

Sub Section 3 Civil Specifications

1 GENERAL

1.1 SPECIFICATION DRAWINGS

The site plan, schematic flow diagram and layout plan drawings of the proposed work(s)/plant(s) are incorporated in tender documents. These drawings are made for Tenderer's guidance only.

The Contractor will have to submit detailed design as well as General Arrangement drawings as well as structural drawings to the Engineer-in-Charge and obtain prior approval to start the construction, erection and commissioning of civil, electrical and mechanical components of the SPS and STP.

Work shall be carried out by Contractor exactly in accordance with the Drawings marked as RELEASED FOR CONSTRUCTION and approved by Engineer-in-Charge and as per the instructions of the Engineer-in-Charge in writing.

1.2 GEO-TECHNICAL STUDIES

The bidders are free to visit and inspect the sites till the submission date for the purpose of quoting and estimation. The Contractor shall carry out geo-technical studies at their cost at the site and with prior permission of Engineer-in-Charge, from MBMC approved soil consultant and the report should be furnished to the MBMC/Consultant and should be approved by MBMC/Consultant prior to start of structural design & drawings. MBMC accepts no responsibility, whatsoever for inferences drawn from this data and the Contractor is to satisfy MBMC on his own responsibility as to the extent to which this information represents the conditions to be encountered.

1.3 MATERIALS

The term "Materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and SPS and plant of every kind to be supplied by the Contractor for incorporation in the works.

Except as may be otherwise specified for particular parts of the Works the provision of clauses in "materials and workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be approved by the Engineer in-charge.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

2 SPECIFIC CIVIL REQUIREMENTS

2.1 DESIGN SUBMISSIONS

The Contractor shall submit complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches to the MBMC. Separate calculations for foundations or superstructures submitted independent of each other should be deemed to be incomplete and will not be accepted by the MBMC.

The design considerations described herewith establish the minimum basic requirements of plain and reinforcement concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of structure partly constructed to comply with design loads.

2.2 DESIGN STANDARDS

All designs shall be based on the latest International or Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the MBMC. In case of any variation or contradiction between the provision of the IS Standards or Code and the specifications given with the submitted tender document, the provision given in the Specification shall be followed.

2.3 DESIGN LOADINGS

All building and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads and uplift pressure.

2.3.1 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents shall be considered.

The following minimum loads shall be considered in design of structures:

Sr.	Parameter	Load
(i)	Weight of water	10.0 kN/cu.m
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc) However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	
		20.0 kN/cu.m
(iii)	Weight of plain concrete	24.0 kN/cu.m
(iv)	Weight of reinforced concrete	25.0 kN/cu.m
(v)	Weight of brickwork (exclusive of plaster)	22.0 kN/cu.m per mm thickness of brickwork
(vi)	Weight of plaster to masonry surface	18.0 kN/cu.m per mm thickness
(vii)	Weight of granolithic terrazzo finish or rendering screed, etc	24.0 kN/cu.m per mm thickness
(viii)	Weight of sand (filter media)	24.0 kN/cu.m

2.3.2 Live Load

Live loads shall be in general as per IS 875. However, the following minimum loads shall be considered in the design of structures.

Sr.	Location	Live Loads
1.	Office, Conference Hall	400 kg/sq.m
2.	Floor supporting Pumping Machinery	1,000 kg/sq.m
3.	Storage	750 kg/sq.m
4.	Platform, Staircase, Corridors, Walkways	500 kg/sq.m
5.	Administration Building – Hall, Toilet	200 kg/sq.m
6.	Laboratory	400 kg/sq.m
7.	Roof Slab	150 kg/sq.m

In the absence of any suitable provisions for live loads in IS Codes or as given above for

any particular type of floor or structure, assumptions made must receive the approval of the MBMC prior to starting the design work. Apart from the specified live loads or any other loads due to material stored any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

2.3.3 Wind Load

Wind loads shall be as per IS:875

2.3.4 Earthquake Load

This shall be computed as per IS:1893 considering in Zone-V.

2.3.5 Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, traveling cranes, etc shall be considered in the design of structures.

2.3.6 Other Loads

In addition to earth pressure and water pressure etc., the surcharge of 1 Ton/sq.m shall be taken into account in the design for channels, tanks, pit, sludge settler, etc.

2.4 JOINTS

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure as per relevant

IS code provisions. Expansion joints of suitable gap at intervals not more than 30 m

shall be provided in walls, floors and roof slabs of Liquid Retaining Structures.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2 m height, PVC water stops of suitable type and approved make, minimum 230 mm width, 6 m thick shall be used for walls and base slabs.

2.5 DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND LIQUID RETAINING STRUCTURES

All underground or partly underground liquid containing structures shall be designed for the following conditions:

1. Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered.
2. Structure empty (i.e. empty of liquid, any material, etc) full earth pressures including saturated condition and surcharge pressure wherever applicable to be considered.
3. Partition wall between dry sump and wet sump to be designed for full liquid depth up to full height of wall
4. Partition wall between two compartments to be designed as one compartment empty and other compartment full
5. Structures shall be designed for uplift in empty conditions with the water table indicated in the geotechnical report or high flood level, whichever is maximum. No reduction factor for the uplift force shall be considered.
6. The dead weight of the empty structures should provide a safety factor of not less than 1.2 against uplift pressures during construction and in service.
7. Wall shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
8. Underground or partially underground structures shall be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab
9. The walls and base slabs shall be designed for saturated earth/water pressure corresponding to high flood level or finished plot level whichever is higher

2.6 FOUNDATION

1. The minimum depth of foundations for all structures, equipment's buildings and frame foundations and load bearing walls shall be as per IS:1094.
2. The earth fill above virgin ground level till formation level shall be taken as a surcharge load and shall be added in the loads coming on foundations appropriately
3. Maximum safe bearing capacity of soil strata shall be taken as indicated in geotechnical reports.
4. Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.
5. Special attention is drawn to danger of uplift being caused by the ground water table
6. Plinth level of all structures/top of tanks shall be at least 500 mm above high flood level.

2.7 DESIGN REQUIREMENTS

The following are the design requirements for all reinforced or plain concrete structures:

1. All blinding and leveling concrete shall be minimum 100 mm thick in concrete grade M10 for Building & minimum 150 mm thick for Water Retaining Structure.
2. All structural reinforced concrete shall be with a maximum 40 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all the Water Retaining Structures & other structural members.
3. All liquid retaining structures shall be designed as per IS:3370. The minimum grade of concrete shall be M 25.
4. All new liquid retaining structures shall be form finished.
5. For all old liquid retaining structures inside finish shall be provided in CM 1:3 smooth cement plaster 20 mm thick and outside finish shall be 20 mm thick sand face plaster CM 1:3. Snowcem shall also be applied for finishing the outer surfaces.
6. Minimum Cement Content shall be 360 kg/cu.m for M 25.
7. The maximum free water cement ratio shall not exceed 0.40 for all liquid retaining structures.
8. The amount of reinforcement in each of the two directions at right angles within each surface zone should not be less than the minimum specified as IS:3370 or IS:456 which ever is applicable for the type of structure.
9. Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.
10. All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15.

The following minimum thickness shall be used for different reinforced concrete members irrespective of design thickness.

Sr.	Civil Member	Width (mm)
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(i)	Walls for liquid retaining structures	200
(ii)	Bottom slabs for liquid retaining structures	200
(iii)	Wall foundation for wall of liquid retaining structures	250
(iv)	Walls of Launderers	150
(v)	Base slab of Launderers	125
(vi)	Roof slabs/Domes for liquid retaining structures	125
(vii)	Floor slabs including roof slabs, walkways canopy slabs	100
(viii)	Walls of cables/pipe trenches, underground pits, etc	125
(ix)	Column footings – Edge Thickness	200
(x)	Column footings - at Face of Column	300
(xi)	Parapets, chajja	100
(xii)	Precast trench cover	75
(xiii)	Beam	230 (width) 300 (depth)

2.8 MINIMUM COVER TO MAIN REINFORCEMENT

Sr.	Member	Details	Cover (mm)
1.	Slab	Free Face	20
		Face in contact with earth	30
2.	Beam	Top/Bottom	30
		Side	30
		Face in contact with earth	40
3.	Column and pedestal	Super Structure	40
		Face in contact with earth	40
4.	Retaining wall, Basement wall	Face in contact with earth	30
		Free face	30
5.	Liquid Retaining Structure	Face in contact with liquid	40
		Face in contact with earth	40
		Free face	40
6.	Foundation	Bottom	60
		Top	60
		Sides	50

2.9 MINIMUM BAR DIAMETER

Sr.	Member	Diameter (mm)
	Major Foundation	10
	Block Foundation – Main Bars	10
	Block Foundation – Tie Bars	8
	Minor Foundation (Local Foundation etc.)	8
	Column, Pedestal – Main Bars	12
	Column, Pedestal – Ties	8
	Beam – Main Bars	12
	Beam – Anchor Bars	10
	Beam – Stirrups	8
	Slab – Main Bars	8
	Slab – Distribution Bars	8
	Wall – Main Bars	8
	Wall – Distribution Bars	8
	Minor elements such as chajjas, Lintel Beams etc.	8

2.10 BAR SPACING

The bar spacing shall be as per design and conform to IS: 456 – 2000.

Sr.	Member	Minimum (mm)	Maximum (mm)
(i)	Foundations	125	200
(ii)	Slabs	100	250
(iii)	Stirrups for Beams	100	250
(iv)	Ties for Columns, Pedestals	100	250
(v)	Walls	100	250

* Bar spacing shall be provided in multiple of 25 cm.

2.11 MATERIALS

2.11.1 General

The term “materials” shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in “Materials and Workmanship” shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the works, the Contractor shall inform the MBMC of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the MBMC which may be withheld until samples have been submitted and satisfactorily tested. The

Contractor shall thereafter keep the MBMC informed of orders for and delivery dates of all materials.

Materials shall be transported handled and stored in such a manner as to prevent deterioration damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

2.11.2 Cement

The Cement shall be Ordinary Portland Cement grade-43 / 53, conforming to the relevant BIS codes and approved by the MBMC. Manufacturers Test Certificate shall have to be furnished.

2.11.3 Reinforcement Steel

Reinforcement Steel shall conform to BIS Specification 432-1966 (with up to date revision) and B.I.S. Specification 1786-1985 (with up to date revision). Only Corrosion Resistant steel shall be used. If steel authority issues non availability/ non marketing certificate for C.R. steel, then epoxy paint for anti-corrosion on Tor Steel / TMT shall be done. Epoxy coating shall be done in stages i.e. pre-treatment, primer coating and final coating. The Contractor shall be required to produce the test certificate of the manufacturers to the department before use of Steel for the work. No untested steel shall be allowed under any circumstances. The Employer, however, reserves the right to get to steel tested at the cost of Contractor. The Epoxy coating of standard manufacturers i.e. Dr. Beck & Co., Ciba Atul and Fosroc (I) Ltd. shall only used as per specifications with prior approval of the Employer.

2.11.4 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per table below.

Sr.	Grade of Concrete	Minimum Cement Content in Concrete (kg/cum of finished Concrete)
(i)	M 15	300
(ii)	M 20	330
(iii)	M 25	360
(iv)	M 30	400

2.12 SAMPLES AND TESTS OF MATERIALS

The Contractor shall submit samples of such materials as may be required by the MBMC and shall carry out the specified tests directed by the MBMC at the site at the Site at the supplier's premises or at the laboratory approved by the MBMC. All testing charges shall be borne by the contractor.

Samples shall be submitted and tests carried out sufficiently

early to enable further samples to be submitted and tested if required by the MBMC.

The Contractor shall give the MBMC seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at

a laboratory approved by the MBMC. The MBMC shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the MBMC to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to MBMC within seven days

of every test such number of certified copies (not exceeding six) of the test results as the

MBMC may require.

Approval by the MBMC as to the placing of orders for materials or as to samples or tests shall not prejudice any of the MBMC powers under the Contract.

The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

2.13 ORIENTATION

The works shall be laid out within the confines of the site in order to be compatible with the existing infrastructure facilities, inlet and outlet pipe work /channels and nearby water bodies. Underground services requiring being relocated in order to accommodate the proposed site layout shall be relocated by the Contractor to alignments approved by the Employers Representative.

2.14 ROADWAYS, PATHWAYS & HARDSTANDINGS

A comprehensive network of roadways shall be provided around the treatment plant to link in with the existing approach road and permit access to the plant for necessary maintenance, delivery of consumables and personnel access. All roads shall be of Water Bound Macadam (WBM) with BM + AC of 4 m wide. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways shall be constructed to provide a network of logical routes inter-linking plant areas. Damage to any existing roads, on account of their use by the Contractor shall be made good to the satisfaction of the MBMC.

Hardstanding areas shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again.

2.15 SITE DRAINAGE

The Contractor shall provide a site drainage system. The system shall comprise of the following:

- Storm Water Drainage
- Foul Drainage

2.15.1 Storm Water Drainage

Storm water drains adjacent to the existing and proposed roads (under this Contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be in stone/brick masonry (1:5) of appropriate thickness topped

with 75 mm thick M10 concrete and internally flush pointed plastered in cement mortar (1:4) mm thick.

The storm water drainage system shall be designed to cater for the run-off from the existing plot areas and structures, if necessary.

2.15.2 Foul Drainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall be conveyed to the nearby sewer manhole.

2.16 CABLES AND PIPEWORK TRENCHES

Cables and pipe work trenches shall generally be constructed in reinforced concrete. However, 500mm x 500mm size or small trenches, not on fill may be constructed in 350 mm thick brick masonry (1:4). The trenches will be plastered internally with cement mortar (1:4) and externally in cement mortar (1:3).

Trenches within the buildings or Plant areas shall be covered with GI chequered plates, suitably painted and that outside the buildings shall be covered with M20 premoulded/branded precast RCC covers. The trenches shall be suitably sloped to drain rainwater.

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the MBMC while planning the works.

2.17 PIPES AND DUCTS

RCC ducts for drainage shall have adequate cover while laid under roads. Access shafts, where required shall not be of size less than not less than 600 mm x 1000 mm.

All drains (except storm water drains adjacent to roads) shall be covered and designed structurally for appropriate loads.

2.18 SOIL DATA & GROUND WATER TABLE

Geotechnical assessment report is enclosed herewith for the reference. However the contractor shall visit the site and should carry soil investigation and confirm the data at his own cost.

2.19 BUILDINGS AND STRUCTURES

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere:

1. All building works shall be reinforced concrete with concrete floors and roofs.

framework

2. All internal partition walls except for toilet shall be in 230 mm thick brick masonry built in cement mortar 1:5 with transomes and mullions as in (2) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transomes and mullions similar to (2) above and shall form panels not exceeding 1200 mm x 1200 mm in size.
3. Toilet floor slab shall be filled with brick bat cobs (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.
4. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.
5. The toilet facilities shall be provided in Administration-cum-Laboratory building separately for men and women which include at least :
 - i) 2 Nos. Toilet (1 no. for men and 1 no. for women) with white porcelain Orissa pan minimum 580 mm long with flushing cistern of 10 litres capacity.
 - ii) 2 Nos. wash basins (1 no. for men and 1 no. for women) of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.
 - iii) 2 Nos. mirrors (1 no. for men and 1 no. for women) of size 400 mm x 600 mm wall mounted type fitted over wash basins.
 - iv) 2 Nos. plastic liquid soap bottles (1 no. for men and 1 no. for women)
 - v) 2 Nos. chromium plated brass towel rails (1 no. for men and 1 no. for women) minimum 750 mm long.
 - vi) All stopcocks, valves and pillar cocks shall be heavy-duty chromium plated brass.
 - vii) All fittings such as "P" or "S" traps, floor traps, pipes, downtake pipes etc.
 - viii) The sewage from toilet blocks shall be led to the nearest MBMC sewerage network sewer line.
6. All staircase shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles of approved shade for risers set in cement mortar or lime mortar to give an overall thickness of 50 mm.
7. All floor cut-outs and cable ducts, etc. shall be covered with precast concrete covers

in outdoors areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with galvanised MS hand railing.
8. All staircases shall be provided with MS galvanised and MS hand railing for protection.
9. For the entire finished roof surface shall have adequate slope to drain quickly the rainwater to rainwater down take inlet points.
10. For roofing drainage, CI rainwater down takes with CI bell mouth and MS grating at top shall be provided. For roof areas up to 40 sq.m. minimum two nos. 100 mm diameter downtake pipes shall be provided. For every additional area of 40 sq.m. or part thereof, at least one no. 100 mm diameter downtake pipe shall be provided.
11. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rainwater.
12. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rainwater splashing into the building. The minimum width of chajja for doors, windows, and rolling shutter shall be 750 mm, 600 mm, and 900 mm respectively.
13. All windows and ventilators shall have 25 mm thick Tandoor/Kota stone stills bedded in cement mortar (1:3)
14. All concrete channels and ducts use for conveying liquid shall have

- inside width not be less than 500 mm. All open channels shall be provided with hand railings. Also all such channels, which are more than 1000 mm above finished plot level, shall be provided with walkways for access.
15. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factor Act.
 16. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of minimum capacity of 2 tons or more as required shall be provided with monorail and operating equipment.
 17. The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall be as far as is possible permit the entry of natural light.
 18. The Laboratory, Chlorine House and office building shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.
 19. The sidewalls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 15% ventilation areas. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect plant or stored materials.
 20. All walkways, staircase, platforms etc, shall be minimum 1200 mm wide and will be provided with hand railing on one or both sides as required.
 21. The floor shall generally be made of 150mm thick concrete slab on grade with 230 mm thick rubble soling and polyethylene sheet. The grade slab shall be provided with TOR 8 mm reinforcement Bars at 200 mm c/c both ways.
 22. All hardware fittings and fixtures for doors, windows and louvers (e.g. Hinges, bolts, locks, latches, stay doorstops, door closers, floor springs) shall be heavy type matching to the size and weight of the door/window/ventilator shutters. These shall operate easily without hindrance secure properly without jamming, require nominal maintenance durable under prevailing site/weather conditions.
 23. Suitable steps and/or ramp with overhead RCC Canopy shall be provided as per requirement, at the entrances of the buildings.
 24. 1,000 mm wide Plinth Protection (Apron) shall be provided all around the Building/Sheds.

2.20 ANTICORROSIVE TREATMENT

All the water retaining RCC structures shall be given anticorrosive treatment. The wall from inside shall be coated with polymer anticorrosive paint. It shall be elastomeric (450% elongation), thermoplastic, fire retardant. The coating skin shall have tensile strength of 18 to 21 kg/cm². It shall be antifungal and antibacterial. The polymer paint shall be of Meta-chem or equivalent make as approved by Engineer-in-charge.

2.21 PRESSURE GROUTING

2.21.1 Products

All components used for grouting repair system are to be of the approved makes of polymers. All components are the same make. No components of different makes can

from one to be of be used in

conjunction with each other. Only be MC Bauchemie product shall be used.

The product shall only be from the approved list of companies.

Proper care is to be taken when using the material to maintain the required consistency and purity.

Only polymer latexes based on Styrene butadiene (SBR), acrylics, polyvinyl acetate or expoxies can be used. The latex should have solid to a maximum of 50% and minimum of 40%. The physical chemical and structural properties of the material used are to be submitted and specific approval to be seek for the material/system, to be used.

2.21.2 Surface Inspection and Preparation

All surfaces to be treated are to be exposed to the base level with removal of all claddings, plasters, facaders, waterproof layers etc. The surface is to be examined for surface cracks, crevices and spalls and honey combing.

Concrete surface to which treatment is to be applied shall be freshly exposed parent concrete free of loose and unsound materials. Prepare surfaces by mechanical abrasion unless prohibited by environmental limitations in which case acid etching may be used.

Mechanical abrasion – Use sandblasting or scarifying or water blasting or other approved means.

ACID ETCHING - Etch surface with a commercial grade (22 deg. Baume) of hydrochloric acid diluted at a ratio of 10:90 to 20:80. After this application, scrub surface with a stiff bristled broom, or similar implement. Immediately after foaming action of acid has subsided, flush surface with water jets until all residue is removed. Repeat procedure until laitance is completely removed. Wash such areas with water at least three times and allow to air dry prior to further treatment. This method of cleaning

is to be used only in exceptional cases and under normal cases permission will not be given for use of this method.

Inspection of concrete surfaces prior to mortar application.

Inspect all concrete surfaces prior to application of mortar to ensure that requirements of this Article are met.

Surfaces shall be free of any deleterious materials such as laitance, curing compounds, dust, dirt and oil. Materials resulting, from surface preparation specified shall be removed.

All concrete surfaces shall be dry as defined in Article 20.2.2.3.2 below unless a water insensitive coating is used. Surface temperature shall be at least 40F to permit wetting of concrete surface by polymer coating.

Valuate moisture content for concrete by determining if

moisture

will collect at surfaces. This may be accomplished by taping a 4 x 4ft polyethylene sheet of concrete surface. If moisture collects on underside of polyethylene sheet before polymer would cure, then all concrete to dry sufficiently. Drying of the surfaces can be accomplished by either heating the surfaces by blow lamps or by use of sawdust, sand or any other means so that the surface is bone-dry.

2.21.3 Identification of Methods of Grouting

2.21.3.1 For All Surfaces having Cracks / Crevices:

Locate the cracks by either surface inspection or by scrubbing the surface. In case the cracks are not visible to naked eye use compressed air to clear marks. Having identified the cracks use light chisel or mechanical/electrical saw to clear the crack upto the depth of the crack. In case widening of the crack is necessary to reach the depth of the crack it is advisable to do so at this juncture.

After cleaning/widening the crack use compressed air/water jet to clean the opened crack surface. Ensure that the surface is dried in case water jet is used.

A method of grouting through rows of grout nipple is to be adopted for all such cases.

2.21.4 Grouting for Honey Combed Surfaces

For surface, which exhibits honeycombed concrete, the surface has to maintained in its dry state and a method of grouting through triangular grout nipples is to be adopted.

The opposite side to the grouting surface has to be sealed for flowing grout by either impervious cement plaster or by use of proper sealant as specified in the material to be used for grouting.

2.21.5 Size and Spacing of Nipples

To determine the size of nipples use a standard caliper or a metric scale and measure the width of the opened crack. The size of the nipple to be fixed within the crack has got to be minimum half the surface width of the crack measured above, but should not exceed 15 mm in dia.

The nipples to be used should be of metal with one end tapered and thickness should be sufficient to withstand 5 m head of water. The spacing for the crack depends inversely to the width of the crack and will not exceed more than 300 mm c/c and will not be less than 125 mm c/c. The number of nipples along the crack will always be a less than two rows of nipples that needs to be fixed parallel to the crack at the same distance as the nipples spacing in the crack so as to form equilateral triangle with the apex in the crack.

3 EARTHWORK AND EXCAVATION

3.1 RELAVENT IS CODE

- IS: 1200 : Method of Measurement for Building Works
 IS: 3764 : Safety code for Excavation Work
 IS: 3385 : Code of practice for measurement of civil engineering works
 IS: 2720 : Part II - Determination of Moisture Content
 : Part VII - Determination of Moisture content dry density relation using
 light compaction
 : Part VIII - Determination of Moisture Content Dry Density using
 heavy compaction
 : Part XXVIII - Determination of Dry Density of soils, in place, by
 the
 sand replacement method
 : Part XXIX - Determination of Dry Density of soils, in place, by the
 core cutter method.

3.2 EXCAVATION

3.2.1 Definitions

The following terms shall have the meanings hereby assigned to them:

- Top Soil** means any surface material, including turf, suitable for use in soiling areas
 to be grassed or cultivated.
- Excavation** means excavation in open cut (excluding trench excavation) down to levels required as per approved Drawings or otherwise as being the general levels after completion of excavation.

3.2.2 Site Clearance

All area of the Site, marked in the Specification Drawings shall be cleared to the extent required by the Engineer-in-Charge of all buildings, walls, gates, fence and other structure and obstructions of all bushes, hedges, trees, stumps, roots and other vegetation except for trees marked for preservation. Material so cleared shall so far as suitable be preserved and stacked will be the property of MBMC for further use but shall otherwise be burnt to ash or disposed off the Site as directed by the Engineer-in-Charge.

Before starting the work the site shall be cleared of

1. All shrubs, grass, and other vegetation including large and small bushes, all stumps, removal of roots, cutting and disposal of small trees up to 300 mm girth etc.
2. All the trees having girth above 300 mm. (the girth shall be measured at a height of 1.5 m above the ground level) by felling, logging, fashioning of timber and billeting of all branches, trunks etc. are including removal of all roots etc. complete as directed.
3. All serviceable reclaimed material shall be stacked separately at the site shown by the Engineer In Charge near the site of excavation and/or transported as directed by

Engineer In Charge

4. After the tree is cut and roots taken out the potholes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer in Charge otherwise. The trees shall be cut in suitable piece as instructed by the Engineer In Charge

3.2.3 General Excavation

1. General excavation means excavation in all types of solid like dry soil, wet soil, murum, boulders, hard strata, rock of any type at different depth and lift required for structures and from borrow areas, and shall not include trench excavation. General excavation may also include miscellaneous isolated lengths of trenches beneath or adjacent to other structures, trial pits along the structural layout or otherwise.
2. The ground shall be excavated by such methods and to such dimensions and Depths as shall allow for the proper construction of the works and safety of personnel and equipment used on excavation. Slopes required for stable formation of sides shall be provided.
3. The excavation in earth, murum, boulders, soft and hard rock shall be carried out to the correct levels required and specified and no tolerance, plus or minus, shall be permitted. However, if any depressions/Loose pockets are formed due to removal of boulders, they shall be made good by filling with 1:5:10 concrete up to the bottom layer of the footing/raft.
4. Payment for all types of excavation shall be made by detailed Measurement supported by ground levels recorded prior to and after completion of excavation, subject to the limit for payment indicated by the slopes of excavation indicated in the specification drawing. Any additional excavation will be at the Contractor's expense, unless specifically approved by the Engineer-in-Charge. Measurement for excavation shall be done all as per dimensions of P.C.C. given in design drawings & specifications. For concrete foundations same shall be paid on least dimensions at bottom and Contractor shall cover any extra excavation required for workspace, supports etc while quoting.
5. As far as possible excavation should be done by means of mechanical equipment. The bidder should quote accordingly and nothing extra will be paid for mechanical excavation and deployment of extra staff.
6. It will be the responsibility of the Contractor to obtain prior permissions from The competent authority to use blasting device, if at all to be resorted to and the license are to be obtained for the same.
7. The chance of blasting required shall be well decided with the expert, to avoid Any damage to the surrounding property. However for any such damage to the surrounding property or public or additional excavation shall be the Contractor's responsibility and the risks what so ever arising from the same will have to be borne by the Contractor.

3.2.4 Lift and Lead

Lead for deposition of the excavated materials should be 5000 m. For the purpose of measurement of lead, the area to be excavated or filled or area in which excavated material is to be deposited /disposed off shall be divided into suitable blocks and for each

of the blocks, the distance between centerlines shall be taken as the lead which shall be measured by the shortest straight line route on plan and not the actual route taken by Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or kaccha land route.

3.2.5 Excavation in Hard Rock

Excavation in hard rock may be done either by blasting or chiseling or by mechanical means depending upon the site conditions. When excavation has reached within 300 mm

of the required formation level, further excavation shall be carried out carefully either by blasting (if as directed by the Engineer-in-Charge) or chiseling. Where blasting is resorted to, small charges shall be used to minimize occurrence of heavy over-cuts. The Contractor shall make every effort to carry out the excavation to correct formation level

as far as practicable. In order to minimize the over break and loosening of materials at

the finished surfaces, final cutting for the last 450 mm to 600 mm in rock shall be carried out by controlled blasting and trimming with the help of pneumatic or other power tools. Unless otherwise specified, the over break shall not exceed 75 mm. The over breakage of

75 mm shall not be measured for payment and therefore the Contractor while quoting his rates for rock excavation has to take this into account. Deduction of 40% or higher percentage as may be decided by the Engineer-in-Charge shall be made to allow for the voids. Stacks shall not be of width greater than 1.5 m wide or of height less than one meter

1. Blasting shall be carried out by the licensed person only if permitted by the Engineer-in-charge for which contractor shall obtain the required permission from police commissioner.
2. The Contractor shall provide a method statement and shall comply fully with the requirements of this clause, or any direction, order, requirement or instruction given by the police department or any other relevant authorities as required by the law.
3. Contractor shall submit Blasting plan to the Engineer-in-charge and take approval for the same on daily basis
4. Contractor shall plan the blasting activities in well advance and convey same to the Project In-charge so as to co-ordinate with all the work groups at site.
5. If blasting is not permitted then contractor shall excavate the rock by manual methods or by mechanical mean like needle breaker, poclairn, rock splitter etc without any extra cost.

This includes rock, which is easily excavated by blasting, but due to close proximity of structures or any other reason that the Engineer-in-Charge may consider, will have to be excavated by chiseling.

Hard rock excavation means excavation in all types of rock at any depth or lead required

as per design and drawings. The contractor shall ascertain the level and type of rock by inspecting site, trial pits or trial bore at his cost before quoting the tender.

It should be noted that this clause does not override the Contractor's obligation to satisfy the requirement of the authorities but sets out the extent to which the engineer in



relevant charge will

exercise his control in approving the Contractor's use of explosive to ensure that explosive are always used in a safe manner. It is the Contractor's sole responsibility to ensure that his method of blasting is safe, that all statutory and imposed limitation are adhered to, and to obtain a permit to use explosive from the relevant authorities and to comply with the condition of issue of the permit.

The Contractor shall be solely responsible for obtaining the necessary licenses for the procurement, possession, transport, storage and handling of explosive and for ensuring the validity of such licenses at all times. Before starting work, the Contractor shall satisfy the engineer that all the requirement permits are in order and that this category of work is adequately covered in the policies of insurance.

Explosives shall be used in the quantities and manner recommended by the manufacturers. All necessary precautions shall be taken to preserve the materials below in the soundest possible condition and also beyond the lines of all excavations.

Blasting by means of drill holes, tunnels or any other similar method shall be the responsibility of the Contractor.

