आय.एस.ओ.९००१:२००८ प्रमाणपत्र प्राप्त संस्था

Pimpri Chinchwad Municipal Corporation
Pimpri-411018
Corrigendum (First)
Tender Notice No. Env/11/2016-17

Tender Notice No. Env/11/2016-17 for work of **"Collection, Transportation, Processing and Management of Construction and Demolition (C&D) waste in Pimpri Chinchwad on Design-Build-Own-Operate (DBOO) model base on site recycling facility (AS PER C&D WASTE MANAGEMENT RULES 2016)"** Submission date is extended from dt.27/3/2017 to 10/04/2017 upto 3.00 P.M.. Detailed tender notice is available on www.pcmcindia.gov.in PCMC web site.

There is no any change in other information.

Additional Commissioner
Pimpri Chinchwad Municipal Corporation
Pimpri-411018

Advt. No. 466
No.Pak/1/kavi/303/2017
Dt. 16/03/2017

ANNEXURE: TECHNICAL SPECIFICATIONS

INDEX

ANNEXURE : TECHNICAL SPECIFICATIONS

Construction and Demolition Waste Management Rules, 2016

[Published In the Gazette of India, Part-II, Section-3, Sub-section (ii)]
Ministry of Environment, Forest and Climate Change

NOTIFICATION

New Delhi, the 29th March, 2016

G.S.R. 317(E).-Whereas the Municipal Solid Wastes (Management and Handling) Rules, 2000 published vide notification number S.O. 908(E), dated the 25th September, 2000 by the Government of India in the erstwhile Ministry of Environment and Forests, provided a regulatory frame work for management of Municipal Solid Waste generated in the urban area of the country;

And whereas, to make these rules more effective and to improve the collection, segregation, recycling, treatment and disposal of solid waste in an environmentally sound manner, the Central Government reviewed the existing rules and it was considered necessary to revise the existing rules with a emphasis on the roles and accountability of waste generators and various stakeholders, give thrust to segregation, recovery, reuse, recycle at source, address in detail the management of construction and demolition waste.

And whereas, the draft rules, namely, the Solid Waste Management Rules, 2015 with a separate chapter on construction and demolition waste were published by the Central Government in the Ministry of Environment, Forest and Climate Change vide G.S.R. 451 (E), datedthe 3rd June, 2015 inviting objections or suggestions from the public within sixty days from the date of publication of the said notification;

And Whereas, the objections or suggestions received within the stipulated period were duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sections 6, 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Municipal Solid Wastes (Management and Handling) Rules, 2000, except as respect things done or omitted to be done before such supersession, the Central Government hereby notifies the following rules for Management of Construction and Demolition Waste –

1. Short title and commencement.-(1) These rules shall be called the Construction and Demolition Waste Management Rules, 2016.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. Application.-The rules shall apply to every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organisation or authority who generates construction and demolition waste such as building materials, debris, rubble.

3. Definitions –(1) In these rules, unless the context otherwise requires,-

(a) " ACT' means the Environment (Protection) Act, 1986 (29 of 1986);

(b) "**construction**" means the process of erecting of building or built facility or other structure, or

building of infrastructure including alteration in these entities,;

(c) "**construction and demolition waste**" means the waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any civil structure;

(d) **"de-construction"** means a planned selective demolition in which salvage, re-use and recycling of the demolished structure is maximized;

(e) "demolition" means breaking down or tearing down buildings and other structures either manually or using mechanical force (by various equipment) or by implosion using explosives.

(f) "form" means a Form annexed to these rules;

(g) "local authority" means an urban local authority with different nomenclature such as municipal corporation, municipality, nagarpalika, nagarnigam, nagarpanchayat, municipal council including notified area committee and not limited to or any other local authority constituted under the relevant statutes such as gram panchayat, where the management of construction and demolition waste is entrusted to such agency;

(h) " schedule" means a schedule annexed to these rules;

(i) "service provider' means authorities who provide services like water, sewerage, electricity, telephone, roads, drainage etc. often generate construction and demolition waste during their activities, which includes excavation, demolition and civil work;

(j) "waste generator" means any person or association of persons or institution, residential and commercial establishments including Indian Railways, Airport, Port and Harbour and Defence establishments who undertakes construction of or demolition of any civil structure which generate construction and demolition waste.

(2) Words and expressions used but not defined herein shall have the same meaning defined in the ACT.

(4) Duties of the waste generator -

(1) Every waste generator shall prima-facie be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated, as directed or notified by the concerned local authority in consonance with these rules.

(2) The generator shall ensure that other waste (such as solid waste) does not get mixed with this waste and is stored and disposed separately.

(3) Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar and shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work and keep the concerned

authorities informed regarding the relevant activities from the planning stage to the implementation stage and this should be on project to project basis.

(4) Every waste generator shall keep the construction and demolition waste within the premise or get the waste deposited at collection centre so made by the local body or handover it to the authorised processing facilities of construction and demolition waste; and ensure that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains.

(5) Every waste generator shall pay relevant charges for collection, transportation, processing and disposal as notified by the concerned authorities; Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall have to pay for the processing and disposal of construction and demolition waste generated by them, apart from the payment for storage, collection and transportation. The rate shall be fixed by the concerned local authority or any other authority designated by the State Government.

(5) Duties of service provider and their contractors -

(1) The service providers shall prepare within six months from the date of notification of these rules, a comprehensive waste management plan covering segregation, storage, collection, reuse, recycling, transportation and disposal of construction and demolition waste generated within their jurisdiction.

(2) The service providers shall remove all construction and demolition waste and clean the area every day, if possible, or depending upon the duration of the work, the quantity and type of waste generated, appropriate storage and collection, a reasonable timeframe shall be worked out in consultation with the concerned local authority.

(3) In case of the service providers have no logistics support to carry out the work specified in sub-rules (1) and (2) , they shall tie up with the authorised agencies for removal of construction and demolition waste and pay the relevant charges as notified by the local authority.

(6) Duties of local authority-The local authority shall,-

(1) issue detailed directions with regard to proper management of construction and demolition waste within its jurisdiction in accordance with the provisions of these rules and the local authority shall seek detailed plan or undertaking as applicable, from generator of construction and demolition waste;

(2) chalk out stages, methodology and equipment, material involved in the overall activity and final clean up after completion of the construction and demolition ;

(3c) seek assistance from concerned authorities for safe disposal of construction and demolition waste contaminated with industrial hazardous or toxic material or nuclear waste if any;

(4) shall make arrangements and place appropriate containers for collection of waste and shall remove at regular intervals or when they are filled, either through own resources or by appointing private operators;

(5) shall get the collected waste transported to appropriate sites for processing and disposal either through own resources or by appointing private operators;

(6) shall give appropriate incentives to generator for salvaging, processing and or recycling preferably in-situ;

(7) shall examine and sanction the waste management plan of the generators within a period of one month or from the date of approval of building plan, whichever is earlier from the date of its submission;

(8) shall keep track of the generation of construction and demolition waste within its jurisdiction and establish a data base and update once in a year;

(9) shall device appropriate measures in consultation with expert institutions for management of construction and demolition waste generated including processing facility and for using the recycled products in the best possible manner;

(10) shall create a sustained system of information, education and communication for construction and demolition waste through collaboration with expert institutions and civil societies and also disseminate through their own website;

(11) shall make provision for giving incentives for use of material made out of construction and demolition waste in the construction activity including in non-structural concrete, paving blocks, lower layers of road pavements, colony and rural roads.

(7) Criteria for storage, processing or recycling facilities for construction and demolition waste and application of construction and demolition waste and its products-

(1) The site for storage and processing or recycling facilities for construction and demolition waste shall be selected as per the criteria given in **Schedule I**;

(2) The operator of the facility as specified in sub- rules (1) shall apply in **Form I** for authorization from State Pollution Control Board or Pollution Control Committee.

(3) The operator of the facility shall submit the annual report to the State Pollution Control Board in **Form II.**

(3) Application of materials made from construction and demolition waste in operation of sanitary landfill shall be as per the criteria given in **Schedule II.**

(8) Duties of State Pollution Control Board or Pollution Control Committee-

(1) State Pollution Control Board or Pollution Control Committee shall monitor the implementation of these rules by the concerned local bodies and the competent authorities and the annual report shall be sent to the Central Pollution Control Board and the State Government or Union Territory or any other State level nodal agency identified by the State Government or Union Territory administration for generating State level comprehensive data. Such reports shall also contain the comments and suggestions of the State Pollution Control Board or Pollution Control Committee with respect to any comments or changes required;

(2) State Pollution Control Board or Pollution Control Committee shall grant authorization to construction and demolition waste processing facility in **Form-III** as specified under these rules after examining the application received in **Form I**;

(3) State Pollution Control Board or Pollution Control Committee shall prepare annual report in **Form IV** with special emphasis on the implementation status of compliance of these rules and forward report to Central Pollution Control Board before the 31st July for each financial year.

(9) Duties of State Government or Union Territory Administration-

(1) The Secretary in-charge of development in the State Government or Union territory administration shall prepare their policy document with respect to management of construction and demolition of waste in accordance with the provisions of these rules within one year from date of final notification of these rules.

(2) The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste.

(3) The Town and Country planning Department shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis.

(4) Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-20%) in municipal and Government contracts subject to strict quality control.

(10) Duties of the Central Pollution Control Board - (1) The Central Pollution Control Board shall,-

(a) prepare operational guidelines related to environmental management of construction and demolition waste management;

(b) analyze and collate the data received from the State Pollution Control Boards or Pollution Control Committee to review these rules from time to time;

(c) coordinate with all the State Pollution Control Board and Pollution Control Committees for any matter related to development of environmental standards;

(d) forward annual compliance report to Central Government before the 30th August for each financial year based on reports given by State Pollution Control Boards of Pollution Control Committees.

(11) Duties of Bureau of Indian Standards and Indian Roads Congress -The Bureau of Indian Standards and Indian Roads Congress shall be responsible for preparation of code of practices and standards for use of recycled materials and products of construction and demolition waste in respect of construction activities and the role of Indian Road Congress shall be specific to the standards and practices pertaining to construction of roads.

(12) Duties of the Central Government -

(1) The Ministry of Urban Development, and the Ministry of Rural Development, Ministry of Panchayat Raj, shall be responsible for facilitating local bodies in compliance of these rules;

(2) The Ministry of Environment, Forest and Climate Change shall be responsible for reviewing implementation of these rules as and when required.

13. Timeframe for implementation of the provisions of these rules -The timeline for implementation of these rules shall be as specified in **Schedule III:**

14. Accident reporting by the construction and demolition waste processing facilities-In case of any accident during construction and demolition waste processing or treatment or disposal facility, the officer in charge of the facility in the local authority or the operator of the facility shall report of the accident in **Form-V** to the local authority. Local body shall review and issue instruction if any, to the in-charge of the facility.

Schedule I
Criteria for Site Selection for Storage and Processing or Recycling Facilities for construction and demolition Waste
[See Rule 7(1)]

(1) The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition and hand over the sites to the concerned local authority for development, operation and maintenance, which shall ultimately be given to the operators by Competent Authority and wherever above Authority is not available, shall lie with the concerned local authority.

(2) The Local authority shall co-ordinate (in consultation with Department of Urban Development of the State or the Union territory) with the concerned organizations for giving necessary approvals and clearances to the operators.

(3) Construction and demolition waste shall be utilized in sanitary landfill for municipal solid waste of the city or region as mentioned at Schedule I of thse rule. Residues from construction and demolition waste processing or recycling industries shall be land filled in the sanitary landfill for solid waste.

(4) The processing or recycling shall be large enough to last for 20-25 years (project based on-site recycling facilities).

(5) The processing or recycling site shall be away from habitation clusters, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest.

(6) A buffer zone of no development shall be maintained around solid waste processing and disposal facility, exceeding five Tonnes per day of installed capacity. This will be maintained within the

total area of the solid waste processing and disposal facility. The buffer zone shall be prescribed on case to case basis by the local authority in consultation with concerned State Pollution Control Board.

(7) Processing or recycling site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.

(8) The approach and or internal roads shall be concreted or paved so as to avoid generation of dust particles due to vehicular movement and shall be so designed to ensure free movement of vehicles and other machinery.

(9) Provisions of weigh bridge to measure quantity of waste brought at landfill site, fire protection equipment and other facilities as may be required shall be provided.

(10) Utilities such as drinking water and sanitary facilities (preferably washing/bathing facilities for workers) and lighting arrangements for easy landfill operations during night hours shall be provided and Safety provisions including health inspections of workers at landfill sites shall be carried out made.

(11) In order to prevent pollution from processing or recycling operations, the following provisions shall be made, namely:

(a) Provision of storm water drains to prevent stagnation of surface water;
(b) Provision of paved or concreted surface in selected areas in the processing or recycling facility for minimizing dust and damage to the site.
(c) Prevention of noise pollution from processing and recycling plant:
(d) provision for treatment of effluent if any, to meet the discharge norms as per Environment (Protection) Rules, 1986.

(12) Work Zone air quality at the Processing or Recycling site and ambient air quality at the vicinity shall be monitored.

(13) The measurement of ambient noise shall be done at the interface of the facility with the surrounding area, i.e., at plant boundary.

(14) The following projects shall be exempted from the norms of pollution from dust and noise as mentioned above:

For construction work, where at least 80 percent construction and demolition waste is recycled or reused in-situ and sufficient buffer area is available to protect the surrounding habitation from any adverse impact.

(15) A vegetative boundary shall be made around Processing or Recycling plant or site to strengthen the buffer zone.

Schedule II

Application of materials made from construction and demolition waste and its products.

[See Rule 7(3)]

Sl. No.	Parameters	Compliance Criteria
1	Drainage layer in leachate collection system at bottom of Sanitary Landfill Gas Collection Layer above the waste at top of Sanitary Landfill and Drainage Layer in top Cover System above Gas Collection Layer of Sanitary Landfill For capping of sanitary landfill or dumpsite, drainage layer at the top	Only crushed and graded hard material (stone, concrete etc.) shall be used having coarse sand size graded material (2mm – 4.75mm standard sieve size). Since the coarse sand particles will be angular in shape (and not rounded as for riverbed sand), protection layers of non-woven geo-textiles may be provided, wherever required, to prevent puncturing of adjacent layers or components.
2	Daily cover	Fines from construction and demolition processed waste having size up to 2 mm shall be used for daily cover over the fresh waste. Use of construction and demolition fines as landfill cover shall be mandatory where such material is available. Fresh soil (sweet earth) shall not be used for such places and borrow-pits shall not be allowed. Exception – soil excavated during construction of the same landfill. During hot windy days in summer months, some fugitive dust problems may arise. These can be minimised by mixing with local soil wherever available for limited period.
3	Civil construction in a sanitary landfill	Non-structural applications, such as kerb stones, drain covers, paving blocks in pedestrian areas.

Schedule III
Timeframe for Planning and Implementation
[See Rule 13]

Sl. No.	Compliance Criteria	Cities with population of 01 million and above	Cities with population of 0.5-01 million	Cities with population of less than 0.5 million
1	Formulation of policy by State Government	12 months	12 months	12 months
2	Identification of sites for collection and processing facility	18 months	18 months	18 months
3	Commissioning and implementation of the facility	18 months	24 months	36 months
4	Monitoring by SPCBs	3 times a year – once in 4 months	2 times a year – once in 6 months	2 times a year – once in 6 months

The time Schedule is effective from the date of notification of these rules.

FORM – I
See [Rule 7 (2)]
Application for obtaining authorisation

To,
The Member Secretary

_____Name of the local authority or Name of the agency appointed by the municipal authority :

Correspondence address Telephone No. Fax No.	
Nodal Officer and designation (Officer authorized by the competent authority or agency responsible for operation of processing or recycling or disposal facility)	
Authorisation applied for (Please tick mark)	Setting up of processing or recycling facility of construction and demolition waste
Detailed proposal of construction and demolition waste processing or recycling facility to include the following Location of site approved and allotted by the Competent Authority. Average quantity (in tons per day) and composition of construction and demolition waste to be handled	

at the specific site. Details of construction and demolition waste processing or recycling technology to be used. Quantity of construction and demolition waste to be processed per day. Site clearance from Prescribed Authority. Salient points of agreement between competent authority or local authority and operating agency (attach relevant document). Plan for utilization of recycled product. Expected amount of process rejects and plan for its disposal (e.g., sanitary landfill for solid waste). Measures to be taken for prevention and control of environmental pollution. Investment on project and expected returns. Measures to be taken for safety of workers working in the processing or recycling plant. Any preventive plan for accident during the collection, transportation and treatment including processing and recycling should be informed to the Competent Authority (Local Authority) or Prescribed Authority	
Date:	**Signature of Nodal Officer**

Form-II

See [Rule (7) (3)]
Format for Issue of Authorisation to the Operator

File No.: _____
Date : _____

To,

_____
_____
_____

Ref : Your application number _____Dt. ……

The _____ State Pollution Control Board or Pollution Control Committee after examining the proposal hereby authorizes _____ having their administrative office at _____ to set up and operate construction and demolition waste processing facility at_____ on the terms and conditions (including the standards to comply) attached to this authorisation letter.

1. The validity of this authorisation is till _____. After expiry of the validity period, renewal of authorisation is to be sought.

2. The _____ State Pollution Control Board or Pollution Control Committee may, at any time, for justifiable reason, revoke any of the conditions applicable under the authorisation and shall communicate the same in writing.

3. Any violation of the provision of the construction and demolition Waste Management Rules, 2016 shall attract the penal provision of the Environment (Protection) Act, 1986 (29 of 1986).

Date: **(Member Secretary)**
Place: **State Pollution Control Board/**
Pollution Control Committee

Form –III

See [Rule 8(2)]

Format of Annual Report to be submitted by Local Authority to the State Pollution Control Board

(i) Name of the City or Town…….
(ii) Population……
(iii) Name and address of local authority or competent authority

Telephone No : ……
Fax : …….
Email ID: …….
Website: ……..

(iv) Name of In-charge or Nodal Officer dealing with construction and demolition wastes management with designation ……

1. Quantity and composition of construction and demolition waste including any deconstruction waste

(a) Total quantity of construction and demolition waste generated during the whole year in metric ton

Any figures for lean period and peak period generation per day ……..
Average generation of construction and demolition waste (TPD)
Total quantity of construction and demolition waste collected per day
Any Processing / Recycling Facility set up in the city ……
Status of the facility

(b) Total quantity of construction and demolition waste processed / recycled (in metric ton)

Non-structural concrete aggregate :
Manufactured sand :
Ready-mix concrete (RMC) :
Paving blocks :
GSB :

Others, if any, please specify :

(c) Total quantity of Construction & Demolition waste disposed by land filling without processing (last option) or filling low lying areas

No of landfill sites used :
Area used :
Whether weigh-bridge facility used for quantity estimation? : Yes No

(d) Whether construction and demolition waste used in sanitary landfill (for solid waste) as per Schedule III

: Yes No

2. Storage facilities

(a) Area orlocation or plot or societies covered for collection of Construction and Demolition waste

(b) No. of large Projects (including roadways project) covered

(c) Whether Area or location or plot or societies collection is Practiced (if yes, whether done by Competent Authority or Local Authority or through Private Agency or Non-Governmental Organization) :

(d) Storage Bins :

	Specifications (Shape & Size)	Existing Number	Proposed for future
(i) Containers or receptacle (Capacity) :			
(ii) Others, please specify :			

(e) Whether all storage bins/collection spots are attended for daily lifting : Yes No

(e) Whether lifting of Construction & Demolition Waste from Storage bins is manual or mechanical (please tick mark) please specify mode and equipment used : Manual Mechanical Others, (specify equipment)

3. Transportation

	Existing	Actually Required/Proposed number
Truck :		
Truck-Hydraulic :		
Tractor-Trailer :		
Dumper-placers :		
Tricycle :		

Refuse-collector :
Others (Please specify) :

4. Whether any proposal has been made to improve Construction and Demolition waste management practices

5. Have any efforts been made to involve PPP for processing of Construction & Demolition waste : If yes, what is (are) the technologies being used, such as:

Processing / recycling Technology	(Quantity to be processed)	Steps taken
Dry Process	:	
Wet Process	:	
Others, if any, Please specify	:	

6. What provisions are available to check unauthorized operations of:

Encroachment on river bank or wet bodies :
Unauthorized filling of low line areas :
Mixing with solid waste :
Encroachment in Parks, Footpaths etc. :

7. How many slums are provided with construction and demolition waste receptacles facilities:

8. Are municipal magistrates appointed for taking penal action for non-compliance with these rules: Yes No
[If yes, how many cases registered & settled during last three years (give year wise details)]

Dated: **Signature of Municipal Commissioner**

Form –IV

See [Rule (8)(3)]

Format of Annual Report to be submitted by the State Pollution Control Board / Committees to the Central Pollution Control Board

To,

The Chairman,
Central Pollution Control Board,
PariveshBhawan, East Arjun Nagar,
Delhi-110032

1. Name of the State/Union territory :

2. Name & address of the State Pollution Control Board/Pollution Control Committee :

3. Number of municipal authorities responsible for management of municipal solid wastes in the State/Union territory under these rules :

4. A Summary Statement on progress made by municipal authorities in respect of implementation of **Schedule III**] : Please attach as Annexure-I

5. A Summary Statement on progress made by municipal authorities in respect of implementation of **Schedule IV** : Please attach as Annexure-II

Date: **Chairman or the Member Secretary**
State Pollution Control Board/
Place: **Pollution Control Committee**

Form –V
See [Rule14]
Accident reporting

1. Date and time of accident :

2. Sequence of events leading to accident :

3. The type of construction and demolition waste involved in accident :

4. Assessment of the effects of the accidents
   a. on traffic, drainage system and the environment :

5. Emergency measures taken :

6. Steps taken to alleviate the effects
   a. of accidents :

7. Steps taken to prevent the recurrence
   a. of such an accident :

8. Regular monthly health checkup of workers at

a. Processing / recycling site shall be made

9. Any accident during the collection,
    a. transportation and treatment including
    b. processing and recycling should be informed
    c. to the Competent Authority (Local Authority) or
    d. Prescribed Authority

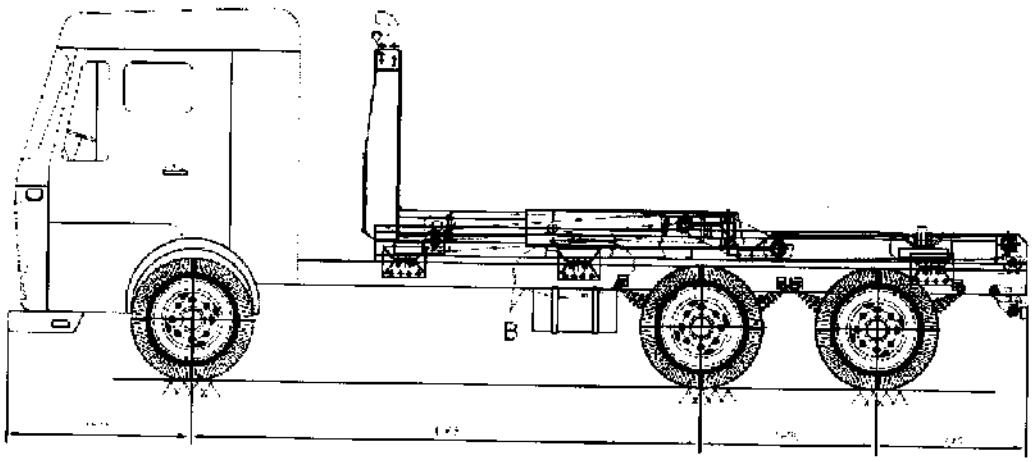
Date : Authorized Signatory
Place: Designation

[18-6/2014-HSMD]
Bishwanath Sinha, Joint Secretary

ANNEXURE : TECHNICAL SPECIFICATIONS

TATA

Sr. No	Parameters	Specification Data
I	MODEL	Hook Loader on LPT 2521/48, BSIV.
II	APPLICATION	Truck Mounted Hook Loader, suitable for lifting upto 18 M_3 volume container is designed to pick up the loaded or empty Roll on – Roll off containers, transport, dumping of material by hydraulic Tipping and thereafter unload the skip containers safely at collection site
III	ENGINE	
	Max. Power	154 KW @ 2300 RPM
	Max. Torque	750 Nm @ 1500-1700 RPM
IV	TYRES	Front- 2; Rear – 8; Spare – 1
V	WEIGHT	
	Max. Permissible GVW (kg)	25000 Kgs
	Max. Permissible FAW (kg)	6000 Kgs
	Max. Permissible RAW (kg)	19000 Kgs
VI	BODY DETAILS	
i.	Material of Construction	Mild steel plates
ii.	Power source	Vehicle PTO driven pump



Technical specification of Hook Loader on LPT 2521/48 BSIV

Truck Mounted Hook Loader, suitable for lifting upto 18 M^3 volume container is designed to pick up the loaded or empty Roll on – Roll off containers, transport, dumping of material by hydraulic Tipping and thereafter unload the skip containers safely at collection site. Hook loaders with their balanced ratio of dead weight and lifting capacity unique in their versatility and flexibility. The telescopic hook arm permits the use of containers in different lengths and therefore opens up a broad range of applications.

The tilt able hook arm with its flat lift angle yields even more variation in the containers that can be used and the applications that can be performed. Underfloor loading and jobs inside buildings become easy to handle. The design meets the requirements of all Garbage container shipments.

The Hook Loader

The Hook Loader meets the highest requirements of comfort, safety and service friendliness. The Soft Stop prevents wear and eases the burden on the truck. The slim ergonomic in-cab control serves as the central control unit with all function displays and is easy to install with the aid of a magnetic holder. The progressive control system permits sensitive working and the comfort hook ensures rapid loading operations.

The extensive safety equipment (load-holding valves on all hydraulically activated movements) meets the required safety standards due to the service-friendly design, the hydraulic control system can be expanded without difficulty to incorporate additional functions.

Features

1. Max Lifting Capacity - 20T
2. Hook Height - 1570 mm
3. Container (in customer scope)
   a. Inner length - 6000 mm
   b. Container Height - 1400 mm
   c. Max Payload - Max up to 12.9T
4. Stabilizer System - Roller Stabilizer

SAFETY FEATURES

1. Hook Safety Provided.
2. Din Locking
3. Container Locking
4. Rear Pulley
5. Under Ride Protection

PAINTING

The entire unit is painted with two coats of superior quality anti-corrosive primer with two coats of approved quality paint to ensure long lasting, resistance to rust, weathering and breakage. The color shade is purchaser's choice selected from the standard colors offered by the supplier.

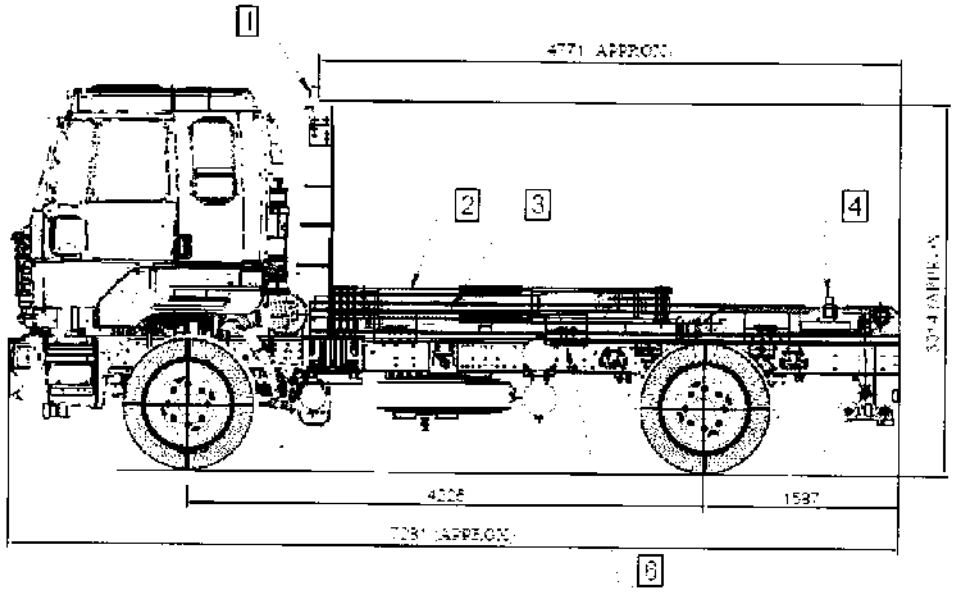
TRUCK CHASSIS

The equipment is suitable for mounting on 25 Ton GVW Truck Chassis with Driver's Cabin and PTO as per below details: -

Model: TATA LPT 2521/48 BSIV Cab (as per ARAI) GVW: 25000 Kgs
Wheel Base: 4800 mm

TATA MOTORS LIMITED

Sr. No	Parameters	Specification Data
I	MODEL	Hook Loader on LPT 1613 697 TCIC/42, BSIV.
II	APPLICATION	Truck Mounted Hook Loader, suitable for lifting the Portable Compactor with integral container unit of 10.5 Cum/Waste Containers upto 14 cum Volume hydraulically The dumping mode is achieved by operating the main rams, actuating arm and tilting frame, with jib extended, pivoting around the rear shaft.
III	ENGINE	
	Max. Power	100KW @ 2400 RPM
	Max. Torque	490 Nm @ 1400-1800 RPM
IV	TYRES	Front- 2; Rear – 4; Spare – 1
V	WEIGHT	
	Max. Permissible GVW (kg)	16200 kgs
	Max. Permissible FAW (kg)	6000 kgs
	Max. Permissible RAW (kg)	10200 kgs
VI	BODY DETAILS	
i.	Material of Construction	Mild steel plates
ii.	Power source	Vehicle PTO driven pump



TATA MOTORS LIMITED

2 III

Technical specification of Hook Loader on LPT 1613 697 TCIC/42, BSIV

Truck Mounted Hook Loader, suitable for lifting the Portable Compactor with integral container unit of 10.5 Cum/Waste Containers upto 14 cum Volume Hydraulically The dumping mode is achieved by operating the main rams, actuating arm and tilting frame, with jib extended, pivoting around the rear shaft.

Hook loaders with their balanced ratio of dead weight and lifting capacity unique in their versatility and flexibility. The telescopic hook arm permits the use of containers in different lengths and therefore opens up a broad range of applications.

The tilt able hook arm with its flat lift angle yields even more variation in the containers that can be used and the applications that can be performed. Underfloor loading and jobs inside buildings become easy to handle. The design meets the requirements of all Garbage container shipments.

The Hook Loader

The Hook Loader meets the highest requirements of comfort, safety and service friendliness. The Soft Stop prevents wear and eases the burden on the truck. The slim ergonomic in-cab control serves as the central control unit with all function displays and is easy to install with the aid of a magnetic holder. The progressive control system permits sensitive working and the comfort hook ensures rapid loading operations.

The extensive safety equipment (load-holding valves on all hydraulically activated movements) meets the required safety standards due to the service-friendly design, the hydraulic control system can be expanded without difficulty to incorporate additional functions.

Features

1. Max Lifting Capacity - 15T
2. Hook Height - 1570 mm
3. Container (in customer scope)
    a. Inner length - 5000 mm
    b. Container Height - 1100 mm
    c. Max Payload - Max up to 7.5T
4. Stabilizer System - Roller Stabilizer

SAFETY FEATURES

1. Hook Safety Provided.
2. Din Locking
3. Container Locking
4. Rear Pulley
5. Under Ride Protection

PAINTING

The entire unit is painted with two coats of superior quality anti-corrosive primer with two coats of approved quality paint to ensure long lasting, resistance to rust, weathering and breakage. The color shade is purchaser's choice selected from the standard colors offered by the supplier.

TRUCK CHASSIS

The equipment is suitable for mounting on 16 Ton GVW Truck Chassis with Driver's Cabin and PTO as per below details: -

Model: TATA LPT 1613/42 BSIV Cab (as per ARAI)

GVW: 16200 Kgs

Wheel Base: 4225 mm

TATA MOTORS LIMITED

2DXL BACKHOE LOADER CABIN, 6 IN1 BUCKET, WITH HEAVY DUTY TYRE AS STATED IN ARAI

The 2DX Backhoe Loader , manufactured by JCB India Ltd, 23/7, Mathura Road, Ballabgarh (Haryana), fitted with Kirloskar Diesel Engine with 4 cylinder, 4R 810 NA2 , complies with the provision of CMVR 1989, delivers 49.5 HP @ 2200 rpm. 6 in 1 type Bucket opening with Industrial Tyre.

Compression Ratio	18:1
Max torque	203 NM
Air Cleaner	Dry Type
Oil Filter	Spin on Type
Fuel Filter	Dual Filter Type
Oil Sump Capacity	18 Litre
Cooling System	Water Cooled
Weight of Engine	360 Kg
Bucket	6 in 1 Type
Gear Box / Model	JCB Make/ SS 500
Gear Box type	Reversing Synchro Shuttle Gears
No of Gears	4 Forward & 4 Reverse
Rear Axle Ratio	17.54:1
Steering	Hydrostatic
Flow	12.5 LPM
Rear Brake	Hydraulically Actuated Self Adjusting, Oil immersed disc brake
Total Braking Area cm^2	1339 cm^2
Front Tyre size	7.5-16, 16 PR
Rear Tyre Size	12x24, 20 PR
Battery	100 AH, 20 Hour Rating
Fuel tank	60L
Max Speed	29 Km/Hour
Seating Capacity	ONE

TECHNICAL SPECIFICATION

Manufacturer's Name and Address	SML ISUZU LIMITED, Village Asron, Distt- Shahid Bhagat Singh Nagar (Nawanshahar)
I. VEHICLE DATA	
Model	
Type (Brief Description)	**SUPER AB 3335 W/O CARGO BOX XM BSIII**
II. ENGINE	
Type	FOUR STROKE DIESEL
Bore X Stroke, mm	100 x 110
Displacement	3455cc
Compression Ratio	16.4:01+-1
Maximum engine output kw @ rpm	75KW+_2% @ 3000 rpm
Maximum torque, Nm @rpm	315 Nm @ 1500 ~ 1750 rpm
III. CAPACITY	
FUEL TANK (ltrs)	90
OIL PAN (ltrs)	6
IV. DRIVE TRAIN	
CLUTCH	DRY/SINGLE PLATE/ DIAPHGRAM TYPE
GEARS	SYNCHROMESH (5 FORWARD AND 1 REVERSE)
GEAR RATIO	1^{st}:5.833, 2^{nd}:2.855, 3^{rd}: 1.651, 4^{th}:1.000, 5^{th}:0.800,reverse:5.372
FINAL DRIVE RATIO	6.571:1
V. CHASSIS AND SUSPENSION	
FRAME	LADDER TYPE, BOX SECTION TUBULAR CROSS BRACES
SUSPENSION	FRONT& REAR: SEMI ELLIPTICAL LEAF SPRING
VI.STEERING	
TYPE	RECIRCULATING BALL AND NUT TYPE WITH VARIABLE GEAR RATIO

VII.BRAKES	
SYSTEM	DUAL CIRCUIT VACCUM ASSISTED HYDRAULIC BRAKES
VIII. DIMENSIONS	
Wheel base, mm	3335
Overall width, mm	2000
Overall Length, mm	5879
Front track, mm	1690
Rear track, mm	1486

NOTE: SPECIFICATIONS GIVEN ARE SUBJECT TO CHANGE WITHOUT NOTICE

For SML ISUZU LIMITED

(Authorised Signatory)

TECHNICAL SPECIFICATION

Manufacturer's Name and Address	SML ISUZU LIMITED, Village Asron, Distt- Shahid Bhagat Singh Nagar (Nawanshahar)
I. VEHICLE DATA	
Model	
Type (Brief Description)	**SUPER AB W/O CARGO BOX BSIV**
II. ENGINE	
Type	FOUR STROKE DIESEL
Bore X Stroke, mm	100 x 110
Displacement	3455cc
Compression Ratio	16.4:01+-1
Maximum engine output kw @ rpm	75KW+_2% @ 2800 rpm
Maximum torque, Nm @rpm	296 Nm @ 1500 ~ 50 rpm
III. CAPACITY	
FUEL TANK (ltrs)	90
OIL PAN (ltrs)	6
IV. DRIVE TRAIN	
CLUTCH	DRY/SINGLE PLATE/ DIAPHGRAM TYPE
GEARS	SYNCHROMESH (5 FORWARD AND 1 REVERSE)
GEAR RATIO	1^{st}:5.833, 2^{nd}:2.855, 3^{rd}: 1.651, 4^{th}:1.000, 5^{th}:0.800,reverse:5.372
FINAL DRIVE RATIO	6.571:1
V. CHASSIS AND SUSPENSION	
FRAME	LADDER TYPE, BOX SECTION TUBULAR CROSS BRACES
SUSPENSION	FRONT& REAR: SEMI ELLIPTICAL LEAF SPRING
VI.STEERING	
TYPE	RECIRCULATING BALL AND NUT TYPE WITH VARIABLE GEAR RATIO

VII.BRAKES	
SYSTEM	DUAL CIRCUIT VACCUM ASSISTED HYDRAULIC BRAKES
VIII. DIMENSIONS	
Wheel base, mm	3335
Overall width, mm	2000
Overall Length, mm	5879
Front track, mm	1690
Rear track, mm	1486

NOTE: SPECIFICATIONS GIVEN ARE SUBJECT TO CHANGE WITHOUT NOTICE

For SML ISUZU LIMITED

(Authorised Signatory)

SUPER AB 3335 W/O CARGO BOX XM BS III @ 22 serial No.

Variant List of Table-7 of AIS - 007

SML ISUZU

TRUCK MODELS AND VARIANTS N2 CATEGORY WITH AIR BRAKE

	VARIANT NAME	SEATING CAPACITY INCL. DRIVER	DIMENSIONS										CARGO AREA	LOAD AREA	DWG. NO.	WEIGHTS						TYRE SIZE	
			WHEEL BASE	WIDTH	LENGTH	OVERALL HEIGHT	FRONT TRACK	REAR TRACK	OVERHANG		GROUND CLEARANCE					GVW	FAW	RAW	KERB	FAW	RAW	FRONT	REAR (DUAL)
	SYMBOLS IN ENCLOSED DRAWINGS	⇨	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'J'		'L' x 'N'	'L' x 'N'									
									FRONT	REAR													
15	"SAMRAT 2815 DUAL CAB WITH CARGO" XM BS III	7	2815	2200	5454	2150	1674	1486	1044	1595	228		2590X2080	2590X2080	LP49 00 196	9500	3100	6400	3010	1520	1490	8.25-16 16PR	8.25-16 16PR
16	"SAMRAT 2815 DUAL CAB W/O CARGO" XM BS III	7	2815	2000	5387	2150	1674	1486	1044	1528	228		---	---	LP49 00 197	9500	3100	6400	2500	1300	1200	8.25-16 16PR	8.25-16 16PR
17	"SAMRAT 2815 CAB CHASSIS TIPPER SOH" XM BS III	3	2815	2000	4694	2150	1674	1486	1044	835	228		--	--	LP49 00 192	9500	3100	6400	2330	1230	1100	8.25-16 16PR	8.25-16 16PR
18	"SAMRAT 2815 WITH CARGO BOX" XM BS III	3	2815	2200	5214	2150	1674	1486	1044	1355	228		3740X2080	3740X2080	LP49 00 191	9500	3100	6400	2890	1470	1420	8.25-16 16PR	8.25-16 16PR
19	"SAMRAT 2815 WITH CARGO BOX" XM BS III	3	2815	2200	5029	2150	1674	1486	1044	1177	228		3740X2080	3740X2080	LP49 00 191	9500	3100	6400	2890	1470	1420	8.25-16 16PR	8.25-16 16PR
20	"SUPER AB 2815 CAB CHASSIS SB TIPPER" XM BS III	3	2815	2000	4694	2150	1690	1486	1044	835	206		--	--	LP49 00 142	8720	3160	5560	2330	1230	1100	7.50-16 16PR	7.50-16 16PR
21	"SAMRAT 3335 with CARGO BOX" XM BS III	3	3335	2200	5714	2150	1674	1486	1355	1595	228		4260X2080	4260X2080	LP49 00 191	10250	3370	6880	3100	1620	1480	8.25-16 16PR	8.25-16 16PR
22	"SUPER AB 3335 W/O CARGO BOX" XM BS III	3	3335	2000	5879	2150	1690	1486	1044	1500	206		---	---	LP49 00 142	8720	3160	5560	2440	1300	1140	7.50-16 16PR	7.50-16 16PR
23	"SUPER AB 3335 SEMI DECK CARGO" XM BS III	3	3335	2200	5974	2150	1690	1486	1044	1595	206		4260X2080	4260X2080	LP49 00 143	8720	3160	5560	3260	1680	1580	7.50-16 16PR	7.50-16 16PR
24	"SUPER AB 3335 STEEL HIGH DECK" XM BS III	3	3335	2200	5974	2710	1690	1486	1044	1595	206		4260X2080	4260X2080	LP49 00 144	8720	3160	5560	3420	1700	1720	7.50-16 16PR	7.50-16 16PR
25	"SUPER AB 3335 ALUMINIUM CARGO BODY" XM BS III	3	3335	2095	5974	2150	1690	1486	1044	1595	206		4260X2045	4260X2045	LP49 00 141	8720	3160	5560	2850	1500	1350	7.50-16 16PR	7.50-16 16PR
26	"SUPER AB 3335 ALUMINIUM HIGH DECK" XM BS III	3	3335	2095	5974	2710	1690	1486	1044	1595	206		4260X2045	4260X2045	LP49 00 144	8720	3160	5560	3100	1620	1480	7.50-16 16PR	7.50-16 16PR
27	"SUPER AB 3335 ALUMINIUM BOX" XM BS III	3	3335	2095	5974	2840	1690	1486	1044	1595	206		4260X2045	4260X2045	LP49 00 145	8720	3160	5560	3150	1630	1520	7.50-16 16PR	7.50-16 16PR
28	"SUPER AB 3335 DUAL CAB WITH CARGO BOX" XM BS III	7	3335	2200	5974	2150	1690	1486	1044	1595	206		3100X2080	3100X2080	LP49 00 146	8720	3160	5560	3200	1630	1570	7.50-16 16PR	7.50-16 16PR

Manufacturer: SML ISUZU LTD	Document No: SML/RND/CMVR/081,Rev - 00	Test Agency:	Cert No :
Signature	Name	Signature	
Name DEEPAK VASHISTA G.M.(R&D)	Sheet No : 6 of 33	Designation ADDL. DIRECTOR VRDE, AHMEDNAGAR	
Designation SML ISUZU LTD	Date:15th.July.2013	Date of issue	PAGE NO OF

(GRM RAO)

SUPER AB W/O CARGO BOX BS IV @ 21 serial No.

Variant List of Table-7 of AIS - 007

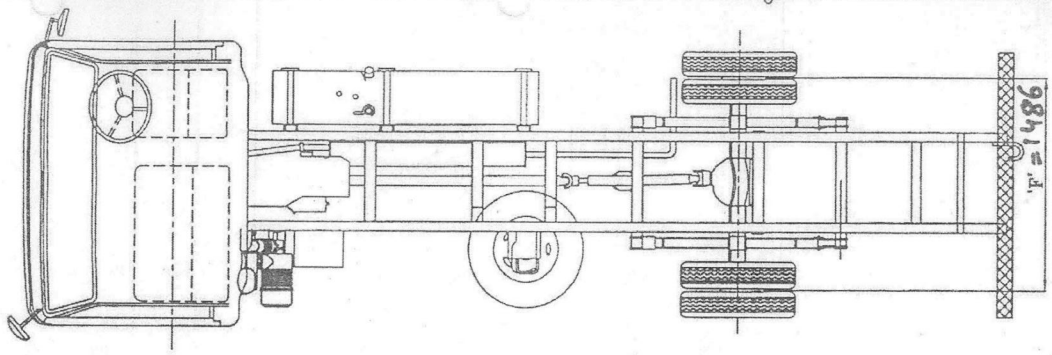
TRUCK MODELS AND VARIANTS N2 CATEGORY WITH AIR BRAKE

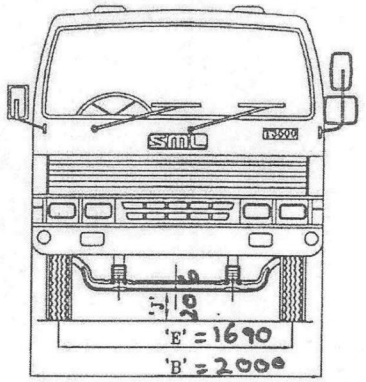
	BASIC MODEL NAME	SEATING CAPACITY INCL DRIVER	DIMENSIONS(mm)									CARGO AREA(mm)	LOAD AREA(mm)	DWG NO.	WEIGHTS(Kg)						TYRE SIZE	
			WHEEL BASE	WIDTH	LENGTH	OVERALL HEIGHT	FRONT TRACK	REAR TRACK	OVERHANG		GROUND CLEARANCE (min)											
									FRONT	REAR					GVW	FAW	RAW	KERB	FAW	RAW	FRONT (SINGLE)	REAR (DUAL)
	SYMBOLS IN ENCLOSED DRAWINGS	⟹	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'J'	'L' x 'N'	'L' x 'N'									
15	"SAMRAT 2815 DUAL CAB WITH CARGO" BS IV	7	2815	2200	5454	2092	1674	1486	1044	1595	228	2590X2080	2590X2080	LP49 00 196	9500	3100	6400	3010	1520	1490	8.25-16 16PR	8.25-16 16PR
16	"SAMRAT 2815 DUAL CAB W/O CARGO" BS IV	7	2815	2000	5367	2092	1674	1486	1044	1528	228	---	---	LP49 00 197	9500	3100	6400	2500	1300	1200	8.25-16 16PR	8.25-16 16PR
17	"SAMRAT 2815 CAB CHASSIS TIPPER SOH" BS IV	3	2815	2200	4694	2092	1674	1486	1044	835	228	---	---	LP49 00 192	9500	3100	6400	2330	1230	1100	8.25-16 16PR	8.25-16 16PR
18	"SAMRAT 2815 WITH CARGO BOX" BS IV	3	2815	2200	5214	2092	1674	1486	1044	1355	228	3740X2080	3740X2080	LP49 00 191	9500	3100	6400	2890	1470	1420	8.25-16 16PR	8.25-16 16PR
19	"SAMRAT 2815 WITH CARGO BOX" BS IV	3	2815	2200	5029	2092	1674	1486	1044	1177	228	3740X2080	3740X2080	LP49 00 191	9500	3100	6400	2890	1470	1420	8.25-16 16PR	8.25-16 16PR
20	"SAMRAT with CARGO BOX" BS IV	3	3335	2200	5714	2092	1674	1486	1355	1595	228	4260X2080	4260X2080	LP49 00 191	10250	3370	6880	3100	1620	1480	8.25-16 16PR	8.25-16 16PR
21	"SUPER AB W/O CARGO BOX" BS IV	3	3335	2000	5879	2150	1690	1486	1044	1500	206	---	---	LP49 00 142	8720	3160	5560	2440	1300	1140	7.50-16 16PR	7.50-16 16PR
22	"SUPER AB SEMI DECK CARGO" BS IV	3	3335	2200	5974	2150	1690	1486	1044	1595	206	4260X2080	4260X2080	LP49 00 143	8720	3160	5560	3260	1680	1580	7.50-16 16PR	7.50-16 16PR
23	"SUPER AB STEEL HIGH DECK" BS IV	3	3335	2200	5974	2710	1690	1486	1044	1595	206	4260X2080	4260X2080	LP49 00 144	8720	3160	5560	3420	1700	1720	7.50-16 16PR	7.50-16 16PR
24	"SUPER AB ALUMINUM CARGO BODY" BS IV	3	3335	2095	5974	2150	1690	1486	1044	1595	206	4260X2045	4260X2045	LP49 00 141	8720	3160	5560	2850	1500	1350	7.50-16 16PR	7.50-16 16PR
25	"SUPER AB ALUMINIUM HIGH DECK" BS IV	3	3335	2095	5974	2710	1690	1486	1044	1595	206	4260X2045	4260X2045	LP49 00 144	8720	3160	5560	3100	1620	1480	7.50-16 16PR	7.50-16 16PR
26	"SUPER AB ALUMINIUM BOX" BS IV	3	3335	2095	5974	2840	1690	1486	1044	1595	206	4260X2045	4260X2045	LP49 00 145	8720	3160	5560	3150	1630	1520	7.50-16 16PR	7.50-16 16PR
27	"SUPER AB DUAL CAB WITH CARGO BOX" BS IV	7	3335	2200	5974	2150	1690	1486	1044	1595	206	3100X2080	3100X2080	LP49 00 146	8720	3160	5560	3200	1630	1570	7.50-16 16PR	7.50-16 16PR

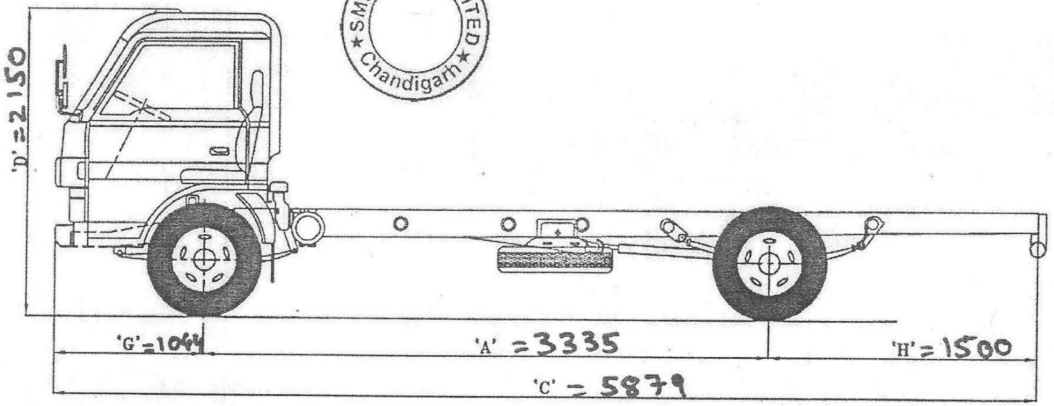
Manufacturer: SML ISUZU LTD	Document No: SML/RND/CMVR/201,Rev - 00	Test Agency: K. Kamaraj	Cert No :
Signature		Signature	
Name: DEEPAK VASHISTA	Sheet No : 06 of 33	Name: (K. KAMARAJ)	
Designation: CHIEF MANAGER R&D, SML ISUZU LTD	Date:15th.November.2011	Designation: Sc 'F' NCAT, VRDE, AHMEDNAGAR	PAGE NO OF
		Date of Issue	

Super AB w/o Cargo Box.

SML ISUZU







SML ISUZU LIMITED ★ Chandigarh ★

(A) ALL DIMENSIONS ARE IN MM UNLESS STATED OTHERWISE
(B) CODE, PRACTICE, ABBREVIATION ETC. TO IS:696
(C) WORK TO MEDIUM TOLERANCES OF IS:2102 TABLE1
PAGE 5 FOR DIMENSIONS FOR WHICH LIMITS HAVE NOT BEEN SPECIFIED.

CAD

K. Kamaraj
Sc 'F'
(K. KAMARAJ)
NCAT, VRDE, AHMEDNAGAR

DEEPAK VASHISTA
CHIEF MANAGER(R&D)
SML ISUZU LTD

NO.	DATE	MODIFICATION	ZONE	DONE	CHD.	APPD.

DRN.	DSGN.	CHD.	APPD.
DALJEET 15-04-04			

SML ISUZU LIMITED

MATERIAL	WEIGHT KG.	SCALE N.T.S	DO NOT SCALE
———	——		

MAIN PRODUCT	PART NAME	DRAWING NO.
SUPER AB TC TRUCK	LAYOUT OF W/O CARGO BOX	LP49 00 142
		SHT 1 OF 1

Specifications are subject to change without notice.

SPECIFICATIONS OF HOOK LOADER MODEL- SML SUPER AB 3335 W/O CARGO BOX XM BSIII AND SUPER AB W/O CARGO BS IV	
Model	Super AB
GVW(Max.)	8720 Kg
Wheelbase	3335 mm
BODY	
Container Capacity	5 CuM
Hydraulic Pump	High performance
Controls	Hydarulic - Manual
Arm cylinders (lift Cylinders)	2 No's Double Acting
Jib Cylinders (Slide cylinders)	1 No's Double Acting
Container Locking cylinder	1 No's Double Acting
Boom Locking	Spring actuated Mechanical Locking arrangement
Safety Device	Overloaded Protection Valve , Load Holding Valve
Painting	PU- Polyurethene (Nippon /APPG)
Note: Specs are subject to change due to improvements	

For SML ISUZU LIMITED

(Authorised Signatory)

For SML ISUZU LIMITED

(Authorised Signatory)

Item No.4

Sr. No	Parameters	Specification Data
I	MODEL	9KL Water Tanker on TATA SE1613/42 with Tata Cummins engine, BS3
	Type	Truck Chassis with Semi Forward Control Cabin
II	ENGINE	
	Max. Power	101.5Kw @ 2500 RPM
	Max. Torque	490Nm @ 1500 RPM
	Displacement	5883cc
	No. of Cylinders	6
III	CLUTCH	Dry, single plate
IV	GEARBOX	Synchromesh, 6F + 1R
V	STEERING	Power assisted
VI	SUSPENSION	Semi elliptical leaf springs at Front & Rear
IX	DIMENSIONS	
	Wheelbase (mm)	4225
X	WEIGHT	
	Max. Permissible GVW (kg)	16200
	Max. Permissible RAW (kg)	10200
	Max. Permissible FAW (kg)	6000
XI	Seating Capacity	D + 1
XII	Optional Fitment	Portable Water Pump with Captive engine

PRAVEEN PRAKASH, IAS
Joint Secretary & Mission Director (SBM)
GOVERNMENT OF INDIA
MINISTRY OF URBAN DEVELOPMENT

प्रवीण प्रकाश, आई.ए.एस.
संयुक्त सचिव एवं मिशन निदेशक (एस.बी.एम.)
भारत सरकार
शहरी विकास मंत्रालय

D.O. No. 16019/1/2014-CPHEEO Dated the 22nd December, 2015

Dear Sir/ Madam,

As you are aware, Ministry of Urban Development is implementing Swachh Bharat Mission with target to clean the country by 2nd October, 2019. Govt. of India is making all efforts to make collection and processing of C&D waste attractive and to expedite recycling and reuse of processed C&D waste.

2. In a welcome move, the Ministry of Urban Development and Ministry of Consumer Affairs have, through the Bureau of Indian Standards (BIS), taken a policy decision for ensuring effective management and utilization of C&D waste. By modifying the existing IS specification (IS 383: 2015) for Coarse and Fine aggregate used for construction purposes, BIS has paved the way for including up to 20% of C&D waste as a constituent of the aggregate in load-bearing concrete and up to 100% in non- load bearing purposes. This is a change from the earlier specification which only allowed natural aggregates such as those from river beds.

3. In view of above, I request you to take full advantage of above said provisions by making usage of C & D waste compulsory in construction activities within your jurisdiction, as it saves cost of transportation and disposal on one hand and on other hand it reduces the time and cost of construction by minimizing dependence on natural aggregates only.

With regards,

COORDINATION SECTION
Dy. No./TS No. 47
Date 12/01/16

Yours Sincerely,

(Praveen Prakash)

To

i) Secretary of all Ministries
ii) Principal Secretary of States/ UTs
iii) State Mission Director (SBM)
iv) Municipal Commissioner of 75 cities having million plus population and State Capitals
v) CPWD/ PSUs/MES
vi) JS(ST)

Office : 140-C, Nirman Bhawan, New Delhi-110011 • Mob : 9013133636, Phone : 011-23062309, Fax : 23062477
praveenprakashud@gmail.com; praveen.prakash71@nic.in

Indian Standard

PRECAST CONCRETE BLOCKS FOR PAVING — SPECIFICATION

1 SCOPE

1.1 This standard specifies constituent materials, products requirements and test methods for solid, un-reinforced pre-cast cement concrete paver blocks and complimentary products used for light, medium, heavy and very heavy traffic paving applications and other applications.

1.2 The standard does not cover concrete masonry units, cellular (hollow) concrete blocks, fly ash masonry blocks, permeable concrete blocks, grid blocks, grass stones and cement concrete flooring tiles.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Actual Dimension — Measured dimensions of a paver block.

3.2 Arris — Part of a block where two faces meet which can be bevelled, rounded, chamfered, or splayed, as shown in Fig. 1.

3.3 Aspect Ratio — The ratio of length to thickness of a paver block.

3.4 Backing Layer — Layer of concrete on the lower face of a two-layer paver block, made of material same as or different from that used in the wearing layer of the block.

3.5 Bed Face — That surface of a paver block which, when paved, comes in direct contact with the bedding material.

3.6 Chamfer — Bevelled arris, as shown in Fig. 1.

3.7 Chased Side Face — The side face of a paver block, having a recessed profile, as shown in Fig. 1.

3.8 Colour — Appearance of a paver block due to pigment used in concrete, other than natural cement colour.

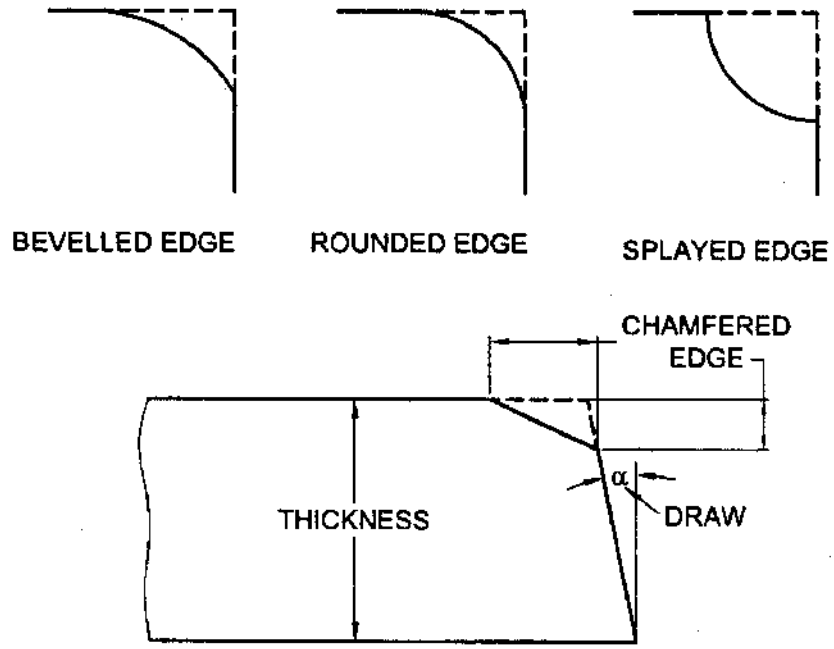


FIG. 1 EXAMPLES OF ARRIS (BEVELLED, ROUNDED, CHAMFERED) CHASED SIDE FACE AND DRAW

3.9 Complementary Product — A pre-cast usually of the shape of part of a block, used for fitting into gaps remaining in a block-paved area, for complete coverage of paved surface.

3.10 Draw — Intended angle of the side face from the vertical plane over the full height of a paver block, as shown in Fig. 1.

3.11 Efflorescence — White deposit formed on paver blocks due to diffusion of calcium hydroxide (solution slaked lime) present in cement, together with various dissolved salts, onto the external surface.

3.12 False Joints/Grooves — Regularly shaped depressions on the wearing layer of a paver block.

3.13 Format — Work dimensions of a paver block, specified in the order of overall length, overall width and thickness.

3.14 Interlocking Mechanism — The mechanism which allows adjacently paved blocks to key into one another and facilitates the sharing of shear, bending and thrust forces between adjacent blocks in a paved system.

3.15 Interlocking/Dentated/Inter-connected Paver Blocks — Paver blocks which key into one another on some or all vertical faces, when paved in any pattern.

3.16 Length — Shortest distance between farthest opposite vertical faces of a parallelopiped enclosing a paver block, excluding the dimensions due to any spacer nibs.

3.17 Overall Length — The longer side of a rectangle with the smallest area enclosing a paver block, excluding any spacer nibs.

3.18 Overall Width — Shorter side of a rectangle with the smallest area enclosing a paver block, excluding any spacer nibs.

3.19 Plan Area — Horizontal area bounded by the vertical faces of a paver block, excluding the area due to any spacer nibs.

3.20 Paver Block — Solid, un-reinforced pre-cast cement concrete paving units used in the surface course of pavements, with minimum horizontal cross-section of 50 mm from any edge in any direction, having aspect ratio not more than four, except for complementary products.

3.21 Pigment — Synthetic or natural colouring agents used in the concrete mix to produce coloured paver blocks.

3.22 Secondary Processing — Manufacturing process to texture the upper face of a paver block, executed before or after hardening of manufactured block.

3.23 Side Face — That face of a paver block which is generally in the vertical direction when paved and which faces adjacent block.

3.24 Skid Resistance — Resistance to relative movement between a vehicle tyre and the trafficked surface of a pavement.

3.25 Slip Resistance — Ability to resist relative movement between a pedestrian foot and the trafficked surface of a pavement.

3.26 Spacer Nibs — Small protruding profiles on the vertical face of a paver block used as a device for keeping minimum joint gap while paving blocks.

3.27 Squareness — Normally between the vertical faces of a paver block and the horizontal wearing surface, and parallelism between wearing surface and lower horizontal surface.

3.28 Surface Relief — Regularly shaped protrusions on the wearing surface of a paver block.

3.29 Surface Texture — Microscopic and macroscopic features of the wearing face of a paver block.

3.30 Thickness — Vertical distance between the upper face and bed face of a paver block.

3.31 Wearing Layer — Layer of concrete or mortar on the upper face of a two-layer paver block, made of material same as or different from that used in the backing layer of the block.

3.32 Wearing Face — That surface of a paver block which, when paved, faces the atmosphere and which is directly subjected to loading and movement of vehicle tyres or pedestrian traffic.

3.33 Wearing Face Area — Horizontal area bounded by the vertical faces of a paver block, minus the area reduced due to the presence of arris.

3.34 Width — Shortest distance between nearest opposite vertical faces or corners of a paver block.

3.35 Wipe — Fine cement mortar slurry applied to the upper face of a paver block or supplementary product.

3.36 Work Dimension — Any dimension of a paver block specified for its manufacture, to which the actual dimension should conform, within specified permissible tolerances.

4 MATERIALS

4.1 Cement and Cement Admixtures

4.1.1 Cement used shall be any of the following:

a) 33 Grade ordinary Portland cement conforming

to IS 269,

b) 43 Grade ordinary Portland cement conforming to IS 8112,

c) 53 Grade ordinary Portland cement conforming to IS 12269,

d) Portland slag cement conforming to IS 455,

e) Portland-pozzolana cement (fly ash based) conforming to IS 1489 (Part 1),

f) Portland-pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2), and

g) Rapid hardening Portland cement conforming to IS 8041.

4.1.2 Mineral admixtures, namely, fly ash conforming to Grade 1 of IS 3812 (Part 1), silica fume conforming to IS 15388, ground granulated blast furnace slag conforming to IS 12089 and rice husk ash and metakaoline conforming to the requirements specified in IS 456 may be used as part replacement of ordinary portland cement provided uniform blending with cement is obtained.

4.2 Aggregates

4.2.1 *Coarse Aggregates*

4.2.1.1 Coarse aggregates shall comply with the requirements of IS 383. As far as possible crushed/ semi-crushed aggregates shall be used. For ensuring adequate durability, the aggregate used for production of blocks shall be sound and free of soft or honeycombed particles.

4.2.1.2 Other types of aggregates such as slag and crushed, over-burnt brick or tile which may be found suitable with regard to strength, durability of concrete and freedom from harmful effects may be used in preparation of concrete for production of paver blocks. However such aggregates shall not contain more than 0.5 percent of sulphates as SO_3 and shall not absorb more than 2 percent of their own mass of water.

4.2.1.3 Heavy weight aggregates or light weight aggregates such as bloated clay aggregates and sintered fly ash aggregates may also be used provided the purchaser is satisfied with the data on the properties of concrete made with them.

4.2.1.4 The nominal maximum size of coarse aggregates used in production of paver blocks shall be 12 mm.

4.2.2 *Fine Aggregates*

Fine aggregates shall conform to the requirements of IS 383. Both river/quarry sand and stone dust meeting the requirements can be used.

4.3 Admixtures

Admixtures, when used shall conform to IS 9103. Previous experience with and data on such materials should be considered in relation to the specified standards of mechanization, supervision and workmanship in production of blocks. They may be added for specific requirements without affecting other quality parameters.

4.4 Pigments

4.4.1 Synthetic or natural pigments may be used in concrete mix to obtain paver blocks with desired shades of colours. The pigment used should result in durable colours of paver blocks. It shall not contain matters detrimental to concrete. Pigments, either singly or in combination, conforming to the following Indian Standards may preferably be used:

Pigments	*Relevant Indian Standard*
Black or Red or Brown pigment	IS 44
Green pigment	IS 54
Blue pigment	IS 55
or	IS 56
White pigment	IS 411
Yellow pigment	IS 50

Pigment quantity to be restricted to a maximum of 9 percent by weight of cement content. The pigment should be finer than the cement (Fineness value between 2-15 m^2/kg).

4.4.2 The pigments shall not contain zinc compounds or organic dyes.

4.4.3 Lead pigments shall not be used unless otherwise specified by the purchaser.

4.5 Water

The water used in production of paving blocks shall conform to the requirements specified in IS 456.

5 GRADE DESIGNATION OF PAVER BLOCKS AND DESIGN OF CONCRETE BLOCK PAVEMENT

Recommended grades of paver blocks to be used for construction of pavements having different traffic categories are given in Table 1. Since zero slump concrete is used in production of paver blocks, the quality of blocks produced will depend upon various parameters like the capacity of compaction and vibration of machine, grade of cement used, water content, quality of aggregates used, their gradation and mix design adopted, additives used, handling equipment employed, curing methods adopted, level of supervision, workmanship and quality control achieved, etc.

Table 1 Recommended Grades of Paver Blocks for Different Traffic Categories

(*Clauses* 5 *and* 9.1.4)

Sl No.	Grade Designation of Paver Blocks	Specified Compressive Strength of Paver Blocks at 28 Days N/mm²	Traffic Category	Recommended Minimum Paver Block Thickness mm	Traffic Examples of Application
(1)	(2)	(3)	(4)	(5)	(6)
i)	M-30	30	Non-traffic	50	Building premises, monument premises, landscapes, public gardens/parks, domestic drives, paths and patios, embankment slopes, sand stabilization area, etc
ii)	M-35	35	Light-traffic	60	Pedestrian plazas, shopping complexes ramps, car parks, office driveways, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads, etc
iii)	M-40	40	Medium-traffic	80	City streets, small and medium market roads, low volume roads, utility cuts on arterial roads, etc
iv)	M-50	50	Heavy-traffic	100	Bus terminals, industrial complexes, mandi houses, roads on expansive soils, factory floor, service stations, industrial pavements, etc
v)	M-55	55	Very heavy-traffic	120	Container terminals, ports, docks yards, mine access roads, bulk cargo handling areas, airport pavements, etc

NOTES

1 Non-traffic areas are defined as areas where no vehicular traffic occurs.

2 Light-traffic is defined as a daily traffic up to 150 commercial vehicles exceeding 30 kN laden weight, or an equivalent up to 0.5 million standard axles (MSA) for a design life of 20 years (A standard axle is defined as a single axle load of 81.6 kN).

3 Medium traffic is defined as a daily traffic of 150 – 450 commercial vehicles exceeding 30 kN laden weight, or an equivalent of 0.5 to 2.0 MSA for a design life of 20 years.

4 Heavy traffic is defined as a daily traffic of 450 – 1 500 commercial vehicles exceeding 30 kN laden weight, or an equivalent of 2.0 to 5.0 MSA for a design life of 20 years.

5 Very heavy-traffic is defined as a daily traffic of more than 1 500 commercial vehicles exceeding 30 kN laden weight, or an equivalent of more than 5.0 MSA for a design life of 20 years.

6 PHYSICAL REQUIREMENTS

6.1 General

6.1.1 The physical requirements of paver blocks are categorized into two groups, namely:

a) Obligatory requirements shall be for ensuring durability of pavements constructed with paver blocks as well as obtaining better levels of service in block paving work, and

b) Optional requirements shall be as per the specific demands of the purchaser. These are described in **6.2** and **6.3**.

6.1.2 All paver blocks shall be sound and free of cracks or other visual defects which will interfere with the proper paving of the unit or impair the strength or performance of the pavement constructed with the paver blocks.

6.1.3 When two layer paver blocks are manufactured there shall be proper bonding between the layers. Delamination between the layers shall not be permitted. The compressive strength of the two layer blocks shall meet the specified requirements.

6.1.4 When paver blocks with false joints, surface reliefs or projections are supplied, the same shall be specified. Also, the surface features shall be well formed and be devoid of any defects.

6.2 Obligatory Requirements

6.2.1 *Visual Inspection*

Visual inspection of quality of paver blocks shall be

carried out in natural daylight, prior to the tests for other properties. The inspection shall be conducted by the purchaser and the manufacturer jointly at a location agreed to between them, normally at the site or factory. Visual inspection shall be conducted as per **7.1**.

NOTE — When efflorescence occurs and it is not deleterious to the performance of the blocks in use and is not considered significant.

6.2.2 *Dimensions and Tolerances*

6.2.2.1 The recommended dimensions and tolerances for paver blocks, measured as per the method in Annex B, are given in Table 2. Minimum block thickness shall be 50 mm and maximum 120 mm. The thicknesses 60 mm, 80 mm, 100 mm and 120 mm will be considered as standard thicknesses under this specification.

6.2.2.2 All blocks manufactured to meet this specification shall have arris/chamfer as per the dimensions and tolerances given in Table 2.

6.2.3 *Thickness of Wearing Layer*

When paver blocks are manufactured in two layers, the wearing layer shall have minimum thickness as specified in Table 2. The thickness of the wearing layer shall be measured at several points along the periphery of the paver blocks. The arithmetic mean of the lowest two values shall be the minimum thickness of the wearing layer.

6.2.4 *Water Absorption*

The water absorption, being the average of three units, when determined in the manner described in Annex C, shall not be more than 6 percent by mass and in individual samples, the water absorption should be restricted to 7 percent.

6.2.5 *Compressive Strength*

6.2.5.1 Compressive strength of paver blocks shall be determined as per the method given in Annex D. Paver block strength shall be specified in terms of 28 days compressive strength. In case the compressive strength of paver blocks is determined for ages other than 28 days, the actual age at testing shall be reported. The average 28 days compressive strength of paver blocks shall meet the specified requirement. Individual paver block strength shall not be less than 85 percent of the specified strength. In case blocks of age less than 28 days are permitted to be supplied, correlation between 28 days strength and the strength at specified age for identified batch/mix of blocks shall be established.

6.2.5.2 The specified average 28 days compressive strengths of different grades of paver blocks are given in Table 3 and the minimum specified strengths of individual paver blocks are given in **6.2.5.1**.

Table 2 Recommended Dimensions and Tolerance for Paver Blocks

(*Clauses* 6.2.2.1, 6.2.2.2, 6.2.3 *and* 9.1.2)

Sl No.	Dimension	Measurement Method, Ref to	Recommended Values	Tolerance Limit for Paver Block	
				Thickness < 100 mm	Thickness ≥ 100 mm
(1)	(2)	(3)	(4)	(5)	(6)
i)	Width, W	Annex B	To be specified by manufacturer	± 2 mm	± 3 mm
ii)	Length, L	Annex B	To be specified by manufacturer	± 2 mm	± 3 mm
iii)	Thickness, T	Annex B	50 to 120 mm	± 3 mm	± 4 mm
iv)	Aspect ratio (L/T)	Annex B	Maximum : 4.0	+ 0.2	+ 0.2
v)	Arris/chamfer	Annex B	Minimum: 5 mm Maximum : 7 mm	± 1 mm	± 1 mm
vi)	Thickness of wearing layer	**6.2.3**	Minimum : 6 mm	+ 2 mm	+ 2 mm
vii)	Plan area, A_{SP}	Annex B	Maximum : 0.03 m^2	+ 0.001m^2	+ 0.001m^2
viii)	Wearing face area, A_{SW}	Annex B	Minimum 75 percent of Plan Area	− 1 percent	− 1 percent
ix)	Squareness	Annex B	Nil	± 2 mm	± 3 mm

Table 3 Compressive Strength Requirements of Concrete Paver Blocks

(*Clauses* 6.2.5.2 *and* 9.1.4)

Sl No.	Grade of Paver Blocks	Minimum Average 28 Days Compressive Strength N/mm²
(1)	(2)	(3)
i)	M-30	≥ f_{ck} + 0.825 × established standard deviation (rounded off to nearest 0.5 N/mm²)
ii)	M-35	
iii)	M-40	
iv)	M-50	
v)	M-55	

6.2.6 *Abrasion Resistance*

The abrasion resistance of paver blocks should be determined as per the method given in Annex E. It may be specified the limits to the test results, which should be complied with by the manufacturer.

