

Volume II - A

Technical Specifications

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PREAMBLE

PREAMBLE

The technical specifications contained herein shall be read in conjunction with the other bidding documents as specified in Volume-I.

1. General requirements

The Technical specifications in accordance with which the entire work described hereinafter shall be constructed and completed by the contractor shall comprise of the following:

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Section - C1
Technical Specification for Road Works

Section – C1

Technical Specifications for Roadworks

- Development of the Project Roads and Utilities/Services
- Development of the Project Roads and Utilities/Services shall include detailed design and Construction of the following as described in this section.
- Design Standards for Roads and utilities

1. General

- Standards and Specifications to be adopted of following Project components are given in this section.
- Road Works: Carriageway, pathway, road furniture, road markings, road signage, traffic control devices, safety Works, pedestrian facilities, median plantation, etc.
- Where the Contractor intends to use an alternative to the Standards/Guidelines defined in section or delivering an equal or better product, he shall be permitted to use such alternative subject to the following conditions:
 - He shall demonstrate that the proposed alternative conforms to any of the following International Standards, Codes of Practice, Specifications, Guidelines, etc.
 - American Association of State Highway and Transportation Officials (AASHTO)
 - American Society for Testing of Materials (ASTM)
 - Euro Codes
- National Standards of any of the following countries: United States of America (USA), Canada, United Kingdom (UK), France, Germany, Sweden, Denmark, Norway, Netherlands, Spain, Australia, New Zealand, Japan and South Africa
- In case the Contractor intends to use any alternative Material / technology/ method, whether patented or otherwise, that is not specifically covered in the Indian or International Standards as listed above, but the use of which has been permitted on similar Projects (similar in category of road, traffic and climatic conditions) as the Project Road, he would be permitted, its use on certification by the owners of such similar Projects regarding the continued successful performance of such Materials, technologies, methods, procedures or processes for at-least 15 years of the service life of the Project. Such a certification shall be supported with details of critical performance parameters.

2. Design Standards

The Project Roads and Utilities/ Services shall confirm to design requirements set forth in this document.

List of Design Standards

List of Standards are given in Table 1, Table 2, Table 3, Table 4. However, EPC Contractor shall refer to latest codes at the time of detailed design and execution.

Table No. 1: Standards and Guidelines for Road design

S. No.	Description	Code/Document No.
1	Lateral and Vertical Clearances at Underpasses for Vehicular Traffic	IRC:54-1974
2	Guidelines for Planning and Design of Roundabouts	IRC:65-2017
3	Space Standards for Roads in Urban Areas	IRC:69-1977
4	Guidelines on Regulation and Control of Mixed Traffic in Urban Areas	IRC:70-2017
5	Geometric Design Standards for Urban Roads in Plains (First Revision)	IRC:86-2018
6	Guidelines for the Design of Interchanges in Urban Areas	IRC:92-2017
7	Guidelines on Accommodation of Underground Utility Services Along and Across Roads in Urban Areas (Second	IRC:98-2011
8	Tentative Guidelines on the Provision of Speed Breakers for Control of Vehicular Speeds on Minor Roads	IRC:99-2018
9	Guidelines for Capacity of Urban Roads in Plain Areas	IRC: 106-1990
10	Vertical Curves for Highways	IRC: SP:23-1983
11	Guidelines for the design of curves for Highways & Design tables (First Revision)	IRC:38-1988
12	Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas	IRC: SP: 41-1994
13	Standard for vertical and horizontal clearances of Overhead electric power and telecommunication lines as related to roads	IRC: 32-1969
14	Dimensions and weights of Road Design Vehicles	IRC:3-1983

Table No. 2: Standards and guidelines used for design of Road related facilities

Element of roads / services	Design Standards/Guidelines used for design	
	Code No	Description
Ground improvement	HRB SR No.14,1994	State-of-the-Art Report: High Embankments on Soft Ground, Part B - Ground Improvement
	IRC:113-2013	Guidelines for the Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils
Embankment filling	HRB SR No.3,1999	State of the Art Report: Compaction of Earthwork and Subgrades
	IRC: SP: 87- 2019	Manual of Specifications and Standards for SIX Laning Highway (Second Revision)
Pavement design	IRC: 37- 2018	Tentative Guidelines for the Design of Flexible Pavements (Fourth Revision)
	IRC: 58- 2015	Guideline for the design of plain jointed rigid pavement for highways (Fourth Revision)
	IRC:109-2015	Guidelines for Wet Mix Macadam (First Revision)
	IRC:111-2009	Specifications for Dense Graded Bituminous Mixes
	IRC:126-2017	Guidelines on Wet Mix Plant
	IRC: SP:63-2018	Guidelines for the Use of Interlocking Concrete Block Pavement (First Revision)
	IRC: SP:19-2001	Manual for Survey, Investigation and Preparation of Road Projects (Second Revision)
	IRC:36-2010	Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works (First Revision)
Road markings	IRC: 35-2015	Code of Practice for Road Markings (Second Revision)
	IRC: SP:19-2001	Manual for Survey, Investigation and Preparation of Road Projects (Second Revision)
	IRC:36-2010	Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works (First Revision)

Element of roads / services	Design Standards/Guidelines used for design	
	Code No	Description
Road markings	IRC: 35-2015	Code of Practice for Road Markings (Second Revision)
Signage	IRC:67-2012 IRC: SP:31- 1992	Code of Practice for Road Signs (Third Revision) New Traffic Signs
Landscaping	IRC: SP:21-2009	Guidelines on Landscaping and Tree Plantation
Pedestrian facilities	IRC:103-2012	Guidelines for Pedestrian Facilities (First Revision)
Cycle tracks	IRC:11-2015	Recommended Practice for the Design and Layout of Cycle Tracks (First Revision)
Safety features	IRC: SP: 44-1996	Highway Safety Code
Parking Facilities	IRC: SP: 12-2015	Guidelines for Parking Facilities in Urban Roads (First Revision)
Traffic lights	IRC: 93-1985	Guidelines on Design and Installation of Road Traffic Signals
Structures	IRC: 112 -2011	Code of Practice for Concrete Road Bridges: IRC: 5-1998- Standard Specification and Code of Practice for Road Bridges, Section I - General Features of Design
	IRC: 5-1998	Standard Specification and Code of Practice for Road Bridges, Section I - General Features of Design
	IRC: 6-2017	Standard Specification and Code of Practice for Road Bridges, Section II - Loads and Stresses
	IRC: 24-2010	Standard Specification and Code of Practice for Road Bridges, Section V - Steel Road Bridges
	IRC: 78-2014	Standard Specification and Code of Practice for Road Bridges, Section VII - Foundations and Substructure
	IRC: 83-2018 (Part III)	Standard Specification and Code of Practice for Road Bridges, Section IX- Bearings, Part-III: POT, POT-CUM-PTFE, PIN and Metallic Guide Bearings
	IRC: 83-2014 (Part IV)	Standard Specification and Code of Practice for Road Bridges, Section IX- Bearings, Part-III: POT, POT-CUM-PTFE,

Element of roads / services	Design Standards/Guidelines used for design	
	Code No	Description
		PIN and Metallic Guide Bearings
	IRC: SP 114 - 2018	Guideline for Design of Seismic Bridges
Protection Works	IRC:89 - 2019	Guidelines for Design and Construction of River Training & Control Works for Road Bridges (Second Revision)
Retaining structure		
High embankments	IRC:75-2015	Guidelines for the Design of High Embankments (First Revision)
Slope stability	HRB SR.No.1,2000	State-of-the-Art-Report: Lime-Soil Stabilization
Kerb and separator	IRC:86-2018	Geometric Design standards for Urban Roads in plains (First revision)
Drains	CPHEEO IRC SP-42 2014 IRC SP-50 2013	Guidelines for Road Drainage Guidelines for Urban Drainage

Table No. 3: Street Light- Standard for installation

Code	Standard for installation
IS: 1255 1983 (Reaffirmed 1995)	Code of practice for installation and Maintenance of power cables up to and including 33 kV rating.
IEC:60947	Switchgear Protective Components
IEC: 60598 - 2 - 3, IUT (Institute of Urban Transport)	Particular requirements luminaries for road & street lighting. Standard for road lighting.
IS: 2309	Code of practice for Lightning Protection
IS: 3043	Code of practice for Earthing

Table No. 4: Streetlight - Design Standards

Code	Design Standards
IS: 7098 (Part- II & Part- III) 2003 IS: 8130	<ul style="list-style-type: none"> Standard for XLPE Cables, Part - II up to 3.3 kV to 33 kV and Part - III from 33 kV to 132 kV). Specification for conductors for insulated electric cables & flexible cords.
IS 1554 (Part I & Part - II)	<ul style="list-style-type: none"> Specification for PVC insulated (Heavy Duty) electric cables Part 1 For working voltages up to and including 1100 Part 2 For working voltages from 3.3 kV up to and including 11 kV

Code	Design Standards
IEC: 61439 IEC: 60947	<ul style="list-style-type: none"> Feeder Pillar & Switchgear (Totally Type tested Assembly TTTA). Switchgear Protective Components.
IEC: 60598 - 2 - 3 IUT (Institute of Urban Transport) CIE (Industrial commission of illumination)	<ul style="list-style-type: none"> Particular requirements luminaries for road & street lighting Standard for road lighting Road Transport Lighting for Developing Countries
IS: 3043	<ul style="list-style-type: none"> Code of practice for Earthing
IS: 1944	<ul style="list-style-type: none"> Code of practice for lighting of public thoroughfares
IS: 1367 BSEN ISO 1461	<ul style="list-style-type: none"> Standards for Poles & Masts
BS EN 10025-1:2004	<ul style="list-style-type: none"> Recommended practice for hot-dip galvanizing of iron & steel Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods Hot rolled products of structural steels. General technical delivery conditions

3. Design and Construction of Roads

The Design and Construction of Roads in Solid Waste Management Plant are as specified in subsequent sections and reference drawings are included in volume-2. Nevertheless, anything to the contrary contained in the document, the Finished Road Level (FRL) shall be designed based on area natural drainage requirement to optimize storm water pumping by the contractor and considering the HFL criteria. The levels given in the bid drawings are for tender purpose only.

The Employer does not warrant either the sufficiency or accuracy of site data provided in the Bid Documents or elsewhere. The Contractor shall be fully responsible for independently verifying or obtaining all site data that Contractor deems necessary to prepare the bid. Any site data in Employer’s possession that is not included in the Bid Documents will be available for inspection at the Employer’s address provided in the Tender.

4. Standards and Specifications

4.1. Construction

- The Contractor shall comply with the Specifications and Standards set forth in this document for Construction of the Project Roads and Utilities/ Services.

- All Materials, Works and Construction operations shall conform to the Specifications for Road and Bridge Works (Fifth Revision, April 2013), issued by the Ministry of Road Transport & Highways (MoRT&H). Where the Standards and Specifications for a work are not given, Good Industry Practice shall be adopted to the satisfaction of the Employer’s Engineer.

4.2. Clearing and grubbing

Clearing Road land including uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth up to 300 mm, removal of stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable material to be used or auctioned, including all leads and lifts, including removal and disposal of top organic soil not exceeding 150 mm in thickness as per Technical Specification Clause 201 MORTH Fifth Revision.

4.3. Roadway Excavation

This work shall consist of excavation, removal and disposal of materials necessary for the construction of roadway, drains in accordance with requirements of the specifications mentioned below and the lines, grades and cross-sections shown in the drawings as per Technical Specification Clause 301 MORTH Fifth Revision.

4.4. Embankment

- Providing and Construction of Embankment with approved materials from borrow areas complete as per Technical Specification Clause 305 of MORTH Fifth Revision with all leads and lifts.
- Construction of Subgrade with approved material satisfying the requirements of minimum soaked CBR value as indicated in the drawings including all leads and lifts complete as per Technical Specifications Clause 305 of MoRTH Fifth Revision.
- No borrow area shall be made available by the employer for this work. The arrangement for the source of supply of the material for embankment meeting the prescribed specifications as well as compliance to the different environmental requirements in respect of excavation and borrow areas as stipulated, from time to time, by the Ministry of Environment and Forest, Government of India, and the local bodies, as applicable shall be the sole responsibility of the Contractor.

4.5. Shoulders

Construction of Earthen shoulders including all leads and lifts complete as per drawing and Technical Specifications Clause 407 of MoRTH Fifth Revision.

4.6. Granular Sub-Base (GSB)

- Construction of Granular Sub-Base by providing close graded material, spreading in uniform layers with motor grader on prepared surface, mechanical Mixer (Pug Mill) as per design mix at OMC and compacting with vibratory roller to achieve the desired density, complete as per clause 401 of MoRTH Fifth Revision.
- The material to be used for the work shall be crushed stone aggregate, natural sand or combination of various sizes of aggregates depending upon the grading required and the strength of minimum 4 days soaked CBR of 30%. The material shall be free from organic or other deleterious constituents and conform to the Grading II given in Table 400-1 & 400-2.”

4.7. Wet Mix Macadam Base (WMM)

Providing, laying, spreading and compacting crushed graded stone aggregate as per MoRTH Table 400- 12 & 400-13 of Wet Mix Macadam specifications including premixing the material with water to OMC in mechanical mixer (Pug mill) as per design mix, carriage of mixed material by tipper to site laying in uniform layers, with Paver Finisher, in sub-base/base course on a well prepared under-base and compacting with Vibratory Roller to achieve the desired density including lighting, guarding, barricading and maintenance of diversion etc. as per Technical Specifications Clause 406 of MoRTH Fifth Revision.

4.8. Kerb Stone

Supplying and laying cement concrete Kerb M20 grade mix for median/island complete as per IRC 86-2018 and as per Technical Specifications Clause 409 of MoRTH Fifth Revision.

4.9. Footpath

Provide cement concrete Paver block 63 mm thick as per IRC: SP: 63 in footpath & courtyard, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 30 mm thick bed of sand. Light shade pigment using white cement, all as per Technical Specifications Clause 410 of MoRTH Fifth Revision.

4.10. Road Furniture

- **IRC 67 Retro Reflective Sign Board**

- Retro- reflectorized cautionary, mandatory and informatory sign should be as per IRC:67 made of high intensity grade sheeting vide clause 801.3, fixed over aluminium sheeting, 1.5 mm thick supported on a mild steel angle iron post 75 mm x 75 mm x 6 mm firmly fixed to the ground by means of properly designed foundation with M15 grade cement concrete 45 cm x 45 cm x 60 cm, 60 cm below ground level as per approved drawing.
 - Retro-reflectorized sign as per IRC:67 made of high intensity grade sheeting vide clause 801.3, fixed over aluminium sheeting, 2 mm thick with area not exceeding 0.9 sqm supported on a mild steel single angle iron post 75 x 75 x 6 mm firmly fixed to the ground by means of properly designed foundation with M15 grade cement concrete 45 x 45 x 60 cm, 60 cm below ground level as per approved drawing.
 - Delineators (roadway indicators, hazard markers, object markers) should be 80-100 cm high above ground level, painted black and white in 15 cm wide strips, fitted with 80 x 100 mm
 - rectangular or 75 mm dia circular reflectorized panels at the top, buried or pressed into the ground and conforming to IRC-79 and the drawings.
 - Road stud 100x 100 mm should be die-cast in aluminium, resistant to corrosive effect of salt and grit, fitted with Lens`e reflectors, installed in concrete or asphaltic surface by drilling hole 30 mm up to a depth of 60 mm and bedded in a suitable bituminous grout or epoxy mortar, all as per BS 873 part 4:1973.
- **IRC 35 Road marking and strips**

The colour width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35, and as specified in the drawings or as directed by the Engineer-in- Charge.

4.11. General

- The thermoplastic material shall be homogenously composed of aggregate, pigment, resins and glass reflectorizing beads.
- The thermoplastic compound shall be screened/extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- The thermoplastic material shall conform to ASTM D36/BS-3262-(Part I).
- The material shall meet the requirements of these specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or un melted particles for the one year storage period. Any material not meeting the above

requirements shall be replaced by the manufacturer/supplier/Contractor.

- Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
 - The name, trademark or other means of identification of manufacturer.
 - Batch number
 - Date of manufacture
 - Color (White or yellow)
 - Maximum application temperature and maximum safe heating temperature.
- Sampling and Testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Employers Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

4.12. Preparation

- The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible
- and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- After transferring to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

4.13. Application

- Marking shall be done by fully /semi-automatic paint applicator machine fitted with profile shoe, glass beads dispenser, propane tank heater and profile shoe heater, driven by experienced operator as specified in item. For locations where painting cannot be done by machine, approved manual methods
- shall be used with prior approval of the Engineer-in-charge. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen. The thermoplastic material shall be applied hot either by screeding or extrusion process.

After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer or otherwise directed by the Employers Engineer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine. The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint. Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed.

4.14. Arrangement of Traffic During Construction

- **General**

- The Contractor shall at all times, carry out work on the road in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing road, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement or along a temporary diversion constructed close to the highway. Before taking up any construction or maintenance operation, the Contractor shall prepare a Traffic Management Plan for each work zone and submit it to the Engineer for prior approval. This plan should include inter alia:
 - A qualified safety officer with support staff to serve as a site safety team.
 - Provision of traffic safety devices as per IRC: SP 55 with the following specifications
 - Signages of retro-reflective sheet of high intensity grade General Section 100
 - Delineators in the form of cones/drums made of plastic/rubber having retro-reflective red and white bands, at a spacing of 5 m along with a reflective tape to be tied in between the gaps of cones/drums. A bulb using solar energy is to be placed on the top of the cone/drum for delineation in the dark hours and night.
 - Barricades using iron sheet with adequate iron railing/frame painted with retro-reflective paint in the alternate yellow and black & white stripes. Warning lights at 5 m spacing shall be mounted on the barricades and kept lit in dark hours and night.
 - Road markings with hot applied thermoplastic paint with glass beads.
 - Safety measures for the workers engaged, including personal protection equipment.
 - First aid and emergency response arrangements
 - Details and drawings of arrangements in compliance with other sub-sections of this Section.

4.15. Width of Carriageway

Width of carriageway is as given in typical cross sections drawings enclosed in Volume II B (Drawings) of bid documents.

4.16. Typical Cross Sections

Typical Cross Sections details for each ROW for the purpose of tender are represented in tender drawings enclosed in the bid documents. This is only for the purpose of tender and the detailed shall be developed by the contractor.

4.17. Geometric Design and other Features

Geometric design and other features of the Project Roads shall be in accordance with the Standards and Specifications as per the sections below.

4.18. Road Length

The lengths of different category roads are presented in Table 5 below.

Table No. 5: Length of roads by ROW

S. No.	Road Classification	Proposed ROW (m)	Road Length (Km)
1.	Internal Driveway	7.2	20.26
2.	Internal Driveway	3.5	175.16
3.	Internal Driveway	3	89.37

4.19. Design Speed

The road classification and the Design Speeds for different category of roads are as given below in Table 6 below.

Table No. 6: Road Classification and Design Speed

S. No.	Road Classification	Proposed ROW	Design Speed (Kmph)
1.	Internal Driveway	3 m	20
2.	Internal Driveway	3.5 m	20
3.	Internal Driveway	7.2 m	20

- Main, Arterial, and Sub-arterial road connect regional roads with primary Phase I roads while local roads in majority cases will provide last mile connectivity to residential, commercial and industrial units. Features like footpath, cycle track, utility corridor, drain would be provided on these roads as well.
- Design speeds given above are general and these may vary at locations due to constraints or safety requirement.

4.20. Coordination on Geometric Design

The contractor, while carrying out detailed design of the Roads shall maintain the coordination among horizontal and vertical alignment to facilitate smooth transitions, pleasing movement and desirable sight distances wherever applicable. The designs at such places must abide to relevant IRC specifications and Guidelines.

4.21. Standard Lane Width

The Standard Lane width shall be as specified in Cross Section drawings provided with this document.

4.22. Shoulders

- The type of shoulders shall be as below:
 - Paved Shoulder - Paved shoulder of same specification as that of main carriageway shall be provided.
 - Earthen Shoulder / Granular Shoulder - Being an access controlled and urbanized set-up, earthen shoulders shall be avoided as far as possible.