The Contractor shall take all necessary precautions during blasting operations to ensure that no injure is caused to persons or damage to property or to the finished works. Shots shall be properly loaded and capped and only appropriate charges shall be used in each hole.

3.2.5.1 Storage and Transport

Proper building or magazine, with separate compartment for detonators in suitable positions for the storage of explosive in the manner and quantities to be approved, shall be provided. Separate vehicles or vessels for detonators shall also be used for the transportation of explosives. The prevention of any unauthorised issue or improper use of any explosive brought on to the site shall be the responsibility of the Contractor and only experienced licensed short firers shall be employed to handle the explosive for the purpose of the work the relevant security regulations dealing with the storage, handling and transport of explosives shall be complied with.

3.2.5.2 Safety

The Contractor shall provide an approved system of warning and preparing the general public and all site personnel of an impending blast by both audible & visual means and shall ensure that the blasting area is cleared of all personnel immediately prior to blasting. This system shall comply with all statutory requirements. The Contractor's attention I drawn to the need to devise adequate system for warning and clearing the public from specified areas during blasting operations and to prevent persons entering the blasting area.

When blasting is near to the proximity of existing public and private thoroughfares, traffic is to be stopped just prior to firing. The operation is to be carried out I close cooperation with the police department and in such a way as to cause minimum traffic delay.

All operations involving explosives shall be suspended on the approach of a thunderstorm and shall not be resumed until the storm has clearly passed.

Blasting screens shall be erected to conform with the permit conditions. Public roads, private roads and property adjacent to the site and services within the site area shall be protected by rock fall fences which will be subjected to the engineer's approval.

The Contractor shall take all necessary precautions to avoid damage to permanent and temporary works already completed. In all cases, delay blasting techniques will be mandatory with the quantity of explosives restricted to ensure that the peak particle velocity generated does not exceed the peak particle velocity of each component of the safe limits of the nearest structure subject to vibration damage. All operations shall stop when these limits are exceeded until reports are made available to the engineer that no damage has occurred and will not occur or corrective action has been taken to lower the vibration. The sound level limit in areas where site personnel or public can access during blasting operation must not exceed 110 dB.

The Contractor may not be permitted to use explosives in areas of the site immediately adjacent to pylon positions. Particular limitations may apply in such areas depending on the Contractor's proposed method of working and a detailed method statement will therefore be required from the Contractor. The method statement shall cover the methods of excavation and protection systems proposed, all of which shall be subjected to the approval of the relevant authorities and the Engineer.

In all such cases particular attention should be paid to the requirements stated above and effects on these structures and installations shall be closely monitored and the quantities of explosives limited accordingly.

Drilling rigs for shot hole shall be of the hydraulic type fitted with efficient silencers and with means of dust separation.

The Contractor may report to any of the following methods to excavate rock by chiseling:

- Wedging by means of crowbars, pick axes or pneumatic drills
- Heating and quenching
- Controlled blasting with a small charge just sufficient to make a crack in rock which will be subsequently removed by wedging
- No extra payment shall be made for removal of rock by chiseling and controlled blasting.

3.2.6 Excess excavation to be made good

The Contractor, at his own expense, shall, if directed, remove from the Site all excess material resulting from excess excavation and shall make good the same with such kind of fill material or in such class of concrete as may be reasonably required by the Engineer-in-Charge having regard to the circumstances.

3.2.7 Stripping Top Soil

Where ordered by the Engineer-in-Charge, top soil shall be stripped to such depths and over such areas as he may direct, as a separate operation prior to any further excavation, which may be required.

3.2.8 Supporting Excavations

1. The Contractor shall properly support the sides and ends of all

excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation.

Any excavation necessary to provide space for such support or other working space shall be carried out. If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way, the Contractor shall at his own expense take all necessary remedial measures including the extra necessary excavation and removal of excess material.

2. Where the Contractor proposes and is permitted by the Engineer-in-Charge to perform excavations with sloping faces (other than sloping excavations shown on the Drawings or required as permanent features of the Works) and without shoring, the excavated faces shall be to stable slopes and heights.

3.2.9 Trimming Excavations

1. When excavating to specified or required levels for the foundation of any structure or to specified or required limits for the face of any structure required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work, except where the Engineer-in-Charge shall permit otherwise. After getting the permission for the commencement of the construction, if the Contractor delays on any account & the formation level gets damaged he will have to do further excavation upto 150mm or as per Engineer-in-Charge's instructions at his own account.
2. Before commencement of any constructional work all shattered and loose materials shall be removed from the excavations by hand so as to ensure that the work rests on a solid and perfectly clean foundation or abuts against solid ground.

3.2.10 Inspection by the Engineer-in-Charge

1. When the specified levels or limits of excavation are reached the Engineer-in-Charge will inspect the ground exposed, and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further. Such further excavation shall be refilled to the specified levels or limits with concrete, selected excavated material or selected imported material as directed by the Engineer-in-Charge.
2. Should the material forming the bottom of any excavation, while acceptable to the Engineer-in-Charge at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or due to flooding or have puddles, soft or loss during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate without any extra cost.

3.2.11 Disposing Excavated Material

All excavated material shall remain the property of the Employer. The Contractor shall ensure that no excavated material which is suitable for and is required for re-use in the Works is transported unless so ordered by the Engineer-in-Charge.

3.2.12 Back-Filling General Site Grading And Sand

Filling

3.2.12.1 Fill Material

1. All fill material whether such material is brought from outside borrow areas or excavation within the site, will be subject to Engineer-in-Charge's approval after carrying required tests at Contractor's Soil testing laboratory. Notwithstanding any approval given to the fill material or borrow areas from which fill material is proposed to be brought, the Engineer-in-Charge reserves the right to reject such material which does not meet the specification requirements or unsuitable for the purpose for which it is intended.
2. Roads, of a temporary nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material, etc. to or over borrow areas and or to or over areas on which fill has to be deposited shall be constructed by the Contractor. Such access roads shall be maintained in good condition during all seasons to ensure completion of the work according to the time schedule. No separate payment shall be made for such items of work.

3.2.12.2 Backfilling

1. Excavated material used as back filling to excavations or completed structures shall be free from rubbish, vegetation, clods and lumps and shall be approved by the Engineer-in-Charge. The approved materials shall be placed in layers, not exceeding 150 mm in depth before compaction and shall be compacted with watering, consolidating and ramming. The maximum boulder size shall be of 150 mm for filling material
2. Soft material shall not be used as back filling around structures in rock. The Contractor shall backfill such excess excavation with concrete; rubble, stone or rock fills as directed by the Engineer-in-Charge. Filling other than concrete shall be placed in layers not exceeding 150 mm in thickness, shall be thoroughly compacted and have adequate fined content to fill the voids.
3. Should the material being placed as back filling, while acceptable at time of selection, become unacceptable to the Engineer-in-Charge due to exposure to weather conditions or due to flooding or have become puddles, soft or segregated during the progress of the works, the Contractor shall remove such damaged, softened or segregated material and replace it with fresh approved material at his expense.
4. The Contractor shall while placing the back filling make due allowance for Any settlement that may occur before the end of the Defects Liability Period, remove any excess material or make up any deficiency by back filling to the specified levels. As a rule material to be back filled shall be stacked temporarily at a suitable place.
5. General Site Grading: Site grading shall be carried out as directed by the Engineer- in-Charge. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under (6) of this Clause unless otherwise indicated below.
6. The approved material shall be placed in layers not exceeding 150 mm in depth before compaction and shall be compacted to 90% of Proctor Density with water contain at OMC.
7. The Contractor shall protect the earth fill from being washed away by

washed

- rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected materials and make good the slip without any extra cost.
8. The fill shall be carried out to such dimensions and levels as directed by the Engineer-in-Charge, after the compaction.
 9. Sand filling below Plinth and other places.

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

Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled rollers.

A smaller weight roller may be used only if permitted by Engineer-in-Charge. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

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

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

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

At some locations / areas it may not be possible to use rollers because of space restrictions etc. Contractor shall then be permitted to use pneumatic tampers, rammers etc and he shall ensure proper compaction.

3.2.13 Fill Density

The compaction, only where so called for, in the schedule of quantities /items shall comply with the specified (proctor/modified proctor) density at moisture content differing not more than 4 percent from optimum moisture content. Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density had been obtained.

3.2.14 Local Rules and Regulations

1. The Contractor shall familiarize himself with the local rules and regulations governing the excavation, quarrying operations, etc. and the work shall be carried out strictly in accordance with rules and regulations, if any. Whenever a quarry is required to be opened in connection with the execution of work covered under this Contract, the

Contractor shall investigate that it shall yield stones and other materials such as sand, murum, soil etc. of approved quality and shall satisfy him as to the availability in desired quantity. He shall supply necessary quantity of sand, stone, metal aggregate etc. to the Engineer-in-Charge for carrying out tests as desired by the Engineer-in-Charge and well in advance of its use so as to carry out tests and to get approval. The cost of opening and operating the quarry & royalties and ant other charges shall be borne entirely by the Contractor.

2. The Contractor shall obtain necessary permission from the concerned authorities before opening the quarry. In case of quarries in private land on payment of whatever charges as may be due to the owner.

3.3 DEWATERING

- a. All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by Engineer-in-Charge any water inclusive of rain water and sub-soil water accumulated in excavation and keep all excavations de-watered until the foundation work is completed and back filled. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. Method of pumping shall be approved by Engineer-in-Charge; but in any case, the pumping arrangement shall be such that there shall be no movement of sub-soil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.
- b. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer-in-Charge, as large, well point system: Single-stage or Multi-stage shall be adopted. Contractor shall submit to the Engineer-in-Charge his scheme of well pointing system including stages, the spacing, number and diameter of well points, headers etc. and the number, capacity and location of pumps for approval.
- c. The rates for excavation are inclusive of dewatering by any means and no extra payment is allowed for excavation in wet condition.

3.4 TIMBER SHORING

The Timber Shoring shall be as per 3764-1966 safety code for excavation work.

- a. Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. The boards shall generally be placed in position vertically side by side without any gap on each side of the Excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 m spacing and suitably strutted. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.
- b. The shoring material shall not be sizes less than those specified below unless steel sheet piling is used or unless otherwise approved by the Engineer-in-Charge in writing:

• Planks	-	5 cm x 25 cm
• Waling pieces	-	10 cm x 20 cm
• Struts	-	15 cm x 20 cm

- c. Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer-in-Charge. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.
- d. Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer-in-Charge.
- e. The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber, which can not be retrieved.
- f. In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm X 5 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Engineer-in-Charge. In all other respects, the specification for close timbering shall apply to open timbering.
- g. In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

3.5 RAIN WATER DISCHARGE

3.5.1 Scope

The scope covers the drainage of the rainwater in excavated areas.

Grading in the vicinity of excavation shall be such as to exclude rain/surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost to the Owner. The scheme for pumping and discharge of such water shall be approved by the Engineer-in-Charge.

4 ANTI TERMITE TREATMENT

IS: 6313 – 1981 : Code of Practice for Anti Termite Measure in Buildings
 IS: 6313 (Part I) – 1981 : Construction Measures
 IS: 6313 (Part II) – 1981 : Pre-Construction Chemical Treatment Measures
 IS: 6313 (Part III) – 1981 : Treatment for existing Buildings

4.1 DELIVERY, STORAGE AND HANDLING

Deliver pesticides to the project site in sealed and labeled containers in good condition as supplied by the manufacturer or formulator. Store, handle, and use pesticides in accordance with manufacturer's labels. Labels shall bear evidence of registration as per the IS or appropriate regulations.

4.2 SAFETY REQUIREMENTS

Formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. The filling operation shall be under the direct and continuous observation of a Contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property

4.3 WARRANTY

Furnish an three-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Perform annual inspections of the building(s) or building addition(s). If live subterranean termite infestation of subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contract shall:

1. Retreat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;
2. Repair damage caused by termite infestation; and
3. Re-inspect the building approximately 180 days after the pretreatment.

4.4 QUALITY ASSURANCE

4.4.1 Application Report

Upon completion of this work, submit Pest Management Report, Identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used. Maintain daily records using Pest Management Maintenance Record, and submit copies of records when requested by the Engineer-in-Charge.

4.5 PRODUCTS

4.5.1 Pesticides

Termiticides bearing current registration or approved for such use by the appropriate agency of the host country. The Contractor shall comply with the requirements on Contractor's licensing, certification, and record keeping.

4.5.2 Execution

4.5.2.1 Verification of Conditions

At the time of application, the soil shall have sufficiently low moisture content to allow uniform distribution of the treatment solution throughout the soil. Do not make applications during or immediately following heavy rains or when conditions may cause runoff and create an environmental hazard.

4.5.3 Application

4.5.3.1 Treatment Area

Apply termiticide to soil material which will be covered by or lie immediately adjacent to the buildings and structures so as to provide a protective barrier against subterranean termites.

4.5.3.2 Treatment Application

Apply termiticide as a coarse spray and in such matter as to provide uniform distribution onto the soil surface. Apply treatment prior to placement of a vapor barrier or waterproof membrane and prior to concrete pouring. Where treated soil or fill material is not to be covered with a vapor barrier or waterproof membrane, exercise adequate precautions to prevent its disturbance. If soil or fill material has been disturbed after treatment, retreat as specified above before placement of slabs or other covering structures. Coordinate treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures with final grading and planting operations so as to avoid disturbance of the treated barriers by such operations. Observe manufacturer's warnings and precautions in the handling and use of such materials. Exercise precaution that these chemicals do not enter water supply systems or potable water supplies or aquifers, and that they do not endanger plants and animals as well. Notify the Contracting Officer at least 48 hours prior to beginning of treatment and perform formulating, mixing, and application in the presence of the MBMC.

4.5.4 Rates and Methods of Application

Apply in accordance with the pesticide label. Provide maximum application or dosage rates. Resolve conflict between this specification and label direction in favor of the label.

5 CONCRETE AND ALLIED WORKS

5.1 GENERAL

- a. The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.
- b. The Engineer-in-Charge shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer-in-Charge's approval obtained, prior to starting of concrete work. However, this shall not relieve the Contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected.
- c. The minimum wall thickness for all RCC wall shall be 225 mm thick.
- d. The liquid retaining structures will be in M 25 grade.
- e. The Contractor will maintain all registers and formats for quantity qualitative and quantitative measures of all concrete works on daily basis of steel consumed and concreting done updated on daily basis.
- f. As per site conditions, if required, contractor may use ready mix concrete of approved mix design from approved ready mix plant without any extra cost.

5.2 APPLICABLE CODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein this bid document, this specification shall govern.

MATERIALS

1. IS:269 - Specification for 33 grade ordinary Portland cement
2. IS:455 - Specification for Portland slag cement.
3. IS:1489 - Specification for Portland-pozzolana cement.
4. IS: 8112 - Specification for 43-grade ordinary Portland cement.
5. IS: 12330 - Specification for sulphate resisting Portland cement.
6. IS: 383 - Specification for coarse and fine aggregates from natural soil concrete.
7. IS: 432 - Specification for mild steel and medium tensile steel (Parts-I & II) bars and hard-drawn steel wires for concrete reinforcement.
8. IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.
9. IS: 1566 - Specification for hard-drawn steel wire fabric for (Part-I) concrete reinforcement.
10. IS: 9103 - Specification for admixtures for concrete.
11. IS: 2645 - Specification for integral cement waterproofing compounds.
12. IS: 4990 - Specification for plywood for concrete shuttering work.

MATERIAL TESTING

1. IS: 4021 - Methods of physical tests for hydraulic cement. (Parts-1 to 13)
2. IS: 4032 - Method of chemical analysis of hydraulic cement.
3. IS: 650 - Specification for standard sand for testing of cement.
4. IS: 2430 - Methods for sampling of aggregates for concrete.
5. IS: 2386 - Methods of test for aggregates for concrete. (parts-I to VIII)
6. IS: 3025 - Methods of sampling and test (physical and chemical) water industry.
7. IS: 6925 - Methods of test for determination of water-soluble chlo concrete admixtures.

MATERIALS STORAGE

1. IS: 4082 - Recommendations on stacking and storing of construction materials at site.

CONCRETE MIX DESIGN

1. IS: 10262 - Recommended guidelines for concrete mix de:
2. SP: 23 - Handbook on Concrete Mixes. (S & T)

CONCRETE TESTING

1. IS: 1199 - Method of sampling and analysis of concrete.
2. IS:516 - Method of test for strength of concrete
3. IS: 9013 - Method of making, curing and determining compressive stre accelerated cured concrete test specimens.
4. IS: 8142 - Method of test for determining setting time of concrete resistance.
5. IS: 9284 - Method of test for abrasion resistance of concrete.
6. IS: 2770 - Methods of testing bond in reinforced concrete.

EQUIPMENT

1. IS: 1791 - Specification for batch type concrete mixers.
2. IS: 2438 - Specification for roller pan mixer.
3. IS: 4925 - Specification for concrete batching and mixing plant.
4. IS: 5892 - Specification for concrete transit mixer and agitator.
5. IS: 7242 - Specification for concrete spreaders.
6. IS: 2505 - General Requirements for concrete vibrators: Imme
7. IS: 2506 - General Requirements for screed board concrete vibrato
8. IS: 2514 - Specification for concrete vibrating tables.
9. IS: 3366 - Specification for pan vibrators.
10. IS: 4656 - Specification for form vibrators for concrete.
11. IS: 11993 - Code of practice for use of screed board concrete vibrators.
12. IS: 7251 - Specification for concrete finishers.
13. IS: 2722 - Specification for portable swing weigh batchers for concrete (single and double bucket type).
14. IS: 2750 - Specification for steel scaffoldings.

CODES OF PRACTICE

1. IS: 456 - Code of practice for plain and reinforced concrete.
2. IS: 457 - Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
3. IS:3370 - Code of practice for concrete structures for storage of liquids.(parts-I to IV)
4. IS: 3935 - Code of practice for composite construction.
5. IS: 2204 - Code of practice for construction of reinforced concrete shell roof.
6. IS: 2210 - Criteria for the design of reinforced concrete shell structures and folded plates.
7. IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.
8. IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
9. IS: 2751 - Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
10. IS: 9417 - Specification for welding cold worked bars for reinforced concrete construction.
11. IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete.
12. IS: 3414 - Code of practice for design and installation of joints in building.
13. IS: 4326 - Code of practice for earthquake resistant construction of building.
14. IS:4014 - Code of practice for steel tubular scaffolding.(parts-I & II)
15. IS: 2571 - Code of practice for laying in-situ cement concrete flooring.
16. IS: 7861 - Code of practice for extreme weather concreting.
Part-I: Recommended practice for hot weather concreting. Part-II: Recommended practice for cold weather concreting.
17. IS: 13920 - Ductile Detailing of Reinforced Concrete Structure subjected to 1993 seismic forces.
18. SP-16 - Design Aids for Reinforcement Concrete to IS:456-1978
(S&T) - 1980
19. SP-24 - Explanatory Handbook on IS:456-1978
20. SP-34 - Handbook on Concrete Reinforcement and Detailing
(S&T) - 1987

CONSTRUCTION SAFETY

1. IS:3696 - Safety code for scaffolds and ladders.(Parts-I & II)
2. IS:7969 - Safety code for handling and storage of building mate
3. IS: 8989 - Safety code for erection of concrete framed structure:

MEASUREMENT

1. IS: 1200 - Method of measurement of building and engineering wor
2. IS: 3385 - Code of practice for measurement of civil engineering w

5.3 MATERIALS FOR STANDARD CONCRETE

- a. The ingredients to be used in the manufacture of concrete shall consist solely of Ordinary Portland Cement or Sulphate Resistant Cement of approved make clean sand, natural coarse aggregate, clean water, and admixtures.
- b. Cement

1. The Contractor will have to make own arrangements for procuring cement and steel.
Cement remaining in bulk storage at the mill, prior to shipment for more than 6 months or cement in bags in local storage in the hands of vendor for more than 3 months after completion of tests may be retested before use and may be rejected if it fails to conform to any of the requirement of IS 269-1976.
2. The Contractor will have to make his own arrangements for transport from supplier godown and storage of adequate quantity of cement. Contractor will construct cement godown at site as per MBMC rules. Cement in bulk may be stored in bins or silos, in batches of 10x10, which will provide complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer-in-Charge. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Stacking of cement shall be done as per IS and in such a way that first come cement shall be used first.
3. Cement held in storage for a period of ninety (90) days or longer shall be tested.
Should at any time the Engineer-in-Charge have reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and or manufacturer's test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. Testing certificates for each batch of cement should be submitted by the Contractor to the Engineer-in-Charge, before starting the concreting work. The Contractor shall not be entitled to any claim of any nature on this account.
4. Aggregates

i) General

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete (Vide BIS 456 & BIS 383) and conforming to tests as per BIS 2386 (Part I to VI)

"Coarse Aggregate" is aggregate most of which is retained when passed through on 4.75 mm BIS sieve.

All fine and coarse aggregates proposed for use in the works shall be subject to the MBMC Quality Control Department approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the MBMC Quality Control Department.

Aggregates shall consist of natural sands, stone (crushed or uncrushed) and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable

against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later.

ii) Sampling and testing

Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer-in-Charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates, shall be furnished to Engineer-in-Charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the

Contractor.

iii) Storage of aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

iv) Specific Gravity

Aggregates having a specific gravity below 2.4 (saturated surface dry basis) shall not be used.

5.4 FINE AGGREGATE

- a) Fine aggregate shall consist of natural or crushed sand conforming to BIS 383 conforming to tests as per BIS 2386 part I to VI. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt, or other deleterious substances, which can be injurious to the setting qualities/strength/durability of concrete.
- b) Screening and Washing: Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.
- c) Foreign Material limitations : The percentage deleterious substances in sand delivered to the mixer shall not exceed the following:

Table 2: Foreign Material Limitations in Fine Aggregate

Sr.	Foreign material	Percentage by weight	
		Uncrushed	Crushed
1	Material finer than 75 micron BIS sieve	3.0	15.0
2	Shale	1.0	
3	Coal & Lignite	1.0	1.0

4	Clay Lumps	-	1.0
	Total	5.0	17.0

d) Gradation: Unless otherwise directed or approved by the Engineer-in-Charge, the grading of sand shall be within the limits indicated hereunder:

Table 3: Grading of Sand for Fine Aggregate

BIS :Sieve Designation **Grading Zone I** **Grading Zone II** **Grading Zone III** **Grading Zone IV**

10 mm	100	100	100	100
4.75 mm	99-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100
300 microns	5-20	8-30	12-40	15-50
150 microns	0-10	0-10	0-10	0-15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 microns IS sieve, by total amount not exceeding 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to grading zone IV shall be used. Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

e) Fineness Modulus

The sand shall have a fineness modulus of not less than 2.0 or more than 3.5. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 microns and 150 microns) and dividing the sum by 100.

5.5 COARSE AGGREGATE

- a) Coarse aggregate for concrete, except as noted above, shall conform to IS 383 & IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.
- b) Screening and Washing: Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer-in-Charge.
- c) Grading
i) Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits:

BIS Size (mm)	Sieve Percentage passing for single size of normal size					Percentage Passing For Graded Aggregate Of Normal Size			
	40 mm	20 mm	16 mm	12.5mm	10mm	40 mm	20 mm	16 mm	12.5mm
	40 mm	20 mm	16 mm	12.5mm	10mm	40 mm	20 mm	16 mm	12.5mm
63	100	-	-	-	-	100	-	-	-
40	85-100	100	-	-	-	95-100	-	-	-
20	0-20	85-100	100	-	-	30-70	95-100	100	-
16	-	-	85-100	100	-	-	-	90-100	-
12.5	-	-	-	85-100	100	-	-	-	90-100
10	0-5	0-20	0-30	0-45	85-100	10-35	25-35	30-70	40-85
4.75	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36	-	-	-	-	0-5	-	-	-	-

ii) The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only within tolerance limits which will not affect adversely the strength and or durability of concrete. The maximum size of coarse aggregate shall be 40 mm for M-7.5 and M-10 and 20mm for M-15 to M-30 concrete, or as directed by the Engineer-in-Charge or specified. The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than $1/4^{\text{th}}$ of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller.

d) Foreign material limitations

The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following:

Table 4 : Foreign Material Limitations in Coarse Aggregate

Sr.	Foreign Material	Percentage by Weight	
		Uncrushed	Crushed

1	Material finer than 75 micron BIS Sieve	3.0	3.0
2	Coal and lignite	1.0	1.0
3	Clay Lumps	1.0	1.0
4	Soft Fragments	3.0	-
	Total	8.0	5.0

5.6 WATER

- a) Water used for washing, mixing and curing shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and curing concrete. Physical and chemical analysis of the water should be submitted to the Engineer-in-Charge, before starting the work.
- b) In case of doubt, the suitability of water for making concrete shall be ascertained by
 - the compressive strength and initial setting time test specified in BIS 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.
- c) Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of BIS 516.
- d) The initial setting time of test block must be made with the appropriate test cement and the water proposed to be used. It shall not be less than 30 minutes and shall not differ by more than +/-30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test block shall be prepared and tested in accordance with the requirements of BIS 4031.
- e) Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-Charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.
 - 1) To neutralise 200 ml sample of water, using phenolphthalein as indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in BIS 3025.
 - 2) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 Normal HCl. The details of test shall be as given in BIS 3025.
 - 3) Percentage of solids, when tested in accordance with the method indicated below shall not exceed the following:

Solids	Percent	Method of test
Ref. to col. no in IS:3025) Organic (organic solid = total solids minus residue)	10	10 and 11

Inorganic	0.03	11(ignited residue)
Sulphates (as So ₄)	0.05	20
Alkali Chlorides (as Cl)	0.20	24
Suspended matter	0.20	12

The pH value of water shall not generally be less than 6.

5.7 STEEL AND ALUMINIUM MEMBERS ENCASED IN CONCRETE

Structural steel and aluminum ladders etc. to be encased in concrete shall be without paint. Primer should be used for encasing purpose. The encasing shall be done in concrete with 10 mm, maximum size aggregate and a works cube strength not less than

150 kg/sq.cm. at 28 days unless otherwise specified. The member shall be wrapped with

galvanized aluminum wire mesh of adequate size. The galvanized aluminum wire mesh shall be kept 20 mm from the edge or surface of the member and shall be held in position securely. The member will have a minimum cover of 50 mm unless otherwise indicated

in the drawings. Where the clear cover is more than 75 mm, concrete with 20 mm coarse

aggregate can be used.

5.7.1 Anchor Bolts, Anchors, Sleeves, Inserts,

The Contractor shall build in to concrete work all the items mentioned in Drawings or Engineer In Charge and shall embed them partly or fully as directed and secure the same

as may be required. The materials if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian standards of approved manufacture and to the satisfaction of the engineer. Exposed surface of embedded materials is to be painted with one coat of approved anti-corrosive paint and/

or bituminous paint without any extra cost to the owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer In Charge.

5.8 CONTROLLED CONCRETE

All concrete in the works shall be "Controlled Concrete" as defined in IS: 456 except for M-7.5 and M-10 for which normal mix concrete shall be used. Whether reinforced or otherwise, all concrete works to be carried out under this specification shall be divided into the following classifications:

Minimum Compressive Strength Of 15 cm cubes at 7 days and 28 days after mixing, conducted in accordance with IS: 516. Any operation of concrete done at atmospheric temperature above 40 degree C or where the temperature of concrete at the time of placement is expected to be beyond 40 degree C may be categorize as hot weather concreting and should be confined to the requirement of IS 7861(Part-I) 1975 and SP-23 (S&T)-1982.

Class	Preliminary Test N/mm²	Works Test N/mm²	Max. Size Of Aggregate mm	Locations For Use
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	At 7 Days	At 28 days	At 7 days	At 28 days		
M40	33.5	50.0	27.0	40.0	20	As indicated
M35	30.0	44.0	23.5	35.0	20	in the
M30	25.0	38.0	20.0	30.0	40 or 20	specifications or as
M25	22.0	32.0	17.0	25.0	40 or 20	required
M20	17.5	26.0	13.5	20.0	40 or 20	
M15	13.5	20.0	10.0	15.0	40 or 20	

Note: It shall be very clearly understood that whenever the grade of concrete such as M-20, etc. is specified it shall be Contractor's responsibility to ensure the minimum crushing strength stipulated for the respective grade of concrete is obtained at works.

5.9 MIX DESIGN

5.9.1 General

- i) This is essential for investigating the grading of aggregates, water-cement ratio, workability and the quality of cement required to give preliminary and works cubes of the minimum strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Determination of mix proportions shall be carried out according to "Recommended guidelines for Concrete Mix Design" conforming to IS: 10262.
- ii) Whenever there is a change either in required strength of concrete, or water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing proportions, over-wet mixes shall always be avoided.
- iii) Mix Design may be done without changing its minimum cement content mentioned in NIT
- iv) While fixing the value for water/cement ratio for preliminary mixes, assistance may be derived from the graph (Appendix A, BIS 456 showing the relationship between the 28 day compressive strengths of concrete mixes with different water/cement ratios and the 7-day compressive strength of cement tested in accordance with IS: 269.

5.9.2 Preliminary Tests

Test specimens shall be prepared with at-least two different water/cement ratios for each class of concrete, consistent with work ability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the properties of cement, aggregates and water necessary to produce concrete of required consistency and to give the specified strength, it will be Contractor's sole responsibility to carry out these tests and he shall therefore furnish to Engineer-in-Charge a statement of proportions preliminary proposed to be used for the various concrete mixes. For

tests, the following procedure shall be followed.

Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water cement and aggregates for each batch shall be determined by weight to an accuracy of 1 part in 100 parts.

Mixing concrete shall be done by hand (for small quantities, as directed by Engineer-in-Charge) or in a small batch mixer as per IS: 516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in color. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minutes until the resulting concrete is uniform in appearance. Each batch of concrete shall be such a size

as to leave about 10% excess concrete, after moulding the desired number of test specimens.