6.3 Optional Requirements

6.3.1 *Tensile Splitting Strength*

The tensile splitting strength of paver blocks should be determined as per the method given in Annex F. When required by the purchaser, the test values for tensile splitting strength of paver blocks may be specified by the manufacturer.

6.3.2 *Flexural Strength/Breaking Load*

The flexural strength/breaking load of paver blocks should be determined as per the method given in Annex G. When required by the purchaser, the test values for flexural strength breaking load of paver blocks may be specified by the manufacturer.

6.3.3 *Freeze-Thaw Durability*

The freeze-thaw durability test of paver blocks should be conducted as per the method given in Annex H. When required for application in freez-thaw environment, the purchaser may specify limits to the test results, which should be complied with by the manufacturer.

6.3.4 *Colour and Texture*

When required, the colour and texture of paver blocks should be mutually agreed to between the purchaser and the manufacturer.

7 TEST METHODS

7.1 Visual inspection shall be conducted by first examining each paver block from a sample lot for any elimination. The blocks shall then be laid out on a level floor in any desired paving pattern, approximately covering a square area of 1 m². Any visual defects of paver blocks, including cracks and flaking, shall be recorded by observing the paved blocks from a distance of approximately 2 m from each edge of the paved area. The texture and colour of the paver blocks shall be compared with the manufacturer's free samples supplies earlier to the purchaser.

7.2 Tests other than for visual aspects shall be carried out in a laboratory agreed to between the purchaser and the manufacturer. Wherever applicable, calibrated equipment shall be used for tests.

7.3 Compliance with the obligatory physical requirements laid down in **6.2** shall be ensured by conducting tests as described in Annexes B to E. Compliance with optional physical requirements laid down in **6.3** shall be ensured by conducting tests as described in Annexes F to H.

7.4 Unless otherwise specified in the enquiry or order, the cost of the tests shall be borne as follows:

a) By the manufacturer, in the event of the test results showing that the paver blocks do not conform to this specification, or

b) By the purchaser, in the event of the test results showing that the paver blocks conform to this specification.

8 SAMPLING

8.1 When the product has been submitted to an assessment of conformity by a third party, acceptance testing is not required, except in case of dispute between the purchaser and the manufacturer, when acceptance testing may be carried out. In such cases, depending upon the circumstances of the case in dispute, the required number of blocks shall be sampled from each batch of the consignment of blocks up to a quantity of 50 000 blocks.

8.2 When the product has not been submitted to an assessment of conformity by a third party, the required number of blocks shall be sampled from each batch of the consignment of blocks up to a quantity of 25 000 blocks.

8.3 When the quantity of a partial batch is less than half of the quantities mentioned in **8.1** and **8.2**, that partial batch of the consignment shall be added to the previous full batch.

8.4 The paver blocks selected for testing shall be representative of the consignment, the points of selection being evenly distributed through the consignment.

8.5 The number of blocks to be sampled from each batch for each test shall be as given in Table 4.

Table 4 Sampling Requirements

(*Clause* 8.5)

Sl No.	Property	Requirement Ref to Cl No.	Test Method Ref to	Number of Paver Blocks for Test	
				Quality Assurance by Third Party	Quality Assurance by Manufacturer/ Purchaser[1]
(1)	(2)	(3)	(4)	(5)	(6)
i)	Visual Inspection	6.2.1	7.1	8[2]	4 (16)[2]
ii)	Dimensions	6.2.2	Annex B	8[2]	4 (16)[2]
iii)	Thickness of wearing layer[3]	6.2.3	6.2.3	8[2]	4 (16)[2]
iv)	Water absorption	6.2.4	Annex C	3	3
v)	Compressive strength	6.2.5	Annex D	8	4 (16)
vi)	Tensile splitting strength	6.3.1	Annex E	8	4 (16)
vii)	Flexural strength/ breaking load	6.3.2	Annex F	8	4 (16)
viii)	Abrasion resistance	6.2.6	Annex G	8	4 (16)
ix)	Freeze-thaw durability	6.3.3	Annex H	3	3

[1] The number within brackets is the number to be sampled to avoid secondary sampling from the batch if on the basis of the conformity criteria, additional blocks are required to be tested to assess conformity.

[2] These blocks may be used for subsequent tests.

[3] Only apply for blocks with a separate every layer.

8.6 The sample paver blocks shall be marked for future identification of the consignment it represents. The block shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind till they are required for test. The test shall be undertaken as soon as practicable after the sample has been taken.

9 ACCEPTANCE CRITERIA

9.1 Obligatory Requirements

9.1.1 The lot shall be considered as conforming to the requirements of this specification if the conditions mentioned in **9.1.2** to **9.1.4** are satisfied.

9.1.2 The sampled blocks tested for dimensions, aspect ratio, chamfer, plan area, wearing face area, deviation from squareness, and, in the case of two layer blocks, thickness of wearing layer shall meet the tolerance limit specified in Table 2. Blocks with visual defects with sample lot shall not be more than three.

9.1.3 For water absorption, the mean value of 3 samples determined shall be not more than the maximum limit specified in **6.2.4**.

9.1.4 The 28 days compressive strengths and tolerance of 8 numbers of paver blocks manufactured as per the grades of paver blocks recommended in Table 1 shall be as given in Table 3.

9.2 Optional Requirements

Acceptance criteria for optional requirements shall be as per mutual agreement by the purchaser and manufacturer.

10 MARKING

10.1 Concrete paver block/package shall be marked with the following information suitably:

a) Identification of the manufacturer,

b) Grade of paver blocks, and

c) Date of manufacture.

10.2 BIS Certification Marking

The paver blocks may also be marked with the Standard Mark.

10.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
44 : 1991	Specification for iron oxide pigments for paints (*second revision*)
50 : 1980	Specification for lead and scarlet chromes (*third revision*)
54 : 1988	Specification for green oxide of chromium for paints (*second revision*)
55 : 1970	Specification for ultramarine blue for paints (*first revision*)
56 : 1993	Specification for Prussian blue (iron blue) for paints (*second revision*)
269 : 1989	Specification for 33 grade ordinary Portland cement (*fourth revision*)
383 : 1970	Specification for coarse and fine aggregates from natural sources for concrete (*third revision*)
411 : 1991	Specification for titanium dioxide, anatase, for paints (*third revision*)
455 : 1989	Specification for Portland slag cement (*fourth revision*)
456 : 2000	Code of practice for plain and reinforced concrete (*fourth revision*)
516 : 1959	Method of test for strength of concrete
1237 : 1980	Specification for cement concrete flooring tiles (*first revision*)
1489	Specification for Portland Pozzolana cement:
(Part 1) : 1991	Fly ash based (*third revision*)
(Part 2) : 1991	Calcined clay based (*third revision*)
2185 (Part 1) : 1979	Specification for concrete masonry units: Part 1 Hollow and solid concrete blocks (*second revision*)
3812 (Part 1) : 2003	Specification for pulverized fuel ash: Part 1 For use as pozzolona in cement, cement mortar and concrete (*second revision*)
8041 : 1990	Specification for rapid hardening Portland cement (*second revision*)
8112 : 1989	Specification for 43 grade ordinary Portland cement (*first revision*)
9103 : 1999	Specification for concrete admixtures (*first revision*)
12089 : 1987	Specification for granulated slag for manufacture of Portland slag cement
12269 : 1987	Specification for 53 grade ordinary Portland cement
15388 : 2003	Specification for silica fume

ANNEX B

(*Clauses* 6.2.2.1, 7.3 *and* D-4.1 and *Tables* 2 *and* 4)

METHOD FOR DETERMINATION OF DIMENSIONS, ASPECT RATIO, PLAN AREA, WEARING FACE AREA AND DEVIATION FROM SQUARENESS

B-1 LENGTH, WIDTH, THICKNESS AND ASPECT RATIO

B-1.1 Apparatus

The apparatus shall comprise:

a) Steel callipers, and

b) Steel rule capable of measuring up to 300 mm to an accuracy of 0.5 mm.

B-1.2 Specimens

The paver block specimens, selected from the group of blocks of specified shape, size and thickness as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

B-1.3 Procedure

B-1.3.1 *Length and Width*

The length and width of the specimen (*see* Fig. 2) shall be measured across two opposite faces by using the steel callipers or steel rule. Two representative positions shall be used for measurement of length and three for measurement of width. The mean values of length and width for the block shall be noted to the nearest 1 mm.

B-1.3.2 *Thickness*

The thickness of the specimen (*see* Fig. 2) shall be measured at four different positions. The mean value of the thickness of the block shall be noted to the nearest 1 mm.

B-1.3.3 *Aspect Ratio*

The aspect ratio of the specimen shall be calculated by dividing the mean length by the mean depth as determined by the procedures in **B-1.3.1** and **B-1.3.2** and shall be noted to the nearest 0.1.

B-2 ARRIS

B-2.1 Apparatus

The apparatus shall comprise of steel callipers.

B-2.2 Specimens

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

B-2.3 Procedure

The depth and width of arris of the specimen (*see* Fig. 2) shall be measured across two opposite faces, to the nearest 0.1 mm, by using the steel callipers. Four representative positions shall be used for measurement of depth and width. The mean values of depth and width of arris for the block shall be noted to the nearest 0.1 mm.

B-3 PLAN AREA AND WEARING FACE AREA

B-3.1 Apparatus

The apparatus shall comprise:

a) Balance capable of weighing 1 N to an accuracy of 0.000 1 N;

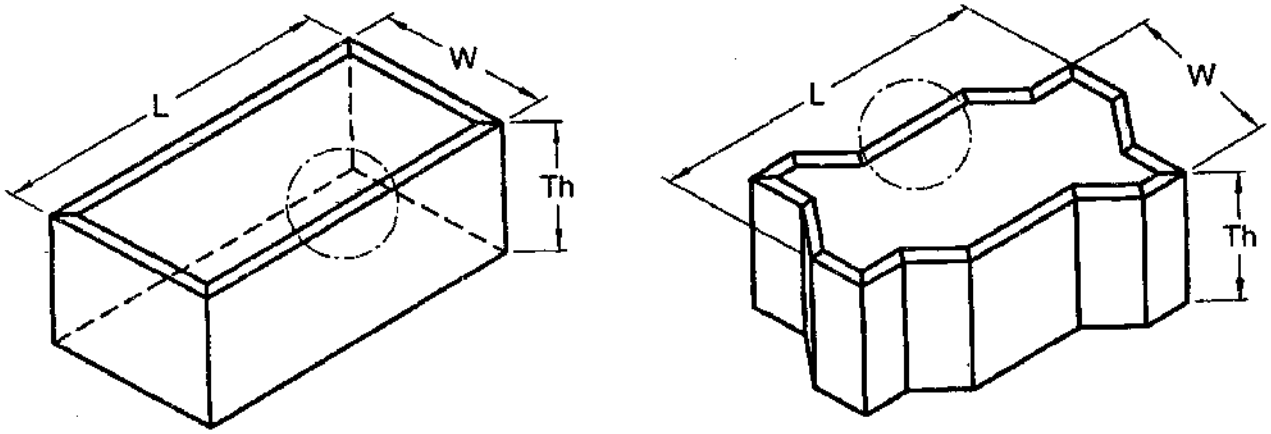


FIG. 2 LENGTH (*L*), WIDTH (*W*) AND THICKNESS (*Th*) OF PAVER BLOCKS

b) Sheets of thin cardboard of uniform thickness;

c) Sharp pencil;

d) Odd-leg marking gauge (*see* Fig. 3);

e) Sharp scissors; and

f) Steel rule marked with graduations of 0.5 mm.

B-3.2 Specimens

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

B-3.3 Procedure

B-3.3.1 *Plan Area (A_{sp}) (Method 1)*

The test specimen shall then be weighed, while suspended by a metal wire, and completely submerged in water, and the weight shall be recorded in N to the nearest 0.01 N (W_a). They shall be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh. Visible water on the specimen shall be removed with a damp cloth. The specimen shall then be immediately weighed and the weight for each specimen noted in N to the nearest $0.01N(W_w)$. The volume of the specimen shall be calculated as follows:

$$\text{Volume} = (W_w - W_a)\ 10^{-3}\ \text{m}^3$$

The thickness of the specimen in mm shall be determined as per **B-1.3.2**. The volume shall be divided by thickness to obtain plan area in mm^2.

In the case of rectangular specimens, the plan area may also be calculated by multiplying the length by the width, as determined by the procedure in **B-1.3.1**.

B-3.3.2 *Plan Area (A_{sp}) (Method 2)*

The specimen shall be placed, wearing face facing up, on the cardboard and its perimeter traced with the pencil. The shape shall be cut out accurately with the scissors and weighed to the nearest 0.000 1 N, and the result recorded as mass m_{sp}. A rectangle measuring 200 mm × 100 mm, accurately cut out from the same cardboard, shall also be weighed to the nearest 0.000 1 N, and the result recorded as mass m_{std}. The plan area for the block shall be calculated from the

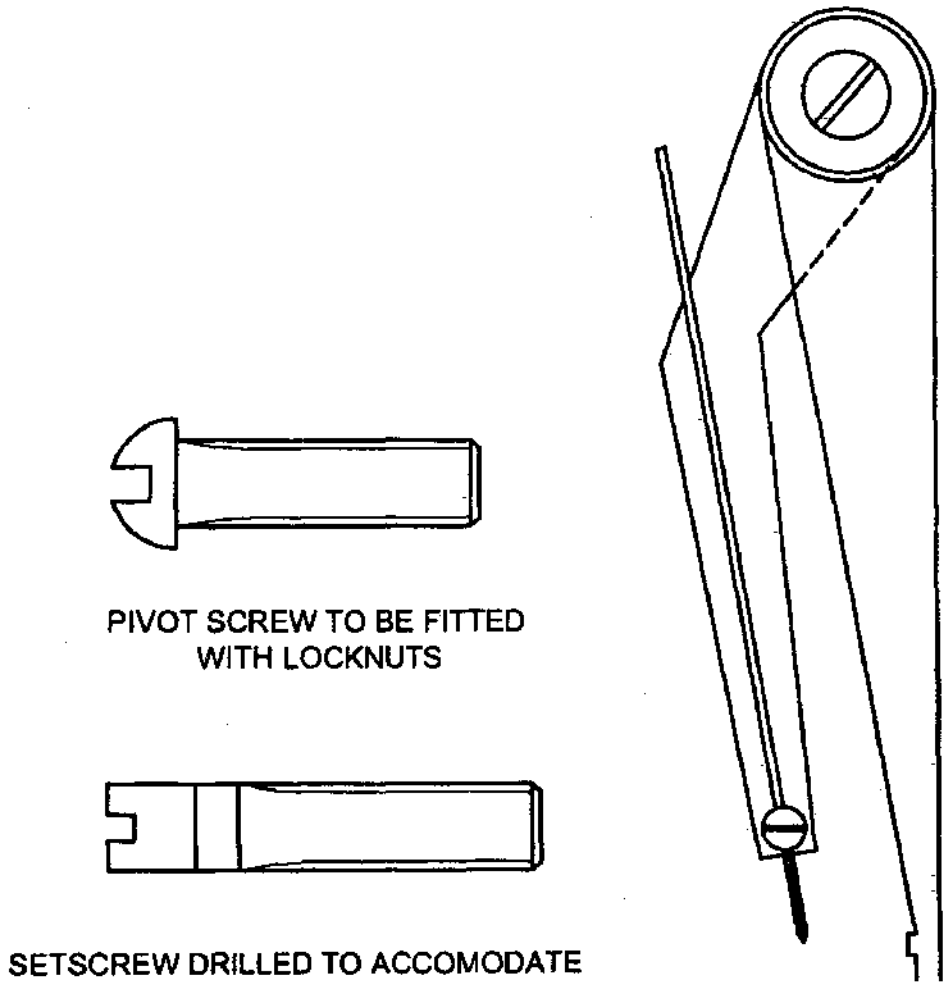


FIG. 2 LENGTH (L), WIDTH (W) AND THICKNESS (Th) OF PAVER BLOCKS

formula:

$$A_{sp} = \frac{20\,000\, m_{sp}}{m_{std}} \text{ mm}^2$$

B-3.3.3 *Wearing Face Area (A_{sw})*

The width of the arris of the block shall be measured at four different locations and their mean value determined. A ballpoint pen refill shall be fixed to the odd-leg marking gauge and the gauge shall be set to the measured mean value of width of the arris. The gauge so set shall be used to draw a line, indicating the width of the arris, along the periphery of the cardboard shape of the plan area of the block with mass m_{sp}, as obtained in **B-3.3.2**. The marked arris width on the cardboard shall be neatly cut away with the scissors, and the cardboard shall be weighed to the nearest 0.000 1 N and the result recorded as mass m_{sw}. The wearing face area for the block shall be calculated from the formula:

$$A_{sw} = \frac{20\,000\, m_{sp}}{m_{std}} \text{ mm}^2$$

B-4 DEVIATION FROM SQUARENESS

B-4.1 Apparatus

The apparatus shall comprise:

a) Engineer's square or a profiled template, and

b) Feeler gauges.

B-4.2 Specimens

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

B-4.3 Procedure

With the stock of the square or profiled template in contact with the top or bottom surface of the block, the blade shall be brought into contact with the vertical face of the block. The clearance, if any, between the square or profiled template and the vertical face of the block shall be measured to the nearest 0.1 mm with the feeler gauge at points 10 mm inside each top and bottom edge of the block. This measurement shall be repeated at six sensibly different locations around the block, and the average of the feeler gauge measurement noted as the deviation from squareness for the block, which shall be noted to the nearest 0.1 mm.

B-5 REPORT

The individual and average values of measured dimensions, arris, aspect ratio, plan area, wearing face area and deviation from squareness of specimens tested as per **B-1, B-2, B-3** and **B-4** shall be reported.

ANNEX C

(*Clauses* 6.2.4 *and* 7.3 and *Table* 4)

METHOD FOR DETERMINATION OF WATER ABSORPTION

C-1 APPARATUS

The balance used shall be sensitive to within 0.5 percent of the mass of the smallest specimen tested.

C-2 SPECIMENS

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

C-3 PROCEDURE

C-3.1 Saturation

The test specimen shall be completely immersed in water at room temperature for 24 ± 2 h. The specimen then shall be removed from the water and allowed to drain for 1 min by placing them on a 10 mm or coarser wire mesh. Visible water on the specimens shall be removed with a damp cloth. The specimen shall be immediately weighed and the weight for each specimen noted in N to the nearest 0.01 N (W_w).

C-3.2 Drying

Subsequent to saturation, the specimens shall be dried in a ventilated oven at 107 ± 7°C for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss not greater than 0.2 percent of the previously determined mass of the specimen. The dry weight of each specimen (W_d) shall be recorded in N to the nearest 0.01N.

C-4 CALCULATION

C-4.1 Percent Water Absorption (W Percent)

The percent water absorption shall be calculated as follows:

$$W \text{ percent} = \frac{W_w - W_d}{W_d} \times 100$$

C-5 REPORT

The individual and average values of measured water absorption of specimens tested as per **C-1** to **C-4** shall be reported.

ANNEX D

(*Clauses* 6.2.5.1 *and* 7.3 and *Table* 4)

METHOD FOR DETERMINATION OF COMPRESSIVE STRENGTH

D-1 APPARATUS

D-1.1 Testing Machine

The apparatus shall comprise of compression testing machine which shall be equipped with two steel bearing blocks for holding the specimen. It is desirable that the blocks have a minimum hardness of 60 (HRC) and a minimum thickness of 25 mm. The block on top through which load is transmitted to the specimen shall be spherically seated. The block below on which the specimen is placed shall be rigidly fitted. When the bearing area of the steel blocks is not sufficient to cover the bearing area of the paver block specimen, two steel bearing plates meeting the requirements of **D-1.2** shall be placed between the steel plates fitted on the machine and the specimen.

D-1.2 Steel Bearing Blocks and Plates

The surfaces of the steel bearing blocks and plates shall not depart from the plane by more than 0.025 mm in any 15 mm dimension. The centre of the sphere of the spherically seated upper bearing block shall coincide with the centre of the bearing surface. If bearing plate is used, the centre of the sphere of the upper bearing block shall be on a line passing vertically through the centroid of the specimen bearing face. The spherically seated block shall be held closely in its seat, but shall be free to turn in any direction. The diameter of the face of the bearing blocks shall be at least 150 mm. When steel plates are employed between the steel bearing blocks and the specimen, the plates shall have a thickness equal to at least one-third the distance from the edge of the bearing block to the most distant corner of the specimen. In no case shall the plate thickness be less than 12 mm.

D-2 SPECIMENS

The paver block specimens selected as per the sampling procedure in **8** and as per the number of specimens mentioned in Table 4 shall be tested.

D-3 CAPPING OF SPECIMENS

D-3.1 The upper face of the specimens shall be capped by one of the methods described in **C-3.1** and **C-3.2** of Annex C of IS 2185 (Part I).

D-3.2 Alternatively, 4 mm thick plywood sheets of size larger than the specimens by a margin of at least 5 mm from all edges of the specimen shall be used for capping the specimens.

D-3.3 When specimen with surface projections or surface relief features has to be tested, its upper face shall be made plain by suitable capping, such as by using sulphur or gypsum, before testing.

D-4 PROCEDURE

D-4.1 The dimensions and plan areas of the specimens shall be determined as described in Annex B. The blocks shall be stored for 24 ± 4 h in water maintained at a temperature of 20 ± 5°C. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates.

D-4.2 The load shall be applied without shock and increased continuously at a rate of 15 ± 3 N/mm^2/min until no greater load can be sustained by the specimen or delamination occurs. The maximum load applied to the specimen shall be noted in *N*.

D-5 CALCULATION

The apparent compressive strength of individual specimen shall be calculated by dividing the maximum load (in *N*) by the plan area (in mm^2). The corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor from Table 5. The strength shall be expressed to the nearest 0.1 N/mm^2.

Table 5 Correction Factors for Thickness and Arris/Chamfer of Paver Block for Calculation of Compressive Strength

Sl No.	Paver Block Thickness mm	Correction Factor for	
		Plain Block	Arrised/Chamfered Block
(1)	(2)	(3)	(4)
i)	50	0.96	1.03
ii)	60	1.00	1.06
iii)	80	1.12	1.18
iv)	100	1.18	1.24
v)	120	1.28	1.34

For other thickness of paver blocks between 50 mm and 120 mm, linear extrapolation of concrete factor shall be made.

D-6 REPORT

The individual and average compressive strength of the specimens tested as per **D-1** to **D-5** shall be reported.

ANNEX E

(*Clauses* 6.2.6 *and* 7.3 and *Table* 4)

METHOD FOR DETERMINATION OF ABRASION RESISTANCE

E-1 APPARATUS

The abrasion testing machine shall be the same as described in Annex F of IS 1237 (*see* Fig. 4).

E-2 SPECIMENS

E-2.1 Square-shaped specimens measuring 71.0 ± 0.5 mm shall be cut from the block specimens selected as per the sampling procedure in **8** and as per the number of specimens mentioned in Table 4. The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in E-4, the opposite face shall, if appropriate, be ground parallel or otherwise machined so as to be parallel.

E-2.2 For testing dry specimens, the specimens shall be dried to constant mass at a temperature of 105 ± 5°C.

E-2.3 For testing wet/saturated specimens; the specimens shall be immersed in water for 7 days and wiped with a damp artificial sponge prior to each weighing (*see* **E-3**) so that all specimens appear equally damp.

E-3 PROCEDURE

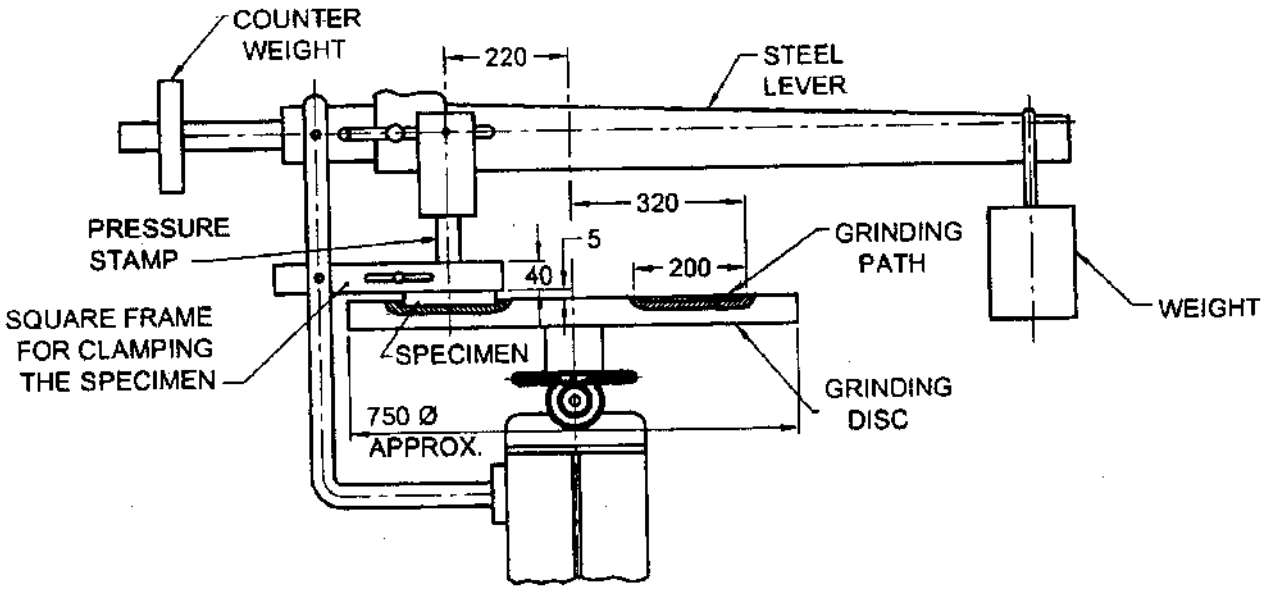
E-3.1 The density of the specimen, *PR* shall be determined nearest to 0.1 g. The weight of the specimen shall be noted to nearest 0.1 g both prior to the abrasion test and after every four cycles (*see* **E-4**).

E-3.2 In the case of two-layer specimens, the density of specimens taken separately from the wearing layer shall be determined.

E-3.3 The grinding path of the disc of the abrasion testing machine shall be evenly strewn with 20 g of the standard abrasive powder as per **F-3** of IS 1237. The specimen shall be fixed in the holding device such that the testing surface faces the grinding disc. The specimen shall be centrally loaded with 294 ± 3 N.

E-3.4 The grinding disc shall be run at a speed of 30 rpm. The disc shall be stopped after one cycle of 22 revolutions. The disc and contact face of the specimen shall be cleaned of abrasive powder and debris. The specimen shall be turned 90° in the clockwise direction and 20 g of abrasive powder shall be evenly strewn on the testing track before starting the next cycle.

E-3.5 When testing wet/saturated specimens, prior to each cycle, the track shall be wiped with a lightly damp artificial sponge and moistened before being strewn with the abrasive powder. From the start of the test, arrangement shall be made for drip-wetting of the central portion of the track, about 30 mm from the specimen (opposite to the direction of motion of



All dimensions in millimetres.

FIG. 4 GENERAL FEATURES OF ABRASION TESTING MACHINE

the disc), by supplying water drops at the rate of 180 to 200 drops (13 ml) per minute. During this test, it should be ensured that the abrasive powder continuously returns to the effective area of the track.

E-3.6 The test cycle shall be repeated 16 times, the specimen being turned 90° in the clockwise direction and spreading of 20 g of abrasive powder on the testing track after each cycle.

E-4 CALCULATION

The abrasive wear of the specimen after 16 cycles of testing shall be calculated as the mean loss in specimen volume, ΔV, from the equation:

$$\Delta V = \frac{\Delta m}{PR}$$

Where :

ΔV = loss in volume after 16 cycle, in mm^3;

Δm = loss in mass after 16 cycles, in g; and

PR = density of the specimen, or in the case of two-layer specimens, the density of the wearing layer, in g/mm^3.

E-5 REPORT

The abrasive wear shall be reported to the nearest whole number of 1 000 mm^3 per 5 000 mm^2.

ANNEX F

(*Clauses* 6.3.1 *and* 7.3 and *Table* 4)

METHOD FOR DETERMINATION OF TENSILE SPLITTING STRENGTH

F-1 APPARATUS

F-1.1 The testing machine shall have a scale with an accuracy of ± 3 percent over the range of the anticipated test loads and be capable of increasing the load at specified rates. The machine shall be equipped with a device composed of two rigid bearers (*see* Fig. 5) whose contact surface has a radius of 75 ± 5 mm. The two bearers shall be held in the same vertical plane with a tolerance of ± 1 mm at the bearers' end. The upper bearer shall be able to rotate in its transverse axis. The two packing pieces shall be 15 ± 1 mm wide (*see* 'b' in Fig. 5), 4 ± 1 mm thick (*see* 'a' in Fig. 5) and at least 10 mm longer than the anticipated fracture plane. The packing pieces shall be made of a material that meets the hardness criterion given in **F-1.2**.

F-1.2 When submitted to a punching test by means of a rod of circular cross-section, having a diameter of 16 ± 0.5 mm and applying a force at the rate of 48 ± 3 kN/min, the instantaneous penetration when the force of 20 ± 5 kN is achieved shall be equal to 1.2 ± 0.4 mm.

F-2 SPECIMENS

The paver block specimens selected as per the sampling procedure in **8** and as per the number of specimens mentioned in Table 4 shall be tested.

F-3 PREPARATION

Whole specimens shall be used and any burrs, high spots, etc, shall be removed. In case a face is rough, textured or curved, it shall be prepared by grinding or capping. The least amount of material shall be removed to obtain a flat face. The specimens shall be immersed in water at 20 ± 5°C for 24 ± 3 h, removed, wiped dry and immediately tested. Other methods of preparation may be used for routine testing, provided there is a correlation between the two methods, for example, using ungrounded rough textured or curved specimens instead of ground specimens.

F-4 PROCEDURE

F-4.1 The specimen shall be placed on the testing machine with the packing pieces on the upper face and the bed face, in contact with the bearers. It shall be ensured that the packing pieces and the axes of the bearers are in line with the splitting section of the specimen. The splitting section shall be chosen according to the following order of priority:

a) The test is carried out along the longest splitting section of the specimen, parallel and symmetrical to the edges, in such a way that the distance of the splitting section to any side face is at least 0.5 times the thickness of the specimen over at least 75 percent of splitting section area.

b) If the condition in (a) cannot be met, the test is carried out along two splitting sections, chosen in such a way that the distance from one splitting section to the other splitting section or to any side face of the specimen is at least 0.5 times the thickness of the specimen over at least 75 percent of the splitting section length considered.

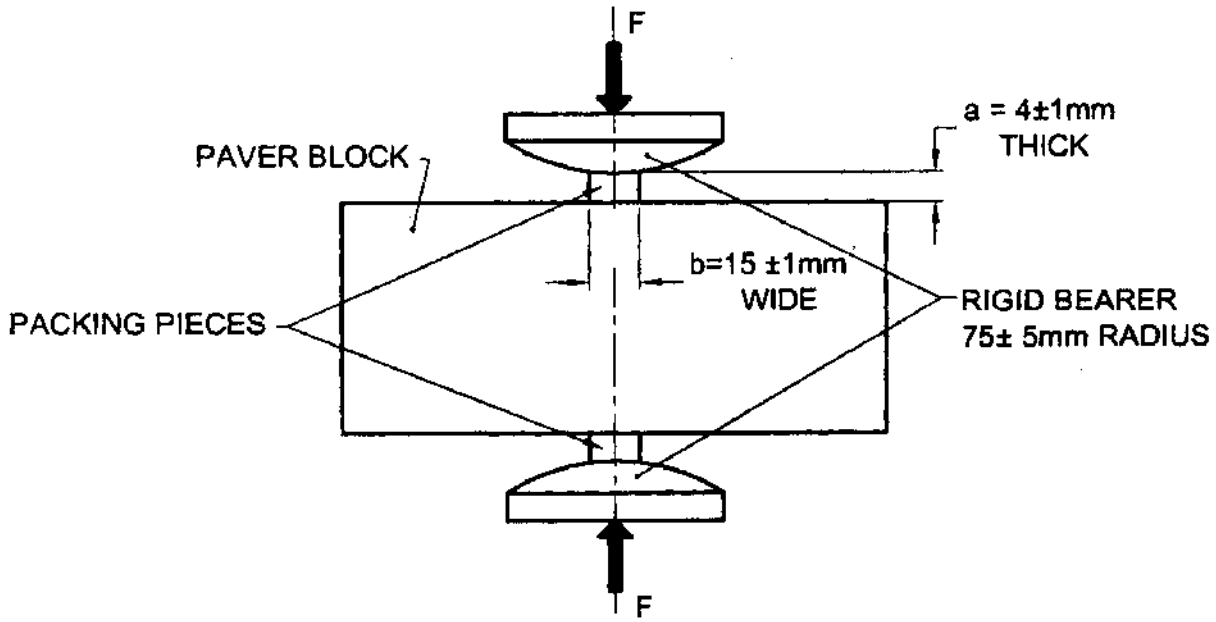


FIG. 5 TENSILE SPLITTING STRENGTH TEST SETUP

c) If neither of the conditions in (a) or (b) can be met, the splitting section shall be chosen in such a way that the greatest total proportional section length satisfying the distance requirement is obtained.

d) In case the section of the specimen is square, hexagonal or circular in plan, the splitting section shall be chosen in such a way that it is the shortest length passing through the centre of the plan area.

F-4.2 The load is smoothly and progressively applied at a rate which corresponds to an increase in stress of 0.05 ± 0.01 MPa. The failure load (P) is recorded in N, to the nearest 0.01 N.

F-5 CALCULATION

F- 5.1 The area of the failure plane(s) of the specimen tested are calculated from the equation:

$$S = l \times t$$

where

S = area of the failure, in mm^2;

l = mean of two measurements of the failure length, one at the top and one at the bottom of the specimen, in mm; and

t = mean of three measurements of thickness at the failure plane, one in the middle and one at either end, in mm.

F-5.2 The tensile splitting strength of the test specimen is calculated from the equation:

$$T = 0.637 \times k \times (P/S)$$

where

T = tensile splitting strength, in MPa; and

P = failure load N.

F-5.3 The failure load per unit length of the specimen is calculated for the equation:

$$F = (P/l)$$

where F is the failure load, in N/mm.

F-5.4 If testing is conducted along two transverse sections of the same specimen, the splitting tensile strength of the specimen is the mean of the two individual results.

F-6 REPORT

The test report shall include the following information:

a) T, the tensile splitting strength of the specimen to the nearest 0.1 MPa; and

b) F, the failure load per unit length of the specimen to the nearest 10 N/mm.

ANNEX G

(*Clauses* 6.3.2 *and* 7.3 and *Table* 4)

METHOD FOR DETERMINATION OF FLEXURAL STRENGTH/BREAKING LOAD

G-1 APPARATUS

The apparatus for the test shall be the same as in 8 of IS 516, with the following modifications:

a) The supporting and loading rollers shall have diameter in the range of 25 to 40 mm. They shall extend on both sides beyond the dimensions of the specimens by at least 10 mm;

b) The distance from centre-to-centre of the two supporting rollers shall be adjustable to the overall length of the specimen minus 50 mm; and

c) The loading roller shall be arranged for application of load from the top of the specimen along the vertical centreline between the supporting rollers.

G-2 SPECIMENS

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens in Table 4 shall be tested.

G-3 CAPPING OF SPECIMENS

G-3.1 The test specimens shall be capped by one of the methods described in D-3 of Annex D.

G-3.2 When specimen with surface projections or surface relief features has to be tested, its upper face shall be made plain by suitable capping, such as by using sulphur or gypsum before testing.

G-4 PROCEDURE

The test procedure shall be the same as in 8 of IS 516, with the following modifications:

a) The load shall be applied from the top of the specimen in the form of a simple beam loading through a roller placed midway between the supporting rollers, as shown in Fig. 6. Loading of irregular-shaped specimens shall be as shown in Fig. 7.

b) The load shall be applied without shock and increased continuously at a uniform rate of 6 kN/min.

c) The load shall be increased until the specimen fails, and the maximum load applied shall be recorded to the nearest *N*.

G-5 CALCULATION

The flexural strength of the specimen shall be calculated as follows:

$$F_b = \frac{3Pl}{2bd^2}$$

where

f_b = flexural strength, in N/mm^2;

P = maximum load , in *N*;

l = distance between central lines of supporting rollers, in mm;

b = average width of block, measured from both faces of the specimen, in mm; and

d = average thickness, measured from both ends of the fracture line, in mm.

The maximum load P shall be reported as the breaking load, nearest to 1 *N*.

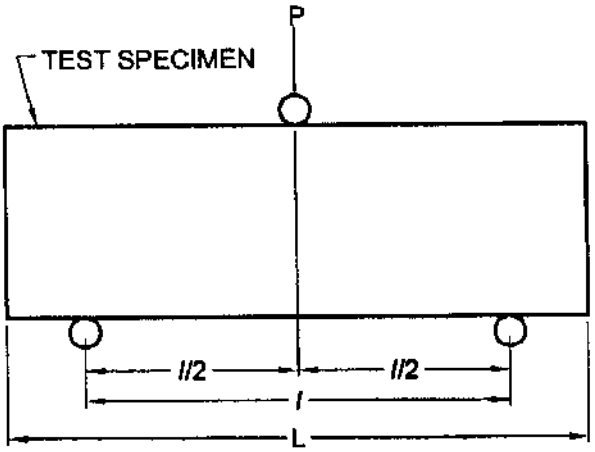
G-6 REPORT

The individual and average flexural strength and breaking load of the specimens tested as per G-1 to G-5 shall be reported.

G-7 SUGGESTED VALUES OF CHARACTERISTIC BREAKING LOAD

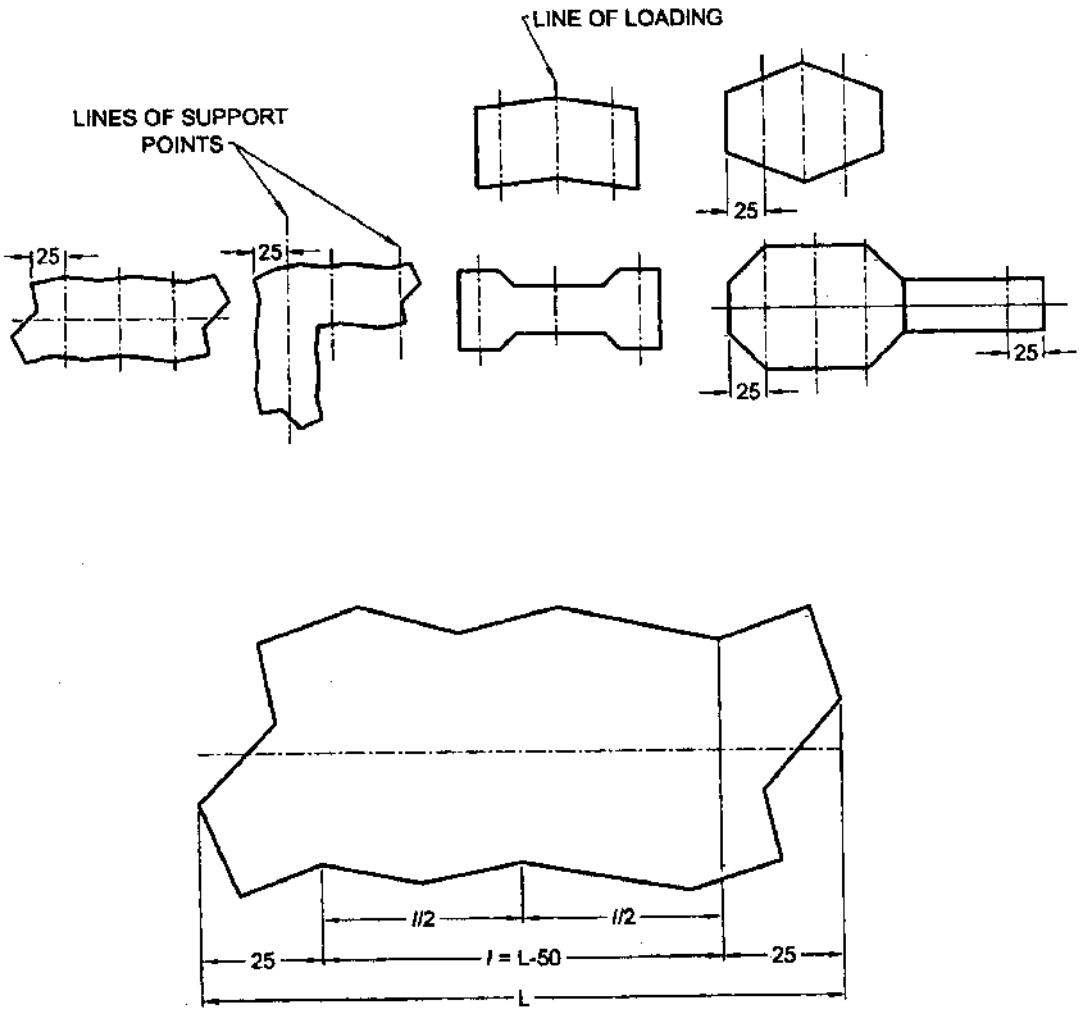
The suggested values of minimum breaking load for different applications are given below:

Application	*Minimum Breaking Load*, kN
Residential pathways/public pedestrian paths	2
Residential driveways — Light vehicles/public pedestrian and light vehicle paths	3
Residential driveways — Commercial vehicles/public pedestrian and commercial vehicle paths	5
Regularly trafficked roads	6
Heavy duty/industrial roads	7



L - OVERALL LENGTH OF THE SPECIMEN
PARALLEL TO THE LONGITUDINAL AXIS (mm)
l - OVERALL LENGTH 50mm
P - LOAD

FIG. 6 METHOD OF LOADING TEST SPECIMEN FOR FLEXURAL STRENGTH/BREAKING LOAD



All dimensions in millimetres.

FIG. 7 LOADING OF COMMON IRREGULAR SHAPES OF FLEXURAL STRENGTH/BREAKING LOAD TEST

ANNEX H

(*Clauses* 6.3.3 *and* 7.3 and *Table* 4)

METHOD OF DETERMINATION OF FREEZE-THAW DURABILITY

H-1 SCOPE

This method covers the determination of the resistance of concrete paver blocks to repeated cycles of freezing and thawing when fully submerged in 3 percent sodium chloride solution.

H-2 APPARATUS

H-2.1 The freezing apparatus shall consist of a suitable cabinet or cold room with controls to reach and maintain an air temperature of –15 ± 2°C within 1 h of the introduction of specimens.

H-2.2 The thawing chamber (cabinet or room) shall be suitable to maintain a controlled air temperature of 23 ± 3°C.

H-2.3 The moist chamber (cabinet or room) shall be suitable to maintain a controlled air temperature of 23 ± 2°C and a relative humidity of 90 percent. If storage in water is desirable, a saturated lime solution shall be used, and the temperature shall be maintained at 23 ± 2°C.

H-2.4 For measuring fine spalled material, a balance having a capacity of not less than 500 g sensitive to 0.1 g shall be used. For measuring the dry weight of paver blocks, a balance having a capacity of not less than 5 000 g sensitive to 1 g shall be used.

H-2.5 The drying oven shall be capable of being maintained at 110 ± 5°C, and the rate of evaporation shall average at least 25 g per hour. This rate shall be determined by the loss of water from 1 L Griffin low-form beakers, each containing 500 g of water at a temperature of 23 ± 2°C, placed at each corner and at the centre of each shelf of the oven, and heated for at least 4 h, during which period the doors of the oven shall be kept closed.

H-2.6 The containers shall be made of non-corroding material and have such dimensions as to permit complete submersion of the specimens in the saline solution.

H-3 SPECIMENS

The paver block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in Table 4 shall be tested.

H-4 PROCEDURE

H-4.1 The specimens shall be oven dried for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss of not greater than 0.2 percent of the last previously determined weight of the specimen.

H-4.2 One freeze-thaw cycle shall be completed every 24 h. The cycle shall consist of 16 ± 1 h of freezing, followed by 8 ± 1 h of thawing. If for any reason a thaw period cannot commence at the specified time, the specimens shall remain in a frozen condition until conditions are suitable for resumption of the test.

H-4.3 Following the completion of the oven drying and cooling to room temperature, the specimens shall be placed in individual containers with the bottom surface of the specimens resting on the glass, stainless steel, ceramic, or plastic spacers (approximately 3 mm high) to ensure exposure of at least 95 percent of the bottom surfaces to the saline solution.

H-4.4 The containers shall be filled with a 3 percent sodium chloride solution at a temperature of 23 ± 3°C for 24 h. The level of the solution shall be at least 2 mm above the surface of the specimens, but excess volume of solution shall be avoided in order to ensure rapid freezing of the specimens.

H-4.5 Following the 24 h saturation period, the specimens shall be subjected to continuous freeze-thaw cycles as outlined in **H-4.2**.

H-4.6 After 10, 25 and 50 cycles the specimens shall be washed with 3 percent sodium chloride solution to remove all loose particles. These particles and spalled material, collected at the bottom of the containers, shall be washed, stained through a filter, and dried to constant weight. This residue shall be defined as weight loss and expressed as a percent of the initial dry weight of the specimens. The residue shall be cumulatively weighed after 10, 25 and 50 cycles.

H-4.7 A new solution of 3 percent sodium chloride shall be used following each weight loss determination. The 24 h pre-soaking period shall be waived at 10 and 25 cycles, provided that the specimens are maintained in a saturated condition during weight determinations.

H-5 CALCULATION

H-5.1 The weight loss shall be calculated to the nearest 0.01 percent.

H-5.2 The test shall continue until 50 freeze-thaw cycles have been completed unless the test specimens have disintegrated or lost more than 1.0 percent of their original dry weight. If, because of high spalling losses or disintegration, testing of the specimen has

to be terminated prematurely, the weight loss shall be determined (*see* **H-4.6**) and added to the previous lost weight.

H-6 REPORT

The report shall include the following:

a) Identification of specimens;

b) Dimensions;

c) Weight losses of the specimens and the average results after 10, 25 and 50 cycles or at the time of termination of the test;

d) Number of cycles at termination time;

e) Visual rating of the specimens after 10, 25 and 50 cycles in accordance with the following scale:

1) 0 : no scaling;

2) 1 : very slight scaling (3 mm depth maximum. No coarse aggregate visible);

3) 2 : slight to moderate scaling;

4) 3 : moderate scaling (some coarse aggregates visible on 50 percent of the surface);

5) 4 : moderate to severe scaling (some coarse aggregates visible on 75 percent of the surface);

6) 5 : severe scaling (coarse aggregates visible on 100 percent of the surface);

f) Description of the damages suffered by the specimens, and photographs where possible;

g) Manufacturer;

h) Date; and

j) Batch.

H-7 GUIDE FOR DURABILITY CHARACTERISTICS

H-7.1 As a guide to the purchaser, the durability characteristics given in **H-7.2** may be adopted.

H-7.2 When tested in accordance with this method, the average weight loss of three paver blocks, after having been subjected to 50 freeze-thaw cycles while totally immersed in a 3 percent sodium chloride solution, shall not exceed 1.00 percent of the initial constant dry weight of the specimens.

ANNEX J

(Foreword)

COMMITTEE COMPOSITION

Flooring, Wall Finishing and Roofing Sectional Committee , CED 5

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Building Materials and Technology Promotion Council, New Delhi	SHRI S. K. GUPTA SHRI PANKAJ GUPTA (*Alternate*)
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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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1700

Structural Concrete

1701 DESCRIPTION

The work shall consist of furnishing concrete mixes, transporting and placing structural concrete including fixing formwork and temporary works etc. and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Engineer.

1702 MATERIALS

All materials shall conform to Section 1000 of these Specifications.

1703 GRADES OF CONCRETE

1703.1 The grades of concrete shall be designated by the characteristic strength as given in Table 1700-1, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 1700-1

Group	Grade Designation	Specified characteristic compressive strength of 150 mm cubes at 28 days, in MPa
Ordinary Concrete	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High strength Concrete*	M 60	60
	M 65	65
	M 70	70
	M 75	75
	M 80	80

* For high strength concrete, design parameters may be obtained from the specialized literature and experimental results.

1703.2 The lowest grades of concrete in bridges and corresponding minimum cement contents and water-cement ratios shall be maintained as indicated in Tables 1700-2 and 1700-3

Table 1700-2 For Bridges With Prestressed Concrete or those with Individual Span Lengths More than 60 M or those that are Built with Innovative Design/Construction.

(A) Minimum Cement Content and Maximum Water Cement Ratio

Structural Member	Min. cement content for all exposure conditions (kg/cu.m)	Max. water cement ratio for all exposure conditions
a) PCC members	360	0.45
b) RCC members	380	0.45
c) PSC members	400	0.40

(B) Minimum Strength of Concrete

Member	Conditions of Exposure	
	Moderate	Severe
a) PCC members	M 25	M 30
b) RCC members	M 35	M 35
c) PSC members	M 35	M 40

Table 1700-3 For Bridges other than those Mentioned in Table 1700-2 and for Culverts and other Incidental Construction

(A) Minimum Cement Content and Maximum Water Cement Ratio

Structural Member	Min. cement content (kg/cu.m)		Max. water cement ratio	
	Exposure conditions		Exposure conditions	
	Moderate	Severe	Moderate	Severe
a) PCC members	250	310	0.50	0.45
b) RCC members	310	360	0.45	0.40

(B) Minimum Strength of Concrete

Member	Conditions of Exposure	
	Moderate	Severe
a) PCC members	M 15	M 20
b) RCC members	M 20	M 25

Notes Applicable to Tables 1700-2 and 1700-3

i) The minimum cement content is based on 20 mm aggregates (nominal max. size). For 40 mm and larger size aggregates, it may be reduced suitably but the reduction shall not be more than 10 percent.

ii) For underwater concreting, the cement content shall be increased by 10 percent.

iii) Severe conditions of exposure shall mean alternate wetting and drying due to sea spray, alternate wetting and drying combined with freezing and buried in soil having corrosive effect, members in contact with water where the velocity of flow and the bed material are likely to cause erosion of concrete.

(iv) Moderate conditions of exposure shall mean other that those mentioned in (iii) above.

The cement content shall be as low as possible but not less than the quantities specified above. In no case shall it exceed 450 kg/cu.m of concrete.

1703.3 Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. “Design Mix” or “Nominal Mix”. For all items of concrete, only “Design Mix” shall be used, except where “Nominal Mix” concrete is permitted as per drawing or by the Engineer. “Nominal Mix” may be permitted only for minor bridges and culverts or other incidental construction where strength requirements are upto M 20 only. “Nominal Mix” may also be permitted for non-structural concrete or for screed below open foundations.

1703.4 If the Contractor so elects, the Engineer may permit the use of higher grade concrete than that specified on the drawing, in which event the higher grade concrete shall meet the specifications applicable thereto without additional compensation.

1704 PROPORTIONING OF CONCRETE

Prior to the start of construction, the Contractor shall design the mix in case of “Design Mix Concrete” or propose nominal mix in case of “Nominal Mix Concrete”, and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor’s option, subject to the approval of the Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Engineer.

1704.1 Requirements of Consistency

The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency. Slump test shall be used to measure consistency of the concrete.

The optimum consistency for various types of structures shall be as indicated in Table 1700-4, or as directed by the Engineer. The slump of concrete shall be checked as per IS:516.

Table 1700-4

	Type		SLUMP (mm) (at the time of placing of concrete)
1	a)	Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b)	plain cement concrete	25
2.	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining		40 - 50
3.	RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm		50 - 75
4.	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm		75 - 125
5.	Underwater concreting through tremie e.g. bottom plug, cast-in-situ piling		100 - 150

However, notwithstanding the optimum consistency indicated under Sl. No. 1 to 3, the situation at hand should be property assessed to arrive at desired workability with the adjustment in admixture in each case where the concrete is to be transported through transit mixer and placed using concrete pump. Under these circumstances, the optimum consistency during placement for the item of mark from Sl. No. 1 to 3 can be considered ranging from 50-100 mm this is, however, subject to satisfying the other essential criteria of strength, durability, finishing in trial mix design stage and approval of the Engineer.

1704.2 Requirements for Design Mixes

1704.2.1 Target mean strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the “current margin”.

i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

ii) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 1700-5 :

Table 1700-5

Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69
M60	14	74

The initial current margin given in Table 1700-5 shall be used till sufficient data is available to determine the current margin as per sub-clause (i) above.

1704.2.2 Trial mixes

The Contractor shall give notice to the Engineer to enable him to be present at the making of trial mixes and preliminary testing of the cubes. Prior to commencement of trial mix design, all materials forming constituents of proposed design mix should have been tested and approval obtained in writing from the Engineer. Based on test results of material, draft mix design calculation for all grades shall be prepared taking into account the provisions in the Contract Technical Specifications, guidelines of IS:10262 IRC:SP:23, IRC:21 and submitted to the Engineer for approval. Prior to commencement of concreting,

trial mix design shall be performed for all grades of concrete, and trial mix which has been found successful should be submitted by the Contractor and approval obtained. During concreting with the approved Trial Mix Design, if source of any constituents is changed, the mix design shall be revised and tested for satisfying the strength requirements.

The initial trial mixes shall generally be carried out in an established laboratory approved by the Engineer. In exceptional cases, the Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. In all cases complete testing of materials forming the constituents of proposed Design Mix shall be carried out prior to making trial mixes.

Sampling and testing procedures shall be in accordance with these Specifications.

When the site laboratory is utilized for preparing initial mix design, the concreting plant and means of transport employed to make the trial mixes shall be similar to that proposed to be used in the works.

Test cubes shall be taken from trial mixes as follows. For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these Specifications. The average strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa

1704.2.3 Control of strength of design mixes

a) Adjustment to Mix Proportion

Adjustment to mix proportions arrived at in the trial mixes shall be made subject to the Engineer's approval, in order to minimize the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

b) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with Clause 1704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced subsequently.

c) Additional Trial Mixes

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in

the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with sub-clause (a) above

1704.3 Requirements of Nominal Mix Concrete

Requirements for nominal mix concrete unless otherwise specified, shall be as given in Table 1700-6.

Table 1700-6 Proportions for Nominal Mix Concrete

Concrete Grade	Total Quantity of dry aggregate by mass per 50 kg of cement to be taken as the sum of individual masses of fine and coarse aggregates (kg)	Proportion of fine to coarse aggregate (by mass)	Maximum quantity of water for 50 kg of cement (litres)	
			PCC	RCC
M 15	350	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5	25	
M 20	250		25	22

1704.4 Additional Requirements

Concrete shall meet any other requirements as specified on the drawing or as directed by the Engineer. Additional requirements shall also consist of the following overall limits of deleterious substances in concrete :

a) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to values given below:

- Prestressed Concrete : 0.1 percent
- Reinforced concrete exposed to chlorides in service (e.g.structures located near sea coast) : 0.2 percent
- Other reinforced concrete construction : 0.3 percent

b) The total sulphuric anhydride (SO) content of all the constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4 percent.

1704.5 Suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the Engineer's approval :

a) Nature and source of each material

b) Quantities of each material per cubic metre of fully compacted concrete

c) Either of the following :

i) appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement (s) as specified.

ii) full details of tests on trial mixes.

d) Statement giving the proposed mix proportions for nominal mix concrete

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

1704.6 Checking of mix proportions and water cement ratio

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the manufacturer's weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weiged from bulk stock at site and not by bag, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible, frequency for a given job being determined by the Engineer according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates IS:2386 (part III) shall be referred to. Suitable adjustments shall also be made in the weight of aggregates to allow for the variation in weight of aggregates due to variation in their moisture content.

1704.7 Grading of aggregates for concrete

Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe.

The grading of aggregates shall be continuous and shall have sufficient ultra fine materials (material finer than 0.25 mm). Proportion of fine aggregates passing through 0.25 mm shall be between 15 and 30 percent and that passing through 0.125 mm sieve shall not be less than 5 percent of the total volume of aggregate. Admixtures to increase workability can be added. When pumping long distances and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactorily after adding plasticisers and super plasticisers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

1705 ADMIXTURES

Use of admixtures such as superplasticisers, air extraining, water reducing, accelerating retardation etc for concrete may be made with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of their products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the work. Admixtures/additives conforming to IS:6925 and IS:9103 may be used subjected to approval of the Engineer. However, admixers/additives generating Hydrogen or Nitrogen and containing Chlorides, Nitrates, Sulphides, Sulphates and any other material likely to adversely affect the steel or concrete shall not be permitted.

The general requirements for admixtures are given in Section 1012.

1706 SIZE OF COARSE AGGREGATES

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as given Table 1700-7.

Table 1700-7

Components	Maximum Nominal Size of Coarse Aggregate (mm)
i) RCC well curb	20
ii) RCC/PCC well steining	40
iii) Well cap or Pile Cap Solid type piers and abutments	40
iv) RCC work in girder, slabs wearing coat, kerb, approach slab, hollow piers and abutments, peir/abutment caps, piles	20
v) PSC Work	20
vi) Any other item	As specified by the Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values :

a) 10 mm less than the minimum lateral clear distances between main reinforcements

b) 10 mm less than the minimum clear cover to the reinforcements

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

1707 EQUIPMENT

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under :

a) For Production of Concrete :

i) For overall bridge length of less than 200 m – bath type concrete mixer diesel or electric operated, with a minimum size of 200 litres, automatic water measuring system and integral with minimum (hydraulic/pneumatic type)

i) For overall bridge length of 200 m or more – concrete batching and mixing plant fully automatic with minimum capacity of 15 cu.m per hour.

All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Its accuracy shall be checked over the range in use, when set up at each site and thereafter periodically as directed by the Engineer.

The accuracy of the measuring devices shall fall within the following limits :

Measurement of Cement : 2 percent of the quantity of cement in each batch

Measurement of Water : 3 percent of the quantity of water in each batch

Measurement of Aggregate : 3 percent of the quantity of aggregate in each batch

Measurement of Admixture : 3 percent of the quantity of admixture in each batch

b)	For Transportation concrete of	:	depending upon actual requirement
	i) Concrete dumpers		minimum 2 tonnes capacity
	ii) Powered hoists		minimum 0.5 tonne capacity
	ii) Chutes		
	iii) Buckets handled by cranes		
	iv) Transit truck mixer		
	v) Concrete pump		
	vi) Concrete distributor booms		
	vii) Belt conveyor		
	viii) Cranes with skips		
	ix) Tremies		
c)	For Compaction of Concrete	:	
	i) Inter vibrators		size 25 mm to 70 mm
	ii) Form vibrators		minimum 500 watts
	iii) Screed vibrators		full width of carriageway (upto two lanes)

1708 MIXING CONCRETE

1708.1 Mixing at Site

Concrete shall be mixed either in concrete mixer or in a batching and mixing plant, as per these specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than 2 minutes. It shall be ensured that the mixers are not loaded above their rated capacities and shall be operated at a speed recommended by the Manufacturer.

Mixers which have been out of use of more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

1708.2 Ready Mix Concrete

Ready mix concrete will be proportioned and mixed off the project site and delivered to the construction site in a freshly mixed and unhardened state, conforming to IS:4926 shall be allowed with the approval of the Engineer.

1708.3 Concreting Process

Once the concreting of a section is started, it has to be completed as a continuous operation. To ensure this, Contractor shall submit to the Engineer his programme backed with resources like availability of adequate equipments for batching, mixing, transporting and placing concrete prior to start of the concreting. Concreting of a section shall have to be done as a continuous operation to be completed within a reasonable time.

1709 TRANSPORTING, PLACING AND COMPACTION OF CONCRETE

The method of transporting and placing concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation or loss of its constituent materials takes place. Concrete shall not be freely dropped into place from a height exceeding 2 m.

The equipment for transporting and placing concrete shall have means for discharging concrete without segregation.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

Placing Concrete with pumps :

Pipelines from the pump to the placing area shall be laid with minimum bends. For large quantity placements, standby pumps shall be available. Suitable air release valves, shutoff valves etc shall be provided as per the site requirements. The pumping of concrete shall precede pumping of priming mix i.e. rich mix of creamy consistency, to lubricate the concrete pump and pipelines. Continuous pumping shall be done to the extent possible. After concreting, the pipelines and accessories shall be cleaned immediately. A plug spung ball shall be inserted at the end near the pump and shall be forced through the pipeline by either water or by air pressure. The pipes for pumping shall not be made of material which have adverse effect on concrete. Aluminum alloy pipelines shall not be used.

All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

No concrete shall be placed in any part of the structure until the approval of the Engineer has been obtained.

If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases.

Concrete when deposited shall have a temperature of not less than 5^{o}C, and not more than 40^{o}C. It shall be compacted in its final position within 30 minutes of its discharge from the mixer, unless carried in properly designed agitator, operating continuously, when this time shall be within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the lacing of each bath of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdown.

Mechanical vibrators used shall comply with IS:2502, IS:2506, IS:2514 and IS:4656.

1710 CONSTRUCTION JOINTS

Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with the express approval of the Engineer. The joints shall be provided in a direction perpendicular to the member axis.

Location, preparation of surface and concreting of construction joints shall conform to the additional specifications given in *Appendix 1700/I.*

1711 CONCRETING UNDER WATER

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used shall be got approved from the Engineer before any work is started. Concrete shall contain 10 percent more cement than that required for the same mix placed in the dry to compensate the loss due to wash.

Concrete shall not be placed in water having a temperature below 5^{o}C. The temperature of the concrete, when deposited, shall not be less than 16^{o}C, nor more than 40^{o}C.

Coffer dams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 m per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimise the formation of laitance, care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

All under water concreting shall be carried out by tremie method only, using tremie of appropriate diameter. The number and spacing of the tremies should be worked out to ensure proper concreting. The tremie concreting when started should continue without interruption for the full height of the member being concreted. The concrete production and placement equipment should be sufficient to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary stand-by equipment should be available for emergency situation.

The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the

pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie in order to allow a uniform flow of concrete, but it shall not be emptied so that water is not allowed to enter above the concrete in the pipe. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. If the charge in the tremie is lost while depositing, the tremie shall be raised above the concrete surface and unless sealed by a check valve, is shall be replugged at the top end, as at the beginning, before refilling for depositing further concrete.

1712 ADVERSE WEATHER CONDITION

1712.1 Cold Weather Concreting

Where concrete is to be deposited at or near freezing temperature, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5^{o}C and that the temperature of the concrete shall be maintained above 4^{o}C until it has thoroughly hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated artificially other than by the heat transmitted to it from other ingredients of the concrete. Stock-piled aggregate may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or on sheet metal over fire. In general, the temperature of aggregates or water shall not exceed 65^{o}C. Salt or other chemicals shall not be used for the prevention of freezing. No frozen material or materials containing ice shall be used. All concrete damaged by frost shall be removed. Concrete exposed to freezing weather shall have entrained air and the water content of the mix shall not exceed 30 litres per 50 kg of cement.

1712.2 Hot Weather Concreting

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40^{o}C while placing. This shall be achieved by stacking aggregate under the shade and keeping them moist, using cold water, reducing the time between mixing and placing to the minimum, cooling formwork by sprinkling water, starting curing before concrete dries out and restricting concreting as far as possible to early mornings and later evenings. When ice is used to cool mixing water, it will be considered a part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted.

The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 40^{o}C during the work.

1713 PROTECTION AND CURING

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor.

Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from :

a) Premature drying out particularly by solar radiation and wind

b) High internal thermal gradients

c) Leaching out by rain and flowing water

d) Rapid cooling during the first few days after placing

e) Low temperature or frost

f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement

Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

1713.1 Water Curing

Water for curing shall be as specified in Section 1000.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members unless it has attained adequate strength.

The concrete should be kept constantly wet for a minimum period of 14 (fourteen) days after concreting except for rapid hardening cement concrete where it can be reduced to 5 (five) days. Water should be applied on surfaces after the final set. Curing through watering shall not be done on green concrete. On formed surfaces, curing shall start immediately after the forms are stripped. The concrete shall be kept constantly wet by ponding or covered with a layer of sacking, canvas, hessian or a similar absorbent material.

After placing and during the first stages of hardening concrete shall be protected from harmful effects of sunrays, drying winds, cold, running water, shocks, vibrations, traffic including construction traffic etc.

1713.2 Steam Curing

Where steam curing is adopted, it shall be ensured that it is done in suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5^{o}C per hour until a maximum temperature of 60^{o}C to 70^{o}C is reached. The maximum temperatures shall be maintained until the concrete has reached the desired strength.

When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5^{o}C per hour until a temperature of about 10^{o}C above the temperature of the air to which the concrete will be exposed, has been reached.

The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

1713.3 Curing Compound

Membrane forming curing compounds consisting of waxes, resins, chlorinated rubbers etc. may be permitted by the Engineer in special circumstances. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist, cured and no curing compound shall be permitted in locations where concrete surfaces are required to be bonded together.

Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking.

1714 FINISHING

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the

resulting holes filled by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good.

a) The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected.

b) Surface defect of a minor nature may be accepted. On acceptance of such work by the Engineer, the same shall be rectified as directed by the Engineer.

1715 TOLERANCES

Tolerances for dimensions/shape of various components shall be as indicated in these specifications or shown on the drawings or as directed by the Engineer.

1716 TESTS AND STANDARDS OF ACCEPTANCE

1716.1 Concrete shall conform to the surface finish and tolerance as prescribed in these Specifications for respective components.

1716.2 Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

1716.2.1 Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following :

i) No individual lot shall be more than 30 cu.m in volume

ii) At least one cube forming an item of the sample representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day.

iii) Different grades of mixes of concrete shall be divided into separate lots.

iv) Concrete of a lot shall be used in the same identifiable component of the bridge.

1716.2.2 Sampling and testing

i) Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS:1199.

ii) A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes shall be adopted.

iii) 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28 day test strength result for each cube shall form an item of the sample.

1716.2.3 Test specimen and sample strength : Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than + 15 percent of the average. If variation is more, the test results of the sample are invalid.

1716.2.4 Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-8

Table 1700-8

Quantity of Concrete in work, m^3	No. of samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 and above	4 plus one additional sample for each additional 50 m^3 or part thereof

At least one sample shall be taken from each shift of work.

1716.2.5 Acceptance criteria

When both the following conditions are met, the concrete complies with the specified compressive strength:

a) The mean strength determined from any group of four consecutive samples should exceed the specified characteristic compressive strength.

b) Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

When the concrete does not satisfy both the above conditions, cores shall be extracted from the representative hardened concrete. Area for compression test in accordance with the method described in IS:1199 and tested whether the concrete satisfies the compressive strength.

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

Chloride and Sulphate Content

The total chloride and sulphuric anhydride (SO_3) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this section of the Specifications.

1716.3 Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1716.4 Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1716.5 Permeability Test

The concrete should pass the following test if it is properly compacted and is not considered permeable :

i) Prepare a cylindrical test specimen 150 mm dia and 150 mm high.

ii) After 28 days of curing, the test specimen is fitted in a machine such that the specimen can be placed in water under pressure upto 7 bars. A typical machine is shown in *Appendix 1700/II.*

iii) At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.

iv) After application of pressure of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.

v) The water penetration in the broken core is to be measured with a scale and the depth of penetration assessed in mm (max. permissible limit 25 mm).

1716.6 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigation, the Contractor shall remove the rejected concrete forthwith.

1717 MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in cubic metres. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

1718 RATE

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the Contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per Section 1500.

Where concrete is found to be acceptable as by the Engineersub-standard work, the Contractor shall be subjected to reduction in his contact unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under

$$\text{Per cent reduction} = \frac{\text{Design Strength - Observed Strength}}{\text{Design Strength}} \times 1000$$

SPECIFICATIONS FOR C & D WASHING, SCREENING UNIT

General Process Description

Stage 1: The circuit includes a Feed Hopper & feeding system for effectively feeding 50 tph of crushed and raw C&D waste. Hopper is provided with a vibrating grizzly with 80mm opening grid to avoid any oversize material to pass through. Raw C&D Waste Material is fed to Hopper to control the feed rate through integrated belt feeder. The speed of belt feeder is controlled by a VFD drive to maintain the desired feed rate (provided the material is available in hopper). The Belt Feeder discharges material to a static feed conveyor to deliver the C&D waste to washing circuit.

Stage 2: The static feed conveyor delivers the material to a pre-screen mounted on **Reurban**® advanced recyling station for partial removal of fine particles to reduce the fines going to next process. The undersize of pre-screen reports to a Sump for further process.

Stage 3: The coarse material (may still contain some amount of <5 mm material) from stage 2 reports to a logwasher that is inbuilt on the **Reurban**® chassis where it undergoes intense scrubbing in wet condition. The water is being added along with the feed to the machine. This helps to loosen up the adhering particles to the lumps and by repeated tumbling in the machine the fine slimes are also released from the surface. All the trash material reporting with the feed are also separated and come out of the machine at the lower end with most of the water. The trash reports to an intergrated trash removal screen where the trash is separated and stockpiled in ground for removal. The water reports to the sump and is pumped to the sump of sand washing system.

The scrubbed material from logwasher falls onto a triple deck wet screen for further washing and separation into different sizes. **Reurban**® incorporates this screen which is built with high pressure water jet washing systems in each deck to ensures thorough rinsing of the material and remove most of the fines from the feed. The washed oversize material from the top deck of screen forms the >20 mm product (Product 1) and that from middle deck forms the (-) 20 mm + 10 mm product (Product 2) and that from the bottom deck (-)10+5/3mm product (Product3). All these are stock piled through stockpiling conveyors. All sand particles along with most of the water flow by gravity to the sump of the sand washing circuit.

Stage 4: Reurban® is also features a sand system is a combination of a sump, pump, dewatering screen and cyclones. The slurry from the sump & pump with required dilution water to maintain desired solid water ratio is pumped to the first stage cyclone mounted on for first cyclone wash. This removes most of ultra-fines as clay (~ <75 microns) out of the system. The underflow (primary washed sand) of the cyclone will fall into the sump and is pumped to the second stage of cyclone mounted on the same system. This removes the remaining <75micron slimes from the material and clean sand falls onto a dewatering screen. Washed sand from the dewatering screen discharges into conveyors and is stockpiled through mobile stockpiler. The overflow from all the cyclones is fed into an intergrated water management system for recycling 80% of the process water.

Stage 5: The combined slurry from the washing circuit (hydrocyclones overflow) will pass to our AquaCycle® High-Rate Thickener to rapidly settle and control the tailings. Dense sludge of circa 450-550g/litre will be issued from the integrated heavy duty pump for discharge to a sludge holding tank (civil tank, client scope) to feed to Filter Press.

Stage 6: The filter press sludge holding tank is equipped with 2 numbers Agitator to keep the slurry in suspended condition to avoid any settling in holding tank. Slurry feed pump feed the sludge to filter press to recover further water and to form cake of sludge. The filter press operates on batch process and after every batch of sludge processing the system starts feeding the next batch of slurry to filter press. The water recovered from Filter press is taken back to washing plant and cake dropped to ground for regular removal from cake drop point. The filter press cloth requires washing at least once a day or as required, depending on number of cycle operated in a day.