4.23. Kerbs and Median

- Along the carriageway barrier type Kerb shall be provided as per IRC:86-2018
- The central median shall have suitable drainage system so that water does not stagnate in the median. Along with the median, longitudinal drain shall be provided to drain off rainwater. The drain should have adequate longitudinal slope to the nearest culvert to drain off transversely. In super elevated sections the longitudinal drains should be designed to take the discharge from one side carriageway also.
- Suitable shrubs shall be planted along the median as per section 2.11.

4.24. Culverts

Details of Box Culverts shown in the below figure

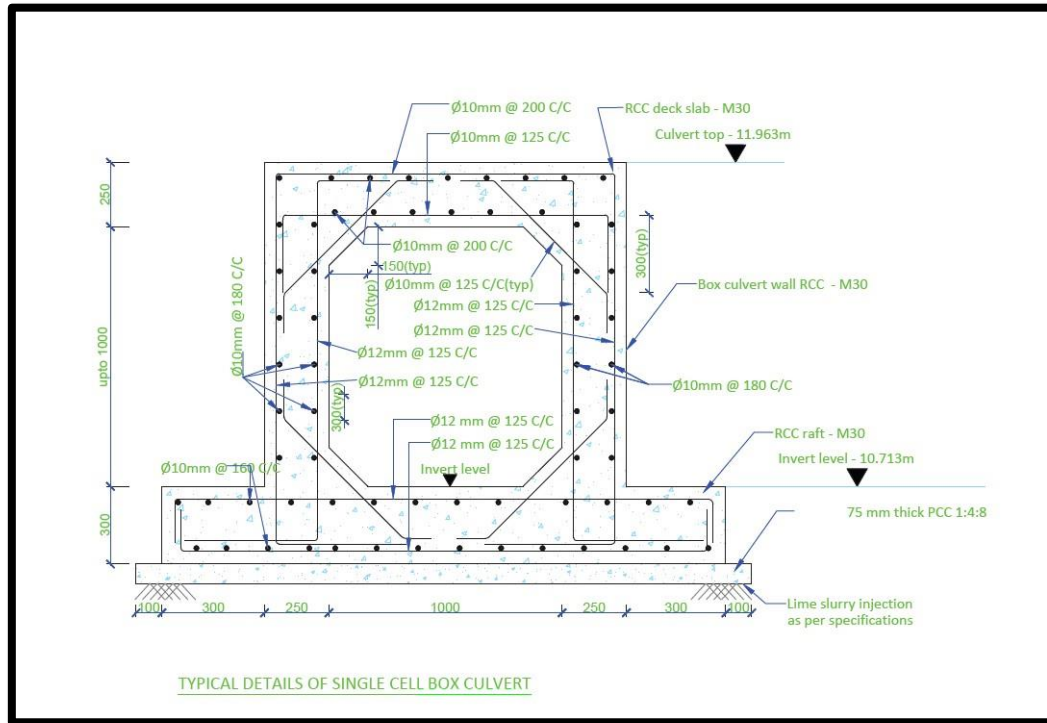


Figure 1: Box Culvert Details

4.25. Embankment & Subgrade

- Construction of embankment and pavement shall conform to the Standards and Specifications as per following sections.
- Embankment and Sub-grade shall meet the requirements stipulated in Cl. 305 of MoRTH specifications. The thickness of sub grade shall not be less than 500mm and effective CBR not less than 8%.
- A report on the soil investigation shall be furnished by contractor along with the design.
- The bottom of subgrade shall be at least 1.0m above the HFL/. At such locations, construction of embankment and subgrade shall follow the applicable provisions of IRC:36-2010.
- When corridor passing through BC soil, the unsuitable top 500 mm thick shall be replaced with a suitable soil.
- Along the corridor, where water table is high and soil has potential for rapid migration of moisture by capillarity, at such locations capillary cut-off shall be provided to arrest the capillary rise of water in the embankment as per the applicable provisions of IRC:34-2011.

4.26. Pavement Design Criteria

- The new pavement shall be designed in accordance with IRC:37-2018 “Guidelines for the design of flexible pavements”.
- Sub-grade shall meet the requirements stipulated in Cl. 305 of MoRTH specifications. The thickness of sub grade shall not be less than 500mm and effective CBR not less than 10%.

4.27. Type of pavement

Type of pavement used is paver blocks of sizes 83mm and 63mm

4.28. Design requirements

- **Design Period**
 - Flexible pavement shall be designed in accordance with IRC:37-2018 for a design period of 20 years.

4.29. Pavement Composition

- The new pavement shall be designed in accordance with IRC:37-2018 - Guidelines for the design of flexible pavements.
- Cement treated subbase and base are not allowed for the construction of GSB and base layer of flexible pavement.
- Paved shoulders/Hard strip shall be of same specification and composition as of main carriageway.
- To ensure internal drainage of the pavement structure, the GSB layer/filter layer, functioning as drainage layer shall be extended to full width of carriageway.

4.30. Footpath

Footpath/Walkway shall be provided as per cross sections using paver blocks and shall be in confirmation with the technical specifications provided in IRC 86-2018. Pattern/style/color of paver block shall be approved from the Authority’s Engineer prior to construction.

- **Drawings**
 - Refer Tender Drawings/Tender Drawing Volume-II

- **Project Facilities**

- The Contractor shall design and construct the Project Facilities in accordance with the provisions of this section.
- Each of the Project Facility is briefly described below;

- **Traffic Signage**

- Traffic signage include roadside signs, curb mounted signs and gantries along the entire road network in scope. Signage shall be provided as per IRC Standards.

4.31. Pavement markings

Pavement markings shall cover road marking for the entire road network in scope as per relevant IRC standards.

4.32. Pedestrian facilities

For the safety of pedestrians, Crossings shall be controlled through provision of zebra crossing and other pedestrian safety measures at the required locations and at the intersections as per the standards and shall be approved by the Authority.

4.33. Landscaping & Tree Plantation

- Trees and shrubs of required number and type at the appropriate locations and in the space earmarked within the Right of way shall be provided.
- Planting along the road corridor shall be as per the relevant clause of IRC: SP: 21-2009.
- Indigenous species that grow in that area shall be preferred and the plantation will be inter- mixed with evergreen species and seasonal flowers.
- Visibility of any signs; signals or any other devices erected for traffic control, traffic guidance and/or information shall not be obstructed by plantation.

Section - C2

Technical specification for Potable Water Supply Network

Section - C2

Technical specification for Potable Water Supply Network

1. Potable Water Supply Network

The scope for Potable water supply scheme shall include complete raw water and potable water networks from the external water supply line.

Contractor has to design the complete potable water distribution system from the external existing water supply line. The contractor scope shall also include surge analysis for the complete water network and shall provide surge protection equipment wherever necessary.

The implementation limit for this distribution system will be from the existing external water supply line to the service connection points outside the plots in the Project area.

2. Background

The Contractor has to design the complete Potable Water distribution system on continuous pressurised supply basis with civil, electromechanical works.

The potable water distribution network drawings schematic is shown in the below figures for reference.



Figure 2: Potable Water Supply Network

For Proposed Potable Water Network with Pipe Diameters in phase 1 refer to the drawing in the Volume -II B Drawings

3. Peak Factors

As far as the design of distribution system is concerned, it is the hourly variation in consumption that matters. The fluctuations in consumption are accounted for, by considering the peak rate of consumption as rate of flow in the design of distribution system.

The following peak factors shall be adopted as recommended in CPHEEO manual for water supply.

Table No. 1: Peak Factors for Contributory Population for Water Supply

Contributory Population	Peak Factor
For population less than 50,000	3

The peak factor shall depend upon contributory population on respective lines of different clusters as shall be proposed during designing of distribution network.

A peak factor of 3 irrespective of population should be adopted.

4. Design Period for Various Components

Water supply projects are designed to meet the future requirement of a stipulated design period. This period, with regard to certain components of the project, depends on their useful life or the facility for carrying out extensions whenever required, so that expenditure far ahead of its utilization is avoided and capital expenditure incurred on the project does not remain idle due to underutilization of these facilities. For the purpose of designing such systems, a 30-year project period is recommended. The design period normally considered for various components is as under:

- Civil structures : 30 years
- Pumping Mains : 30 years
- Mechanical and Electrical Components : 15 years
- Distribution System: : 30 years

MS hollow door frame with cold rolled processed steel sheet 1.25mm thick bright CRCA conforming to IS 4351/76, Flush door shutters with solid bond wood bond board doors shall be provided. N.C.L. Windows centre fixed both sides openable shutter window 1.35 X 1.35mts outer frame section 48 x50mm shutter frame section with a size of 48 X20 mm mullion section of size 48 X 50mm fixed

beading section of 12 X 12 mm shall be provided. Flooring with polished Kadapa stone shall be provided. Walls shall be provided with snowcem paint in two coats over primary coat. Electrical and water supply arrangements shall be provided as directed by department officer. Water Storage tank made with plastic/polymer material of reputed make with necessary outlet and inlet connection pipes shall be provided. A septic tank for 5 users shall be provided.

- Site clearance
- Boundary wall with top barbed fencing for the complete perimeter of site.
- Considered the basic wind speed to be 50m/s and seismic zone III
- Inspection and Quality Control of all equipment and civil work, Erection, Commissioning, trial run, along with all consumables and manpower, project management and monitoring for timely submission of design documents and drawings and timely execution of the project with demonstration of performance guarantee parameters including supply of all measuring instruments and manpower.
- Pipe connections & Specials with HDPE materials.
- All pipe connections for Inlet, Outlet, Overflow, scour pipes shall be provided with HDPE material.
- The Valves for above pipe connections also shall be of HDPE material of PN 16.
- All specials such as Bends, Tees, Reducers, Duck foot, Bends, Bell mouths etc., shall be of HDPE material.
- All manhole Frames & Covers shall be made of CI/DI materials with min. size of 0.60mX 0.60m
- - For Roof & Valve Chambers.
- Construction of Internal Roads (Min. width 3.5 m), including connecting road to site from existing road to have a separate and independent entry to plant/site.
- Storm water Drainage within battery limits and extension up to nearest drain/point of disposal, drinking water & sanitation water system for operating & maintenance personnel, yard lighting, fencing, etc.
- Construction of permanent boundary walls and/or fence and internal fencing, entry gates and lighting including any tempbrick masonry walls on three side and a collapsible MS gate on front side up to 1st brace level, to prevent unauthorized entry.
- Construction of R.C.C valve chambers as per Standard
- Ventilation system for all buildings and units, Fire Fighting System, Tools & Tackles for handling of equipment during maintenance.
- Commissioning spares
- Lay-down areas, warehouses, workshops for site construction and pre-fabrication purposes, vehicles, mobile equipment etc.
- Material of Construction: For any proprietary or generic design, the Material of Construction shall be as per the tender document - (e.g. Pipes, Plates, Valves etc.)

- The purpose facilities shall require minimum skilled manpower for the operation and maintenance and shall have a complete PLC based operation of all units in proposed plant.

Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.

The Contractor shall ensure that all designs and equipment for which he is responsible are safe. Nothing in this requirement shall remove the Contractors obligation from drawing the attention of the Employers Representative to any feature of the Works, which is not consistent with safety, or to prevent him making proposals for incorporating equipment or designs which would increase the safety of the site and plant.

The installation layout and system design shall not allow any item of plant to be so positioned that danger to operating personnel could arise during normal operation and maintenance. Particular attention shall be paid to the position of pipes, air vents, electrical cables and rotating machinery.

All rotating shafts, couplings, gears, flywheels, belt drives or other moving parts shall be fully guarded. Guards shall be designed to provide ready access to bearings, grease points, thermometer sockets/instrument probes and other check points and to allow safe routine observation and servicing to be executed without the need to dismantle any part of their structure.

However, prior to commencement of the work, the Contractor shall submit the following:

1. Layouts, general arrangements, dimensional elevations and cross-sectional drawing for all the project components, equipment, structures and facilities of the works.
2. Hydraulic gradient diagram, Process & Instrumentation Diagrams, Piping isometric, composite layout and fabrication drawings, Piping engineering Diagrams, pipe and fittings schedules, valve schedules, pipe support schedules.
3. Technical data sheets and calculations for all bought out and manufactured item.
4. Detailed design calculations including sizing calculations for all system and equipment like pump, pumping station equipment's, piping, valves, Electrical systems, Control and Instrumentation systems and civil works.
5. Characteristic Curves/ Performance Correction Curves.
6. Hydraulic & Mechanical design calculations
7. Comprehensive list of all terminal points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.,

8. Power distribution scheme indicating the equipment’s rating
9. Protection system diagrams.
10. Cables schedules, termination and interconnection diagrams
11. Sequence and protection interlock schemes
12. Type test reports
13. Foundation Plan and Loading Data for Civil Design and drawings.
14. Model study reports wherever applicable.
15. Functional & guarantee test procedures and test reports
16. Documentation in respect of the Quality Assurance System as listed out elsewhere in this Specification.
17. Other Criteria to be considered:

Reinforcement steel shall be Fe500 (TMT) for water retaining structures.

All pipe connections for Inlet, Outlet, Overflow, Scour pipes shall be provided with HDPE material. The Valves for above pipe connections also shall be of HDPE material of PN 6

All specials such as Bends, Tees, Reducers, Duck foot, Bends, Bell mouths etc., shall be HDPE material.

All manhole Frames & Covers shall be made of CI/DI materials with min. size of 0.60mX 0.60m
- For Roof & Valve Chambers.

5. Distribution Network

The distribution network shall be designed on a continuous pressurized water supply. Hazen William’s formula will be used for calculation of velocities and head losses. Water distribution network shall be mostly closed network system so that uniform pressure is maintained at most Underground reservoir points for each consumer. The Hazen Williams formula is expressed as under:

$$S = hf / L = 10.67 [(Q / C)^{1.85} [1 / (d^{4.87})]]$$

Where,

- S : Hydraulic slope
- hf: head loss in meters (water) over the length of pipe
- L : length of pipe in meters
- Q: volumetric flow rate, m³/s (cubic meters per second)
- C : pipe roughness coefficient
- d : inside pipe diameter, m (meters)

Following considerations shall be taken into account while designing the network:

- Minimum velocity = 0.6 m/s
- Maximum velocity = 1.5 m/s

For specials like reducers, bell-mouths, tees, elbows, etc., the 'k' values shall be as recommended by the British Hydromechanics Research Association (BHRA), Volume 5, in the BHRA fluid Engineering Series or any other equivalent with prior approval of Employers Engineer/PMNC.

6. Excavation Depth

All water supply pipes shall be laid below ground with the minimum clear cover of 1m above the crown of the pipes. No cover less than the above is acceptable.

Contractor also need to check and design anchoring arrangement to mitigate the uplift of pipes due to high water table in the project area.

7. Residual Pressure

As per CPHEEO, single storied buildings should have a minimum residual pressure of 7 m at ferrule point. To meet the fire demand, a residual pressure at the ferrule point shall be considered as 14 m.

8. Property Connections

Service pipes should be laid up to plot boundaries in the Project area. The service pipe details are as defined below:

Table No. 2: Tentative Details of Property Connections

S. No.	Description	Value
1.	Pipe Diameter	As per service connection
2.	Pipe Material	HDPE PE100 PN 6
3.	Number of property connections	13 Nos

6. Design Parameters for Distribution Network

Table No. 3: Design Parameters for Potable Water Distribution Network

S. No	Design Parameter	Value
1.	Minimum residual pressure at Consumer connection (unless otherwise specified by Employer/ Employer’s Engineer)	7
2.	Peak factor	A peak factor of 3 irrespective of population should be adopted.
3.	Losses as Unaccounted for water (UFW) to be considered for designing	2% Treatment loss, 3% Pumping and Raw Water Transmission loss and Clear water transmission & distribution loss shall be restricted to 10%
5.	Clear cover over pipe	1.0 m (minimum); increase if needed to counter flotation.
6.	Basis of supply to consumers	Continuous pressurized
7.	Max. Unit head loss in the pipe	10m/KM
8.	Hazen William Coefficient	145(HDPE)
9.	Pipe Material	150 mm and below Dia: HDPE (PE-100); PN 6

Network shall be designed as per ring main unit with flow and pressure monitoring system with maximum looping for guaranteed residual head at ferrule point as per desired service level.

The network shall be optimized for 5 % loss in transmission and distribution network.

7. Required Analysis of Source Water

The contractor has to perform the following analysis of source water as per IS 10500: 2012.

Table No. 4: Organoleptic and Physical Parameters

S. No.	Characteristic
1.	Colour, Hazen units, Max
2.	Odour
3.	pH value
4.	Taste
5.	Turbidity, NTU, Max
6.	Total dissolved solids, mg/l, Max

Table No. 5: General Parameters Concerning Substances Undesirable in Excessive Amounts

S. No.	Characteristic
1.	Aluminum (as Al), mg/l, Max
2.	Ammonia (as total ammonia-N), mg/l, Max
3.	Anionic detergents (as MBAS) mg/l, Max
4.	Barium (as Ba), mg/l, Max
5.	Boron (as B), mg/l, Max
6.	Calcium (as Ca), mg/l, Max
7.	Chloramines (as Cl ₂), mg/l, Max
8.	Chloride (as Cl), mg/l, Max
9.	Copper (as Cu), mg/l, Max
10.	Fluoride (as F) mg/l, Max
11.	Free residual chlorine, mg/l, Min
12.	Iron (as Fe), mg/l, Max
13.	Magnesium (as Mg), mg/l, Max
14.	Manganese (as Mn), mg/l, Max
15.	Mineral oil, mg/l, Max
16.	Nitrate (as NO ₃), mg/l, Max
17.	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max
18.	Selenium (as Se), mg/l, Max
19.	Silver (as Ag), mg/l, Max
20.	Sulphate (as SO ₄) mg/l, Max
21.	Sulphide (as H ₂ S), mg/l, Max
22.	Total alkalinity as calcium carbonate, mg/l, Max
23.	Total hardness (as CaCO ₃), mg/l, Max
24.	Zinc (as Zn), mg/l, Max

Table No. 6: Bacteriological Quality of Drinking Water

S. No.	Organisms
1.	All water intended for drinking: a) E. coli or thermotolerant coliform bacteria
2.	Treated water entering the distribution system: E. coli or thermotolerant coliform bacteria Total coliform bacteria
3.	Treated water in the distribution system: E. coli or thermotolerant coliform bacteria Total coliform bacteria

8. List of Standards and Specifications

Detailed specification for water supply system has been presented in section 12.7. Key standards have been listed below.

