KSIIDC

KARNATAKA STATE INDUSTRIAL & INFRASTRUCTURE DEVELOPMENT CORPORATION

4th Floor, East Wing, Khanija Bhavan, Race Course Road, Bengaluru

DEVELOPMENT OF
"BENGALURU SIGNATURE BUSINESS PARK"
ADJACENT TO KEMPEGOWDA INTERNATIONAL AIRPORT AT DEVENAHALLI, BENGALURU

Section-7
TECHNICAL SPECIFICATIONS
February - 2019

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SECTION: A

TECHNICAL SPECIFICATIONS –

ROAD WORKS

TECHNICAL SPECIFICATION FOR ROAD WORKS

This shall comprise the MORT&H specifications for Road and Bridge Works (Fifth Revision) with latest Addendum / Corrigendum / revision (if any), published by Indian Roads Congress, New Delhi 2013 and shall be deemed to be bound into this document.

1. All the codes of practice, standards and specifications applicable shall be the latest editions with all correction slips, addenda, corrigendum and amendments. In general if no definite provisions contained in all the outline specifications indicated herein, reference may be to the MORTH 5th revision, latest CPWD, and relevant IRC/IS Codes of latest revisions The specific clauses as applicable for the material type, specifications and quality control as per relevant and applicable IRC codal provisions shall be used in conjunction with MORTH 5th revision.

2. The following table will provide minimum reference for the work.

Sl. No.	Clause/ Section	Clause No.
1	General	100
2	Site clearance	200
3	Earthwork, erosion control, drainage (including Turfing)	300
4	Subbases, Bases & shoulders (Non bituminous)	400
5	Bases & surface courses (Bituminous)	500
7	Traffic signs, Markings & other road appurtenances	800
8	Quality control for works involved	900
9	Structural steel	1900
10	Maintenance of road	3000
11	Illumination	IS:1944 & BS 5489-1-2003

For the items of work indicated in the Bill of Quantities and not included in this Technical Specification document, the material specifications, construction procedure and Quality requirements shall be as per applicable clauses of MORTH (related IRC and IS clauses.

3. The Contractor shall include in the QA/QC Plan the following minimal requirements:

3.1. Demonstrate to the satisfaction of the Employer's representative the suitability of source of pavement materials like aggregates, bitumen and other materials, before the finalization of the mix design and maintain detailed records of source, testing and compliance with quality standards as applicable (IRC standards)

3.2. Bitumen plant shall be finalized in consultation with Engineer-in-Charge, near to project site. Hot Mix Plant shall be of Weigh Batch Mix type.

3.3. Bitumen plant shall have necessary laboratory facility to perform a full-fledged mix designs. Contractor shall mobilize required number of staff at plant for mix designs and subsequent daily quality control testing.

3.4. Necessary calibration shall be carried out for all testing equipments including the batch mix plant before starting production for the Works and same shall be verified and when required recalibrated, depending upon the quality of mix delivered to the site.

3.5. Mix design shall be performed as per technical specification & MORT&H Rev.05 (Latest revision) requirements; laboratory and field trials should be carried out before final acceptance.

3.6. All necessary quality testing shall be carried out on daily basis. Gradation test, bitumen content and necessary corrections shall be carried out if required, by the Contractor. Proper documentation of tests shall be maintained for review and submission to client.

3.7. A computerized delivery Challan shall be sent along with each vehicle mentioning the vehicle number, quantity, start and end time of loading, temperature of mix with time while leaving, duly signed by the Contractor's representative at plant.

3.8 The Contractor shall collect sufficient sample from the Site for every 200 tons or minimum 2 samples per day to establish the mix grading, stability and void analysis of the mix and test the same at a laboratory to be established by the Contractor at Site.

3.9. Compaction of the layer shall be tested by taking cores as per MORT&H Rev.05 (Latest revision) and minimum compaction to be achieved shall not be less than (Density mentioned in Approved drawing) of the lab density.

3.10 The contractor is expected to provide safe and secure barricading plan and implement at site for construction to ensure safety to road users, traffic, public and their own employees. The contractor shall prepare and submit proposal for implementation of barricading and get it approved prior to taking up the work. The contractor shall be responsible for any damages occurring on account of defective and / or insufficient barricading which forms part of temporary works for construction.

TECHNICAL SPECIFICATION

(AMENDMENTS/MODIFICATIONS/ADDITIONS TO EXISTING CLAUSES OF SPECIFICATIONS FOR ROAD AND BRIDGE WORKS, MoRT&H (FIFTH REVISION or Latest revision))

The entire works, as described in Scope of Work shall be done in accordance with the Technical specifications. These technical specifications shall comprise the following.

Part I - General Specifications:

Part - I shall comprise the "Specification for Road and Bridge Works" Fifth Revision - with latest Addendum / Corrigendum / revision (if any), published by Indian Roads Congress, New Delhi- 2013, on behalf of Government of India, Ministry of Surface Transport (Road Wing), and shall be deemed to be bound into this document and becomes part and parcel of the agreement.

Part II- Supplementary Specifications:

Part-II shall comprise various substitutes. Modified and Additional Clauses to the "Specification for Road and Bridge Works" referred to in Part I (to cover specific aspects of the particular works not covered by the same) and accordingly, the said specification so amended shall form part of the contract.

CLAUSE 106: CONSTRUCTION EQUIPMENT:

(Addition)

Add the following sub Para (l) after sub Para (k):

l) All measuring devices and gauges shall be in good working condition.
Measuring devices that can affect product quality shall be calibrated prior to use and at prescribed intervals (clause 103) against certified equipment. Calibration procedures shall be established, maintained and documented and corrective actions taken when results are unsatisfactory and submitted for approval from Engineer -in- Charge prior to use Accuracy and fitness of measuring devices shall be ensured by proper maintenance".

SECTION 300 EARTHWORK, EROSION CONTROL AND DRAINAGE:

CLAUSE 301: <u>EXCAVATION FOR ROADWAY & DRAINS:</u>

Clause 301.3.11 <u>Disposal of excavated materials</u>

(Substitution)

Delete this Sub-Clause and replace with:

"All the excavated materials shall be the property of the Employer. Suitable material obtained from the excavation of the roadway, shoulders, verges, drains, cross drainage works, etc. shall be used for:

i) Filling roadway embankment.
ii) Filling existing pits/ ponds in the right of way as directed by the Engineer, including leveling and spreading, with all lifts and leads.
Iii) For landscaping of the road as directed by the Engineer, including levelling and spreading, with all lifts and leads.

Unsuitable and surplus material, which, in the opinion of the Engineer cannot be used in the works, shall be removed from site by the Contractor and disposed at the nearest dip or other approved location in accordance with all statutory requirements."

Clause 301.6 Preparation of Cut Formation

(Substitution)

Delete the first sentence of the second paragraph and replace with:

"Where the material in the subgrade (that is within 500 mm from the lowest level of the pavement, which is bottom of granular subbase) has a density less than specified in Table 300-2, the same shall be loosened and removed to a depth of 500mm, replaced with the same cut soil in layers not greater than 250mm each and re-compacted in accordance with the requirement of Clause 305."

Clause 301.9 Rates

Clause 301.9.2

(Modification) This Clause shall be read as under:

The Contract unit rate for loosening and recompacting the loosened materials at subgrade level shall include full compensation for loosening to the specified depth, removing the loosened soil outside the roadway excavation, rolling the surface below, breaking the clods, spreading the excavated soil in layers, watering where necessary and compacting to the requirements.

CLAUSE 304 EXCAVATION FOR STRUCTURES

Clause 304.3.7 Backfilling

(Deletion)

Delete the word 'Mechanical tamper' in line 5 and substitute it with "Roller (the capacity shall be as per site requirements)".

CLAUSE 305 EMBANKMENT CONSTRUCTION

Clause 305.2 Materials and General Requirements

Clause 305.2.1 Physical requirements

Clause 305.2.2.2 Borrow Materials

(Modification)

Para 1 of this Clause shall read as under:

"No borrow area will be made available by the Employer for this work. The arrangement for the source of supply of the material for embankment and sub-grade as well as compliance to the different

environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable shall be the sole responsibility of the Contractor. No earth, except when the road is in cutting, shall be borrowed from the Right of Way if such materials comply to standards". In case of unavailability of sufficient suitable material Premises, contractor shall raise concern with Engineer-in-charge and follow as directed by Engineer-in-charge.

Clause 305.2.2.4 Compaction Requirements (Modification)

Last Para of this clause given below Table 300-2 shall read as under:

" Contractor shall submit below mentioned test reports within 21 working days of commencement of compaction activity at site.

i) The values of maximum dry density(MDD), optimum moisture content(OMC), Atterberg limits, shrinkage and swell(FSI) properties and gradation obtained in accordance with IS:2720(Latest Revision) for all filling material proposed to be used in the construction of embankment and subgrade.

ii) The graphs showing values of dry density against moisture content from which each of the values in (i) above (maximum dry density and optimum moisture content) was determined.

iii) Material proposed to be used as subgrade (borrow and existing) shall be tested for CBR value of soil (4 day soaked in addition to the tests mentioned in Sl. (i) above. The CBR value (soaked CBR) shall be as specified in the drawing at the unit weight applicable as per Table 300-2

iv) The dry density-moisture content-CBR relationships for all the filling materials proposed to be used in the subgrade.

The above information shall form the basis for compaction, only upon its approval by the Engineer-in-charge."

Clause 305.3 <u>Construction Operations</u>

Clause 305.3.4 (Addition) Compacting Ground Supporting Embankment/ Sub-grade.

Add the following sentence at the end of paragraph 2.

"Wherever necessary to facilitate compaction of the ground / sub-grade to 97% relative compaction as stated above, a further depth of maximum of 0.25 meter thickness shall be loosened, watered and compacted in accordance with Clauses 305.3.5 and 305.3.6 to not less than 95% of maximum dry density, determined in accordance with MoRT&H (Latest revision)."

Clause 305.4 <u>Construction of Embankment and Sub-grade under Special Conditions</u>

Clause 305.4.4 <u>Embankment and Sub grade around structures</u>
(Substitution)

In the last line of paragraph-3, substitute "compacted thoroughly to the requirements of Table 300-2" by "compacted thoroughly to not less than 97% MDD"

Clause 305.4.6 Embankment Construction under Water and Waterlogged Areas

Clause 305.4.6.2 Embankment Construction in Waterlogged and Marshy Areas
(Addition)

Marshy soil in and around the water body area, to be excavated / removed for a specified depth, minimum of 2m and refilled with good soil up to the required / desired level as per instructions and Drawings.

Clause 305.4.7 Earthwork for high embankment
(Modification)

Delete the first paragraph and replace with:

"Material used in high embankments, including subgrade material constituting the 500mm of embankment immediately below the pavement, shall have minimum effective angle of internal friction (ø) of not less than 25^0 and minimum effective Soil cohesion (c') of not less than 4.0 t/m^2. High embankment shall be constructed from borrow material in accordance with Sub-Clause 305.2.2.2 unless otherwise approved by the Engineer.

SECTION 400 SUBBASES, BASES (NON-BITUMINOUS) AND SHOULDERS

Clause 401 Granular sub-base

Clause 401.1 Scope
(Modification)

The second sentence of this clause shall read as follows.

The Granular Sub-base shall be provided by using close graded material, mixing in a Mechanical mix plant, carriage of mixed materials to work site, laying in uniform layers with mechanical paver or Motor Grader and compacting with vibratory power roller to achieve desired density as necessary according to lines, grades and cross-section shown on the drawings or as directed by the Engineer.

Clause 401.2 Materials

Clause 401.2.2 (Addition)

Paragraph 1 of this Clause shall read as under:

Add the following
"Granular Sub-base serves as a drainage layer in addition to being a part of the structural pavement, the material must satisfy drainage criteria. For such requirement, the grading of material should be as per Table 400-1 (Grading – I) and CBR should be Minimum 30%.

Clause 401.3 Construction Operations

Clause 401.3.2 Spreading and compacting

(Modification)

Add the following in the first para after second sentence.

"Granular Sub-base shall be prepared in an approved mixing plant like pug mill, concrete batching plant or concrete mixer located at Plant / Laboratory area. The mixed materials shall be carried to work site by Tipper / dumper. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work."

The third paragraph of this Clause shall read as under:

"The Granular sub-base material shall be spread in layers of uniform thickness of 200 mm compacted thickness over the entire width of sub-base. Immediately thereafter, rolling shall start with the help of a vibratory roller of 100 kN static weights with plain drum or heavy pneumatic tyred roller of 300 kN weight. 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 centre of portions having cross fall on both sides."

Clause 406 Wet Mix Macadam Sub-Base/Base

Clause 406.1 Scope

(Modification)

Delete "in one or more layers" and replace with "in two uniform layers" in the last sentence of first paragraph.

Read "125mm" in place of "200mm" in the last sentence of second paragraph.

Clause 406.2 Materials

Clause 406.2.1 Aggregates

Clause 406.2.1.1 Physical Requirements

(Modification)

Add at the end of first paragraph:

The WMM shall be prepared in an approved mixing plant like pug mill, concrete batching plant only. The Mix design shall be carried for confirmation of compliance with MoRT&H rev.05 (Latest revision) requirements.

"The fraction of materials passing through 4.75 mm sieve shall be crusher run screening only."

Clause 406.3 Construction operations

Clause 406.3.4 Spreading of Mix

(addition)

Add at the end of first paragraph

"The first layer of mix shall be spread by paver finisher. The second or final layer of mix shall be spread by paver finisher preferably in full width of the pavement including hard shoulder."

Proper benching shall be ensured between every layers to make ease during compaction of succeeding layers.

Clause 406.3.5 Compaction

(Deletion & modification)

Delete second sentence of first paragraph.

Contractor shall ensure even compaction for every layer for full width of section. Read "125mm" in place of "200mm" in the third sentence of first paragraph.

Clause 406.4 Opening to Traffic.

(Modification)

The clause shall read as:

"No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and covered upto the completion of DBM".

Clause 408 Shoulders, Islands and Median

Clause 408.1 Scope

(Modification)

Replace the Sub-Clause with the following:

"The work shall consist of constructing shoulder (hard/paved/earthen) on either/one side of the pavement, median in the road dividing the carriageway into separate lanes and islands for channelising the traffic at junctions in accordance with the requirements of these specifications and in conformity with the lines, grades and cross sections shown on the drawings or as directed by the Engineer".

Clause 408.2 Materials

(Modification)

Replace the first paragraph by the following paragraph:

"Hard shoulder on either/ one side of the road shall be of Granular sub-base conforming to the requirements of Clause 401. Earthen shoulder on either/ one side of the road shall be of granular material conforming to requirements of Clause 408. The median /Islands shall also be with granular material conforming to requirements of Clause 408. "

CLAUSE 409 Cement Concrete Kerb and Kerb with Channel

Clause 409.5 **Construction Operations**

Clause 409.5.1 (Substitution) Substitute first sentence of Clause 409.5.1 as under :

"For the new carriage way or eccentric widening side, Kerb shall be laid on firm foundation of wet mix macadam and extending 300 mm inside the median as shown in drawings."
"For the existing pavement side, Kerb shall be laid on the firm foundation of WMM. WMM construction shall be flushed with the existing carriage way and up to the level of DBM bottom from the road top level, 300mm offset beyond the kerb shall be provided inside the median OR as directed by the Engineer."

"In case of shorter widths (less than 750mm) available at the existing carriage way for the construction of the kerb, firm foundation with M-15 grade of 150mm thick shall be done just below the WMM Top Level and over that kerb laying shall be done."
"In case WMM is not provided, kerb to be laid on PCC M15". If Kerbs are laid before laying of DBM/BC. Contractor shall protect the Kerb surface from emulsion splashes.

Clause 409.5.2 (Modification) Add the words "or to accommodate drainage pipes" at the end of the paragraph after the words "drainage openings".

SECTION 500 **BASE AND SURFACE COURSES (BITUMINOUS)**

Clause 501 **General Requirements for Bituminous Pavement Layers**

Clause 501.2 **Materials**

Clause 501.2.2 (Modification & deletion) **Coarse Aggregates**

The first sentence of paragraph 1 shall read as:
"The course aggregates shall consist of crushed rock and shall be obtained through the use of Cone crusher, Vertical Shaft Impactor and vibratory screens of suitable capacity."

The third paragraph of this Clause shall be deleted.

Clause 501.5 Laying

Clause 501.5.3 (Modification) **Spreading**

Replace the second sentence of paragraph 1 as follows:

"Except in areas where a Electronic Sensor paver cannot access,

bituminous materials shall be spread, levelled and tamped by electronic sensor paver having a paving width of carriage way and paved shoulder together and with a guide wire (or guide wires) fixed at points not exceeding every 5.0 meters. At the discretion of the Engineer, the Contractor is required to lay first layer of DBM including necessary Profile corrective course in first layer but second or final layer of DBM and BC layer shall be laid in full paving width without any longitudinal joints."

Clause 501.6 Compaction

(Addition)

Add at the end of 6th paragraph:

"Rolling shall be continued till the density achieved satisfies the requirements of Clause 903.4.2 and all roller marks are eliminated."

Clause 501.8 Preparation of Surface

Clause 501.8.3.4 Profile corrective course (if applicable)

Clause 501.8.3.4 b (Modification) This Clause shall be read as under:

"The surface on which profile corrective course is to be laid shall be thoroughly swept clean of dust and any other extraneous material using mechanical broom and dust collected, removed or blown off using compressed air except in places where mechanical means cannot reach.

After preparing the granular surface as in Clauses 501.8.3.1., 501.8.3.2 and 501.8.3.3, the profile corrective course with materials as per Clause 501.2.3/501.2.4 shall be laid and compacted to the requirement of particular specification clause.
Where a bituminous profile corrective course is to be laid over primed granular surface, a tack coat conforming to Clause 503 shall be applied prior to laying the profile corrective course."

Clause 501.8.3.4.c (Modification) This Clause shall be read as under :

"An existing bituminous surface shall be prepared as per Clauses 501.8.3.3 and 501.8.3.4.b The bituminous profile corrective course shall be laid after applying tack coat conforming to Clause 503, and compacted to the requirement of specification Clause."

The profile corrective course upto 50 mm average thicknesses shall be laid with dense bituminous concrete only.

If the profile corrective course average thickness is more than 150mm for a length exceeding 100m, the existing Bituminous surface shall be

removed completely and subsequent road crust layer shall be laid as per the available thickness.

Clause 502 Prime Coat Over Granular Base

Clause 502.1 Scope
(Modification)

The first sentence of this Clause shall be read as under:

"This work shall consist of the application of a single coat of low viscosity Bitumen Emulsion @ 1Kg per square meter to a granular surface preparatory to the superimposition of bituminous treatment or mix."
The Emulsion once spread on WMM shall be left for curing atleast for 24 Hrs. for next activity. The rate of spray test shall be done as per clause.

Clause 502.8 Rate
(Deletion)

Delete the second sentence from the paragraph as under: "Payment shall be…..... in Clause 502.4.3."

Clause 503 Tack Coat

Clause 503.1 Scope
(Modification)

This Clause shall be read as under:

"This work shall consist of the application of a single coat of low viscosity Bitumen Emulsion @ 0.25Kg per square metre to an existing bituminous road surface and @ 0.275Kg per square metre to a primed granular surface preparatory to the super imposition of bituminous treatment or mix."
The rate of spray test shall be carried as per the clause requirement.

Clause 503.8 Rate
(Deletion)

Delete the second sentence from the paragraph as under: "The rate shall cover…..... accordingly."

Clause 505 Dense Bituminous Macadam

Clause 505.2 Materials

Clause 505.2.2 Coarse Aggregates
(Modification)

The first sentence of paragraph 1 shall read as:

"The course aggregates shall consist of crushed rock and shall be

obtained through the use of Cone crusher, Vertical Shaft Impactor and vibratory screens of suitable capacity."

The second paragraph of this Clause shall be deleted

Clause 505.4 Construction Operations

Clause 505.4.9 (Addition) Rolling

Add after the last paragraph:
"Rolling shall be continued till the density achieved is at least 98% of the Marshall Density.

Clause 505.9 Rate
(Modification)

This Sub-Clause shall be substituted as under:

The item (viii) of Clause 501.8.8.2 shall be substituted as under for DBM.

"The rate shall include any variation in the bitumen content in excess of 4.5 percent by weight of bituminous mix and no adjustment on this account shall be admissible."

Clause 507 Bituminous Concrete

Clause 507.1 Scope
(Modification)

The last sentence of this Clause shall read as:

"A single layer shall be 40mm in thickness (Grade 2)."

Clause 507.2 Materials

Clause 507.2.1 Bitumen
(Modification)

This Clause shall be read as under:

"The Base binder shall be paving bitumen of penetration grade VG30 as per Indian Standard Specification for Paving Bitumen –IS: 73. Modified Bitumen confirming to IRC –SP-53 shall be used which is compatible with the base binder and which allows the properties given in Clause 521.3 to be achieved. The modifier, in the required quantity shall be blended at the refinery or at a centralised plant approved by Engineer, capable of producing modified binder. Technical specification clause 521 for modified binder and IRC: SP-53- shall be referred to.

Clause 507.2.4 Filler

(Modification)

This Clause shall be read as under:

Filler 2 % by weight of mix shall consist of finely divided cement as approved by Engineer.

Clause 507.2.5 **Aggregate Gradation**
(Modification)

This Sub Clause shall be read under:

When tested in accordance with IS: 2386 Part I (Wet grading method), the combined grading of the coarse and fine aggregates shall fall within the limits shown in Table 500-17 for grading 2.

Clause 507.9 Rate
(Modification)

This Sub-Clause shall be substituted as under:
The item (viii) of Clause 501.8.8.2 shall be substituted as under for BC.

The rate shall include any variation in the bitumen content in excess of 5.4 percent by weight of bituminous mix and no adjustment on this account shall be admissible."

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SECTION 800 TRAFFIC SIGNS, MARKINGS & OTHER ROAD APPURTENANCES

Clause 801 Traffic Signs

Clause 801.3 Traffic Signs having Retro-Reflective Sheeting

Clause 801.3.1 **General Requirements**
(Modification)

In this clause, the 5th sentence shall be read as:

"The retro-reflective sheeting shall be micro prismatic grade retro-reflective element material as specified in clause 801.3.4.3"

Clause 801.3.8 **Colour for Signs**

Add the following in the clause

"All the facility information and place identification signs shall have colours specified in IRC 67."

Clause 801.4 Installation
Clause 801.4.1

(Modification)

Last sentence of the sub-clause shall read as follows:
All signposts shall be embedded in concrete (M-15) for stability and safeguard against theft. The cost of excavation, concrete and backfill, if any shall be deemed to be included in the rate of signboard.

Clause 801.4.2 (Addition) Add the following Sentence to the clause

"Alternate band of Black and white Painting for the posts to be done and the cost thereof is included in the Sign boards Installation items."

Clause 801.6 Rate
(Addition)

Add, "including cost of concrete" after the word "at the site" in the 2nd line.

Clause 802 Overhead Signs

Clause 802.4 Materials for Overhead Sign and Support Structures

Clause 802.4.3 (Modification) Replace "1.5mm" with "2.0mm" in the last sentence.

Clause 802.4.6 (Modification) This Clause shall be read as under :

"All Overhead signs shall be of retro-reflective micro prismatic sheeting confirming to ASTM D4956, Type XI, fixed over aluminium sheeting as per these specifications."

Clause 803 Road Markings

Clause 803.2 Materials
(Deletion)

Delete "of ordinary road marking paint," from the 1st line of this clause.

Clause 803.3 Ordinary Road Marking Paint
(Deletion)

This Clause shall be "deleted".

Clause 803.6 Application

Clause 803.6.1 (Modification) The first sentence of this clause shall read as:

"The road marking shall be made with the appropriate road marking machinery as approved by the Engineer-in-charge."

Clause 806 Road Delineators

Clause 806.2 (Modification) This clause shall read as under:

Road way indicators shall be made of crash proof material of the type approved by Engineer-in-charge. Hazard markers and object markers shall be as shown in the relevant drawing and the materials to be used for the markers and the locations shall be as approved by Engineer. The reflective sheeting shall conform to Clause 801.
Crash barrier (Concrete or Steel) markers shall be of the type approved by Engineer

Clause 811 Crash Barrier

Clause 811.2 Concrete Crash Barrier

Clause 811.2.1 Materials

Clause 811.2.1.2 (Modification) This Clause shall be read as under:

Concrete barriers shall be constructed with M-40 grade concrete and with High Yield Strength deformed reinforcement conforming to IRC: 112.

Clause 811.3 Metal Beam Crash Barrier

Clause 811.3.1 Materials

Clause 811.3.1.3 (Addition) Add at the end of this Clause:

"The size of the concrete foundation block for embedding the posts and grade of concrete shall be as shown on the drawing."

Clause 811.3.3 Installation of Posts
(Modification)

This Clause shall be substituted as under:

"The posts shall be embedded in the concrete foundation block of size and Approved grade of concrete along with the depth of embedded post as shown in the drawing.

Clause 811.3.7 Measurement for Payment

Clause 811.3.7.1 (Deletion)

The 2nd sentence "Terminals ……..for by numbers" shall be deleted.

Clause 811.3.8 Rate
(Addition)

Add at the end of last sentence of Clause "and drawings."

SECTION 900 QUALITY CONTROL FOR ROAD WORKS

Clause 901 General

Clause 901.1
(Modification)

This Clause shall read as under:

"All materials to be used, all methods adopted and all works performed shall be strictly in accordance with the requirements of these Specifications. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out all required tests and Quality Control work as per Specifications and/or as per Clause 120 and/or as directed by the Engineer. The list of laboratory equipment and the facilities to be provided shall be as per Clause 120 and shall be approved by the Engineer-in-charge in advance."

Clause 902 Control of Alignment, Level and Surface Regularity

Clause 902.3 Surface Levels
(Modification)

This Clause shall read as under:
The levels and or thickness of the subgrade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross profile of the road shown on the drawings or as directed by the Engineer-in-charge beyond the tolerances mentioned in Table 900-1.

Add at the end of first sentence "or as desired by the Engineer" in the last paragraph.
Add the following sentence at the last: Towed fifth wheel Bump Integrator Test is to be conducted on the bituminous surfaces to evaluate the surface regularity. Results are to be taken on Electronic Graph. In Each lane, at four locations longitudinally, in uni-direction, this bump integrator test is to be done.

Clause: 902.4 Surface Regularity of Pavement Courses
(Addition)

Add after the last paragraph:

"In addition to the above requirements, the surfaces of both the base course (DBM) and wearing course (BC) shall have smooth longitudinal profiles which provide a high standard of riding quality. Roughness testing with towed fifth wheel Bump Integrator shall be carried out up on completion of the DBM top layer and again up on completion of the BC to evaluate the surface regularity. The riding

quality of the base course surface and the wearing course surface shall have Unevenness Index (UI) values of not greater than 2000 and 1800 respectively. Results are to be taken on Electronic Graph."

Pavement Unevenness Index:

Roughness testing shall be carried out for each lane length constructed, at four locations longitudinally, in uni-direction. The equipment has to be run on the road stretch under study once for each wheel path in each direction. For the purpose of determining ride ability:

Each lane shall be divided into sections of 500m long (can vary as per client representative decision)

Any remaining length less than 500m shall be included with the section immediately preceding it and an average value of Unevenness Index (UI) determined for the total section.

Average value of Unevenness Index (UI) is expressed in terms of mm/km. If 'W' indicates Distance counter Reading in test length and 'B' the bumps counter reading in 'cm' then,

UI Value = B / W x R x 10 mm/km

Where R is the Distance counter Reading per Km = 1000
Roughness testing shall be carried out using a calibrated Bump Integrator trailer in accordance with IRC and CRRI guidelines.

A lower riding quality than that specified above may be accepted at the discretion of the Engineer subject to deductions to the schedule rate applied to the quantity of base course and /or wearing course represented by the test section.

a. For DBM base course

Roughness (UI, mm/km)	Deduction (%) for the value of the section
Less than 2000	No deduction
2000 – 2200	2
2200 – 2400	4
2400 – 2600	8
2600 – 2800	16
Greater than 2800	Material to be removed

b. For BC wearing course

Roughness (UI, mm/km)	Deduction (%) for the value of the section
Less than 1800	No deduction

1800 – 2000	2
2000 – 2200	4
2200 – 2400	8
2400 – 2600	16
Greater than 2600	Material to be removed

Deductions may be applied to both the DBM and BC courses on a given test sections in accordance with the above tables."

SECTION 1900 STRUCTURAL STEEL

Clause 1903 MATERIALS

Clause 1903.1 (Modification) Paragraph 2 of this clause shall be read as under

"IS -226 is to be replaced with IS -1367 (Part-3) for Nuts and Bolts and Grade Of Bolts shall confirms to Approved Drawing /BOQ."

The following shall be added under this sub-clause:

IS : 2062 – Hot Rolled Medium and High Tensile Structural Steel .

IS : 1161 – Steel Tubes for Structural Purpose .

IS :4923 - Hollow Steel Tubes for Structural Use .