Technical Specifications and List of Equipment

Sl. No.	Item Description	UOM	Qty	
1	**Hopper & Feeder: Model M10** 	**No.**	**1**	✓
1.1	10 tons holding capacity Hopper with VFD controlled 800 mm wide Belt Feeder.			✓
1.2	Vibrating Grizzly Deck with 80mm slot			✓
2	**Feed Conveyor** 	**No.**	**1**	✓
2.1	800mm belt with one side walkway fitted with Belt weigher			✓

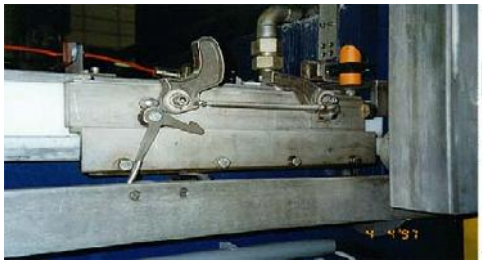
Sl. No.	Item Description	UOM	Qty	
3	**Reurban® Waste recyling Station Model: Prime** 	**Set**	**1**	✓
	Consisting of following components and features:			
3.1	**ProGrade® Pre-Screen**	**No.**	**1**	✓
3.2	Fully modular polyurethane panels – non bolted			✓
3.3	Size 1200 x 2400 Rinsing screen			✓
3.4	Adjustable offset 3.6kW vibrating motors			✓
3.5	Replaceable modular polyurethane liners along screen sides and front dam bar			✓
3.6	**RotoMax® Logwasher: Model Rx 80W** 	**No.**	**1**	✓
3.7	6 Mtr long twin shaft Log washer			✓
3.8	92 numbers of blade are truly intermeshing paddle			✓
3.9	45 KW single motor for synchronized operation, fluid coupling for progressive loading on motor			✓
3.10	Chrome-Molly blades for maximum wear resistance property			✓
3.11	Flat bottom trough design, material creates own bed minimum wear			✓
3.12	Support structure, walkways with handrail			✓

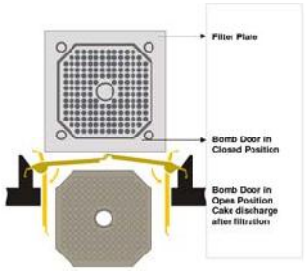
Sl. No.	Item Description	UOM	Qty	
3.13	**ProGrade® Rinsing Screen: Model P3-36** 			✓
3.14	Triple Deck Rinsing cum Sizing Screen with 4 discharge outlet			✓
3.15	PU mesh for all 3 decks			✓
3.16	1.2 Mtr x 3.6 Mtr			✓
3.17	Self-supported Structure includes walkways, access stair and toe plates.			✓
3.18	Series of spray lines with 5 nozzles in each			✓
3.19	Rubber lining for the front chute and funnel to reduce noise and improve durability			✓
3.20	Separation Sizes : 20 mm Top Deck , 10 mm for middle deck and 5/3 mm for Bottom deck			✓
3.21	**ProGrade® Trash Screen** 	**No.**	**1**	✓
3.22	Fully modular polyurethane panels – non bolted			✓
3.23	1200 x 2400 Trash screen			✓
3.24	Adjustable offset 3.6kW vibrating motors			✓
3.25	Replaceable modular polyurethane liners along screen sides and front dam bar			✓
3.26	Splash protection cover over rear of screens			✓

Sl. No.	Item Description	UOM	Qty	
3.27	Replaceable modular back splash panels			✓
3.28	Slurry Pump for feeding to EvoWash sump			✓
3.29	Discharge Chute for Trash Material			✓
4	**EvoWash® Dual Pass Sand Washing Station:** 	**No.**	**1**	✓
4.1	Dual Pass Hydrocyclone(s)			✓
4.2	Hot vulcanised rubber lined modular cyclone c/w overflow discharge chamber			✓
4.3	Rubber lined Cyclone Apex & spigot.			✓
4.4	EvoScreen® 1200 x 2400 Dewatering screen with PU modular Panels			✓
4.5	Adjustable offset 3.6kW vibrating motors			✓
4.6	High-efficiency 'Marsh Mallow' rubber screen mounts.			✓
4.7	Skid mounted with integrated base for pumps and motors			✓
4.8	Support Structure, Walkway and Stair case			✓
5.0	**Wing Conveyor Model W9** 	**No.**	**1**	✓
5.1	650 mm wide belt with Feed boot to receive material			✓

Sl. No.	Item Description	UOM	Qty	
6	**AquaCycle® Model A400** 	**No.**	**1**	✓
6.1	8 Mtr Dia High Rate Thickener made of Mild Steel Pre-fabricated bolted construction			✓
6.3	Steel support structure and necessary bracings			✓
6.4	*QuadRake* four-arm rake system with angled scrapers for conditioning of sludge			✓
6.5	Direct drive motor and gearbox and heavy duty shaft			✓
6.6	De-aeration chamber fitted to side of Thickener for primary treatment			✓
6.7	Conical bottom section complete with flushing valves, connections, and pipe-work			✓
6.8	Heavy-duty centrifugal sludge pump to discharge thickened sludge to your settlement area or buffer tank for Filter Press			✓
6.9	Pneumatic and electrically operated valves for control of sludge / fresh water discharge fitted to base of Thickener			✓
6.10	Compressor for pneumatics			✓
6.11	Scraper support bridge and walkway with Access Stairs & all necessary handrail			✓
6.12	Automatic flushing of sludge pipe-work after de-sludging cycle			✓
6.13	Requires constant uninterrupted power supply of 400V			✓

Sl. No.	Item Description	UOM	Qty	
6.14	**AquaStore® Cylindrical steel water tank Model: W374** 	**No.**	**1**	✓
6.15	Complete with water recycle pump and motor for feeding the fluidising sump			✓
6.16	Ultra sonic probe for measuring water level			✓
6.17	Mounted with Sieve Bend for protection from lightweights			✓
7	**FlocStation® Model P25**	**No.**	**1**	✓
7.1	Fully Automatic Polyelectrolyte Dosing Station with loading hopper & screw feeder for powder based polyelectrolyte			✓
7.2	Powder educter system with cone to transfer powder to make-up tank			✓
7.3	Mixing tank with lid consists with Stirrer unit twin propellers & Level electrodes			✓
7.4	Transfer pump to convey matured polyelectrolyte to storage tank			✓
7.5	Storage tank incorporating level electrodes			✓
7.6	Plant will require a clean water supply for polyelectrolyte make-up (~4m3/hr)			✓
8	**Mobile Stockpile Conveyor Model M1565** 	**No.**	**3**	✓
8.1	650 mm wide belt with Feed boot to receive material with radial movement wheel (Manual Operation)			✓

Sl. No.	Item Description	UOM	Qty	
9	**Additional Items & Services**			✓
9.1	PLC Control Panel for CDE supplied items.	**No.**	**1**	✓
9.2	20ft. Cabin to house main control panel and polyelectrolyte dosing station.			✓
9.3	Electric wiring for all CDE supplied equipment			✓
9.4	Pipe-work and connections for the plant			✓
9.5	Sludge discharge pipework up-to 100 meters			✓
9	**Side Bar Frame Type Chamber Filter Press**	**No.**	**1**	✓
9.1	Size : 1500 X 1500 - 55 chambers with 50 mm depth Semi-Automatic Filter Press			✓
9.2	Type : Semi – Automatic (Manual Cloth Washing System).			✓
9.3	Arrangement : Stationary on foundations			
9.4	Layout pressure : 15 bar absolute			
9.5	Automatic hydraulic with pressure maintaining device with a sealing pressure of 380 bar, double acting cylinder with power pack.			✓
9.6	Electric power : 5.5 kW			✓
9.7	Of rectangular design, of high-grade steel (ST52.3), laterally beside the filter pack, with stainless steel covering on the sliding surfaces resistant to corrosion and wear and tear.			✓
9.8	Air blow inlet filtrate discharge chute laterally below and outside the filter pack			✓
9.9	Parts in contact with product : Polypropylene			✓
9.10	Parts not in contact with product : Mild Steel (painted)			✓
9.11	Material of filter pack : Polypropylene			✓
9.12	1 Set filter cloths, consisting of 56 nos. bottle-neck type cloths			✓
9.13	**Core Blow Device – Automatic**	**No.**	**1**	✓
9.14	Consisting of a special end filter plate, NRV, Solenoid Valve, ball valve Pipeline fittings.			✓
9.15	**Automatic Plate Shifting Device – Type 668**	**No.**	**1**	✓
9.16	 **Side Bar mounted Filter Plate Shifting Device in Stainless Steel with fully enclosed drive chain and PVC guiding profile.**			✓
9.17	To transport the filter plates, automatic working, arranged at the sidebars, consisting of:			✓

Sl. No.	Item Description	UOM	Qty	
9.18	Plate Shifting Device (multiple pawl plate shifter) 2 parallel shifting carriages, hydraulic motor with control valves and progressive speed adjustment, changeover of direction of rotation controlled by pressure switch, drive chain and tightening station, supply of power to hydraulic motor via central hydraulic power pack.			
9.19	CDE offers, automatic plate shifting device,			✓
9.20	– For reduction in cycle time (where in, if manual, the time taken is not 100 % fixed and assured), plate shifting mechanism, has a strong control on cycle time of the filter press operation. – Automatic Plate shifting device will also act as a cake discharge unit , due to the vibrating and movement force – No manual Interference, hence reduced Risk of accident in the working zone Plate shifting system comes with mandatory safety features like:			✓
9.21	**Automatic Drip Trays (Bomb Doors)**	**No.**	**1**	✓
				✓
9.22	Arranged below the filter pack			✓
9.23	Tray Material : FRP			✓
9.24	**RLC Control**	**Set**	**1**	✓
9.25	Electric switch box with operating and control elements control and power part for are as follow.			✓
9.26	– Hydraulic Power Pack for Automatic Plate shifting – Core Blow System & Automatic Bomb doors operation			✓
9.27	IP class : IP 55			✓

	Buffer Tank for Sludge Holding
	Civil Structure / Filter Press Building
	Unloading and/or storage of equipment at job site
	Foundation design and engineering (CDE will furnish equipment drawings and load data)
	Utilities for erection and operation
	Gauges and instrumentation not specifically mentioned in our scope of supply
	Interconnecting wiring, conduit, piping, tubing, valves, etc., between filter, control panel, and upstream or downstream equipment
	High pressure water pump and washing jet nozzle for cloth washing

Paver Block Specification

Supply of 80mm thick inter locking cement concrete Vibro Compaction make paving blocks having compressive strength not less than 400 Kg/cm2.

Technical Specification of Paver Block:-

1 Paver Block Manufacturing facilities:

BMC, at its discretion shall nominate its representative for inspection of the factory. Party shall co-ordinate and cooperates with representative of BMC. The party shall inform the address, telephone numbers and other details of the workshop and the contact person to enable BMC depute its representative. The party shall allow entry to BMC representative during all working days and time. The Paver Block shall be made in factory with following minimum facilities:

1.1 Design Mix Concrete:

(a) All pavers designated by strength shall be treated as design mix concrete. The aggregate and cement shall be measured by weight in an approved weigh batching plant. Mixing water shall be measured.

One or more complete bags of cement shall be used for each batch of concrete.

(b) The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and characteristic strength. The mix design shall be finalized before manufacturing of the paver considering a set of suppliers for cement, sand and aggregates. In case of any change of suppliers of cement, sand or aggregates, party should have design mix ready for alternate suppliers.

(c) The minimum cement content for compacted concrete of pavers shall not be less than 380 Kg/cum.

(d) The maximum water cement ratio for pavers concrete shall not be more than 0.40.

(e) The design mix proportions for each set of raw material suppliers shall be finalized and approved by the authorized lab for the required compressive strength and the lab report with proportions should be available with the vendor at all times for scrutiny and verification purpose.

1.2 Paver Block Making Machine:

(a) The machine should be capable of producing high quality Paver Blocks by obtaining high level of compaction by application of hydraulic compaction and also by high intensity vibration to the moulds. The machine should have automatic control panel and shall apply a minimum pressure of 5000psi.

(b) The machine should be multi purpose so that there could be other cement precast itmes like Kerb Stone, Solid Block, Concrete Bricks, Hollow Blocks, Grass Pavers or similer kind of item could be manufactured from the same machine.

(c) The Operation of machine must be automized so that production cycle time could be minimized & we can get higher production, raw material consumption per day minimum 150-160 tonnes, to complete entire project within time limit successfully.

1.3 Weigh Batching & Mixing Equipment:

(a) The proportioning of ingredients of concrete per batch of concrete shall be performed by an approved weigh batching plant. Water shall be fed into the mixer from a tank provided with means for adjusting the flow of water so as to supply the quantity determined for concrete as per mix design.

(b) Volumetric batching of concrete may be allowed after the design mix is approved by lab after testing, by converting the proportion of concrete from weight to volumetric measurement subject to facilities being made available by the contractor for verifying and monitoring this.

(c) Concrete shall be machine mixed until there is a uniform distribution of materials and uniform colour and consistency is achieved and under no circumstances for less than two minutes. The concrete Mix Design should be followed for each batch of materials.

1.4 Curing :

The factory should have well designed curing area to ensure adequate (minimum 21 days) curing of paver blocks.

1.5 Laboratory

The factory should have the following:

(i) In house Compression testing machine of capacity minimum 200 MT

(ii) Other tools and equipment for quality test of raw materials and paver blocks like water absorption test, abrasive resistivity test & flexural strength test as per IS15658:2006.

(iii) (1) Systematic record of test results of various paver blocks manufactured in the factory.

(2) Concrete Mix Design for desired grade of concrete used for making of paver blocks.

2. Raw Materials.

2.1 CEMENT

The cement used in the manufacture of high quality precast concrete paving blocks shall be conforming to IS 12269 (53 grade ordinary Portland cement). The minimum cement contenting concrete used for making paver blocks should be 380 kg/Cum.

2.2 AGGREGATES

The fine and coarse aggregates shall consist of naturally occurring crushed or uncrushed materials, which apart from the grading requirements comply with IS 383-1970. The fine aggregates used shall contain a minimum of 25% natural silicon sand. Lime stone aggregates shall not be used. Aggregates shall contain no more than 3% by weight of clay & shall be free from deleterious salts and contaminants. Zone iv sand shall not be acceptable. Course aggregate shall be 10 mm and below.

2.3 WATER

The water shall be clean and free from any deleterious matter. It shall meet the requirements stipulated in IS: 456-2000.

2.4 OTHER MATERIALS

Any other materials / ingredients used in the concrete shall conform to I.S. Specifications.

PIGMENT: The pigment shall be used only on wearing and top surface and throughout the paver block. The pigment used shall not be more than 10% of weight of cement used in the wearing course layer. However, use of pigment shall in no way alter the required strength of the paver block. Pigment used for coloring paver blocks shall have durable color. It shall not contain matters detrimental to concrete. The pigment shall not contain Zinc compound. Lead pigment shall not be used.

3. Pavers Block Characteristics

3.1 The inter locking concrete paver tiles should conform to IS-15658: 2006.They shall be tested as per the code and have to qualify limits specified by us down below.

3.2 The paver tiles should be made of M-40 design mix concrete in approved size and shape. For acceptance the average of compressive strengths of 8 pavers shall be minimum 35 N/mm2 (MPa). Any paver in the tested lot shall not have compressive strength less than 35 MPa. Testing shall be done as per relevant clauses of IS-15658:2006.

3.3 The concrete pavers should have perpendicularities after release from the mould and the same should be retained until the laying.

3.4 The surface should be of anti skid and anti glare type.

3.5 The paver should have uniform chamfers to facilitate easy drainage of surface run off.

3.6 The concrete mix design should be followed of each batch of materials separately and weigh batching plant is to be used to achieve uniformity in strength and quality.

3.7 The pavers shall be manufactured in two layer to ensure smooth surface on top and to remove all voids.

3.8 The pavers shall be of cement Grey colour without any pigment or colored with pigment or with chemically treated top surface as specified.

3.9 All paver blocks shall be sound and free of cracks or other visual defects, which will interfere with the proper paving of the unit or impair the strength or performance of the pavement constructed with the paver blocks.

3.11 The compressive strength requirement of concrete paver block shall beminimum 35.00 MPa (N/sqmm) for 28 days (Testing as per IS-15658)after applying the correction factor as per IS-15658:2006.

4. Paver Block Dimensions:-

Thickness	80mm/60mm
Shape	Regular (Uniform shape with no Hollow or Cracks)
Chamfer	5 mm to 7 mm along top edges
Thickness of Wearing Layer	Minimum 6 mm (The thickness of the wearing surface shall be measured at several points along the periphery of paver blocks. The arithmetic mean of the lowest two values shall be the minimum thickness of the wearing layer)
Plan Area Asp (Ref. Cl.B-3.3 Annex B, IS-15658:2006)	Maximum 0.03 m2
Colour	Natural cement Grey colour without use of any pigment OR colour as specified by EIC
Dimensional Tolerance	Tolerances as per IS-15658:2006

Note: All other visual/physical & dimensional acceptance on parameters like aspect ratio, squareness etc to be as per IS-15658:2006

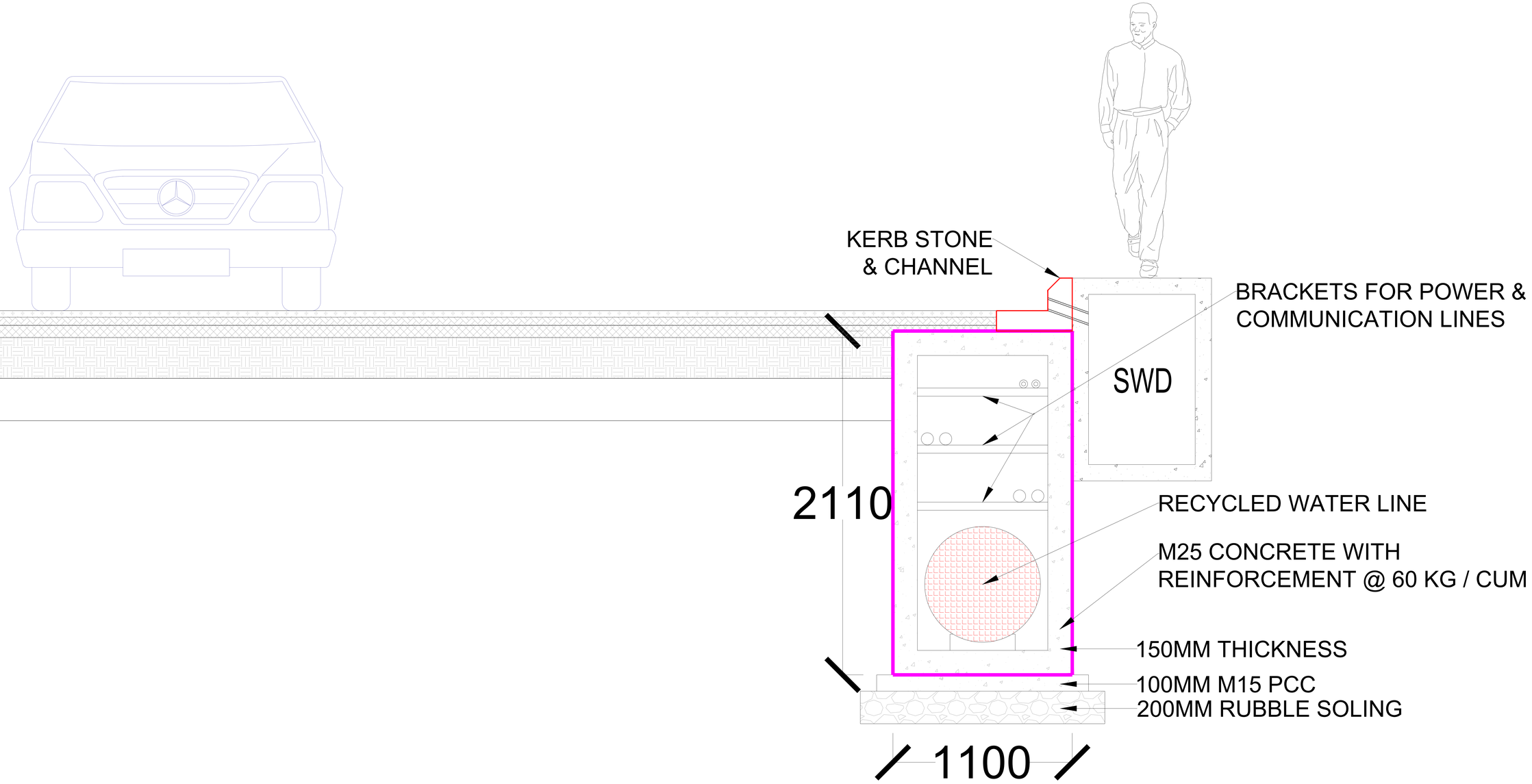
5. Testing of Paver Blocks:-

FOR 80MM PAVER BLOCK

SR. NO.	TEST	SPECIFICATION Average Values
1	28 day Compressive Strength	Minimum 35 MPa (N/Sqmm) (for 80mm)
2	Abrasion Resistance	Maximum 2 mm [i.e. 10 units of 1000 mm3 per 5000 mm2 reported as per E-5 of Annex E of IS-15658:2000]
3	Water Absorption	Avg. of 3 units - Maximum 6% by mass (restricted to 7% in individual test units)

Sampling and Testing Procedure strictly As Per IS – 15658; 2006.

6. Manufacturing Experience:-



NAME OF DRAWING	PROJECT NAME	NAME OF THE CLIENT	NAME OF THE CONSULTANT
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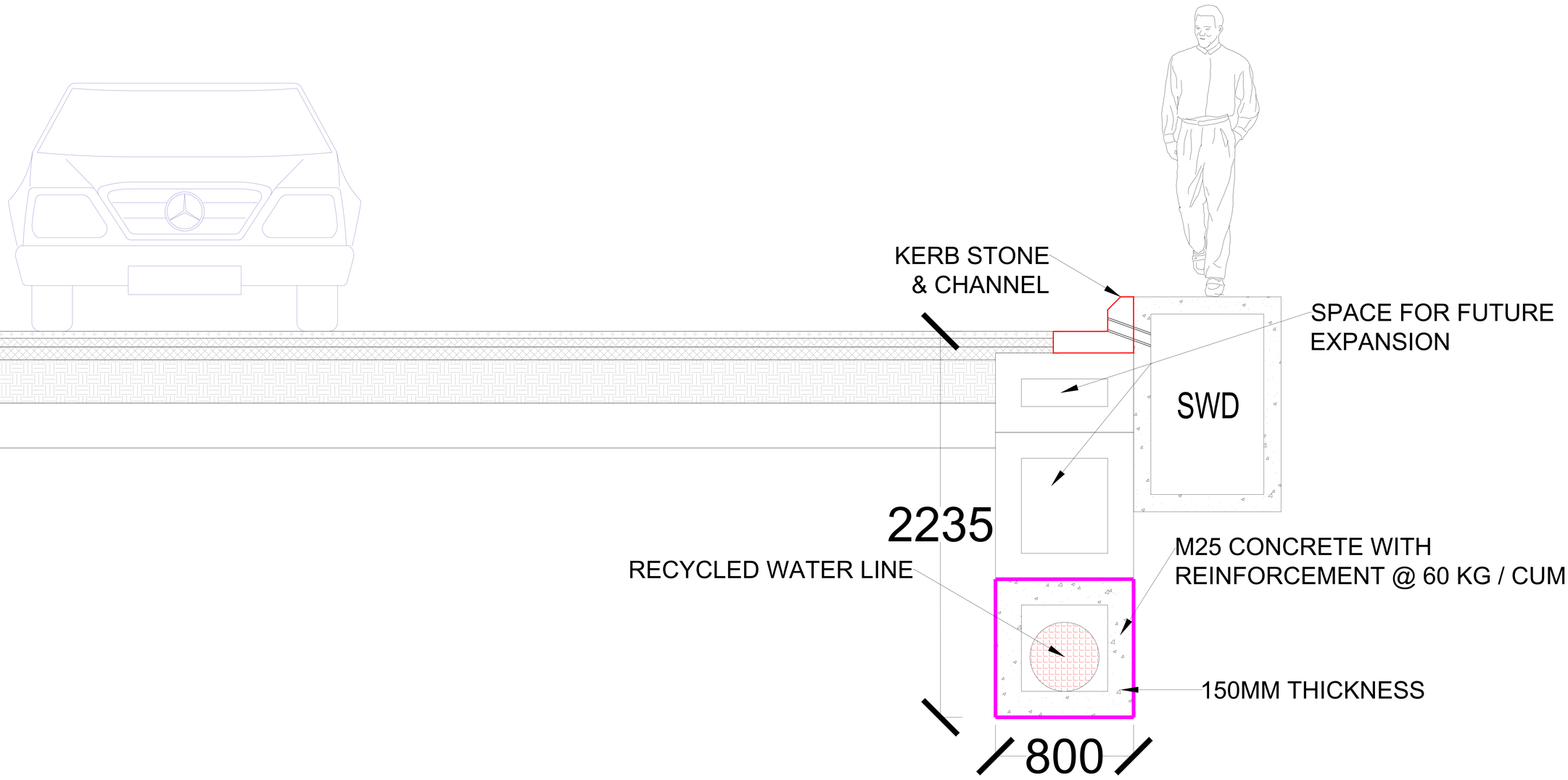
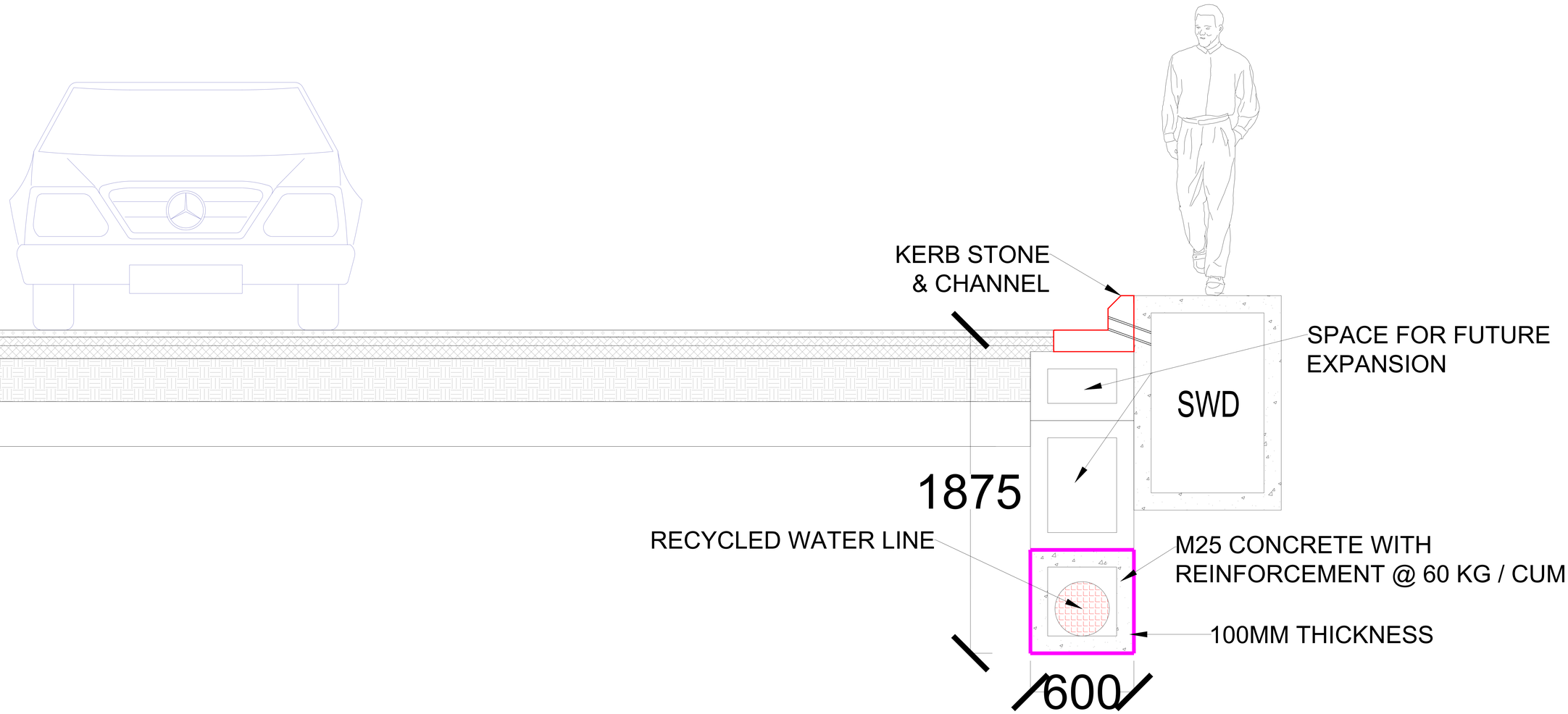
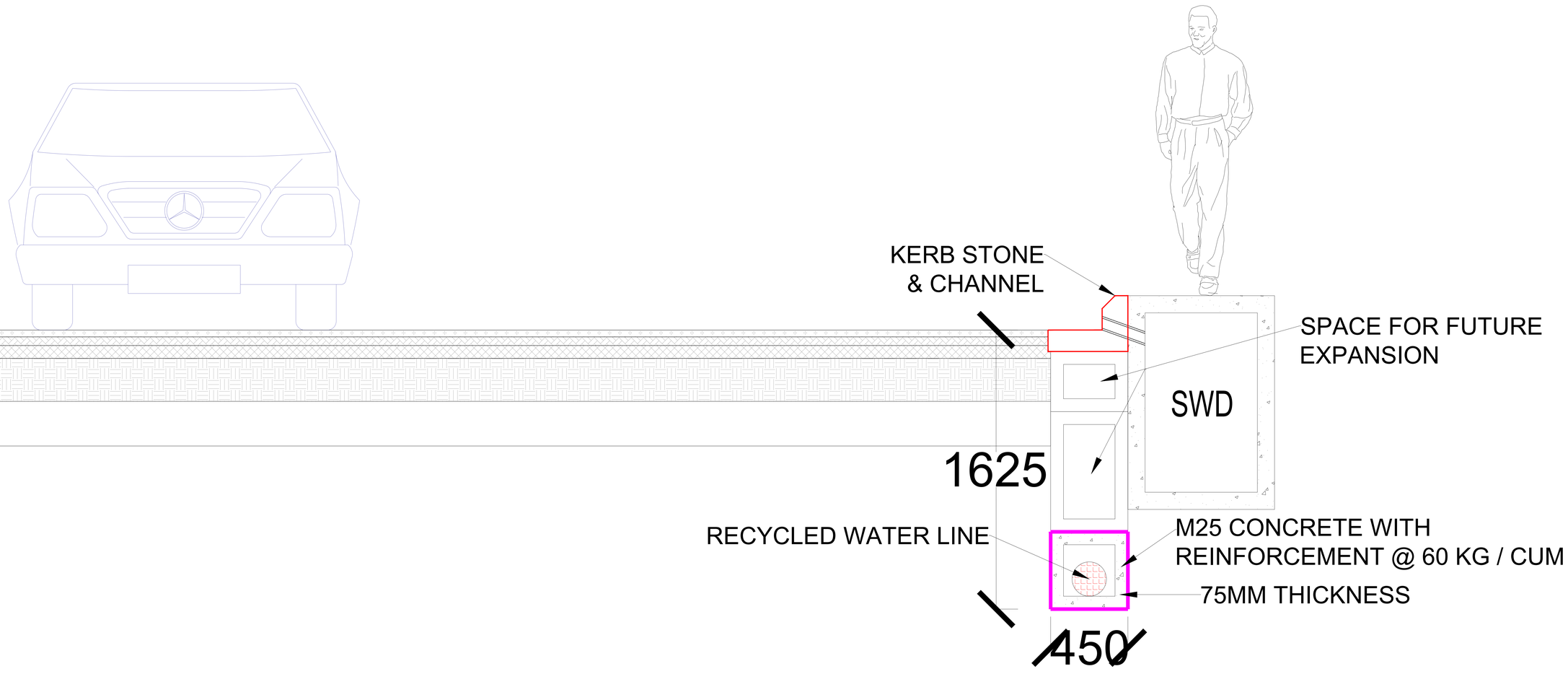


NAME OF DRAWING	PROJECT NAME	NAME OF THE CLIENT	NAME OF THE CONSULTANT
TYPICAL ARRANGEMENT FOR ROAD-SIDE UTILITY DUCT OF SIZE 800MM X 800MM	PROPOSED CONSTRUCTION AND DEMOLITATION PLANT	MUNICIPAL CORPORATION	



NAME OF DRAWING	PROJECT NAME	NAME OF THE CLIENT	NAME OF THE CONSULTANT
TYPICAL ARRANGEMENT FOR ROAD-SIDE UTILITY DUCT OF SIZE 600MM X 600MM	PROPOSED CONSTRUCTION AND DEMOLITATION PLANT	MUNICIPAL CORPORATION	



NAME OF DRAWING	PROJECT NAME	NAME OF THE CLIENT	NAME OF THE CONSULTANT
TYPICAL ARRANGEMENT FOR ROAD-SIDE UTILITY DUCT OF SIZE 450MM X 450MM	PROPOSED CONSTRUCTION AND DEMOLITATION PLANT	MUNICIPAL CORPORATION	

TECHNICAL SPECIFICATIONS

Please note that “capacity” and “specifications” suggested below are “minimum required”. Agency is free to use higher capacity or higher specifications.

(1) TECHNICAL SPECIFICATIONS FOR WHEEL LOADER

L&T Model 9020 Wheel Loader or EQUIVALENT : Tyre mounted Wheel loader, powered by Ashok Leyland - *ALH6ETIC3RU23/3*,
6 cylinder, 4-Stroke, water-cooled, turbo charged with direct injection diesel engine developing 133 HP @ 2300 RPM, equipped with *1.7 Cu.m / 2 Cu.m Bucket*

ENGINE

L&T Wheel Loader WL9020 with Gross Power rating *99.2 kW (133 HP) @ 2300 rpm* with operating weight of 11,500 kg powered with Ashok Leyland - *ALH6ETIC3RU23/3* , 6 cylinder, 4-Stroke, water-cooled, turbo charged with direct injection diesel engine and confirming to *CEV Bharat Stage III emission regulations.*

Transmission

AVTEC Transmission TT2221-1 direct mounted , powershift cycling transmission with 4F / 2R speeds ,with electric gear shift enabling effortless fatigue free operation thus maximizing productivity .

RUGGED FRAME & Z
–BAR LINKAGE

The front and rear frames alongwith the loader linkages have high rigidity to withstand repeated twisting and bending loads. The rugged *Z-bar linkage* is designed for higher breakout force and higher payloads.

AXELS

The DANA Spicer axles 113 & 123 have been engineered to provide rugged , reliable performance , along with easy , low cost service and maintenance for off-highway applications. The limited slip differential for front axle provides improved traction in poor or un even underfoot conditions, save wear of tyres, and safety for operator and machine.

BRAKES:

Provided with Full Power Hydraulic Wet Multi-Disc brakes at each wheel are fully sealed and adjustment free to reduce contamination , wear and maintenance. Added dependability is designed into the braking system by the use of two independent hydraulic circuits with accumulator.

(2) TECHNICAL SPECIFICATIONS FOR HYDRAULIC EXCAVATOR

KOMATSU MODEL PC210-8M0
HYDRAULIC EXCAVATOR-21 Tons or
EQUIVALENT

Crawler mounted Hydraulic Excavator, powered by Komatsu SAA6D107E-1, 4 cycle, Common rail direct injection, water cooled, emissionised (Fully compliant with EU Stage III A and EPA tier III exhaust emission regulations), turbo-charged, after-cooled diesel engine, equipped with backhoe attachment consisting of 5.7 m boom, 2.41 m stick and Heavy Duty Bucket.

- A UNIQUE MACHINE WITH UNRIVALLED BENEFITS

Most rugged and productive machine specially designed & expressly built for INDIAN MARKETS. It delivers outstanding productivity, reliability and operator comfort in a robust, environmentally friendly package. Komatsu's exclusively designed Hydraumind system provides enhanced machine performance.

- HYDRAUMIND HYDRAULIC SYSTEM (CLOSED CENTRE LOAD SENSING SYSTEM)

Results in extended hydraulic oil change interval to 5000 hours compared to 1500 hours for other make of premium range excavators.

- NEW HYBRID FILTER ELEMENT IN THE HYDRAULIC CIRCUIT

Hydraulic filters uses high performance filtering material for long element replacement intervals (1000 hrs for bucket operations), which significantly reduces maintenance cost & resulting in higher life of hydraulic components in excess of 15000 hours

- REVOLUTIONARY MACHINE MANAGEMENT – KOMTRAX

Komtrax, Komatsu's state of the art satellite monitoring system helps you to work more efficiently. Customer can have ready information on Machine Monitoring, Total Fleet Management and Maintenance Schedules

- EQUIPMENT MANAGEMENT AND MONITORIG SYSTEM – EMMS

It controls and monitors all the excavator functions. The user interface is highly intuitive and provides the operator with easy access to wide range of functions and operating information. Large TFT monitor display can be easily read at various angles and in various lighting conditions

Fuel efficient Komatsu engine (With Auto - Idling). The average life of Komatsu engine is over 15000 hours.

- Single piece boom bottom plate , Robot welding of structures, Cast structures at the ends and 600 mm triple grouser track shoes.

- AC Operator cabin (Optional) is highly pressurized and tightly sealed hyper-viscous mounted with reduced noise levels and equipped with FM/Radio

(3) ROLL-ON ROLL-OFF CONTAINER OF 2 CUM, 5 CUM AND 10 CUM VOLUME

General Description: The Open top type containers shall be compatible with Hook loader to be placed at designated locations. The containers shall be designed in such a manner that the Silt collected in the Garbage Tippers can be directly unloaded into the container. The container shall have rear door opening for unloading the collected silt at dumping ground.

TECHNICAL SPECIFICATION
Volumetric Capacity= 2 cum, 5.0 cum, 10 cum,
Floor Thickness= 5.0 MM,
Side and Top Thickness= 4.0 MM,
Rollers= 2 Nos. Heavy Duty Rollers at rear side,
Material= IS 2062

(4) TECHNICAL SPECIFICATIONS OF TRUCK MOUNTED BIN LIFTER/ HOOK LOADER MOUNTED ON 16 T GVW BS – IV TRUCK CHASSIS

Product Description:

Truck Mounted Hook Loader, suitable for lifting 2 and 5 M^3 Volume container hydraulically, is designed to pick up the loaded or empty Roll on – Roll off containers, transport, dumping of material and thereafter unload the skip containers safely and faster.

The telescopic Jib enables proper load distribution on the chassis.

Technical Features:

Designed to handle containers of 2 and 5 M^3 Volume. The dumping mode is achieved by operating the main rams, actuating arm and tilting frame, with jib extended, pivoting around the rear shaft.

- A sub-frame made out of bend steel plates and cross members is mounted on the truck chassis frame.
- A tilting frame hinged to the sub frame with a steel shaft carry the rear centering rollers.
- A main arm hinged on the tilting frame with a mechanical locking mechanism allows the dumping mode.
- A telescopic jib, sliding in the arm, supporting a wide-open lifting hook enables loading of container.

Hydraulic Specifications:

Pump - High Performance Vane Type Pump

Controls - low pressure hydraulic – Manual

Filter - 10 micron, return line with replaceable cartridge

Arm cylinders (lift cylinders) - 2 Nos., double acting, equipped with counter balance valves and built in by pass valves.

Jib cylinder (slide cylinders) – 1 No. Double acting, equipped with built in counter balance valves, Hoses, tubes & fittings.

Container Locking Cylinder - 1 No., Double Acting

Boom Locking Cylinder - 1 No., Double Acting

Stabilizers are provided at suitable locations along the rear of the vehicle to ensure vehicle stability during the loading & unloading cycle of operation.

All Hydraulic Cylinders, allied components and all hydraulic pumps shall be supplied from manufacturer of ISO 9001:2008 certified company.

SAFETY DEVICES	-	Safety valve prevents jib operation during dump Mode
	-	Automatic locks on arm
	-	Slide through container catches

TRUCK CHASSIS

The Equipment shall be mounted on Standard 16 T GVW BS – IV Truck Chassis with Non Sleeper's Driver's Cabin and PTO of Make Ashok Leyland/TATA/Eicher or equivalent.

Welding

Structure welding confirming to relevant IS standards.

Hook for Container Lifting

The hook for lifting the container would be integral to the structure. It shall be provided with the necessary reinforcement to handle the design weight for lifting with adequate factor of safety. The shape and size would as per design of the lifting tackle.

(5) TECHNICAL SPECIFICATIONS OF TRUCK MOUNTED HOOK LOADER MOUNTED ON 25 T GVW BS – IV TRUCK CHASSIS

Product Description:

Truck Mounted Hook Loader, suitable for lifting 10 M^3 Volume container hydraulically, is designed to pick up the loaded or empty Roll on – Roll off containers, transport, dumping of material and thereafter unload the skip containers safely and faster.

The telescopic Jib enables proper load distribution on the chassis.

Technical Features:

Designed to handle containers of 10 M^3 Volume. The dumping mode is achieved by operating the main rams, actuating arm and tilting frame, with jib extended, pivoting around the rear shaft.

- A sub-frame made out of bend steel plates and cross members is mounted on the truck chassis frame.
- A tilting frame hinged to the sub frame with a steel shaft carry the rear centering rollers.
- A main arm hinged on the tilting frame with a mechanical locking mechanism allows the dumping mode.
- A telescopic jib, sliding in the arm, supporting a wide-open lifting hook enables loading of container.

Hydraulic Specifications:

Pump	-	High Performance Vane Type Pump
Controls	-	low pressure hydraulic – Manual
Filter	-	10 micron, return line with replaceable cartridge
Arm cylinders (lift cylinders)	-	2 Nos., double acting, equipped with counter balance valves and built in by pass valves.
Jib cylinder (slide cylinders)	–	1 No. Double acting, equipped with built in counter balance valves, Hoses, tubes & fittings.
Container Locking Cylinder	-	1 No., Double Acting
Boom Locking Cylinder	-	1 No., Double Acting

Stabilizers are provided at suitable locations along the rear of the vehicle to ensure vehicle stability during the loading & unloading cycle of operation.

All Hydraulic Cylinders, allied components and all hydraulic pumps shall be supplied from manufacturer of ISO 9001:2008 certified company.

SAFETY DEVICES	-	Safety valve prevents jib operation during dump Mode
	-	Automatic locks on arm
	-	Slide through container catches

TRUCK CHASSIS

The Equipment shall be mounted on Standard 25 T GVW BS – IV Truck Chassis with Non Sleeper's Driver's Cabin and PTO of Make Ashok Leyland/TATA/Eicher or equivalent.

Welding

Structure welding confirming to relevant IS standards.

Hook for Container Lifting

The hook for lifting the container would be integral to the structure. It shall be provided with the necessary reinforcement to handle the design weight for lifting with adequate factor of safety. The shape and size would as per design of the lifting tackle.

(6) TECHNICAL SPECIFICATIONS FOR CRUSHING UNIT

Terex jw42 primary jaw crusher with 110kw motor or equivalent

- Single Toggle Jaw Crusher
- Electrically driven through V-belt drive
- Jaw size of 42” x 30”
- Four piece bolted and dowelled heavy duty main frame
- Reversible cast manganese steel corrugated jaw faces
- Electric/Hydraulic CSS unit (Hydraulic Power Unit) with electric valves (not manual valves)
- Special tools required for routine maintenance
- Robust Frame design and large diameter, forged main shaft One piece cast flywheels

Sample Machineries which may be considered for manufacturing of Pre cast concrete members:

Wet-cast Production Equipment

F M S (Flexible Manufacturing System)

This sytem allows the concrete precast producer to pour almost any type of product using a flexible and
underground lift carrier. This system is used for moving the forms from the stripping area to pouring area.
The FMS is installed level to the production floor allowing for a clean and safe environment.

L - Crane Pouring System

This is a pouring system that is used for large scale or heavy forms which which cannot be poured using
the FMS (Flexible Manufacturing System).
The L-Crane System allows the use of minimal floor space for precast forms by manuvering overhead for filling of the forms.
Production efficiency can be greatly increased by including the use of the TMD (Toyota Monorail Distributor).

275 Production Line (Pushing Conveyer Line)

This line made it possible to produce huge quantities in high productivity for producing the products like roadside drains, kerb blocks, etc.
“275” means all the moulds moving on the line are all with the base pallet in the dimension of 550W X 2750L.

ＴＭＤ（Toyota Monorail Distributor）

This sytem allows the concrete precast producer to pour almost any type of product using a flexible and
underground lift carrier. This system is used for moving the forms from the stripping area to pouring area.
The FMS is installed level to the production floor allowing for a clean and safe environment.

Site Supervision Vehicle Specifications

	Bolero ZLX BS4 Or Equivalent
Engine	2523 cc m2DiCR Engine
Maximum Power	46.3 kW @ 3200 rpm
Maximum Torque	195 NM @ 1400-2200 rpm
Gear Box	NGT 520, 5 speed, all synchromesh with overdrive in 5th gear
Suspension	Front - Independent with Coil Spring and Anti Roll Bar Rear - Ellipitical Leaf Springs
Tyres	215/75 R 15
Turning Radius	5.8 m
Dimensions (lxbxh)	4107 x 1745 x 1880 mm
Wheelbase	2680 mm
Brake Clutch	Front - Disc Rear - Drum

Technical Specification for Electronic Weigh Bridge

1. Scope: (a) Design, fabrication, supply, installation, testing & commissioning of surface mounted Electronic Weighbridge of 100 tons X 20 kilograms capacity with Kit, Indicator, Load cells, Platform, LED display, PC, Printer, UPS, suitable software and third party inspection as per specifications.

(b) The job shall be undertaken on turnkey basis covering mechanical, civil, electrical & electronic works including of all required civil construction, electrical works including earthing.

(c) Making of approach ramps to weighbridge shall also be included in the scope.

(d) Verification & Stamping of Weighbridge by Legal Metrology dept. (Weights & Measures dept) shall be under vendor's scope, by paying necessary fees.

2. Guarantee: The equipment shall be guaranteed for a period of 12 months from the date of commissioning (or) 18 months from the date of supply whichever is later.

3. Drawings & Manuals: 3 sets of operation & maintenance manuals and approved drawings pertaining to structural, mechanical, electrical & electronic shall be submitted along with the equipment. List of all required spares shall be incorporated in manuals.

4. Detailed Specifications:

4.1 Principal particulars:

(a) Capacity : 100 Tons X 20 Kilograms
(b) Platform length : 18 m
(c) Platform width : 03 m
(d) Duel/ triple axel rating : Min. 50T DTA/ Min. 65T TTA
(e) Mounting : Surface mountable
(f) Load cells : as per para 4.2 (a)
(g) Weigh bridge : Sand witch chequered steel deck design.
(h) Corrosion protection : External steel surfaces must be blast cleaned before application of primer and Epoxy coatings

4.2 Accessories:

(a) Load cells : 8 Nos.
  i. Capacity : Minimum 45 T each,
  ii. Height : Minimum 200 mm
  iii. Load cell construction : Stainless Steel
  iv. Safe load in the Load cell : 125% of rated capacity.
  v. Max. load in the Load cell : 150% of rated capacity
  vi. Destructive load in the Load cell: 220% of rated capacity.
  vii. Repeatability and creep : Better than +/- 0.010 % FS in Load cell.
(b) Mounting / Assembly: 1 set
(c) Cable indicator : 1 set
(d) Cable: power panel to load cells to Junction Box and to Indicator.

contd….2

(e) Computer: 1 no. PC: Intel core i3, 2 GB RAM, 320 GB HDD, DVD COMBO / WRITER, 22" Colour LED Monitor with Windows 7 operating system, Key board, Optical Mouse.
Make: Hp / Lenovo / Dell / Acer or Equivalent reputed make
UPS : 1000 VA online UPS with 2.00 hrs. battery backup.
Printer: Laser Jet Printer(Black).

(f) Software : Complete weighbridge management user friendly Software for processing data date wise, truck wise, challan wise, shift wise, customer wise product wise etc. for generation of daily, weekly & monthly reports. Preparing Transport Permit, Invoice etc. as per our requirement. Provision for connecting with other weighbridges / server computer by LAN & sharing the common data base. The software should be compatible for integrating with Terminal Automation System software and migration of data. Software must be password protected for operation and editing.

(g) Digital indicator : 1No Digitizer
i Display : Blue backlit, graphics up to 64 x 240 pixels up to 8 digits characters of size 17 mm x 10 mm
ii Mounting : wall / Desk
iii Options : 1. Graphic display
2. Serial test
3. Network interface
4. Ethernet port
5. Analogue out
iv Repeatability : 0.01% of rated output

(h) Red LED Jumbo Display having Characters of size 120 mm X 100mm

(i) 2 Ton capacity Split Air Conditioner for control room

4.3 <u>Specifications & Standards</u>:

The following Standards shall be complied:

(a) Electronic Weigh Bridge specification confirming to IS 9281
(b) Platform Material for steel construction confirming to IS 2062.
(c) Fabrication & Construction conforming to IS 800
(d) Road bridges Standards conforming to Indian Standard IRC 5
(e) Dimensions & weights of road design vehicles conforming to IRC 3
(f) Road weigh bridges standards confirming to IRC 24
(g) Epoxy coating standards confirming to is 2074.
(h) Longitudinal joints : specify British/Indian standards like BS-4
(g) Load cell performance: Digital load cells conforming to OIML C5 accuracy
(h) Junction Box : S.S. with IP 65 protected
(i) Earthing conforming to IS 3043
(j) Digital indicator
i Serial interface : RS 232/485/422 or RS 232/20mA
ii Housing : Stainless Steel
iii Internal Resolution : 16777216

SPECIFICATION FOR ROAD WORKS

SCOPE OF ROAD WORK

Scope of road work includes construction of earthwork for subgrade of 300mm and laying of 100mm granular sub-base, 75mm water bound macadam and 150mm pavement quality concrete of grade M-40 along with road side drains, road painting and sign boards with following detailed specifications:

SECTION I: EARTHWORK FOR SUBGRADE

GENERAL

This work shall consist of construction of earthwork for subgrade including earthen shoulders and miscellaneous backfills with approved material obtained from excavation, borrow pits or other sources.

The work shall be carried out in accordance to Clause 305 of Specification for Road and Bridge Works (Fourth Revision August 2001), issued by the Ministry of Road Transport & Highways, Government of India and published by the Indian Roads Congress, henceforth called MORT&H Specifications.

MATERIALS

All material for embankment whether such material is brought from excavation within the site /borrow areas, will subject to Engineer's approval. Notwithstanding any approval given to the fill material proposed to be used, Engineer/Employer reserves the right to reject such material which in his opinion either does not meet the specification requirements or is unsuitable for the purpose for which it is intended. If demanded by Engineer, Contractor shall have to arrange trial pits of specified dimensions and numbers dug at location specified, for Engineer to examine the nature & type of material likely to be obtained for the embankment. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment / subgrade.

The following types of material shall be considered unsuitable for embankment:

- Materials from swamps, marshes and bogs;
- Peat, log, stump and perishable material: any soil that classifies as OL, OI, OH or PT in accordance with IS: 1498;
- Materials susceptible to spontaneous combustion;
- Clay having liquid limit exceeding 70 and plasticity index exceeding 45;
- Materials with sails resulting in leaching in the embankment;

- Expansive clay with free swelling index exceeding 50 per cent when tested as per IS: 2720 – Part 40;
- Any fill material with a soluble sulphate content exceeding 1.9 gm. of sulphate per liter when tested in accordance to BS: 1377 Test 10; and
- Materials with a total sulphate content exceeding 0.5 per cent by mass, when tested in accordance to BS: 1377 Test 9.

The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm in soil embankment and 100 mm in Rock fill embankment when being placed in the embankment. However, the Engineer may use his discretion in the selection of material if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications.

The materials satisfying the density requirements given in Table 300-1 of MORT&H specifications and presented in Table below.

Density Requirements of Embankment & Subgrade Materials

Sr. No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2720 (Part 8)
1	Subgrade and earthen shoulders / verges / backfill	Not less than 17.5 kN/cum

The contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing program approved by the Engineer. It shall be ensured that the subgrade material when compacted to the requirements as presented in Table below shall yield the design CBR value of the subgrade.

Compaction Requirements of Embankment & Subgrade Materials

Sr. No.	Type of Work	Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1	Subgrade and earthen shoulders	Not less than 97

SETTING OUT

The limits of embankment shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of

bench marks and other marks and stakes as long as in the opinion of the Engineer they are required for the work.

The limits of embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure their safety, it is desirable to fix the pegs about 500 mm back from the actual limits of the fill and to paint them in a distinctive colour.

DEWATERING

If embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost. Cost of dewatering and removal of sludge including disposal of same within airport boundary is included in the rate quoted by the agency. If removal of slush is required to be done again during the execution of work as per instruction of Engineer in writing, the same shall be done by contractor at no extra cost.

SPREADING AND COMPACTION

Filling shall be permitted after removing vegetation, trees, roots etc. Approved soil fill consisting of ordinary soil, murum, graded material of rock etc. shall be deposited in layers not exceeding 200 mm compacted thickness where particle size of soil being laid does not exceed 40mm for fill. When soil particle exceeds more than 40mm, then compacted thickness of layer shall be accepted up to 300mm and unless otherwise stated, every layer shall be power rolled with 80-100 KN vibro-rollers as directed by Engineer to achieve 97% of modified Proctor density. The material shall be spread by a motor grader uniformly. The motor grader blade shall have hydraulic control suitable for initial adjustments and maintain the same so as to achieve the specified slope and grade.

Contractor should ensure that all clods of earth are broken down to a size not larger than 75 mm and coarser material of rock not larger than 75 mm.

The moisture content to be used where proctor density or modified Proctor density is used shall be strictly controlled to within 2% of the optimum moisture determined in accordance with IS: 2720 Part II. Where the moisture is higher, the soil shall be raked and moisture allowed evaporating before rolling is commenced. Water shall always be sprayed and not poured. Ponding shall never be allowed. In wet weather, the work may have to be suspended for which no extra would be payable to the contractor. Care shall be taken to see that moisture is uniformly spread throughout the layer and where necessary mixing with harrows or rakes shall be done. The dry density of the compacted layers shall be determined as per IS: 2720 Part XXVIII. The frequency of carrying out tests for determining moisture content and density will be as directed by Engineer.

If the fill material has to be compacted by use of rollers, Contractor shall ensure necessary compaction by means of 80 to 100KN rollers smooth weeded, sheep-foot or vibro rollers. A smaller weight roller may be used only if permitted by Engineer. As rolling proceeds water sprinkling shall be done to assist consolidation. Engineer will determine the thickness of the

layers in which fill has to be consolidated depending on the fill material and equipment used. Rolling shall commence from the outer and progress towards the center and continue until compaction is to the satisfaction of Engineer, but in no case less than 10 passes of the roller will be accepted for each layer. The compacted surface shall be properly shaped, trimmed and consolidated to and even and uniform gradient. All soft spots shall be excavated and filled and consolidated. At some locations it may not be possible to use rollers because of space restrictions, etc. Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

To ensure that the fill has been compacted as specified, field & laboratory tests shall be carried out by Contractor at his cost. Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

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

FINISHING OPERATIONS

Finishing operations shall include the work of shaping and dressing the shoulders/verge, runway bed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerances described below. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

When earthwork operations have been substantially completed, the area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

QUALITY CONTROL TESTD DURING CONSTRUCTION

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests in accordance with Section 900 of MORT&H specifications.

ROCK FILL CONSTRUCTION

Where specifically permitted by the Engineer because of imperative economic or technical reasons, construction of rock fill fillings shall be in accordance with the lines, grades and cross-sections as shown in drawings or as directed by the Engineer.

Rock fill shall not be used at least for a depth of 750 mm below the formation level. The size of rock pieces used in rock fill fillings shall be such that they can be deposited in layers so as to suit the conditions evaluated in the field compaction trials or as directed by the Engineer. The rock fill shall consist of hard, durable and inert material, preferably maximum size not exceeding 100 mm.

Argillaceous rocks (clay, shale's etc.), un-burnt colliery stock and chalk shall not be used in rock fill. The rock fragments and blinding material required for filling the voids shall also satisfy the above requirements.

The material shall be tipped, spread and levelled in layers extending to the full width of filling by a suitable dozer. Fragments of rock shall then be spread on the top of layer to the required extent and layer compacted by minimum of 5 passes of vibratory roller having static weight 80-100 KN. The compacted thickness of each layer shall not exceed 300 mm. After compaction of each layer, the surface voids shall be filled with broken fragments. Next layer, where required, shall be placed in the same manner, above the earlier compacted layer.

The top layer of rock fill, on which normal earth fill will rest, shall be thoroughly blinded with suitable granular material to seal its surface.

SECTION II: GRANULAR SUB BASE

GENERAL

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as sub-base according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

The work shall be carried out in accordance to Clause 401 of Specification for Road and Bridge Works (Fourth Revision August 2001), issued by the Ministry of Road Transport & Highways, Government of India and published by the Indian Roads Congress, henceforth called MORT&H Specifications.

MATERIALS

The material to be used for the work shall be crushed stone. The material shall be free from organic or other deleterious constituents and conform to the Grading II given in Table 400-2 of Specification of Road & Bridge Works and presented in Table below with the percentage passing 0.075mm size restricted to 5%. The portion of the total aggregate passing 4.75 mm sieve shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part – 37) and material passing 425 micron shall be silica or lime stone and not clay.

Grading for Coarse Graded Granular Sub-Base

IS Sieve designation	Percent by weight passing the IS sieve
53.0mm	100
26.5 mm	50-80
9.50 mm	-
4.75 mm	15-35

2.36 mm	-
0.425 mm	-
0.075 mm	< 5

The material to be used in the sub-base course shall have a 4-day soaked CBR value not less than 30 per cent. Besides the CBR (not less than 30), the typical stipulations in regard to the physical characteristics of coarse fraction of sub-base materials shall be as under:

- LA value of the material shall not exceed 50 or AIV shall not be more than 30 per cent.
- Ten percent fines value of 50 KN or more (soaked condition) when tested as per BS: 812 (Part-III).
- Combined Flakiness and Elongation Indices (Total) not more than 30 percent.
- The water absorption value shall not exceed 2 per cent, (as per IS: 236- part-3).
- Sodium sulphate soundness (5 cycles) shall be less than 15% (as per IS: 383).
- The material passing 425 micron (0.425 mm) sieve when tested according to IS: 2720 (Part 5) shall have Liquid Limit and Plasticity Index and Plasticity Modulus (product of Plasticity Index and percentage passing 0.425mm Sieve Size) values not more than 25 per cent, 6 per cent and 90 respectively.

The Contractor shall, at least 21 working days before the commencement of the construction of the sub-base course, submit to the Engineer, the results for approval of the laboratory testing on the physical properties defined above. The construction of the sub-base course can be taken of only upon the Engineer's approval of the material.

CONSTRUCTION OPERATIONS

Immediately prior to the laying of sub-base, the subgrade shall be prepared in accordance to Clause 301 and 305 of MORT&H specifications by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 KN smooth wheeled roller.

The thickness of the loose layers shall be so regulated that the maximum thickness of the layer after compaction does not exceed 150 mm. The sub base material shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity.

Moisture content of the loose material shall be checked in accordance with IS: 2720 Part 2 and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1% above to 2% below the optimum moisture content corresponding to IS: 2720 Part 8.

Immediately thereafter, rolling shall start with the help of a vibratory roller of minimum 80 to 100 KN static weights with plain drum or pad foot-drum / heavy pneumatic tired roller of minimum

200 to 300 KN weight having a minimum tire pressure of 7 kg/cm^2 or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super elevation and shall commence at the edges and proceed towards the center of portions having cross fall on both sides.

It is recommended to achieve the desired density of 98% of MDD as recommended in IS: 2720 Part 8.

SURFACE FINISH AND QUALITY CONTROL

Horizontal alignment shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 10 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 25 mm.

Tolerance in surface level of granular sub base shall be ± 20 mm for flexible pavements and ± 6 mm for concrete pavements.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests in accordance with Section 900 of MORT&H specifications.

SECTION III: GENERAL SPECIFICATION FOR CONCRETE PAVEMENTS

The contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 45 days before such materials are to be used with relevant test data.

CEMENT

The general term ‘cement’ in this specification means Portland cement complying with minimum following grades.

- Ordinary Portland cement, *33* Grade. IS : 269,
- Ordinary Portland cement, 43 Grade. IS : 8112,
- Ordinary Portland cement, 53 Grade. IS: 12269.

If the soil around has soluble salts like sulphates in excess of 0.5 per cent, the cement used shall be sulphate resistant and shall conform to IS:12330.

The characteristics of different types of cement grades proposed for construction shall be as presented in Table below.

Characteristics of Cement Grades proposed for Construction

Characteristics	OPC 53	OPC 43	OPC 33
Fineness – Minimum specific surface (cm^2/gm.)	3000	3000	3000
Setting time (minutes)			
Initial – not less than	30	30	30
Final – not more than	600	600	600
Soundness – expansion by			
Le-Chatelier (mm)	10 (max)	10 (max)	10 (max)
Autoclave (%)	0.8 (max)	0.8 (max)	0.8 (max)
Minimum compressive strength (kg/cm^2)			
3 days	270	230	160
7 days	370	330	220
28 days	530	430	330

AGGREGATES

The Works Contractor shall inform the Project Engineer of the source and aggregate properties of each aggregate and provide all technical information as required this specification. Tests for the initial consent of aggregates shall be carried out by the Works Contractor before mixing starts. Aggregates shall consist of naturally occurring material. They shall not contain deleterious material is such a form or in sufficient quantity to adversely affect the strength at any age of the durability of the surfacing, including resistance to frost. Examples of such deleterious materials include, clay, loam, chalk particularly as an adherent coating; mica, shale and other laminated materials; coal and other organic impurities, sulphates and chlorides or other reactive materials liable to break down during drying or subsequent exposure to weather or moisture. Weathered rock shall not be permitted. Fine aggregates shall be approved sharp grained clean natural bank, river, dune, or pit sand, or crushed rock, and shall be free from loosely bonded aggregations and other foreign matter. When crushed rock is selected for a part or the whole of the fine aggregate, the parent rock shall be tested for stripping. Sea-dredged sand shall not be used. The physical requirements of coarse or fine aggregate to be used for pavement concrete shall be as shown in Table below. Fine aggregate from each supply source shall be tested for absorption as per IS: 2386 (P-3) and if absorption exceeds 2% that source shall be rejected.

Physical Requirements of Aggregates for Pavement Concrete

Property	Situation	Test Method	Test Reference	BC

Strength	Crushed Rock Gravel	Los Angeles Abrasion Value	IS: 2386: Part 4	Max30%
		Aggregate Impact Value	IS: 2386: Part 4	Max30%
Durability (Soundness)	Fine Aggregate	Magnesium Sulphate	IS: 2386: Part 5	Max15%
	Fine Aggregate	Sodium Sulphate	IS: 2386: Part 5	Max10%
	Coarse Aggregate	Magnesium Sulphate	IS: 2386: Part 5	Max18%
	Coarse Aggregate	Sodium Sulphate	IS: 2386: Part 5	Max12%
Water Absorption	All	Water Absorption	IS: 2386: Part 3	Max2%
Chemical Content	All	Total Chloride content	-	Max0.06%
		Total Sulphate Content	-	Max0.25%
Deleterious substances	All	Clay lumps	IS:2386: Part 2	Max1%
	All	Coal & lignite	IS:2386: Part 2	Max1%
	All	Materials passing IS sieve No. 75 micron	IS:2386: Part 1	Max3%

Aggregates shall also be tested for deleterious reactivity with alkalis in the cement, which may cause excessive expansion of the concrete. Tests of coarse and fine aggregate shall be made in accordance with ASTM C 1260. If the expansion of the coarse or fine aggregate test specimens, tested in accordance with ASTM C 1260, does not exceed 0.10 % at 16 days from casting, the coarse or fine aggregates shall be accepted.

If the expansion at 16 days is greater than 0.10%, tests of combined materials shall be made in accordance with ASTM C 1260 or ASTM C 1567 using the aggregates, cementitious materials, and/or specific reactivity reducing chemicals in the proportions proposed for the mixture design. If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C 1260 or ASTM C 1567, does not exceed 0.10 % at [30] days from casting, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 30 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10 % at 30 days, or new aggregates shall be evaluated and tested.

WATER

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, sail, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

When water is not available from a Public Utility Undertaking or from the Establishment, the Contractor is to arrange for tests in accordance with IS 456, and shall submit the resulting report to the Project Engineer for his consent prior to commencement of trial areas.

ADMIXTURES

Wherever applicable, admixtures conforming to IS:6925 and IS:9103 shall be permitted to improve workability of the concrete or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used must be furnished to the Engineer in advance to obtain the approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in trial paving works.

MILD STEEL BARS FOR DOWELS AND TIE BARS

Wherever applicable, these shall conform to the requirements of IS: 432, IS: 1139 and IS: 1786 as relevant. The dowel bars shall conform to grade S 240 and tier bars to Grade 425 of IS.

PREMOULDED JOINT FILLER

Joint filler board for expansion joints shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS: 1838, or BS specification clause no. 2630 or specification for Highway Works, Volume: I Clause 1015. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

The Contractor shall obtain a copy of the manufacturer's technical description of its composition and qualities for his records will provide a copy to the Project Engineer on request.

JOINT SEALING COMPOUND

The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening and durability.

For hot application, an approved Type F1 compound complying with the requirements of BS 2499- 1 shall be used as indicated. For cold application, an approved compound Type FB, as shown on the drawings, complying with the requirements of BS 5212-1 shall be used. Only sealing systems which include separately applied primers shall be used and the primers shall be as recommended by the manufacturers of the sealing compounds. Compounds shall maintain adhesion and concrete which has been cleaned, dried and primed according to the manufacturer's instructions.

SEPARATION LAYER

A waterproof membrane shall be provided, which shall be two coats of bituminous spray. Where a bituminous spray has been used to cure the dry lean and wet lean concrete then only those areas which have been damaged shall be re-sprayed after making good. A further coat of bituminous spray shall be applied over the whole area and allowed to cure prior to concreting. If a satisfactory finish to the dry lean or wet lean concrete cannot be achieved a 125 microns thick impermeable polythene sheet shall be used.

SIZE AND GRADING OF AGGREGATES

The maximum nominal size of aggregate for PQC shall not exceed 25mm. continuously graded or gap graded aggregates may be used depending on grading of fine aggregates. The particle size distribution of the combined aggregates when plotted shall give a smooth curve throughout the whole range of the sieve sizes.

The proportioning of other sizes of coarse aggregates shall be as recommended in Table 2 of IS: 383-1970 and presented in Table below.

Proportioning of Course Aggregates for Pavement Concrete

IS SIEVE DESIGNATION (mm)	Percentage passing of Nominal size	
	40 mm	20 mm
63	100	-
40	85-100	100
20	0-20	85-100
16 mm	-	-
12.5 mm	-	-
10 mm	0-5	0-20
4.75 mm	-	0-5
2.36 mm	-	-

Fine aggregates particle size distribution shall meet the limits of Grading Zone 1 or Grading Zone 2 as recommended in Table 3 of IS: 383-1970 and presented in Table below. Particle size limits shall be met by the aggregate as delivered or after blending two or more separate aggregates together before or during batching.

Proportioning of Fine Aggregates for Pavement Concrete

IS SIEVE DESIGNATION (mm)	Percentage Passing For Fine Aggregates Of	
	Grading Zone I	Grading Zone II
10	100	100
4.75	90-100	90-100
2.36	60-95	75-100
1.87	30-70	55-90
0.6	15-34	35-59
0.3	5-20	8-30
0.150	0-10	0-10

HANDLING AGGREGATES

Aggregates stockpiles shall be on concrete or other approved hard surfaces, laid to falls to allow unrestricted drainage. Aggregates shall be stockpiled separately for each size delivered from each source of supply. Each size from each source shall be separated in the stockpiles by sturdy bulkheads. The methods to be adopted to prevent overspill between adjacent stockpiles, 'coning' or segregation of the aggregate in the stockpile, particularly during tipping, shall comply project specific requirements. Care shall be taken to avoid crushing by stockpiling equipment. At all times the aggregates shall be kept free from contact with deleterious matter. All aggregates shall be handled from the stockpiles to the batching plant in a way which will ensure a uniform grading of the material. Aggregates containing more than 5% passing a 4mm sieve shall not be batched until they have been deposited for at least 8 hours. All aggregates produced or handled by hydraulic methods or which have been washed shall be stockpiled for at least 24 hours before batching. For Dry lean and Wet lean concrete, aggregates may be delivered either "all-in" or in separate sizes.

BATCHING AND MIXING OF CONCRETE

Concrete shall be mixed in approved static mixers. The mixer shall be controlled by an experienced operator. The proportion of each constituent in the mixture by weight shall be that approved by the Project Engineer, allowance being made as detailed below for the weight of free water in the aggregates.

When Pavement Quality Concrete is specified the mixer and batching plant shall be within the site boundary in a location to be approved by the Project Engineer.

For mixers fitted with consister/wattmeter, a fixed amount of water shall be added to the mixer and the workability shall be achieved by trickling additional water into the mix as required to achieve the pre-determined reading on the consister/wattmeter. This additional water shall be reported as part of the total water by the batch plant computer. For mixing plant not fitted with consistor or other moisture measuring devices, the allowance made for free water in aggregates shall be determined, on representative samples from each of the aggregate stockpiles.

Regular determinations shall be made before mixing starts each day and afterwards at 4 hourly intervals until mixing stops for the day. Additional determinations shall be made when mixing restarts after precipitation has stopped production.

Following each determination of free water in the aggregates the precise quantity of added water required to make up the total proportion of mixing water approved shall be calculated. Aggregates from each stockpile and the cement shall each be proportioned separately by weight to the tolerances given in IRC: 15 - 2002. When the cement is delivered in bags, proportioning by weight of all constituents shall be based on the incorporation of whole bags. The added water content calculated as detailed above may be measured by either weight or volume to the tolerance given in IRC: 15 - 2002. All mixing water shall be added to each batch in the approved static mixing plant. Each admixture shall be measured separately at the mixer in pre-set automatic dispensers to within +5% of the quantity approved for the mixture. Admixtures shall be added with the water and the mixing time shall be such as to ensure uniform distribution of the admixture throughout the batch. Mixing within the approved static mixer shall continue until a well-mixed homogenous concrete has been produced. The total mixing time shall be agreed following trials with the mixture and mixing shall be carried out for this period. The consistency of each batch of concrete shall be checked by use of a watt meter monitoring the power supply to the mixer, or other proven reliable device, and each batch of concrete shall be inspected prior to discharge. Mixers shall be emptied before being charged with a new batch of concrete. When delay of 30 minutes or more occurs during concrete production, mixing shall not restart until the mixer and handling plant has been thoroughly cleaned out. Mixing shall be carried out by an experienced operator.

CONCRETE MIXERS

Mixers shall be sufficient mixing capacity to provide the required output without overloading. Continuous mixers will not be allowed for PQ concrete and bonded concrete. The use of a mixing plant other than that approved will not be allowed. The weighing mechanism of each batching plant shall be checked by either its manufacturer or an independent testing authority, who shall certify its compliance with the tolerances given in IRC: 15 - 2002. The Contractor shall submit the test certificate to the Project Engineer prior to the start of mixing. Further checks shall be made and the certificates passed to the Project Engineer at the end of each month during mixing and whenever a mixer is re-sited or disturbed. The Contractor shall check the calibration of the water measuring devices and admixture dispensers prior to start of mixing and at weekly intervals during mixing. The results shall be passed to the Project Engineer. In addition, the Contractor shall himself check the accuracy of the devices and dispensers each day before mixing starts and retain records.

TIME ALLOWED FOR CONCRETING

The total time taken shall not exceed 90 minutes for either:

- From the addition of water to the dry lean or wet lean mixture to the completion of the layer (including placing curing membrane if applicable); or,
- From the addition of water to the Pavement Quality Concrete or bonded concrete mixture to the finishing of the slab including placing the initial curing membrane.

The method statement shall include details of a sequence of operations commencing with addition of water at the mixer and finishing with final texturing of the concrete surface giving estimated times for each operation and an estimated overall time. The estimates given shall be verified on site using the actual concreting equipment during the laying of the trial areas. A record shall be kept for areas of concrete which fail to meet this requirement. The record shall be produced on daily basis to ensure quality compliances.

WORK IN ADVERSE WEATHER

Wet Weather

Concrete shall not be laid during precipitation or when precipitation is imminent. A suitable protection shall be provided to the concrete during transportation and placing to enable completion of the finishing processes (including the necessary joint forming) to a standard equal to that of the approved trial area. Where a new PQC concrete surface is damaged by precipitation it shall be replaced in accordance with relevant clause of this document.

Hot Weather

When the air/shade temperature is above 25°C, or has been above 25°C in the previous 24 hours, the temperature of the fresh concrete shall be measured when mixing begins and at hourly intervals during curing using the method described in IRC: 15 - 2002. Concrete of temperatures above 30°C shall not be placed and all necessary measures shall be taken to achieve a uniform temperature below 30°C in the concrete at the time of placement.

CURING LIQUID

1) For curing of dry lean and wet lean concrete and the vertical faces of PQC slabs the curing liquid shall be Class A1-40, K1-40 or K1-60 bitumen emulsion. It shall be delivered to the site in weather-proof containers each clearly marked by the supplier to show the Class and binder contents of the emulsion, or in bulk carriers accompanied by a certificate from the supplier stating the Class and binder content of the consignment. Drums or other containers shall be stored under clean conditions and protected from freezing. If the storage period exceeds one month the drums shall be turned or inverted at least once a month.

2) For initial curing of the top surfaces of PQC slabs: The curing compound for Pavement Quality Concrete surfaces exposed immediately after finishing shall be an approved spray-applied resin-based compound containing flake aluminium in finely divided dispersion which will not separate out when the compound is applied and which will produce a complete coverage of the sprayed surface with a metallic finish. It shall

become touch-dry within 5 minutes, stable and impervious to evaporation of water from the concrete surface within 60 minutes and shall not disintegrate for 3 weeks. When tested the compound shall have an efficiency index of at least 90%. The compound shall not react chemically with the concrete.

SECTION IV: WATER BOUND MACADAM

The construction work for Water Bound Macadam – Grading 2 shall be carried out in accordance to Clause 404 of MORT&H specifications.

SECTION V: PAVEMENT QUALITY CONCRETE

NOMINAL SLAB THICKNESS

The nominal slab thickness of the PQC slab shall be 150mm. It shall be the minimum thickness of the slab at any point after compaction and it shall not be exceeded by more than 25mm.

MATERIALS

The contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 45 days before such materials are to be used with relevant test data.