The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1199. If in the slump test, care is taken to ensure that no water or other material is lost, the material used for the slump test may be

re-mixed with the remainder of the concrete for making the specimen test cubes. The period of re-mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

The samples for compression tests of concrete shall be made as per IS: 516 on 15 cm cubes. Each mould shall be provided with a metal base plate having a plate surface so as to support the mould during filling without leakage. The base plate shall be preferably attached to the mould by springs or screws. The parts of the mould when assembled shall be positively and rigidly held together. Before placing concrete, the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the following limits. Height and distance between the opposite faces of the mould shall be of specified size ± 0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom faces of mould shall be 90- degree ± 0.5 degree. The interior faces of the mould shall be plane surfaces with a permissible variation of 0.03 mm.

Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS 516.

Curing shall be as specified in IS 516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27 degree C \pm 2 degree C for 24 hours \pm 2 hours from the time of adding water to the dry ingredients. Thereafter they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27 degree C \pm 2 degree C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-Charge. The test results shall be accepted by the Engineer-in-Charge if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the

condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Engineer-in-Charge may direct the Contractor to repeat the tests if the results are not satisfactory and also make such changes as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by the Contractor at his own cost in an approved laboratory of MBMC.

5.10 PROPORTIONING, CONSISTENCY, BATCHING AND MIXING OF CONCRETE

The determination of the water cement ratio and proportion of aggregates to obtain the required strength shall be made from preliminary tests by designing the concrete mix. Controlled concrete shall be used on all concrete work complying with all the requirements of IS: 456. Cube tests shall be carried out by the Contractor on the trial mixes before the actual concreting operation starts. Based on the strength of the concrete mix sanction for the use has to be obtained from Engineer-in-Charge.

If during the execution of the works it is found necessary to revise the mix because of the cube tests showing lower strengths than the required one due to inconsistency of quality

of material or otherwise, The Engineer-in-Charge shall ask for fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such change in mix variations, as it is the Contractor's responsibility to produce the concrete of the required grade.

Great care shall be exercised when mixing the actual works concrete using the proportions of the selected trial mix. The final concrete mix shall have the same proportions and same source of cement, fine and coarse aggregates and water as that of the approved selected mix.

A reasonable number of bags should be weighed separately to check the Net weight, where the weight of cement is determined by accepting the manufacturer's weight per bag at the site. Proper control of mixing water is deemed to be of paramount importance.

If mixers with automatic addition of water are used, water should be either measured by volume in calibrated buckets, tins or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked and certified and the Engineer-in-Charge's approval obtained.

The Engineer-in-Charge may require the Contractor to carry out moisture content tests in both fine and coarse aggregates. The amount of the added water shall then be adjusted to compensate for any observed variations in the moisture contents. BIS: 2386 shall be referred to for determination of moisture content.

No substitution in material, used on the work or alteration in the established proportions shall be made without additional tests to show that the quality and strength of concrete are satisfactory. No alterations shall be permitted without the prior sanction of the Engineer-in-Charge.

5.10.1 Mixing of Concrete

The mixing of concrete shall be strictly carried out in an approved type of mechanical Concrete mixer. The mixing equipment shall be capable of combining the aggregates. Cement and water within the specified time into a thoroughly mixed and uniform mass,

and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the 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. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 nor more than 20 revolutions per minute.

Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. Hand mixing of concrete shall not be permitted at all.

For quantities less than 1 cum of concrete, hand mixing may be permitted at the discretion of the Engineer-in-Charge with 10% excess cement quantity.

5.10.2 Grade of Concrete

The different grades of concrete specified shall conform to the strengths as required by IS: 456-1987. Standard deviation shall be calculated as stated in 14.5 of IS: 456-1978. The acceptable criteria for concrete shall be as stated in clause 15 of IS: 456 - 1978. The assumed standard deviations as given in table 6 of IS: 456-1978 has to be followed and are given here under. However, the minimum cement content shall be as per *Table no. 7: Minimum Cement Content in Concrete* in this tender document.

Table 5: Grade of Concrete

Grade of Concrete	Assumed Standard Deviation N/sq.mm
M 10	2.3
M 15	3.5
M 20	4.6
M 25	5.3

In order to get a quick idea of quality of concrete the optional tests are conducted as stipulated in 14.1.1 of IS: 456-1978 and the results are analyzed according to table 5 on page 41 of IS: 456-1978.

5.10.2.1 Controlled Concrete

Controlled concrete shall be used on all concreting works except where specified otherwise the mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to the values specified in table below for respective grades of concrete.

Table 6: Compressive Strengths at 28 days

Grade	Specified Characteristic Compressive Strength at 28 days (N/sq.mm)
M15	15
M20	20
M25	25
M30	30

The maximum Water : Cement ratio for all controlled concrete works shall be as specified in IS: 456-1978 as Preliminary tests as specified in the BIS code and required by the Engineer-in-Charge shall be carried out sufficiently ahead of the actual

commencement of the work with different grades of concrete made from representative samples of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement of total quantity of fine and coarse aggregates and the water cement ratio required to produce a concrete of specified strength and desired workability.

The minimum cement content for each grade of concrete shall be as per table below.

Table 7: Minimum Cement Content in Concrete

**Grade of Concrete Minimum Cement Content in Concrete
(kg/cum of finished Concrete)**

M 15	300
M 20	330
M 25	360
M 30	400

At least 4 (four) trial batches are to be made and 7 test cubes should be taken for each

batch noting the slump on each mix. These cubes shall then be properly cured and two cubes from each mix shall be tested in a testing laboratory approved by the Engineer-in- Charge at 7 days and others at 28 days for obtaining the ultimate compressive strength. The test reports shall be submitted to the Engineer in charge. The cost of mix design and testing shall be borne by the Contractor. On the basis of the preliminary test reports for trial mix, a proportion of mix by weight and water cement ratio will be approved by the Engineer-in-Charge, which will be expected to give the required strength. Consistency and workability and the proportions so decided for different grades of concrete shall be adhered to during all concreting operations. If however at any time the Engineer-in- Charge feels that the quality of material, being used has been changed from those used for preliminary mix design, the Contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency.

The mix once approved must not be varied without prior approval of the Engineer-in- Charge. However should the Contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same

to the Engineer-in-Charge and bring fresh samples sufficiently ahead to carry out fresh trial mixes. The Engineer-in-Charge shall have access to all places and laboratory where design mix is prepared. Design mix will indicate by means of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed.

In designing the mix proportions of concrete, the quantity of both cement and aggregate shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodically checked.

To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and course aggregates and determination of the same shall be made as frequently as directed by the Engineer-in-Charge. The determination of moisture contents shall be according to IS: 2386 (Part III). Absorption of water by dry aggregates shall not be more than 5%.

5.10.2.2 Strength Requirements

Where ordinary Portland cement conforming to IS: 269 or blast furnace slag cement conforming to IS: 455 is used the compressive strength requirements for various grades of

Portland
concrete

shall be as shown in table below. Where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table- hereunder shall be met in 7 days. The strength requirements specified in table shall apply to both controlled concrete and ordinary concrete. Strength Requirements of Concrete

Grade of Concrete	Minimum Compressive Strength Concrete in Accordance with IS: 516 (In kg/cm) As per IS: 456-1978			
	For 15 cm cube specimens at 7 days		For 15 cm cube Specimens at 28 da	
	Work Test	Preliminary	Work Test	
M 15	100	200	150	
M 20	135	260	200	
M 25	170	320	250	
M 30	200	380	300	

Other requirements of concrete strength as may be desired by the Engineer-in-Charge shall be in accordance with Indian Standard IS: 456 (latest revision). The acceptance of strength of concrete shall be as per clause 5.4 "Sample size and Acceptance Criteria" of IS: 456 (latest revision) subject to stipulation and/or modifications stated elsewhere in this specification if any.

Concrete work found unacceptable shall have to be dismantled and replaced to the satisfaction of the Engineer-in-Charge by the Contractor free of cost to the Owner. No payment will be made for the dismantled concrete, the relevant formwork and reinforcement, embedded mixtures etc. wasted in the dismantled portion shall be made.

In the course of dismantling if any damage is done to the embedded items or adjacent structures, the same shall also be made good free of charge by the Contractor to the satisfaction of the Engineer in charge. If the water quantity has to be increased in special cases, cement also has to be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete.

5.10.2.3 Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners

of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests. The limits of consistency for structures are as specified in the table below:

Table 8: Limits of Consistency

Placing Conditions	Degree of Workability	Values of Workability
Concreting of shallow Sections with vibration	Very low	20-10 seconds Veebee time or 0.75-0.80 compacting factor

Placing Conditions	Degree of Workability	Values of Workability
Concreting of lightly Reinforced sections With vibration	Low	10-5 seconds or 0.80-0.85 compacting factor
Concreting of lightly Reinforced sections Without Vibration or Heavily reinforced Section with Vibration	Medium	5-2 seconds Veebee time or 0.85-0.92 compacting factor or 25-75mm slump for 20 mm Aggregate
Concreting of heavily Reinforced sections compacting Without vibration factor	High	Above 0.92 compacting factor or 75-125 mm slumps for 20 mm aggregate

5.10.3 Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the Contractor shall obtain the approval of the Engineer-in-Charge and all other concerned department including safety dept, in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of test cubes to be taken, finishing to be done and any admixture to be added etc.

5.11 SAMPLING AND TESTING OF CONCRETE IN THE FIELD

Sampling and Testing of Concrete shall conform to IS: 456 2000.

- a) Facilities required for sampling materials and concrete including whether proof buildings to house the facilities in the field, shall be provided by the Contractor at no extra cost. The following equipment with operator shall be made available in serviceable conditions.
- i. Concrete cube-testing machine suitable for 15 cm cubes of 100 tonnes capacity with proving calibration ring 1 no.
 - ii. Cast iron cube moulds 15 cm size 12 nos.
 - iii. Slump cone complete with tamping rod 1 set
 - iv. Laboratory balance to weigh upto 5 kg with sensitivity of 10 gm 1 no.
 - v. BIS sieves for coarse and fine aggregates 1 set
 - vi. Set of measures from 5 litres to 0.1 litre 1 set
 - vii. Electric oven with thermostat upto 120° C 1 no.
 - viii. Flakiness gauge 1 no.
 - ix. Elongation index gauge 1 no.
 - x. Sedimentation pipette 1 no.
 - xi. Calibrated glass jar 1.0 litre capacity 2 nos.
 - xii. Glass flasks and metal containers As required
 - xiii. Chemical reagents like sodium hydroxide, tannic acid, litmus paper etc. - As required
 - xiv. Laboratory balance of 2 kg capacity and sensitivity of 1 gm - 1 no.
 - xv. Weighing Machine for cement bags of 6 Nos.: 2 no.
 - xvi. Vernier Calipers As required
 - xvii. Thermometer for concrete 1 no.

- b) No concrete of any kind may be placed until the field concrete testing laboratory as specified is provided to the satisfaction of the Engineer. The Contractor shall notify the Engineer in advance of all concrete and concrete material testing as provided in the clause to provide the Engineer/his representative with an opportunity to witness all prescribed tests.
- c) At least 6 test cubes of each class of concrete shall be made of every 50cum concrete or part thereof or from different batches as directed by Engineer-in-Charge. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The cubes must be casted from various batches to arrive at an average strength. The laboratory test results shall be tabulated and furnished to the Engineer. The Engineer will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but
this shall not be less than 90% of the specified strength.
- d) Consistency: Slump tests shall be carried out as often as requested by the Engineer and invariably from the same batch of concrete from which the test cubes are made. Slump tests shall be done immediately after sampling.

5.12 CONCRETE TESTS

The Engineer-in-Charge, may order tests to be carried out on cement, sand, coarse aggregate, water in accordance with the relevant Indian standards.

Tests on Cement shall include:

- Fineness test
- Test for normal consistency
- Test for setting time
- Test for soundness
- Test for tensile strength
- Test for compressive strength
- Test for heat of hydration (by experiment and by calculations) in accordance with BIS 269

Tests on Sand shall include:

- Sieve test
- Test for organic impurities
- Decantation test for determining clay and silt content
- Specific gravity test
- Test for unit weight and bulkage factor
- Test for sieve analysis and fineness modulus

Tests on Coarse Aggregate shall include:

- Sieve analysis
- Specific gravity and unit weight of dry, loose and rodded aggregate
- Soundness and alkali aggregate reactivity
- Petrography examination
- Deleterious materials and organic impurities
- Test for aggregate crushing value

Any or all these tests would normally be ordered to be carried out only if the Engineer feels the materials are not obtained and shall be performed by the Contractor at a test laboratory approved by MBMC. The Contractor shall bear the charges of these optional tests.

Concrete not made to the requirements of specification in all respects may be rejected by the Engineer-in-Charge in which case it shall be removed and reconstructed entirely at the expense of the Contractor.

5.12.1 Load Test on Members or Any Other Tests

- i) In the event of any work being suspected of material or workmanship or both, the Engineer-in-Charge requiring its removal and reconstruction may order, or the Contractor may request that it should be load tested in accordance with the following provisions.
- ii) The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.
- iii) If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer-in-Charge, the cost of all the new construction and the load tests shall be borne by the Contractor.
- iv) Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by the Engineer-in-Charge, sonic testing etc. shall be carried out by the Contractor, if so directed, at no extra cost.

5.12.2 Unsatisfactory tests

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, the Contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by the Engineer-in-Charge.

5.13 ADMIXTURES

5.13.1 General

Admixtures may be used in concrete where required, only with the approval of the Engineer-in-Charge. However it should be seen that, with the passage of time, neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1.5% of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instruction and in the manner and with the control specified by the Engineer-in-Charge.

5.13.2 Air Entraining Agents

Neutralized Vinson resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

5.13.3 Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Engineer-in-Charge. The admixtures shall be added in the form of a solution.

5.13.4 Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Engineer-in-Charge.

5.13.5 Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

5.13.6 Other Admixtures

The Engineer-in-Charge may at his discretion allow the Contractor to use any other admixture in the concrete.

5.14 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

- a. Before the concrete is actually placed in position, the insides of the formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottoms of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be suitably plugged later.
- b. The various agencies shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as specified or required or as is necessary for the proper execution of the work as specified in the drawings.
- c. All embedded parts, inserts, etc. supplied by the MBMC or the Contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.
- d. All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Engineer-in-Charge.
- e. Slots, openings, holes, pockets etc. shall be provided in the concrete work in the position specified in drawing or required or as directed by the Engineer-in-Charge.
- f. Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.
- g. Prior to concrete placement, all work shall be inspected and approved by the Engineer-in-Charge and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected.
- h. Approval by the Engineer-in-Charge of any and all materials and work as required herein shall not relieve the Contractor from his obligation to produce finished concrete in accordance

with the requirements of the specifications.

- i. Rain or wash water
No concrete shall be placed in wet weather or on a water-covered surface. Any concrete that has been washed by heavy rains shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage, which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided. During summer season, temperature of water should be maintained, as per the criteria and for the same, icing should be done for concreting work.
- j. Bonding Mortar
Immediately before concrete placement begins, prepared surfaces except formwork, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified.
- j. The corrosive matters on the reinforcement should be removed by means of wire brush.
- k. Laitance should be removed by means of chiseling from top concrete layer which was earlier concreted

5.15 TRANSPORTATION

5.15.1 General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight, leak proof irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-Charge and concrete shall not be re-handled before placing.

5.15.2 Retempered or Contaminated Concrete

Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing. Concrete, which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by the Engineer-in-Charge.

5.15.3 Avoiding Segregation

Concrete shall, in all cases, be deposited as nearly as practicable directly, in its final position and shall not be re-handled to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded insets, or impair its strength. For locations where direct placement is not possible, and in narrow forms, the Contractor shall provide suitable drop and "Elephant Trunks" to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in column and the walls.

5.15.4 Placing by Manual Labour

Except when otherwise approved by the Engineer-in-Charge, shall be placed in the shuttering by shovels or other implements, and shall not be dropped from a height more

concrete approved than 1.0 m

or handled in a manner, which will cause segregation.

5.15.5 Placing by Mechanical Equipment

The following specification shall apply when placing concrete by use of mechanical equipment is warranted considering the nature of work involved. The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

5.15.5.1 Types of Buckets

Central-bottom-dump buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete in all dumping positions, shall be employed.

5.15.5.2 Operation of Bucket

In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner, which results in separation of ingredients or disturbance of previously placed concrete, will not be permitted.

5.15.6 Placement of Restricted Forms

Concrete placed in restricted forms by barrows, buggles, cars, short chutes or hand shoveling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

5.15.7 Chuting

Where it is necessary to use transfer chutes, specific approval of Engineer-in-Charge must be obtained to type, length slopes, baffles, vertical terminals and timing of operations. These shall be so arranged that an almost continuous flow of concrete is obtained at the discharge and without segregation. Concrete should flow smoothly in the chute and there should not be any obstruction to the flow. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the wastewater shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use shall have slopes not flatter than 1 vertical, 3 horizontal and not steeper than 1 vertical, 2 horizontal. Chutes shall be of metal or metal lined end of rounded cross section. The slopes of all chute sections shall be approximately the same. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

5.15.8 Placing by Pumping/Pneumatic Placers

Concrete may be conveyed and placed by mechanically operated equipment e.g., pumps or pneumatic placers only with the written permission of the Engineer-in-Charge at no extra cost. The slump shall be held to the minimum necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is pipeline shall be lubricated with one or two batches of mortar of one part cement and two parts sand. Care shall be taken



started, the composed to avoid

stoppages in work once pumping has started.

When a pneumatic placer is used, the manufacturer's advice on layout of the pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end. Manufacturer's recommendations shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipment is used. It should be noted that no extra payment is made for these items, if required and directed by Engineer-in-Charge.

5.15.9 Concrete in Layers

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm to 45 cm directed by Engineer-in-Charge. These shall be placed as rapidly practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer-in-Charge.

5.15.10 Cover Blocks

Cover blocks of required size depending on the cover of the reinforcement as mentioned in the drawings shall be prepared in 1:3 cement mortar with fine aggregates and minimum compressive strength of 300 kg/sq.cm.

5.15.11 Bedding of Layers

The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed. Top layer should be rough and with key for further extension of work.

5.15.12 Compaction

Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results.

5.15.12.1 Type of Vibrators

Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

5.15.12.2 Use of Vibrators

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention be paid to vibration at the top of a lift e.g. in a column or wall.

5.15.12.3 Melding Successive Batches

When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration blending and melding of the concrete between the succeeding layers.

5.15.12.4 Penetration of Vibrators

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

5.15.12.5 Vibrating against Reinforcement/Formwork

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

5.15.12.6 Use of Form Attached Vibrators

Form attached vibrators shall be used only with specific authorization of the Engineer-in-Charge.

5.15.12.7 Use of Surface Vibrators

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, surface vibrating by specially designed vibrators may be permitted, upon approval of Engineer-in-Charge.

5.15.12.8 Stone Pockets And Mortar Pondages

The formation of stone pockets and mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by the Engineer-in-Charge.

5.15.13 Placement Interval

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for atleast 24 hours after the final set of concrete and before the start of a subsequent placement.

5.15.14 Special Provision in Placing

When placing concrete in walls with openings, in floors of integral slabs and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be.

Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by the Engineer-in-Charge.

5.15.15 Placing Concrete Through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to obtain Engineer in-Charge's permission for temporarily moving the top steel aside for proper placement & for restoring reinforcement as per drawing.

5.15.16 Bleeding

Bleeding or free water on top of concrete being deposited into the forms, shall be the cause to stop the concrete pour and the conditions causing this defect corrected before any further Concreting is resumed.

5.16 APPLICATION OF ARALDITE FOR BONDING OF NEW AND OLD CONCRETE

5.16.1 General

Araldite epoxy resins will be used to bond fresh concrete to concrete that is fully cured, to give a monolithic bond capable of transmitting high stresses when traditional bonding agents such as cement slurry cannot always be relied upon to provide good adhesion which is particularly the case when large areas are involved.

- a. The Araldite based formulation shall be applied to a suitably prepared concrete sub- strata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive.
- b. Materials used shall be of best quality like CIBA, FOSROC or ROFF and approved by the Engineer-in-Charge.
- c. Manufacturer's instructions shall be followed in all respects.
- d. No separate payment shall be paid for this item of work.

5.16.2 Formulation

ARALDITE	GY250	100	Parts by weigh
Hardener	HY825	20	Parts by weigh
Hardener	HY830	20	Parts by weigh
Hardener	HY850	20	Parts by weigh
Silica Flour		20	Parts by weigh

5.16.3 Application

The application of the adhesives shall be as per manufacturer standards.

5.16.3.1 Preparation of the Substrata

To obtain good adhesion, it is necessary to have clean and sound substrata. Preparation can be carried out using a variety of techniques including chemical treatment and mechanical methods such as grinding, milling, abrading, planing and sand blasting. Dust and loose particles resulting from the pretreatment should be removed by vacuum cleaning or oil-free or blast.

5.16.3.2 Mixing

The resin and hardener should be thoroughly mixed in the dry filler. The mixed, ready to use adhesive should not contain lumps of unwetted filler and should be of uniform color. For a total weight of 1 kg or less hand mixing should be sufficient. For quantities in excess of 1 kg, the use of a mechanical mixer is recommended.

5.16.3.3 Pot life and 'Open time'

The pot life is the period during which the ready to use ARALDITE based formulation must be applied. After this period, the mix can no longer be worked and will have begun to set in its container. The table below indicates the pot life at different temperatures:

Mix Temperature	Pot life in minutes
25° C	90 Minutes
30° C	60 Minutes
35° C	45 Minutes

(The figures in this table are for batches less than 1 kilogram).

The 'Open time' is the maximum period of time allowable between application of the ARALDITE adhesive and pouring the fresh concrete. Exceeding the 'Open time' would result in considerably reduced adhesion. The adhesive should be applied to the pre-treated substrata as soon as the components have been mixed and fresh concrete poured immediately afterwards.

Accurate knowledge of the 'Open time' is essential in case the work is interrupted.

Table gives the 'Open time' of ARALDITE based formulations as a function of substrata temperature. In all cases, the adhesives shall be applied immediately after mixing. Any delay between mixing and application will reduce the 'Open time'. Fresh concrete must be poured before the adhesive begins to gel. New to old concrete bonding is not recommended at temperatures below 5-Degree Centigrade, as curing cannot be assured under these circumstances.

5.16.3.4 Methods of Application

The shape and size of the concrete structure will determine the method of application used. The ARALDITE based adhesive may be applied by hand using brushed, brooms or any other suitable applicator.

5.16.3.5 Suitability of Fresh Concrete

Best results are obtained when the water/ cement ratio of the new concrete is low as is practicable.

5.16.3.6 Coverage

One kilogram of the mixed ARALDITE adhesive including hardeners and filler covers an area of 2 to 3 sq.m. when applied with a stiff nylon bristle brush. However, the coverage is very much dependent on the finish in the concrete.

5.17 HANDLING PRECAUTIONS

Epoxy resins can cause irritation of the skin in sensitive person if incorrectly handled. Certain safety precautions must therefore be observed and those handling the resins and hardeners should be given suitable instructions. Those working with epoxy resins should, above all, be instructed that personal cleanliness at the place of work is essential. The resin and hardener should not be allowed to come into direct contact with the skin.

The most effective protection is achieved by wearing rubber or polythene gloves, the latter having the advantage that they can be replaced when dirty. They are more pleasant to wear if cotton gloves are worn underneath. Parts of the skins, which have come into contact with the resin or hardener, should be washed with lukewarm water and a mild soap. Special cleaning creams may be used as they have proved to be highly suitable.

5.18 CONSTRUCTION JOINTS

a. A construction joint is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken to achieve subsequent continuity without provision for further relative movement.

b. No concreting shall be started until the Engineer-in-Charge has approved the method of placing the positions and form of the construction joints and lifts. The construction joints shall be so located as not to impair the strength of the structure. Water stops shall be inserted as per clause 3.20

c. Concrete placed to form the face of a construction joint shall have all Laitance removed and the aggregate exposed prior to the placing of fresh concrete. The Laitance shall wherever practicable be removed by spraying the concrete where it is still green. The whole of the concrete surface forming part of the joint shall be hacked to expose the aggregate to the 1/3rd size of maximum size of aggregate. Where aggregate is damaged during hacking, it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blasting or washing, leaving the surface clean and damp. Immediately before fresh concrete is placed, a 12 mm thick layer of sand/cement mortar mixed in the same proportions as in the concrete shall be spread in the horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid Laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

5.19 MOVEMENT JOINTS

a. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The Contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer-in-Charge, demonstrate that the jointing materials can be applied satisfactorily.

b. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.

c. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the caulking strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

5.20 WATER STOPS AND JOINT FILLERS

5.20.1 Water stops

- a. At all construction, contraction and expansion joints in the water retaining structures and wherever specified or directed by the Engineer-in-Charge, water stops shall be provided. The water stops shall be PVC type or of any other equivalent material as approved by the Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14 MN/m² and elongation at break of not less than 300%. Water stops shall not be exposed to direct sunlight for long periods. Before being concreted in water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.
- b. As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops and all the joints should be monolithic. Where it is agreed with the Engineer-in-Charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-Charge may require.
- c. Flexible water stops shall be fully supported in the form work, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort or displace.
- d. The different types of water stops to be used in liquid retaining structures will be as follows:

Table 9 : Types of Water Stops

Sr.	Type of Joint	Type of water stops
1.	Partial/complete Contraction joint in walls and slabs	in 230 mm wide, ribbed with hollow centre bulb & 6 mm minimum thickness
2.	Expansion joints in walls and slabs	230 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness
3.	Construction joint in raft	230 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness
4.	Construction joint in wall	230 mm wide, ribbed with hollow centre bulb & 6 mm minimum thickness
5.	Expansion joint raft	230 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness
6.	Partial/complete Contraction joint in raft	230 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness

5.20.2 Jointing fillers

Joint fillers shall be of durable, compressible and non-extruding material.

Details of jointing material required here. Type of joint, size or width of joint and joint filler material to be used with preferred brands if any.

5.21 SEALING COMPOUNDS

Horizontal joints shall, where used in water-retaining structures be sealed with a cold pouring polysulphide rubber sealing compound of quality equal to, or better than serviced "Paraseal". Horizontal joints in roofs, floors and other non-water retaining structures shall be sealed with an approved sealant with properties equal to or better than

serviced "Paraplastic 41". Vertical joints and joints in the soffits of slabs in both water retaining as well as non-water retaining structures shall be sealed with a trowel or gun applied polysulphide rubber sealing compound such as serviced "Vertiseal" or equivalent. Sealing compounds shall be fully cured before water is permitted to come in contact. At 40°C, the curing time would be approximately 7 weeks for polysulphide compounds like CIBA, FOSROC or ROFF as approved by Engineer-in-Charge.

5.22 TOLERANCES IN CONCRETE SURFACES

- Concrete surfaces for the various classes of unformed and formed finishes specified in various clauses shall comply with the tolerances shown in Table hereunder, except where different tolerances are expressly required by the specification.
- In the table 'line and level' and 'dimension' shall mean the lines, levels and cross-sectional dimensions as specified and required.
- Surface irregularities shall be classified as 'abrupt' or 'gradual'. Abrupt irregularities include by shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces and 1.5 m long formed surfaces.

Class of finish	Line & level	Maximum tolerance (mm) in:		
		Abrupt irregularity	Gradual irregularity	Dimension
U 1	12	6	6	-
U 2	6	3	3	-
U 3	6	3	3	-
F 1	12	6	6	+12-6
F 2	6	6	6	+12-6
F 3	3	3	3	+6-

5.23 CURING, PROTECTING, REPAIRING AND FINISHING

5.23.1 Curing

All concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for atleast seven days from the date of placing concrete in case of OPC and 10 days

in case of mineral admixture or blended cements are used. The period of curing shall be not less than 10 days for concrete exposed to dry and hot weather condition

5.23.2 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened.

Water shall be applied to formed surfaces immediately upon forms. Quantity of water applied shall be controlled so as to



Water removal upon prevent

erosion of freshly placed concrete.



5.23.3 Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer-in-Charge.

5.23.4 Alternate Curing Methods

Whenever in the judgement of the Engineer-in-Charge, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-in-Charge. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

5.23.5 Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer-in-Charge. Curing compounds shall be liquid type white pigmented, conforming to US Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified. Curing compound shall be used only after getting sufficient/satisfactory test results at site.

5.23.6 Curing Equipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

5.23.7 Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period as specified in section D3 of this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineer-in-Charge shall also be taken to protect immature concrete from damage by debris, excessive lading, vibration, abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer-in-Charge may require that bridges be placed over the area.

5.23.8 Repair and Replacement of Unsatisfactory Concrete

5.23.8.1 General

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of the Engineer-in-Charge who may permit patching of the defective areas or also reject the concrete unit either partially or in its entirety. Rejected concrete shall be removed and replaced by the Contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm

I.S sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer-in-Charge. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer-in-Charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer-in-Charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface.

Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer-in-Charge shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

For small repairs concerned Engineer-in-Charge shall permit to repair the same and shall be repaired at his directions. For major repairs Contractor shall submit the method of statement and on approval of same shall carry such repairs with strict compliance to the method of statement.

5.23.8.2 Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Engineer-in-Charge. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

5.23.8.3 Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer-in-Charge, to match the shade of the patch with the original concrete.

5.23.8.4 Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

5.23.8.5 Approval by the Engineer-in-Charge

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer-in-Charge.

5.23.9 Finishing

5.23.9.1 General

The type of finish for formed concrete surfaces shall be as follows, unless varied by the design/architectural drawings and specifications.

When the structure is in service all the surfaces shall receive no special finish, except repair of damaged or defective concrete, removal of fine and abrupt irregularities, filling defective concrete, filling of holes left by form ties and rods and clean up of loose or adhering debris. Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless a horizontal surface or the slope required is specified, the tops of narrow surfaces such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surfaces such as walkways, and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, subfloors to be covered with concrete topping, terrazzo or quarry tiles and similar surfaces shall be smooth ascended and leveled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside decks, floors of galleries and sumps, parapets, gutters, side-walks, floors and slabs, shall be consolidated, screened and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as specified or as directed by the Engineer-in-Charge.

5.23.9.2 Standard Finish For Exposed Concrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the works. Unless otherwise specified, the standard finish for exposed concrete shall be a smooth finish. A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels of forms shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothed off and all blemishes, protections etc., removed leaving the surfaces smooth.