- CPHEEO Manual for Water Supply & Treatment, 1999
- SP 7 (2016): National Building Code of India, 2016
- Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014
- SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987
- Manual on norms and standards for environment clearance of large construction projects, MoEF
- IS 1172: Code of Basic requirements for water supply, drainage and sanitation
- IS 8329: Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage- Specification
- IS 12288: Code of practice for laying of ductile iron
- IS 9523: Ductile iron fittings for pressure pipes for water, gas and sewerage
- IS 4984: High Density Polyethylene Pipes for Water Supply
- Fire Hydrant: As per IS 908 (Specification for Fire Hydrant, Stand Post Type) The hydrant shall consist of one or two sluice valves with road surface boxes, a duck foot bend, flange riser and a stand post column fitted with 63-mm male coupling(s).
- Sluice valves shall be of Class I type with cap conforming to IS 780, it shall be provided with false spindle.
- The road surface box shall conform to IS 3950.
- Duck foot bend shall conform to IS 1538 heavy duty type.
- The flange riser shall conform to IS 7181. The length of the pipe shall be as required.
- Stand post column shall be of cast iron, cast in one piece conforming to Grade 20 of IS 210

Section - C3
Technical specification for Storm Water Drain

Section - C3

Technical specification for Storm Water Drain

1. Scope

The Scope of Work shall include:

- Detailed Design, plans, L sections and construction drawings of storm water system of the project area
- Submission of design calculations plans and drawings for approval to the client.
- Construction of storm water Network as per approved design and plans
- Groundwater level and quality shall be considered as per geo-technical report for designing of storm water system.
- Concrete lining of channel.
- The contractor shall design and construct the storm water drainage system and shall furnish all required facilities, plant, instruments, materials including water, electricity, labour, consumables, etc., any and everything necessary for construction of the works, whether or not such items are specifically stated elsewhere in this bid.
- The contractor shall make his/their own arrangements for water and power required for the work and nothing extra will be paid for the same. This will be subject to the conditions that the water used by the contractor (s) shall be fit for construction purposes to the satisfaction of the Employers Engineer. No underground water usage for construction is permitted. Arrangement of Power for construction purpose is the contractors responsibility.
- In general, this work shall include construction of RCC Rectangular drain and providing, laying, jointing and testing of all straight HDPE pipes and specials / fittings HDPE pipe specification shall be accordingly to IS 14333
- Standards and Specifications for the Design and Construction of Storm Water Drainage are given in this section.
- Major objective of flood control /drainage design is to protect the area from flooding and efficient operation of systems during the design storm events. The drainage system is designed to collect storm water run-off from roadway surface and right-of-way along with runoff from plots and convey it along and through the storm water network and discharge into a receiving body without causing adverse site impacts.
- Storm water collection systems shall be designed to provide adequate surface drainage. Surface drainage is a function of transverse and longitudinal pavement roughness, inlet spacing and inlet capacity.
- Storm water drainage system shall be designed with an integrated approach considering

- relevant external catchment. Further it shall be designed considering all the relevant parameters including future development works. Further refer Tender drawings for disposal point of storm water drain. Outfall Location shall be verified on site and design to be done by EPC contractor. Outlet points shall be terminated in any natural water retaining body / any natural valley
- The discharge design facilities for storm water collection and conveyance systems include consideration of storm water quantity and quality. The general considerations in design of storm water drain shall be:
 - Drains shall be design for appropriate design frequency/return period depending on importance of development and economic considerations.
 - Drains shall be planned to take into consideration the ground levels, slope of the ground, valley, and ridges and also the land uses planned for urban development.
 - Drains shall be planned to get good longitudinal slope, considering the nature of soil and subsoil water level. Drainage of large areas can be better achieved by subdividing it into small grids to avoid a long main drain. The aim should be to get a high velocity for the dominant flow.
 - Efficiency in maintenance of drainage system is an important consideration in selecting the size, shape, and location. The specification of the drain shall also aim at preventing the possibility of ingress of other extraneous materials, debris, vegetation etc. where grating are provided on drains, they shall be so located as to attract attention of maintenance staff, easy to approach, inspect and clean it.

2. Storm Frequency/ Return Period

The components of proposed storm water drainage system shall be designed for the following design standards based on the national and international best practices:

- Once in 2 - year event flows for storm water drain / channels;
- Once in 25 - year event flows for minor culverts
- Once in 100 - year event flows for major drainage channels within the site.

3. Drain Size, Depth and Type

RCC rectangular drain with Precast RCC cover is proposed at edge of carriageway on both sides of road. Runoff from carriageway is collect at 10-15 meter interval through pipes. Minimum size of the rectangular drain shall be 300mm X 600mm with a raft and wall thickness of 125mm. However, the sizes shall be finalised in consultation with employer’s Engineer during Detailed Engineering Stage.

The inlet to the storm water system from the road side entry shall not be more than 30 m c/c duly grated with CI gratings. However, contractor can propose other type of grated inlets to storm water with approval of Employer Engineer

4. Drain Velocity, Gradient and Spacing

4.1 Maximum velocity under drain

- To ensure self-cleaning of the drain, a minimum velocity of 0.8 m/ s may be desirable. (Ref: CPHEEO)
- However, as per IRC SP 50, 0.75 m/sec is proposed, as main drain network is proposed for storm water network.
- The velocity of flow in a drain shall not be too great to cause excessive scouring or hydraulic jumps.
- However, the velocity of flow in a concrete-lined drain can be maximum of 1.5 m/s or below the critical velocity, whichever is lower.

4.2 Minimum Longitudinal Gradient

A minimum longitudinal gradient of 0.3 percent shall be provided for satisfactory drainage as per Ref: IRC: SP: 50-2013. Steeper gradient as per site requirement shall be calculated and submitted for Employer Engineer approval.

4.3 Inlet Spacing

The spacing of inlets depends on condition of road surface size and type of inlet/Catch basin* and rainfall. They shall be provided at closer intervals near junctions and valley curves; however maximum spacing shall not be more than 30 m. (Ref: IRC: SP:50-2013).

4.4 Freeboard

Freeboard refers to the depth from the top of the drain (cope/bank) to the top of the water surface in the drain at design flow condition. Sufficient freeboard shall be provided to prevent waves or fluctuation of the water surface from overflowing the cope/bank. Free board shall be as per IRC SP 50 as below:

Table No. 1: Minimum Free Board

S. No.	Drain Size	Free Board
1.	Beyond 300 mm bed width	10 cm
2.	Beyond 300 mm & upto 900 mm bed width	15 cm
3.	Beyond 900 mm & upto 1500 mm bed width	30 cm
For larger drains the free board shall be higher than 90cm depending upon the discharge		

5. Drain Design

5.1 Rational Method

Storm runoff is that portion of the precipitation which drains over the ground surface. Estimation of such runoff is dependent on the intensity and duration of rainfall, characteristics of tributary area and the time required for such flow to reach the drain. The usual case for urban drainage system, the Rational method is widely used for estimating the peak runoff rates. The formula is:

$$Q = 0.00278 CIA$$

Where:

Q = flow, m³/s

C = weighted runoff coefficient I = rainfall intensity in mm/hr A = drainage area in hectares

Assumptions

Assumptions inherent in the Rational Formula are that:

- Peak flow occurs when the entire watershed is contributing to the flow.
- Rainfall intensity is the same over the entire drainage area.
- The frequency of the computed peak flow is the same as that of the rainfall intensity,
- The coefficient of runoff is the same for all storms of all recurrence probabilities

5.2 Hydraulic Calculations

Once the quantity of runoff is determined, the stage is set for the next step which is hydraulic design of the drain. The hydraulic capacity of the drain should be checked to ensure that it is capable of handling the expected flows without affecting the traffic and the pavement. The drainage design has been done in such a way that it will cater the rainwater being collected on the road and also from the adjacent plots. In engineering practice, the storm water flow is assumed as open channel flow and the flow is uniform. The basic relationships are expressed by the Manning's Formula.

Where, Q = Peak discharge in cum/sec

n = Manning’s roughness coefficient

R = Hydraulic mean radius (A/P) in m

Theoretical Velocity of Drain (m/s) = $V = 1/n * R^{0.67} * S^{0.5}$

Drain Capacity or Discharge (Q) in m³/s = AV

A -Area of Drain

Actual Velocity =

Q/A

5.3 Manning’s Coefficient

Manning’s coefficient (n) depends upon the surface characteristics of longitudinal drain section. It varies for the different types of drain. The value of Manning’s coefficient for various types of drain is given in Table 6 of IRC SP: 42. According to this table the ‘n’ value adopted are given below:

Open Rectangle RCC drain- 0.014.

Open Trapezoidal stone pitched drain - 0.028 RCC Box drain - 0.014

5.4 Velocity of Flow

As per Section 4.9.1 of IRC SP: 50, the velocity of drain is calculated using Manning’s equation as

$$V = \frac{1.49 R^{2/3} S^{1/2}}{n}$$

Where,

V = Velocity of drain m/sec

n = Manning’s roughness coefficient

R = Hydraulic mean radius (A/P) in m

S = longitudinal gradient of drain

Minimum self-cleaning velocity and allowable velocity for different drains are considered as given in section 4.9.3 of IRC SP: 50 and Table 6 of IRC SP: 42 as presented below:

5.5 Trapezoidal stone pitched drain

Minimum self-cleaning velocity - 0.75 m/sec

Allowable Permissible Velocity - 3.0 m/sec

5.6 RCC Box & Rectangle Drain

Minimum self-cleaning velocity - 0.75 m/sec

Allowable Permissible Velocity - 6.0 m/sec

5.7 Capacity of Longitudinal Drain

Capacity of the longitudinal box and trapezoidal open drain is normally designed using Manning’s equation as given in Section 11.2 of IRC SP: 42.

$$Q = A \times V$$

Where,

Q = Capacity of drain cum/sec

A = Area of drain cross section

m² V = Velocity of drain flow

m/sec

The capacity of the drain is designed in such a way that it can carry the surface runoff generated from the given stretch.

5.8 Critical Depth

In design of roadside channels, the flow of water is assumed as subcritical flow. The slope and velocity are kept below the critical level. Critical depth of flow ‘D_c’ in open channel is that depth at which specific energy is minimum. On mild slope flow is sub-critical and normal depth of flow D_n is more than critical depth.

Normal depth D_n should be more than critical depth D_c

I.e. D_n>D_c

If D_n<D_c, the slope and channel section should be redesigned so that D_n>D_c.

As per Section 11.2 of IRC SP: 42 critical depths for different sections are given below, For Rectangular and Box Section, Critical Depth =

$$D_c = \left[\frac{Q^2}{b^2 g} \right]^{1/3}$$

Where,

Q = Capacity of drain
cum/sec
b = Base width of Channel
g = Gravitational Constant

For Trapezoidal Section, a trial and error or successive approximations approach is required when critical depth D_c is unknown with equation.

$$Q = \left[\frac{gA^3}{T} \right]^{1/2}$$

Where,

Q = Capacity of drain
cum/sec
g = Gravitational constant
A = Area of Section
T = Top width of drain

6. Other General Standards

6.1 Natural Drainage Channels

Storm water drainage arrangement is proposed along road side to cater water from the road surface and adjoining land / catchment area. Accordingly, runoff for each road collected through storm water drain at the end of pavement edge. The trunk storm water drain is proposed at the end of ROW to collect storm water from plots and carriageway runoff water which is forming a grid type arrangement based on the natural slope (gravity flow) and finally to be discharged in outfall locations. proposed in the project site. Existing streams/channels are retained as per the TOR compliance with adequate buffer.

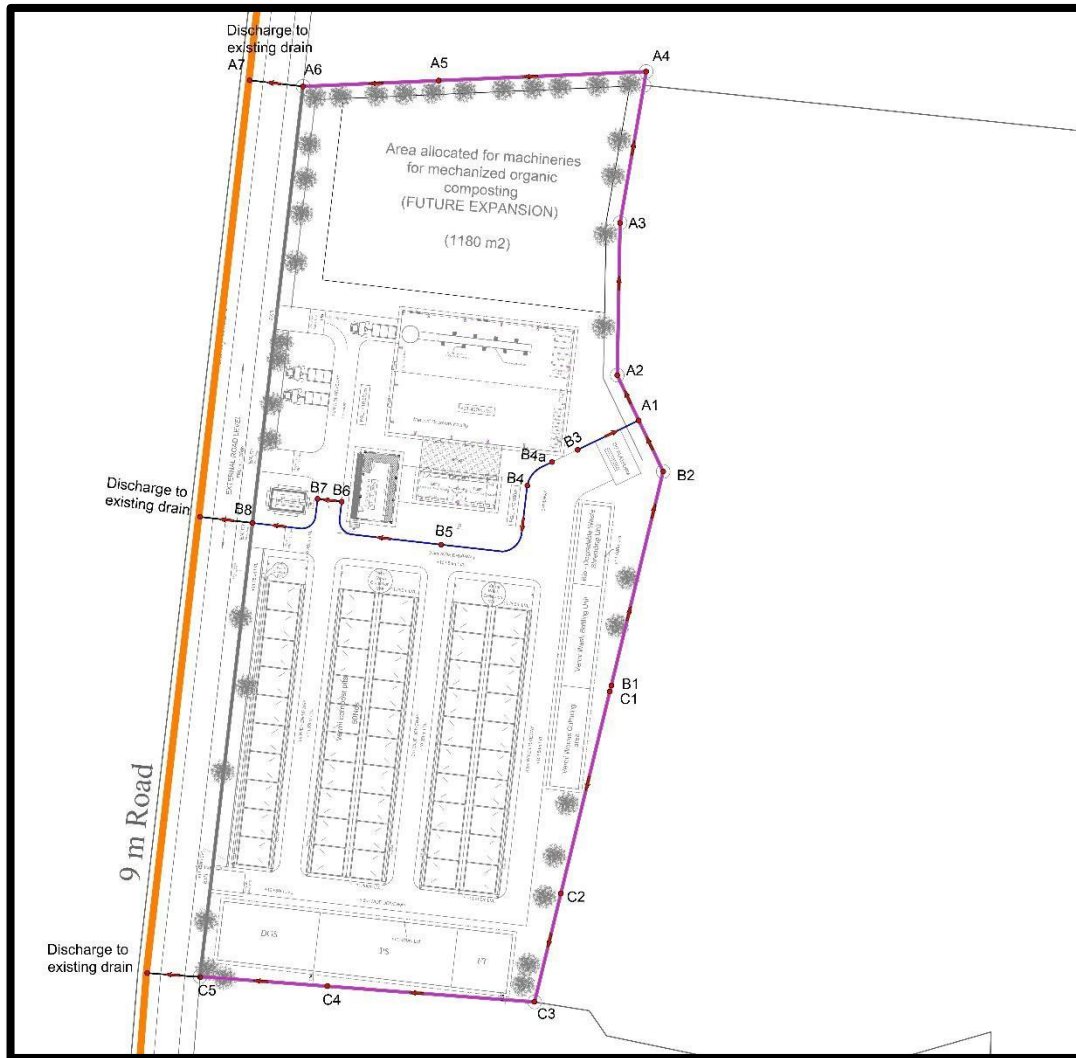


Figure 3: Drainage Network along with the discharge locations

6.2 Utility Crossing Provision

In order to avoid any kind of excavation of the constructed infrastructure in future, it is proposed to lay NP-4 category pipes of 600mm diameter at an interval of 250m on all roads and also at the junctions to allow crossing of utilities.

Two rows of pipes shall be laid in order to allow crossing of multiple utilities at every crossing location.

6.3 Rubble Stone Pitching

- Rubble stone pitching shall be carried out at outfalls locations to designed to cater flow to discharge as natural drainage.

- Stones for the works shall be of the specified varieties which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part-1).
- The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The CONTRACTOR shall supply sample stones to the Employers Engineer for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.
- For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.
- Chips and spalls shall be used wherever necessary to avoid to ensure that no hollow spaces are left in the pitching. Gravel quarry spells should be laid underneath the ground to level undulations.
- All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. However if any part of the pitching is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45 degree. Stone pitching shall be of 230mm thick of not less than 150mm x 150mm size. These shall be roughly dressed on sides and surface and the joints filled with small chips on the exposed surface unless otherwise specified.

6.4 List of Standards and Specifications

The design and Construction of storm water drainage network and the outfalls shall conform to design requirements and Construction specifications set out in the following Indian and International Standards.

- IS - 456 Code of practice for Plain & Reinforced concrete;
- IRC SP-50-1999 - Guidelines on Urban Drainage
- IS - 458 Pre-cast Concrete Pipes (with and without reinforcement);
- IRC SP-42-1994 - Guidelines on Road Drainage
- IS 4985-2000 Unplasticized PVC pipes for potable water supplies - specification;
- IS 12235- (Parts 1 to 19) Thermoplastics pipes and fittings - methods of test; and
- IS 12592 Pre-cast Concrete Manhole Covers and Frames - Specifications.
- Schedule of specifications of TGIIC and C.P.W.D. specifications (Govt. of India) 2009 with all latest amendments issued from time to time;
- CPHEEO Manual for Sewerage and Drainage -2014 - MoUD, GoI
- SP 35:1987 - Hand book of Water Supply and Drainage, Bureau of Indian Standards;
- Manual on artificial recharge of ground water by Central Groundwater Board Ministry of Water- Resources Government of India;

- Rainwater harvesting and conservation Manual by consultancy services organization CPWD, New Delhi, India;
- Code of Practice on Surface Water Drainage by Public Utilities Board, Singapore; and
- Managing Urban Runoff Drainage Handbook by Public Utilities Board, Singapore.
- IS14333:1994 High Density Polyethylene Pipes for Sewerage-Specification.
- IS 3873:1993 Laying of Cement Concrete /Stone Slab Lining on Canal.

Section - C4
Technical specification for Sewage Network

Section - C4

Technical Specification for Sewerage Network

The sewerage network will collect the sewage from plots and convey it to the Sewage Treatment Plant (STP) located within the Project area. The sewer network shall be designed in such a fashion so as to minimize any pumping requirement but in unavoidable circumstances Intermediate sewage pumping stations may be provided at places, if required.

Contractor has to design the complete sewerage network system from plot boundary to STP for the entire Project area.

The implementation limit of this network will be from the Property connection point inside the plot boundaries to the inlet points of the intermediate sewage pumping station, if any and/or directly to STP premises by gravity system to the best possible extent. The design and construction of property sewage chamber for connection is in scope of the present contract.

The contractor scope for this item includes designing of the gravity sewer system, providing, supplying, lowering, laying and jointing of sewer including excavation, backfilling, and bedding of pipes for domestic sewage collection. The scope of services includes hydraulic testing and carrying out hydraulic test for network and manholes.

The scope for manholes includes the design and construction of sewer manholes, drop manholes, and pumping manholes as per the approved type designs, using RCC M-30 (Batch Mix). The work also includes the provision and installation of SFRC manhole frames and covers over the manholes. Additionally, the inner surfaces of the HDPE/RCC manholes shall be treated with epoxy paint. The scope further includes all associated civil works such as excavation, backfilling, RCC construction, and related activities to complete the works in all respects.

1. Background

The Sewerage network system will be designed and implemented primarily for the collection of domestic sewage from Amenity areas and the same is represented in **Figure 4**.

The sewage network will collect sewage from plots and convey it to the Sewage Treatment Plant (STP) located within the project area. The sewage network will be designed as gravity system. All sewer lines will be designed for the peak flow generation with different peak factor for sewer network.

The STP is planned to be developed in modular basis and will be built under the same contract package.

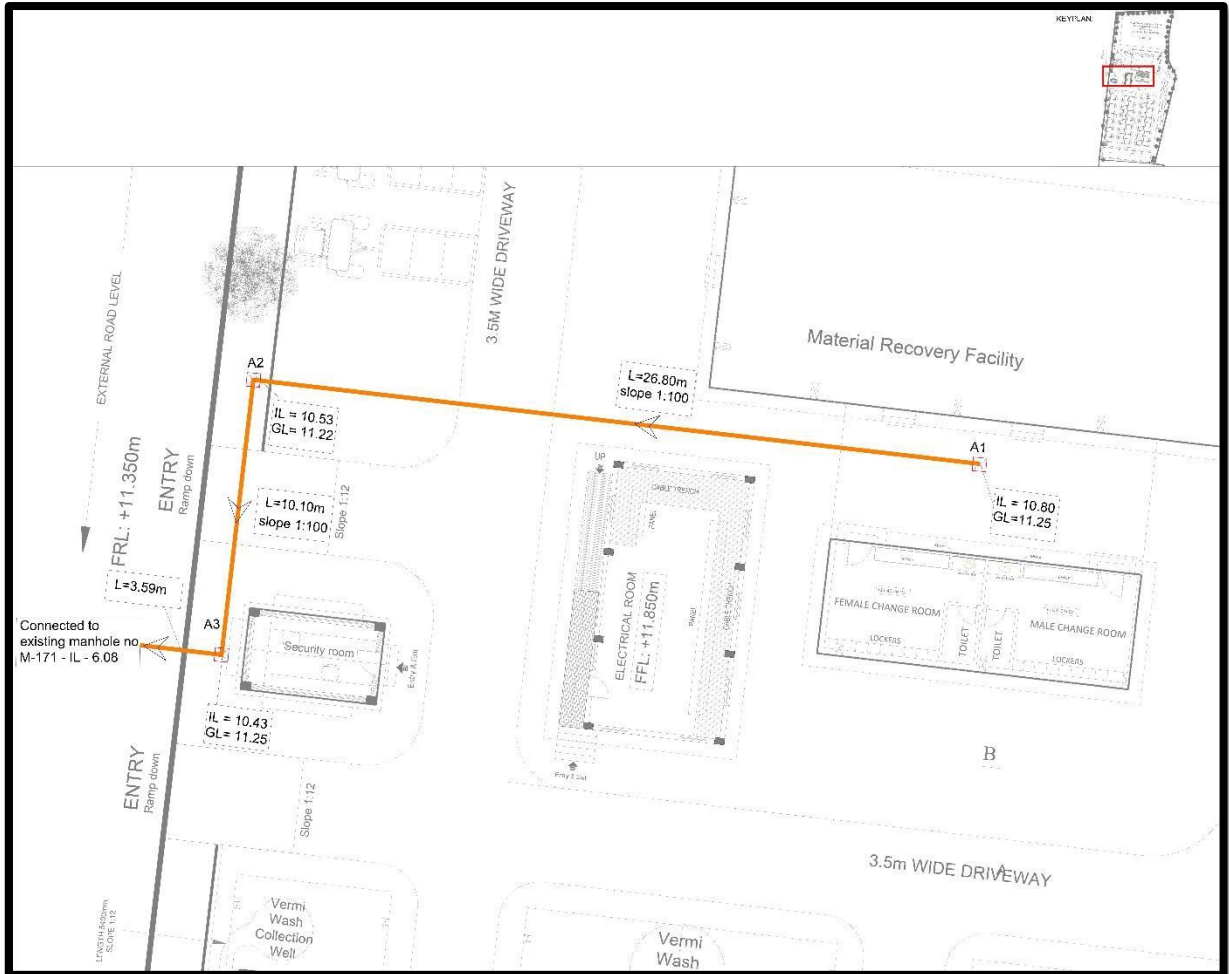


Figure 4: Sewage Network

2. Rate of Infiltration

Infiltration into the sewerage system occurs through defective sewers, manholes, etc. The rate of infiltration into sewers also depends upon the ground water table and permeability of the surrounding soil. Though strict quality control and good workmanship would ensure minimum infiltration, however as the system condition deteriorates with age, the possibility of infiltration increases.

