiffened with M. S. angles or flats at top and bottom edges and in transverse directions in case of wider shutters and shall be supported at proper intervals to prevent sagging.

80.3 Types of shutters

The rolling shutters are classified depending on their size and operation and shall be provided with other auxiliary parts as follows :

80.3.1 Self coiling or push and pull type of shutters

These shall be manually operated and shall be provided up to 12 m² area. The suspension shaft shall have ball bearings as specified above. Fabrication shall provide a pulling hook for each of the rolling shutters. The pulling hook shall consist of 12 mm rod having a hook at one end and a loop at the other. The length shall be adequate to push the bottom lock plate to the topmost position with ease.

80.3.2 Gear Operated Mechanical

Gear operated mechanical type rolling shutters shall be provided beyond 12 m² area up to 25 m². In this case, the rolling shutters shall have bevel gear arrangement at the suspension shaft and a gear box at the operational height with a crank shaft connection. A gear handle shall also be provided along with such arrangements and the gear box shall be such that it can be operated from both sides i.e. inside and outside. The same mechanical arrangements shall be provided except for the gear box shall be replaced by suitable chain wheel and hand chain mounted directly on the worm shaft.

80.3.3 Electrically Operated Type

Electrically operated type shutters shall be used beyond 35 m² and up to 50 m². These shall consist of an electric motor suitably sized and shall drive the worm shaft by chain or "V" B1 belt drive through reduction gear box. Provision of an alternative arrangement of chain gear operating mechanism shall also be made to cater for periods of electric failure. The upward or downward speed to shutter shall not exceed 10 cm/sec. Controls for the electric motor shall be provided for reverse operation or stop position as required and shall have limit switches to cut off operation beyond and limits.

The gear worms etc. used in the assembly of Rolling shutters shall be of high grade cast iron or mild steel or phosphor bronze and shall be machine cut.

Wherever, necessary , the provision of gear mechanism for operating Rolling shutters may be provided or omitted depending upon the frequency of operation and other considerations.

80.4 Additional Fixtures and Provisions

Additional Fixtures such as safety devices consisting of additional reinforcement for the bottom lock plate, anchoring rods, central hasp and staple arrangement may be provided whenever called out.

Intermediate mullions or posts of fixed removable or sliding type may be provided for section lining the Rolling shutters of multiple door installation for wide openings.

Wicket Doors may be provided wherever called out. Size shall be as shown on the Drawings. These shall be erected in such a way as not to foul with the main rolling shutter while opening or closing. These shall be fitted with good lever lock operated by key lockable from inside and outside both.

Safety Lever Lock may be provided on either end of two bottom lock plate in addition to padlock arrangement to secure the slide bolts in closed position for extra security.

80.5 Galvanising

The rolling shutters shall be of galvanised type wherever so called out. The various parts under 'Materials and Fabrication' above shall be hot dipped G. I. Sheets readily available in the market. The galvanising shall be effected by using 97.50 % pure zinc and the zinc coating shall be not less than 230 gms per sq. meter . The coating shall be free from flaking or peeling. The galvanising shall be done in accordance with IS:1477.

80.6 Painting

All the component parts of the rolling shutter described above except the spring and the inside of the guide channels shall be painted with red oxide primer unless otherwise specified. The rolling shutter shall be painted after erection with 2 coats of enamel paint of approved make and shade, unless otherwise mentioned.

80.7 Rolling Grills

These are similar in design, construction and operation to rolling shutters and consequently all provisions mentioned herein above shall be equally applicable to the rolling grills except in respect of curtains. The curtain shall be replaced by hinged type of grills made out of cold rolled steel sheet links of 0.90 mm thickness assembled on tubes or rods. Grills may also be manufactured out of 8 mm dia M. S. rods bent of shape and be M. S. links. This shall however be as per the approved design.

80.8 Erection

The rolling shutter shall be erected by the manufacturer or his authorised representative or by the CONTRACTOR in sound and neat manner so as to provide trouble free and easy operation and neat appearance wherever necessary for erection purpose and shall finish the same after the complete installation.

81 Sliding Doors

Unless otherwise mentioned, all the sliding doors shall be top hung, with Coburn Track and with Galvanised corrugated sheeting of thickness of 24 BG (0.63 mm) on the outer face. At the bottom a guide angle shall be provided with the frame of the door and a channel shall be anchored in the floor concrete as per details. The framing angles for the door frame shall be as per the detailed drawing and the Patent Hangers shall be provided as per details. The doors shall be provided 16 mm dia handle as per details. The details for the Coburn Track and hangers shall be as specified by the manufacturers.

82 Hollow Metal Pressed Steel Doors

82.1 General

Wherever required the standard Hollow metal pressed steel doors (HMPS) shall be provided. The shutters shall be of pressed steel, plain flush type, and shall be furnished by the approved door manufacturing with doors mortised, machined and prepared for hardware attachment.

82.2 Materials

Steel for all hollow metal pressed steel and sliding doors and frames shall be cold rolled best quality furniture steel of gauges as specified herein and conforming to IS:513 and IS:1730, IS:1001 – case of practice for fixing and glazing of steel doors and windows. Steel for doors shall be stretcher pressed steel glazing beads wherever indicated. Erection fittings shall be of steel designed to provide for normal expansion and contraction erection, fastenings- holdfasts, screws, nuts and anchor clips shall be of steel.

Sections shall be formed true to details as shown on the drawings with clean, straight, sharply defined profiles and free from defects impairing strength and durability.

82.3 Fabrication

All metal doors shall be hollow metal steel of the thickness and type shown on the drawings. Dimensions shall allow + 3 mm tolerance. Doors shall be fabricated from 16 mm S.W.C. M.S. black sheets, stiffened with vertical channel or z-members spaced at not more than 300 mm on centres. The doors shall be filled with "TF" quality thermocole insulation, tightly packed, to eliminate metallic sounds. The doors shall be free from metallic ring. Door surface shall be flat and level to within 1 mm in 600 mm. Glazing beads shall be of 18 ga. Steel formed or drawn and shall be designed and fitted for receiving 5.50 mm thick sheet glass.

Doors shall be out and framed for fixed louvers and vision panels as designated and shown on the drawings. The louvers shall be built in at the manufacturer's plant. The doors shall be mortised for hinges and locks and reinforced with 16 gauge steel. Similar reinforcement shall be provided for a surface applied hardware for door closers and door stops, etc. wherever required. In double shutter doors, the first closing leaf shall be fitted with concealed tower bolts at top and bottom. The second closing leaf shall be fitted with mortise lock or padlock as indicated in hardware group. Double shutter door shall have strangles where shown and as detailed on the Drawings.

Rubber linings or gaskets of approved thickness shall be provided on the closing joints for air tight fittings. Continuous sponge rubber gaskets housed in bronze or Aluminium channels shall be provided on the jambs and heads of the door frame whereas the bottom gasket shall be fixed on the shutter. Door corners shall be mitered, reinforced, continuously welded and ground smooth. The appearance of the door shall be identical on both sides except for removable glazing beads.

82.4 Door Frames

Frames for hollow metal doors shall be pressed out of 14 S. W. G. M. S. black sheets to the sized and design shown on the drawings. Frames corners shall be flat and square. All joints shall be continuously reinforced at back fitted and continuously welded along a butting edges. Surfaces along joints shall be machined and buffed to attain a smooth matching surface even and flush with adjacent surface. The edges of the finish wall surface shall be bent back as detailed on a even line. Hinge jamb shall be mortised for hinges, lock jamb for lock strikes with dust cover plate. Frames shall be reinforced with reinforcing M. S. plate for attachment of hardware (Locks and door closers) and equipped with all requisite wall anchors. All door frames shall extend to that floor slab and bottom tie bar shall be provided and joined by means of screws to the corner of outer frame. The heads of frames having width of more than 1200 mm shall be suitably reinforced to prevent sagging, when installed.

82.5 Sliding Doors

Sliding door shall be complete with M.S. brackets, track and "coburn" or approved equal sliding gear, all as per drawings. Necessary door stops and sunk push and pull type of handles shall be provided.

82.6 Steel Fireproof Doors

These can be hinged or sliding type. The doors shall have automatic closing devices such as fusible links and counter weights, in case of sliding doors whenever called out. These shall generally conform to IS:1648 for fire safety of buildings including construction and installation of fire proof doors.

The doors shall be either all steel type or pressed steel type with approved packing. These shall be manufactured by approved agencies and the installation of the same shall be governed by the relevant statutory regulations if necessary.

82.7 Fixtures and Hardware

Hollow metal pressed steel doors shall have M. S. hinges as required and the frame shall be provided with minimum nos. M.S. holdfasts as required. The minimum hardware for single or double shuttered doors shall be as specified below :

Sr.no	Type	Single Shuttered door	Double shuttered door
1	M.S. Hinges	3 nos.	6 nos.
2	Tower Bolts	2 nos (one top & one at mid height or bottom)	3 nos. (2 nos closing shutter & 1 no on the other.
3	Handles	2 nos. (1 of each side)	4 nos. (2 nos. on each shutter

			on each side)
4.	Aldrop (or mortise latch & lock)	1 no.	1 no.
5	Stoppers	1 no.	2 nos. (one on each)

Handles provided on shutters shall be replaced with spring handles if required. Wherever mortise latch and lock is specified, door handles and aldrops need not be provided. All the hardware (except hinges) and fixtures shall be oxidised brass type unless otherwise specified. Any additional fixtures other than above shall be indicated on the drawings and shall conform to the specifications captioned under 'Finish Hardware'.

Fireproof doors shall have all the minimum fixtures indicated by the manufacturer. The auxiliaries and hardware shall be as called out and shall conform to any statutory regulations if necessary.

Sliding doors shall have all the auxiliaries such as rail, sliding gears, brackets etc. as indicated on drawings. The doors shall also have floor stoppers, sunk door handles, guide bars etc. as shown on the drawings.

Additional facilities such as view windows (glazed with 4 mm thick glass and beading etc.) or louver grills etc. shall be provided whenever so specified.

82.8 Installation

Frames shall be installed and fixed in the masonry/concrete structures as shown on the drawings, to plumb and true line, square in openings, so that the operation is smooth and easy. Parts such as hinges, pulleys should be cleaned of the construction waste and be greased.

82.9 Painting

The frames and shutters shall be painted with one coat of red oxide primer unless otherwise specified. The parts coming in contact with Masonry need not be painted, however inaccessible parts not coming in contact with masonry shall be painted in two coats of heavy red oxide zinc chromate primer doors shall be finished with 2 coats of approved enamel paint wherever called out.

Fire doors shall be provided with Red lead as primer and shall be finished in two coats of enable or any approved fire resisting paint whenever so specified.

83 Timber Doors and Windows

The Work covered by the specification consists of furnishing and installing of timber doors and windows in strict accordance with the specification and applicable drawings.

All timber material shall be as per the material specifications. The timber shall be properly placed and wrought in a workmanlike manner. All timber when embedded in masonry shall be well painted with coaltar.

All joints and jointary work shall be accurately cut and fitted together according to details shown on the drawings or in the manners most appropriate to the job with all necessary spikes, pins, screws, wedges etc.

83.1 Material

83.1.1 Frames

7.1.1.1 Door and window frames shall be minimum 150 x 65 mm and 125 mm x 65 mm respectively in size unless otherwise stated on drawings. Where frames are to be erected flush with plain or reinforced concrete structural members ; they shall be fixed on to concrete with three 12 mm dia; 150 mm long coach screws and white bronze of lead rawplus for each jamb. The heads of the screws when counter sunk shall be plugged with timber plugs. When the frames are embedded in masonry jambs, two on each vertical side be

properly anchored by holdfasts in masonry. Hold fasts can be made from 40 mm x 30 mm steel bars bent over at both ends leaving 200 mm clear between ends. These shall be anchored in masonry by P. C. C. 1:2:4. Additional holdfasts on each side may be provided where sill has not been provided. The frames shall be protected during the progress of work by necessary boxing or as may be directed. All exposed edges of the frames shall be chamfered suitably.

7.1.1.2 All timber shall be well seasoned for a minimum period of two years, shall be straight and free from large knots, shakes, cracks, sapwood, appearance of rot and other defects. All wrought timber is to be sawn planned or worked to correct sized and shapes as shown on the drawings. An allowance of + 2 mm shall be permitted for each wrought face. All timber to be exposed on the finished surfaces shall be wrought on appropriate faces. All surfaces in contact masonry shall be coated with a thick mixture of white lead and linseed oil.

83.1.2 Panelled Shutter

7.1.2.1 These shall be made from approved C.P. teak scantlings. The styles and rails shall be 40 mm thick unless otherwise specified and mortised and tenoned together in workmanlike manner. The thickness of tenon shall not exceed one fourth the thickness of the plank and width shall not exceed five times the thickness. All rails over 180 mm in depth should have double tenon. Framed joints should be coated with white lead before frames are put together. The styles and rails shall be moulded and of width approved by the Engineer-in-Charge.

Each panel shall be in one plank 40 mm thick unless otherwise specified and moulded. Middle lock rail is 750 mm above floor level. Where mortise locks are used, the lock rail shall not be less than 200 mm width.

83.1.3 Flush Doors, Shutters

7.1.3.1 Flush doors shall be either solid core or hollow core as specified on the drawings or elsewhere and shall conform to IS:2202 or IS:2191 respectively. Solid core shall be 30 mm to 40 mm or 50 mm thick as specified. They shall be covered on both sides with plywood. The door shall be lipped and edged with sisum or teak wood strips on the sides. The wooden battens forming the solid core and other parts should be seasoned and treated to guard against termite and temperature and humidity changes. In general these shall be of approved type and shall be obtained from approved manufacturers. Where French polishing is to be done the shutter shall have veneer plywood finish. The rate to include providing vision panels etc. if any.

83.1.4 Glazed Shutters

7.1.4.1 These shall be similar to panelled shutters except that such parts as are directed shall be glazed with sheet glass as specified on the drawings. Styles and rails in the glazed shutters shall be rebated 12 mm to receive the glass. Sash bars shall be moulded and mitred and rebated 12 mm on one side to receive glass. Glass panels shall be fixed by means of beading and/or putty first applied in the rebate and then over the glass panels. A cushion or rubber felt or canvas shall be given in between to absorb shocks. Putty shall be made as required, or if used as ready mix, it should be of an approved manufacturer.

83.1.5 Louvered Shutters

7.1.5.1 The teakwood blades shall generally be 90 mm wide and 10 mm thick and shall overlap about ½ their width. They shall be secured to side frames when used as fixed. Whenever the louvers are of movable type, they shall be secured to moulded stanchion by 1" mm/or Aluminium hinges. The louvered shutters shall, however, be made as per details shown on the drawings.

83.1.6 Cover moulds, architraves and skirtings

Cover moulds, architraves and skirtings prepared to the selections shown in the detailed drawings and shall be moulded as required. They should be prepared from best quality seasoned teakwood and shall be fixed with screws. They shall be painted, varnished or polished as required.

83.1.7 Vision Panels and Louvers

Wherever shown in the drawings, the vision panels or louvers shall be provided in the shutters, with teakwood beading on both sides.

83.1.8 Hardware and Fixtures

7.1.8.1 The doors and windows shall have following minimum hardware and fixtures unless otherwise specified on the drawings, and shall be of approved make :

Sr no.	Type	Doors		Windows (on each shutter)
		Single shuttered	Double shuttered	
1	Butt Hinge (100 mm long approx.)	3 nos	3 nos. on each shutter	2 nos.
2	Tower Bolts (100 mm long approx)	2 nos.	3 nos. (2 nos. on closing shutter and 2 no. on the other)	2 nos.
3	• Handles (150 mm long approx.)	1 no. (on each side)	2 nos. (on each side)	1 no. on inside face
4	• Aldrop (or Mortise latch and lock) (300 mm long approx.)	1 no.	1 no.	-
5	Stoppers (of approved type)	1 no.	1 no.	1 no.

Handles provided on door shutters shall be replaced with latches with spring handle. Wherever Mortise latch and lock is specified, door handles may not be provided. All the hardware and fixtures as stated above shall be oxidized brass type. Any other fixtures in addition to above such as floor drop stoppers, decorative handle, door closers etc. wherever required shall be indicated on drawing and shall conform to relevant specifications described under heading "Finish Hardware".

83.2 Installation

Frames shall be installed and fixed in the masonry/concrete structures as required to plumb and true line; square in opening. The door shutters shall be fixed up normally after the flooring is installed. The glazing work shall be taken up on the specific instructions of the CONTRACTOR.

83.2.1 Painting Polishing

The wood work for the doors or windows shall be painted or polished as required. The painting will be done in 3 coats of enamel paint, after usual surface preparation such as cleaning, sand papering and putty coats. The paint and shade shall be approved by the CONTRACTOR prior to use and shall be of approved manufacture.

The polishing can be glossy or mat finished. The wood work shall be first cleaned and scraped thoroughly with sand paper. It shall be painted with filler or whiting and mythilated spirit and again sand papered. Minor knots and cracks shall then be filled with bees wax, coloured to match and thin coats of French polish or wax polish shall then be applied to a uniform finish. Work shall finally be approved by CONTRACTOR.

84 Glass & Glazing

84.1 Scope of work

The work covered under this specification shall consist of supply and fixing of the glass for doors, windows, view panels, louvers etc in strict accordance with this specification and applicable drawings.

84.2 General

The size of glass panes used shall be approximate when indicated on the drawings. The exact size shall be decided by measuring the shutters and or frames which shall receive glass. The glass shall be of

“Hindustan Pilkington” or approved equal ; and shall be free from any defects such as bubbles, undulations local cracks etc. The glass panes shall have manufacturer’s labels which shall be removed only after inspection. In case of wired glass it shall be free from distorted wire mesh.

84.3 Material

The glass used for glazing shall be plain translucent sheet otherwise specified. The thickness shall be varied on the type of use and shall generally be as follows :

Sr. no.	Thickness of plain sheet glass	Use	Wired Glass
1	4 mm	For view panels & shutters of smaller panels	6.3 mm wired glass shall be used for north light glazing
2	4 mm	For shutters of windows and doors in general having panel size more than 0.5 sq. mtrs. & louvers.	
3	6.3 mm to 12 mm	To be used only. When so specified	

The glass shall be ground or buffed whenever so required.

Putty shall conform to IS:420, IS:419 or IS:1635 as required.

The clips shall be spaced according to the slots in the members however the spacing shall not exceed 30 cm in any case.

84.4 Installation

There shall be a space of 1/5 mm all round the panes between the edge of the glass and the rebate. The glass shall be cut to the required size and the edges shall be true to line without any undulated surface/ glass shall be fixed by means of glazing chips or beading as the case may be. The edges shall be puttied thoroughly before and after placing of the pane and shall be finished smooth. Damaged glass panes while installation shall be replaced by new panes.

The glass panes used as louvers shall be put to correct size and the edges shall be ground smooth.

85 Aluminium Doors & Windows

85.1 General

The work covered by the specifications consists of furnishing and installing of anodized extruded Aluminium doors and windows in strict accordance with relevant I.S. codes, specification and applicable drawings.

All joints and jointary work shall be accurately cut and fitted together according to details shown on the drawings or in the manner most appropriate to the job with all necessary pins, screws etc.

85.2 Material

All materials, fitting and fixtures shall be of anodized extruded Aluminium of Indal / Ajit Indian / equivalent as approved by Engineer-in-Charge.

Fabrication, size of panel frames, fittings and fixtures shall be as per the approved drawings.

85.3 Workmanship

Doors, windows shall be installed / erected as per any approved standard practice and by expert workers who has field experience in this regard.

Proper care shall be taken so that the doors, windows or parts thereof are not deformed or damaged during erection.

Fixing bolts and accessories shall form a part of CONTRACTOR'S scope of supply. Final painting / surface finishing work shall be done only after clearance received from the Engineer-in-Charge.

Material test certificate is to be obtained from the manufacturer by the CONTRACTOR before start of erection and shall be furnished to the Engineer-in-Charge for his approval.

Door and window panels shall be fabricated in such a manner so that the same can be handled by one person without much difficulty.

86 Finish Hardware

86.1 Scope

The work covered by this specification consists of furnishing and installation hardware specified herein and in the door, window and louver schedule.

86.2 Material

Material, design and quality of construction shall conform to the Indian Standards unless otherwise note. Following are few of them generally to be followed :

IS:204	:	Tower Bolts
IS:205	:	Butt Hinges (non – ferrous)
IS:208	:	Door handles
IS:281	:	Sliding Bolts
IS:206	:	Tee and Strap hinges
IS:453	:	Parliamentary hinges
IS:1341	:	Butt hinges (steel)
IS:363	:	Hasps and staples
IS:1823	:	Floor door stoppers

Door hardware shall be of the type indicated on the drawing. These shall be supplied with screws, bolts and nuts and other fastenings for attaching hardware. These shall be of the same finish as the material to which they attach. Working and moving parts of locks shall be accurately fitted to smooth close bearings and shall be free from rattle.

All knobs, handles and pulls and other exposed items shall be suitably wrapped and protected. All hardware shall be free from defects which may affect the appearance and serviceability.

86.3 Samples

The CONTRACTOR shall obtain the owner/cons. approval of samples of all items of finish hardware as to the quality, finish and design.

86.4 Type of hardware

Butt hinges shall be oxidised brass with brass pins and washers of heavy-duty type, first quality.

Projecting type hinges shall be pressed steel with brass washers and pins, first quality.

Tower bolt shall be manganese brass, concealed type, vertical bolt, heavy duty 20 mm half round ,at top and bottom of double shutters of first closing log (LH shutter locking from inside)

Two point handles, shall be manganese brass or cast-iron or die-cast zinc base alloy.

Peg stays shall be manganese brass or die cast zinc base alloy to keep the shutters at least open in three different positions up to 90 degree.

Mortise locks shall be fitted in the second closing leaf ; heavy duty type, 5 lever, brass and steel construction quiet and smooth in operation, double throw and lever handle, chrome finish.

Mortise bathroom locks 5 lever, with knob handles, Godrej or approved equal ,chrome finish, with match for bolting the door from inside (operated from inside).

Bar handles shall be manganese brass or zinc base alloy, plain design.

Padlocks shall be 7 lever, brass steel shackle "Godrej" make or equal.

Push plates shall be brass or cut out of Perspex sheets with round corners and edges plain design.

Kick plates shall be 16 Ga. Aluminium, natural finish screwed on both sides of doors.

Door closers shall be "AJIT INDIA", "Everite" (or approved equivalent) hydraulic, (liquid control type) surface mounted, with regulating arm ; checking fluids shall be lubricating and non-freezing. Finish shall be dull bronze. The mechanical device shall be such as to close doors, positively and be quite in peration with a smooth, steady motion and without rebound. Suitable adjusting wrench shall be provided.

Regulating valves shall be accessible and provide and maintain close positive adjustment. All castings shall be sound and all joints effectively sealed against leakage.

Aldrops shall be plain design, chromium plated or brass oxidised.

Keys shall be stainless steel, provided in duplicate.

Floor door stoppers shall conform to IS:1823 in general.

Sunk handles : These shall be either manganese brass type or Aluminium. These shall be provided on sliding doors.

Buffers : These shall be either P.V.C. or hard rubber type and shall be screwed on walls or floors as required.

Any other hardware shall be provided if so specified.

87 Quality Assurance Plan

CONTRACTOR has to submit Quality Assurance Program and the method of Quality Control which shall be in operation after necessary approval from the Engineer-in-Charge.

**Standard Specification
for
Roofing and Cladding
(A-9)**

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88 General

88.1 Scope

This specification used in conjunction with the contract document, bill of quantities and drawings establishes the minimum requirement for roofing and its allied works. Reference to other material standards for compliance shall be interpreted as an integral part of the specification.

Any special requirement as shown or noted in the drawing shall be given preference over the provision of this specification.

89 Regulations, Codes and Standards

The roofing and its allied works shall be in compliance with all applicable federal, state local laws and regulations.

The following Indian Standard Codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS:277	-	Galvanized steel sheet (plain and corrugated)
IS:730	-	Hook bolts for corrugated sheet roofing
IS:459	-	Specification for unreinforced corrugated and semi corrugated asbestos cement sheets
IS:3007	-	Code of practice for laying of asbestos cement sheets
IS:1322	-	Bitumen felts for water proofing and damp proofing
IS:702	-	Specification for industrial bitumen.
IS:73	-	Specification for paving bitumen

90 Material

90.1 G.I. Sheet

Galvanised corrugated steel sheets in roofs, sides and gable end shall be 10/75 corrugation and conforming to IS:277 (Class- I)

90.2 A.C. Sheet

Asbestos cement corrugated sheets in roof, side and gable shall be at least 6 mm thick and shall conform to IS:459

90.3 Bitumen

Bitumen shall be of grade 80/100.

90.4 Bitumen Felt

Bitumen felt shall be of type 3 grade.

90.5 Fixing Accessories

All fixing accessories for G.I. and A.C. roof sheets shall be of galvanised steel and shall conform to IS:730. Bitumen washers shall be of approved quality.

91 G.I. Sheet

91.1 Laying & Fixing

Laying of sheets shall commence from the end opposite to the direction of the prevailing wind. The sheets shall be laid commencing from eaves for roofing and from bottom for side and gable.

Fixing of roof and side sheeting shall be by 10 mm and 8 mm dia galvanised hook bolts respectively.

All bolts shall pass through the crown of the corrugations and shall be provided with diamond washers, round washers over bitumen felt washer and square nuts. All washers and nuts shall be of galvanised steel, fixing to the runner or purlin shall be provided through at least every fourth corrugation.

All sheets shall be stitched together by 6 mm diameter galvanised steel sheeting bolts and square nuts @ 250 mm c/c unless otherwise stated. In case of double side steel lap, the pitch shall be staggered between alternate crowns. Galvanised steel diamond washer and round washer shall be provided under the screw head which shall be always on the outside of the building

91.2 Holing

All holes for sheeting and flashing shall be drilled and/or punched from the bottom side of the crown and shall be in exact position to suit the purlin.

91.3 Laps

All roofing sheets shall be provided with double corrugation side laps and all side and gable sheets shall be provided with single corrugation side laps unless stated otherwise. The end lap of sheets shall be 200 mm for roofing and 100 mm for side and gable sheeting.