5.23.9.3 Integral Cement Concrete Finish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by the Engineer-in-Charge. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or

a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

5.23.9.4 Rubbed Finish

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

5.23.9.5 Protection

All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

5.24 HOT WEATHER REQUIREMENT

- a. All Concrete work performed in hot weather shall be in accordance with IS:456, except as herein modified.
- b. Admixtures may be used only when approved by the Engineer-in-Charge.
- c. Adequate provisions shall be made to lower give limit concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 degrees centigrade.
- d. Consideration shall be given to shading aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available, and burying, insulating, shading and/or painting white the pipelines and water storage tanks and conveyance.
- e. In order to reduce loss of mixing water, the aggregate, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting, placement and finishing shall be done as quickly as possible.
- f. Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

5.25 PLACING CONCRETE UNDERWATER

a) Under all ordinary conditions, all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS:456 and the procedure shall be as follows:

Method of Placement

Concrete shall be deposited underwater by means of tremises, or drop bottom buckets of approved type.

Direction, Inspection and Approval

All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to specifications approved by the Engineer-in-Charge.

b) Special precautions shall be taken for prevention of



lifting of

concrete due to uplift pressure of subsoil water.

5.26 PRECAST CONCRETE

5.26.1 General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

5.26.2 Striking Forms

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

5.26.3 Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, Contractor shall satisfy the Engineer-in-Charge or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

5.26.4 Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

5.27 SLOTS, OPENINGS, ETC.

5.27.1 General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions as per design drawings and as directed by Engineer-in-Charge and extra reinforcement should be provided as per design requirement. Short pipes with puddle collar shall be fixed in the side wall of suction pipes. They shall be supplied at the appropriate time during construction. Any deviation from the approved drawings shall be made good by Contractor at his own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

5.27.2 Grouting

5.27.2.1 Standard Grout

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows:

Table 10 : Proportions for Standard Grout

Sr.	Use	Grout thickness	Mix proportions	W/c ratio (max.)
1.	Fluid	Under 25 mm	One part Portland cement to one part sand	0.44
2.	General	25mm & over but less than 50mm	One part Portland cement to 2 parts of sand	0.53
3.	Stiff Mix	50mm & over	One part Portland cement to 3 parts of sand	0.53

Sand shall be such as to produce a flowable grout without any tendency to segregate.

Sand for general grouting purposes, shall be graded within the following limits:

- Passing BIS 2.36 mm sieve 95 to 100%
- Passing BIS 1.18 mm sieve 65 to 95%
- Passing BIS 300 micron sieve 10 to 30%
- Passing BIS 150 micron sieve 3 to 10%

Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves

at the upper limits specified above. Sand, for still grouts, shall meet the usual grading specifications for concrete laitance. Anchor bolts, anchor bolt holes and the bottoms of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

Water in anchor boltholes shall be removed before grouting is started. Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place. Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side

of one end to the other to prevent entrapment of air. To distribute the grout and to ensure

more complete contact between base plate and foundation and to help release trapped air, link chains can be used to work the grout into place. Grout throughout holes in base plates shall be by pressure grouting. Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-Charge.

5.27.2.2 Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as mentioned below:

Table 11 : Proportions for Non-Shrinking Grout

Sr.	Properties	Values
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout	2.27 - 2.30 gm/m ³
4	Compressive strength N/mm ²	
Sr.	Properties	Values
	Minimum 3 days	23
	7 days	34
	28 days	45
5	Expansion %	
	Free	0.10 - 0.20
	Restrained	0.08 - 0.12
	Restrained	0.08 - 0.12

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions. Brands like FOSROC / BUILDMASTER etc or equivalent brand as approved by Engineer-in-charge shall be used as per manufacturer specifications.

5.28 INSPECTION

- All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer-in-Charge.
- All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
- All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

5.29 CLEAN-UP

- Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
- All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer-in-Charge.
- The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer-in-Charge.

5.30 RECORDS OF CONCRETING

An accurate and up to date record showing times, dates, weather and temperature conditions when various positions of all the concrete structures forming the works were concreted will be kept by the Contractor and shall be countersigned by the Engineer-in-Charge. If the Contractor fails to sign the Engineer-in-Charge's record, it shall nevertheless be regarded as correct and binding on the Contractor.

The Contractor has to submit concrete pour card in duplicate duly to be signed to the Engineer-in-Charge for each type of concreting work. Contractor shall keep copy of it, after Engineer-in-Charge has checked and signed

the pour card.

5.31 SUPPLY OF CEMENT

Contractor shall procure / purchase the cement and shall be sacked and well maintained as specified in the earlier sections. Contractor shall procure cement in those quantities required for maximum one month of concreting work and more than the prescribed time limit is not allowed. For any damage to cement MBMC will not be responsible and the damaged cement will not be used in the work.

5.32 FOUNDATION BEDDING, BONDING AND JOINTING

In no case foundation shall rest on any loose strata or loose pockets etc. even though it has reached level shown on design drawings and referred back to design engineer / Engineer-in-Charge

- a. All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering, as specified or as the Engineer-in-Charge may direct, to meet the various situations encountered in the work.
- b. Soft or spongy areas shall be cleaned out and backfilled with lean concrete or clean sand fill compacted.
- c. Prior to construction of formwork for any item where soil will act as bottom form, approval shall be obtained from the Engineer-in-Charge for the suitability of the soil.

5.33 PREPARATION OF ROCK STRATA OF FOUNDATIONS

- a. To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.
- b. Concrete shall not be deposited on large sloping rock surfaces. Where required by the Engineer-in-Charge, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.
- c. Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.
- d. Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.
- e. Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.
- f. Before placing concrete on rock surfaces all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

6 FORMWORK

6.1 FORMWORK, FIXING AND GENERAL

- a) All formwork shall be constructed of waterproof plywood or preferably sheet metal. Plywood used for form work shall be conforming to BIS:4990 i.e. Specification for plywood for concrete shuttering works. The materials for formwork shall got approved by the Engineer-in-Charge before starting the work. Formwork shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffits of beams other than pre-stressed beams shall in the absence of any specified camber, be erected with an upward camber of 6 mm for each 3 meters of span.
- b) The Contractor shall be responsible for the calculations and designs for the formwork, and if required, shall submit them to the Engineer-in-Charge for approval before construction. On form work to external faces, which will be permanently, exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the form work for standard sized manufactured form work panels, the size of such panels shall be approved by the Engineer-in-Charge before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by form work and by construction joint to ensure continuity of horizontal and vertical lines.
- c) Faces of form work in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all form work shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes on the face of the concrete and no bleeding should be allowed through the joints.
- d) Form work shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation, care being taken to prevent air being trapped.
- e) Openings for inspection of the inside of the form work and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete. Before placing concrete, all bolts, pipes or conduits or other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without approval of the Engineer-in-Charge.
- f) All exterior angles on the finished concrete of 90 degree or less shall be given 20 mm x 20 mm chamfers unless otherwise ordered by the Engineer-in-Charge.
- g) No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer-in-Charge. The whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concrete and 150 mm in the case of un-reinforced concrete.

Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.

- h) Formwork in contact with the concrete shall be treated with suitable non-staining mould oil to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Engineer-in-Charge.
- i) No formwork shall be started or placed unless the requirement work is fully completed and checked by Engineer-in-Charge.
- j) Necessary cover blocks shall be provided before starting connection.

6.2 REMOVAL OF FORMWORK

- a) Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete.
- b) The periods of time elapsing between the placing of the concrete and the striking of

the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer-in-Charge, remove the formwork at the earlier times listed below provided that the props are left in position.

Table 12 : Period for Formwork

Position of formwork	Days for striking
Walls	1
Sides of beams and columns	2
Slabs (Drops left under)	3
Props to slabs (span not exceeding 4.5m)	7
Props to slabs (span exceeding 4.5 m)	14
Beams soffits (props left under)	7
Props to beams (span not exceeding 6 m)	14
Props to beams (span exceeding 6 m)	21
Circular structures, domes ,cantilever portions etc.	21

- c) Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.
- d) Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the formwork it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.
- e) Reinforced temporary openings shall be provided, as directed by the Engineer-in-Charge, to facilitate removal of formwork which otherwise may be inaccessible.
- f) The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade



beams will not be permitted.

- g) For liquid retaining structures, no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall be cut at 25 mm depth or more from the surface and then the hole shall be made good by cement sand mortar of the same proportions as the concrete just after striking the form work.

6.3 FORMED SURFACES - CLASSES OF FINISH

- a) Finishes to formed surfaces of concrete shall be classified as F1, F2, or F3, or such other special finish as may be particularly specified. Where the class of finish is not specified the concrete shall be finished to Class F1.
- b) Form work for Class F3 finish shall be lined with as large panels as possible of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fiber board, arranged in a uniform approved pattern and fixed to back form work by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.
- c) Form work for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.
- d) Form work for Class F1 finish shall be constructed in sheet metal. Surfaces subsequently to be rendered, plastered or tiled shall be adequately scabbled or hacked as soon as the form work is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

6.4 DEFECTS IN FORMED SURFACES

- a. Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.
- b. If any blemishes are revealed after removal of formwork, the Engineer-in-Charge's decisions concerning remedial measures shall be obtained immediately. These measures may include, but shall not be limited to the following:
- Fins, pinhole bubbles, surface discolouration and minor defects may be rubbed down with sacking immediately after the formwork is removed.
 - Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured. These and any other defects shall be remedied by methods approved by the Engineer-in-Charge which may include using a suitable epoxy resin or, where necessary, cutting out to a regular dovetail shape at least 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.
- c. The form work shall be checked by the Engineer-in-Charge before the form work starts and form found defective shall be rejected and the same can be used after rectifying the defects and with due approval of the Engineer-in-Charge

6.5 HOLES TO BE FILLED

1. Holes formed in concrete surfaces by form work supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary Portland cement and one part fine aggregate passing BIS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.
2. The Contractor shall thoroughly clean any hole that is to be filled with dry-pack mortar and where the surface has been damaged, the Contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall be dried so as to leave a small

amount of free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

3. The dry-pack material shall then be placed and packed in layers having a compacted thickness not greater than 15 mm. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction, the surface of each layer shall be scratched the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

6.6 TOLERANCES

Tolerance is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for RCC Structures

- i. Variation from the plumb

In the lines and surfaces of columns, piers, walls 5 mm per 2.5 m or 25 mm, whichever is less.

For exposed corner columns and other conspicuous lines

In any bay or 5 m maximum	5 mm
In 10 m or more	10 mm

- ii. Variation from the level or from the grades indicated on the approved drawings

In slab soffits, ceilings, beam soffit, and in arises

In 2.5 m	5 mm	In any bay or 5 m maximum	10 mm
In 10 m or more	15 mm		

For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines

In any bay or 5 m maximum	5 mm
In 10 m or more	10 mm

- iii. Variation of the linear building lines from established position in plan and related position of columns, wall and partitions

In any bay or 5 m maximum	10 mm
In 10 m or more	20 mm

- iv. Variation in the sizes and locations of sleeves, openings in walls and floors Except in the case of and for 5mm anchor bolts

- v. Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus	5 mm
Plus	10 mm

vi. Footings

Variation in dimension in plan

Minus	5 mm
Plus	10 mm

vii. Misplacement or eccentricity 2% of footing width in the direction of misplacement but not more than 50 mm Reduction in thickness: Minus 5% of specified thickness subject to a maximum of 50 mm

viii. Variation in steps

In a flight of stairs

Rise	3 mm Tread 5 mm In consecutive steps
Rise	1.5 mm
Tread	3 mm

Tolerances in other Concrete Structures

ix. All structures

Variation of the constructed linear outlines from established position in plan

In 5 m	10 mm
In 10 m or more	15 mm

Variations of dimensions to individual structural features from established positions

In 20 m or more	25 mm
In buried construction	50 mm

Variation from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m	10 mm In 5 m	15 mm In 10 m or more
In 2.5 m	25 mm	
In buried construction	twice the above amounts	

Variation from level or grade indicated on approved drawings in slab, beams, soffits, horizontal grooves and visible arises

In 2.5 m	5 mm
In 7.5 m or more	10 mm
In buried construction	Twice the above amounts

Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members

Minus	5 mm
Plus	10 mm

x. Footings for columns, piers, walls, buttresses and similar members

Variation of dimensions in plan

Minus	10 mm Plus 50 mm Misplacement or eccentricity
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2% of footing width in the direction of misplacement but not more than 50 mm.
 Reduction in thickness
 5% of specified thickness subject to a maximum of 50 mm

xi. Tolerance in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Formwork (American Concrete Institute Act 347).

xii. Tolerance in fixing anchor bolts shall be as follows: Anchor bolts without sleeves
 + 5 mm
 Anchor bolts with sleeves + 5 mm for bolts up to 20 mm dia
 3 mm for bolts above 32 mm dia
 Embedded parts + 5 mm in all directions

6.7 BRACING, STRUTS AND PROPS

- a. Form work shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboo shall not be used as props or cross bearers.
- b. The formwork for beams and slabs shall be so erected that the formwork on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Repropping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the formwork.
- c. If the formwork for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of the concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m as directed by the Engineer-in-Charge.

Contractor shall submit the detailed design and methodology with applicable drawings if any of Formwork system for different members for approval of Engineer-in-Charge.

7 REINFORCEMENT

7.1 RELEVANT IS CODES

- IS:432 : Mild steel and medium tensile steel bars & hard drawn steel wire for concrete reinforcement
- IS:1786 : Cold twisted steel bars for concrete reinforcement (CTD).
- IS:2502 (1963) : Code of practice for bending and fixing of bars for concrete reinforcement
- IS:55225(1969) : Recommendations for detailing of reinforcement in RCC works
- IS:2751 : C.P. for welding of MS bars used for RCC
- IS:9417 : Recommendations for welding cold worked steel bars for RCC
- IS:10790 : Methods of sampling of reinforced steel

7.2 GENERAL

Reinforcement shall be CTD and high strength deformed corrosion resistant (CRS) bars

as per IS:1786 – Fe415. Wire mesh or fabric shall be in accordance with IS:456. Substitution of reinforcement will not be permitted except upon written approval from the Engineer-in-Charge.

7.3 STORAGE

- a. The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.
- b. If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the Engineer-in-Charge.
- c. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.
- d. It should be seen that the reinforcement will not be exposed to direct sunlight and preventive measures should be taken for the same.

7.4 QUALITY

All reinforcements shall be clean, free from grease, oil paint, dirt, loose mill scale, loose rust, dust bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-Charge. If welding is approved, the work shall be carried out as per IS:1786 - Fe415 according to the best modern practices and as directed by the Engineer-in-Charge. In all cases of important connections, tests shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Engineer-in-Charge, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

7.5 LAPS

Laps and splices for reinforcement shall be as per IS:456-2000. Splices in adjacent bars shall be staggered as mentioned in structural drawings and locations of all splices shall be approved by the Engineer-in-Charge.

Also Contractor shall submit the Bar bending schedule for approval of Engineer-in-Charge and shall follow same unless and until changed by any design changes.

7.6 BENDING

- a. Reinforcement bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars.
- b. All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material; bars containing cracks/splits shall be rejected. They shall be bent cold, except bars of over 25 mm in diameter, which may be bent hot if specifically, approved by the Engineer-in-Charge. Bars, which depend for their strength of cold working, shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (nor exceeding 845°C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and re-bending be such as shall not, in the opinion of the Engineer-in-Charge, injure the material. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

7.7 FIXING

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the approved Drawings by the use of blocks, spacers and chairs, as per IS:2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge GI wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars. No binding wire shall protrude in cover area and shall be bent inside.

7.8 COVER

Unless indicated otherwise, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish) shall be as follows:

- a. At each end of a reinforcement bar, not less than 25 mm nor less than twice the diameter of the bar whichever is greater
- b. For a longitudinal reinforcing bar in a column, not less than 40 mm, nor less than the diameter of the bar. In case of columns of minimum dimension of 20 cm or under with reinforcing bars of 12 mm and less in diameter, a cover of 25 mm may be used.
- c. For longitudinal reinforcing bars in a beam, not less than 40 mm nor less than the diameter of the bar, whichever is greater
- d. For tensile, compressive, shear or other reinforcement in a slab, or wall, not less than, 20 mm, nor less than the diameter of such reinforcement.
- e. For any other reinforcement, not less than 20 mm, nor less than the diameter of such reinforcement.
- f. For footing and other principal structural members in which the concrete is poured on a layer of lean concrete, the bottom cover shall be reduced to 60 mm.
- g. For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and tops, etc.

not less than 40 mm

- for bars larger than 16 mm diameter and not less than 30 mm for bars 16 mm diameter or smaller.
- h. For liquid retaining structures, the minimum cover to all steel shall be 40 mm or the diameter of the main bar, whichever is greater.
 - i. The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concrete blocks as approved by the Engineer-in-Charge. The use of pebbles or stones shall not be permitted.
 - j. The 28 day crushing strength of cement mortar cubes/precast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.
 - k. The minimum clear distance between reinforcing bars shall be in accordance with IS:456

7.9 INSPECTION

After final erection of reinforcement, it shall be intimated to Engineer-in-Charge in writing or through pour cards. Erected and secured reinforcement shall be inspected and approved by the Engineer-in-Charge prior to placement of concrete.

7.10 WELDING OF REINFORCEMENT

- a. Reinforcement which is specified to be welded shall be welded by any process which conforms with the requirements of IS:2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no deviation from this procedure shall be permitted.
- b. Welds in positions other than those shown on the approved Drawings shall not be permitted. Tack welding to lightly secure reinforcement in place will be permitted subject to approval of the Engineer-in-Charge.

7.11 SUPPLY OF REINFORCING BARS

Steel reinforcement, such as MS bars HYSD bars etc. required for the works shall be procured by Contractor. The Contractor shall arrange for transport, loading, unloading and storage at the work sites. The Contractor should plan the procurement of steel in such a way that at least required quantity of steel of specified sizes is available at site for 3 months period.

Steel brought on site shall be stored in proper manner as approved by Engineer In Charge so as to avoid distortion, deterioration and corrosion. The Contractor shall maintain proper register for the steel account, showing the steel received at site, steel used, and the balance stock on site, to the entire satisfaction of the Engineer-in-Charge

8 STRUCTURAL STEEL WORK

8.1 RELEVANT IS CODES

IS:2062	: Specification for Structural Steel (Fusion Welding Quality)
IS:800	: C.P. for general construction in steel
IS:808	: R.S. beam, channel and angel sections
IS:814	: Covered electrodes for metal arc welding of structural steel
IS:1148	: Hot rolled steel rivet bars for structural purpose
IS:1363	: Black hexagon bolts, nuts, and lock nuts (dia 6 to 39mm) hexagon screws (dia 6 to 24mm)
IS:2062	: Structural steel (fusion welding quality)
IS:3954	: Hot rolled steel channel sections for general engineering purpose
SP-6 (I – VII)	: ISI Handbook for Structural Engineers
SP-40	: Handbook on structures with steel portal frames (without cranes)

8.2 GENERAL

Structural steel fabrication work shall include all types of steel structural work required for installation of platform for operation and installation of equipment where rolled steel sections are joined together either by bolting or riveting or welding as specified in the drawings/bill of quantities/directed by the Engineer. It shall also include fabrication and installation of air vessels/pressure vessels etc. Covers for ducts for electrical panels along with their seating arrangements are also classified under this heading unless they are provided separately under a different heading. Reaction tanks or storage vessels are also classified under this heading.

8.3 MATERIALS

The MS structural members such as MS angles, channels, flats, I sections etc. shall conform IS 2062. Structural steel that is used for fabrication shall be conforming to any

of the following grades of steel as specified to each of the works:

- IS:2062 : Specification for Structural Steel (Fusion Welding Quality)
- IS:1977-1975 : Structural steel (ordinary quality)
- IS:2062-1980 : Weldable Structural steel (fusion quality)

Whenever the Contractor supplies steel, he shall on demand the test certificates from the manufacturer.

The welding rods used for fabrication shall conform to IS:814-1974 (parts I and II). The fasteners like bolts, nuts etc., shall conform to IS:1367. Rivets shall conform to IS:1184-1982. Plain washers shall conform to IS:2016-1967. Spring washers shall conform to IS:3063-1972.

MS rivets shall conform to IS:1148 and IS:1929-1967 bolts and nuts shall conform to IS:1363 - 1967.

If metal arc welding is to be done as per design or as the Engineer-in-Charge the electrodes used for strength conform to IS: 814 and shall be of such shape



ordered by
welds shall

and size approved by the Engineer-in-Charge and shall be prevented from oxidation and shall be kept in clean condition.

Paints used shall be of approved manufacture and shade and shall conform to the ISI standards.

8.4 FABRICATION AND ERECTION

All the shop drawings shall be prepared by the Contractor and submitted in advance of atleast 15 days to the Engineer for his approval. The drawings shall be submitted in triplicate. The fabrication work shall not be taken in hand until the shop drawings are approved by the Engineer. Approval of the shop drawings however shall not relieve the Contractor of his responsibility of correct conformation to the designs and fabrications of the structure to meet the requirements of the contract. One copy of the approval drawings shall be given to the Contractor for going ahead with the fabrication work.

In the shop drawings to be submitted by the Contractor, standard symbols as described in the IS:813-1961 shall be followed.

Fabrication work shall be carried out as laid down in IS:800-1984 Code of practice for general construction in steel.

Welding shall be carried out in accordance with the following specifications as applicable:

IS:803 - 1976	: Code of practice for design fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS: 816 - 1969	: Code of practice for use of metal and welding for general construction in mild steel
IS:822 - 1970	: Code of practice for manual and welding of mild steel
IS:9595 - 1980	: Recommendations for metal are welding of carbon Radiographic tests are required to be carried out as directed by the Engineer in case of pressure vessels.
IS:818 - 1968	: Code of practice for safety and health requirements in electric and gas welding and cutting operations
IS:3016-1982	: Code of practice for fire precautions in welding and cutting operations
IS:7205 – 1973	: Safety code for erection of structural steel work

The sections shall be fixed absolutely vertical or to the specified angle as shown in the drawings/as desired/directed by the Engineer.

All connections like angle brackets, cleats, gusset plates, anchor bolts, bearing plates shall all be fixed as shown in the drawings or as directed by the Engineer.

The items of work shall include supply of materials, fabrication and erection in position on site as shown in the drawings. This shall also include all labour consist, materials and equipment required for all fabrication, hoisting, erection, and satisfactory completion of the item of work.

The supply of materials includes all structural members like rolled sections, plates, brackets, rivets, bolts and nuts and welds.

The steelwork shall be painted as specified in the drawings, described in the bill of quantities or as directed by the Engineer. Unless otherwise provided for in the bill of quantities separately, the rate quoted for the item is inclusive of all costs for painting like cost of paint, cost of labour, scaffolding etc. Welding work shall be done generally using electric arcs welding. Where public electricity is not available, generators shall be arranged by the Contractor shall be arranged by the Contractor himself.

Gas welding shall not be allowed to be resorted to for welding. Under special circumstances if in the opinion of the Engineer it cannot be avoided, gas welding can be done with the prior permission of the Engineer. However gas welding shall not be used where structural strength is the criteria for consideration.

All arrangements shall be made by the Contractors for access for inspection by the Engineer or his representative to the workshop where the welding work is being carried out and necessary equipment like gauges, measuring instruments etc., shall be made available to the inspecting personnel.

Painting work shall not be started without the express approval of the Engineer and the painting shall be started only after his inspection and approval of the works after carrying out surface preparations.

All holes shall be carefully marked. Holes shall have their axis perpendicular to the surfaces bored through. Holes being made through two or more members shall be truly concentric. Holes shall not be formed cutting process.

All the temporary connections of parts during assembly shall be done in the following ways. For welded structures. Tack welding fixtures.

After welding is over, the surface on the joint should be ground and made smooth and even. The welding should be so perfect so as to give required strength as taken for designed purpose at joints in particular. The Contractor will make necessary arrangements for testing of joints as required by Engineer in Charge.

Welded joints shall be free from defects that would impair the service performance of the construction. All the welds shall be free from incomplete penetration, incomplete fusion, slag inclusion, burns, un-welded creases undercuts and cracks in the welded metal, porosity etc. All the defects shall be rectified as directed by the Engineer. Defective portions shall be removed to the sound metal and re-welded. Rectification of the welds by caulking shall not be permitted.

All welds shall be cleaned of slag and other deposits after completion.

8.5 PAINTING

Painting shall generally comply with IS subject to addition and alterations as may be prescribed in the special provisions for any particular item. It shall also comply with the requirements of the manufacturer's specifications. One priming coat of red lead shall be applied immediately after fabrication. Two coats of oil paint of approved shade shall be applied after complete erection. The structural steel to be embedded in concrete shall not be painted.

Inspection and testing shall be carried out in conformity with IS:800.

Riveting, welding and bolting shall not be started until such time as the Engineer has personally satisfied himself that the alignment is correct, in the vertical plumb, the camber correct with camber packs, screwed tight, all joints and cover plates fixed tightened with service bolts and field rivet holes coinciding. While assembling holes in different components shall be made concentric with the use of drills before service bolts are fixed.

Welding if required shall be done as per standard practice and as approved by the Engineer-in-Charge.

All permanent machine fitted nuts and bolts must be perfectly tight and shall be burred or otherwise checked to prevent nuts from becoming loose. No unfitted rivet or bolt holes are to be left in any of the structure.

Structural Steel

All structural steel shall conform to IS:2062-1984. The steel shall be free the defects mentioned in IS given above and shall have a smooth finish. The material shall be free from loose mild scale, rust pits or other defects affecting the strength and directly.

8.5.1 General

Engineer's approval shall be obtained before commencing the painting work. All paints and preserves shall be of approved make and colour and their application shall conform to the manufacture's instructions. Where more than one undercoat is specified it shall be applied in coats of distinctive tints. Workmanship shall conform to the requirement of IS:2395

Unless the manufacturer's instructions state otherwise 48 hours drying time shall elapse between successive applications of any primer and 24 hours between applications of all subsequent coats. The surface of bituminous paints shall be left at least 3 days before further handling.

No paints in any coats shall be applied until the engineer is satisfied that the surface is clean and dry. And that any previous coat is satisfactory and has hardened adequately. When a surface has been approved, it must be painted immediately.

Paint work shall be rubbed down with a glass paper between coats. No paint shall be applied to a surface, which is damp, dirty or otherwise inadequately prepared.

8.5.2 Ironwork and Ungalvanised Steelwork

Structural steelwork shall be shot blasted to a "white metal" finish, and grease and oil removed prior to painting. Priming shall immediately follow blast cleaning and no cleaned surface shall be left unprimed for more than four hours. Only primers that chemically inhibit corrosion shall be used. Where the iron or steelwork is not in contact with raw or treated water, the primer shall be red lead complying with IS: 57. Where there is a possibility that the steel or ironwork may come in contact with water, the priming treatment shall be non toxic, zinc chromate or equivalent. Where it is anticipated that further welding will be required. an approved welding primer shall be applied to the areas to be welded and re primed with the main primer when welding has been completed. Primer coats shall not be less than 0.05 mm each.

After erection, all damaged areas shall be made good, and re primed where the original coat has spread under the primer, the affected surface shall be cleaned down to bare metal to the satisfaction of the Engineer and then re primed.

Repainting shall be carried out as soon as possible after erection. If it is to be exposed to weather or condensation, it shall receive one further coat of primer.

Metalwork in intermittent or permanent contact with raw or treated water shall have two finishing coats of an approved coal tar pitch epoxy paint such as "Epilux 5" by Berger Paints, or equivalent. The total coating shall be minimum of 0.125 mm thick.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, be undercoat of synthetic enamel paint conforming to IS:2932 of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

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

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

9 BRICK WORK AND STONE MASONRY

These specifications deal with all types of brickwork required for buildings, manholes, drains, retaining walls or any construction made out of bricks.

9.1 RELEVANT IS CODES

IS:1077 : Common burnt clay building bricks
IS:2180 : Heavy duty burnt clay-building bricks
IS:2212 : C.P. for brickwork
IS:3495 (I – IV): Method of test for clay building bricks
IS:5454 : Method of sampling of clay building bricks

9.2 MATERIALS

9.2.1 Bricks

Bricks used for the construction of brick masonry shall be sound, hard, rectangular in shape and size and well burnt of uniform deep red, cherry or copper colour and shall conform to IS:1077-1986.

The bricks shall be brought from approved brick kilns. The bricks shall be free from cracks, chippings flaws, stones or lumps of any kind. The bricks shall not show any signs of efflorescence and shall be homogeneous in texture.

They should emit a clear metallic sound on being struck and shall have a minimum compressive strength of 50 kg/sq.cm. They shall not absorb water more than specified in the Indian Standard Specifications, of its dry weight when soaked in cold water for 24 hours.

9.2.2 Mortar

The proportion of the cement mortar used for the masonry work shall be as specified on the various drawings for different places/types of construction, bills of quantities, specifications for each part of the work.

Mortar should be prepared by volume using boxes of appropriate sizes on clean platform or this sheet to avoid mixing of foreign material and maintain consistency of mortar.

Sharp coarse sand is mixed with the required quantity of cement for the preparation of the mortar. Mortar shall be prepared in accordance with IS:2250-1981. The sand used for the masonry mortar shall meet the requirements as specified in IS:2116-1980. Sand for masonry mortars. Sand and cement of required proportions are mixed in small quantities in a dry state first and then water is added to make the mortar of required the consistency suitable for the type of work it is required as directed by the Engineer-in- Charge. No left over mortar shall be used and therefore only that much quantity of mortar that can be consumed within 30 minutes shall be mixed in batches.

9.3 CONSTRUCTION

The brick masonry shall be constructed as per the Indian Standard Code of Practice for Brick Work - IS:2212-1962. The thickness of the joints shall not be thicker than those specified in of the above Code of Practice.