Clause 1903.2.4 (Addition) Welding

The following sections shall be added under this sub-clause:
ASME –Section –9

ASME –Section- 5

AWS D 1.1

Clause 1904 FABRICATION

Clause 1904.2 (Addition) Lamination in Plates

The following shall be added under this sub-clause:

Plates with thickness more than 32 mm thick need to be checked for Lamination by Ultrasonic Testing.

Clause 1906 PAINTING

Clause 1906.2 (Modification) Surface Preparation

The following shall be added under this sub-clause:

Surface Preparation by Copper Slag and Grid Blasting only is applicable.

Surface Preparation Profile as per SA 2.5 to be mentioned

Clause 1906.3 (Modification)

Coatings

The following procedure shall be followed under this sub-clause:

Applying one coat of zinc phosphate grey primer paint to all surfaces of steel that are scratched in transit or unloading prior to storage before erection. Surface preparation to be done using copper slag/Grid blasting to match the profile of SA-2.5

Applying one coat Zinc phosphate grey primer paint and two coats of finishing paint as specified in schedule to all surfaces which will be inaccessible after erection, except surfaces coming in contact with concrete. It should be noted that all steel work such as Trusses, Purlins etc., are considered inaccessible.

After steel has been erected, all burrs and abraded spots scratched surfaces, field welds, bolt heads and nuts shall receive one coat of primer paint. Before the paint is applied the surface shall be dry and free from dust, dirt, scale and grease. No paint shall be applied to bolt or field welds until these bolts or field welds have been approved by the Engineer.

All steel material except surfaces coming in contact with concrete shall receive one coat of primer paint after erection after having been thoroughly cleansed of dust and foreign matter. No paint shall be applied when humidity is such as to cause condensation on the surfaces to be painted. Paint shall be stirred frequently to keep the pigment in suspension.

All the external structural steel works shall be painted with two coats of approved anti-corrosive paint with two coats of compatible primer.

Surface preparation to be done using copper slag/Grid blasting to match the profile of SA-2.5

Anti-corrosive Paint shall be lead free types with VOC content not exceeding 250mg/lit.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling and shall be from the same manufacturer for each painting system.

Final Paint:

The final painting of structural steel shall be 2 coats of PU inline with recommendations of approved manufacturer& as specified by the Engineer-in-charge.

Setting Column bases and grouting:

Column bases shall be set so that the column load is uniformly transmitted to the foundation with column centre line aligned with the foundation as shown in the drawings. The location and layout of anchor bolts are to be correctly set to ensure that the structures are erected as shown in the drawings. Where ever pilot study is required to be carry out by the Employer's Representative the same shall be arranged to be carried out at no extra cost.

The Contractor shall be responsible for the correct alignment and leveling of all steelwork at site to ensure that the columns are plumb.

Before erection of columns on foundations, the top surface of the base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material. The Contractor shall be responsible to provide all packing and shim plates that may be required for the proper erection and bedding of the columns with base plates. No steel structure shall be erected on the foundation unless the foundation has been certified fit for erection of steel, by the Employer's Representative. Adequate number of air releases and inspection holes shall be provided in the base plate.

After the column is erected and alignment is checked and accepted, the column with base shall be held firmly in position by shims and pickings. The space between the column base and the base concrete shall be grouted with approved non-shrink grout.

The substrate surface must be free of contaminants and all dirt and dust blown clean. The surface shall be thoroughly cleaned with water and all free water removed after cleaning. A containing formwork or other arrangement shall be made to hold the grout without leaks.

The grout powder shall be mixed with recommended quantity of water and stirred till a grout of smooth consistency is obtained. It shall be poured as soon as possible in order that the expanding properties are fully availed of. Where a thicker section is encountered, 10 mm aggregate chips may be added to the grout. This may slightly affect the flow properties of the grout and additional powder may be needed to restore the same. Bolt holes shall be filled in first and then the gap between the column base and base concrete grouted. It is essential that the grout flow is continuous. For larger areas suitable pumps shall be employed. The air must escape and shall not be trapped inside. Grouting shall not be done in extreme hot or cold weather.

Grouting material used will be as per drawing and instructions of Engineer in charge.

SECTION 3000 **MAINTENANCE OF ROAD:**

This work covers maintenance and preparation of existing road in accordance with the details shown on the drawings and conforming to

the requirements of these Specifications or as directed by the Engineer. The work shall conform to sub clauses 3000 of MoRTH 5th revision.

SECTION 3100 **REINFORCED EARTH:**

This work covers construction of Reinforced soil structures together with the construction of earthwork in layers, assembly and placing of reinforcing elements and facia elements during the construction process and all associated works in accordance with the details shown on the drawings and conforming to the requirements of these Specifications or as directed by the Engineer. The work shall conform to sub clauses 3100 of MoRTH 5th revision (Latest revision).

List of Approved / Recommended Makes and Manufacturers

Sl No	Description of Item	Recommended Make / Manufacturer
1	Ordinary Portland Cement	
1.1	Grey Cement	ACC / Ultratech / JK Cement/ Grasim
1.2	White Cement	Birla White / JK
2	Water Proofing Chemicals	
2.1	Integrated Water Proofing Compound	Ardex-Endura/Fosroc / MYK/ SIKA / BASF / Penetron
2.2	Crystalline Water Proofing Compound	Krystol T1 & T2 / Krystalline / Peneseal CWP / Aquafin IC / Vandrex / BASF / Zuba
2.3	Membrane Water Proofing System	Elastodek P4 / MYK Aquafin-2KM / Ardex-Endura / IWL / STP Ltd / BASF
2.4	Water Stopper	Fixopan, Caliplast or equivalent
3	Construction Chemicals	
3.1	Curing Compound	Fosroc / Sika / BASF
3.2	Concrete Admixture	Fosroc / Sika / BASF / Roffe / Fairmate
3.3	Non-Shrink Grouting / Concrete Rapair	Ardex-Endura/Fosroc / MYK/ SIKA / BASF
3.4	PVDF Coating, Polyester Powder Coating	Akzonobel / Jotun
3.5	Floor Hardeners - Dry Shake/Liquid Nonmetallic	Fosroc / Roffe / MYK / STP Ltd / Ardex-Endura

3.6	Tile Adhesive	Ardex-Endura / Laticrete / MYK / BASF
3.7	Anti Termite / Pest control	Pest Control India Ltd / BIGICO
3.8	Formwork Release Agent	Fosroc / Sika / BASF / Roffe / Fairmate
3.9	Expansion Filler Boards	Neoprene / STP
3.10	Adhesive for wood work	Dunlop / Fevicol
4	Steel	
4.1	HYSD/TMT Bars	TISCO / RINL / JSW / SAIL
4.2	Structural Steel	TATA / SAIL /JSW/JSPL
4.3	Stainless Steel	Salem Steel / Indalco
4.4	High Tensile Bolts	Unbrako /TVS
4.5	Mechanical Splicing Couplers	Jianmao Bldg / Technology Pvt Ltd / G-Tech / SHA MARTIN
4.6	Chemical / Mechanical Anchor Fastners	Hilti / Fischer / MKT (Germany)
4.7	Steel Hollow Sections	TATA / SAIL /JSW/JSPL / Apollo
5	Paints	
5.1	Fire Retardant Paint	Akzonobel /NEWKEM/Berger/ Promat
5.2	Synthetic Enamel Paints & Primer	ICI (Akzonobel) / Asian Paints / Goodlass Nerolac / Berger
5.3	Epoxy Paint	ICI (Akzonobel) / Asian Paints / Goodlass Nerolac / Jotun / Berger
5.4	Acrylic Weather Shield Paint	ICI (Akzonobel) / Asian Paints / Berger
5.5	Plastic emulsion & Acrylic distemper	ICI (Akzonobel) / Asian Paints / Goodlass Nerolac / Jotun / Berger
5.6	Synthetic Textured Paint	Spectrum / Asian Paints / Berger
5.7	Premium Textured Exterior Paint	Terraco India Ltd / Spectrum / Asian Paints / Berger
5.8	Interior Textured Paints	Oikas / Caprol / Berger / Asian Paints
5.9	Anti Carbonation Paint	Dr. Fixit / Xypex / Berger

6	Concrete	
6.1	Ready Mix Concrete Plant Around	Aparna / UltraTech / Lafarge / ACC
7	Road Works	
7.1	Bitumen (All Grades)	MRPL , CPCL
7.2	Emulsion (RS1 , SS1)	Hincol , Ooms , IWL
7.3	Reflectors	3M
7.4	Road Marking Paint (GLASS BEADS)	POTTER-THILAND
7.5	Kerb Marking Paint	Asian Paints / Jotun / Berger
7.6	Crash Barriers	Valmount - Aircon / SAFE
7.7	Road Signage	3M / Avery Dennison/ Alcolite
7.8	Concrete Paver Tiles	Everest / Q-CON / Shobha
7.9	Cobble Stone	Everest / Q-CON / Shobha

SECTION: B

TECHNICAL SPECIFICATIONS –

STORM WATER DRAINAGE SYSTEM WORKS

1 DRAINAGE & RWH SYSTEM

1.1 General:

These specifications cover the items of work in structural and non- structural parts of the works coming under purview of this document. All work shall be carried out in conformation with this. in general, provisions of Indian standards, Indian Roads Congress Codes and other National Standards shall be followed. These specifications are not intended to cover the minute details. The work shall be executed in accordance with best modern practices and ensure effective functionality of the system. All codes and standards referred to in these specifications shall be the latest thereof.

Generally all the Civil works shall be carried out as per the latest edition of "Specifications for Road and Bridge Works" of Ministry of Road Transport & Highways (MoRTH) (Revision - V) as published by Indian Roads Congress and Standard Specifications with correction slips & amendments up to date to the extent they are applicable to the works covered under scope of works.

All the works shall be carried out, in accordance with the "Good for Construction" drawings and designs as would be issued to the Contractor by the Employer's representative duly signed and stamped by him. The Contractor shall not take cognisance of any drawings, designs, specifications, etc. Not bearing Employer's representative's signature and stamp. Similarly the Contractor shall not take cognisance of instructions given by any other authority except the instructions given by the Employer's representative in writing.

Absence of terms such as Providing, Supplying, Laying, Installing, fixing etc., In the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc., unless an explicit stipulation is made in this contract.

The specifications have been divided into different sections / sub-heads for convenience only. They do not restrict any cross-references. The Contractor shall take into account inter-relations between various parts of works/trades.

1.2 Reference Code & Standards:

MORTH (Revision - V)
Section 100,200,300,900,1000,1100,1500,1600,1700,2100,2200,2300,2500,2600,2700 shall be referred. Any other section of MORTH as deemed necessary for particular work shall be referred.

Manual on Sewerage and Sewage Treatment Published by CPHEEO, MOUD (Latest Revision)
National Building Code

ICAO Guidelines (For Landside Development Works)

Relevant IS Codes, Code of Practices and Standard Specifications

(For use of construction materials, testing, materials transportation & storage, quality assurance and quality control, product testing, setting out of works, equipments, sampling, design mix, workmen ship, civil works – excavation, foundation works, formworks, sub structure, super structure, reinforcement, concrete works, curing, finishes, tolerances, construction joints, grouting, water stopper, weep holes, filter media, back filling, repair of defective works, recording measurements, disposal, safety etc.).

1.3 Specifications:

The detailed specifications, IS codes, code of practices and standard applicable for use of construction materials, testing, materials transportation & storage, quality assurance and quality control, product testing, site clearance, setting out of works, equipments, sampling, design mix, workmen ship, civil works – excavation, foundation works, formworks, sub structure, super structure, reinforcement, concrete works, RCC/ humepipe culvert/drain, kerb/street inlets, gully pits, stone revetment, curing, finishes, tolerances, construction joints, grouting, water stopper, weep holes, filter media, back filling, repair of defective works, wearing coat, recording measurements, disposal, safety etc., shall be as per the latest edition of “specifications for road and bridge works” of ministry of road transport & highways **(MORTH) (Revision – V)** as published by Indian Roads Congress and standard specifications and construction criteria’s mentioned elsewhere in the document under general civil works.

A reference Index Table, depicting the (MORTH) (Revision - V) Clause reference and page nos. is appended below;

Sl. No.	Item Of Work	Morth Clause Reference	Page No.
1	Earth Work Excavation	304	17
2	PCC	2100	663
3	RCC Foundation		
	Form Work	1500,	519
	Structural Concrete	1700,	535
	Open Foundations	2100	663
4	Sub Structure	2200	669
	Filter Media	2200-9	
5	Super Structure	2300	675
6	Reinforcement Steel		
	Steel Reinforcement	1600	527
	Sub Structure	2200	669
7	Expansion Joint	2600	723
8	Wearing Coat And Appurtenance	2700	751
	Drainage Spout	2705	
	Approach Slab	2704	
	Wearing Coat	2702	
	RCC Railing	2703	
	Weep Holes	2706	
9	RCC Hume Pipe Culvert / Drain	2900	663
10	Stone Revetment / Pitching	2504	709

1.4 Site Clearance (Clearing and Grubbing):

This work shall consist of cutting, removing and disposing of all materials such as shrubs, stumps, roots, grass, weeds, top organic soil, rubbish, silt, debris, etc., from the area of works which in the opinion of the Employer's representative are unsuitable for incorporation in the works, and such other areas as may be specified on the drawings or by the Employer's representative. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these specifications.

Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

1.5 Reinforced Cement Concrete Pipes:

1.5.1 Design

Design of RCC pipes including reinforcement details and the ends of pipes shall be in accordance with the relevant clauses of IS: 458 and latest amendments.

1.5.2 Manufacturing

1.5.2.1 General

The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

The RCC pipes and collars/rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.

The Employer's representative shall at all reasonable times have free access to the place where the pipes and collars/rubber rings are manufactured for the purpose of examining and testing the pipes and collars/ rubber rings and of witnessing the test and manufacturing.

All tests specified either in this employer's requirements or in the relevant Indian standards shall be performed by the supplier/Contractor at his own cost and in presence of the Employer's representative if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Employer's representative.

If the test is found unsatisfactory, the Employer's representative may reject any or all pipes of that lot. The decision of the Employer's representative in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

1.5.3 Materials

For all materials factory's test result, and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the Employer's representative before carrying to sites.

1.5.3.1 Cement

Cement used for the manufacture of RCC pipes and collars shall conform to relevant is codes. The use of pozzolana as an admixture to portland cement shall not be permitted.

1.5.3.2 Aggregates:

Aggregates used for the manufacture of RCC pipes and collars shall conform to IS: 383. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20mm, whichever is smaller.

1.5.3.3 Mixing and Curing Water

Water shall be clean, colour less and free from objectionable quantities of organic matter, alkali, acid, salts, or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar. Contractor shall submit water quality report before using it.

1.5.4 Reinforcement

Reinforcement used for the manufacture of the RCC pipes and collars shall be mild steel Grade - I or medium tensile steel bars conforming to IS:432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (Part-2). Reinforcement cages for pipes and collars shall be as per relevant requirement of IS:458.

1.5.4.1 Concrete

Concrete used for the manufacture of RCC pipes and collars shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15 Cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

1.5.4.2 Curing

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

1.5.5 Dimensions

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover To reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes.

The tolerances regarding overall length, internal diameter of pipes or sockets and barrel wall thickness shall be as per relevant clause of IS: 458.

1.5.6 Workmanship and Finish

Pipes shall be straight and free from cracks. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes upto 600mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between the Employer's representative and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipe throughout its effective length, tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm for every meter run.

1.5.7 Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.Employer's representative reserve the right to attend all testing.

During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by the Employer's representative the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Employer's representative and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

i) Hydrostatic Test
ii) Three Edge Bearing Test
iii) Absorption Test
iv) Visual Examination

1.5.8 Sampling and Inspection

In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this employer's requirements shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with table 15 of IS: 458.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every pipe be selected till the requisite number is obtained, or being The integral part of N/N Where N is the lot size and N is the sample size.

All pipes selected shall be inspected by Employer's representative for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested shall be in accordance with column 4 of table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS: 458.

All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

All result of tested data must be prepared by Contractor at site so that the Employer's representative shall make decision of "Fail or Pass" at once. All cost for the test shall be borne by the Contractor.

1.5.9 Marking

The following information shall be clearly marked on each pipe:

A) Internal and external diameter and length of pipe
B) Class of pipe
C) Date of manufacture and
D) Name of manufacturer or his registered trade-mark or both.

1.5.10 Jointing

1.5.10.1 General

Jointing of RCC pipes shall be done as per the requirements of following employer's requirements and as per the relevant is standard. After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

1.5.10.2 Spigot and Socket Joint (Rigid)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar which shall be rammed with caulking tool. This joint is used for low pressure pipe line.

1.5.10.3 Collar Joint (Rigid)

After laying the RCC pipes at proper alignment and gradient their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with a tarred gasket in one length for each joint. The collar shall then be slipped over the end of the pipe and the next pipe butted well against the tarred gasket by suitable appliances approved by the Employer's representative so as to thoroughly compress the tarred gasket into the grooves, care being taken that the concentricity of the pipes and levels are not disturbed during this operation.

The collar shall then be place symmetrically over the end of the two pipes and the space between the inside of the collar and the outside of the pipe filled with a mixture of cement and sand to withstand any stress and prevent any water leakage, tempered with just sufficient water to have a consistency of the semi-dry conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at 450 to the side of the pipe. The finished joints shall be protected and cured thoroughly as directed by the Employer's representative. Any plastic solution or cement mortar that may have been squeezed into the inside of the pipe shall be removed so as to leave the inside of the pipe perfectly clean.

1.5.10.4 Flush Joint (Internal)

This joint shall be generally used for culvert pipes of 900 mm diameter and over. The ends of the pipes are specially shaped to form a self centering joint with an internal jointing space 13 mm wide. The finished joint is flush with both inside and outside with the pipe wall. The jointing space is filled with cement mortar mixed sufficiently dry to remain in position when forced with a trowel or rammer.

1.5.10.5 Flush Joint (External)

This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

1.5.10.6 Spigot and Socket (Semi-Flexible)

This joint is composed of specially shaped spigot and socket ends on the RCC pipes. A rubber ring shall be lubricated and then placed on the spigot which is forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and socket, stiff mixture of cement and mortar shall then be filled into the remaining annular space with a caulking tool.

1.5.10.7 Collar Joint (Semi-Flexible)

This joint is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and collar, seals the joint. Stiff mixture of cement mortar shall then be filled to withstand stress and prevent any water leakage, into the remaining annular space and rammed with a caulking tool.

1.5.10.8 Spigot and Socket Joint (Flexible)

The RCC 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 RCC pipes shall be of spigot and socket type and rubber rings shall be used, and the manufacturer's instructions shall be deemed to form a part of these 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.

1.5.11 Cleaning of Pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by the Employer's representative, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Employer's representative to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Employer's representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, Contractor shall amend the work and carry out such further tests as are required by the Employer's representative.

It shall also be ascertained by Contractor that each stretch from manhole to manhole or the stretch as directed by Employer's representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

1.5.12 Testing at Work Site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following employer's requirements and as directed by the Employer's representative. All equipment for testing at work site shall be supplied and erected by Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be Contractor's responsibility and shall be rectified by him to full satisfaction of the Employer's representative. Water used for the 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 Employer's representative and before back filling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight by filling in pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour. The apparatus used for the purpose of testing shall be approved by the Employer's representative. Contractor if required by the Employer's representative shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 liter/ hour/100 linear metres / 10mm of nominal internal diameter. 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.

In case of pressure pipeline, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

All of results of test and inspection data must be prepared by Contractor at site so that the Employer's representative shall make decision of "Fail or Pass" at once. All cost for the inspection shall be borne by the Contractor.

1.6 Earthwork for Laying Of Pipes:

1.6.1 General:

The work shall include supplying, handling, laying and jointing of pipes, hydraulic testing, backfilling, restoration and maintenance of surface as per IS: 12288, IS: 783, IS: 4127 and IS: 458, IS: 536 as and were applicable.

1.6.2 Excavation of Trench:

The trench shall be so dug that the pipe may be laid to the required alignment and at the required depth. De-watering of trench shall be made by the Contractor, depth of trench shall be as per drawings and a minimum cover of 1.0 m or as recommended by Employer's representative - in -charge shall be adopted, but it may be modified according to imposed load and local site conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the Employer's representative. The trench shall be so braced and drained that the workmen may work therein safely and efficiently. The discharge of the trench, de-watering pumps shall be conveyed either to drainage channels or to natural drains.

The excavation work includes cutting and dismantling of existing road surface / floor surface / pavement surface. The type of road / pavement / flooring along the proposed pipeline alignments and at manholes varies from granite flooring, concrete flooring, rcc, asphalt road, interlocking block pavement, tiled flooring etc. Contractor shall assess the quantum of work involved through site visit.

1.6.3 Width of Trench:

The width of trench at bottom faces of sheeting shall be such as to provide not less than 210 mm clearance on either side of the pipe. Trenching shall be of such extra width, when required will permit the convenient placing of pipe supports, strutting and planking and handling of specials.

1.6.4 Wooden Shoring

Contractor shall suitably design polling boards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Employer's representative. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

The Employer's representative may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. In close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

1.6.5 Steel Plate Shoring

Where the subsoil conditions are expected to be of a soft and unstable character in

trench/pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the instructions, manner and method directed by the Employer's representative. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the employer's requirements.

1.6.6 Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Employer's representative.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of meters and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. As the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 m of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and the Employer's representative gives permission to proceed with the backfilling.

1.6.7 Provisions for Joints:

Additional width shall be provided at positions of sockets and flanges for jointing to be made properly. Depth of pits / trench at such places shall also be sufficient to permit finishing of joints.

1.6.8 Pipe Clearance in Rocks:

Ledge rocks, boulders and large stones shall be removed to provide a clearance of at least 150 mm below and on each side of pipes and fittings for pipes 600 mm in diameter or less, and 200 mm for pipes larger than 600 mm in diameter.

1.6.9 Trimming of Trench Bottom:

The bottom of the trench shall be properly trimmed off to present a plain surface and shall be leveled. Where rock and large stones or boulders are encountered the trench shall be trimmed to a depth of at least 150 mm below the level in which the barrel of the pipe is to be laid and filled with bedding material as specified which shall be well rammed to form a fair and clean bed for pipes.

1.6.10 Special Foundation in Poor Soil:

Where the bottom of the trench at sub-grade is found to consist of material which is unsuitable to such a degree that, in the opinion of the Employer's representative, either it can be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly or it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable form foundation for the pipe, consisting of piling, timbers and other materials, in accordance with plans prepared by Employer's representative shall be constructed.

1.6.11 Shifting of Underground Services:

Any or all the existing underground utility lines such as telephone cables, water mains, fire hydrants, etc., which may be encountered during the progress of work shall have to be very carefully supported and maintained.

In case any of the existing utility lines is to be shifted or attended in any fashion, the **Contractor shall intimate Employer**. The Contractor shall also get the Necessary Alteration Done To the satisfaction of the Employer's representative. No Attempt Should Be Made On The Part Of The Contractor To Shift Or Alter Any Of The Utility Lines Without Specific Instruction From Employer's representative.

With The Progress Of The Excavation, If Any Pipe, Conduit, Electric Cable, Telephone Cable, Gas Main Or Other Underground Structure Is Encountered, Digging By General Equipment Shall Be Discontinued And The Excavation Shall Be Done By Hand Tools Or By Special Equipment Suitable For Such Excavations.

1.6.12 Braced And Sheeted Trenches:

Open cut trenches shall be sheeted and braced as required and as may be necessary to protect life, property or the work.

All timbering, sheeting and piling with their wallings, and supports shall be of adequate dimension and strength and fully braced and strutted so that no risk of collapses or subsidence of the walls of the trench shall take place. The Contractor shall be held responsible and accountable for the sufficiency of all timbering, bracing, sheeting and piping used for, all damage to persons and property resulting from the improper quality, strength, placing, maintaining or removing the same.

1.6.13 Care of Surface Material For Re-Use:

All excavated materials which in the opinion of the Employer's representative, are suitable for reuse in restoring the surface shall be kept separate from the general excavated material as directed by the Employer's representative.

1.6.14 Stacking of Excavated Material:

All excavated material shall be stacked in such a manner that it will not endanger the work or workman and it will avoid obstructing footpaths and roads, hydrants, surface boxes, fire, drainage or other utility controls shall be left unobstructed and accessible until the work is completed.

1.6.15 Safety Provisions:

To protect from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for traffic to use the road ways. Temporary support, adequate protection and maintenance of all underground and surface structures in the progress of the work shall be furnished under the direction of Employer's representative. Suitable signs shall be placed and necessary detour signs shall be provided.

1.6.16 Backfilling:

Backfilling shall be carried out in layers as per specifications and shall be compacted to 95% of MDD. Backfilling to be done with crusher sand in layers not exceeding 200mm. In areas not feasible to backfill with sand the backfilling shall be carried with Lean mix concrete.

All backfill material shall be free from cinders, ashes, slag, refuse, rubbish, vegetable or organic material, lumpy material, boulders, rocks or other material which in the opinion of Employer's representative is unsuitable or deleterious.

Pipe trenches shall be backfilled as per IS: 12288 or as directed by the Employer's representative.

1.6.17 Restoration and Cleaning Up:

All structures, compound wall, footpaths, gutters, poles or other property and surface structures removed or disturbed as a part of the work shall be restored to a condition

equal to that before the work began.

All surplus materials, all tools and temporary structures shall be removed from the site as directed by the Employer's representative. All dirt, rubbish and excess earth from the excavation shall be removed and the construction site left clean to the satisfaction of the Employer's representative.

1.7 LAYING OF PIPES & FITTINGS

1.7.1 Carting & Handling

Pipes and fittings /specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Employer's representative. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

1.7.2 Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.

Fittings/specials shall be stacked under cover and separated from pipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

1.7.3 Inspection and Acceptance of Pipe:

The pipe and fittings shall be inspected for defects as per relevant standards. Inspection may be made at the place of manufacture or on the work site after delivery

or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirement as per relevant is, even though sample pipe unit may have been accepted as satisfactory at the place of manufacture.

The Contractor shall submit tests and certified copies of test results for the materials and finished pipe units before acceptance of the same. In spite of submission of the certified copies of test result, the **EMPLOYER** reserves the right to test any of the material and pipe units at the Contractor's cost.

1.7.4 Installation of Pipes and Fittings:

Unless otherwise specified, pipes and fittings shall be placed in position singly and shall not be jointed until after they have been inspected by the Employer's representative..

The Contractor shall mark the alignment of pipeline on the ground and notify the Employer's representative for his inspection and approval. Such notice shall be given to the Employer's representative at least 72 hours in advance. The pipes and fittings shall be accurately installed to the levels, grades and positions set out in the trench and as directed by the Employer's representative. Changes in direction or in grade of the pipeline shall be carried out by making use of any permissible deflection or proper bends as may be directed by the Employer's representative.

When the grade of the pipeline is steeper than 1 in 20, installation of pipes and fittings shall proceed on an ascending grade and (where appropriate) with the socket end leading. Where the grade is not steeper than 1 in 20 installations may proceed without break on both ascending and descending grades unless the Employer's representative directs otherwise.

Pipes and fittings which are required to be fixed on to or built into other structure shall be positioned as shown on drawings or as directed by the Employer's representative. Brackets, steelwork, cradles and similar details shown on the drawings or, if not so detailed, shall be as approved by the Employer's representative. Brackets and fittings shall be painted with two coats of bituminous paint over a coat of primer.

The Contractor shall keep the interior of pipelines clean and free from water, dirt, stones or other foreign matter as installation proceeds and the end of each pipeline laid and fittings installed shall be sealed off by a wooden plug or by other approved means.

1.7.5 Bedding:

Pipes shall be rested on min. 150 mm thick M: 15 Grade plain cement concrete bedding / as per approved drawing.

1.7.6 Anchor / Thrust Blocks:

Contractor shall provide anchor / thrust blocks at all bends and at all other places as directed by the Employer's representative. Anchor blocks shall be in cement concrete as per dimensions given in the drawing. The grade of concrete in relevant sections shall be strictly followed.

1.7.7 Pipe Work Surrounded by Concrete:

When pipe work is surrounded by concrete at crossings etc., the pipes shall be given the normal external protection and shall be wrapped with at least two layers of waterproof paper securely fixed with waterproof tape.

Where pipe work is built into the concrete walls of chambers and structures or surrounded by concrete externally monolithic with such wells, before being concreted in place the pipe work shall be protected as referred to in relevant clause without additional protection.

1.7.8 Cover to Pipelines:

The cover from the crown of the pipe to finished ground level shall not be normally less than 1000 mm.

1.7.9 Jointing of Pipes and Fittings:

The requirements of this clause shall be read in conjunction with the particular requirements specified in relevant IS as and where applicable.

Before making any joints, the Contractor shall ensure that the interior of each pipe and fitting is clean and that it remains clean. Immediately before starting a joint, the Contractor shall clean the end of each pipe and fittings to be jointed and shall otherwise specially prepare the ends for jointing as may be necessary for the particular kind of joint. All mechanical joints shall be cleaned and have their paint-work or coating made good before assembly.