92 A.C. Sheets

92.1 Workmanship

Workmanship for laying asbestos cement corrugated sheets shall conform to IS:3007 Part I.

Cutting of sheets shall be done with a wood saw and the sheets shall never be chipped. All holes in the sheets shall be drilled and shall not be punched. The holes for fixing shall be 2 mm larger than the diameter of fixing bolts and the holes shall be drilled through the crown of corrugation and never through the valleys. Holes shall not be closer than 40 mm to any edge of sheet or any accessory.

92.2 Laying and Fixing

The sheets shall be laid with the smooth side facing the weather. Laying of sheets shall commence from the end opposite to the direction of the prevailing wind. The sheets shall be laid commencing from eaves for roofing and from bottom for side and gable.

Fixing of asbestos cement corrugated roof sheeting shall be 10 mm dia galvanised steel 'J' and 'L' hook bolts. Fixing of side sheeting shall be at least by 8 mm dia galvanised steel 'J' or 'L' hook bolts. All bolts shall pass through the crown of corrugation and shall be provided with galvanised steel nuts, galvanised steel flat washers and bitumen washer. Each sheet shall be fixed / anchored to purlins / runners at four corners and four centers.

As far as possible asbestos cement accessories shall be secured to the sheets by same bolts which secure the sheets. Where this is not possible, these shall be secured to the sheets by galvanised steel mushroom head roofing bolts (seam bolts) with galvanised steel nuts, galvanised steel flat washer and bitumen washers.

92.3 Laps

All roof, side and gable sheets shall be provided with half corrugated side lap. The end lap for sheets shall always fall over a purlin and shall be minimum 150 mm for roofing and 100 mm for side and gable sheeting unless otherwise shown on the drawings. The free overhang in case of eaves for roofing and bottom for side and gables shall not exceed 300 mm measured from free edge to the centre of bolts.

93 Water Proofing Treatment

93.1 Tarfelting

6.1.1 Workmanship

Roof surface shall be thoroughly cleaned, levelled and free from dust etc before starting the work of waterproofing.

First coat of blown / residual bitumen shall be applied @ 1.20 kg./sq.m. over the cleaned surface.

Bitumen shall also be applied over every second, fourth and sixth layer of tar felt @ 1.20 kg. Per sq. m.

Tar felt of type 3 grade I (Hessian base self finished bitumen felt) shall be laid as second, fourth and sixth layer over the bitumen layer. Lap of the tar felt should be minimum 150 mm.

Final course shall consist of pea gravel of size 6 mm and down spread evenly all over the area.

6.1.2 Guarantee

The CONTRACTOR shall furnish a guarantee which shall be agreed upon in the contract for a period of 10 years against any leakage. Any work required to be carried out as a result of any defects in workmanship or use of defective material during the period of guarantee shall be carried out by the CONTRACTOR at his own cost.

93.2 Chemical Water Proofing

Water proofing shall be carried out by means of approved fibrous rubberized resin compound and shall be strictly as per manufacturer's recommendations.

The surface must be prepared before application of the chemical. The surface must be cleaned to remove all dust, foreign material, loose materials or any other deposits or contaminants which could affect the bond between the surface and the chemical coating.

The CONTRACTOR shall provide a minimum guarantee of ten years against leakages for all such treatments.

94 Foam Concrete (Roof Insulation)

94.1 General

The roof insulation shall be poured in place with foam concrete or any other light weight concrete as specified with a density of 318 kg/cu. m. or as per manufacturer's specifications.

Portland cement shall conform to IS:269.

Water shall be clean and free from deleterious organic materials, acids and alkali.

94.2 Workmanship

The CONTRACTOR shall first ensure that the surface of the roof panels is rough enough to have proper bond for this foam concrete. The surface shall be cleaned of the operation. The CONTRACTOR shall be cleaned of all loose material with stiff broom before starting of the operation. The CONTRACTOR shall install (poured in place) foam concrete of 75 mm minimum thickness and slope to ensure a run-off gradient as specified and in all areas indicated to the drawings, in strict accordance with the standard specification. The concrete shall be carefully deposited and screeded in continuous operation until a panel is

completed. The panel shall consist of the section between expansion joints. No joints shall be allowed in the panel.

94.3 Curing & Protection

The surface of freshly finished concrete shall be prevented from drying out for not less than three days, or sufficiently long to allow the concrete to develop the desired strength. The curing shall start immediately following partial set of the concrete. Wet gunny bags with frequent water sprinkling shall be used for curing and all exposed surfaces shall be protected from excessive heat or rains. The surface left for application of built-up roofing shall be of satisfactory hardness, smooth and firmly bound, and shall have adequate bonding characteristics. The concrete shall be allowed to dry as thoroughly as possible following curing and before applying the built-up roofing. The minimum crushing strength for the foam concrete shall be 3.5 kg/sq. m.

The hardness of the surface shall be considered adequate when it shall withstand foot traffic and other light operations of roofing without damage, but must be protected from gouging of excessive loading.

Surface Finish

The surface shall be firmly bound and free of all loose material. The screeded surface shall be free from extreme roughness capable of interfering with proper bonding and damaging tar-felt.

95 Quality Assurance Plan

The CONTRACTOR shall submit the Quality Assurance Plan for the approval of the Engineer-in-Charge. The approved QAP shall be strictly followed.

**Standard Specification
for
Roads and Concrete
Pavements (A-10)**

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96 General

96.1 Scope

This specification used in conjunction with the contract document, bill of quantities and drawings establishes the minimum requirement for concrete paved areas. Reference to other material standards for compliance shall be interpreted as an integral part of the specification.

This specification covers the material and construction details for earthwork in filling for embankments, filling with sand/murum, WBM sub base, WBM base coarse and shoulders for roads and flexible pavements with bitumen premix carpet.

Road diversions shall be provided by the CONTRACTOR while the work is in progress till the completion of the work with out any extra payment. The diversion shall be maintained in proper condition. If necessary water shall be sprinkled on diversions.

97 Regulations, Codes and Standards

The road shall be in compliance with all federal, state and local laws and regulations which are applicable.

The following Indian Standard Codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS:2720 - Methods of test of soil

IRC: 19 - Standard specification and code of practice for water bound macadam

98 Material

98.1 Soil

Only material considered suitable by the Engineer-in-Charge shall be employed for the construction and that considered unsuitable shall be disposed off as directed by Engineer-in-Charge at his own cost and no claim for compensation will be entertained. The contractor shall give the samples of earth, he proposes to use for filling along with the following characteristics of the sample to Engineer-in-Charge, prior to collection and use, for approval.

Mechanical analysis or grain size analysis as per IS:2720 Part IV.

Liquid limit as per IS:2720 Part V.

Plastic limit as per IS:2720 Part V.

Moisture density relationship as per IS:2720 Part VIII.

The soil used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.

Soil having plasticity index less than 20 shall be used for filling purposes.

Soil having laboratory maximum dry density of less than 1.5 gm/cc shall not be used.

98.2 Sand/Murum

Sand for filling shall preferably be locally available sand, clean and free from any chemical or other impurities. Murum for filling shall be clean and well graded. Sand/murum shall not contain any vegetation, organic, clayey or other material and shall be obtained from a source approved by Engineer-in-Charge.

98.3 Stone Aggregates for WBM

The coarse aggregates shall be hard, crushed or broken stone metal from quarries approved by Engineer-in-Charge, it shall be hard durable and free from flat elongated, soft and disintegrated particles. It shall not have excess of dirt and other objectionable matter. The quality, size and grading of the coarse aggregate shall be conforming to IRC : 19.

- a) The grading of the coarse aggregates for the sub base coarse shall be as below.

Size Range	Sieve Designation (IS:460)	% by weight passing the sieve
90 mm to 45 mm Grade-I	125 mm	100
	90 mm	90-100
	63 mm	25-60
	45 mm	0-15
	22.4 mm	0-5

- b) The grading of the coarse aggregates for the base course shall be as follows:

Size Range	Sieve Designation (IS:460)	% by weight passing the sieve
63 mm to 45 mm Grade-II	90 mm	100
	63 mm	90-100
	53 mm	25-75
	45 mm	0-15
	22.4 mm	0-5

Physical requirement of coarse aggregates of sub base coarse shall be as follows :

- i) Los Angles Abrasion Value 60%(Maximum)

or

- ii) Aggregate Impact Value 50% (Maximum)

Physical requirements of coarse aggregates for base course shall be as follows :

- i) Los Angles Abrasion Value 50%(Maximum)

or

- ii) Aggregate Impact Value 40% (Maximum)

- iii) Flakiness index value 15% (Maximum)

Samples of test shall be representative of the material to be used and collected as per IS:2430.

The aggregate shall be stacked at the road side on firm, well drained ground in regular stacks, as directed by Engineer-in-Charge. The various grade shall be stacked separately and contamination by earth and other extraneous matter shall be stacked separately, and contamination by earth and other extraneous matter shall be prevented effectively.

98.4 Binding Material Murrum

The binding material shall be clean, dry murrum free from leaves, organic matter and any deleterious material.

It shall be obtained from quarries approved by Engineer-in-Charge.

98.5 Screening Material

Screenings to fill the voids in the coarse aggregates shall, as far as possible be the same material as the coarse aggregates. Where it is decided by the Engineer-in-Charge to use other materials, the same shall be predominantly non-plastic materials such as Kankar nodules, gravel (other than river-born rounded aggregate) or murrum, provided that the liquid limit and plasticity index of such material is below 20 and 6 respectively, and the fraction passing 75 micron sieve does not exceed 10%.

Grading requirements of screening are as follows :

Size of Screening	Sieve Designation (IS:460)	% by weight passing the sieve
13.2 mm Grade-II	13.2 mm	100
	11.2 mm	95-100
	5.6 mm	15-35
	180 micron	0-10

The grading, however, shall not be mandatory, in case either murrum or gravel is used as screenings.

98.6 Binding Material

Binding material, to prevent reveling of WBM, shall consist of fine grained material possessing P.I value upto 6.

Binding material shall be obtained from quarries/sources approved by the Engineer-in-Charge.

98.7 Bitumen Premix Carpet

3.7.1 Coarse aggregate

The aggregate shall consist of crushed stone of clean, hard, tough, durable rock of uniform quality and shall be clean, free from excess of dust, flat or elongated pieces, soft or disintegrated stone, clay or other deleterious matter. The size of aggregate shall be as mentioned in the schedule of quantities.

3.7.2 Sand

The sand shall consist of clean, hard, durable, uncoated, coarse dry particles and shall be free from injurious amounts of dust, soft or flaky particles, organic matter or other deleterious substances.

3.7.3 Binder

The binder shall be bitumen of penetration 80/100 conforming to IS:73. The bitumen shall be collected on road side drums. Any drum leaking or damaged shall not be accepted.

99 Earthwork In Filling

The area where filling is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 90% of maximum laboratory dry density of the soil. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted.

Approved fill material shall be spread in uniform layers not exceeding 20 cms in loose depth for embankment filling. Shoulder construction shall be so organised as to keep pace with the construction of different layers of the pavement, which may require earth fill thickness less than 20 cm. All clods, lumps etc. shall be broken before compaction.

In general the soil shall be spread uniformly over the entire width of embankment or shoulder as the case may be. For large embankments, the spreading of soil shall be as directed by Engineer-in-Charge.

Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down in this specification.

Prior to rolling, the moisture content of material shall be brought to within plus or minus 2% of the optimum moisture content as described in IS:2720 – Part-VIII. The moisture content shall preferably be on the wet side for potentially expensive soils.

After adjusting the moisture content as described in above, the layers shall be thoroughly compacted by means of rollers till 90% of maximum laboratory dry density is obtained as per IS:2720 part VIII.

Each layer shall be tested in field for density and accepted by Engineer-in-Charge subjected to achieving the required density before laying the next layer. A minimum of one test per 500 m² area for each layer shall be conducted.

The type of rollers that should be employed for compaction shall be as per direction of Engineer-in-Charge.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-Charge to obtain the required density.

The filling shall be finished in conformity with alignment, levels, cross-sections and dimensions as shown in the drawings.

Extra material shall be removed and disposed off as directed by Engineer-in-Charge.

Embankment and shoulders for roads, units etc. shall be carried to within a tolerance of 3 cm. From final lines but shall be to required grades and slopes.

100 Filling with Sand/Murum

Murum/sand shall be spread in layers not exceeding 15 cm in loose thickness over the areas. Each layer shall be uniform in density, quality of material and moisture content before compaction. The moisture content shall be within 2% of the optimum moisture content as per IS:2720 part VIII.

In case of pure sand, flooding with water is permissible.

Compaction of each layer shall be by mechanical means as per directions of Engineer-in-Charge. Only inaccessible reaches shall be worked manually. Each layer shall be uniformly compacted to obtain 90% of maximum laboratory dry density of the material. If the material fails to achieve the required density, the layer shall be reworked with necessary alteration in compaction, so that the required compaction is obtained. A minimum of one test per 500 m² area for each layer shall be conducted.

Subsequent layers shall be placed only after the layer already laid has been compacted to the required density and approved by Engineer-in-Charge.

The finished surface must be dressed to required grade and slope. Excess material must be removed from site, as directed by Engineer-in-Charge.

101 Water Bound Macadam Sub Base/Base Course

The sub base course shall consist of one or more layers, each of 100 mm compacted thickness.

The base course shall consist of one or more layers, each of 75 mm compacted thickness.

101.1 Spreading Coarse Aggregates

The sub grade or sub base to receive WBM coarse shall be prepared to the required grade and camber. Before starting with WBM construction, side shoulders shall be constructed in advance to a thickness corresponding to the compacted layer of the WBM coarse for lateral confinement of aggregate. After shoulders are ready, their inside edge shall be trimmed vertical to receive the aggregate. The practice of constructing WBM in a trench section excavated on the embankment/formation must be avoided.

The coarse aggregate shall be spread uniformly and evenly on the prepared base in required quantities from the stacks. The aggregate shall be spread to proper profiles by using templates across the road about 6 m apart.

The surface of the aggregates shall be carefully trued up and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked from time to time, during the spreading and rolling of the coarse aggregate to ensure a finished surface without variation greater than 12 mm, when 3 m long straight is laid parallel to centre line of the road.

The WBM layer shall be tested by depth blocks. No aggregates on large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pocket of fine materials.

The coarse aggregate shall not be spread in lengths more than 3 days average work in advance of the rolling, spreading murrum and bonding of the preceding section.

101.2 Rolling Road Metal

Immediately following the spreading of the coarse aggregates, it shall be compacted to full width by rolling with either three wheeled power roller of 8 to 10 tonnes weight or equivalent vibratory roller true to the line and camber as shown in the drawing. The course shall not be rolled when the sub grade is soft or yielding or the rolling causes a wave like motion in the base course or sub grade. When rolling develops irregularities

that exceed 12 mm when tested with a 3 m straight edge, the irregular surface shall be loosened and the aggregate added to or removed from it is required and the area rolled until it gives uniform surface conforming to the desired cross section and grade. The surface shall also be checked transversely by template and any irregularities corrected as above. The use of murrum to make up depression shall not be permitted.

The rolling shall begin from edges with roller running forward and backward until the edges have been firmly compacted. The rolling shall then progress gradually from edges to the centre parallel to the centre line of the road lapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. On the super elevated portions of road, the rolling shall commence from the lower edge and progress gradually towards the upper edge of the road.

Rolling shall be discontinued when aggregate are thoroughly keyed and creating of stone wheel of roller is no longer visible partially compacted with sufficient void space in them to permit application of screenings. Slight sprinkling of water may be done if required.

101.3 Application of Screenings

After the coarse aggregate has been rolled, screening shall be applied uniformly and gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller will cause them to settle into the voids of the coarse aggregates.

The screening shall not be dumped in piles on coarse aggregate but shall be spread uniformly in successive thin layers either by spreading motion of hand shovels or by mechanical spreaders.

The screenings shall be applied at a uniform and slow rate (in three or more applications) so as to ensure fillings of all voids. Rolling and brooming shall continue with the spreading of the screenings. Either mechanical brooms or hand brooms or both may be used. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface making the filling of the voids difficult or preventing the direct bearings of the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation and shall continue until no more screenings can be forced in the voids of the coarse aggregates. Damp and wet screenings shall not be used under any circumstances.

The quantity of screenings used shall be such as to fill all voids in the water bound macadam courses.

101.4 Sprinkling and Grouting

After spreading the screenings, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling shall be continued and additional screenings applied where necessary until the coarse aggregates are well compacted and grout of screenings and water form a wave ahead of wheels of the roller. Care shall be taken to see that the base of sub grade does not get damaged due to the addition of the excessive quantity of water during the construction.

101.5 Application of Binding Material

After the application of screenings as described above, the binding material shall be applied at a uniform and slow rate (in two or more successive thin layers) so as to ensure filling of all voids.

After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with hand brooms/mechanical brooms or both so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller during which water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading, rolling and brooming of binding material shall be performed on sections which can be completed within one day's operation and shall continue until no more binding material and water forms a wave ahead of the wheels of moving roller. Damp and wet binding material shall not be used under any circumstances.

The quantity of binding material used shall be such as to fill all voids in the water bound macadam.

101.6 Subsequent Layers of WBM

Before laying the subsequent layers of WBM, the surface shall be scarified and reshaped to the required camber and profile, and all ruts, depressions, pot holes etc. made good. The second layer shall be laid after the surface preparation is approved by Engineer-in-Charge. The specification and mode of measurement for subsequent layers of WBM will be similar to that described before.

102 Bitumen Premix Carpet

102.1 Quantities of material

7.1.1 For premix carpet 20 mm thick

Material	For premix carpet Per 100 m ²	For seal coat Per 100 m ²
Coarse Aggregate 12mm and down size	2.75 m ³	-
Bitumen 80/100	150 Kg	68.3 Kg
Coarse sand as Sealing aggregate	-	0.6 m ³

7.1.2 For premix carpet 25 mm thick

Material	For premix carpet Per 100 m ²	For seal coat Per 100 m ²
Coarse Aggregate 12mm and down size	3.5 m ³	-
Bitumen 80/100	185 Kg	68.3 Kg
Coarse sand as Sealing aggregate	-	0.6 m ³

7.1.3 For premix carpet 50 mm thick

Material	For premix carpet Per 100 m ²	For seal coat Per 100 m ²
Coarse Aggregate 12mm and down size (For 35 mm thick carpet-I layer)	5.5 m ³	-
Coarse Aggregate 12mm and down size (For 15 mm thick carpet-II layer)	2.0 m ³	-

Bitumen 80/100 (For 35 mm thick carpet-I layer)	269 Kg	68.3 Kg
Bitumen 80/100 (For 15 mm thick carpet-II layer)	110 Kg	-
Coarse sand as Sealing aggregate	-	0.6 m ³

7.1.4 For premix carpet 75 mm thick

Material	For premix carpet Per 100 m ²	For seal coat Per 100 m ²
Coarse Aggregate 25mm and down size (For 50 mm thick carpet-I layer)	8.5 m ³	-
Coarse Aggregate 25mm and down size (For 25 mm thick carpet-II layer)	3.5 m ³	-
Bitumen 80/100 (For 50 mm thick carpet-I layer)	375 Kg	68.3 Kg
Bitumen 80/100 (For 25 mm thick carpet-II layer)	185 Kg	-
Coarse sand as Sealing aggregate	-	0.6 m ³

102.2 Laying

7.2.1 Preparation of road surface

The existing surface shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign matter with the help of wire brush, chisel, picks etc. before laying the tack course. The cleaning shall be carried out in such a manner as to expose the stone metal to a depth of 1 to 2 mm without dislodging the interlocking of the metal. All dust and other material thus removed shall be carried away and dumped at suitable places as directed by the Engineer-in-Charge.

If pot holes are found on the existing road surface, these irregularities must be filled in with premix chippings and well rammed about a week before the carpet is laid.

7.2.2 Tack Coat

The bitumen shall be heated in asphalt boilers to 177°-188° C and shall be spread uniformly at the rate of 1 kg/m² by means of sprayers. The applied binder shall be evenly brushed.

The tack coat shall be applied just ahead, keeping pace with laying of premix carpet.

7.2.3 Preparation of premix

Mechanical mixers shall be generally used for preparation of premix. Improvised hand mixing drums may be used if permitted by the Engineer-in-Charge. Stone chippings of specified size shall be thoroughly mixed dry in the mixer at the rate indicated above. Binder heated at temperature suitable for the grade of bitumen is added to the mixer drum at the specified rate per 100 m² of surface and thoroughly mixed till the stone chips are completely coated with the binder.

The premix shall be emptied on to wheel barrows or stretchers and carried to work site.

7.2.4 Spreading of Premix

Immediately after applying the tack coat, the premix shall be spread with rakes to the required thickness distributed evenly by means of a drag spreader. The camber shall be checked by means of camber board and the unevenness shall be rectified.

7.2.5 Rolling

When the premix has been laid for a length of 15-20 metres, rolling shall be commenced with tandem rollers(8 to 10 tonnes). Rolling should commence from edges and proceed towards centre longitudinally.

The wheels of roller shall be continuously moistened to prevent the premix adhering to the wheels and being picked up.

After the preliminary rolling and honey combing, high spot or depressions shall be rectified by adding or removing the premix as per requirements and the surface shall be rolled again to compaction. Camber shall be checked at every stage and any defects found shall be rectified. Excessive rolling shall be avoided.

7.2.6 Seal Coat

7.2.6.1 (For low rainfall areas – under 150 cm/yr)

A premix seal coat, mix preferably in a mechanical mixer after heating the sand should be applied immediately after laying the carpet and rolled. The materials required for this seal coat are as per clause 7.1

7.2.6.2 (For high rainfall areas – over 150 cm/yr)

The materials requirement for seal coat in high rainfall areas is as under : -

Binder 80/100	98 Kg/100 m ² of road surface
Coarse aggregates 6.3 mm passing IS 10 mm	0.9 m ³ /100m ² of road surface square mesh retained on IS sieve 2.36 mm

A liquid seal coat, preferably with chippings as above(through coarse sand can also be used) should be applied after laying the carpet. The binder heated to permitted temperature should be applied to the cleaned surface, blinded with chippings and rolled.

Traffic may be allowed on the road preferably 24 hours after providing the seal coat.

103 Removal of Surplus Earth

Surplus earth and soil from excavation shall be removed from Refinery boundary to the area demarcated by the Contractor with approval of the Engineer-in-Charge.

104 Construction of Shoulders or Berms

After the WBM course is laid and compacted, the existing surface at side berms or shoulders of the roadway must be scarified. Fresh quantity of approved earth must be spread in layers for building up of berms upto the required level and scope.

The earth must be consolidated by at least three passes of an 8-10 tonne road roller. The edges must be well consolidated by suitable means to prevent edge slips and the work properly trimmed and dressed.

105 Job Specification for Brick Pitching

105.1 Excavation

Trench shall be excavated/dressed true to line, section and grade as per drawings prior to start the pitching work.

105.2 Material

Brick shall be locally available best brick. Cement, sand and water shall be as per IS:269, IS:2116.

The concrete mix used for bedding shall be as per drawings and schedule of rates.

The work of pitching shall be done after the bottom concrete has been laid and sides properly trimmed to the required grade and thoroughly compacted.

Brick pitching shall be done in 1:4 cement mortar using best quality locally available bricks.

Bricks shall be laid in herring bone pattern with their length at 450 to the length of the ditch as shown in drawings.

Mortar joints shall never exceed 6 mm in thickness and all bricks shall be laid with vertical joints quite full of mortar.

Bricks shall be soaked for a period of at least 12 hours immediately before use and no broken and damaged bricks shall be used in any part of the work except such as will be required to close any line of bricks.

The face of pitching shall be made even and smooth.

The brick work shall be raked and flush pointed with cement mortar 1:3 specified.

106 Quality Assurance Plan

The CONTRACTOR shall submit the detailed quality assurance plan for road work to the Engineer-in-charge for approval. The approved plan shall be strictly followed by the CONTRACTOR.

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107 General

107.1 Scope

This specification used in conjunction with the contract document, bill of quantities and drawings establishes the minimum requirement for Drainage and Sewerage lines.

Any special requirement as shown or noted in the drawing shall be given preference over the provision of this specification.

The construction of underground sewers shall be done in accordance with the levels and locations shown in the approved construction drawings.

Manholes shall be provided on sewers as shown in the drawings. The details of manholes shall also be as per the approved construction drawings

At road crossings where the clear cover from top of sewer pipe to road top elevation is less than 1200 mm, the pipes shall be encased in M15 concrete as per the approved detail drawing.

108 Regulations, Codes and Standards

The drainage and sewerage work shall be in compliance with all applicable federal, state local laws and regulations. The following Indian Standard Codes unless otherwise specified herein shall be applicable.

IS:1172	-	Code of basic requirements for water supply, drainage and sanitation
IS:1230	-	Cast iron rain water pipes and fittings
IS:1742	-	Code of practice for building drainage
IS:458	-	Specification for pre-cast concrete pipes
IS:4127	-	Code of practice for laying of glazed stone ware pipes
IS:651	-	Specification for salt glazed stone ware pipe and fittings
IS:3006	-	Specification for chemically resistant glazed stone ware pipes and fittings.
IS:783	-	Code of practice for laying of concrete pipes.
IS:1726	-	Specifications for cast iron man hole covers and frames.
IS:782	-	Specifications for caulking lead
IS:1200	-	Mode of Measurements.

109 Hume Pipe

109.1 Material

Concrete pipes shall be non-pressure type and shall be of class NP2 conforming to IS:458. Minimum dia of the pipe shall be 150 mm. All the pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipe shall be smooth.

109.2 Laying of RCC Hume pipe

The pipes shall be laid on concrete bed or cradle and shall be lowered gradually in the trenches without causing any damage either to the trench, bed concrete or cradle. Extra earth at joints shall be scooped out to accommodate the collar. The pipes shall be laid to required levels and alignments throughout the length. The laying of concrete pipes shall conform to clause 9 of IS:783.

109.3 Joining of RCC Hume pipe

The joints shall be made by using standard collars which shall have surface inside to have proper grip. The joints shall be packed from either side with spun yarn dipped in cement slurry thoroughly rammed with caulking tools. Stiff cement mortar (1:1) shall be filled from both sides and splayed at all angles of 45 degree on both sides. The joints shall be adequately cured and interior of the pipes shall be cleaned off immediately.