The bricks shall be thoroughly soaked in water before using them on the work for at least six hours and all the air bubbles shall come out during soaking process. The soaked bricks shall be stacked on wooden planks/platforms so as to avoid sticking of the earth and other materials on to the surfaces of bricks. Bricks required for construction in mud mortar or lime mortar shall not be soaked. Brickwork shall be laid in English Bond unless otherwise specified. Half bricks shall not be used except when need to complete the bond. Each course shall be perfectly straight and horizontal. The masonry shall be true to plumb in case of vertical walls and in case of battered construction the batter or slope shall be truly maintained. The level of the courses completed shall be checked at every metre interval or less as required.

The bricks shall be laid frogs upwards. While laying the bricks they shall be thoroughly bedded and flushed in mortar and well trapped into position with wooden mallets and superfluous mortar shall be removed.

No part of the structure shall be raised more than one meter above than the rest of the work. In case it is unavoidable the brickwork shall be raked back at an angle of not more than 45 degrees so as to maintain a uniform and effectual bond, but raking shall not start within 60 cms from a corner.

In cases of construction of buttresses, counterforts, returns they are built course by course carefully bound into the main walls. At all junctions of walls the bricks at alternate courses, shall be carried into each of the respective walls so as to thoroughly unite both the walls together. The brickwork shall not be raised more than 14 courses per day.

All the beds and joints shall be normal to the pressures applied upon them i.e. horizontal in vertical walls, radial in arches and at right angles to the face in battered retaining walls.

Vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken to ensure that all the joints are fully filled up with mortar, well flushed up where no pointing is proposed, neatly struck as the work proceeds. The joints in faces, which are plastered or painted, shall be squarely raked out to a depth not less than 12 mm while the mortar is still green. The raked joints shall be well brushed to remove the loose particles and the surfaces shall be cleaned with a wire brush so as to remove any splashes of mortar sticking to the surfaces during the construction.

All iron fixtures, pipes, bolts, conduits, sleeves, holdfasts etc., which are required to built into the walls shall be embedded in cement mortar or cement concrete as shown in the drawings/indicated in the specifications directed during the execution by the Engineer- in-Charge as the work proceeds and no holes be left for fixing them at a later date unless authorised by the Engineer-in-Charge.

9.4 CURING

Fresh work shall be protected from rain by covering the work suitably. Masonry work as it progresses shall be thoroughly kept wet by watering on all the faces for atleast 7 (Seven) days after completion of the parts of the work. Proper watering cans, flexible pipes, nozzles shall be used for the purpose. The top of the masonry work shall be kept flooded at the close of the day's work by constructing fillets of mortar 40 mm high all around the edges of the top course. In case of fat lime mortar curing shall start two days after construction of masonry and shall continue for seven days. No additional payment is admissible for curing and the rates quoted are deemed to be inclusive of the cost of curing.

9.5 SCAFFOLDING

Double scaffolding sufficiently strong so as to withstand all loads that are likely to come upon it and having two sets of vertical supports shall be provided. Where two sets of vertical supports are not possible the inner end of the horizontal supporting pole shall rest in a hole provided in a header course only. Only one header for each pole shall be left cut. Such holes, however shall not be permitted in pillars under one meter in width or immediately near the skewbacks of arches. Such holes shall be filled up immediately after removal of the scaffoldings. Safety Code for Scaffolds and Ladders, IS:3696-1987 (Parts I and II) shall be followed. The cost of scaffolding is deemed to be included in the rates quoted for brick masonry and no separate costs are payable.

9.6 STONE MASONRY FOR RETAINING WALLS

Stone masonry in general is to be used for retaining walls as per engineer in-charge's instructions and as per drawings, which will be supplied during course of construction to suit site conditions.

Following Indian Standards shall be applicable:

IS:1122-1974	Methods of determination of specific gravity and porosity of natural building stones
IS:1200	Method of measurement of stone masonry.
IS:1597	Code of practice of construction of rubble stone masonry. IS:1805 Glossary of terms relating to stone quarrying and dressing IS:4101 Stone facing
IS:1121	Determination of strength, properties of natural building stones

9.7 UNCOURSED STONE MASONRY

Uncoursed stone masonry shall be built in layers not exceeding 450 mm in height. No stone shall be less in breadth than 14 times its height and less in length than twice its height. Every stone whether large or small, shall be laid in its natural bed and set flush in mortar, and the small stones used for wedging or filling being carefully selected to fit the interstices between the large stones. Care shall be taken to see that no dry work or hollow space is left in the masonry. The stones shall be so arranged as to break joints at least every 80 mm and long vertical joints of joints shall be avoided. The joints at the face shall be finished off neatly, being struck and smoothed with a trowel while the mortar is fresh. The upper surface of the work shall be brought to a uniform level at the height of each course. The faces of masonry walls shall be kept in perfect plumb and where batter has to be given it shall, be uniform. The stones at all comers and junctions of walls shall be of large sizes and hammer dressed to the correct angle.

Each stone shall be thoroughly wetted before being used in the work. The masonry shall be kept thoroughly wet during the progress of the work, (care being taken to water it even on Sundays and Holidays, special labour being employed if so required for this purpose) until it becomes hard. As far as practicable, the whole of the masonry shall be raised in one uniform level and no part of the masonry shall be allowed to rise more than 1 metre above the rest to avoid unequal settlement. If raising one part of wall before the other becomes unavoidable the end of the raised portion shall be racked back in steps to prevent cracks developing at the junction of the old and new work. Care shall be taken to see that the sides of the wall are not built separately from the hearting, the faces and internal filling being done simultaneously. The stones shall overlap and cross each other as much as possible. No course shall be laid unless the previous course is perfectly set.

At least one header or through stone per square metre of wall face shall be built into the work. The headers or through stones shall be at least 0.05 m² in area at face and shall have at least 0.025 m² area at the back face. Where the thickness of the wall is more than 600 mm a series of through stones shall be laid through the work so as to form a tie from front to back, breaking joints or overlapping each other for at least 150 mm. No stone whose length is less than 600 mm shall be used in such work as a header.

All the through stones shall be marked inside and outside and the marks shall be retained until ordered by the Engineer to be removed. Sufficient number of headers shall be collected on site before commencing any masonry work. Where adequate sized through stones are not available in required quantities, the use of pre-cast plain concrete headers in M-20 mix may be permitted at the discretion of the Engineer. No extra payment will be made for the provision of substitute headers in concrete.

Quoins shall be 150 mm high and formed of header stones at least 300 mm long. They shall be laid lengthwise alternately along each face and square on their beds, which shall be dressed to a depth of at least 80 mm.

Weep holes 80 mm wide and 150 mm in height shall be provided in retaining walls at the rate of one per square metre as specified or directed. They shall be pointed with 1:2 cement sand mortar after raking the joints to a minimum depth of 25 mm. Completed masonry shall be kept wet for a minimum period of 14 days. In wet weather newly laid masonry shall be protected from the effects of heavy rainfall by tarpaulins or other approved material.

9.7.1 Pointing of Uncoursed Masonry

Joints in exposed masonry faces shall be formed while the mortar is still green and shall be finished as flush joints, weathered joints, round-recessed joints or square-recessed joints as directed by the Engineer. Masonry which is to be rendered or plastered shall have the joints raked out to a depth of 15 mm to form a key.

9.8 STONE PITCHING

Stone pitching: to slopes shall be carried out where specified or as directed by the Engineer. Stone for pitching shall be obtained from an approved source and shall be hard, sound, durable, clean and generally as specified. The minimum dimension of any stone shall be, at least equal to the specified thickness of the pitching.

After excavation and trimming, slopes to be pitched shall be spread with a 75mm thick layer of crusher run rock or graded coarse aggregate ranging from 75mm particle size to fines. The slope shall then be hand packed with hard broken rock to a total thickness of 150 mm, each stone being individually placed and rammed home, with smaller stones edged into the cracks. 50mm dia weep-holes shall be provided where specified at intervals not exceeding two meter's in both directions. Joints in stone pitching shall be flushed up with sand/cement mortar on completion.

9.9 RUBBLE PACKING

Rubble used for packing under floors, foundations, etc. shall be hard and durable rock, free from veins, flaws and other defects. The quality and size of the rubble shall be subject to the approval of the Engineer.

Rubble shall be hand packed as directed by the Engineer. They shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stones and shall not lag behind.

Small interstices shall be filled with hard clean sand and well watered and rammed.

9.10 CONCRETE BLOCK MASONRY

9.10.1 Materials

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

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS:2185(Part 3).

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

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

The nominal dimensions of concrete block shall be as under. Length 400, 500 or 600 mm
Height 100 or 200 mm
Width 100 to 300 mm in 50 mm increments

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

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

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

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

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

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

9.10.2 Workmanship

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

The workmanship shall generally conform to the requirements of IS:2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and 15:6041 for autoclaved cellular concrete block masonry works.

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

Concrete blocks shall be embedded with a mortar, which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works.

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

course is laid to ensure good bond for the plaster.

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

As per the design requirements and to effectively control cracks in the masonry, RCC bound beam/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis.

For jambs of doors, windows and openings, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At Intersection of walls, the courses shall laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks.

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

Double scaffolding shall be adopted for execution of block masonry work.

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

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

9.11 DAMP-PROOF COURSE

9.11.1 Materials and Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:1 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

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

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

10 PLASTERING

10.1 RELEVANT IS CODES

IS:1542	: Sand for plaster
IS:1661	: C.P. for application of ferrous metals in building
IS:2394	: C.P. for application of lime plaster finish

10.2 PLASTERING

Cement mortar used for plastering shall be of the mix proportions and thickness as specified on the drawings or bill of quantities or particular specifications for the various different parts of the works.

The materials used i.e. cement, sand and water shall be of the same quality and of the same specifications as indicated for plain and reinforced cement concrete works in the Section D2 of this tender.

Sand further shall meet the specifications as laid down in IS:1542-1977 Specification for sand for plaster.

For plastering on old existing surfaces polymers shall be added as bonding agents.

The surfaces that are to be applied with plaster shall be thoroughly cleaned to remove dust, dirt, loose particles, oil, soil, slats etc. that may be sticking to the surfaces. The surfaces shall be washed clean and watered properly for 4 hours before applying plaster.

Plaster shall not, in any case, be thinner than specified. It shall have uniform specified thickness. When smooth finishing is required the cement plastering shall be floated over with neat cement within 15 minutes after application of the last coat of plastering.

The plaster shall be protected from the sun and rain by such means as the Engineer-in-Charge in charge may approve. The plastered surfaces shall be cured for 7 (seven) days. Construction joints in plastering shall be kept at places approved by the Engineer-in-Charge. When the thickness of the plaster specified is to be made up in more than one layer, the second layer shall be applied only when the lower coat is still green. After applying the first layer the surface should be roughed and wherever specified, approved brands of additives like water proofing compounds shall be added in specified quantities as recommended by the manufacturer of the compound, or as directed by the Engineer-in-Charge.

Wherever scaffolds are necessary for plastering they shall be provided. Stage scaffolding shall be provided for ceiling plaster. To ensure even thickness and true surface, patches

of plaster about 15 cms x 15 cms shall be first applied both horizontally as vertically 2 m apart. Plastering shall be done from top to bottom and care shall be taken to avoid joints on continuous surface.

Sand face plaster shall consist of first layer of 16mm average thick cement plaster in cement mortar 1: 6 (One part cement and Six parts coarse sand). A second layer of 4 mm average thick in cement mortar 1:4 (one part cement and four part coarse sand) shall be applied. After the application of final coat, the surface shall be finished with the

application of sponge rubber or as directed to obtain a uniform sand particle surface finish.

In case any other finish like rough cast finish or dry dash finish is specified in the drawings the same shall be provided as directed by the Engineer-in-Charge. Surfaces, which are to be plastered, shall be roughened while they are still green or raked so as to give proper bond between the surface and plaster.

All corner, edges, junctions shall be truly vertical or horizontal as the case may be and carefully finished. Rounding or chamfering of corners shall be carried out with proper templates to the required size and shapes.

No additional charges for works like scaffolding curing etc. are payable over and above the rates quoted for brickwork. The rates quoted shall be deemed to be inclusive of all such works.

10.3 NEERU

10.3.1 Material

Neeru shall be made of the best description of lime slaked with fresh water and sifted. The lime to be reduced to fine powder by grinding it on a stone or in a hand mill, with a thick solution of mussalla to be made or as may be desired by the engineer. The neeru thus prepared shall be kept moist until used and the quantity to be prepared at one time shall be such that it can be consumed in eight days.

10.3.2 Workmanship

All stone or brick masonry shall be thoroughly wetted and joints raked out to a depth of at least 20mm and walls washed before any plastering is done. The surface shall then rendered with fine sand, to the specified thickness and roughness. The surface shall then be floated or set with a thin coat, 3mm thick of cement and polished, well with a trowel or flat board. The cement mortar shall be used within 30 minutes after it leaves the mixing board or mill. Before any plasterwork is started patches of plaster 150mm x 150mm shall be put on at every 3 meters apart as gauges so as to ensure an even thickness throughout the work. Cement plaster shall be done in even square or strips. Care shall be taken to keep the whole surface thoroughly wetted for at least a week. The finishing surface shall be as specified and directed. If neeru finish is specified then the same shall be applied to the prepared and partially set but somewhat plastic surface with steel trowel to a thickness slightly exceeding 1.5 mm and rubbed down to 1.5mm thickness and polished to a perfectly smooth and even finish working from top to bottom. The surface shall be then colored, if required with 3 coats of white or colour wash for which no extra payment shall be made.

11 FLOORING

11.1 RELEVANT IS CODES

IS:777	: Glazed earthen ware tiles
IS:1237	: Cement Concrete flooring tiles
IS:1443	: C.P. for laying & finishing of cement concrete flooring tiles
IS:2114	: C.P. for laying in-situ terrazzo floor finish

11.2 GENERAL

The materials and workmanship conform to the provisions of the following codes and standards. In particular and with such other standards as mentioned hereinafter. BIS: 269, 385, 515, 653, 712, 809, 1077, 1195, 1196, 1197, 1198, 1237, 1344, 1443.

11.3 CEMENT CONCRETE FLOORING

11.3.1 General

Flooring shall consist of a sub-base laid on the compacted earth or sand fill as required, a base course laid on the sub-base and then a finishing layer of concrete, Terrazzo or any other material as specified to be laid. The materials for filling (Earth or sand as specified in drawings) shall be brought from the source as approved by the Engineer-in-Charge.

11.3.2 Filling

The surface to receive the filling shall be first cleared free of all roots, vegetation and wetted. Filling in plinth or other specified levels shall proceed in layers of 15 cm. Along with the construction of building, it shall be watered and well rammed in layers as mentioned above and compacted to the satisfaction of the Engineer-in-Charge.

Care shall be taken to remove all roots, vegetation, foreign matter, etc. from the earth used for filling. After thorough consolidation, required quantity of the filling corresponding to the thickness of floor shall be scrubbed to make space for the flooring. Where sand filling is specified, the sand shall be clean, free from vegetation and other deleterious materials and same procedure followed as for earth filling. In case of sand filling, if required, flooding shall be done to achieve required compaction.

11.3.2.1 Preparation of Bed

The bed for flooring shall be prepared either level or sloped as per relevant drawings or as instructed by Engineer-in-Charge. Care shall be taken that there are no roots, vegetation, foreign matter, etc.

11.3.2.2 Sub-Base

On the prepared bed as indicated above, boulder, or gravel or broken bricks or sand or cement concrete (1:4:8 as per BIS: 465) shall be laid to thickness as specified. This layer shall be beaten with rammers until thoroughly consolidated. All the material used shall conform to the required specifications.

The materials proportion, mixing, laying, and curing, etc. for concrete shall be carried out as specified.

cement

The finished work shall be of uniform depth over the whole floor with surface even and parallel to the prepared bed as per drawing or as directed by Engineer-in-Charge.

a. Boulders as Sub-base Course

Boulders shall be laid over the prepared bed as per general specification and shall be of size 100 to 150 mm and shall be of approved quality. Boulders being used shall be free from decay, weathering and be stacked in such heaps in place as directed by Engineer-in-Charge, the thickness being as specified in the relevant drawings.

b. Sand Layer

Sand for sand layer to be laid over the prepared bond shall be clean, free from admixture as per specification. Sand layer shall be spread in one or more layers to the thickness as indicated in drawings or schedule of item watered and rammed.

11.3.3 Base Course

11.3.3.1 Cement Concrete

It shall be of specified mix and shall generally conform to "Construction Specification for Cement Concrete".

11.3.3.2 Panels

To prevent construction cracks, the floor space shall be divided into square or rectangular panels. The base course of specified thickness shall be laid in alternate panels or any other pattern as approved by Engineer-in-Charge. The panels shall be of uniform size, not exceeding 4.0 m. in any direction for a floor having thickness 40 mm and above. Alternate panels shall be laid on different days.

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

11.3.3.3 Shuttering

The panels shall be bounded by glass strips having the same depth as the concrete floor. These shall be fixed in position with their top at proper level, giving slope. The floors shall butt against masonry of wall before it is plastered.

11.3.3.4 Concreting

Cement concrete shall be placed in position with or without MS reinforcements as shown in drawings and beaten with trowel and finished smooth or left rough as directed by the Engineer-in-Charge. Beating shall cease as soon as surface is found covered with cream of mortar. The surface shall be checked with the help of straight edge and made true.

The shuttering shall be removed next day. Care shall be taken to see that edges are not damaged and fresh mortar from adjacent panels is not splashed over them. The joints between panels shall come out as fine straight line.

MS reinforcement used for concrete base course with reinforcement shall conform to relevant BIS Specifications as detailed in drawings. Before placing of those reinforcements, they shall be cleared of scales with wire brush and oily stains removed.

11.3.4 Floor Finish Plain Cement Finish

Finishing of the surfaces shall follow immediately after the completion of base course. The surface shall be left for some time till the moisture disappears from it. Use of dry cement or cement and sand mixture sprinkled on the moisture shall not be permitted.

Fresh quantity of cement at 2.2 kg per square metre of flooring shall be mixed with water to form thick slurry and spread over the surface, while the concrete is still green. It shall be pressed twice by means of iron floats, once when the slurry is applied and second time when cement starts setting.

The junction of floor with wall plaster, clods or skirting shall be rounded off uniformly where so required upto 25 mm radius or as directed. The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as floor finish is specified, the top surface of floor finish shall be chequered with mesh or similar impression before the finish has set.

11.3.5 Curing

Each finished portion of floor, on completion, shall be kept wet with ponding or moist sand or moist gunny bags as per specifications. At no time, cement concrete layer, plain or reinforced shall be allowed to dry during curing time.

11.4 GRANOLITHIC (IPS) FLOORING

The requirement for filling, preparation of bed, sub-base and base course concrete shall be same as in clauses above.

11.4.1 Finished Layers

Granolithic finish of the thickness as indicated in drawings or as specified shall consist of 2 layer of M15 grade cement concrete. The first layer of concrete shall be laid with 10 mm to 6 mm grade aggregate and well compacted. Within 15 minutes of laying this course the second layer with 6 mm down aggregate shall be laid. The cement and aggregates for the top layer shall be mixed dry.

Sufficient quantity of washed sand and water shall be mixed so as to make it plastic but not flowing. This mixture shall be laid on the first layer so that the two layers firmly grip together. The top layer shall be well tamped, spaded, trowelled and finished with neat cement slurry or with non-skid finish as required. At the junction of adjoining panels a thin string shall be given.

The casting of the granolithic finish layer shall be done in rectangular or square panels not exceeding 1.8 M on any side, using glass strips of height equal to the specified thickness of the floor finish. Required slope in the floor shall be given in the base course concrete without reduction in thickness.

11.4.2 Curing

Curing shall be done as per above mentioned clause.

11.5 TERRAZZO (MOSAIC) TILE

The tiles shall be approximately 22 mm thick of approved shade, color and chips. The tiles shall be pressure made conforming to IS:1237 in all respects. The sizes of the tiles shall be as given in table below:

Table 13 : Sizes of Terrazzo Tiles

Sr.	Nominal Length (cm)	Actual Length (cm)	Nominal Breadth (cm)	Actual Breadth (cm)	Thickness Not less than (mm)
1	20	19.85	20	19.85	20
2	25	24.85	25	24.85	22
3	30	29.85	30	29.85	25

11.5.1 Tolerances

Tolerances on length and breadth shall be ± 1 mm. Tolerance on thickness shall be ± 5 mm. The range of dimension in any one direction of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness.

11.5.2 Manufacture

The tiles shall be manufactured under hydraulic pressure of not less than 140 kg/cm² and shall be given the first grinding with machine before delivery to the site. The proportion of cement to aggregate in the backing of the tiles shall not be leaner than 1:3 by weight. Similarly the proportion of cement to marble chips aggregate in the wearing layer of the tiles and the proportion of pigment to be used therein shall not exceed 10% by weight of cement used in the mix. The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips from the smallest upto 6 mm, and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for sizes of marble chips varying from the smallest upto 20 mm.

11.5.3 Laying

The sub-grade concrete or the R.C.C slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with lime mortar of either:

- i. 1:1:2 (lime putty:surkhi :coarse sand)
- ii. 1:3 (lime putty :surkhi)
- iii. 1:3 (lime putty : coarse sand)

The bedding ingredients shall be thoroughly mixed by volume in the dry form. Care shall be taken to ensure that there are no hard lumps present. Water shall then be added and the ingredients thoroughly mixed. The average thickness of the bedding mortar shall be 30 mm.

Lime mortar bedding shall be spread, tamed and corrected to proper levels and allowed to be hardened for a day before the tiles are set. Over this bedding, neat grey cement slurry of honey like consistency shall be spread at the rate of 44 kg of cement per sq.m. over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1.5 mm and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge atleast 2 m long, so as to obtain a true surface with the specified slope. In situations where full size tiles cannot be fixed, these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure a straight and true joint. Tiles, which are fixed in the floor adjoining the wall, shall enter not less than 12 mm under the plaster, skirting or dado. The junction between the wall plaster and tile work shall be finished neatly and without any waviness. After laying the tiles, the surplus cement grout shall be cleaned off.

11.5.4 Curing, Polishing and Finishing

After laying the tiles the day after all the joints shall be cleaned of the grey cement grout with a wire brush or trowed to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shade of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat for protecting the surface from abrasive damage and fill the pin holes that may exist on the surface.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit blocks No.60. Water shall be used profusely during grinding. The surface shall be washed thoroughly with water to remove all grinding mud, cleaned and mopped. Then it shall be corrected with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured, the second grinding shall then be carried out with machine fitted with fine grade grit blocks No. 120.

The final grinding shall be carried out with the machine fitted with finest grade grit blocks No. 320, the same day after the second grinding described above.

The small areas or where circumstances so required hand polishing may be permitted in lieu of machine polishing after laying. For hand polishing coarse grade stone No. 60

Water shall be used for 1st rubbing stone of medium grade No.80 for second rubbing and stone of fine grade No.120 for final rubbing and polishing.

After the final polish oxalic acid shall be dusted over the surface of 33 gm/sq.m sprinkled with water and rubbed hard with a 'namdah' block (pad or woolen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.6 TERRAZZO (MOSAIC) IN-SITU FLOORING

The requirements for filling, preparation of bed, sub- base and base course concrete shall be same as above.

Trained worker shall carry out terrazzo works.

11.6.1 Material

Best quality marble chips of uniform tint and color, 6 mm maximum and 3 mm minimum size, as approved by Engineer-in-Charge shall be used. They shall be machine crushed, free from foreign matter and of approved quality.

11.6.2 Preparation of Surface and Laying Over Base Course Concrete

Total thickness of cast-in-situ Terrazzo shall be at least 40 mm unless otherwise indicated. This shall be in two layers bottom layer of M:15 concrete bedding with 10 mm down aggregate of specified thickness and the top layer of 10 mm thickness, consisting of a mix of cement and marble chips in the proportion of 1:1/2 marble powder : 2 marble chips). The bottom layer shall be laid in bays not exceeding 1.2 m on either side and leveled 10 mm below the finished floor level.

The cement and marble chips including powder shall be mixed dry. Water shall be added gradually after through mixing until the mix become plastic but flowing.

Within one hour of laying of the bottom layer of cement concrete the upper layer of marble chips and cement paste shall be laid over a coat of cement slurry and the surface tamped lightly and finished to the required level and slope.

While the bottom layer is still plastic glass dividing strips 35 mm wide x 16 SWG thick shall be fixed on the base course concrete with proper anchoring features to allow top edge to be flushed with the finished floor. The strip shall be laid, forming panels not exceeding 1.2 m x 1.2 m size.

11.6.3 Curing, Polishing and Finishing

The floor shall then be kept wet for a minimum period of six days. The surface shall thereafter be ground evenly to the satisfaction of the Engineer-in-Charge with machine grinders in three phase with grade stones from coarse to fine grade. The surface shall receive wash of neat cement mixed with or without pigment and cured before every grinding operation.

After final grinding, surface shall be cleaned and oxalic acid shall be dusted over the surface @ 35 grams. per sq.m. sprinkled.

11.7 GLAZED TILE FLOORING

11.7.1 White Glazed Tiles

The glazed tiles shall conform to IS:777-1970. They shall be flat and true to shape and free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade.

11.7.2 Size and Tolerance

The tiles shall be of nominal sizes such as 150 x 150 mm and 100 x 100 mm or as specified. The thickness of the tiles shall be 5 mm, or 6 mm as specified. The tolerance on facial dimension value shall be ± 1.0 mm and ± 0.5 mm on thickness.

The top surface of the tiles shall be glazed. The glaze shall be either glossy or matt as specified. The underside of the tiles shall be completely free from glaze in order that the tiles may adhere properly to the base. The edge of the tiles shall be preferably free from glaze, however any glaze if unavoidable, shall be permissible on any one edge of the tile.

11.7.3 Coloured Tiles

The sizes and specifications shall be the same as for the white glazed tiles described above. The only difference shall be in the colour.

11.7.4 Decorative Tiles

The type and size of the decorative tiles shall be as follows:

- a. Decorated white background tiles shall be of 152 x 152 x 6 mm and 108 x 108 x 6 mm sizes.
- b. Decorated and having coloured background shall be of 152 x 152 x 6 mm and 108 x 108 x 6 mm sizes.
- c. Fantasy glazed tiles (108 x 108 x 6 mm) other specifications will be the same as that of white glazed tiles.

11.7.5 Preparation of Surface and Laying

Sub grade concrete or the R.C.C slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with 1:3 (cement: coarse sand) mortar or as specified, having average 10 mm thickness. The bedding thickness under the tiles shall not be less than 5 mm.

The mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and square on it. Over this mortar bedding neat grey cement slurry of honey - like consistency shall be spread at the rate of 3.3 kg of cement per sq. m over such an area as would accommodate about twenty tiles. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints in between the tiles shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface or the flooring during laying shall be frequently checked with a straight edge about 2 m long, for obtaining a true surface with the specified slope. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure straight and true joints. The tiles, which are fixed in the floor adjoining the wall, shall enter not less than 10 mm under the plaster, skirting or dado. After laying the tiles the surplus cement grout shall be cleaned off.

11.7.6 Pointing and Finishing

The joints shall be cleaned off the grey cement grout with wire brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of the tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and cleaned. The finish floor shall not sound hollow when tapped with a wooden mallet.

11.8 KOTA STONE FLOORING

Kota Stone Slabs- shall be of selected quality hard, sound, dense and homogeneous in texture, free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness and shall be of the colour indicated in the drawings or as directed.

The top (exposed) face of the slabs shall be polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required and samples shall be got approved before starting the work. 20, 30 or 40 mm or specified thickness slabs shall be used.

11.8.1 Tolerances

Of ± 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs, a tolerance of ± 5 mm shall be allowed.

11.8.2 Dressing

Each slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth, so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the tiles shall be true, square and free from chipping and the surface shall be true and plane.

11.8.3 Surface Preparation and Laying

Sub-grade concrete on the R.C.C slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 or with lime mortar 1:1:1 (lime putty : surkhi : coarse sand) as given in the description of item. The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab not be less than 12 mm.

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness as specified. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey-like consistency shall be spread over the same at the rate of 4.4 kg of cement per sq.m. The edge of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the kota stone slabs as given or specified. The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine joint as possible. All the subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface shall be cleaned off. The flooring shall be cured for at least 7 days.

Slabs, which are fixed in the floor adjoining the wall, shall enter at least 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without any wavings.

11.8.4 Polishing and Finishing

Shall be done as described in the above article of 'Terrazzo Tile Flooring' except that:

- a. First polishing with coarse grade carborundum stone shall not be done.
- b. Cement slurry with or without pigment shall not be applied on the surface before polishing.

11.9 MOSAIC FINISHED DADO OR SKIRTING

For skirting and dado the brickwork or concrete surface shall be raked and shall be well watered for four hours. A dubbing coat of cement mortar 1:3 (1 cement: 3 sand) of sufficient thickness shall be applied so as to bring the surface in line with the plastered surface. The surface shall be carried by lines with trowel so as to receive mosaic tiles or the top layer or cement and marble chips in proportion of 1:1/2:2 (1 cement: 1/2 marble powder: 2 marble chips) of 7 mm thickness with 3-5 mm size for flooring including dividing strips (20 mm x 15 SWG) @ 600 mm c/c.

11.10 HARDONITE FLOORING

These specifications cover the guidelines for providing hardonite topping (industrial flooring) for floor subjected to heavy wear and tear viz., workshop and stores, engine room, and Generator room etc.

The item includes providing hardonite topping as specified to the thickness and satisfaction of the Engineer-in-Charge, supply of all material, labour, tools and plant required for completing the work in best workmanlike manner.

11.10.1 Workmanship

The person executing the topping shall be an experienced mason familiar with flooring works of similar nature. Flooring shall be laid uniformly, the tolerance for variation of level being + 3 mm.

Hardonite material shall be mixed with cement concrete thoroughly to give a uniform mix.

11.10.2 Preparation of Surface

Hardonite shall be laid over a wet concrete surface screened to receive the topping. The base shall be leveled to within + 12 mm.

11.10.2.1 Preparation of Topping

Hardonite shall consist of a mixture of cement concrete in proportion of 1:2:4 and well graded iron fillings added in a proportion of 1.50 kg/bag of cement.

11.10.2.2 Application

Hardonite shall be placed uniformly in a layer of specified thickness and finished with a steel trowel. Care shall be taken to place hardonite in a separate layer while the base concrete is still wet.