All the construction materials (i.e. cement, aggregates, water, admixtures, mild steel bars, premoulded joint filler, joint sealing compound and separation layer) shall comply with requirements stipulated in relevant clauses of this document.

MIXTURE DESIGN

The PQC mixture shall be designed within the following limits:

- Cement content per cum of concrete — 400 kg/cum
- Minimum Cement Content Free Water/Cement ratio — 0.45 max
- Volume of entrained air (20mm aggregate) — 5±1%

The Contractor shall be responsible for constructing a Pavement Quality Concrete pavement slab such that the mean of the corrected core strength values at 28 days ± 3 days of cores

cut from the slab, then cured, prepared and tested, all in accordance with relevant clauses of this document, is at least 40N/mm^2. Testing regimes and assessment of compliance shall be as described in relevant clauses of this document.

The concrete shall be of consistence suitable for full compaction without undue flow to be achieved with the plant used. When it is proposed to spread, compact and finish the by semi-mechanized means as specified in relevant clauses of this document, the aggregates shall be combined so as to comply with the following requirements.

1. The masses of the separate nominal single size coarse aggregates, as specified in relevant clauses of this document, in the mixture shall be in the fixed proportions chosen so that the total coarse aggregate satisfies the grading requirements IS: 383.
2. The mass of fine aggregate, as specified in relevant clauses of this document, in the mixture shall be of a fixed proportion so that the mass of fine aggregate is 30% - 37% of the total mass of the aggregate. When it is proposed to spread, compact and finish the concrete using a slip-form paver, as specified in relevant clauses of this document, the aggregates shall be combined so as to comply with the following requirements:-

    - The masses of the separate nominal single sized coarse aggregate, as specified in relevant clauses of this document, in the mixture shall be in the fixed proportions chosen so that the total coarse aggregate satisfies the grading requirements for 20mm size aggregate.
    - The mass of fine aggregate, as specified in relevant clauses of this document, in the mixture shall be of a fixed proportion so that the mass of fine aggregate is 32% - 40% of the total mass of aggregate. The suitability of the design shall have been demonstrated by trial mixtures and trial areas in accordance with relevant clauses of this document.

TRIAL MIXTURES

The Contractor shall prepare trial mixtures in the approved mixer and with the approved materials to the design requirements of relevant clauses of this document. The concrete shall be of suitable consistence for full compaction to be achieved without undue flow with the plant used. The consistence shall be determined in accordance with one of the methods given in IS: 4031 Part 4 – 1995 or Compaction Factor (CF) for slip form concrete or slump for hand lay concrete as given in IS: 1199 - 1959. A job standard value for the mixture and plant being used shall be determined by the Contractor. For each mixture proposed, a set of three pairs of 150mm cubes from at least four separate batches shall be made, cured and tested in accordance with IS: 516 – 1959. The mean of the two results from each pair shall be taken as the test result. When the difference between a pair of results divided by their

mean exceeds 15%, the test result shall be deemed invalid and shall be excluded from assessment of compliance. If less than 9 valid results remain, the trial shall be repeated. The mean strength at 7 days of all the valid results shall not be less than 47N/mm^2 for Grade 53 mixture or 41.8N/mm^2 for Grade 43 mixture or whatever higher values the Contractor considers necessary to ensure compliance with the requirements of relevant clauses of this document.

If the test results fail to satisfy these requirements, the Contractor shall repeat the trial making such adjustments to the mixture as are necessary to give compliance. The Contractor shall report the proportions of the complying mixtures to the Project Engineer. The information provided shall include plots of the particle size distribution for the fractions of the combined aggregates retained on a 4.0mm sieve and passing a 4.0mm sieve, confirming compliance with the requirements of relevant clauses of this document. Concrete laying shall not begin until consent has been obtained.

TRIAL AREAS

Once the trial mixture has been approved trial areas shall be constructed. At least one month prior to the construction of the trial length, the contractor shall submit for the Engineer's approval a detailed method statement giving description of the proposed materials, plant, equipment and construction methods. All the major equipment's like paving train, batching plant, tippers, etc. proposed in the construction are to be approved by the Engineer before their procurement.

No trials of new materials, plant, equipment or construction methods nor any development of them shall be permitted either during the construction of trial length or in any subsequent paving work, unless they form part of further, approved trials. These trial lengths shall be constructed away from the project corridor but with at least sub base layer below it.

The contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 60 m but not more than 300 m long for mechanized construction and at least 30 m long for hand guided methods. If the first trial is unsatisfactory, the contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

Transverse joints and longitudinal joints of each type that are proposed for dowel jointed unreinforced concrete slabs in the main work shall be constructed with at least 2 expansion joints and first 150 m of longitudinal construction joint for mechanized paving as the trial length for these joints.

A minimum of 12 pairs of 150mm cubes shall be collected during the laying of a trial area. Each pair shall be from sample taken from a different delivery at the point of placing. The cubes shall be cured and tested for compressive strength for 7 days. The mean of the two results from each pair shall be taken as a test result. When the difference between a pair of results divided by their mean exceeds 15%, the test results shall be deemed invalid and shall be excluded from assessment of compliance. The mean of all the valid test results shall not be less than 47/mm^2 for Grade 45 & 53 mixes or 41.8N/mm^2 for Grade 45/30%PFA

blend No more than one result shall be below 35N/mm^2 for Grade 45 & 53 mixes or 31.3N/mm^2 for Grade 45/30%PFA blend.

The saturated densities of the cores shall be determined and recorded. Corrected core strengths shall be determined as described in relevant clauses of this document. The mean corrected core strength value at 28 + 3 days of all the cores taken from a trial area shall be at least 45N/mm^2 and no individual value shall be below 33N/mm^2. If this specified mean corrected core strength value from cores is not achieved, the mixture design procedure shall be repeated with a design target mean 7 day cube strength calculated to give at least the specified mean corrected core strength value from cores, using the relationship between mean values from cubes and cores established on the trial area. Trial mixtures and trial areas shall be repeated using this revised target mean 7 day cube strength value in place of the 47N/mm^2.

If in the opinion of the Project Engineer, any of the trial areas fail to comply with any of the Specification requirements, revisions to the mixture or modifications to plant or working methods shall be made as the Contractor considers necessary to ensure future compliance. New trial areas shall be laid in accordance with this clause. All of the failed areas shall be cut out. Each trial area will be approved by the Project Engineer when it has satisfied all of the specified requirements and shall then be clearly marked. Until consent has been given, no laying of Pavement Quality Concrete, other than trial areas, shall begin. A written statement of the mixture proportions (by weight) and the job standard value of the trial mix shall be submitted to the Project Engineer for approval.

Approval of the materials, plant, equipment and construction methods shall be given when a trial length complies with relevant clauses of this document.

PREPARATION OF UNDERLYING SURFACES

In areas of new build PQC before laying the separation layer specified in relevant clauses of this document, the surface shall be clean, smooth and free of standing water, mud, grit and other extraneous matter. Where existing pavements are to be overlaid with new PQC, including the provision of a regulating layer, the following shall be carried out:

- All vegetable growth and loose particles shall be removed from the surface.
- All joints and cracks 20mm or more wide in the existing pavement shall be filled with lightly compacted 0/2mm size fine graded coated macadam surface laid to a convex finish proud of the general surface level. All other joints or cracks shall be leveled by removing extruded material to a finish flush with the adjacent surface level. Potholes shall also be made good with 0/2mm fine graded surface course or, alternatively with hot rolled asphalt complying with IRC: 27-1967.
- Before the regulating or separation layer is laid, the surface shall be clean, smooth and free of standing water, mud, grit and other extraneous material.

REGULATION OF EXISTING SURFACES

In areas where the existing pavement surfaces are to be overlaid with new Pavement Quality Concrete, if there are areas where the depth of the new construction will exceed the nominal slab thickness and tolerance as specified in relevant clauses of this document, the levels of these areas shall be regulated in advance of concreting.

The regulating course material along the edge of the area to be regulated shall be raked and rolled in a way which will feather it out as far as is practicable and which will obviate an abrupt step. Where existing pavements are to be overlaid with new PQC, these areas shall be prepared in accordance with relevant clauses of this document and regulated in advance of the concreting. Marshall Asphalt and Rolled Dry Lean Concrete shall be used as regulating materials. Hot Rolled Asphalt and Asphalt Concrete (Macadam) will only be permitted with prior consent of the Project Engineer. When tested by the method, the divergence between the bottom of the straight edge and the finished surface of the regulating material shall be more than 15mm and shall show no abrupt steps.

FORMS

Forms for use with the laying methods specified in relevant clauses of this document shall be purpose made square angled steel road forms, provided with adequate devices for secure setting so that, when in place, they will withstand, without springing or settlement, the impact and vibration of the spreading, compacting and finishing plant. The depth of the forms shall be adequate to fully support the slab thickness specified in relevant clauses of this document. The thickness of packing below the forms shall not exceed 30mm. The ratio of height: base of forms shall not exceed 1.5:1. Forms shall be set to the correct lines, levelled by careful adjustment with steel shims, and shall be packed with Portland cement mortar. The mortar shall not extrude beyond the vertical inside face of the form. The sections shall be tightly joined by locked joints free from play in any direction. The forms and rails shall be kept free from dirt, mud, and other extraneous matter. Forms which are not straight within a tolerance of 3mm in 3m or which are battered shall be removed from the site. Repaired forms shall not be used without the consent of the Project Engineer. The line and levels of all forms shall be checked, and corrected if necessary immediately before placing the concrete. The vertical inside faces and tops of the forms shall be inspected to see that they are clean, and shall be generously oiled to facilitate easy removal. Forms shall not be removed until at least twelve hours after the finishing of the concrete. Mortar packing along the vertical faces of the finished slabs shall be broken down and removed.

PLACING SEPARATION LAYER

The separation layer complying with relevant clauses of this document shall be checked and any repairs made prior to concreting. A second coat of bituminous spray shall then be applied at a rate of 0.7 to 0.9 liter/m^2. If a smooth finish to the lean concrete cannot be achieved a polythene sheet separation layer shall be used in accordance with relevant clauses of this document. The sheet shall be laid flat without folds or ripples. The membrane shall be laid beneath all joints with the laps specified. Except where it is laid in strips under forms, the membrane shall be laid immediately before concrete is spread. It shall be secured without puncturing against disturbance by wind. Laps shall not be less than 150mm in any direction. Damaged or torn sheets shall not be used. Standing water on the sheet shall be

removed before concreting is allowed to commence. Any sheets which become torn or damaged before concrete is spread shall be replaced or overlain with additional sheets.

TRANSPORTING AND PLACING OF CONCRETE MIXTURES

Freshly mixed concrete shall be transported without segregation or loss of constituent materials. It may be required to be covered during transit and while awaiting discharge to prevent wetting by precipitation or evaporation of moisture. Sufficient delivery trucks shall be used to maintain a continuous supply of concrete to the paving operations.

ROUTINE TESTS ON CONCRETE MIXTURES THROUGHOUT PLANT MIXING

- Workability

The workability requirement at the batching plant and paving site shall be established by slump tests carried out during trial paving. The optimum workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer. A slump value in the range of 30 ± 15 mm is reasonable for paving works. These tests shall be carried out on every truck/dumper at plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate trucks or as per the instructions of the Engineer.

- Compressive Strength of Cubes

Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

In order to get a relatively quicker idea of the quality of concrete, optional tests on beams for modulus of rupture at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the values should be arrived at based on actual testing. In all cases, the 28 days compressive strength specified in Clause 3.3.3 shall be alone be the criterion for acceptance or rejection of the concrete.

The random sampling procedure shall be adopted and spread over the entire period of concreting with frequency as presented in Clause 15.2 of IS: 456-2000.

Three test specimens shall be made for each sample for testing at 28 days. Additional samples shall also be collected to determine the strength of concrete at 7 days or at the time of striking or to check the testing error.

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ± 15 percent of the average.

The concrete shall be deemed to comply with the strength requirements as specified in Clause 16 & Table 11 of IS: 456-2000.

- Air Entrainment

Samples of concrete for air content determination shall be taken in accordance with the methods described in IRC 15 - 2002. The Contractor shall measure the volume of entrained air in the concrete mixtures by the test method detailed in IRC 15 - 2002. One test shall be

made at the same time as each Compaction Index determination. The concrete shall be sampled and tested at the point of delivery to the paving plant. The Contractor shall periodically check the aggregate correction factor and shall make a re-determination whenever the aggregates or aggregate proportions are changed. If any tests fail to come within the limits specified in relevant clauses of this document two further tests on the same or next delivery shall be carried out. If any of these also fail to satisfy this requirement the Contractor shall immediately cease mixing and shall adjust the quantity and/or uniformity of the air content of the mixture to ensure compliance.

SPREADING, COMPACTING AND FINISHING CONCRETE BY PAVING TRAIN

The concrete shall be evenly distributed across the lane with a spreader box designed to ensure uniformity of pre-compaction and continuity of spread. The spreader box shall provide a method for striking-off the concrete to a regular profile at a depth which gives an adequate surcharge so that after compaction the nominal slab thickness as shown on the drawings or specified in relevant clauses of this document will be achieved. The spreading equipment and method will be approved by the Project Engineer on the basis of its performance on the trial areas specified in relevant clauses of this document. Equipment not approved shall be removed from the airfield and methods not agreed will be prohibited. The concrete shall be compacted and finished by approved self-propelled compacting and finishing machines, running on the rails on the forms specified in relevant clauses of this document on at least one side of the lane. Each train shall include units, incorporated in a single carriage or as a combination of separate units, which strike-off the concrete to the correct pre-compaction level by means of rotating paddles or a screw device, compact it by vibration or by a combination of vibration and mechanical tamping, and finish it with an oscillating screed. A duplication of one or more units shall be included in the train if necessary to achieve the compaction and finishing requirements of this Specification. The compacted concrete when hardened shall satisfy the test requirements specified in relevant clauses of this document. All units shall be properly maintained. The units shall be controlled by experienced operators at all times. Immediately following the completion of compaction but before texturing or application of the curing liquid, scraping straightedges shall be used to remove laitance and minor irregularities from the surface. Scraping straightedges shall have 3 m long blades and flexible handles of sufficient length to reach across the width of a concrete lane. A scraping straight edge shall have a 3m long blade and a flexible handle of sufficient length to reach across the width of a concrete lane. Alternative designs may be proposed to the Project Engineer for consent. Floats shall not be used. Concreting shall not commence until consent has been obtained.

The scraping straightedge shall be operated by two persons, one on either side of the concrete lane. While the concrete is still plastic and workable, the blade of the straightedge shall be carefully positioned on the surface of the concrete and parallel to the forms. The blade shall be worked uniformly backwards and forwards across the full width of the lane by the first person until all irregularities and blemishes have been removed from the surface of the concrete. The blade shall then be picked up on the other side of the lane by the second person, cleaned and moved along the lane by not more than half the blade length. The scraping process shall then be repeated.

The concrete surface shall not be overworked. Hand floating shall not be allowed, apart from the minimum required to finish alongside joints. Each unit in the train shall be of the type and model recommended by the manufacturer for mixtures complying with the requirements of this specification and for the thickness of slab to be laid. The Contractor shall give details of the equipment he proposes to use, together with a detailed methodology for the spreading, finishing, texturing and curing operations. If the Contractor's proposals are considered satisfactory in principle, a qualified preliminary acceptance of the equipment will be given by the Project Engineer. Final consent to the equipment shall rest with the Project Engineer on the basis of the performance of the particular units provided following an assessment of their compactive efficiency in the laying of the trial areas specified in relevant clauses of this document. General laying of concrete shall not begin until final consent has been obtained.

SPREADING COMPACTING AND FINISHING CONCRETE BY SEMI-MECHANISED MEANS

The concrete shall be evenly distributed across the lane by methods which minimize differential pre-compaction and segregation. Where the maximum lane width is greater than 4.5m a 360 dig excavator with a materials handling bucket shall be used The spreader box shall provide a method for striking off the concrete to a regular profile at a depth which gives an adequate surcharge so that after compaction the nominal slab thickness as shown on the drawings will be achieved. The spreading equipment and method will be approved by the Project Engineer on the basis of performance on the trial areas specified in relevant clauses of this document. Equipment not approved shall be removed from the airfield and methods not agreed will be prohibited. Internal vibration over the whole area of the slab shall be provided by poker vibrators. These shall be inserted at points not more than 500 mm apart and withdrawn when air bubbles no longer come to the surface. The vibrators shall not come in contact with the joint filler boards or the underlying surface. They shall ensure uniform compaction throughout. After internal vibration, the concrete shall be struck-off at sufficient level above the forms to ensure that during surface vibration the concrete is everywhere in contact with the compacting beam. The concrete shall be compacted and shaped to the correct finished profile and levels by the use of one or more trussed twin-beam screed/compactor units providing air-driven multiple point high-frequency vibration (Bunyan Roller. not tri-screeds) Each of these units shall be supported on rails, the tops of the forms or on the edges of concrete previously laid and shall be moved forward at a steady rate of 0.5-2.0 m/min. If the unit is winched forward against an anchorage, this shall not be made by fixture into previously laid concrete or the joint grooves thereof. If the profile, degree of compaction or surface finish after the first pass of the unit(s) is not adequate, a second pass may be made. The compacted concrete when hardened shall satisfy the test requirements specified in relevant clauses of this document. Immediately following the completion of compaction but before texturing or application of the curing liquid, Blue-Glider floats, 1.2m long shall be used to remove laitance and minor irregularities from the surface. While the concrete is still plastic and workable, the blade of the Blue-Glider float shall be carefully positioned on the surface of the concrete and parallel to the forms. The Blue-Glider float shall be worked uniformly across the full width of the lane by the first person until all irregularities and blemishes have been removed from the surface of the concrete. The

concrete surface shall not be overworked. Hand floating shall not be allowed, apart from the minimum required to finish alongside joints. The Contractor shall give details of the equipment he proposes to use, together with a detailed methodology for the spreading, compacting and finishing operations. If the Contractor's proposals are considered satisfactory in principle, a qualified preliminary acceptance of the equipment will be given by the Project Engineer. Final consent to the equipment shall rest with the Project Engineer on the basis of the performance of the particular units provided following an assessment of their compactive efficiency in the laying of the trial areas specified in relevant clauses of this document. General laying of concrete shall not begin until final consent has been obtained.

SPREADING, COMPACTING AND FINISHING CONCRETE BY SLIP-FORM PAVER

The concrete shall be spread, compacted and finished in a continuous operating by a train of approved self-propelled machines. The slip-form paving machine shall compact the concrete by means of internal vibration and shape it between sliding side forms by means of a conforming plate. The weight and rigidity of the plate shall be adequate to enable the concrete to be laid consistently to required levels and profiles within the tolerances permitted in this Specification. The concrete shall be deposited without segregation in front of the slip-form paver across its whole width to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck-off to the necessary differential surcharge by means of a quickly adjustable strike-off plate or a screw device extending across the whole width of the lane.

The level of the conforming plate shall be controlled automatically from the guide wire(s), by sensors attached at the four corners of the slip-form paving machine. The alignment of the machine shall be controlled automatically by at least one sensor attached to it. The alignment and level of any ancillary machines for finishing, texturing and curing of the concrete shall also be automatically controlled relative to the guide wire(s). The slip-form paving machine shall have vibration of variable output to suit different concrete mixture characteristics, slab widths and thicknesses and rates of progress. The compacted concrete when hardened shall satisfy the test requirements specified in relevant clauses of this document. The machine shall have sufficient power and mass to maintain uniform forward movement during the placing of concrete in all situations. A guide wire shall be provided along each side of each lane to be laid by slip-form paving plant. This may be reduced to a single wire if the machine is working from skids on a lane already laid or with a constant cross fall device from the one wire. Each guide wire shall be at the required finished level of the edge of the slab as shown on the drawings, or a constant height above it, and parallel to the required line of the lane joint within a vertical tolerance of + 3mm. Additionally, one of the wires shall be at a constant horizontal distance from the required line of a lane joint within a lateral tolerance of + 6mm. The guide wires shall be supported from stakes not more than 8m apart by connectors capable of fine vertical and horizontal adjustment. The guide wires shall be tensioned on the stakes so that a 500gm weight shall produce a deflection of not more than 20mm when suspended at the mid-point between any pair of stakes. The end of the guide wires shall be anchored to fixing points which shall not be closer to the edge of the slab than the line of stakes. The ends of the guide wires shall not be anchored to the stakes. Finishing behind the slip-form paving machine shall be carried out mechanically by means of a longitudinal finishing beam. The concrete surface shall not be overworked. Hand floating

shall not be allowed, apart from the minimum to finish alongside joints. Purpose made forms with adjustable jacks may be used immediately behind the slip form paving machine to prevent the edges of the newly compacted concrete from slumping. Sufficient forms for a continuous length of 50m of joint shall be available for use at the beginning of each laying shift. Use of makeshift forms, props or jacks shall not be allowed.

All units shall be properly maintained. The units shall be controlled by experienced operators at all times. The Contractor shall give details of the equipment he proposes to use, together with a detailed methodology for the spreading, finishing, texturing and curing operations. If the Contractor's proposals are considered satisfactory in principle, a qualified preliminary acceptance of the equipment will be given by the Project Engineer. Final consent to the equipment shall rest with the Project Engineer on the basis of the performance of the particular units provided following an assessment of their compactive efficiency in the laying of the trial areas specified in relevant clauses of this document. General lying of concrete shall not begin until final consent has been obtained.

METHODS OF FORMING JOINTS

The methods of forming joints and grooves are specified in relevant clauses of this document. All joints shall be straight throughout their length and shall be vertical. The pavement surfaces across the joints shall be finished so as to satisfy the regularity teat requirements of relevant clauses of this document.

EXPANSION JOINTS

Expansion joints between new and previously laid or existing concrete pavements, around box-gutters, and where shown on the drawings, around other obstructions in the continuity of the new slab, shall be formed by placing the approved joint filler board specified in relevant clauses of this document against the exposed face of the existing slab, gutter or obstruction, prior to the laying of the concrete. Only where lengths of joint filler greater than the standard length for the approved product are required shall two lengths be butt jointed together. The board shall be held rigidly in position so that it cannot be displaced or disturbed during subsequent concreting. All necessary measures shall be taken to ensure that "bridging" of concrete does not occur beneath or around lengths of filler. Alternatively the slip formed concrete shall be cut to its full depth with a 3mm wide blade at the time of cutting crack inducing grooves to ensure complete separation before cracking can occur. After completion of concrete, at the time of forming the sealing grooves, if required, a 25mm wide blade shall be used to form a void to receive the filler board. Alternatively, main expansion joints may be performed in advance of concreting by placing the joint filler board specified in relevant clauses of this document in the required location prior to the laying of the concrete. The filler board shall be held rigidly in position against a steel channel secured firmly to the surface on which the concrete is being laid, or in an approved cradle assembly designed for the purpose, equally rigid and equally secured, which cannot be displaced or disturbed during subsequent concreting. The filler board shall extend the full depth of the joint with no gap between the bottom of the board and the surface on which it is resting. The concrete shall be spread, compacted and finished up to the filler board on one side, and after the initial set of the slab against the board, the channel or cradle shall be removed before laying of the concrete continues from the other side of the board.

A purpose-made, bull nosed arris trowel shall be the final tool to be drawn, lightly and carefully, along the edge of the concrete, on the line of the filler board, to leave the new joint edge rounded-off to a radius not greater than 5 mm.

SEALING OF EXPANSION JOINTS

Prior to sealing of the expansion joints specified in relevant clauses of this document approved rotary cutters shall be used to remove the top of the filler board to the required depth. Removal of the filler board by ploughs will not be permitted. The exposed inside faces of the concrete along the edges of the joints shall be scoured with a power-driven rotary wire brush until all loose fractions have been dislodged. Scouring shall be carried out with care to ensure that the arises are not damaged. Each joint shall then be inspected to ensure that the filler board is exposed for the whole length of the joint and extends without bridging either from edge to edge of the lane or continuously longitudinally. Any deficiency shall be corrected with concrete saws, with blades suitably set to cut the full width of the joints. The inside faces shall then be rescoured, grit blasted and re-cleaned. A primer shall be applied to the cleaned concrete faces as specified by the compound manufacturer. A separation membrane shall be laid on the exposed filler board. Sealing compounds in accordance with relevant clauses of this document shall be prepared and poured by the manufacturer or the manufacturer's approved agent. During sealing, the joint and filler board shall be touch dry. The air temperature shall exceed the minimum specified for pouring by the manufacturer of the compound. Cold poured compounds shall be prepared and poured in accordance with the manufacturer's instructions. Hot poured compounds shall be heated in an indirectly heated melter-pourer to a temperature within the pouring range recommended by the manufacturer. They shall not be heated at this temperature for a period longer than the safe heating time stated by the manufacturer. The method of heating shall be proof against fire risk and explosive hazard. The melter-pourer shall include a device for the mechanical agitation of the compound during heating and an accurate thermometer for gauging the temperature of the compound. It shall be cleaned out at the end of each day's work. Reheated material shall not be used.

CONTRACTION GROOVES

Contraction grooves shall be sealed as shown on the drawings. Contraction grooves shall extend vertically from the surface of the slab to a depth of 40 mm, or to a depth equal to one -fifth of the actual thickness of the slab, whichever is the greater.

The grooves shall be sawn to a maximum width of 3 mm. The Contractor shall saw the grooves as soon as the concrete has gained sufficient strength to prevent the surface being ripped or damages by the operation. The Contractor shall ensure that random cracking due to late saw-cutting does not occur and that all sawing is completed within 18 hours of concrete finishing. All sawn joints shall be flushed out using a water pressure jet to remove all slurry and other debris immediately after sawing while not damaging the joint. Joints shall be kept clean and free of deleterious material until the joint is sealed. When the trial lanes required by relevant clauses of this document are laid the Contractor shall conduct trials to

prove that the type of saw and blade he proposes to use is suitable for the intended purpose on the concrete with the particular ingredients being used. If the cutting of the grooves fails to meet the time limit given above or if cracking should occur before or during saw cutting, the placing of the concrete shall stop until the difficulties have been resolved. Where shown on the drawings construction joints and contraction grooves shall be widened, prepared and sealed as specified below. After removal of the polythene sheeting used for curing as specified in relevant clauses of this document, concrete saws with diamond tipped blades shall be used to form slots for sealing at the tops of joints. Each slot shall be 13mm (+3, -0mm) wide and shall be of sufficient depth to allow a minimum sealant depth of 15mm for cold applied or 20mm for hot applied sealing compound (or the minimum sealant depth specified by the manufacturer, if this is greater) with the top of the seal finished 5mm below the pavement surface. An accurate method of guidance approved by the Project Engineer on the basis of its performance on the trial area specified in relevant clauses of this document shall be used to ensure that the edges of the slots area parallel and straight. Each slot shall be prepared for sealing in the manner specified for expansion joints in relevant clauses of this document. In contraction grooves, the top of the groove below each slot shall then be plugged with closed cell polyethylene foam or inert caulking cord. If recommended by the manufacturer of the sealing compound a bond breaking tape shall be placed at the base of each slot. The slots shall then be primed and sealed in the manner specified for expansion joints in relevant clauses of this document.

CONSTRUCTION JOINTS

All construction joints shall be sealed joints as shown on the construction drawings. The longitudinal construction joints shall be made against the forms specified in relevant clauses of this document or against the travelling forms or conforming plate of a slip form paving machine, and against previously laid concrete as the laying of the concrete proceeds. At the end of a day's work, and when mixing stops for more than 90 minutes, transverse construction joints shall be made. They shall be constructed against a form, in lieu of the contraction grooves specified in relevant clauses of this document. A purpose-made bull nosed arris trowel shall be the final tool to be drawn, lightly and carefully, along the edge of the concrete between it and the forms to leave it rounded off to a radius not exceeding 5 mm. The surface texture, specified in relevant clauses of this document shall extend to the edge of the 5 mm arris next to the forms. The forms shall be removed without damaging the concrete, particularly the rounded arris. Any minor surface cavities exposed shall immediately be filled with mortar composed of 1 part cement to 2 parts fine aggregate. The exposed vertical face of the slab shall then immediately be painted with a uniform film of bitumen emulsion as specified in relevant clauses of this document.

When the lane of concrete has been placed by slip-form paver, before an adjacent lane is laid against it the straightness of the vertical edges of the lane shall be checked using a 1m long straightedge. Any deviations in excess of 5mm beneath the straightedge shall be corrected by grinding, or by any other means acceptable to the Project Engineer. Any concrete which may have escaped beneath the side forms of the paver shall be trimmed back the same straightedge tolerance. Any minor surface cavities left by the slip forming

process shall be filled with mortar composed of 1 part cement to 2 parts fine aggregate. The exposed vertical face of the slab shall then immediately be painted with a uniform film of bitumen emulsion as specified in relevant clauses of this document.

Where concrete is to be placed against hardened concrete laid under this contract the exposed edge of the hardened concrete shall be examined immediately before laying commences. Any cracks which have been induced in the hardened concrete by the contraction grooves shall be noted and taped over to prevent ingress of grout from the fresh concrete. In addition, contractions grooves which are found to have induced cracks shall be sealed temporarily by use of paper cord or other approved means to prevent ingress into the cracks of slurry created while sawing contraction grooves in the new slab. The cord and any slurry, grout or other materials lodged in the grooves shall be removed before the pavement is considered complete. During the laying of the adjacent slab, the concrete along the surface margin shall not be overworked. Only a minimum of hand tool finishing will be allowed. For unsealed joints when the slab on the second side of a construction joint is laid, a purpose-made bull nosed arris trowel shall again be the final tool to be drawn, lightly and carefully, along the edge of the slab to produce an arris of 5mm maximum radius to match that on the first side. All sealed construction joints shall be widened, prepared and sealed in the same manner as contraction grooves as specified in relevant clauses of this document.

JOINTS BETWEEN NEW PQC AND EXISTING BITUMINOUS SURFACING

The joints shall be made in accordance with the drawings. The existing bituminous pavement shall be cut back from the line of the junction between the bituminous pavement and the new concrete pavement by a maximum distance of 500mm to permit the erection of the forms specified in relevant clauses of this document or to allow the passage of the side forms of a slip-form paver. The dry lean concrete base shall then be carried through to abut the cut-back edge of the existing pavement. If the existing pavement is thicker than the new pavement, the extra thickness at the base of the pavement in the cut-back area shall be restored with dry lean concrete, laid and compacted in separate layers if necessary to comply with the specified requirements for maximum dry lean concrete layer thickness. After the specified forms have been fixed on the surface of the dry lean concrete, the new Pavement Quality Concrete surfacing shall be completed. Immediately after the forms have been removed, or, when a slip-form paver has been used, prior to refilling the space between the new concrete and the bituminous surfacing, the exposed vertical edge of the new concrete slab shall be painted or sprayed with the bitumen emulsion specified in relevant clauses of this document. The space between the new concrete slab and the existing pavement shall then be filled with dry lean concrete compacted to within 100mm of the surface of the new slab. The remainder of the space shall be filled with hot rolled asphalt complying with IRC 27 -2000 Designation 35% 0/14 incorporating crushed rock aggregate and 70/100 pen bitumen binder.

Before any asphalt is placed, all exposed surfaces to which it is to be bonded shall be tack coated in accordance with BS 434-2, Clause 14. The asphalt shall be placed in two layers, each of 50mm and separately compacted. At the time of compaction the temperature of the mixture shall not be less than 120°C. The final layer shall be laid slightly proud of the

existing asphalt surfacing. Hand tampers shall have a mass of not less than 25 kg and a face area not exceeding 0.065 m^2.

Where ramps are to be provided between new Pavement Quality Concrete and existing bituminous pavements, these shall be constructed to the details shown on the project drawings.

ROUTINE TESTS ON CONCRETE AFTER LAYING (SURFACE ACCURACY)

The finished surface levels of the concrete shall conform to the levels, profiles and contours shown on the drawings and the finished levels of the underlying courses are to be such that at no points will the thickness of the concrete be less than the nominal thickness specified. Levelling shall be undertaken on the corners of each bay. Where the Project Engineer so directs, deviations from the required levels exceeding 6 mm shall be corrected by cutting out and replacing the concrete in the offending area by the means specified in relevant clauses of this document. Where the Project Engineer is satisfied that the permitted deviation is exceeded only at a local high spot, correction by an approved grinding method and/or scoring as specified in relevant clauses of this document will be permitted. At junctions between new and existing or new and new pavements the level difference must not exceed 3mm at any point. Tests for the surface regularity of the finished Pavement Quality Concrete shall be carried out as soon as the polythene sheet used for final curing is removed, i.e. 4 days after laying unless delayed by frost. The following minimum number of tests shall be made on each lane:-

1. One test at each longitudinal construction or expansion joint, with test alignment normal to the joint, for each 10m of such joint. The straightedge shall be positioned with 2m of its length on the test lane and 1m on the adjacent lane. When the adjacent lane has yet to be laid, the straightedge shall be positioned with one end on the joint line.
2. Two tests across each transverse construction or expansion joint, with test alignment normal to the joint.
3. Two tests on the interior of the lane, one test aligned normal to and one parallel to the longitudinal joints, for each 50 m^2 of surface laid. The positions for test shall be selected by the Project Engineer and the testing shall be carried out in his presence. Neither the clearance beneath the straightedge between points of contact with the surface during test nor the calculated height of any high spot shall exceed 6mm in tests at longitudinal joints or 3mm in other test positions. Points on the surface which fail to comply with this requirement shall be marked and the following action taken:-
    - At each failure position at a longitudinal joint, ten further tests, five in each direction, shall be made at 1m intervals along the lane. If more than two of these additional tests also fail, or if in any test, including the initial one, clearance beneath the Straightedge between points of contact with the surface or calculated height of any

high spot exceeds 8mm, the length of the lane concrete bounding the failure positions shall be condemned.

- At each failure position on a transverse construction or expansion joint, further tests shall be taken at 1m intervals along the whole length of joint to determine the extent of the deficiency. Correction by an approved grinding method and/or scoring as specified in Clause 3.3.31 may be allowed but, if this is not feasible, one or both of the bays of concrete adjoining the joint shall be condemned.
- At each failure position on the interior of a lane, the straightedge shall be used as directed by the Project Engineer within the bay containing the failure to determine whether the failure is due to an isolated high spot. Isolated high spots may be corrected by an approved grinding method and/or scoring as specified in Clause 3.3.31. Bays containing more than one high spot or one or more depressions which will cause water to pond shall be condemned. If the Contractor fails to meet the specified requirement for surface accuracy in any two consecutive days' work all concreting work shall stop until the spreading, compacting and finishing processes have been checked, the cause of the failure has been established and corrections have been made, to the satisfaction of the Project Engineer.

TEXTURING OF SURFACE

After eliminating surface blemishes with scraping straightedges, as specified in relevant clauses of this document or longitudinal finisher as specified in relevant clauses of this document and before the application of the curing liquid specified in relevant clauses of this document, the surface of the concrete shall be textured as detailed below.

1. All surfaces except aircraft wash downs and hangar floors While the concrete is still soft enough to take an impression, a 900mm wide texture brush with 100mm long flat steel 'bristles' shall be drawn, mechanically or by hand, from a bridge platform spanning the lane, lightly across the surface at right angles to the slab edges and square to the runway or taxiway centreline, to match existing texture direction in areas of bay replacement or with the cross fall of the pavement. Care shall be taken not to damage that arises on the joints during this operation.
2. Hangar Floors: The surface shall receive no texturing treatment. Following the use of the scraping straightedge or longitudinal finisher, steel floats may be used to the minimum extent necessary to remove minor blemishes. If a proprietary finish to the floor is shown on the drawings, the manufacturer's instructions n finishing and texturing the concrete shall be followed.

3. Trial Areas: The trial area(s) specified in relevant clauses of this document shall be textured as above and clearly defined section(s) of the trial area(s) shall be approved as standard(s) by the Project Engineer. They shall be permanently marked `Approved Texture` and dated. Uniform texture(s) similar to the approved texture(s) shall be reproduced throughout the work. The surface texture shall satisfy the texture depth test requirements specified in relevant clauses of this document.

INITIAL CURING

Immediately after the surface of the compacted concrete has been textured as detailed in relevant clauses of this document, initial curing of the concrete surface shall be carried out with the approved compound specified in relevant clauses of this document. The curing compound shall be handled and applied strictly in accordance with the manufacturer's instructions. Each container of curing compound shall be agitated vigorously immediately prior to use to ensure full dispersal of the flake aluminum within the compound. The compound shall be sprayed on at a uniform rate of spread, which shall be sufficient to obtain a complete coverage of the surface and shall be at least equal to that specified by the manufacturer on the consignment certificate. After application, the compound shall give a continuous film of uniform thickness with an unbroken metallic finish, free from pinholes or other imperfections, over the entire surface of the concrete. When the concrete has been compacted by a slip-form paving machine, as specified in relevant clauses of this document, the compound shall be applied by hand held lances operated from the work platform, supplied by mechanical pump. The compound shall be continuously agitated and mixed in its container during spraying by mechanical means. The nozzles shall be arranged in a manner that will ensure a uniform coverage, free of streaks and lines, and shall be protected by an efficient shield to prevent wind-blown losses. Hand operated spraying equipment shall be held on each site to complete the spraying of concrete already laid in the event of temporary breakdown of the mechanical sprayer. In this event further concreting shall cease until the Contractor provides an efficiently operating mechanical sprayer to the satisfaction of the Project Engineer. When the concrete has been laid by semi-mechanized means in accordance with relevant clauses of this document, or by hand, the Contractor will be allowed to use hand operated spraying equipment for the whole of the application. Immediately after removal of forms, exposed vertical edges shall be painted or sprayed with the bitumen emulsion specified in relevant clauses of this document.

FINAL CURING

Where there is a risk of rain, following the initial curing specified in relevant clauses of this document the concrete shall be immediately protected for a period of not less than 4 hours by covered frames, spanning the lane. Frames shall be wheeled and secured once in place to avoid movement by wind or jet blast. The covering shall be of an approved opaque light coloured material. It shall be stretched over the top of the form so that it is not less than 75 mm or more than 500 mm above the surface of the concrete. The sides and ends of the frames shall be panelled down to the surface level of the concrete. The frames shall be positioned to give complete coverage of the concrete. Tentage shall be available at all time

in case of unforeseen heavy showers. All covered frames and sheeting shall be kept in good condition.

ROUTINE TESTS ON CONCRETE AFTER LAYING (CORES)

The density of the compacted concrete shall be such that the total air voids are not more than 3 per cent. The air voids shall be derived from the difference between the theoretical maximum dry density of the concrete calculated from the specific gravities of the constituents of the concrete mix and the average value of three direct density measurements mad on cores at least 150 mm diameter.

The mean value, for the purpose of testing shall be defined as the mean result for each construction phase calculated separately. Similarly sets for the testing regime shall be defined as for each phase of pavement construction.

- Depth, Voidage and Compressive Strength of Cores

1. For the first 500 m^3 of routine production of Pavement Quality concrete, one core shall be cut from each 50 m^3 of concrete laid or one per day. Thereafter, the rate shall be one core per 100 m^3 laid or one per day. Each core shall be taken from a location corresponding to a delivery of concrete sampled for cube testing in accordance with Clause 3.3.11(2).

2. The cores shall be prepared by trimming and capping or grinding each end for compression testing. Each core shall be reduced in length by sawing off the top so that the lower section shall have a length/diameter ratio in the range of 1.0 to 2.0 as recommended below. The core shall then be stored in a curing tank before testing at 28 ± 3 days. The saturated density and compressive strength shall be determined in accordance. The corrected core strength of the concrete shall be calculated using the values presented as below.

Length/diameter ratio	**Correction factor**
1.00	1.00
1.25	1.07
1.50	1.12
1.75	1.16

2.00 1.18

3. Each core shall comply with all of the following three requirements:-
   - The total length of the core shall not be less than the nominal slab thickness nor exceed it by more than 25mm.
   - The results shall be no worse than those of the 'approved' core, which was cut from the approved trial area in accordance with Clause 3.3.5, in respect of honeycombing and visible voids.
   - The corrected core strength at 28 + 3 days shall not be less than 33N/mm2.

4. If any core fails to satisfy any of the requirements of 3) above, four additional cores shall be cut at 5m spacing along the lane in positions symmetrical about the position of the failed core. All 4 new cores shall satisfy requirements 3(i) and 3(ii).

   If the failure of the original core included lack of compliance with requirement 3(iii), the 4 new cores shall be prepared and tested for compressive strength and using the correction as presented above at 35 ± 3 days. The mean 35 day corrected core strength value of the 4 cores shall be at least 40N/mm2 and no more than one individual value shall be below 36N/mm2. If either or both of these requirements and/or either or both of requirements (i) and (ii) are not satisfied, the area of pavement slab represented by the 4 cores shall be condemned. The minimum area shall be taken as the 20 m length of the pavement lane symmetrical about the core positions and the area shall extend to the nearest transverse joint. The extent of any further unacceptable concrete in each direction along the lane adjacent to the condemned are shall be investigated by cutting at 5m spacing and testing additional groups of 4 cores until a group in each direction satisfies all of the requirements.
5. The mean 28 day corrected core strength value for the set of routine cores representing the first 500 m^3 of normal production and for subsequent sets each representing 1000 m^3 of production (to correspond with sets of 7 day cube strength values specified in 2) above shall not be less than 45N/mm2. If the mean value from any set of results falls below 45N/mm2, either:-
   - The concrete mixture shall be adjusted to increase its strength, using the relationship between cube and core strengths obtained from this set of results to estimate the revised target mean 7 day cube strength value necessary, or,
   - If core densities indicate that compaction is inadequate, measures shall be taken to the satisfaction of the Project Engineer to improve compaction.

If the mean value from a set of results is below 40N/mm2, work shall cease until the trial mixture and trial area procedures specified in Clauses 3.3.4 and 3.3.5 have been repeated.

The area of pavement from which a set of cores fail to achieve mean 28 day corrected core strength of 45N/mm2 shall be condemned should the Project Engineer so instruct.

ROUTINE TESTS ON CONCRETE AFTER LAYING (SURFACE TEXTURE)

Where a surface texture is required, it shall be measured by volumetric patch tests as soon as final curing is achieved, i.e. 4 days after laying, unless delayed by frost. Three sets of five tests shall be made with a frequency of one set along each lane of concrete for each 150m laid, or a minimum of one set per days' work when this is less. The position of the test shall be selected by the Project Engineer. The 5 positions for each set of tests shall be at the center point of each quarter of the bay on a diagonal line drawn between opposite corners of the bay and at the intersection point of the diagonals. For runways, short takeoff and landing (STOL) strips, concrete dummy deck facilities and rapid exit taxiways, the average mean texture depth (MTD) for each set of tests shall not be less than 0.85mm or greater than 1.1mm. Not more than one test of each set shall show a MTD less than 0.75mm or greater than 1.2mm. For taxiways and hard standings, the average MTD for each set of tests shall not be less than 0.5mm and not more than one test of each set shall show a MTD less than 0.35mm When compliance with minimum MTD requirement is not achieved over localized areas less than $20m^2$ the deficiencies shall be made good by transverse scoring by the method specified in relevant clauses of this document. For widespread or repeated failure the concrete shall be broken out and replaced as specified in relevant clauses of this document. When compliance with the maximum MTD requirement is not achieved, the Contractor shall submit proposals to the Project Engineer for remedial actions to reduce the MTD to acceptable levels. Where the proposals are not accepted or the deficiencies cannot be subsequently achieved, the concrete shall be broken out and replaced as specified in relevant clauses of this document.

FILLING CORE HOLES

Before refilling the hole from which a core has been cut the base of the hole shall be coated with two coats of bitumen tack coat or a layer of building paper cut to suit. The hole shall be filled with the approved Pavement Quality Concrete mixture and shall be tamped in separate lifts of not greater than 100mm. The surface shall be finished flush with the adjacent concrete and with a texture to match it. All cores shall be filled within 24 hours of being taken.

TRAFFIC ON FINISHED CONCRETE

Except for the saws specified in relevant clauses of this document and the coring rigs specified in relevant clauses of this document, the concrete shall not be subjected to the weight of any traffic or equipment for at least 7 days after laying. Then, and only subject to the consent of the Project Engineer, the concrete shall only be used by the minimum of equipment essential for continuing the work, and only by traffic when no other means of

access to the lane under construction is possible. Metal wheels shall not be allowed to run on the concrete at any time. The crawler tracks of slip-form pavers shall be fitted with neoprene pads.

The Contractor shall be responsible for the protection of the finished concrete and shall take precautions to prevent damage to the edges, marking of the surface, or shattering of the joint or groove arises. Any defacements, defects, or damage shall be made good by the methods and to the standards of this Specification.

CUTTING OUT CONCRETE

Existing pavement concrete or new pavement quality concrete that has been condemned shall be removed within 3 days of the Contractor being notified of such condemnation. When concrete is cut out it shall be removed for the full depth of the slab. When the concrete bays are less than 4.5 m square, or equivalent area, or have an irregular shape, the whole bay shall be removed. When the bays a 4.5m square or larger, a half bay only may be removed, providing the half bay which will remain is free of defects. The bay to be removed shall be defined on four sides by bay joints or grooves. When only three sides are so defined, the additional side shall be marked out by a straight saw cut at least 40mm deep. The joints and grooves shall be cleaned out and a leg of a length of rolled steel angle wrapped in Hessian or other shock absorbing material shall be carefully tamped into the saw cut and joints to cover and protect the arises of adjoining concrete during drilling and breaking out. Full depth cores shall be made adjacent to grooves and joints and the bay or section shall be carefully broken out between the holes with percussion chisels or feather wedges. The exposed edges of the adjoining bays or section shall be trimmed to a vertical and reasonably fair face. With the consent of the Project Engineer, full depth saw cuts may be used instead of coring and wedging. Care shall be taken to ensure that all concrete remaining in the vicinity of cutting-out is sound and without fracture. If damage or fractures are discovered, an additional area of concrete shall be cut out by the means specified in this Clause until only sound concrete remains.

REPLACEMENT OF CONCRETE

Before replacing the concrete the separation layer shall be repaired, as specified in relevant clauses of this document. If an exposed edge of the adjoining bay was that of an expansion joint, filler board shall be placed against the exposed edge, and the joint shall be reformed and sealed in the manner in relevant clauses of this document. All other edges of adjoining bays or sections exposed by cutting out, shall be replaced as construction joints as specified in relevant clauses of this document. The approved Pavement Quality Concrete mixture shall be spread and compacted as specified in relevant clauses of this document and finished to the surface accuracy specified in relevant clauses of this document. The concrete shall be textured to relevant clauses of this document, and shall be cured, as specified in relevant clauses of this document.

SCORING AND GROOVING HARDENED CONCRETE

- Scoring

All areas to be scored shall be treated transversely by a single pass of a cutting drum incorporating 3mm diamond saw blades at 6mm centers. The drum shall be set to give a uniform 3mm depth of scoring over the whole surface. If the requirements, specified for texture depth are not achieved scoring shall stop until either adjustments have been made to the setting or new drums have been fitted to the satisfaction of the Project Engineer.

- Grooving

Where indicated on the Contract drawings grooving shall be carried out using a suitable machine with diamond tipped saw blades. Grooves will be continuous for the entire length of the relevant area and perpendicular to the centreline. Grooves shall terminate within 1.5 to 3 meters of the pavement edge to allow for operation of grooving equipment and shall not extend into the drainage channel. The grooves shall be 4mm in depth by 4mm in width at a spacing of 25mm center to center. Grooving shall not be carried out within 150mm of the runway centreline, or within 50mm of transverse joints or working cracks, through compression seals, in-runway lighting fixtures or similar items, or the first three meters either side of an arresting barrier cable which requires hook engagement for operation.

SAW CUTS ADJACENT TO AGL FITTINGS, MANHOLE COVERS, PIT COVERS ETC.

Where the manhole covers or pit covers are closer than 1m to the edge of the bay, additional grooves shall be sawn to a maximum width of 3mm and to the depth shown for contraction joints. The location of the grooves shall be as shown on the construction drawings.

HIGH PERFORMANCE JOINT

A high performance joint shall be constructed in the locations shown on the drawings between Pavement Quality Concrete and bituminous materials. The joint shall be an Armourscreed AS100, Fibrescreed or similar approved inset joint installed as the manufacturer’s instructions.

SECTION VI: TESTING

TEST RESULTS

The Contractor shall be responsible for carrying out all the testing in accordance with the requirements of this Section and shall provide the Project Engineer with a written copy of all results on request. Testing shall be started on specimens within 2 working days of sampling and shall be carried out in an expeditious manner.

TESTS FOR INITIAL APPROVAL OF MATERIALS

Before mixing starts and as part of the Quality Assurance requirements the Contractor (or his materials supplier/s on his behalf) shall carry out relevant tests to determine the properties and grading of the aggregates for comparison with the relevant specification clauses as listed in Table below.

Tests for Initial Approval of Materials

Test	Test Reference
Coarse Aggregate	
Sieve Analysis	IS: 2386 – 1963 Part 1
Flakiness Index (Shape Index)	IS: 2386 – 1963 Part 1
Resistance to Fragmentation (Crushing Value or Impact Value)	IS: 2386 – 1963 Part 4
Fines Content (Material Finer than 0.075mm Sieve)	IS: 2386 – 1963 Part 1
Shrinkage	IS: 2386 – 1963 Part 3
Magnetic Permeability	
Fine Aggregate	
Sieve Analysis	IS: 2386 – 1963 Part 1
Durability (Magnesium Sulphate Value)	IS: 2386 – Part 5
Fines Content (Material Finer than 0.075mm Sieve)	IS: 2386 – Part 1
Magnetic Permeability	

In addition, the Contractor shall obtain and incorporate in site records the appropriate certificates for:

- Cement
- Water
- Admixtures
- Joint filler
- Curing compound for exposed surfaces
- Joint sealing compound
- Concrete for ancillary purposes

ROUTINE TESTS ON BULK SUPPLIES THROUGHOUT PLANT MIXING

The Quality Assurance procedures for the supply of component materials shall include carrying out tests in order to check on the consistency of bulk supplies, to compare the properties and grading of bulk supplies with the samples provided and to enable actions to be taken to cope with variations. The tests should include the following:

Test	**Reference**
Sieve analysis of aggregates	IS: 2386 Part 1
Fines content of aggregates	IS: 2386 Part 1
Chloride ion content in aggregates	-
Moisture content in aggregates	IS: 2386 Part 3
Loss on ignition of cement	IS: 4031 – 1968

If the result of any test indicated that the bulk deliveries are not of a grading or quality consistent with the approved samples, the Contractor shall, at his own expense, carry out further tests to establish the location and extent to which the materials already stockpiled fail to meet the approved standard and, if stored on site, shall remove all non-compliant from the airfield.

ROUTINE TESTS ON PLANT THROUGHOUT PLANT MIXING

The Contractor shall arrange for checks on the calibration of weighing, water measuring and admixture dispensing mechanisms to be checked before mixing starts and at specified intervals during production.

ROUTINE TESTS ON CONCRETE THROUGHOUT PLANT MIXING

As part of the Quality Assurance requirements, the Contractor shall carry out the tests as listed in Table below on concrete (including trials). The procedure shall ensure that the positions of concrete batched from which tests samples are taken fully traceable in the finished pavement.

Routine Tests on Concrete throughout Production

Test	**Reference**
Degree of Compactability of Compaction Index (CI)	IS: 1199-1959
Slump	IS: 1199-1959

Air content	IS: 1199-1959
Cube strength	IS: 516-1959
Temperature (Hot or Cold weather only)	BS EN 206-1 & BS 800-2

ROUTINE TESTS ON CONCRETE AFTER LAYING

The Contractor shall undertake the series of tests on hardened concrete incorporated in the necessary to comply with the relevant specifications.

CERTIFICATES THROUGHOUT THE WORK

Throughout the course of the work, the Contractor shall obtain certificates for all consignments of the following and retain in site records:

- Cement
- Curing compounds for exposed surfaces
- Joint sealing compounds

- ***Storm drain arrangement on one side of roads shall be provided for collecting and disposing dewatering rain and other water with interconnectivity. The water shall be disposed from storm drain from the area at safe and suitable disposal point. The drains shall be constructed as per the relevant sections of MORT&H guidelines.***
- ***Road Markings & Signboards shall as per the relevant sections of MORT&H guidelines.***

General Civil Specifications

1. GENERAL

1.1 SPECIFICATION DRAWINGS

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

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

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

1.2 GEO-TECHNICAL STUDIES

The bidders are free to visit and inspect the sites till the submission date for the purpose of quoting and estimation. The Contractor shall carry out geo-technical studies on at least 10 locations at their cost at the site and with prior permission of Engineer-in-Charge, from ULB approved soil consultant and the report should be furnished to the ULB/Consultant and should approved by ULB/Consultant prior to start of structural design & drawings. ULB accepts no responsibility, whatsoever for inferences drawn from this data and the Contractor is to satisfy ULB on his own responsibility as to the extent to which this information represents the conditions to be encountered.

1.3 MATERIALS

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

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

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

Materials shall be transported, handled and stored in such a manner as to

prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

2. SPECIFIC CIVIL REQUIREMENTS

2.1 DESIGN SUBMISSIONS

The Contractor shall submit complete detailed design calculations of foundations and superstructure for every civil work with general arrangement drawings and

explanatory sketches to the ULB. Separate calculations for foundations or superstructures submitted independent of each other should be deemed to be incomplete and will not be accepted by the ULB.

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

2.2 DESIGN STANDARDS

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

2.3 DESIGN LOADINGS

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

2.3.1 Dead Load

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

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

Sr.	Parameter	Load
(i)	Weight of water	10.0 kN/cu.m
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc) However, for checking stability against uplift, actual weight	

	of soil as determined by field test shall be considered	20.0 kN/cu.m
(iii)	Weight of plain concrete	24.0 kN/cu.m
(iv)	Weight of reinforced concrete	25.0 kN/cu.m
(v)	Weight of brickwork (exclusive of plaster)	22.0 kN/cu.m per mm thickness of brickwork
(vi)	Weight of plaster to masonry surface	18.0 kN/cu.m per mm thickness
(vii)	Weight of granolithic terrazzo finish or rendering screed, etc	24.0 kN/cu.m per mm thickness
(viii)	Weight of sand (filter media)	24.0 kN/cu.m

2.3.2 Live Load

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

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

In the absence of any suitable provisions for live loads in IS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the ULB prior to starting the design work. Apart from the specified live loads or any other loads due to material stored any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

2.3.3 Wind Load

Wind loads shall be as per IS: 875

2.3.4 Earthquake Load

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

2.3.5 Dynamic Load

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

2.3.6 Other Loads

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

2.4 JOINTS

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure as per relevant IS code provisions. Expansion joints of suitable gap at intervals not more than 30 m shall be provided in walls, floors and roof slabs of Liquid Retaining Structures.

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

2.5 DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND LIQUID RETAINING STRUCTURES

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

1. Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered.

2. Structure empty (i.e. empty of liquid, any material, etc) full earth pressures including saturated condition and surcharge pressure wherever applicable to be considered.

3. Partition wall between dry sump and wet sump to be designed for full liquid depth up to full height of wall

4. Partition wall between two compartments to be designed as one compartment

empty and other compartment full

5. Structures shall be designed for uplift in empty conditions with the water table indicated in the geotechnical report or high flood level, whichever is maximum. No reduction factor for the uplift force shall be considered.

6. The dead weight of the empty structures should provide a safety factor of not less than 1.2 against uplift pressures during construction and in service.

7. Wall shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;

8. Underground or partially underground structures shall be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab

9. The walls and base slabs shall be designed for saturated earth/water pressure corresponding to high flood level or finished plot level whichever is higher

2.6 FOUNDATION

1. The minimum depth of foundations for all structures, equipment's buildings and frame foundations and load bearing walls shall be as per IS:1094.

2. The earth fill above virgin ground level till formation level shall be taken as a surcharge load and shall be added in the loads coming on foundations appropriately

3. Maximum safe bearing capacity of soil strata shall be taken as indicated in geotechnical reports.

4. Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

5. Special attention is drawn to danger of uplift being caused by the ground water table

6. Plinth level of all structures/top of tanks shall be at least 500 mm above high flood level.

2.7 DESIGN REQUIREMENTS

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

1. All blinding and leveling concrete shall be minimum 100 mm thick in concrete grade M15 for Building & minimum 150 mm thick for Water Retaining Structure.

2. All structural reinforced concrete shall be with a maximum 40 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all the Water Retaining Structures & other structural members.

3. All liquid retaining structures shall be designed as per IS:3370. The minimum grade of concrete shall be M 30.

4. All new liquid retaining structures shall be form finished.

5. For all old liquid retaining structures inside finish shall be provided in CM 1:3 smooth cement plaster 20 mm thick and outside finish shall be 20 mm thick sand face plaster CM 1:3. Snowcem shall also be applied for finishing the outer surfaces.

6. Minimum Cement Content shall be 400 kg/cu.m for M 30.

7. The maximum free water cement ratio shall not exceed 0.42 for all liquid retaining structures.

8. The amount of reinforcement in each of the two directions at right angles within each surface zone should not be less than the minimum specified as IS:3370 or IS:456 whichever is applicable for the type of structure.

9. Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

10. All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15.

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

Sr.	Civil Member	Width (mm)
(i)	Walls for liquid retaining structures	200
(ii)	Bottom slabs for liquid retaining structures	200

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

2.8 MINIMUM COVER TO MAIN REINFORCEMENT

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

2.9 MINIMUM BAR DIAMETER

Sr.	Member	Diameter
1	Major Foundation	10
2	Block Foundation – Main Bars	10
3	Block Foundation – Tie Bars	8
4	Minor Foundation (Local Foundation etc.)	8
5	Column, Pedestal – Main Bars	12
6	Column, Pedestal – Ties	8
7	Beam – Main Bars	12
8	Beam – Anchor Bars	10
9	Beam – Stirrups	8
10	Slab – Main Bars	8
11	Slab – Distribution Bars	8
12	Wall – Main Bars	8

13	Wall – Distribution Bars	8
14	Minor elements such as chajjas, Lintel Beams etc.	8

2.10 BAR SPACING

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

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

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

2.11 MATERIALS

2.11.1 General

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

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

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

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

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

2.11.2 Cement

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

have to be furnished.

2.11.3 Reinforcement Steel

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

2.11.3.1 **Providing Anti-corrosive Treatment to HYSD Reinforcement Bars with Fusion Bonded Epoxy Coating (FBEC)**

2.11.3.1.1 Reinforcing Bars

The reinforcing bars to be provided with Fusion Bonded Epoxy Coating shall conform to the tender specifications and relevant I.S. Specifications. Inspite of producing test certificates by contractor for the proper quality of reinforcing bars, the quality of steel could also be tested by the FBE coating firm at plant site for bend test before doing coating and that if the reinforcing bar fails in bend test, then it shall not be provided with FBEC and in that case, cost of conveyance of such steel to plant and removing form plant shall be of the contractor. The rechecking quality of steel, for bend test will be done by the coating agency in the presence of contractor provided the contractor chooses to remain present.

Reinforcing bars to be coated shall be fresh from rolling mills as far as possible. If the bars are very much rusted in quality before providing FBEC, such bars shall have a loss of weight at contractor's risk.

To ascertain the loss in weight of reinforcing bars on account of removal of rust during coating, random weighment before and after coating shall be done and that loss in weight shall be borne by the contractor.

2.11.3.1.2 Coating Bars with FBEC

The FBEC coating shall be done confirming to I.S. Code 13620:1993 with additional

stipulations as under.

2.11.3.1.3 The Fusion Bonded Epoxy Coating shall be carried out by an authorised FBE coating agency approved by Department.

2.11.3.1.4 Patch-up materials shall be procured in sealed containers with certificates from coating agency for supply of such patch-up materials.

2.11.3.1.5 The tender rate for FBE coating shall include using PVC coated G.I. Binding Wires of 18G.

2.11.3.2 Tests for FBE Coating on Reinforcing Bars

2.11.3.2.1 The contractor shall produce certificate from the FBE coating agency that the quality of powder epoxy material and other components of FBEC conform to I.S. 13620:1993. Such certificates shall accompany each delivery challan of coated bars while leaving the plant. The contractor may also carry out such tests at plant jointly or separately of the coating agency to confirm use of proper quality of coating material.

2.11.3.2.2 The coated reinforcement bars shall be tested at plant by the contractor. Test reports shall be jointly signed by authorised representatives of contractor and the coating agency. The tests on coated bars shall be as per I.S. for the following tests:

a) Thickness
b) Continuity
c) Adhesion

The frequency of tests shall be for the thickness of coating minimum two bars of each size from each production shifts.

Random tests shall be made for continuity of coating.

2.11.3.2.3 Inspite of above tests and test certificates produced by the contractor and coating agency, the Department/Owner reserves the rights to carry out independent tests at coating plant for cross checking. The contractor's agreement with coating agency shall include the provisions for Department's/Owner's cross checking and that if the coating quality is not approved by the Department/Owner the decision of the Department/Owner to reject or repair the coating shall be final and binding on all parties.

2.11.3.3 Thickness of Fusion Bonded Epoxy Coating shall be 200 to 250 microns.

2.11.3.4 Holidays in coating shall not be more than two holidays per linear foot (six holidays per meter) of coated bar.

2.11.3.3 Handling

2.11.3.3.1 The coated bars shall be carefully handled in order not to drop them, not to rub them on hard surface or against another coated bar while conveying, stacking, placing or stacking of fabricated bars and that for this purpose, wooden packing batons shall be used at spacing of not more than 60 cms.
The coated bars shall be tied to make bundles with PVC binding material to avoid damages to coating.

2.11.3.3.2 The coated bars shall be stacked with separation gap between ground and bars with wooden batons between rows of bars or bundles of such tied bars. Such wooden or padded contact shall be at spacing of not more than 60 cms.

2.11.3.3.3 The cut ends of bars shall be touched up with special touch up materials of specifications as provided by coating agency. There shall be minimum time gap to repair the cut ends and damaged portions with touch up materials and that failure to do so may cause complete rejection of the coated bars. The cut ends and damaged portions shall be touched up with repair patch-up material within four hours time gap. All damages to coating in handling etc. shall be repaired irrespective of their size. This stipulation supersedes provision of I.S. Code.

2.11.3.4 No payment will be made for coated bars which are not used in the work and that if they were paid either on account of coating of the rejectable part of bars or doing extra fabrication etc., the amount paid will be recovered from contractor. The contractor will be paid for the same quantity of steel bars used in the work and paid under relevant item.

2.11.3.5 While bending the bars, the pins of workbenches shall be provided with PVC or plastic sleeves. It is preferable that contractor install bar bending machines suitable for FBE coated bars and that each bending operation is done in a time of not less than 90 sec.

2.11.3.6 The coated steel shall not be directly exposed to sun rays and rains and shall be protected with opaque polythene sheets or such other approved materials.

2.11.3.7 While doing concreting, the workmen or trolleys shall not directly move on coated bars but can move on wooden planks placed on the bars by contractor.

2.11.3.8 In spite of all test certificates, if the coated bars are roughly handled by

contractor either during transport, fabrication, stacking, placing and concreting etc. or handled in such a manner as to damage the coating for area or portion more than reasonable, the Engineer-in-charge or Department/Owner reserve the right to reject the FBE coated bars and that if rejected then such rejected bars shall be removed by contractor from work site within three days. The decision of Engineer-in-charge will be final as to reject the bars with damage coating or to allow repairing the coating, or to get it recoated entirely at contractor's cost.

2.11.4 Minimum Cement Content

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

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

2.12 SAMPLES AND TESTS OF MATERIALS

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

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the ULB.

The Contractor shall give the ULB seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by the ULB. The ULB shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the ULB to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to ULB within seven days of every test such number of certified copies (not exceeding six) of the test results as the ULB may require.

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

The provisions of this clause shall also apply to materials supplied under any

nominated sub-contract.

2.13 ORIENTATION

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

2.14 ROADWAYS, PATHWAYS & HARDSTANDINGS

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

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

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

2.15 SITE DRAINAGE

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

- Storm Water Drainage
- Foul Drainage

2.15.1 Storm Water Drainage

Storm water drains adjacent to the existing and proposed roads (under this Contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be in stone/brick masonry (1:5) of appropriate thickness topped with 75 mm thick M10 concrete and internally flush pointed plastered

in cement mortar (1:4) mm thick.

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

2.15.2 Foul Drainage

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

2.16 CABLES AND PIPEWORK TRENCHES

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

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

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

2.17 PIPES AND DUCTS

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

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

2.18 SOIL DATA & GROUND WATER TABLE

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

2.19 BUILDINGS AND STRUCTURES

All the building and structure works shall generally comply with the following

Employer's Requirements unless otherwise specified elsewhere:

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

2. All internal partition walls except for toilet shall be in 230 mm thick brick masonry built in cement mortar 1:5 with transoms and mullions as in (2) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transomes and mullions similar to (2) above and shall form panels not exceeding 1200 mm x 1200 mm in size.

3. Toilet floor slab shall be filled with brick bat cobs (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

4. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.

5. The toilet facilities shall be provided in Administration-cum-Laboratory building separately for men and women which include at least :

   i) 2 Nos. Toilet (1 no. for men and 1 no. for women) with white porcelain Orissa pan minimum 580 mm long with flushing cistern of 10 litres capacity.

   ii) 2 Nos. wash basins (1 no. for men and 1 no. for women) of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.

   iii) 2 Nos. mirrors (1 no. for men and 1 no. for women) of size 400 mm x 600 mm wall mounted type fitted over wash basins.

   iv) 2 Nos. plastic liquid soap bottles (1 no. for men and 1 no. for women)

   v) 2 Nos. chromium plated brass towel rails (1 no. for mean and 1 no. for women) minimum 750 mm long.

   vi) All stopcocks, valves and pillar cocks shall be heavy-duty chromium plated brass.

   vii) All fittings such as "P" or "S" traps, floor traps, pipes, downtake pipes etc.

   viii) The sewage from toilet blocks shall be led to the nearest ULB sewerage network sewer line.

6. All staircase shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles of approved shade for risers set in cement mortar or lime mortar to give an overall thickness of 50 mm.

7. All floor cut-outs and cable ducts, etc. shall be covered with precast concrete covers in outdoors areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with galvanised MS hand railing.

8. All staircases shall be provided with SS hand railing for protection.

9. For the entire finished roof surface shall have adequate slope to drain quickly the rainwater to rainwater down take inlet points.

10. For roofing drainage, CI rainwater down takes with CI bell mouth and MS grating at top shall be provided. For roof areas up to 40 sq.m. minimum two nos. 100 mm diameter downtake pipes shall be provided. For every additional area of 40 sq.m. or part thereof, at least one no. 100 mm diameter downtake pipe shall be provided.

11. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rainwater.

12. All doors, windows, rolling shutters shall have lintels above. Chaija protection to lintels on external walls shall be such as to prevent the rainwater splashing into the building. The minimum width of chajja for doors, windows, and rolling shutter shall be 750 mm, 600 mm, and 900 mm respectively.

13. All windows and ventilators shall have 25 mm thick Tandoor/Kota stone stills bedded in cement mortar (1:3)

14. All concrete channels and ducts use for conveying liquid shall have inside width not be less than 500 mm. All open channels shall be provided with hand railings. Also all such channels, which are more than 1000 mm above finished plot level, shall be provided with walkways for access.

15. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factor Act.

16. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of minimum capacity of 2 tons or more as required shall be provided with monorail and operating equipment.

17. The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall be as far as is possible permit the entry of natural light.

18. The Laboratory, Chlorine House and office building shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

19. The sidewalls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 15% ventilation areas. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect plant or stored materials.
20. All walkways, staircase, platforms etc, shall be minimum 1200 mm wide and will be provided with hand railing on one or both sides as required.
21. The floor shall generally be made of 150mm thick concrete slab on grade with 230 mm thick rubble soling and polyethylene sheet. The grade slab shall be provided with TOR 8 mm reinforcement Bars at 200 mm c/c both ways.
22. All hardware fittings and fixtures for doors, windows and louvers (e.g. Hinges, bolts, locks, latches, stay doorstops, door closers, floor springs) shall be heavy type matching to the size and weight of the door/window/ventilator shutters. These shall operate easily without hindrance secure properly without jamming, require nominal maintenance durable under prevailing site/weather conditions.
23. Suitable steps and/or ramp with overhead RCC Canopy shall be provided as per requirement, at the entrances of the buildings.
24. 1,000 mm wide Plinth Protection (Apron) shall be provided all around the Building/Sheds.

2.20 ANTICORROSIVE TREATMENT

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

2.21 PRESSURE GROUTING

2.21.1 Products

All components used for grouting repair system are to be from one of the approved makes of polymers. All components are to be of the same make. No components of different makes can be used in conjunction with each other. Only be MC Bauchemie product shall be used.

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

Proper care is to be taken when using the material to maintain the required

consistency and purity.

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

2.21.2 Surface Inspection and Preparation

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

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

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

ACID ETCHING - Etch surface with a commercial grade (22 deg. Baume) of hydrochloric acid diluted at a ratio of 10:90 to 20:80. After this application, scrub surface with a stiff bristled broom, or similar implement. Immediately after foaming action of acid has subsided, flush surface with water jets until all residue is removed. Repeat procedure until laitance is completely removed. Wash such areas with water at least three times and allow to air dry prior to further treatment. This method of cleaning is to be used only in exceptional cases and under normal cases permission will not be given for use of this method.

Inspection of concrete surfaces prior to mortar application.

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

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

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

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

2.21.3 Identification of Methods of Grouting

2.21.3.1 For All Surfaces having Cracks / Crevices:

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

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

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

2.21.4 Grouting for Honey Combed Surfaces

For surface, which exhibits honeycombed concrete, the surface has to maintained in its dry state and a method of grouting through triangular grout nipples is to be adopted.
The opposite side to the grouting surface has to be sealed for flowing grout by either impervious cement plaster or by use of proper sealant as specified in the material to be used for grouting.

2.21.5 Size and Spacing of Nipples

To determine the size of nipples use a standard caliper or a metric scale and measure the width of the opened crack. The size of the nipple to be fixed within the crack has got to be minimum half the surface width of the crack measured above, but should not exceed s15 mm in dia.
The nipples to be used should be of metal with one end tapered and thickness should be sufficient to withstand 5 m head of water. The spacing for the crack depends inversely to the width of the crack and will not exceed more than 300 mm c/c and will not be less than 125 mm c/c. The member of nipples along the crack will always be a less than two rows of nipples that needs to be fixed parallel to the crack at the same distance as the nipples spacing in the crack so as to form equilateral triangle with the apexes in the crack.

3. EARTHWORK AND EXCAVATION

3.1 RELAVENT IS CODE

IS: 1200 : Method of Measurement for Building Works

IS: 3764 : Safety code for Excavation Work

IS: 3385 : Code of practice for measurement of civil engineering works

IS: 2720 : Part II - Determination of Moisture Content

: Part VII - Determination of Moisture content dry density relation using light compaction

: Part VIII - Determination of Moisture Content Dry Density using heavy compaction

: Part XXVIII - Determination of Dry Density of soils, in place, by the sand replacement method

: Part XXIX - Determination of Dry Density of soils, in place, by the core cutter method.

3.2 EXCAVATION

3.2.1 Definitions

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

- **Top Soil** means any surface material, including turf, suitable for use in soiling areas to be grassed or cultivated.

- **Excavation** means excavation in open cut (excluding trench excavation) down to levels required as per approved Drawings or otherwise as being the general levels after completion of excavation.

3.2.2 Site Clearance

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

Before starting the work the site shall be cleared of

1. All shrubs, grass, and other vegetation including large and small bushes, all stumps, removal of roots, cutting and disposal of small trees up to 300 mm girth etc.

2. All the tress having girth above 300 mm. (the girth shall be measured at a height of1.5 m above the ground level) by felling, logging, fashioning of timber and billeting of all branches, trunks etc. are including removal of all roots etc. complete as directed.

3. All serviceable reclaimed material shall be stacked separately at the site shown by the Engineer In Charge near the site of excavation and/or transported as directed by Engineer In Charge

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

3.2.3 General Excavation

1. General excavation means excavation in all types of solid like dry soil, wet soil, murum, boulders, hard strata, rock of any type at different depth and lift required for structures and from borrow areas, and shall not include trench excavation. General excavation may also include miscellaneous isolated lengths of trenches beneath or adjacent to other structures, trial pits along the structural layout or otherwise.

2. The ground shall be excavated by such methods and to such dimensions and Depths as shall allow for the proper construction of the works and safety of personnel and equipment used on excavation. Slopes required for stable formation of sides shall be provided.

3. The excavation in earth, murum, boulders, soft and hard rock shall be carried out to the correct levels required and specified and no tolerance, plus or minus, shall be permitted. However, if any depressions/Loose pockets are formed due to removal of boulders, they shall be made good by filling with 1:5:10 concrete up to the bottom layer of the footing/raft.