109.4 Testing

The drains shall be tested under a head of at least 2.0 M of water above the crown of the pipe. A strong approved colour shall be added to the water for testing and defective pipes shall be replaced. The defective joints shall be made good by cutting and redoing. The joints where leakage persists, shall be encased in PCC 1:2:4 without any additional cost, wherever permitted. The test for leakage shall be conducted at least for an hour after application of water head.

110 Stone Ware Pipes

110.1 Material

Salt glazed stone ware pipe and fittings shall conform to IS:651 and IS:3006 respectively. The pipes shall be of best quality stone ware, salt glazed, thoroughly burnt through out the whole length and thickness, free from holes, fire blisters, cracks and other blemishes according to drawings and shall conform to this specification and IS:6248.

110.2 Laying of Stone Ware Pipes

The laying of stone ware pipelines shall commence only bottom of the trench has been leveled. The pipes shall be carefully laid to the alignment, levels and gradients as shown on the drawings. The laying shall generally conform to IS:1742. These pipes shall be laid with socket facing up the gradient beginning at the lower end up and all sockets laid to levels in the holes or scoops out for the purpose. The pipes shall be haunched with concrete tangentially up to the crown of the diameter of pipes as shown on the drawings. When the pipe crosses under the road, it shall be fully encased in concrete as directed by the Engineer-in-charge.

110.3 Jointing of stone ware pipe

The type of jointing for stone ware pipes shall be socket and spigot type and shall be done as stated under clause 5.6 of IS:1742. This shall be taken up only after final alignment is made and gradient, invert levels etc. are checked by the Engineer-in-charge.

The inside of the socket shall be first painted with a thin layer of cement mortar (1:2) and a gasket of yarn dipped in cement slurry shall be inserted in the socket of the pipe with a wooden caulking tool and wooden mallet in such a way that the gasket shall fully encircle the spigot with a slight overlap. When the spigot end receives the gasket, it shall be wrapped round with two or three turns of treated spun yarn at its end before being inserted into the socket. The rest of the joint shall then be completely filled with cement. Sand mortar (1:1) having very little water and the joint shall be leveled to form a smooth splayed fillet at an angle of 45 degrees. All excess cement mortar left inside the pipe joint shall be neatly cleaned off and the joint shall be adequately cured by covering with wet gunny bags and pouring water after frequent intervals.

110.4 Testing of stone ware pipe

All pipes shall be carefully examined with a light hammer for soundness before laying. After each section of pipe line has been laid and joined the joint shall be allowed to set properly and shall be inspected and tested.

Stone ware pipes used for sewers shall be subjected to a test pressure of 1.5M head of water at the highest point of the section under test. A buckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Where leakage is observed, it shall be made good by the CONTRACTOR.

111 Cast Iron Pipe

111.1 Material

Cast iron pipes with spigot and socket ends shall conform to IS:1230 & IS:1729.

111.2 Laying of cast iron pipes

The laying of cast iron pipe lines shall commence only after the bottom of the trench has been leveled in accordance the drawings. The sides of the trenches shall be as vertical as possible and width of the bottom shall be 300 mm wider than the diameter of the pipe. Where joints are made, the trench shall be widened suitably to provide room for caulking joints. For pipes buried in the ground , the CONTRACTOR shall always maintain minimum cushion of earth over the pipes as indicated in the drawings. All pipes and fittings shall be sounded with a light hammer and checked properly to detect any crack or blow holes before laying. The excavated material shall be stacked on one side of the trench and the pipes on the other side. The inside of the socket and the outside of the spigot shall be thoroughly cleaned of all foreign matters before laying. The pipes shall be laid with their socket ends facing the direction of flow. After each section of pipe line has been laid, it shall be tested for water tightness before backfilling of the trench. On successful completion of testing, the trench shall be backfilled with the excavated earth in layers of 200 mm and shall be watered and rammed thoroughly.

Cast iron rain water pipes encased fixed exposed to the external walls shall conform to IS:1230 and shall be fixed at least 20 mm from the plastered surface by means of cast iron clamps. The rain water pipes at the roof level shall be fitted with a cast iron bend with masonry bell mouth of suitable size fitted with cast iron grating. The bottom of the down pipe shall be fixed with a shoe fixed 150 mm above ground/apron level of the building

111.3 Joining of cast iron pipe

The type of jointing for C.I. pipes shall be socket and spigot filled either with molten lead or lead wool and gasket conforming to IS:782

If the joints used are spigot and socket type, the spigot shall be carefully centered in the socket by one or more laps of clean white hamp spurn yarn with about 25 mm over lap. Sufficient yarn shall be forced into the socket to leave a correct depth of lead for caulking. The pipe shall then be examined again for line and level and proper depth of each joint shall be tested before running the molten lead. The lead should be run at a single pouring. For pouring of molten lead a ring of hamp rope shall be wrapped round the pipe at the end of socket and the joint shall be covered with stiff damp clay. The rope then shall then be removed carefully leaving a V shaped large hole at the top of the joint to pour the Morton lead. After a section of convenient length of pipe has been laid, the lead shall be caulked sufficiently with caulking tools and hand hammered till the excess lead is removed and the joint shall be made neat and clean.

Cement jointing of pipes shall conform to IS:1230. The spigot shall be carefully inserted and center in the socket by one or more laps of thin clean hamp spun yarn and shall be forced into the socket to leave a correct depth of 30 mm around cement mortar. The pipe shall then be examined for line and level and the proper depth of each joint shall be tested before inserting the cement mortar. The joints shall then be carefully filled with stiff cement and sand mortar 1:1 and then joints shall be leveled to the edge of the socket. Each joint shall be adequately cured by covering with wet cloth and pouring water at frequent intervals.

111.4 Testing of cast iron pipes

On completion of laying and jointing, the cast iron pipes shall be tested by the CONTRACTOR to detect leakage and any other defects in the pipe line by means of smoke test.

Smoke test shall be conducted using proper apparatus with attachments for smoke making machine for applying smoke to the pipelines under pressure. Only cotton waste or brown paper soaked in creosol oil shall be used and fire to obtain dense smoke. While conducting smoke test, top of soil waste and ventilation pipes shall be kept open till smoke starts coming out of the openings. The openings shall be securely plugged with expanding rubber or any other approved plug. The floor traps and other openings for connecting sanitary fixtures shall be sealed with water or approved plug the entire pipe line shall be tested in suitable sections as directed by Engineer-in-charge. The entire length of pipe lines including all joints

under test shall be closely observed for any sign of smoke leakage . All leakage and defects shall be rectified by the CONTRACTOR to the satisfaction of the Engineer-in-charge.

112 Pre Fabrication

In case of M.S. or HDPE pipe sewers the piping work shall be prefabricated in suitable sections to minimise the jointing work in the trenches. Where possible prefabricated section may cover the entire length between two successive manholes. It is contractor's responsibility to work exact dimensions of the header including the branch connections for prefabrication. The prefabricated sections in case of M.S. pipes shall be coated and wrapped before laying.

112.1 HDPE Piping

HDPE pipes shall be jointed as per the manufacturer's recommendations by the skilled fitters with past experience in doing similar type of jobs. In general the HDPE pipes shall be butt jointed by heating the pipes upto 200 degree electrically by using a special hot plate covered with Teflon on both sides. The pipe ends shall be butted accurately on hydraulic jack platform with the hot plate inserted in between and shall be heated till a uniform rim of melted metal is formed. Immediately the hydraulic jack shall be released, the hot plate removed and pipe ends shall be butted together to form a good joint between the pipes.

113 Earthwork in Excavation for Pipe Trenches

Trenching work shall be carried out in all classes of soil including soft rock and excluding hard rock.

The trench shall be cut true to the line and level as per approved drawings. It shall follow the gradient of the piping to be laid. If the trench is excavated below the required level as indicated in the drawing, the extra depth shall be filled with concrete or approved equivalent materials as directed by the Engineer-in-Charge at no extra cost to the owner.

The width of the trench shall be sufficient to give free working space on each side of the pipe. The free working space shall conform to IS:783. Generally it shall not be less than 150 mm on either side or 1/3 dia of the pipe whichever is greater.

All earthwork involved in excavations of all types of manholes, catch pits, valve chamber which form a part of the U/G piping work shall be deemed to have been covered in the rate for pipe laying.

Excavated material shall not be deposited within 1.5 M from the top edge of the excavation or within a distance equal to the depth of excavation whichever is higher.

Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed.

All types of shoring and strutting wherever necessary shall be adopted to with-hold the face of the earth or cutting in slope as per site requirements and as directed by the Engineer-in-Charge.

Dewatering, if required, shall be done in advance of the installation of the pipe to allow adequate inspection of padding of the bottom if required and shall be continued throughout during installation and backfilling.

The contractor shall keep the trench in good condition until the pipe is laid and tested and no extra claim shall be entertained due to its caving or setting down either before or after the pipe is laid.

In muddy or slushy ground, the bed shall be provided with a layer of sand or 1:5:10 concrete as directed by the Engineer-in-Charge.

Necessary barricading and protection of slopes against slips due to traffic shall be provided to the satisfaction of Engineer-in-Charge. Also necessary warning flags and lights shall be provided to caution traffic.

In case of road cutting, all material, i.e., metal, soling, stones, etc. shall be taken out carefully and kept separately for reuse and road work shall be redone upto the original level prior to cutting the road with the excavated road materials after laying and testing of the pipeline within 10 days from the date of starting this work at the cost of the contractor. The contractor shall provide suitable warning signs and barricades to prevent accidents. He shall also provide reasonable bye pass at his own cost when a road is cut for laying pipeline. Tankage dykes cut due to laying of the pipes, shall be redone conforming to the original specifications by the Contractor.

114 Bedding

In case of HDPE pipe and places where a sound compact bottom surface is not possible to prepare due to soil conditions, a minimum 100 mm thick bedding using 1:5:10 plain cement concrete with 100 mm and down size stone aggregate shall be provided. The bedding shall be properly compacted before laying the pipes.

115 Man Holes and Chambers

The Manholes and chambers shall be constructed at locations as detailed on drawings. Additional man holes and/or junction chambers shall be constructed wherever required.

Construction of man holes shall be as described below unless stated other wise :

Floor shall be in P.C.C.

Side walls shall be in brick or concrete.

Relieving arches in the brick work shall be around pipes.

All C.I. rungs, ladders etc as required shall be provided.

The man hole covers shall conform to the relevant Indian Standards and shall be embedded either in P.C.C. coping or cement mortar.

Inside and out side surface of the man hole shall be plastered.

116 Inspection Pits and Trap Pits

Construction of pits shall commence only after the pipes have been laid in position to true line and levels as shown on the drawings.

116.1 Inspection Pits

Inspection pits shall be constructed as indicated in the drawings. Unless other wise specified, all inspection pits shall be constructed with brick masonry in cement mortar (1:4). Half round channels of size suitable for inlet and outlet pipe diameters shall be formed on the floor pit with P.C.C. M 10. The floor of the pit shall be haunched towards the channel. Inside of the pit shall be finished with cement sand plaster (1:4) and finished smooth with neat cement slurry.

116.2 Trap Pits

The pits for the glazed stone ware master trap shall be constructed as indicated in the drawings. The construction and finishing of the pit shall be as described for inspection pit. The floor of the pit shall be haunched towards the intercepting / master trap.

116.3 Gully Trap Pit

Gully trap pits shall be constructed as indicated in the drawings. The construction and the finishing of the pit shall be as described for inspection pit. The cast iron grating shall be set flush with the finished ground / approved level.

117 Storm Water Surface Drain

The surface drains shall be either dry rubble stone pitched sections pointed in CM 1:4 or constructed in brick work as sides and concrete bed.

The stone pitching shall be in approved rubble, the thickness being minimum 230 mm unless otherwise stated. The edges of the drains at the top portion shall be pitched horizontally (with slight slopes towards drains) to minimum distance of 300 mm to prevent erosion of backing. The slopes of the beds and sections shall be shown in the drawings.

Whenever there is an abrupt drop in the bed elevation or the drains a rubble masonry wall shall be constructed at such a drop, across the sections of the drains.

Whenever the brick work is used for drains, the brick work shall conform to the requirements of the specification of brick work. The interior of the drains & the top sides of masonry shall be plastered in CM 1:4.

118 P.V.C. Pipe

118.1 Material

PVC pipes, fittings etc shall conform to relevant Indian Standards.

118.2 Laying of PVC pipes

Laying of PVC pipes shall conform to IS:3114.

The pipes, shall be embedded in concrete whenever necessary.

Jointing of PVC Pipes

The pipes shall be jointed by methods as specified by the manufacturer.

119 Civil and Other Miscellaneous Works

119.1 Civil Work

All civil work including plain and reinforced concrete, brick masonry plastering etc. for construction of manholes, clean outs and other pits shall be done as per relevant Indian Standards and in accordance with approved construction drawings. All materials used for construction shall also conform to Indian Standards.

119.2 C.I. Manhole Frame and Cover

C.I. manhole frame and cover shall conform to IS:1726 unless otherwise specified in the approved drawing heavy duty frame and cover shall be used in paved areas and medium duty in unpaved areas.

119.3 Vent pipes of Oily Sewer System

Vent pipes for oily sewer systems shall be of M.S. Black Steel Tubes conforming to IS:1239.

119.4 C.I. Steps

C.I. steps where used shall conform to IS:5455.

119.5 Chequered Plates

Chequered plates shall be 6 mm thick (7 mm with chequeres) and shall conform to IS:3502.

119.6 Gratings

Cast Iron gratings shall be of sound, casting free from air, sand, shrinkage, gas inclusions and any other holes with carefully dressed sides and approved by Engineer-in-Charge.

M.S. gratings shall be fabricated as per approved drawings from M.S. flat angles, rounds etc.

119.7 Anticorrosive Treatment

All exposed cast iron and steel surfaces shall be painted two coats of approved bituminous paint..

119.8 Haunching for HDPE Piping

After laying of the HDPE pipe in position in trenches over the concrete bedding 1:5:10 PCC with 20 mm and down size stone aggregate shall be filled in pipe haunches. The concrete shall be compacted properly and carefully without damaging the pipe. Before backfilling the bedding and haunching concrete shall be properly cured and approved by the Engineer-in-Charge.

119.9 Hydraulic Sealing of Manholes

In case of oily sewers, wherever required, the hydraulic sealing shall be provided on the manholes to check the free travel of oil vapors. It shall be done either providing a baffle valve between the inlet and outlet pipes or by dipping the pipe below water level in the manhole. In both the case a minimum of 150 mm hydraulic seal shall be ensured.

120 Backfilling

The soil used shall be selected and approved by Engineer-in-Charge. Suitable material can be extracted from available excavated material. The soil shall be free from rubbish, grass organic matter, stones, building waste etc. It shall be free from clods and hard lumps.

The filling shall commence only after the approval of Engineer-in-Charge is obtained and after the structures or pipes getting buried are tested and approved. Otherwise, if required contractor shall uncover the buried portion and refill it at his own cost.

Filling shall be done in layers. Each layer shall be not more than 20 cm thick when loose and shall be well rammed. With necessary watering, to obtain at least 90% of maximum laboratory dry density.

Care shall be taken to protect cables, pipes and other features from damage due to backfilling and consolidation.

Filling shall extend upto the level of original ground surface or as per drawing or as directed by Engineer-in-Charge. The finished surface shall be properly trimmed and dressed. The adjoining area shall be cleaned and no heaps of surplus earth shall be left out.

Restoration of Damaged Surfaces and Clearing the Site

All pavements, structures, pipelines, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original conditions.

All surplus earth and rubbish generated due to pipe laying, valve chamber and manhole construction etc. shall be transported to an area demarcated by the CONTRACTOR.

Quality Assurance Plan

The CONTRACTOR shall submit the detailed quality assurance plan for drainage and sewerage work for the approval of the Engineer-in-charge. The CONTRACTOR shall strictly follow the approved plan.

**Standard Specification
for
Sanitary, Plumbing and Water Supply Works
(A-12)**

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121 General

121.1 Scope

This specification used in conjunction with the contract document, bill of quantities and drawings establishes the minimum requirement for sanitary and plumbing work. Reference to other materials standards for compliance shall be interpreted as an integral part of the specification.

Respective specifications shall apply for items like excavation, concrete, brickwork, stonework, painting, etc. unless specified otherwise.

Unless otherwise, all exposed work such as cistern brackets, piping etc. shall be painted with one coat of approved red oxide Zinc Chromate primer and two coats of flat oil paint.

The prices quoted by the CONTRACTOR shall be deemed to include all breakage and wastage of various materials, fittings and appliances. All such materials damaged during the execution of the work or otherwise till handing over shall be removed by the CONTRACTOR at his own expense.

The price shall also include the cost of making necessary holes, chases etc. in walls, floors and also making them good on completion of the work. Any damage caused to the floors, walls etc. during fixing of sanitary installations and plumbing work shall be made good by the CONTRACTOR at his own cost to the satisfaction of the Engineer-in-charge.

The CONTRACTOR shall furnish materials, labour, plant, equipment and tools to complete the work as specified herein and/or as shown in the drawings.

An special requirement as shown or noted in the drawings shall be given preference over the provision of this specification.

122 Regulations, Codes and Standards

The sanitary and plumbing work shall be in compliance with all applicable federal, state local laws and regulations.

All sanitary and plumbing work shall be executed by a licensed plumber under the supervision of a licensed supervisor and shall be in accordance with local municipal laws / bylaws.

The following Indian Standard Codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

- | | | |
|---------|---|--|
| IS:4984 | - | Specification for high density polyethylene pipes for potable water supplies, sewage and industrial effluents. |
| IS:2556 | - | Specification for vitreous sanitary appliances |
| IS:782 | - | Specification for caulking lead |
| IS:1239 | - | Mild steel tubes, tubular and other wrought steel fittings. |
| IS:2548 | - | Specification for plastic seats and covers for water closets. |

123 Materials

The materials, fittings, appliances used in work shall be as specified here-in-under or as approved by the Engineer-in-Charge. The CONTRACTOR shall submit the samples of materials, fittings and appliances for approval of the Engineer-in-Charge, well in advance of starting of the work. All materials, fittings and appliances used in the work shall conform to the approved samples.

123.1 Galvanized pipes and fittings

Galvanized steel pipes, fittings and accessories for water services shall be of tested quality and shall conform to IS:1239.

123.2 Bottle Trap

Bottle trap shall be of approved quality, heavy brass chromium plated trap and made particularly smooth on the inside and shall have minimum 50 mm water seal and cleaning screw at the bottom.

123.3 High density polyethylene pipes and fittings

High density polyethylene pipes and fittings shall be of tested quality and shall conform to IS:4894.

123.4 Sanitary appliances

All sanitary appliances shall be of approved type and shall conform to IS:2556.

124 Workmanship

124.1 Water Supply

124.1.1 Jointing and laying of galvanised steel water supply pipes

The depth at which the underground water supply pipe is to be laid shall be as shown on the drawings. The service pipe passing into or beneath the building shall be laid at least 200 mm below the ground floor level and accommodated in a previously laid sleeve in the structure where it enters the building shall be filled with a bituminous materials for a minimum length of 150 mm at both ends. Piping shall not be buried in walls or floors as far as possible. However, when unavoidable, piping shall be buried for the shortest distance necessary and adequate protection shall be provided against damage.

Galvanized steel piping shall be secured by iron or steel clamps and hooks when fixed on walls. All pipe work shall be completely watertight and the joints shall be such that there are no projection of jointing materials or the like in the interior of pipes. Before the pipeline is commissioned, all piping and fittings shall be flushed clean.

124.1.2 Jointing of G.I. Pipes

Galvanized steel pipes conforming to IS:1239 shall be jointed with screwed socket joints and screwed fittings of same materials as that of the pipes. Any burrs remaining on pipe ends after the threads are cut shall be removed. An approved jointing compound together with be removed. An approved jointing compound together with a grommet of few strands of fine yarn shall be used for jointing pipes and fittings. Any pipe threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved bituminous compound to prevent corrosion.

124.1.3 Testing

After the laying and fixing of all galvanized steel water supply pipes and fittings are completed, the line shall be slowly and carefully charged with water to a test pressure of 5 kg per sq. cm or the specified working pressure plus 50 % as may be prescribed. Care shall be taken that air in pipelines is completely eliminated while filling the pipelines with water. The pressure shall be maintained for at least one hour unless otherwise directed. The pipes and fittings shall then be inspected for any leakage of water. Defects in pipes and fittings , if detected, shall be rectified by the CONTRACTOR at his own cost.

124.2 High density polyethylene water pipes

All high density polyethylene pipes shall have screwed ends and shall be jointed with screwed fittings of same materials as that of pipes. Any burrs remaining on the pipe ends after cutting threads shall be removed. If necessary, an approved jointing compound with a few strands of fine yarn may be used for jointing pipes and fittings. All exposed high density polyethylene pipes thick wooden blocks securely fixed on walls at suitable intervals not exceeding 1 M pipes. Wherever installed in wall chasing shall be fixed as in the case of galvanised steel pipes.

124.3 Installation of Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floors and walls as indicated in the drawings.

124.3.1 European Water Closet

European type water closet shall be rigidly fixed on the finished floor by means of 75 mm long brass screws with suitable plugs. It shall consist of :

Approved wash down closet in white glazed or earthen ware with integral "P" or "S" trap.

Rubber joints for inlet connection.

Black or any other colour of solid plastic seat and cover with chromium plated hinges and rubber buffers.

Low level mosquito proof flushing cistern of 15 liters capacity fordham or equivalent make porcelain enameled with all fittings and accessories with 32 mm flush chromium plated flush bend.

Porcelain enameled supporting brackets for cistern.

12 mm lead connection and 12 mm C.P. brass stop cock easy clean type.

Standard toilet paper roll holder of approved type shall be provided, and this shall be surface mounted type fixed with C.P. counter sunk brass screws.

All the necessary work required for satisfactory working.

124.3.2 Indian Water Closet (Orissa Pan or approved equivalent)

Water closet shall be fitted on tap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be leveled properly and set flush with the finished floor. It shall consist of :

- a) Best Indian make water closet pan of 685 mm (i.e. 27") size with "P" or "S" trap in white glazed earthenware.
- b) Flushing cistern of 15 liters capacity of approved make with 12 mm copper ball valve, 12 mm inlet connection 12 mm chromium plated brass stop cock easy clean type C.I. supporting brackets, all assemblies painted in three coats of approved enamel paint.
- c) 32 mm lead lush pipe of appropriate length with necessary brass unions and wiped soldered joints bend to proper shape and fixed in position in chases and the chases shall then be finished smooth to match.
- d) The brick bat lime or cement concrete required to be filled around the entire space of the W.C. pan properly rammed and consolidated without damaging the pan.
- e) C.I. soil waste pipe bend with cleaning cap extending up to Gulley Trap Chamber beyond the "P" trap.
- f) The work shall include all the primary works such as cutting and other member, excavating pits in C.F. for fixing closet pan etc.
- g) All other work necessary for satisfactory working of the closet.

124.3.3 Wash Basins

This shall be the best available type of wash basin of approved manufacturer and shall consist of following approved accessories :

- a) Wash basins of size as specified in the materials schedule and shall be in vitreous chinaware with or without antisplash rim with tap holes overflow slit etc.
- b) Supporting cast iron brackets.
- c) 12 mm chromium plated pillar type of tap with appropriate marks for cold or hot water.
- d) 32 mm chromium plated brass waste coupling with rubber plug and chain.
- e) 32 mm chromium plated brass bottle trap with extension pieces and chromium plated all flanges.
- f) 12 mm lead connection with wiped joints and 12 mm C.B. brass stop cock.

- g) All the accessories wherever necessary shall be painted in 3 coats of approved enamel paint.
- h) The wash basin shall have glazed chinaware pedestal whenever so specified in the material schedule.
- i) All the necessary work that will be necessary for its satisfactory working.

124.3.4 Urinals

Standing type urinals shall be firmly fitted on walls by means of 50 mm long brass screws and suitable plugs. Height of lip from the standing point shall be as shown on the drawings or as directed.

The arrangements of waste pipes and discharge to the floor trap shall be as shown on the drawings or as directed. For single urinal the discharge may be direct to the floor trap through a 40 mm dia waste pipe. For a range of urinals, the discharge may be collected in a common waste pipe of 50 mm dia leading to the floor trap. Each urinal shall be connected to the common discharge pipe by 40 mm dia waste pipes. Alternatively, the discharge from each urinal through 40 mm dia pipe shall be led to a half round channel bed on the floor leading to the floor trap.

The urinals shall consist of the following :

- a) Vitreous chinaware long flat back or as specified in the Bill of Quantities.
- b) 32 mm chromium plated brass waste coupling
- c) Suitable supporting arrangement
- d) All other necessary work for satisfactory working.

124.3.5 Automatic Flushing Cistern

- a) These shall be either glazed chinaware or M.S. Porcelain enameled type cistern of various capacities such as 5, 10 or 15 liters with all accessories such as metal siphon, lid, inlet and outlet connections, fixing arrangement etc. The supporting brackets shall be either cast iron or as specified by the manufacturer.
- b) This shall have a 12 mm lead connection with brass unions and wiped joints and a 12 mm brass chromium plated stop cock.
- c) The cistern shall have 12 mm chromium plated brass spreader pipe arrangement with necessary accessories such as tees, unions, couplings, bends & spreaders. The pipe provided shall be from cistern to the urinals.
- d) This shall also consist of 12 mm G.I. overflow pipe from cistern up to 150 mm above floor level with perforated brass cap.
- e) All other work necessary for the satisfactory working.

124.3.6 Other miscellaneous fittings (i.e. mirror, towel rails, marble partitions soap cases etc.)

All such fittings shall be of types and sizes as approved by the Engineer-in-Charge and shall be fitted in position true to line, level and plane as shown on the drawings or as directed.

124.3.7 Sink

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

124.3.8 Bib and Stop Cocks

Bib and stop cocks of screw-down type shall conform to IS:781. All taps shall be of heavy grade. The taps shall be chromium plated brass or ordinary brass easy cleaning type as specified.