11.10.2.3 Trowelling

Surface of floor shall be finished with steel trowel only and trowelled just sufficient so as to give a finished surface. The surface shall be left for some time till moisture disappears from it. Trowelling shall be done three times at intervals so as to produce a uniform hard surface in no case cement should come up to the surface.

11.10.2.4 Curing

The entire surface shall be kept uniformly wet for seven days.

11.10.2.5 Opening for use

The surface shall be allowed to be used only after curing over.

period is

12 DISTEMPERING AND PAINTING

12.1 GENERAL

Engineer's approval shall be obtained before commencing the painting work. All paints and preserves shall be of approved make and colour and their application shall conform to the manufacturer's instructions. Where more than one undercoat is specified it shall be applied in coats of distinctive tints. Workmanship shall conform to the requirement of IS:2395 Unless the manufacturer's instructions state otherwise 48 hours drying time shall elapse between successive applications of any primer and 24 hours between applications of all subsequent coats. The surface of bituminous paints shall be left at least 3 days before further handling.

No paints in any coats shall be applied until the engineer is satisfied that the surface is clean and dry. And that any previous coat is satisfactory and has hardened adequately. When a surface has been approved, it must be painted immediately.

Paint work shall be rubbed down with a glass paper between coats. No paint shall be applied to a surface, which is damp, dirty or otherwise inadequately prepared.

12.2 CONCRETE, BRICKWORK AND PLASTER

Where specified to be painted, concrete and plaster shall be rubbed smooth and any cracks, blister holes and other imperfections cut out, filled and made good. The surface shall be dried to the satisfaction of the engineer before painting is commenced and drying time if at least 28 days shall be allowed after laying brickwork and plaster or stripping formwork from concrete. The surface shall be brushed to remove any efflorescence and then painted with the following:

1. for interior brick work and concrete, apply two coats of oil paint up to 1 meter height and for remaining part two coats of plastic emulsion paint over a coat of primer.
2. For exterior brickwork and concrete, apply two coats of cement based paint over a coat of primer with a water repellent coat of silicate solution of approved make.

Where painting with plastic emulsion is specified, all uneven surface shall be made up by use of putty of appropriate quality, after the surface has been thoroughly cleaned of all dust and dirt and sand papered.

12.3 IRONWORK AND UNGALVANISED STEELWORK

Structural steelwork shall be shot blasted to a "white metal" finish, and grease and oil removed prior to painting. Priming shall immediately follow blast cleaning and no cleaned surface shall be left unprimed for more than four hours. Only primers that chemically inhibit corrosion shall be used. Where the iron or steelwork is not in contact with raw or treated water, the primer shall be red lead complying with IS: 57. Where there is a possibility that the steel or ironwork may come in contact with water, the priming treatment shall be non toxic, zinc chromate or equivalent. Where it is anticipated that further welding will be required, an approved welding primer shall be applied to the areas to be welded and re primed with the main primer when welding has been completed. Primer coats shall not be less than 0.05 mm each.

After erection, all damaged areas shall be made good, and re primed where the original coat has spread under the primer, the affected surface shall be cleaned down to bare metal to the satisfaction of the Engineer and then re primed.

Repainting shall be carried out as soon as possible after erection. If it is to be exposed to weather or condensation, it shall receive one further coat of primer.

Metalwork in intermittent or permanent contact with raw or treated water shall have two finishing coats of an approved coal tar pitch epoxy paint such as "Epilux 5" by Berger Paints, or equivalent. The total coating shall be minimum of 0.125 mm thick.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, be undercoat of synthetic enamel paint conforming to IS:2932 of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

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

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

12.4 GALVANISED STEELWORK

Newly galvanised steelwork shall be primed with an etch primer such as calcium plumbate. Steelwork that has been galvanised for a long period so that the surface has oxidised adequately to allow adhesion of under-coats, need not have an initial coat of each primer.

After priming, galvanised steelwork in constant or intermittent contact with raw or treated water shall be given two coats of an approved coat of tar pitch epoxy paint such as "Epilux 5" by Berger Paints, or equivalent. The total coating shall have a minimum thickness of 0.1 25 mm.

Protective coats for galvanised steelwork not in contact with water shall be:

1. One coat of micaceous iron oxide paint for interior galvanised steel work.
2. Two coats Of micaceous iron oxide paint for external galvanized steelwork.

Galvanised steelwork not in contact with water shall be finished with at least one coat of gloss paint on top of an approved undercoat.

12.5 BITUMINOUS SURFACES

Metalwork items that have been given a shop treatment of bituminous paint shall be painted with two coats of an approved anti-bleed paint before applying a coat of decorative finishing paint.

12.6 ALUMINIUM SURFACES

Aluminum surfaces shall be worked clean, dried and thoroughly degreased before painting, by an appropriate solvent (such as one consisting of equal parts of white spirit and light solvent naphtha). Flame cleaning shall not be permitted. The clean degreased surface shall be treated to ensure paint adhesion either by mechanical roughening, chemical adhesion, or etch primers or wash primers applied in strict conformity with the manufacturer's instructions or by other treatment approved by the Engineer.

The pretreated surface shall receive a priming coat with an inhibiting pigment containing not less than 20% by weight of fine chromate or other approved chromate in a suitable water-resisting vehicle.

The priming coat shall not contain any copper or mercury compounds and it shall also be free from graphite and carbonaceous materials and shall not contain any lead. Priming coat shall consist of a tung-oil phenolicresin which is pigmented with equal parts of zinc tetroxy chromate and red iron oxide.

Aluminum surfaces in contact with concrete, or resting on pads on concrete, shall be painted with two coats bituminous paint, and the concrete surfaces shall also receive two coats bituminous paint.

12.7 WOODWORK

Woodwork for painting shall be carefully rubbed down, treated with preservatives and knotted, stopped and primed in the shop. Care shall be taken to ensure that priming is thoroughly brushed into every part of the surface and in particular at end grains, joint and notches where two coats are to be applied. Primers for wood shall be of a standard equivalent to, or better than "Aluminum Wood Primer Sealer A519-3697" by I.C.I. Paints.

After the woodwork has been fitted and all defects in the surfaces have been made good and re primed, one coat of approved undercoat shall be applied to internal surfaces and two coats to external surfaces. An undercoat of quality equal to or better than "Delux Undercoat A522 line" shall be used.

"Timber work shall be decoratively finished with one coat of finishing paint of standard equal to, or better than "Delux Gloss Finish A365 line".

12.8 WATERPROOF CEMENT PAINT

12.8.1 Surface Preparation

The wall should be washed thoroughly with clean soft water and freed of all loose particles, dust, dirt, lichen, moss, efflorescence and Lime wash by Scrubbing with a wire brush. Inequality and holes shall be filled up with cement paste, which should be allowed to set. To get even uniform mat finish it is necessary to keep the surface damp throughout the operation. In hot dry weather the wall should be frequently sprinkled with water to keep it moist.

12.8.2 Mixing the paint

Loosen the contents by either rolling the drum or shaking the container before opening it. Take one measure of water by volume in a clean pot and add two volumes of approved quality waterproof cement paint conforming to IS: 5410. Stir well to make a paste of high consistency then add one more measure of water constantly stirring the mixture. The final composition of water and paint is now 1:1 by volume. Keep stirring the mixture all the time and use it up within an hour. Do not use the mix if it is left over for more than two hours.

12.8.3 Method of Application

Wet the surface by any convenient method. A small surface can be wetted by brush. When applying paint surface should be damp and not wet. While applying the first coat brush hard into the surface to cover pores and cavities to ensure better bond. Twelve hours after applying the first coat cure the surface by sprinkling the water. Before applying the second coat damp the surface and after the application of second coat cure it as directed above. In hot climate repeat curing at least twice at the interval of six hours for optimum best results.

12.8.4 Curing

After sprinkling fine spray of water should cure each application paint normally after twelve hours when paint film is hardened satisfactorily. In summer when weather is hot, curing may be done little earlier. Water marks may be left over the surface if a stream of water is allowed to flow before the paint film is hardened.

12.9 SILICON PAINT

12.9.1 Preparation

A solution for application shall be prepared from Syltrit 1772 or equivalent. The Manufacturer's instructions shall be followed. This solution shall be prepared to a concentration of about 3 % solids by mixing 1 kg. of water dilatable solution of sodium methyl siliconate with 9 kg. of water. Concentration higher than 3% solids are not recommended as they may cause a white precipitate of sodium carbonate formation.

12.9.2 Application

A flooding technique should be used in applying to obtain the best penetration. When spraying, the solution should not be atomized or misted, but flowed on in a solid stream, with the spray gun held, at a distance just enough to eliminate foaming on the masonry surface. If foaming is allowed then certain visible marks might appear after application. The run down of 150 to 300 mm should be maintained with generous overlapping of passes. Dipping and brushing methods are also suitable. After application of the solution, the treated surface should be allowed to dry at least 24 hours to develop maximum water repellency. This interval may be shortened somewhat by force drying at temperatures to 30 degree C. Though this removes the water quickly, time must still be allowed for the curing. Reaction between the solution and the surface being treated. Until the reaction is complete the applied film still remains water soluble and any rain falling during this time can wash it out. So application should be done in dry weather or at least in absence of rain and fog.

12.9.3 Spraying Equipment

Spraying equipment shall be hand operated stirrup pump with stainless steel nozzle fitted with PVC or polyethylene delivery pipe. Components of the spraying, equipment that are in contact with the treating solution should be of black iron, mild steel, stainless steel, Teflon, PVC or polyethylene. They should not be of aluminum or galvanised steel. .

12.9.4 Safety

The solution should always be applied in a liquid stream, not by misting or fogging. If misting occurs, avoid inhalation. Contact with the eyes or skin should be treated immediately by flooding the area with large quantities of water for at least 15 minutes.

12.10 RELEVANT IS CODES

IS:63	: Whiting for paints
IS:133	: Enamel, interior, undercoating & finishing colour as required
IS:2395	: C.P. for painting concrete, masonry & plaster surfaces
IS:5410	: Cement paint, colour as required
IS:5411	: Plastic emulsion paint for interior use

12.11 DISTEMPERING

12.11.1 Type Distempering shall be of the oil or water bound type as specified.

12.11.2 Material

Dry distemper or oil bound washable distemper of approved brand and manufacture for water bound and oil bound respectively conforming to IS:426 shall be used. The proportions of the mix shall be as per the approved manufacturer's instructions.

The dry distemper shall be stirred slowly in clean warm water using 8.6 liters of water per kg. of distemper or as specified by the approved makers. The mixture shall be well stirred before and during use to maintain an even consistency.

Thinner as stipulated by approved manufacturer shall be used in case of distemper for oil bound type.

Dry distemper shall not be mixed in larger quantity than is actually required for one day work.

12.11.3 Preparation of Surface and Priming Coat

The surface shall be thoroughly brushed free from mortar dropping and other foreign matter and sand papered smooth.

A priming coat of whiting shall be applied over the prepared surface in case of water bound distempering and distemper primer or cement primer shall be applied in the case of oil bound distemper. The white washing coat shall be used as priming coat for distemper.

12.11.4 Application

After the primer coat is dried for atleast four hours, the entire surface shall be coated uniformly with proper distemper brushed in horizontal strokes, immediately followed by vertical ones which together shall constitute one coat.

Subsequent coats shall be applied in the same way and only after the previous coat has dried. Enough distemper shall be mixed to finish one room at a time. The finished surface shall be even and uniform and shall no brush marks. After each days work, the brushes shall be washed in hot water and hung down to dry. Old brushes, which are dirty or caked with distemper, shall not be used.

12.12 DECORATIVE FINISH CEMENT PAINT

12.12.1 Surface Preparation

Plastered surface shall be thoroughly cleaned of dust, dirt, grease, oil marks, etc. before the coat is applied. All the holes and depressions should be filled with gypsum prior to application of the paint. The surface shall be wet with clean water before paint is applied. Application of primer shall be as per specifications recommended by approved manufacturer and as directed by the Engineer-in-Charge.

12.12.2 Preparation of Mix and Application

Any approved cement paint shall be mixed in such quantities as can be used up within an hour of mixing. The solution shall be applied on the prepared surface with good quality brushes and no brush mark shall be visible on the finish work.

12.13 PAINTING

12.13.1 Painting General

Paints, oils, varnishes etc. of approved brand and manufacture conforming to relevant Indian Standard Codes shall be used. Ready mixed paints as received from approved manufacturer without any admixture shall be used. The Contractor shall obtain permission for the make and color of the paint he proposes to use and if required, polish for wood work shall be tested as per IS:5807 (parts I and II).

Whenever thinning is necessary, the brand of thinner recommended by approved manufacturer or as instructed by Engineer-in-Charge shall be used. Paints, oil, varnishes, thinner, etc. shall be brought to the site in the original containers in sealed condition and shall be kept in the joint custody of Contractor and Engineer-in-Charge.

12.13.2 Commencing the Work

Painting except priming coat shall generally be taken in hand after all other building work is practically finished. Approval of Engineer-in-Charge shall be sought before commencing the work.

12.13.3 Workmanship

All the work shall be carried out wherever applicable as per IS:1477 (Parts I & II) and IS:2338 (Part I)

12.13.4 Preparation of Surface

The surface shall be thoroughly cleaned. All dirt, dust, scales and grease shall be removed before painting is started. The surface shall be perfectly dry to permit good absorption. The prepared surface shall receive approval from Engineer-in-Charge for commencing the painting work. For wood surfaces, a priming coat without coloring material should be applied after which all the holes, cracks etc shall be stopped with putty and all knots properly killed with quick lime.

Specially for wood surface, knots if visible shall be covered with red lead conforming to BIS:103. Holes and indentation on the surface shall be filled with wood putty and rubbed smooth. Surface should be thoroughly dry.

12.13.5 Application

Paint shall be thoroughly stirred in the container when pouring into smaller containers for use. It shall be continuously stirred while applying on the surface. The painting shall be applied evenly and smoothly in the direction of grains of wood and perpendicular to it. Each coat shall be allowed to dry before the next coat is applied.

Specified number of coats shall be applied and atleast 24 hours shall elapse between application of the first coat and the subsequent second coat. No painting shall be carried out on exterior work in wet weather condition or on surface which are not entirely dry. Each coat shall be lightly rubbed down with sandpaper or fine pumice stone and cleaned of dust before the next coat is laid. No left over paint shall be put back into stock tins.

The finished surface shall be free from hair or brush marks, strokes, clogging of paint puddles in the corners of panels, angles of moulding, etc.

12.14 PAINTING WITH SYNTHETIC ENAMEL/ENAMEL PAINT

12.14.1 Material

Synthetic enamel/enamel paint of approved brand and manufacture and of required shade shall be used for the topcoat only. The paint for under coat shall be of shade to match the topcoat, as recommended by approved manufacturer shall be used.

12.14.2 Preparation of Surface

The surface shall be thoroughly cleaned. All dirt, scales and grease shall be removed before painting started. The surface shall be perfectly dry to permit good absorption. The prepared surface shall receive approval from Engineer-in-Charge for commencing the painting work.

Specially for wood surfaces, knots if visible shall be covered with red lead conforming to IS:103. Holes and indentation on the surface shall be filled with good putty and rubbed smooth. Surface should be thoroughly dry.

12.14.3 Application

12.14.3.1 Under Coat

One coat of the specified paint of shade matching with the shade of the top coat shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure smooth and even surface, free from brush marks and all loose particles

dusted off.

12.14.3.2 Top Coat

Top coats of specified paint in the desired shade shall be applied after the under coat is thoroughly dried. Additional finishing coat shall be applied if found necessary to ensure a properly uniform glossy surface.

13 EXPANSION JOINTS AND CONSTRUCTION JOINTS

13.1 GENERAL

The item of providing expansion joints and construction joints in concrete includes all the material, labour, tools and plants necessary for completing the item in best workmanlike manner.

13.2 MATERIAL

The Material to be used in the joints shall be ribbed PVC water stop of specified width approved by the Engineer, bitumen impregnated fibre board as filler conforming to IS:10566 and approved sealant material (In case of movement joint only). In addition, IS:12220-1987 and 1838 shall also be adhered.

13.3 JOINTS IN FLOOR

Joints in floor shall be provided as specified on drawings. In case of PVC water stops to be provided horizontal position flat-footed PVC water stops shall be used. The water stops shall be provided in such a way that half the portion of water stop (width wise) is embedded in the concrete and half remains exposed for next concrete. Steel reinforcement shall not be discontinued where construction joints in floor are provided.

13.4 JOINTS IN WALLS

13.4.1 Expansion Joint

Expansion joints shall be provided in the roof slab and wall and divide wall is of R.C.C. The joints shall be so located that in no case the slab shall be more than 45 metres long in one stretch. The general layout of roof slab showing the position of expansion joint is given in the accompanying drawing. The two adjoining portions of the roof slab at the expansion joints shall be separated by a gap of about 25 mm width which shall be bridged by means of 230 mm wide water stop. These water stops shall be fixed in such a manner that it is equally embedded in each portion of the slab on either side of the joint and shall be located at mid section of the slab. The joint shall be continuous in length and shall be properly joined together or welded at all junction along its length. The gap between the adjacent slab below the water stops shall be filled with filler material like thermocol or such compound which may be approved by the Engineer.

This may be achieved by placing a strip of filler material in position adjacent to the face of concreted slab panel while concreting the adjoining panel. The space above, water stop shall be filled with sealant material overlaid by filler material like thermocol and polysulphide sealant as shown in the drawing.

The expansion joints in the end wall and divide wall shall be provided in such a manner that the joint shall divide the structure longitudinally and transversely as shown in the drawing. The two adjacent parts of the wall shall be separated by a gap of about 25 mm width which shall be bridged by 300 mm wide PVC water stop. However, no gap shall be provided in the footing of the wall. The gap on water face shall be treated with

polysulphide sealant material as shown in the drawing. The water stops shall be either PVC or either equivalent approved by the Engineer as per specifications given hereinafter.

13.4.2 Construction Joint

The construction joints shall be generally provided at the end of the concreting or colcreting operation of an element or a member of a structure, or at boundary of the panels or segments or at pre-determined locations. The construction joints in the R.C.C. slab shall be characterised by the continuance of the reinforcing steel, being a structural R.C.C. member. The concreting of a slab at the joint shall be done by laying the concrete against the vertical stopping off boards, the adjoining panels being cast butting against each other.

Construction joints in the side wall and the divide wall of reservoir shall be of two types (i) horizontal construction joints and (ii) vertical construction joints.

The horizontal construction joints shall be serrated type where stones from the lower lift of the wall shall be projecting out sufficiently and will be embedding into the over laying lift of the wall masonry giving a well bonded, and consequently, a water tight joint.

The vertical construction joints in the wall shall be of tongue and groove type. The groove of these joints shall be 300 mm x 300 mm and it shall be provided 300 mm away from the water face of the wall. These joints shall be provided with PVC water stop at a depth of 200 mm from water face which shall be primarily responsible for the water tightness of the joints. These joints shall have a plain finish for a depth of 300 mm from water face by virtue of its casting against vertical face of the centering of vertical face of the previously cast panels cast butting against each other while the remaining depth beyond 300 mm shall have masonry facing which will present a rough surface and thus provide a good bond between the consecutive panels.

In the case of divide wall the water stop shall be located at the centre of the key which shall be located at the centre of divide wall. The key shall be of the same dimensions as that in the end walls.

The construction joints in the bottom layer of the floor which shall be case in colcrete shall be cast against vertical stopping off boards. On the water face the vertical joints shall have a groove provided with bitumen of 12 mm x 20 mm size which shall be filled with polysulphide sealant material.

No such special treatment need be done for the joints provided in the roof slab, bottom layer of the floor and the horizontal joints in the wall. The joints in roof slab and bottom layer of the floor shall however, be staggered with those in the overlaying layers such as brick bat coba, I.P.S. and top R.C.C. layer of the floor to minimise the chances of leakage by increasing its path, if any.

13.4.3 Complete Construction Joints

These joints are provided in the top layer of the floor of the reservoir with a view to localise shrinkage cracks at these joints. These joints are characterised by complete discontinuity of steel without any initial gap as in the case of expansion joints. The joints between the adjacent panels of the floor shall be provided with a groove at top of

dimension 12 mm x 20 mm and it shall be filled with polysulphide sealant and they shall be provided with water stops as specified earlier.

The joint between top layer of the floor and the walls or between the top layer of the floor and the column footing, shall also be provided with a groove of 12 mm x 20 mm which shall be filled with sealant material as per specifications given below:

Joint Fillers : Joint fillers shall be of durable, compressible and non-extruding material. It shall be non-staining, non-absorbent and compatible with sealant material used.

Sealant Material : The joint sealing compounds should be capable of properly ensuring water tightness in vertical and horizontal and inclined joints in water retaining and other structures having severe service conditions in respect of anticipated movement or exposure to weather. Typical uses include expansion joints in the walls of water tanks, and in roof and deck slabs exposed to the weather.

The compound should be flexible, durable and weather proof and should have sufficient elasticity to allow joint movements of the concrete components wherever necessary.

The sealant shall be polysulphide rubber sealing compound conforming to BS 4254 of 1967 or ASA-A 116-1-1960 or any other equivalent specifications. It shall be capable of cold pouf application for horizontal joints and cold application of vertical and inclined joints. The sealing compounds shall be suitable for use in the tropics where it will be subjected to high ambient temperatures, humidity and very strong sunlight. It shall not degrade under these conditions and shall be suitable for use with raw and treated water including water dosed with chlorine. The sealant shall be odour and taint free from lead. It shall be available in choice of colours and shall give a tough, permanent seal, be waterproof, non-staining and remain resilient. Sealing compounds for vertical and horizontal joints shall be used complete with the appropriate quantity of primer as per manufacturer's instruction for use. The primers should ensure good adhesion to the concrete and should be specially developed for respective sealing compounds. The sealants shall be applied with pressure guns or without guns as specified by the manufacturers. Sealing compound shall be fully cured before water is permitted to come in contact.

The sealant material should be formulated as to have a storage period of one year at a temperature of 40°C.

14 EPOXY COATING, BITUMINOUS, POLYMER PAINTING

14.1 EPOXY COATING

14.1.1 General

Epoxy coating is to be applied to the internal surface of the unit wherever specified. The thickness of epoxy film shall be 300 microns.

14.1.2 Materials

A solvent free epoxy coating like "Araldite GY 255" manufactured by Hindustan CIBA Geigy Limited, Bombay or equivalent product of FOSROC is to be used for forming the film. In case of use of an equivalent it should be got approved by the Employer placing supply orders. Materials used and process of application to the concrete of other surfaces should be strictly according to the instructions of the suppliers of the epoxy. Araldite GY 255 one part by weight is to be mixed with 1 part by weight of Hardener H Y 45. The viscosity should be such that it is convenient for brush application.

14.1.3 Subsurface Preparation

The concrete surface should be cleaned thoroughly by sand blasting. The mild steel parts also are to be cleaned to be free of grease and thoroughly sand blasted. The coverage should not be more than 6 sq.m. for concrete and 5 sq.m. for mild steel per kg of epoxy respectively.

The moisture content of concrete before application of epoxy coating shall be less than 4%. This has to be checked properly through a small sample. To achieve this epoxy coating shall be done in hot season.

14.1.4 Curing

The curing should be done for 7 days at room temperature. If the temperature is less than 15°C the space should be warmed up by incandescent lamps, heaters, blowers or infrared lamp. The instructions of the supplier manufacturer of the product both as for use of materials and application take priority over the above instructions and they should be followed very rightly.

14.2 BITUMINOUS PAINTING

Two coats of bituminous paint of 80/100 grade, with 1.65 kg/m² spread will be provided on internal face of sludge sump.

14.2.1 Material

The material shall be of best quality un-pigmented bituminous base paint of such a composition as to satisfy the requirements of IS-9862. with total volatile matter contained in the paint shall not exceed 55% by weight.

At least 95% of the solid materials shall be soluble, in carbon di-sulphide or in benzene, and the closed flash point as determined in Abel's apparatus shall not be less than (86°F)30°C. The paint shall remain liquid and retain its consistency at the ordinary

atmospheric temperature when packed in suitable containers. The drying time shall not be less than 2 hours and not more than 8 hours, and after drying, paint shall not show any surface cracks, tendencies to powder or discoloration due to weathering action or expansion and contraction. It shall also be able to resist the action of acids and alkalis. It shall not soften under the action of mineral turpentine.

The film resulting from brushing the material on a strip of tinned iron, 30 standard wire gauge after being allowed to dry at room temperature not below (65°F) 18.3°C for 48 hours shall not, when bent double over a (quarter inch) 6 mm dia rod, show any signs of flaking or cracking. The time occupied for the actual bending shall not exceed one second. When the paint has dried hard, a 4H pencil should not be capable of scratching it. The weight of the paint shall be from 0.83 to 1.25 kg per liter, the component of the paint shall be such as not to react with water chlorinated or otherwise and develop poisonous or harmful elements thereto.

The paint shall be of Indian manufacture of approved make and quality

14.2.2 Application

All corners and junctions shall be properly rounded off to present a uniform and smooth finish. After complete curing of the plaster, it will be allowed to dry up. After drying the moisture content shall be brought to a value less than 4% by using a blow-lamp. The surface should be well cleaned with smooth brush to make it dust free. The coating shall be allowed to dry and kept in dry condition till final setting takes place.

14.3 POLYMER PAINTING

Polymer paint shall be elastomeric (450% elongation), thermoplastic, fire retardant, coating skin tensile strength 18 to 21 kg/cm², antifungal, antibacterial anticorrosive graft polymer paint of approved make Meta Chem or equivalent.

Fire retardant coating shall conform BS 3119 specifications

15 DOOR, WINDOWS, GRILLS, SHUTTERS, ETC.

15.1 RELEVANT IS CODES

IS:1003 (I)	: Timber paneled and glazed door & ventilator shutters
IS:1003 (II)	: Timber paneled and glazed window & ventilator shutters
IS:1038	: Steel doors, windows & ventilators
IS:1081	: Fixing & glazing of metal doors, windows & ventilator
IS:1361	: Steel windows for industrial buildings
IS:2202	: Wooden flush door shutter (solid core type)
IS:2202 (I)	: Plywood face panels
IS:2202 (II)	: Particle board and hardboard face panel
IS:4020	: Methods of test for wooden flush doors
IS:6248	: Metal rolling shutters & rolling grills
IS:7452	: Hot rolled steel sections for doors, windows & ventilators
IS:10451	: Steel sliding shutters
IS:10521	: Collapsible gates

15.2 GENERAL

The items under this clause cover doors, windows, grills, rolling shutters, collapsible gates etc. normally required to be provided in a building used whether for residential, office, laboratory or industrial purpose.

Doors and windows Shutter shall be of Teakwood as specified in the bill of quantities/drawings or as directed by the Engineer. The sizes of the above items and locations of the same shall be as shown in the drawings.

The frames and shutters shall be of either steel or wood of thickness of members as shown on the drawings. The material used shall be of good quality seasoned timber of specified wood or rolled steel sections as the case may be.

They shall be provided with all necessary fittings like hold fasts, hinges, locking arrangements stoppers, eyes and hooks, tower bolts, handles, fixing lugs etc., of sizes and quality grade as specified.

They shall be provided in complete form including painting, glazing, fixing in position true to level and plumb.

Steel rolling shutters shall be of approved make and shall conform to IS **6248 - 1979**. Metal rolling shutters and rolling grills.

The builder's hardware shall all be as per relevant Indian Standards.

15.3 WOODWORK IN DOORS, WINDOWS, PARTITIONS, LOUVERS, RAILINGS ETC.

Wood used for all work shall be the best of the respective class specified, and properly seasoned by at least 6 months air drying, suitable for joiner's work, should be of natural

growth, uniform in texture, straight grained, free from sapwood, dead knots, open shakes, boreholes, rot, decay and any and all other defects and blemishes.

The thickness specified for joiner's wrought timbers are, unless otherwise specified, prior to planning and 3 mm will be allowed from the thickness stated for each wrought faces.

All joining shall be wrought on all faces and finished off by hand with sandpaper, with slightly rounded arises.

The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mortise and tenon or dovetailed joints as approved.

Any joiner's work which shall split, fracture, shrink, or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound material at the Contractor's expense.

Doors, windows and ventilator frames, transoms and mullions shall be rebated. All dimensions shall be as per drawings. The top framing member of doors and top and bottom framing of windows and ventilators shall project about 25 mm below finished floor. Surface coming in contact with brickwork shall be painted with bitumen as directed by the Engineer-in-Charge. Each of the door and window frames shall be provided with 3 Nos. M. S. 225 x 25 x 6 flat split holdfasts on each side. These holdfasts shall be embedded in masonry of concrete work. The work shall conform to IS:4021.

The doors shall be paneled or solid flush doors as described in the item of work. All flush doors shall be supplied with approved fittings such as hinges, mortise lock of approved make with handles on both sides, oxidised brass tower bolts and latch arrangements, door stops etc. and as shown in drawings but exclusive of door closers. Door closers, where separately specified shall be of heavy duty hydraulic type to be approved by Engineer-in-Charge. Paneled doors shall have the same fittings except in place of union lock, an aldop shall be provided. Each door leaf shall have two 250 mm tower bolts, two aluminum or oxidised brass handles, and one door stopper be made of weatherproof plywood. Flush doors shall conform to IS:2202 (Part-I).

Doors will generally have no sills but if a few have to be provided, the Contractor shall do so at no extra cost to the Owner.

The type of window shall be as specified. Each shutter shall have one pair of hinges, two tower bolts (one 225 mm long and another 150 mm long), one handle and one hook with eye and pegstay. Ventilators shall have two M. S. hold fasts and hinges, one handle and one hook and eye at each and one small tower bolt in the centre. Where so directed by the Engineer-in-Charge, the doors and windows shall be provided with parliamentary type hinges at no extra cost.

The workmanship of all door and window shutters shall conform to the requirements of IS:1003 (Part-I & II) and IS:2202 (Part-I). If required, flush door panels shall be got tested as per IS:4020.