For the said project, the hydraulic design of sewers, an allowance for infiltration for the project area will be 10% of the total sewage flow per day for project area as per Part-A of CPHEEO Manual.

3. Design Period

Sewerage projects are designed to meet the future requirement of a stipulated design period. This period, with regard to certain components of the project, depend on their useful life or the facility for carrying out extensions whenever required, so that expenditure far ahead of its utilization is avoided and capital expenditure incurred on the project does not remain idle due to underutilization of these facilities. For the purpose of designing such systems, a 30-year project period is recommended. The design period normally considered for various components is as under:

- Sewer and its appurtenances : 30 years
- Pumping Mains : 30 years
- Mechanical and Electrical Components : 15 years

4. Tentative Details of Residential/Domestic Sewerage Network

The tentative details of the Sewerage network system shall be as follows:

Table No. 1: Tentative Details of Residential/Domestic Sewerage Network

S. No.	Description	Value
1	Sewer Pipe Diameter	As per design but not less than 200 mm dia OD DWC
2	Sewer Pipe Material along the Road below	
3	250 mm dia OD DWC and above 300 mm dia OD HDPE	SN8 and PE-80
4	Sewer Pipe Material Crossing the Road	RCC NP4

5. Hydraulics of Sewage Network

The Manning’s Formula for Gravity Flow will be used to design the sewerage network; The Manning’s Formula for circular conduits is expressed as under.

$$V = [(1/n)] \times [R^{2/3} S^{1/2}]$$

For Circular Conduits,

$$V = (1/n) (3.968 \times 10^{-3}) D^{2/3} S^{1/2}$$

And,

$$Q = (1/n) (3.118 \times 10^{-6}) D^{2.67} S^{1/2}$$

Where,

Q: Discharge in l/s

S: Slope of hydraulic gradient

D: Internal diameter of pipe line in mm R: Hydraulic radius in

m V: Velocity in m/s

n: Manning’s coefficient of roughness

6. Co-efficient of Roughness

The coefficient of roughness is based on type of sewer material proposed for the sewage conveyance. The coefficient of roughness “n” for DWC-PE and HDPE pipe as indicated in CPHEEO sewerage manual, 2013 shall be 0.010. Similarly, the coefficient of roughness “n” for RCC pipes shall be considered as 0.011 as indicated in CPHEEO sewerage manual, 2013

7. Design Capacity of Sewer

Sewers shall be designed to carry estimated peak flows generated in the design year and would be designed 80% full at ultimate peak flow. This is to ensure proper ventilation and prevent septicity of sewage. No sewer pipe shall run at any time more than 80% full

8. Minimum and Maximum Velocity in Sewer

Considering typical values of particle size and specific gravity, minimum partial flow velocities is considered at present peak flows and at design peak flows. The maximum velocity shall be considered in order to prevent scouring.

A velocity of 0.6 m/s would be required to transport sand particles of 0.09 mm size with a specific gravity of 2.65. Thus, the sewers are designed on the assumption that although silting might occur at minimum flow, it would be flushed out during peak flows. Erosion of sewers is caused by sand and other gritty material in the sewer and also by excessive velocity. Velocity in a sewer is recommended not to exceed 3 m/s and same is in table below.

Table No. 2: Maximum and Minimum Velocity in Sewer

S. No.	Criteria	Velocity (m/s)
1	Minimum velocity at initial peak flow	0.6
2	Minimum velocity at ultimate peak flow	0.8
3	Maximum velocity	3.0

9. Slope in Sewerage System

Minimum slopes that will be considered for design of collection network are as in table below:

Table No. 3: Minimum Slopes

S. No.	Sewer Size (Mm)	Minimum Slope (1 In)
1	200	250
2	250	360
3	300	450
4	375	670
5	450	830
6	>=525	1000

10. Bedding

For RCC (NP3 class) pipes bedding shall be designed taking into account the required external loading conditions, geotechnical requirements such as sub soil and bearing capacity of soil encountered in respective sewer line, type, class and material of pipe used for the laying purposes as per CPHEEO manual and IS 783.

Laying and lowing of polyethylene pipe and bedding shall be as per IS 7634 (Part 2) : 2012. Be noted all DWC and HDPE pipes shall be provided with minimum 6 inches of uniform river natural graded sand bedding free from any foreign /sharp etc. material which may damage the outer surface of the HDPE pipe. The HDPE bedding specification shall be referred from Annexure B IV above.

Contractor also need to check and design anchoring arrangement to mitigate the uplift of pipes due to high water table in the project area.

The type of bedding to be used depends on the bedding factor as per Part A of CPHEEO Manual, 2013 & mentioned in subsequent table:

Table No. 4: Type of Bedding for RCC pipes

Bedding Factor	Type of Bedding	Type of Bedding
Up to 1.9	Granular Bedding with Carefully Compacted Backfill (GRB)	B
For more than 1.9 and up to 2.8	Concrete Cradle Bedding with Carefully Compacted Backfill (PCCB)	Ab
For more than 2.8 and up to 3.4	Reinforced concrete cradle with percentage of reinforcement `p` equal to 0.4% with carefully compacted backfill (RCCB)	Ac
For more than 3.4 and up to 4.8	Reinforced Concrete Encasement with percentage of reinforcement `p` equal to 1% (RCE)	A

10.1 General

10.2 Ambient conditions

All items of material and equipment shall be in every respect suitable for storage, installation, use and operation in the conditions of temperature and humidity appertaining in Sri Lanka.

The annual average temperature is 35°C while the relative humidity varies generally from 70% during the day to 90% at night. The pH of wastewater to be conveyed ranges from 5.5 - 9.0

The climate is hot and the sunlight is intense. The temperature of wastewater to be conveyed in the pipelines will be below 40°C.

10.3 Materials

All materials shall fulfill the requirement mention in ISO 13272:2011. The general characteristics, geometrical characteristics and mechanical characteristics of IC chambers and manholes shall conform the ISO 13272:2011.

All fittings shall be of black colour and shall comply with the ISO 13272:2011. This specification covers the material, fabrication, joining methods and general installation practice for high density polyethylene (HDPE) manholes/IC chambers. Manholes shall be fabricated by an approved manufacturer, holding an ISO 9001 quality system certificate.

Modular polyethylene manhole, made with 100% new material, density 930 kg/m³ (ISO 1183), supplied by a company certified UNI EN ISO 9001/2008. For installation heights up to 5.0 m, the

manhole must guarantee resistance to static pressure at the same pressure of water in full load conditions; for greater heights sealing must be guaranteed at the maximum pressure of 50 kPa.

The bottom thickness of the manholes will meet the required limits for stress and deflection as required in ASTM F1759. Bottom or top plates may have additional support ribs, gussets or bracing as methods to reduce stress and deflection to acceptable levels.

The inlets and outlets shall be extrusion welded on the inside and outside of the structure, where access is available. Gussets shall be attached at 90 degrees, 180 degrees, 270 degrees, and 360 degrees around the inlets and outlets unless impractical.

The ladders in the manholes, if specified, shall conform to OSHA requirements. Ladders will be of fiberglass material with stainless steel hardware, and will be mechanically affixed to HDPE braces welded to the manhole body.

Except for when impractical, lifting eyes will be integral to the manhole body and located on shop drawings.

Manhole structures and outlets should not be used as anchor points when axial loads or movement is anticipated. Where large changes in temperature are expected, restraints shall be designed to isolate the structure and prevent strain at the inlets or outlets. These restraints shall be cast into a concrete block or collar around the pipe. Anti-flotation and/or anti-settling measures such as anchor lugs, rings, or collars, if required, shall be provided as an integral part of the manhole by the fabricator/manufacturer of the manhole.

The top of the structures and/ or man way of the manhole shall be built to meet the requirements of contract drawings. If testing is required, flanged tops or man ways may be required, and additional bolts may be needed to withstand test conditions.

Reinforced concrete pads at surface level spanning the HDPE manhole footprint will be required when HDPE manholes are used in traffic areas. The pad shall transfer live loads to the surrounding fill and remove direct to the manhole riser or man way.

10.4 Inspection and Testing

10.4.1 Tests

Following tests shall be performed on the samples taken from polyethylene inspection chamber body.

10.4.2 Density

Density of the sample taken from the inspection chamber shall be minimum 930kg/m³

10.4.3 Jointing Print Tightness

No leakage shall be observed when 0.5 bar water pressure is applied on inlet outlet joints of the inspection chamber for 15 minutes.

10.4.4 Impact Test

No breakage, cracking or deformation which may impair the function of the base shall occur when a 1 kilogram with r=50 mm radius is dropped on the inspection chamber base member at the angle of 23 + 2 o from 2.5m height.

10.4.5 Vertical Load Test

Flexion shall not be greater than 10 mm when 20 kN vertical load is applied on the ladder of the inspection chamber body.

10.4.6 Tightness Test

Tightness test shall be performed by covering inspection chamber inlet and outlets with suitable caps and filling water up to the top level of the chamber for checking any leaks at the joints.

10.4.7 Taking Sample

Inspection and tests of the products randomly selected from the batch presented for the acceptance of the procurement commission shall be performed at the laboratory of the manufacturer company. Laboratory test devices shall be of sufficient capacity to perform the tests and have calibration certificates.

10.5 Manufacturing Inspection

Tender authority may perform manufacturing inspection any time at the production facilities of the awarded company.

The Contractor shall supply, furnish and prepare the necessary test pieces and samples of all materials and supply the labour facilities and appliances for such testing as may be required to be carried out in

his premises according to this specification. If there are no facilities at his manufacturer’s factory for

making the prescribed tests the Contractor shall bear the cost of carrying out the tests elsewhere.

The Engineer, his representative or nominated inspection authority shall have full access to all parts of the manufacturing plant that are concerned with the testing, furnishing and preparation of materials for the performance and testing of work under this Specification.

The Contractor shall furnish the Engineer with reasonable facilities and space at no cost to the employer for the inspection, testing and obtaining of such information, as he desires regarding the character of material in use and the progress and manner of the work.

The contractor shall provide results of tests conducted, in accordance with the standards given in the ISO 13272:2011.

10.6 Marking of Fittings and Specials

All markings described below shall be legible and indelible unless otherwise specified All products shall be marked as specified in clause 11.1 & 11.2 of BSEN 12201:02:2011+A1:2013, ISO 8772:2006, ISO 21138-1:2007, ISO 13272:2011 and as specified in the Table 1 hereof. The manufacturer’s Name, Identification Mark and the PN rating shall be marked legibly and indelibly on the pipes together with the information shown below.

Specifications require at least the following information to be included. Colours of markings shall be visible at a glance.

- Manufacturer's identification or logo,
- Standard number (Specification number)
- The designation of the material
- The dimensions (Nominal outside diameter, nominal wall thickness - dn x en)
- The Production Period (date and code)
- Nominal Pressure (PN)
- SDR Series

In addition to the information given, following information to be marked on the fitting.

- In case of a bending manhole, bending angle.
- Pressure rating at relevant temperature

All fittings must be packed in such a way to allow instant use on site without additional cleaning. The Contractor shall label and clearly mark all crates and boxes legibly and indelibly as specified in the notes forming a part of this Specification.

All fittings shall be marked with the corresponding item number in the Bills of Quantities or any other number specified by the Engineer. An individual data carrier card in compliance with ISO 7810 and ISO 7811 containing a magnetic strip and appropriate bar codes as well as manual setting information for data transfer purposes must be supplied with each item as appropriately.

10.7 Protection during Delivery

The Contractor shall provide methodology of protection of HDPE manholes, to the approval of the Engineer and obtain written approval prior to the manhole and fittings leaving the place of manufacture and shall maintain such protection until the items reach their destination in order to guard effectively against damage during handling transit and storage and ingress of foreign matter inside the manhole & fittings.

All fittings shall be securely packed in crates and boxes to prevent damage during delivery. The cost of packing shall be deemed to be included in the Contract rates and crates will not be returned.

The manufacturer shall provide necessary details to the shipping line on precautions to be taken during loading/unloading handling & transport of the manhole & fittings and other components, in the sea, manufacturer shall provide to the purchaser a set of recommendations of manufacturer for handling, loading, unloading, transporting and storing of polyethylene manholes and fittings.

manholes and fittings likely to be stored outside should be covered by a tarpaulin or black polyethylene sheeting to prevent ultra violet degradation from sunlight.

10.8 Storing, Handling and Hauling of Products, Fittings and Specials

All materials shall be stored in an approved location and in such a manner as to preserve their quality and condition as recommended by the manufacturer.

All materials should be carefully inspected at the time of delivery and any defective material set aside before accepting the delivery into stores. Any such defects should be notified to the manufacturer immediately.

Materials and components shall be handled in such a manner as to avoid any damage or contamination and in accordance with all applicable recommendations of the manufacturer's recommendations.

During loading, transportation, and unloading, every precaution should be taken to prevent damage to the products. HDPE manholes shall be stored on clean, level, and dry ground to prevent undue scratching or gouging. The handling of HDPE manholes shall be done in such a manner that there is no damage. Nylon slings are often used. PPI Handbook of Polyethylene Pipe (2nd Edition), Chapter 2 offers guidance on handling of HDPE pipe/fittings and is appropriate to consider for HDPE manholes and structures.

10.9 General Principles

Polyethylene is a tough resilient material which is relatively light and easy to handle although it is prone to damage through scouring by sharp objects. Manhole and fittings showing obvious defects or excessive scoring should be withdrawn, clearly identified as unsuitable and, where appropriate, returned to the source of supply.

The general properties of polyethylene are unaffected by low ambient temperatures but, having very smooth surfaces, the pipes and fittings become slippery in wet or frosty weather. Particular attention should be given to effective securing and storage under such conditions. Extra care should also be taken when handling large diameter prefabricated fittings during very cold weather.

The packaging of pipes by the manufacturer is normally consistent with the requirement to prevent damage and to comply with safety considerations. Fittings are normally supplied in separate bags or cartons together with any associated small items, such as bolts and gaskets.

As far as practicable the protective packaging (pallets, strapping, bags etc.) should be kept intact until the material is required for use. The temporary capping or plugging of pipe ends is recommended.

Manhole and fittings likely to be stored outside should be covered by a tarpaulin or black polyethylene sheeting to prevent ultra violet degradation from sunlight. Electro fusion fittings should be stored under cover and in their protective packaging.

The pipe ends must be protected from the ingress of dirt/water etc. This protection should be carefully disposed of following use.

10.10 Transport and Delivery

For transporting bulk loads, vehicles should be provided with a clean flat bed, free from nails or other projections, which may cause damage. If high sided lorries are used, special care must be taken to prevent slippage or excessive bowing and extra protection given at all sharp edges.

Care should be taken to avoid positioning products and fittings near or adjacent to exhaust systems or other heat sources and to avoid possible contamination from materials.

Metal chains or slings should not be brought into direct contact with the material. Webbed slings of polypropylene or nylon are recommended.

10.11 Storage at Depot

Materials of different polymer manufacture should be kept separately and clearly identified.

All polyethylene products should preferably be stored under cover and protected from direct sunlight until required for use.

Polyethylene fittings should be stored under cover, preferably on racking and in the manufacturer's protective wrapping or cartons which should be kept intact until the fitting is required for use.

At all times products should be stored away from exhaust outlets and all other high temperature sources. Care should also be taken to avoid contact with lubricating or hydraulic oils, gasoline, solvents and other aggressive chemicals.

All special tools and equipment associated with the jointing of HDPE pipes and fittings should be stored separately and securely until they are required for use. The heating faces of fusion tools should be kept in a position where the surfaces are protected from scratching or other damage. Tools incorporating cutting edges should likewise be protected from damage that could cause poor joint preparation.

10.12 Packing of Bolts, Joint Rings and Gaskets

Bolts of the same length and size (and their accompanying nuts and washers) shall be packed together in boxes not exceeding 100 kg. gross weight.

Joint rings and gaskets shall be packed in boxes and separate packages shall be provided for each size and description of ring or gasket.

Each box and package therein shall be clearly labeled stating the number, size and description of the contents.

10.13 Manufacturer's Certificate

The Contractor shall supply to the Engineer a certificate stating that each item supplied has been subjected to the tests laid down herein and conforms in all respects to this Specification or such other Specification which has been submitted to and approved by the Engineer.

10.14 Quality and Workmanship

All products, fittings and accessories shall be manufactured in compliance with the ISO 9001 : 2015 quality management system standards for the manufacturing factory. In addition to product quality control tests the manufacturers also must perform and satisfy long term type tests to demonstrate long term performance of product as detailed in relevant standards. Quality Management System Certification should be from an organization which is a member of International Accreditation Forum (IAF) having the scope of the accreditation for HDPE products to issue such certification and the manufacturer shall have this certification valid during the supply and delivery of the materials. Document evidence regarding accreditation together with the scope of certification should be provided.

10.15 Quality Assurance (Q/A) at Manufacturer's Works

The manhole fabricator shall submit certification that the HDPE material meets the specifications. The fabricator of the manholes shall submit shop drawings for approval as part of the submittal data showing the position of the inlets, outlets and the overall dimensions along with any other special features such as man ways, ladders, internal piping, valves, etc.

The fabricator shall submit calculations for review by the project engineer, or owner, indicating that the vertically installed manholes have been analyzed using the guidance of ASTM F1759, “Design of High Density Polyethylene (HDPE) Manholes for Subsurface Applications”. The data shall contain information related to the following areas: Ring Compressive Strain, Combined Ring Compressive and Ring Bending Strain, Ring Buckling, Axial Stain, Axial Buckling, and the thickness of the bottom based on depth and groundwater. Thickness should be based on acceptable stress and deflection limits. Data and calculations are supplied for informational purposes and will be part of the submittal package that are reviewed and approved by the project engineer. The project engineer will review any data/calculations submitted for accuracy, including any site specific variables, and confirm the structure is suitable for the intended service including installation and operating conditions.

When requested, the fabricator shall submit the ISO 9001:2008 Certificate of Registration for the manufacturing facility and/or the written quality assurance program used during fabrication of the manholes, including documentation that personnel responsible for fabrication have been trained and qualified. The fabricator may be required to submit their QA/QC program for fabricating thermoplastic structures prior to beginning work and the qualifications of the fabrication technician upon beginning of work on the structure.

When required, the manholes and pipe shall be tested in accordance with the specification. A written certification shall be sent as an addendum to original submittal package, certifying the manholes are leak free. The test results shall become part of the submittals. When requested, an identification plate indicating, the job number, testing data, and when built and by whom, shall be attached to the manhole.

Engineer of record will review submittal information and provide written approval or rejection of submittal data, shop drawings, and verify proposed manhole will meet installation and service requirements.

ENGINEER reserves the right to require changes to the proposed product so as to meet intended installation and service conditions.

In the event such changes impact price or timing, the purchase contract will be adjusted to reflect those changes.