124.3.9 H.C.I. Nahni Trap (Floor trap)

Nahni trap shall be of heavy cast iron as per IS:3989 with 100 mm inlet and 80/100 mm outlet with CP proposed steel grating. It shall be of self cleaning design (Grating shall be of either hinged or screwed down type). It shall be fixed in cement mortar 1:2 and as directed by Engineer-in-Charge.

124.3.10 Stoneware Gully Trap Chamber

The square mouth gully trap shall be of 100 mm dia conforming to IS: 651 as specified and/or approved quality stoneware, complete with cast iron grating and shall be got approved by the Engineer-in-Charge. The size of CI frame and cover shall be 300 mm X 300 mm. It shall be properly fixed as directed by the Engineer-in-Charge.

The size of the chamber shall be 300X300X675 mm (internal). It shall be constructed of brick masonry walls 115 mm thick in 1:4 cement mortar and M-15 concrete foundations. Inside and outside faces of the masonry walls shall be plastered with 1:3 cement mortar. The top of the chamber shall be provided with CI cover and frame.

124.3.11 Manholes/Inspection Chamber and Valve Chamber

The size of the manholes and valve chambers shall be as specified in the drawings. It shall be constructed of brick masonry walls of 230 mm thick in 1:4 cement mortar (1 cement : 4 sand) resting on M15 concrete foundations. The inside and outside face of the masonry wall shall be plastered with 13 mm thick plaster of 1:3 cement mortar (1 cement : 3 sand).

The top of the chamber shall be provided with reinforced concrete M20 grade slab as per drawing and directions of Engineer-in-Charge.

M.S. rungs made out of 16 mm dia M.S. bars shall be fixed inside the manhole as shown in the drawing after applying two coats of anticorrosive paint.

Valve chambers shall be provided and fixed with a light duty CI cover and frame.

The top of chamber shall be provided with reinforced cement concrete M15 grade as per drawings and direction of Engineer-in-Charge.

The C.I. manhole covers and frames shall conform to IS:726. The type, size and grade shall be as per drawings and directions of Engineer-in-Charge.

The frame shall be fixed in position during concreting of top slab, inside faces of frame and cover shall be given two coats of approved anticorrosive paint.

The specification for brick masonry, plastering, concreting, excavation and back-filling, etc. as given under relevant clauses shall be applicable for this work also.

124.3.12 C.I. Soil/Waste Pipes

Cast iron pipe, socket and spigot shall be of standard quality conforming to IS:3486(heavy duty).

The spigot of the pipe shall be placed fully resting inside the socket and hemp caulked home to leave space for lead depth as specified. Lead conforming to IS:782 in molten state shall then be poured into the joint filling the same in one pouring. The lead shall be caulked by proper tools to make it even all round. Depth of lead in the joints from the top of the socket shall be 37 mm for 150 mm dia pipes, 25 mm for 100 mm and 80 mm dia pipes. All pipes shall be fixed 25 mm clear of the wall with MS clamps or as approved by the Engineer-in-Charge. All holes in walls and floors shall be made good by cement concrete M15 grade and should be leak proof. All soil and waste pipes shall be tested for leakage by hydraulic test. The pipes shall be concealed in wall wherever required as shown in scope drawings.

All pipes shall be painted with two coats of paint of approved make and shade over a coat of primer.

124.3.13 C.I./Soil/Vent Pipes

CI pipes shall be of standard quality conforming to IS:1729. The supply shall include all necessary accessories, e.g., bends, tees, etc. complete.

Jute yarn gasket of suitable diameter shall be used as required to support the spigot of the pipe at the proper grade and make truly concentric joints. Single piece of sufficient length shall be used to pass around the pipe and lap at the top and shall be thoroughly saturated in bitumen. This gasket shall be laid in the socket for lower third of the circumference of the joint and covered with cement mortar. The spigot of the

pipe thoroughly cleaned with wet brush, inserted and carefully driven home, after which a small amount of cement mortar(1:2) shall be inserted in the annular space around the entire circumference of pipe and solidly rammed into the joint with caulking tool. The joint shall then be completely filled with mortar and beveled of at an angle of 45° with outside of the pipe. Cement used for joint shall conform to IS:269.

All holes in walls and floors shall be made good by cement concrete of M-15 grade.

All CI pipes shall be painted with two coats of anticorrosive bituminous paint externally.

124.3.14 Pipes and Fittings

All GI pipes and fittings shall conform to IS:1239 and shall be of medium grade for water supply system.

All screwed tubes and sockets shall have pipe threads in accordance with the requirements specified in IS:554. Unless specified otherwise, pipes shall be supplied screwed with taper threads and sockets with parallel thread.

All fittings shall be malleable galvanised iron approved by the Engineer-in-Charge. Fittings in GI line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts & bolts and rubber insertions, bushes and all other fittings to make a complete job.

Screwed GI pipes shall be jointed with screwed socket joints using screwed fittings. Care shall be taken to take any burr from the end of the pipes after threading. White lead with a few strands of fine hemp shall be applied while tightening. Compounds containing red lead shall not be used.

All pipes above ground shall be fixed with GI holders but clamps clear off the wall at 1.2 m centres. If the pipes are fixed with chases or embedded in wall, they shall be secured in position by iron hooks at 1.2 m centres. All visible pipes and clamps within and outside building shall be painted with two coats of white paint or aluminium paint as directed by the Engineer-in-Charge.

All underground pipes shall have a minimum earth cover of 600 mm or as directed by the Engineer-in-Charge. Before any pipes are painted or covered up they shall be tested to a hydro-static pressure of 6 kg/sqcm.

124.3.15 Gun Metal Valve

All full way and globe valves shall be heavy gunmetal and tested at 300 psi and shall be approved by the Engineer-in-Charge. Valves shall conform to IS:778. Size of valve chamber shall be as per item description. Construction of valve chamber shall be carried out as detailed in clause 13 above. Valve chamber shall be provided and fixed with heavy duty CI surface box conforming to IS:3950. The surface box shall be hinged pin open type and shall be fixed in the chamber slab. It shall have a hole for opening.

124.3.16 Half Round Channel

Half round channel shall be plain or with stop end and shall have internal dia of 100 mm approved by the Engineer-in-Charge. The jointing work shall be done with white cement slurry. The drains shall be provided with proper slopes as indicated in drawings or as specified by the Engineer-in-Charge. Channel shall be covered with matching tiles leaving provisions for cleaning the same.

124.3.17 Marble Partitions

The marble partition shall be 25 mm thick and approved by the Engineer-in-Charge.

The edges of marble shall be fixed in position with cement mortar(1:3) as directed by Engineer-in-Charge for minimum depth of 100 mm in the wall. It shall be polished after fixing. Two horizontal faces shall be supported by MS channels of size 35 mm deep embedded into wall.

124.3.18 Showers

The shower head shall be chromium plated brass, 100/150 mm dia with holes of one millimeter diameter each, is sufficiently large for all ordinary requirements. It shall be fixed at a height of 2.0 m from floor level or as directed by Engineer-in-Charge. It shall conform to IS:2064.

124.3.19 Toilet Paper Holder

Toilet paper holders shall be of chromium plated brass as approved by the Engineer-in-Charge. It shall be 100 mm long. It shall be fixed on wooden cleats as directed by Engineer-in-Charge.

124.3.20 Coat and Hat Hooks

Coat and hat hooks shall be chromium plated brass or equivalent as approved by Engineer-in-Charge. They shall be fixed on teak wood plate of 75 mmX 75 mm and 12 mm thick. Teak wood plate shall be properly polished. Wooden cleats shall be inserted in wall to fix wooden plates. CP brass screws shall be used.

124.3.21 R.C.C. Pipe

4.3.21.1 Materials

For pipe materials, the following specifications shall apply

RCC Pipes & Collars IS : 458

Laying of Pipes IS : 783

For cement, sand, mortar, water etc., the specifications laid down for concrete works shall apply.

All pipes must be new and perfectly sound, free from cracks, cylindrical, straight and of standard nominal diameter and length with even texture. Each pipe shall have one collar with it.

The contractor shall submit manufacturer's test certificate whenever demanded by Engineer-in-Charge or his authorised representative. Spun yarn for pipe joints shall be of best quality. It shall be from dust etc.

4.3.21.2 Transportation and Stacking

The transportation of materials to the work site and stacking shall be done in a manner to cause minimum inconvenience to the traffic and other construction works. The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

The contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

4.3.21.3 Lowering and Laying of Pipes

The laying and joining of pipes shall conform to IS:783. The trench shall be checked for proper level, gradient and alignment before lowering the pipes.

The pipe shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy pipes shall be lowered by means of proper shear legs, chain pulley blocks or as directed by Engineer-in-Charge. Great care should be taken to prevent sand etc. from entering the pipes.

Laying of pipes shall proceed up grade of slopes. The error of grade shall not be rectified by packing up earth underneath the pipes. If required, concrete shall be used for packing.

The ends of the pipes shall be kept closed to keep out dirt, mud and foreign materials. Adequate provision shall be made to prevent floating of pipe in the event of flooding of trenches.

The body of the pipe for its entire length shall rest on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

A few skeins of spun yarn soaked in neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes butted against each other. Collar shall be slipped over the joint covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tools from both ends of the collar.

Cement mortar 1:2(1 cement:2 sand) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall then be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both side at an angle of 45°.

The cement mortar joints shall be cured at least for seven days.

All joints in the pipes shall be tested to a head of 1.5 meter of water above the top of the highest pipe.

4.3.21.4 MS Rungs/CI Steps

The rungs for pits/manholes and septic tanks shall be of MS conforming to Indian Standard and to the shape and size as shown in the drawings.

CI steps for manholes if needed shall be as per IS:5455

MS rungs shall be coated with 2 coats of approved bituminous paint.

124.3.22 Soak Pits

All earth work in excavation, brick work etc. shall conform to relevant IS standard.

**Standard Specification
for
Anti Termite Treatment
(A-13)**

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General

124.4 Scope

This specification, used in conjunction with contract document, Bill of Quantities and drawing establishes the minimum requirements for pre-constructural anti-termite treatment.

This specification establishes the materials and method of accomplishing pre-constructural anti-termite treatment of soil for protection of buildings against attack by sub-terranean termites with the usage of chemical emulsions in accordance with the procedure laid down.

125 Regulations, Codes and Standards

The work for anti-termite treatment for building construction shall be in compliance with all applicable state/local law and regulations.

The following Indian Standards codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS :1307	-	Aldrin emulsifiable concentrates
IS :6439	-	Heptachlor emulsifiable concentrates
IS :2682	-	Chlordane emulsifiable concentrates
IS :6313	-	Code of practice for anti-termite measures in buildings.

126 Materials

Emulsifiable concentrates of Aldrin (0.5 %) / Heptachlor (0.5 %)/ Chlordane (1 %), conforming to relevant IS Standards in water emulsions, shall be used for treatment of soil.

127 Procedure for Treatment

The treatment shall be carried out by an approved agency specialised in the field. Apart from this specification, the work shall be carried out in compliance with IS:6313.

127.1 Site Preparation

Treatment of solid shall start when foundation trenches/pits are ready to take concrete/masonry in foundations and plinth area ready for laying the sub-grade. Treatment shall not be carried out when it is raining or soil is wet.

127.2 Treatment of Foundations

The bottom surface and the sides (up to a height of 300 mm) of the excavated pits/trenches for masonry foundations of R.C.C. plinth beams shall be treated with specified chemical emulsion @ 5 liters/sq. m. of the surface area.

After the masonry foundation comes up, the backfill in immediate contact with the sub-structure shall be treated with emulsion @ 7.5 litres/ sq. m of the vertical surface of the sub-structure for each layer of soil, by rodding the earth at 150 mm centers close of the wall surface and working the rod backward and forward (parallel to the wall surface) and then spraying the specified dosage of emulsion. The emulsion shall be directed towards the masonry surfaces so that the soil in contact with the surface is well treated with the chemical. After the treatment, the soil shall be tamped back into place.

127.3 Treatment of Plinth / Basement and Apron

The top surface of the consolidated earth below the floor slab and the peripheral apron shall be treated with chemical emulsion @ 5 litres / sq. m. of the surface area. Holes 50 to 75 mm deep at 150 mm centres both ways shall be made on the surface with 12 mm diameter mild steel rod and then emulsion shall be sprayed uniformly over the area. At expansion joint locations, anti-termite treatment shall be supplemented by treating through the expansion joint @ 2.00 litres per linear meter of joint after the sub-grade has been laid.

Along junction of plinth filling and wall/column faces, a small channel 30 x 30 mm shall be made and rod holes 150 mm apart (up to the ground level) made in the channel and rod moved backward and forward to

break up the earth and chemical emulsion poured along with channel @ 7.5 litres/sq. m. of the vertical wall / column surface so as to soak the soil right to the bottom. The soil shall be tamped back into place after the treatment.

127.4 Treatment of soil along External Perimeter of Building

After the building is complete, the earth along with external perimeter shall be rodded at intervals of 150 mm and to a depth of 300 mm. The rod shall be moved backward and forward parallel to the wall to break up the earth and chemical emulsion poured along with wall @ 7.5 litres / sq. m. of vertical surface (i.e. $7.5 \times 0.300 = 2.25$ litres / meter of perimeter). After the treatment, the earth shall be tamped back into place.

127.5 Performance Guarantee

The CONTRACTOR shall submit a performance guarantee towards anti-termite treatment for 10 years from the date of completion of work on a non judicial stamp paper. Any defect observed during this period shall be rectified by the CONTRACTOR at his own cost.

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128 General

128.1 Scope

This specification used in conjunction with the contract document, bill of quantities and drawings establishes the minimum requirement for concrete paved areas. Reference to other material standards for compliance shall be interpreted as an integral part of the specification. This specification covers the requirements of material, laying and finishing concrete pavement.

Road diversions shall be provided by the CONTRACTOR while the work is in progress till the completion of the work with out any extra payment. The diversion shall be maintained in proper condition. If necessary water shall be sprinkled on diversions.

129 Regulations, Codes and Standards

The road shall be in compliance with all federal, state and local laws and regulations which are applicable.

The following Indian Standard Codes unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS:2720 - Methods of test of soil

130 Material

130.1 Water

Water used for cement concrete, mortar, plaster, grout, curing etc. shall be clear and free from injurious amount of oils, acids, alkalis, organic matters or other harmful substances. Only natural water suitable for drinking shall be used. It shall conform to IS:456.

Aggregate for Concrete

The aggregates for concrete shall comply in all respects with IS:383 and IS:456. This should be furnished in at least two separate sizes with separation at 20 mm when combined material graded from 5 to 38 mm is specified and at 25 mm IS sieve when combined material graded from 20 to 50 mm IS sieve is specified. This shall be obtained from a source approved by Engineer-in-Charge and shall be chemically inert, strong, hard, durable and of limited porosity. This shall be of the gauge specified in the schedule of rates and approximately cubical in shape. It shall be free from soft or decayed pieces, dirt, clay, leaves or any organic matter. The aggregate shall not have any injurious effect when mixed with cement nor shall it corrode the reinforcement, nor otherwise impair the strength and durability of the concrete. The size of the coarse aggregate mentioned in this specification denotes maximum size of aggregate and the same shall be graded downwards as per IS:383.

130.2 Sand for Concrete and Mortar

Fine aggregate shall preferably be natural sands. In case of crushed sand the very fine natural sand amount passing IS:No. 383. Sand shall consist of clean, hard, strong, sharp, durable, uncoated particles free from any mix of clay, dust, vegetable matter, mica, iron, pyrites, shells, soft or flakey and elongated particles, alkali organic matter, salts, loam and other impurities which may be considered by the Engineer-in-Charge as harmful. Sulphate content should not exceed 1%. Total content of all deleterious matter should not exceed 5%. The source of sand shall be approved by the Engineer-in-Charge. Sand obtained from river bed subject to tidal effect will not be allowed in works. All sand shall be washed before being brought to site.

130.3 Storage of Aggregates

The subcontractor shall at all time maintain at the site of work such of quantities of aggregates as are considered by the Engineer-in-Charge to be sufficient to ensure continuity of work. Each type and grade of aggregates shall be stored separately. The ground on which the aggregates are stored shall be firm and have sufficient slope to ensure adequate drainage of rain water.

Any wet aggregate delivered to site shall be placed in storage for at least 24 hours to ensure adequate drainage before it is used for concreting.

130.4 Cement

The cement used shall be ordinary portland cement conforming to IS:269, unless otherwise specified.

The cement issued to the contractor shall be stored in a suitable weather tight building and in such a manner as to permit easy access for proper inspection. All cement stored at site by the contractor shall be arranged in batches and used in the same order as received from the owner. Contractor shall maintain a cement register in which all entries shall be completed day to day showing quantities received, date of receipt and daily cement consumption.

The Engineer-in-Charge may reject cement which has deteriorated after issue to the contractor owing to inadequate protection against moisture or other causes or in any other case where the cement is not to his satisfaction.

No admixtures shall be normally permitted for concrete or mortar. Water proofing compound to be used in concrete in concrete, plaster, damp proof course etc. where specified, shall be either CICO or approved equivalent make. It shall be mixed as per manufacturers specification and as approved and directed by the Engineer-in-Charge.

Joint sealing in pavements and around equipment, structural columns shall be approved compound conforming to IS:1834 type 'B' (Shalitex or approved equivalent).

131 Grades and Proportioning

The grades indicated in drawings and schedules shall conform to IS:456, the strength being indicated below:

Minimum crushing strength of 15 cm cube in N/Sq.mm at 28 days

Grade	Prel. Test	Works cube test
M-10	13.5	10
M-15	20.0	15
M-20	26.0	20
M-25	32.0	25
M-30	38.0	30

The water cement ratio, aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards of prescribed strength of mix. The mix proportions, however, shall be revised if the results of the cube tests during the construction show consistently lower or higher strength than the prescribed one. No claim to alter the rates of concrete work will be entertained due to such changes in mix designs, as the contractor will be responsible to produce the concrete of required grade. The slump of concrete mix for pavements compacted by vibrations should not be more than 25 mm and that for manual compaction not more than 50 mm.

All concrete shall be controlled concrete conforming to IS:456. For mud-mat and filling purpose ordinary concrete of 1:4:8 mix proportion may be used as indicated in drawings.

132 Preparation of Sub Grade

The sub grade or sub base for laying of the concrete slab shall comply with the following requirements

That no soft spots are present in the sub grade or sub base

That the uniformly compacted sub grade or sub base extends at least 300 mm on either side of the width to be concreted.

The sub grade is properly drained

That the minimum modulus of sub grade reaction obtained with a plate bearing test shall be 5.54 Kg/cm².

Sub grade shall be prepared to the lines and grades shown on the drawings.

No concrete shall be placed around manholes or other structure until they have been brought to required grade and alignment.

The sub grade shall be in moist condition at time of concrete placement.

133 Forms

All side forms shall be of mild steel unless use of wooden sections are specially permitted. The steel forms shall be MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of at least 3.0 m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

The forms should be in a sufficient number and they should not be removed until concrete is hardened sufficiently.

In case wooden forms are permitted, these shall have minimum base width of 100 mm for 200 mm slabs and 150 mm for more than 200 mm thickness.

134 Reinforcement

All reinforcement work shall conform to IS:456. Reinforcing steel shall be free from dirt, scale or other foreign matter and rust. The number, size, form and position of all the reinforcement shall unless otherwise directed or authorised by Engineer-in-Charge be strictly as per drawings. The placing of reinforcement shall be such that when properly placed into the work, extreme longitudinal bars will be located not less than 50 mm nor more than 100 mm from the edges of the slab except for dummy joints. The length of reinforcement will keep clear of transverse joints by not less than 50 mm nor more than 100 mm as measured from the centre of the joint to the ends of longitudinal bars.

While overlapping the bars in either direction the overlap shall be at least equal to spacing between bars in the respective direction.

To prevent displacement before or during concreting, the bars shall be secured to one another with 16 SWG black soft annealed binding wire. Wooden planks provided for labour to move shall be supported independent of reinforcement and the cage shall never be permitted to sag or get displaced during concreting. Concrete spacer blocks shall be used to ensure correct cover of concrete over bars as shown in drawings.

Dowels if used as load transferring device shall be checked for exact position before concreting. Dowels shall be parallel to the surface and perpendicular to the joint and shall not place any restraint on the movement of the joint.

135 Mixing

Mixing shall be carried out in mechanical mixers. Drum of the mixer shall rotate at peripheral speed of 600 rpm. Hand mixing can, however, be permitted by the Engineer-in-Charge in special cases. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly into the mixing pan. The water shall be introduced into the drum within first 15 seconds of mixing, but not until all the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and for not less than 2 minutes after all the materials and water are in the drum. The entire content of the drum shall be discharged before any materials are placed therein for the succeeding batch.

Correction for Bulking – In volume batching suitable allowances shall be made for the bulking of fine aggregates due to presence of water. For this purpose the bulking shall be determined as directed by Engineer-in-Charge.

136 Placing

The place where concrete is to be poured should be clean and free from all loose dirt, wooden pieces, dust, standing water etc.

Walking on reinforcement layers is not permissible. Walkways on wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-Charge. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

Concrete should not be dropped from a height of over 1.5 m.

To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid rehandling of concrete. Where however, a certain amount of redistribution is necessary it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by the Engineer-in-Charge continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge.

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS:456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided to protect it from the direct rays of the sun and from drying winds.

All concrete placement should be coordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

Concrete in standing water shall be executed strictly as per IS:456. This shall be paid as a separate item where applicable.

The concrete shall be laid in panels not exceeding 4mX4m as shown in layout drawing or as directed by Engineer-in-Charge.

137 Compaction & Finishing

137.1 Compaction

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the slab is very small as the corner of street junction etc. hand consolidation and finishing shall be done as follows :

Concrete as soon as placed, shall be struck off uniformly and screeded to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross section indicated by the plans. The entire surface shall then be tamped until a close knit dense surface is obtained.

The tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts, the aim of this operation being compaction and screeding to the approximate level required. Subsequent tamping should advance 75 mm at a time in the direction in which the work is proceeding and in final stages the tamping should be closer about 12 mm at a time until a level and dense surface is obtained.

If so directed by Engineer-in-Charge, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

Segregated particles of coarse aggregate which collect in front of the tamper shall be thrown outside the forms or thoroughly mixed by hand with a mass of concrete already on the base.

Compaction by tamping shall be carried on till the mortar in the mix just works upto the surface. The surface shall be examined after compaction correction, if needed, shall be made by adding or removing concrete followed by further compaction and finishing.

137.2 Floating

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothened and compacted by means of a longitudinal float 1200 mm long and 75 mm wide operated from a foot bridge.

137.3 Straight Edging

After floating is completed and excess water removed but while concrete is still plastic the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

137.4 Belting

Just before the concrete becomes non-plastic, the surface shall be belted with a two ply canvas belt not less than 200 mm wide and at least 1.0 m longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transverse to the carriage way center line and a rapid advance parallel to the center line.

137.5 Brooming

After belting and as soon as surplus water has risen to the surface the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

137.6 Edging

Before the concrete has its initial set the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

138 Curing

138.1 Initial curing

Immediately after the completion of the finishing operations, the surface of pavement shall be entirely covered with wetted burlap, cotton or jute mats.

138.2 Final Curing

Upon the removal of the mats, the slab shall be thoroughly wetted and covered by the following method:

Curing with wet earth – A system of transverse and longitudinal dykes of clay about 50 mm high shall be laid over the slab. These dykes shall be blanketed with sandy soils free from stones to prevent drying up. The rest of the slab shall be covered with sufficient sandy soil so as to produce a blanket of earth not less than 37 mm depth after wetting. The earth shall be kept thoroughly wet till the concrete has attained the required strength but not less than 14 days.

139 Joints

Wherever called for on the drawings expansion joints, dummy joints and longitudinal joints shall be provided as per details indicated in the drawing and as directed by Engineer-in-Charge.

After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved joint sealing compound.

The edges of the joints shall be thoroughly cleaned and primed with a thin bituminous paint which shall be allowed to dry before the sealing compound is applied.

The primer shall be applied with a brush. The composition shall be as follows :

	Name of Material	Percent by weight
1.	200 – Penetration Bitumen	66% Blended
2.	Light creosole oil	14% Hot Cold
3.	Solvent Naphtha	20%

The bitumen shall be melted and fluxed with oil. When cold, solvent Naphtha shall be added. BITUMINOUS emulsion shall not be used as primers. Care shall be taken to ensure that the sealing compound is not heated above 200 degree centigrade and the temperature does not exceed 180 degree centigrade for long periods.

Sealing compound shall be poured into the joint opening in such a manner that the material will not be spilled on the exposed surface of the concrete. When required to prevent pick up under traffic, the expose surface of the sealing compound shall be dusted with hydrated lime.

140 Opening to Traffic

Traffic shall not be allowed for a period of 28 days after laying of concrete.

Before opening the roads to traffic all joints shall be filled and trimmed or topped out as required.

141 Quality Assurance Plan

The CONTRACTOR shall submit the detailed quality assurance plan for road work to the Engineer for approval. The approved plan shall be strictly followed by the CONTRACTOR.

**Standard Specification
for
Material for Concrete
(A-15)**

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142 General

142.1 Scope

This specification establishes the material specifications of reinforced cement concrete to be used in pile foundations. Any special requirements as shown or noted on the drawings shall govern over the provision of these specifications.

For specific work requirements concerning design and construction otherwise modifying or supplementing the provision of this specifications refer to the specific requirements. In case of conflict between specific requirements and provision of this requirements, former shall govern.

142.2 Definitions

Reference to Indian Standard Codes shall always mean reference to latest issue of the relevant standards including all its amendments.

142.3 Codes

All design & construction shall be performed in accordance with the Indian Standard Codes of Practice for Plain & Reinforced Concrete IS-456.

143 Materials for Concrete

143.1 General

All materials which may be used in the Plain or Reinforced Cement Concrete work shall be of standard quality manufactured by renowned concerns conformity to IS or equivalent and shall have IS certification mark as far as possible unless otherwise approved by the Engineer-in-charge. The contractor shall get all materials approved by Engineer-in-charge prior to its procurement and before actual use. The Engineer-in-charge shall have the right to determine whether all or any of the materials offered or delivered for use in the works are acceptable. Any material brought out to site and not conforming to specification and instruction, Engineer-in-Charge shall reject and the contractor shall have to remove the same immediately from site at his own expenses.