Cupboards, almirahs and shelves shall be provided as per Engineer-in-Charge. The doors could be of either hinged type or sliding type as approved by the Engineer-in-Charge. All dimensions as furnished in the approved drawings

shall be followed. Fixtures and fittings as shown on drawings or as directed by Engineer-in-Charge shall be used.

Railings and architraves shall conform to the shape shown on drawings or as approved and fixed by means of screws (counter sunk or otherwise) or bolts.

The finish expected is of a very high order and the work shall be all-inclusive weather or not all detailed specifications have been spelt out and the work shall be free from blemish. No iron bars or grills are proposed to be provided in the windows or ventilators. Glass louvred ventilators where specified shall be provided.

Glazed windows, louvres, ventilators and doors shall be provided with either clear or pinheaded glass 5.5 mm thick which shall be free from all blemishes and shall conform to IS:1761. It should be clearly understood that glass which does not have uniform refractive index or which is wavy will be rejected. Woodwork shall not be painted, oiled or otherwise treated before the Engineer has approved it.

15.4 STEEL DOORS, WINDOWS AND FITTINGS

The steel doors, windows, ventilators shall conform to IS:4351 and IS:1038. All steel doors windows, ventilators, louvres etc. shall be of sizes as specified and conform to the description in the respective item of work. Whether or not specifically mentioned, all fixtures and fittings necessary for the satisfactory operation of the doors and windows shall be provided. Doors, windows and ventilators shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample shall also be got approved before further manufacture starts, unless this is waived in writing by the Engineer-in-Charge. All steel doors shall be of pressed steel (18 gauge) flush type with or without removable transoms. All doors shall be provided with a three way bolting device and locking arrangement with duplicate keys and handles of both sides and operable from either side. The Contractor shall obtain windows with friction hinges in place of windows with pegstays if so directed by the Engineer-in-Charge. For centre hung and top hung ventilators suitable spring catch/pulley and chord arrangement shall be provided for facility of opening. Whenever fly mesh over windows have been called for, they shall be fixed on the window and suitable lever type or rototype arrangement shall be provided for opening or closing of the glazed panels from inside. Prior approval of Engineer shall be taken before order is placed with the manufacturer.

Where specified, steel doors supplied shall be airtight. For this purpose, the Contractor shall provide necessary padding material such as rubber, felt or any other approved material.

15.5 ROLLING SHUTTERS

The rolling shutters shall conform to the size indicated in drawings and shall be of quality specified in the Schedule of Quantities. The rolling slats shall be in one piece and be made of heavy gauge steel sheets minimum 18 SWG in thickness. A cylindrical hood shall be provided on the top to enclose the shutter when it is open. The rolling shutters shall be provided with suitable locking arrangements and deep channel guides, In case galvanised rolling shutters are specified the rolling shutter shall be made of hot dip galvanised slats, hood, deep channel guides all preferably in one piece. In case of hand operated pull & push type rolling shutters of sizes larger than 10 sq.m. in area and in case of very large gear operated and/or as directed by the Engineer, rolling shutters shall be provided with ball bearings for smooth & efficient operation. In case of large rolling shutters & depending upon local wind conditions, the rolling shutters should

be provided with special locking type of wider channel
it shall be provided with central moveable channel supports
design wind pressures in the area.



guides or
to take up

16 HAND RAILING

Hand railing and vertical posts shall be made from galvanised mild steel pipes and fittings. The design of the railing shall be approved by the Engineer to whom the Contractor shall submit manufacturer's drawings showing positions of vertical posts, joints, expansion joints and joint details and all fixing details. Fabrication shall not start until these drawings have approved by the Engineer.

Hand railing and vertical posts fabricated from galvanised mild steel pipes and fittings shall conform to the following requirements.

The height of the top railing shall be 1000 mm above finished floor level unless otherwise shown. There shall be total 3 horizontal rows. Top row shall be of 32 mm dia and middle two rows shall be of 25 mm dia GI medium class pipe. The lower railing shall 550 mm above finished floor and Toe plate should be provided at the bottom of the rail of the size 100mm wide x 5 mm thick subject to the Engineer's approval these and other leading dimensions may be varied slightly to suit manufacturer's standard products.

- a. Unless otherwise shown, vertical posts shall be made of galvanised mild steel tubes (medium class) of 40 mm nominal bore and fittings such as Tees, Bends, Crossed etc. of heavy class conforming to IS:1239.
- b. Unless otherwise shown, top horizontal post shall be made of galvanised mild steel tubes (medium class) of 32 mm nominal bore and fittings such as Tees, Bends, Crossed etc. of heavy class conforming to IS:1239.
- c. Unless otherwise shown, lower two horizontal post shall be made of galvanised mild steel tubes (medium class) of 25 mm nominal bore and fittings such as Tees, Bends, Crossed etc. of heavy class conforming to IS:1239.
- d. In general the vertical posts shall be spaced at 1.5 metre c/c and shall be built into the concrete or bolted to the MS plate embedded in concrete as shown on detailed drawing.
- e. Hand railing and vertical posts shall be painted with 2 coats of approved paint.

17 RUNGS

Rungs shall be provided in all manholes/inspection chambers/pumping stations over 0.6 m in depth and shall be of cast iron conforming to IS:5455. These rungs shall be fixed staggered in two vertical runs, 300 mm apart horizontally and 300 mm c/c vertically. The top rung shall be 450 mm below the manhole/inspection chamber cover and the lowest not more than 300 mm above the benching. The rungs shall be of 20 mm diameter with epoxy paint for corrosion resistance or equivalent as approved by Engineer in Charge.

18 PIPING WORK

18.1 REINFORCED CEMENT CONCRETE PIPES (CLASS NP 3)

18.1.1 Applicable Codes

Laying of pipes and fittings/ special shall comply with all currently applicable statues, regulation, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred to. In all cases the latest revision of the standards/ codes shall be referred to.

- | | | |
|-----|-------------------------|---|
| (a) | IS: 783 | Code of practice for laying of concrete pipe |
| (b) | IS 458 | Specification for pre- cast concrete pipes (with and without reinforcement) |
| (c) | IS 3597 of 1966 I.S.458 | Method of tests for concrete pipes |
| (d) | IS 5382 | Specifications for rubber sealing rings for g mains, water mains |

ISI Marked RCC NP3 Socket and Spigot pipes conforming to IS: 458/1988 shall only be used under this contract. Sulphate resistance cement shall be used in manufacturing of the pipes. The Pipes to be used shall be perfectly cylindrical; sound without any damage. The pipes shall be suitable for rubber jointing. The rubber shall be of good quality conforming to relevant I.S. Specifications and duly inspected by the approved third party inspecting agency.

18.1.2 Laying of Pipes

Care shall be exercised in loading, transporting, and unloading of concrete Pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block for higher, diameter is recommended.

Pipes shall be lowered into the trench carefully, mechanical appliances may be used. Under no circumstances shall the pipes be dropped or dumped into the trench without proper support.

All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used, and if such defective sections are found, the same shall be removed by the Contractor at his cost and risk and shall have to be rebuilt with good pipes and materials.

All lumps, blisters and excess coating materials shall be removed gently from the ends of each pipes and they shall be wiped clean and dry before the pipe is laid.

For spigot and socket pipes, with rubber jointing rings, proper jointing shall be ensured.

Every precaution shall be taken to prevent foreign materials from entering in to pipe when it is being placed in the trench.

Pipes shall be laid true to line and grade as specified.

Laying of pipes shall always proceed upgrade of a slope. However, for pipes having spigot and socket joints, the socket ends shall face upstream.

The pipe shall be secured in place with approved back fill material or concrete tamped under it except at the joint portions.

At times when pipe laying is not in progress the open ends of pipe shall be closed by a water tight plug or canvas or other means approved by the Engineer in charge.

Trench shall be kept free from water until the material in the joints has hardened. If bailing out of water is required for excavation and laying of pipe no extra payment for bailing out water shall be made in any form and this shall be done by the Contractor at his own cost.

When the pipe is closed and the trench liable to be flooded by water, care shall be taken to prevent the pipe from floating.

Walking or working on the completed sewer shall not be permitted until the trench has been back filled to a height of at least 30 cm over a pipe.

The cutting of pipes for inserting fittings or closure shall be done in a neat and workman like manner without danger to the pipe so as to leave a smooth surface and at right angles to the axis of the pipe.

Before connecting a pipe to a manhole, a relieving arch or any other similar protection device shall be made in the manhole for the safety of the pipe.

The pipe when laid shall not be subjected to super imposed load beyond what the pipe can safely with stand

The pipe shall be laid along the side of the trench, each pipe in its proper position for laying with an extra pipe after every 20 nos. to allow for cutting, if necessary. Where the trench crosses a road or place where such distribution is inadmissible, the pipes shall be stacked in heaps at each end, sufficient to fill in the length. As far as possible, pipe shall be laid straight in rising gradient. It should be possible to empty the pipe readily and completely. The socket end of the pipe shall be facing up hill. All the pipes shall be used in standard length as far as possible. Cut length may be used only where necessary, to make up to exact length. All the pipes shall be first inspected for any damage and cracks. No cracked or damaged pipes shall be used.

The connection to an existing sewer shall be done through manhole chamber. However, before connecting a pipe to a manhole, a relieving arch or any other similar protection device shall be made in the manhole for the safety of the pipe.

18.1.3 Pipe Bedding

The pipe bedding of class A, B, C will be provided as per requirement and instructions of Engineer in charge according to approved design and drawings, as per site condition.

In places where the natural foundation is inadequate, the pipes shall be laid either in a concrete cradle, supported on proper foundation or on any other suitable designed structure, to be approved by the department.

Pipes laid in trenches in earth shall be bedded evenly and firmly and as for as the haunches of the pipe so as to safely transmit the load expected from the back fill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve and around the curve of the pipe to form an even bed, necessary provision shall be made for joints, wherever required.

When the pipe is laid in trench in rock, hard clay, shale or other hard material, the space below the pipe shall be excavated and replaced with an equalising bed of sand or compacted earth. In no case, shall the pipe be laid directly on such hard material.

Wherever required, the encasing of pipe shall be done with concrete. Suitable nos. of manholes shall be provided at proper interval or at the places where there is change of direction of the alignment and grade as per the direction of Engineer in charge.

18.1.4 Jointing

Each concrete pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformity applied pressure with the aid of a jack or similar appliance.

Concrete pipes of the spigot and socket type with roll on rubber rings shall be used, and the manufacturer's instructions shall be deemed to form a part of this specification.

Rubber rings shall be lubricated before making the joint and the lubricant shall only be soft soap water or an approved lubricant supplied by the manufacture.

In case of RCC Pipe entering or leaving a manhole a flexible joint may be provided at least within 0.60 M from the outer end of the manhole.

The spigot and socket pipes shall be jointed with rubber joints for which rubber gasket shall be arranged by Contractor and such rubber gaskets / rings shall conform to relevant I.S. Specifications. The department shall provide no jointing material.

The section of the pipe shall be jointed together in such a manner that there shall be as little unevenness as possible along the inside of the pipe.

18.1.5 Testing

All pipelines shall be subjected to a test pressure of at least 2.50 m head of water, at the highest point of the section under test.

The tolerance of two liters per centimeter of diameter per kilometer shall be allowed during a period of ten minutes.

Before commencing the hydraulic test the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary under a head of 60 cms of water.

The test shall be carried out by suitably plugging the low end of the drains and the ends of connections, if any and filling the system with water.

A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top end may be plugged with a connection to a hose ending, in funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

If any leakage is found visible then the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

Any joint found leaking or sweating shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 Cm in length and the section re-tested.

The testing of the rubber rings shall confirm to I.S 3400 of 1965 and also I.S. 5382 of 1969. However, after the delivery of the pipes made at sites, the Contractor shall have to arrange for visual tests for whole of the lot, received from time to time at site.

18.1.6 Inspection of the Joints

After the joints of any pipes in underground work have thoroughly set, the Engineer in charge (or any person whom he may appoint) any inspect the joints and if he has any doubt as to their soundness he may required the Contractors to cut open and clean away the cement or lead as the case may be of any joint that he may select and to make good the same at their expense provided that unless some defect be found, they shall not be required to open more than one joint in 20 M of pipe length if the defect be found the Engineer in charge may direct them to open as many joints as he may deem necessary.

18.1.7 Cleaning of the Pipes

As soon as a stretch of pipe whether of stoneware or Cast iron or R.C. Pipes has been laid from manhole to manhole, the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer in charge to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Engineer in charge considers that damages may have been caused to the pipelines, he shall be entitled to order the length to be re tested at the expense of the Contractor. Should such retest prove unsatisfactory the Contractor shall at his own expenses amend the work and carry out such further tests as are required by the Engineer in charge. It shall also be ascertained by the Contractors that each stretch from manhole to

manhole

is absolute clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

18.1.8 Fracture of Pipes

In the event of pipes being fractured after being laid whether due to imperfect loads have or the material for refilling have been improperly selected or to any other cause, the Contractor in every instance will be held responsible and will be called upon to replace such defective pipes at his own cost, if such defect appears before the expiration of the period of maintenance.

Any pipe or length of pipes found to be defective shall be immediately removed and replaced at the Contractor's expense and leaking joints shall be remade. The inspections and tests shall then be repeated as often as necessary until the whole line under inspection or test is accepted by the Engineer in charge.

18.1.9 All works to be clear clean and perfect

The Contractors shall after completion or whenever required by the Engineer in charge, prove all pipes and fitting to be clear clean and perfect, and for this purpose shall at their own expense and in the presence of the Engineer in charge or his appointee, provide suitable instruments and appliances and pass them through the pipes and shall, if required, throw in water and show that it passes freely through every portion of the work. Brick, mortar and rubbish shall not be allowed to fall into the manholes of sewer lines while fixing or if allowed, shall be removed by the Contractors at their own expense.

18.1.10 Measurement of Pipes

All pipes be measured according to the work actually done by them and no allowance will be made for any waste in cutting to the exact length required. An exception to this will be made only in the case of short branches of 100 mm dia stoneware pipe, which be treated in the manner here after described with regard to fittings. The Contractors, shall be under obligation to use the pieces or part of the pieces cut off from 100 mm stoneware pipes, if it be deemed by the Engineer in charge practicable to do so; and no further payments shall be made for the same to the Contractors. A socket attached to be straight pipe will not be measured, but a spigot end of a straight pipe whether such end be free for entering into a socket will be measured to its full length.

A bend, junction, or any separate piece of fitting which may have necessarily been cut for the exigencies of the work will be taken into account as if whole provided that the cutting has been done properly and that the portion used in the work is sound. This clause shall not apply to a straight pipe under any circumstances, except only at 100 mm dia stoneware pipes as here in before described. In measuring the lengths of pipes laid deduction shall be made for the lengths of channels between the inside face of the walls of manholes.

18.2 CENTRIFUGALLY CAST (SPUN) DUCTILE IRON PIPE

The material of construction for the pipe line shall be Ductile Iron (DI) with internal cement mortar lining (Class K7)

18.2.1 Scope of Work

Laying in trenches centrifugally cast (spun) ductile iron pressure pipes of class K7 as per IS: 8329: 2000 (Code of practice for use and laying of ductile iron pipes) including jointing (tyton push joint), bends of all degrees, tees, collars, tapers, crosses, flange sockets & spigots, branched pipes, chamfering etc. where required. Testing of pipes should be done as per IS: 8329: 1994.

18.2.2 Applicable Codes

Important IS codes applicable in case of Ductile iron pipes, fittings, jointing & laying are:

Sr.	IS Codes	Description
1	8329	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification
2	9523	Ductile iron fittings for pressure pipes for water, gas and sewage
3	12288	Code of practice for use and laying of ductile iron pipes
4	12820	Dimensional requirements of rubber gasket for mechanical joints and push-on joints for use with cast iron pipes and fittings for carrying water, gas and sewage

18.2.3 Pipe & Pipe Joint

Ductile iron pipe of K7 class of socket & spigot end suitable for tyton push on joints or mechanical joints is recommended for the project wherever required.

Push-on-Joint: A flexible joint in which an elastomeric gasket is located in the socket and the joint assembly is effected by entering the spigot through the gasket into the socket. Allowable angle of deflection for push on joints are tabulated below.

Nominal Diameter,mm	Allowable angle of deflection
80 to 200	5.0 degree
250 to 350	4.0 degree
400	3.5 degree
450 to 600	3.0 degree
700 to 900	2.5 degree

Mechanical Joint: A flexible joint in which an elastomeric gasket is located in the socket, sealing being obtained by applying pressure to the gasket by means of a gland bolted to the socket. Allowable angle of deflection for mechanical joints is tabulated below.

Nominal Diameter,mm	Allowable angle of deflection
80 to 300	5 degree

350	4 degree, 50 seconds
400	4 degree, 10 seconds
450	3 degree, 50 seconds
500	3 degree, 20 seconds
600	2 degree, 50 seconds
700	2 degree, 30 seconds

Ductile iron pipe having screwed on flanges and welded on flanges shall conform to the requirement of Table 4 & 13 of IS 8329:1994. Shielded Nickel- iron electrodes is the preferred material for manual arc welding of flanges. Flange shall preferably be of ductile iron. For screwed on flanged pipes, the method of screwing and the exact form of thread are left to the discretion of the manufacturer in view of the fact that flanges are never removed after screwing on the barrels of the pipes.

18.2.4 Rubber Gasket

Rubber gasket for use with push-on-joints or mechanical joints shall conform to IS 12820:1989. Rubber gasket for use with flanged joints shall conform to IS 638: 1979. Rubber gasket shall be compatible with the fluid to be conveyed for materials, pressure and temperature. While conveying potable water the gaskets should not deteriorate the quality of water or should not impart or odour.

18.2.5 Hydrostatic Test

All pipes shall be tested hydrostatically at a pressure specified below. To perform the test, pressure shall be applied internally and shall be steadily maintained for a period of minimum 15 seconds during which the pipes may be struck moderately with a 700 g hammer. The pipes shall withstand the pressure test and shall not show any sign of leakage, sweating or other defects of any kind.

Nominal Diameter, mm	80 - 300	350 – 600
Class	K9	K9
Working Pressure	1.8 MPa	1.8 MPa
Max. works test pressure	5.0 MPa	4.0 MPa
Max. site test pressure	3.2 MPa	2.4 MPa

18.2.6 Pipe Lining

Lining of pipes & fittings are recommended for corrosion resistance & improved hydraulic carrying capacity.

External surface of pipe & fittings is protected with epoxy coating material having a minimum dry film thickness of 80 microns.

Pipe should be internally lined with sulphate resistance cement mortar of minimum thickness as given below. The internal lining should be done by centrifugal method.

Dia of pipe, mm	Thickness of lining, mm
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Upto 250	4
300 – 600	6
700 – 900	8

Cement lining of the fitting is done with spray gun and then by hand to give a smooth and uniform thickness, as it is not practicable to utilise centrifugal methods.

18.2.7 Use and Laying of Ductile Iron Pipe

Excavation, backfilling, laying & jointing of pipe should be strictly as per IS: 12288-1987 (Code of practice for Use & laying of Ductile Iron Pipes).

The width of trench at bottom between the faces of sheeting shall be such as to provide 300mm clearance on either side of the pipe. Trenches may require extra width to permit placement of timber supports, sheeting, bracing and appurtenances if they are employed. Holes for pipe socket should be provided at each joint, but should be no longer than necessary for joint assembly and for assurance that pipe barrels will lay flat on the trench bottom. Pipe bottom should be true and even in order to provide support for full length of the pipe barrel.

Special consideration should be given to the depth of the trench. Minimum earth cover over pipeline should not be less than 1000mm. It may be necessary to increase the depth of pipeline to avoid land drains or in the vicinity of heavy traffic roads, railways or other crossings.

A minimum earth cushion of 150mm depth should be provided below the pipe line to protect the pipe and its coating. Earth cushion should be of sand or fine graded excavated material.

Back Filling: For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

Zone A : From the bottom of the trench to the level of the centre line of the pipe. Backfilling in zone A shall be done by hand with sand, fine gravel or other fine graded material placed in layers of 150mm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Zone B : From the level of the centre line of the pipe to a level 300mm above the top of the pipe. Backfilling in zone B shall be done by hand or approved mechanical methods in layers of 150mm. The type of back fill material to be used and the method of placing and consolidating shall be prescribed by the executing authority keeping in view the local condition.

Zone C : From a level 300mm above the top of the pipe to the top of the trench. Back filling in zone C shall be done by hand or approved mechanical methods. The types of back fill material and method of filling shall be as prescribed by the executing authority.

When pipes are laid under roads and pavement subjected to heavy traffic loads, the trenches may be covered with reinforced concrete slabs of suitable dimensions. Laying of pipe: Pipes shall be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 250mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes, either a well designed set of shear legs or mobile crane should be used.

On gradients of 1:15 or steeper, precautions shall be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is backfilled over the barrel of the pipe. The backfill should be well compacted.

Supporting pipes above ground: It is recommended that above ground installations of spigot and socket pipes be provided with one support per pipe, the supports being positioned behind the socket of each pipe. If necessary, unsupported spans between 4 and 6 m may be obtained by positioning the pipe supports relative to the pipe joints. The recommended maximum unsupported span for flanged pipe is 8m. Pipe should be fixed to the supports with mild steel straps so that axial movement due to expansion or contraction resulting from temperature fluctuation, is taken up at individual joints in the pipe line.

Cutting of pipe for inserting valves, fittings, etc, shall be done as per para 5.4 of IS: 12288 – 1987.

Pipeline Anchorage: All pipelines having unanchored flexible joints require anchorage at the changes of directions and at dead ends to resist the static thrusts developed by internal pressure. Anchorage is also required on steep slopes to resist pipe against slippage.

18.2.8 Hydraulic Testing of Pipeline

After a new pipeline is laid and jointed, testing shall be done for: Mechanical soundness and leak tightness of pipes and fittings, Leak tightness of joints, and Soundness of any construction work, in particular that of the anchorages.

The completed pipeline may be tested either in one length or in sections. The length of section depends upon the availability of suitable water, number of joints to be inspected and difference in elevation between one part of the pipeline and another. The maximum field hydrostatic test pressure for ductile iron pipelines with flexible joints as per IS

12288: 1987 is tabulated below.

Nominal Bore,mm	Maximum field hydrostatic test pressure, N/mm ²
Up to 300	4.5
350 to 600	3.0
700 to 1200	2.1

18.2.9 Restoration and cleaning up

Where any road, payment, shrubbery, fences, poles or other property and surface structures have been damaged, removed or disturbed during the course of work, such property and surface structures shall be replaced or repaired after completion of work.

All roads, pavements, paved footpaths, curbing, gutters, shrubbery, fences, poles or other property and surface structures removed or disturbed, as a part of the work shall be restored to a condition equal to that before the work began.

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the executing authority.

18.3 GENERAL SPECIFICATIONS FOR CI PIPING WORK

18.3.1 Cast Iron Pipe and Specials

1. All CI Pipes and specials supplied for this contract shall confirm to the following specifications:
 - a. IS 1536 - 1976 Specification for centrifugal cast (Spun) iron pressure pipes for water, gas and sewage.
 - b. IS 1538 - 1976 (Part V) Specification for cast iron fittings for pressure pipes.

Wherever reference is made for Indian Standard Specification the latest specification is applied.

2. All cast iron pipes supplied shall confirm to class LA of Indian Standard specifications. The work test pressure and the hydrostatic test pressure shall be as follows:

- a. Hydrostatic Test pressure at works 3.5 N/mm^2 (35 kg/sq.cm.)
- b. Hydrostatic test pressure after installation 1.2 N/mm^2 (12 kg/sq.cm.) All pipes to be supplied in this contract shall have SBR quantity rubber gaskets rubber tyton joints as per BIS 5282, 12820 with the spigot end suitably chamfered for smooth entry of pipe in the socket fitted with SBR quality rubber gasket. Care shall be taken to ensure that fittings fit easily into this pipe.
- c. Each pipe shall be coated in accordance to Indian Standard specification. All pipe shall be marked as under:
 - Manufacturer's name or identification mark
 - The Nominal Diameter
 - Class Reference
 - Mass of pipe
 - The number of this Indian Standard and
 - The last two digits of the year of manufacture.

18.3.2 Cast Iron fittings

All cast iron fittings supplied shall confirm to heavy class of IS:1538, Part 1 to 23. The work of Test pressure and Hydrostatic test pressure shall be as follow:

18.3.2.1 Test Pressure

- 300 mm to 600 mm 2.5 N/sq.mm (25 kg/sq.cr)
- 600 mm to 1200 mm 1.0 N/sq.mm (10 kg/sq.cr)

Where non standard fittings are required in special locations, this shall be supplied of steel of minimum plate thickness of 6 mm and fabricated as per drawings and directions of Engineer-in-Charge. These mild steel fittings will be specially protected against corrosion with painting as shown on drawing.

All Standard fittings marked as under:

- a. Manufacturer's name or identification mark,
- b. The Nominal Diameter,
- c. Class Reference,
- d. Mass of pipe,
- e. The Number of this Indian Standard, and
- f. The last two digits of the year of manufacturer.

18.4 SPECIFICATION FOR LAYING, JOINTING & TESTING OF CI PIPE

18.4.1 Stacking

The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing uphill or in the direction of flow of water.

18.4.2 Trench For CI Pipes and Specials

The trenches for the pipes shall be excavated to lines and levels as directed. The bed of the trench shall have to be truly and evenly dressed throughout from one change of grade to next. The gradient is to be set out by means of bonning rods and the required depth is excavated at any point. The depth of the trench shall not be less than 1 meter measured from the top of the pipe to the surface of the ground under roads crossing and not less than 0.75m elsewhere.

The width of the trench shall be the nominal diameter of the pipe plus 40 cm. but it shall not be less than 60 cm. in case of all kinds of soils excluding rock and not less than 55 cm. in case of rock. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions if any shall be properly filled with earth and consolidated in 20 cm. layers. If the rock is met with, it shall be removed to 15 cm. below the level of the pipe and the trench will be refilled with excavated materials and consolidated to the required grade.

The excavated materials shall not be placed within 1 meter or half of the depth of the trench whichever is greater from the edge of the trench.

The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the MBMC. The trench shall be kept free of water. Shoring and Timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

After the excavation of the trench is completed, hollows shall be cut at the required positions to receive the sockets of the pipes and these hollows shall be sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing to underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

All types of pipes water mains, cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cables.

18.4.3 Laying of Pipes and Specials

Before being laid the pipes shall be examined to see that there are no cracks or defects. The cracked or defective pipes shall be summarily rejected. The pipes shall be thoroughly cleaned of all dust and dirt and special care shall be taken to clean the inside of the socket and outside of the spigots.

The pipes shall be lowered into the trench by means of suitable pulley blocks, sheet legs, chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe shall be carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipeline shall be laid to the levels required. Specials shall also be laid in their proper position as stated above. For pipe bedding PCC of grade M10 shall be used for which payment shall be done as per PCC 1:3:6 item of work. Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground shall be laid with socket facing the direction of the flow of water. In all other cases, the sockets shall be laid facing up hill.

Any deviation either in plan or elevation less than $11\frac{1}{4}$ degree shall be effected by laying the straight pipes round a flat curve, of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6 mm. or the opening between spigot and socket increased beyond 12 mm at any point. A deviation of about $2\frac{1}{4}$ degree can be affected at each joint in this way. At the end of each day's work, the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

Cement concrete thrust blocks of suitable design as approved by the Owner/Consultants shall be provided at 45 degree and 90 degree bands of the pipes and also at places where there is likelihood of thrust so as to withstand the dynamic and static forces developed due to water in the pipe line. The thrust blocks shall be made after the joints have been made.

18.4.4 Jointing

Jointing shall be carried out using approved quality rubber rings.

18.4.5 Testing of Joints

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. For hydraulic tests, all pipes shall be kept under test for 15sec at works and shall withstand hydrostatic test pressure as specified in BIS 1536/1989. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer.

The draw off takes and stopcocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrate before the test. The test pump having been stopped the test pressure should maintain without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

18.4.6 Backfilling

The trenches prepared for laying of pipes shall be backfilled as described under Chap.

19 VALVES

Gate Valves shall be either solid wedge or knife gates unless specifically defined on the drawings.

19.1 SOLID WEDGE GATE-TYPE SLUICE VALVES

19.1.1.1 General

All valves shall be double-flanged. Valves of Indian manufacture and in the size ranging 50mm to 300mm shall conform to BIS 780 and those of size ranging from 350 mm and larger to BIS:2906. Imported valves shall conform to the relevant British or American Standards. The materials used in construction, the design and all other relevant features shall be such that the valves are entirely suitable for use on sewer/sludge pipelines, force mains and within sewage pumping stations. Valve shall be of suitable pressure rating which shall not be less than twice the normal operating

- | | | |
|------------------------|-----|---------------|
| pressure rating | low | 100 m – PN1.0 |
| • For duty heads above | | 100 m – PN1.6 |

19.1.1.2 Design

The design of the valves will be such that erosion, cavitation, vibration and head loss (in the fully open position) shall be a minimum external lubrication. The valves should be capable of being opened and closed against working pressure which exceed the maximum working pressures by 15 percent.

19.1.1.3 Materials

The materials used for the manufacture of each component shall be the best available for the specific purpose and shall not, in any case be inferior to the following:

- Cast Iron : BIS. 210 Grade 20
 Stainless Steel : BIS. 1570 Grade, BS 970 Type EN, ASTM A 473. Gun Metal : BIS.1400-LG 2 -C or the equivalent Indian Std.
 Cast Steel : Plain Carbon Steel complying with BIS. 1570 Grade, or BS: 970 Grade 431 S 29.

19.1.1.4 Valve Bodies

a. Castings

The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings, which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

b. Forgings

All major stress bearing forgings shall be made to a standard specification, which shall be submitted if required to the Engineer-in-Charge for approval before work is commenced. Forging shall be subjected to non-destructive tests to detect flaws if any. Forging shall be heat treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for such forging shall be submitted to the MBMC. The Engineer-in-Charge or his inspector may inspect such forging at the place of manufacture with a representative of the Contractor.

c. Workmanship

Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice.

All similar items of the valve and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit in place of all similar items.

All parts, which can be worn or damaged by dust shall be totally enclosed in dust proof housings.