The Contractor shall use only the proper jointing parts as specified and obtained through the suppliers of pipes and fittings and he shall take account of the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. All joints shall be accurately made and shall be capable of passing tests for individual joints and for the complete pipeline as may be specified hereinafter.

After completing a joint, any protective paint or other coating shall be made good and any metal joint which is not already coated shall be cleaned and painted with two coats of approved protective paint. Internal lining and additional external protection of joints, where ordered by the Employer's representative shall be carried out as specified.

Flanged tail pieces shall be provided for mounting of flange special necessary. All the flanged ci pipes shall have flanged joints conforming to relevant is using compressed fibre board or natural / synthetic rubber of thickness between 1.5 to 3 mm.

Contractor is free to adopt any other mechanical joint which has got a proven record. In such case, Contractor should inform in writing the Employer's representative, well in advance for his approval for using such joint with two copies of relevant specification if

IS: is not available.

1.7.10 Pipe Sleeves:

Pipe sleeves shall be provided for pipelines passing through foundations, walls, floors, roofs, etc. They shall be sufficient in size to permit the passage of flanges or fittings assembled with the line. No extra payment will be made for providing such sleeves.

1.7.11 Hydraulic Testing:

All pipelines should be tested before being brought into service. The test should be a hydrostatic test performed by filling the pipeline with water as prescribed in relevant IS. If the test is not satisfactory, the fault should be found, rectified and pipe retested without any extra cost. Contractor has to arrange for the water required for testing at their own cost.

1.7.12 Restoration of Road / Pavement / Flooring:

The road surface / pavement surface / floor surface dismantled during execution of pipeline works and construction of manholes and collection well shall be restored to its original condition on completion of works to the satisfaction of Employer's representative.. The type of road / pavement / flooring along the proposed pipeline alignments and at manholes varies from granite flooring, concrete flooring, rcc, asphalt road, interlocking block pavement, tiled flooring etc. Contractor shall assess the quantum of work involved through site visit.

1.8 MANHOLES

1.8.1 Excavation

Excavation, shoring, dewatering etc. For the pits of manholes, laying of pipes and fittings/specials shall be done in accordance with employer's requirements described elsewhere in the document.

1.8.2 Bed Concrete

The bed concrete for manholes shall be done in accordance with employer's requirements described elsewhere in the document and approved drawings.

1.8.3 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 shall have a raised chequered design to provide an adequate non-slip grip. C.I. 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 to 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 C.I. steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole.

1.8.4 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/Storm Drain,
Arrow Showing Direction of Flow

1.8.4.1 Cast Iron Frame and Cover

The cast iron frame and cover shall be of grey 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 7.15.10. 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 employer's representative. 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 employer's representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 Kg. Including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 Kg. In case of scraper manhole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

1.8.4.2 Fiber Reinforced Concrete Frame and Cover

Fiber 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 fiber reinforced frame shall have clear opening of 560 mm diameter and weighing 102 Kg. The cover shall have a minimum thickness of 100 mm and weighing 78 Kg. The fibers 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 fiber reinforced frame and cover shall be manufactured as approved.

1.8.4.3 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. The frame and cover shall be cast in cement concrete of M25 Grade. 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.

1.8.5 Specification of RCC Drains:

This specification shall read in conjunction with RCC clauses of structure in MoRTH. The more onerous specification between MoRTH / below mentioned clauses will apply for RCC DRAIN.

a) Specifications For Earth Work In Excavation & Backfilling:

This part of the specification deals with general requirements for earthwork in excavation in different materials, site grading, filling back with approved borrowed earth around foundations, plinths and approach ramps, conveyance and disposal of excess excavated soil or stacking them properly as directed by the Employer's representative. The excavation in rock by blasting etc. Shall be as per relevant specifications.

b) Applicable Codes:

The provisions of the latest Indian Standards listed below, but not restricted to, form part of these specifications:

IS: 783	Code of Practice for Laying of Concrete Pipes.
IS: 1200	Method of Measurement of Civil Engineering Works - Part I Earth Work.
IS: 1498	Classification and Identification of Soils for General Engineering Purposes
IS: 2720	Methods of Test for Soils (All Parts)
IS: 2809	Glossary of Terms and Symbols Relating to Soil Engineering.
IS: 3764	Safety Code for Excavation Work

c) Excavation:

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's representative, the work involved requires it to be carried out by manual methods.

The Contractor shall ensure the stability of the excavation so that the surrounding ground and all adjoining structures and plants will be safe against settlement, subsidence and damage and that there is no risk of injury to personnel.

Excavation for structures shall consist of removal of materials for the construction of the foundations, retaining walls, pipe trenches and other similar structures in accordance with the requirements of this specification and the lines and dimensions shown on the drawings or as indicated by the Employer's representative in charge. The work shall

include construction of shoring, bracing, draining, dewatering and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction necessary for placing the foundations, trimming bottoms of excavation; backfilling with approved material brought from outside or brought from approved borrow pits cleaning up the site and disposal of all surplus materials.

After the site has been cleared, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Employer's representative in charge. The Contractor shall provide all labour, survey instruments and materials such as string, pegs, nails, bamboo, stones, lime, mortar, concrete etc. Required in connection with the setting out of works and establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as they are required for the work in the opinion of the Employer's representative in charge.

Excavation shall be taken to the width of the lowest step of footing and the sides shall be left plumb where the nature of the soil allows it. Where the nature of the soil or the depth excavated trench/pit does not permit vertical sides, the Contractor at his own expense shall put up the necessary shoring, strutting and planking or sheet piling or cut slopes to a safe angle or all with due regard to the safety of personnel and the works and to the satisfaction of the Employer's representative in charge.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Employer's representative. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete of Grade M10 with 40 mm downgraded aggregates as approved by the Employer's representative. The final excavation should be carried out just prior to laying the blinding course.

Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by Employer's representative, at his own cost outside the lines shown on the drawings or directed by Employer's representative. Should any excavation be taken below the specified elevations, Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by Contractor on this account.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

d) Timber Shoring:

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Employer's representative. 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 meter spacing, strutted with ballies or as approved by the Employer's representative. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

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 the Employer's representative. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. From collapsing.

Timber shoring may also 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 Employer's representative.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

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 4 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 Employer's representative. In all other respects, the specifications for close timbering shall apply to open timbering.

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. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

e) Preparation Of Foundation:

The bottom of the foundation shall be leveled both longitudinally and transversally or stepped as directed by the Employer's representative in charge. Before the footing is laid, the surface shall be slightly watered and rammed. In the event of the excavation having been made deeper than that shown on the drawing or as otherwise ordered by the Employer's representative in charge, the extra depth shall be made up with

concrete of the foundation grade at the cost of the Contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed of all loose and soft materials, cleaned and cut to a firm surface either level, stepped, or serrated as directed by the Employer's representative in charge. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Employer's representative in charge.

f) Fill, Backfilling And Site Grading:

General:

All fill material shall be subject to the Employer's representative's approval. If any material is rejected by Employer's representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Employer's representative after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Employer's representative.

The Contractor shall not commence the placement of any fill or backfill at any location without the approval of the Employer's representative.

Material:

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

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer's representative. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed off as directed by Employer's representative. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist, at his cost.

g) Filling In Pits And Trenches Around Foundations Of Structures, Walls, Etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Employer's representative. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall

be allowed unless the Employer's representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's representative.

Backfilling:

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

Selected fill material is required to be borrowed, the Contractor shall make arrangement for bringing the material from outside borrow pits. The material sources shall be subject to the prior approval of the Employer's representative in charge. The Contractor shall make necessary access roads to such borrow areas at his own cost, if such access roads do not exist.

Backfilling of the foundation/pits shall be done as soon as the foundation work has been completed to the satisfaction of the Employer's representative in charge but not earlier than the full setting of the concrete or masonry of the foundation. Backfilling shall be carried out in such a manner as to not cause undue thrust on any part of the structure. Backfilling shall be done in space around the foundations after clearing it of all debris and in layers of 150 mm. Loose thickness, watered and compacted with plate compactor of min.2t capacity to the satisfaction of the Employer's representative in charge and to the original surface. The soil compaction shall be verified by testing as per codal provisions & standards.

Filling In Trenches:

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

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

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murrum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

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

1.9 Concrete And Allied Works:

1.9.1 Applicable Codes:

Materials:

1) IS: 269 Specification For 33 Grade Ordinary Portland Cement.
2) IS: 455 Specifications For Portland Slag Cement.
3) IS: 1489 Specification For Portland-Pozzolana Cement (Part 1&2).
4) IS: 8112 Specification For 43 Grade Ordinary Portland Cement.
5) IS: 12269 Specification For 53 Grade Ordinary Portland Cement.
6) IS: 12330 Specification For Sulphate Resisting Portland Cement.
7) IS: 383 Specification For Coarse And Fine Aggregates From Natural Sources For Concrete.
8) IS: 432 Specification For Mild Steel And Medium (Tensile Steel Bars And Hard- Drawn Steel) Wires For Concrete Reinforcement. (Part 1 And 2)
9) IS: 1786 Specification For High Strength Deformed Steel Bars And Wires For Concrete Reinforcement.
10) IS: 1566 Specification For Hard-Drawn Steel Wire Fabric For Concrete Reinforcement.
11) IS: 9103 Specification For Admixtures For Concrete.
12) IS: 2645 Specification For Integral Cement Water- Proofing Compounds For Cement Motar & Concrete
13) IS: 4990 Specification For Plywood For Concrete Shuttering Work.

Material Testing:

1) IS: 4031 Methods of Physical Tests For Hydraulic Cement (Parts 1 To 15)
2) IS: 4032 Method 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 1 To 8)
6) IS: 3025 Methods of Sampling and Test (Physical And Chemical) For Water Used In Industry.
7) IS: 6925 Methods of Test For Determination Of Water Soluble Chlorides In Concrete Admixtures.

Material Storage:

1) IS: 4082 Recommendations On Stacking And Storing Of Construction Materials And Components at Site

Concrete Mix Design:

1) IS: 10262 Recommended Guidelines For Concrete Mix Design.
2) SP: 23 (S&T) Handbook on Concrete Mixes.

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 Strength of Accelerated Cured Concrete Test Specimens.
4) IS: 8142 Method of Test For Determining Setting Time of Concrete By Penetration Resistance.

5) IS: 9284 Method of Test For Abrasion Resistance of Concrete.
6) IS: 2770 Methods of Testing Bond In Reinforced Concrete. Part I-Pullout Test
7) IS: 2911 Code of Practice For Design And Construction of Pile Foundations (Part

Equipments:

1) IS: 1791 General Requirements 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: 3370 Code of Practice For Concrete Structures For Storage of Liquids (Parts 1 To 4)
3) IS: 3935 Code of Practice For Composite Construction.
4) IS: 2502 Code of Practice For Bending And Fixing of Bars For Concrete Reinforcement.
5) IS: 5525 Recommendation For Detailing of Reinforcement In Reinforced Concrete Works.
6) IS: 2751 Code of Practice For Welding of Mild Steel Plain And Deformed Bars Used For Reinforced Concrete Construction.
7) IS: 2571 Code of Practice For Laying Insitu Cement Concrete Flooring.
8) IS: 2911 Code of Practice For Design And Construction of Pile Foundations
9) SP: 16 – 1980 Design Aids For Reinforced Concrete To IS 456: 1978
10) SP: 34 – 1987 Handbook on Concrete Reinforcement And Detailing

Construction Safety:

1) IS: 3696 Safety Code For Scaffolds And Ladders. (Parts 1 & 2)
2) IS: 7969 Safety Code For Handling And Storage of Building Materials.

1.9.2 Tests & Standards of Acceptance:

1.9.2.1 Defective Concrete:

Any concrete which gives results below the results specified in relevant codes, becomes severely damaged due to cracking, shows excessive honey-combing and exposure of reinforcement or exhibits any fault which, in the opinion of the Employer's representative., seriously impairs its function, may be declared defective concrete. Such concrete shall be cut out, removed from the site and replaced by fresh concrete

of the specified quality at the Contractor's own expense to the satisfaction of the Employer's representative.. Alternatively, the Contractor shall carry out at his own expense whatever other remedy the Employer's representative. may reasonably require having regard to all the circumstances.

1.9.2.2 Tests:

In case of doubt regarding grade of concrete used, either due to poor workmanship or based on results of cube crushing strength, tests of concrete on the basis of any or all the following shall be carried out. The Employer's representative shall be the final authority for interpreting the results of all these tests and the Contractor shall carry out these tests at his own expense without any additional cost to the employer.

1.9.2.3 Core Test:

The points from which cores are to be taken and the number and size of cores required shall be the discretion of the Employer's representative. and shall be representative of the whole of the concrete concerned. In no case, however, shall fewer than three cores be tested.

Core shall be prepared and tested as described in IS: 516. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent strength of 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75 percent.

1.9.2.4 Non Destructive Test:

Non-destructive test e.g. rebound hammer test, ultrasonic test - as directed by the Employer's representative..

the non-destructive tests on various elements (except on piles) such as core test and ultrasonic pulse velocity test shall be carried out by the Contractor at his own expense if so desired by the Employer's representative. However, non-destructive testing shall be carried out by an agency approved by the Employer's representative and shall be done using only recommended testing equipment. The acceptance criteria for these tests shall be as specified by the testing agency or good Engineering practice and as approved by the Employer's representative.

1.9.3 Spacers & Cover Blocks:

Spacers & cover blocks should be of concrete of same strength or PVC as per IS 456-2000, for reinforcements to ensure specified cover according to drawings.

1.9.4 Design Mix Concrete:

Mix design & testing: for design mix concrete, the mix shall be designed according to IS: 10262 And SP:23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS:456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for design mix concrete shall be as per Table-5 of IS: 456 or as given below, whichever is higher.

Grade Of Concrete	Minimum Cement Content In Kg/Cu.m of Concrete
M15	250
M20	260
M25	315
M30	360
M35	375

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the Contractor in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same Contractor's equipment and the same materials as are proposed for the permanent works. The Contractor shall give 24 hours notice of such trials to enable the Employer's representative's representative to attend. For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with IS: 516. Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production.

The Contractor shall not commence concreting in the permanent works until details of trial mixes and test results for each class of concrete have been submitted to and approved by the Employer's representative.

Unless otherwise specified, only medium graded fine aggregate shall be used

A trial mix design will be approved by the Employer's representative with respect to strength if the average compressive strength of the nine cubes so tested is more than the target mean strength appropriate to the grade of concrete.

For concrete of grade 30 and over the Contractor shall cast two sample wall panels 48 hours apart. Each shall be cast in two equal lifts to form a wall panel having one horizontal construction joint formed in the manner proposed by the Contractor for the works. The top surface of the second lift shall have a Type U3 finish. The panels shall not be touched up after stripping. The panels shall be 300 mm thick and 1.5 m long by 1.5 m high. The Contractor shall not commence concreting in the permanent works until the test panels have been approved by Employer's representative.

The Contractor shall not alter the approved mix proportions nor the approved source of supply of any of the ingredients without having previously obtained the approval of the Employer's representative.

During production, the Employer's representative may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.

It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to the Employer's representative at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456 as follows:

Grade of Concrete	Minimum Compressive Strength N/Sq.mm At 7 Days	Specified Characteristic Compressive Strength N/Sq.mm At 28 Days
M 10	7	10.0
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Employer's representative is given below:

Structure/Member	Slump In Millimeters	
	Maximum	Minimum
Reinforced Foundation Walls And Footings	75	40
Plain Footings, Caissons And Substructure Walls	75	40
Slabs, Beams And Reinforced Walls	100	40

Note: All concreting done for water retaining structures shall have a minimum slump value of 60 mm and maximum of 100 mm

Batching & Mixing Of Concrete: it is expected that batching plants of minimum 20 m^3 capacity and pumps for placing concrete shall be used. Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Employer's representative shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Employer's representative. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456.

Nominal Mix Concrete:

Mix design & testing: mix design and preliminary tests are not necessary for nominal mix concrete. However works tests shall be carried out as per IS:456. Proportions for nominal mix concrete and w/c ratio may be adopted as per Table 9 of IS:456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching & Mixing of Concrete: Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only, using whole bags of cement.

Foundation Bedding:

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Employer's representative. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

Formwork:

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, false work, wedges etc.

The design and Engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Employer's representative, the drawings and calculations for the design of the formwork shall be submitted to the Employer's representative for approval.

Formwork shall be designed to fulfill the following requirements:

a) **Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.**
b) **Made of suitable materials.**
c) **Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.**

d) **Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.**
e) **Capable of easily striking without shock, disturbance or damage to the concrete.**
f) **Soffit forms capable of imparting a camber if required.**
g) **Soffit forms and supports capable of being left in position if required.**
h) **Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.**

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Employer's representative. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before placing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. Shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Employer's representative. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left insitu shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

All corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size, except where specified in the drawings.

Forms for substructure may be omitted when, in the opinion of the Employer's representative, the open excavation is firm enough (in hard non-porous soils) to act as

a form. Such excavations shall be larger, as approved by the Employer's representative, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Employer's representative. The Contractor shall temporarily and securely fix items to be cast (embedment's/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

1. Development of adequate concrete strength;
2. Permissible deflection at time of striking form work;
3. Curing procedure employed - its efficiency and effectiveness;
4. Subsequent surface treatment to be done;
5. Prevention of thermal cracking at re-entrant angles;
6. Ambient temperatures; and
7. Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20^{o}c) forms may be struck after expiry of the time period given In IS:456 unless approved otherwise by the Employer's representative. For portland pozzolana/slag cement the stripping time shall be suitably modified as approved by the Employer's representative. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

1.9.5 Reinforcement Workmanship:

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5^{O}C. Local warming may be permitted if steel is kept below 100^{o} C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by the Employer's representative.

Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Employer's representative.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Employer's representative prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Employer's representative's approval.

1.9.5.1 Tolerances:

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

1.9.5.2 Tolerances In Other Structures:

All Structures

(I) Variation of the construction linear outline from established position in plan

In 5 M	-	10 Mm
In 10 M or More	-	15 Mm

(Ii) Variations of dimensions to individual structure features from established positions

In 20 M or more	-	25 Mm
In Buried Construction	-	50 Mm

(Iii) 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

(Iv) Variation from level or grade indicated on 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

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

Minus	-	5 Mm
Plus	-	10 Mm

(Vi) Variation in the thickness of slabs, walls, arch sections and similar members

Minus	-	5 Mm
Plus	-	10 Mm

Footing For Columns, Piers, Walls, Buttresses and Similar Members

(I) Variation of Dimension In Plan

Minus	-	10 Mm
Plus	-	50 Mm

(ii) Misplacement Or Eccentricity
2% footing width in the direction of misplacement but not more than 50 mm

(iii) Reduction In Thickness
5% of specified thickness subject to a maximum of 50 Mm.

1.9.5.3 Tolerances in Formwork:

The Formwork Shall Be Designed And Constructed To The Shapes, Lines And Dimensions Shown On The Drawings Within The Tolerances Given Below:

(I)	Deviation From Specified Dimensions Of Cross Section Of Columns And Beams	- 6 Mm + 12 Mm
(Ii)	Deviations from dimensions of footings (tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
	- Dimension In Plan	- 12 Mm + 50 Mm
	- Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
	- Thickness	± 0.05 Times the specified thickness

1.9.5.4 Mass Concrete Works:

Sequence of pouring for mass concrete works shall be as approved by the Employer's representative. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

1.9.6 Preparation Prior to Concrete Placement:

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. Provided all arrangements-

formwork, equipment and proposed procedure, shall be approved by the Employer's representative. Contractor shall maintain separate pour card for each pour as per the format enclosed.

1.9.7 Transporting, Placing and Compacting Concrete:

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.

Concrete Shall Not Be Placed In Flowing Water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

a) Continuously between construction joints and pre- determined abutments.
b) Without disturbance to forms or reinforcement.
c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
d) Without dropping in a manner that could cause segregation or shock.
e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
f) Do not place if the workability is such that full compaction cannot be achieved.
g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
i) Ensure that there is no damage or displacement to sheet membranes.
j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Employer's representative. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Employer's representative. Concrete shall be protected against damage until final acceptance.

1.9.7.1 Hot Weather Requirements:

Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 33^{o} C at the time of placement of fresh concrete.

Where directed by the Employer's representative, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

1.9.8 Construction Joints and Keys: (For Work Continuation):

Construction joints will be as shown on the drawing or as approved by the Employer's representative. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Employer's representative.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Employer's representative.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

1.9.9 Construction Joints:

Concreting shall be carried out continuously up to the construction joints, the position and details of which shall be as shown on approved drawings or as directed by the Employer's representative in charge/PMC Employer's representative. Such joints shall, however, be kept to the minimum.

For a vertical construction joint, a stopping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concrete is compacted against it. Concreting shall be continued right up to the board. The board shall not be removed before the expiry of the specified period for removal of vertical forms.

In all cases, the position and detailed arrangement of all construction joints shall be predetermined and got approved by the Employer's representative in charge/PMC Employer's representative.

1.9.10 Water Stops:

1.9.10.1 Material:

The material for the PVC water stops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS: 8543.

A)	Tensile Strength	:	11.6 N/Mm^2 Minimum
B)	Ultimate Elongation	:	300% Minimum
C)	Tear Resistance	:	4.9 N/Mm^2 Minimum
D)	Stiffness in Flexure	:	2.46 N/Mm^2 Minimum

E)	Accelerated Extraction		
	I) Tensile Strength	:	10.50 N/Mm^2 Minimum
	ii) Ultimate Elongation	:	250% Minimum
(F)	Effect of Alkali	:	7 Days
	I) Weight Increase	:	0.10% Maximum
	ii) Weight Decrease	:	0.10% Maximum
	Iii) Hardness Change	:	± 5 Points
(G)	Effect of Alkali	:	28 Days
	I) Weight Increase	:	0.40% Maximum
	ii) Weight Decrease	:	0.30% Maximum
	iii) Dimension Change	:	±1%

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Employer's representative before procurement for incorporation in the works.

1.9.10.2 Workmanship:

Water stops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Water stops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard l or t type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of water stops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Water stops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Particular care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips. Projecting portions of the water stops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting water stop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets.

1.9.11 Preformed Fillers and Joint Sealing Compound:

1.9.11.1 Materials:

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of Polyethylene board conforming to IS code with adhesive as approved by Employer's representative.

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

Sealants shall be of the following types:

Sealant Type A:

Sealant Type A shall be a gun grade, Non-Slumping compound suitable for sealing Horizontal, Vertical and Soffit joints in water retaining structures. It shall be a UK WFBS material approved for unrestricted use in contact with potable water to the full exposure condition of 15,000 mm^2/l, and shall not support bacterial growth.

It shall be stable and shall have a low water absorption and good adhesion to concrete.

Hardness (Shore A)	:	> 12
Transverse movement accommodation	:	±15%

Sealant Type B:

Sealant type shall be a gun grade compound, suitable for sealing vertical movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (Shore A)	:	> 12

Transverse movement accommodation : ±12.5%

Sealant Type C:

Sealant Type C shall be similar to Type B above. In addition it shall have been designed for sealing movement and construction joints in hydraulic and water retaining structures and shall be suitable for use in contact with potable water.

Hardness (Shore A) : > 20

Transverse movement accommodation : ±12.5%

Sealant Type D:

Sealant Type D shall be a pourable compound suitable for sealing horizontal movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (Shore A) : > 9

Transverse movement accommodation : ±12.5%

Sealant Type E:

Sealant Type E shall be a cold pouring compound complying with BS 5212, suitable for sealing movement and construction joints in concrete paved areas. It shall be resistant to fuels, oils and hydraulic fluids. It shall be tough, abrasion-resistant and shall not decompose in strong sunlight.

Hardness (Shore A) : > 12

Transverse movement accommodation : ±12.5%

Approved Sealants:

The following approved sealants meet the above specifications.

Sealant Type A, B And C : Thioflex 600 Gun Grade

Sealant Type D : Thioflex 600 Pourable Grade

Sealant Type E : Colpor 200

The hardness value specified in the above summaries is the shore A Durometer Value At 14 Days At 25° C And 50% RH. The specified transverse movement values are based on joints having a width to depth ratio of 1.5: 1.

The Contractor may use the above sealants or ones meeting equivalent or higher specifications.

1.9.11.2 Workmanship:

The Thickness Of The Preformed Bitumen Filler Shall Be 25mm For Expansion Joints And 50mm For Isolation Joints Around Foundation Supporting Rotatory Equipments. Contractor Shall Procure The Strips Of The Desired Thickness And Width In Lengths As Manufactured. Assembly Of Small Pieces/Thicknesses Of Strips To Make Up The Specified Size Shall Not Be Permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of Grade 85/25

conforming to IS: 702 shall be applied hot by brushing at the rate of 1.20 Kg/Sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 Kg/Sq.m.

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

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

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the drawings or as agreed with the Employer's representative.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the site and shall if requested supply to the Employer's representative sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attach from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive polysulphide and polyurethane sealants shall be kept free from bituminous paints. All sealants shall be appropriate for the prevailing climatic conditions. Bituminous sealants shall comply with the BS 2499 For Type A1. Polysulphide sealants shall comply with IS 12118.

1.9.12 Finishes:

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or

misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

1.9.12.1 Surface Finish Type F1:

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

1.9.12.2 Surface Finish Type F2:

The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

1.9.12.3 Surface Finish Type F3:

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discoloration, blemishes, arises, air holes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

1.9.12.4 Unformed Surfaces:

Finishes to unformed surfaces of concrete shall be classified as U1, U2, U3, 'Spaded' or 'bonded' concrete. Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 Finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a leveled and screeded, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.

A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of shovels as it is placed in the works.

Class U2 Finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface has hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 Finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations.

Integral Cement Finish On Concrete Floor:

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Employer's representative shall be supplied and used as recommended by the manufacturer.

1.9.13 Curing:

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

a) Premature drying out, particularly by solar radiation and wind;
b) Leaching out by rain and flowing water;
c) Rapid cooling during the first few days after placing;
d) High internal thermal gradients;
e) Low temperature or frost;
f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Employer's representative, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Employer's representative, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Employer's representative before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

1.10 Dry Rubble Pitching:

The pitching shall consist of large stones, regular in shape, as far as possible and no stone shall be specified in the item. The edges of the stones shall be dressed even arid regular by hammer. The stones shall be laid regularly and, evenly, breaking joints as much as possible and shall be beat n down with heavy hammer so that the stones shall be carefully into the earth. The interstices between the stones shall be carefully filled in with stone chips, closely and firmly packed and well driven with hammer. Loose stones in packing shall be on no account be allowed. The entire surface shall be thoroughly rammed, set in place and made compact with a log hammer so that the surface of entire pitching when completed shall be flat and even.

SECTION: C

TECHNICAL SPECIFICATIONS –

WATER SUPPLY AND SEWERAGE SYSTEM WORKS

TECHNICAL SPECIFICATIONS FOR WATER SUPPLY AND SEWERAGE SYSTEM WORKS

1.0 HDPE PIPES AND SPECIALS:

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of High Density Polyethylene pipes used for water comprising of PE100, HDPE pipelines of pressure rating as specified in BOQ .

Applicable Codes

The manufacturing, testing, supplying, laying, jointing and testing at worksites of HDPE pipes shall comply with IS: 4984 (1995) all currently applicable statutes, regulations, standards and amendments and others as follows;

Code No.	Title / Specification
IS 4984	High Density Polyethylene Pipes for Water Supply
IS 2530	Methods of test for polyethylene molding materials and Polyethylene compounds
IS 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS 4905	Methods for random sampling
IS 7328	High density polyethylene materials for molding and extrusion
IS 7634	Laying and Jointing of Polyethylene (PE) Pipes

Colour

The color of the pipe shall be black.

Materials

The material used for the manufacture of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odor, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any internationally reputed organization as per the satisfaction of the Engineer-in-Charge in charge.

Raw Material

(a) Resin used to manufacture the HDPE pipes shall be ***100% virgin PE Black*** pre compounded confirming to IS: 4984, IS: 7328 and ISO: 4427 - 2007 (latest version). The resin proposed to be used for manufacturing of the pipes should also comply with the following norms as per ISO 9080 - 2003 (latest version).

(b) The resin should also have been certified by an independent laboratory of international repute like Bodycote / Slevan / Advantica for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10 MPa. There should not be any brittle knee at $80^{O}C$ before 5000 hours. Internal certificate of any resin manufacturer will not be acceptable.

(c) Certificate from reputed organization or raw material supplier for having passed the full scale rapid crack propagation test as per ISO 13478. IS 9845 Method of analysis for the determination of specific and / or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs IS 10141 Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water. IS 10146 Polyethylene for its safe use in contact with foodstuff, Pharmaceuticals and drinking water. High Density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-50-T-003 of IS 7328. HDPE conforming to designation PEEWA-50-T-003 of IS: 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g / 10 min. In addition the material shall also conform to clause 5.6.2 of IS:7328.