143.2 Cement

2.2.1 General

The cement used shall be ordinary Portland Cement or Blast Furnace slag cement conforming to IS:455 or Portland Pozzolana cement conforming to IS:1489 or as specified and/or directed by the Engineer-in-Charge.

2.2.2 Tests after delivery

Each consignment of cement may, after delivery on the site and at the discretion of the engineers-in-charge be subjected to any or all of tests and analysis required by the relevant Indian Standard Specification. Facilities for testing shall be provided by Contractor at his own cost.

2.2.3 Storage on the site

The cement should be stored in a suitable weather tight building and in such a manner as to permit easy access for proper inspection to prevent deterioration due to moisture and to minimise warehouse deterioration. Cement of different types and brands shall be kept in separate storage.

All accepted cement stored on the site shall be arranged in batches and used in the same order as received from the manufacturer. The contractor shall maintain a cement register in which all entries shall be completed day to day showing the quantities received, date of receipt, source of despatch, type of cement

etc. and also the daily cement consumption on site. The register shall be accessible to the Engineer-in-Charge for his verification.

2.2.4 Rejection of cement

The Engineer-in-Charge may reject any cement as a result of any tests thereof, notwithstanding the manufacturer's certificate. He may also reject cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or other causes. Any cement which is considered defective by the Engineer-in-Charge shall not be used and shall be promptly removed from the site of the work by the contractor at his own expense.

143.3 Aggregates for concrete

2.3.1 General

Coarse and Fine Aggregates for concrete shall conform in all respects to IS:383. "Specification for Coarse and Fine Aggregates from Natural Sources for concrete". Aggregates shall be obtained from a source known to produce those satisfactory for concrete. Aggregates shall consist of naturally occurring sand and gravel or stone, crushed or uncrushed or a combination thereof. They shall be chemically inert, hard, strong, dense, durable, clean and free from veins, adherent coatings and shall be of limited porosity.

Flaky and elongated pieces shall not be used. Whenever required by the Engineer-in-Charge the aggregates shall be washed by the contractor before use in the work.

The source of aggregates shall be approved by the Engineer-in-charge and shall not be changed during the course of the job without his approval. Rejected aggregates shall be removed from the work site by the contractor at his own expenses.

2.3.2 Deleterious Materials

Aggregates shall not contain any harmful materials such as non-pyrites, coal, mica, shale or similar laminated materials, clay, alkali, soft fragments, shells, organic impurities etc. in such quantities as to affect the strength or durability of the concrete in addition to the above, for reinforced concrete, any material which might cause corrosion of the reinforcement, and aggregates which are chemically reactive with the alkalis of cement shall not be used.

The maximum quantities of deleterious materials in the aggregates, as determined in accordance with IS:2386 (Part-II) – Methods of Test for Aggregates for concrete, shall not exceed the limits given in Table 1 of IS:383.

The sum of the percentages of all deleterious materials shall not exceed five. Deleterious materials also include material passing 75 micron IS sieve.

2.3.3 Coarse Aggregates

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

These may be obtained from crushed or uncrushed gravel or stone as per Cl 2.3.1 and may be supplied as single sized or graded aggregates given in Table-II of IS:383.

The Engineer-in-Charge may allow all in aggregate to be used provided they satisfy the requirements of clause 4.4 and Table IV of IS:383.

2.3.4 Fine Aggregates

Fine aggregate is aggregate most of which passes 4.75 mm IS sieve but not more than 10% pass through 150 micron IS sieve. These shall comply with the requirements of grading zones I, II & III and given in Table-III of IS:383. Fine aggregate conforming to grading zone IV shall not be normally used in reinforced concrete unless tests have been made by the contractor to ascertain the suitability of the proposed mix proportions and approved by the Engineer-in-Charge.

Fine aggregate shall consist of natural sand resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies or crushed stone sand or crushed gravel sand.

2.3.5 Sampling and Testing

In case of doubt the Engineer-in-Charge may require the contractor to carry out tests at the Contractor's expense in accordance with :

- | | | |
|---------|---|---|
| IS:516 | - | Method of tests for strengths of concrete |
| IS:2386 | - | Method of tests for aggregates for concrete |

2.3.6 Storage of aggregates

The contractor shall at all times maintain at the site of work such quantities of aggregate as are considered by the Engineer-in-charge to be sufficient to ensure continuity of work.

Each type and grade of aggregate shall be stored separately on hard firm ground having sufficient slope to provide adequate drainage to rain water.

Any aggregate delivered to site in a wet condition or becoming wet at site due to rain shall be kept in storage for at least 24 hours to obtain adequate drainage, before it is used for concreting or the water content of mix must be suitably adjusted as directed by Engineer-in-charge.

143.4 Water

Water used for concrete shall be clear and free from injurious amounts of Oil, Acid, Alkali, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for mixing and curing concrete.

The Engineer-in-Charge may require the contractor to prove at latter's expense, that the concrete mixed with water proposed to be used should not have a compressive strength lower than 90% of the strength of concrete mixed with distilled water.

The Engineer-in-charge may require the contractor to get the water tested from an approved laboratory at his own expense and in case the water contains any sugar or an excess of acid, alkali, any injurious salts etc. the Engineer-in-charge may refuse to permit its use.

144 Admixtures

Admixtures such as CICO Grade-1 or Puddlo or equivalent may be used in concrete only with the approval of Engineer-in-charge.

145 Reinforcement

145.1 Mild Steel Bars

The reinforcement shall normally be mild steel in the form of round bars, conforming to IS:432 Grade-I unless specified otherwise.

145.2 Hard-Drawn Steel Wire Fabric

When specified on the drawings, hard drawn steel wire fabric shall be used conforming to IS:1566, it shall be of an approved type and of the weights and dimensions shown on the drawing.

145.3 High Yield Deformed Steel Reinforcement

Cold twisted high yield deformed steel bars shall conform to IS:1786.

Hot rolled high yield strength deformed steel bars shall conform to IS:1139.

145.4 Other bars and Sections

Any other type of reinforcement bars specified on the drawings shall conform to its respective Indian Standard Specification Medium Tensile Steel bars when specified on the drawings shall conform to IS:1139.

145.5 Welding

Field welding of reinforcing bars will not be permitted without the written consent of the Engineer-in-Charge where welding is permitted it must be at staggered locations. Tests shall be made to prove that the joints are of the full strengths of bars connected. Welding of reinforcement shall be done in accordance with the recommendation of IS:2751.

145.6 Storage

The steel reinforcement shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion.

145.7 Other Specifications

General construction details and workmanship relative to reinforcement including bar bends, lap, splices and installation shall be in accordance with IS:2502. Code of practice for Bonding and fixing of bars for concrete reinforcement as well as the detailing of reinforcement given in IS:456.

Hot bending of bars shall not be allowed.

The number, sizes, shape and position of all the reinforcement shall, unless otherwise directed to by the Engineer-in-charge, be strictly in accordance with the drawings. The reinforcement shall be adequately secured and held in position by metal chairs and spacers. Ties at inter-sections shall be made with 16 SWG soft black annealed binding wire.

The contractor must obtain the approval of the Engineer-in-charge for the reinforcement placed before any concrete is placed in the forms. The reinforcement at this time shall be free from loose rust or scale or other coatings that will destroy or reduce bond.

Concrete spacer blocks of the same strength as parent concrete, shall be used to ensure correct cover to the reinforcement. This clear cover shall be as shown on the drawings or as per instructions of the Engineer-in-charge.

All the reinforcing bars shall be so tied as to form a rigid cage to prevent displacement before or during concreting.

The CONTRACTOR shall take minimum one sample per layer for every 500 sq. m. of compacted filling.

**Standard Specification
for
Testing of Concrete Piles
(A-16)**

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146 General

146.1 Scope

This specification covers the requirements and methods of testing of a single pile for evaluating its safe capacity in

- a) Vertical Loading (Compression)
- b) Lateral Loading
- c) Pull Out
- d) Combined vertical and Lateral Loading
- e) Special type of loading such as vibratory loadings

These specification shall be applicable for all types of piles in general excepting sheet piles

For specific work requirements or otherwise modifying or supplementing the provisions of this specification, refer to specific requirements. In case of conflict between requirements set forth in the specific requirements and the provisions of this specification the specification requirements shall govern.

146.2 Definitions

Reference to Indian Standard Codes shall always mean reference to the latest issue of the relevant standards, including all the amendments up to date.

146.3 Codes

All testing shall be performed in accordance with the following codes and the provisions of these specifications

IS:2911 (Part IV) : Code of Practice for Design and Construction of Pile Foundations Load Test on piles

146.4 Requirements

The load test shall be required to provide data regarding the load deformation characteristics of the pile up to failure or otherwise specified and the safe design capacity.

Full details of the requirement proposed to be used and the test set up shall be submitted to the Engineer-in-charge with detailed sketches for approval. Approval of the Engineer-in-Charge shall also be obtained after the test set up is complete prior to commencement of loading.

All measuring devices shall be tested for satisfactory performance and accuracy at an approved institution and a certificate to that effect obtained and submitted to the Engineer-in-charge, prior to use.

The test pile shall be constructed using the same equipment and technique as for the job piles.

A minimum time period of one week shall be allowed between the time of installation and testing in case of a cast-in-situ piles.

Records

A full record giving all details of the test in the problems shown in Appendix-1 shall be submitted in triplicate to the Engineer-in-charge immediately on completion on each test. The record shall also include the plot of load time settlement characteristics of piles.

147 Vertical Loading Tests

147.1 Equipment and Test Set-up

2.1.1 Test Pile

- 2.1.1.1 The test pile shall be decided by the Engineer-in-charge. It may be one of the working piles or a separate test pile.
- 2.2.1.2 The head of the test pile shall be brought to the proper level and provided with a pile cap with a level and plane surface and with adequate space for proper seating of a jack and dial gauges.
- 2.2.1.3 Test pile surface shall be prepared for testing purposes on the expiry of one week after casting the pile.

2.1.2 Loading Systems

- 2.1.2.1 Loading shall be applied by the reaction method consisting of an hydraulic jack centrally against a loaded platform. Supports of the platforms shall be adequately designed. Special anchor piles or any other suitable type of anchorage systems may also be used. However, use of the uplift capacity of neighbouring piles for providing the reaction shall normally not be permitted.
- 2.1.2.2 The loading system shall be adequate to ensure that the test can be carried up to the specified limit. The reaction to be made available for the test shall be at least 25% greater than the maximum jacking force required.

2.1.3 Measuring System

2.1.3.1 Loading on Piles

The load applied on the pile shall be recorded on a calibrated pressure gauge mounted on the jack.

2.1.3.2 Settlement of Pile

- a) Settlement of the pile shall be recorded by dial gauges suspended from datum bars.
Four dial gauges of 0.01 mm sensitivity shall be positioned on four corners around the pile.
- b) The datum bars shall have rigid supports preferably of concrete pillars or steel sections, embedded well into the ground. The supports shall be located more than three times the pile diameter, subject to a minimum of 1.5 m clear away from the pile face and also sufficiently away from the supports of the loaded platform to avoid any disturbances on these accounts. Movements near the supports of the datum bar shall be avoided while the test is in progress.

147.2 Method of Conducting Test

The test shall be carried out by the direct method of loading in successive increments or by the cyclic loading method as specified and as directed by the Engineer-in-Charge.

Direct method of loading in successive increments

The test shall be carried out as per the procedure outlined

- a) The load shall be applied to the pile top in increments of about one fifth the rated capacity of the pile or as specified. Settlement readings shall be taken before and after the application of each new load increment and at 2,4,8,15,30,60 minutes and at every two hours until application of the next load increment.
- b) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour or until two hours have elapsed, whichever is later.
- c) Further loading shall then be continued as in (a) above till one of the following occurs :
 - i) Yield of soil-pile system occurs causing progressive settlement of the pile exceeding a value of one tenth of the pile diameter.
 - ii) The loading on the pile top equals twice the rated capacity or as specified in the case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.
- d) Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for 24 hours or more if necessary and settlement readings shall be take at 6 hours interval during the period.

- e) Unloading shall be carried out in the same steps as loading. A minimum of ½ hour shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.
- f) If so directed by the Engineer-in-Charge, loading and unloading cycles shall be carried out for all load stages within the assumed working load.

g) Assessment of safe load

The safe capacity of the pile shall be the least of the following values:

- i) 2/3 of the final load at which the total displacement attains a value of 12 mm unless otherwise required, in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible.
- ii) 50 percent of the final load at which the total displacement equals 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of under deemed piles.

Cyclic load test

The test shall be carried out as per the procedure outlined by IS:2911 – (Part IV) and as described below :

- a) The load shall be applied to the pile top in increments of about one fifth the estimated safe capacity of the pile or as specified. Settlement readings shall be taken before and after the application of each new load increment at 2,4,8,15,30,60 minutes and at every two hours until application of the next load increment.
- b) Alternate loading and unloading shall be carried out at each stage and the total and new settlements recorded as specified if so directed by Engineer-in-charge more than one cycle of loading and unloading shall be carried out at any or all of the stages.
- c) Each stage of loading or unloading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour provided the minimum period is two hours for loading and one hour for unloading. The following load stages shall however be maintained for longer periods as given below :
 - i) At 1.5 times assumed safe capacity (for routine test only) – 24 hours.
 - ii) At load of twice assumed safe capacity (for initial test only) – 24 hours

The loading shall be continued till one of the following occurs:

- i) Yield of the soil pile systems occurs causing progressive settlement exceeding one tenth of the pile diameter.
 - ii) The loading on the pile top equals twice the estimated safe load in case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.
- d) Assessment of safe load

The safe capacity of the pile shall be the least of the following :

- i) Two thirds of the final load at which the total settlement attains a value of 12 mm or as specified.
- ii) Two thirds of the final load at which the net settlement attains a value of 6 mm.

Half of the Final load at which the total settlement equals one tenth of the pile diameter.

148 Lateral Loading test

148.1 Equipment and Test Set up

3.1.1 Test Pile

The test pile shall be decided by the Engineer-in-charge. It may be one of the working piles or a separate test pile.

The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having an adequate area for proper seating of the jack and dial gauges.

3.1.2 Loading System

- 3.1.2.1 Loading shall be applied by an hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make the gap.

3.1.3 Measuring System

- 3.1.3.1 Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg.
- 3.1.3.2 Deflection of the pile head shall be measured by dial gauges, fixed to datum bars and having a least count of 0.01 mm. The datum bars shall be provided with rigid supports as described in clause 2.1.3.2 (b) above.

148.2 Method of conducting tests

The test shall be carried out in accordance with the provisions of IS:2911 (Part-1) and as detailed below :

Loading shall be applied in increments of 500 kgs or as specified

Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.2 mm/hr or 1 hr whichever is greater.

Loading shall be continued till one of the following occurs :

Deflection of the pile head exceeds 12 mm

The applied load on the pile is twice the assumed lateral load capacity of the pile in case of a separate test pile and 1 ½ times the rated capacity in the case of a working pile.

Assessment of safe load

The safe load shall be the smaller of the following :

- i) Half the final load for which the total deflection is 12 mm
- ii) Load corresponding to 5 mm total deflection.

Note : The deflection is at the cut off level of the pile.

149 Pull Out Capacity of Piles

149.1 Equipment and test set up

4.1.1 Test Pile

- 4.1.1.1 The test pile shall be decided by the Engineer-in-charge. The test shall be conducted on separate pile installed specifically for this purpose.
- 4.1.1.2 The test pile shall be built up to the proper length and the head provided with suitable arrangements for anchoring the load applying system.

4.1.2 Loading system

- 4.1.2.1 Load shall be applied using an approved reaction system. Uplift force on the pile may be applied directly to the test pile or through a lever system. The reaction may be provided by neighbouring piles or blocks may be constructed for the purpose. A hydraulic jack shall be used for load application.

4.1.3 Measuring System

- 4.1.3.1 Load applied by jack shall be measured by a calibrated pressure gauge with a least count of 1000 kgs.
- 4.1.3.2 Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. A minimum of two dial gauges, placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports as described in 2.1.3.2 (b) above.

149.2 Method of Conducting Test

The test shall be conducted as outlined below :

Loading shall be applied to the pile top in increments of one fifth the rated capacity of pile.

Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.2 mm/hr or one hour, whichever is greater.

Loading shall be continued till one of the following occurs :

Yield of soil pile system occurs causing progressive movement of the pile exceeding 12mm.

The loading on the pile top equals twice the estimated safe load or as specified.

149.3 Assessment of safe load

The safe capacity of the pile shall be the least of the following :

- a) Two thirds of load at which the total displacement is 12 mm or the load corresponding to a specific permissible uplift and
- b) Half of the load which the load displacement curve shows a clear break.

150 Combined Vertical and Lateral Loading

150.1 Equipment and Test set-up

The equipment and test set up shall be same as described in clause 3. In addition a platform shall be constructed on the pile top and loaded to 10 times the pile capacity in vertical loading.

The pile load test subjected to the full vertical load and lateral load shall commence after all settlements due to the vertical load have ceased and when the full vertical load is in position.

151 Special Type of Loading

This shall include evaluating the pile response to vibratory loads both horizontal and vertical in nature. The test set up and method of conducting the test shall be covered under specific requirements.

APPENDIX -1

PILE LOAD TEST RECORD VERTICAL LATERAL - PULL OUT RECORD

Date of			WT of Hammer		
Driving			AVR Drop of Hammer		
Casting			Total no. of blows		
Commencement of Date			Sum of Temporary		
			Compression in cms		
Completion of Test			Ground Level		
Type of test			Direct Cycle loading		
Total	Load	Load	Total	Settlement	AVR Settlement
Time	On	Off	Load	Deflection	(Deflection) Rebound
			Gauge		
			1	II	Total
			MM	MM	MM
					Net
					MM
					MM

**Standard Specification
for
Acid & Alkali Proof Tiles
(A-17)**

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152 General

152.1 Scope

This specification describes the technical requirement for the materials and laying of acid proof tile lining for flooring in acid storage areas.

153 Codes & Standards

All work shall be carried out strictly in accordance with the Technical Specifications, unless otherwise approved by Engineer-in-Charge in writing. Wherever not specified, the latest edition of one or more of the following IS Codes of practice or any other applicable code shall be as followed.

IS : 4832 - Part-I -Chemical resistant mortar silicate type.

IS : 4832 - Part-II -Chemical resistant mortar resin type.

IS : 4860 - Acid resistant bricks

154 Materials

154.1 Acid Proof tiles

The tiles shall conform to IS:4860 - class I quality. All tiles shall be dense, homogenous and manufactured out of special raw material which shall have low lime, flint, sand and iron contents. These shall be specially fired and vitrified at high temperature to have qualities of low absorption. The size of tiles shall normally be 230 mm X 115 mm or as per IS Standard. The thickness shall be as specified in the item.

154.2 Acid Proof Mortar

154.2.1 Silicate Mortar

It shall consist of selected potassium silicate solution and inert filter powder. Both mixed well to enable to set a ambient temperature. The mortar shall conform to IS:4832 (Part-I). The mortar shall conform to IS:4832 (Part-I). The mixing proportion and other instructions for use shall be as specified by standard manufacturers. "Cement Proctor S.W.K." manufactured by Corromondal Prodorite or equivalent may be used.

154.2.2 Resin Mortar

The furnace and phenolic mortar for jointing consist of an inert powder synthetic resin syrup. No water shall be used during mixing. The mortar shall conform to IS:4832 (Part – II). The mixing proportion and other instructions shall be as specified by standard manufacturers. "Furacin" and "Phencil" manufactured by Coromondel Prodorite or equivalent may be used.

155 Laying

155.1 Surface Preparation

- a) All damaged and questionable areas should be chipped out and replaced.
- b) Adequate floor slope for good drainage is important.
- c) Low spot should be avoided because finished floor will follow contour or sub floor.
- d) Concrete should be dry, clean and well cured before application of membrane is started.

155.2 Primer Application

A bitumen primer is an asphalt based material thinned with petroleum solvent (conforming to ASTM D-41) should be applied over the surface. It is allowed to dry before applying the membrane material.

155.3 Membrane Application

Bitumen mastic is used to build up the membrane. It is heated to 120⁰-205⁰ C and applied to the primed surfaces. Multiple coat application should be made to thickness requirements. Each coat should be inspected for blisters and pinholes. If present, they should be broken and filled before applying subsequent coats. Bitumen mastic should not be used as the membrane material where solvents are involved.

155.4 Reinforcement Application

Bitumen coated glass cloth can be used for membrane reinforcement at corners, edges, walls etc. depending on the requirements.

155.5 Application of Mortar and Bricks

There are two ways of lining Acid Resistant linings.

When bedding and jointing materials are the same a thin layer of about 6 mm suitable silicate type mortar is spread on the back of the acid proof tiles and the tiles are pressed down on the bed. Proper joint thickness of about 3 mm should be maintained and filled up with a suitable resin type mortar. Pointing is also done with resin type mortar. In case of pointing the joint thickness should be 6 mm and depth of the pointing should be 19 mm.

In this case, joints with silicate mortar should be acid cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulfuric acid before applying the resin type mortar. After acid curing, the free acid in the joints shall be cleaned with water and sufficient time shall be allowed for thorough drying. After curing resin mortar is used for filling up the joints.

156 Guarantee

The vendor shall give material and performance guarantee for a period of minimum one year from the date of commissioning of the plant.

**Standard Specification
for
Cable Trenches and Road Crossings
(A-18)**

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157 General

The scope of the specification covers cable trenches and road crossings. The construction shall be done as per the approved drawings. During the design proper care shall be taken for the movement of vehicles over the crossings.

158 Materials

158.1 Water

Water shall be clear and free from injurious amounts of oils, acids, alkalis, organic matters or other harmful substances. Only natural water suitable for drinking shall be used. It shall conform to IS : 456.

158.2 Aggregate for Concrete

The aggregates for concrete shall comply with all respect with IS: 383 and IS : 455. This should be furnished in at least two separate sizes with separation at 20mm when combines material graded from 5 to 38mm is specified and at 25mm IS sieve when combined material graded from 20 to 50mm is specified. This shall be obtained from a source approved by Engineer-in-Charge and shall be chemically inert, strong, hard, durable. It shall be free from set of decayed pieces, clay, leaves or any organic matter. The aggregate shall not have the injurious effect when mixed with cement not shall it connect the reinforcement nor otherwise impair strength and durability of the concrete. The size of coarse aggregate mentioned in this specification denotes maximum size of aggregate and the same shall be graded downwards as per IS : 383.

158.3 Sand for Concrete and Mortar

Fine aggregates shall preferably be natural sands in case of crushed sand the very fine natural sand amount passing IS : No. 383. Sand shall consist of clean, hard, strong, sharp, durable uncoated particles free from any mix of clay, dust, vegetable matter, mica, iron pyrites, shells, soft or flakey and elongated particles, alkali organic matter, salts, loam and other impurities which may be considered by the Engineer-in-Charge as harmful. Sulphate content should not exceed 1%. Total content of all deleterious matter should not exceed 5%. The source of sand shall be approved by the Engineer-in-Charge. Sand obtained from river bed subject to tidal effect will not be allowed in works. All sand shall be washed before being brought to site.

158.4 Storage of Aggregate

Quantities of aggregates at the site of work should be such that the quantities shall be considered as sufficient by Engineer-in-Charge to ensure continuity of work.

Each type and grade of aggregates shall be stored separately. The ground on which the aggregates are stored shall be firm and have sufficient slope to ensure adequate drainage of rain- water.

Any aggregate delivered to site wet shall be placed in storage for at least 24 hours to ensure adequate drainage before it is used for concreting.

Sand heaps shall be covered with bricks or such other materials to prevent blowing off and to assist in good house keeping.

158.5 Cement

The cement used shall be ordinary portland cement, conforming to IS : 269, unless otherwise specified.

The cement shall be stored in a suitable weather tight building and in such a manner as to permit easy access for proper inspection. All cement stored at site shall be arranged in watches and used in the same order. Cement register shall be maintained in which all entries shall be completed day to day showing quantities received, date of receipt and daily cement consumption.

Rejection of Cement

The Engineer-in-Charge may reject cement owing to inadequate protection against moisture or other causes or many other case where the cement is not to his satisfaction.

Admixture

No admixture shall be normally permitted to concrete.

159 Grade and Proportioning

The grades indicated in drawings and schedules shall conform to IS : 456, the strength being indicated below :-

Min Crushing Strength of 15cm.Cube in Kg sq. cm at 28 days.

Grade	Prel. Test	Works cube test
M-15	200	150
M-20	260	200
M-25	320	250

The water cement ratio, aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength of mix. The mix proportions however, shall be revised if the results of the cube tests during the construction show consistently lower of higher strength than the prescribed one.

All concrete shall be controlled concrete conforming to IS : 456. For mud-mat and filling purpose ordinary concrete of 1:4:6 proportion may be used as indicated in drawings.

160 Forms

The term 'shuttering' shall include all centerings and formwork required to support the concrete during the process of laying, compacting and setting and all items such as blanking, lagging, walling, moulds, covers, cross-bearers, struts, props, bracing's etc. shall be covered by the term.

Shuttering shall be strong and rigidly constructed so that there shall not be any deformation under sight and pressure of wet concrete, constructional loads, and other forces. It shall be constructed in such a manner that it can be easily removed afterwards.

The shuttering shall have smooth and even surface and so constructed as to remain sufficiently rigid during the placing and compacting of concrete and sufficiently tight to prevent loss of liquid from concrete.

Steel Shuttering only shall be used for formwork.

The shuttering shall be such that when it is removed the exposed concrete surface shall be smooth and even. If any unevenness is found, the CONTRACTOR shall chip the bulged portion of the concrete and plaster with 6 mm thick cement plaster (1:4) at his own cost after getting approval from the Engineer-in-charge.

161 Reinforcement

All reinforcement work shall confirm to IS:456. Reinforcing steel shall be free from dirt scale or other foreign matter and dust. The number, size form and position of all the reinforcement shall unless otherwise directed or authorised by Engineering-in-Charge be strictly as per drawings. The placing of reinforcement shall be such that when properly placed into the work, extreme longitudinal bars will be acted not less than 50mm nor more than 100mm from the edges of the slab except for dummy joints, the length of reinforcement will keep clear of transverse joints by not less than 50mm more than 100mm as measured from the centre of the joint to the ends of longitudinal bars.