4. Payment for all types of excavation shall be made by detailed Measurement supported by ground levels recorded prior to and after completion of excavation, subject to the limit for payment indicated by the slopes of excavation indicated in the specification drawing. Any additional excavation will be at the Contractor's expense, unless specifically approved by the Engineer-in-Charge. Measurement for excavation shall be done all as per dimensions of P.C.C. given in design drawings & specifications. For concrete foundations same shall be paid

on least dimensions at bottom and Contractor shall cover any extra excavation required for workspace, supports etc while quoting.

5. As far as possible excavation should be done by means of mechanical equipment. The bidder should quote accordingly and nothing extra will be paid for mechanical excavation and deployment of extra staff.

6. It will be the responsibility of the Contractor to obtain prior permissions from The competent authority to use blasting device, if at all to be resorted to and the license are to be obtained for the same.

7. The chance of blasting required shall be well decided with the expert, to avoid Any damage to the surrounding property. However for any such damage to the surrounding property or public or additional excavation shall be the Contractor's responsibility and the risks what so ever arising from the same will have to be borne by the Contractor.

3.2.4 Lift and Lead

Lead for deposition of the excavated materials should be 5000 m. For the purpose of measurement of lead, the area to be excavated or filled or area in which excavated material is to be deposited /disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centerlines shall be taken as the lead which shall be measured by the shortest straight line route on plan and not the actual route taken by Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or kaccha land route.

3.2.5 Excavation in Hard Rock

Excavation in hard rock may be done either by blasting or chiseling or by mechanical means depending upon the site conditions. When excavation has reached within 300 mm of the required formation level, further excavation shall be carried out carefully either by controlled blasting (if as directed by the Engineer-in-Charge) or chiseling. Where controlled blasting is resorted to, small charges shall be used to minimize occurrence of heavy over-cuts. The Contractor shall make every effort to carry out the excavation to correct formation level as far as practicable. In order to minimize the over break and loosening of materials at the finished surfaces, final cutting for the last 450 mm to 600 mm in rock shall be carried out by controlled blasting and trimming with the help of pneumatic or other power tools. Unless otherwise specified, the over break shall not exceed 75 mm. The over breakage of 75 mm shall not be measured for

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

1. Controlled Blasting shall be carried out by the licensed person only if permitted by the Engineer-in-charge for which contractor shall obtain the required permission from police commissioner.

2. The Contractor shall provide a method statement and shall comply fully with the requirements of this clause, or any direction, order, requirement or instruction given by the police department or any other relevant authorities as required by the law.

3. Contractor shall submit Blasting plan to the Engineer-in-charge and take approval for the same on daily basis

4. Contractor shall plan the blasting activities in well advance and convey same to the Project In-charge so as to co-ordinate with all the work groups at site.

5. If blasting is not permitted then contractor shall excavate the rock by manual methods or by mechanical means like needle breaker, poclain, rock splitter etc without any extra cost.

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

Hard rock excavation means excavation in all types of rock at any depth or lead required as per design and drawings. The contractor shall ascertain the level and type of rock by inspecting site, trial pits or trial bore at his cost before quoting the tender.

It should be noted that this clause does not override the Contractor's obligation to satisfy the requirement of the relevant authorities but sets out the extent to which the engineer in charge will exercise his control in approving the Contractor's use of explosive to ensure that explosive are always used in a safe manner. It is the Contractor's sole responsibility to ensure that his method of blasting is safe, that all statutory and imposed limitation are adhered to, and to obtain a permit to use explosive from the relevant authorities and to comply with the condition of issue of the permit.

The Contractor shall be solely responsible for obtaining the necessary licenses for

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

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

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

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

3.2.5.1 Storage and Transport

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

3.2.5.2 Safety

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

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

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

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

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

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

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

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

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

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

3.2.6 Excess excavation to be made good

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

3.2.7 Stripping Top Soil

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

3.2.8 Supporting Excavations

1. The Contractor shall properly support the sides and ends of all excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation. Any excavation necessary to provide space for such support or other working space shall be carried out. If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way, the Contractor shall at his own expense take all necessary remedial measures including the extra necessary excavation and removal of excess material.
2. Where the Contractor proposes and is permitted by the Engineer-in-Charge to perform excavations with sloping faces (other than sloping excavations shown on the Drawings or required as permanent features of the Works) and without shoring, the excavated faces shall be to stable slopes and heights.

3.2.9 Trimming Excavations

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

3.2.10 Inspection by the Engineer-in-Charge

1. When the specified levels or limits of excavation are reached the Engineer-in-Charge will inspect the ground exposed, and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further. Such further excavation shall be refilled to the specified levels or limits with concrete, selected excavated material or selected imported material as directed by the Engineer-in- Charge.

2. Should the material forming the bottom of any excavation, while acceptable to the Engineer-in-Charge at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or due to flooding or have puddles, soft or loss during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate without any extra cost.

3.2.11 Disposing Excavated Material

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

3.2.12 Back-Filling General Site Grading and Sand Filling

3.2.12.1 Fill Material

1. All fill material whether such material is brought from outside borrow areas or excavation within the site, will be subject to Engineer-in-Charge's approval after carrying required tests at Contractor's Soil testing laboratory. Notwithstanding any approval given to the fill material or borrow areas from which fill material is proposed to be brought, the Engineer-in-Charge reserves the right to reject such material which does not meet the specification requirements or unsuitable for the purpose for which it is intended.

2. Roads, of a temporary nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material, etc. to or over borrow areas and or to or over areas on which fill has to be deposited shall be constructed by the Contractor. Such access roads shall be maintained in good condition during all seasons to ensure completion of the work according to the time schedule. No separate payment shall be made for such items of work.

3.2.12.2 Backfilling

1. Excavated material used as back filling to excavations or completed structures shall be free from rubbish, vegetation, clods and lumps and shall be approved by the Engineer-in-Charge. The approved materials shall be placed in layers, not exceeding 150 mm in depth before compaction and shall be compacted with watering, consolidating and ramming. The maximum boulder size shall be of 150 mm for filling material

2. Soft material shall not be used as back filling around structures in rock. The Contractor shall backfill such excess excavation with concrete; rubble, stone or rock fills as directed by the Engineer-in-Charge. Filling other than concrete shall be placed in layers not exceeding 150 mm in thickness, shall be thoroughly compacted and have adequate fined content to fill the voids.

3. Should the material being placed as back filling, while acceptable at time of selection, become unacceptable to the Engineer-in-Charge due to exposure to weather conditions or due to flooding or have become puddles, soft or segregated during the progress of the works, the Contractor shall remove such damaged, softened or segregated material and replace it with fresh approved material at his expense.

4. The Contractor shall while placing the back filling make due allowance for Any settlement that may occur before the end of the Defects Liability Period, remove any excess material or make up any deficiency by back filling to the specified levels. As a rule material to be back filled shall be stacked temporarily at a suitable place.

5. General Site Grading: Site grading shall be carried out as directed by the Engineer- in-Charge. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under (6) of this Clause unless otherwise indicated below.

6. The approved material shall be placed in layers not exceeding 150 mm in depth before compaction and shall be compacted to 90% of Proctor Density with water contain at OMC.

7. The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected materials and make good the slip without any extra cost.

8. The fill shall be carried out to such dimensions and levels as directed by the Engineer-in-Charge, after the compaction.

9. Sand filling below Plinth and other places.

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

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

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

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

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

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

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

3.2.13 Fill Density

The compaction, only where so called for, in the schedule of quantities /items shall comply with the specified (proctor/modified proctor) density at moisture

content differing not more than 4 percent from optimum moisture content. Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density had been obtained.

3.2.14 Local Rules and Regulations

1. The Contractor shall familiarize himself with the local rules and regulations governing the excavation, quarrying operations, etc and the work shall be carried out strictly in accordance with rules and regulations, if any. Whenever a quarry is required to be opened in connection with the execution of work covered under this Contract, the Contractor shall investigate that it shall yield stones and other materials such as sand, murum, soil etc. of approved quality and shall satisfy him as to the availability in desired quantity. He shall supply necessary quantity of sand, stone, metal aggregate etc. to the Engineer-in-Charge for carrying out tests as desired by the Engineer-in-Charge and well in advance of its use so as to carry out tests and to get approval. The cost of opening and operating the quarry & royalties and ant other charges shall be borne entirely by the Contractor.

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

3.3 DEWATERING

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

b. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer-in-Charge, as large, well point system: Single- stage or Multi-stage shall be adopted. Contractor shall submit to the Engineer-in- Charge his scheme of well pointing system including stages, the spacing,

number and diameter of well points, headers etc. and the number, capacity and location of pumps for approval.

c. The rates for excavation are inclusive of dewatering by any means and no extra payment is allowed for excavation in wet condition.

3.4 TIMBER SHORING

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

a. Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. The boards shall generally be placed in position vertically side by side without any gap on each side of the Excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 m spacing and suitably strutted. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical wallings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

b. The shoring material shall not be sizes less than those specified below unless steel sheet piling is used or unless otherwise

- Planks – 5 cm x 25
- Waling – 10 cm x 20
- Struts – 15 cm x 20

approved by the Engineer-in-Charge in writing:

c. Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer- in-Charge. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

d. Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer-in-Charge.

e. The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically

to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber, which can not be retrieved.

f. In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm X 5 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Engineer-in-Charge. In all other respects, the specification for close timbering shall apply to open timbering.

g. In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

3.5 RAIN WATER DISCHARGE

3.5.1 Scope

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

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

4 ANTI TERMITE TREATMENT

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

4.1 DELIVERY, STORAGE AND HANDLING

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

4.2 SAFETY REQUIREMENTS

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

4.3 WARRANTY

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

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

4.4 QUALITY ASSURANCE

4.4.1 Application Report

Upon completion of this work, submit Pest Management Report, Identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used. Maintain daily records using Pest Management Maintenance

Record, and submit copies of records when requested by the Engineer-in-Charge.

4.5 PRODUCTS

4.5.1 Pesticides

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

4.5.2 Execution

4.5.2.1 Verification of Conditions

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

4.5.3 Application

4.5.3.1 Treatment Area

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

4.5.3.2 Treatment Application

Apply termiticide as a coarse spray and in such matter as to provide uniform distribution onto the soil surface. Apply treatment prior to placement of a vapor barrier or waterproof membrane and prior to concrete pouring. Where treated soil or fill material is not to be covered with a vapor barrier or waterproof membrane, exercise adequate precautions to prevent its disturbance. If soil or fill material has been disturbed after treatment, retreat as specified above before placement of slabs or other covering structures. Coordinate treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures with final grading and planting operations so as to avoid disturbance of the treated barriers by such operations. Observe manufacturer's warnings and precautions in the handling and use

of such materials. Exercise precaution that these chemicals do not enter water supply systems or potable water supplies or aquifers, and that they do not endanger plants and animals as well. Notify the Contracting Officer at least 48 hours prior to beginning of treatment and perform formulating, mixing, and application in the presence of the ULB.

4.5.4 Rates and Methods of Application

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

5. CONCRETE AND ALLIED WORKS

5.1 GENERAL

a. The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

b. The Engineer-in-Charge shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer-in-Charge's approval obtained, prior to starting of concrete work. However, this shall not relieve the Contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected.

c. The minimum wall thickness for all RCC wall shall be 225 mm thick.

d. The liquid retaining structures will be in M 30 grade.

e. The Contractor will maintain all registers and formats for quantity qualitative and quantitative measures of all concrete works on daily basis of steel consumed and concreting done updated on daily basis.

f. As per site conditions, if required, contractor may use ready mix concrete of approved mix design from approved ready mix plant without any extra cost.

5.2 APPLICABLE CODES

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

MATERIALS

1 IS:269 - Specification for 33 grade ordinary Portland cement
2 IS:455 - Specification for Portland slag cement.

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

MATERIAL TESTING

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

MATERIALS STORAGE

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

CONCRETE MIX DESIGN

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

CONCRETE TESTING

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

EQUIPMENT

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

CODES OF PRACTICE

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

CONSTRUCTION SAFETY

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

MEASUREMENT

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

5.3 MATERIALS FOR STANDARD CONCRETE

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

b. Cement

1. The Contractor will have to make own arrangements for procuring cement and steel. Cement remaining in bulk storage at the mill, prior to shipment for more than 6 months or cement in bags in local storage in the hands of vendor for more than 3 months after completion of tests may be retested before use and may be rejected if it fails to conform to any of the requirement of IS 269-1976.

2. The Contractor will have to make his own arrangements for transport from supplier godown and storage of adequate quantity of cement. Contractor will construct cement godown at site as per ULB rules. Cement in bulk may be stored in bins or silos, in batches of 10x10, which will provide complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer-in-Charge. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Stacking of cement shall be done as per IS and in such a way that first come cement shall be used first.

3. Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time the Engineer-in-Charge have reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and or manufacturer's test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until

the results of such tests are found satisfactory, it shall not be used in any work. Testing certificates for each batch of cement should be submitted by the Contractor to the Engineer-in- Charge, before starting the concreting work. The Contractor shall not be entitled to any claim of any nature on this account.

4. Aggregates

i) General

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

2386 (Part I to VI)

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

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

Aggregates shall consist of natural sands, stone (crushed or uncrushed) and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later.

ii) Sampling and testing

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

determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the Contractor.

iii) Storage of aggregates

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

iv) Specific Gravity

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

5.4 FINE AGGREGATE

a) Fine aggregate shall consist of natural or crushed sand conforming to BIS 383 confirming to tests as per BIS 2386 part I to VI. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt, or other deleterious substances, which can be injurious to the setting qualities/strength/durability of concrete.

b) Screening and Washing: Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.

c) Foreign Material limitations : The percentage deleterious substances in sand delivered to the mixer shall not exceed the following:

Table 2: Foreign Material Limitations in Fine Aggregate

Sr.	Foreign material	Percentage by weight	
		Uncrushed	Crushed
1	Material finer than 75 micron BIS sieve	3.0	15.0

2	Shale	1.0	-
3	Coal & Lignite	1.0	1.0
4	Clay Lumps	-	1.0
	Total	5.0	17.0

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

Table 3: Grading of Sand for Fine Aggregate

BIS: Sieve Designation	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	99-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100
300 microns	May-20	Aug-30	Dec-40	15-50
150 microns	0-10	0-10	0-10	0-15

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

e) Fineness Modulus

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

5.5 COARSE AGGREGATE

a) Coarse aggregate for concrete, except as noted above, shall conform to IS 383 & IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

b) Screening and Washing: Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer-in-Charge.

c) Grading

i) Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits:

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

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

d) Foreign material limitations

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

Table 4: Foreign Material Limitations in Coarse Aggregate

Sr.	Foreign Material	Percentage by Weight	
		Uncrushed	Crushed
1	Material finer than 75 micron BIS Sieve	3.0	3.0
2	Coal and lignite	1.0	1.0
3	Clay Lumps	1.0	1.0
4	Soft Fragments	3.0	-
	Total	**8.0**	**5.0**

5.6 WATER

a) Water used for washing, mixing and curing shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and

curing concrete. Physical and chemical analysis of the water should be submitted to the Engineer-in-Charge, before starting the work.

b) In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in BIS 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

c) Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of BIS 516.

d) The initial setting time of test block must be made with the appropriate test cement and the water proposed to be used. It shall not be less than 30 minutes and shall not differ by more than +/-30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test block shall be prepared and tested in accordance with the requirements of BIS 4031.

e) Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-Charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.

1. To neutralise 200 ml sample of water, using phenolphthalein as indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in BIS 3025.

2. To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 Normal HCl. The details of test shall be as given in BIS 3025.

3. Percentage of solids, when tested in accordance with the method indicated below shall not exceed the following:

Solids	**Percent**	**Method of test**

Ref. to col. no in IS:3025) Organic (organic solid = total solids minus ignited residue)	0.02	10 and 11
Inorganic	0.03	11(ignited residue)
Sulphates (as So4)	0.05	20
Alkali Chlorides (as Cl)	0.2	24
Suspended matter	0.2	12
The pH value of water shall not generally be less than 6.		

5.7 STEEL AND ALUMINIUM MEMBERS ENCASED IN CONCRETE

Structural steel and aluminum ladders etc. to be encased in concrete shall be without paint. Primer should be used for encasing purpose. The encasing shall be done in concrete with 10 mm, maximum size aggregate and a works cube strength not less than 150 kg/sq.cm. at 28 days unless otherwise specified. The member shall be wrapped with galvanized aluminum wire mesh of adequate size. The galvanized aluminum wire mesh shall be kept 20 mm from the edge or surface of the member and shall be held in position securely. The member will have a minimum cover of 50 mm unless otherwise indicated in the drawings. Where the clear cover is more than 75 mm, concrete with 20 mm coarse aggregate can be used.

5.7.1 Anchor Bolts, Anchors, Sleeves, Inserts,

The Contractor shall build in to concrete work all the items mentioned in Drawings or

Engineer In Charge and shall embed them partly or fully as directed and secure the same as may be required. The materials if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian standards of approved manufacture and to the satisfaction of the engineer. Exposed surface of embedded materials is to be painted with one coat of approved anti-corrosive paint and/ or bituminous paint without any extra cost to the owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

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

5.8 CONTROLLED CONCRETE

All concrete in the works shall be “Controlled Concrete” as defined in IS: 456 except for M-7.5 and M-10 for which normal mix concrete shall be used. Whether reinforced or

otherwise, all concrete works to be carried out under this specification shall be divided into the following classifications:

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

Class	**Preliminary Test N/mm^2**		**Works Test N/mm^2**		**Max. Size Of Aggregate mm**	**Locations For Use**
M40	33.5	50.0	27.0	40.0	20	
M35	30.0	44.0	23.5	35.0	20	
M30	25.0	38.0	20.0	30.0	40 or 20	
M25	22.0	32.0	17.0	25.0	40 or 20	
M20	17.5	26.0	13.5	20.0	40 or 20	
M15	13.5	20.0	10.0	15.0	40 or 20	
	At 7 Days	At 28 days	At 7 days	At 28 days	As indicate in the specification or as required	

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

5.9 MIX DESIGN

5.9.1 General

i) This is essential for investigating the grading of aggregates, water-cement ratio, workability and the quality of cement required to give preliminary and works cubes of the minimum strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Determination of mix proportions shall be carried out according to "Recommended guidelines for Concrete Mix Design" conforming to IS: 10262.

ii) Whenever there is a change either in required strength of concrete, or water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing proportions, over-wet mixes shall always be avoided.

iii) Mix Design may be done without changing its minimum cement content mentioned in NIT

iv) While fixing the value for water/cement ratio for preliminary mixes, assistance may be derived from the graph (Appendix A, BIS 456 showing the relationship between the 28 day compressive strengths of concrete mixes with different water/cement ratios and the 7-day compressive strength of cement tested in accordance with IS:269.

5.9.2 Preliminary Tests

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

concrete mixes. For preliminary tests, the following procedure shall be followed.

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

Mixing concrete shall be done by hand (for small quantities, as directed by Engineer-in- Charge) or in a small batch mixer as per IS: 516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in color. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minutes until the resulting concrete is uniform in appearance. Each batch of concrete shall be such a size as to leave about 10% excess concrete, after moulding the desired number of test specimens.

The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1199. If in the slump test, care is taken to ensure that no water or other material is lost, the material used for the slump test may be re-mixed with the remainder of the concrete for making the specimen test cubes. The period of re-mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

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

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

Curing shall be as specified in IS 516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27 degree C + 2 degree C for 24 hours +2 hours from the time of adding water to the dry ingredients. Thereafter

they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27 degree C +2 degree C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-Charge. The test results shall be accepted by the Engineer-in-Charge if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Engineer-in-Charge may direct the Contractor to repeat the tests if the results are not satisfactory and also make such changes as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by the Contractor at his own cost in an approved laboratory of ULB.

5.10 PROPORTIONING, CONSISTENCY, BATCHING AND MIXING OF CONCRETE

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

If during the execution of the works it is found necessary to revise the mix because of the cube tests showing lower strengths than the required one due to inconsistency of quality of material or otherwise, The Engineer-in-Charge shall ask for fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such change in mix variations, as it is the Contractor's responsibility to produce the concrete of the required grade.

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

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

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

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

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

5.10.1 Mixing of Concrete

The mixing of concrete shall be strictly carried out in an approved type of mechanical Concrete mixer. The mixing equipment shall be capable of combining the aggregates. Cement and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixing drum, provided that all of the mixing water shall be introduced before one fourth of the mixing time has elapsed. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 nor more than 20 revolutions per minute.

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

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

5.10.2 Grade of Concrete

The different grades of concrete specified shall conform to the strengths as required

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

Table 5: Grade of Concrete

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

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

5.10.2.1 Controlled Concrete

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

Table 6: Compressive Strengths at 28 days

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

The maximum Water : Cement ratio for all controlled concrete works shall be as specified in IS: 456-1978 as Preliminary tests as specified in the BIS code and required by the Engineer-in-Charge shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative samples of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement of total quantity of fine and coarse aggregates

and the water cement ratio required to produce a concrete of specified strength and desired workability.

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

Table 7: Minimum Cement Content in Concrete

Grade of Concrete	Minimum Cement Content in Concrete (kg/cum of finished Concrete)
M 15	300
M 20	330
M 25	360
M 30	400

At least 4 (four) trial batches are to be made and 7 test cubes should be taken for each batch noting the slump on each mix. These cubes shall then be properly cured and two cubes from each mix shall be tested in a testing laboratory approved by the Engineer-in- Charge at 7 days and others at 28 days for obtaining the ultimate compressive strength. The test reports shall be submitted to the Engineer in charge. The cost of mix design and testing shall be borne by the Contractor. On the basis of the preliminary test reports for trial mix, a proportion of mix by weight and water cement ratio will be approved by the Engineer-in-Charge, which will be expected to give the required strength. Consistency and workability and the proportions so decided for different grades of concrete shall be adhered to during all concreting operations. If however at any time the Engineer-in- Charge feels that the quality of material, being used has been changed from those used for preliminary mix design, the Contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency.

The mix once approved must not be varied without prior approval of the Engineer-in- Charge. However should the Contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same to the Engineer-in-Charge and bring fresh samples sufficiently ahead to carry out fresh trial mixes. The Engineer-in-Charge shall have access to all places and laboratory where design mix is prepared. Design mix will indicate by means of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed.

In designing the mix proportions of concrete, the quantity of both cement and

aggregate shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodically checked.

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

5.10.2.2 Strength Requirements

Where ordinary Portland cement conforming to IS: 269 or Portland blast furnace slag cement conforming to IS: 455 is used the compressive strength requirements for various grades of concrete shall be as shown in table below. Where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table- hereunder shall be met in 7 days. The strength requirements specified in table shall apply to both controlled concrete and ordinary concrete. Strength Requirements of Concrete

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

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

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

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

5.10.2.3 Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests. The limits of consistency for structures are as specified in the table below:

Table 8: Limits of Consistency

Placing Conditions	Degree of Workability	Values of Workability
Concreting of shallow Sections with vibration	Very low	20-10 seconds Veebee time or 0.75-0.80 compacting factor
Concreting of lightly Reinforced sections With vibration	Low	10-5 seconds or 0.80-0.85 compacting factor
Concreting of lightly Reinforced sections Without Vibration or Heavily reinforced Section with Vibration	Medium	5-2 seconds Veebee time or 0.85-0.92 compacting factor or 25-75mm slump for 20 mm Aggregate
Concreting of heavily Reinforced sections compacting Without vibration factor	High	Above 0.92 compacting factor or 75-125 mm slumps for 20 mm aggregate

5.10.3 Workmanship

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

5.11 SAMPLING AND TESTING OF CONCRETE IN THE FIELD

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

a) Facilities required for sampling materials and concrete including whether proof buildings to house the facilities in the field, shall be provided by the Contractor at no extra cost. The following equipment with operator shall be made available in serviceable conditions.

i. Concrete cube-testing machine suitable for 15 cm cubes of

	100 tonnes capacity with proving calibration	1 no.
ii.	Cast iron cube moulds 15 cm size	12 nos.
iii.	Slump cone complete with tamping rod	1 set
iv.	Laboratory balance to weigh upto 5 kg with sensitivity of 10 gm	1 no.
v.	BIS sieves for coarse and fine aggregates	1 set
vi.	Set of measures from 5 litres to 0.1 litre	1 set
vii.	Electric oven with thermostat upto 120□ C	1 no.
viii.	Flakiness gauge	1 no.
ix.	Elongation index gauge	1 no.
x.	Sedimentation pipette	1 no.
xi.	Calibrated glass jar 1.0 litre capacity	2 nos.
xii.	Glass flasks and metal containers	As require
xiii.	Chemical reagents like sodium hydroxide, tannic acid, litmus paper etc. -	As require
xiv.	Laboratory balance of 2 kg capacity and sensitivity of 1 gm -	1 no.
xv.	Weighing Machine for cement bags of 6 Nos	2 no.
xvi.	Vernier Calipers	As require
xvii.	Thermometer for concrete	1 no.

b) No concrete of any kind may be placed until the field concrete testing laboratory as specified is provided to the satisfaction of the Engineer. The Contractor shall notify the Engineer in advance of all concrete and concrete

material testing as provided in the clause to provide the Engineer/his representative with an opportunity to witness all prescribed tests.

c) At least 6 test cubes of each class of concrete shall be made of every 50cum concrete or part thereof or from different batches as directed by Engineer-in-Charge. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The cubes must be casted from various batches to arrive at an average strength. The laboratory test results shall be tabulated and furnished to the Engineer. The Engineer will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength.

d) Consistency: Slump tests shall be carried out as often as requested by the Engineer and invariably from the same batch of concrete from which the test cubes are made. Slump tests shall be done immediately after sampling.

5.12 CONCRETE TESTS

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

Tests on Cement shall include:

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

Tests on Sand shall include:

- Sieve test
- Test for organic impurities
- Decantation test for determining clay and silt content

- Specific gravity test
- Test for unit weight and bulkage factor
- Test for sieve analysis and fineness modulus

Tests on Coarse Aggregate shall include:

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

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

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

5.12.1 Load Test on Members or Any Other Tests

i) In the event of any work being suspected of material or workmanship or both, the Engineer-in-Charge requiring its removal and reconstruction may order, or the Contractor may request that it should be load tested in accordance with the following provisions.

ii) The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.

iii) If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not

at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer-in-Charge, the cost of all the new construction and the load tests shall be borne by the Contractor.

iv) Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by the Engineer-in-Charge, sonic testing etc. shall be carried out by the Contractor, if so directed, at no extra cost.

5.12.2 Unsatisfactory tests

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

5.13 ADMIXTURES

5.13.1 General

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

5.13.2 Air Entraining Agents

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

5.13.3 Water Reducing Admixtures

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

5.13.4 Retarding Admixtures

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

5.13.5 Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

5.13.6 Other Admixtures

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

5.14 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

a. Before the concrete is actually placed in position, the insides of the formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottoms of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be suitably plugged later.

b. The various agencies shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as specified or required or as is necessary for the proper execution of the work as specified in the drawings.

c. All embedded parts, inserts, etc. supplied by the ULB or the Contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

d. All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Engineer-in- Charge.

e. Slots, openings, holes, pockets etc. shall be provided in the concrete work in the position specified in drawing or required or as directed by the Engineer-in-Charge.

f. Reinforcement and other items to be cast in concrete shall have clean

surfaces that will not impair bond.

g. Prior to concrete placement, all work shall be inspected and approved by the Engineer-in-Charge and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected.

h. Approval by the Engineer-in-Charge of any and all materials and work as required herein shall not relieve the Contractor from his obligation to produce finished concrete in accordance with the requirements of the specifications.

i. Rain or wash water

No concrete shall be placed in wet weather or on a water-covered surface. Any concrete that has been washed by heavy rains shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage, which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided. During summer season, temperature of water should be maintained, as per the criteria and for the same, icing should be done for concreting work.

j. Bonding Mortar

Immediately before concrete placement begins, prepared surfaces except formwork, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified.

k. The corrosive matters on the reinforcement should be removed by means of wire brush.

l. Laitance should be removed by means of chiseling from top concrete layer which was earlier concreted

5.15 TRANSPORTATION

5.15.1 General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight, leak proof irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity without segregation

or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-Charge and concrete shall not be re-handled before placing.

5.15.2 Retempered or Contaminated Concrete

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

5.15.3 Avoiding Segregation

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

5.15.4 Placing by Manual Labour

Except when otherwise approved by the Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements, and shall not be dropped from a height more than 1.0 m or handled in a manner, which will cause segregation.

5.15.5 Placing by Mechanical Equipment

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

5.15.5.1 Types of Buckets

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

5.15.5.2 Operation of Bucket

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

5.15.6 Placement of Restricted Forms

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

5.15.7 Chuting

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

5.15.8 Placing by Pumping/Pneumatic Placers

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

When pumping is adopted, before pumping of concrete is started, the pipeline shall

be lubricated with one or two batches of mortar composed of one part cement and two parts sand. Care shall be taken to avoid stoppages in work once pumping has started.

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

5.15.9 Concrete in Layers

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

5.15.10 Cover Blocks

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

5.15.11 Bedding of Layers

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

5.15.12 Compaction

Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form

surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results.

5.15.12.1 Type of Vibrators

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

5.15.12.2 Use of Vibrators

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

5.15.12.3 Melding Successive Batches

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

5.15.12.4 Penetration of Vibrators

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

5.15.12.5 Vibrating against Reinforcement/Formwork

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with

reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

5.15.12.6 Use of Form Attached Vibrators

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

5.15.12.7 Use of Surface Vibrators

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

5.15.12.8 Stone Pockets And Mortar Pondages

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

5.15.13 Placement Interval

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

5.15.14 Special Provision in Placing

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

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

5.15.15 Placing Concrete Through Reinforcing Steel

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

5.15.16 Bleeding

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

5.16 APPLICATION OF ARALDITE FOR BONDING OF NEW AND OLD CONCRETE

5.16.1 General

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

a. The Araldite based formulation shall be applied to a suitably prepared concrete sub- strata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive.

b. Materials used shall be of best quality like CIBA, FOSROC or ROFF and approved by the Engineer-in-Charge.

c. Manufacturer's instructions shall be followed in all respects. d. No separate payment shall be paid for this item of work.

5.16.2 Formulation

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

5.16.3 Application

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

5.16.3.1 Preparation of the Substrata

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

5.16.3.2 Mixing

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

5.16.3.3 Pot life and 'Open time'

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

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

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

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

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

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

5.16.3.4 Methods of Application

The shape and size of the concrete structure will determine the method of application used. The ARALDITE based adhesive may be applied by hand using

brushed, brooms or any other suitable applicator.

5.16.3.5 Suitability of Fresh Concrete

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

5.16.3.6 Coverage

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

5.17 HANDLING PRECAUTIONS

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

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

5.18 CONSTRUCTION JOINTS

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

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

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

5.19 MOVEMENT JOINTS

a. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision

being made where necessary for maintaining the water tightness of the joint. The Contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer-in-Charge, demonstrate that the jointing materials can be applied satisfactorily.

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

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

5.20 WATER STOPS AND JOINT FILLERS

5.20.1 Water stops

a. At all construction, contraction and expansion joints in the water retaining structures and wherever specified or directed by the Engineer-in-Charge, water stops shall be provided. The water stops shall be PVC type or of any other equivalent material as approved by the Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14 MN/m^2 and elongation at break of not less than 300%. Water stops shall not be exposed to direct sunlight for long periods. Before being concreted in water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.

b. As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops and all the joints should be monolithic. Where it is agreed with the Engineer-in-Charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-Charge may require.

c. Flexible water stops shall be fully supported in the form work, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort or displace.

d. The different types of water stops to be used in liquid retaining structures will be as follows:

Table 9 : Types of Water Stops

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

5.20.2 Jointing fillers

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

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

5.21 SEALING COMPOUNDS

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

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

5.22 TOLERANCES IN CONCRETE SURFACES

- Concrete surfaces for the various classes of unformed and formed finishes specified in various clauses shall comply with the tolerances shown in Table hereunder, except where different tolerances are expressly required by the specification.

- In the table ‘line and level’ and ‘dimension’ shall mean the lines, levels and cross- sectional dimensions as specified and required.

- Surface irregularities shall be classified as ‘abrupt’ or ‘gradual’. Abrupt irregularities include by shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces and 1.5 m long formed surfaces.

Class of **Maximum tolerance (mm) in:**

finish	Line & level	Abrupt irregularity	Gradual irregularity	Dimension
U 2	6	3	3	-
U 3	6	3	3	-
F 1	12	6	6	+12-6
F 2	6	6	6	+12-6
F 3	3	3	3	+6-

5.23 CURING, PROTECTING, REPAIRING AND FINISHING

5.23.1 Curing

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

curing shall be not less than 10 days for concrete exposed to dry and hot weather condition

5.23.2 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

5.23.3 Continuous Spraying

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

5.23.4 Alternate Curing Methods

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

5.23.5 Curing Compound

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

5.23.6 Curing Equipment

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

5.23.7 Protecting Fresh Concrete

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

5.23.8 Repair and Replacement of Unsatisfactory Concrete

5.23.8.1 General

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of the Engineer-in- Charge who may permit patching of the defective areas or also reject the concrete unit either partially or in its entirety. Rejected concrete shall be removed and replaced by the Contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm I.S sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer-in-Charge. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer-in-Charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer-in-Charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface.

Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The

decision of the Engineer-in-Charge shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

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

5.23.8.2 Use of Epoxy

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

5.23.8.3 Method of Repair

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

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

5.23.8.4 Curing of Patched Work

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

5.23.8.5 Approval by the Engineer-in-Charge

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

5.23.9 Finishing

5.23.9.1 General

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

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

produce a surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as specified or as

directed by the Engineer-in-Charge.

5.23.9.2 Standard Finish For Exposed Concrete

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

5.23.9.3 Integral Cement Concrete Finish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by the Engineer-in-Charge. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

5.23.9.4 Rubbed Finish

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

5.23.9.5 Protection

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

5.24 HOT WEATHER REQUIREMENT

a. All Concrete work performed in hot weather shall be in accordance with IS:456, except as herein modified.

b. Admixtures may be used only when approved by the Engineer-in-Charge.

c. Adequate provisions shall be made to lower give limit concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 degrees centigrade.

d. Consideration shall be given to shading aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available, and burying, insulating, shading and/or painting white the pipelines and water storage tanks and conveyance.

e. In order to reduce loss of mixing water, the aggregate, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting, placement and finishing shall be done as quickly as possible.

f. Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

5.25 PLACING CONCRETE UNDERWATER

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

- Method of Placement

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

- Direction, Inspection and Approval

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

b) Special precautions shall be taken for prevention of lifting of concrete due to uplift pressure of subsoil water.

5.26 PRECAST CONCRETE

5.26.1 General

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

5.26.2 Striking Forms

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

5.26.3 Precast Units

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

5.26.4 Curing

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

5.27 SLOTS, OPENINGS, ETC.

5.27.1 General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions as per design drawings and as directed by Engineer-in-Charge and extra reinforcement should be provided as per design requirement. Short pipes with puddle collar shall be fixed in the side wall of suction pipes. They shall be supplied at the appropriate time during construction. Any deviation from

the approved drawings shall be made good by Contractor at his own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

5.27.2 Grouting

5.27.2.1 Standard Grout

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

Table 10 : Proportions for Standard Grout

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

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

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

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

Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above. Sand, for still grouts, shall meet the usual grading specifications for concrete laitance. Anchor bolts, anchor bolt holes and the bottoms of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

Water in anchor boltholes shall be removed before grouting is started. Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be

worked properly into place. Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release trapped air, link chains can be used to work the grout into place. Grout throughout holes in base plates shall be by pressure grouting. Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-Charge.

5.27.2.2 Non-Shrinking Grout for Equipment Foundation

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

Table 11 : Proportions for Non-Shrinking Grout

Sr.	Properties	Values
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout	2.27 - 2.30 gm/m1
4	Compressive strength N/mm^2	

Sr.	Properties	Values
	Minimum 3 days	23
	7 days	34
	28 days	45
5	Expansion %	
	Free	0.10 - 0.20
	Restrained	0.08 - 0.12
	Restrained	0.08 - 0.12

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

5.28 INSPECTION

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer-in-Charge.

b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.

c. All concrete shall be protected against damage until final acceptance by

the Engineer-in-Charge.

5.29 CLEAN-UP

a. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

b. All debris i.e. empty containers, scrap wood, etc., shall be removed to “dump” daily,or as directed by the Engineer-in-Charge.

c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer-in-Charge.

5.30 RECORDS OF CONCRETING

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

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

5.31 SUPPLY OF CEMENT

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

5.32 FOUNDATION BEDDING, BONDING AND JOINTING

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

a. All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering, as specified or as the Engineer-in- Charge may direct, to meet the various situations encountered

in the work.

b. Soft or spongy areas shall be cleaned out and backfilled with lean concrete or clean sand fill compacted.

c. Prior to construction of formwork for any item where soil will act as bottom form, approval shall be obtained from the Engineer-in-Charge for the suitability of the soil.

5.33 PREPARATION OF ROCK STRATA OF FOUNDATIONS

a. To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.

b. Concrete shall not be deposited on large sloping rock surfaces. Where required by the Engineer-in-Charge, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.

c. Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.

d. Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.

e. Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.

f. Before placing concrete on rock surfaces all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

6.FORMWORK

6.1 FORMWORK, FIXING AND GENERAL

a) All formwork shall be constructed of waterproof plywood or preferably sheet metal. Plywood used for form work shall be conforming to BIS:4990 i.e. Specification for plywood for concrete shuttering works. The materials for formwork shall got approved by the Engineer-in-Charge before starting the work. Formwork shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffits of beams other than pre-stressed beams shall in the absence of any specified camber, be erected with an upward camber of 6 mm for each 3 meters of span.

b) The Contractor shall be responsible for the calculations and designs for the formwork, and if required, shall submit them to the Engineer-in-Charge for approval before construction. On form work to external faces, which will be permanently, exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the form work for standard sized manufactured form work panels, the size of such panels shall be approved by the Engineer-in-Charge before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by form work and by construction joint to ensure continuity of horizontal and vertical lines.

c) Faces of form work in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all form work shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes on the face of the concrete and no bleeding should be allowed through the joints.

d) Form work shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation, care being taken to prevent air being trapped.

e) Openings for inspection of the inside of the form work and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete. Before placing concrete, all bolts, pipes or conduits or other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without approval of the Engineer-in-Charge.

f) All exterior angles on the finished concrete of 90 degree or less shall be given 20 mm x 20 mm chamfers unless otherwise ordered by the Engineer-in-Charge.

g) No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer-in-Charge. The whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concrete and 150 mm in the case of un-reinforced concrete.

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

i) Formwork in contact with the concrete shall be treated with suitable non-staining mould oil to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Engineer-in-Charge.

j) No formwork shall be started or placed unless the requirement work is fully completed and checked by Engineer-in-Charge.

k) Necessary cover blocks shall be provided before starting connection.

6.2 REMOVAL OF FORMWORK

a) Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete.

b) The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table below. Where soffit formwork is constructed

in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer-in-Charge, remove the formwork at the earlier times listed below provided that the props are left in position.

Table 12 : Period for Formwork

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

c) Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

d) Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the formwork it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.

e) Reinforced temporary openings shall be provided, as directed by the Engineer-in-Charge, to facilitate removal of formwork which otherwise may be inaccessible.

f) The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

g) For liquid retaining structures, no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall

be cut at 25 mm depth or more from the surface and then the hole shall be made good by cement sand mortar of the same proportions as the concrete just after striking the form work.

6.3 FORMED SURFACES - CLASSES OF FINISH

a. Finishes to formed surfaces of concrete shall be classified as F1, F2, or F3, or such other special finish as may be particularly specified. Where the class of finish is not specified the concrete shall be finished to Class F1.

b. Form work for Class F3 finish shall be lined with as large panels as possible of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fiber board, arranged in a uniform approved pattern and fixed to back form work by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.

c. Form work for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

d. Form work for Class F1 finish shall be constructed in sheet metal.Surfaces subsequently to be rendered, plastered or tiled shall be adequately scrabbled or hacked as soon as the form work is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

6.4 DEFECTS IN FORMED SURFACES

a. Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.

b. If any blemishes are revealed after removal of formwork, the Engineer-in-Charge's decisions concerning remedial measures shall be obtained immediately.

These measures may include, but shall not be limited to the following:

- Fins, pinhole bubbles, surface discolouration and minor defects may be rubbed down with sacking immediately after the formwork is removed.

- Abrupt and gradual irregularities may be rubbed down with carborundun and water after the concrete has been fully cured. These and any other defects shall be remedied by methods approved by the Engineer-in-Charge which may include using a suitable epoxy resin or, where necessary, cutting out

to a regular dovetails shape at least 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.

c. The form work shall be checked by the Engineer-in-Charge before the form work starts and form found defective shall be rejected and the same can be used after rectifying the defects and with due approval of the Engineer-in-Charge

6.5 HOLES TO BE FILLED

1. Holes formed in concrete surfaces by form work supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary Portland cement and one part fine aggregate passing BIS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

2. The Contractor shall thoroughly clean any hole that is to be filled with dry-pack mortar and where the surface has been damaged, the Contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

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

6.6 TOLERANCES

Tolerance is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines

or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for RCC Structures

i. Variation from the plumb

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

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

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

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

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

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

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

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

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

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

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

Minus	5 mm
Plus	10 mm

vi. Footings

Variation in dimension in plan

Minus 5 mm

Plus 10 mm

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

viii. Variation in steps

In a flight of stairs

Rise 3 mm Tread 5 mm In consecutive steps

Rise 1.5 mm

Tread 3 mm

Tolerances in other Concrete Structures

ix. All structures

Variation of the constructed linear outlines from established position in plan

In 5 m 10 mm

In 10 m or more 15 mm

Variations of dimensions to individual structural features from established positions

In 20 m or more 25 mm

In buried construction 50 mm

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

In 2.5 m 10 mm In 5 m 15 mm In 10 m or more 25 mm

In buried construction twice the above amounts

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

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

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

Minus	5 mm
Plus	10 mm

x. Footings for columns, piers, walls, buttresses and similar members Variation of dimensions in plan

Minus	10 mm Plus 50 mm Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm. Reduction in thickness

5% of specified thickness subject to a maximum of 50 mm

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

xii. Tolerance in fixing anchor bolts shall be as follows: Anchor bolts without sleeves + 5 mm

Anchor bolts with sleeves	+ 5 mm for bolts up to 20 mm dia
3 mm for bolts	above 32 mm dia
Embedded parts	+ 5 mm in all directions

6.7 BRACING, STRUTS AND PROPS

a. Form work shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboo shall not be used as props or cross bearers.

b. The formwork for beams and slabs shall be so erected that the formwork on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Repropping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the formwork.

c. If the formwork for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of the concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m as directed by the Engineer-in-Charge.

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

7. REINFORCEMENT

7.1 RELEVANT IS CODES

IS:432 : Mild steel and medium tensile steel bars & hard drawn steel wire for concrete reinforcement

IS:1786 : Cold twisted steel bars for concrete reinforcement (CTD).

IS:2502 (1963) : Code of practice for bending and fixing of bars for concrete reinforcement

IS:55225(1969) : Recommendations for detailing of reinforcement in RCC works

IS:2751 : C.P. for welding of MS bars used for RCC

IS:9417 : Recommendations for welding cold worked steel bars for RCC IS:10790 : Methods of sampling of reinforced steel

7.2 GENERAL

Reinforcement shall be CTD and high strength deformed corrosion resistant (CRS) bars as per IS:1786 – Fe415. Wire mesh or fabric shall be in accordance with IS:456. Substitution of reinforcement will not be permitted except upon written approval from the Engineer-in-Charge.

7.3 STORAGE

a. The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

b. If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the Engineer-in-Charge.

c. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

d. It should be seen that the reinforcement will not be exposed to direct sunlight and preventive measures should be taken for the same.

7.4 QUALITY

All reinforcements shall be clean, free from grease, oil paint, dirt, loose mill scale, loose rust, dust bituminous material or any other substances that will destroy or reduce

the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-Charge. If welding is approved, the work shall be carried out as per IS:1786 - Fe415 according to the best modern practices and as directed by the Engineer-in-Charge. In all cases of important connections, tests shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Engineer-in-Charge, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

7.5 LAPS

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

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

7.6 BENDING

a. Reinforcement bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars.

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

7.7 FIXING

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

7.8 COVER

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

a. At each end of a reinforcement bar, not less than 25 mm nor less than twice the diameter of the bar whichever is greater

b. For a longitudinal reinforcing bar in a column, not less than 40 mm, nor less than the diameter of the bar. In case of columns of minimum dimension of 20 cm or under with reinforcing bars of 12 mm and less in diameter, a cover of 25 mm may be used.

c. For longitudinal reinforcing bars in a beam, not less than 40 mm nor less than the diameter of the bar, whichever is greater

d. For tensile, compressive, shear or other reinforcement in a slab, or wall, not less than, 20 mm, nor less than the diameter of such reinforcement.

e. For any other reinforcement, not less than 20 mm, nor less than the diameter of such reinforcement.

f. For footing and other principal structural members in which the concrete is poured on a layer of lean concrete, the bottom cover shall be reduced to 60 mm.

g. For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and tops, etc. not less than 40 mm for bars larger than 16 mm diameter and not less than 30 mm for bars 16 mm diameter or smaller.

h. For liquid retaining structures, the minimum cover to all steel shall be 40 mm or the diameter of the main bar, whichever is greater.

i. The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concrete blocks as approved by the Engineer-in-Charge. The use of pebbles or stones shall not be permitted.

j. The 28 day crushing strength of cement mortar cubes/precast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.

k. The minimum clear distance between reinforcing bars shall be in accordance with IS:456

7.9 INSPECTION

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

7.10 WELDING OF REINFORCEMENT

a. Reinforcement which is specified to be welded shall be welded by any process which conforms with the requirements of IS:2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no deviation from this procedure shall be permitted.

b. Welds in positions other than those shown on the approved Drawings shall not be permitted. Tack welding to lightly secure reinforcement in place will be permitted subject to approval of the Engineer-in-Charge.

7.11 SUPPLY OF REINFORCING BARS

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

Steel brought on site shall be stored in proper manner as approved by Engineer In Charge so as to avoid distortion, deterioration and corrosion. The Contractor shall

maintain proper register for the steel account, showing the steel received at site, steel used, and the balance stock on site, to the entire satisfaction of the Engineer-in-Charge

8 STRUCTURAL STEEL WORK

8.1 RELEVANT IS CODES

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

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

8.3 MATERIALS

The MS structural members such as MS angles, channels, flats, I sections etc. shall conform IS 2062. Structural steel that is used for fabrication shall be conforming to any of the following grades of steel as specified to each of the works:

Specification for Structural Steel (Fusion Welding Quality)

- IS:2062 : Structural steel (ordinary quality)
- IS:2062-1980 : Weldable Structural steel (fusion quality)

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

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

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

If metal arc welding is to be done as per design or as ordered by the Engineer-in-Charge the electrodes used for strength welds shall conform to IS: 814 and shall be of such shape and size approved by the Engineer-in-Charge and shall be prevented from oxidation and shall be kept in clean condition.

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

8.4 FABRICATION AND ERECTION

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

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

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

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

IS:803 - 1976 : Code of practice for design fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.

IS: 816 - 1969 : Code of practice for use of metal and welding for general construction in mild steel

IS:822 - 1970 : Code of practice for manual and welding of mild steel

IS:9595 - 1980 : Recommendations for metal are welding of carbon Radiographic tests are required to be carried out as directed by the Engineer in case of pressure vessels.

IS:818 - 1968 : Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS:3016-1982 : Code of practice for fire precautions in welding and cutting operations

IS:7205 – 1973 : Safety code for erection of structural steel work

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

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

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

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

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

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

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

Painting work shall not be started without the express approval of the Engineer and the painting shall be started only after his inspection and approval of the works after

carrying out surface preparations.

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

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

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

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

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

8.5 PAINTING

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

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

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

Welding if required shall be done as per standard practice and as approved by

the Engineer-in-Charge.

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

Structural Steel

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

8.5.1 General

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

Unless the manufacturer's instructions state otherwise48 hours drying time shall elapse between successive applications of any primer and 24 hours between applications of all subsequent coats. The surface of bituminous paints shall be left at least 3 days before further handling.

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

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

8.5.2 Ironwork and Ungalvanised Steelwork

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

when welding has been completed. Primer coats shall not be less than 0.05 mm each.

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

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

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

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

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

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

9 BRICK WORK AND STONE MASONRY

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

9.1 RELEVANT IS CODES

IS:1077 : Common burnt clay building bricks IS:2180 : Heavy duty burnt clay-building bricks IS:2212 : C.P. for brickwork

IS:3495 (I – IV) : Method of test for clay building bricks

IS:5454 : Method of sampling of clay building bricks

9.2 MATERIALS

9.2.1 Bricks

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

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

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

9.2.2 Mortar

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

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

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

9.3 CONSTRUCTION

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

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

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

No part of the structure shall be raised more than one meter above than the rest of the work. In case it is unavoidable the brickwork shall be raked back at an angle of not

more than 45 degrees so as to maintain a uniform and effectual bond, but raking shall not start within 60 cms from a corner.

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

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

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

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

9.4 CURING

Fresh work shall be protected from rain by covering the work suitably. Masonry work as

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

9.5 SCAFFOLDING

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

9.6 STONE MASONRY FOR RETAINING WALLS

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

Following Indian Standards shall be applicable:

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

9.7 UNCOURSED STONE MASONRY

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

to a uniform level at the height of each course. The faces of masonry walls shall be kept in perfect plumb and where batter has to be given it shall, be uniform. The stones at all comers and junctions of walls shall be of large sizes and hammer dressed to the correct angle.

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

Al least one header or through stone per square metre of` wall face shall be built into the work. The headers or through stones shall be at least 0.05 m^2 in area al face and shall have at least 0.025 m^2 area at the back face. Where the thickness of the wall is more than 600 mm a series of through stones shall be laid through the work so as to form a tie from front to back, breaking joints or overlapping each other for at least 150 mm. No stone whose length is less than 600 mm shall be used in such work as a header.

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

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

Weep holes 80 mm wide and 150 mm in height shall be provided in retaining walls at the rate of one per square metre as specified or directed. They shall he pointed

with 1:2 cement sand mortar after raking the joints to a minimum depth of 25 mm.

Completed masonry shall be kept wet for a minimum period of 14 days. In wet weather newly laid masonry shall be protected from the effects of heavy rainfall by tarpaulins or other approved material.

9.7.1 Pointing of Uncoursed Masonry

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

9.8 STONE PITCHING

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

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

9.9 RUBBLE PACKING

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

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

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

9.10 CONCRETE BLOCK MASONRY

9.10.1 Materials

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

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

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2l85(Part 3).

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

The nominal dimensions of concrete block shall be as under. Length 400, 500 or 600 mm
Height 100 or 200 mm
Width 100 to 300 mm in 50 mm increments
Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full-length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

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

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

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

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

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

9.10.2 Workmanship

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

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

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

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

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

Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of' maximum water absorption permissible shall not be used. The blocks should not be wetted before or

during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

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

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

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

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

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

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

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

9.11 DAMP-PROOF COURSE

9.11.1 Materials and Workmanship

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

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

upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

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

10 PLASTERING

10.1 RELEVANT IS CODES

IS:1542 : Sand for plaster

IS:1661 : C.P. for application of ferrous metals in building

IS:2394 : C.P. for application of lime plaster finish

10.2 PLASTERING

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

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

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

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

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

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

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

Wherever scaffolds are necessary for plastering they shall be provided. Stage scaffolding shall be provided for ceiling plaster. To ensure even thickness and true surface, patches of plaster about 15 cms x 15 cms shall be first applied both horizontally as vertically 2 mapart. Plastering shall be done from top to bottom and care shall be taken to avoid joints on continuous surface.

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

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

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

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

10.3 NEERU

10.3.1 Material

Neeru shall be made of the best description of lime slaked with fresh water and

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

10.3.2 Workmanship

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

11 FLOORING

11.1 RELEVANT IS CODES

IS:777 : Glazed earthen ware tiles

IS:1237 : Cement Concrete flooring tiles

IS:1443 : C.P. for laying & finishing of cement concrete flooring tiles

IS:2114 : C.P. for laying in-situ terrazzo floor finish

11.2 GENERAL

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

11.3 CEMENT CONCRETE FLOORING

11.3.1 General

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

11.3.2 Filling

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

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

11.3.2.1 Preparation of Bed

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

11.3.2.2 Sub-Base

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

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

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

a. Boulders as Sub-base Course

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

b. Sand Layer

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

11.3.3 Base Coarse

11.3.3.1 Cement Concrete

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

11.3.3.2 Panels

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

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

11.3.3.3 Shuttering

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

11.3.3.4 Concreting

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

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

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

11.3.4 Floor Finish Plain Cement Finish

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

Fresh quantity of cement at 2.2 kg per square metre of flooring shall be mixed with

water to form thick slurry and spread over the surface, while the concrete is still green. It shall be pressed twice by means of iron floats, once when the slurry is applied and second time when cement starts setting.

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

11.3.5 Curing

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

11.4 GRANOLITHIC (IPS) FLOORING

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

11.4.1 Finished Layers

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

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

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

11.4.2 Curing

Curing shall be done as per above mentioned clause.

11.5 TERRAZZO (MOSAIC) TILE

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

Table 13 : Sizes of Terrazzo Tiles

Sr.	Nominal Length	Actual Length	Nominal Breadth	Actual Breadth	Thickness Not less (mm)
2	25	24.85	25	24.85	22
3	30	29.85	30	29.85	25

11.5.1 Tolerances

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

11.5.2 Manufacture

The tiles shall be manufactured under hydraulic pressure of not less than 140 kg/cm^2 and shall be given the first grinding with machine before delivery to the site. The proportion of cement to aggregate in the backing of the tiles shall not be leaner than 1:3 by weight. Similarly the proportion of cement to marble chips aggregate in the wearing layer of the tiles and the proportion of pigment to be used therein shall not exceed 10% by weight of cement used in the mix. The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips from the smallest upto 6 mm, and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for sizes of marble chips varying from the smallest upto 20 mm.

11.5.3 Laying

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

i. 1:1:2 (lime putty:surkhi :coarse sand)

ii. 1:3 (lime putty :surkhi)

iii. 1:3 (lime putty : coarse sand)

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

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

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

11.5.4 Curing, Polishing and Finishing

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

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

that appear. The surface shall be again cured, the second grinding shall then be carried out with machine fitted with fine grade grit blocks No. 120.

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

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

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

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

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

11.6 TERRAZZO (MOSAIC) IN-SITU FLOORING

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

Trained worker shall carry out terrazzo works.

11.6.1 Material

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

11.6.2 Preparation of Surface and Laying Over Base Course Concrete

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

The cement and marble chips including powder shall be mixed dry. Water shall

be added gradually after through mixing until the mix become plastic but flowing.

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

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

11.6.3 Curing, Polishing and Finishing

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

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

11.7 GLAZED TILE FLOORING

11.7.1 White Glazed Tiles

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

11.7.2 Size and Tolerance

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

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

11.7.3 Coloured Tiles

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

11.7.4 Decorative Tiles

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

a. Decorated white background tiles shall be of 152 x 152 x 6 mm and 108 x 108 x 6 mm sizes.

b. Decorated and having coloured background shall be of 152 x 152 x 6 mm and 108 x 108 x 6 mm sizes.

c. Fantasy glazed tiles (108 x 108 x 6 mm) other specifications will be the same as that of white glazed tiles.

11.7.5 Preparation of Surface and Laying

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

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

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

11.7.6 Pointing and Finishing

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

11.8 KOTA STONE FLOORING

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

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

11.8.1 Tolerances

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

11.8.2 Dressing

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

11.8.3 Surface Preparation and Laying

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

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness as specified. The slab shall be washed clean before laying. It

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

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

11.8.4 Polishing and Finishing

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

a. First polishing with coarse grade carborundun stone shall not be done.

b. Cement slurry with or without pigment shall not be applied on the surface before polishing.

11.9 MOSAIC FINISHED DADO OR SKIRTING

For skirting and dado the brickwork or concrete surface shall be raked and shall be well watered for four hours. A dubbing coat of cement mortar 1:3 (1 cement: 3 sand) of sufficient thickness shall be applied so as to bring the surface in line with the plastered surface. The surface shall be carried by lines with trowel so as to receive mosaic tiles or the top layer or cement and marble chips in proportion of 1:1/2:2 (1 cement: ½ marble powder: 2 marble chips) of 7 mm thickness with 3-5 mm size for flooring including dividing strips (20 mm x 15 SWG) @ 600 mm c/c.

11.10HARDONITE FLOORING

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

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

11.10.1 Workmanship

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

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

11.10.2 Preparation of Surface

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

11.10.2.1 Preparation of Topping

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

11.10.2.2 Application

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

11.10.2.3 Trowelling

Surface of floor shall be finished with steel trowel only and trowelled just sufficient so as

to give a finished surface. The surface shall be left for some time till moisture disappears from it. Trowelling shall be done three times at intervals so as to produce a

uniform hard surface in no case cement should come up to the surface.

11.10.2.4 Curing

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

11.10.2.5 Opening for use

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

12. DISTEMPERING AND PAINTING

12.1 GENERAL

Engineer's approval shall be obtained before commencing the painting work. All paints and preserves shall be of approved make and colour and their application shall conform to the manufacturer's instructions. Where more than one undercoat is specified it shall be applied in coats of distinctive tints. Workmanship shall conform to the requirement of IS:2395 Unless the manufacturer's instructions state otherwise48 hours drying time shall elapse between successive applications of any primer and 24 hours between applications of all subsequent coats. The surface of bituminous paints shall be left at least 3 days before further handling.

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

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

12.2 CONCRETE, BRICKWORK AND PLASTER

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

1. For interior brick work and concrete, apply two coats of oil paint up to 1 meter height and for remaining part two coats of plastic emulsion paint over a coat of primer.

2. For exterior brickwork and concrete, apply two coats of cement based paint over a coat of primer with a water repellant coat of siliconate solution of app[roved make.

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

12.3 IRONWORK AND UNGALVANISED STEELWORK

Structural steelwork shall be shot blasted to a "white metal" finish, and grease and oil removed prior to painting. Priming shall immediately follow blast cleaning and no cleaned surface shall be left unprimed for more than four hours. Only primers

that chemically inhibit corrosion shall be used. Where the iron or steelwork is not in contact with raw or treated water, the primer shall be red lead complying with IS: 57. Where there is a possibility that the steel or ironwork may come in contact with water, the priming treatment shall be non toxic, zinc chromate or equivalent. Where it is anticipated that further welding will be required. an approved welding primer shall be applied to the areas to be welded and re primed with the main primer when welding has been completed. Primer coats shall not be less than 0.05 mm each.

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

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

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

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

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

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

12.4 GALVANISED STEELWORK

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

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

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

1. One coat of micaceous iron oxide paint for interior galvanised steel work.

2. Two coats Of micaceous iron oxide paint for external galvanized steelwork.

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

12.5 BITUMINOUS SURFACES

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

12.6 ALUMINIUM SURFACES

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

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

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

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

12.7 WOODWORK

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

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

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

12.8 WATERPROOF CEMENT PAINT

12.8.1 Surface Preparation

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

12.8.2 Mixing the paint

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

12.8.3 Method of Application

Wet the surface by any convenient method. A small surface can be wetted by brush. When applying paint surface should be damp and not wet. While applying the

first coat brush hard into the surface to cover pores and cavities to ensure better bond. Twelve hours after applying the first coat cure the surface by sprinkling the water. Before applying the second coat damp the surface and after the application of second coat cure it as directed above. In hot climate repeat curing at least twice at the interval of six hours for optimum best results.

12.8.4 Curing

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

12.9 SILICON PAINT

12.9.1 Preparation

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

12.9.2 Application

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

12.9.3 Spraying Equipment

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

12.9.4 Safety

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

12.10RELEVANT IS CODES

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

12.11 DISTEMPERING

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

12.11.2 Material

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

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

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

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

work.

12.11.3 Preparation of Surface and Priming Coat

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

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

12.11.4 Application

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

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

12.12DECORATIVE FINISH CEMENT PAINT

12.12.1 Surface Preparation

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

12.12.2 Preparation of Mix and Application

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

12.13 PAINTING

12.13.1 Painting General

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

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

Engineer-in-Charge.

12.13.2 Commencing the Work

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

12.13.3 Workmanship

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

IS:2338 (Part I)

12.13.4 Preparation of Surface

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

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

12.13.5 Application

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

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

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

12.14PAINTING WITH SYNTHETIC ENAMEL/ENAMEL PAINT

12.14.1 Material

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

12.14.2 Preparation of Surface

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

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

12.14.3 Application

12.14.3.1 Under Coat

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

12.14.3.2 Top Coat

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

13. EXPANSION JOINTS AND CONSTRUCTION JOINTS

13.1 GENERAL

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

13.2 MATERIAL

The Material to be used in the joints shall be ribbed PVC water stop of specified width

approved by the Engineer, bitumen impregnated fibre board as filler conforming to IS:10566 and approved sealant material (In case of movement joint only). In addition, IS:12220-1987 and 1838 shall also be adhered.

13.3 JOINTS IN FLOOR

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

13.4 JOINTS IN WALLS

13.4.1 Expansion Joint

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

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

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

The water stops shall be either PVC or either equivalent approved by the Engineer as per specifications given hereinafter.

13.4.2 Construction Joint

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

Const6ruction joints in the side wall and the divide wall of reservoir shall be of two types

(I) horizontal construction joints and (ii) vertical construction joints.

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

The vertical construction joints in the wall shall be of tongue and groove type. The groove of these joints shall be 300 mm x 300 mm and it shall be provided 300 mm away from the water face of the wall. These joints shall be provided with PVC water stop at a depth of 200 mm from water face which shall be primarily responsible for the water from water face which shall be primarily responsible for the water tightness of the joints. These joints shall have a plain finish for a depth of 300 mm from water face by virtue of its casting against vertical face of the centering of vertical face of the previously cast panels cast butting against each other while the remaining depth beyond300 mm shall have masonry facing which will present a rough surface and thus provide a good bond between the consecutive panels.

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

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

No such special treatment need be done for the joints provided in the roof slab,

bottom layer of the floor and the horizontal joints in the wall. The joints in roof slab and bottom layer of the floor shall however, be staggered with those in the overlaying layers such as brick bat coba, I.P.S. and top R.C.C. layer of the floor to minimise the chances of leakage by increasing its path, if any.

13.4.3 Complete Construction Joints

These joints are provided in the top layer of the floor of the reservoir with a view to localise shrinkage cracks at these joints. These joints are characterised by complete discontinuity of steel without any initial gap as in the case of expansion joints. The joints between the adjacent panels of the floor shall be provided with a groove at top of dimension 12 mm x 20 mm and it shall be filled with polysulphide sealant and they shall be provided with water stops as specified earlier.

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

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

It shall be non-staining, non-absorbent and compatible with sealant material used.

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

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

The sealant shall be polysulphide rubber sealing compound conforming to BS 4254 of 1967 or ASA-A 116-1-1960 or any other equivalent specifications. It shall be capable of cold pouf application for horizontal joints and cold application of vertical and inclined joints. The sealing compounds shall be suitable for use in the tropics where it will be subjected to high ambient temperatures, humidity and very strong sunlight. It shall not degrade under these conditions and shall be suitable for use with raw and treated water including water dosed with chlorine. The sealant shall be odour and taint free from lead. It shall be available in choice of colours and shall give a though, permanent seal, be waterproof, non-staining and remain resilient.Sealing

compounds for vertical and horizontal joints shall be used complete with the appropriate quantity of primer as per manufacturer's instruction for use. The primers should ensure good adhesion to the concrete and should be specially developed for respective sealing compounds. The sealants shall be applied with pressure guns or without guns as specified by the manufacturers. Sealing compound shall be fully cured before water is permitted to come in contact.

The sealant material should be formulated as to have a storage period of one year at a temperature of $40^{o}C$.

14. EPOXY COATING, BITUMINOUS, POLYMER PAINTING

14.1 EPOXY COATING

14.1.1 General

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

14.1.2 Materials

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

14.1.3 Subsurface Preparation

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

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

this epoxy coating shall be done in hot season.

14.1.4 Curing

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

14.2 BITUMINOUS PAINTING

Two coats of bituminous paint of 80/100 grade, with 1.65 kg/m^2 spread will be provided on internal face of sludge sump.

14.2.1 Material

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

At least 95% of the solid materials shall be soluble, in carbon di-sulphide or in benzene, and the closed flash point as determined in Abel's apparatus shall not be less than (86°F)30°C. The paint shall remain liquid and retain its consistency at the ordinary atmospheric temperature when packed in suitable containers. The drying time shall not he less than 2 hours and not more than 8 hours, and after drying, paint shall not shoe any surface cracks, tendencies to powder or discoloration due to weathering action or expansion and contraction. It shall also be able to resist the action of acids and alkalis. It shall not soften under the action of mineral turpentine.

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

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

14.2.2 Application

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

14.3 POLYMER PAINTING

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

Fire retardant coating shall confirm BS 3119 specifications

15. DOOR, WINDOWS, GRILLS, SHUTTERS, ETC.

15.1 RELEVANT IS CODES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The type of window shall be as specified. Each shutter shall have one pair of hinges,

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

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

Cupboards, almirahs and shelves shall be provided as per Engineer-in-Charge. The doors could be of either hinged type or sliding type as approved by the Engineer-in-Charge. All dimensions as furnished in the drawings shall be followed. Fixtures and fittings as shown on drawings or as directed by Engineer-in-Charge shall be used. Railings and architraves shall conform to the shape shown on drawings or as approved and fixed by means of screws (counter sunk or otherwise) or bolts.

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

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

15.4 STEEL DOORS, WINDOWS AND FITTINGS

The steel doors, windows, ventilators shall conform or IS:4351 and IS:1038. All steel doors windows, ventilators, louvres etc. shall be of sizes as specified and conform to the description in the respective item of work. Whether or not specifically mentioned, all fixtures and fittings necessary for the satisfactory operation of the doors and windows shall be provided. Doors, windows and ventilators shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample shall also be got approved before further manufacture starts, unless this is waived in writing by the Engineer-in-Charge. All steel doors shall be of pressed steel (18 gauge) flush type with or without removable transome. All doors shall be provided with a three way bolting device and locking arrangement

with duplicate keys and handles of both sides and operable from either side. The Contractor shall obtain windows with friction hinges in place of windows with pegstays if so directed by the Engineer-in-Charge. For centre hung and top hung ventilators suitable spring catch/pulley and chord arrangement shall be provided for facility of opening. Whenever fly mesh over windows have been called for, they shall be fixed on the window and suitable lever type or rototype arrangement shall be provided for opening or closing of the glazed panels from inside. Prior approval of Engineer shall be taken before order is placed with the manufacturer.

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

15.5 ROLLING SHUTTERS

The rolling shutters shall conform to the size indicated in drawings and shall be of quality specified in the Schedule of Quantities. The rolling slats shall be in one piece and be made of heavy gauge steel sheets minimum 18 SWG in thickness. A cylindrical hood shall be provided on the top to enclose the shutter when it is open. The rolling shutters shall be provided with suitable locking arrangements and deep channel guides, In case galvanised rolling shutters are specified the rolling shutter shall be made of hot dip

galvanised slats, hood, deep channel guides all preferably in one piece. In case of hand operated pull & push type rolling shutters of sizes larger than 10 sq.m. in area and in case of very large gear operated and/or as directed by the Engineer, rolling shutters shall be provided with ball bearings for smooth & efficient operation. In case of large rolling shutters & depending upon local wind conditions, the rolling shutters should be provided with special locking type of wider channel guides or it shall be provided with central moveable channel supports to take up design wind pressures in the area.

16. WATER SUPPLY AND SANITARY WORKS

16.1 APPLICABLE CODES

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

IS 210	:	Specification for grey iron castings
IS 269	:	Specification for ordinary and low heat Portland cement
IS 383	:	Specification for coarse and fine aggregates from natural sources for concrete

IS 432	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS 456	:	Code of Practice for plain and reinforced concrete
IS 458	:	Concrete Pipes (with and without reinforcement)
IS 516	:	Methods of tests for strength of concrete
IS 554	:	Dimensions for pipe threads where pressure tight joints are required on the threads
IS 651	:	Salt glazed stoneware pipes and fittings
IS 774	:	Flushing Cisterns for water closets and urinals (valveless siphonic type)
IS 775	:	Cast iron brackets and supports for wash basins and sinks
IS 781	:	Sand-cast brass screw-down bib taps and stop taps for water services
IS 783	:	Code of practice for laying of concrete pipes
IS 1068	:	Electroplated coatings of nickel and chromium of iron and steel
IS 1077	:	Specification for common burnt clay building bricks
IS 1172	:	Code of practice for basic requirements for water supply, drainage and sanitation
IS 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS 1239	:	Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
IS 1536	:	Centrifugually cast (spun) iron pressure pipes for water, gas and sewage
IS 1626	:	Asbestos cement building pipes, gutters and fittings (spigot and socket types)
IS 1703	:	Copper Alloy float valves (horizontal plunger type) for water supply purposes
IS 1726	:	Cast iron manhole covers and frames
IS 1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS 1742	:	Code of practice for buildings drainage
IS 2065	:	Code of practice for water supply in Buildings
IS 2116	:	Specification for sand for masonry mortars
IS 2212	:	Code of practice for brickwork
IS 2250	:	Code of practice for preparation and use of masonry mortars
IS 2326	:	Automatic flushing cisterns for urinals
IS 2470	:	Code of practice for design and construction of septic tanks (Parts I & II)
IS 2556	:	Vitreous sanitary appliances (Part I to Part XV)
IS 2963	:	Specification for copper alloy waste fittings for wash basins and sinks
IS 3306	:	Specification for chemically resistant glazed stoneware pipes and fittings
IS 3025	:	Method for sampling and test (Physical and chemical) for water and waste water (Parts 1 to 44)
IS 3311	:	Waste plug and its accessories for sinks and wash basins

IS 5455	:	Specification for cast iron steps for manholes
IS 4127	:	Code of Practice for laying of glazed stoneware pipes
IS 3495	:	Methods of tests of burnt clay building bricks
IS 4111	:	Code of practice for ancillary structures in sewerage system manholes
IS 5382	:	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5329	:	Code of practice for sanitary pipe work above ground for buildings
IS 5434	:	Non-ferrous alloy bottle traps for marine use

16.2 SANITARY INSTALLATION

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Engineer-in-Charge.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

Licensed plumbers shall carry out all sanitary and plumbing work.

All sanitary appliance including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Engineer-in-Charge.

All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

Joints between iron and earthenware pipes shall be made perfectly air and watertight by caulking with neat cement mortar.

16.3 INDIAN TYPE WATER CLOSET

Water closets shall be white porcelain Orissa type Indian soil pans, 690mm long conforming to IS:2556 of approved make and pattern. Flushing cistern of 15b litres capacity with accessories such as chain, handle, stop tap, brass unions, jamb nuts, overflow pipe and bends, etc. shall be provided.

16.4 URINALS

Urinals shall be white glazed flat back type of approved make and of size 430 mm x 260 mm x 350 mm conforming to IS 2556. High level automatic CI flushing cistern of 10 litre capacity as per IS 2326 with necessary CI brackets, GI pipes for water connection from cistern to urinals, stop tap, waste pipe upto CI waste shaft etc. shall be provided.

16.5 WASH BASIN

Wash basin shall be of white glazed earthenware conforming to IS 2556 of approved make and of size 560mm x 410mm. The wash basins shall be provided with water supply GI pipe, chromium plated tap, stopcock, CP bottle trap, GI waste water pipe and all necessary accessories and fittings.

16.6 SINKS

Sinks shall be of white glazed earthenware conforming to IS 2556 of approved make and of size 450mm x 300mm x 150mm. The sink shall be provided with CP tap, water supply GI pipe, non-ferrous waste fitting, waste plug and necessary accessories and fittings.

16.7 CAST IRON SOIL WASTE AND VENT PIPES AND FITTINGS

All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS:1536. The diameter approved shall be internal diameter of pipe. The pipe and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All popes and fittings shall be properly cleaned of all foreign materials before being fixed.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I or MS holder bat clamps unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakage shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished

smooth on top at an angle of 45 □. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

C.I pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimension approved for the corresponding sizes of straight pipes.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm Dia. Puff pipe where the length of the waste is more than 1800mm or the floor trap is connected to a waste stack through bends.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer-in-Charge and left in working condition after completion. The smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest and from a smoke machine, which consists of a bellow and a burner. The material usually burnt is greasy cotton waste, which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.

Water test and air test shall be conducted as stipulated in IS:5329

16.8 ASBESTOS CEMENT PIPES AND FITTINGS

All Asbestos Cement (AC) soil, waste, vent pipes, and fittings shall conform to IS 1626. The pipes shall have spigot and socket ends. These shall be composed of an inert aggregate consisting of clean asbestos fibre cemented together by ordinary Portland cement conforming to IS:269, or Portland blast furnace slag cement conforming to IS.455. No organic material shall be added to the composition.