(d) The specified base density shall be between 940 kg/m³ and 958 kg/m³ (both inclusive) when determined at 27℃ according to procedure prescribed in IS 7328. The value of the density shall also not differ from the nominal value by more than 3 kg/m³ as per 5.2.1.1 of IS 7328. The MFR of the material shall be between 0.20 and 1.10 (both inclusive) when tested at 190℃ with nominal load of 5 kgf as determined by method prescribed in IS 2530. The MFR of the material shall also be within ± 20 percent of the value declared by the manufacturer.

(e) The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ± 0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS: 2530.

Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harming less and shall be selected from the list given in IS: 10141

Reworked Material

No addition of Reworked / Recycled Material from the manufacturer's own rework material resulting from the manufacture of pipes is permissible and the Vendor is required to use only 100% virgin resin compound.

Maximum Ovality of Pipe

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in Table 2 of IS 4984. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the ovality shall be measured prior to

coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

Detectability

HDPE pipes shall be detectable when buried underground, by providing an insulated copper wire having minimum diameter of 1.20 mm, firmly attached along the entire length of pipe.

To avoid theft or dislocation during handling / laying or earth refilling in trench, the insulated copper wire shall be firmly fixed on the outer surface of HDPE pipe at pipe manufacturer's works through external adhesion or co-extrusion or any other appropriate method.

Length of Straight Pipe

The length of straight pipe used shall be more than 6 m or as agreed by Engineer-in-Charge in charge. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110 mm diameter shall be supplied in straight length not less than 6 m.

Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe. IS 4984:1995 will be followed for visual appearance.

Handling, Transportation Storage and Lowering of pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole. The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60 ^{o}C.

- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials. Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.

- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.

- Only polyester webbing slings should be used to lift heavy PE (> 315 mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.

- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.

- During coiling care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken that sharp objects do not scour the pipe.

- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil will depend on the size of the pipe, the SDR of the pipe, and the size of the coil.

- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set. Bare coils shall be wrapped with hessian cloth for long distance (> 300 Kms) transportation. The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded - especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the pipe.

- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment / road side / elsewhere near by the work site or as directed by the Engineer-in-Charge.

- Damages during transit, handling, storage will be to the Contractor's account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer-in-Charge.

Lowering, Laying of Pipes

- Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer-in-Charge shall be laid.

- Pipe laying shall be inside RCC ducts with supports and "U" clamps with fasteners as specified elsewhere in the document. While installing the pipes in RCC ducts on supports, the supports should be level and free from sharp edges.

- As PE pipes are flexible, long lengths of electro-fusion jointed pipes having joints made above ground can be rolled or snaked into narrow ducts.

- During the pipe laying of continuous electro-fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion / contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day).

- For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

- The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

- The pipe should not be cold bend to a radius less than 25 times the OD of the pipe.

- The installation of flanged fittings such as connections to sluice valve / air valve / gate valve / scour valve and tees etc., shall be with the use of stub ends, flange adaptors complete with backing rings, gaskets, hexagonal nut, bolt, washers etc. Care should be taken when tightening these flanges to provide even and balance torque.

- Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange on the supports) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.

- Care should be taken that the duct is not filled with water under any circumstances.

Jointing of Pipes

The pipe shall have **Electro-fusion** jointing system that shall provide for fluid tightness for the intended service conditions.

Thrust Resistance Supports at Bends

Thrust resistance supports should be designed and provided at all bends.

Fittings & Specials

All HDPE fittings / specials shall be of pressure class as specified in BOQ, fabricated in accordance with IS: 8360 (Part I & III). PE injection molded fittings shall be as per IS: 8008 (Part I to IX). All fittings / specials shall be fabricated or molded at factory only. No fabrication or molding will be allowed at site, unless specifically permitted by the Engineer-in-Charge. Fittings will be welded on to the pipes or other fittings by use of Electro-fusion process only.

Bends

HDPE Bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends shall be molded.

Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees shall be molded.

Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. Reducer must be molded.

Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VI Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of all flanges shall be PN10.

Electro Fusion Tapping Saddle, Branch Saddle & Electro Fusion fittings :

a. All the Electro fusion fittings should be manufactured with top quality virgin pre compounded PE 100 resin which should be compatible with the distribution mains.

b. The products shall comply with the requirements of EN 12201-3, EN 1555-3 or ISO 8085-3.

c. All the fittings shall be of SDR 11 rating.

d. The fittings shall have the approval from any three Agencies like KIWA, DVGW, and WRC-NSF, U.K. CIPET etc.

e. All the products shall be manufactured by injection molding using virgin compounded PE 100 polymer having a melt flow rate between 0.2 - 1.4 grams / 10 minutes and shall be compatible for fusing on PE 100 distribution mains manufactured according to the relevant national or international standards. The polymer used should comply with the requirements of EN 12201 - 1.

f. Process voltage of all saddles must not exceed a maximum of 40 volts.

g. The heating elements should be designed for fusion at any ambient temperatures between -5 to +40 degree centigrade.

h. The heating coils contained in each individual saddle should be so designed that only one complete process cycle is necessary to fully electro fuse the fitting to the adjoining pipe or pipeline component as applicable. The heating coils shall be terminated at terminal pins of 4.0 or 4.7 millimeter diameter.

i. No heating element shall be exposed and all coils are to be integral part of the body of the fitting.

j. The EF tapping / branch saddles should be fixed by fixation device and shall be achieved by external or integral clamping device.

k. The cutter should be designed in such a way that the cut coupon is not allowed to fall into the pipeline and is retained inside the body of the cutter.

l. A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle should be incorporated into the body of each fitting near the terminals. The fusion indicators should not allow the escape of the molten polymer through them during or after the fusion process.

m. All the sockets in the electro fusion fittings should include a method of tapping controlling the pipe penetration (pipe positioner / stopper).

n. All the electro fusion products should be individually packed in transparent protective bags to allow easy identification without opening the bag and must clearly indicate its contents

o. The brand name, size, raw material grade, SDR rating and batch identification are to be embedded as part of the injection molding process. Each fitting should also be supplied with a Data Card or stickers with appropriate barcode as well as manual setting information for data transfer purpose.

p. Installation and Fusion Jointing

The fusion jointing process is to be carried out is as per the procedure outlined in the DVS2202 standard, if not available equivalent standards acceptable to employer. A protocol for each fusion joint to be printed to ensure the joint process carried out is error free. The electro fusion machine shall have the facility to record & make print for each joint.

The precautions & measures as mentioned by electro fusion fittings / machine manufacturer should be taken up rigorously while making the joints in the field. The jointing procedures shall be performed with required accessories and tools as recommended by the fittings manufacturer.

The related pipe jointing accessories such as rotary pipe cutter, Universal clamping tools, Pipe cleaners, Pipe peelers supplied by the same electro fusion fitting / machine supplier shall be used to ensure perfect jointing. The usage of tapping tools such as taping keys, supplied by the same electro fusion fitting / machine supplier must be used to ensure perfect tapping of main lines.

The piping system will be tested as per the guidelines given by ISO standard. The guideline shall be furnished by the supplier of electro fusion fittings, tools and machines.

Hydraulic Testing

Pipes shall be given different hydraulic tests for ensuring quality of manufacture as per clauses of Standard Specification.

Site Fabrication of PE Fittings as Permitted by Engineer-in-Charge for only Specific Works

Two or more PE specials coming at one place (like PE Tee, Reducer, Flanged end etc.,) shall be jointed at Contractor's workshop and transported to the site of works for final installation with proposed PE pipelines. In no case, jointing of three or more welds in one place, at site will be allowed.

Manuals

Technical Manual on PE pipes including precautions to be taken during operation of the pipeline.

Flanges

All flanges employed in the project must be compatible whatever material used.

Marking

All pipes shall be marked as per Clause 10 of IS 4984-1995.

Packing & Transport

The pipes should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.

Summary of quality Tests :

1. **Quality Mark :**Pipe: IS 4984

2. **Material :** As per IS 4984. However only virgin resin is allowed, reworked material is not allowed.

3. **Grade of Material :** PE 100 as per IS 4984 (Certificate from raw material manufacturer

is required).

4. **Pressure Rating :** As per BOQ.

5. **Colour :**as per IS 4984

6. **Dimensions of Pipe :**

Diameter : The nominal diameter (outside)

Wall thickness : As per IS 4984.

Length :

i. **For diameter 90 mm and 110 mm :** 100 meter

ii. **For diameter more than 110 mm :** minimum 6 meter.
(Tolerance as per IS 4984)

7. **Visual Appearance :** as per IS 4984.

8. **Test and sampling :** as per IS 4984.

9. **Special Test :** Notch hydraulic Test for the HDPE pipe made from PE-100 grade raw material as per ASTM 1474 OR ISO 13479 at manufacturers laboratory or independent laboratory and should pass the Hydraulic test as per IS:4984:1995 for a minimum 165 Hours. The test reports shall not be more than three months old. Pipe shall convey water under variable temperature conditions ranging from 4 degree centigrade to 45 degree centigrade.

10. **Jointing of pipes (pipe end):**

All diameters : Electro-fusion Process

11. **Quality Assurance :**Quality Assurance Plan shall be got approved from the employer before production start.

Note: All remaining parameters / specifications are as per respective BIS specifications.

Inspection &Testing :

The inspection and testing of the sample pipes shall be carried out as per relevant IS and / or ISO standards (latest version) by the CEIL (Certification Engineers International Ltd.) or CIPET (Central Institute of Plastic engineering & Technology) or any other agency approved by the Concerned department / Third party in the manufacture's works before dispatch and / or picking random samples of pipe from the work site.

Field Hydraulic testing of the pipelines

Sectional tests

After laying and jointing the pipeline in ducts, the pipeline shall be tested for tightness of barrels and joints, and stability of thrust supports in sections approved by the Engineering-in-Charge. The length of the sections depends on the profile conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber or junctions). At the beginning, the Contractor shall test stretches not exceeding 1 Kms. After successful organization and execution of tests the length may be extended to more than 1 Kms after approval of the Engineer-in-Charge. The hydraulic testing shall have to be commenced immediately after laying and jointing of 1 Kms reach is completed.

The water required for testing shall be arranged by the Contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test / saturation and test, immediately following the pre-test. Generally, the following steps are required which shall be monitored and recorded in a test protocol.

- complete fixation of the pipeline over supports inside ducts.
- complete fixation of the thrust supports.
- opening of all intermediate valves (if any)
- fixing the end pieces for tests and after temporarily anchoring them against the duct
- at the lower end with a precision pressure gauge and the connection to the reciprocating pump for establishing the test pressure
- at the higher end with a valve for air outlet
- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- slowly filling the pipe from the lowest point(s).
- the water for this purpose shall be clear and free of solids and suspended matter
- complete removal of air through air valves along the line.
- closing all air valves and scour valves.
- slowly raising the pressure to the test pressure while inspecting the thrust supports and the temporary anchoring.
- keeping the pipeline under pressure for the duration of the pre-test / saturation of the

lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.

- Start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added carefully and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period. The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits and no leakage is observed either through the surface of the pipe or through the joints. No section of the pipe work shall be accepted by the Engineer-in-Charge until all requirements of the test have been obtained.

Flushing and disinfecting of pipelines

After testing and commissioning, the Contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Engineer-in-Charge with good quality water. Disinfection of drinking water pipelines should be done by Contractor.

2.0 STRUCTURED WALL PLASTIC PIPE (DOUBLE WALL CORRUGATED HDPE) FOR GRAVITY SEWERS:

2.1 Scope

This specification covers the requirements for manufacturing, supplying, transportation, handling, stacking, installation, jointing, and testing of Class SN 8 Double Wall Corrugated (external annular corrugated and smooth internal wall) with integral socket confirming to IS: 16098 Part - 2.

2.2 Applicable Codes

The manufacturing, testing at factory, supplying, transportation, handling, stacking, installation, jointing, and testing at sites shall comply with all currently applicable statutes, manuals, regulations, standards & codes. In particular, following BIS code with latest revisions shall be referred. If requirements of this specifications are at variance with any other standards, this particular document shall govern the proceedings.

IS : 16098 (Part - 2)	Structured - Wall Plastics Piping Systems for Non - Pressure Drainage and Sewerage - Specification - Part - 2 : Pipes and Fittings with Non Smooth External Surface, Type B

2.3 Manufacturing

The DWC PE Piping System of stiffness class designation SN 8 shall confirm to IS : 16098 (Part - 2) standards. Each pipe shall be with integral socket along with rubber sealing ring.

Clean, reprocessable material generated from a manufacturer's own production according to IS: 16098 Part - 2 may be used if it is derived from the same raw material as used for the relevant production. Reprocessable material obtained from external sources and recyclable material shall not be used.

2.4 Transportation

The arrangement of loading the pipes in a telescopic manner is advised, i.e. smaller diameters inserted into the next higher sizes of pipes. While loading the pipes onto the truck, care should be taken that the socket end should be arranged alternatively in the corresponding layers so as to avoid the damage to the socket ends.

2.5 Handling

Following recommendations shall be followed while handling the pipes:

- Adherence to National Safety requirements
- Pipes to be smoothly lowered to the ground
- Pipes should not be dragged against the ground to avoid the damages to the socket / pipes.
- 800 mm and larger diameter pipes are carried with slings at two points spaced approximately at 3 meters apart
- For smaller diameters (400 mm – 800 mm) one lift point shall be sufficient & can be handled either manually or mechanically
- Do not use a loading Boom or Fork Lift directly on or inside pipe.

2.6 Pipe Storage at Site

- Stockpiling shall be done temporarily on a flat clear area as per Fig. 1 & 2.
- For avoiding collapse of stacks, use wooden posts or blocks
- Stacking shall not be higher than 2.5 meters
- While stacking, alternate the socket ends at each row of stacked pipes as per Fig. 2.

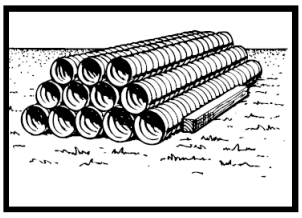


Fig 1

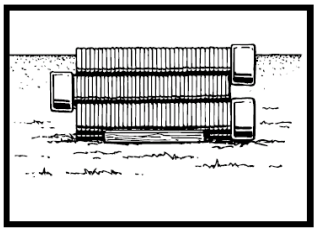


Fig 2

2.7 Lowering, Laying & jointing of Pipes

Lowering, laying & jointing of pipes shall be as per IS: 16098 Part - 2. The width of a sewer trench depends on the soil condition, type of side protection needed and the working space required at the bottom of trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe. Considering all above factors, the minimum trench width is specified as per Table below :-

All dimensions in millimetres.

Sl No. (1)	Pipe Diameter (2)	Trench Width (3)
i)	75 to 200	0.6
ii)	250	0.7
iii)	300	0.8
iv)	400	0.9
v)	600	1.2
vi)	800	1.3
vii)	900	1.6
viii)	1 000	1.8
ix)	1 200	2.0

The pipe segment between two manholes shall be laid in straight line as required gradient without any undulations. The piping system shall rest on the carefully prepared bedding portion of the Backfill Envelope as shown in **Figure - 3** and at appropriate jointing locations the trenches shall be excavated deeper to accommodate the bulges of spigot joints. However, special care shall be ensured as mentioned below;

- Excavation of trenches shall be carried out in accordance with the drawing and specifications and as directed by the field engineer as well.

- The piping system shall be laid and jointed in true to gradient with the help of sight rails and boning rods as detailed in CPHEEO Sewerage and Sewerage Treatment manual. The levels need be checked with calibrated modern leveling instruments. Specific care shall be taken to prevent entry of sand / mud / slush / any other foreign material etc into the system during the installation operation.

The bedding (Ref: Figure - 3) is an essential portion of back fill envelope and shall be constructed with granular material. The bedding shall be laid to specified thickness and gradient with proper manual compaction of the granular material.

The socket end shall push fit over the spigot end of the next pipe. On valley of the corrugation of spigot end (destined to receive the pushed socket) the sealing rubber ring of standard as specified in IS: 16098 Part - 2 shall be placed so that the socket end of the pipe smoothly but tightly slides over the sealing ring for making an absolute watertight joint.

For quality connections following steps are to be ensured;

- The socket end needs to be thoroughly cleared and shall be free from any foreign material.

- Clean and lubricate the socket end of the pipe.
- Lubricate the exposed gasket in the same manner.
- Keep the spigot end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised.
- Push the socket into spigot and align properly. Always push socket end into spigot end.

For smaller diameter pipes simple manual insertion shall be sufficient. It should be ensured that the socket end is adequately 'homed' within spigot end to ensure installation and tight joining seal. Therefore prior to insertion always place a 'Homing Mark' on appropriate corrugation of the 'Spigot End'.

2.8 Construction of backfill envelope and final backfilling of the trenches

DWC PE piping system with well compacted backfill envelope along with the bottom and sides of trench (granular material) work together to support soil overburden and superimposed (traffic) loads. The carefully constructed backfill envelop has three distinct but non-isolated stages (Ref: Figure - 3). The construction need to be done stage by stage as per the sequence stated below:

- Bedding portion
- Up to haunch level
- Remaining portion

- The material for backfill envelop shall be granular material as approved by Engineer-in-Charge. In no circumstances, the flexible pipe should not be embedded in cement concrete (un - reinforced or reinforced) which invariably induces undesired rigidity in the system.
- The remaining portion of backfilling which do not contribute to the structural integrity of the system may be the selected materials that were removed in the course of excavation. These materials shall consist of clean earth and shall be free from large clod or stone, ashes, refuse and other injurious materials.
- After completion of bedding portion of the backfill envelop and subsequent lying of pipes, etc, first the haunch portion and then upper portion of backfill envelope shall be constructed with granular material around the pipe. Voids must be eliminated by knifing under and around pipe or by some other indigenous tools.
- The compaction, by hand rammers or compactors with necessary watering to a possible maximum level of proctor density shall be ensured.
- Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open.
- Precautions shall be taken against floatation (if at all necessary) as per the specified methodology and the minimum required cover.

2.9 Continuity Test / Hydraulic Testing

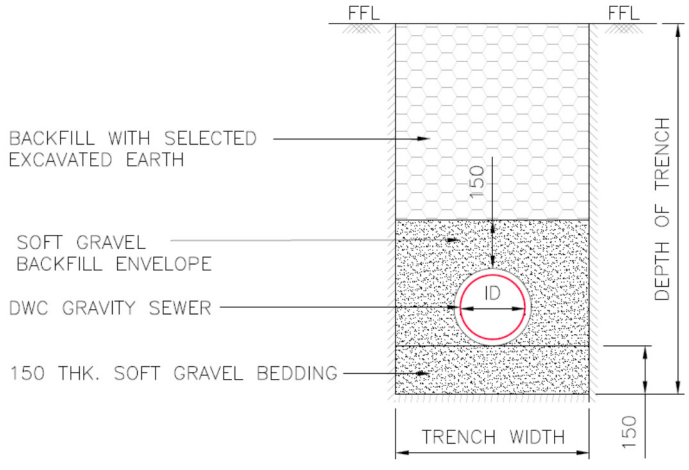
Continuity of the pipe segments in between two manholes is required to be ensured. hydraulic testing of pipes shall be done. All pipelines should be tested before being brought into service. The test should be a hydrostatic test performed by filling the pipeline with water as prescribed below. If the test is not satisfactory, the fault should be found, rectified and pipe retested without any extra cost. Contractor has to arrange for the water required for testing at their own cost.

Methodology for Hydraulic Testing of Pipeline

After laying and jointing of pipes is completed the pipeline shall be washing out with sufficient water and be tested at work site as directed by Engineer-in-Charge. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipes shall be arranged by the Contractor. Damage during testing shall be Contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer-in-Charge. Water used for the test shall be removed from pipes and not released to the excavated trenches. After the jointing is done and has been checked by the Engineer-in-Charge and before back filling the trenches, the entire section of the sewer shall be proved by the Contractor to be water tight by filling in pipes with water to the level of 1.50 m above the top of the highest pipe in the stretch and heading the water up for a period of one hour.

The apparatus used for the purpose of testing shall be approved by the Engineer in-Charge. Contractor shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 litre / hour / 100 linear metres / 10 mm of nominal internal diameter. 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.

FIGURE - 3



TRENCH DETAILS

3.0 DUCTILE IRON PIPES:

3.1 GENERAL

In particular, the following standards, specified herein shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of specifications conflict with the requirements of the codes and standards, this specification shall govern.

IS: 8329 Specification for Centrifugally Cast (spun) Ductile Iron pressure pipes for water, gas and sewage specification.

IS: 1387 General requirements for supply of metallurgical materials.

IS: 1500 Methods for Brinell hardness test for metallic materials.

IS: 9523 Ductile Iron fittings for pressure pipes for water, gas and sewage.

IS: 12820 Dimensional requirements. of rubber gaskets for mechanical joints and push on joints for use with cast Iron pipes and fittings for carrying water, gas and sewage.

ISO: 4179 Ductile iron pipes for pressure and no pressure - centrifugal cement mortar lining - General requirements.

ISO: 2531 Ductile iron pipes, fitting and accessories for pressure pipe lines.

IS: 12288 Code of practice for use and laying of ductile iron pipes.

3.2 MANUFACTURING:

GENERAL:

a) DI pipes shall be systematically checked for any manufacturing defects by experienced supervisors and a very high standard quality shall be maintained.

b) Owner / Engineer shall at all reasonable times have free access to the place where the pipes are manufactured for the purpose of examining and testing the pipes and for witnessing the test and manufacturing.

c) All tests specified either in this specification or in the relevant Indian Standards shall be performed by the supplier / contractor at his own cost and in presence of Owner / Engineer if desired. For this, sufficient notice before testing of the pipes shall be given to Owner / Engineer.

d) If the test is found unsatisfactory, Owner / Engineer may reject any or all pipes of that lot. The decision of Owner / Engineer in this matter shall be final and binding of the contractor and not subject to any arbitration or appeal.

e) All DI pipes shall be of K9 Class unless specified otherwise and shall be of socket and spigot type joints at buried stretches and flanged type for above ground pipelines including carrier pipes laid through MS sleeve pipes at HDD crossings.

MATERIALS;

The general requirements relating to the supply of material shall be as per IS: 1387.

DIMENSIONS:

The internal diameter, thickness and length of barrel, dimensions of pipes shall be as per the relevant tables of IS.8329 / IS: 9523 for different class of pipes. The tolerances for pipes regarding dimensions and deviations from straight line shall be as per relevant IS codes. The standard weight of uncoated pipes and the permissible tolerances shall be per relevant IS codes.

TESTING

Mechanical Tests:

Mechanical tests shall be carried out during manufacture of pipes as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to Owner / Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes shall be as per IS: 8329.

COATING:

All DI pipes shall be delivered with internal lining and external coating. Coating shall not be applied to any pipe unless its surface is clean dry and free from rust. All DI pipes shall be mortar lined on internal surface as specified in ISO: 4179 and externally coated with bituminous paint as specified in IS: 8329.

MARKING:

Marking shall be done as per IS: 8329. After laying of the pipeline, pipe route markers shall be installed at 100 m intervals along the length of pipeline as specified elsewhere in the document.

TRANSPORTING OF PIPES;

All pipes manufactured in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The transport shall cover the cost of loading in the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking.

The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted.

The material stacked at site shall be jointly inspected by the Engineer and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is admitted. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth. As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer.

3.3 LAYING OF DUCTILE IRON PIPES AND FITTINGS / SPECIALS:

SCOPE

The specification covers laying of DI pipes and DI fittings / specials for over ground / underground works.

CARTING & HANDLING

Pipes and fittings / specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by Owner / Engineer and as specified by manufacturer. Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading. Every care shall be exercised in handling pipes and fittings / specials to avoid damage. While unloading, the pipes and fittings / specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes for by any other approved means. Padding shall be provided between coated pipes, fittings / specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. in case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible, pipes shall be unloaded on one side of the trench only. All pipes shall be checked for any visible damage (such as broken edges, cracking or spilling of pipe) while unloading and shall be sorted out for recantation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fitting / specials along concrete and similar pavement with hard surfaces shall be prohibited.

STORAGE

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m. fittings / specials, shall be stacked under cover and separated from pipes. Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

LAYING

Excavation

Before excavating trench the alignment of pipeline shall be approved by Engineer. The excavation shall be carried out in accordance with the relevant Standards. To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways.

The relevant Indian standards and the rules and regulations of local authorities in regards to safety provisions shall be observed. Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 in apart and they shall not be less than 75 mm in diameter or less than 1.2 m above surface of the ground. There shall be two rails, one near the

top of the post and the other about 450 mm above the ground and each shall be from 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope.

The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by Owner / Engineer for further protection. The road metal and also the rubble packing shall first be stripped off for the whole width of the trench / pit and separately deposited in such place or places as may be determined by Owner / Engineer. During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately.

The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as Owner / Engineer may direct.

Contractor shall take into account additional excavation if any as Owner / Engineer may require in order locating the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches/pits while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as Owner / Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work.

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipe line of water, gas, sewage etc. If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon or the setting in of rain whichever is earlier, or before the day fixed by Owner / Engineer for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling. Utmost care shall be taken to see that the width of the trench upto ground level is not more than as per required standards.

If any extra width is provided in the pipe zone, the Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of Owner / Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches/pits shall be saturated with water well rammed wherever Owner / Engineer may consider if necessary to do so.

Wherever a socket or collar of pipe or fitting/special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint, and the grip shall be maintained clear until the joint has been approved by Owner / Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shal1 be made at joints in order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by Owner / Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by Owner / Engineer and any claim or dispute shall not be entertained in this respect. The contractor shall make proper provision for protecting the work by fencing, watch and ward lighting at right on in another manner as may be directed by Engineer.

De-watering

During the excavation, if subsoil water is met with, Contractor shall have to provide necessary equipment and laborers for dewatering the trenches/pits by bailing out water or water mixed with clay if pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient.

Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Owner / Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, Contractor shall take necessary permission from the local authorities.

Special foundation in poor soil

Where the bottom of the trench and subgrade is found to consist of material which is unstable to such a degree that in the opinion of Owner / Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, limbers or other materials, in accordance with Relevant drawings and as instructed by Owner / Engineer shall be constructed.

REPAIRS OF DAMAGED CEMENT MORTAR LININGS

The mortar lining is strongly bonded with the pipe wall at all places. However, near the spigot end due to rough handling of pipes or on account of incidental shock loads the mortar lining may get damaged over a small area. Such damages if taken place shall be immediately identified and repaired before installation. When repairing damaged cement-mortar-lining, the following shall be adhered to:

I. Materials required

(a) Standard Cement (of the same quality as in the lining)
(b) Argillaceous Sand (size of coarse grains max. 1.6 mm)
(c) Acrylic Emulsion for cement mortar
(d) Potable water

II. Preparation of the areas to be repaired

The damaged lining shall be removed with hammer and chisel, with due care without disturbing the surrounding lining. Contractor shall supply protective spectacles for workmen to prevent penetration of cement fragments into their eyes.

III. Composition of repair mortar

The proportion of the materials will be as follows:

IV. Dry mixture of mortar:

One part of cement
One part of sand

V. Emulsions:

One part of acrylic emulsion, four parts of potable water. Firstly the dry sand and the dry cement shall be mixed separately. The acrylic emulsion shall be added to the water stirring constantly (The container for acrylic emulsion should be resealed at once after use and stored in a cool place) Small quantities of the treated water shall be gradually added to the cement and sand mixture mixed thoroughly. Care shall be taken not to prepare too large quantity of cement to avoid premature hardening.

Any loose sand from the areas to be repaired shall be brushed off. Moisten the areas under repair and surrounding areas with water but avoid water accumulations. Mortar is to be applied to cleaned areas and the lining surface is to be smoothened.

VI. After - Treatment of repaired areas

In order to ensure faultless hardening of cement it is recommended that the repaired area to be covered temporarily with plastic sheet. In the case of diameters exceeding DN 300 it is possible that after cutting off a piece the new spigot end has become out of round. On account of the elastic and plastic properties of ductile iron, it is possible to re-round these pipe ends. This shall be done on site by means of a hydraulic or mechanical jack, acting from inside and pressing outwards or by using press acting from outside the pipe and pressing inwards by the contractor.

In order to avoid damage to the cement mortar lining it is recommended that hardwood ads of a shape to match the pipes internal diameter be used. The re-rounding device should remain in place during assembly. If necessary the manufacture may consulted for resounding.

THRUST BLOCKS

Thrust blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by Engineer in charge

JOINTING

Jointing for pipes and fittings/specials shall be done in accordance with the relevant specifications for DI pipes and DI fittings and as recommended by manufacturer. The recommended bolting torque to be followed for assembling flanges as specified in manufacturer instructions.

TESTING AND COMMISSIONING

Testing and commissioning of pipes shall be done in accordance with IS: 12288.

BACKFILLING

Trenches shall be backfilled with approved selected excavated material only after the

successful testing of the pipeline as directed by engineer. The tamping around the pipe shall be done by hand or other hand-operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both side of the pipe in such a manner that unequal pressure does not occur.

Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care being taken to avoid damage to the pipeline. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

REINSTATEMENT OF ROAD / FOOTPATH

Reinstatement of road/footpath shall be done as per the requirements of local Authorities and the relevant specifications after completion of work.