The manufacturer shall operate a quality assurance scheme complying with ISO 9001: 2015 and on award of order shall submit a copy of his quality assurance guidelines, as issued to his production works sections. Material Quality Certificate shall be from one of the **Independent Testing Agencies**.

11. Manhole size, depth and type

The channels in manholes at junctions and bends shall be smooth with gradual transitions to avoid turbulence and deposition of solids. Manholes are usually constructed directly over the line of the sewer. They are circular, rectangular or square in shape. Manholes should be of such size that will allow necessary cleaning and inspection. As per IS-4111: 1986 “Circular type manholes are much stronger than rectangular and arch type manholes and thus these are favoured over rectangular as well as arch type manholes”. Therefore circular manholes shall be proposed on all sewer lines for all depths starting from 0.9m. Diameter of manhole varies with change in depth of manhole. Poly elastomeric MS flats footrest shall be suggested for entry into manholes.

The scope for this item includes providing and constructing of HDPE/precast RCC circular manhole, Drop manholes and flushing manhole in accordance with CPHEEO and IS 4111 part 1 and 2. Contractor need to minimize the number of drop manholes however if required drop manholes shall be provided in line with recommendation of CPHEEO. Flushing manholes if required shall be connected with recycled network system with all necessary arrangement. Contractor scope also includes provision of flushing water in case of non-availability on recycled water during initial years

Table No. 5: Manhole Sizing

Range of Depths, m	Maximum Opening Upto	Manhole Size
above 0.90 m and up to 1.65 m	500 mm	900 mm dia.
above 1.65 m and up to 2.30 m	600 mm	1200 mm dia.
above 2.30 m and up to 9.0 m	900 mm	1500 mm dia.
above 9.0 m and up to 14.0 m	1200 mm	1800 mm dia.

12. Spacing of Manholes

- As per IS - 4111: 1986, For inspection, cleaning and testing of sewers, manholes should be built at every change of alignment, gradient or diameter, at the head of all sewers and branches and at every junction. This shall be kept in mind while designing the system.
- The Sewer shall be in a straight line between two manholes.
- Maximum distance between service manholes should not be more than 30 m.
- Manhole spacing is limited to 30m for sewers having service connections. For Outfall sewers with no service connections the spacing can be increased, with prior approval of Employer’s Engineer.

Table No. 6: Manhole Spacing

Sewer Size	Maximum Manhole Spacing
Up to 600mm	up to 60 m
600mm to 900mm	90 m
900mm to 1200mm	120 m
1200mm to 1500mm	150 m

13. Cover Frame

- As per IS-4111: 1986, the size of manhole covers should be such that there should be clear opening of not less than 560 mm diameter for manholes exceeding 0.9 m depth.

- Manhole cover and frame will be SFRC (Steel Fiber Reinforced Concrete) conforming to the IS 12592.

Table No. 7: Manhole Cover Details as per IS 12592

Manhole Type	Load withstanding capacity	Suitable Locations
L.D (Light Duty)	2.50 MT	Footpaths, Two wheelers
M.D (Medium Duty)	10.00 MT	Light four wheelers
H.D (Heavy Duty)	20.00 MT	Heavy vehicles
E.H.D (Extra Heavy Duty)	35.00 MT	Heavy traffic roads

14. List of applicable Codes and Standards

Detailed specification for the water supply system has been presented in section 12.7. Key standards have been listed below.

- CPHEEO Manual for Sewerage and Sewage Treatment, 2013
- SP 7 (2005): National Building Code of India, 2005
- Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014
- SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987

Section - C5
Technical Specification for General Civil and Structural Specifications

Section - C5

Technical specification for General Civil and Structural Specifications

1. General and Preliminary Specification of Materials

- a. All materials to be used shall conform to the relevant specifications as per the latest edition
- b. of Indian Standard, unless otherwise stated in the detailed specifications of items of work.
- c. All materials to be used shall be of approved quality & make as per list of approved make attached with the tender documents.
- d. Wherever a reference to any Indian Standard appears in the specification, it shall be taken to mean as a reference to the latest version of the standard.
- e. The following specifications, standards, and codes are made a part of this specification\Tender document.

Indian Standards: specification for building materials, specification for equipment, method of test, method of measurement of building works, code of practice for construction, safety code for demolition of building, safety code for scaffolds etc. published by the Bureau of Indian Standards

- a. The contractor shall invariably carry out Materials & work Tests as specified in the tender document (**B2- Form**) and IS code. However, if the additional tests are required as per the opinion of the Engineer-in-charge, the same shall also have to be carried out. All such tests shall be got carried out in Government or as approved laboratories and cost thereof shall be entirely borne by the contractor. No collection of materials shall be made before it is got approved from the Engineer-in-charge.
- b. Collection of approved materials shall be done at site of work in a systematic manner. Materials shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.
- c. Materials, if rejected by the Engineer-in-charge, shall be immediately removed from the site of work. If they are not removed within twenty four hours of receiving such intimation, Engineer-in-charge shall get the same removed at contractor’s cost.
- d. The Engineer-in-charge shall dispose off such materials in a manner as he chooses and the contractor shall not entitle to any compensation for the cost of such materials.
- e. Approval to the samples of various materials given by the Engineer-in-charge will not absolve the contractor from the responsibility of replacing the defective material brought onsite of materials used in the work found defective at a later date. The contractor shall have no claim to any payment or compensation whatsoever on account of any such materials being rejected by the Engineer-in-charge.
- f. The contractor shall be responsible for observing the law, rules and regulations imposed under the “Minor Minerals Act “and such officer laws and rules prescribed by

Government from time to time.

M-1 Water

- a. Water shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil and injurious alkalies, salts, organic matter and other deleterious material which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C: Container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-1978.
- b. If required by Engineer-in-charge it shall be tested by comparison with distilled water.
- c. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in I.S. 269-1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 percent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.
- d. Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements which significantly affect the hydration reaction or otherwise interfere with the hardening of concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.
- e. Hard and bitter water shall not be used for curing.
- f. Potable water will be generally found suitable for curing mortar or concrete.

M-2 Lime

- a. Lime shall be hydraulic lime as per I.S. 712-1973. Necessary test shall be carried out as per I.S. 6,932 (Parts I to X) 1973.
- b. The following field tests for limes are to be carried out:
- c. A very rough idea can be formed about the type of lime by its visual examination i.e. fat lime bears pure white colour, lime in form of porous lumps of dirty white colour indicates quick lime, and solid lumps are the unburnt limestone.
- d. Acid tests for determining the carbonate content in lime. Excessive amount of impurities and rough determination of class of lime.
- e. Storage shall comply with I.S. 712-1973. The slaked lime, if stored, shall be kept in a weatherproof and damp-proof shed with impervious-floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it. All lime that has been damaged in any way shall be rejected and all rejected materials shall be removed from site of work.
- f. Field testing shall be done according to I.S. 1624- 1974 to show the acceptability of materials.

M-3 Cement

Cement shall be sulphate resisting cement (SRC) as per I.S. 12330 - 1988 or latest revision.

M-4 White Cement

The white cement shall conform to I.S.,80412”-E 1978.

M-5 Coloured Cement

- a. Coloured cement shall be with white or gray Portland cement as specified in the item of the work.
- b. The pigments used for coloured cement shall be of approved quality-and shall not exceed 10% of cement used in the Mix, the mixture of pigment shall be properly grounded to have a uniform colour and shade. The pigments shall have such properties to provide-for durability under exposure to sunlight and weather.
- c. The pigment shall have the property such that it is neither affected by the cement nor detrimental to it.

M-6 Sand

Sand shall be natural sand, clean, well graded, hard strong durable and gritty particle free from injurious-amounts of dust clay, kankar nodules, soft or flaky particles Shale, alkali, salts-organic matter, loam, mica or other deleterious substance and shall be got approved, from the Engineer-in-charge. The sand shall not contain more than 8 percent of silt as determined by field test. If necessary, the sand shall be washed to make it clean.

Coarse Sand:

The fineness, modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.00. The sieve analysis of coarse shall be as under:

Table 8 I.S Sieve Sizes

I.S. sieve	Percentage by weight passing through
4.75 mm	100
2.36 mm	90-100
1.18 mm	70-100
600 Micron	30-100
300 Micron	5-70
150 Micron	0-50

Fine Sand

The fineness modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under:

Table 9 Sieve analysis of Fine sand

I.S Sieve Designation	Percentage by weight through	I.S. Sieve Designation	Percentage by Weight Passing
4.75mm.	100	600 Micron	40-85
2.36mm	100	300 Micron	5-50
1.18mm	70-100	150 Micron	0-10

M-7 Stone Dust

- a. This shall be obtained from crushing hard black trap or equivalent. It shall not contain more than 8% of silt as, determined by field test with measuring cylinder. The method of determining silt contents by field test is given as under:
- b. A sample of stone dust to be tested shall be placed without drying in 200mm. measuring cylinder. The quantity of the sample shall be such that it fills the cylinder upto 100 mm. mark. The clean water shall be added upto 150 mm. mark. The mixture shall be stirred vigorously and the content allowed to settle for 3 hours.
- c. The height of silt visible as settled layer above the stone dust shall be expressed as percentage of the height of the stone dust below. The stone dust containing more than 8% silt shall be washed so as to bring the silt content within the allowable limit.
- d. The fineness modulus of stone dust shall not be less than 1.80.

M-8 Stone Grit

- Grit shall consist of crushed or broken stone and be hard strong, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent adhesion of mortar Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless special stone of particular quarries is mentioned, grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer-in-charge. The grit shall have no deleterious reaction with cement.

- The crushing strength of grit will be such as to allow the concrete in which it is used to built up the specified strength of concrete.
- The necessary tests for grit shall be carried out as per the requirements of I.S. 2386 (Parts I to VII) 1963, as per instructions of the Engineer-in-charge. The necessity of test will be decided by the Engineer-in-charge.

M-9 Cinder:

- Cinder is well burnt furnace residue which has been fused or sintered into lumps of varying sizes.
- Cinder aggregates shall be well burnt furnace residue obtained from furnace using coal fuel only. It shall be sound clean free from clay, dirt, ash or other deleterious matter.
- The average grading for cinder aggregate shall be as mentioned below:

M-10 Lime Mortar

- Lime shall conform to Specification M-2. Water shall conform to specification M-1. Sand shall conform to specification M-6.

Proportion of Mix:

- Mortar shall consist of such proportions of slaked lime and sand as may be specified in the item. The slaked lime and sand be measured by volume.

Preparation of mortar:

- Lime mortar shall be prepared by wet process as per I.S. 1625-1971. Power driven mill shall be used for preparation of lime mortar. The slaked lime shall be placed in the mill in an even layer and ground for the 180 revolutions with a sufficient water. Water shall be added as required during grinding (care being taken not to add more water) that will bring the mixed material to a consistency of stiff paste. Thoroughly wetted sand shall then be added evenly and the mixture ground for another 180 revolutions.

Storage:

- Mortar shall always be kept damp, protected from sun and rain till used up, covering it by tarpaulin or open sheds.

Use:

- All mortar shall be used as soon as possible after grinding. It should be used off the day on which it is prepared. But in no case mortar made earlier than 36 hours shall be permitted for use.

M-11 Cement mortar

- Water shall conform to specification M-1. Cement shall conform to specification M-3. Sand shall conform to M-6.

Proportion of Mix:

- Cement and sand shall be mixed to specified proportion; sand being measured by measuring boxes. The proportion of cement will be by volume on the basis of 50 Kg. /Bag of cement being equal to 0.0342 Cum. The mortar may be hand mixed or machine mixed as directed.

Preparation of mortar:

- In hand mixed mortar cement and sand in the specified proportions shall be thoroughly mixed dry on a clean Impervious platform by turning over at least 6 times or more till a homogenous mixture of uniform colour is obtained. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar or mortar shall flow out. While mixing, the water shall be gradually added and thoroughly-mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The water cement ratio shall be adopted as directed.
- The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes.

M-12 Stone Coarse Aggregate For Nominal Mix Concrete

- Coarse aggregate shall be machine crushed stone of black trap or equivalent and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.
 - The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain-cement concrete and ordinary

reinforced cement concrete shall generally be as per the table given below. “However, in case of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6 mm. less than the cover, whichever is smaller.

Table 10 Percentage passing for single sized aggregates of Nominal size.

I.S. Sieve Designation	Percent passing for single sized aggregates of nominal size.			I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominal size.		
	40mm	20mm	16mm		40mm	20mm	16mm
80mm.	—	—	—	12.5mm.	—	—	—
63mm.	100	—	—	10mm.	0.5	0.02	0.30
40mm.	85-100	100	—	4.75mm.	—	0.5	0.5
20mm.	0-20	85-100	100	2.35mm	—	—	—
16mm.	—	—	85-100				

- Note: This percentage may be varied somewhat by Engineer- in-charge when considered necessary for obtaining better density and strength of concrete.
- The grading test shall be taken in the beginning and at the change of source of materials. The necessary test indicated in I.S. 383-1970 and I.S, 456-1978 shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates, If the aggregates are covered with dust they shall be washed with water to make them clean.

M-13 Black trap or equivalent hard stone coarse.

- Aggregate For Design Mix Concrete: Coarse aggregate shall be of machine crushed stone of black trap or equivalent hard stone and be hard strong dense, durable clean and free from skin and coating likely to prevent proper adhesion of mortar.
- The aggregates shall generally be cubical in shape. Unless special stones of particular quarries are mentioned, aggregate shall be machine crushed from the best, black trap or equivalent hard stones as approved. Aggregate shall have no deleterious reaction with cement.
- The necessary tests indicated in I.S. 383-1970 and I.S. 456-1978 shall have to be carried out to ensure the acceptability of the material.
- If aggregate is covered with dust, it shall be washed with water to make it clean.

M-14 Brick Bats Aggregate

- Brick bat aggregate shall be broken from well burnt or slightly over burnt and dense brick. It shall be homogeneous in texture roughly cubical in shape, clean and free from dirt of any other foreign material. The brick bats shall be of 40 mm. to 50 mm. size unless otherwise specified in the item. The under burnt off over burnt brick bats shall not be allowed.
- The brick bats shall be measured by volume by suitable boxes or as directed.

M-15 Brick

- The bricks shall be hand or machine moulded and made from suitable soils and klin-burnt. They shall be free Iron crack and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour.
- The bricks shall be moulded with a frog of 100mm. x 40 mm. and 10mm. to 20 mm. deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 600 mm.
- The size of modular bricks shall be 190 mm. x 90 mm. x 90 mm. The size of the conventional bricks shall be as under:
- (9" x 4 3/8" X 2 3/4") 225 x 110 x 75 mm.
- Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.
- ☐ Length + 1/8" (3.0 mm) Width: ±1/16" (1.50 mm) Height: ± 1/6" (1.50 mm)
- The crushing strength of the bricks shall not be less than 35 Kg./Sq. Cm. The average water absorption shall not be more than 20 percent by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per I.S. 3495 (Part-I to IV) 1976.

M-16 Stone

- The stone shall be of the specified variety such as Granite/Trap Stone/Quartzite or any other type of good hard stones.
- The stones shall be obtained only from the approved quarry and shall be hard, sound, durable and free from defects like cavities, cracks, sand holes, flaws, injurious veins, patches of loose or soft materials etc. and weathered portions and other structural defects or imperfections tending to affect their soundness and strength. The stone with round surface shall not be used. The percentage of water absorption shall not be more than 5% of dry weight, when tested in accordance, with I.S. 1134- 1974. The minimum crushing strength of the stone shall be 200 Kg./Sq.Cm. unless otherwise specified.
- The samples of the stone to be used shall be got approved before the work is started.
- The Khanki facing stone shall be dressed by chisel as specified in the item for khanki facing

in required shape and size. The face of stone shall be so dressed that the bushing on the exposed face shall not project by more than 40 mm. from the general wall surface and on face to be plastered it shall not project by more than 19 mm. nor shall it have depressions more than 10 mm. from the average wall surface.

M-17 Laterite Stone

- Laterite stone shall be obtained from the approved quarry. It shall be compacted in texture, sound, durable and free from soft patches. It shall have a minimum crushing strength of 100 Kg./Sq.Cm. in its dry condition. It shall not absorb water more than 20% of its own weight, when immersed for 24 hours in water. After quarrying the stone shall be allowed to weather for some time before using in work.
- The stone shall be dressed into regular rectangular blocks so that all faces are free from waviness and unevenness, edges true and square.
- Those types of stone in which white clay occur, should not be used. Special corner stones shall be provided where so directed.

M-18 Mild Steel Bars

- Mild steel bars reinforcement for R.C.C. work shall conform to I.S, 432 (Part-II) 1966 and shall be of tested quality. It shall also comply with relevant part of I.S. 456- 1978. All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing.
- For the purpose of payment, the bar shall be measured correct upto 100 mm. length and weight payable worked out at the rate specified below:

1	6 mm.	0.22Kg/Rmt.	8	20mm.	2.47Kg/Rmt.
2	8 mm.	0.39Kg/Rmt.	9.	22mm.	2.98Kg/Rmt.
3	10 mm.	0.62Kg/Rmt.	10.	25mm.	3.85Kg/Rmt.
4	12 mm.	0.89Kg/Rmt.	11.	28mm.	4.83Kg/Rmt.
5	14 mm.	1.21Kg/Rmt.	12.	32mm.	6.3.1Kg/Rmt.
6	16 mm.	1.58Kg/Rmt,	13.	36mm.	7.99Kg/Rmt.
7	18 mm.	2.00Kg/Rmt.	14.	40mm.	9.86Kg/Rmt.

M-19 High Yield Strength Steel Deformed Bars / Tmt/ Crs

- The High yield strength steel deformed bars of CRS (Corrosion Resistant) Fe500D reinforcement steel shall be used as per I.S.1786 (2008)
- Other provision and requirements shall conform to specification No. M-18. for Mild steel bars.

M-20 High Tensile Steel Wires

- The high tensile wires for the use in prestressed concrete work shall conform to I.S. 2090-1962.
- The tensile strength of the high tensile steel bars shall be as specified in the item. In absence of the given strength, the minimum strength shall be taken as per para 6.1 of I.S. 1785-1962, Testing shall be done as per I.S. requirements.
- The high tensile steel shall be free from loose mill scale, rust oil, grease, or any other harmful matter. Cleaning of steel bars may be carried out by immersion in solvent solution, wire brushing or passing through a pressure box containing carborundum.
- The high tensile wire shall be obtained from manufactures in coil having diameter not less than 350 times the diameter of wire itself so that wire springs back straight on being uncoiled.

M-21 Mild Steel Binding Wire

- The mild steel wire shall be of 1.63 mm. or 1.22 mm. (16 or 18 gauge) diameter and shall conform to I.S. 280- 1972.
- The use of black wire will be permitted for binding reinforcement bars, it shall be free from rust, oil paint, grease, loose mill scale or any other undesirable coating which may prevent adhesion of cement mortar.

M-22 Structural Steel

- All structural steel shall conform to I.S. 226-1965. The steel shall be free from the defects mentioned in I.S. 226- 1975 and shall have a smooth finish. The material shall be free from loose mill scale, rust pits or other defects affecting the strength and durability. Rivet bars shall conform to I.S. 1148-1973.
- When the steel is supplied by the Contractor test certificates of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

M-23 Galvanised Iron Sheets

- The galvanized iron sheets shall be plain or corrugated sheets of specified in item. The G.I. Sheets all conform to I.S 277-1977. The sheets shall be undamaged in carriage and handling either by rubbing off of zinc coating or otherwise they shall have clean and bright surface and shall be free from dents, holes, rust or white powdery deposit.
- The length and width of G.I. sheet shall be as directed as per site condition.

M-24 Valleys gutter ridges

- The G.I. ridges and hips shall be of plain galvanized sheets class-3 of the thickness as specified item. These shall be 600 mm. in width and properly bent up to shape without damage to the sheets in process of bending.
- Valleys gutters and flashings shall also be galvanized sheet of thickness as specific in item, Valleys shall be 900 mm. wide overall and fishing shall be 380 mm. wide overall. They shall be bent (o the required shape without damage to the sheet in the process of bending.