The pipes shall be straight and the ends of the pipes and fittings shall be finished square to their axes. The finished pipes and fittings shall be true and smooth, their inner and outer surfaces shall be concentric. They shall be in all respects sound, homogenous and free from impurities or other imperfections.

The permissible tolerance on the thickness and external dimensions of pipes and

fittings including hydraulic test pressure of the pipes and fittings shall conform to IS.1626.

All AC pipes and fittings shall be of approved make and with necessary accessories, wherever required. The diameter wherever approved for pipes and fittings shall be clear internal diameter. All gaps between pipes and fittings and walls shall be filled with cement mortar 1:3 neatly finished. All pipes and fittings shall be supported with standard fixing brackets.

The annular space between the socket and spigot shall be filled with a gasket of hemp and spun yarn soaked in tar. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tools and finished smooth on top with near cement paste at an angle of 45□. The joint shall be kept wet for not less than 7 days by typing a piece of gunny bag kept moist. Joint shall be perfectly airtight as well as watertight.

Pipes and fittings shall be tested with a smoke test as approved.

16.9 GALVANISED MILD STEEL (GI) PIPES

The pipes shall be galvanised mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS.1239, for medium grade. These shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

The pipes and fittings shall be inspected at site before use to ascertain that they

conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or re-threaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two piece are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as the make them slack, water tight joint. The screw thread of pipes and fitting shall be protected from damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc, with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pies are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps. Keeping the pipe about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc, provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solids floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried MS pipe sleeve shall be fixed at a place where a pipe is passing through a wall of floor for reception of the pipe and to allow freedom for expansion/contraction and other movements maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contract with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Engineer-in-Charge.

GI pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS:3114.

The work of excavation and backfilling shall be done true to line and gradient in accordance with general Employer's requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0 cm sand and sand filled upto 15 cm above the pipes. A sand cushion of 15 cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. When excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Engineer-in-Charge and shall satisfactorily pass the test. Pipeline system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw-off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking should be removed and replaced by the Contractor.

The GI pipeline shall be cut to the required length at the position where the meter and stopcock are required to be fixed. The ends of the pipes shall be threaded. The meter and stopcock shall be fixed in position by means of connecting pipe, G.I nuts, sockets, etc. The stopcock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipeline, the pipeline will have to be completely washed before fixing the meter. For the purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipeline. The water shall be allowed to flow completely to wash the pipeline and then the meter installed as described above by replacing the connecting piece.

16.10 STONEWARE PIPE AND FITTINGS

All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade `A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting:

a. Internal diameter

b. Grade

c. Date of manufacture;

d. Name of manufacture or his registered trade-mark or both

All pipes and fittings shall have ISI mark jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In cased, rubber sealing rings are used for jointing, these shall conform to IS:5382.

16.10.1 Spigot and Socket Joint (Cement Joint)

The Spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one fourth of the depth or socket.

Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees.

The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantities of cement required for each joint for certain common sizes of pipes are given below for guidance:

Nominal diameter of pipe (mm)	**Cement (kg)**
150	1.5
200	2.0

250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

16.10.2 Spigot and Socket Joint (Rubber Ring Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS: 5382 shall be used and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

16.10.3 Cleaning of Pipes

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Engineer-in-Charge, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Engineer-in-Charge to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Engineer-in-Charge considers that damage may have been caused to the pipelines, he shall be entitled to order the length to be tested immediately. Should such a test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Engineer-in-Charge.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Engineer-in-Charge is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

16.10.4 Testing at Work Site

After laying and jointing of GSW pipes is completed the pipeline shall be tested as per

the following Employer's Requirements and as approved by the Engineer-in-Charge. All equipment for testing at work site shall be supplied and erected by the Contractor. Potable water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer-in-Charge. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer-in-Charge and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water. If necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The leakage tolerance of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified, the Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Engineer-in-Charge.

Water for testing of pipeline shall be arranged by the Contractor.

16.11 STOP COCK AND BIB COCK

Stopcocks and Bibcocks shall be of brass heavy class, chromium plated and of approved manufacture and pattern complying with IS: 781. They shall be of specified size and of the screw down type. The cocks shall open in anti-clockwise direction and chromium plating shall be done in accordance with IS: 1068.

16.12 SOAK PIT

Soak pit shall be constructed at the location specified by the Engineer-in-

Charge. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level up to ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

16.13 MANHOLES/INSPECTION CHAMBERS

16.13.1 Location

Manholes / Inspection chambers shall be constructed at places approved by the Engineer-in-Charge.

16.13.2 Excavation

Excavation, shoring, dewatering etc. for the pits of manholes / Inspection chambers, laying of pipes and fittings/specials shall be done in accordance with Engineer-in-Charge requirements described elsewhere in the document.

16.13.3 Bed Concrete

The bed concrete (min grade M15) for manholes/Inspection Chambers shall be done in accordance with Engineer-in-Charge's requirements described elsewhere in the document.

16.13.4 Bricks

Bricks used for construction of manholes / Inspection chambers shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than $1/6^{th}$ of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm, unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS: 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm unless otherwise specified; but tolerance upto + 3 mm in each direction shall be permitted. Only full size brick

shall be used for masonry work. Brickbats shall be used only with the permission of Engineer-in- Charge to make up required wall length or for bonding.Sample bricks shall be submitted to the Engineer-in-Charge for approval and bricks supplied shall conform to approved samples. If required by the Engineer-in-Charge, brick samples shall be tested as per IS:3495 by Contractor. Bricks rejected by the Engineer-in-Charge shall be removed from the site within 24 hours.

16.13.5 Cement Mortar

Mortar for brick masonry shall be prepared as per IS:2250, Manholes / Inspection chambers shall be constructed in brick masonry with cement mortar (1:3) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Engineer-in-Charge. If required by the Engineer-in- Charge and shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

The Contractor shall arrange for tests on mortar samples if so required by Engineer-in- Charge. Retempering of mortar shall not be permitted.

16.13.6 Brick Masonry

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick course shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of

pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work.Where this is not possible, the work shall be raked back according to bond (and not saw-toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 m. Workmanship shall conform to IS:2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned of all dirt before another course is laid on top. If mortar in the lower course has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

16.13.7 Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm with hooked took made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetter for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant IS. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

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

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then

be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Engineer-in-Charge.

16.13.8 Cement Concrete Channel

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

16.13.9 Pipe Entering or Leaving Manhole / Inspection Chamber

Whenever a pipe enters or leaves a manhole / inspection chamber, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

16.13.10 Cast Iron Steps

Cast iron steps shall be as per IS:5455. The steps shall be of grey cast iron of grade 15 as per IS:210. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and wrappings. The portion of the step which projects from the wall of the manhole / inspection chamber shall have a raised chequered design to provide an adequate non-slip grip CI steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as a chip of at temperature of 0 degree C.

Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the brick work at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type CI steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole / inspection chamber.

16.13.11 Frame and Covers

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

- Year of manufacture,
- Identification mark of the purchaser
- SEWERS/SWD
- Arrow showing direction of flow

Approved Makes: KK Manholes and Gratings S.S., Manholes, Bharat Pipes and Covers

16.13.11.1 Cast Iron Frame and Cover

The cast iron frame and cover shall be of gray cast iron as per IS: 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 15.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Engineer-in-Charge. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Engineer-in-Charge. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. Including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole he frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole / inspection cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

16.13.11.2 Fibre Reinforced Concrete Frame and Cover

Fibre reinforced concrete frame and cover shall be capable of withstanding load of 35 tonnes. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fibre-reinforced frame shall have clear opening of 560 mm diameter and weighing 103 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured

as approved.

16.13.11.3 Reinforced Cement Concrete Frame and Cover

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor and approved by the Engineer-in-Charge. The frame and cover shall be cast in cement concrete of M20 grades. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

16.13.12 Drop Manhole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) or main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the black drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following approved methods.

a. A cascade,

b. A ramp,

c. By drops in previous manholes.

16.13.13 RCC Manhole

M20 grade of concrete used for construction of RCC manhole shall have min cement content of 390kg/cum of concrete. Min cover to the reinforcement shall be

50mm.

16.14VENT SHAFTS

16.14.1 General

Vent shafts shall be erected at such places as approved by the Engineer-in-Charge.

16.14.2 GI Pipe Vent Shaft

GI pipe vent shall be of 100 mm diameter of 'C' class as per IS: 1239 and 6 metre height from ground level with slotted cap. The vent shaft shall be embedded in concrete of M10 grade and anchored with a 6mm thick MS base plate of 200 mm x 200 mm. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Engineer-in-Charge.

16.14.3 RCC Vent Shaft

Reinforced cement concrete vent shaft shall be of M20 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

16.15 SEPTIC TANK

The sewer line shall be connected to a septic tank of adequate capacity and design including necessary soak pit. All the works involved, such as excavation, refilling, accessories, fittings, vent pipe, cowl cap, etc. as specified & directed shall be carried out.

16.16 MISCELLANEOUS

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Engineer-in-Charge. The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by the Contractor.

17. ROAD SIDE DRAINS

17.1 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes are referred to in this part

All earthwork shall be according to Engineer-in-Charge specified under Section n "*Earthwork*".

17.2 SLAB CULVERT

Slab culverts shall be constructed at specified locations of the existing cross drainage works as directed by the Engineer-in-Charge. The Concrete works specifications for construction of RC slab and the rubble masonry specifications for the supporting rubble walls shall be followed as per Employer's Requirements described elsewhere:

17.2.1 Bitumen at Location of Contact

The bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats shall be straight run bitumen of specified grade.

17.2.2 Graded Gravel Free Draining Backfill

On each side of the uncoarsed rubble walls supporting the slab culvert a free draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, enlongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in hereunder.

Sieve Designation	**Percent Passing by Weight**
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

17.2.3 Weep Holes

Weep holes as shown on the drawings or as directed by the Engineer-in-Charge shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of asbestos cement pipes conforming to IS: 6908 in rubber walls with

necessary M10 concrete cushioning 75 mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal towards the drainage face.

17.3 PIPE DRAINS

Wherever required, pipe drains shall be provided for cross drainage purposes.The sequence of construction shall be as follows:

i) laying of sand/shingle bedding on the original ground

ii) laying of PCC of M10 grade

iii) laying of concrete pipes of NP3 class as per IS:458

iv) Constructing embankment above in compacted murum, laying of the sub-base and Water bound Macadam as specified hereinabove.

The details of above works as directed by Engineer-in-Charge shall be followed.

17.3.1 Materials for Pipe Drains

All materials used in the construction of pipe drains shall conform to Engineer-in-Charge. RCC pipes class NP3 shall conform to IS: 458.

Each consignment of cement concrete pipes shall be inspected, tested if necessary, and approved by Engineer-in-Charge at the place of manufacture or at site before their inCorporation in the Works.

17.3.2 Excavation for pipes

The foundation bed for pipe drain shall be executed true to the lines and grades shown on the drawings or as directed by the Engineer-in-Charge. The pipes shall be placed in shallow excavation of the natural ground in open trenches cut in the existing embankment, taken down to levels as shown in the drawings. Where trenching is involved, its width on either side of pipe shall not be less than 150 mm nor more than one-third the diameter of pipe. The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Engineer-in-Charge. Before placing any backfill material, exposed surface of the soft soil shall be lightly compacted with one pass of 0.5 T

roller. On the lightly compacted surface, coarse sand and shingle shall be spread in two successive layers of 300 mm and each layer shall be compacted by rolling with a min 0.5 T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions.

When bed rock or boulder strata are encountered, excavation shall be taken down at least 200 mm below bottom level of pipe as directed by Engineer-in-Charge and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes. Trenches shall be kept free from water until the pipes are installed and the joints have been hardened.

17.3.3 Bedding for pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade. The pipe shall be bedded in a cradle of concrete having a mix not leaner than M-10. The pipe shall be laid on the concrete bedding before the concrete has set.

17.3.4 Laying of pipes

No pipes shall be placed in position until the foundations have been approved by Engineer-in-Charge. When pipes are to be laid adjacent to each other, they shall be separated by a distance at least equal to or greater than half the diameter of pipe subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

17.3.5 Jointing

All the joints shall be made with care so that their interior face is smooth and consistent with the interior surface of the pipes. The ends of the pipes should be so shaped as to form a self-centering joint with jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. After finishing the joints shall be kept covered and damp for at least four days.

17.3.6 Back filling

Trenches shall be backfilled with selected materials as per Employer's Requirements given in this part. Backfilling upto 0.3 metre above the top of pipe shall be carefully done and murum shall be thoroughly consolidated under the haunches of the pipe.

17.3.7 Concrete Encasement

Concrete encasement shall be provided at places wherever directed by the Engineer-in-Charge. Concrete shall be of M 20 grade.

ELECTRICAL SPECIFICATION

SPECIFICATIONS FOR DG SET

List of Contents

Specifications for Diesel Generator Set

SPECIFICATION OF DIESEL GENERATOR SET

1. SCOPE

This specification covers the design, performance, manufacture and testing of Diesel Generating Set.

2. CODES AND STANDARDS

The Diesel Generating Set with all its components shall comply with the latest statutory regulations and safety codes applicable in the locality where the equipment will be installed. The equipment shall conform to the following standards of the latest edition:

BS: 649 Diesel Engine for general purposes
IS: 1000 Type testing of constant speed internal combustion engines for general purposes.
IS: 1002 Performance of constant speed internal combustion engines for general purposes.
IS:1460 Specification for diesel fuels.
IS:4722 Rotating electrical machines.
IS:4691 Degrees of protection provided by enclosures for rotating electrical machinery.
IS:4729 Measurement and evaluation of vibration of rotating Electrical Machines
BS:5514/Reciprocating internal combustion engine driven AC Generators.
IS:3046/ IS:8528

3. GENERAL REQUIREMENTS

3.1. The Diesel Generating Set shall be indoor type, manually / automatically operated, as specified, designed for continuous operation. The set shall consist of diesel engine coupled to suitable alternator having static excitation system and include all necessary accessories and control panel, as specified in the data sheet.

3.2. The engine and generator shall be mounted on a robust, fabricated steel frame and with anti-vibration mountings. All required set of foundation bolts, nuts, washers, etc. and set of spanners and tools shall be supplied.

4. DIESEL ENGINE

4.1. The diesel engine shall be vertical, single acting, mechanical injection type and shall be complete with all necessary equipment according to standard practice. The horsepower rating, auxiliaries, guarantees of fuel consumption, parallel operation, governor performance and torsional vibration shall be in accordance with BS: 649 or approved equivalent standard. The engine shall be complete with the following:

4.1.1. Fuel Oil System

A “Day Tank” of not less than 24 hours’ rated capacity with mechanical oil level indicator to indicate low and high levels shall be supplied. An engine-driven booster pump shall be provided to deliver fuel oil from the supply line to the fuel oil injectors through duplex filters or two full capacity filters. Hand pump shall be supplied for pumping and storing oil from barrels to “Day Tank” as and when necessary.

4.1.2. Lube Oil System

Automatic pressure lubrication shall be provided by engine-driven gear type pump. The system should be complete with an oil cooler and duplex fine mesh filters, or two full capacity filters and differential pressure gauge across the filters or pressure gauge on either side of the filters. Hand pump shall be provided for priming. In addition, one no. electric-motor-driven Lube oil priming pump is also to be provided. The Lube oil system shall comprise of one particle detection filter, one thermostatic valve to control automatically the temperature of lube oil inlet to engine, one safety valve, one oil sump and piping for the lubrication system.

4.1.3. Jacket Water system (If supplied)

This shall be complete with air or water cooled heat exchangers, thermostatic control with alarm on high jacket water temperature and expansion tank.

4.1.4. Engine Starting System

Starting of the diesel engine shall be by electric starting system, as specified in Data Sheet. The starting system shall meet with the following requirements:

4.1.4.1. Compressed Air System - Not Applicable

a) The air-starting system may comprise of a camshaft-driven rotary air distributor admitting air to a series of automatic air-starting valves fitted on individual cylinder heads, or an air cranking motor operating through a ring gear on the engine fly wheel. The system shall consist of :

i) One 100% capacity A.C. motor driven air compressor. An additional diesel engine driven air compressor shall also be supplied, if specified in Data Sheet.

ii) One Air Receiver of adequate capacity to supply air for six (6) starts of the engine.

iii) Solenoid operated valves for manual operation with start push button or automatically driven by an impulse given from control panel.

iv) Pressure Switches for automatic starting and stopping of the compressor.

v) After-coolers for Compressor, if required, suitable for the raw cooling water.

b) The starting and stopping of the motor of the air compressor shall be controlled automatically by suitable pressure switches so that the Air Receiver always remains fully charged.

4.1.4.2. Electrical Starting System

The Electrical starting system shall comprise of starter, motor, Ni-Cd battery and Static type battery charger and all necessary instruments and accessories.

4.1.5. Air In take & Exhaust System

4.1.5.1. Air intake filter and Residential type Silencer with Exhaust System shall be provided.

4.1.5.2. The exhaust system shall consist of an exhaust gas driven turbocharger, exhaust gas silencer, necessary piping, adapters, Bellows, etc.

4.1.6. Governing System

4.1.6.1. Electronic type governor shall be provided for keeping constant speed of the engine even with variable loads. The governor shall have following features:

a) The governor speed drop shall be adjustable between 3.5% to 4% of the nominal speed at any load up to full load. The nominal speed shall be adjustable by + 5%. The rate of frequency variation shall not exceed 0.5 Hz in every second. An over speed trip mechanism shall be provided to automatically cut off fuel in case the D.G. set reaches over speed between 110% to 130% of rated speed. An engine-mounted emergency stop push

button shall be provided for tripping the engine. Governing system shall be suitable for parallel operation of the D.G. Set with other set(s) or the mains supply as may be applicable.

b) The governor shall be provided with an electrically operated speeder gear working on DC for remote adjustment of generator frequency.

4.1.7. Flexible Coupling with guard.

4.1.8. RPM Indicator / Tachometer and Tacho generator to trip D.G. set in case of over speed.

4.1.9. Instruments

4.1.9.1. The following instruments shall be provided on engine mounted panel:

a) Dial type thermometers with alarm and trip contacts, for the following: Temperature of Lube oil at bearing, cooler inlet/outlet, Jacket water temperature at cylinder outlet or heat exchanger inlet and Jacket water temperature at heat exchanger outlet.

b) Pressure gauges at –
- Discharge of all auxiliary pumps.
- Lube oil cooler outlet.

c) Battery charging Ammeter

d) d) Starting switch key

e) e) Emergency stop push button

f) f) RPM Meter cum Running Hour Meter

5. ALTERNATOR

5.1. The alternator shall be designed for the rating, voltage, etc. as indicated in the data sheet and with class ‘H’ insulation with temperature rise limited to class ‘B’ level.

5.2. The alternator shall be capable of carrying an unbalanced load of 25% without injurious heating of any part, provided rated current is not exceeded. The voltage unbalance consequent to 25% unbalanced load between phases shall not exceed + 2% of the average terminal voltage, provided the power factor in any phase does not fall below 0.8.

5.3. The alternator shall withstand without any damage a short circuit at its terminals for three seconds with excitation adjusted to develop rated voltage at no load.

5.4. The field winding shall be fully insulated from the core. The field system shall have low inductance to allow good voltage regulation.

5.5. The alternator shall be self excited through a suitable transformer rectifier combination with adjustable compounding to provide a flat or rising characteristic with load. The excitation unit shall have necessary protection for field discharge and easy arrangement to re-magnetise in case of loss of residual magnetism.

5.6. The alternator shall be externally regulated type with a voltage variation of + 5% of the rated voltage with + 2% frequency variation. Shunt-field Regulator and Automatic Voltage Regulator shall be provided as required.

5.7. The alternator shall be of drip proof construction and shall have suitable fan for cooling. The temperature rise shall be within the limits of class B insulation even when feeding 10% overload for one hour during every 12 hours' run on full rated load with the cooling air at ambient temperature.

5.8. The line and neutral ends of the phase windings of the alternator shall be brought out on six suitably located terminals. Suitable size of cable and box shall be provided to accommodate the number and the size of the cables, to be provided by Purchaser, is indicated in the Data Sheet. Vendor shall provide suitable clamping arrangement for connecting the cables so as to prevent short circuits by rodents, etc. Cable glands shall be provided on the enclosure to facilitate entry of the above cables.

5.9. 500KVA and above rated Alternator shall be provided 2 nos. thermistor per phase.

5.10. 240V, 1 phase space heater shall be provided in the lower part of the stator frame. Arrangement shall be made so that the space heater shall be cut out automatically, when the alternator starts running.

5.11. The neutral shall be terminated on a fully insulated terminal and a separate Neutral bushing shall be provided out side the Alternator for connection of Neutral earthing strip.

5.12. The alternator frame shall be provided with two nos. of earthing terminals, isolated from the neutral terminal.

6. PERFORMANCE REQUIREMENTS

6.1. The D.G. set shall be capable of starting from cold condition.

6.2. It shall be capable of a peak output of 10% in excess of the rated output for a period of one hour after 12 consecutive hours of operation at full load without exceeding the specified temperature limits and with a fairly visible exhaust.

6.3. The unit shall operate up to 110% of the rated speed over the entire range of output without undue vibration and noise.

6.4. The unit shall meet with the updated CPCB norms of noise limits and Exceeding Mass Emission and Smoke norms. Therefore, factory fitted acoustic enclosure is required as

mandatory.

The Acoustic Enclosure shall be of modular steel, powder coated, fireproof and weatherproof (suitable for open to sky installation) construction, heat resistant type with sleek design with low noise level of 70 db.

7. ENGINE CONTROL PANEL

7.1. The Engine Local Control Panel (ELCP) shall be mounted on Generator set, environmentally sealed type having Micro processor based module for engine controls and metering. The ELCP shall provide the following control and monitoring features: -

Programmable safety shutdowns and associated flashing LED indicators for Low oil pressure, high coolant temperature, over speed, over crank and emergency stop.

LCD digital readouts for Engine oil pressure, Coolant temperature, engine rpm, system DC volts, engine running hours, eight system diagnostic codes, generator AC volts, generator AC Amperes and Generator frequency.

Cool down timer - adjustable 0 - 30 minutes.

Energized to run or shut down the fuel control system.

Engine control switch.

Ammeter - Voltmeter phase selector switch.

Indicator / Display test Switch.

Voltages adjust potentiometer.

Speeds adjust potentiometer.

7.2. During the running of the set, the control panel shall shut down the DG set and give alarm and indication on Annunciator under conditions of:

a) Lubrication Oil Low Pressure

b) High Cooling Water Temperature

c) Over Speed, Over Crank

d) Operation of the protective relays

e) Excitation failure due to tripping of field breaker or failure of excitation voltage to build up.

f) D.G. Set fails to start.

g) Low Coolant Level

All control wiring inside the panels shall be carried out with 2.5 sq.mm Copper conductor,

FRLS PVC, 650V grade, single core wires. The control panel shall be provided with suitable cable glands for power and control cables for the sizes as indicated in the date sheet.

7.3. The control system for the diesel generator shall be suitable for automatic mains failure starting (AMF) with a provision of manual starting.

8. PACKING & DESPATCH

The unit shall be packed suitably to facilitate transportation and installation. During transport, care shall be taken to avoid damage to paint or accessories of the equipment. If any damage is caused during transport, the vendor shall repair the same free of cost.

9. TESTS

Following tests as per relevant British Standards shall be carried out on the Diesel Generator:

9.1. Routine tests for engine, like fuel consumption test, 24 hours' running test, etc.,

9.2. Routine tests for Alternator, like insulation resistance test, high voltage test, etc.

9.3. Vendor shall also perform the following tests at site to the satisfaction of Purchaser:

- AMF logics
- Starting up and Interlock
- Governor Response
- Voltage Regulator Response
- Various functional tests on Generator Control Panel and Engine Local Control Panel

Vendor shall submit 6 copies of the certificates of routine tests and type tests for approval before despatch.

10. INSPECTION

10.1. Inspection including witnessing of tests will be carried out by Purchaser or his authorised representative(s).

10.2. Vendor shall notify Purchaser or his authorised representative in writing at least fifteen (15) days prior to the schedule for inspection / tests.

11. GUARANTEE

Vendor shall guarantee the design, materials, workmanship and performance of all equipment supplied under the order for a period of twelve (12) months from the date of initial operation or eighteen (18) months after delivery at site, whichever may occur earlier.

12. DRAWINGS

12.1. Vendor shall submit four (4) copies of the following for Owner's/Consultant's approval

a) Outline dimensional drawing with general arrangement

b) Single Line Diagram with all details

c) Electrical Schematic and wiring diagrams along with cable schedule and general arrangement drawing for Control Panel.

d) Piping Flow Sheets and Piping Layout and P & I Diagrams

e) Foundation drawings

f) Fuel Oil System with instrumentation and control, with write-up

g) Lube Oil System with instrumentation and Control, with write-up

h) Jacket water scheme with Instrumentation and Control, with write-up.

i) D.G. Set Instrumentation and Control System, with write-up.

12.2. One print of each drawing will be returned to vendor with owner's/ consultant's comments and required clarifications if any. Vendor shall incorporate these and send within fifteen (15) days each drawing for final approval and subsequently for records and use.

12.3. The vendor shall also supply six sets of Instruction Manuals for Installation, Operation, Maintenance and Over-hauling.

13. The enclosed Data Sheets indicate the detailed technical and other requirements.

DATA SHEET - 150 KVA DG Set

GENERAL

Rating	:	150 KVA
Quantity	:	1 No.
Ambient Temperature max.	:	47^{o} C

DIESEL ENGINE

Rating	:	* BHP - Vendor to specify
Duty	:	Continuous
Governor	:	Electronically operated
Operating Speed	:	1500 RPM
Engine Starting	:	AMF starting
Type of Cooling	:	Radiator Water Cooled

GENERATOR

Rating	:	40 KVA
Voltage	:	415 Volts
Frequency	:	50 Hz.
Class of Insulation	:	H (Temp. rise limited to Class-F)
Type of Enclosure	:	Drip -Proof
Excitation System	:	Self- Excited
Neutral Earthing	:	solidly earthed

STARTING SYSTEM

Manual / AMF	:	AMF
Starter	:	Vendor to supply
Compressed Air / Battery System	:	Battery System

ENGINE AND GENERATOR CONTROL PANEL :

AMF Panel	:	To be given by the bidder
Erection and Commissioning	:	to be quoted separately

DATA BY BIDDER

1	DIESEL ENGINE AND AUXILIARIES (Design Features)	
1.1	Name of Manufacturer	:
1.2	Rating Standard BHP	:
1.4	Maximum Engine rating (site)	:
1.5	Derating factors	
i)	Altitude	)
ii)	Inlet air temperature	)
iii)	Humidity	)
iv)	Others	)
1.7	Operating speed	:
1.8	No. of strokes/cycles	:
1.9	No. of cylinders	:
1.10	Arrangement of cylinders	:
1.11	Rotation direction (viewed from driving end)	:
1.12	Compression ratio	:
1.13	Supercharging air pressure at rated speed	:
1.14	Firing order (viewed from power take off end)	:
1.15	J W Temperature rise at rated load	:
1.16	J W Pressure (at engine inlet)	:
1.17	Fuel system injector pressure	:
1.18	Fuel system booster pump pressure	:
1.19	Lube oil temperature at pump in engine sump.	:
1.20	Lube oil pressure at pump discharge	:
1.21	Minimum acceptable lube oil	:
1.22	Maximum period for which the engine can operate without raw cooling water supply.	:
1.23	Fuel oil system	
1.23.1	Type	:
1.23.2	Filters	
	a) Type	:
	b) Numbers	:
	c) Location	:
1.23.3	Day Tank	
	a) Capacity	:
	b) Material	:
	c) Location	
1.23.4	Grade of Fuel Oil to be used	:
1.24	Lube Oil System	
1.24.1	Type	:
1.24.2	Filters	

	a) Type	:
	b) Numbers	:
	c) Location	:
1.24.3	Lube Oil Tank (Sump)	
	a) Capacity	:
	b) Material	:
	c) Location	:
1.24.4	Grade of lube oil to be used	:
1.24.5	Lube Oil Cooler	:
1.25	Jacket Water System	
1.25.1	Type	:
1.25.2	Quality of water to be used	:
1.25.3	Quantity of water	
	a) Engine cooling circuit	)
	b) Lube oil cooler	) :
	c) Turbocharger cooler	)
1.25.4	Make up Tank	
	a) Capacity	:
	b) Material	:
	c) Location	:
1.26	Air intake system	
	a) Intake filter type	:
	b) Location	:
1.27	Exhaust Gas System	
1.27.1	Manifolds	
	a) Location	:
	b) Size	:
	c) Construction	:
	d) Material	:
1.27.2	Exhaust Silencer	
	a) Type	:
	b) Location	:
1.28	Terminal Piping	
1.28.1	Day Tank	
	a) Size	:
	b) Type	:
	Cooling water “out”	
	a) Size	:
	b) Type	:
1.28.2	J Heat Exchanger Cooling water “in”	
	a) Size	:
	b) Type	:
1.29	Heat Exchanger (Shell & Tube Type)	

	a) Constructional Features	
	1. Position (Horizontal/Vertical)	:
	2. Size (Shell dia x Str. Tube Length)	:
	3. Type	:
	4. Surface	:
b)	b) Shell Side	
	1. Fluid circulated	:
	2. Quantity fluid circulated	:
	3.Temperature (inlet):	
	4. Temperature (outlet)	:
	c) Tube Side	
	1. Fluid circulated	:
	2. Quantity fluid circulated	:
	3. Temperature (inlet):	
	4. Temperature (outlet)	:
	d) Heat Exchanger Capacity :	
	e) Balance Water Tank capacity	:
	c) Circulating water pump	:
2	GENERATOR AND ACCESSORIES:	
2.1	Name of the Manufacturer	:
2.2	Design rating	:
2.3	Continuous output rating	:
2.4	Maximum rating	:
2.5	Power factor	:
2.6	Rated voltage	:
2.7	Rated current/phase	:
2.8	Speed	:
2.9	Frequency	:
2.1	Field current at rated output and voltage	:
2.11	Insulation class	
	a) Stator	:
	b) Rotor	:
	c) Exciter	:
2.12	Temperature rise above ambient at 50oC (by thermometer)	
	a) Stator	:
	b) Rotor	:
	c) Exciter	:
2.13	WR^2 of rotating mass in diesel engine generator, exciter, etc.	:
2.14	Generator Parameters	
	a) Synchronous Reactance	:

	b) Transient Reactance	:
	c) Sub-transient Reactance	:
	d) Zero sequence reactance :	
	e) Negative sequence reactance	:
	f) Open circuit field time constant	:
	g) Short circuit ratio	:
	h) Resistance of field winding at operating temperature	:
	i) Resistance of stator winding at operating temperature.	:
2.15	Generator Performance	
	a) Full load losses	:
	b) Armature copper loss	:
	c) Core loss	:
	d) Stray losses	:
2.16	Efficiency	
	a) $^{1}/_{4}$ load	:
	b) $^{1}/_{2}$ load	:
	c) $^{3}/_{4}$ load	:
	d) Full load	:
3	MAIN EXCITOR	
3.1	Rated voltage	:
3.2	Rated current	:
3.3	Ceiling voltage at zero load and rated speed	:
3.4	Ceiling voltage at rated current and rated speed	:
3.5	Excitation system response ratio	:
3.6	Insulation Class	
	a) Stator	:
	b) Rotor	:
4	AUTOMATIC VOLTAGE REGULATOR:	
4.1	Type and Characteristics	:
4.2	Dead band (if any)	:
5	PERFORMANCE GUARANTEE :	
5.1	Net electrical output at site after engine derating factors and auxiliary power requirements have been taken into account	:
5.2	Fuel oil consumption	
	a) Full load	:
	b) 75% load	:
	c) 50% load	:

	d) 25% load	:
5.3	Lube oil consumption at rated load, lit/engine hr. operation	:
5.4	Jacket water temperature “IN” to engine	:
5.5	Jacket water temperature “OUT” from engine.	:
5.6	Lube oil temperature “IN” to engine	:
5.7	Lube oil temperature “OUT” from engine	:
5.8	Freedom from vibration and noise	:
5.9	Generator efficiency:	
	a) Full Load	:
	b) 75% load	:
	c) 50% load	:
	d) 25% load	:
5.10	Voltage regulator response	:
5.11	Excitation at full load and under specified variation of voltage speed.	:
6	WEIGHT SCHEDULE :	
6.1	Weight of engine, less flywheel including standard accessories	:
6.2	Weight of flywheel	:
6.3	Weight of tank (fuel)	:
6.4	Total shipping weight	:
6.5	Weight of Generator	:
6.6	Weight of Exciter	:
6.7	Weight of outboard bearing	:
6.8	Weight of sub-base	:
6.9	Weight of control panel	:
6.10	Total equipment weight	:
6.11	Heaviest single piece to be handled during erection and maintenance and its weight.	:
7	DIMENSIONS :	
7.1	After engine and generator assembled Specifications for MV Switchgear Panel	:

Specifications for MV Switchgear Panel

List of Contents

Specifications for MV Switchgear Panels

1. SCOPE

1.1. This specification covers the requirement for Medium Voltage (MV) Switchboard or Main LT Panel or Power Control Centre (PCC), Motor Control Centre (MCC) or the combination of both of these (PMCC) and Power Distribution Board required to distribute power in the plant / building at medium voltage.

1.2. The enclosed drawings and / or data sheets form part of the specification.

1.3. The drawings and specifications complement each other and what is shown or called for in one shall be interpreted as being called for in both. Material(s), if any, which may have been inadvertently omitted but fairly implied as required to make a complete assembly of the switchgear as shown in the drawing and the specification to make the unit properly operational shall be construed as required and covered in the Vendor's scope.

2. CODES AND STANDARDS

2.1. The design, manufacture and performance of the equipment shall comply with all Indian Standards, I.E. Rules, Statutory Regulations and Safety Codes currently applicable in the locality where the equipment will be installed.

2.2. Unless otherwise specified, the equipment shall conform to the latest applicable Indian Standards and, in particular, the following:

i)	IS:13947 (Part-1 to 5)	-	Low voltage switchgear and controlgear.
ii)	IS:9224	-	Low Voltage Fuses
iii)	IS:2705	-	Current Transformers
iv)	IS:3156	-	Voltage Transformers
v)	IS:3231	-	Specification for electrical relays for power system protection.
vi)	IS:4237	-	General requirements for switchgear and control gear for voltages not exceeding 1000V A.C.
vii)	IS:1248	-	Direct-acting electrical indicating instruments.
viii)	IS:5578	-	Guide for marking of insulated conductors.
ix)	IS:11353	-	Guide for uniform system of marking and identification of conductors and apparatus

terminals.

x) IS:8623 - Specifications for factory-built assemblies of switchgear and control gear (up to 1000 Volts. A.C.)

3. GENERAL REQUIREMENT

3.1. All identical equipment and parts shall be interchangeable.

3.2. The switchgear shall consist of indoor, floor-mounted, metal-enclosed, compartmentalised (if not indicated specifically in data sheet), modular type, totally front side operated vertical sections.

3.3. It shall be dust and vermin proof and shall be easily extensible on both sides.

3.4. All doors and removable covers shall be gasketed all around with neoprene gaskets.

3.5. Each vertical section shall comprise the following:

3.5.1. Metal-enclosed busbar compartment, running horizontally throughout the length of the switchgear.

3.5.2. Individual feeder modules in multi-tier formation.

3.5.3. Shrouded main and vertical busbars and individual feeder connection.

3.5.4. Vertical cable alley and busbar alley with doors or covers covering the entire height of the feeder module panel.

3.5.5. Horizontal wire way for control wiring.

3.5.6. Space heater with thermostat and MCB in each vertical panel.

3.5.7. Sheet steel barrier between two adjacent vertical sections except for horizontal bus bar compartments.

3.5.8. Separate door for each feeder module.

3.5.9. 20 % additional space in the panel (in terms of vacant feeder compartments of various sizes), to accommodate the future requirement, if any.

3.5.10. totally front operated panel, i.e. cable and busbar alleys of suitable sizes (minimum 300 mm width) shall be on the panel front side only.

3.5.11. Each vertical panel should be divided into the distinct zones for busbars, feeders, power cabling, control cabling and power & control terminals.

3.6. The switchgear unit shall consist of rigid structural frame enclosed by 2 mm thick cold rolled (CRCA) sheet steel. Doors and covers shall be of 1.6 mm thick cold rolled (CRCA) sheet steel. Structural framework with foundation bolts, etc. at the bottom shall be provided to mount the switchgear directly on concrete/steel channel base.

3.7. The switchgear shall be provided with removable cable gland plate (of minimum 3 mm thickness), with brass cable glands and crimping type cable lugs, as indicated in the data sheet.

3.8. Separate metal labels shall be provided for switchgear modules, relays, instruments, switches, etc. Approval for the type of label shall be taken from the Owner/Consultant.

3.9. Control switches, push buttons, indicating lamps, meters and relays shall be mounted on the front door. Current Transformers (CTs) and Voltage Transformers (VTs) shall be mounted on the fixed portion. For fully drawout / semi drawout execution, all other equipment shall be mounted on withdrawable chassis with suitable guides for easy withdrawal.

3.10. Painting shall be done by surface coating comprising pre-treatment, electrostatic powder spraying and curing. The surfaces to be coated shall be chemically derusted and degreased at a temperature of 70^{o} to 80^{o}C, zinc phosphatised and then passivated at about 60^{o}C and, after proper drying, subjected to spraying of powder charged at about 90 KV through electrostatic guns. Curing shall be done in stoving oven at 180^{o} to 200^{o} C for 12 to 15 minutes ensuring a uniform and continuous coating. The colour of the shade shall be 631 of IS 5.

3.11. Feeder control and motor control equipment not incorporating circuit breaker shall either be of fully drawout, semi drawout or fixed type execution, as specified in the drawing/data sheet.

3.11.1. In the case of fully drawout type withdrawable chassis, all electrical power and control connections shall be of plug-in type.

3.11.2. In the case of semi drawout type withdrawable chassis, all electrical power connections shall be of plug-in type. All control connections shall be of screwing-in type.

3.12. 300 mm clearance shall be provided between the finished floor and the bottom of the lower most feeder compartment.

3.13. Panel lifting lugs shall be of removable type and to be fixed with panel using bolts and nuts.

4. MAIN BUS BARS:

4.1. Main bus bars shall be of uniform cross section in aluminium or copper as specified in the drawing/data sheet.

4.2. Wherever aluminium to copper connections is required, suitable bimetallic connections/clamps shall be provided.

4.3. Maximum temperature of the bus bars and the bus connections shall not exceed 85oC.

4.4. The bus bars shall be provided with heat shrinkable sleeves and colour coded for identification.

4.5. Separate supports shall be provided for each busbar. If common support is provided for all busbars, anti-tracking barriers shall be incorporated.

4.6. In order to avoid any accidental hazards, busbar compartments shall be protected with 3 mm thick hylem / Bakelite sheets.

4.7. The size of the neutral busbar shall be similar to that of phase busbars in the case of Main L.T. Panels, PCCs, PMCCs, PDBs, Main and Sub Lighting DBs. However, the neutral busbar shall be of half size that of phase busbars in the case of Moto control centres.

5. CIRCUIT BREAKERS

5.1. AIR CIRCUIT BREAKER

5.1.1. These shall be air-break, fully draw-out type, and shall consist of the following:

5.1.2. Shunt and/or series trip as specified in drawing/data sheet. Co-ordination shall be ensured between successive breakers.

5.1.3. Mechanical OPEN/CLOSE position indicator, visible with door closed.

5.1.4. Emergency trip push button.

5.1.5. `Red', `Green' and `Amber' indicating lamps for Breaker ON, Breaker OFF and

Breaker trip on fault.

5.1.6. There shall be `Service', `Test' and `fully withdrawn' positions for the breakers along with their indications on the breaker front facia.

5.1.7. Electrical and Mechanical anti pumping and over & under voltage trip facility should be provided.

5.1.8. It shall be possible to with-draw the breaker only in open position.

5.1.9. Compartment door of the breaker shall not open unless the breaker is in open position.

5.1.10. Automatic safety shutters shall be provided to cover live contacts when carriage is withdrawn.

5.1.11. Relays shall have potential-free contacts.

5.1.12. Facility shall be provided for blocking under-voltage releases.

5.1.13. Manual operating mechanism shall be of spring charged stored energy type or spring assisted type, independent of the speed at which the handle is operated.

5.1.14. Power-operated mechanism shall be of motor-wound spring-charging stored energy type. Emergency manual charging facility shall also be provided.

5.1.15. Indicators shall be provided to show `charged' and 'discharged' conditions of the spring.

5.1.16. The operating mechanism shall be trip-free.

5.1.17. The breaker shall be provided with the microprocessor based release with breaker control through RS 485 port and communication with PC through universally used protocol if asked for in the drawing.

5.1.18. The Micro processor release should have over current / short circuit and earth fault protections along with their indications due to which the breaker has tripped.

5.2. MOULDED CASE CIRCUIT BREAKER

5.2.1. The moulded case circuit breaker (MCCB) shall be air break type and having quick make quick break with trip free operating mechanism.

5.2.2. Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

5.2.3. Rotary type operating handle of MCCB shall be provided in front and should clearly

indicate ON/OFF/TRIP positions and should have padlocking facility.

5.2.4. The electrical contact of the MCCB shall be of high conducting non deteriorating silver alloy contacts.

5.2.5. The MCCB should have shunt trip release, earth fault release with adjustable current setting facility and mechanical interlock facility. Incase of MCCB with Earth Fault Protection, CBCT shall be of cast resin type and of the same make of MCCB.

5.2.6. The MCCB should be provided with adjustable type thermal overload release and adjustable type short circuit protection device. All the release shall operate on common trip busbar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

5.2.7. The MCCB wherever called for in the appended drawings shall provide an earth fault relay.

5.2.8. The MCCB shall provide required sets of extra auxiliary contacts for the indication circuit, control circuit and for remote signalling purpose and should have inbuilt indications for tripping due to over current, short circuit or earth fault.

5.2.9. The electrical parameters of the MCCB shall be as per the description given in the appended drawings

6. AIR BREAK SWITCHES

6.1. Switches shall withstand a short circuit current of value equal to the let-through current of the associated fuse for 1 second and peak short circuit current equal to cut-off current of the fuse.

6.2. Switches of motor feeders shall be of motor duty (AC23A), group-operated, fault-make, load-break type. All other switches shall be of heavy-duty type. All the Switches shall be provided with phase barriers and auxiliary contacts.

6.3. Switch handle shall have padlocking facility in `OFF' position.

6.4. It shall be possible to open the door only when switch is in `OFF' position and it shall not be possible to close the switch when the door is open. However, defeat mechanism shall be provided for inspection purpose.

7. FUSES

7.1. Fuse shall be of HRC cartridge plug-in type, with visible indication of operation.

7.2. 1 no. fuse pulling handle shall be provided for each Switch-board / Power Control Centre / Motor Control Centre.

8. MOTOR STARTERS

8.1. Contactors

8.1.1. Contactors shall be air break, double break, single throw, electromagnetic type.

8.1.2. Main contacts shall be of silver faced copper.

8.1.3. Minimum Two `N.O.' and two `N.C.' auxiliary contacts shall be provided for each power contactor. However, additional nos. of auxiliary contactors should be added in the control scheme as per the requirement.

8.2. Direct-on-line (DOL) starters

DOL starters shall be suitable for AC3 utilisation category as per IS : 13947(Part-4/Sec-1)

8.3. Automatic star delta starters

8.3.1. These starters shall comprise three sets of contactors and a timer relay.

8.3.2. Starters shall be suitable for AC3 utilisation category as per IS: 13947 (Part-4 /Sec-1).

8.4. Reversing Starters - Not Applicable

8.4.1. Forward and reverse contactors shall be mechanically and electrically interlocked.

8.4.2. Reversing starters shall be suitable for AC4 utilisation category as per IS: 13947(Part-4/Sec-1)

8.5. Thermal Overload Relays

8.5.1. Starters shall be complete with three-element, ambient temperature compensated, time-lagged thermal overload relays with adjustable settings.

8.5.2. Thermal overload relays shall be of Auto / hand reset type. A hand reset push button,

separate from the stop push button, shall be brought out on the front of the compartment door.

8.6. Micro Computer Motor Protection Relay- Not Applicable

8.6.1. Starters shall be complete with Micro computer based Motor protection relay with display facility for the motors of 20HP and above rating and without display for motors below 20HP rating.

8.6.2. The relay shall have over current protection (with medium tripping characteristics), Under current protection, Instantaneous short circuit protection, Single phasing protection, Current unbalance protection - for all the ratings of motors and for motors above 75HP ratings, in addition to the above standard protections, the relay should be provided with Stator Ground Fault Protection, over temperature protection and locked rotor protection.

9. SINGLE PHASING PREVENTERS

Separate single phasing preventer also shall be provided in the starters. The relay shall be current operated and hand reset type with separate hand reset push button.

10. INSTRUMENT TRANSFORMERS

10.1. CTs and VTs shall conform to the requirement of IS:2705 and IS:3156 respectively. The ratings specified are indicative only and it shall be Vendor's responsibility to ensure that the ratings offered are adequate for the relays/meters provided considering lead resistance, etc.

10.2. CTs and VTs shall be of dry air insulated type.

10.3. Facility shall be provided in the terminal blocks for shorting and earthing the CTs.

10.4. VTs shall be provided with adequately rated primary and secondary fuses.

11. INSTRUMENTS

11.1. Indicating instruments shall be of Digital type, Minimum 96 x 96 Sq.mm size, suitable for flush mounting.

1. Watt-hour and Var-hour meters shall be suitable for 3 phase, 4 wire system, balanced as well as unbalanced load and suitable for semi-flush mounting.
2. All Meter shall have communication facility through Rs485 or RS 232 port. Wherever communication through port is not available, communication facility through 4-20mA Signal should be provided. Transducers with 4-20mA output should be used wherever Meters are not available with 4-20mA output.

12. PROTECTIVE RELAYS

12.1. Relays shall be Micro processor based and suitable for flush or semi flush mounting with connections from rear. Protective relays shall be in drawout cases. Load Analyser / Load manager shall have Communication port to interface with the Plant DCS / Control room.

12.2. All protective and tripping relays and timers shall be provided with fault display LEDs.

13. AUTOMATIC POWER FACTOR CORRECTION RELAYS

APFCR Panel shall have intelligent Microprocessor based relay, 12 steps based on the requirement. The relay shall have auto manual selection feature and shall adapt the direction of CT besides, it shall possess salient features like -

13.1. Auto self adjustment to any capacitor step value

13.2. Multiple LCD data indication of Power factor at each phase(lead/lag), KW, KVA, KVAR, Voltage, Load Current at each phase, Capacitor current at each phase, Injected KVAR to reach target power factor, Frequency, etc. incl. of all preset parameters & specified installation data

13.3. Automatic Self-adjustment for C/K value.

13.4. Three phase sensing suitable for three phase-unbalanced loads.

13.5. Operation time delay facility for 10-240 sec.

13.6. Memory back up to save the data in the event of power failure.

13.7. Alarm output for Capacitor or Contact failure, abnormal values of voltage, current, KVAR, Power factor, Temperature, Frequency, etc.

13.8. No-volt relay features to immediately disconnect all capacitors in the event of power failure.

13.9. Various protections i.e. over temperature, over harmonics, overload, etc.

13.10. Remote fault alarm indicator.

13.11. Power factor correction fault.

13.12. Facility to connect computer.

13.13. RS 232 serial port.

14. MISCELLANEOUS ACCESSORIES

14.1. Breaker control switch shall be :

- Spring return-to-neutral type with pistol grip handl
- Lockable in neutral position.

14.2. Indicating lamps shall be multiple LED type made from FR type polycarbonate material with Low voltage glow protection (up to 50V) and translucent lamp covers. Lamps shall be replaceable from front. The power consumption of each indicating lamp should not exceed 0.5 Watts.

14.3. Push buttons shall be momentary contact type rated for 10A at 500 V AC. The colour of push buttons shall be as follows:

Start	-	Green
Stop (stay put, mushroom, lockable type)	-	Red
All others	-	Black

All push buttons are required to have functional labels.

14.4. Alarm Annunciator

14.4.1. Alarm Annunciator shall be provided, if specified in drawing/data sheet.

14.4.2. Alarm Annunciator shall comprise flush mounted facia units with two lamps and series resistor and ground glass plate in front for inscriptions.

14.4.3. Alarm annunciation scheme shall include facia units with relay for each fault, a common alarm bell and Accept / Reset / Test Push buttons.

14.4.4. The alarm annunciation scheme shall operate as follows :

Condition	Visual	Audible

Normal	Off	Off
On occurrence of fault	Flashing	On
Acknowledge fault	Steady	Off
Reset, Fault Cleared	Off	Off
Reset, Fault Not Cleared	Steady	Off
Lamp test	Steady	Off
Alarm Annunciation test	Flashing	On

15. INTERNAL WIRING

15.1. All wiring inside the switchgear shall be carried out with 650V grade FRLS PVC insulated flexible stranded copper wires. Minimum size of conductor for control wiring shall be 2.5 mm^2 Copper.

15.2. Ferrules shall be provided on each wire.

15.3. All wiring shall be terminated on terminal blocks with crimping type Copper cable lugs.

15.4. Power connections above 100A shall be carried out with PVC insulated copper links

15.5. Vertical / horizontal Al. wire ways shall be provided to run the control wires within the same vertical panel and / or between different vertical panels.

16. TERMINAL BLOCKS

16.1. All terminal locks for power and control circuits shall be of 650V grade stud type and shall be properly separate from each other.

16.2. Terminal blocks of different voltage groups shall be segregated and suitably labelled.

16.3. Terminals shall be numbered as per wiring diagrams.

16.4. 20% spare terminals shall be provided.

16.5. Shorting links shall be provided for all C.T. terminals.

17. EARTHING

17.1. An earth bus extending throughout the length of the Switch-board / PCC / MCC/ PMCC / DBs / APFCR Panel shall be provided.

17.2. The earth bus shall be of sufficient cross section to carry safely momentary short circuit current for 3 sec.

17.3. All non-current carrying metal parts shall be effectively bonded to the earth bus.

18. TESTS

18.1. Vendor shall test the switchgear to conform to IS: 4237 with all components assembled and fully wired.

18.2. The following routine tests shall be carried out on all the components and the assembled switchgear, as per relevant standards :-

a) Mechanical and Electrical Operation tests by simulating operating conditions as at site.

b) High voltage test (2.5 KV for one minute).

c) Test for verification of calibration of releases thro' primary injection test.

d) Insulation resistance test.

e) Test for verification of calibration of protective relays thro' secondary injection test

18.3. Seven (7) copies of the routine and type test certificates shall be submitted for Owner's approval before despatch of the switchgear

19. INSPECTION

19.1. Inspection, including witnessing routine tests, will be carried out by Owner / Consultant or their authorised representatives.

19.2. Vendor shall notify Owner or his authorised representative(s) in writing at least fifteen (15) days prior to the schedule for inspection and tests.

20. GUARANTEE

Vendor shall guarantee the design, materials, workmanship and performance of all goods to be supplied under the order for a period of twelve months (12) from the date of

initial operation or eighteen (18) months after delivery at job site, whichever earlier.

21. DRAWING AND INSTRUCTION MANUALS

21.1. Vendor shall submit two sets of G.A. drawings, bill of quantities, make of materials, standard product catalogues, etc., along with the initial offer and four (4) sets of the following drawings for approval after award of contract :

21.1.1. Complete assembly drawing of the switchgear, showing plan, elevation and typical sections with dimensions and location of terminals for external connections.

21.1.2. SWITCHGEAR elevation and layout plan with floor openings and floor fixing arrangements.

21.1.3. Schematic diagrams with terminal and ferrule numbers for each module/switchboard panel.

21.1.4. Wiring diagram for each module indicating terminal blocks and various apparatus.

21.1.5. Final list of apparatus for each module.

21.1.6. Manufacturer's descriptive literature on various components used in the switchgear.

21.2. One print of each drawing will be returned to vendor with comments and required clarifications, if any. Vendor shall incorporate these and send within fifteen days, seven prints of each drawing marked "Certified for record and use".

21.3. Vendor shall also submit seven (7) copies of `Installation and Instruction' manual.

22. APPROVED MAKE OF SWITCHGEAR EQUIPMENT/COMPONENTS.

Unless approved in writing, equipment/components of following makes only shall be acceptable:

Moulded Case Circuit Breaker (MCCB)	: L&T - DH, D Sine / SIEMENS 3VL Schneider
ICs = 100% ICu	Equivalent / Control & Switchgear - equivalent
Switch Disconnectors Fuse Units AC23A Duty	: L&T - FNX/ SIEMENS - 3KL8 / Schneider - Equivalent/ Control & Switchgear -equivalent
Contactors and O/L Relays AC3 Duty	: L&T - MNX / SIEMENS -3TF / Schneider - / Equivalent Control & Switchgear equivalent

Push Buttons	:L&T / SIEMENS / Teknic / Schneider
Indicating lamps	:L&T / SIEMENS / Teknic / Schneider
Load Manager/Multi function meter	:Enercon (Conserve) / L& T / Trinity /
Meters	Enercon (Conserve) / L& T / Trinity/ Meco/AE
HRC Fuses & base	L&T / SIEMENS / GE
Terminals	Elmex / Connectwell / Phoenix
Timers	L&T / SIEMENS
MCB	L&T/SIEMEN / Havells / Schneider/Indoasian
ELCB	L&T/SIEMENS/Havells / Schneider/indoasian
Wires	Polycab / Finolex / Havells / RR Kabel / L&T / KEI
Capacitors	Neptune Ducati, EPCOS, L&T, Asian, Schneider
Protective Relays	Areva / ABB / CSPC / L&T
Selector Switches	Salzer / Kaycee

Final selection of the make will remain with the Client / Consultant.

DATA SHEET FOR MEDIUM VOLTAGE SWITCHGEAR PANEL

1	SITE CONDITIONS.		
1.1	Maximum ambient temperature	:	47 Degree C
1.2	Minimum ambient temperature	:	06 Degree C
2	OPERATING CONDITIONS		
2.1	Voltage	:	415V + / - 10 %
2.2	Frequency	:	50 Hz + / - 3 %
2.3	No. of phases	:	Three
2.4	System fault level	:	35 KA at 415V for 1 Sec.
2.5	System earthing	:	Solid Earthing
2.6	Control supply	:	
	For ACB Closing and Tripping Coils	:	110V AC at MLTP. 240V AC at other Panels
	For Protective Relays	:	110V AC
	For indicating lamps	:	110V AC at MLTP. 240V AC at other Panels
	For Alarm / Hooter	:	110V AC at MLTP. 240V AC at other Panels
	For Panel illumination lamp	:	240V AC
	For Thermostat	:	240V AC
	For Contactor coils	:	240V AC
3	ELECTRICAL DATA		
3.1	1 sec short circuit withstand capacity	:	As Per SLDs / Data sheet
3.2	Busbar current rating inside panel at Specified ambient temperature	:	As indicated in the drawings / Datasheet
3.3	Busbars	:	Electro grade Aluminium Sleeved (heat shrinkable)
3.4	Busbars current density	:	1 Sq.mm = 0.8 Amp
3.5	Busbars location	:	at Top / Bottom section of the Panel
3.6	Cable entry (Incoming & Outgoing)	:	Shall be informed later
3.7	Earth bus size and material	:	50 x 6 Sq.mm, Aluminium
3.8	Busbars and cable alley	:	On front side of the panels
3.9	Cable sizes	:	As indicated in the drawings / Datasheet
3.1	Colour shade	:	Powder coating - shade shall be 631 of IS 5
3.11	Feeder arrangement	:	All panels are Single front type-Front operated
3.12	Floor fixing	:	Integral base frame
3.13	Degree of protection for panel	:	IP 44 enclosure
3.14	Maximum operating height	:	1800 mm
3.15	Maximum Panel height	:	2300 mm

TO BE FILLED UP BY VENDOR ALONG WITH OFFER

1.0	Make	:	
2.0	Type/designation	:	
3.0	Degree of protection	:	
4.0	Overall weight of complete Panel	:	kg
5.0	Overall dimensions		
	Length	:	mm
	Depth	:	mm
	Height	:	mm
6.0	Overall weight and dimensions of largest shipping section		
	Weight	:	kg
	Length	:	mm
	Depth	:	mm
	Height	:	mm
7.0	Recommended clearances		
	Front	:	mm
	Rear	:	mm
	Above	:	mm
8.0	Clearance in air of main busbars.		
	Phase to phase	:	mm
	Phase to earth	:	mm
9.0	MAIN BUSBAR DETAILS	:	
9.1	Busbar current rating at design temperature (50 Degree C)	:	
9.2	Main busbar material	:	
9.3	Main busbar size	:	
9.4	Main busbar location	:	
10.0	Vertical Busbar Details:		
10.1	Current rating/size	:	
11.0	Insulating material	:	
12.0	Earth bus size/material	:	Sq.mm
13.0	1 min power frequency voltage	:	KV
14.0	1 sec.short circuit withstand capacity	:	KA
15.0	Peak dynamic withstand capacity	:	KA

16.0 AIR CIRCUIT BREAKER
16.1 Make & Type (s)
16.2 Rated voltage & frequency
16.3 Normal current under site condition
16.4 Rated making capacity
16.5 Rated breaking capacity
16.6 Rated short time rating for 1.0 sec.
16.7 Duty cycle
16.8 Type of operating mechanism
16.9 Voltage and power rating for operating mechanism closing coil trip coil
16.10 Operating time
16.10.1 Closing time
16.10.2 Opening time
16.11 Fixed trip/ trip free
16.12 Number and Rating of breaker auxiliary contacts
16.13 Details of releases, if any

17.0 CHANGE OVER SWITCH
17.1 Rated voltage, frequency & type
17.2 Rated current under site condition
17.3 Test insulation voltage
17.4 Short time with stand current for 1.0 sec.
17.5 Rated fused short circuit current
17.6 Rated operational current
17.6.1 At 415V, AC-23 duty
17.6.2 At 660V, AC-23 duty
17.7 Mechanical operations
17.8 Electrical operations (AC-23)
17.9 Rated operational power at 415V
17.1 Short circuit making capacity (Peak)
17.1 AC breaking capacity at PF 0.2 and at 415V
17.1 Rated capacitor duty - Ic

18.0 MOULDED CASE CIRCUIT BREAKERS (MCCBS)
18.1 Make & type (s) :
18.2 Rated voltage, frequency :
18.3 Normal current under site conditions :
18.4 Symmetrical interrupting current :
18.5 Short time current and duration :
18.6 Operating mechanism :
18.7 Shunt trip :
18.8 Relays / Releases :

19.0	CONTACTORS		
19.1	Make	:	
19.2	Type designations	:	
19.3	Rated voltage	:	
19.4	Rated current :		
	AC-3 Duty	:	
	AC-4 Duty	:	
19.5	Thermal rating	:	
19.6	Making capacity	:	
19.7	Breaking capacity	:	
19.8	DC rating	:	
19.9	Switching frequency	:	Operations/hour
19.10	Life	:	
	Electrical	:	Operations (at rated voltage)
	Mechanical	:	Operations.
19.11	Coil consumption-pick up	:	VA atP .F.
19.12	Coil consumption-Hold on	:	VA
19.13	Closing time	:	Secs.
19.14	Opening time	:	Secs.
19.15	No.of aux.contacts	:	To be provided as required.

20.0	SWITCHES		
20.1	Rated voltage	:	
20.2	Rated current	:	
20.3	AC23A rating	:	
20.4	Rated making capacity	:	
20.5	Rated breaking capacity	:	
20.6	Rated short circuit withstand current with max.permissible rated fuses	:	
20.7	Mechanical life	:	

NOTE :Above particulars are required for each rating of switch offered.

21.0	THERMAL OVERLOAD RELAYS		
21.1	Make/type	:	
21.2	Setting range	:	
21.3	Type of operation	:	Direct/CT operated

22.0 ANY OTHER SWITCHGEAR, IF ANY.

Specifications for LV Cables

List of Contents

Specifications for LV Cables

1. General

These specifications are for 650/1100 Volts grade solid/stranded, copper/aluminium conductors, PVC / XLPE insulated and sheathed galvanised round/flat steel wire armoured and PVC overall sheathed cables.

2. Code and Standards

2.1. The cables shall comply with all currently applicable Standards, Electricity Rules, approval of Fire Insurance Association and Electrical Inspector.

2.2. Unless otherwise specified, cable shall conform to the following latest applicable Standards.

IS	:	1554	PVC insulated (heavy duty) electric cables
IS	:	7098	Cross linked polyethylene insulated PVC sheathed cables
IS	:	8130	Conductors for insulated electric cables and flexible cords
IS	:	5831	PVC insulation and sheath of electric cables
IS	:	3975	Mild steel wires, strips and tapes for armouring of cables
IS Part 41	:	10810	Methods of test for cables : Mass of zinc coating on steel armour
IS	:	209	Specification of zinc
IS Part-2	:	3961	Recommended current ratings for cables: Part-2 PVC insulated and PVC sheathed heavy duty cables
IS	:	10418	Drums for electric cables
IS Part 58	:	10810	Method of test for cables : Part 58 Oxygen Index test
IS Part 61	:	10810	Method of test for cables : Part 61 Flame Retardant test
IS Part 62	:	10810	Method of test for cables : Part 62 Fire Retardant test for bunched cables
IEC	:	332-3	Tests on electric cables under fire conditions
IEC	:	502	Extruded solid dielectric insulated power cables for rated voltages from 1KV up to 30KV
IEC	:	540 & 540A	Test methods for insulation and sheaths of electric cables and cords
ASTM	:	D2863	Standard method of test for flammability of plastics using oxygen index method

The cables and accessories shall also conform to the provisions of Indian Electricity Rules and relevant statutory regulations.

3. Climatic Conditions

Cables shall be installed in air/ground, in atmosphere having maximum ambient temperature and relative humidity as specified in data sheet.

4. Constructional Requirement

4.1. Conductor

The material of conductor shall be Electrical grade high conductive, compacted, aluminium / copper. Conductor shall be solid for conductor of nominal area up to and including 4 sq.mm and stranded beyond 4 sq.mm. Conductors of nominal area less than 25sq.mm shall be circular or shaped. Cables with reduced neutral conductor shall have sizes as per table 1 of IS 1554 (part-1).

Strand details shall be as below:

6 to 10 sq mm [CU/AL]	-	7 strands
16 to 50 sq mm [CU/AL]	-	7 strands
70 to 150 sq mm [CU/AL]	-	19 strands
185 to 300 sq mm [CU/AL]	-	37 strands
400 to 630 sq mm [CU/AL]	-	61 strands
800 to 1000 sq mm [CU/AL]	-	91 strands

4.2. Insulation

The material of insulation shall be with PVC compound / cross linked polyethylene applied over the conductor by extrusion. Insulation shall be free from contamination and water voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. The thickness of the insulation shall be as per relevant Indian standards.

Control cables having 6 cores and above shall be identified with prominent and indelible numerals on the outer surface of the insulation. Colour of the numbers shall be in contrast with the colour of insulation.

4.3. Inner Sheath

The inner sheath shall be applied over the cores by a method of extrusion and shall be of PVC conforming to the requirements of Type ST-1 PVC compound as IS:5831. The thickness of inner sheath shall be as per relevant standards. There will be no sheath for single core cables.

4.4. Armouring

If armouring is specified for multicore cables, the same shall be single round galvanised steel wires / galvanised steel strips as per the requirement. If armouring is specified for single core cables, the same shall be with H4 grade hard drawn aluminium round wire of 2.5 sq.mm diameter.

Requirement and methods of tests for armour material, galvanising uniformity and dimensions of armour shall be as per relevant standards.

4.5. Outer Sheath

This shall consist of extruded ST-1 flame retardant PVC compound having oxygen index value of minimum 30% at 27+ 2 deg. C, is resistant to termite and rodent attack. Outer sheath shall be of black colour, external surface of which shall be embossed with voltage designation and manufacturer's name at regular interval. The thickness of outer sheath shall be as per IS: 1554 - part 1.

Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing / engraving shall be legible and indelible.

PVC / Rubber end caps shall be supplied free of cost for each drum with a minimum of twenty per thousand metre length.

Outer sheath with FRLS compound shall be provided for better fire resistance.

5. General Requirements

5.1. The cables shall be suitable for laying in trays, trenches, ducts, conduits and for underground buried installation with uncontrolled backfill and possibility of flooding by water and chemicals. Cables shall be suitable for keeping in a proper looped position for longer period without occurring of any damage to the insulations and armour.

5.2. The material of conductors shall be from annealed high conductivity copper/aluminium. The maximum conductor temperature in deg. C shall be limited to data as specified in data sheets. Conductor shall be of either circular or sector shaped stranded conductor or circular solid construction as specified in data sheet.

5.3. Cables shall be supplied wound on non returnable wooden drums of heavy duty construction and of suitable barrel diameter and shall be covered fully with wooden battens. Wooden drums shall be properly seasoned and treated with anti rodent material and painted with good quality paint to increase the life of the drum.

Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

Drums shall be suitably marked with manufacturer's name, customer's name, project title, cable type, size, voltage grade of cable, length of cable in metres, drum number, IS certification mark, gross weight, rolling direction etc.

Packing should be sturdy and adequate to protect the cables from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC / heat shrinkable end caps so as to eliminate the ingress of water during transportation, storage and erection.

5.4. Negative tolerance on cable drum length is not acceptable.

5.5. The material of insulation shall be of PVC / XLPE as specified in Data sheet. Also insulation of cores shall be colour coded for identification. Insulation shall be free from contamination and voids.

5.6. Unless otherwise specified, cables shall be supplied in following drum lengths: -

- Medium voltage power cables up to and including 6 sq.mm 1000 Mtr.
- Medium voltage power cables from 10 sq.mm up to and 500 Mtr. including 300 sq.mm
- Control cables up to and including 27 cores 1000 Mtr.

6. Inspection

6.1. The cables shall be tested and inspected at the manufacturer's works. All the materials employed in the construction of cable, before and after the manufacture, shall be subjected to examination, testing and approval by consultant's / owner's representative, The consultant's / owner's representative(s) have free access to the manufacturer's works for the purpose of stage and final inspections and will have the power to accept or reject any material on quality issues.

6.2. Contractor shall notify Owner or his authorised representatives in writing at least fifteen (15) days prior to contractor's scheduled inspection date.

7. Tests

7.1. After completion of manufacture of cables and prior to despatch, the cables shall be subject to type, routine, acceptance and special tested as detailed below. Consultant / Owner reserve the right to witness all the tests with a prior notice from manufacturer.

Manufacturer shall get approved all the test reports from Consultant / Owner before despatch of the cables.

All routine tests, acceptance tests, type tests shall be carried out as per IS 1554 part 1 and IS:7098 part 2.

The inner and outer sheath of XLPE cables shall be subjected to all the tests applicable for PVC cables. The test requirements for insulation and sheath of PVC cables shall be as per IS:5831.

7.2. Seven (7) copies of type test and routine test certificates shall be submitted for customer's approval before despatch.

8. Guarantee

Vendor shall guarantee design materials/workmanship and performance for a period of twelve (12) months from the date of commissioning and handing over the installation to the Owner, duly certified by the site-in-charge. Owner representative for satisfactory operation of the equipment or 18 months from the date of receipt of material at site, whichever is earlier.

9. Instruction Manual

Catalogues giving all technical details and instruction booklets on installation in seven (7) copies such shall be furnished. Cables shall be packed suitably to facilitate installation / transportation and to prevent damage during transportation.

10. Data Sheet / List of Cables

The enclosed data sheets & list of cables indicate detailed technical requirement and bill of quantities / material takes off.

11. Quality Assurance

Vendor shall submit their internal quality assurance plan followed for manufacturing of the equipment for approval of owner / consultant this shall be adhered to and shall be monitored by owner consultant during manufacture.

12. Deviation

12.1. Deviation from specification must be stated in writing at the quotation stage.

12.2. In the absence of such a statement, it will be assumed that the requirements of specification are met without any deviation.

Specifications for Lighting Panel (MCB Distribution Boards)

SPECIFICATIONS FOR LIGHTING PANELS (MCB DISTRIBUTION BOARDS)

1. SPECIFICATIONS

Relevant Indian Standard Specifications and Codes shall apply for Lighting Panel Boards and their components wherever such Standard Specifications exist. The panel shall be approved by the Fire Insurance Association.

Lighting Panels shall be generally comprised of Isolators, MCBs, ELCBs, ELMCBs and HRC fuses (if asked for in BOQ), Potential Indicating lamps, set of separate phase terminal strips, Neutral terminal strip and Earthing terminal strip and any other components as indicated in the Bill of quantities

2. GENERAL REQUIREMENTS

i) Lighting panels shall be made of 14SWG sheet steel and painted with powder spray to prevent corrosion.

ii) Lighting panels shall have properly hinged cover of min. 2 mm thick CRCA sheet on its front so that all the Electrical components and accessories can be accessed only after opening of the front cover.

After opening of the front cover, the panel shall have another hinged door made of min. 2 mm thick CRCA sheet with necessary cut-outs for mounting the all Electrical components with adequate clearances.

The Panel shall be suitable for Top / Bottom entries for incoming and outgoing Cables/Circuits. The incoming Switchgear component shall have suitable provision for terminating a looping cable (of max. 50 sq.mm size) for feeding to another Panel in the zone.

All the Panel wiring shall be carried out using 660/1100V grade FRLS insulated, flexible, multi-core Copper conductors of reputed make and of rating considering the respective Isolator / MCB/ ELCB rating with all de-rating factors.

iii) The Switchgear components such as MCB, ELCBs, etc. shall be of 10KA breaking capacity with mid trip position for easy identification of the fault conditions. The components shall have shock proof and safe finger touch terminals. The components shall have lower watt losses and shall have provision for mounting the additional accessories such as auxiliary blocks, shunt trip, etc.

iv) Lighting panels shall be suitable for 3 Phase, 4 Wire, 415/240 Volts as per the distribution schemes indicated in the relevant drawings.

v) The lighting panels shall be completely dust and vermin proof, double door type and

provided with neoprene gaskets and free of mechanical and electrical defects. The degree of protection for the panel enclosure shall be minimum IP 54.

vi) Knockouts for branch circuit conduits or cables shall be provided on the top and bottom as required.

vii) Tinned copper sockets shall be provided for the main connections to the panel.

viii) All panels shall be self-supporting, wall / steel structure mounting type unless otherwise specified in the schedule of quantities

ix) All the lighting panels shall be provided with two external Earthing terminals and suitable tinned copper lugs for connection to the Earthing system

x) The neutral terminal block shall have sufficient number of terminals for all single-phase outgoing branch circuits.

xi) Means for easy identification of each and every branch circuit shall be provided. A Circuit Distribution diagram shall be pasted on the rear side of the front door of the panel for the easy reference.

xii) Vendor shall furnish the GA drawings with supporting and connection arrangement and wiring diagrams with the detailed bill of quantities, for the approval of Owner / Consultant, before executing the work.

General Specifications for Electrical Materials for Electrical Installation Work

GENERAL SPECIFICATIONS FOR ELE. MATERIALS FOR ELECTRICAL INSTALLATION WORK

1. GENERAL

a) All materials covered in these specifications shall be of heavy duty rigid type, neat in appearance and suitable for the purpose specified.

b) The materials shall be of standard and reputed makes and shall conform to the requirements/approval of:

i) Fire Insurance Association.
ii) Indian Electricity Rules & Relevant Indian Standard Codes
iii) Electrical Inspector
iv) Owner and Engineer-in-charge.

Any materials not approved by any of the above mentioned authorities, shall be replaced by suitable approved materials free of cost. Routine and type test certificates and technical literature shall be furnished for all items.

c) Relevant drawings and technical data, where applicable, shall be furnished to owner for his approval, before supply of the items.