While overlapping the bars in either direction the overlap shall be at least equal to spacing between bars in the respective direction.

To prevent displacement before or during concreting, the bars shall be secured to one another with 16 SWG black soft annealed binding wire. Wooden plants provided for labour to move shall be supported independent of reinforcement and the cage shall never be permitted to sag or get displaced during concreting. Concrete spacer blocks shall be used to ensure correct cover of concrete over bars as shown in drawings.

Dowels if used as load transferring device shall be checked for exact position before concreting. Dowels shall be parallel to the surface and perpendicular to the joint and shall not place any restraint on the movement of the joint.

162 Mixing

Mixing should be carried out in mechanical mixers. Hand mixing can, however, be permitted by Engineer-in-Charge in special cases. Water cement ratio shall be rigidly controlled.

163 Compaction & Finishing

Each layer of concrete shall be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corners of the formwork with suitable type of equipment until the concrete has been consolidated to the maximum practicable density.

Concrete shall be compacted with mechanical vibrating equipment supplemented if necessary to obtain consolidation by hand spading and tamping. The vibrators shall be of Internal or Immersion type high frequency vibrators with speed not less than 7000 rpm when immersed in concrete. Concrete shall be placed in layers at least 300 mm deep in walls and approximately 450 mm in mass pours. Vibrators shall not penetrate more than 50 mm into the surface of previously placed layer but shall completely vibrate any concrete and specially those with higher slumps. Under no circumstances vibrators shall be attached to or allowed to touch reinforcement.

164 Curing

Curing of concrete shall be done in accordance with IS:456. Concrete shall be cured by keeping it continuously moist after placing.

165 Opening To Traffic

Traffic shall not be allowed for a period of 28 days after laying of concrete.

Before opening the roads to traffic all joints shall be filled and trimmed or topped out as required.

**Standard Specification
for
RCC Pipe Culverts
(A-19)**

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166 General

166.1 Scope

The scope of this specification covers R.C.C. pipe culverts and E.R.C. crossings etc.

167 Codes & Standards

IS : 458 - RCC Pipes & Collars

IS : 783 - Laying of Pipes

168 Materials

Pipe materials shall conform to the above codes.

All pipes shall be new and perfectly sound, free from cracks, cylindrically straight, and of standard nominal diameter and length with even texture. Each pipe shall have one collar with it.

The Contractor shall submit a Manufacturer's Test Certificate whenever demanded by Engineer-in-Charge or his authorised Representative.

Spun yarn to be used for pipe joints shall be of best quality. It shall be free from dust etc.

169 Transportation and Stacking

The transportation of material to the worksite and stacking shall be done in a manner so as to cause minimum inconvenience to the traffic and other construction work.

The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

The Contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

Earthwork shall be carried out according to Standard Specification 4LI SP02 unless directed otherwise.

170 Construction Details

170.1 Lowering of Pipes

The laying and jointing of pipes shall conform to IS : 783. Pipes shall be jointed by collar joints.

The trench shall be checked for proper level, grade and alignment before lowering the pipes.

The pipes shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy pipes shall be lowered by means of proper impods, chain-pully blocks or as directed by Engineer-in-Charge. Great care should be taken to prevent sand, etc. from entering the pipes.

170.2 Laying of Pipes

Laying of pipes shall proceed up grade of slopes.

The error of grade shall not be rectified by packing up earth underneath the pipes. If required, concrete shall be used for packing.

The ends of the pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipe in the event of flooding of trenches.

The body of the pipe for its entire length shall rest on an even bed in the trench and places shall be excavated to receive the Collar for the purpose of jointing. Jointing of Pipes

A few skeins of spun yarn soaked in neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes butted against each other. The collar shall then be slipped over the joint covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tools from both ends of the collar. More skeins of yarn shall be added and well rammed home. The object of the yarn is to centre the two ends of the pipes within the collar and to prevent the cement mortar of the joint penetrating into the pipes.

Cement Sand Mortar (1:2) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall then be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both side at an angle 45°.

Any surplus mortar projecting inside the joint is to be removed and to guard it against any damage, sack or gunny bags shall be drawn past each joint after completion.

170.3 Curing

The cement mortar joints shall be cured at least for seven days.

171 Testing

All joints in culvert pipe lines shall be tested to a head of 1.5 Metres of water above the top of the highest pipe.

**Standard Specification
for
Civil Work for Underground Piping
(A-20)**

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172 General

172.1 Scope

This specification covers the following items of civil work connected with underground piping :

- a) Earth work
- b) Plain and Reinforced Cement Concrete
- c) Brick Work
- d) Plastering
- e) Manhole covers, frames ladder rungs, gratings etc.
- f) Structural Steel Work

The work shall include supply of various materials as per relevant standards, required for the execution of work except for those items designated as Owner's scope of supply in the special condition's of contract or elsewhere in the contract documents.

Contractor shall transport from Owner's stores those materials which are a part of owner's supply.

This specification shall specifically apply to the following:

- a) All earthwork except for Site Grading;
- a) Plain and reinforced cement concrete work in Catch Pits; Clean-outs; Manholes; Pipe Supports; Water Monitors; Hydrant Pedestals; Thrust Block etc.
- b) Brick work for various structures such as Manholes; Catch Basins; Valve Chambers; Instrument-tapping Chambers; Flushing Chambers etc.
- c) Plastering for the above structures as applicable.
- d) Manhole Frames; Manhole Covers; Ladder rungs etc. for the above structures as applicable.
- e) Miscellaneous structural steelwork such as ladders; platforms; chequered plate covers; gratings etc. included in scope of work under this contract.

173 Codes & Standards

IS : 1200 (Part I) & IS : 3764	- Earth Work
IS : 456	- Plain & Reinforced Concrete
IS : 800	- Structural Steel Work
IS : 1077; IS : 2250	- Brick & Mortar
IS : 2212	- Brick Work

174 Material

All materials used for the works covered under this specification shall conform to the following Standards.

IS : 383	- Aggregate
IS : 268	- Cement
IS: 432; IS: 1139; IS:1566; IS: 2751; & IS: 1786	- Reinforcement
IS : 2062	- Structural Steel
IS : 814 & IS : 815	- Electrodes for Welding

IS : 1077	- Bricks
IS : 3502	- Chequered plates
IS : 5961	- C.I. gratings
IS : 5455	- C.I. Steps

Material not covered above and which may be used in the WORK shall be of quality approved by the Engineer-in-Charge, who shall have the right to determine whether all or any of the Materials offered or delivered for use in the WORK are suitable for the purpose. CONTRACTOR shall give the samples of material to the Engineer-in-Charge and shall get it approved before procurement and use.

175 Earthwork & Backfilling

Excavation carried out for Foundation, Pits, Walls etc. shall be covered by the specification.

Excavation shall be carried out to true line and levels in all types of soil except hard rock. Excavation shall be carried out for all lifts as required by the work.

Any rock which requires blasting for removal shall be classified as hard rock.

When hard rock is encountered the matter shall be referred to Engineer-in-Charge before proceeding with the work.

Contractor shall provide suitable drainage arrangement to keep the pits dry. He shall also carry out all dewatering which shall be included in the quoted rate.

All shoring and strutting required to hold the sides of excavation from collapse shall be carried out by the Contractor and shall be included in the quoted rate.

No excavated material shall be deposited within 1.5 M of edge of excavation

Contractor shall carry out excavation with side slopes as permitted by the Engineer-in-Charge.

Backfilling shall be carried out of selected earth coming out of excavation.

Backfilling shall be carried out in layers of 15 cms and compacted to achieve 90% maximum dry density of the soil being used.

Any surplus earth generated shall be transported to areas designated by the Engineer-in-Charge.

176 Plain And Reinforced Cement Concrete

Water used for concreting work shall be suitable for drinking and shall conform to IS : 456. It shall be free from injurious substances.

Coarse and Fine aggregates shall be from a source approved by the Engineer-in-Charge.

Contractor shall store each type and grade of aggregate separately. He shall maintain at site of work adequate quantities to ensure continuity of work. Wet aggregate delivered to site shall be stored for 24 hrs to facilitates drying before being used.

In case cement is in the contractor's scope of supply, the contractor shall include as a part of his quoted rates testing, if any, specified by the Engineer-in-charge to ensure the material's conformity with the relevant standards.

In the event of either unsatisfactory test results or of deterioration in material quality due to age, bad storage etc., the Engineer-in-Charge may reject such cement. Decision of Engineer-in-Charge shall be final in this regard.

Admixtures required, if any, shall be used only with the specific permission of Engineer-in-Charge, and where used shall be in conformity with the instructions of the manufacturer. Grades & Proportioning of Concrete

All concrete shall be controlled concrete confirming to IS : 456.

The grade of concrete indicated in drawing and schedule shall conform to IS : 456. The minimum compressive strength shall be as indicated below (15 cm cube at 28 days) in N/sq. mm:

M-10	10
M-15	15
M-20	20

The water cement ratio, coarse aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength mix. The mix proportions, however, shall be revised if the results of the cube tests during the construction are consistently lower than the prescribed one. No claim to alter the rates of concrete work will be entertained due to such changes in mix designs, as the contractor will be responsible to produce the concrete of required grade. The ingredients viz. cement, coarse and fine aggregates shall be measured by weight unless specified otherwise by the Engineer in-charge.

For mud-mat and filling purpose, ordinary concrete of 1:4:8 for proportion or as specified may be used as indicated in drawing.

176.1 Mixing

Mixing shall be carried out in mechanical mixers. Hand mixing can however be permitted by Engineer-in-Charge in special cases subject to addition of an extra 10% cement being used without extra cost.

Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly to the mixing pan. The water shall not be admitted to the drum until all the cement and aggregate constituting the batch are thoroughly mixed.

Mixing shall continue until the concrete is uniform in colour. Mixing time of not less than 2 minutes after all the materials and water are in the drum shall be allowed.

176.2 Placing

The place where concrete is to be poured should be clean and free from all loose dirt, wooden planks, dust, standing water etc. The form-work must be right and rigid, with all holes and crevices plugged effectively, to prevent cement slurry from running out.

Walking on reinforcement layers shall not be permitted. Walkways of wooden planks or similar can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed and shall be adequately supported against sagging during carriage and placement of concrete.

Placing and vibrating of concrete should not totally take more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-Charge.

Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

Concrete shall not be dropped from a height of over 1.5M.

To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green out" by wire brushing or chipping. The initial green cutting may be done by wire brush after 8 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement slurry with 1:1 mix (1 cement : 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

Concrete shall be placed in a single operation to the full thickness of slabs, beams and similar members and shall be placed in horizontal layers not exceeding 1.5m deep in walls, columns and similar members. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge.

176.3 Placing in inclement weather/special conditions

All precautions shall be taken for concreting in extreme weather in accordance with relevant clause of IS : 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains and necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

All concreting placement should be co-ordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

Concrete in standing water shall be executed strictly as per IS : 456. This shall be paid as a separate item where applicable.

176.4 Vibration

Concrete shall be compacted by means of vibrators of approved type under proper supervision as directed by the Engineer-in-Charge. The whole mass of concrete shall be well vibrated until a dense mass with a jelly like appearance and consistency and water just appearing on the surface is obtained. Over vibration or vibration of very wet mixes shall be avoided. Care should be taken to avoid segregation and formation of air bubbles.

176.5 Construction Joint.

Construction joints shall be made in the position as indicated in the drawing and as approved by Engineer-in-Charge. Such joints shall be truly vertical or horizontal as the case may be except that in an inclined or curved member the joint shall be strictly at right angles to the axis of the member.

176.6 Curing & Protection

The concrete shall be kept constantly wet for at least seven days from the date of placing of concrete. In very hot weather precaution shall be taken to see that temperature of wet concrete does not exceed 38 degrees C while placing. Concrete shall not be disturbed after initial setting has started. For freshly laid concrete, from work shall not be jarred. Concrete placed below ground surface shall be protected from falling earth during and after placing.

176.7 Finishes

On striking the form work, all blow holes and honey combing observed shall be brought to the notice of Engineer-in-Charge. The Engineer-in-Charge may at his discretion allow such honey combing or blow holes to be rectified by necessary chipping and packing or grouting with concrete or cement mortar.

If mortar is used, it shall be 1:3 mix or as specified by Engineer-in-Charge. However, if honey-combing or blow holes are of such extent as being undesirable the Engineer-in-Charge may reject the work totally and his decision shall be binding on the contractor. Not extra payment shall be made for rectifying these defects. All burrs and uneven faces shall be rubbed smooth by carbo stone.

The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish equal to that of the tube down shuttered faces. Concealed concrete faces shall be left as item the shuttering except that honey combed surface shall be made good as detailed above. The top faces of slabs not intended to be surfaced shall be levelled and floated smooth at the levels or slopes shown on drawings. The floating shall not be executed to the extent of bringing excess fine materials to the surface. The top faces or slab intended to be covered with screed, grandic or similar surface shall be left with a rough finish. Sides and soft is to be later covered with plaster shall be suitably roughened. Testing of Concrete / Structure

The contractor shall be furnish and test six cubes for each batch of 150M3 of concrete or as desired by Engineer-in-Charge as per Table 5 Cl. 14.10 of IS : 456. The contractor shall furnish the moulds and the cubes and test the cubes at his own cost but as directed by Engineer-in-Charge.

The Engineer-in-Charge may instruct the contractor for loading test as per Cl. 16.5 of IS : 456 to be carried out on any concrete structure if in his opinion such test is deemed necessary for any of the following reasons.

- 1) The concrete test cubes failing to attain the specified strength.
- 2) Suspected over-loading of the structure during construction.
- 3) Shuttering being prematurely removed and not as per time specified in IS : 456.
- 4) Concrete improperly cured.

The contractor shall carry out such test at his own cost. If the results of the loading test be unsatisfactory, the Engineer-in-Charge may instruct the contractor to demolish and reconstruct the structure or part thereof at the contractor's cost.

176.8 Formwork & Centering

Form work in general shall conform to IS : 456.

For complicated work the contractor shall submit his proposal of form work before starting the work for the approval of the Engineer-in-Charge. The number of props. Their sizes and dispositions shall be such as to

be able to safely carry the full dead load and constructional load. However, approval of the Engineer-in-Charge to this effect shall not relieve the contractor of his responsibility for proper work and safety.

All forms of beams, slabs and similar members shall be so designed and erected that the sides can be removed without disturbing the soft shutter and supports there to.

Beam soffits shall be provided with an upward, camber of 6mm for each 3M of horizontal span or as directed by the Engineer-in-Charge.

Vertical props shall be supported on wedges or sole plates or other measures where by the props can be gently lowered while commencing to remove the shuttering. Columns shuttering shall not be over 1.5M on height a piece.

Before removal of the shuttering the concrete shall be examined and its removal order taken from the Engineer-in-Charge. In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of striking.

Shuttering shall not be removed until the number of clear days specified in IS : 456 have elapsed since the last day of placing concrete in the member concerned. All form work shall be removed without such shock or vibration as would damage the reinforced concrete. Before the soffits and struts are removed the concrete surface shall be exposed, where necessary, in order to ascertain that the concrete has sufficiently hardened. The specified period may be extended if desired by the Engineer-in-Charge on account of delayed hardening caused by low atmospheric temperature.

176.9 Reinforcement

The Steel for reinforcing bars shall be as indicated in drawings and conforming to following specifications:

IS : 432 (part – I) - MS Rounds Bars

IS : 1139 - Deformed bars

IS : 1786 - Cold Twisted Bars

IS : 1566 - Hard drawn steel wire fabric

IS : 2751 - MS Welded wire mesh

All reinforcement at the time of concreting, shall be free from loose rust or scales, oil, grease or other harmful matter, and other coatings that will destroy or reduce the bend.

The number size, form and position of all the reinforcement Engineer-in-Charge, be strictly in accordance with the drawings shall, unless otherwise directed or authorised by the. Wherever inserts interfere with the placing of reinforcement as called for, proper adjustment shall be made as directed by Engineer-in-Charge, before concrete is placed.

All reinforcement work shall conform to IS : 456.

The steel reinforcement shall be connected to form a rigid cage. To prevent displacement before or during concreting the bars shall be secured to one another with 16 SWG black annealed binding wire Bars intended to be in contact at passing points shall be securely wired together similarly at all such points. Wooden planks provided for labour to move shall be supported independent from the reinforcement cage, and the cage shall never be remitted to sag or get displaced during concreting.

The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provisions of steel spacer bars inserted at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

Concrete spacer blocks shall be used to ensure covered concrete over the bars. The concrete over the reinforcement bars shall be as shown in drawings and shall be the clean cover.

The contractor must obtain the approval of the Engineer-in-Charge to the reinforcement placed before any concrete is deposited.

177 Brick Work

177.1 Materials

6.1.1 Bricks

Bricks shall conform to IS: 1077 in general requirements and tests. All bricks shall be thoroughly burnt but not over burnt. They shall have uniform colour, plane rectangular faces, with parallel sides and sharp straight right angled edges. They shall have a fine compact and uniform texture. Bricks shall give a clear ringing sound when struck against each other. They shall not absorb more than 22% of water by weight when immersed in water for 24 hours. Locally available best quality bricks shall be acceptable at the discretion of the Engineer-in-Charge.

6.1.2 Sand

Sand used for mortar shall conform to IS : 2116.

6.1.3 Water

Water used for masonry work shall be clear and free for amounts of delete materials and shall be portable.

6.1.4 Mortar

Mortar for masonry shall be prepared in accordance with IS : 2250. The proportion of mix shall be as shown in the schedule of work or in drawings or directed by the Engineer-in-Charge.

177.2 Brick Masonry

All brickwork shall be carried out as per IS : 2212

All bricks shall be thoroughly soaked in water for at least 6 hours before use.

177.3 Bonds

The bonds shall be English or such other bond as may be specified and shall be carried throughout the wall. At angles forming the junction of any two wall, the brick shall, at each alternate course, be carried into each of the respective walls, so as to thoroughly unit the work. The brick work shall not be raised more than 14 courses per day. The construction of walls shall be carried out in regular and level courses.

177.4 Joints

Joints shall be restricted to 10mm (unless any wider vertical joints upto 13mm are necessary to give the required thickness of the wall).

The brick shall be laid with frogs up, and no broken or chipped bricks shall be used for brick work. The joints shall be filled up with cement mortar (proportion as specified in items in schedule of rates) and squarely raked out to a depth of 12mm while the mortar is still green. The raked joints shall be well brushed to remove loose particles. After the work, the faces of the brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of work.

177.5 Curing

Brick work shall be kept constantly moist while under construction and continuously for a period of 10 days after completion.

177.6 Scaffolding

Where the scaffolding poles on inner side rest on the brick work under construction only one header brick shall be left out, so that bond of the wall can be easily made, such holes shall be filled up immediately after removal of scaffoldings.

Pockets for inserts shall be left in the brick work as shown in the drawings or as directed by the Engineer-in-Charge, without.

Where specified, brick walls less than one brick thick shall be provided with 2 Nos 6mm dia. Reinforcing M.S. Bars at even fourth course, embedded inside the joint, one each side of uniform distances from the face and shall have a side cover of 12mm together by 16 SWG Black soft iron binding wire at 500mm c/c. At ends of wall, the reinforcement shall be carried at least 150mm into the adjoining walls or other structures.

178 Plastering

178.1 Materials

The specification of cement, sand and water as given in specification including relevant clauses for quality and testing of materials shall also apply for cement plaster materials and works.

Cement mortar shall be of grade and thickness specified in drawing or as directed by the Engineer-in-Charge, if not specified. The surface on which plastering is to be done shall be thoroughly cleaned from dust, dirt, oil etc. It should be washed properly and watered for 4 hours before plastering. The joints of brick work shall be raked out to a depth of at least 12mm when plastering has to be done. On cement concrete surface, the surface shall be scarified by lines with trowel then it is still green or hacked if concrete is hard as directed by Engineer-in-Charge.

Plaster shall not in any case, be thinner than specified, it shall have uniform specified thickness. Any extra thickness of plaster done by contractor will not be paid for. When smooth finishing is required the cement plaster shall be floated over with heat cement within 15 minutes of the application of the final coat.

During the process of plastering all corners shall be rounded to a radius of 25mm unless otherwise specified.

The plaster shall be protected from sun and rain by such means as the Engineer-in-Charge may approved. The plaster shall be cured for 14 days.

Construction joint shall be kept in plastering work at places approved by Engineer-in-Charge.

179 M.S. Rungs / C.I. Steps

The rungs for valve pits / manholes shall be of M.S. conforming to Indian Standard and to the shape and site as shown in Drgs.

C.I. steps for manholes if used shall be as per IS : 5455.

M.S. Rungs or CI steps shall be coated with 2 coats approved bituminous paint.

Chequered Plates & Structural Steel Works

Chequered plates shall be 6mm (7mm moreover chequers and shall conform to IS : 3502). Steel for chequered plate shall conform to IS : 2062 shall be clearly rolled and shall be free from harmful surface defects such as crack surface, flaws etc. The plate shall be cut to shape and fixed to the bearing members as shown in relevant drawings and directed by Engineer-in-Charge. The edges shall be made smooth no burrs or gagged ends shall be left. The plates may be spiced with prior consent of the Engineer-in-Charge. But in that case care should be taken so that there is continuity in the pattern of the plates between the portions.

Lifting arrangements shall be provided including lifting rods.

Grating shall be fabricate out of M.S. flats angles rounds etc. as per drawings and as approved by Engineer-in-Charge. Steel for grating plates shall conform to IS : 226 of general Weldable quality and shall be clearly rolled shall be free from harmful surface defect. All gratings and chequered plates shall be hot-dipped galvanised. The minimum thickness of galvanising shall be 90 microns.

180 C.I. Manhole Frame And Cover

C.I. manhole frame and covers shall conform to IS : 1726 with size and grade as shown in drawings.

181 Vent Pipes

These shall be M.S. Black Steel Tube conforming to IS : 1239 or as specified in drawings. The pipe bends shall be embedded in 1:3:6 grade cement concrete or as shown in drawings.

All pipes shall be 25mm clear of wall or column with M.S. holder bat clamp as per instructions of the Engineer-in-Charge. All bores in wall and column shall be made good by 1:2:4 grade cement concrete. All pipes and clamps shall be painted with two coats of paints of approved make.

182 Funnels, Clean Outs, Plugs

- These shall be fabricated from M.S. Plates pipe plate chequered Plate round, angles etc. supplied the by contractor. The fabricator shall be in accordance with the approved drawings.
- Connection of tunnel / cleanout / plugs / grating etc. where necessary shall be made with furnace based resin cement mixed with finally ground grade of a pipe material or other suitable material approved by the Engineer-in-Charge.

183 Cast Iron Grating

- The CI grating and frame shall conform to IS : 5961. The grating shall be of 450 x 500 size and minimum 75 kg. Weight.
- The casting shall be clearly cast and free from air sand shrinkage gas inclusion or any other holes with carefully dressed sides.
- The grating cover shall be hinged to frame to facilitate its easy opening and closing for repairs of manholes / catchpits etc. and fixed in position during concreting of top.

184 Brick Bat Fill

The brick bats used as filling valve pits shall be from B class bricks, and shall not be over burnt. As sample of brickbats used shall be got approved from Engineer-in-Charge.

The compaction of the layer of brick bats shall be proper so that brickbats are not disturbed and do not suit in the soil.

**Standard Specification
for
Epoxy Screed Lining to Concrete
floors / Paving
(A-21)**

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185 Purpose

The purpose of this document is to state the requirements of materials, workmanship and construction procedure to be followed during the execution of Epoxy Screed lining.

186 Scope of Work

This specification shall cover the materials, surface preparation and application of epoxy screed lining to concrete floors/paving for protection from corrosive environments.

This shall conform to IS 4631: Code of practice for laying epoxy resin floor toppings.

187 Technical Requirements

187.1 Materials

All materials, which may be used in this work, shall be of standard quality manufactured by renowned manufacturer and conforming to relevant Indian Standard or conforming to International Standards, where relevant Indian Standards are not available. The contractor shall get all the materials approved by Owner/Consultant prior to procurement and use. The Owner/Consultant shall have the right to determine whether all or any of the material offered or delivered for use in the works is suitable. Any material brought to site and not conforming to specifications and satisfaction of the Owner/Consultant shall be rejected and the contractor shall remove the same immediately from the site.

The materials used for the coating/lining shall consist of solvent less epoxy resin systems consisting of epoxy and polyamide/amine type hardeners to be mixed in ratios recommended by manufacturer and an inert filler generally silica or quartz sand. Primers/putty/sealing coats shall also consist of similar materials in proportions recommended by manufacturers. Resins, hardeners shall conform to IS:9197.

Standard systems supplied by manufacturers include: (Application as per manufacturer's specifications)

Ciba Geigy

Araldite GY 257 Resin and Hardener HY 840

Coromandel Prodorite

Corocrete I HS-BV is supplied as primer (comp A : Comp. B to be mixed in ratio 3 parts to 1 part) and Corocrete BB as screed material. (comp A: Comp B to be mixed in ratio 5:1 with sand filler in ratio 1:1 for self levelling mortar and 1:4 for screed).

Fosroc

Nitoprime 25 is supplied as primer. Nitoflor SL 2000 is supplied as 2 mm self levelling floor topping.

Nitoflor TF30 is supplied as 3 to 6 mm thick epoxy resin floor screed. The components are prepared and mixed in ratios supplied.

Nitoflor TF 5000 is supplied as 5 mm thick epoxy resin floor screed. The components are prepared and mixed in ratios supplied.

SIKA

Sikafloor 91

187.2 Surface Preparation

Concrete surfaces to receive screed shall be sound without honeycombing, levelled and well cured. They shall be freed from laitence and dust by sand blasting abrading with hard wire brush or chemical etching using 15% HCl solution and leaving the solution for 15 minutes. Any grease/oil on surface shall be removed by degreasing solution. The surface shall then be thoroughly washed to remove all traces of acid / chemicals and dust and dried completely.