M-25 Asbestos Cement Sheets

- Asbestos cement sheets plain, corrugated or semi corrugated shall conform to I.S. 459-1970. The thickness of fee sheets shall be as specified in the item. The shells shall be free front all defects such as cracks, holes deformities, chipped edges or otherwise damaged.

Ridged-& Hips

- Ridges and hips shall be of same thickness at that of A.C. sheets. The types of ridges suitable for the type of sheets and locations.
- Other accessories to be used in roof such as flashing pieces, caves filler pieces, valley gutters, north light and ventilator curves, barge boards etc. shall be standard manufacture and shall be suitable for the type of sheets and location.

M-26 Mangalore Pattern Roof Tiles

The Mangalore pattern tiles shall conform to I.S. 654-1972 for Class AA or Class 'A' type as specified in item. Samples of the tiles to be provided shall be got approved from the engineerin charge. Necessary tests shall be carried out as directed.

M-27 Shuttering

- The shuttering shall be either of Wooden planking of 30 mm. minimum thickness with or without steel lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical ballies properly cross braced together so as to make the centering rigid. In places of bullie props, brick pillar of adequate section built in mud mortar may be used.
- The form work shall be sufficiently strong and shall have camber, so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration of live load of men working over it and other incidental loads associated with it. The shuttering snail have smooth and even surface and its joints shall not permit leakage of cement grout.

- If at any stage of work during or after placing concrete in the structure, the form work sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and got approved from the Engineer-in-charge, before the reinforcement bars are placed in position.
- The props shall consist of bullies having 100 mm. minimum diameter measured, at mix length and 80 mm, at thin end and shall be placed as per design requirement. These shall rest squarely on wooden sole plates 40 mm; thick and minimum bearing are if 0.10 sq. m. laid on sufficiently hard base.
- Double wedges shall further be provided between the sole plate and the wooden props so as to facilitate tightening and easing of shuttering" without jerking the concrete.
- The timber used in shuttering shall not be so dry as to absorb water from concrete and swell or bulge nor so green or wet as to shrink after erection. The timber shall be properly sawn and planed on the sides and surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted.
- As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.
- The surface of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Alternatively coat of raw linseed oil or oil of approved manufacturer may be applied in place of soap solution. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances black or burnt oil shall be permitted.
- The shuttering for beams and slabs shall have camber of 4 mm. per metre (1 in 250) or as directed by the Engineer-in- charge so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50 of the projected length or as directed by the Engineer- in-Charge.

M-28 Expansion Joints- Premoulded Filter

- The item provides for expansion joints in R.C.C. frame structures for internal joints, as well as exposed pints, with the use of premoulded bituminous joint filler.
- Premoulded bituminous joint filler, i.e., performed strip of expansion joint filler shall not get deformed or broken by twisting, bending or other handling when exposed to atmospheric condition. Pieces of joint filler that have been damaged shall be rejected.
- Thickness of the pro-moulded joint filler shall be 25 mm. unless otherwise specified. Premoulded bituminous joint filler shall conform to I.S. 1838-1961

M-29 Expansion Joints-Copper Strips & Hold Fast

- The item provides for expansion joints in R.C.C. frame structure for internal joint as well as for exposed joints with the use of necessary copper strip and holdfasts.
- Copper sheet shall be of 1.25 mm. thick and of 1.25 mm. width with the 'U' shape in the middle. Copper strip shall have holdfast of 3 mm. diameter copper rod fixed to the plate soldered on strip at intervals of about 30 cm. or as shown in the drawing or as directed. The width of each flange (horizontal side) of the copper plate to be embedded in the concrete work shall be 25 mm. Depth of 'U' to be provided in the expansion joint, in the copper plate shall be of 25 mm.

M-30 Teak Wood

- The teak wood shall be of good quality as required for the item to be executed. When the kind of wood is not specifically mentioned, good Indian teak wood as approved shall be used.
- Teak wood shall generally be free from large, loose, dead or cluster knots, flaws, shakes, warps, twists bends, or any other-defects. It shall generally be uniform in substance and of straight fibres as far as possible. It shall be free from rot, decay, harmful fungi and other defects of harmful nature which will affect the strength durability of its usefulness for the purpose for which it is required. The colour shall be uniform as far as possible. Any effort like painting, using any adhesive or resins materials made to hide the defects shall render the pieces liable to rejection by the Engineer in-charge.
- **All scantlings:** planks etc. shall be sawn in straight lines and planes in the direction of grains and of uniform thickness.
- The tolerances in the dimensions shall be allowed at the rate of 1.5 mm. per face to be planed.
- **First class teakwood:** First class teak wood shall have no individual hard and sound knots, more than 6 sq. cm. size and the aggregate area of such knots shall not be more than 1% of area of piece. The timber shall be closed grained.
- **Second Class Teak wood:** No individual hard and sound knots shall be more than 15 sq. cms. in size and aggregate area of such knots shall not exceed 2% of the area of piece.

M-29. A. Non-Teak Wood

- The non-teak wood shall be chemically treated, seasoned as per IS Specifications and of good quality. The type of wood shall be got approved Before collecting the same on site. Fabrication of wooden members shall be started only after approval.
- For this purpose, wood of Bio, Kalali, Siras, Bchda, Jamun, Sisoo will be used for door frames whereas only Kalali, Siras, Halda, Kalam etc, will be permitted for shutters after proper seasoning and chemical treatment.
- The non-teak wood shall be-free from large, loose, dead of cluster knots, flows shakes,

warps, bends or any other defect. It shall be uniform in substance and of straight fibers as far as possible. It shall be free from rots, decay harmful fungi and other defects of nature which effect the strength, durability or its usefulness for the purpose for which it is required. The colour of wood shall be uniform as far as possible. The scantlings planks etc. shall be sawn in straight lines and planes in the direction of grain and uniform thickness.

- The department will use the Agency to produce certificate from Forest Department in event of Dispute and the decision of the Department shall be final and binding to me contractor.
- The tolerance in the dimension shall be allowed as 1.5 mm. per face to be planed.

M-31 Wooden flush door shutters (solid core)

- The solid core type flush door shutters shall be decorative or non-decorative type as specified in the drawing. The-size and thickness of the shutter shall be as specified in drawings or as directed. The limber, species for core shall be used as per I.S. 2202 - (Part-I) 1980. The timber shall be free from decay and insect attack. Knots and knot holes less than half the width of cross-section of the members in which they occur may be permitted. Pitch pockets, pitch streaks and harmless pin holes shall be permissible except in the exposed edges of the core members. The commercial plywood, cross-bands shall conform to I.S. 303-1275.
- The face panel of the shutters shall be formed by gluing by the hot press process on both face of the core with either ply wood or cross-bands and face veneers. The hopping rebating opening of glazing Venetian etc. shall be provided if specified in the drawing.
- All edges of the door shutters shall be square. The shutters shall be free from twist or warp in its plane. Both faces of the shutters shall be sand papered to smooth even texture. The shutters shall be tested for
- **End immersion test:** The test shall be carried out as per I.S. 2202 (part-I) 1980. There shall be no delamination at the end of the test.
- **Knife Test:** The face panel when tested in accordance with I.S. 1659-1979 shall pass the test.
- **Glue adhesion test:** The flush door shall be tested for glue adhesive test in accordance with KS.2202 (Pan 4) 1930, The shutters shall be considered to have passed the test if no delamination occurs in the-glue lines in the plywood and if no single delamination more than 80 mm. in length and more than 3 mm. in depth has occurred in the assembly glue lines between the plywood face and the style and rail. Delamination at the comer shall be measured continuously around the comer. Delamination at the knots, knot holes and other permissible wood defects shall not be considered in assessing the sample.
- The tolerance in size of solid core type flush door shall be as under:
- In Normal thickness ± 1.2 mm.
- In Normal height ± 3 mm.

- The thick of the shutters shall be uniform throughout with a permissible variation of not more than 0.8 mm. when measured at any two points.

M-32 Aluminium Doors, Windows, Ventilators

- Aluminum alloy used in the manufacture of extruded window sections shall conform to I.S. designation HEA-WP of I.S.: 733-3975 and also to I.S. Designation WVG-WP of I.S. 1285-1975. The Section shall be as specified in the drawing and design. The fabrication shall be done as directed.
- The hinges shall be cast or extruded aluminium hinge of same type as in window but of large size.
- The hinges shall normally be of 50 mm. projecting type. Non-projecting type of hinges may also be used if directed. The handles of door shall be of specified design. A suitable lock for the door operatable either from outside or inside shall be provided. In double shutter door, the first closing shutter shall have concealed aluminium alloy bolt at top and bottom.

M-33 Rolling shutters

- The rolling shutters shall conform to I.S. 6248-1979. Rolling shutters shall be supplied of specified type with accessories. The size of the rolling shutters shall be specified in the drawings. The shutters shall be constructed with interlocking lath sections formed from cold rolled steel strips not less than 0.9 mm. thick and 80 mm: wide for shutters upto 3.5mm., width not less than L25 mm. thick and 80 mm; wide for shutters 3.5 mm in width and at above unless otherwise specified.
- Guide channels shall be of mild steel deep channel section and of rolled pressed or built up (fabricated) joint construction. The thickness of sheet used shall not be less than 3.15mm.
- Hood covers shall be made of M.S. Sheets not less than 0 92 mm. thickness. For shutters having width 3.5 Meter and above, the thickness of M.S. Sheet for the hood cover shall be not less than 1.25 mm.
- The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in all position. The spring pipe shaft etc. shall be supported on strong M.S. or malleable C.I. brackets. The brackets shall be fixed on or under the lintel as specified with raw plugs and screws bolts etc.
- The roiling shutters shall be of self-rolling type up to 8 Sq. in. clear area without ball bearing and up to 12 sq. m. clear area with ball bearing. If the rolling shutters are larger, then gear operated type shutters shall be used.
- The locking arrangement shall be provided at the bottom of shutter at both ends. The shutters shall be opened from outside.

- The shutters shall be completed with door suspension shafts, locking arrangements, pulling hooks, handles and other accessories.

M-34 Collapsible. Steel-gate

- The collapsible steel gate shall be in one or two leaves and size as per approved drawings or as specified. The gate shall be fabricated from best quality mild steel channels, flats etc. Either steel pulleys or ball bearings shall be provided in every double channel. Unless otherwise specified the particulars of collapsible gate shall be as under:
 - (a) Pickets: These shall be of 20 mm. M.S., channels of heavy sections unless otherwise shown on drawings. The distance centre to centre of pickets shall be 12 cms. with an opening of 10 cms.
 - (b). Pivoted M.S. flats shall be 20 mm x 6 mm.
- Top and bottom guides shall be from tee or flat iron of approved size.
- The fittings like stoppers, fixing hold fasts, locking cleats, brass handles and cast-iron rollers shall be of approved design and size.

M-35 Welded Steel Wire Fabric

- Welded steel wire fabric for general purpose shall be manufactured from cold drawn steel wire “as drawn” or galvanised steel conforming to I.S. 226-1975 with longitudinal and transverse wire securely connected at every intersection by a process of electrical resistance welding and conforming to I.S. 4948-1974. It shall be fabricated and finished in workmanlike manner and shall be free from injurious defects and shall be rustproof. The type of mesh shall be oblong or square as directed. The mesh sizes and size of wire for square as well as oblong welded steel wire fabric shall be as directed the steel wire fabric in panels shall be in one whole piece in each panel as far as stock size permit.

M-36 Expanded Metal Sheets

- The expanded metal sheets shall be free from flaws, joints, broken strands, laminations and other harmful surface. Expanded metal steel sheet shall conform to I.S. 412-1975, except that blank sheet need not be with guaranteed mechanical properties. The size of the diamond mesh of expanded metal and dimensions of strands (width and thickness) shall be as specified. The tolerance in nominal weight of expanded metal sheets shall be of + 10 percent.
- Expanded metal in panels shall be in one whole piece panel each as far as stock size permit. The expanded metal sheets shall be coated with suitable protective coating to prevent corrosion.

M-37 Mild Steel Wire (Wire Gauze Jali)

- Mild steel wire, may be galvanised, as indicated. All finished steel wire shall be well cleanly drawn to the dimensions and-size of wire as specified in item. The wire shall be sound, free from splits, surface flaws, rough jagged and imperfect edges and other harmful surface defects and shall conform to I.S. 280-1978.

M-38 Plywood

- The plywood for general purpose shall conform I:S. 303- 1975.
- Plywood is made by cementing together thin boards or sheets of wood into panels. There are always an odd number of layers 3, 5,7, 9 ply etc. The plies are placed so that grain of each layer is right angle to the grain in the adjacent layer.
- The chief advantages of plywood over a signal board of the same thickness is the more uniform strength of the plywood, along the length and width of the plywood and greater resistance to cracking and splitting with change in moisture content,
- Usually synthetic resins are used for gluing, pherolic resins are usually cured in a hot press which compresses and simultaneously heats the plies between hot plates which maintain a temperature of 900C. to 1400C. and a pressure of 11 to 14 Kg/Sq. Cm. on the wood. The times of healing may be anything from 2 to 60 minutes depending upon thickness.
- When water glue are used, the wood absorbs so much water that the finished plywood must be dried carefully. When synthetic resins are use as adhesive finished plywood must be exposed to an atmosphere of controlled humidity until the proper amount of moisture, has been absorbed.
- According to I.S. 303-1975 the plywood for general purpose shall be of three grades namely BWR, WWR and CWR, depending upon the adhesives used for bonding and veneers, and it will be farther classified into six types of namely AA. AB. AC, BB, BC and C, C based on the quality of the two faces, each face being of three finds namely, A, B. and C. After pressing, the finished plywood should be reconditioned to a moisture content not less than 8 percent and not more than 16 percent.
- Thickness of plywood Boards:

Table 11 Thickness of plywood Boards

Board	Thickness	Board	Thickness	Board	Thickness	Board	Thickness
3 ply	3 mm.	5 ply	5 mm	7ply.	9 mm	9ply.	13 mm
	4 mm.		6 mm		13 mm		16mm
	5 mm.		8 mm		16 mm		19mm.
	6 mm.		9 mm				

						11Ply.	19mm. 22mm. 25mm.
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M-39 Glass

- All glass shall be of the best quality, free from specks, bubbles, smokes, veins, air holes blisters and other defects. The kind of glass to be used shall be mentioned in the item or specification or in the special provisions or as shown in detailed drawings. Thickness of glass panes shall be uniform. The specifications of different kinds of glass shall be as under:
- Sheet Glass: In absence of any specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 73 Kg/Sq.m. for panes upto 600 mm x 600 mm.
- For panes larger than 600 mm. x 600 mm. and upto 800 mm. x 800 mm. the glass weighing not less than 8.75 Kg/Sqm. shall be used. For bigger panes upto 900 mm. x 900 mm. glass weighing not less than 11.25 Kg/Sq. m. shall be used.
- Sheet glass shall be patent, flattened glass of best quality and for glazing and framing purposes shall conform to I.S.: 1761 -1960. Sheet glass of the specified colours shall be used, if so, shown on detailed drawings or so specified. For important buildings and for panes with any dimension over 900 mm. plate glass of specified thickness shall be used.
- Plate Glass: When plate glass is specified, it shall be ‘Polished patent plate glass’ of best quality.
- It shall have both the surface ground flat and parallel and polished to obtain clear undisturbed vision and reflection. The plate glass shall be of the thickness mentioned in the item or as shown in the detailed drawing or as specified. In absence of any specified thickness the thickness of plate glass to be supplied shall be 6mm and a tolerance of 0.20 mm. shall be admissible.
- Obscured Glass: This type of glass transmits light so that vision is partially or almost completely obscured. Glass shall be plain rolled, figured, ribbed or fluted or frosted glass as may be specified as required. The thickness and type of glass shall be as per details on drawings or as specified or as directed.
- Wired Glass: Glass shall be with wire netting embedded in a sheet of plate glass electrically welded 13 mm. Georgian square mesh may be used. Thickness of glass shall not be less than 6 mm. Wired glass shall be of type and thickness as specified.

M-40 Acrylic Sheets

Acrylic sheet shall be of thickness as specified in the item and of an specified shape and size as the case may be. Panels may be flat or curved. It should be light in weight. It shall be colourless or coloured or opaque as specified in the item. Colourless sheet shall be as transparent as the finest optical glass, its light transmission rate shall be about 95%. Transparency shall not be affected for

the sheets of larger thickness. It shall be extremely resistant to sunlight, weather and low temperatures. It shall not show any significant yellowing or change in physical properties or loss of light transmission over a longer period of use. The sheet shall be impact resistant also. Sheets should be available in complete range of standard transparent, translucent and opaque colours. Sheets shall be of such quality that they can be cut bent and jointed as desired. Solution for the joints shall be used as per the requirement of manufacturer.

M-41 Particle Board

The particle boards used for face panels shall be of best quality free from any defects. The particle boards shall be made with phenolaldehyde adhesive. The particle boards shall conform to I.S.: 3087- 1965. "Specification for wood particle board for general purpose". The size and the thickness shall be as indicated.

M-42 Expanded Polystyrene Of Framed Styroper Slabs

The expanded polystyrene ceiling boards and files shall be of approved make and shall be of size, thickness, finish and colour as indicated. It shall be of high density and suitable for use as insulating material. The insulating material shall be like slab of Thermo-Cole etc.

M-43 Resin Bonded Fibre Glass

- The resin bonded fibre glass tiles, or rolls shall be of approved make and shall be of sizes, thickness and finish as indicated.
- For test of Mineral wool thermal insulation Blanket I.S.: 3144/1965 shall be followed. Insulation wool blanket shall be with following coverings on one or both sides as indicated.
 1. Bituminized hessian Kraft paper suitable for use in position where moisture has to be excluded.
 2. Hessian cloth or Kraft paper for keeping out dust.
 3. G.I. wire netting, suitable for surfaces to be plastered over.

M-44 Fixtures And Fastenings General:

- The fixtures and fastenings, that is, butt, hinges, tee and strap hinges, sliding door bolts, tower bolts, door latch, bathroom latch, handles, door stoppers, casement window fasteners, casement stays and ventilators catch shall be made of the metal as specified in the item or its specifications.
- They shall be of iron, brags, aluminium, chromium plated iron, chromium plated brass, copper oxidised iron, copper oxidised brass or anodised aluminium as specified.
- The fixtures shall be heavy, medium or light type. The fixtures and fastenings shall be smooth finished and shall be such as will ensure ease of operation.
- The samples of fixtures and fastenings shall be got approved as regards quality and shape before providing them in position.
- Brass and anodised aluminium fixtures and fastenings shall be bright finished.
- **Holdfasts:** Holdfasts shall be made from mild steel flat 30 cm. length and one of the holdfasts shall be bent at right angle and two nos. of 6 mm. diameter holes shall be made in it for fixing it to the Farme with screws. At the other end, the holdfast shall be forked and bent at right angles in opposite directions.
- **Butt hinges:** Railway standard heavy type butt hinges shall be used when so specified. 43.3.2. Tee and strap hinges shall be manufactured from M.S. Sheet.
- **Siding door bolts (Aldrops):** The aldrops as specified in the item shall be used and shall begot approved.
- **Tower bolts (Barrel Type):** Tower bolts as specified in the item shall be used and shall be got approved.
- **Door latch:** The size of door latch shall be taken as the length of latch.
- **Bathroom Latch:** Bathroom latch shall be similar to tower bolt.
- **Handle:** The size of the handles shall be determined by the inside grip length of the handles. Handles shall have a base plate of length 50 mm. more than the size of the handle.
- **Door Stoppers:** Door stoppers shall be either floor door stopper type or door catch type. Floor stopper shall be of overall size as specified and shall have a rubber cushion.
- **Door Catch:** Door catch shall be fixed at a height of about 900 mm. from the floor level so that one part of the catch is fitted on the inside of the shutter and the other part is fixed in the wall with necessary wooden plug arrangements for appropriate fixity. The catch shall be fixed 20 mm. inside the face of the door for easy operation of catch.
- **Wooden Door Stop with hinges:** Wooden door stop of size 100 mm x 60 mm x 40 mm shallbe fixed on the door frame with a hinge of 75 mm size and at a height of 900 mm. from the floor level. The wooden door stop shall be provided with 3 coats of approved oil paint.
- **Casement window Fastener:** Casement window fastener for single leaf window shutter shall be left or right handled as directed.