2. POWER, LIGHTING AND CONTROL CABLES

a) General

i) All conductors shall be either copper or aluminium stranded and as specified on the drawings. Sizes and types specified on the drawings shall not be changed without prior approval of the Engineer-in-charge.
ii) Ends of cables shall be properly sealed to prevent ingress of moisture.
iii) Wherever specified as half core in multi core cables, the half core shall be a neutral conductor having reduced section in relation to the main conductor size.
iv) The insulation of conductors in the multi core cables shall be colour-coded to facilitate identification. The colours shall be red, yellow and blue for phases, black for neutral and green for earthing.
v) All single core copper or aluminium cables shall preferably have stranded conductors unless otherwise specified.

vi) The insulation shall be suitable for operation in an ambient temperature of 45 Degree C with a maximum conductor temperature of 70 Degree C without any harmful effects.

b) Specifications

i) 1100 Volts multi core armoured cables with PVC / XLPE insulation and extruded PVC inner and extruded FRLS outer sheath shall conform to I.S.S 1554.

ii) 660 Volts single core un-armoured wires and cables with FRLS PVC / XLPE insulation shall conform to I.S.S. 694.

c) Multi core Power Cables

Multi core power cables shall be of 1100 Volts grade, PVC / XLPE insulated and extruded FRLS PVC inner and extruded FRLS PVC outer sheath and armoured type, of make as approved by Owner/Consultant.

d) Wires and Cables

i) Single conductor wires for lighting shall be of minimum 2.5sq.mm. Copper as indicated in applicable drawings.

ii) All wires for lighting and power plug points shall be 660 Volts/1100 Volts multi stranded, flexible, FRLS PVC insulated unarmoured type of make as approved by Owner/Consultant.

iii) Single core for power receptacles shall be of minimum 4sq.mm. Copper unless otherwise indicated on applicable drawings/ Datasheet.

e) Multi core Control Cable

i) Multi core control cable shall be 660/1100 Volts PVC / XLPE insulated and extruded FRLS PVC inner and extruded FRLS PVC outer sheath armoured type of make as approved by Owner/Consultant.

ii) Each core shall be of 2.5 sq.mm. Copper or 4 sq.mm. Aluminium, as indicated in applicable drawings / Datasheet.

iii) The size and number of cores shall be as indicated in the drawings

/Datasheet.

f) Flexible wires

i) Minimum size of flexible stranded wires shall be of 2.5 sqmm. Cu conductor.

ii) Voltage grade of the flexible wires shall be not less the 660 Volts.

iii) Insulation shall be of FRLS PVC unless otherwise specified in the drawings.

3. CONDUITS

a) General

i) All Conduits shall be of heavy duty PVC type. The conduits shall be of make as approved by Owner / Consultant.

ii) All conduits shall have a smooth interior, free from burrs and sharp edges.

iii) The sizes of the conduits shall be as indicated in the applicable drawings.

iv) Flexible conduits shall be of steel reinforced PVC type and of make as approved by Owner/Consultant.

b) Specifications

i) All rigid PVC conduits shall conform to I.S. Specifications 9537.

ii) All flexible conduits shall conform to I.S.3480

4. CONDUIT FITTINGS

i) All conduit fittings shall have a smooth interior free from burrs and sharp edges.

ii) All conduit fittings shall be of heavy duty PVC type as specified in the schedule of quantities.

iii) Each conduit fitting shall have a gasket and screwed on rigid covered for hazardous areas. The gasket shall be of neoprene make. Gaskets need not be provided for conduit fittings for non-hazardous areas conduit fittings.

5. EARTHING SYSTEM

a) Materials

i) Earthing electrodes, buses, strips and wires shall be of

galvanised steel/copper as per relevant drawings and I.S .specifications.

ii) Sizes of the earth electrodes, the main Earthing bus and the Earth wires shall be as mentioned in applicable drawings/specifications.

iii) Earthing clamps, nuts, bolts, etc. shall be of copper or galvanised steel as shown on the drawings.

iv) Lightning finials shall be of G.I. / Copper (as per the schedule of rates and drawings) as per I.S. Specification 3070 and/or the type as indicated in the applicable drawings.

6. LIGHTING FIXTURES AND LAMPS

a) Specifications

Relevant Indian Standard Codes and Specifications shall be applicable for lighting fixtures and their components wherever such specifications and standards exist. Lighting fixtures shall also have the approval of the Fire Insurance Association.

b) Type of fixtures

i) Incandescent Fixtures

ii) Fluorescent Fixtures

iii) Compact fluorescent fixtures

iv) Mercury Vapour Fixtures

v) Sodium Vapour Fixtures

vi) Metal Halide Fixtures

vii) Halogen Fixtures

c) General Requirements for all fixtures

i) All fixtures shall be suitable for 240 Volt, single phase, 50 Hz. supply.

ii) Fixtures of each type shall be of one make and identical with one another.

iii) All incandescent and mercury vapour lamp fixtures shall have porcelain lamp holders of suitable type and size for the wattage of lamp specified.

iv) All fixtures shall be supplied complete with all necessary accessories and lamps.

v) All fixture components shall be suitable to withstand a high humid atmosphere so that any damage due to corrosion, distortion etc. can be avoided.

vi) All fluorescent fixtures shall have detachable reflectors with easy access for maintenance purpose.

vii) Fluorescent and mercury vapour fixtures shall have super low loss ballasts, noiseless in operation similar to Super Low Loss type or Electronics type as approved by Owner/Consultant and also suitable condensers for high power factor. Chokes shall be suitable for a range of voltage of 210-240V. If necessary, tapping shall be provided for 210,220,230 and 240V.

viii) All fluorescent fixtures shall have rotor lamp holders with cadmium plated spring loaded contacts.

ix) All fixtures shall also have earthing provision made as per Indian Electricity Rules.

d) Lamps : LED Fixtures

General

i) All lamps shall be rated for 240V.

ii) Wattage shall be as indicated in the Schedule of Quantities.

Internal and External Illumination and Other Electrical Works

General:

Illumination system shall consist of lighting fixtures complete with LED fixtures. All materials, fittings and appliances used in the installation shall conform to the relevant IS specification and shall be anticorrosive painted for treatment plant area.

Illumination Levels:

The following minimum levels of illumination shall be provided in the respective areas:

Area		Illumination Level
Platforms and Chlorine house		
Offices, Laboratory	:	300 lux
Switch Gear rooms	:	200 lux

Area		Illumination Level
Transformer substation yard/ clarifier bridges	:	150 lux
Toilets, Staircase	:	90 lux
Plant Outdoor area	:	50 lux
Roads etc.	:	30 lux

Area Lighting/External Electrification

Scope

The scope of this specification covers design, manufacture, inspection of manufacturer's works and installation of MS/high Tensile Steel galvanized octagonal street light poles. The specifications of poles are as under: -

Specifications of Octagonal Poles:

This specification determines the requirements of the octagonal poles in respect of design, manufacture, testing and supply of galvanized poles, base plate and bracket arms for use in street lighting.

This specification covers tapered octagonal single piece columns of required mounting height.

High tensile steel round as well as octagonal poles of 3 mm thickness with hot dip galvanized in the bat tub up to 9-11 meter. single pole with minimum thickness of galvanizing as 36 micron. Contractor may use M.S. steel poles with 4mm thickness single pole of 9 to11m, (as per outdoor lighting design) length with hot dip galvanized in the bathtub upto 12 mtr. single pole with minimum thickness of galvanizing 86 micron.

Galvanized base plate of special steel having thickness of 20mm is to be considered alternatively Bidder can quote for MS base plate with 25mm thickness.

Octagonal poles shall be of flanged type to be fixed on the foundation bolts.

Possible loading configurations for different types of octagonal poles are indicated in respective GA drawings.

The octagonal poles shall be designed for 180 km/Hr. maximum wind speed.

The pole shall be provided with a common base plate of suitable size.

Galvanized iron junction box of adequate size, 2.7mm thick (water tight – IP 66 grade) shall be provided for each street light pole. The box shall have arrangement to receive designed size and number of cables. The terminal strip selected shall be suitable for the same.

The box shall also be provided with a required rating/capacity MCB for controlling the individual lighting fixture. It shall be wired up in the respective phase. 3 x 25 sq. mm PVC insulated multi-strand copper wires shall run from the junction box to the lighting fixture. The sires shall run through the pipe. The wires shall be protected to avoid any damage at the entry point by providing rubber grommet. A suitable clamping arrangement shall also be provided. An arrangement for earthing to the pole shall be provided.

Two numbers of 50mm dia G.I. conduits shall be provided in the foundations from the directly buried main cable upto the junction box for incoming and outgoing cables with G.I. clamps of size 25 x 3 mm.

Suitable cement concrete foundation for the octagonal pole shall be designed by the successful Tenderer considering soil bearing capacity of 10 Tons/sq.mtr.

An earthing bolt (M6) shall be provided with a suitable nut to receive two number of 8 SWG G.I. earth wire.

General Standards

The methods and materials used shall comply with BSEN 10025 with yield strength of 355 Mega Pascal for octagonal pole shaft.

Hot dip galvanizing shall be in accordance with IS 2629-1966 except otherwise modified by provisions of this specification for poles and brackets.

Material

The steel used for manufacture of octagonal pole shaft and bracket shall be as per BSEN 10025 grade 355 Mega pascal or equivalent and the material for the base plate, brackets, flange plates shall be as per IS 1062.

The steel used shall be welded, ageing resistant and suitable for hot dip galvanizing when such surface protection is required.

Manufacture

The octagonal pole shall be evenly tapered with single longitudinal welding from base to top. It shall be fabricated in one single section and shall be no circumferential weld joint.

Electrodes used shall be compatible with the grade of steel being used and have mechanical properties at least equal to those of the steel used. All welds shall comply with the following basic requirements: -

Base Plate

100% penetration between plates of all thickness. No fissures on inside or outside surface. No under cutting on the outside surface. Blowholes, spherical inclusions beyond standard minimum thickness shall be refused. Detectable angular inclusions shall not be acceptable.

Longitudinal Welds

60% penetration between plates of all thickness. No fissures on inside or outside surface. No undercutting on outside surface. No blowholes.

Galvanising

All components of the columns and brackets shall be hot dip galvanized after completion of fabrication. No further touching up, finishing or modification shall be done after galvanizing. The overall length of each section/bracket shall be immersed in one dipping operation.

The galvanizing coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale or blister nor be removable while handling or packing.
There shall be no impurities in the zinc nor additives to the smelter bath which could have a deleterious effect on the zinc coating.

Before pickling, all welding, drilling, cutting, binding etc. must be completed and all grease, paint, varnish, oil, welding slag etc. completely removed. All protuberances, which would affect the life of the galvanizing should be also be removed.

During pickling each article shall be completely immersed in one dip. Care shall be taken to ensure that the pickling solution is completely removed.

Weight of Zinc Coating

The weight of zinc deposited shall be not less than 86 microns.

Brackets

The bracket shall be hot dip galvanized after fabrication. The bracket shall be manufactured as per the GA drawing and with best workmanship. The bending of the pipes shall be without any kinks/visible marks. Arms shall be symmetrical.

Electricals

The octagonal pole shall be provided with a door flush with the pole surface without any projection. Required door reinforcement shall be determined by the manufacturer. Inside the door a suitable plate shall be welded for mounting 6A MCB and neutral link. Three core 2.5 sq.mm. copper wires shall be run for each luminaire individually.

Cable Laying

The cable laying shall be from supply point to the feeder pillar Panel and from feeder pillar Panel to street lighting poles.

The cable from supply point up to the feeder pillar shall be laid underground in excavated trench RCC pipe and HDPE pipe. The trench shall be at least 0.7 mtr. deep and 0.4 mtr. wide sand cushioning of 20mm shall be provided before laying the cable. The cable shall be protected with good quality bricks on all the sides. At road crossings, the cable shall be laid in 100mm dia RCC hume pipe of NP-2 class.

The cable from feeder pillars to the lighting poles shall be laid in suitable sized HDPE pipes buried at a depth of 0.7 mtrs. Loop of at least 1 mtr. shall be provided on either side of the pole.

Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

LED light fittings

The fixture for housing 150 W or equivalent LED light fittings should integral street light lantern with semi cut off with prismatic bowl with single piece cast alum. Body nickel-chrome plated reflector with unbreakable acrylic cover and necessary control gear etc. erected on provided brackets.

This item is for supplying and erecting integral 150 Watt LED fixtures with semi cut off prismatic bowl, with unbreakable acrylic cover suitable for 150 Watt. LED lamp with control gear box. The lantern should be erected on the provided bracket on the pole. The fixtures should be tested for acceptance in manufacturer works in presence of ULB's representative with satisfying all the technical details as given in relevant IS. The fixtures should have following technical details and features.

The Street light fixture should be complete with all parts and accessories such as housing assembly facetted mirror, felt gasket, lamp holder, lamp holder bracket, toggle, lead for gear compartment, gear try, ballast, capacitor, ignitor, terminal block, pole clamp, unbreakable polycarbonate acrylic cover etc. It should have following features:

Light distribution pattern confirm to IS and BS specifications.

Facility for cut off/semi cut off light distribution as per CIE recommendations. Optimum lamp holder position with respect to the mirror system for use with various light resources.

Use of aluminium/stainless steel poly-metal met acrylic cover. Universal geared tray incorporative ballast, condenser, ignitor, connector, suitable for flexible choice of light source, pre wired for operation.

A felt gasket impregnated with insecticides and water repellent chemical.

Simplicity in replacement of bowl assembly, optical unit and gear trey.
Single piece construction die-caste aluminium housing (Contractor/ manufacturer should mention the percentage of copper for corrosion resistivity MBV treated and hear resistance housing.
High purity, highly brighten anodized aluminum facetted mirror with special peet of blue for excellent optical control and protecting reflectivity and abrasion.

Electrited ceramic lamp holder confirming to the DEC/finger set.

Sticking bracket to hold the acrylic cover when it is open.

Hexagonal bracket for holding the mask arm gift effectively.

Stainless steel toggle hooks for clamping the acrylic cover over the canopy for prevention of entry of insects.
Alluminium lead for gear compartment.
Zinc plated and yellow passivated hard.
Skirted lamp holder as per IEC figure test.
Cassette type loading of the gear unit.

Pot optics reflector for the fitting.
Cast aluminium in one piece with facility of toe in angle.

LED (Discreet LED)

The Contractor will have to supply Suitable watts of LED lamp which is operating on single phase 50 Hz 230/250 volts A.C. electric supply. They have to supply the approved makes as specified in this Tender. The LED lamps should be tested in presence of ULB's representative in the manufacturing work before dispatch.

Trench

Trench shall be of suitable width and 0.7 mtr. deep for laying provided L.T. cable and refilling the same with screened sand bed for 20 cms to embed the cable and bricks placed on both side and top all over the run and with excavated earth without stones or hard materials and making the surface proper with 15 cms. Crown on the top when more than on cable is to be laid in the same trench additional bricks should be used to form another compartment. After laying of the cable in above manner the trench should be backfilled with the excavated soil without hard stones and should be provided with 15 cm crown on top all over.

Area Light Control

1) All area lights inside premises are proposed to be controlled from one control pillar.
2) For metering the energy consumption, a separate 1 phase/3 phase energy meter shall be provided in the control pillar.
3) The cable between 6 way feeder pillar and the area light control pillar shall be laid by the agency.
4) For automatic ON/OFF operation of the area light automatic timer shall be provided with energy saving device.

Light fittings:

The lighting fixtures shall comply with the following requirements:

The fixture shall be suitable for operation on a nominal supply voltage of 240 volts, signal phase, 50 Hz with voltage variation of 10%. All fixtures shall be designed for minimum glare. The finish of all parts of the fixtures shall be such that no bright spots are produced, either by direct light source or by reflection. For multi lamp fluorescent fittings, the circuit shall be designed in such a manner to reduce the stroboscopic effect to a minimum.

The LED lighting fixture ballast shall comply with the following requirements.

TECHNICAL SPECIFICATIONS

APPLICABLE STANDARDS

The required materials should confirm to the following Indian & International standard specification.

S. No.	IS No./International standard No.	Specification
1	IS 16105	Measurement of lumen maintenance of LED sources (LM80)
2	IS 15885 (Part I and II)	Safety of Lamp control gear (equivalent IEC in case of driver)
3	IS 16104	Performance requirement for Electronic Control gear for LED modulers (IEC equivalent)
4	IS 16106	Method of electrical and photometric measurements of solid state lighting product (LM 79)
5	IS 16108	Photo biological safety of lamps and lamp systems (IEC equivalent)
6	IEC 60598(60598-2-3)	Particular requirements – Luminaries for road and street lighting
7	LM-79	Approved method for electrical and photometric measurements of solid-state lighting products

8	LM-80	Approved method for measuring maintenance of LED light sources
9	IEC 61347-1,-2- 13,	Particular Requirements for D.C. or A.C. Supplied Electronic Control Gear for LED Modules.
10	IS 10322	Specification for the luminaries

Materials meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standards mentioned above, shall also be considered. In such case the salient points of difference along with advantages between the standards adopted and the specified standards shall be clearly brought out in a schedule For values not available in relevant IS values indicated in the GTP/ specification shall be valid. In case of discrepancies between values of IS and GTP the better will prevail

TECHNICAL REQUIREMENT FOR LED STREET LIGHTS

GENERAL:

Bid	Street lighting
Rated Voltage	140-270 volts AC
Rated Frequency	50Hz
Usage	Avg.12 hrs/day
Color	Cool White

CONSTRUCTION:

The lamps should be robustly built with adequate mechanical strength, heat resistance, insulation resistance and flame resistant material complying with relevant clauses of IS 16102. It should be made of pressure die cast Aluminum with toughened glass / poly carbonate cover suitable for mounting on a pole pipe bracket with complete locking arrangement. The complete housing of the lamp should have an ingress protection level of IP 66 for the lamp compartment as well as the driver circuit.

The viewing angle of the luminaries shall be suitable for street lighting bids to achieve required uniformity. The weight of the lighting fixtures should be compatible with the existing pole and its associated structures. The total power consumption in the LED lighting fixture shall not exceed the total guaranteed power consumption including power consumption in the electronic circuit of the driver for that particular bid over the entire voltage range given in clause 2.1. The fluctuations in line voltage shall have no visible effect on luminous intensity of the LED luminaries.

DESIGN AND OUTPUT

Detailed design shall be done on the basis of following parameters.

Lux Level as per IS 1944 / IEC - Confirming to road category

Uniformity Ratio shall be >/= 0.4 & Longitudinal Uniformity shall be be >/= 0.7

Lighting recommendations for different roads types- CIE Classification.

Sl. No	Lighting Class	All Roads	Roads with few Juctions TI (%) (max)	Roads with foot ways Surrund Ration (SR)

		Lav	Uo	UL (min)		
1	M1	0.2	0.4	0.7	10	0.5
2	M2	1.5	0.4	0.7	10	0.5
3	M3	1.0	0.4	0.5	10	0.5
4	M4	0.75	0.4	-	15	-
5	M5	0.5	0.4	0.4	15	-

Where:

Lav= Average Luminance;

Uo= Overall Uniformity;

UL= Langitudinal Uniformity and;

TI= Threshold increment.

The illumination output of the LED fixtures reduce over the lifetime in accordance to norms of L70 of IS:16103 (Part-2). This is termed as Lumen Maintenance. The LED fixtures are expected to not lose Lumen output by more than 70% over the period of 60,000 hours.

The luminaries should be able to operate with constant light output from 90V–300V supplied voltages using the same driver

Power Factor of the electronic driver should be at least > 0.9 and with THD<20%,

The luminaries should be semi cut off type as per IS 1944, the throw & spread should be able to deliver uniform light with exactly the desired intensity. The Luminaries shall employ structured LED array for optimized roadway photometric distribution with photometric lenses designed to optimize lumen efficacy and minimal glare, individual optical lens to be provided on each LEDs on a lens plate.

The fixture should have a minimum impact resistant of IK 07 while the ingress protection with suitable protection by using cover for driver and LEDs should confirm to minimum IP 66.

Heat dissipation should be managed through a built-in external heat-sink.

For the driver, an internal type test report complying with international standards with reference to various general and safety requirements & parameters needs to be submitted. The efficiency of the driver shall be more than 85 % in all cases at all times.

2.2.2 Performance Standards:

The Bidder shall furnish the details of LED lighting module specification:

2.2.2.1 LM80 compliance certificate to be adhered by the LED chip manufacturer. LED data sheet should comprise of Lumen depreciation (life) data, lumen output, junction temperature, pad temperature, thermal resistance, and LED drive current, efficacy of LED should not be less than 100 lm/watt.

(LM 80 report should be scanned & uploaded) (IESNA: Approved Method for Measuring Lumen Maintenance of LED Light Sources and LED lumen depreciation time to L70 based on LM-80 data

(Approved method for the Electrical and Photometric Measurements of Solid-State Lighting Products).

LM-79 compliance certificates from UL/ERTL or Govt. approved laboratory subject to submission of required certificate. (LM 79 report should be scanned and uploaded).

Electrical safety as per IEC. - As per IEC safety standards IEC61000, 61547, 61347.

The luminaries should be tested as per IEC 60598 standards and following test reports should be submitted: Heat Resistance Test, Thermal Test, Ingress Protection Test, Electrical / Insulation Resistance Test, Endurance Test, Humidity Test.

The luminaries should be tested for 'Drop test' as per IEC 60068-2-31/IS9000 Part 7 / Sec 3 standards.

The luminaries should be tested for 'Vibration test' as per ANSI/IEC 68-2-6 standards.

The luminaries should be able to operate with constant light output from 140V–270V supplied voltages using the same driver, delivering nominal >100 lumens/watt at system level & >120 lumens at LED level.

MARKING:

The following information shall be distinctly and indelibly marked on the housing:

Manufacturer's name. /Year of Manufacturer.

Rated voltage (marked "V" or volt).

Rated wattage (marked "W" or watts)

Rated lumens.

Batch No. /Serial No. Not for sale - , PCMC-PUNE.

TOTAL HARMONIC DISTORTION: Should be less than 20%.

LED LAMP EFFICACY : Should not be less than 120 lumens per watt.

POWER FACTOR: Should be greater than 95% including the driver circuit

COLOUR RENDERING INDEX :Nominal CRI of 70.

DRIVER CIRCUIT EFFICIENCY: Should be greater than 85%. The control gear should be complying with IEC 61347-2-13 and relevant IEC certification as per requirement. The driver should comply with CISPR-15 for limit and methods of measurement of radio disturbance characteristic. Retaining to drivers need to be produce

CORRELATED COLOUR TEMPERATURE : Should be between 4500 º K to 5500 ° K.

LIFE EXPECTANCY: Should be 50000 glow hours at normal ambient conditions or better for L70 as per IS 16102 (Part-2):2012.

WORKING CONDITIONS: Temperature: -5to50°C; Humidity: 10%to90%RH

SWITCHING

The street light to be operated through group switching device for operation during night hours only and the street light should be operated individually from the feeder panel for repair purpose in day time.

Earthing

Developer should ensure the pole earthing and if the earthing is not proper, the contractor should provide dedicated earthing and should use 3 core shielded copper cable /wire from fixture to pole earthing and should provide safe connection of fixture.

STANDARDS:

FIXTURE:

1. The luminary should confirm to IEC 60598(60598-2-3)/IS10322.

2. LM-79 Fixture Test Report.

3. EPMC test report(EN 55015,EN 61547,61000-3-2)

LED:

1. LM-80 LED Test report.

DRIVER:

1. IEC 61347-1,-2-13, Test report.

2. IEC 62384. Test report.

GENERAL REQUIREMENTS FOR STREET LIGHTING:

The fixture shall be capable of installation on the existing poles, brackets, and in the existing lighting segment as per specified in the document.

Only OSRAM/ LUMILEDS/CREE (USA) or equivalent to IS /IEC/USA/UK and approved by Corporation, LEDs shall be used for the street lights.

The luminaries casing/housing shall be of pressure die cast aluminium having high conductivity heat sink material.

The electronic components used shall be as follows:-

IC (Integrated circuit) shall be of industrial grade or above.

Metallic film / Paper/Polyester Capacitor shall be rated for a sustained operating temperature of 105ºC.

The resistors should be preferably made of metal film of adequate rating. The actual rating versus loading shall be by a factor of 3.

The junction temperature of the Switching devices such as transistors and MOSFETs etc. shall not exceed 125ºC (allowing thermal margin of 25 ºC).

The protective cum adhesive coating used on PCBs should be cleared and transparent and should not affect color code of electronic components or the product code of the company.

The construction of PCBs and the assembly for components for PCBs should be as per IS standards.

The electronics covered for this equipment shall pass all the tests called for in the above specification. The Bidder shall indicate the deviation or compliance otherwise the offer shall not be considered for evaluation.

The infrastructure for Quality Assurance facilities as called for in the above specification must be available at the manufacturing facility. In house testing facility for Quality Assurance should be present. The compliance shall be indicated clearly in itself.

Care shall be taken in the design that there is no water stagnation anywhere and entire housing shall be dust and water proof having IP66 protection as per IEC 60529.

The manufacturers shall ensure that the fixture is designed in such a manner that it conducts the heat away from the LEDs as efficiently as possible. The design shall ensure that the junction temperature is kept as low as possible during operation. Thermal management shall be in such a way that Luminary shall have trouble free operations from -20 ºC to +50ºC. The following test shall be done to determine efficient thermal management:

All the material used in the luminaries shall be halogen free and fire retardant confirming to UL94.

Lighting Distribution Type Cut Off/ Semi Cut Off type as per IESNA. Type II/ III Lighting Distribution.

The manufacturer /Bidder should also offer Comprehensive Maintenance Contract (CPMC) for the post Warranty period.

All the supplied lamps, luminaries and fittings shall carry permanent marking as “Not for sale – PCMC…..

- All lighting fixtures shall be supplied complete with lamps and all necessary accessories for satisfactory operation. Lighting fixture reflector shall generally be manufactured from sheet steel or aluminium of not less than 20 SWG. They shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. The following type of lighting fixtures shall be supplied:
- Each fixture shall be complete with a four way terminal block for the connection and looping of incoming and outgoing supply cable. Each terminal shall be able to accept two Nos. 2.5 sq.mm copper conductor cables and shall be provided with an earthing terminal suitable for 12 SWG GI wire.
- Lighting fixture starters shall be of safety type i.e., if the lamp fails to ignite at the first start, no further starting shall be possible without attending to the lamp. Starters shall have bimetal electrodes of high mechanical strength.
- The enamel finish shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading. On completion of manufacture, all surfaces of the fixture shall be thoroughly cleaned and digressed. The fixture shall be free from scale, rush, sharp edges and burrs.
- All light reflecting surfaces shall have optimum light reflecting coefficient such as to ensure the overall uniform light output.
- The fixture capacitors shall be suitable for operation at 240 V + 10%, single phase, 50 HZ, with a suitable value of capacitance to correct the power factor of the corresponding lamp circuit to the extent of 0.925 lag. The capacitors shall be hermitically sealed preferably in a metal container to prevent see page of impregnating material and ingress of moisture.
- Louvers shall be of polystyrene egg box type. Appropriate captive type fixing devices shall be incorporated for securing the louvers.

- Emergency light fitting shall be 240 V self contained 2 x 10 W LED Fixture with built in Ni – cd battery having charging facility and six hours back-up time. The emergency light fitting shall be provided at strategic locations of each house / area.

HIGH MAST SPECIFICATIONS

HIGHMAST:

1. **Structure:**

   The Highmast shall be of continuously tapered, polygonal cross section, at least 20 sided, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above, to given an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS 875 and part 3 1987. The manufacture should have carried out the wind tunnel test on sample model of high mast and relevant test certificates to be submitted.

2. **Construction:**

   The mast shall be fabricated from special steel plates, conforming to BSEN10025 or equivalent, cut and folded to form a polygonal section as stated at 1 above and shall be telescopically jointed and welded. The welding shall be in accordance with BS.5135/AWS. The procedural weld geometry and the workmanship shall be exhaustively tested on the completed welds.

   The mast shall be delivered in sections of approximately 10 to 11 meters at site. Each section shall be fabricated out of individual plates duly folded and welded. There shall be only one longitudinal seam weld per section. Sections fabricated out of multiple plates or with more than one weld shall not be accepted. At site the sections shall be joined together by slip-stressed-fit method. No site welding or bolted joint shall be done on the mast. The minimum over lap distance shall be 1.5 times the diameter at penetration. The dimensions of the mast shall be decided based on proper design and design calculations shall be submitted for verification. The mast shall be provided with fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the boltholes to ensure elimination of helical stress concentration. For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform thickness As per BSEN ISO-1461. The galvanizing have to be done by single dipping method only for better adhesion and life.

3. **Door Opening:**

An adequate door opening shall be provided at the base of the mast and the opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with a heavy-duty double internal lock with special paddle key. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected an undue buckling of the cut portion is prevented. Size of door opening shall not be more that 1200X250 mm to avoid buckling of the mast section under heavy wind conditions.

4. **Dynamic loading for the Mast:**

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 (three second gust), and shall be measured at a height of 10 meters (or as per site requirements) above ground level. The design life of the mast shall be minimum of 25 years.

5. **Fabrication:**

A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gear boxes. The Lantern Carriage shall be of special design and shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gear boxes, and also have a perfect self balance. The Lantern Carriage shall be fabricated in two halves and joined by bolted flanges with stainless steel bolts and nyloc type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage. The entire Lantern Carriage shall be hot dip galvanized after fabrication.

6. **Junction Box**

Weather proof junction box, made of Cast Aluminium shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaries and associates control gears fixed on the carriage shall be made.

7. **Raising and lowering mechanism:**

For the installation and maintenance of the luminaries and lamps, it shall be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch

Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

8. Winch:

The winch shall be completely self sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, by gravity activated PAWLS. Individual drum also should be operated for fine adjustment of lantern carriage. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch.

The gear ratio of the winch shall be 53:1 . The winch shall be self-lubricating type by means of a oil bath and the oil shall be readily available grades of reputed producers.

The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. The rope termination in the winch shall be such that distortion or twisting is eliminated and at least 5 to 6 turns of rope remains on the drum even when the lantern carriage is fully lowered and rested on the rest pads. It shall be possible to operate the winch manually by a suitable handle and by an integral power tool. Operation of the winch with manual handle shall be independent of the power tool. Winches with manual operation through the power tool shaft shall not be accepted. Individual drum operation of the winch shall be possible. A double drum winch shall have 2 drum and two worm gears independent in operation for increased safely. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. Also, a winch gearbox for simultaneous and reversible operation of the double drum winch shall b provided as part of the contract.

The winch shall be type tested in presence of a reputed Institution and the test certificates shall be furnished before supply of materials. A test certificates shall be furnished by the Contractor for each winch in support of the maximum load operated by the winch.

9. Head Frame:

The head frame which is to be designed as a capping unit of the mast, shall be of welded steel construction, galvanized both internally and externally after assembly. The top pulley shall be of appropriate diameter, large enough to accommodate the stainless steel wire ropes and the multi-core electric cable. The pulley block shall be made of non-corrodable material, and shall be of die cast Aluminium Alloy(LM-6).Pulley made of synthetic materials such as Plastic or PVC are not acceptable. Self-lubricating bearing and stainless steel shaft shall be provided to facilities smooth and maintenance free operation for a long period . The pulley assembly shall be fully protected by a canopy galvanized internally and externally.

Close fitting guides and sleeves shall be provided to ensure that the ropes and cables do not dislodged from their respective positions in the grooves. The head frame shall be provided with guides and stops with PVC buffer for docking the lantern carriage.

10. Stainless Steel Wire Ropes:

The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 of better grade.

The stainless steel wire ropes shall be of 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less that 6 mm. The breaking load of each rope shall not be less that 2400 kg. giving a factor of safely of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes to the winch drum shall be fitted with telluric.

11. Electrical System, Cable and Cable Connections:

A suitable terminal Box shall be provided as part of the contract at the base compartment of the high mast for terminating the incoming cable. The electrical connections from the bottom to the top shall be made by special trailing cable. The cable shall be EPR insulated and PCP sheathed to get flexibility and endurance. The cable shall be of reputed make. At the top there shall be weather proof junction box to terminate the trailing cable. The system shall have in-built facilities for luminaries while in lowered position. Also, suitable provision shall be made at the base compartment of the mast to facilitate the operation of internally mounted, electrically operated power tool for raising and lowering carriage rings shall be terminated by means of specially designed, metal clad, multi pin plug and socket provided in the base compartment to enable easy disconnection when required.

12. Power Tool for the Winch:

A suitable, high-powered, electrically driven, internally mounted power tool, with manual over ride shall be supplied for the raising and lowering of the lantern carriage for maintenance purpose. The speed of the power tool shall be to suit the system. The power tool shall be single speed, provided with a motor of the required rating.

The power tool shall be supplied complete with a suitable control arrangement so that the operation of the mast can be done at a safe distance. The capacity and speed of the electric motor used in the power tool shall be suitable for the lifting of the design load installed on the lantern carriage.

The power tool mounting shall be so designed that it shall be not only self supporting but also aligns the power tool perfectly with respect to the winch spindle during the operations. Also, a handle for the manual operation of the winches in case of problems with the

electrically operated tool, shall be provided. There shall be a separate torque-limiting device to protect the wire ropes from over stretching. It shall be mechanical with suitable load adjusting device. The torque limitor shall trip the load when it exceeds the adjusted limits. There shall be suitable provision for warning the operator once the load is tripped off. The torque limitor is a requirement as per the relevant standard in view of the overall safety of the system. Each mast shall have its own power tool motor.

13. Lighting Finial

One number heavy duty hot dip galvanized lighting finial shall be provided for each mast. The lighting finial shall be minimum 1.2 M in length and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth through the mast. The lightning finial shall not be provided on the lantern carriage under any circumstances in view of safety of the system.

14. Aviation Obstruction Lights:

Suitable Aviation Obstruction Lights of reliable design and reputed manufacturer shall be provided on top of each mast.

15. Earthing Terminals:

Suitable earth terminal using 12mm diameter stainless steel bolts shall be provided at a convenient location on the base of the Mast, for lighting and electrical earthing of the mast.

16. Feeder Pillar:

Each mast shall be provided with a feeder pillar fabricated out of 14 SWG CRCA sheet and finished with two coates of red oxide primer and gray enamel paint of shade 631 of IS-5. The feeder pillar shall comprise of incoming MCB Isolator, Copper wiring, suitable timer, contractor to switch on the luminaries at a pre-set time. There shall be suitable control arrangement to change the direction of rotation of the power tool-motor. Feeder pillar shall be mounted on suitable foundation near to the mast.

STANDARD MAST DIMENSIONS

MAST HT (M)	TOP DIA (mm)	BOT DIA (mm)	PLATE THK (mm)	PCD (mm)	FOUNDATION BOLTS	LAMP CAPACITY
16	150	410	3,4	490	M30/580 x 8	16

7. LIGHTING PANELS - FOR NON HAZARDOUS AREAS

a) Specifications

Relevant Indian Standard Specifications and Codes shall apply for Lighting Panel Boards and their components wherever such Standard Specifications exist. The panel shall be approved by the Fire Insurance Association.

b) General Requirements

i) Lighting panels shall be made of 14SWG sheet steel and painted with powder spray to prevent corrosion.

ii) Lighting panels shall be suitable for 3Phase, 4Wire, 415/240 Volts as per the distribution schemes indicated in the relevant drawings.

iii) The lighting panels shall be completely dust and vermin proof, double door type and provided with neoprene gaskets and free of mechanical and electrical defects. The degree of protection for the panel enclosure shall be IP54.

iv) Knockouts for branch circuit conduits or cables shall be provided on the top and bottom as required.

v) Tinned copper sockets shall be provided for the main connections to the panel.

vi) All panels shall be self supporting, wall mounting type unless otherwise specified in the schedule of quantities

vii) All the lighting panels shall be provided with two external Earthing terminals and suitable tinned copper lugs for connection to the Earthing system

viii) The neutral terminal block shall have sufficient number of terminals for all single phase outgoing branch circuits.

ix) Means for easy identification of each and every branch circuit shall be provided.

8. MISCELLANEOUS ACCESSORIES

a) MCB/MCCB

i) Switches shall have fuseless units for each phase as indicated in the drawings.

ii) The switches shall be load breaking type suitable for breaking circuits on full load.

iii) All switches shall be rated for 500 Volts and shall be metal clad heavy duty type and shall have neutral links. The sizes shall be as specified and indicated in the applicable drawings.

iv) For exposed and outdoor locations, the switches shall be weather-proof type

i.e. IP66.

v) Nameplates of adequate size shall be provided to indicate the name of the equipment and/or the circuit number controlled by the switch fuse unit.

vi) A nameplate and/or designation number shall also be provided approximately on the top middle portion of the complete assembled unit, as mentioned in the drawings, for identification.

b) Switches - Single Pole

i) Single pole general purpose switches shall be of 250Volts, conforming to I.S. specifications. Switches above 5A shall be of rotary type.

ii) Unless otherwise shown in the drawings, all single pole switches shall be of minimum 5 amperes rating.

iii) Each 5A switch shall have a porcelain base mounted in a sheet steel box with the operating knob projecting out of the box and held in position by a threaded tightening ring from the outside. The rotary switches shall be as approved by the Engineer-in-charge.

iv) Unless otherwise specified switch housing shall have threaded hub for heavy wall rigid conduit as approved by the Owner/Consultant.

v) Switch housing shall be provided with Earthing screw.

Socket Outlets and Plugs

i) Single phase socket outlets, receptacles and plugs shall be 3 pin, 250Volts, conforming to I.S.1293. Ratings are as specified in drawings.

ii) Each socket outlet unit shall be provided with a single pole Industrial rotary switch of suitable rating unless otherwise indicated.

iii) The socket outlet and switch shall be encased in a suitable metal box. The metal box shall be provided with earthing screw. Approval from Engineer-in-charge is essential before taking up fabrication.

iv) The socket outlets shall have suitable Porcelain bases and metal cover.

v) The unit (of socket outlet and switch) shall be complete with necessary integral wiring and/or interlocking.

vi) Each socket outlet shall be provided with an attached metal cap to cover the outlet when not in use to make the receptacle safe and weatherproof.

vii) The earthing pin of the plug shall be the one to contact first and break contact last at the time of inserting or removing the plug as the case maybe.

viii) The earthing terminal shall be connected to the encasing metal body of the unit.

c) **Three Phase Receptacles** -

i) These receptacles and plugs shall be 4 Pole, 500 Volts and of current rating as indicated on the applicable drawings.

ii) Each receptacle and plug shall be coupled to a 3-pole & neutral switch to form a complete unit.

iii) An interlock shall be provided to prevent the insertion or withdrawal of the plug with the switch ON.

iv) This unit of switch with interlocked plug and socket shall be of a make being approved by Owner/Consultant.

v) The socket shall be suitable for surface or flush mounting as indicated in the drawings.

vi) A nameplate of adequate size shall be provided to indicate the name of the equipment connected.

vii) For flush mounting, the switch shall be of the rotary type of approved make and the combination of socket and switch shall be mounted in a M.S.sheet metal box suitable for conduit/cable entry. The M.S.sheet metal box shall be provided with duplicate external Earthing terminals and tinned copper lugs for connection to the Earthing system.

d) Push Button Stations (General Purpose)

i) Metal clad start-stop push button stations shall be of momentary contact type with provision for locking in 'OFF' position. The boxes shall be supplied with necessary cable /conduit entry at the bottom.

ii) All contacts shall be silver tipped and be capable of interrupting minimum 10Amperes at 250Volts without damage to the contacts.

iii) Push button stations shall be provided with mounting holes for mounting on the wall or on a steel frame as shown the drawings.

iv) A nameplate of adequate size shall be provided to indicate the name of the equipment and/or circuit number controlled by the push-button station.

v) The degree of protection for the push button enclosure shall be IP 55 and the unit shall be provided with suitable rain hood and made weatherproof

type is to be installed in outdoor area.

vi) The push button stations shall be provided an Ammeter wherever mentioned in the drawings.

e) Flame proof Materials / Accessories

All flame proof materials / accessories shall be of cast iron or LM-6 or suitable alloy metal. The enclosure shall conform to the requirements of IS: 2148 or IS: 6381 as indicated. Further, flameproof accessories shall meet all requirements of Indian Electricity rules, Fire Insurance Association of India, Electrical Inspector, CMRS Dhanbad, Chief Inspector of Explosives (Nagpur), Director General (Factory safety), Service and Labour Institute (Bombay), etc.

9. CABLE GLANDS AND CABLE TERMINATING ACCESSORIES

i) All cable glands shall be of brass metal and screwed type and single compression type for indoor application and double compression type for outdoor application.

ii) Cable glands for Hazardous area shall be of flame proof, double compression type.

iii) All cable sockets for cable termination shall be of tinned copper only.

iv) Cable identification tags shall be of 6 mm thick Aluminium flat of suitable size with neatly engraved marking. Cable trays, shall be G.I. Perforated or M.S. painted, site fabricated, Ladder type as indicated on the drawings and the schedule of quantities.

10. HARDWARE AND STRUCTURAL STEEL

i) All hardware and structural steel being used for the various installations, Cable trays, supports, frames, etc. shall be as per relevant I.S. The sizes of the sockets shall be as per the approved drawings.

ii) All nuts, bolts, washers, spring washers, etc. shall be of galvanised steel.

Note –

In case of any duplication of data / specifications of any item / equipment in the tender document, the specification / data shown in the bill of quantities shall be given the first priority, the specification / data shown in the exclusive Specifications of the relevant item / equipment

shall be given the second priority and the specification / data indicated in the General Specifications shall be given the last priority.

Specifications for Electrical Installation – Standards & Specifications

ELECTRICAL INSTALLATION - STANDARDS & SPECIFICATIONS

1. GENERAL

a) Scope of Work

The scope of work shall include the furnishing of all labour, materials, appliances, superintendence and services required to construct and install a complete and operable electrical system as herein specified and covered by the accompanying drawings. The items of work include, but are not limited to, the following:

1. Complete electrical power and lighting systems, covering H.T. Switchgear, Transformer, 415 volts Switchgear, switches, starters, lighting installation, cabling and other equipment including all outside conduits, wiring and incidentals as required.

2. Complete branch circuit wiring installation for lighting receptacles and miscellaneous items.

3. Installing and connecting all lighting luminaires complete with lamps, unless otherwise specified.

4. Supply and installing complete earthing system and test thereof.

5. Installing and connecting motor starters where specified.

6. Temporary electric lights and powers facilities, if required on the instruction of Engineer-in-Charge.

7. Complete conduit and wiring system including supply of plugs and sockets for telephones.

8. Materials or appliances, general purpose / weatherproof / flameproof as required, forming part of the electrical system and necessary for its operation, though not specifically mentioned, shall also be furnished and installed without additional charges.

b) Drawings

1. The work covered by these specifications is shown on the drawings, which constitute an integral part of the specifications.

2. The electrical contractor shall work in close co-ordination with the architectural, structural, HVAC, plumbing and piping contracting sections, to avert possible installation conflicts. Discrepancies if any on different plans, or between plans and actual field conditions or between plans and specifications shall be promptly brought to the attention of the Engineer-in-Charge at site for a decision before proceeding with the work.

3. The drawings and specifications shall be considered complementary so that anything or any matter shown upon one or described by the other or fairly implied by either or both shall be done and performed as if shown upon and described by both. One set of drawings shall be kept as record drawings. All deviations of the actual proposed installations as shown on the drawings should be marked in red on these drawings. On completion of the project, as-built drawings shall be prepared by the electrical contractor incorporating these changes and four sets of such drawings shall be handed over to the Engineer-in-Charge at the time of final handing over.

c) Personnel

All work shall be performed by Contractor under the direct supervision of a qualified person appointed by him and regularly engaged in the installation of electrical equipment. The contractor shall place in charge of the work at all the times during the construction. Qualified and experienced electrical engineer who shall be responsible for keeping liaison and co-ordination between Employer's personnel and his own men at site. He shall also submit progress reports every fifteen days. Anyone not deemed capable by the owner shall be replaced immediately upon such advice.

d) Tools and Testing Equipment

The work shall be performed using tools and testing equipment designed and approved for the purpose. The following tools and testing equipments are recommended for carrying out the electrical installation work. The electrical contractor shall bring tools and equipment which may be necessary to carry out /

complete the work, in addition to the tools and equipment suggested hereunder, if asked for by Engineer-in-Charge.

- 5000 volts constant pressure type motorised insulation tester(megger)
- 1000 volts constant pressure type insulation tester (megger)
- 500 volts constant pressure type insulation tester (megger)
- Universal Earth Tester
- Welding Sets
- Cutting Tools
- Derricks, if required
- Jacks
- Electric Blower
- Drilling Machines (different sizes)
- Grinding Machine
- Cable Crimping Tool
- Relay testing kit
- Tong Tester
- Portable Voltmeter
- Pipe bending machine
- Phase sequence indicator
- Portable test lamps with prongs
- Tachometer (0-3000 r.p.m.)
- Constant pressure type continuity tester
- Wiremen kits
- Fitter’s tools
- Vices
- Die sets with difference dies
- Ladders (different sizes)
- Cable laying tools

e) Materials and Equipment

1. The materials and equipment to be installed as indicated on the electrical drawings and materials and equipment specifications, shall conform to the applicable codes and specifications mentioned in section I (f). The materials and equipment wherever specified and / or indicated as supplied by others shall be installed by the contractor as recommended and advised by the manufacturers of such equipment. Care shall be taken in handling the materials to properly protect them from damage during transport and installation. All electrical materials supplied by the contractor shall be new, unless agreed otherwise in writing by Engineer-in-Charge.
2. The contractor shall obtain the approval of Engineer-in-Charge for all the materials to be used by him prior to installing them. Equipment damaged by the contractor in the course of handling, installation or test shall be replaced or repaired by him without any additional charges and subject to the approval of the owner / engineer-in-charge.

f) Codes and Specifications

All materials and equipment shall be installed in accordance with the latest Indian Electrical Codes and Standards. Installation shall be approved by the Chief Electrical Inspector. It will be the Contractor's responsibility to obtain the approval of the electrical installation work from all Statutory Authorities.

g) Cutting, Patching and Excavation

The contractor shall do all excavation and cutting required for the installation work and shall be responsible for any damage that may be caused to the work of others. He shall, where possible, keep the excavation, cutting and patching to a minimum. If the electrical contractor fails to perform his work in the proper manner or at proper time and due to this, additional excavation, cutting and patching is required, the contractor shall do such additional cutting and patching without any extra cost to employer.

h) System of Working

The work shall be carried out in a systematic way in proper sequence and order. Priorities of work shall be fixed by the Engineer-in-Charge at site. All these priorities shall be strictly adhered to. Untill the particular part of the work is approved or certified complete by the Engineer-in-Charge at site, the contractor shall not take up the consequent work connected with the part work completed but uncertified as completed.

i) Protection

The contractor shall furnish and place proper guards for prevention of accidents. He shall provide and maintain any other necessary constructions required to ensure safety of life and property involved in his work.

2. L.T.SWITCHBOARD

a) These shall be installed with utmost care as per the recommendations of the manufacturer and the drawings. The electrical contractor shall be responsible to replace or repair any part, free of cost, if it gets damaged during the installation or due to mishandling of equipment.

b) All connections shall be made as per vendor's drawings and before commissioning, over load and relay settings shall be adjusted as directed by the equipment supplier / Engineer-in-Charge.

c) If any switch bends is supplied in sections, assembly of the same will be the electrical contractor's responsibility. Relays and instruments, if received separately, will be installed and connected by the electrical contractor.

d) Installation of all switchgear shall conform to IS - 10118.

e) After the installation, assembly and connection, the tightness of all connections shall be checked. All panels and modules shall be cleaned by blower before energising.

3. WIRES AND CABLES

a) General

i. Installation of wires and cables shall be in accordance with I.S. 732. All wires shall run from box to box without splices. Sharp bends shall be

avoided. They shall be pulled in or laid in such a manner that the insulation is not damaged at the time of installation or in service. Care shall be exercised to ensure avoidance of any moisture in terminations. The wire / cable being laid shall be in one length, and straight joints shall be avoided as far as possible.

Insulation shall be removed for making terminations in such a manner that the conductor is not damaged. Conductors shall be clean and free from burrs.

ii. The current carrying ability of the terminations shall be equal to or greater than the wire / cable being terminated, without dependence on the solder. The termination shall be mechanically secure, without dependence on the crimping. Solder and soldering flux, if used, shall be non-corrosive and of a make approved by the cable or wire manufacturer.

iii. Minimum wire size shall be 2.5 sq.mm. copper. Above 10 sq.mm. size, all wires shall be stranded. All wire and cable runs under (i) poured concrete or road beds and (ii) passing through walls shall be in (i) RCC pipes and (ii)conduit sleeves respectively.

No wire or cable shall be run through any equipment foundation unless specifically indicated in the drawings, or directed in writing by Engineer-in-Charge. Cables shall be kept at least 300 mm away from steam or other hot lines. Where closer than this, asbestos barrier shall be used between pipe and cables. The armouring of all armoured cables shall be electrically continuous from Switchgear to equipment and shall be terminated by an appropriate gland fitting and grounded at both ends. Minimum bending radius shall be 12 to 15 times the outside diameter of the cables as recommended by the cable manufacturer.

iv. The colour code of wires shall be same throughout the installations and shall be approved by the Engineer-in-Charge. (Where more than one neutral is carried in the same conduit, the neutral conductors shall be identified.)

v. Where colour coding is not practicable or possible, the above scheme shall be achieved by the use of colour bands provided by the electrical

contractor.

vi. No oil, grease or compound other than powdered soap stone shall be used to facilitate the pulling of wires. Buried cable shall be installed with sufficient slack in the trench along the cable length.

vii. The electrical contractor shall arrange all cables and wires in neat formations along the wall or in suitable cable trays as shown and indicated in the drawings, including supply and installation of all supporting steel work like angles, channels, etc. and painting of the same.

b) 415/240V System

i. Wires drawn in conduit will be unarmoured. Cables laid in trays or buried in the ground shall be armoured.

ii. The number of wires and conduit sizes indicated for the various circuits (control, alarm and signal) were decided for a general scheme of wiring. The actual number of wires installed for each circuit and the required size of conduit shall, however, be as required to accomplish the specified results as required by the manufacturer of the said control equipment.

Wires connected to the same phase and for the required neutral only can be grouped in one conduit, for lighting installation.

iii. No single core wire alone shall run in any conduit unless clearly shown in the drawings.

iv. This part of the specifications cover the responsibility of selecting the proper branch circuit designation in the panel boards and to install the branch circuit wiring in accordance with the phasing sequence as shown on the drawings, so that the loads are balanced across all the phases as closely as possible and to cause minimum unbalance in the panel board neutral wires. If any changes are to be made, approval of the Engineer-in-Charge is essential.

v. No wire shall be pulled until the complete conduit is installed. No splices

or joints shall be permitted in either feeders or branches except at the outlet of accessible junction boxes.

vi. Termination of wires and cables at main boards, M.C.Cs lighting /power panels, fixtures, etc. is to be done preferably with solderless tinned copper terminal lugs duly crimped and using petroleum jelly at all connections. Special permission shall be taken from the Engineer-in-charge for termination with soldering method.

4. BURIED CABLES

a) Only armoured cables shall be buried directly in the ground. Trench for H.T. cables shall be 900 mm deep and for L.T. and other lower voltage cables shall be 600 mm deep or as specified in the drawings. Where both H.T. and L.T. cables follow the same route, one trench may be used. In that case, the higher voltage cables shall be installed at 900 mm and then the trench shall be filled to 600 mm with sand and pebbles and the low voltage cables shall be then installed. High voltage cables shall be spaced minimum 75 mm on centres.

b) When it is necessary to pull the cable into the trench, rollers or a greased wooden trough should be used to reduce friction. A series of sleeves may be necessary to guide the cable around corners. Care should be exercised to avoid contact with sharp stones and other heavy objects in the trench. A two-inch layer of sand or clean earth shall be placed at the bottom of trench to avoid sharp objects coming in contact with the cables.

c) After the cables are installed, cover the cables with 150 mm of rock-free earth or sand, place a layer of bricks or concrete tiles over that and backfill to grade. Concrete markers shall be placed at each bend and at a approximately 15 meters' intervals along straight runs to show the location of the cables. These markers shall extend above the grade by 25 mm.

d) Cables shall be laid with slight slack in the trench to allow for the settlement of earth.

e) After confirming with the Engineer-in-Charge, necessary loops shall be made at the locations indicated by him.

f) Concrete-lined cable trenches for cables inside buildings, if shown on the

drawings, shall be provided by others.

5. MOTORS

a) Normally, along with the driven equipment, motors may be installed by other contractors but whenever the electrical contractor installs a motor, he shall co-ordinate with the other contractor to align the motor properly with the driven equipment.

b) The electrical contractor shall be responsible for checking and correcting the direction of all electrical motors connected by him.

c) At least 300 mm. Length of flexible conduit shall be provided before connecting cables / wires in conduit to the terminal box for all motors which are belt driven. In case belt driven motors are connected directly with cable, then some slackness in the cable shall be provided.

d) Installation of motors shall conform to IS-900.

6. LIGHTING

a) The lighting system will operate from 415/240 V, 3 phase, 4 wire, 50 cycles A.C. supply. Lighting branch circuits will be supplied from miniature circuit breakers in the lighting panel as indicated in the applicable drawings. All branch circuits shall be operated on single phase 240 V supply.

b) Lighting panels and lighting fixtures shall be installed as shown in the applicable drawings.

c) All lighting circuits will run in rigid PVC heavy duty conduits unless otherwise indicated on the drawings.

d) Any lighting fixtures so located that the light from them would be obstructed by pipes or other objects shall be brought to the attention of the Engineer in-Charge or his authorised representative for necessary correction or change in location as may be desired.

e) The street light fixtures shall be installed on OCTAGONAL GI poles as per details in the drawings. The tubular poles and cable box shall have a primer coating and two final coats of Al. paint.

7. CONDUITS

a) All conduits shall be heavy duty, PVC as specified in the schedule of quantities.

Minimum size shall be 19 mm unless specifically stated otherwise. Conduits and fitting shall be cleaned to remove sludge, dirt or trash from the inside, prior to installation.

b) The conduits shall be securely fastened by means of straps and hangers designed for the purpose. Conduit runs on walls, columns or partitions shall be secured with hot dip galvanised C-Clamps or saddles and back spacers. These straps and hangers shall be fastened at each 400 mm length. Where supported on masonry walls, the conduit shall be spaced at a minimum of 6 mm from the wall using galvanised mild steel spacers. Conduit half straps (C-Clamps) attached to masonry or concrete walls, floors screw anchors or lead anchors. A maximum of four 90^0 bends only shall be used from pull point to pull point. The maximum distance between pull points shall be 90 metres but this shall be reduced by 15 metres for each 90^0 bend. Screws used for fixing C-Clamps on to spacers shall be of brass only. Special permission shall be taken from the Engineer-in-Charge for using hot dip galvanised screws.

c) All conduit bends shall be made with conduit benders or hackles designed for the purpose. Bends shall not be less than 6 times the nominal size of the conduit. They shall be free from creeps and flattening. In general, exposed conduit runs shall be in straight lines parallel to or 90^0 to the building or pipe racks in which they are running. Each conduit run shall be completed before the wire or cable is pulled in. Whenever conduit enters outlet boxes, panels, pull boxes, switches or conduit fittings, an offset shall be formed on the conduit as close to the fittings as possible.

d) In no case shall conduits be fastened to other pipes or installed in such a manner as to obstruct the ready removal of pipes for repair or replacement.

e) All conduit openings shall be capped with steel / PVC caps (conduit plugs) during or immediately after installation. Before wires are drawn into conduits, the conduits shall be thoroughly cleaned by use of a swab or blown out with compressed air.

f) All outdoor conduit fittings shall be provided with neoprene gaskets.

g) Conduit installation should conform to I.S. 732.

h) In concealed conduit system, grooving in the wall shall be neatly carried out by electrically driven cutter only and be of ample dimensions to permit the conduits to be fixed in the manner desired. Chases in the wall shall be done before the plaster work is done by civil section, and after laying of conduit in wall, the chased portion should be filled in by electrical contractor with

suitable material and to the satisfaction of the Engineer-in-Charge.

i) Fixing of conduit pipes in chase should be done by means of staples or saddles not more than 400 mm apart.

j) Suitable inspection boxes shall be provided to permit periodical inspection and to facilitate removal of wires when necessary.

k) Positions of lighting panels, switches, sockets etc. shown in drawings shall be adhered to. If desired by the Engineer-in-Charge, the positions of these shall be changed without any extra cost.

l) The heights for switches and receptacles are as indicated on the respective drawings / standard notes.

m) All conduit drops from ceiling to the wall must be nearly in the centre of the wall. Conduit drops going out of the wall will have to be made good by the contractor at his cost without damaging / weakening the building structure.

8. EARTHING

a) General

i. All electrical equipment shall be earthed as per details on applicable drawings.

ii. All metal vessels, process pipe lines, tanks, buildings and other metal structures that may receive lightning stroke or develop a static charge shall be earthed, as per details on applicable drawings.

iii. All equipment to be earthed shall be cleaned down to bare metal before attaching the ground wire.

iv. NEUTRAL CONDUCTORS SHALL NOT BE USED FOR EQUIPMENT EARTHING.

v. All earthing connections shall be carried out in an approved manner and with specified materials. Typical methods of earthing as per standard drawings, will be adopted for the earthing, as indicated in the applicable drawings.

vi. The entire plant shall be earthed by a series of ground loops. The loops will be effectively earthed by means of earthed electrodes.

vii. All earth connections shall be applied bitumen compound if welded with

the system earthing grid / equipment. However, welding should be avoided as far as possible.

viii. Sizes of the earth wires shall be as shown in the applicable standard drawings.

ix. Copper strip if used shall be tinned at the joints.

x. Armouring of cables shall be earthed at both ends through suitable cable glands.

xi. Earthing wires and cables shall be terminated on the earth bus with solder less cable sockets with silicon bronze / G.I. bolts.

xii. Each earthing wire shall be in one length from the equipment to the earth bus.

xiii. Pipe electrodes in earth pit as per standard drawing shall be provided unless otherwise indicated in the relevant drawings. The earthing electrode and pits shall be in accordance with IS: 3043.

xiv. The earth pit centre shall be at a minimum of 2 metres distance from the nearest building. Distance of not less than 3 meters shall be maintained between centres of two earth pits.

xv. The neutrals of transformers shall be connected to separate earth electrodes.

xvi. Specialised Earthing shall be provided to the sensitive equipment by means of dedicated Cu. earthing pits, Cu. earthing conductor and Cu. earth bus bar mounted on the insulators.

b) 240 V Equipment

i. All 240 V equipment shall be earthed with minimum one number of 12 SWG cu. wire unless stated otherwise on the relevant drawing.

ii. For lighting circuits in conduits, one number 12 SWG. copper wire shall run inside the conduit for earthing.

iii. Fluorescent fixtures and all other fixtures provided with earthing terminals shall be earthed by 12 SWG copper wire.

iv. Switch and single phase lighting receptacle housings shall be earthed with 12 SWG copper wire. The earthing wire shall be connected to the earthing screw on the switch or receptacles by a solder less cable socket duly crimped.

v. All street lighting poles shall be earthed as indicated in the drawings.

c) 415 V Equipment

All 415 V equipment shall be earthed by 2 independent paths to earth through earth wires. The earthing conductors shall be of the sizes as specified on the drawings and be of G.I., aluminium or bare copper where buried. Outside the building, a minimum of 300 mm of cover shall be provided.

i. All motor frames, hoist rails, pipe racks, etc. shall be effectively earthed, as shown on the applicable drawing.

ii. Earth strip extending above the floor shall be protected from mechanical injury by running it through GI pipe sleeve to at least 300 mm height.

iii. The entire conduit system, supports, cabinets, transformers, motor control centres and equipments shall be effectively earthed as shown on the drawings and in accordance with the latest Indian Codes.

iv. All three phase receptacles shall be earthed with 8 SWG G.I. wire or as specified in the drawing.

9. RECEPTACLES AND SWITCHES - COMMERCIAL TYPE Conforming to IS 3854, IS 1293, IS 3854, IS 2500

a) All single pole switches shall be commercial modular type and shall be connected to phase wire only.

b) The switches shall be mounted in such a way that circuit is ON when the knob is pressed in at the bottom.

c) All three phase receptacles shall be wired with the same sequence of rotation of phases.

d) The electrical contractor shall consult the architectural plans to check for door

swings. Where switches are located near doors, they shall be located “on the lock side” ensuring that the switch board is not covered or hidden by the door.

e) In general, all receptacles and switches shall be mounted at a height of 600 mm from the finished floor level unless otherwise shown in the drawings.

f) Where more than one switch of the same phase are shown at one place, then these should be all mounted in a common hot dip galvanised M.S. box. Switches of different phases shall be mounted in different boxes.

g) Switches proposed to operate on emergency power (i.e. DG set, etc.) should have an indicator for the separate identification.

10. PUSH BUTTON STATIONS

The contractor shall check the actual location of the push-button stations in the field so that the mounting channel does not interfere with the removal and maintenance of the motor or equipment.

11. EMBEDDED OR RECESSED EQUIPMENT

The electrical contractor shall take special care to co-ordinate this work with the civil contractor.

If recess or opening is not provided where it is required, the electrical contractor shall draw the attention of the Engineer-in-Charge at site to this fact. But, the electrical contractor may have to provide such recess or opening, if it is called for, without any additional cost.

12. BATTERY AND BATTERY CHARGER

a) Inspect battery and battery charger thoroughly for any damage to meters, push buttons or to the panel and report to Engineer-in-Charge.

b) Check whether all parts and accessories are supplied by the manufacturer, as per the packing list and purchase order and report to the Engineer-in-Charge. Check that the electrolyte (acid) is supplied in a separate container by the manufacturer.

Inspection & Field Tests of Electrical Installations

1. INSPECTION & FIELD TESTS OF ELECTRICAL INSTALLATIONS

The work to be performed under these guidelines cover the quality assurance plan for the inspection and testing of electrical installations.

2. GENERAL REQUIREMENTS

a) The electrical contractor shall furnish necessary meters, instruments, temporary wiring and labour to perform all required tests, adjustments and wiring of all equipment installed and/ or connected under the contract including electrical equipment supplied by others, if any, to determine proper polarity, phasing, freedom from grounds and shorts and the proper operation of the equipment, meters, relays, etc. All testing instruments shall be calibrated and certified for accuracy by competent authority.

b) Inspection and testing shall be carried out to ensure that all equipment and materials have been installed as required and as per the relevant International Standard Specifications and Codes, Local Rules and Regulations, requirements of Fire Insurance, Chief Electrical Inspector and any other authorities having jurisdiction. The installation must pass all inspection and will be subject to the approval of the Engineer-in-charge and the concerned local authorities.

c) Before the electrical facilities are placed in operation, the contractor shall make suitable tests to establish to the satisfaction of the Engineer-in-charge that all equipment, devices and wiring have been correctly installed, are in satisfactory condition and will operate as intended.

d) All tests shall be performed by or under the direct supervision of men qualified for carrying out inspection and testing.

e) Engineer-in-charge reserves the right to witness all tests, and he shall be informed in this regard two weeks before the tests are to take place. Engineer-in-charge reserves the right to approve the test results before circuits or equipment will be energised for the first time.

f) If motors record low insulation resistance, then they must be dried to obtain the required insulation resistance values. Approval of the drying methods shall be obtained from Engineer-in-charge before applying heat.

g) All results of the tests shall be recorded on prescribed test data sheets. All tests described herein shall be recorded on forms provided or agreed upon by Engineer-in-charge. Test reports shall include, for each test, the date of

performance and name of the person in charge of the test.

h) Before starting the tests, a visual inspection of the material / equipment is to be made to determine that all components are installed as per drawings and in a neat and workman-like manner and that, in general, the equipment is ready for testing.

i) In case of fault, the contractor shall isolate the fault and shall take necessary steps to eliminate the fault to the satisfaction of Engineer-in-charge. All defects through faulty workmanship of contractor or of equipment and material supplied by him shall be corrected or replaced at his own expense.

j) Before commencement of any test, all equipment shall be thoroughly cleaned by blower and checked for proper and rigid connection of termination, fixing of foundation bolts, etc.

k) Contractor shall submit all formats for tests to be conducted on each equipment/system in accordance with these specifications for approval to the Engineer-in-charge / Consultant before entering the test readings.

3. TEST PROCEDURES

3.1. MEDIUM VOLTAGE SWITCHGEAR

MAIN L.T. SWITCH BOARD / POWER CONTROL CENTRE / POWER AND MOTOR CONTROL CENTRE / DISTRIBUTION BOARDS

a) Before switchgear is energised, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth. Measurements shall be repeated with circuit breakers in operating position and contacts open. Each test shall be held until constant reading is obtained. Minimum time shall be ten seconds. Minimum megger reading shall be 10 Mega ohms.

b) Before switchgear is energised, the insulation resistance of all D.C. control circuits shall be measured from phase to earth. Minimum acceptable value shall be 1 Mega ohm.

c) Each adjustable protective relay shall be set, calibrated and tested by using a cycle counter, load box, ammeter and voltmeter as required or by using a suitable relay test set having good wave form. Settings, calibration points and test points shall be in accordance with values given for the approved relay settings for the job.

d) Test all current transformer secondary circuit by applying current (thro secondary injection test) to transformer secondary windings and verifying that relay(s) and/or meter(s) operate properly.

e) Test all the relevant circuit breakers for proper interlocking operation. The sequence of interlocking is as indicated on single line diagram.

f) Test the operation of tie breakers / bus couplers.

g) The following tests shall be performed on all circuit breakers before they are operated:-

   i. Contact alignment shall be checked and adjusted where necessary in accordance with manufacturer's instructions.

   ii. Each circuit breaker shall be drawn out of its cubicle and shall be closed manually, and then its insulation resistance shall be measured from phase to phase and from phase to earth.

   iii. All adjustable direct acting trip devices shall be set using values given in the approved relay settings for the job.

h) Before switchgear is energised, the following tests shall be performed on each circuit breaker in its 'test' position:-

   i. Close and trip circuit breaker from its control switch, push button or operating handle.

   ii. Test operation of circuit breaker latch and check switch, where provided.

   iii. Test proper operation of lockout device in the closing circuit, where provided, by simulating conditions, which would cause a lockout to occur.

   iv. Trip breaker by manual operation or by applying current or voltage to each of its associated protective relays.

   v. All automatic control operations and interlocks shall be tested for correct operation.

i) After completion of tests, all test results shall be recorded in standard format approved by Engineer-in-charge, witnessing site engineer and contractor's representative.

j) All test reports shall indicate the details of the instruments used for test with date and time of test.

k) After commissioning of the equipments, all measuring and indicating instruments to be checked properly for operation. Any improper operation of these indicating lamps / instruments shall be corrected by checking fuse / connections, polarity, etc. If still these are found to be not in working condition, the supplier should report the same to the Engineer-in-charge for suitable action for replacement.

3.2. MOTOR CONTROL CENTRE, DB

a) Before energising, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth with disconnecting devices. Repeat measurements with devices closed but with contactors open. Minimum acceptable value shall be 10 Mega ohms.

b) Contact alignment of each contactor shall be checked and adjusted where necessary in accordance with manufacturer's instructions.

c) Before energising, the insulation resistance on both the "line side" and "load side" of each contactor shall be measured separately from phase to phase and from phase to earth. Minimum acceptable value shall be 10 Mega ohm.

d) Set each adjustable relay and direct acting trip device in accordance with values given in the approved relay setting record.

e) Each contactor shall be closed and tripped from its control switch and/or push button station to test proper operation.

3.3. OTHER DISTRIBUTION BOARDS

a) Before energising, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth with circuit breakers/isolating switch open. Measurements shall be repeated with circuit breakers/isolating switch closed.

b) The distribution boards shall be checked for rigid mounting, earthing connections, proper rating and size of components, interlocking and overload settings.

3.4. MOTORS

3.4.1. General Inspection

a) Check for installation according to drawings.

b) Check equipment for clean and dry conditions, proper lubrication of bearings, earthing and terminations.

3.4.2. Testing

c) Before connecting power cables to motor, the insulation resistance of all motor windings shall be measured with 500 Volts megger for 415 Volts systems and with 5 KV megger for H.V system. Minimum megger reading shall be 10 Mega ohms. Measurements shall be repeated after power cable terminations are completed.

d) After checking the direction of rotation, all motors shall be run uncoupled for a minimum period of 4 hours before the driven equipment is placed in regular service.

e) Do not energise motors that are coupled to equipment without approval of Engineer-in-charge.

3.5. L.T. CABLE

a) A megger test shall be made for continuity and proper end-to-end connection and correct termination after installation, on all feeder cables including motor feeder cables.

b) Record test data between phase to phase and phase to earth.

c) The test voltage, duration of test and test procedure shall be in accordance with IS : 4288.

3.6. WIRING

a) Before energising, the insulation resistance of every circuit shall be measured from phase to phase, from phase to neutral and phase to earth.

b) The insulation resistance of the circuits noted below shall be measured as follows:-

i. Motor feeders: with motors disconnected, measure insulation resistance from load side of circuit breakers or contactors.

ii. Motor control circuits: With push buttons and over current devices connected, measure insulation resistance from phase to earth.

iii. Lighting feeders: Measure insulation resistance with circuit breakers or switch-

fuse units on panel boards connected but with lighting branch circuit breakers or switches open.

iv. Lighting branch circuits: Measure insulation resistance after all lamp holders, receptacles, fixtures, etc. Are connected but before fixing oflamps.

c) Where splices or terminations are required in circuits rated above 600 Volts, measure insulation resistance of each length of cable before splicing and/or terminating. Repeat measurements, after splices and/or terminations are complete.

d) Measure the insulation resistance of buried cable circuits before cable trenches are backfilled. Repeat measurements after backfilling.

e) Test light intensity of each room by light intensity meter at working height and record the same.

f) All receptacles shall be tested for correct phase sequence and by test lamp for operation of switch and continuity of earthing.

3.7. ALARMS

All electrical alarms shall be tested for proper operation by causing alarm to sound under simulated abnormal conditions.

3.8. EARTHING

Earthing shall be carried out as per IS Code of Practice: 3043 and as shown in the relevant drawings.

3.9. Specifications

a) Check that earthing system is installed as per drawings.

b) Check that all connections are tight and connections are protected from mechanical injury.

3.10. Testing

a) The resistance to ground shall be measured at the following locations:

i. The resistance of the system/neutral earthing should be maintained preferably at less than 1 Ohm.

ii. At each earthing point provided for lightning protection, the earth resistance shall preferably not exceed 1 Ohm.

iii. At any one point of each system used to provide earthing to electrical equipment enclosures, resistance shall not preferably exceed 1 Ohm.

b) Measurements shall be done before connection is made between the earth and the object to be earthed.

3.11. BATTERIES

All substation batteries shall be given a booster charge in accordance with manufacturers' instructions and adjusted for float operation before being placed in regular service.

3.12. BATTERY CHARGERS

Battery charger shall be tested for proper operation and to verify that chargers deliver their maximum rated output.

3.13. INSULATING LIQUID DIELECTRIC TEST

For test of the dielectric strength of insulating liquid or oil in transformer or reactor, test sample of liquid shall be drawn from equipment after filling. In some cases, a test also shall be made with samples drawn from the liquid container before the equipment is filled. Tests shall be carried as per IS : 335.

General Notes for Power & Earthing

1. GENERAL NOTES FOR POWER AND EARTHING

1.1. All dimensions are in millimetres, unless otherwise mentioned.

1.2. For cable sizes and details of circuit numbers, refer respective Electrical single line diagrams indicated in the layout drawing.

1.3. All L.T. Power and control cables shall be 1.1 KV grade, aluminium / copper stranded conductor, PVC/XLPE insulated,. Extruded PVC inner sheathed and extruded FRLS PVC outer sheathed, flat / round wire armoured.

1.4. Wherever cables cross roads or drains, cables shall be laid in stranded RCC pipes (provided by civil contractor) . The RCC pipes shall be sealed by electrical contractor with jute, felt, etc. in an approved manner after laying of cables.

1.5. Cable trench shall be sealed with water-proofing compound at the entry to the building after laying of all cables by electrical contractor.

1.6. Cables shall be laid in G.I. pipe sleeves wherever they cross walls, beams, etc.

1.7. Cables running along wall, beam, column, etc. shall be installed with G.I. spacers and saddles at an interval of 400 mm. Cables on trays shall be clamped with common saddle.

1.8. Wherever cables are to be embedded directly in the floor, they shall be embedded with their top at least 40 mm below finished floor level.

1.9. Minimum bending radius for cables shall be as under:

1.1 KV grade single core cable	15 times D
1.1 KV PVC/XLPE arm. Multi core cable	12 times D
11/22 KV XLPE cable	20 times D

1.10. Cables buried in the ground shall have slight slack to allow for settling of the earth.

1.11. For cables buried in ground, cable route markers shall be provided on the surface of the ground along the cable route at every 15 Mtrs. Interval, at every bend and where change of level takes place.

1.12. All cables shall be provided with suitable aluminium tag, indicating circuit description

and size of cable at both the ends and also at every bend.

1.13. Pipe sleeves provided in fire walls, including spare sleeves, shall be sealed by electrical contractor with bitumen-based cold-setting compound.

1.14. The main earthing strip outside the building shall be laid at a minimum depth of 350 mm below finished grade level.

1.15. No earthing strips for system/equipment earthing shall be connected to the earthing strip provided for lightning protection system.

1.16. Test point shall be provided in lightning down conductor on insulator mounted on column/wall at 1500 mm above finished grade level.

1.17. All earthing joints and connections shall be carried out as per enclosed standards with duplicate conductors for systems of 415 V, 3 phase & above and single conductor for 240V, 1 phase system.

1.18. Isolators, plug receptacles, starters, push button stations, distribution boards, etc. shall be installed with their bottom side at 1200 mm above finished floor level.

1.19. Location of isolators, starters, push button stations, etc. Shall be finally checked in the field by electrical contractor to ensure ease of removal and maintenance of motors and other equipment.