Protective coating shall comply with BS 1218 Clause 16, for use in tropics, or BIS 2906, Clause 7.

19.1.1.5 Spindle Details

The spindles shall be of Bronze and to permit the solid wedge gate to be so raised as to permit an unimpeded flow passage through the valve in open position. Where handwheels are provided the direction of rotation and the words 'OPEN' shall be marked prominently on the upper side. All spindles contacting surfaces in the valve body shall be bushed with gunmetal.

19.1.1.6 Valve Gates

Each face of the gate shall be lined with heavy gunmetal rings, which will match with corresponding rings in the body. The rings shall be force fitted by special fixtures and riveted in the case of valves in the size range 450 mm and larger. When finally assembled, the body and wedge faces shall provide a watertight bearing surface. When shut, the gates shall ride on the body seats, to allow for wear.

19.1.1.7 Operation

The tops of the spindles or gears operated with extension spindles or tee keys shall be provided with caps of dimensions conforming to BIS 2906 Table III. The direction of opening shall be indicated on the caps.

19.1.1.8 Lubrication

At the points where lubrication is needed the Contractor shall furnish full details of the method to be employed. The requirement of the requisite lubricating equipment and lubricants for commissioning and operating and maintaining the valves for one year shall be furnished by the Contractor.

19.1.1.9 Spare Parts

One spare spindle and nut shall be supplied under this contract for each group of 10 sluice valves or less of the different sizes. The Contractor shall take this into account while quoting the rates for individual items. No separate payment shall be made for this work. In addition the Contractor shall submit a list of recommended spares for 5 years of operation and maintenance of all mechanical, electrical and instrumentation works covered under this contract. Spares supplied shall be new, unused and interchangeable with the corresponding components they are intended to replace.

19.1.1.10 Flanges

Valves of sizes from 80 mm to 300 mm shall have flat flanges as per BIS:1538 Part IV Table I. Valves of sizes from 350 mm and larger shall have raised flanges as per BIS: 4504, Table 10/11 for 10 bar valves. The flange to flange distances shall be as per BIS:780 for 80 mm - 300 mm valves and BIS : 2906 for 350 mm and larger valves.

19.1.1.11 Jointing Materials

Each valve shall be supplied under this Contract, with all-requisite joint rings, nuts, bolts and washers for making the joints on all the valves to be installed under this Contract. Jointing material between the connecting flanges shall conform to the requirements of BIS 638- 1965. Unless otherwise specified bolting used for jointing exposed connections shall be carbon steel, conforming to BIS 210 Grade 20 Grade B, with galvanized finish. Bolting for buried joints and joints that could come into contact with raw sewage shall be Stainless Steel, as per Clause 2.02 A3. Boltholes shall be off-centre and in correct adjustment longitudinally.

19.1.1.12 Special Requirements - 450 mm and Larger Valves

Sluice valves in the size range 450 mm to 1200 mm shall have, in addition to the above requirements, the following features.

- a. The valves shall have machined gun metal gate slides. Hard bronze shoes shall be provided on the gate and machined gunmetal channels in the body. The bronze shoes will be machined accurately to give a close working clearance with the channels. They shall provide corrosion resistant bearing surfaces and minimize sliding friction and vibration while maintaining accurate alignment. The use of cast iron channels with brass lining will be permitted if the lining is at least 6mm thick. The use of other materials for holding the channels in position will not be permitted.
- b. The valves shall be provided with spur gearing consisting of machined mild steel pinions and cast iron wheels for valves installed underground. The pinion shafts shall run in gun metal bushes in a cast iron bearing bracket with provision for lubricating by a grease gun.

Gear wheel ratios will be such that a force of 270 Newton's applied on each end of a bar in combination with a Tee Key or extension spindle at the following distances from the key centre will permit smooth operation.

Valve size range (mm)	Distance of application of force (mm)
450 - 900	600
1200	750

Valves installed above ground shall be provided with worm gearing. These shall be machined cut, with bronze wheel and steel worm enclosed in a cast iron gear case which shall be mounted on a fitting connected to the valve cover flange and shall be complete with indicator column.

The worm shafts shall be equipped with ball thrust bearing and gunmetal bushes. The gearbox shall be oil filled and sealed. The worm shaft bearing shall be provided with grease gun nipples. The gear ratios shall be so selected that the maximum force required to develop the requisite operating torque shall not exceed 180 Newton's.

All valves of size 450 mm or more shall have valve gate indicator

columns with 10 mm graduations and indicating the fully open and closed positions. The indicator assembly should be sufficiently watertight to prevent entry of rainwater into the worm gear box in outdoor valves.

19.1.1.13 Factory Tests

All the valves shall be tested at the factory for smooth, trouble free operation and operating torque requirements by operating between fully open and fully closed position three times.

The hydrostatic tests shall consists of -

- a. Application of a pressure equal to 1 and a half times the maximum working pressure specified in this section with both ends closed and valve fully open, for ten minutes. No leakage of water should occur through the metal, flanged joints or valve packing gland, nor should any permanent deformation of any part occur.
- b. The pressure shall then be reduced to the working pressure and the wedge gate lowered, thus closing the valve. The stipulated pressures shall then be maintained for 5 minutes on each side in turn during which no leakage should occur on the downstream side of the valve seating.

19.2 KNIFE GATE VALVES

Knife gate valves shall be suitable for use at suction and delivery side of pumps. The valve should be provided with gate made of stainless steel and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment. The valve should be bonnet-less and suitable for face to face flange connection in between pipelines. It should be suitable for uni-directional application.

The valve body should be of Cast Iron GR.FG 260. The body shall be designed to withstand 6 bar pressure.

The valve shall be provided with replaceable type flexible seating seats to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seal retainer ring should be designed in a manner so that the flow of the fluid should be away from the sealing perimeter and towards the center of the valve

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished and buffed.

The valve shall be provided with sufficient ply of stuffing seals in the in built stuffing box to seal the rear opening. The stuffing box should have internal tappers for pushing the seals on to the gate. The seals should be of non-asbestos PTFE to reduce the friction and offer higher life. Provision shall be made to enable tighten the stuffing seals by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of stuffing seals should be done in installed condition of the valve.

The spindle should be double start threaded and non-rising type for compact and safe operation. The gate movement area should be covered by protection shields. Gate opening indicating arrangement should be provided to find out the extent of gate opening / closing.

Flange drilling suitable to mount between flanges as per IS 1538-1993

- Body Cast Iron FG 260 as per IS 210
- Knife gate : AISI:304 Gr: ASTM A240
- Retainer ring: SS:304 ASTM A351 Gr. CF:8
- Inlet Seal: EPDM
- Spindle: AISI:410 Gr. ASTM A276
- Spindle Nut: Cast Iron Gr. FG 200 as per IS 210
- Stuffing plate: Cast Steel ASTM A216 Gr. WCB
- Stuffing seal: Synthetic yarn with PTFE

Factory Test:

Body Test: The valves shall be hydrostatically pressure tested at specified pressure without any visible leakage.

Seat test: The valve shall be hydrostatically pressure tested for seat leakage at 2.8 bar for no visible leakage.

	ZFT-STD-X-CI-F1-M
Body (Housing)	Cast Iron Gr. FG 260 as per IS 210
Flange Drilling	Suitable to mount between DIN PN 10/IS:1538-1993 flanges
Knife gate	Stainless Steel ASTM A 240 AISI:304
Seal Retainer Ring	Cast Stainless Steel ASTM A 351 GR. CF:8
Inlet Seal	EPDM Rubber
Gland Packing	Synthetic Yarn with PTFE
Stuffing Plate	Cast Steel Galvanized
Spindle (Stem)	Stainless Steel ASTM A276 AISI:410
Spindle Nut	Cast Iron
Supporting channels	Mild Steel Painted
Adapter plate	Cast iron / Mild steel painted
Hand Wheel	Cast iron as per IS 210 Grade 260
Fasteners	High Tensile Galvanized
Body test	10 bar (hydro-static)
Seat test	2.8 bar (Hydro-static) generally as per MSS SP-81
Painting Internal	Red Oxide
Painting External	Two coats epoxy paint RAL 5022

19.3 CHECK VALVES

19.3.1.1 Cast Iron Check Valves

60 mm to 350 mm diameter valves shall be swing check- valves of the lever and spring type, flanged, and shall have cast iron body and renewable bronze seat, bronze hinge, stainless steel hinge shaft. The valve shall conform to IS 5312 and, where any of the requirements specified are not covered therein, to U.S. Federal Specification WW-V-51 D, Type IV, Class A.

Cast Iron shall conform to ASTM A-126-66 and flanges to 16.1. The valves shall be designed for low head loss, shall adjustable for non-slamming closure and shall be seat-tight.



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showing direction of flow shall be prominently cast on body of valve. The water working pressure shall be 10 kg/cm square except that the valve shall have pressure rating same as the piping where the pipe class is higher. Valves shall be from approved manufacturer only.

19.3.1.2 Pump Check Valves larger than 400 mm Diameter

All check valves larger than 400-mm diameter installed on the pump discharge shall be flanged ductile iron body, cover disc, arm and levers. The seat shall be of renewable bronze ASTM B 148. The disc shall be hinged on a stainless steel shaft. The gate pins shall also be of stainless steel. The valves shall be designed for a working, pressure of 10kg/cm square. Valve operation shall be of the oil cushioned type such that the valve swing to 90 percent closed immediately upon stoppage of flow and cushioning cylinders shall control the final closure, to prevent mechanical slamming, within an adjustable timing of one to three seconds. The valves shall be from approved manufacturers only.

20 SINGLE FACED SLUICE GATES

20.1 GENERAL SPECIFICATIONS

The frames, doors, sealing faces and spindles shall be as specified in the appropriate clauses herein.

Each gate shall be provided with a suitable handwheel of adequate diameter for the duty required and gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25 kg.

Handwheels shall have cast on them the direction of closing which shall be clockwise and vandal and weatherproof clear poly-carbonate tube covers shall be securely fitted to protect the threads of rising spindles. Each tube shall be clearly and permanently engraved to indicate the position of the Penstock to which it is fitted.

Spindles shall have machine cut robust trapezoidal or square form threads. They shall be of stainless steel or manganese steel, with the exception of non-threaded sections of extended spindle installations, which may be of mild steel. Extension spindle couplings shall be of the muff type and they shall be drilled and provided with a nut and bolt for securing the spindle to the Penstock spindle head, which shall likewise be drilled to receive the bolt.

Where extended spindles require to be operated at open flooring level, spindle guides or guide brackets shall be provided close to flooring level.

All Handwheels, headstocks, floor brackets and guide brackets shall be of cast iron. Thrust tubes shall be galvanized mild steel or cast iron.

Fixing nuts and bolts supplied by the manufacturer shall be as specified in the appropriate clauses herein.

All gates shall be of the rising spindle type and provided with headstocks. Unless otherwise stated thrust tubes shall be provided between Penstock frame and headstock in order to absorb thrust in both directions of operation for gates of 300 mm (square or circular) and above. Thrust tubes shall incorporate all necessary fixing brackets and spindle guide plates.

All materials used in the manufacture of gates shall conform to the following minimum standards:

Sr.	Sluice Gate Component	Materials	Specification	Grades
1	Gate Frame, Shutter	Mild steel Stainless Steel Aluminum alloy	IS:2062-1992 ASTM A276	Grade A AISI:304, 316, 410
2	Resilient rubber seal	Natural Rubber EPDM Rubber Neoprene Rubber		
3	Rubber seal retainer bar	Mild Steel Stainless Steel	IS : 2062-1992 ASTM A276	Grade A AISI : 410 FG 200
4	Coupling	Cast Iron Mild Steel Stainless Steel	IS : 210-1993 IS : 2062-1992 ASTM A276	Grade A AISI : 410
5	Operating Nut / Stem Nut	Leaded Tin Bronze	IS : 218-1981	LTB 1, LTB 2
6	Head stock, Stem guide bracket Stop nut	Cast Iron	IS : 210-1993	FG : 200
7	Fasteners & Studs	Mild Steel Stainless Steel	IS : 2062-1992 ASTM A276	Grade A AISI:410 Grade A AISI:410
8	Anchor Bolts	Mild Steel Stainless Steel	IS:2062-1992 ASTM A276	
9	Yoke	Mild Steel	IS : 2062-1992	Grade A

21 WATER SUPPLY AND SANITARY WORKS

21.1 APPLICABLE CODES

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

IS : 210	:	Specification for grey iron castings
IS : 269	:	Specification for ordinary and low heat Portland cement
IS : 383	:	Specification for coarse and fine aggregates from natural sources for concrete
IS : 432	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS : 456	:	Code of Practice for plain and reinforced concrete
IS : 458	:	Concrete Pipes (with and without reinforcement)
IS : 516	:	Methods of tests for strength of concrete
IS : 554	:	Dimensions for pipe threads where pressure tight joints are required on the threads
IS : 651	:	Salt glazed stoneware pipes and fittings
IS : 774	:	Flushing Cisterns for water closets and urinals (valveless siphonic type)
IS : 775	:	Cast iron brackets and supports for wash basins and sinks
IS : 781	:	Sand-cast brass screw-down bib taps and stop taps for water services
IS : 783	:	Code of practice for laying of concrete pipes
IS : 1068	:	Electroplated coatings of nickel and chromium of iron and steel
IS : 1077	:	Specification for common burnt clay building bricks
:	:	:
IS : 1172	:	Code of practice for basic requirements for water supply, drainage and sanitation
IS : 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 1239	:	Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
IS : 1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS : 1626	:	Asbestos cement building pipes, gutters and fittings (spigot and socket types)
IS : 1703	:	Copper Alloy float valves (horizontal plunger type) for water supply purposes
IS : 1726	:	Cast iron manhole covers and frames
IS : 1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS : 1742	:	Code of practice for buildings drainage
IS : 2065	:	Code of practice for water supply in Buildings
IS : 2116	:	Specification for sand for masonry mortars
IS : 2212	:	Code of practice for brickwork
IS : 2250	:	Code of practice for preparation and use of masonry mortars
IS : 2326	:	Automatic flushing cisterns for urinals

IS : 2470	: Code of practice for design and construction of septic tanks (Part I & II)
IS : 2556	: Vitreous sanitary appliances (Part I to Part XV)
IS : 2963	: Specification for copper alloy waste fittings for wash basins and sinks
IS : 3306	: Specification for chemically resistant glazed stoneware pipes and fittings
IS : 3025	: Method for sampling and test (Physical and chemical) for water and waste water (Parts 1 to 44)
IS : 3311	: Waste plug and its accessories for sinks and wash basins
IS : 5455	: Specification for cast iron steps for manholes
IS : 4127	: Code of Practice for laying of glazed stoneware pipes
IS : 3495	: Methods of tests of burnt clay building bricks
IS : 4111	: Code of practice for ancillary structures in sewerage manholes
IS : 5382	: Specification for rubber sealing rings for gas mains, water mains and sewers
IS : 5329	: Code of practice for sanitary pipe work above ground for buildings
IS : 5434	: Non-ferrous alloy bottle traps for marine use

21.2 SANITARY INSTALLATION

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Engineer-in-Charge.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

Licensed plumbers shall carry out all sanitary and plumbing work.

All sanitary appliance including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Engineer-in-Charge.

All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

Joints between iron and earthenware pipes shall be made perfectly air and watertight by caulking with neat cement mortar.

21.3 INDIAN TYPE WATER CLOSET

Water closets shall be white porcelain Orissa type Indian soil pans, 690mm long conforming to IS:2556 of approved make and pattern. Flushing cistern of 15b litres capacity with accessories such as chain, handle, stop tap, brass unions, jamb nuts, overflow pipe and bends, etc. shall be provided.

21.4 URINALS

Urinals shall be white glazed flat back type of approved make and of size 430 mm x 260

mm x 350 mm conforming to IS 2556. High level automatic cistern of 10



CI flushing

litre capacity as per IS 2326 with necessary CI brackets, GI pipes for water connection from cistern to urinals, stop tap, waste pipe upto CI waste shaft etc. shall be provided.

21.5 WASH BASIN

Wash basin shall be of white glazed earthenware conforming to IS 2556 of approved make and of size 560mm x 410mm. The wash basins shall be provided with water supply GI pipe, chromium plated tap, stopcock, CP bottle trap, GI waste water pipe and all necessary accessories and fittings.

21.6 SINKS

Sinks shall be of white glazed earthenware conforming to IS 2556 of approved make and of size 450mm x 300mm x 150mm. The sink shall be provided with CP tap, water supply GI pipe, non-ferrous waste fitting, waste plug and necessary accessories and fittings.

21.7 CAST IRON SOIL WASTE AND VENT PIPES AND FITTINGS

All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS:1536. The diameter approved shall be internal diameter of pipe. The pipe and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign materials before being fixed.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I or MS holder bat clamps unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakage shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

C.I pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimension approved for the corresponding sizes of straight pipes.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm Dia. Puff pipe where the length of the waste is more than 1800mm or the floor trap is connected to

a waste stack through bends.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer-in-Charge and left in working condition after completion. The smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest end and from a smoke machine, which consists of a bellow and a burner. The material usually burnt is greasy cotton waste, which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.

Water test and air test shall be conducted as stipulated in IS:5329

21.8 ASBESTOS CEMENT PIPES AND FITTINGS

All Asbestos Cement (AC) soil, waste, vent pipes, and fittings shall conform to IS 1626. The pipes shall have spigot and socket ends. These shall be composed of an inert aggregate consisting of clean asbestos fibre cemented together by ordinary Portland cement conforming to IS:269, or Portland blast furnace slag cement conforming to IS.455. No organic material shall be added to the composition.

The pipes shall be straight and the ends of the pipes and fittings shall be finished square to their axes. The finished pipes and fittings shall be true and smooth, their inner and outer surfaces shall be concentric. They shall be in all respects sound, homogenous and free from impurities or other imperfections.

The permissible tolerance on the thickness and external dimensions of pipes and fittings including hydraulic test pressure of the pipes and fittings shall conform to IS.1626.

All AC pipes and fittings shall be of approved make and with necessary accessories, wherever required. The diameter wherever approved for pipes and fittings shall be clear internal diameter. All gaps between pipes and fittings and walls shall be filled with cement mortar 1:3 neatly finished. All pipes and fittings shall be supported with standard fixing brackets.

The annular space between the socket and spigot shall be filled with a gasket of hemp and spun yarn soaked in tar. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tools and finished smooth on top with neat cement paste at an angle of 45°. The joint shall be kept wet for not less than 7 days by typing a piece of gunny bag kept moist. Joint shall be perfectly airtight as well as watertight.

Pipes and fittings shall be tested with a smoke test as approved.

21.9 GALVANISED MILD STEEL (GI) PIPES

The pipes shall be galvanised mild steel welded pipes and seamless screwed and socketed tubes conforming to the requirements of IS.1239, for medium grade. These shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or re-threaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two piece are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as to make them slack, water tight joint. The screw thread of pipes and fitting shall be protected from damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc, with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps. Keeping the pipe about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc, provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solids floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried MS pipe sleeve shall be fixed at a place where a pipe is passing through a wall of floor for reception of the pipe and to allow freedom for expansion/contraction and other movements maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contract with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Engineer-in-Charge.

GI pipes with socket and spigot ends shall be provided with caulked joints wherever specified and the joints shall conform requirements of IS:3114.



to lead the

The work of excavation and backfilling shall be done true to line and gradient in accordance with general Employer's requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0 cm sand and sand filled upto 15 cm above the pipes. A sand cushion of 15 cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. When excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Engineer-in-Charge and shall satisfactorily pass the test. Pipeline system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw-off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking should be removed and replaced by the Contractor.

The GI pipeline shall be cut to the required length at the position where the meter and stopcock are required to be fixed. The ends of the pipes shall be threaded. The meter and stopcock shall be fixed in position by means of connecting pipe, G.I nuts, sockets, etc. The stopcock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipeline, the pipeline will have to be completely washed before fixing the meter. For the purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipeline. The water shall be allowed to flow completely to wash the pipeline and then the meter installed as described above by replacing the connecting piece.

21.10 STONEWARE PIPE AND FITTINGS

All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade

'A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting:

- a. Internal diameter
- b. Grade
- c. Date of manufacture;
- d. Name of manufacture or his registered trade-mark or both

All pipes and fittings shall have ISI mark jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In cased, rubber sealing rings are used for jointing, these shall conform to IS:5382.

21.10.1 Spigot and Socket Joint (Cement Joint)

The Spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one fourth of the depth of socket.

Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees.

The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantities of cement required for each joint for certain common sizes of pipes are given below for guidance:

Nominal diameter of pipe (mm)	Cement (kg)
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

21.10.2 Spigot and Socket Joint (Rubber Ring Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS: 5382 shall be used and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

21.10.3 Cleaning of Pipes

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Engineer-in-Charge, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Engineer-in-Charge to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Engineer-in-Charge considers that damage may have been caused to the pipelines, he shall be entitled to order the length to be tested immediately. Should such a test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Engineer-in-Charge.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Engineer-in-Charge is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

21.10.4 Testing at Work Site

After laying and jointing of GSW pipes is completed the pipeline shall be tested as per the following Employer's Requirements and as approved by the Engineer-in-Charge. All equipment for testing at work site shall be supplied and erected by the Contractor. Potable water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer-in-Charge. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer-in-Charge and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water. If necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The leakage tolerance of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified, the Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Engineer-in-Charge.

Water for testing of pipeline shall be arranged by the Contractor.

21.11 STOP COCK AND BIB COCK

Stopcocks and Bibcocks shall be of brass heavy class, chromium plated and of approved manufacture and pattern complying with IS: 781. They shall be of specified size and of the screw down type. The cocks shall open in anti-clockwise direction and chromium plating shall be done in accordance with IS: 1068.

21.12 SOAK PIT

Soak pit shall be constructed at the location specified by the Engineer-in-Charge. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level up to ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

21.13 MANHOLES/INSPECTION CHAMBERS

21.13.1 Location

Manholes / Inspection chambers shall be constructed at places approved by the Engineer-in-Charge.

21.13.2 Excavation

Excavation, shoring, dewatering etc. for the pits of manholes / Inspection chambers, laying of pipes and fittings/specials shall be done in accordance with Engineer-in-Charge requirements described elsewhere in the document.

21.13.3 Bed Concrete

The bed concrete (min grade M15) for manholes/Inspection Chambers shall be done in accordance with Engineer-in-Charge's requirements described elsewhere in the document.

21.13.4 Bricks

Bricks used for construction of manholes / Inspection chambers shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm, unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS: 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm unless otherwise specified; but tolerance upto + 3 mm in each direction shall be permitted. Only full size brick shall be used for masonry work. Brickbats shall be used only with the permission of Engineer-in-Charge to make up required wall length or for bonding. Sample bricks shall be submitted to the Engineer-in-Charge for approval and bricks supplied shall conform to approved samples. If required by the Engineer-in-Charge, brick samples shall be tested as per IS:3495 by Contractor. Bricks rejected by the Engineer-in-Charge shall be removed from the site within 24 hours.

21.13.5 Cement Mortar

Mortar for brick masonry shall be prepared as per IS:2250, Manholes / Inspection chambers shall be constructed in brick masonry with cement mortar (1:3) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Engineer-in-Charge. If required by the Engineer-in-Charge and shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be

rejected.



The Contractor shall arrange for tests on mortar samples if so required by Engineer-in-Charge. Retempering of mortar shall not be permitted.

21.13.6 Brick Masonry

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick course shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw-toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 m. Workmanship shall conform to IS:2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned of all dirt before another course is laid on top. If mortar in the lower course has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

21.13.7 Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetter for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant IS. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

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

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Engineer-in-Charge.

21.13.8 Cement Concrete Channel

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

21.13.9 Pipe Entering or Leaving Manhole / Inspection Chamber

Whenever a pipe enters or leaves a manhole / inspection chamber, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

21.13.10 Cast Iron Steps

Cast iron steps shall be as per IS:5455. The steps shall be of grey cast iron of grade 15 as per IS:210. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and wrappings. The portion of the step which projects from the wall of the manhole / inspection chamber shall have a raised chequered design to provide an adequate non-slip grip. CI steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as a chip of at temperature of 0 degree C.

Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the brick work at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type CI steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole / inspection chamber.

21.13.11 Frame and Covers

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

- Year of manufacture,
- Identification mark of the purchaser
- SEWERS/SWD
- Arrow showing direction of flow

Approved Makes: KK Manholes and Gratings
S.S. Manholes
Bharat Pipes and Covers

21.13.11.1 Cast Iron Frame and Cover

The cast iron frame and cover shall be of gray cast iron as per IS: 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 15.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Engineer-in-Charge. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Engineer-in-Charge. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. Including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole / inspection cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

21.13.11.2 Fibre Reinforced Concrete Frame and Cover

Fibre reinforced concrete frame and cover shall be capable of withstanding load of 35 tonnes. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fibre-reinforced frame shall have clear opening of 560 mm diameter and weighing 103 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured as approved.

21.13.11.3 Reinforced Cement Concrete Frame and Cover

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor and approved by the Engineer-in-Charge. The frame and cover shall be cast in cement concrete of M20 grades. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

21.13.12 Drop Manhole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) or main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the black drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to

the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following approved methods.

- a. A cascade,
- b. A ramp,
- c. By drops in previous manholes.

21.13.13 RCC Manhole

M20 grade of concrete used for construction of RCC manhole shall have min cement content of 390kg/cum of concrete. Min cover to the reinforcement shall be 50mm.

21.14 VENT SHAFTS

21.14.1 General

Vent shafts shall be erected at such places as approved by the Engineer-in-Charge.

21.14.2 GI Pipe Vent Shaft

GI pipe vent shall be of 100 mm diameter of 'C' class as per IS: 1239 and 6 metre height from ground level with slotted cap. The vent shaft shall be embedded in concrete of M10 grade and anchored with a 6mm thick MS base plate of 200 mm x 200 mm. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Engineer-in-Charge.

21.14.3 RCC Vent Shaft

Reinforced cement concrete vent shaft shall be of M20 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

21.15 SEPTIC TANK

The sewer line shall be connected to a septic tank of adequate capacity and design including necessary soak pit. All the works involved, such as excavation, refilling, accessories, fittings, vent pipe, cowl cap, etc. as specified & directed shall be carried out.

21.16 MISCELLANEOUS

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Engineer-in-Charge. The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by the Contractor.

22 ROAD SIDE DRAINS

22.1 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes are referred to in this part

All earthwork shall be according to Engineer-in-Charge specified under Section n “*Earthwork*”.

22.2 SLAB CULVERT

Slab culverts shall be constructed at specified locations of the existing cross drainage works as directed by the Engineer-in-Charge. The Concrete works specifications for construction of RC slab and the rubble masonry specifications for the supporting rubble walls shall be followed as per Employer’s Requirements described elsewhere:

22.2.1 Bitumen at Location of Contact

The bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats shall be straight run bitumen of specified grade.

22.2.2 Graded Gravel Free Draining Backfill

On each side of the uncoarsed rubble walls supporting the slab culvert a free draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in hereunder.

Sieve Designation	Percent Passing by Weight
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

22.2.3 Weep Holes

Weep holes as shown on the drawings or as directed by the Engineer-in-Charge shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of asbestos cement pipes conforming to IS: 6908 in rubber walls with necessary M10 concrete cushioning 75 mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal towards the drainage face.

22.3 PIPE DRAINS

Wherever required, pipe drains shall be provided for cross drainage purposes. The sequence of construction shall be as follows:

i) laying of sand/shingle bedding on the original ground

ii)

layin

- iii) laying of concrete pipes of NP3 class as per IS:458
- iv) Constructing embankment above in compacted murum, laying of the sub-base and Water bound Macadam as specified hereinabove.

The details of above works as directed by Engineer-in-Charge shall be followed.

22.3.1 Materials for Pipe Drains

All materials used in the construction of pipe drains shall conform to Engineer-in-Charge. RCC pipes class NP3 shall conform to IS: 458.

Each consignment of cement concrete pipes shall be inspected, tested if necessary, and approved by Engineer-in-Charge at the place of manufacture or at site before their incorporation in the Works.

22.3.2 Excavation for pipes

The foundation bed for pipe drain shall be executed true to the lines and grades shown on the drawings or as directed by the Engineer-in-Charge. The pipes shall be placed in shallow excavation of the natural ground in open trenches cut in the existing embankment, taken down to levels as shown in the drawings. Where trenching is involved, its width on either side of pipe shall not be less than 150 mm nor more than one-third the diameter of pipe. The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Engineer-in-Charge. Before placing any backfill material, exposed surface of the soft soil shall be lightly compacted with one pass of 0.5 T roller. On the lightly compacted surface, coarse sand and shingle shall be spread in two successive layers of 300 mm and each layer shall be compacted by rolling with a min 0.5 T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions.

When bed rock or boulder strata are encountered, excavation shall be taken down at least 200 mm below bottom level of pipe as directed by Engineer-in-Charge and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes. Trenches shall be kept free from water until the pipes are installed and the joints have been hardened.

22.3.3 Bedding for pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade. The pipe shall be bedded in a cradle of concrete having a mix not leaner than M-10. The pipe shall be laid on the concrete bedding before the concrete has set.

22.3.4 Laying of pipes

No pipes shall be placed in position until the foundations have been approved by Engineer-in-Charge. When pipes are to be laid adjacent to each other, they shall be separated by a distance at least equal to or greater than half the diameter of pipe subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

22.3.5 Jointing

All the joints shall be made with care so that their interior face is smooth and consistent with the interior surface of the pipes. The ends of the pipes should be so shaped as to form a self-centering joint with jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. After finishing the joints shall be kept covered and damp for at least four days.

22.3.6 Back filling

Trenches shall be backfilled with selected materials as per Employer's Requirements given in this part. Backfilling upto 0.3 metre above the top of pipe shall be carefully done and murum shall be thoroughly consolidated under the haunches of the pipe.

22.3.7 Concrete Encasement

Concrete encasement shall be provided at places wherever directed by the Engineer-in-Charge. Concrete shall be of M 20 grade.

PAGE NO 151 TO 166 ARE OMITTED