- **Casement stays (Straight Peg Stay):** The stays shall be made from a channel section having three holes at appropriate position so that the window can be opened either fully or partially as directed. Size of the stay shall be 250 mm. to 300 mm. as directed.
- **Ventilator Catch:** The pattern and shape of the catch shall be as approved.
- **Pivot:** The base and socket plate shall be made from minimum 3 mm. thick plate and projected pivot shall not be less than 12 mm. diameter and 12 mm. length and shall be firmly riveted to the base plate in case of iron pivot and in single piece base plate in the case of brass pivot.

M-45 Paints

a. Emulsion paints:

- Emulsion paints shall be of the specified colour and shade, and as approved. The ready mixed paints shall only be used. However, if ready mixed paint or specific shade or tint is not available, white ready mixed paint with approved stainer will be allowed. In such a case, the contractor shall ensure that the shade of the paint so allowed shall be uniform.
- All the paints shall meet with following general requirements:
- Paint shall not show excessive setting in a freshly opened full can and shall easily be redispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, levering, caking or colour separation and shall be free from lumps and skins.
- The paint as received shall brush easily, possess good levering properties and show no running or sagging tendencies.
- The paint shall not skin within 48 hours in three quarters filled closed container.
- The paint shall dry to a smooth uniform finish free from roughness, grit, unevenness and other imperfections.
- Ready mixed paint shall be used exactly as received from the manufacturers and generally according to their instructions and without any admixtures whatsoever.

Enamel Paints:

The enamel paint shall satisfy in general requirements as mentioned in specification of oil paints. Enamel paint shall conform to I.S. 2933-1975.

M-46 French polish

The French polish of required tint and shape shall be prepared with the below mentioned ingredients and other necessary materials:

- Denatured spirit of approved quality (ii) Chandras (iii) Shellac (iv) Pigment. The French polish so prepared shall conform to I.S.: 348-1968.

M-47 Marble Chips For Marble Mosaic Terrazzo

- The marble chips shall be of approved quality and shades. It shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks decay and weathering.
- The size of various colours of marble chips ranging from the smallest upto 20 mm. shall be used where the thickness of top wearing layer is 6 mm. size. The marble chips of approved quality and colours only as per grading as decided by the Engineer-in-charge shall be used for marble mosaic tiles or works.
- The marble chips shall be machine crushed. They shall be free from foreign matter, dust etc. Except as above, the chips shall conform to I. S.: 2114-1962.

M-48 Flooring Tiles

a. PLAIN CEMENT TILES:

- The plain cement tiles shall be general purpose type. These are the tiles in the manufacturer of which no pigments are used. Cement used in the manufacture of tiles shall be as per Indian Standards.
- The tiles shall be manufactured from a mixture of cement and natural aggregates by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 140 Kg/Sq. Cm. The proportion of cement to aggregate in the backing of the tiles shall be not less than 1:3 by weight. The wearing face through the tiles are of plain cement, shall be provided with stone chips of 1 to 2 mm. size. The proportions of cement to the marble chips aggregate in the wearing layer of the tiles shall be three parts of cement to one-part chips by weight. The minimum thickness of wearing layer shall be 3 mm. The colour and texture of wearing layer shall be uniform throughout its face and thickness. On removal from mould, the tiles shall be kept in moist conditions continuously at least for seven days and subsequently, if necessary, for such long period as would ensure their conformity to requirements of I.S.: 1237- 1980 regarding strength resistance to wear and water absorption.
- The wearing face of the tiles shall be plain, free from projections, depressions and cracks and shall be reasonably parallel to the back face of the tile. All angles shall be right and all edges shall be sharp and true.
- The size of tiles shall generally be square shape 24.85 Cm. x 24.85 Cm. or 25 Cm. x 25 Cm. The thickness of tiles shall be 20 mm.

- Tolerance of length and breadth shall be plus or minus one millimeter. Tolerance on thickness shall be plus 5 mm.
- The tiles shall satisfy the tests as regards transverse strength resistance to wear and water absorption as per I.S: 1237-1980.

b. Plain Coloured Tiles

- These tiles shall have the same specification as per plain cement tiles as per (A) above except that they shall have a plain wearing surface wherein pigments are used. They shall conform to I.S. 1237-1980.
- The pigment used for colouring cement shall not exceed 10 percent by weight of cement used in the mix. The pigments synthetic or otherwise, used for colouring tiles shall have permanent colour and shall not contain materials detrimental to concrete.
- The colour of the tiles shall be specified in the item or as directed.

c. MARBLE MOSAIC TILES:

- These tiles have, the same specifications as per plain cement tiles except the requirements as stated below:
- The marble mosaic tiles shall conform to I. S. 1237-1980. The wearing face of the tiles shall be mechanically ground and filled. The wearing face of tiles shall be free from projections, depressions and cracks and shall be reasonably parallel to the back face of the tiles. All angles shall be right angles and all edges shall be sharp and true.
- Chips used in the tiles be from smallest upto 20 mm. size. The minimum thickness of wearing layer of tiles shall of 6 mm. For pattern of chips to be used on the wearing face, a few samples with or without their full size photographs as directed shall be presented to the Engineer-in- charge for approval.
- Any particular samples, if found suitable shall be approved by the Engineer-in-charge, or he may ask for a few more samples to be prepared indicating roughly the particular sized chips to be more-or less in the samples presented. The samples have to be made by the contractor till a suitable sample is finally approved for use in the work.
- The Contractor shall ensure that the tiles supplied for the work shall be in conformity with the approved sample only, in terms of its dimensions, thickness of backing layer and wearing surface, materials, ingredients, colour shade, Chips, distribution etc. required.
- The tiles shall be prepared from cement conforming to Indian Standards or coloured Portland cement generally depending upon the colour of tiles to be used or as directed.

d. Chequered Tiles

- Chequered tiles shall be plain cement tiles or marble mosaic tiles. The former shall have

the same specification as per

- (A) above and the latter as per marble mosaic tiles as per (C) except as mentioned below:
- The tiles shall be of nominal size of 250 mm. x 250 mm. or as specified. The centre-to-centre distance of chequer shall not be less than 25 mm. and not more than 50 mm. The overall thickness of the tile shall be 22 mm.
- The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered shall be plain, coloured or mosaic as specified. The thickness of the upper layer measured from the top of the chequers shall not be less than 6 mm. The tiles shall be given the first grinding with machine before delivery to site.
- Tiles shall conform to relevant I.S. 1237-1930.

e. Chequered Tiles For Stair Case

- The requirements of these tiles shall be the same as chequered as per (D) above except in following respects.
 1. The length of a tile including nose shall be 330 mm.
 2. The minimum thickness shall be 28 mm.
 3. The nosing shall have also the same wearing layer as at the top.
 4. The nosing edge shall be rounded.
 5. The front portion of the tile for a minimum length of 75 mm. from and including the nosing shall have grooves running parallel to nosing and at centre not exceeding 25 mm. Beyond that the tiles shall have normal chequer pattern.

M-49 Rough Kotah Stone

- The kotah stones shall be hard, even, sound, and regular in shape and generally uniform in colour. The colour of the stone shall generally be green. Brown colour stones shall not be allowed for use. They shall be without any soft veins, cracks or flows.
- The size of the stones to be used for flooring shall be of size 600 mm x 600 mm and/or size 600 mm x 450 mm, as directed. However smaller sizes will be allowed to be used to the extent of maintaining required pattern. Thickness shall be as specified.
- Tolerance of minus 30 mm. on account of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be + 3 mm.
- The edges of stones shall be truly chiselled and table rubbed with coarse sand before paving. All angles and edges of the stone shall be true, square and free from chipping and me surface shall be true and plain.
- When machine cut edges are specified, the exposed edges and the edges at joints shall be machine cut. The thickness of the exposed machine cut edges shall be uniform.

M-50 Polished Kotah Stones

- Polished kotah stone shall have the same specifications as per rough kotah stone except as mentioned below:
- The stones shall have machine polished smooth surface. When brought on site, the stones shall be single polished or double polished depending upon its use. The stones for paving shall generally be single polished. The stones to be used for dedo, skirting, platforms, sink, veneering, sills, steps, etc. where machine polishing after the stones are fixed in situ is not possible, shall be double polished.

M-51 Dholpur Stone Slab

- Dholpur stone slab shall be of best quality as approved by the Engineer-in-charge. The stone slab shall be even, sound and durable, regular in shape and of uniform colour.
- The size of the stone shall be specified in the item or detailed drawings or as approved by the Engineer-in-charge. The thickness of the stone shall be as specified in the item of work with the permissible tolerance of plus or minus 2 mm. The provisions in respect of polishing as for polished Kotah stone shall apply to polished Dholpur stone also. All angles and edges of the face of the stone slab shall be fine chiselled or polished as specified in the item of work and all the four edges shall be machine cut.
- All angle and edges of the stone slab shall be true and plane.
- The sample of stone shall be got approved from the Engineer-in-charge for shade and tint for a particular work. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint from the approved sample.

M-52 M-51. Marble Slab

- Marble slab shall be white or of other colour and of best quality as approved by the Engineer-in-charge.
- Slabs shall be hard, uniform and homogeneous in texture. They shall have even crystalline grain and free from defects and cracks. The surface shall be machine polished to an even and perfectly plane surface and edges machine cut true and square. The rear face shall be rough to provide key for the mortar.
- Marble slabs with natural veins, if selected shall have to be laid as per the pattern given by the Engineer-in-charge. Size of the slab shall be minimum 450 mm x 450 mm. and preferable- 600 mm x 600 mm. However, smaller sizes will be allowed to be used to the extent of maintaining required pattern.
- The slab shall not be thinner than the specified thickness at its thinnest part. A few specimen of finished slab to be used shall be deposited by the Contractor in the office for

reference.

- Except as above, the marble slabs shall, conform to I.S. 1130-1969.

M-53 Granite Stone Slab

- Granite shall be of approved colour and quality. The stone shall be hard, even, sound regular in shape and generally uniform in colour. It shall be without any soft veins, cracks of flows.
- The thickness of the stone shall be as specified in the items.
- All exposed face shall be double polished to tender truly smooth and the even reflecting surface. The exposed edges and corners shall be rounded off as directed. The exposed edges shall be machine cut and shall have uniform thickness.

M-54 P.V.C Flooring

- P. V.C sheets for P.V.C. floor covering shall be of homogeneous flexible type, conforming to I.S. 3452-1966. The
- P.V.C. covering shall neither develop any toxic effect while put to use nor shall give off any disagreeable odour.
- Thickness of flexible type covering tiles shall be as specified in the description of the item.
- The flexible type shall be backed with hessian or other woven fabric. The following tolerances shall be applicable on the nominal dimension of the sheet rolls or tiles:
- Thickness 0.15 mm
- Length or Width:

1. 300 mm. square tiles	± 0.20 mm.
2. 600mm. square tiles	±0.30 mm
3. 900mm square tiles	± 0.40mm.
4. Sheets and rolls	+ 0.10 percent

Adhesive:

The adhesive for PVC flooring shall be of the type and make recommended by the manufacturers of PVC sheets/tiles.

M-55 Facing Tiles

- The facing tiles (burnt clay facing bricks) shall be free from cracks, flaws and nodules of free lime. They shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right edged faces. The texture of the finished surface that will be exposed when in place, shall conform to an approved sample consisting not less

than four stretcher bricks each representing the texture desired. The facing tiles shall have a pleasing appearance, sufficient resistance to penetration by rain and greater durability than common bricks. The tiles shall conform to I.S. 2691-1972.

- The standard size effacing brick tiles shall be 19 x 9 x 4 cms. The facing brick tiles shall be provided with frog which shall conform to I.S. 1077-1976.
- The permissible tolerance in dimensions specified above shall be as follows: Size

Tolerance for 1st class Brick	2nd class Brick
19 Cm. ± 6mm.	±10 mm.
9cm. ± 3mm.	± 7mm.
4cm. ±1.5 mm	±3 mm.
- The tolerance for distortion or warpage of face or edges of individual brick from a plane surface and from a straight line respectively shall be as follows:
 - Facing dimensions Permissible tolerance Max. below 19 cms. Max. 2.5mm.
 - -do- above 19 cm. Max. 3.0 mm.
- The average compressive strength obtained as a sample of five dies when tested in accordance with the procedure laid as per I.S. 1077-1976 shall be not less than 175 Kg/Sq. Cm. The average compressive strength of any individual bricks shall be not less than 160 Kg/Sq.Cm.
- The average water absorption for five bricks files shall not exceed 12 percent of average weight of brick before testing.
- The absorption for each individual brick snail not exceed 25 percent.
- The brick tiles when tested in accordance with I.S. 1077-1976, the rate of efflorescence shall not be more than 'Slightly effloresced.'

M-56 White Glazed Tiles

- The tiles shall be of best quality as approved by the Engineer-in-charge. They shall be flat and true to shape. They shall be free from craks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade.
- The tiles shall be nominal size of 150 mm. x 150 mm. unless otherwise specified. The maximum variation from the stated sizes, other than me thickness of tile, shall be plus or minus 1.5 mm. The thickness of tile shall be 6 mm. Except as above the dies shall conform to I.S. 777 1970.

M-57 Galvanised Iron Pipes And Fittings

Galvanised iron pipe shall be of the medium type and of required diameter and shall comply with I.S.I 239-1979. The specified diameter of the pipes shall refer to the inside diameter of the bore.

Clamps, screw and all galvanised iron fittings shall be of the standard 'R' or equivalent make.

M-58 Bib Cock And Stop Cock

- A bib cock is a draw off tap with a horizontal inlet and free outlet. A stop cock is a valve with a suitable means of connection for insertion in a pipeline for controlling or stopping the flow.
- They shall be of screw down type and of brass chromium plated and of diameter as specified in the description of the item. They shall conform to I.S. 781-1977 and they shall be of best Indian make. They shall be polished bright.
- The minimum finished weight of bib cock and stop cock shall be as given below

Diameter	Bib cock	Stop cock
8 mm	0.25 Kg.	0.25 Kg.
10 mm.	0.30 Kg.	0.35 Kg.
15 mm.	0.40 Kg.	0.40 Kg.
20 mm.	0.75 Kg.	0.75 Kg.

M-59 Gun Metal Wheel Valve

The gun metal wheel valve be of approved quality. These shall be gun metal fitted with wheel and shall be of gate valve opening full way and of the size as specified. These shall conform to I.S. 778- 1971.

M-60 White Glazed Porcelain Wash Basin

- Wash basin shall be of white porcelain first quality best Indian make and it shall conform to I.S. 2556 (Part-IV) 1972 and I.S. 771-1979.
- The size of the wash basin shall be as specified in the item, Wash basin shall be of one-piece construction with continued over-flow arrangements. All internal angles shall be designed so as to facilitate cleaning. Wash basin shall have single tap hole or two holes as specified. Each basin shall have a circular waste hole which is either rabbled or bevelled internally with 65 mm. diameter at top and 10 mm. depth to suit the waste fining. The necessary stud slot to receive the bracket on the underside of (The basin shall be provided. Basin shall have an internal soap holder recess which shall fully drain into the bowl.
- White glazed pedestal of the quality and colour as that of the basin shall be provided where specified in the item. It shall be completely recessed at the back for reception of supply and wash pipe. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from floor to top of the rim of basin 750 mm. to 800 mm. as directed.

M-61 European Type Water Closet/With Low Level Flushing

- The European type of water closet shall be white glazed porcelain first quality and shall be of wash down type conforming to I.S. 2556-1973 and I.S. 771-1979.
- 'S' trap shall be provided as required with water seal not less than 50 mm. The solid plastic seat and cover shall be of the best Indian make conforming to I.S. 2548-1980. They shall be made of moulded syntactic materials which shall be tough and hard with high resistance to solvents and shall be free from blisters and other surface defects and shall have chromium plated brass hinges and rubber **buffer of suitable size**.

M-62 Orissa Type Water Closet

The specification of Orissa type white glazed water closet of first quality shall conform to I.S.2556 (Pan- III) 1981 and relevant specification of Indian type water closet except that pan will be with the integral squatting pan of size 580 mm. x 440 mm. with raised footrest.

M-63 Indian Type Water Closet

- The Indian type white glazed water closet of first quality shall be of size as specified in the item and conforming to I.S.
- 771-1979 and I.S. 2556 (Part-II) 1981. Each pan shall have integral flushing ring of suitable type with adequate number of holes around as directed to have satisfactory flushing. It shall also have an inlet at back or front for connecting flush pipe as directed. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and **surface** shall be uniform and smooth.
- Pan shall be provided with 100 mm. diameter 'P' or 'S' trap with approximately 50 mm. water seal and 50 mm. diameter vent horn.

M-62. A Foot Rests

A pair of white glazed-earthen ware rectangular footrests of minimum size 250 mm. x 130 mm. 20 mm. shall be provided with water closet.

M-64 Glazed Earthen Ware Sink

- The glazed earthen-ware sink shall be specified size, colour and quality. The sink shall conform to I.S. 771 Part-II-1979. The brackets for sinks shall conform to I.S. 775-1970.

- The pipes shall conform to I.S. 1239-Part-11973 and I.S. 404-1962 for steel and lead pipes respectively 32 mm. brass waste coupling of standard pattern with brass chain and rubber plug shall be provided with sink.

M-65 Glazed Earthen Ware Lipped Type Flat Back Urinal/Corner Type Urinal

- The lipped type urinal shall be flat back or corner type as specified in the item and shall conform to I.S. 771-1979. It shall be of best Indian make and size as specified and approved by the Engineer-in-charge. The flat back or corner type urinal must be of 1st quality free from any defects, cracks, etc.

M-66 Low Level Enamel Flushing Tank

- The low-level enamel flushing tank shall be of 15 liters capacity. It shall conform to I.S. 774-197 It the flushing cistern shall be of best quality and free from any defects. The flushing tank shall have outlet 32 mm. diameter. The outlet shall be connected with W.C. Pan by lead pipe or P.V.C. pipe as specified. The flushing tank shall be provided with inlet and outlet for fixing
- G.I. inlet pipes and over-flow pipes. The flushing cistern shall be provided with chromium
- plated handle for flushing. The flushing tank shall be provided with bracket of cast iron so that it can be fixed on wall at specified height. The brackets shall conform to I.S. 775-1970.

M-67 Cast Iron Flushing Cistern

The cast iron flushing cistern shall be of 15 litres capacity. It shall conform to I.S. 774-1971. The flushing cistern shall be of best quality free from any defects. The flushing cistern shall have outlet of 32 mm. diameter. The outlet shall be connected to lead pipe of 32 mm. diameter. The lead pipe shall conform to I.S. 404 (Part-I) 1962. For fixing G.I. inlet pipes and overflow pipes 20 mm. dia. inlet and outlet shall be provided. The flushing cistern shall be provided with galvanised iron chain and pull of sufficient length and shall be got approved from the Engineer-in-charge. The cast iron flushing cistern shall be painted with one coat of anticorrosive paint and two coats of paints. The flushing cistern shall be fixed on two C.I. brackets. The C.I. brackets shall conform to I.S. 775-1970.

M-68 Flush Cock

Half turn flush cock (Heavy weight) shall be of gun metal chromium plated of diameter as specified in the description of the item. The flush cock shall conform to relevant Indian Standard.

M-69 Cast Iron Pipes And Fittings

- All soil, water, vent and antisiphonage pipes and fittings shall conform to I.S. 1729-1964. The pipe shall have spigot, and socket ends with head on spigot end. The pipes and fittings shall be true to shape, smooth, cylindrical, their inner and outlet surfaces being as nearly as practicable concentric. They shall be sound and nicely cast and shall be free from cracks, laps, pinholes or other imperfection and shall be neatly dressed and carefully fettled.
- The end of pipes and fittings shall be reasonable square to their axis.
- The sand cast iron pipes shall be of the diameter as specified in the description and shall be in lengths of 1.5 M. 1.8 M. and 2 M. including socket ends of the pipe unless shorter lengths are either specified or required at junctions etc. The pipes and fittings shall be supplied without ears unless specified or directed otherwise.
- **Tolerances:**
- The Standard weights and thickness of pipes shall be as shown in the following table:
- A tolerance upto minus 10 per cent may however be allowed against these standard weights.