1.20. Push button stations located in out-door areas shall be provided with M.S. canopy duly painted with primer and finishing coats.

1.21. Main earth grid, all switchgear panels, isolators, push button stations, motors, equipment, vessels, etc. shall be earthed with wire/strip as per following list for G.I. conductor and for copper conductor, as applicable connected to the nearest earth bus.

➢ Main Earth Grid Conductor	50 x 10 mm G.I. Strip
➢ For PCC, Main LT Panel	50 X 10 mm G.I. Strip
➢ For MCC, PDB, LDB	50 x 6 mm G.I. Strip
➢ For Lightning Protection	25 x 6 mm G.I. Strip
➢ For Lighting Panels, Power DBs	25 x 3 mm G.I. Strip / 4 Sq.mm Cu. FRLS Wire
➢ For Push Button Stations	2.5 sq.mm Cu. FRLS wires

➢	For 1-Phase Power Sockets	2.5 sq.mm Cu. FRLS wires
➢	Pump Motors up to 15 HP	2.5 sq.mm Cu. FRLS wires
➢	Pump Motors from 20 HP to 30 HP	25 x 6 mm G.I. Strip
➢	Pump Motors from 35 HP to 75 HP	25 x 6 mm G.I. Strip
➢	Pump Motors above 75 HP	50 x 6 mm G.I. Strip

All the equipments (i.e. three phase equipments) shall have two earthing connections. Al. earth busbar shall be used for connecting copper earthing wires using tinned copper lugs of suitable sizes. Busbar shall be installed on wall structures near the equipments / motors / LCS.

General notes for Lighting

1. GENERAL NOTES FOR LIGHTING

1.1. All dimensions are in millimetres, unless noted otherwise.

1.2. Wiring for non-flame proof type lighting fixtures and 6/16 A, 1 phase, receptacles shall be carried out with 250 V grade, stranded, 2.5 / 4 sq.mm copper FRLS PVC insulated flexible wires in heavy gauge PVC conduit. For flameproof type light fixtures and power sockets and for non - flameproof type fixtures wherever asked for, 3C X 2.5/4 sq.mm armoured copper FRLS PVC cable of 1.1 KV grade shall be used.

1.3. Lighting fixtures, switch boxes and receptacles shall be earthed by 12 SWG G.I / 14 SWG Cu. wires running all along the conduit / cable, connected to the nearest earth bus.

1.4. Switches and receptacles of same phase located closed to each other shall be housed in a common 14 SWG MS enclosure.

1.5. A maximum of following nos. and size of the wires can be taken through conduits of the sizes indicated. (Conduit of less than 19 mm dia shall not be used).

CONDUIT SIZE IN MM	MAXIMUM NOS. OF WIRES IN A CONDUIT				
	1 SQ.MM	1.5 SQ.MM	2.5 SQ.MM	4 SQ.MM	6 SQ.MM
19	7	6	5	3	2
25	13	10	10	6	5
32	20	14	14	10	7
40	---	---	---	14	9

1.6. Conduits and cables shall be supported at every 400 mm interval respectively with GI. Spacers and clamps.

1.7. Threaded conduit terminating on flameproof equipment shall be made of minimum 25 mm length of engaged threads.

1.8. Conduits shall be sealed properly at entry to flame proof switchgear and also wherever passing from non hazardous area to hazardous area.

1.9. Switches, switch boxes, receptacles, etc. shall be mounted in such a manner that their bottom side shall remain at a height of 1200 mm from the finished floor level. Lighting Panels shall be mounted at 1500mm height from FFL. - Subject to Approval of Architect.

1.10. Looping of wires / cables should be made from fixture to fixture.

1.11. Casings / battens shall be fixed by means of screws and PVC wall plugs at intervals of 400 mm.

1.12. Conduits and conduit fittings shall be of heavy duty PVC type.

1.13. Conduits / cable runs shown on drawings are for guidance. Exact locations shall be determined at site by the Electrical contractor.

1.14. Lighting fixtures, switches, receptacles, junction boxes, etc. located in hazardous areas shall be of flameproof construction as per IS : 2148.

1.15. Conduits / cables for lighting fixtures located outside the building shall come out from inside near the location of the lighting fixtures.

1.16. Wiring shall be colour coded and wires of the same phase only shall run in the same conduit.

1.17. Three phase lighting distribution board/ lighting panels shall be earthed with two independent earth strips / wires connected to the nearest earth bus, as per std. drawing. Single phase lighting distribution board / lighting panel shall be earthed with one earth wire.

1.18. All emergency lighting units shall be mounted at 2500 mm height from F.F.L. However, receptacles for the same shall be mounted as per note. 13.9.

1.19. All runners, G.I. Pipe sleeves, tray buckets, cleats, supports, etc. required to mount the lighting fixtures / lighting distribution boards / receptacles / switch boxes / lighting panels and laying of cables / conduits shall be provided by the Electrical contractor.

1.20. All telephone and computer points shall be at 750 mm height from F.F.L

FIRE ALARM SYSTEM

FIRE ALARM SYSTEM

1.0 General:

This specification covers the design, supply, installation, testing & commissioning of Intelligent Fire Alarm System for the whole premise.

2.0 Scope of Supply :

The contractor shall supply & install microprocessor based, addressable and intelligent (analog), fire detection and alarm system complete with addressable, intelligent (analog) heat and smoke sensors, Addressable Manual call point and sounders. The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel. FACP shall have its own microprocessor, software and memory complying with BS5839 Part 4 (1995) and should bear CE mark.

3.0 Intelligent Fire Alarm System :

Features:

- analog addressable
- each loop consist of 125 detector & 125 devices
- Automatic electronic device addressing
- 16 bit processor
- Up to 1,000 history events
- RS-485 local rail communications
- Multiplexed audio channels
- Network communication RS-485
- RS-232 communication card
- Form ‘C’ contacts for: Alarm, Supervisory and Trouble
- Simultaneous display of eight events
- 24 lines by 40 character graphic LCD display - 960 Characters Total
- "Device location supervision
  - Unexpected additional device addresses
  - Missing device addresses
  - Switched device locations

– Programmed device parameters"

- Automatic day/night sensitivity
- Setting smoke sensor sensitivity remotely

The addressable and intelligent system shall be such that smoke sensors, thermal sensors, manual call points, etc. can be identified with point address. IFAS shall operate on 230 V AC supply & Smoke detectors shall be powered using the IFAS based smoke detection circuits. Devices shall receive power and communication from the same pair of conductors. IFAS shall provide for resetting smoke detectors, fault isolation and sensor loop operation. It shall be possible to mix different fire devices within the same loop to optimize field wiring.

The panel should check each detector once every 24 hrs. for contamination for this purpose. Based on the site condition the user should have the discretion to either clean the detector immediately or manually change the alarm threshold level on the panel (by programming) after ascertaining that it is a pre-maintenance alarm and not a developing alarm condition at the site. The Panel should provide alarm indication of INDIVIDUAL sensors. Systems that provide alarm indication on a zone basis alone shall not be acceptable. Panels should provide for detector premaintenance alarm indication for dust accumulation.

The memory data for panel configuration and operation shall reside in non-volatile memory (EEPROM). Removal of the board shall not cause loss of memory. IFAS shall provide general purpose inputs for monitoring such functions low battery or AC power failure. IFAS shall provide password protection and programmable outputs, which can operate relays or logic level devices. Each IFAS shall have a battery back up.

Monitor Modules shall be provided to monitor and address Manual Pull Stations and other contact type input devices.

The panel should have a 80 character backlit LCD display which shall display date, time & description for Analog Sensors to indicate alarms and trouble situations. This display is to be utilized by the panel to display various information as per design.

LCD display at the IFAS shall be provided to indicate point in alarm or trouble. It shall be possible to command test, reset and alarm silence from the FACP. IFAS switches shall allow authorized personnel to accomplish the following independent of the control

console :

Fault isolation of fire zones shall be provided to enable part of a fault-tolerant loop to continue operating when a short occurs on the loop. Fault-isolation module shall have a LED that latches to indicate a short on the loop.

4.0 SMOKE DETECTORS :

Features:

- Integral microprocessor
- Non-volatile memory
- Automatic mapping device
- Electronic addressing
- Environmental compensation
- Intelligent detector
- Wide 0.67% to 3.77%/ft. sensitivity range
- Twenty pre-alarm sensitivity values, set in 5% increments
- Identification of dirty or defective detectors
- Automatic day/night sensitivity adjustment
- Twin RED/GREEN status LEDs
- Standard, relay, fault isolator, and audible mounting bases
- Designed and manufactured to ISO 9001 standards

Technical Specification:

- Sensing Element: Photoelectric - Light Scattering Principle
- "Storage & Operating Environment:

  Air Velocity Range: 0 to 5,000 ft/min (0 to 25.39 m/s);

  Humidity: 0 to 93% RH, Non-Condensing

  Operating Temp: 32ºF to 120ºF (0ºC to 49ºC);

  Storage Temp: -4ºF to 140ºF (-20ºCto 60ºC) "
- Sensitivity Range: ULI/ULC - 0.67% to 3.77% obscuration/foot
- "User Selected Alarm Sensitivity Settings: Most Sensitive: 1.0%/ft.;

  More Sensitive: 2.0%/ft.;

  Normal: 2.5%/ft.;

Less Sensitive: 3.0%/ft.;

Least Sensitive: 3.5%/ft."

- Pre-alarm Sensitivity: 5% increments, allowing up to 20 pre-alarm settings
- Operating Voltage: 15.2 to 19.95 Vdc (19 Vdc nominal)
- "Operating Current: Quiescent: 45µA @ 19 V; Alarm: 45µA @ 19 V

Emergency Stand-alone Alarm Mode: 18mA

Pulse Current: 100 µA (100 msec);

During Communication: 9 mA max."

- Construction & Finish: High Impact Engineering Polymer - White
- "LED Operation: On-board Green LED - Flashes when polled;

On-board Red LED - Flashes when in alarm

Both LEDs - Glow steady when in alarm (stand-alone)

Compatible Remote Red LED (model SIGA-LED)

Flashes when in alarm"

- Address Requirements: Uses one Device Address
- Agency Listings: UL, ULC, MEA, CSFM
- UL Listed Spacing: 30 ft

5.0 HEAT DETECTOR:

Features:

- 70 foot (21.3 meter) spacing
- 15oF (9oC)/min rate-of-rise/135oF (57oC) ft. and135oF (57oC) fixed temperature type
- Intelligent detector c/w integral microprocessor
- Non-volatile memory
- Automatic device mapping
- Electronic addressing
- Identification of defective detectors
- Twin RED/GREEN status LEDs
- Standard, relay, fault isolator, and audible mounting bases
- Designed and manufactured to ISO 9001 standards

Technical Specification:

- Heat Sensing Element
- Alarm Point
- UL Listed Detector Spacing: 70 feet (21.3 meters) center to center spacing
- "Operating and Storage Environment: Operating Temp: 32ºF to 100ºF (0ºC to 38ºC)

  Storage Temp: -4ºF to 140ºF (-20ºC to 60ºC)

  Humidity: 0 to 93% RH, Non-Condensing"
- Operating Voltage: 15.2 to 19.95 Vdc (19 Vdc nominal)
- "Operating Current: Quiescent: 45µA @ 19 V

  Alarm: 45µA @ 19V

  Emergency Stand-alone Alarm Mode: 18mA

  Pulse Current: 100 µA (100 msec)"
- Construction & Finish: High Impact Engineering Polymer - White
- "LED Operation: On-board Green LED - Flashes when polled

  On-board Red LED - Flashes when in alarm;

  Both LEDs - Glow steady when in alarm (stand-alone)

  Compatible Remote Red LED

  Flashes when in alarm"
- Address Requirements: Uses one device address
- Agency Listings: UL, ULC, MEA, CSFM

6.0 MULTI DETECTOR:

Features:

- Integrates photoelectric smoke and 135o F (57o C) fixed-temperature heat sensing technologies
- Non-volatile memory
- Automatic device mapping
- Electronic addressing
- Environmental compensation
- Integral microprocessor - intelligent detector
- Wide 0.67% to 3.77%/ft. sensitivity range

- Twenty pre-alarm sensitivity values, set in 5% increments[1]
- Identification of dirty or defective detectors
- Automatic day/night sensitivity adjustment
- Twin RED/GREEN status LEDs
- Standard, relay, fault isolator, and audible mounting bases
- Designed and manufactured to ISO 9001 standards

Technical Specification:

- Smoke Sensing Element: Photoelectric - Light Scattering Principle
- Heat Sensing Element: Fixed Temperature Alarms at 135ºF (57ºC) Ambient
- "Operating and Storage Environment: Operating Temp: 32ºF to 100ºF (0ºC to 38ºC)

  Storage Temp: -4ºF to 140ºF (-20ºC to 60ºC)

  Humidity: 0 to 93% RH, Non-Condensing"
- Sensitivity Range: ULI/ULC - 0.67% to 3.77%
- "User Selected Alarm Sensitivity Settings: Most Sensitive: 1.0%/ft.

  More Sensitive: 2.0%/ft.Normal: 2.5%/ft.

  Less Sensitive: 3.0%/ft.

  Least Sensitive: 3.5%/ft."
- • Pre-alarm Sensitivity: 5% increments, allowing up to 20 pre-alarm settings
- Operating Voltage: 15.2 to 19.95 Vdc (19 Vdc nominal
- "Operating Current: Quiescent: 45µA @ 19 V

  Alarm: 45µA @ 19 V

  Emergency Stand-alone Alarm Mode: 18mA

  Pulse Current: 100 µA (100 msec)

  During Communication: 9 mA maximum"
- Construction & Finish: High Impact Engineering Polymer - White
- "LED Operation: On-board Green LED - Flashes when polled

  On-board Red LED - Flashes when in alarm

  Both LEDs - Glow steady when in alarm (stand-alone)

  Compatible Remote Red LED

  Flashes when in alarm"
- Address Requirements: Uses one Device Address

- Agency Listings: UL, ULC, CSFM, MEA
- UL Listed Spacing: 30 ft

7.0 FAULT ISOLATOR DEVICE :

Features:

- Automatic device mapping
- Electronic addressing
- Ground fault detection by address
- Self-restoring
- 2-gang mounting
- Designed to ISO 9001 standards

Technical Specification:

- Description: Isolator Module - factory set hardware type code
- Address Requirements: Uses One Detector Address
- Circuit Resistance: Six ohms maximum between isolators
- Operating Current: Standby = 45µA; Activated = 45µA
- Operating Voltage: 15.2 to 19.95 Vdc (19 Vdc nominal)
- Construction & Finish: High Impact Engineering Polymer 2-gang front plate - White Finish
- Storage Environment: Temperature: -4°F to 140°F (-20°C to 60°C)
- Operating Environment: Temperature: 32°F to 120°F (0°C to 49°C); Humidity: 0 to 93% RH
- LED Operation: On-board Green LED - Flashes when polled (normal)
- Compatibility: Use with: Signature Loop Controller
- Agency Listings: UL, ULC, CSFM, MEA

The fault isolator device shall detect and isolate a short-circuited segment of a fault tolerant loop.

The devices shall automatically determine a return to normal condition of the loop and restore the isolated segment.

Devices shall be placed every 20 detectors / modules / field devices to limit the number lost on the event of short-circuit.

8.0 MANUAL CALL POINT :

Features:

- Break glass operation
- Intelligent device c/w integral microprocessor
- Non-volatile memory
- Automatic device mapping
- Electronic addressing
- Stand-alone operation
- Diagnostic LEDs
- Designed for high ambient temperature operation
- Designed to ISO 9001 standards

Technical Specification:

- Addressing Requirements :Uses 1 Module Address
- "Operating Current :Standby = 250µA
  Activated = 400µA"
- Construction & Finish Diecast Zinc - Red Epoxy w/Aluminum markings
- Operating Voltage 15.2 to 19.95 Vdc (19 Vdc nominal)
- "Storage and Operating Environment Operating Temperature: 32ºF to 120ºF (0ºC to 49ºC)
  Storage Temperature: -4ºF to 140ºF (-20ºC to 60ºC)
  Humidity: 0 to 93% RH"
- "LED Operation On-board Green LED - Flashes when polled
  On-board Red LED - Flashes when in alarm
  Both LEDs - Glow steady when in alarm "
- Agency Listings UL, ULC (note 1), MEA, CSFM

Under normal conditions push button shall be in the depressed condition. In the case of fire when the glass cover is broken the push button shall be released by the spring action and shall actuate an alarm at the control panel through its switching contacts. In additions to this, there shall be a LED indicator on the monitor module for visual indication to locate the call point easily.

The manual stations shall be the non-coded resettable key insert type general alarm

devices, painted red and suitable for surface for surface or flush mounting. Manual stations shall be interfacible to a monitor module that is addressable. The manual station shall have normally open fire alarm and annunciator contacts and these contacts shall close on activation. Contacts shall remain closed until station is manually reset.

9.0 SOUNDER

Features:

- 15, 30, 75, or 110 cd strobe output
- high (default) or low dB horn output
- temporal (default) or steady horn output
- public mode flash rate (default) or private mode temporal flash
- Single microprocessor controls both horn and strobe
- Meets tough synchronizing standards for strobes

10.0 Technical Specification:

- "Housing: Red or white textured UV stabilized, color impregnated engineered plastic.
- Exceeds 94V-0 UL flammability rating."
- Lens : Optical grade polycarbonate (clear)
- "Operating environment : Indoor only: 32-120°F (0-49°C) ambient temperature. 93%
- relative humidity "
- "Agency listings/approvals : UL 1971, UL 1638, UL 464, ULC S525, ULC S526, CSFM,"
- Operating voltage : 16 - 33 Vdc or unfiltered 16-33 Vdc FWR
- Strobe output rating : selectable 15 cd, 30 cd, 75 cd, or 110

CCTV SYSTEM

CLOSED CIRCUIT TELEVISION SYSTEM

1.0 General:

This specification covers the design, supply installation, testing & commissioning of the CCTV system for the whole premise.

2.0 Scope of Supply :

The contractor shall supply and install CCTV system with all necessary accessories. The CCTV System shall comprise of Dome Cameras, Varifocal/fixed lens Dome Cameras, Digital Multiplex Video Recorder, Monitor, Switcher etc and other associated accessories.

3.0 Outdoor Weather Proof Camera

The Outdoor Weather Proof Camera shall have built in 2.3 to 12mm varifocal/ fixed lens. The complete unit shall be housed in a Weather proof enclosure with integrated dome and base unit, both preferably made from injection moulded plastic. It shall be possible to adjust the camera head inside the dome in both the planes so that it can be wall or ceiling mounted. The camera shall operate on Dual Switching Power 24 V AC or 12 volts D.C.

Features:

- 540TVL, 50dB S/N Ratio, Crisp Images
- White Balance
- 2.3x Optical Zoom (2.3 to 12mm Lens)
- Multi function switches
- Wide Power Supply +9 - +18VDC
- AGC , ATW , AES , ATW
- CE Certified

Technical Specification:

- Signal System: PAL
- Picture Elements: 470,000 pixels
- Imager: 1/3” Sony CCD Sensor
- Scanning System: 2:1 interlace
- Horizontal Resolution: 540 TV lines

- Minimum Illumination: 0.28 lux
- Video Signal to Noise Ratio: 50dB (AGC off)
- Video Output: 1V Composite Video, 75 ohms
- AGC: Switchable; On; Auto (28dB), Off
- AES: Switchable; On; 1/50 - 1/100,000, Off
- ATW: Switchable; On 2300K to 11,000K, Off
- Lens: 2.5 mm to 12 mm as per site requirement.
- Iris Control: Auto or internal
- Operating Voltage: 9VDC to 18VDC, 12 VDC recommended
- Power Consumption: 2W
- Operating Temperature: +10 to 50 deg C.

4.0 Fixed Dome Camara

The Fixed Dome Camara shall have builtin 3.6mm focal lens. The complete unit shall be housed in a integrated dome and base unit, both preferably made from injection moulded plastic. It shall be possible to adjust the camera head inside the dome in both the planes so that it can be wall or ceiling mounted. The camera shall operate on Dual Switching Power 24 V AC or 12 volts D.C.

Features:

- 540TVL, 50DB S/N RATIO, CRISP IMAGES
- WHITE BALANCE
- MULTI FUNCTION SWITCHES
- WIDE POWER SUPPLY +9 - +18VDC
- AGC,BLC ,AES
- CE Certified

Technical Specification:

- SIGNAL SYSTEM: PAL
- PICTURE ELEMENTS: / 470000 PIXELS
- IMAGER: 1/3" CCD SENSOR
- SCANNING SYSTEM: 2:1 INTERLACE
- HORIZONTAL RESOLUTION: 540 TV LINES
- MINIMUM ILLUMINATION: 0.28 LUX

- VIDEO SIGNAL TO NOISE RATIO: 50DB (AGC OFF)
- VIDEO OUTPUT: 1V COMPOSITE VIDEO, 75OHMS
- AGC: SWITCHABLE; ON; AUTO (28DB), OFF
- AES: SWITCHABLE; ON; 1/50 - 1/100,000, OFF
- ATW: SWITCHABLE; ON 2300K TO 11,000K, OFF
- LENS: 3.6MM GLASS
- IRIS CONTROL: INTERNAL
- OPERATING VOLTAGE: 9VDC TO 18VDC, 12 VDC RECOMMENDED
- POWER CONSUMPTION: 2.2W
- OPERATING TEMPERATURE: +10 TO 50 DEG C.
- WEIGHT: 200 TO 450G
- DOME MATERIAL: 2" / 3" PLASTIC

5.0 Outdoor Speed Dome Camera

The Fixed Dome Camera shall have built in 26X: f4-104mm focal lens. The complete unit shall be housed in weatherproof housing with rotating mechanism & integrated dome and base unit, both preferably made from injection moulded plastic. It shall be possible to adjust the camera head inside the dome in both the planes so that it can be wall or ceiling mounted. The camera shall operate on Dual Switching Power 24 V AC or 12 volts D.C.

Features:

- 480TVL, 50dB S/N Ratio, Crisp Images
- Auto White Balance
- 26x Optical Zoom
- Multi Protocols
- Wide Power Supply
- 128 presets

Technical Specification:

- Signal system: PAL standard
- Picture device: 1/4-inch color IT CCD with internal lens
- Number of pixels: PAL:752(H)×582(V)
- Scanning system: 2:1 interlaced, 625 lines

- Horizontal resolution: 480TVL
- Mini illuminance: 0.28Lux
- Video S/N: 50dB (AGC: OFF)
- Video output: composite video signal: 1.0±0.2V(p-p), 75 ohms
- Zoom ratio: optical zoom: 26x
- Focal length: 26x: f4~104mm
- White balance: Auto
- AGC: Auto
- Lock Method: Line lock/internal lock, up to camera unit
- BLC: Off /Auto up to camera unit
- Preposition point: 128
- Pan/tilt speed: pan:0.5°~110°/s; tilt:0.5°~300°/s
- Preset speed: approx 300°/s
- Tour: 4 tracks
- Private shelter: N/A
- Motion detect ing: N/A
- Power requirement: AC24V 50/60Hz
- Power consumption: approx 42W(heater 30W)
- "Operating temperature range: -30 degree C to +50 degree C
  -20 degree C to +40 degree C(recommended)"

6.0 DIGITAL VIDEO RECORDER

16 channel standalone DVR with real time display & real time recording, 1 TB HDD, 400 fps, CE certified

Features:

- Embedded OS
- H.264 Compression
- Video - Audio Sync Store
- Motion Detection
- Networkable
- CIF / Half D1 Recording

Technical Specification:

- Video input quantity: 16
- Video input: 1Vp-p 75 Ohms, PAL or NTSC Standard, BNC
- Audio input: 1V, 0dBV, Single channel, No balance, match video, RCA
- Video Compressing Arithmetic: H.264 compress arithmetic upgraded by TEO MDCV core
- Audio Compressing Arithmetic: G.722
- Code Stream: 32,000bps to 1,152,000bps
- Horizontal resolution: Realtime display:704X576; Recording:352X288; 704X288
- Video Output: Video1 Output,1Vp-p, 75Ohms, BNC; VGA: 1 channel, 1024X768
- Audio Output: 1 channel, aV, dBV, No balance, RCA
- Minimum Alarm Input Quantity: 9
- Minimum Alarm Output Quantity: 4
- Encryption Technique: data encryption, multi-user management
- Control interface: RS-485
- Net Interface: 10/100M Ethernet support multi-broadcasts, UPD,WAN,LAN
- Hard Disk Interface: 4-channel;4SATAs,8/16-channel:4IDEs
- Backup Interface: Internal IDE, SATA port support hot plugging
- Update Interface: 10/100M Ethernet
- Power Supply: ~220VAC +/-15% 60Hz
- Power Consumption (Not included HD): Approx 30 W
- Operating Temperature Range: -10 degree C to +50 degree C
- Dimension(WXHXD)mm: (440.0X96.0X436.0)

7.0 COLOUR MONITOR

The monitor shall be suitable with the standards of the selected cameras. It shall be solid state and modular in design. It shall provide a bright, clear and well-defined picture display on the screen.

All controls for brightness, contrast etc. Shall be provided on the front panel for readily adjusting the levels of the video signal. The rear panel shall be provided with input and output BNC connectors for coupling the video output to other Monitors. The video monitors installed shall be atleast 14” size or more and shall comply with

the specification

TECHNICAL SPECIFICATIONS FOR 19” COLOUR MONITOR

Video	:	PAL/ NTSC color composite 1.0 v p-p
CRT	:	19” diagonal, 0.7 mm Stripe pitch
Resolution	:	More than 600 TVL
Power Input	:	96 - 256 VAC, 50/60 Hz
Consumption	:	75 Watts
Operating temperature	:	-10 to 50 degree C
Storage temperature	:	-20 to 70 degree C (30-90% RH)
Horizontal /vertical frequency	:	plus or minus 500 Hz (or) plus or minus 4 Hz
Certifications	:	UL, CE, CSA, FDA, FCC, CUL, TUV

TROLLEY MOUNTED TELESCOPIC TILTING TYPE LIGHT TOWER

FLOOD LIGHTS AND BUILTIN DIESEL GENSET.

16 MTRS. HIGH TROLLEY MOUNTED MOBILE TELESCOPIC & TILTING TYPE LIGHTING TOWER.complete with inbuilt DED Gen Set, long range Energy efficifient flood lights, mast lighting control panel, easily portable with light motor vehicle.
Make : SIGMA / B.P. PROJECTS / BAJAJ OR EQUIVALENT

Scope of Supply:

Lighting Tower: The lighting tower shall be fully galvanized telescopic unit having minimum 2 sections with suitable brackets for mounting 8 nos. of floodlights. The mast shall be adjusted for telescopic and tilting action with the help of motorized winches operated on 230 volts AC supply with necessary safety arrangements. Provision for hand operation of winches shall also be provided. Wire ropes of sufficient length and size shall be provided for Telescopic and Tilting actions. The tower assembly shall be mounted on a ruggedly built Trolley.
Specifications of lighting tower and winch motor:

a) Height Raised on telescopic mode: 16000 mm(minimum)
b) Overall length (In closed and tilting position):7000mm (max.)
c) Outrigger width: max.2150mm (when closed)
d) Outrigger width: max.5250mm (when open)
e) Wind withstanding capacity: 40 mtrs/sec (minimum)
f) IS standard: IS: 800-1984, IS: 875-1987 &IS: 6533 for structural design.
g) Winch motor:1 -ph,SCIM,230 V,50 Hz,IP55 .Make:NGEF,Bharat Bijlee,Crompton and Greaves or similar.

Trolley:
The Trolley should rest on 2nos. of pneumatic tyres of reputed make, front wheel with spring leaves and shock absorbers. The Trolley with complete Tower assembly can be easily towed by hitching with any light motor vehicle. The trolley should be covered with C.R. sheet housing duly painted to protect the DG set, panel and winches which are mounted on there.

Luminaries:
8 nos. of 2X400 W Metal Halide high intensity search cum floodlights of reputed make with

stainless steel reflectors for long-range illumination to be mounted on the tower. Luminaries are to be vibration, shock and pilfer proof to enable safe operation of the system and should have proper gasket to protect ingress of insects.

Make : Philips/CG/Sigma /Bajaj or similar.

Specifications of Luminaire:
IS standard: IS 10322(part5/sec3)-1987 Protection: IP65
Luminaries are to be supplied with lamp and necessary control gears like choke, ignitor, capacitor,fuse etc. All inclusive.

DG Set and Lighting Panel:
1Phase 7.5kva Diesel Generating Set with mast Lighting panel to control the 8 nos. of search cum flood lights and should be capable of hoisting and tilting of the Tower. Generating set is to be securely fitted on the Trolley.

Specification of alternator:
7.5 KVA ,230 V AC, 50 Hz,Brushless alternator,Duty:S1,Class of insulation:H,Make:Crompton/AVKSEG/Kirlosker/NGEF

Mast Lighting Control Panel:
Mast lighting control panel should be incorporated with incoming and outgoing control circuits protected by suitable MCB & ELCB for 2X400W Metal Halide luminaries. A voltmeter and ammeter of digital type (Make:Conzerv/AE) ,size 96mmx96mm,accuracy class 0.5 also to be incorporated to monitor the system voltage and total loads. All the ballasts, ignitors etc. to be wired with copper cables of 2.5 sq mm up to the lights. Panel should be properly and securely fitted on the Trolley.

Specification of control panel:
Incomer:1 No,DP,32 A MCB with ELCB of sensitivity 500 mA
Outgoing : 3 Nos, SP 10 A MCB with RCBO of sensitivity of 300 mA Make: MDS Legrand/Merlin Gerin
Earthing Specification:
1 No,50 mm,3 mtrs GI pipe with 3/8 SWG GI wire.

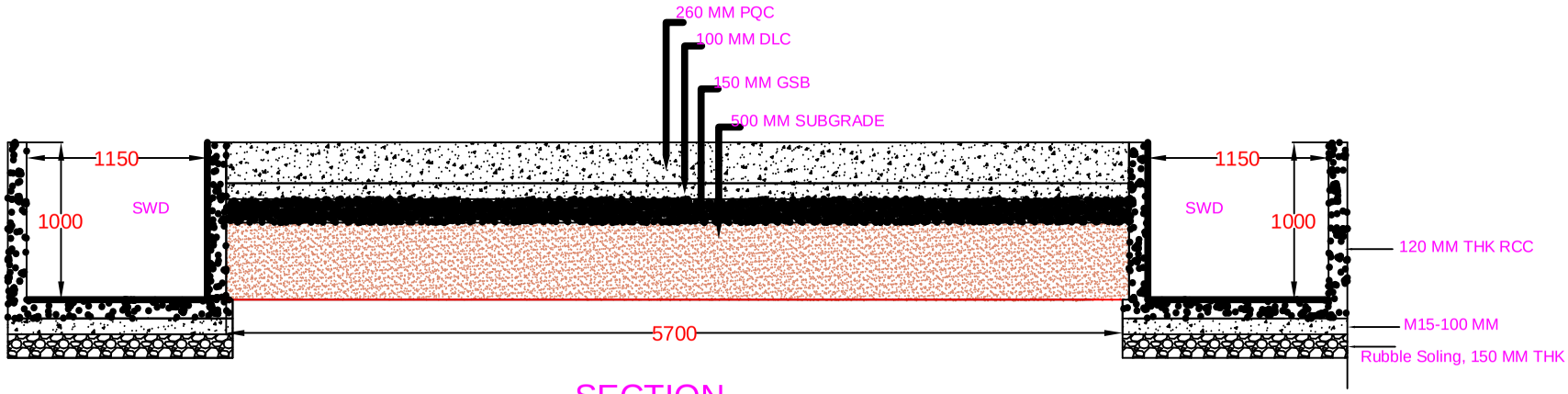
LIST OF APPROVED VENDORS

Sr. No.	Item	Make
1	HT Panel (VCB)	ABB / Schneider / Crompton / Siemens
2	Transformer	Voltamp / Crompton / Areva / T&R / Kirloskar Electric
3	DG Set	Supearnova / sudhir / Cumins / greaves
4	LT Panel - MV Switchgear Panels / Distribution Boards	ELECMECH / Swati Switchgears / Active Engineers / Industrial Controls / SUN Automat Controls Pvt. Ltd.
5	LV Cables	CCI / Gloster / Torrent / Polycab / Finolex / Havells / KEI
6	Lighting	Philips / Wipro / Crompton / Bajaj / GE / Schreder / Pierlite
7	Flexible Cable and FRLS Copper wires	Polycab / Finolex / Havells / RR Kabel / L&T / KEI /Anchor
8	Modular type Switch, Socket and Plug /Modular Accessories	MK / Crabtree / LEGRAND / Clipsal / Northwest / ABB / Salzer
9	MCB / ELCB / ELMCB & MCB DB	Hager/LEGRAND / Schneider / Siemens / Havells / Control & Switchgear /Indo Asian / ABB
8	Weatherproof type Cable Glands	Comet / Electromac / HMI / LAPP
9	Outdoor Flameproof / Weatherproof Junction Box	Dynamic control / EX-Protecta/ Hensel
11	Cable Lugs	Dowells / 3-D
12	PVC/HDPE Conduits and accessories Cable Lugs	Precision Plastic / Nihir Polymers / Clipsal Dowells / 3-D
13	PVC/HDPE Conduits and accessories	Precision Plastic / Nihir Polymers / Clipsal
14	Ceiling and Exhaust Fans	Crompton / Usha / Khaitan / Orient / Bajaj / Havells
15	T V Cable - coaxial	Finolex/ Airtech/Comscope
16	Telephone Cable	Finolex/ Delton/ Havells
17	Cat-5 Cable	Polycab/ Finolex/ PR/Systimax
18	Telephone tag block	Krone

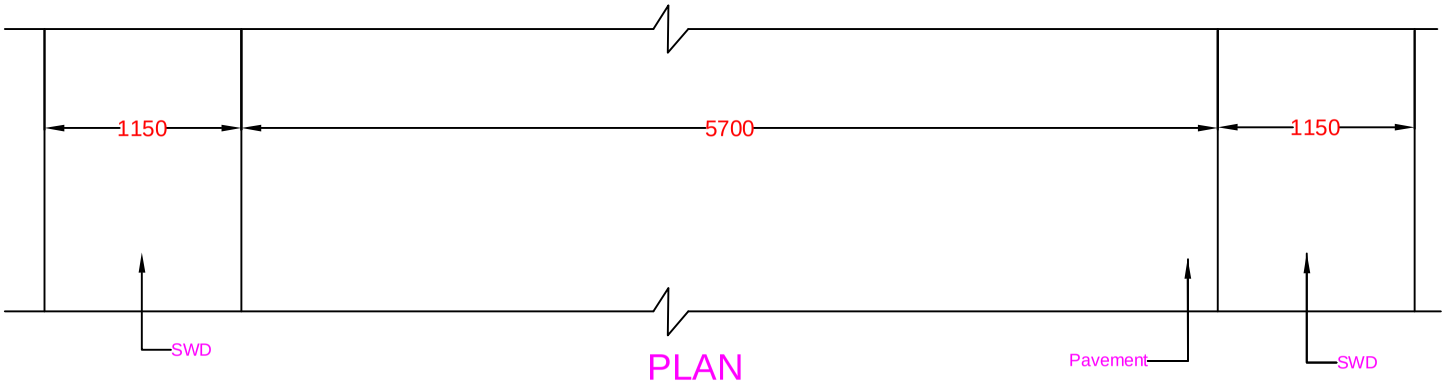
19	Fire Alarm System	GE / Siemens / Honeywell
20	CCTV System	Honeywell / Bosch / L&T / BPL

Final choice of the make from the above list shall be decided by the Owner / Consultant.

Make of any other equipment / components not mentioned above shall have to be approved by Owner / Consultant.



SECTION



PLAN

TYPICAL CROSS SECTION OF 8. METER ROAD

NOTES:-

1. ALL DIMENSIONS ARE IN MILIMETRES.

TENDER DRAWING

DRG TITLE.

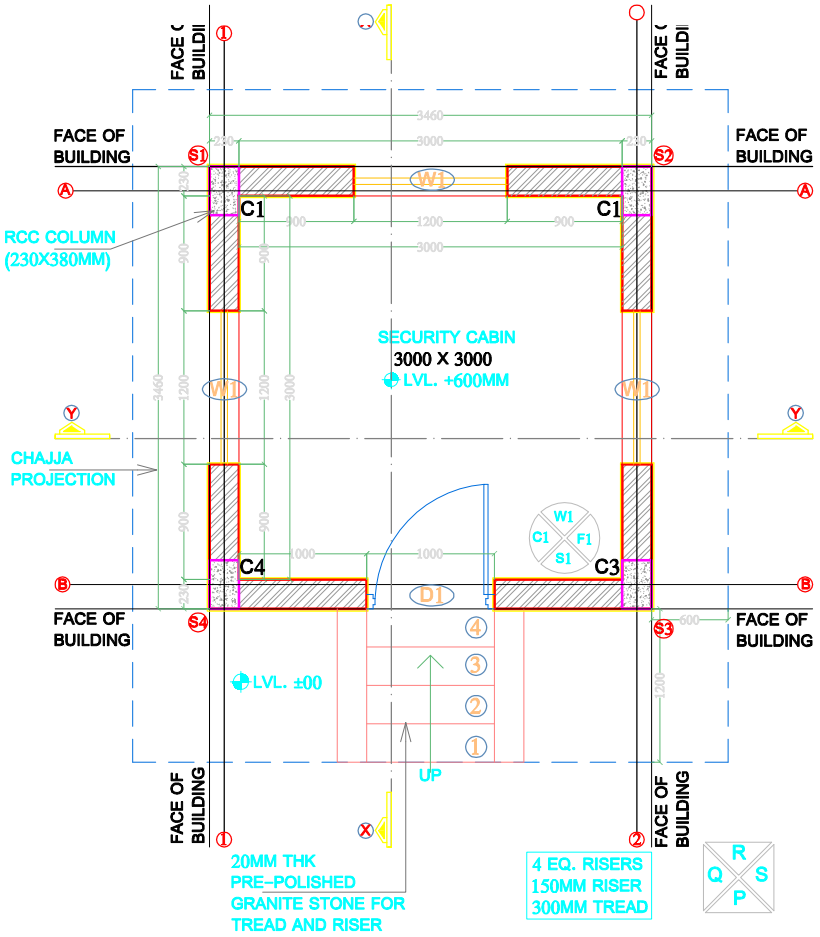
TYPICAL CROSS SECTION OF 8.0 METER ROADS .

CLIENT.

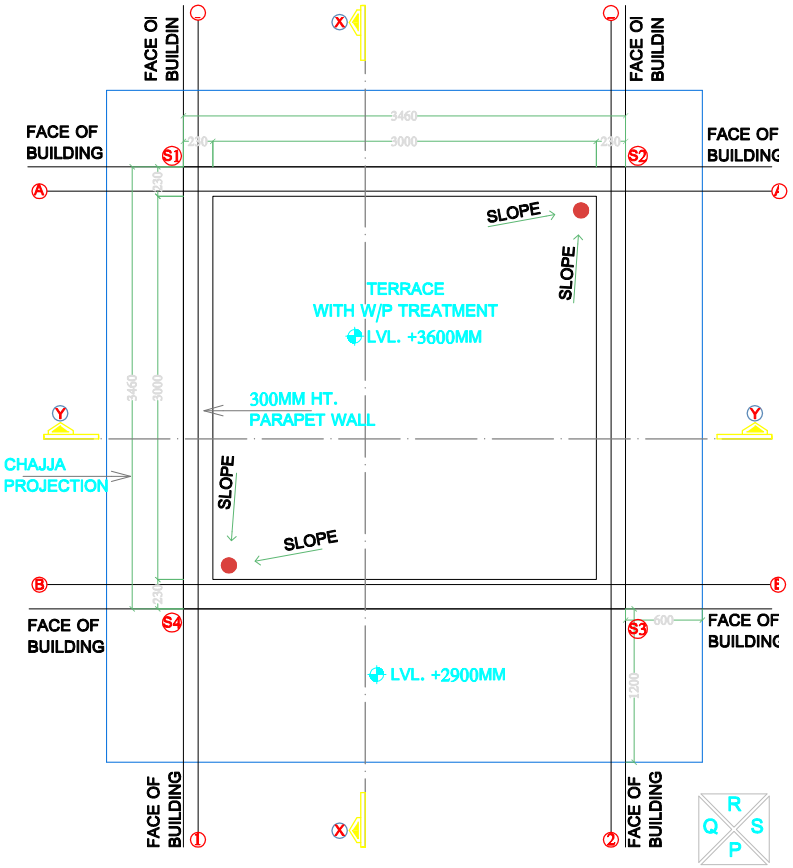
PREPARED BY: CHECKED BY:

APPROVAD BY:

DWG NO.	DATE :	SCALE
		NTS



GROUND FLOOR PLAN



TERRACE FLOOR PLAN

SCHEDULE OF FINISHES

NO.	TYPE	DESCRIPTION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR - 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING INCLUDING PASSAGE AND LOBBY AREA

DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRIPTION	ELEVATION
D1	1000 X 2100	0	1	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICE LOCK • CHROMIUM PLATE HANDLE	
W1	1200 X 1200	900	3	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE MENTIONED.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT STRUCTURAL DRAWING.
- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

DRG TITLE.

FLOOR PLANS OF SECURITY CABIN

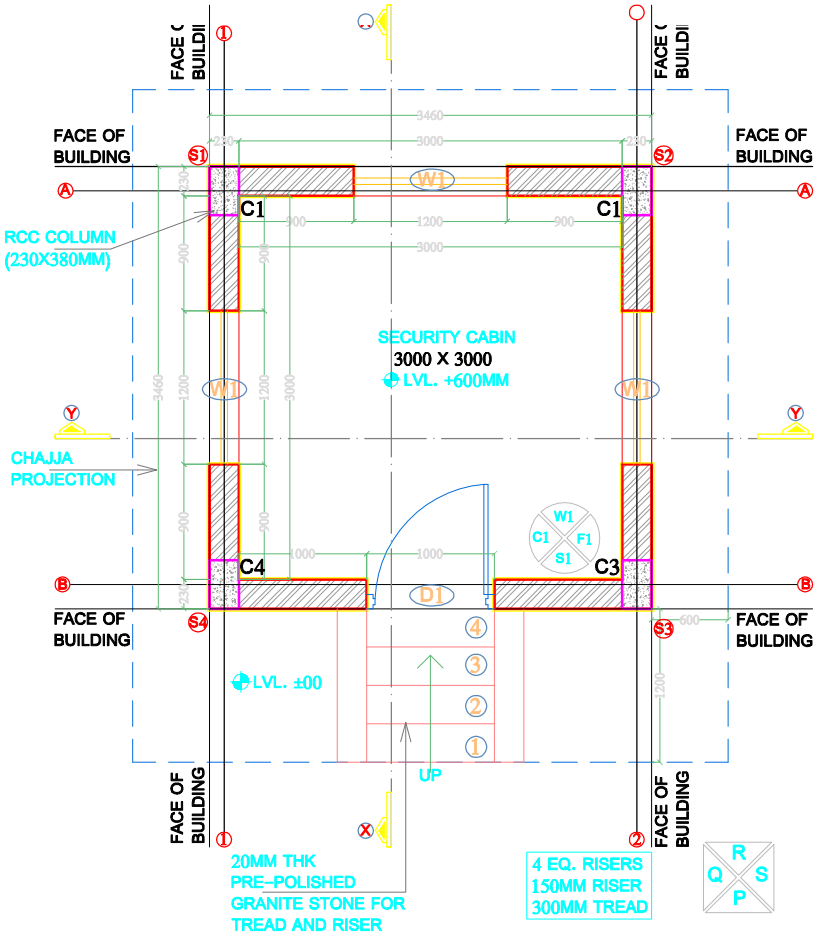
CLIENT.

PREPARED BY: SHR CHECKED BY: SAC

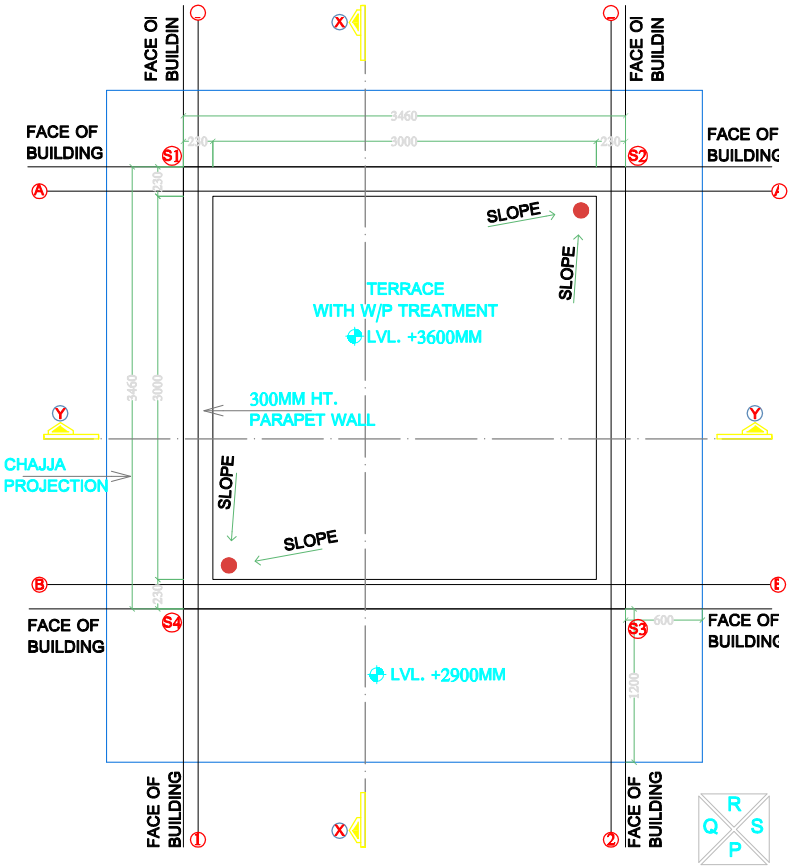
APPROVED BY:

DWG NO:	DATE :	SCALE
		1:40

N



GROUND FLOOR PLAN



TERRACE FLOOR PLAN

SCHEDULE OF FINISHES

NO.	TYPE	DESCRIPTION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR - 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING INCLUDING PASSAGE AND LOBBY AREA

DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRIPTION	ELEVATION
D1	1000 X 2100	0	1	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICE LOCK • CHROMIUM PLATE HANDLE	
W1	1200 X 1200	900	3	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE MENTIONED.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT STRUCTURAL DRAWING.
- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

DRG TITLE.

FLOOR PLANS OF SECURITY CABIN

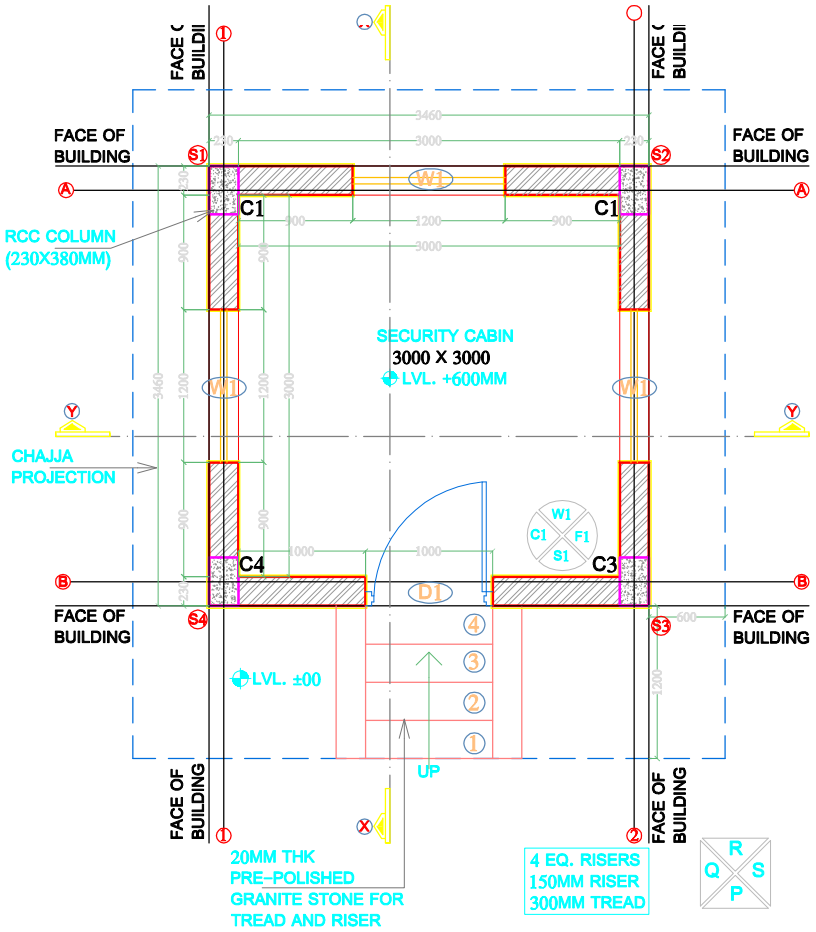
CLIENT.

PREPARED BY: SHR CHECKED BY: SAC

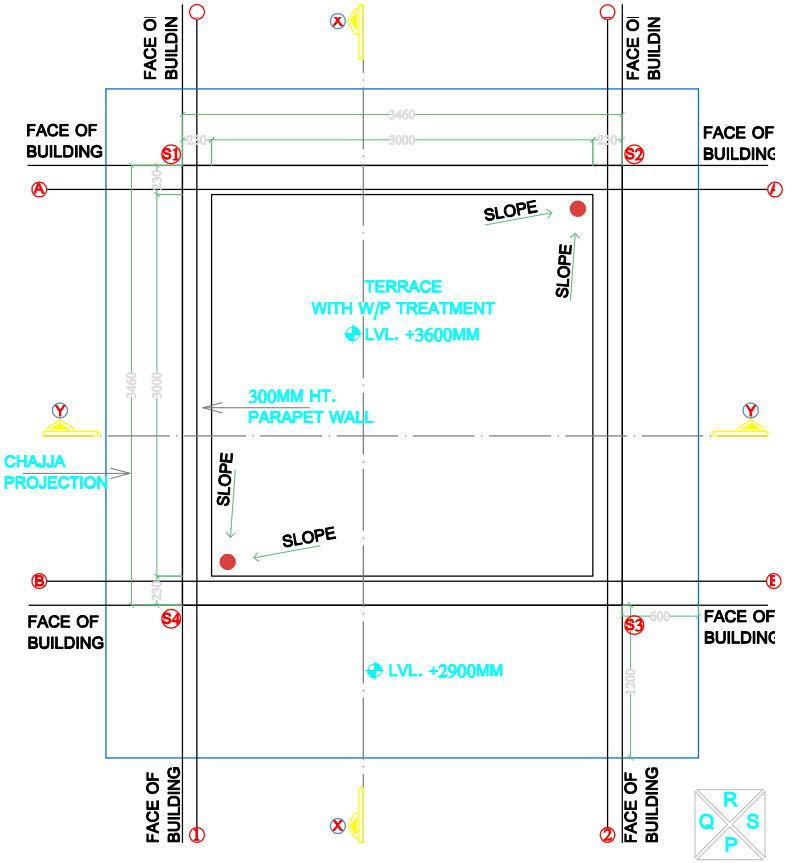
APPROVED BY:

DWG NO:	DATE :	SCALE
		1:40

N



GROUND FLOOR PLAN



TERRACE FLOOR PLAN

SCHEDULE OF FINISHES

NO.	TYPE	DESCRPITION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR - 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING INCLUDING PASSAGE AND LOBBY AREA

DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRPITION	ELEVATION
D1	1000 X 2100	0	1	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICE LOCK • CHROMIUM PLATE HANDLE	
W1	1200 X 1200	900	3	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE MENTIONED.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT STRUCTURAL DRAWING.
- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

DRG TITLE.

FLOOR PLANS OF SECURITY CABIN

CLIENT.

MUNICIPAL CORPORATION

PREPARED BY: SHR CHECKED BY: SAC

APPROVED BY:

DWG NO:	DATE :	SCALE
		1:40

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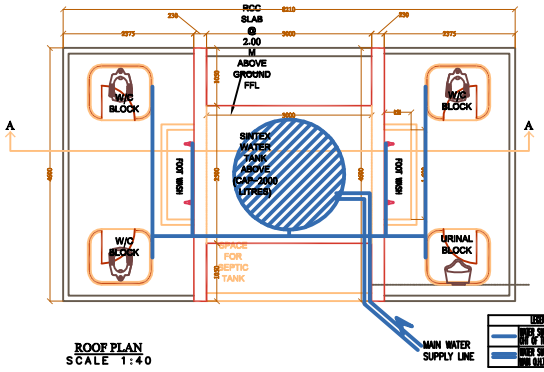
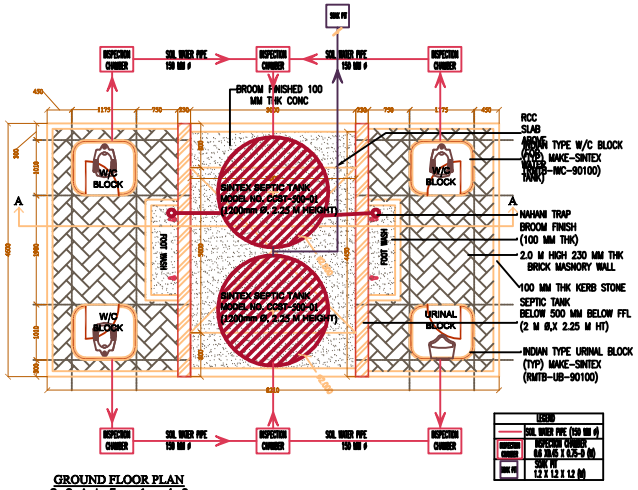


ROOF PLAN
SCALE 1:40

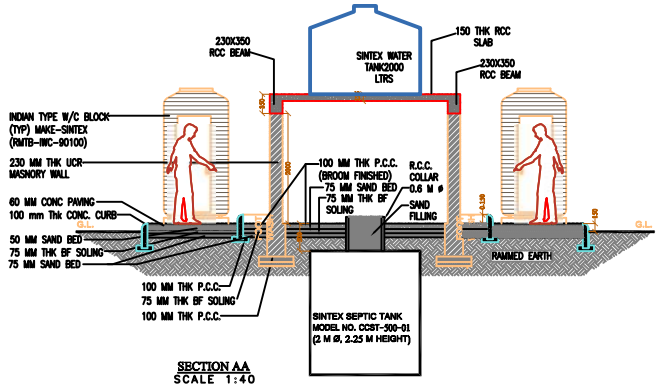
NOTES:

1. ~~All~~ DIMENSIONS ARE IN 'mm' UNLESS SPECIFIED.
2. ALL STRUCTURAL CONC. SHALL BE OF M30.
3. 'Y' DENOTES HIGH YIELD STRENGTH DEFORMED BARS OF GRADE Fe415 CONFORMING TO IS:1786.
4. REINFORCEMENT, WHERE SPLICED, SHALL HAVE LAP OF 50 DIA FOR DEFORMED STEEL BARS.
5. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE:
   BEAMS = 30mm.
   SLAB = 25mm.

R.C.C. SLAB DETAIL



GROUND FLOOR PLAN
SCALE 1:40



SECTION AA
SCALE 1:40

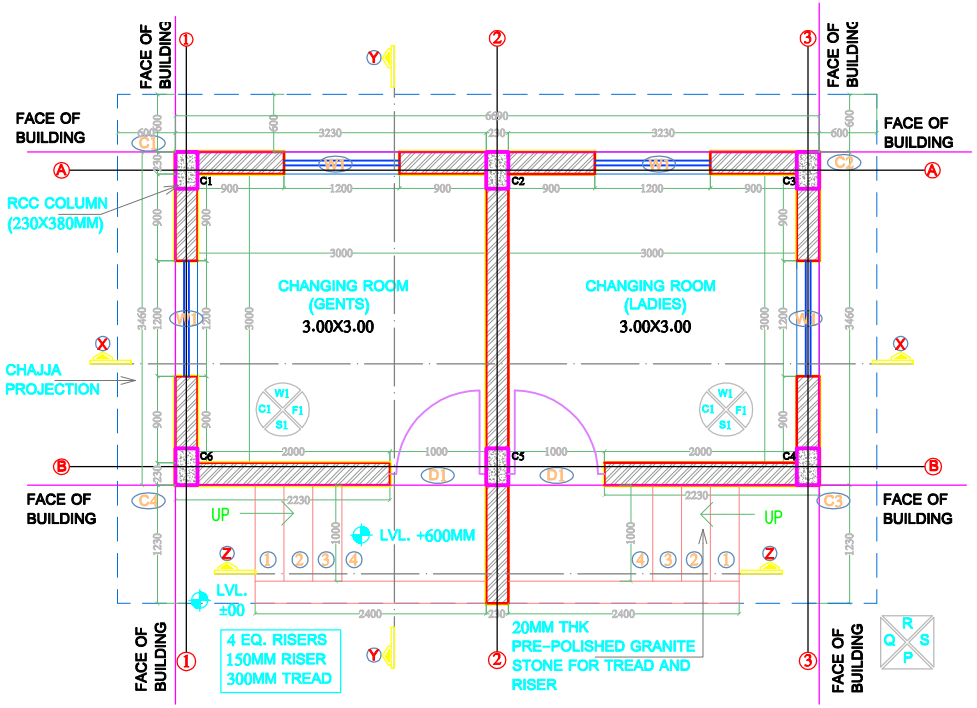
TENDER DRAWING

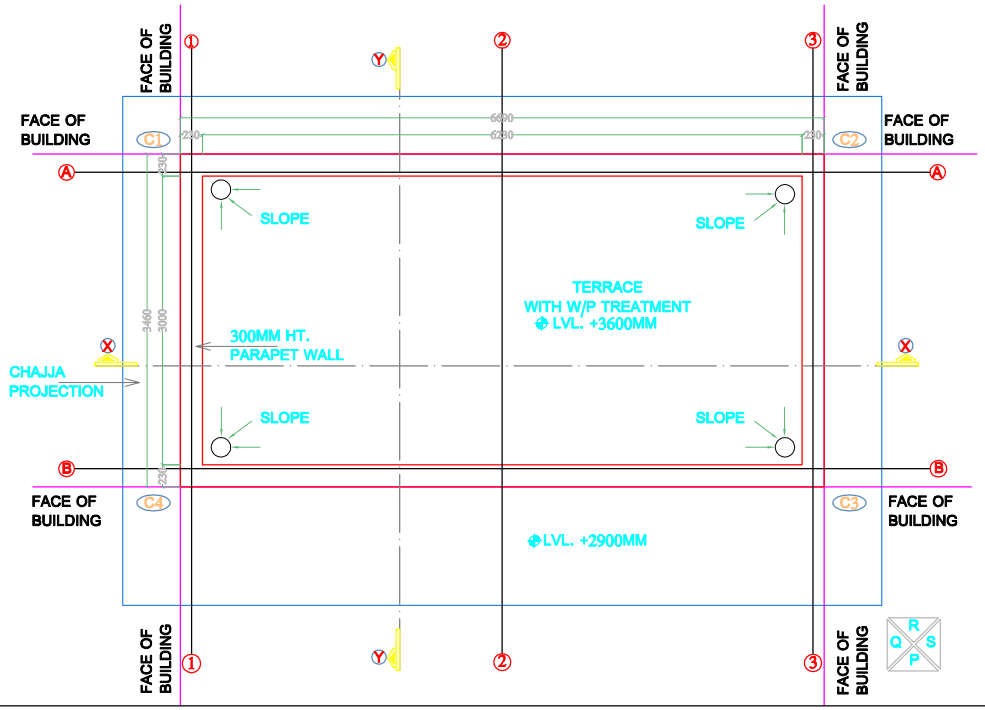
PROJECT

DRG TITLE.
TOILET BLOCK DETAILS

CLIENT.

PREPARED BY:SHR	CHECKED BY:SAC	
APPROVED BY:		
DWG NO:	DATE :	SCALE
PMC/C&D/05		1:30





SCHEDULE OF FINISHES

NO.	TYPE	DESCRIPTION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR – 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING INCLUDING PASSAGE AND LOBBY AREA

DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRIPTION	ELEVATION
D1	1000 X 2100	0	1	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICE LOCK • CHROMIUM PLATE HANDLE	
W1	1200 X 1200	900	3	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE MENTIONED.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT STRUCTURAL DRAWING.
- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

DRG TITLE.

GROUND FLOOR PLAN & TERRACE PLAN OF CHANGING ROOM

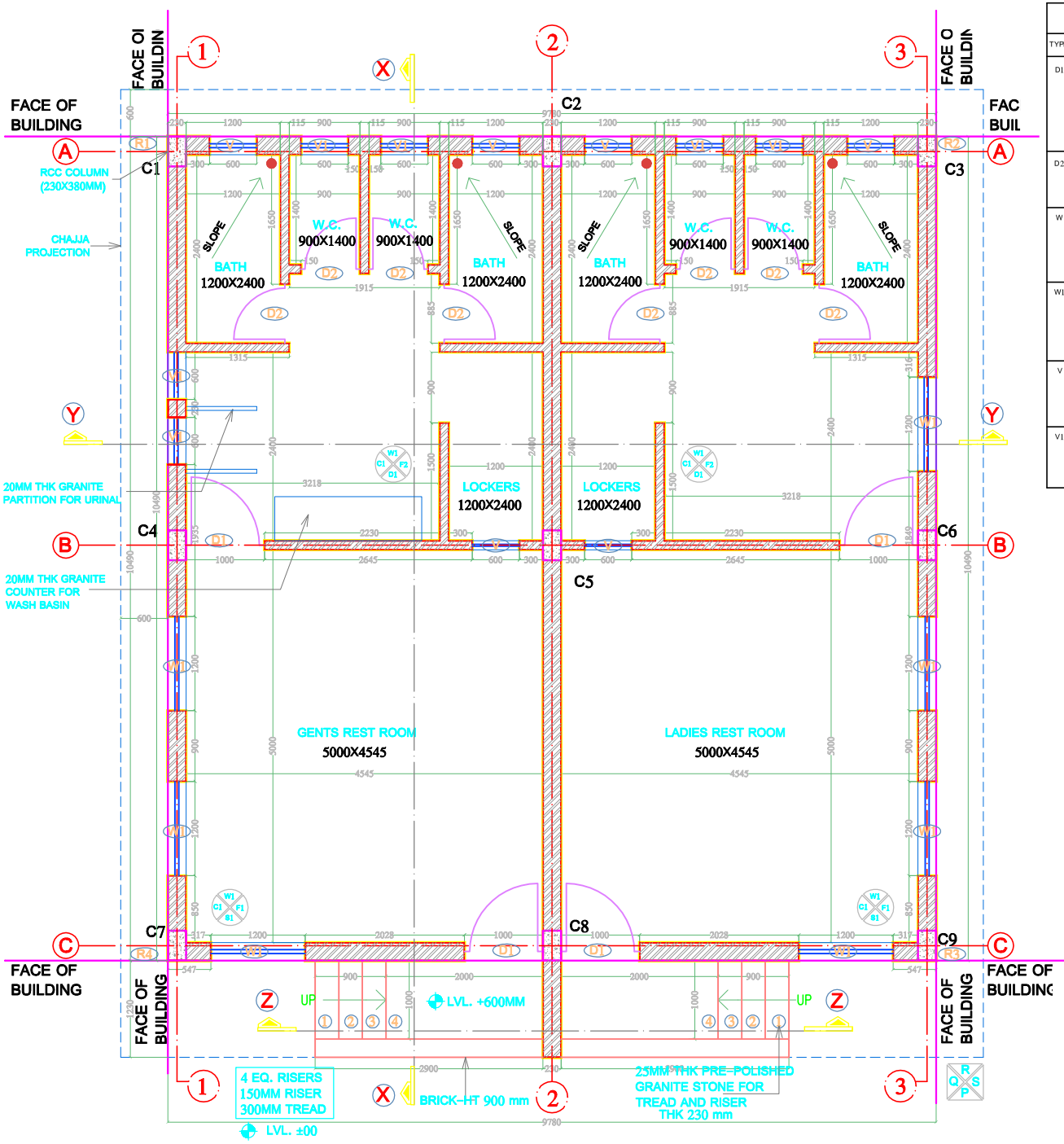
CLIENT.

PREPARED BY: SHR CHECKED BY: SAC

APPROVED BY:

DWG NO:	DATE :	SCALE
		1:50

N



DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRPITION	ELEVATION
D1	1000 X 2100	0	4	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICSE LOCK • CHROMIUM PLATE HANDLE	
D2	750 X 2100	0	8	20MM THK UPVC DOOR • POLISHED GRANITE STONE FRAME	
W	900 X 1200	900	1	SINGLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	
W1	1200 X 1200	900	7	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	
V	600X 900	1200	6	LOUVERED GLASS VENTILATOR • 4MM THK GLASS • ALUMINIUM FRAME	
V1	600X 900	1200	6	LOUVERED GLASS VENTILATOR • 4MM THK GLASS • ALUMINIUM FRAME • OPENING FOR EXHAUST FAN	

SCHEDULE OF FINISHES

NO.	TYPE	DESCRPITION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR - 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
F2	FLOORING	ANTI-SKID VITRIFIED TILES OF SIZE 30X30CM	TOILET
D1	DADO	VITRIFIED TILES OF SIZE 30X30CM	TOILET DADO TILES
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING NCLUDING PASSAGE AND LOBBY AREA

NOTES:

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- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

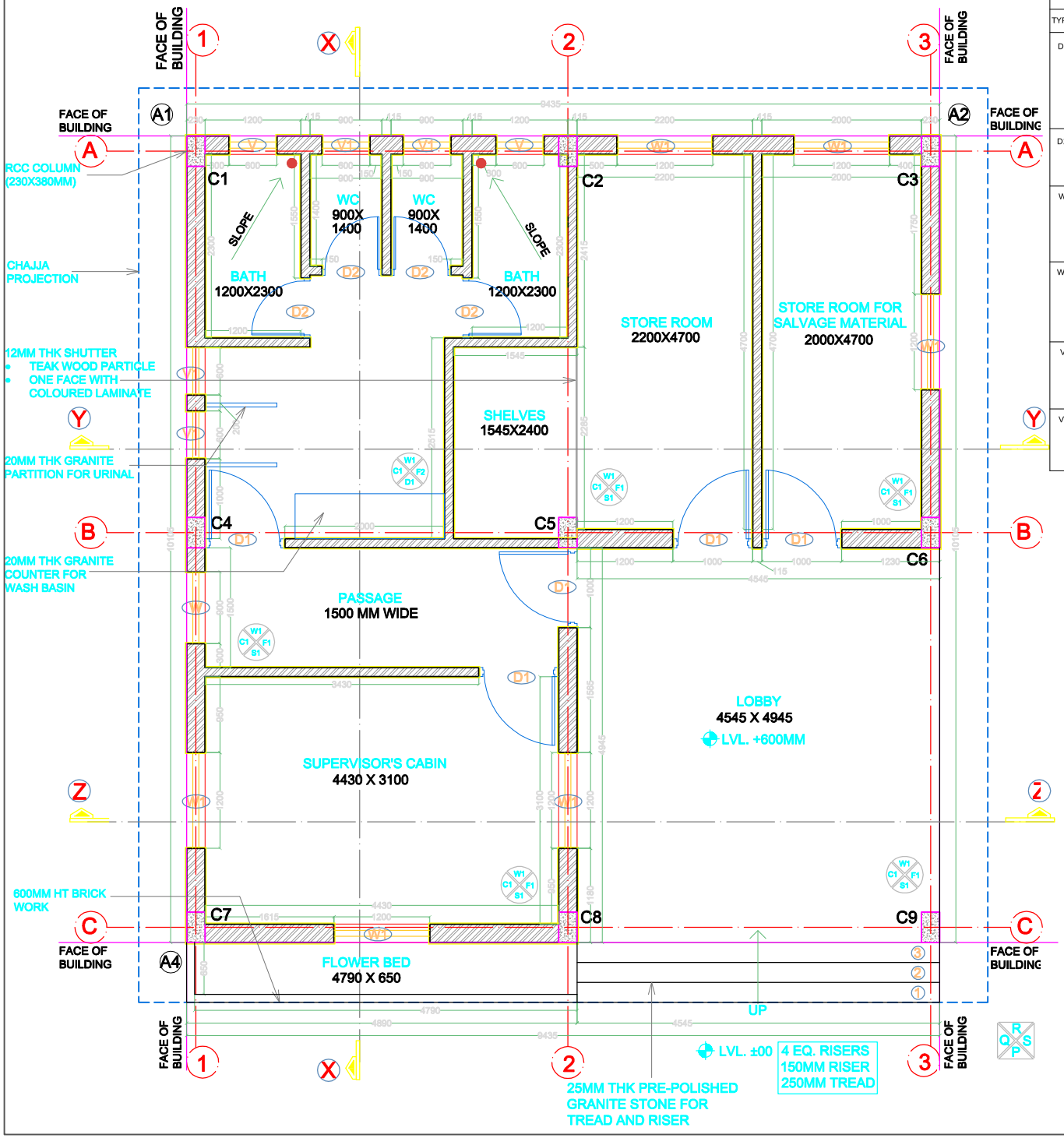
DRG TITLE.

GROUND FLOOR PLAN OF WORKER'S REST ROOM

CLIENT.

MUNICIPAL CORPORATION

PREPARED BY: SHR	CHECKED BY: SAC	
APPROVED BY:		
DWG NO:	DATE :	SCALE 1:50



DOOR & WINDOW SCHEDULE

TYPE	SIZE	SILL LVL.	NOS.	DESCRPITION	ELEVATION
D1	1000 X 2100	0	5	35MM THK SOLID CORE FLUSH DOOR • COUNTRY CUT TEAK WOOD FRAME • FACE VENEER ON BOTH SIDES • POWDER COATING FIXTURES • FASTENING WITH MORTICE LOCK • CHROMIUM PLATE HANDLE	
D2	750 X 2100	0	4	20MM THK UPVC DOOR • POLISHED GRANITE STONE FRAME	
W	900 X 1200	900	1	SINGLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	
W1	1200 X 1200	900	6	DOUBLE LEAF STEEL WINDOW • 12MM SQUARE BARS • 4MM THK GLASS • ZINC COATING	
V	600X 900	1200	4	LOUVERED GLASS VENTILATOR • 4MM THK GLASS • ALUMINIUM FRAME	
V1	600X 900	1800	2	LOUVERED GLASS VENTILATOR • 4MM THK GLASS • ALUMINIUM FRAME • OPENING FOR EXHAUST FAN	

SCHEDULE OF FINISHES

NO.	TYPE	DESCRPITION	REMARK
W1	WALL	• 2ND CLASS BURNT BRICK • 18MM THK EXTERNAL PLASTER CM 1:3 WITHOUT NEERU FINISH • 12MM THK INTERNAL PLASTER CM 1:3 WITH NEERU FINISH • 3 COATS WASHABLE OIL BOUND DISTEMPER.	ALL INTERNAL & EXTERNAL WALLS
C1	CEILING	• 12MM THK CEILING PLASTER CM 1:4 • LIME RENDERING • 2 COATS WHITE WASH	ALL INTERNAL ROOMS CEILING INCLUDING PASSAGE & LOBBY
F1	FLOORING	25MM THK KOTA STONE FLOORING • CEMENT MORTAR - 1:6	ALL ROOMS INCLUDING PASSAGE & LOBBY
F2	FLOORING	ANTI-SKID VITRIFIED TILES OF SIZE 30X30CM	TOILET
D1	DADO	VITRIFIED TILES OF SIZE 30X30CM	TOILET DADO TILES
S1	SKIRTING	25MM THK & 100MM WIDTH KOTA STONE SKIRTING, CM-1:6	ALL INTERNAL SKIRTING INCLUDING PASSAGE AND LOBBY AREA

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRE, UNLESS OTHERWISE MENTIONED.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE RELEVANT STRUCTURAL DRAWING.
- ANY DISCRIPANCY IN THE DRAWING SHALL BE BTOUGHT TO HE NOTICE OF THE PROJECT ENGINEER BEFORE COMMENCING THE WORK.
- WALLS (WITH EXCEPTION MENTIONED)

EXTERNAL WALL THICKNESS: 230 MM
INTERNAL WALL THICKNESS: 115 MM

- PLASTER (WITH EXCEPTION MENTIONED)

EXTERNAL PLASTER THICKNESS: 18 MM
INTERNAL PLASTER THICKNESS: 12 MM

LEGEND:

BRICK WALL

RCC COLUMN (230X380)

TENDER DRAWING

PROJECT

DRG TITLE.

GROUND PLAN OF ADMINISTRATIVE OFFICE BUILLDING

CLIENT.

MUNICIPAL CORPORATION

PREPARED BY: SHR	CHECKED BY: SAC	
APPROVED BY:		
DWG NO:	DATE :	SCALE 1:50

N