4.0 SLUICE VALVES

(a) Sluice valve shall generally confirm to IS 14846.

(b) Sluice valves shall be of non-rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage.

(c) Valves of 400 mm and above shall be provided with thrust bearing arrangement for ease of operation.

(d) Valves of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

(e) All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

(f) All the hand wheels shall be arranged to turn in a clockwise direction to close the valve. The direction of rotation for opening and closing of the valve shall be indicated on the hand wheels.

(g) The material of construction of valve shall be as follows :

Sl. No.	Component	Material
(i)	Pressure class	As per BOQ Min. PN 1.0
(ii)	Body / dome / wedge	Ductile Iron GGG 50
(iii)	Body and wedge rings	Stainless Steel ASTM A 276 Type 304
(iv)	Spindle	Stainless Steel ASTM A 276 Type 431
(v)	Gasket	Natural rubber
(vi)	Fasteners	SS 316

5.0 AIR VALVES

The air valves shall be of Ductile Iron material and minimum PN: 10 Class unless specified otherwise. The valve shall be Single Chamber Triple Function Tamper Proof (Both the Orifices to be housed in the single chamber) Air Valves with body and cover in Ductile Iron of Grade GGG 50.

All internal parts such as float, shell etc., all cover bolts of austenitic alloy steel, float shall be of HOSTAFLON and Gaskets and seals of EPDM. Epoxy powder coating (EP-P) shall be provided inside and outside with colour blue RAL 5005. The valve should be designed for all the three functions i.e. 1. large orifice for venting of large air volumes on start up. 2. Large orifice for intake of large air volumes. 3. Small orifice for discharge of pressurized air during operation.

The valves should be capable of venting at high velocities up to sound velocity by stabilized float. For isolation, isolation valve shall be provided resilient seated soft sealing approved make sluice valve with body, bonnet of Ductile Iron of grade GGG40, wedge fully rubber lined with EPDM and seals of NBR and the valves should be of vaccum tight and 100% leak proof with face dimensions as per BS 5163-89 / IS 14846-2000 / DIN 3202 F4 \ F5.

The stem sealing should be with torodial sealing rings (Minimum 2 O-rings). All the valves should be with electrostatic powder coating with inside and outside with pocket less body passage. The valves shall be supplied with suitable size galvanized bolts and nuts of required numbers of GKW / KITO / NEXO / TECHMAN or any other equivalent approved brand.

The contractor shall provide test certificates for materials and properties shall be in accordance with relevant standards.

6.0 NON RETURN VALVES

Non Return Valves shall confirm to API 594 standards with latest amendments. The valves shall be suitable for mounting on horizontal pipeline. The internal parts shall be easily accessible for inspection through inspection hole. Hydraulic passages and doors shall be designed to avoid cavitation.

The valve flange shall be parallel to each other and flange face should be at right angle to the valve centerline. Backside of the valve flanges shall be machined or spot faced for proper seating of bolt head and nut.

Valves shall be of swing type, quick closing and shall be with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever / damping arrangement.

Direction of the flow shall be clearly embossed on the valve body. Maximum pressure drop across the valves shall be 0.4 mwc. Maximum allowable leakage rate shall be 7 cc / hr / mm diameter.

Suitably designed RCC / CC or structural steel supports shall be provided underneath the valves.

The Tenderer's shall submit complete technical data sheets and drawings for the valves.

Material of Construction:

The material of construction for different components of Non Return Valve shall be as below.

Sl. No.	***Component***	***Material***
1.	Pressure Class	As per BOQ or Minimum PN : 10
2.	Body, Door, Cover	Ductile Iron GGG 50
3.	Hinge Pin	Stainless Steel : AISI 410
4.	Body and Door Ring	Stainless Steel : AISI 410
5.	Bearings	Teflon
6.	Fasteners, Anchors bolts, Foundation Bolts etc. both in wet and dry areas	Stainless Steel : 316

7.0 CAST IRON SLUICE GATES:

7.1 General

The construction of sluice gate shall be in accordance with the specification and shall be generally confirming to IS: 13349. All sluice gates shall be of rising spindle type. The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

Seating faces shall be made of full width, solid section and dovetail strips of stainless steel. They shall be secured firmly by means of counter sunk fixings in finished dovetail grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place, free from distortion and loosening during the life of the sluice gate.

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices as required, to provide contact between the slide and frame facing when the gate is in closed position. The gate shall be operated through suitable lifting mechanism which shall incorporate suitable gearing if required to keep the torque requirement within 7.0 Kg.m.

Lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain. The mechanism shall be provided with a suitable position indicator to show the position of the gate at all times.

The cross section of the thimble shall have the shape of the letter "F". Lifting lugs shall

be provided for all gates. When sluice gates are provided with flush bottom seals, the wedging device and facing along the bottom edge of the slide and frame shall be omitted.
A solid square cornered, resilient rubber seal shall be provided on the bottom facing of slide. The seal shall be securely fastened to the bottom face of the slide by a retainer bar and stainless steel fasteners. The top surface of the bottom facing of frame shall be flush with invert of the gate opening. Bottom facing of the slide shall be accurately machined to make contact with the seal when the slide is closed.

The painting specification for sluice gates shall be as detailed below;

- Surface preparation shall include hand tool cleaning as per IS: 1477, Part 1 and is 6005
- Primer: two packs of zinc phosphate epoxy with DFT of each coat 50 µ.
- Undercoat: two packs of titanium dioxide epoxy with DFT of each coat 50 µ.
- Finish: two packs of silicate extender epoxy with DFT of each coat 100 µ.

7.2 Material of Construction

The material of construction for different components of the sluice gate shall be as below.

Sl. No.	Component	Material
1.	Wall Thimble	Cast Iron :IS 210 Gr. FG 260
2.	Frame and Slide	Cast Iron :IS 210 Gr. FG 260
3.	Seating Facing, Seal Retainer Flat	Stainless Steel SS 316 ASTM A240 countersunk fixing
4.	Wedge and Stem	Stainless Steel : ASTM A 743 CF8M
5.	Stem / Spindle	Stainless Steel : SS 316
6.	Stem Coupling	Stainless Steel : SS 316
7.	Stem nut, fasteners, anchor bolts etc. both in wet and dry areas	Stainless Steel : SS 316
8.	Lifting mechanism, pedestal, gear house cover and stem guide	Cast Iron :IS 210 Gr. FG 260
9.	Lift nut	Bronze : IS: 318 LTB2
10.	Indicating Scale	Stainless Steel : ASTM A 276 Type 316

8.0 HORIZONTAL SPLIT CASE PUMPS:

8.1 General

The pumps proposed shall be suitable for installation at site whose altitude is as per site level and shall work under maximum ambient temperature of 50°C. The pump and motor shall be capable of providing the required output when working under above conditions.

8.2 Codes and Standards

The design, manufacture and performance of the pumps shall comply with all currently applicable statutes, regulations and safety codes in the area where the pumps will be installed and shall confirm to IS: 1520. The performance of pumps shall be guaranteed as per IS: 5120 and IS: 9137 with zero negative tolerance. The pump set shall be coupled to 3 Phase, TEFC horizontal mounted induction motor. The synchronous speed of pump shall not be more than 1500 RPM.

8.3 Features of Construction

i. Operation of pumps shall be automatic with working and standby pumps operated in rotation such that no pump shall be operated continuously for longer duration.

ii. The minimum clearance between adjacent pumps and between pump and wall shall be as per Hydraulic Institute Standards.

iii. For all the pumps the selected model shall be such that the operating point shall lie nearest to maximum efficiency point but towards the left of the maximum efficiency point.

iv. The impeller diameter selected shall be such that there shall be a minimum of one diameter higher and one diameter lower size impeller is available for all the pumps.

v. The impeller shall be enclosed type, securely keyed to the shaft. Means shall be provided to prevent losing operation including rotation in reverse direction.

vi. The pump shall be provided with renewable type casing ring.

vii. The first critical speed for the pump rotor shall be at least 30% above the operating speed.

viii. Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing boxes.

ix. Stuffing boxes shall be of such design that they can be repacked by removing the gland and lantern ring.

x. Pump shall be furnished complete with flexible coupling. Coupling guard made of expanded metal bolted to the base plate shall be furnished.

xi. The base plate for pump and motor shall be common. Suitable holes shall be provided in the foundations for fixing of bolts and grouting. Foundation bolts shall be complete with nuts and washers.

xii. The gland and cooling water shall be collected and led by suitable pipeline up to the sump pit.

xiii. Suction and discharge connections shall be flanged.

xiv. Pump impeller shall be dynamically and statically balanced.

xv. The pumps of a particular category shall be identical. Components of identical pumps shall be interchangeable.

xvi. The pump shall be capable of developing the required total head at rated capacity for continuous operation. The pumps shall operate satisfactorily at any point on the H-Q characteristic curve over a range of 50% to 130% capacity.

xvii. The NPSH required shall be at least 1.0 m less than the NPSH available under all operating conditions.

xviii. The shut off head shall be at least 110% of total head and maximum of 130%.

xix. Pumps shall run smooth without undue noise and vibrations. The velocity of vibrations and the noise level shall be as per latest IS code. To detect excessive vibrations exceeding design limits as per standards, three axis vibration monitors shall be installed. The motor shall stop automatically when the vibration exceeds the limits.

xx. The pumps shall be with zero negative tolerance (and not 5% as indicated in IS - 5120).

xxi. The total head capacity curve shall be continuously rising towards the shut-off point with the highest head at shut-off.

xxii. The pump that works at the best efficient point for specified duty conditions would only be selected. However the pump should have a very good efficiency when it works at lower heads due to higher level in the sump.

xxiii. Tappings at suction and discharge nozzles shall be provided for pressure gauge connection. Casing drain connection with stainless steel collared plug shall be provided.

The pump shall be provided with the following accessories;

- Pressure Gauge: 200 mm Dia. of suitable range with stainless steel connecting pipes, gooseneck, cocks etc. complete.
- Priming Cock.
- Suitable piping for collection and leading off gland leaks etc. up to discharge point.

The power rating of the pump motor shall be higher of the following:

115% of the power input to the pump at duty point at a speed corresponding to given frequency.

Maximum power input while operating single pump corresponding to the speed of 50 Hz.

8.4 Material of Construction

The material of construction for different components of pump shall be as below.

Sl. No.	*Component*	*Material*
1	Casing	CI to IS: 210 GR FG 260
2	Gland	CI to IS: 210 GR FG 260
3	Impeller	Stainless Steel : AISI CF8M
4	Wearing rings, Inter Stage Ring	Phosphor Bronze
5	Shaft	Stainless Steel: SS AISI 410
6	Shaft Sleeve, Neck Ring	Bronze
7	Packing	PTFE braided with graphite
8	Fasteners, Anchors bolts, Foundation Bolts etc. both in wet and dry areas	Stainless Steel : 316
9	Base Plate	MS with epoxy coated

8.5 Testing

The pumps shall be subjected to inspection by KSIIDC / Third Party. The performance of all the pumps shall be demonstrated during factory testing as per curves submitted during tendering. The pump efficiency shall be demonstrated with zero negative tolerance (and not 5% as indicated in IS: 5120). The pumps shall be tested over the range covering from shut off head to maximum flow. The duration of test shall be minimum one hour. Minimum 5 readings approximately equidistant shall be taken for plotting the performance curve.

In addition to above, dry run test after installation shall be carried out to test the vibration characteristics, bearing performance etc. and to determine if the pumps have been properly erected. A vent test also be conducted to verify the operating characteristics, water tightness of the system etc. as per latest IS codes.

8.6 Rejection

If on shop testing, the guaranteed efficiency considering the zero percent negative tolerance is not met, the pump shall stand rejected.

8.7 Technical Data Sheet

The Tenderer's to include a detailed technical data sheet with their technical proposal giving all the details of pumps.

9.0 SUBMERSIBLE SUMP DRAINAGE PUMPS

Sump pumps shall be of the open-impeller centrifugal-type, vertically-mounted and close coupled to their fully-submersible electric motors. Sump pumps of 1.5 kW and under shall incorporate an integral level detector, control and motor starter and shall be powered only with a suitably-fused three-phase or single-phase low-voltage supply and with supply isolation at the supply point.

Sump pumps over 1.5 kW shall be controlled and started from the supply point. Control shall be by means of adjustable float level switches mounted near the pump.

Pumps shall be supplied with all necessary pipe work to discharge to surface drainage. Each pump shall be provided with delivery reflux and isolating valves, and suitable lifting gear for lowering and lifting the pump from the sump. Pumps weighing 40 kg or more shall be lowered into the sump on guide rails and be located to their respective discharge pipe work with an angle flange connection and self-locating clamps. Pump impellers shall be designed to pass solids of the sizes which pass through the inlet ports of the pump and shall be capable of pumping solids of up to 50 mm diameter.

10.0 HORIZONTAL CENTRIFUGAL DRAINAGE PUMPS

The total head capacity curve shall be continuously rising towards the shutoff with the highest at the shutoff.

The pump shall run without undue noise and vibration. The power rating of the pump motor shall not be less than the power required from zero discharge to zero head.

The pump shall be dry pit type with double mechanical seals. The motors shall be provided with Class F insulation with temperature rise limited to that of Class B insulation. The degree of protection shall be IP: 55.

The pump shall be suitable to handle turbid water. Both pump and motor shall be provided with a common shaft.

Delivery pipe of drainage pumps shall be of size 40 NB and shall be as per IS: 1239, heavy class. The pumping main shall be common for two pumps.

Level switch to start and stop the pump automatically shall be supplied with the pump.

The pump shall be provided with necessary medium duty GI piping, valves, specials etc. complete so as to discharge the spillages and leakages to nearby natural drain as directed by Engineer-in-Charge.

The material of construction for different components of the pumps shall be as specified below;

Sl. No.	*Component*	*Material*
1	Impeller	Stainless Steel
2	Casing	Cast Iron IS: 210 GR FG 260
3	Shaft	Stainless Steel: BS: 970 GR 304
4	All fasteners including nuts, bolts, washers, anchor bolts, foundation bolts etc. both in wet and dry areas	Stainless Steel : 316

11.0 SUBMERSIBLE PUMPS:

11.1 Pump

11.1.1 General

The total head capacity curve shall be continuously rising towards the shut off with highest at shut off. Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistance and shall be designed to handle solid sizes of up to 50 mm. The pumps shall run smooth without undue noise and vibration and shall be suitable for starting with discharge value open and / or closed. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

11.1.2 Features of Construction

Pump shall be centrifugal, vertical spindle, non-clog, wear resisting, single stage type with 1450 RPM rated speed. Casing shall be of robust construction and liquid passages shall be finished smooth and designed as to allow free passage of solids. The volute tongue shall be filled to a smooth rounded edge.

Double mechanical seals shall be provided to protect the motor from ingress of sewage along the shaft. The primary and secondary seals shall be oil lubricated with tungsten carbide or silicon carbide faces and they shall be equipped with an electrical monitoring system for seal failure detection.

Impeller shall be non-clog enclosed type with smooth blunt edges and large water ways so as to allow free passage of the larger size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. The critical speed of the rotor shall be at least 30% above the operating speed. Pump sets shall have double bearings and the bearing life shall be minimum 40.000 hrs of operation.

Each pump shall be complete with duck foot bend and delivery connection arrangement for fixing to the concrete floor of the suction well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails / rope from access level. It shall be provided with all necessary fixings for guiding the pumps during lifting / lowering. Each pump shall be provided with a stainless steel lifting chain.

Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at low level even whilst the pump is submerged without the need for personnel to enter the well. This automatic coupling device shall easily and automatically couple and uncouple the hoist hook and shall be complete with necessary accessories. All links and cables shall be multi-stranded stainless steel.

The materials of construction for submersible pumps shall be as follows:

SL. No.	Component	Material
1.	Impeller	Stainless Steel : AISI CF8M
2.	Pump and Motor Casing	CI : IS 210, FG 200 with 1.5 to 2.0% Nickel
3.	Shaft	Stainless Steel : SS 410
4.	Guide Pipe and Lifting Chain	Stainless Steel : SS 304
5.	Fasteners, Anchors bolts, Foundation Bolts etc.	Stainless Steel : SS 316
6.	Lifting Bracket	Stainless Steel : SS 316
7.	Bearings	Pre-lubricated heavy duty ball bearings
8.	Auto coupling system	Stainless Steel : SS 316

Note: 1. Material test certificates shall be submitted for all the parts.
2. The material of construction for all the other parts shall be suitable for use in adverse environmental conditions of sewage / sludge.

11.1.3 Testing:

The pumps shall be tested over the range covering from shut off head to maximum flow. The duration of test shall be minimum one hour. Minimum 5 readings approximately equidistant shall be taken for plotting the performance curve.

11.1.4 Rejection:

If on shop testing, the guaranteed efficiency considering the zero percent negative tolerance is not met, the pump shall stand rejected.

11.2 Induction Motor

11.2.1 Performance and Characteristics

The submersible motor shall confirm to IS: 9283 and submersible cable shall conform Clause No: 4.4 of IS: 9283.

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions.

(i) Variation in supply voltage from rated motor voltage +/- 10%
(ii) Variation in supply frequency from rated frequency +/- 5%
(iii) Combined voltage and frequency variation +/- 10%

The starting current of motor shall not exceed 200% of rated full load current for star / delta starting and 600% of rated full load current for DOL starting under any circumstances. Motors shall be suitable for full voltage DOL starting or star / delta starting.

Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage.

The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard, IS: 9283.

Protection against increase in stator winding temperature (150°C), bearing temperature, leakage in stator housing and terminal box shall be provided. Minimum three number thermistors in series are to be provided to sense the stator winding temperature. Sensors are to be provided to detect if leakage of sewage / water into the oil housing is above 30% concentration. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The power rating of the motor shall be larger of the following:

115% of the power input to the pump at duty point at a speed corresponding to the frequency of 50 Hz.

Maximum power input while operating single pump corresponding to the speed of 50 Hz.

11.2.2 Submersible Cable

The power cable shall be PVC insulated, flexible, 3.5 core and flat type. The cable shall be sheathed in suitable material to withstand adverse environmental conditions of sewage. The size of the conductor shall be adequate for continuous use under water and air. The half core shall be used for earthing.

The control cable shall also be PVC insulated, flexible, flat type and shall be adequate for continuous use under adverse environmental conditions of sewage. The control cable for stator winding temperature sensor (thermistors) 3 core x 2.5 sq.mm copper conductor and for bimetallic thermal switch 2 core x 2.5 sq.mm copper conductor shall be provided.

The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3.0% of the rated voltage.

11.2.3 Earthing

Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043. For the purpose of earthing these motors, earthing connection may be made to discharge pipe.

11.2.4 Insulation

Any joints in the motor insulation such as at coil connections or between slot and end winding sections shall have strength equivalent to that of the slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot humid and tropical climate. The tropicalising treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, PVC insulated winding wires conforming to IS: 8783 for wet type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 for dry type motors.

11.2.5 Temperature Rise

The temperature rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature rise of the stator winding by the resistance method shall not exceed 35 °C. During the test, the temperature of the cooling water may not exceed 35 °C. As the cable resistance will also be substantial it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

11.2.6 Constructional Features

The motor shall be suitable for continuous use in fully or partially submerged condition. A built in cooling system must allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not by providing either external or internal cooling arrangement.

11.2.7 Terminal Box

Terminal box shall be of weather proof construction to eliminate entry of water and dust. The terminals shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearance.

12.0 MANUALLY OPERATED TROLLEY AND CHAIN PULLEY BLOCK

The manually operated hoist shall be suitable for operating on the lower flange of a monorail (I - Beam). The load chain shall be of alloy steel as per IS: 3109 and shall be heat treated to give ductility and toughness so that it will stretch before breaking. The chain shall be of welded construction with a factor of safety not less than 5. The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. Hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guarding to prevent snagging and fouling of the chain.

The gearing shall be totally encased and proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks and shall confirm to IS: 4460 and pinions shall be of heat treated alloy steel. The trolley track wheels shall be rim toughened, heat treated carbon steel or low alloy steel or CI and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.

The travelling trolley frame shall be made of rolled steel confirming to IS: 2062. The side plates of trolley shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalising pin. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

The lifting hooks shall be of forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depress type safety latch. They shall swivel and operate on antifriction bearings with hardness races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per IS: 3815. The brake for the lifting gear shall be automatic and always in action. It shall be screw and friction disc type self actuating load pressure brake. The brakes shall offer no resistance during hoisting.

13.0 ELECTRIC HOIST

The electric hoist shall consist of load chain, bottom block, gears, load chain wheel, electrical control panel, bottom block, main body and operating pendent. The hoist shall have overload slipping clutch for safety. The body shall be compact, light weight, precision engineered and shall be made of aluminium cast alloy material. The finishing at top shall be anticorrosive powder coated. The load chain shall be strong, wear resistant and shall be made of grade 80 surface hardened materials confirming to IS: 3109. The chain shall be of welded construction with a factor of safety not less than 5. The swivelling bottom block shall provide free rotation handling of loads. Gears shall be made of precision machined case hardened alloy steel and shall confirm to IS: 4460. Lifting speed shall be maximum 4 MPM and travelling speed shall be maximum 15

MPM. The motor shall be squirrel cage type with TEFC IP: 55 enclosure, Class F insulation and temperature rise limited to Class B.

14.0 PRESSURE GAUGES

The pressure gauges shall be of dial type, stainless steel material and glycerin filled suitable for connecting to suction / delivery pipes of each pump and shall include nipple, stop cock and three way cock for cleaning and necessary length of stainless steel tubing. The pressure gauges shall be connected to the suction / delivery pipes by nipple. The tapping shall be provided with 15 NB isolating valve and shall include required fittings.

15.0 ELECTROMAGNETIC FLOW METER

Electromagnetic bulk flow water meters shall be provided at locations as specified. The flow meter shall have minimum conductivity of 5 S/cm and of approved make conforming to relevant BIS or ISO Standards based on the origin of the goods. The flow meter shall be complete with sensors, loggers, signal convertor and all other accessories. The acceptance / routine tests shall be either conducted at M/s. Fluid Control Research Institute, Palghat, Kerala / any of the Laboratories approved by the National Accreditation Board for calibration Laboratories (NABL) or EEC pattern approval certificate / equivalent institutions approved by the employer.

Inline magnetic inductive flow meters factory assembled and factory calibrated on a precision calibration rig only are accepted. Alternate forms of measuring devices like insertion flow meters, clamp on flow meters, turbine or PD flow meters are not acceptable

The process connection shall be flanged end connections to ANSI B 16.5 Class 150 lbs up to 600 mm size and above 600 mm and up to 1000 mm flanged to AWWA Class D (10 bar) pressure rating. Above 1000 mm up to 2000 mm flanges to AWWA Class B (6 bar) pressure rating.

Temperatures:	Ambient - up to 60 Deg C; Process - up to 90 Deg C.
Insulation of field coils:	Class E
Electrode Design:	Flat elliptical electrodes, solidly fitted and surface polished
Protection energy:	IP 68, equivalent to NEMA 6

Materials of Construction :

Measuring tube	SS 304
Liner	P.T.F.E / Neoprene up to 400 mm size and KTW approved rubber above 400 mm size

Electrodes Hastalloy 'C'	SS 316 / SS 316 Ti
Connecting flanges	Carbon steel
Coil housing	Sheet steel with polyurethane paint
Terminal Box	Die-Cast aluminium with polyurethane paint

Signal Convertor :

Type:	Digital microprocessor based with display
Mounting :	Remote mounting with distance up to 300 mtrs from the primary head without any signal boosters.
Output signals:	1 x 4.20 mA & 1 x pulse outputs, 1 x status output for flow direction, errors or trip point
Low flow cut off:	Required up to 20 % flow range adjustable in steps of 1%
Local Display:	2 - line LCD Backlit for actual flow rate, forward, reverse and sum totalisers (7 - digits), display engg. Units programmable to use defined unit.
Accuracy:	+/- 0.5 % of measured value up to 600 mm size +/- 0.8% of measured value above 600 mm size (Refer Note 2) Linearity +0.5 % of flow rate Reliability +0.1 % of reading +0.2% of full scale
Meter flow range:	Fully programmable from front facia of instrument without opening the cover
Housing material:	Polycarbonate, Die cast Aluminium

Protection category: IP 67 equivalent to NEMA 4/4 X

Cables:	The special cable for signal and the coil supply cable both are required to be supplied (Refer Note 3)

Behaviour in case of flow reversal : Meters which may be subjected to an accidental reversal of flow shall be capable of withstanding it without any deterioration or change in their metrological properties, and at the same time shall record such a reversal.

Sealing : Flow meters shall have protective devices which can be sealed in such a way that after sealing, both before and after the flow meter has been correctly installed, there is no possibility of dismantling or altering the flow meter or its adjustment device without damaging the protective devices.

Meter markings

The water meter shall be marked with the following identifications:

Direction of water flow with an arrow indicating the direction
Trade mark and / or name of the manufacturer.
The metrological class and Qn rate in m^3 per hour.
The manufacturer's serial number of the meter permanently affixed to the meter's upper or lower case.
Stamped with the initial "KSIIDC"
Working pressure
Approval marking and no. of approval certificate.
Year of manufacturing printed on the counter or engraved the head ring
Minimum sustainable pressure shall be PN 10 bar

Flow rate: Minimum, Maximum and transition flow shall be as per relevant standards.

Notes:

1) If the flow meter size works out to be smaller than the pipeline size, suitable reducers and expanders shall be provided. The reducers / expanders shall be of MS, smaller dia end flanged to suit the flow meter flanges and the larger dia end finished for welding to the pipe. The conical angle of reduction should not exceed 10 Deg. The bidder should guarantee that installation of such reducers and expanders immediately before and after the flow meter will not affect the accuracy stated above for the flow meter.

2) The accuracy of calibration of flow meters at the factory shall be better by a factor of 2 than the guaranteed accuracy. This higher accuracy should be reflected in the calibration certificate of the flow meter (+/- 0.25% 0.5 % accuracy and +/- 0.4 % for 0.8% accuracy)

3) Bidder shall include cable for required length.

4) All flow meters shall be housed in chamber / room as per approved design.

5) Supplying and laying Data cable.

6) Supply & laying of suitable capacity signal cable

7) Supply & laying of suitable capacity supply cable

8) Supply and installation of calibration unit which including training of personnel

9) Data Loggers
Input: Current (4-20Ma)
Totaliser: Inbuilt
Display: LED display, 5 digit for flow rate & 8 digits totaliser
Logging Time: Programmable

Accuracy:0.25% of Full Scale
Datalogging: Memory capacity 512 KB
Communication Port for SCADA ; RS485(Modbus)
Parallel port : For Dot-matrix Printing
Conditions:

1) The offered flow meter should be calibrated at the factory on calibration rigs having an accuracy at least ten times better than the flow meter accuracy guaranteed. Further the calibration rig accuracy should be traceable to National / International standards. The calibration facility should be accredited/certified by an independent authority of International reputation. This accreditation certificate for the calibration facility should be furnished along with the offers.

2) Each flow meter supplied should be accompanied by the calibration certificate

3) The flow meters shall have arrangements for servicing / repairing without resorting to dismantling the flanged joints or removing entire unit.

16.0 ULTRASONIC LEVEL MEASUREMENT

Ultrasonic level type measurement devices shall be used incorporating integral temperature compensation.

(i) Ultrasonic Level Measuring System

General Service	:	Level measurement in all wells / sumps including D.G. set day tanks etc.
Overall accuracy of measurement Loop	:	± 0.5% of measured value

(ii) Level Sensor / Transmitter

Mounting	:	Field on top of the channel / tank
Type	:	Indicating type having back lit LCD / LED Display
Output signal	:	4 - 20 mA
Programming facility with Programmer	:	Required
Prefabricated integral cable for connecting sensor and transmitter	:	Required

(iii) Level Indicator

Type	:	Microprocessor based
Display	:	Digital, seven segments back lit LCD / LED display
Digit Height	:	14 mm or higher
Zero and span adjustment	:	Required
Engineering units for display	:	Meters
Accuracy	:	± 0.25% of full scale
Enclosure protection class	:	IP: 52 of IS: 13947 (Part - I)

Retransmission output : 4 - 20 mA
Power supply to transmitters : Required
Alarm outputs : 2 NO + NC for high and low alarms (adjustable)

17.0 FLOAT TYPE LEVEL DETECTION

(a) Float Type Level Switches

Float type level switches shall be provided as specified for detection of high middle and low levels in the wells / sumps. The level switches shall have top mounting arrangement with IP: 68 weather protection class. The level switch shall have 2 NO + 2 NC contracts rated for control voltage.