187.3 Primer Application

Primer shall be applied to the prepared surface as per manufacturer's specification. The components are mixed either manually or by means of a mixer to achieve a homogeneous mixture and applied to prepare surface. This is allowed to cure overnight to form a tacky surface. Some silica may be sprinkled over this to give a rough surface, for good bonding.

187.4 Top Coat Application

Epoxy resin may be applied either as a coating 200 – 500 micron thick; or as a self levelling mortar topping typically about 2 mm thick; or as a trowel applied screed 3-10 mm thick. Amount of silica (inert filler) added to top coat depends on the purpose of the coating. If only a coating is to be applied, silica flour may be added to 10-20% to increase abrasion resistance depending on manufacturer's instruction. If self levelling flow mortar is desired, 1 part epoxy material to 1 part filler is provided. If trowel applied screed mortar is required, the quantity of inert filler is increased to 5 to 8 parts for 1 part resin mixture. Proper curing shall be carried out for 7 days after laying of floor topping before subjecting it to traffic.

Care needs to be taken regarding the following, and manufacturer's instructions should be strictly complied with regarding the following:

- i) Moisture present on substrata should be measured and ensured to be within manufacturer's limits.
- ii) Ambient temperature should be ensured to be within the working limits prescribed by manufacturer.
- iii) Ambient humidity should be within the limits prescribed by the manufacturer.
- iv) Mixture should be used within the pot life period specified.
- v) On vertical sides and on floor screeds with heavy traffic, epoxy compatible glass fibre reinforcement 110 gm/m² shall be provided where indicated in drawings / manufacturer's specifications or instructed by Owner/Consultant.

187.5 Seal Coat / Non Skid Surfaces

Seal coats as recommended by manufacturer shall be provided for a smooth surface over trowel finished screeds.

Where non skid surface is specified, grit shall be sprinkled on epoxy resin topping when still tacky.

187.6 Inspection

Bonding with substrata is checked by tapping with wooden hammer. Hollow sound or bulging show poor bonding with substrata. Fine pin holes on surface blisters, peeling coating and poorly bonded areas should be chipped, primed with primer and affected area filled and levelled with fresh epoxy mortar. Cracks observed on surface are to be widened and filled with epoxy mortar and levelled off. The decision of Owner/Consultant shall be final in respect of the workmanship.

188 Related Documentation

Nil

189 Attachments

Nil

**Standard Specification
for
Demolition and Dismantling Works
(A-22)**

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190 Purpose

The purpose of this document is to state the requirements of tools, equipment, workmanship and construction procedure to be followed during the execution of demolition and dismantling works.

191 Scope of Work

The Specification covers the procedure and safety measures requirement for demolition and dismantling of masonry (Brick & Stone), Concrete (Plain & Reinforced), Structural Steel (sheeted/un-sheeted) work.

192 Technical Requirements

192.1 General

Apart from this Specification, the demolition and dismantling of structures (part or whole) shall be in compliance with any special requirements as shown/noted in the drawings.

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

Where it becomes necessary to disconnect any existing service line(s) (such as electrical, piping etc.) during dismantling/demolishing operation and where so required by Owner/Consultant, suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service line(s).

192.2 Safety Precautions

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

Necessary propping and/or under pinning shall be done for the safety of the adjoining structures (whose safety is likely to be endangered) before taking up the demolishing and dismantling work.

Temporary enclosures/fencing, danger lights etc. shall be provided wherever specified by Owner/Consultant, to prevent accidents.

All equipment, pipes, fixtures etc. located in the vicinity shall be protected by suitable means, as decided by Owner/Consultant, during demolishing and dismantling operation.

Necessary measures shall be taken to keep the dust nuisance minimum

Dismantled elements/components shall not be dropped from a height or thrown from a distance so as to avoid damaging the same. Dismantling of elements (fixed by screws/bolts/hooks etc.) shall be done by taking out the fixtures with proper tools only. Such fixtures may be cut by sawing or frame cuttings, in the event of their being stuck-up due to rusting etc. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.

192.3 Procedure

Entire work of demolishing and dismantling shall be carried out very carefully. Prior to start of work, the Contractor shall prepare and submit the proposed scheme of demolishing and dismantling to the Owner/Consultant for their approval.

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

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

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

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

192.4 Cleaning and Stacking

Wherever directed, retrieved material such as bricks/stones, reinforcement bars, sheeting etc. shall be separated out, cleaned and properly stacked.

192.5 Disposal

All unserviceable materials shall be disposed off as per the direction of the Owner/Consultant.

193 Related Documentation

Nil

194 Attachments

Nil

**Standard Specification
for
Bored Cast-in Situ Piles
(A-23)**

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195 Scope

This standard specification covers the construction and installation of load bearing reinforced concrete bored cast-in-situ piles.

For specific work requirements concerning construction or otherwise modifying or supplementing the provisions of this specification, reference may be made to 'Specific requirements'. In case of any conflict between the requirements set forth in 'Specific Requirements' and the provisions of this specification, the 'Specific Requirements' shall govern.

196 Codes

IS:2911 (Part-I/Sec.2) – Indian Standard Code of Practice for Design and Construction of Pile Foundations : Part-I Concrete Piles, Section 2 – Bored Cast-in-Situ Piles, shall be referred in conjunction with these specifications during the entire design, construction and installation work.

Reference to any code shall always mean reference to the latest revised edition of the code including all its amendments up-to-date, unless otherwise specified. In the event of any conflict between the requirements of this specification and those of the referred codes, the former shall govern.

197 Materials

All materials, viz. cement, steel, aggregates, water, etc. which are to be used in the construction work, shall conform to IS Specification for Reinforced Concrete Piles No. 2911.

197.1 Concrete

Methods of the manufacture of cement concrete shall in general, be in accordance with IS:2911 (Part-I/Sec.2) and as per following clauses.

The grade of concrete shall be M-20 with a min. cement of 400 kg/Cu.M.

Slump of Concrete

Slump of concrete shall range between 100 to 180 mm depending on the manner of concreting. The table below gives the general guidance :

PILING	SLUMP (in MM)		TYPICAL CONDITIONS OF USE
	Min.	Max.	
A.	100	180	Poured into water-free unlined bore having widely spaced reinforcement. Where reinforcement is not spaced widely enough, cut off level of pile is within the casing and diameter of pile is less than or equal to 600 mm, higher order of slump within this range may be used.
B.	150	180	Where concrete is to be placed under water or drilling mud, by tremie or by placer.

198 Design Considerations

198.1 Structural Design

The piles shall have necessary structural strength to transmit the loads imposed on it, to soil, Relevant parts of IS:2911 (Part-I/Sec.2) and specific requirements shall be considered to apply for assessing the structural capacity of piles.

198.2 Reinforcement

Clear cover to the main reinforcement shall be 75 mm.

The vertical reinforcement shall project at least 50 times its diameter above the cut-off level.

The lateral ties in the reinforcing cage shall be tack welded to the main reinforcement.

199 Equipment and Accessories

The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the subsoil conditions and the manner of operations etc. These shall be of standard type and shall have the approval of the Engineer-in-Charge.

The capacity of the rig shall be adequate so as to reach the desired depth.

Provision shall be kept for chiseling within the bore hole in case of any underground obstruction / hard strata. However, chiseling shall be carried out only with the approval of Engineer-in-Charge.

In case pile is required to be socketted in medium or good quality rock strata, the equipment mobilized shall have adequate capability to do so upto the required socket length. For the purposes of classification of rock for the determination of length of socketting and payment pilot drill holes shall be carried out in the areas to be piled.

Pilot drill holes shall be of Nx or Bx size as per specific requirements. Rock drilling shall be carried out using double tube core barrel. Drilling and storing of rock cores shall conform to relevant IS codes. Rock quality shall be classified as under depending upon the RQD.

<u>RQD (%)</u>	<u>ROCK QUALITY</u>
25	Poor
25 to 75	Medium
75	Good

200 Piling Installation

200.1 Control of Alignment

The piles shall be installed as accurately as possible as per the designs and drawings. The permissible positional deviations shall be governed by IS:2911 (Part-I/Sec.2). In case of piles deviating beyond such permissible limits, the piles shall be replaced or supplemented by additional piles, as directed by Engineer-in-Charge.

200.2 Boring

The boring shall be done by one of the following methods : (a) Direct mud circulation; (b) Reverse mud circulation. The actual method of construction to be followed shall be as per specific requirements.

In case the strata being bored through is reasonably stiff or dense and the length of the pile is less than 10 mtr. use of bailer bentonite method may be permitted.

In very soft soil a permanent liner shall be installed to ensure stability of bore hole. A liner shall be used to protect the green concrete where a high hydrostatic pressure exists in the subsoil or where an underground flow of water exists and which is likely to damage the concrete on withdrawal of casing.

Use of temporary liner in lieu of bentonite to stabilize sides of bore holes shall not be permitted.

Properties of bentonite used and quality control shall be as per IS:2911 (Part-I/Sec.2).

200.3 Concreting of Piles

6.3.1 Reinforcement

- The reinforcements shall be made into cages sufficiently rigid to withstand handling without damage. In case the casereinforcement is made up of more than one segment, the same shall be assembled by providing necessary laps of, preferably, by welding.

- Stirrups to the main bars shall be tack welded.
- Care shall be taken to ensure that the reinforcement bars do not move together before the cage is lowered down the hole.
- Proper cover and central placement of the reinforcement shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

6.3.2 Concreting

- Concreting shall not be commenced until the Engineer-in-Charge satisfies himself that at final bore hole depth the soil is not weaker than that taken as the basis for pile design. If necessary, SPT or similar test shall be conducted to ensure the above.
- Bore hole bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before lowering the reinforcement cage. The full length of reinforcement cage shall be in position before start of concreting.
- Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS:2911 (Part-I/Sec.2).
- The concrete placing shall not proceed if density of fluid near about the bottom of bore hole exceeds 1250 kg/Cu.M. Determination of the density of the drilling mud from the base of the bore hole shall be carried out by taking samples of fluid by suitable slurry sample approved by the Engineer-in-Charge, in first few piles and at a suitable interval of piles thereafter and the results recorded. Control of consistency of drilling mud shall be carried out throughout boring as well as concreting operations.
- Care shall be exercised to preserve correct cover and alignment of reinforcements and avoid any damage to it throughout the complete operation of placing the concrete.
- The top of the pile shall be brought up above the cut off level by 0.75 mtr. to 1.0 mtr. so as to permit removal of all laitance and weak concrete before capping and to ensure good and sound concrete at the cut-off level for proper embedment into the pile cap. Any defective concrete in the head of the completed pile shall be cut-away and made good with new concrete.

201 Defective Piles

Defective piles shall be removed or left in place, as judged convenient by the Engineer-in-Charge, without affecting the performance of adjacent piles or capping above and additional piles shall be provided to replace them at no additional cost to the Owner.

202 Recording of Data

A competent supervisor shall be present to record the necessary information during the installation of piles. The data to be recorded shall include

- a) The dimensions of the piles, including the reinforcement detail and the mark of the pile.
- b) The type of boring employed.
- c) The type of soil in which piles is constructed.
- d) The depth bored.
- e) The depth of water table.
- f) When drilling mud is used, the specific gravity of the fresh supply and contaminated mud in the bore hole before concreting is taken up, in case of first few piles and subsequently at suitable interval of piles.
- g) The time taken for concreting.

- h) The cut off level / working level.
- i) The consumption of cement.
- j) Any other important observations.

Typical data sheets of recording piling data shall be as given in Appendix-D of IS:2911 (Part-I/Sec.2).

Any deviation from the designed location, alignment or load carrying capacity of any pile shall be noted and promptly reported to the Engineer-in-Charge.

SPECIFICATION FOR TESTING OF CONCRETE PILES

203 General

203.1 Scope

This specification covers the requirements and methods of testing of a single pile for evaluating its safe capacity in :

- a) Vertical Loading (Compression)
- b) Lateral Loading
- c) Pull Out
- d) Combined vertical and Lateral Loading
- e) Special type of loading such as vibratory loading.

These specifications shall be applicable for all types of piles in general excepting sheet piles.

For specific work requirements or otherwise modifying or supplementing the provisions of this specification, refer to specific requirements. In case of conflict between requirements set forth in the specific requirements and the provisions of this specification, the specific requirements shall govern.

203.2 Definitions

Reference to Indian Standard Codes shall always mean reference to the latest issue of the relevant standards, including all the amendments upto date.

203.3 Codes

All testing shall be performed in accordance with the following codes and the provisions of these specifications :

IS:2911 – (Part-IV) – Code of Practice for Design and Construction of Pile Foundation – Load Test on Piles.

203.4 Requirements

The load test shall be required to provide data regarding the load-deformation characteristics of the pile upto failure or otherwise specified and the safe design capacity.

Full details of the equipment proposed to be used and the test set up shall be submitted to the Engineer-in-Charge with detailed sketches for approval. Approval of the Engineer-in-Charge shall also be obtained after the test set up is complete, prior to commencement of loading.

All measuring devices shall be tested for satisfactory performance and accuracy at an approved institution and a certificate to that effect obtained and submitted to the Engineer-in-Charge, prior to use.

The test pile shall be constructed using the same equipment and technique as for the job piles.

A minimum time period of one week shall be allowed between the time of installation and testing in case of a precast pile and not less than four weeks from the time of casting in case of a cast-in-situ pile.

Records

A full record giving all details of the test in the program shown in Appendix-I shall be submitted in triplicate to the Engineer-in-Charge immediately on completion of each test. The record shall also include the plot of load time settlement characteristics of the piles.

204 Vertical Loading Tests

204.1 Equipment and Test Set-up

10.1.1 Test Pile

- The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or a separate test pile.
- The head of the test pile shall be brought to the proper level and provided with a pile cap with a level and plane surface and with adequate space for proper seating of a jack and dial gauges.
- Test pile surface shall be prepared for testing purposes on the expiry of one week after casting the pile.

10.1.2 Loading System

- Loading shall be applied by the reaction method consisting of an hydraulic jack reacting centrally against a loaded platform. Supports of the platforms shall be adequately designed. Special anchor piles or any other suitable type of anchorage system may also be used. However, use of the uplift capacity of neighbouring piles for providing the reaction shall normally not be permitted.
- The loading system shall be adequate to ensure that the test can be carried up to the specified limit. The reaction to be made available for the test shall be at least 25% greater than the maximum jacking force required.

10.1.3 Measuring system

- Loading on Piles

The load applied on the pile shall be recorded on a calibrated pressure gauge mounted on the jack.

- Settlement of Pile.

- a) Settlement of the pile shall be recorded by dial gauges suspended from datum bars.

Four dial gauges of 0.01 mm sensitivity shall be positioned on four corners around the pile.

- b) The datum bars shall have rigid supports preferably of concrete pillars or steel sections, embedded well into the ground. The supports shall be located more than three times the pile diameter, subject to a minimum of 1.5 mtr. clear away from the supports of the loaded platform to avoid any disturbance on these accounts. Movements near the supports of the datum bar shall be avoided while the test is in progress.

204.2 Method of Conducting Test

The test shall be carried out by the direct method of loading in successive increments or by the cyclic loading method as specified and as directed by the Engineer-in-Charge.

10.2.1 Direct Method of Loading in Successive Increments

The test shall be carried out as per the procedure outlined.

- a) The load shall be applied to the pile top in increments of about one fifth the rated capacity of the pile or as specified. Settlement readings shall be taken before and after the application of each new load increment and at 2,4,8,15,30,60 minutes and at every two hours until application of the next load increment.
- b) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour or until two hours have elapsed, whichever is later.
- c) Further loading shall then be continued as in (a) above till one of the following occurs:
 - i) Yield of soil-pile system occurs causing progressive settlement of the pile exceeding a value of one tenth of the pile diameter.
 - ii) The loading on the pile top equals twice the rated capacity or as specified in the case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.
- d) Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for 24 hours or more if necessary and settlement readings shall be taken at 6 hours interval during the period.

- e) Unloading shall be carried out in the same steps as loading. A minimum period of ½ hour shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.
- f) If so directed by the Engineer-in-Charge, loading and unloading cycles shall be carried out for all load stages within the assumed working load.

g) Assessment of Safe Load :

The safe capacity of the pile shall be the least of the following values :

- i) 2/3 of the final load at which the total displacement attains a value of 12 mm unless otherwise required, in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible.
- ii) 50 percent of the final load at which the total displacement equal 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of under reamed piles.

10.2.2Cyclic Loading Test

The test shall be carried out as per the procedure outlined by IS:2911 – (Part-IV) and as described below :

- a) The load shall be applied to the pile top in increments of about one fifth the estimated safe capacity of the pile or as specified. Settlement reading shall be taken before and after the application of each new load increment and at 2,4,8,15,30,60 minutes and at every two hours until application of the next load increment.
- b) Alternate loading and unloading shall be carried out at each stage and the total and net settlements recorded as specified. If so directed by the Engineer-in-Charge, more than one cycle of loading and unloading shall be carried out at any or all of the stages.
- c) Each stage of loading or unloading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour provided that the minimum period is two hours for loading and one hour for unloading. The following load stages shall however be maintained for longer periods as given below :
 - i) St. 1.5 times assumed safe capacity (for routine test only) – 24 hrs.
 - ii) At load of twice assumed safe capacity (for initial test only) – 24 hrs.

The loading shall be continued till one of the following occurs :

- i) Yield of the soil pile system occurs causing progressive settlement exceeding one tenth of the pile diameter.
- ii) The loading of the pile top equals twice the estimated safe load in case of a working pile.

a) Assessment of Safe Load :

The safe capacity of the pile shall be the least of the following :

- i) Two thirds of the final load at which the total settlement attains a value of 12 mm or as specified.
- ii) Two thirds of the total final load at which the net settlement attains a value of 6 mm.
- iii) Half of the final load at which the total settlement equals one tenth of the pile diameter.

205 Lateral Loading Test

205.1 Equipment and Test Set-up

11.1.1Test Pile

The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or a separate test pile.

The test pile shall be cut off at the proper level and provided with a cap with vertical plane side having an adequate area for proper seating of the jack and dial gauges.

11.1.2 Loading System

Loading shall be applied by an hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap.

11.1.3 Measuring System

- Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack having a least count of 500 kg.
- Deflection of the pile head shall be measured by dial gauges, fixed to datum bars and having a least count of 0.01 mm. the datum bars shall be provided with rigid supports as described in Clause No. 10.1.3 (b) above.

205.2 Method of Conducting Tests :

The load shall be applied in accordance with provisions of IS:2911 (Part-1) and as detailed below :

Loading shall be applied in increments of 500 kg. or as specified.

Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.2 mm/hr. or 1 hr. whichever is greater.

Loading shall be continued till one of the following occurs :

- a) Deflection of the pile head exceeds 12 mm.
- b) The applied load on the pile is twice the assumed lateral load capacity of the pile in case of a separate test pile and 1.5 times the rated capacity in the case of a working pile.

Assessment of Safe Load :

The safe load shall be the smaller of the following :

- i. Half the final load for which the total deflection is 12 mm.
- ii. Load corresponding to 5 mm total deflection.

NOTE : The deflection is at the cut off level of the pile.

206 Pull Out Capacity of Piles

206.1 Equipment and Test Set up

12.1.1 Test Pile

- The test pile shall be decided by the Engineer-in-Charge. The test shall be conducted on a separate pile installed specifically for this purpose.
- The test pile shall be built upto the proper length and the head provided with suitable arrangements for anchoring the load applying system.

12.1.2 Loading System :

- Load shall be applied using an approved reaction system. Uplift force on the pile may be applied directly to the test pile or through a lever system. The reaction may be provided by neighbouring piles or blocks may be constructed for the purposes. A hydraulic jack shall be used for load application.

12.1.3 Measuring System

- Load applied by jack shall be measured by a calibrated pressure gauge with a least count of 1000 kgs.
- Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. A minimum of two dial gauges, placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports as described in 10.1.3 (b) above.

206.2 Method of Conducting Test

The test shall be conducted as outlined below :

Loading shall be applied to the pile top in increments of one fifth the rated capacity of pile.

Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.2 mm/hr. or one hour, whichever is greater.

Loading shall be continued till one of the following occurs.

- a) Yield of soil pile system occurs causing progressive movement of the pile exceeding 12 mm.
- b) The loading on the pile top equals twice the estimated safe load or as specified.

206.3 Assessment of safe load :

The safe capacity of the pile shall be the least of the following :

- a) Two-thirds of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible up lift and
- b) Half of the load at which the load displacement curve shows a clear break (downward trends).

207 Combined Vertical and Lateral Loading

207.1 Equipment and Test set-up :

The equipment and test set up shall be same as described in Clause-11. In addition a platform shall be constructed on the pile top and loaded to 1.0 times the pile capacity in vertical loading.

The pile shall be first subjected to the full vertical load. The lateral load shall commence after all settlements due to the vertical load have ceased and while the full vertical load is in position.

The loading system, measuring system and recording of results shall be the same as described in Clause – 11.

Method of Conducting Test & Assessment of Safe Load.

This shall be in accordance with the provision of Clause – 11.2 above.

208 Special Type of Loading

This shall include evaluating the pile response to vibratory loads, both horizontal and vertical in nature. The test set up and method of conducting the test shall be covered under specific requirements.

**Standard Specification
for
Site Grading
(A-24)**

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209 General

209.1 Scope

This specification, used in conjunction with the contract document, bill of quantities and drawings, establishes the minimum requirements for site preparation within the specified limits of the site, herein for compliance shall be interpreted as an integral part of this specification.

The CONTRACTOR shall maintain adequate drainage facilities at SITE at all times during the execution of work. Additional ditches, drains and such other temporary means to achieve this, over and above what is shown in the drawings, shall be provided and maintained by the CONTRACTOR at his own cost.

Adequate de-watering facilities which may be required like de-watering pumps, pipes etc. shall be provided by the CONTRACTOR for the work at his own cost.

Temporary roads and necessary approaches for execution shall be provided by the contractor.

For general classification of soil refer specification for Earthwork and Backfilling (No. 4LISP02).

210 Regulations, Codes and Standards

The site preparation work shall be in compliance with all state, local laws and regulations, which are applicable.

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to :

IS: 3764	-	Safety Code for excavation work
IS: 4014	-	Safety Regulations for scaffolding work
IS: 4081	-	Safety Code for drilling and blasting operations
IS: 4138	-	Safety Code for working in compressed air
IS: 7923	-	Safety Code for working with construction machinery
IS: 2720	-	Methods of test for soils
IS: 1200	-	Method of measurement of building works.

211 Material for Earth Work

The CONTRACTOR shall collect adequate number of samples of the soil proposed to be used for filling with the approval of Engineer-in-charge. The following tests shall be carried out by the CONTRACTOR in a approved laboratory / Test house at his own cost. The earthwork in filling shall be carried out only with the material duly approved by Engineer-in-charge. The tests shall be carried out for the following characteristics of soil.

- (i) Mechanical analysis or grain size distribution as per IS : 2720 Part IV.
- (ii) Liquid Limit as per IS: 2720 Part V
- (iii) Plastic Limit as per IS: 2720 Part V
- (iv) Moisture density relationship as per IS: 2720 Part VII.

The soil used for filling shall be free from boulders, lumps, tree roots, rubbish or from any other organic deleterious matter.

Soil having plasticity index less than 20 shall be used for filling purpose.

Soil having laboratory maximum dry density of less than 1.5 gm/cc shall not be used for filling purpose.

212 Protection

Specified trees, bushes, shrubs, structures, fencing and other objects marked as exceptions, shall remain and shall be protected from damage during the progress of work.

CONTRACTOR shall provide all necessary protective measures for the safety of public and workmen.

CONTRACTOR shall provide adequate and approved means for properly protecting existing facilities, adjacent buildings, pavements, landscaped areas bench mark, site survey reference points and other installation in the area of operations.

All cost resulting from any damage due to negligence of the CONTRACTOR shall be borne by the CONTRACTOR.

213 Clearing, Grubbing and Stripping of Top Soil

Clearing operation shall consists of the cutting and removal of bushes, roots, vegetation, plantation trees, shrubs, trees up to 30 cms girth, organic and other objectionable materials up to a depth of 150 mm. All these shall be completely uprooted and virgin soil should be exposed.

Grubbing operation shall consist of removal of all stumps, roots and other objectionable material to a minimum depth of 1.0 M below Natural Ground Level and filling up of the resulting holes up to the surrounding Natural Ground Level with a good quality approved earth. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and the areas compacted to obtain 90% of maximum laboratory dry density of soil, as per IS:2720 Part VII. The depth of stripping shall be generally 50 – 150 mm as desired by the Engineer-in-charge.

Material obtained from clearing shall be stacked or disposed off as directed by the Engineer-in-charge.

214 Cutting Trees

All trees not marked for preservation shall be cut down and their roots dug up to a depth of 1.0 M from the existing ground level.

All holes or hollows produced by digging up roots shall be carefully filled with approved soil including all leads and lifts rammed and compacted to obtain 90% of maximum laboratory dry density of soil.

All uprooted trees shall be stacked or disposed off as directed by the Engineer-in-charge.

215 Earthwork in Excavation / Cutting for Site Grading

After clearing, grubbing and stripping of top soil as described in Clause no. 5, spot levels at regular intervals and pattern shall be taken jointly by the CONTRACTOR and the Engineer-in-charge.

If the CONTRACTOR excavates/cuts beyond the required level, additional quantity of earth shall not be paid for. The excavation taken below the specified level shall be made good by filling with approved material to the required compaction at Contractor's cost.

The areas under excavation for site grading shall be levelled properly.

If required, shoring and strutting shall be provided by the CONTRACTOR.

If required, de-watering shall also be carried out by the CONTRACTOR.

216 Earthwork In Filling

After clearing, grubbing and stripping of top soil as described in Clause No. 5, spot levels at regular intervals and pattern shall be taken jointly by the CONTRACTOR and the Engineer-in-charge.

The CONTRACTOR has to make his own approach and access roads from the borrow area to the demarcated filling areas. OWNER does not guarantee any passage or right of way for the CONTRACTOR other than available at site. No claim shall be admissible to the CONTRACTOR on

account of his having to take longer leads or routes for earth movement than envisaged by him, either due to road cuttings, non-availability of routes, or any other ground whatsoever.

Earth from borrow areas required for filling can be used only after the available earth from excavation has been utilised and clearance to this effect obtained from the Engineer-in-charge.