Table 12 Standard weights and thickness of pipes

Sr. No.	Nominal dia. of bore	Thickness	Overall, Weight of pipe excluding ears		
			1.5 m. long	1.8 m. long	2 m. long
1.	75 mm	5.0 mm	12.83 kg	16.52 kg	18.37 kg
2.	100 mm	5.0 mm	18.14 kg	21.67 kg	24.15 kg

- A tolerance upto minus 15 percent in thickness and 20 mm. in length will be allowed. For fittings tolerance in lengths shall be plus 15 mm. and minus 10 mm.
- The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerances in weights and thickness shall be the same as for straight pipes.

M-70 Nahni Trap

- Nahni trap shall be of cast iron and shall be sound and free from porosity or other defects which affect serviceability. The thickness of the base metal shall not be less than 6.5 mm. The surface shall be smooth and free from craze, ships and other flaws or any other kind of defects
- which affect serviceability. The size of nahni trap shall be as specified and shall be of self cleansing design.
- The nahni trap shall be of quality approved by the Engineer-in-charge and shall generally conform to the relevant Indian Standards.
- The Nahni trap provided shall be with deep seal, minimum 50 mm, except at places where trap with deep seal cannot be accommodated. The cover shall be cast iron. Perforated cover shall be provided on the trap of appropriate size.

M-71 Gully Trap

- Gully trap shall conform to I.S. 651-1980. It shall be sound, free from defects such as fire cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.
- The size of the gully trap shall be as specified in the item.
- Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a watertight C.I. cover with frame inside dimensions 300 mm; x 300 mm., the cover with frame inside dimension, 300 mm. x 300 mm., the cover weighing not less than 4.53 Kg. and the frame not less than 2.72 Kg. The grating cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

M-72 Glaze Stone Ware Pipe And Fitting

- The pipes and fittings shall be of best quality as approved by the Engineer-in-charge. The pipe shall be of best quality manufactured from stoneware of fire clay, salt glazed thoroughly burnt through the whole thickness, of a close even texture, free from air blows, fire blisters, crack and other imperfections, which effect the serviceability. The inner and outer surfaces shall be smooth and perfectly glazed. The pipe shall be capable to-withstand pressure of 1.5
- m. lead without showing sign of leakage. The thickness of the wall shall not be less than 1/12th of the internal dia. The depth of socket shall not be less than 38 mm. The socket shall be sufficiently large to allow a joint of 1 mm. around the pipe.
- The pipes shall generally conform to relevant I.S. 651 -1980.

M-73 Wall Peg Rail

The aluminum wall peg rail shall have three aluminum pegs of approved quality and size. It shall be fixed on teakwood plank of size 450 mm. x 75 mm. x 20 mm. The teakwood shall be french polished or oil painted as specified.

M-74 G.I. Water spot

- The G.I. pipes of 40 mm. dia shall be of medium quality and specials shall be of 'R' brand or equivalent brand of best approved quality.
- The pipe shall have length as required for the thickness of wall in which it is fixed, and at the outside end tee and bend cut at half the length shall be provided and at other end coupling shall be provided to have better fixing. The waterspout shall be provided as per

detailed drawing or as directed.

M-75 Asbestos cement pipe (a.c. Pipe)

The asbestos cement pipe of diameter as specified in the description of the item shall conform to I.S. 1626-1980. Specials like bends, shoes, cowls, etc. shall conform to relevant Indian Standards. The interior of pipe shall have a smooth finish, regular surface and regular, internal diameter. The tolerance in all dimensions shall be as per I.S. 1626-Part-1-1980.

M-76 Crydon Ball Valve

Ball valve of screwed type including polyethylene float and necessary lever etc. shall be of the size as mentioned in the description of item and shall conform to I.S. 1703-1977.

M-77 Bitumen Felt For Water Proofing And Damp Proofing

Bitumen felt shall be on the fibre bases and shall be type 2, self-finished grade-2 and shall conform to I.S. 1322-1970.

M-78 Select Earth

- The selected earth shall be that obtained from excavated material or shall have to be brought from outside as indicated in the item. If item does not indicate anything, the selected earth shall have to be brought from outside.
- The selected earth shall be good yellow soil and shall be got approved from the Engineer-in-charge. In no case black cotton soil or similar expansive and shrinkable soil shall be used. It shall be clean and free from all rubbish and perishable materials, stones or brick bats. The clods shall be broken to a size of 50. mm or less, Contractor shall make his own arrangement at his own cost for land for borrowing selected earth. The stacking of material shall be done as directed by the Engineer-in-charge in such a way as not to interfere with any constructional activities and in proper stacks.
- When excavated material is to be used, only selected stuff got approved from the Engineer-in-charge shall be used. It shall be stacked separately and shall comply with all the requirements of selected earth mentioned above:

M-79 Barbed Wire

- The barbed wire shall be of galvanised steel and it shall generally conform to I.S. 278-1978. The barbed wire shall be of type-I whose nominal diameter for line wire shall be 2.5 mm. and point wire 2.24 mm. The nominal distance between two bars shall be 75 mm. unless otherwise specified in the item. The barbed wire shall be formed by twisting together two-line wires, one containing the barbs. The size of the line and point wires and barb spacings shall be as specified above. The permissible deviation from the nominal diameter of the line wire and point wire shall not exceed ± 0.08 mm.
- The barbs shall carry four points shall be formed by twisting two-point wires, each two turns, lightly round one line wire, making altogether four complete turns. The barbs shall be so finished that the four points are set and locked at right angles to each other. The barbs shall have a length of not less than 13 mm. and not more than 18 mm. The point shall be sharp and cut at an angle not greater than 35 degrees of the axis of the wire forming the barbs.
- The line and point wire shall be circular section free from scale and other defects and shall be uniformly galvanised. The line wire shall be in continuous length and shall not contain any weld other than those in the rod before it is drawn. The distance between two successive splices shall not be less than 15 meters.
- The lengths per 100 Kg. of barbed wire I.S. type I shall be as under Nominal 1000 metre Minimum 834 Metre Maximum 1066 Metre.

M-80 Urinal

- Urinal shall be approved quality white porcelain of approved quality; best Indian make and it shall conform to IS 1556-Part-II 1974 with suitable size of side collar for fixing in position. The size of urinal shall be as specified in the item. Urinal shall be of one-piece construction. All internal angles shall be designed so as to facilitate cleaning. Urinal shall have single tap hole as specified. Urinal shall have a circular waste hole which is 65mm dia and 100 mm deep to suit the waste fitting.
- Necessary C.P. brass stop cock with PVC connection of specified size shall conform to I.S. 781- 1977. Necessary PVC reducer with PVC waste pipe of 25mm dia shall be designed to make height from the floor to the top of the rim of the urinal 550 to 600 mm as directed

M-81 M-80water Proofing Cement Paint

Water proofing cement paint of approved shade shall conform to IS-5410-1969 or as revised from time to time. Primer shall be best quality, make and as approved by the Engineer-in- charge. The materials required for work of painting shall be obtained directly from approved manufacturer or approved dealer and brought to the site in maker's drums, keys etc. with seal unbroken.

M-82 Stone For Bela Masonary

- Pucca approved white stone Bella of sand of uniform size shall be dressed, earth / murrumy or discoloured or weathered or water worm stone shall not be used. The size of Bella stone shall as by directed by Engineer to suit the width of wall. Corner stones & quoins shall be of good quality and should be dressed to correct angle. The corner stone shall be got approved before bringing to site.
- The stone shall be free from defects like cavity, flaws, sand holes, and veins, patches of soft or loose material. The percentage of water absorption shall generally not exceed 5 % by weight. Generally, the stone shall not contain silica or chert, mica or any other deleterious material like iron oxide organics impurities etc. The crushing strength of Bella stone shall not less than 300 Kg/cm². Transverse strength shall not less than 70 Kg/cm².

M-83 Vitriified Floor Tiles

- Vitriified floor tiles shall be of best quality & approved make as approved by the Engineer. They shall conform to the relevant I.S. codes.
- Vitriified tiles using for floor finishing should confirm ISO13006/E176 group B.1.a of international standards and also should confirm of testing methods of norms EN 98.

- The vitrified tiles shall be Monolithic and available in smooth, mirror polished and anti-skid finish. Their water absorption rate shall be less than 0.5%. They shall offer hard working and hardwearing floors for public buildings. The tiles shall be of ASTM or DIN standards.
- The vitrified tiles shall be extremely strong breaking strength of the tiles being 1600 kg./cm², flexural strength 200 kg. / Cm² and bounding strength of 2500 kg/cm². There shall after good resistance to abrasion i.e. greater than 100. There shall be scratch resistance; their hardness on the Moh's scale shall be min. 7. They shall also to resist thermal shock up to 10 cycles. They shall have a density of 2.2 gm/cc. They shall have 0.6 co-efficient of friction for polished / unpolished surfaces.

M-84 85 Mm Thick Pre-Cast Rubber Molded Interlock Paver Concrete Block

- The 85 mm thick pre-cast Rubber molded interlock paver concrete block shall be manufactured by electrical hydraulic operated block marking machine. The block should have minimum compression strength of 300 kg. Per sq.cm. The minimum thickness of the pre-cast Rubber molded interlock paver concrete block shall be 85mm and minimum size shall be 300x300mm. The block shall be of approved make & best quality as approved by the Engineer-in-charge. The size, shape, and shade of pre-cast Rubber moulded interlock paver concrete block shall be as approved by the Engineer-in-charge. There shall be true to shape. There shall be free from crack, crazing, and spots etc.

M-85 Acrylic Roof Sheets

Acrylic roof sheets shall be of thickness as specified in the item. The shape and size of sheet shall be as directed. Acrylic roof Sheets may be flat or curved. It should be light in weight. It shall be colourless or coloured or opaque. Colourless sheet shall be as transparent as the finest optical glass. Its light transmission rate shall be about 95%. Transparency shall not be affected for the sheets of larger thickness. It shall be extremely resistant to sunlight, weather and low temperatures. It shall not show any significant yellowing or change in physical properties or loss of light transmission over a longer period of use. The sheet shall be impact resistant also. Sheet should be available in complete range of standard transparent, man lucent and opaque colors. Sheets shall be of such quality that they can be cut bent and jointed as desired. Solution for the joints shall be used as per the requirement of manufacturer.

FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK

Base Interlocking paver block to be fixed on the bed 50 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Engineer-in-charge.

Interlocking Paver Block

Factory made precast paver block of M-30 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Minimum strength as prescribed by manufacturer and as per direction of Engineer-in-Charge.

Measurement & Rates

Area provided with paver block to be measured in sqm. correct upto two places of decimal. The rate include the cost of the material, labour, tools etc. required in all the operations described above.

Structural steel work

All the structural design must be vetted by the contractor, review the drawings & prepare the shop drawings for construction before making components. The shop drawing must be getting approval from the Employer/Engineer in charge

All steel work shall conform to IS 800-1962 and shall be free from defects impairing strength, durability or appearance and shall be of the best quality for the purposes specified, possessing structural properties to withstand safely stresses to which these shall be normally subjected. The Contractor shall bear the cost of all tests.

All structural steel members brought by or handed over to the Contractor shall be handled with care, stacked on edge and supported evenly.

The structural steel and rivet bars shall conform to IS:226. Before any fabrication work is commenced all plates shall be flattened and all bars and sections straightened or otherwise turned and made free from twists or other distortions. Method adopted for the purpose shall be such as not to injure the material.

Cutting shall be effected by shearing, cropping or sawing and shall be clean, reasonably square and free from distortion. If directed the edges shall be ground. Gas cutting by mechanically controlled torch shall be permitted for mild steel only with the approval of the Employer/Engineer in charge .

It shall be the responsibility of the Contractor to submit shop drawings to the Employer/Engineer in charge. All shop drawings shall be prepared in advance of the actual fabrication and shall show full size sections and all joints and connections, thickness of material used and details of welds, bolts, rivets etc., They shall clearly distinguish between shop and field rivets, bolts and welds. Drawings shall be made in conformity with the IS Code for shop drawings with due regard to speed and economy in fabrication and erection. A marking diagram allotting distinct identification marks to

each separate piece of steel, sufficient to ensure convenient assembly and erection at site, shall be prepared. All shop drawings also shall show temporary bracings and connections required during fabrication and erection.

Riveting

All holes in plates or sections over 1mm thick must be drilled (not punched) and accurately gauged. All holes (except in purlins, runners, packing plates, lacing bars) shall be drilled to required size. All matching holes for rivets or black bolts shall be such that a gauge 0.8mm less in diameter than the hole can pass freely through members assembled for riveting and bolting. All holes for turned and fitted bolts shall be drilled and reamed, if necessary, to a tolerance of only plus 0.13mm. When the number of thickness to be riveted exceeds three or the total thickness is 90mm or more, the holes shall be drilled or reamed in position after assembly, except when steel bushed jigs are used. Parts shall be firmly held together during such block drilling and taken apart for removal of burrs, after drilling.

All parts assembled for riveting shall be in close contact and all bearings stiffeners shall bear tightly at both top and bottom without being drawn or caulked. All parts of riveted members shall be temporarily pinned or bolted while riveting. Drifting of holes shall not be permitted except to draw the parts together and no drift used shall be larger in any part than the nominal diameter of rivet or bolt. Drifting done during assembling shall not distort metal or enlarge holes. Rivets when cold shall be of size shown on drawing and shall preferably fill the hole and form the head of standard dimension, unless otherwise stated. All riveting wherever practicable shall be done by hydraulic or pneumatic process. All loose, burnt or badly formed rivets with eccentric or deficient heads shall be cut and replaced by sound rivets. Counter sunk heads shall be provided wherever required. Caulking and recouping shall not be permitted.

Bolting

All turned and fitted bolts shall be parallel throughout the barrel within the tolerance of only minus 0.13mm and faces of heads and nuts bearing on steel work shall be machined. All such bolts shall be provided with washers of standard size so that the nut when turned shall not bear the unthreaded body of the bolt. Heads and nuts shall be hexagonal, of whit worth screws and shall be well formed. Where the full bearing area of the rivet is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together. Threaded portion of each bolt shall project beyond the nut at least by one thread. Tapered washers shall be provided for all heads and nuts bearing on beveled surfaces.

Welding

Welding wherever indicated on the drawings shall conform to IS:814-1963 unless otherwise specified. Welding shall be carried out by experienced welders only, who if necessary shall produce testimonials about their work and if required by Employer/Engineer in charge shall undergo qualifying tests as prescribed in IS:1181. Welding work shall be carried out as per IS:816. Welding shall be done in flat position wherever possible and adequate steps shall be taken to maintain the correct arc length, rate of travel, current and polarity for the type of electrode and nature of work.

Steel shall not be painted or oiled and any areas where welding is to be performed shall be well cleaned to remove any paint, scale or rust immediately before welding for a distance of at least 2m (3/4") on either side.

The work shall be securely held in position by means of tack welds, service bolts, clamps or lugs before commencing the welding so as to prevent any relative movements due to distortion, wind or other causes. When welding is liable to cause distortion, the work shall be securely held in approved frames or jigs. Parts to be fillet welded shall be brought into contact as close as practicable and in no event shall be separated more than 4.75mm (3/16"). If the separation is 1.6mm (1/16") or greater, the size of the fillet welds shall be increased by the amount of the separation. The separation between facing surfaces of the joints shall not exceed 1.6mm (1/16") the fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting.

Abutting parts to be butt welded shall be carefully aligned. Misalignment greater than 3mm (1/8") shall be corrected and in making the correction, the parts shall not be drawn into a sharper slope than two degree (11mm in 30cm or 7/16" in 12").

The sequence of welding shall be such that when possible the members which offer the greatest resistance to compression are welded first.

Welded joints showing slag inclusion or lack of proper penetration shall be cut and rewelded. Overlap of the toe of the weld and undercutting of the parent metal should be avoided and where present to a serious extent shall be rectified.

All slag shall be removed from each run before another run is super-imposed. When cold the final run shall be protected with clear boiled linseed oil and shall be protected with clear boiled linseed oil and shall not be painted until approved by the Employer/Engineer in charge.

Grinding of finished weld is permitted provided the weld is not reduced below the prescribed section. All exposed welds shall be ground smooth. Welds which have not been ground shall be scrubbed with a 10% solution of Hydrochloric acid which shall be washed off with water before paint is applied unless an alkali resisting paint is used.

Fabrication and Erection

In order to facilitate handling, transportation and execution the Contractor may fabricate the structural members in suitable sections. The details of site connections and their locations shall be approved by the Employer/Engineer in charge.

Frame or lattice sections intended for use parts of composite construction which are likely to deflect considerably during handling shall be suitably stiffened by means of steel angles.

Roof and other structures shall be supported at close intervals during the welding / bolting of site connections.

The frames of steel skeleton buildings shall be carried up true and plumb, and temporary bracings shall be introduced wherever necessary to take care of all loads to which structure may be subjected including erection equipment and operation of the same. Such bracings shall be kept in positions as long as required for safety or as deemed necessary by the Employer/Engineer in charge.

As erection progresses, the work shall securely bolted to take care of all dead load, wind load and erection stresses. No riveting or welding shall be done until the structure has been properly aligned. Rivets driven in field shall be heated and driven with the same care as taken in the shop.

In the setting or erection of steel work the individual pieces shall be considered plumb or level when the error does not exceed 1 to 500; For exterior columns the error shall not exceed 1 to 1000. Slight bends in the members of fabricated structure shall not be straightened unless strictly necessary on account of danger of overstraining connections and rivets, welds or bolts, connection plates. If slightly bent or twisted the member shall be straightened cold; if bent so sharply as to require heating, the whole piece thus heated shall be subsequently annealed. No straightening whatsoever shall be carried out without the previous sanction of Employer/Engineer in charge.

Painting joints

The surface of all joints must be thoroughly scraped, cleaned and given the first coat of red lead paint before joining up which should be done while the paint is still wet. This procedure shall not apply to welded joints. All rivets, bolts, washers, etc., shall be thoroughly cleaned and dipped in boiled linseed oil. All machined surfaces shall be well coated with a mixture of white lead and to allow.

Measurements

The weights of all fabricated trusses, frames, gantry girders, crane rails, square or round bars etc., stanchions, built up girders and purlins shall be calculated on the basis of standard net section weight according to IS code. Net weight of packing plates, distance pieces, separators, gussets, holding down bolts, fish plates, etc., shall be added to the respective items. No deduction shall be made for holes, bolts or notching ends of sections or intermediate points for making connections. No separate payment shall be made for welds cleats, brackets, rivets, bolts etc.

CORRUGATED GALVANISED STEEL SHEET ROOFING

C.G.S. Sheets

These shall be of the thickness specified in the description of the item and shall conform to IS 277. The sheets shall be of 275 grade of coating (See Appendix-A) unless otherwise specified in the description of item.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

Purlins

Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table 12.1)

TABLE 12.1

Thickness of C.G.S. sheet	Maximum spacing of purlins
1.00 mm	2.00 metre
0.80 mm	1.80 metre
0.50 mm	1.60 metre

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

Slope

Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontals. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

Laying and Fixing

The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs. The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side.

The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm.

The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively.

These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys.

They shall be cut carefully with a straight edge chisel to give a smooth and straight finish. Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm. The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanised J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

The galvanised coating on J or L hooks, and bolts shall be continuous and free from defects

such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanised iron bolts and nuts 25 × 6 mm size, each bolt provided with a bitumen and a G.I. limpet washer or a G.I. limpet washer filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zig-zag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seams bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. The ties shall be paid for separately unless described in the item of roofing.

Finish

The roof when completed shall be true to lines, and slopes and shall be leak proof.

Measurements

The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.S. sheets. This includes the cost of roof sheets, galvanised iron J or L hooks, bolts and nuts, galvanised iron seam bolts and nuts, bituminous and galvanised iron limpet washers etc.

RIDGES AND HIPS OF PLAIN GALVANISED STEEL SHEETS

Ridges and Hips

Ridges and hips of C.G.S. roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.S. sheet, 0.6 mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.

Fixing

Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanised iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

Surface of C.G.I. sheets of ridge and hip sections and the roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. Sheets before they are fixed in place.

Finish

The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

Measurement

The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.

Rate

The rate shall include the cost of all labour and materials specified above, including painting, cost of seam bolts and any extra G.I. hook bolts, nuts and washers, required.