LIST OF APPROVED MAKES:

Sl. No.	Item	Approved Make
1	HDPE pipes and specials for water supply	Jain Irrigation Systems Ltd. / Duraline India Pvt. Ltd. / Reliance Industries / Pioneer Polyfab / Pennwalt Agro Plastics Ltd. / Rishi Polymach Pvt. Ltd. / Supreme Industries Ltd. / Approved Equiv.
2	DWC PE pipes for sewerage	Alom Poly Extrusions Ltd. / Jain Irrigation Systems Ltd. / Supreme Industries Ltd.
3	DI pipes and specials	Jindal / Electrosteel / LANCO Kalahasti / or Approved Equivalent
4	Sluice valves	VAG Valves (India) Pvt. Ltd. / Kirloskar Brothers Ltd. / Indian Valve International / Durga Engineering Co.
5	Air valves	VAG Valves (India) Pvt. Ltd. / Kirloskar Brothers Ltd. / Fouress Engg. (I) Ltd. / Durga Engineering Co.
6	Non return valves	VAG Valves (India) Pvt. Ltd. / Kirloskar Brothers Ltd. / Indian Valve International / Durga Engineering Co.
7	Sluice gates	Jash Engineering / IVC (Nashik)
8	Horizontal centrifugal pumps / End suction pumps	M/s.Kirloskar Brothers Ltd. / Beacon Weir Ltd. / Flowmore Pvt. Lid. / Jyothi Ltd. / Worthington Pvt. India Ltd. (WPIL) / Mather & Platt Pumps Ltd. / Grundfoss Pumps India Pvt Ltd.
9	Submersible sewage pumps	Grundfos / KSB / ABS / or Approved Equivalent
10	Induction motors	KEC / Crompton (CGL) / Alstom / Siemens / Bharat Bijali
11	Mechanical / electrical hoists	Indef / W H Brandy
12	Pressure Gauges	General Instruments / H Guru / Forbes Marshall
13	Electromagnetic Flow Transmitter	E & H - Germany / Forbes Marshall / Krohne / Danfoss / ABB
14	Ultrasonic level Transmitter / Float type level switch / Pressure Switch	E & H - Germany / Forbes Marshall / Krohne / Danfoss / ABB

SECTION: D

TECHNICAL SPECIFICATIONS –

BUILDING & ANCILLARY WORKS

TECHNICAL SPECIFICATIONS FOR BUILDING & ANCILLARY WORKS

SPECIFICATIONS - GENERAL

1.0 PREAMBLE

These Specifications cover the items of work in structural and non- structural parts of the works coming under purview of this document. All work shall be carried out in conformation with this. In general, provisions of Indian Standards, and other national standards have been followed. These specifications are not intended to cover the minute details. The work shall be executed in accordance with best modern practices. All codes and standards referred to in these specifications shall be the latest thereof.

2.0 Inclusive documents:

Then provisions of special conditions of contract, those specified on the tender as well as execution drawings and notes or other specifications issued in writing by the Engineer shall form part of these specifications.

3.0 Order of precedence, clarifications and interpretation

When the various specifications and codes referred to in preceding portion are at variance with these specifications and with each other the following order of precedence will generally be accepted.

i. Construction Drawings

ii. Special conditions of contract

iii. General conditions of contract

iv. Technical Specifications

v. Additional Technical specification

vi. Codes of practice of BIS.

vii. Codes of practice of Euro / BS.

The attention of the contractor is drawn to those clauses of BIS codes which require either specification by the Engineer or the mutual agreement between the supplier and purchaser. In such cases it is the responsibility of the contractor to seek clarification on any uncertainty and obtain previous approval of the Engineer before taking up the supply / construction.

4.0 Measurement and Payments

The methods of measurement and payment shall be as described under various items and in the bill of quantity. Where specific definitions are not given, the methods described in IS code will be followed. Should there be any detail of construction or materials which has not been referred to in the specification or in the bill of quantities and drawings but the necessity for which may be implied or inferred wherefrom, or which are usual or essential to the completion of the work in the trades, the same shall be deemed to be included in the rates and prices quoted by the contractor in the bill of quantities.

5.0 **Unacceptable work**

All defective works are liable to be demolished, rebuilt and defective materials replaced by the contractor at his own cost. In event of such works being accepted by carrying out repairs etc. as specified by the engineer, the cost of repairs will be borne by the contractor.

6.0 GENERAL SPECIFICATIONS

a) Material and Test Standards

Testing

The Contractor shall set up a field laboratory with necessary equipments for testing of all materials and finished products used in the construction as per requirements of the relevant specifications. The testing of all materials shall be carried out by the Engineer or his representative for which the Contractor shall make all the necessary arrangements and bear the entire cost.

Tests, which cannot be carried out in the field laboratory, shall be got done at the Contractor's cost at any recognised laboratory / testing establishment approved by the Engineer-in-charge.

Sampling of Materials

Samples provided to the Engineer-in-charge or his representative for their retention are to be in labelled boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer-in-charge or his representative, and shall be removed from the site as directed by the Engineer-in-charge at the Contractor's cost.

Samples required for approval must be supplied well in advance. Delay to the works arising from late submission of samples will not be acceptable as a reason for delay in the completion of the works.

Material for Structures

Cement

High strength ordinary Portland cement conforming to IS:8112 and IS:12269, capable of achieving the required design concrete strength shall only be used. If cement conforming to IS:12269 is used, it shall be checked in advance for compatibility with the admixture. Portland pozzolana or portland slag cement or supersulphate cement or any other type of blended cement shall not be used without the written permission of the Engineer-in-charge.

The quality of cement to be used in the job shall be subject to the approval of the Engineer-in-charge. For each batch of cement delivered to the site the Contractor shall forward to the Engineer a certificate to the effect that such cement was tested and analysed at the works and that the results of such tests and analysis satisfactorily meet the requirements of the relevant standards, as

mentioned above.

Notwithstanding the provision of such certificates, however, the Engineer-in-charge may require independent tests to be carried out on the cement stored at site, or require relevant tests to be carried out to determine its suitability for use in works as required by IS: 12269/ IS: 8112. The Contractor shall arrange for samples to be provided either direct from the manufacturer or from cement stored at site, as may be determined by the Engineer and any cement which has been stored at the site for a period in excess of three months shall be re-tested before use. The cost of providing such samples and retesting shall be borne by the Contractor.

Admixture

a. Prior written approval of the Engineer-in-charge for use of admixture shall be obtained.
b. In case of higher grade of cement, compatibility of admixture with every batch of cement used shall be established by means of field tests.

Water

Water shall be clean and free from deleterious materials and shall be tested to determine its suitability for concreting work as directed by the Engineer. The permissible limits for solids must satisfy the following:

		Permissible limit (Maximum)
Organic	}	200 mg/lit
Inorganic	}	3000 mg/lit
Sulphate (S04)	}	400 mg/lit
Chlorides	}	500 mg/lit
Suspended matter	}	2000 mg/lit

Tests & Standards of Acceptance

Defective Concrete

Any concrete which gives results below the results specified in relevant codes becomes severely damaged due to cracking, shows excessive honey-combing and exposure of reinforcement or exhibits any fault which, in the opinion of the Engineer-in-charge, seriously impairs its function, may be declared defective concrete. Such concrete shall be cut out, removed from the site and replaced by fresh concrete of the specified quality at the Contractor's own expense to the satisfaction of the Engineer-in-charge. Alternatively, the

Contractor shall carry out at his own expense whatever other remedy the Engineer-in-charge may reasonably require having regard to all the circumstances.

Tests

In case of doubt regarding grade of concrete used, either due to poor workmanship or based on results of cube crushing strength, tests of concrete on the basis of any or all the following shall be carried out. The Engineer shall be the final authority for interpreting the results of all these tests and the Contractor shall carry out these tests at his own expense without any additional cost to the Employer.

Core Test

The points from which cores are to be taken and the number and size of cores required shall be the discretion of the Engineer-in-charge and shall be representative of the whole of the concrete concerned. In no case, however, shall fewer than three cores be tested.

Core shall be prepared and tested as described in IS: 516. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent strength of 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75 percent.

Non Destructive Test

Non-destructive Test e.g. rebound hammer test, ultrasonic test - as directed by the Engineer-in-charge.

Special Specifications

a. If construction of any particular item of work is not covered by the Codes and specifications or deemed so by the Engineer the same shall comply with special specifications, conforming to sound engineering practice. Such special specifications shall be based on the specialised literature including B.I.S and other national or international codes of practice where relevant. These special specifications shall be submitted to the Engineer-in-charge for his approval. Contractor shall also furnish literature reference, bibliography and copies of relevant extracts as may be deemed necessary by the Engineer-in-charge for scrutiny and approval of such special specifications. The decision of Engineer-in-charge in respect of such specifications shall be final and binding on Contractor.

b. Supplementary information regarding the structure, where deemed appropriate shall be furnished to the complete satisfaction of the Engineer-in-charge

c. Engineer-in-charge may order additional testing by the Contractor or any independent agency. If the results obtained by such tests require any modification, these shall be duly incorporated and no claims for any extra payment on this account shall be valid.

d. Notwithstanding any approval given by the Engineer-in-charge the Contractor shall be totally responsible for the adequacy and safety for staging, Building construction, deep excavation, shoring, dewatering system etc. The Contractor, nevertheless, shall take into consideration any comments made by the Engineer-in-charge for providing additional safety in the design construction/erection operations.

Spacers & Cover Blocks

Spacers & Cover blocks should be of concrete of same strength Or PVC as per IS 456-2000, for reinforcements to ensure specified cover according to drawings.

2.0. TECHNICAL SPECIFICATIONS – CIVIL WORKS

TECHNICAL SPECIFICATIONS – 2.1

SPECIFICATIONS FOR EARTH WORK IN EXCAVATION & BACKFILLING

EARTH WORK IN EXCAVATION AND BACKFILLING

1.0 SCOPE

This part of the specification deals with general requirements for earthwork in excavation in different materials, site grading, filling in areas shown in drawings, filling back with approved borrowed earth around foundations, plinths and approach ramps, conveyance and disposal of excess excavated soil or stacking them properly as shown on the drawings or as directed by the Project manager and all operations covered within the intent and purpose of the specifications. The excavation in rock by blasting etc. shall be as per relevant specifications.

2.0 APPLICABLE CODES

The provisions of the latest Indian Standards listed below, but not restricted to, form part of these specifications:

IS: 783	Code of practice for laying of concrete pipes.
IS: 1200	Method of measurement of building and (Part I) civil engineering works - Part I Earth work.
IS: 1498	Classification and identification of soils for general engineering purposes
IS: 2720 (All Parts)	Methods of test for soils
IS: 2809	Glossary of terms and symbols relating to soil engineering.
IS: 3764	Safety Code for excavation work
IS: 4081	Safety Code for blasting and related drilling operations
IS: 4988 (All parts)	Glossary of terms and classifications of earth moving machinery

3.0 CLASSIFICATION OF EARTH

For purpose of earth work soil shall be classified as under:

Loose/Soft soil:

Any soil which generally yields to the application of picks and shovels, phawras, rakes or any such ordinary excavating implements or organic soil, gravel, silt, sand, turf loam, clay, peat etc. fall under this category.

Dense/Hard Soil:

Any soil which generally requires the close application of picks, or jumpers or scarifies to loosen it. Stiff clay gravel and cobble stone etc. fall under this category.

(Note: Cobble stone is the rock fragment usually rounded or semi-rounded having maximum diameter in any one direction between 80 & 300 mm)

Mud:

Mud is a mixture of ordinary soft soil and water in fluid or weak solid state.

Soft/Disintegrated Rock : (Not requiring blasting).

This shall include the type of rock and boulders, which may be quarried or split with crow-bars. Laterite, hard conglomerate and amygdaloidal basalts also come under this category.

Hard Rock : (Requiring Blasting).

This shall include the type of rock or boulder, which for quarrying or splitting requires the use of mechanical plant or blasting.

(Note : Boulder is a rock fragment usually rounded by weathering, disintegration and exploitation or abrasion by water or ice having minimum dimension in any direction of more than 300 mm).

Hard Rock : (Requiring Blasting but where blasting is prohibited).

Under this category shall fall hard rocks, which though normally requires blasting for their removal but blasting is prohibited and excavation has to be done by chiselling, wedging or other suitable method.

4.0 GENERAL

4.1 The contractor shall furnish all tools, plant, instruments, qualified supervisory staff, labour, materials, any temporary works, consumable and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with the specification requirements.

4.2 The contractor shall carry out the surveys of the site before excavation and set out properly all lines and establish levels for various works such as earth work in excavation for grading, foundations, plinth filling, road drains, cable trenches, pipe lines, culverts, retaining walls etc. Such surveys shall be carried out taking accurate cross sections of the area perpendicular to the grid lines at intervals determined by the Project manager, depending on the ground profiles. These will be checked by the Project manager or is representative and thereafter properly recorded.

4.3 The excavation shall be done to correct lines and levels. This shall include where required, proper shoring to maintain excavation and also the furnishing, erection and maintaining of substantial barricades around excavations and warning lamps at night for safety purposes.

4.4 The rates quoted shall include for dumping of excavated material in regular heaps, bunds, rip rap with regular slopes as directed by the Project manager within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavation shall be properly stacked as directed by the Project manager. As a rule all softer materials shall be laid along the centre of the heaps, the harder and more resistant materials, forming the casting on the sides and the top. Rock shall be stacked separately.

5.0 CLEARING

The area to be excavated/ filled shall be cleared of all fences, trees, plant logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall be removed. The material so removed shall be disposed off as directed by the Project manager. Where earthfill is intended, the area shall be cleared of all loose or soft patches, top soil containing objectionable matter/materials before filling commences. No separate payment shall be made for such clearing works.

6.0 PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITIES ETC.

All gold, silver, oil, minerals, archaeological and other findings of importance or other materials of any description and all precious stones, coins, treasures trove, relics, antiquities and similar things which may be found in or upon the site shall be property of the owner and the contractor shall duly preserve the same to the satisfaction of the Project manager and from time to time deliver the same to him.

7.0 EXCAVATION FOR STRUCTURES

7.1 Description

Excavation for structures shall consist of removal of materials for the construction of the foundations, retaining walls, pipe trenches, tunnels and other similar structures in accordance with the requirements of this specification and the lines and dimensions shown on the drawings or as indicated by the Project manager. The work shall include construction of shoring, bracing, draining, dewatering and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction necessary for placing the foundations, trimming bottoms of excavation; backfilling with approved material brought from outside or brought from approved borrow pits cleaning up the site and disposal of all surplus materials.

7.2 Setting out:

After the site has been cleared as per clause 4 above, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Project manager. The contractor shall provide all labour, survey instruments and materials such as string, pegs, nails, bamboo, stones, lime, mortar, concrete etc. required in connection with the setting out of works and establishment of

bench marks. The contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as they are required for the work in the opinion of the Project manager.

7.3 Excavation

Excavation shall be taken to the width of the lowest step of footing or the pile caps and the sides shall be left plumb where the nature of the soil allows it. Where the nature of the soil or the depth excavated trench/pit does not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or sheet piling or cut slopes to a safe angle or all with due regard to the safety of personnel and the works and to the satisfaction of the Project manager. The depth to which the excavation is to be carried out shall be as shown on the drawings unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Project manager.

7.4 Dewatering and Protection:

Where water is met within excavation due to stream flow, seepage, springs, rain or other reasons, the contractor shall take adequate measures such as bailing, pumping, construction of diversion channels, drainage channels, bunds and other necessary works to keep the foundation trenches/pits dry when so required and to keep the green concrete/masonry against damage by erosion or sudden rise of water level. The method to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to the approval of the Project manager. Approval of the Project manager shall, however, not relieve the contractor of his responsibility for the adequacy of dewatering and protection arrangements and the safety of the works. Pumping from inside of any foundation enclosure shall be done in such a manner as to preclude the possibility for the movement of water through any freshly placed concrete. No pumping shall be permitted during the placing of concrete or for any period of atleast 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water tight wall or similar means. At the discretion of the contractor and at his cost, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area. The contractor shall take all precautions in diverting channels and in discharging the drained water so as not to cause damage to the works or to adjoining property.

7.5 Preparation of Foundation:

The bottom of the foundation shall be levelled both longitudinally and transversally or stepped as directed by the Project manager. Before the footing is laid, the surface shall be slightly watered and rammed. In the event of the excavation having been made deeper than that shown on the drawing or as otherwise ordered by the Project manager, the extra depth shall be made up with concrete of the foundation grade at the cost of the contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed of all loose and soft materials, cleaned and cut to a firm surface either level, stepped, or serrated as directed by the Project manager. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Project manager.

7.6 Slips & Blows:

If there are any slips or blows in the excavation, these shall be removed by the contractor at his own cost.

7.7 Backfilling:

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

Selected fill material is required to be borrowed, the contractor shall make arrangement for bringing the material from outside borrow pits. The material sources shall be subject to the prior approval of the Project manager. The contractor shall make necessary access roads to such borrow areas at his own cost, if such access roads do not exist.

Backfilling of the foundation/pits shall be done as soon as the foundation work has been completed to the satisfaction of the Project manager but not earlier than the full setting of the concrete or masonry of the foundation. Backfilling shall be carried out in such a manner as to not cause undue thrust on any part of the structure. Backfilling shall be done in space around the foundations after clearing it of all debris and in layers of 150 mm. loose thickness, watered and compacted with Plate compactor of min.2T capacity to the satisfaction of the Project manager and to the original surface. The soil compaction shall be verified by testing as per codal provisions & standards.

7.8 Disposal of Surplus Excavated Materials:

All the excavated material shall be the property of the employer. Where the excavated material is directed to be used in the construction of the works for general grading, plinth filling or embankments, the operations shall be arranged in such a manner that the capacity for cutting, haulage and compaction are nearly the same.

All hard materials such as hard murrum, rubble etc. not intended for filling in foundations, plinth or embankments, shall be stacked neatly for future use as directed by the Project manager. Unsuitable or surplus materials not intended for use in part of the works or for reuse shall be disposed off outside the colony complex as directed by the Project manager.

The dimensions of the trenches and pits shall be measured correct to the nearest cm. and cubical contents worked out in cubic metres, correct to two places of decimal. The measurement shall be generally conforming to IS:1200 Part I unless specified otherwise.

7.9 Scope of the earth work shall include the following:

a) Excavation and disposing earth as specified.

b) Setting out works, profiles etc.

c) Site clearance such as cleaning of rank vegetation, shrubs, bushwood.

d) Forming (or leaving) "Deadmen" or "Tell Tales" and their removal after measurement.

e) Bailing/pumping out water in excavation from rains, sub-soil water etc.

f) Protection, temporarily supporting of existing service, i.e pipes, water mains, cables etc. met within the course of excavation. Care shall be taken not to disturb electric and communication cables, removal of such cables, if necessary, shall be arranged by the Project manager.

g) Forming (or leaving) steps in sides of deep trenches and their removal:

h) Removing slips or falls in excavation

i) Fencing and/or other suitable measures for protection against risk of accidents as approved by the Project manager

j) Excavation for insertion of planking and strutting where required &

k) Backfilling the trenches with approved selected material.

TECHNICAL SPECIFICATIONS – 2.2

SPECIFICATIONS FOR ANTI-TERMITE TREATMENT

ANTI-TERMITE TREATMENT

The specifications have been formulated for all types structure, RCC framed type (with plinth beams) and with load bearing wall foundations.

1.0 Chemicals

The chemicals used for the soil treatment shall be environmental friendly and the toxicity shall be as per the standard norms.

Barrier shall be complete and continuous under the whole of the structure to be protected. All foundations shall be fully surrounded by and be in close contact with the barrier of treated soil. Each part of the area treated shall receive the prescribed dosage of chemical.

Soil treatment should start when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or when the soil is wet with rain or sub soil water. The foregoing applies also in the case of treatment to fill up earth surface within the plinth area before laying the sub grade for the floor. Once formed, treated soil barriers shall not be disturbed. If by chance treated soil barriers are disturbed immediate steps shall be taken to restore the continuity and completeness of barrier system.

2.0 Precautions:

The chemicals used for anti-termite are poisonous and hazardous to health. Therefore, necessary safety precautions shall be taken in handling and use of the chemicals and emulsions. “The containers should be stored carefully so that it is well away from children and pets. They should be kept seemly closed”. “The chemicals used are highly inflammable due to the pressure of petroleum product and hence any flame should be avoided during mixing”. Care should be taken at the application of chemicals to see that they are not allowed to contaminate wells or spring which serve as sources of drinking water”.

3.0 Soil Treatment:

The bottom surface and the sides (upto a height of 300mm above concrete foundation level) of the excavations made for column pits, wall trenches and basements shall be treated with the chemical at the rate of 5 litres per Sqm. of surface area. After the column foundations and retaining walls of the basement come up, the back fill in immediate contact with the foundation structure shall be treated at the ratio of 15 letres per sqm. of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill the chemical treatment shall be carried out after ramming operation is done by rodding the earth at 150 mm centers close to wall surface and spraying the chemical with the above doze. As earth is filled in layers the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that earth in contact with these surfaces is well treated with the chemicals. In the case of RCC framed structure with columns and plinth beams and RCC basements the treatment shall start at the depth of 500 mm below ground level. From this depth the back fill around the columns

beams and RCC basement walls shall be treated at the rate of 15 litres per Sq.m of vertical surface. The other details of treatment shall be as described below:

4.0 Termite Proof Course DPC in Plinth

(a) If there is provision of a Damp Proof Course in the Construction, it should be located just below the level of the filled earth, in the plinth area. Although this acts as an effective barrier impervious to termite entry, the DPC surface should be treated at 5 litres per Sqm immediately after the course is laid and the concrete is green.

(b) If there is no provision for a DPC the top surface of the masonry course just below the level of plinth filling mentioned above should be soaked with the chemical emulsion at the rate of 5 litres per sqm. of the surface. This application should be carried out slowly to enable the masonry surface to absorb the emulsion properly. Both steps (a) & (b) above help in creating a barrier which is impervious to termite entry.

5.0 Treatment at Junction of Walls and Floor:

Rodding shall be carried out along the junction of walls and earth filling at 15cm intervals down to or slightly lower than the DPC or the chemical barrier described above. Emulsion shall be sprayed along the wall junction at 1 litre per linear metre so that it mixes intimately with the broken up soil and seeps to the DPC level or chemical barrier thus establishing continuity of the anti-termite layer. The disturbed earth is then tamped back in place.

6.0 Treatment to Top Surface of Plinth Filling:

(a) After the earth filling is completed in the plinth area and before the rubble packing or sub grade is laid, the entire surface of the filled earth shall be treated with the chemical emulsion at the rate of 5 litres per sqm. Light rodding may be carried out in the soil surface to facilitate absorption saturation of the soil with chemical solution.

(b) For buildings where construction has advanced already for facility of construction, the treatment could also be done effectively, over the base concrete (lean mix) under the floor taking care that the emulsion at the rate of 5 litres per sqm., soak fully into the concrete.

(c) The above application effectively prevents entry of termites through the floor structure.

7.0 Treatment of Soil Along External Perimeter:

Finally the earth around the external perimeter of the building up to a depth of 30 cm shall be treated at the rate of 5.0 litres per running meter of the external WALL. To facilitate this treatment solid MS rods Should be driven into the soil as close as possible to the plinth wall at internals of 15 cm., and up to a depth of 30 cm., and the roads moved backwards and forwards in a direction parallel to the wall to break up the earth so that the emulsion mixes intimately with the soil.

8.0 Treatment of Soil Surrounding Pipe, Wastes And conduits:

When pipes, wastes and conduits enter the soil inside the area of the foundation, the soil surrounding the points of entry shall be loosened around each such pipe, waste or

conduct for a distance of 15cm, and up to a depth 7.5cm. before the treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 7.5 cm for a distance over 30 cm.

9.0 Miscellaneous

9.1 Spraying Equipment

A pressure pump shall be used to carry out spraying operations to facilitate uniform spraying and penetration of chemicals in to the earth. The chemicals, concentration and dosage for horizontal and vertical surfaces are based on the IS code of practice for anti termite measures in buildings IS 6313 (part II).

9.2 Mound Treatment:

If termite mounds are found with in the plinth area, this should be destroyed by means of insecticides in the form of water suspension are emulsion which should be poured in to the mounds at several places after breaking open the earthen structure and making holes with crow bars. The quantity to be used will depend upon the size of the mound.

9.3 Treatment for Expansion Joints:

Expansion joints at ground floor level are one of the biggest hazardous for termite infestation. The soil beneath these joints should receive special attention when the treatment under para 8.5 is carried out. This treatment should be supplemented by treating through the expansion joint after the subgrade has been laid at the rate of 2 ltr/linear m. Measurements for payments. In case of pre construction treatment as described above, area covered by the building at ground level shall be the basis for payments. For post construction treatment the payment shall be on linear basis that is per meter run of treatment around buildings including forming trench, treatment with chemicals and refilling etc complete.

9.4 Free Service Guarantee:

The contractor shall note that termite proofing work, is subject to a free service guarantee from the date of completion of the treatment. The contractor shall give an under taking in writing to the effect that during the guarantee period any infestation of subterranean termites will be eradicated and necessary treatment carried out to prevent reinfestation, free of cost to the owners.

TECHNICAL SPECIFICATIONS – 2.3

SPECIFICATIONS FOR PLAIN, REINFORCED

CONCRETE

PLAIN, REINFORCED CONCRETE

1.0 General

These specifications cover the requirements of plain, reinforced concrete for use in various components of structures. For all items of concrete in any portion of the structure or its associated works controlled concrete shall be used unless otherwise specified. When ordinary concrete of the mix shown on drawings or directed by the Engineer, the same may be used.

The provisions of the latest revisions of the following I.S Codes shall form a part of this specification to the extent they are relevant.

IS - 226 Specification for structural steel (standard quality)

IS - 269 Specification for ordinary and low heat Portland cement

IS - 303 Plywood for general purposes

IS - 383 Specification for coarse and fine aggregate

IS - 432 (All Parts) - Specifications for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement.

Part I - Mild steel and medium tensile bars

Part II - Hard drawn steel wire

IS - 455 Specification for Portland blast furnace slag cement

IS - 456 Code of practice for plain and reinforced concrete for general building construction

IS - 460 Specification for test sieves

IS - 516 Methods of test for strength of concrete.

IS - 650 Standard sand for testing of cement

IS - 1139 Hot rolled mild steel, medium tensile steel and HYSD bars for concrete reinforcement

IS - 1199 Sampling and analysis of concrete

IS - 1200 Method of measurement of building

	Part II works
IS - 1343	Code of practice for prestressed concrete.
IS - 1489	Specification for Portland pozzolana cement
IS - 1542	Sand for plaster
IS - 1566	Specification for hard-drawn steel wire fabric
IS - 1732	Dimensions for round & square steel bars for structural & general engineering purposes.
IS - 1785	Plain hard drawn steel wire for PRESTRESSED concrete Part I) Cold drawn stress-relieved wire.
IS - 1786 reinforcement	Specification for high strength deformed steel bars & wires for concrete
IS - 1791	Batch type concrete mixers
IS - 2062	Hot Rolled Low, Medium and High tensile Structural Steel
IS - 2386	Method of test for aggregates
(8 Parts)	for concrete
IS - 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS - 2505	Immersion type concrete vibrators
IS - 2506	Screed board concrete vibrators
IS - 2722	Specification for portable swing weigh batcher (single and double bucket type)
IS - 2751	Code of practice for welding of M.S bars
IS - 2911	Code of practice for design & construction of pile foundation
IS - 3366	Pan vibrators
IS - 3370	Code of practice for concrete
(All Parts)	structure for the storage of liquids
IS - 3558	Code of practice for the use of immersion vibrators for consolidating concrete.
IS - 4656	Form vibrators for concrete
IS - 5525	Recommendation for detailing of reinforcement in reinforced

concrete works

IS - 5640 Method of test for determining aggregate impact value of coarse aggregate.

1.11 IS - 5816 Method of test for splitting tensile strength of concrete cylinder
IS - 6006 Uncoated stress relieved strand for PRESTRESSED concrete.

IS - 6461 Cement concrete : glossary of terms

IS - 8041 Specifications for rapid hardening Portland cement

IS - 8043 Specifications for hydrophobic Portland cement

IS - 8112 Specifications for 43 Grade ordinary Portland cement.

IS - 9103 Admixtures for concrete

IS – 12269 Specifications for 53 Grade ordinary Portland cement.

SP-34 Handbook on Concrete Reinforcement and detailing

Other codes and specifications

Other IS codes pertaining to the items of cement concrete work in structural work and not listed above shall also be deemed to come under the purview of this clause. All Indian Roads Congress Standards, specifications and codes of practice also come under this purview.

2.0 Grade of Concrete

2.1 Controlled Concrete

For controlled concrete, design of the mix shall be arrived at after preliminary tests and in its production all necessary precautions shall be taken to ensure that the required works cube strength is attained and maintained. The controlled concrete shall be in nine grades designated as M10, M15, M20, M25, M30, M35, M40,M45 and M 50.

3.0 Strength Requirement of Concrete:

Where Ordinary Portland Cement conforming to IS: 269, IS: 8112, IS: 12269 or Portland Blast Furnace Cement conforming to IS: 456 is used, the compressive strength requirements for various grades of concrete controlled as well as ordinary shall be as given in Table 1. Where rapid hardening Portland cement is used, the 28 days compressive strength requirements specified in Table 1 shall be met at 7 days.

For controlled concrete, the mix shall be so designed as to attain in preliminary tests a strength at least 33 per cent higher than that required on work tests, for concrete upto and including M25 and 25 per cent higher for higher strengths.