Approved fill material shall be laid in layers not exceeding 300 mm loose thickness. Each layer shall be uniformly compacted by earth moving and spreading equipment to achieve a dry density equal to 90 % of dry density obtained by compaction using Standard Proctor Test.

Earth layer shall be tested in field for density and approved by Engineer-in-charge subject to achieving the required density before laying the next layer. A minimum of one test per 500 sq. m. for each layer shall be conducted.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-charge, to obtain the required density.

The filling shall be finished in conformity with the alignment, levels, cross-section and dimensions as shown in the drawings.

217 Tolerances

General site grading including cutting and filling in depressions shall be carried out to within up down tolerance of ± 5 cms of final lines, grades and slopes.

218 Removal of Surplus Earth

Surplus earth, if any, shall be removed from site to an area outside refinery boundary with prior approval of the Engineer-in-charge. EPCC Contractor shall be responsible to identify the area outside/inside the GNFC boundary to dispose the surplus earth.

219 Quality Assurance

A testing laboratory shall be arranged by the CONTRACTOR to perform the required testing on fill materials and soil compaction.

The CONTRACTOR shall take minimum one sample per layer for every 500 sq. m. of compacted filling.

**Standard Specification
for
Kerb Stone A-25**

The work shall consist of providing and fixing precast concrete kerb stone of gray cement base concrete block 30 cm length, 30 cm height and 15 cm thick of M-250 grade concrete as per approved design.

The pre cast Cement Concrete Kerb block of specified size shall be made from M250 grade cement concrete. The kerb block shall be fixed in position in true line and level as directed by the Engineer in charge. Necessary excavation shall be carried out and kerb blocks shall be fixed in position. The joint between kerb blocks shall be filled with C.M. 1:3 (1 cement : 3 sand) and it shall be cured properly.

The item shall be measured as finished work in running meter.

Unit rate for concrete kerb stone shall include the cost of all materials, labour for excavation, fixing in position, finishing, curing, etc. complete.

**Standard Specification
for
Rubber dye inter locking
concrete block A-26**

RAW MATERIAL

CEMENT :-

The cement used in the manufacture of high quality pre-cast concrete paving block shall be conforming to IS 12269 (53 grade ordinary Portland Cement) or IS 8112 (43 grade ordinary Portland Cement). The minimum cement content in concrete used for making paver blocks should be 310 Kg/Cu.M. and the upper limit of cement shall not be more than 425 kg./Cu.M.

AGGREGATES :-

The fine and coarse aggregates shall consist of naturally occurring crushed or uncrushed materials which, apart from the grading requirements comply with IS 383-1970. The fine aggregates used shall contain a minimum of 25% natural silicon sand. Lime stone aggregates shall not be used. Aggregates shall contain no more than 3% by weight of clay and shall be free from deleterious salts and contaminants.

WATER :-

The water shall be clean and free from any deleterious matter. It shall meet the requirements stipulated in IS: 456-2000.

OTHER MATERIALS :-

Any other material / ingredients used in the concrete shall conform to latest IS specifications.

PAVER BLOCKS CHARACTERISTICS

The concrete pavers should have perpendicularities after release from the mould and the same should be retained until the laying.

The surface should be of anti-skid and anti glare type. The paver should have uniform chamfers to facilitate easy drainage of surface run off.

The pavers should have uniform interlocking space of 2 mm to 3 mm to ensure compacted sand filling after vibration on the paver surface.

The concrete mix design should be followed for each batch of materials separately and automatic batching plant is to be used to achieve uniformity in strength and quality.

The pavers shall be manufactured in single layer only.

Skilled labour should be employed for laying blocks to ensure line and level for laying, desired shape of the surface and adequate compaction of the sand in the joints.

LAYING OF PAVER BLOCKS :-

PRIMING :-

It will be responsibilities of the Contractors to ensure that the manhole/pipeline cable trenches/circular drainage system etc. raised to driveway level using the requisite materials as per instruction of Engineer. The areas of potholes/deep depressions at the isolated locations also have to be filled up before laying the paver blocks. No extra payments will be made for this purpose.

It will be the responsibility of the Contractor to ensure that undulations on the paver blocks are eliminated after the traffic is allowed on it. Proper slope for drainage of water needs to be ensured by the Contractor. All necessary materials, tools, tackles are required to be arranged by the Contractor.

BEDDING SAND COURSE :-

The bedding sand shall consist of a clean well graded sand passing through 4.75 mm sieve and suitable for concrete. The bedding should be from either a single source or blended to achieve the following grading.

In sieve size	% passed
9.52 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	60-100
600 microns	25-60
300 microns	10-30
150 microns	5-15
75 microns	0-10

Contractor shall be responsible to ensure that single-sized, gap graded sands or sands containing an excessive amount of fines or plastic fines are not used. The sand particles should preferably be sharp not rounded as sharp sand possess higher strength and resist the migration of sand from under the block to less frequently areas even though sharp sands are relatively more difficult to compact than rounded sands, the use of sharp sands is preferred for the more of any deleterious soluble salts or other contaminants likely to cause efflorescence.

The sand shall be of uniform moisture content and within 4% - 8% when spread and shall be protected against rain when stock piled prior to spreading. Saturated sand shall not be used. The bedding sand shall be spread loose in a uniform layer as per drawing. The compacted uniform thickness shall be of 45 mm and with + / - 5 mm. Thickness variation shall not be used to correct irregularities in the base course surface.

The spread sand shall be carefully maintained in a loose dry condition and protected against pre-compaction both prior to and following screening. Any pre-compacted sand or screened sand left overnight shall be loosened before further laying of paving blocks take place.

Sand shall be slightly screened in a loose condition to the pre-determined depth only slightly ahead of the laying of paving unit.

Any depressions in the screened sand exceeding 5 mm shall be loosened, raked and re-screened before laying of paving blocks.

6.4.0 LAYING OF INTERLOCKING PAVER BLOCKS :-

Paver blocks shall be laid in herringbone laying pattern throughout the pavement. Once the laying pattern has been established, it shall continue without interruption over the entire. Pavement surface. Cutting of blocks, the use of infill concrete or discontinuities in laying pattern is not be permitted in other than approved locations.

Paver blocks shall be placed on the un-compacted screened sand bed to the nominated laying pattern, care being taken to maintain the specified bond through out the job. The first row shall be located next to an edge restraint. Specially manufactured edge paving blocks are permitted or edge blocks may be cut using a power saw, a mechanical or hydraulic guillotine, bolster or other approved cutting machine.

Paver blocks shall be placed to achieve gaps nominally 2 to 3 mm wide between adjacent paving joints. No join shall be less 1.5 mm not more that 4 mm. Frequent use of string lines shall be used to check alignment. In this regard the "laying face" shall be checked at least every two meters as the face proceeds. Should the face become out of alignment, it must be corrected prior to initial compaction and before further laying job is proceeded with.

In each row, all full blocked shall be laid first. Closure blocks shall be cut and fitted subsequently. Such closer blocks shall consist of not less than 25% of a full blocks.

To infill spaces between 25 mm and 50 mm wide concrete having screened sand, coarse aggregate mix shall

be used. Within such mix the nominal aggregate size shall not exceed one third the smallest dimension of the infill space. For smaller spaces dry packed mortar shall be used.

Except where it is necessary to correct any minor variations occurring in the laying bond, the paver blocks shall not be hammered into position. Where adjustment of paver blocks necessary care shall be taken to avoid premature compaction of the sand bedding.

6.4.1 INITIAL COMPACTION :-

After laying the paver blocks, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than two (2) passes of a suitable plate compactor. The compactor shall be a high-frequency, low amplitude mechanical flat plate vibrator having plate area sufficient to cover a minimum of twelve paving blocks. Prior to compaction all debris shall be removed from the surface.

Compaction shall proceed as closely as possible following laying and prior to any traffic. Compaction shall not, however, be attempted within one metre of the laying face. Compaction shall continue until lipping has been eliminated between adjoining blocks. Joints shall then be filled and re-compacted as described in Cl. 3.5.

All work further than one metre from the laying face shall be left fully compacted at the completion of each day's laying.

Any blocks that are structurally damaged prior to or during compaction shall be immediately removed and replaced.

Sufficient plate compactors shall be maintained at the paving site for both bedding compaction and joint filling.

8.4.2 JOINT FILLING AND FINAL COMPACTION :-

As soon as possible after compaction and in any case prior to the termination of work on that day and prior to the acceptance of vehicular traffic, sand for joint filling shall be spread over the pavement.

Joints sand shall pass a 2.36 mm (No. 8) sieve and shall be free of soluble salts or contaminants likely to cause efflorescence. The same shall comply with the following grading limits.

In sieve size	% passed
2.36 mm	100
1.18 mm	90-100
600 microns	60-90
300 microns	30-60
150 microns	15-30
75 microns	10-20

The Contractor shall supply a sample of the jointing sand to be used in the contract prior to delivering any such materials to site for incorporation in the works. Certificates of test results issued by a recognized testing laboratory confirming that the samples conform to the requirements of this specification shall accompany the sample.

The jointing sand shall be broomed to fill the joints. Excess sand shall then be removed from the pavement surface and the jointing sand shall be compacted with not less than one (1) Pass by the plate vibrator and joints refilled with sand to full depth. This procedure shall be repeated until all joints are completely filled with sand. No traffic shall be permitted to use the pavement until all joints have been completely filled with sand and compacted.

Both the sand and paver block shall be dry when sand is spread and broomed into the joints to prevent premature setting of sand.

The difference in level (lipping) between adjacent blocks shall not exceed 3 mm with not more than 1% in any 3 mm x 3 mm area exceeding 2 mm. Pavement which is deformed beyond above limits after final compaction shall be taken out and reconstructed to the satisfaction of the Engineer.

9.4.3 EDGE RESTRAINT :-

Edge restrains need to be sufficiently robust to withstand override by the anticipated traffic, to withstand thermal expansion and to prevent loss of the laying course material from beneath the surface course. The edge restraint should present a vertical face down to the level of the underside of the laying course.

The surface course should not be vibrated until the edge restraint, together with any bedding or concrete hunching, has gained sufficient strength. It is essential that edge restraints are adequately secured.

6.5 SAMPLING AND TESTING PROCEDURES FOR PAVE BLOCKS :-

6.5.1 SAMPLE SIZE :-

Internal - Average of minimum 3 samples per 5000 blocks – for paver block manufacturers.

External – Minimum 2 blocks per 10000 blocks, Average of minimum 8 blocks per site – for captioned contractors.

6.5.2 SAMPLING FOR TESTING :-

Sampling for testing of paver blocks shall be done in accordance with Appendix-A.

6.5.3 COMPRESSIVE STRENGTH :-

Testing for 28 days compressive strength shall be undertaken in accordance with Appendix-B. The average compressive strength of 60 mm thick paver blocks tested shall be 25 MPa.

Note:- 10% lower tolerance limit in compressive strength shall be allowed.

6.5.4 WATER ABSORPTION :-

Testing for water absorption shall be in accordance with IS 2185:1979: Part I (Specifications for concrete masonry blocks) Appendix–C.

APPENDIX-A

SAMPLING OF PAVER BLOCKS :-

Method of Sampling :

The paver blocks required for carrying out the tests, a sample of 20 blocks shall be taken from every consignment of 4000 blocks or part thereof the same size, shape and thickness and the same batch of manufacture from these samples the blocks shall be taken at random for conducting the tests

6.5.5 MARKING AND IDENTIFICATION :-

All samples shall be clearly marked at the time of sampling in such a way that the designated section of part thereof and the consignment represented by the sample are clearly defined.

The sample shall be dispatched to the approved test laboratory taking precaution to avoid damage to the paving in transit. Protect the paving from damage and contamination until they have been tested. The samples shall be stored in water at 20°C + 5°C for 24 hours prior to testing.

APPENDIX-B

PROCEDURE FOR TESTING OF COMPRESSIVE STRENGTH FOR PAVER BLOCK

Reference: BS 6717 Part I (1993) Specification for Paver Blocks

B-1 Testing Machine: The testing machines shall be of suitable capacity for the test and capable of applying the load at the rate specified. It shall comply, as regards repeatability and accuracy with the requirements of relevant IS specification.

B-2 Procedure: The sample specimens shall be tested in wet condition after being stored at least 24 hours, in water maintained at a temperature of 20°C + 5°C before the specimens are submerged in water, the

necessary area shall be determined.

The plates of the testing machine shall be wiped clean and any loose grit or other material removed from the contact faces of the specimen. Plywood nominally 4 mm thick, shall be used as packing between the upper and lower faces of the specimen and the machine plates, and these boards shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested. The specimen shall be placed in the machine with the wearing surface in a horizontal plane and in such a way that the axes of the specimen are aligned with those of the machine plates. The load shall be applied without shock and increased continuously at the rate of approximately 15 maximum load applied to the specimen shall be recorded.

B-3 CALCULATION OF CORRECTED STRENGTH :

The compressive strength of each block specimen shall be calculated by dividing the maximum load by full cross section area and multiplying by an appropriate factor.

Thickness and Chamfer Correction Factors

For Compressive Strength

Work size Thickness in mm	Correction Factors	
	Plain Block	Chamfered Block
60	1.00	1.06
80	1.12	1.08
100	1.18	1.24

B-4 COMPRESSIVE STRENGTH CALCULATIONS :-

The average corrected compressive strength for the designed block section shall be calculated.

APPENDIX-C

METHOD FOR THE DETERMINATION OF WATER ABSORPTION :-

The test specimens shall be completely immersed in water at room temperature for 24 hours. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water.

They shall be removed from the water and allowed to drain for one minute visible surfaces water being removed with a damp cloth and immediately weighed.

Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100 to 115°C for not less than 24 hours and until two successive weightings at intervals of 2 hours show an increment of loss not greater, than 0.2 percent of the last previously determined mass of the specimen.

Calculate the absorption as follows:

$$\text{Absorption, Kg/m}^3 = \frac{A - B}{B - C} \times 10000$$

$$\text{Absorption, percent} = \frac{A - B}{B} \times 100$$

A = wet mass of unit in kg.

B = dry mass of unit in kg. And

C = suspended immersed mass, of unit in kg.

MODE OF MEASUREMENT AND PAYMENT

The rate includes cost of all labour, materials, tools and plants etc. required for satisfactory completion of these items. The rate shall be for a unit of One square met.

**Standard Specification
for
Polycarbonate Roofing Sheet**

A-27

1.0. Materials

All structural Steel shall conform to I.S. 226-1985: The steel shall be free from the defects mentioned in I.S. 226-1975 and shall have a smooth finish. The material shall be free from loose mill scale, rust pits or other defects affecting the strength and durability. River bars shall conform to I.S. 1148-1973.

1.1 When the steel is supplied by the Contractor test certificate of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

1.2 Red lead paint shall conform to I.S. : 102-1962.

2.0. Workmanship

2.1. The steel sections as specified or required, shall be cut, square and to correct lengths, as per drawings and design. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member, except as indicated in the drawing or as directed. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permited.

2.2. Steel riveted or bolted in built up sections, frame work.

2.2.1. The steel structure as shown in the drawings or as per direction of the Engineer-in-charge shall be laid out on a level platform to full scale and to full size in parts. A steel tape shall be used for measurements to ensure maximum accuracy.

2.2.2. Wooden templates 12 mm. to 19 mm. thick or metal sheet template shall be made to correspond to each connecting gussets plate and rivet holes shall be accurately marked on them and drilled. The templates shall be laid on the steel members and holes of the steel members shall also be marked for cutting. The base of steel column and the position of Anchor bolts shall be carefully set out

2.2.3. Ail stiffeners shall be formed by pressure and where practicable the metal shall not to be cut and welded in making these. In major work, or where so specified, shop drawings giving complete details and information for the fabrication of the component parts of the structure including location, type, size, (origin and details of rivets, bolts or weld shall be prepared in advance of the actual fabrication and as distinctly marked or stenciled with paint with the identification mark as given in the shop drawings. The bars shall be thickened at the ends, so as to provide for screwed threads and gradually tapered off to meet their normal section.

Great accuracy shall be observed in fabrication of various member, so that these can be assembled without being unduly packed, stained, or forced into position and when build up, shall be true and free from twists, brinks, buckles, or open joints.

Before making holes in individual members for fabrication the steel work intended to be riveted or belted together shall be as ambled or clamped properly and tightly so as to ensure close abutting or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or crossed true and straight and fitted close together. Web splice plates and tillers under stiffened shall be cut to fit within 3 mm. or flange Angles Web plates of Girders shall have no cover. Plates, shall have their ends flush with the top of angles forming the flanges unless otherwise required. The web plates when spiced shall have clearance of not more than 6 mm. The erection, clearance for created ends of members connecting steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm. at each end but where for a practical reason greater clearance is necessary, suitably designed seating shall be provided.

Rollers shall be accurately tuned to gauge. These straight and smooth and free from flaws. The roller bearing shall be provided with adequate arrangements for holding the girders or truss resting on it. In columns caps and bases, the ends of shifts together with the attached gussets Angles, channels etc after riveting together shall be accurately mechanized so that the parts connected butt against each other over the entire surfaces of contact connecting angles or channels shall be fabricated and placed in position with greater accuracy so that they are not unduly reduced in thickness by machining. The ends of bearing stiffeners shall be mechanized or ground to fit tightly both at the top and bottom, All holes shall generally be drilled to the required size and at required, position. Sub punching shall be permitted provided it is done 3 mm. or less in diameter and reamer thereafter to the required size. The holes for rivets and bolts shall be larger by 0.4 to 6 mm. than the nominal diameter of rivets or bolts depending upon the diameter of rivets.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes should be clean and accurate holes for counter sunk bolts shall be made in such a manner that their heads fit flush with the surface after fixing.

The fabrication work shall be completed in workshop as far as it is practicable to do so. Site joints shall be done with rivets and fitted bolts or black bolts, as shown in the drawings or as directed. Generally the following principles shall govern the use of rivets turned and fitted bolts, and black bolts.

(i) Rivets and turned and fitted bolts shall be used where the connections is such that slip under load has to be avoided.

(ii) Black bolts may be used very sparingly where a force is carried through a connection without impact, vibration or reversal or stresses.

2.2.4. Riveting:

The parts assembled for riveting shall be in close contact with each other and the bearing stiffeners shall bear tightly both at top and bottom without being drawn or caulked. Members to be riveted shall be properly pinned or bolted and rigidly held to gather while riveting. Drifting of holes shall not be permitted Except to draw the parts together and the drifting tools so used shall have maximum diameter not exceeding, the nominal diameter of rivets or bolts. Drifting done during assembling shall not distort the metal or enlarge the holes.

The shanks of rivets shall project beyond the plate-surface sufficiently so as to fill hole thoroughly and form the required head after riveting.

The riveting shall be done by hydraulic or pneumatic process. However, where such facilities are not available, hand riveting may be permitted. The rivet shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10 mm. may be fitted cold. Rivets shall be of heat finish with heads full and of equal size. All loose, burnt or badly formed rivets with concentric or deficient heads shall be cut out and replaced. The heads of rivets shall be central to shanks and shall grip the assembled member firmly. In cutting out rivets, care shall be taken so as not to injure assembled members, caulking or reequipping shall not be permitted.

For testing rivets, a hammer weighing approximately 0.25 kg shall be used. Both heads of the rivets shall be tapped, slack rivets will give a hollow sound and a jar.

All rivet heads shall be painted with red lead paint within a week of their fixing.

2.2.5. All bolt heads and nuts shall be hexagonal and of equal size unless specified otherwise. The screwed heads shall conform to I.S. 1363-1960 and the threaded surface shall not be tapered. The bolts shall be of such length so as to project two clear threads beyond the nuts when fixed in position and these shall fit in the holes without any shakes. The nut shall be fit in the threaded ends of bolts properly.

Where turned and fitted bolts are required to be used in place of rivets shall be provided with washers not less than 6 mm. thick so that the nut when tightened shall not bear on the unthreaded body of the bolt. Tapered washers shall be provided for all heads and nuts bearing on leveled surfaces. The threaded portion of the bolt shall not be within the thickness of the parts bolted together, the faces of the bolt heads and nuts abutting against steel members shall be machine finished. Where there is a risk of the nut being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of locknuts, spring washers, cross-cutting or hammering down of threads as directed.

Bolts, nuts, and washers shall be thoroughly cleaned and dipped in double boiled linseed oil before use. The whole steel work shall be painted with a coat of priming coat of red lead, as per relevant specification of painting.

3.0 Mode of measurements & payment

3.1. The steel work shall be measured in general as under:

(a) All work shall be measured on the basis of finished dimensions as fixed at site and measured net unless specified otherwise.

(b) The weight of steel sections, steel rods, and steel strips in finished work shall be calculated from standard weight on the same basis on which steel is supplied to Contractor by department or those given in relevant I.S. : if steel is arranged by the contractor.

(c) The weight of steel plates and strips shall be taken from relevant I.S. based on 7.35 kg./ sq. meter for every millimeter sheet thickness if steel is supplied to the contractor by department.

(d) Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washer, distance pieces, separators, diaphragm gusset (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items.

(e) In riveted work allowance is to be made for weight of rivet heads. No deductions shall be made for rivet or bolt holes excluding holes for anchor or holding down bolts.

(f) For forged steel and steel castings, weight shall be calculated on the basis of 7850 kg./cum.

(g) Unless otherwise specified, no allowance shall be made for the weld metal in case of welded steel structure.

- (i) Dimensions other than cross sections and thickness of plates shall be measured to nearest 0.001m
- (j) Mill tolerance shall be ignored when weight is determined by calculation.

3.2. The rate includes cost of all material, labour, erection, hoisting scaffolding, protective measure, required for proper completion of the item of work. This shall also include conveyance and delivery handling, loading, unloading and storing etc. required for completing the item described above including necessary wastage involved.

1.2. Welding shall generally be done by electric process. Gas welding shall be resorted to, using oxyacetylene flame with specific prior approval. Gas welding shall not be permitted for structural steel work.

1.3. The work shall be done as shown in the shop drawings which should clearly indicate various details of the joints to be welded, shop and site welded as well as type of electrodes to be used, symbol for welding on plans and shop drawings shall be according to I.S. 813-1961. As far as possible every effort shall be made to limit the welding that must be done after improper welding that is likely to be done due to heights and difficult positions on scaffoldings etc. The welding work shall conform to I.S. 816-1969.

1.4. Preparation of surfaces: Surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

1.5. Assembly for welding: Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the plates accurately in place without displacement.

1.6. Precautions: All operations connected with welding and cutting equipment shall conform to safety requirement given in I.S. 818-1968.

The following points shall be borne in mind during the process of welding:

(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.

(c) The segments of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.

1.7. Defective welds which shall be considered harmful to the structural strength shall be cut out and reworked.

1.8. Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed. Welds and adjacent parts shall be oil painted after they are approved.

1.9. All the members shall be thoroughly cleaned of rust-scales, dust etc. and given a priming coat of red lead paint before fixing them in position.

Testing of welding to be added in the specification I.N. 12.2.2.12-(i) to (viii)

Material & Workshop for Polycarbonate Sheet

1.10 Best Quality of 10mm thick polycarbonate sheet as approved by engineer.

50mm X 3mm thick strip profile.

25mm X 4mm aluminum Patti.

25mm size machine bolt.

Workmanship

1.11 It shall be carried out as per item No. 15.1 Page no 104 except that proper fixing sheet with 50mm X 3mm thick bottom strip profile & top of 25mm X 4mm thick aluminum Patti for end with fixing with 25mm size machine bolt of spacing of 25 complete. With line & level as directed by engineer in charge etc complete

Mode of measurement & Payment:

The Rate of item including all type of materials, labour, tools, plant and machinery & paid on the basis of sq. mtr.

**Standard Specification
for
Structural Glazing
A-28**

MATERIAL

Main frame shall be of colored anodized aluminum frame section having standard weight per running meter of adequate size hollow sections as described in details in item of schedule B

Aluminum alloy used in the manufacture of extruded window section shall confirm to IS designation HEA-WP of IS 733-1975 and also designation WVG-WP of IS-1285-1975 section shall be as specified in the drawing and design.

All sections shall be free from any scratches or holes or any damages on surface. All section shall have finished luster surface on all sides.

Antiglare colored glass

The glass sheet shall be antiglare and of approved color and quality equivalent to globin India having specified thickness the sheet shall be as per M-39 page NO. 30 of general technical specification booklet.

Glass shall be in specified size or as directed by engineer in charge for glazing as specified or as directed by engineer in charge.

All glass shall be of the brief quality, free from specks, bubbles,. Smokes, veins, air holes blisters and other defects. The kind of glass to be used shall be as mentioned in the item specification or in the special provision or as shown in detailed drawings. Thickness of glass panels shall be uniform. The specification for different kinds of glass shall be as under.

In absence of ay specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 7.5 kg/sq. m. for panels up to 600 mm x 600 mm.

For panels larger than 600 mm x 600 mm and up to 800 mm x800 mm the glass weighing not less than 8.75 kg/sq. m shall be used for bigger panels upto 900 mm x 900 mm .Glass weighing not less than 8.75 kg/sq. m shall be used. For bigger panels up to 900 mm x 900 mm .glass weighing not less than 11.25 kg/sq. m. shall be used.

Sheet glass shall be patent flattened glass of best quality and for glazing and framing purpose shall conform to I.S. 1761-1960. Sheet glass of the specified colors shall be used, if so shown , on detailed drawings or so specified for important buildings and for panels with any dimension over 900 mm plate glass of specified thickness shall be used.

Structural silicon sealant GE-SSG4000

Structural silicon sealant GE-SSG4000 shall be of approved brand and make as approved by engineer in charge. Holes or any damages on surface. And shall have finished luster surface on all sides.

Workmanship

The structural glaze panels shall be fabricated as contractors own structural design and as directed by engineer in charge, only approved material shall be used in structural glaze panels color of anodizing shall be approved color and shall be anodized up to the satisfaction of engineer in charge. Complete structural glaze panels shall be fixed in position in true line and level and shall be got tested as shown in the drawing as per instruction of engineer in charge.

Mode of measurement & payment

The item shall be measured for its breadth and height limiting dimensions to those specified on plan or as directed .The rate shall be for a unit of one square meter.

The payment will be made on square meter basis of the finished work.

The rate shall be for a unit of one square meter.