TABLE – 1

Grade of Concrete	Compressive Works test strength in N/sq. mm on 150mm cubes after testing Conducted in accordance with IS: 516	
	Min at 7 days.	Min at 28 days.
M10	7	10
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45
M50	33.5	50

Note: In all cases, the 28 days compressive strength specified in Table 1 shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in table 1, such concrete shall be classified for all purposes as a concrete belonging to the lower of the two grades between which its strength lies.

4.0 Materials

4.1 Cement

All types and brands of cement shall be subject to the approval of the Project manager.

a) Following types of cement shall be used.

i) All cement used for the work shall be ordinary Portland cement or such other cement as may be permitted by the Project manager. Portland cement shall comply with the requirements of the latest issue of IS 269, IS: 8112 & IS: 12269. High alumina cement, rapid hardening cement and Portland Slag cement etc., can be used only when permitted by the Project manager. Such cements shall be in accordance with relevant IS Codes. Portland Pozzolana cement when permitted by the Project manager shall conform to IS 1489.

ii) Cement which has remained in bulk storage at the mill for more than 6 months, or which has remained in bags at the dealer's storage for over 3

months, or which has been stored at project site for more than 3 months shall be re-tested before use. Cement shall also be rejected if it fails to conform to any of the requirements of these specifications.

4.2 Fine Aggregates

Fine aggregates shall consist of natural sand, manufactured sand, or an approved combination thereof and shall conform to IS: 383. The grading zone of sand proposed for use shall be supplied by the contractor and got approved by the Project manager.

The sand shall be of siliceous material, sharp, hard, strong and durable and shall be free from adherent coatings, clay, dust, alkali, organic material, deleterious matter, lumps, etc.

Either natural or manufactured sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter. Natural sand shall be washed, unless specific written authority is given by the Project manager to use sand that meets specifications and standards of cleanliness without washing. The cost of screening and washing must be borne by the contractor. The fine aggregate shall be taken from a source approved by the Project manager.

4.3 Coarse Aggregates

Coarse aggregates shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, organic or other deleterious matter. It shall not have adherent coatings. It will be from a source approved by the Project Manager.

Coarse aggregate shall conform to IS: 383.

Coarse aggregate shall be washed if necessary to remove all vegetable and other perishable substances and objectionable amounts of other foreign matter, the cost of washing and screening being borne by the contractor.

4.4 Size of Coarse Aggregates

Following shall be the maximum nominal size of coarse aggregate for the different items of work:

	Item of Construction	**Max. nominal size of coarse aggregate**
i)	RCC well steining concrete, RCC well curb & RCC piles in plum concrete	63 mm
ii)	Well cap, solid type piers, abutments and wing walls, and pier caps.	40 mm

iii)	RCC works in foundations, beams, girders, deck slab, floor slabs, columns, pile, pile caps, wearing coat, kerb, light posts, ballast walls, approach slab etc. and hollow type piers, abutments, wing walls, pier caps and all general item of work in bridge and building construction.	20 mm
iv)	RCC bearings, shells and other thin walled members and in zones of congestion	20 mm
v)	For any other item of construction not covered by items (i) to (iv) shall be as specified in the drawings or as desired by the Project manager in case it is not specified on the drawing.	

For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of aggregate shall usually be restricted to 5 mm less than the minimum lateral clear distance between the main bars, or 5 mm less than the minimum cover to the reinforcement, whichever is smaller. However, if required under special circumstances, the Project manager may permit nominal maximum aggregate size of 25% more than these critical spacing/cover, provided that proper vibrating is ensured.

4.5 Reinforcing Steel

Steel for reinforcement shall be high yield strength deformed bars having corrosion resistant characteristics. The steel shall be either TISCO of grade Fe 500 or SAIL's HCR – Rebars Gr M of grade Fe 415 / Fe 500 or RINL Steel's A1 – Rebars of grade Fe 415 / Fe 500 or equivalent having similar compositions and shall have mechanical & chemical properties as per IS: 1786. The reinforcement supplied shall have the following Chemical Properties:

Carbon	% max	:	0.200
Sulphur	% max	:	0.55
Phosphorus	% max	:	0.120
S + P	% max	:	0.175
Silicon	% max	:	0.450
Manganese	% max	:	1.200
Corrosion Resistance Elements	% max	:	1.500

(a) Testing of Materials :

(i) Manufacturer's Tests

For each batch of materials supplied Manufacturers' Test Certificate shall be submitted for approval. This certificate shall clearly state that the material being supplied is Corrosion Resistant Steel and has been tested for corrosion resistance properties.

(ii) Confirmatory Test

3 specimens of each diameter from each batch shall be tested in an approved laboratory for the following:

Salt Spray Test as per ASTM : B117 – 94 for 96 hours.

For the above test Corrosion Resistance Index (CRI) shall be calculated as :

$$\text{CRI (of CRS Bar)} = \frac{\text{Corrosion rate in mm/year of Mild Steel bar of same diameter in the particular test}}{\text{Corrosion rate in mm/year of CRS bar in the same test}}$$

(b) Acceptance Criteria

Based on the results of tests carried out as mentioned above, the Employer's Representative will decide the acceptance of the batch under test for use in RCC structures, and his decision shall be final and binding on the Contractor.

The charge for all the tests shall be borne by the Contractor and are deemed to have been included in the quoted price. It shall be clearly understood by the Contractor that the confirmatory test stipulated above is mandatory and the time required for such testing shall be catered for in the construction period.

Reinforcing steel shall be clean and free from loose mill scales, dust, loose rust and coats of paints, oil, grease or other coatings which may impair or reduce bond.

Mild steel and medium tensile steel bars and hard drawn steel wire shall conform to the latest edition of IS: 432.

Structural steel sections and plates shall conform IS : 226 and IS : 2062.

4.6 Water

Water used for mixing and curing shall be free from injurious amounts of deleterious materials. Potable waters are generally considered satisfactory for mixing and curing concrete.

4.7 Admixtures

No materials other than the essential ingredients, i.e., cement, aggregates and water, shall ordinarily be used in the manufacture of concrete or mortar. But the Project manager may permit the use of approved admixtures conforming to IS: 6925 for imparting special characteristics to the concrete, on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. Admixtures where allowed will generally be conforming to relevant ASTM standards and IS : 9103. All admixtures shall be checked for compatability before use.

4.8 Materials for Repair Work

The use of epoxy for bonding fresh concrete used for repairs will be permitted on written approval of the Project manager. Epoxies shall be applied in accordance with the instructions of the Manufacturer. The cost of such repair when approved by the Project manager shall be borne by the contractor.

4.9 Storage of Materials

(i) Cement

The contractor shall make arrangements to the satisfaction of the Project manager for the storage of cement to prevent deterioration due to moisture and/or intrusion of foreign matter. Bulk cement shall be stored in approved water-proof bin or silo. Bagged cement shall be stored in a suitable weather tight warehouse in a manner to provide easy access for identification and inspection of each consignment. Stored cement shall meet the test requirements as per IS-269, IS: 8112 & IS: 12269 at any time after storage, when a retest is ordered by the Project manager. Each consignment shall be stacked separately with the date of receipt of flagged on it, not more than 12 bags being stacked in height, the bags being arranged with headers and stretchers. Normally consignments shall be used in the order of receipt at site unless otherwise directed. In the case of large concrete pours the Project manager will decide on the batch of cement to be used taking into consideration the quantity of cement with particular reference to the concerned concrete pours. Any additional work in handling and storage of cement contingent upon this requirement shall be to the contractors' account and no extra claim will be entertained. Cement shall be protected from exposure to moisture in transit, in storage at the works and until it enters the concrete mixers. The contractor shall keep accurate records of the deliveries of the cement and of its use in the work.

(ii) Aggregates

Coarse and fine aggregates shall be stacked separately in such manner as to prevent contamination by foreign materials. All aggregates shall be stored on concrete or masonry platforms. each size shall be kept separate with wooden, steel, concrete, or masonry bulk heads, or shall be stored in separate stacks, taking care to prevent the materials at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart. The aggregates shall be stored in easily measurable stacks of suitable heights

as may be directed by the Engineer- in-Charge.

(iii) Reinforcing Steel

Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil, grease and distortions as directed by the Project manager.

5.0 Proportioning Concrete

5.1 Controlled Concrete

Concrete mix shall be designed on the basis of preliminary tests. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available.

Except where it can be shown to the satisfaction of the Project manager that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions as required. The different sizes, shall be stocked in separate stock piles. Required quantity of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Project manager to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. 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, the moisture content in both fine and coarse aggregates shall be determined by the Project manager 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 weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The minimum quantity of cement to be used in concrete shall not be less than 250 kg per cubic metre for plain concrete and not less than the values specified in table 5 of IS:456, for reinforced concrete structural members, subject to a maximum limit of 450 kg per cubic metre.

6.0 Mixing Concrete

For all works concrete shall be mixed in approved RMC/Batching plant only. A mechanical mixer with weigh batcher along with other accessories may be allowed for

mixing only under exceptional conditions. The Contractor must take the permission of the Project manager in advance. 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 a complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Project manager, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate. The mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

The design mix of different grades of concrete shall be re design when the source of materials changed or every12 months.

7.0 Transport, Placing and Compaction of Concrete

The method of transporting and placing concrete shall be approved by the Project manager. Concrete shall be transported and placed such that no contamination, segregation or loss of its constituent materials takes place.

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

No concrete shall be placed in any part of the structure until the approval of the Project manager has been obtained in approved concrete pour card.

If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Project manager. Concreting shall then proceed continuously over the area between 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.

Concrete when deposited shall have a temperature of not less than 4.5 deg. C and not more than 38 deg. C unless otherwise specified. It shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried on properly designed agitators, operating continuously, in which case this time shall be within 90 minutes of the addition of cement to the mix and within 30 minutes of its discharge from the agitator.

Concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 m using internal vibrators.

Unless otherwise agreed to by the Project manager, concrete shall not be dropped into place from a height exceeding 2 metres. When trunking or chutes are used, they shall be kept clean and used in such a way as to avoid 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 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.

All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators. For exceptional cases, where vibrators cannot be used an alternate scheme of compaction shall be approved by the Project manager. Sufficient vibrators, in serviceable condition, shall be kept at site so that spare equipment is always available in the event of breakdowns.

The performance requirements of vibrators shall conform to relevant IS Codes. Vibration shall not be applied through reinforcement, and where vibrators of the immersion type are used, contact with reinforcement and all inserts shall be avoided as far as practicable.

8.0 Concreting under Water:

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be got approved from the Project manager before any work is started. Such concrete shall not be considered as `Controlled Concrete'.

Concrete shall not be placed in water having temperature below 4.5 Deg.C. The temperature of the concrete, when deposited, shall be not less than 16 Deg.C., nor more than 38 Deg.C.

Concrete shall contain 10 per cent more cement than that required for the same mix placed in the dry. The materials shall be so proportioned as to produce a concrete having a slump of not less than 100mm. and not more than 180mm. The slump shall be tested as per IS: 516.

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 metres 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 wells. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter.

Concrete shall be deposited continuously until it has been brought to the required height. While depositing, the top surface shall always be kept as nearly level as possible and formation of seams avoided. For depositing concrete any one of the following methods may be used:

(a) Tremie - When concrete is to be deposited under water by means of tremie, the top section of the tremie shall be a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket if any. The tremie pipe shall not be less than 200mm 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 enters above the concrete in the pipe. At all times after the 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 top 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 it shall be re-plugged at the top end, as at the beginning, before refilling for depositing further concrete.

(b) Drop Bottom Bucket - The top of the bucket shall be closed. The bottom doors shall move freely downward and outward when tripped. The bucket shall be filled completely and lowered slowly to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

To minimize the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

9.0 Curing of Concrete

9.1 Protection and Water Curing

Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes and premature drying out. It shall be covered with wet sacking, Hessian or other similar absorbent material approved by the Project manager soon after the initial set, and shall be kept continuously wet for a period of not less than 21 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 21 days.

Required no. of water storage tanks with hose pipe shall be provided at different locations.

9.2 Working in Extreme Weather

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 38 deg. C while placing. This shall be achieved by stacking aggregate under sheds and keeping it moist using cold water or crushed or flaked ice if specified and permitted by the Engineer, reducing the time between mixing and placing to the minimum, cooling formwork by sprinkling water on the exterior, starting curing before the concrete dries out and restricting concreting, as far as possible, to mornings and evenings.

During hot weather and rains the concrete shall be covered with tarpaulin and transported and placed in the forms and consolidated to final state in as short a time as possible.

Commencement of concrete pours shall be avoided during heavy rains, storms and high winds.

10.0 Finishing

10.1 General

Immediately after the removal of forms, all exposed bars or bolts passing through the reinforced cement concrete member and used for shuttering or any other purpose shall be cut inside the reinforced cement concrete member to a depth of at least 25 mm below the surface of the concrete and the resulting holes be closed by cement mortar. All fins caused by form joints shall be broken. All cavities produced by the removal of form ties, all holes and depressions, honey-comb spots, broken edges or corners and all 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 a 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 filled / pointed shall be kept moist for a period of twenty-four hours. Any repair and rectification of defective work is to be undertaken and carried out as directed by the Project manager and the cost is to be borne by the Contractor.

If rock pockets/honey-combs, in the opinion of the Project manager, are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the affected portions of the structure.

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.

Curing of the surface shall be continued for a period of 21 days.

10.2 Classes of Finishing

The surface finish for formed and unformed surfaces are classified and defined as below. Surface irregularities permitted for the various classes of finishes are termed either “abrupt" or "gradual". Fins or offsets caused by displaced or misplaced form sheeting, lining or form sections, by loose knots in form timber or by otherwise defective form timber are considered abrupt irregularities. All other cases are described as gradual irregularities. Gradual irregularities will be measured with a template consisting of a straight edge for plane surfaces or its equivalent for curved surfaces. The length of template for testing gradual irregularities on formed surfaces shall be 1.5 m in length, the permissible gradual irregularities being measured over this length of the template.

Special surfaces, finishes and treatments falling outside the classes described here but defined elsewhere by the Project manager shall also form part of these specifications.

Finish F1, F2 and F3 shall describe formed surfaces.

Finish U1, U2 and U3 shall describe unformed surfaces.

Class F1 Finish

This class of finish shall apply to all formed surfaces for which class F2 or F3 is not specified. It shall generally be formed by sawn timber formwork so constructed that there shall be no loss of material from the concrete during placement and compaction. After hardening, the concrete shall be in the position required and shall have the shape and dimensions called for in the drawings. Any abrupt irregularities shall not exceed 8 mm and gradual irregularities shall not exceed 16 mm. All fins and drifts in excess of the above limits shall be made good by chipping and grinding if required by the Project manager. Small blemishes caused by entrapped air or water may be expected but the surface shall be free from voids, honeycombing or other large blemishes.

Class F2 Finish

Class F2 finish shall be obtained by the use of properly designed forms, either close jointed wrought timber forms or with forms having plywood or steel sheet lining. The abrupt irregularities shall not exceed 5mm and gradual irregularities shall be less than 8mm. Small blemishes caused by entrapped air or water may be permitted but the surface shall be generally free from honeycombing, voids and large blemishes. Surface irregularities in excess of those stipulated shall be removed by chipping or rubbing with abrasive stone.

Class F3 Finish

Class F3 finish shall be formed by specially designed close jointed rigid forms having lining of high quality form plastic coated / laminated plywood. The surface irregularities shall be limited to nil for abrupt irregularities and 3 mm for gradual irregularities. Unless otherwise specified the surface finish shall be understood to be Class F3 finish. If steel forms are used they shall be subject to Project manager's approval.

In addition, finish F3 shall include filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up of loose and adhering debris. For a sack rubbed finish, the surface shall be prepared within two days after of removal of the forms. The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and one half parts by volume of fine (I.S. No. 16 mesh) sand. Only sufficient mixing water to give the mortar a workable consistency shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean with clean burlap such that all air holes etc. are filled and the entire surface presents a uniform appearance without air holes, irregularities etc.

Class U1 Finish

This is the screeded finish used on surfaces over which other finishes such as wearing coats etc. are to be placed. It is also the first step in the formation of U2 and U3 finishes. The finishing operation consists of levelling and screeding the concrete to

produce an even and uniform surface so that the gradual irregularities are not greater than 6 mm. Surplus concrete should be removed immediately after consolidation by striking it off with a sawing motion of a straight edge or template across a wooden or metal strip that has been set as guide. Unless the drawings specify a horizontal surface or show the slope required, the tops of narrow surfaces, such as stair treads, walls, curbs and parapets shall be sloped approximately 10 mm per 300 mm width. Surfaces to be covered with concrete topping, terrazzo, and similar surfaces shall be smooth screeded and levelled to produce even surfaces, irregularities not exceeding 6mm.

Class U2 Finish

This is a floated finish used on all outdoor unformed surfaces not prominently exposed to view such as tops of piers etc. The floating may be done by hand or power driven equipment. It should not however be started until some stiffening has taken place in the surface concrete and the moisture film or "shine" has disappeared. The floating should work the concrete no more than is necessary to produce a surface that is free from screed marks. All joints and edges should be finished with edging tools. It shall include the repair of gradual irregularities exceeding 6 mm. All abrupt irregularities shall also be repaired unless a roughened texture is specified.

Class U3 Finish

This is a trovelled finish used on all surfaces exposed to view at close quarters such as tops of parapets and kerbs etc. Steel trovelling should not be started after the moisture film and "shine" have completely disappeared from the floated surface and the concrete has hardened enough to prevent an excess of fine material and water from being worked to the surface. Excessive trovelling, especially if started too soon, tends to produce crazing and lack of durability. Too long a delay will result in a surface too hard for proper finishing. Steel trovelling should be performed with a firm pressure that will flatten and smooth the sandy surface left by floating. Trovelling should produce a dense, uniform surface free of blemishes, ripples and trovel marks. It shall include the repair of all abrupt irregularities and the repair of gradual irregularities exceeding 6 mm. It shall also include finishing the joints and the edges of concrete with edging tools.

If, ply wood form is used for shuttering, only wax coated water proofing high quality 12mm thk. are allowed and it has to be stacked properly after deshuttering. Also damaged plywood shutter which is not meeting the required finish shall not be used further.

11.0 Construction Joints

Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown on approved drawings or as directed by the Project Manager. Such joints shall, however, be kept to the minimum.

For a vertical construction joint, a stopping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concrete is compacted against it. Concreting shall be continued right upto the board. The board shall not be removed before the expiry of the specified period for removal of vertical forms.

In all cases, the position and detailed arrangement of all construction joints shall be predetermined and got approved by the Project Manager

12.0 Tests and Standards of Acceptance

12.1 Preliminary Tests for Controlled Concrete

For controlled concrete preliminary tests referred to in Paras 2.1 & 3.0 shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimens in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests of 7 days are intended only to indicate the strength likely to be attained at 28 days.

12.2 Work Strength Tests for Controlled and Ordinary Concrete

Works strength tests shall be made in accordance with IS 516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. However, if in each grade concreting done in a day, the minimum 6 number of cubes shall be taken.

Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Project manager, when procedure of tests given above reveals a poor quality of concrete and in other special cases.

All work shall be carried out under the supervision of a qualified and a competent Engineer who will supervise proportioning, placing and compacting of concrete at all stages.

All necessary labour, materials, equipment, etc. for sampling, preparing test cubes, curing, etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Project manager in an approved laboratory at the cost of the contractor.

12.3 Standard of Acceptance

The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength. 20 percent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of specified strength.

12.4 Manufacturer's Certification: Testing Results etc.

For all materials required for concrete construction including cement, aggregate, water, reinforcing and prestressing steel the original copies of test certificates, test results etc. either carried out by the manufacturer or any other agency, the mix design recommendations etc. shall be submitted to the Project manager for his approval and record. It shall remain the property of the Corporation.

12.5 Chloride Contents

Since the chloride contents of the constituent materials of the concrete would be additive, it is desirable to keep a check on the overall chloride content of the concrete to keep it minimal. Specially, for prestressed concrete, the total chloride content of the concrete when manufactured according to the requirements of workability and strength shall not exceed 500 ppm. by weight of cement. The costs of testing for the chloride content of the ingredients of concrete and of undertaking remedial measures if the chloride content is more than the permissible limit shall be borne by the contractor.

13.0 Repair Work

Concrete which is unsatisfactory shall be repaired by cutting out the unsatisfactory material and by replacing it with new concrete. Voids to be so filled shall be provided with anchors, keys or dovetail slots wherever necessary to attach the new material securely in place. Surface of prepared voids shall be wetted for 24 hours immediately before the patching material is placed. Repair of concrete shall be made by skilled workmen. Repairs shall be made as soon as practicable after removal of forms and in a manner to meet the requirements for the finish specified for the particular location.

Repairing leakage in liquid retaining structures which become apparent during leak-testing will also have to be repaired by the contractor at his own cost following methods & specifications as directed by the Project manager.

For repair of the concrete works, the contractor may use epoxy as a bonding agent prior to placing fresh concrete. The use or otherwise of epoxy for the repair work will be at the discretion of the Project manager. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

Epoxy is a two packed or three packed system containing base and hardner/s. The shelf life of the unmixed cans is about one year or more when stored in a place where ambient temperature does not increase beyond 75 deg. F. The base and hardner/s shall be mixed in the correct proportions recommended by the manufacturer. The blend, after mixing intimately, shall have a pot life of one hour and the material shall be applied over the old concrete to form a thin film. Fresh concrete shall be deposited immediately prior to the film drying up so as to ensure proper bonding between both concrete.

Where the dry pack method is used, holes shall be sharp and square at the surface edges, but corners within holes shall be rounded. The perimeter of the hole shall be under-cut in several places. Holes for dry pack shall have a minimum depth of 25mm. The holes to be repaired shall be scrupulously clean and slightly wet with no free water on the surface. The surface shall then be dusted lightly with cement by means of dry brush. Under no conditions shall the holes be painted with neat cement grout.

The dry pack mix shall be proportioned by weight: 1 part cement to 2.5 parts of sand that will pass a No.16 screen. Only enough water shall be used to produce a mortar which will stick together when moulded into a ball by a slight pressure of the hands and will not extrude water but will leave the hands just damp.

Dry pack material shall be placed and packed in layers having a compacted thickness

of about 10mm. Each layer shall be solidly compacted over its entire surface by use of hardwood stick and hammer. The stick is normally about 300mm to 460mm long and not over 30mm in diameter. Most of the tamping should be directed at a slight angle and towards the side of the hole to assure maximum compaction and bond. Water shall not be used to facilitate finishing.

Filling material used in repair of surfaces which will be exposed after completion of the project shall be made with cement from the same sources as that used in concrete and blended with a sufficient amount of white Portland cement to produce the same colour as in the adjoining concrete. Patched surfaced shall be given a final treatment as required to make the texture of the patch match that of the surrounding material.

Immediately after patching is completed, the patched area shall be covered with an approved non-staining, water-saturated material which shall be kept wet and protected against sun and wind for a period of 12 hours. Thereafter, the patched area shall be kept continuously wet by a fine spray or sprinkling of water for not less than 10 days as required under section 9.1 and 11.1 of this specification. The layers of gunite may be reinforced with steel mesh if directed by the Project manager.

All materials, procedures and operations used in the repair of concrete and also the finished work shall be subject to the approval of the Project manager. All fillings shall be tightly bonded to the concrete and shall be sound, free from shrinkage cracks, or dummy areas after the fillings have been cured and dried.

The extent of repair shall be decided upon by the Project manager. The cost of repairs of defective areas shall be borne by the contractor. The Project manager may adopt at his discretion any other method of repairing like grouting with cement grout, epoxy grouts or guniting etc., which will be carried out by the contractor at his cost as per the specifications supplied by the Project manager.

14.0 Use of Plums in Ordinary Concrete

Stone plums shall not be used unless specified on the drawings. When used the size of stone plums may be from 150 to 300 mm. The maximum dimension of these stones or plums shall not exceed 1/3rd the least dimension of the members.

All plums shall be hard, durable, clean and free from soft materials or loose piece or deleterious substance in them and shall not have sharp corners.

During concreting the first layer of concrete of the specified mix shall be laid to a thickness of atleast two and a half times the thickness of the maximum size of plums to be used. The plums shall then be laid while the top portion of this concrete is still green but sufficiently stiff to prevent complete submergence of the plums under their own weight. These plums shall be about half embedded in the concrete and the remaining part exposed so as to form a key with the next layer of concrete. No plums shall be used for concrete laid under water.

While placing the plums, care shall be taken to see that the clear distance between any two plums is not less than either the width or thickness of either of the plums. The distance from plums to the outer surface or from any steel reinforcement shall be equal to greatest width of the plum.

If plums of stratified stone are used, they shall be laid on their natural bed. Stones with concave faces shall be laid with the concave upwards.

The thickness of the next and successive layers of concrete shall be at least twice that of the largest plums.

The total volume of plums shall not exceed 15% of the volume of the finished concrete.

The grade of plum concrete shall be M15

15.0 Scope

The scope for concrete works shall include the cost of all materials, labour, tools and plant required for mixing, placing in position, vibrating and compacting, including staging, shuttering, form work, finishing as per directions of the Project manager, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making, fixing and removing of all centres and forms required for the work unless otherwise specified in the contract.

All expenses likely to be incurred by the contractor in transporting materials supplied to him to the site of works, the expenses incurred in improving the quality of materials to acceptable levels (such as screening, washing, etc.) and expenses incurred in proper storage of materials as directed by the Project manager etc. are to be included in the unit rate.

16.0 Steel Reinforcement

16.1 Bending of Reinforcement

Reinforcing steel shall conform accurately to the dimensions shown on relevant drawings and conforming to IS: 2502.

The contractor shall make bar bending schedules, based on the drawings furnished to him and submit the same for the Engineer's approval at no extra cost. Approval by the Engineer does not relieve the contractor of his responsibility to ensure correctness in respect of details/placing.

Bars shall be bent cold to the specified shape and dimensions or as directed by the Project manager using a proper bar bender, operated by hand or power to attain proper radii of bends. Bars shall not be bent or straightened in a manner that will injure the material.

Bars bent during transport or handling shall be straightened before being used on work; they shall not be heated to facilitate bending.

Unless otherwise specified, a U type hook at the end of each bar shall invariably be provided. The radius of the bend shall not be less than twice the diameter of the round bar for mild steel plain bars and not less than four times the diameter for high strength deformed bars. In case of bars with diameters greater than 25mm, the minimum radius

should be three times the diameter for mild steel bars and six times the diameter for high strength deformed bars. The length of the straight part of the bar beyond the end of the curve shall be at least four times the diameter of the bar. In the case of bars which are not round, and in the case of deformed bars, the diameter shall be taken as the diameter of a circle having an equivalent effective area. The hook shall be suitably encased to prevent any splitting of the concrete.

16.2 Placing of Reinforcement

All reinforcing bars shall be accurately placed in the exact position shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm in size and conforming to IS: 280, and by using stays, blocks or metal chairs, spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars will not be allowed to sag between supports nor displaced during concreting or any other operation over the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports will not extend to the surface of concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing will not be allowed. Pieces of broken stone, brick or wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices.

Reinforcement after being placed in position shall be maintained in a clear condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed.

To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

In the case of columns and walls, vertical bars shall be kept in normal position with timber templates having slots accurately cut in for bar position. Such templates shall be removed after the concreting has progressed upto a level just below them.

Bars crossing each other, where required, shall be secured by annealed binding wire of size not less than 1 mm and conforming to IS:280 in such a manner that they do not slip over each other at the time of fixing and concreting.

As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the Project Manager. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm or 1.25 times the maximum size of the coarse aggregate in the concrete between them, whichever is greater. Where this is not feasible, overlapping bars shall be bound with annealed steel wire, not less than 1 mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending moment is maximum.

16.3 Welding of Bars

When permitted or specified on the drawings, joints of reinforcement bars shall be butt-

welded so as to transmit their full strength. Welded joints shall preferably be located at points where the reinforcement steel will not be subject to more than 75 percent of the maximum permissible stresses and the welded joints should be staggered such that, at any one section, not more than 33 percent of the bars are welded. Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work will be accepted. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, the previous surfaces shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work.

The M.S electrodes used for welding shall conform to IS: 814. Welded pieces of reinforcement shall be tested. Specimens shall be taken from the actual site and their number and the frequency of tests shall be as directed by the Project manager.

16.4 Scope

Scope for reinforcement shall include cost of all steel at works spot and its bending, placing, binding and fixing in position as shown on the drawings and as directed by the Project manager. It shall also include cost of all devices for keeping reinforcement in approved position, cost of jointing as per approved method, and all wastage, overlaps and spacer bars.

17.0 Form Work, Falsework and Scaffolding Form, Centering and Temporary Works

All centering, formwork and temporary works shall be constructed according to drawings and specifications prepared by the Contractor and approved by the Project manager. The design criteria and loading for these works shall be as per American Concrete Institutes' relevant specifications.

As soon as practicable after the acceptance of his tender the contractor shall submit a scheme showing the order of the procedure and methods by which he proposes to carry out the work together with such details as are necessary to demonstrate the adequacy, stability and safety of the methods which the contractor proposes to adopt. The approval to this general scheme of centering as well as design criteria and loading shall be obtained in good time to facilitate all preparatory work. Any delay on this account shall be the responsibility of the contractor.

After approval of the general scheme the contractor will prepare detailed designs and drawings for execution of the work, centering and temporary works. These shall also be forwarded for approval. No work shall be carried out without prior approval of the Project manager.

Not withstanding the approval given to design criteria and loading and the general scheme for the centering, the entire responsibility for the satisfactory execution of the centering and all temporary works shall rest with the contractor and he shall be liable to pay all claims and compensations arising from any loss or damage to life and property due to any deficiency, failure or malfunctioning of the centering or any of the temporary works.

17.1 Re-use of Forms, etc.

Forms required to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned and repaired before reuse. Where metal sheets are used for lining forms the sheets shall be placed and maintained in the forms with minimum amount of wrinkles, lumps or other imperfections. All forms shall be checked for shape and strength before reuse.

17.2 Execution and Removal of Forms

i) Before placing concrete the surface of all forms shall be coated with suitable non-staining form releasing agents such as raw linseed oil so as to prevent adhesion of concrete and to facilitate removal of forms.

ii) The form releasing agent shall cover the forms fully and evenly without excess overdrip. Care shall be taken to prevent form releasing agents from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to thoroughly cover form strips for narrow grooves, so as to prevent swelling of the forms and the consequent damage to concrete prior to or during removal of forms.

iii) Immediately before concrete is placed care shall be taken to see that all forms are in proper alignment and the supports and fixtures are properly secured and tightened.

iv) Where forms for continuous surfaces are placed in successive units, the forms shall lap and fit tightly over the completed surface so as to prevent leakage of cement slurry from the fresh concrete and to maintain accurate alignment of the surface.

v) Forms shall be left in place until their removal is authorised and shall then be removed with care so as to avoid injury to concrete.

vi) Removal of forms shall never be started until the concrete is thoroughly set and adequately hardened such that it can carry its own weight, besides the live load which is likely to come on the work during construction. The length of time for which the forms shall remain in place shall be decided by the Project manager, with reference to weather conditions, shape and position of the structure or structural member and nature and amount of dead and live loads. In normal circumstances and where ordinary Portland cement is used, forms can be allowed to be struck as mentioned IS: 456 – 2000 based on the spans:

Note : Time shall be measured from last batch concreted in respect to the structural member under consideration.

In no case shall forms be removed until there is an assurance that removal can be accomplished without damaging the concrete surface. Heavy loads shall not be permitted until after the concrete has reached its design strength. The forms shall be removed with great caution and without jerking the structure.

17.3 Settlement of Formwork and Camber

Due to various reasons such as closure of form joints, shrinkage of timber, dead load deflections, elastic shortening of form members or formwork deflections, settlement may occur. The contractor shall take precautions, including using adequately rigid formwork, in order to prevent excessive settlement/deflection; the usual acceptable limit being 1/500 of the spans of the formwork.

In the absence of any specified camber on the drawings, soffit of all beams more than 5 m. in span and other than prestressed concrete beams shall be laid to a camber, the amount of which at mid span shall not be less than 1/500 of the span of the structure. The profile of soffit shall be parabolic.

17.4 Mock-ups

The method for pouring difficult zones of concrete will be pre-studied on mock-ups. Mock-ups will be particularly necessary for the following:

i) Zones around penetrations and openings.

ii) Behind anchorage of prestressed members.

iii) Dome and shell in general requiring single and double forms.

iv) Various zones of large thickness for studying placement temperatures in relation to internal temperature build ups.

Work involved in mock-up pours will not be paid to the contractor. Sampling and testing of all samples will be done by the Contractor. Unsuccessful mock-ups may have to be repeated in full or in part as required by the Engineer.

18.0 Tolerance

All works will be carried out true to the lines, levels and grades shown on the drawings and within the tolerances specified below. The contractor shall establish, erect and maintain in an undisturbed condition until final completion and acceptance of the project control, points and bench marks necessary and adequate to establish these tolerances.

For all elements, departure from

established alignment	:	30 mm
Departure from established grades	:	10 mm
Variation from plumb or specified	)	12mm in 3 m. if
batter in lines and surfaces of	)	exposed
piers, walls and abutments	)	25mm in 3 m. if backfilled
Variation from level or indicated		) 12mm in 3 m. if
grade in slabs, beams, horizontal	)	exposed
and railing offsets		25mm in 3 m. if backfilled.

Variation in cross sectional dimensions of columns, piers, slabs, walls, beams and similar parts	:	-6mm, + 12mm
Variation in slab thickness	:	-3mm, + 6mm
Footings: Plan dimensions	:	-15mm, + 30mm
Misplacement or eccentricity		:2% of footing width in the direction of misplacement and not exceeding 30mm.
Reduction in thickness	:	5% of specified thickness
Variations in size and locations of slab or wall openings	:	12mm

TECHNICAL SPECIFICATIONS – 2.4

2.4 SPECIFICATIONS FOR MASONRY

STONE MASONRY

1.0 General

This specification refers to providing materials and construction of course and random rubble masonry in foundations, plinth, basement walls and superstructure.

2.0 Stones

Stones to be used in the masonry should be approved quality. They shall be trap, granite, quartzite or gneiss. The stones shall stand weathering well and when immersed in water for 24 hours shall not absorb water more than 5% of its dry weight, when tested according to IS : 114. The stone of the required quality shall be obtained from quarries approved by the Project manager. All stones shall generally be freshly quarried. They shall be sound and of uniform colour. Unless otherwise approved, stones from one single quarry shall be used for any work. The stone shall be kept free from dirt, dust, oil or any other injurious materials which may attack the stone or mortar or prevent adhesion of mortar. Stones with skins shall not used. Different categories of stones such as face stone, backing stone, hearting stone, headers, quoins etc. shall be collected in advance to suffice at least for a week's requirement and shall be stacked separately category-wise.

2.1 Dressing for stones

Different types of dressing

The exposed faces of the stones shall be dressed to one of the following types specified for the work in the description of item in bill of quantities. If not specified stones dressed with hammer dressed shall be provided and the bushing on the face shall not exceed 10 cm.

a) Rough tooled dressing

Rough tooled surface shall have series of bands, 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45 degree as required. The dressed stones may have depression on the surface, the depth of gap between the surface and the straight edge held against it, i.e. the busing shall not exceed 3 mm. This is also called as "one line dressing".

b) Chisel or punch dressing

A chisel dressed surface shall have series of parallel ridges. Chisel marks shall be left all over the surface. This dressing shall be more even than rough tooled dressing. The depth of the gap between the surface and a straight edge held against the surface shall not exceed 2 mm. The surface dressing is also called as "two line dressing"

c) Close punched or picked dressing

A close punched dressed surface shall be closer dressed further giving finer surface than the chisel or punch dressing. The depth of gap between the surface and the straight edge held against it shall not exceed 1 mm. This is also called as “three line dressing”.

d) Fine tooled dressing

A fine tooled dressing is the one which is finer than the close punched dressing such that all the unevenness is removed and a fairly smooth surface is obtained. The surface shall have 4 to 5 lines per centimeter width. Other types of dressing may also be specified in the special provisions.

Note

Samples of each category of stones of the specified quality and dimensions dressed to the specified requirements shall be got approved by the Project Manager who will keep them in this office for reference.

3.0 Exposed Coursed Rubble Masonry

3.1 Face and Backing Stones

These stones shall be chisel dressed top and bottom, true and square for at least 5 cm back from the face; the rest of the width shall tail into the work and shall not project below or above the plane of dressing. No stone shall tail to a point. The vertical joints shall be chisel dressed for a depth of not less than 4 cm from the face. Individual stones shall have thickness and width not less than 15 cm in its thickest part and no stone shall have its lengths less than 1½ times its height. If higher course thickness is specified, in bill of quantities the same shall be adopted.

The face stones and backing stones shall be selected from the mass of quarry stones for their greater size, good beds, close grain and uniform colour. 50 percent of the stones shall be more than 0.010 cu.m in walls upto 50 cm. In thickness and 0.015 cu.m in thicker walls.

3.2 Through stones or bond stones

Bond stones shall be about 300 sq.cm in face area and shall have a tailing for the full width of the masonry when the width is 60 cm or less. If the wall or masonry be over 60 cm in width, line of bond stones overlapping each other by at least 15 cm shall be laid right through the wall from face to back. The length of the interior headers shall not be less than 45 cm and their average cross sectional area shall not be less than 250 sq.cm. Face header shall be distinctly marked on its face. One through stone or a set of through stones shall be provided per half square metre of facing evenly distributed.

3.3 Vertical headers

For the massive work with a width of a metre and above, vertical headers, 45 cm long or depth of two courses whichever is more, shall be provided at the rate of one for every sq.m of area in plan. For every course a new set of headers shall be introduced

at this rate in a staggered pattern. Their average sectional area shall not be less than 300 sq.cm.

3.4 Hearting stones

These can be random rubble stones. In walls of 50 cm and less, about 30 percent of the stones shall not be less than 0.010 cu.m and for thicker walls about 30 percent of stones shall not be less than 0.015 cu.m. The hearting stones shall be hammer dressed on the top and bottom beds. A small proportion of spalls and chips can be used to fill the hollows between the sides of the hearting stones in each course so as to avoid thick mortar joints. However, spalls shall not be used for making up the height of hearting to that of the course. Their height shall be same as that of the course in which they occur.

3.5 Quoins

The quoins shall be of selected stone. The faces of quoins shall be rough tooled or provided the same type of dressing as that of the face stones as directed. Chisel draft of about 40 mm shall be provided on each side of the exposed corner.

The beds and top shall be dressed square to the face and rough tooled to 10 cm from the face and vertical joints similarly dressed to 4 cm from the face. In the embedded portion of the length of the side shall not be less than that of the exposed side opposite, by more than 8 cm, for the longer side and 3 cm for the shorter side.

3.6 Mortar

Cement, sand and water shall be as specified elsewhere in this document. Cement and sand shall be mixed in specified proportions sand being measured in measuring boxes. The proportions will be by volume on the basis of 5 kg. Of cement being equal to 35 liters. The mortar may be hand mix or machine mixed.

Preparation

In hand mixed mortar, cement and sand in the specified proportions shall thoroughly mixed dry on a clean impervious platform by turning over at least 3 times till a homogenous mixture of uniform colour is obtained. Fresh and clean water as specified above shall be added gradually through a hose and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The water cement ratio shall be as directed by the Project manager.

Mixing platform shall be so arranged that no deleterious material shall get mixed with mortar nor the mixing water of the mortar shall flow out. Machine mixed mortar shall be prepared in an approved mixer. About 5 percent to 10 percent of mixing water shall be put into the mixer and sand and cement in the required proportions shall be then added. The remainder of water, quantity of which shall be predetermined by consideration of strength and consistency shall be added uniformly. Mixing will be continued until all particles of sand are uniformly coated with cement paste. Mixing for 1½ to 2 minutes will normally be sufficient. Only such quantity of mortar shall be

prepared as can be used within 30 minutes, of adding water. The mortar remaining unused after that period or mortar which has partially hardened or is otherwise damaged shall not be retempered or remixed, it shall be destroyed or thrown away.

3.7 Construction

The masonry shall be laid to lines, levels, curves, and shapes down on the drawings. All iron, stone, concrete or other fixtures, plugs, frames, etc. if any shall be built and bonded in at places shown on the drawing or as directed by the Project manager, as the work proceeds and not inserted or joggled on after the masonry is advanced.

Holes of the required size and shape shall be left in the masonry during construction itself for fixing pipes, service lines or for passage of water. After the service lines, pipes, etc. are fixed the extra hollow left if any shall be filled with plain cement concrete of grade M10 and the face shall be neatly finished to match with the stones. If any fixtures are to be provided they shall be neatly embedded in the required position while laying the masonry. Iron fixtures shall be embedded in M10 concrete. Stones in the hearting shall be laid on their broader face which gives better opportunity to fill the space between stones. Stratified stones must be laid on their natural beds. All beds joints shall be normal to the pressure upon them. The stones shall be wetted before laying in mortar. Each mason shall be supplied by the contractor with a vessel full of water and tumbler for wetting stones, care being taken not to spill any water on green masonry. The bed which is to receive the stone shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a mallet immediately on placement and solidly bedded in mortar before it has set.

Clean chips and spalls, carefully, selected to fit in the space shall be wedged into the mortar joints wherever necessary, to avoid thick joints of mortar. In any case stone already set in mortar is disturbed or the joint broken the stone shall be taken out without disturbing the adjoining stones and joints, the mortar thoroughly cleaned from the joints and the stone reset in fresh mortar. Attempts shall never be made to slide one stone over another already laid.

Shaping and dressing shall be done before the stone is laid in the work. No dressing or hammering which will loosen the masonry will be permitted after it is placed.

There shall be good collection of stones and spalls within easy reach of every mason to enable proper selection of stones for individual location while laying. The stones shall be continuously replenished. The face stones and backing stones shall be laid without any pinnings on the exposed faces. In each course the header or lines of headers, as the case may be shall be kept in position at specified intervals and with specified laps, where such laps are required before the masonry of the layer is commenced to ensure that they are being laid properly and in required numbers and intervals. They shall be embedded in mortar, masonry in that layer progresses.

Quoins shall be laid stretcher and header wise as seen on each face and shall correspond to the arrangement of quoins in the same course. The quantity of mortar for 1 cubic metre of thin and massive masonry shall range from 0.30 cu.m to 0.35 cu.m respectively and for water retaining masonry from 0.46 to 0.48 cu.m.

3.8 Bond

a) Lateral bond

To give sufficient later bond a stone in any course shall break joint with the stone in the course below or above, about half the height of the course and generally not less than 8 cm. Joints parallel to the pressure, in courses above and below shall not lie too closely near the same vertical line.

b) Transverse bond

To give sufficient transverse bond, the prescribed number of headers shall extend from front to back of thin walls upto a width of 60 cm or prescribed number of lines of over-lapping headers from face to back of walls over 60 cm thick. Overlaps shall be 15 cm at each end. To ensure provision of full number of headers of the required size, they shall be kept at specified intervals in each course in advance of starting masonry and then embedded in mortar. Their position in each course shall be staggered, so that each will be near about the middle of the two in the course below and above. Their faces shall be marked with a distinguishing sign to identify them.

c) At junctions

To bend the work at all angles junctions of walls, the stones at each alternate course shall be so carried into each of the respective walls as to joint the work thoroughly. Quoins shall be laid header and stretcherwise when seen on each side of the wall.

c) With old work

When new work has to be started on the old or on completed a long while ago in the previous working season, care shall be taken to roughen and clean masonry before laying the new. It shall be wetted before laying the bedding mortar.

d) Progress of work

When practicable the whole of the masonry in the structure shall be carried upto a uniform level throughout. But where breaks are unavoidable in carrying up the work continuously in horizontal course, sufficiently long stop shall be left to join the courses to be laid later. All junctions of walls shall be formed at the time the walls are being built, cross-walls should be carefully bonded into the main walls. The practice of building two thin faces tied with occasional through stones and filling up the middle with dry packing of stones and spalls and putting mortar on top must be strictly guarded against. Putting dry chips in the joints of stones before filling them with mortar shall not be permitted. For ensuring good bond, masonry shall be left uneven at the top of each course. But the top of plinth and verandah walls and shall be leveled up with flat chips laid in mortar if necessary to receive damp proof course, coping, etc.

3.9 Joints

No face joints shall exceed 12 mm. The face joints should be properly struck while the mortar is still green, so that the same could be finished later either by pointing or plastering. While striking, the joints shall be raked to a depth of not less than 12 mm. All extra mortar from the face of stones shall be removed and made clean.

3.10 Watering

All masonry shall be initially protected from sun, rain, etc. by wet Hessian or straw till set and thereafter kept continuously wet for 7 days from the date of lying, unless other length of period is ordered in the special provisions. Watering shall be done carefully in the beginning through a hose so as not to wash the mortar out of the joints. On holidays and at the close of days work and other periods of cessation of work, the masonry is to be kept continuously wet for the specified period of curing and labourers are to be employed for the purpose. Should the contractor fail to water the work to the satisfaction of the Project manager, the latter may order the masonry to be dismantled and redone at the contractor's cost.

3.11 Bad work

Should the mortar perish, i.e. become dry, or powdery through neglect of watering or if the masonry shows hollow joints or non-adherence of mortar to the stones or if the work does not conform to drawings and these specifications, the work must be pulled down and redone at the contractor's expense without any delay after the order of the Project manager to do so.

3.12 Final finish

All masonry shall be washed down on completion and all stains and adhering mortar removed from the face as the scaffolding is being lowered and removed.

3.13 Wet foundations

In wet foundations, or other situations where water is met with, the work space shall be kept free of water by the contractor while the masonry is in progress and until the Project manager considers the mortar has sufficiently set. Dewatering shall be carried out in such a way as not to injure the concrete or masonry in any way. Dewatering shall also be done when required for taking checking measurements, passing foundations, etc.

3.14 Scaffolding

Scaffolding required for facility of construction shall be provided by the contractor at his expense. Scaffolding shall be with sets double of verticals. Where single scaffolding is specified the ends of poles should not be placed in the position of header stones. Scaffolding shall be erected with steel sections of pipes, bullies or bamboos of adequate strength so as to be safe for all construction operations. The Contractor shall take all measures to ensure the safety of the work and working people. Any instructions of the Project manager in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to property or injury to persons resulting from ill-erected scaffolding, defective ladders and materials or otherwise arising out of this default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be allowed. Put-log holes shall be made good by stones to match the face work when scaffolding is being removed after ensuring that all holes behind are solidly filled in with M10 concrete.

3.15 Rate of raising masonry

The rate of raising coursed rubble masonry brought up in uniform levels may be limited to a height of 60 cm, for walls upto 450mm thick and 2 courses per day for thicker walls. But no fresh course shall be laid over masonry previously laid within 4 hours of its laying.

3.16 Items to include

Quoted rate shall include the cost of all the following items :

Coursed rubble masonry laid in cement mortar of specified proportion, built in any position to any height or depth and to lines, levels, curves and batters shown on the drawings/bills of quantities or as ordered by the Project manager including quoins, headers etc., and striking joints and curing.

- Erecting and removing all scaffolding, ladders and use of plant required for execution of the item, clearing the site round the masonry, dewatering, shoring, strutting during construction.

- Providing M15 concrete wherever necessary and required as per this specification (T.S.6). All labor, use of tools, materials and other items incidental to satisfactory completion of the item.

The mode of measurement and payment shall be as per Clause 6.5.

4.0 Random (or uncoursed) rubble masonry

4.1 Random rubble masonry may be used in buildings, boundary walls etc., as indicated in the drawing.

4.2 Stones

Except to the extent specified otherwise, the stones may be as received from the quarry, without any dressing or shaping except knocking off weak corners and edges. While laying the stones, however, it shall be ensured, by any further hammer-dressing as may be necessary, that the rough rock face (or busing) does not project by more than 4 cm beyond the normal face and also that the sides and beds of the stones fit in reasonably with the neighboring stones. No stone shall be less than 12.5 cm in any direction except that a small proportion of smaller stones may be used in the hollows between the larger stones to avoid thick mortar joints. The bushing on the face shall not project more than 40mm on an exposed face and 10mm on the face to be plastered.

4.3 Mortar

The mortar to be used for jointing shall be as specified in the bill of quantities.

4.4 Laying

Selected stones, not less than 0.05 sq.m on the face, shall be used for the face work. These stones shall not be of height greater than the breadth or the depth into the work. Headers or bond stones shall be provided every 1m apart horizontally and every 0.5m vertically. These shall not be less in depth than 4 times, nor less in breadth on the face than 1½ times the height, and when so directed, the depth shall extend for the full thicknesses of the wall. All stones shall be wetted before use. They may be laid at random without being brought upto any level except at plinth, window sills and roof level and top level in case of compound wall. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones. Face stones shall extent and bond well into the backing. Proper breaking of joints shall be done. Their height shall not be greater than the breadth at face or the depth inward. Interior filling of the wall face shall consist rubble stones not less than 130 mm in any direction, carefully laid, hammered down with a mallet into position and solidly bedded in mortar. No hollow space shall be left anywhere in the masonry. Chips not more than 20% of quantity of stone masonry may be used in the interior to fill interstices between adjacent stones in hearting wherever necessary to avoid thick mortar bed or joints. At about one metre interval vertical 'Plumbs' projecting upward about 150 to 200mm shall be firmly embedded to form a bond between successive courses. The masonry in a structure shall be carried regularly.

The work shall be flushed up at every 1 to 1.5m of its height and a course of squared stone laid horizontally through the whole width of the work. The quoins (at corners and ends of walls) and the stones at the edges of plasters and around openings in the wall shall also be of squared fitted stones. All these will not be measured separately and they shall be paid as for random rubble only.

The largest stones shall, as far as possible, be placed in the lower part of the work. Care shall be taken to fit the stones so that the joints are as thin as possible and the use of smaller stones to fill up hollows is kept to a minimum. In no case shall these smaller stones show up on the face work.

5.0 Joints

Stones shall be so laid that all joints are full of mortar. Face joints shall vary from 12mm to 25mm thick, but not less than 12mm. Joints shall be struck flush and finished with CM 1:3 at the time of laying when plastering and pointing is not required. Joints shall be raked to a depth of 20 mm during construction, if walls are to be plastered or pointed. For the faces of walls which are not to be plastered stone surfaces shall be cleared of mortar dropping to give uniform appearance.

5.1 Other clauses relating to mortar, watering, bad work, final finish, wet foundation and scaffolding, rate of raising masonry shall remain same as for the coursed rubble masonry.

5.2 Quoted rate shall include all items of work specified including the supply of stone and with required dressing etc., and mode of measurement and payment shall be as per cl. 6.5.

6.0 Ashlar Masonry

6.1 Stones

The stones for ashlar masonry shall be of specially selected quality and dressed on all beds, joints and faces, in the manner specified. The stones shall be to the correct shapes and dimensions. Surfaces which are to be plane shall be free from winding and those which are to be curved shall be truly as per the design. Except where specified otherwise, no stone shall be less n length than 3 times its depth.

6.2 Laying

a) The stones shall also be laid as to create proper bond. The stones is successive courses shall break joint to the extent of 1 to 1½ times the depth of the course. The face stones shall be laid header and stretcher alternately, unless otherwise directed by the Project manager, with the headers being arranged to come as nearly as possible, in the middle of the stretcher in the course below.

b) Each stone shall first be fitted into its place dry and its correct fitting ensured by any further dressing found necessary before being finally set in mortar on its bed.

c) Unless otherwise ordered, the depth of each course shall be not less than 20 cm and all courses shall be of the same height.

d) Joints, both bed and side, shall be not more than 6mm thick. The joints shall be struck flush as the work proceeds, except where these are to be pointed, in which case these shall be raked out to the required depth while the mortar is still green.

6.3 Other clauses given for rubble masonry which are relevant for this work completion shall apply for this work.

6.4 Quoted rate shall include all items of work including the supply of dressed stone as per specification. Mode of measurement and payment shall be as per cl.6.5.

BRICK WORK

1.0 SCOPE

These specifications cover the use of Brick Masonry for the structural purposes.

2.0 GENERAL

The provision of the latest Indian Standards listed below form part of these specifications:

IS:1077 Specifications for common burnt clay building bricks

IS:1200 Measurement for Building works

IS:1725 Specifications for solid cement blocks used in general building construction.

IS:1905	Code of practice for structural safety of buildings Masonry walls.
IS:2116	Sand for masonry mortars.
IS:2180	Specification for heavy duty burnt clay building bricks.
IS:2185	Specification for concrete masonry units: Hollow and solid concrete blocks.
IS:2212	Code of practice for brick work.
IS:2222	Specification for burnt clay perforated building bricks.
IS:2250	Code of practice for preparation and use of masonry mortar.
IS:2691	Specification for burnt clay facing bricks.
IS:3115	Specification for lime based blocks.
IS:3414	Code of practice for design and installation of joints in buildings.
IS:3466	Specification for masonry cement.
IS:3861	Method of measurement of plinth, carpet and rentable areas of buildings.
IS:3952	Specification for burnt clay hollow blocks for walls and partitions.
IS:4098	Specification for lime-puzzolona mixture.
IS:4139	Specification for sand lime bricks
IS:4441	Code of practice for use of silicate type chemical resistant mortars.
IS:4442	Code of practice for use of sulphur type chemical resistant mortars.

Other I.S. Codes not specifically mentioned here but pertaining to the use of bricks for structural purposes form part of these specifications.

3.0 MATERIALS

3.1 Bricks

Bricks shall be of regular and uniform size, shape and colour, uniformly well burnt throughout but not overburnt. They shall have plane rectangular faces with parallel sides and sharp straight and right angled edges. They shall be free from cracks or other flaws. They shall have a frog of 10 mm. depth on one of their flat faces.

They shall give a clear metallic ringing sound when struck. They shall show a fine grained, uniform homogeneous and dense texture on fracture and be free from lumps of lime, laminations, cracks, airholes, soluble salts causing efflorescence or other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not have any parts under-burnt. They shall not break when thrown on the ground on their flat face in a saturated condition from a height of 60 cm.

Size of bricks

(a) The size of the conventional bricks may vary from 8 3/4" x 4.3/16" x 2.5/8" to 9" x 4 1/4" x 3". Only bricks of one standard size, shall be used on one work unless specially permitted by the Engineer. The following tolerances are permitted in the standard conventional size adopted on a particular work:

Length - plus or minus 3 mm (about 1/8")

Breadth - plus or minus 1.5 mm (about 1/16")

Depth - plus or minus 1.5 mm (about 1/16")

(b) When metric bricks are used they shall comply with I.S: 1077 - 1976.

Concrete Block

a. The size of the concrete block (solid block) shall be 400 mm x 200 x 200 mm only be used for construction.

Absorption

After immersion in water, absorption by weight shall not exceed 20% of the dry weight of the brick when tested according to IS: 1077-1976

Crushing strength

The load to crush the brick when dry shall not be less than 50 kg/sq.cm. and when thoroughly soaked, shall not be less than 35 kg/sq.cm.

The load to crush the concrete block when dry shall not be less that 50 kg/sq.cm.

3.2 Cement, Fine Aggregate and Water

Refer relevant clauses of these specifications.

3.3 Mortars

Cement and sand shall be mixed in specified proportions given on the drawings. cement shall be proportioned only by weight, by taking its unit weight as 1440 kg per cubic metre and the sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.

The mixing shall be done intimately in a mechanical mixer unless hand-mixing is specifically permitted by the Engineer. If hand mixing is done, the operation shall be carried out on a clean watertight platform and cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed for atleast two minutes after addition of water. The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes. The mortar remaining unused after that period or mortar which has partially hardened or is otherwise damaged shall not be retempered or remixed. It shall be destroyed or thrown away.

In case of cement mortar that has stiffened because of evaporation of water the same shall be retempered by adding water as frequently as needed to restore the requisite consistency, but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

Necessary tests to determine compressive strength of the mortar, for consistency of the mortar and its water retentivity shall be carried out in accordance with IS:2250. The frequency of testing shall be one cube for every 2 cubic metre of mortar prepared subject to a minimum of 3 cubes for a day's work.

4.0 CONSTRUCTION

4.1 Soaking of Bricks

Bricks shall be soaked in water for a minimum period of one hour before use so that they will be saturated and will not absorb water from the mortar. When bricks are soaked they shall be removed from the tank sufficiently in advance so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not spoil by dirt, earth, etc.

4.2 Laying of Bricks

All brick work shall be laid in English bond, even and true to line, plumb, level and all joints accurately kept. The bricks used on the face shall be selected whole ones of uniform size and with true rectangular face. Brick shall be laid with frogs up, if any, on a full bed of mortar. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pores of bricks to ensure proper adhesion. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left.

Before laying bricks in foundation, a layer of not less than 12 mm of mortar shall be spread to make the surface on which the brick work will be laid even. Immediately thereafter, the first course of bricks shall be laid.

The brick work shall be built in uniform layers, corners and other advanced work hall be raked back. Brick work shall be done true to plumb or in specified batter. No part of it, during construction, shall rise more than one meter above the general construction level, to avoid unequal settlement and improper jointing.

Toothing may be done where future extension is contemplated but shall be used as an alternative to raking back.

The concrete block shall be completely wetted before placing in position.

4.3 Joints

The thickness of joints shall not exceed 10 mm and this thickness shall be uniform throughout.

4.4 Joining with existing structure

When fresh masonry is to be placed against existing surfaces of structures, these shall be cleaned of all loose material, roughened and wetted as directed by the Engineer so as to effect a good bond with the new work.

4.5 Curing

Green work shall be protected from rain by suitable covering. Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day. During hot weather all finished or partly completed work shall be covered or wetted in such manner as will prevent rapid drying of the brick work.

4.6 Scaffolding

The scaffolding shall be sound and strong to withstand all loads likely to come upon it and will be double or single as is warranted for the particular work. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with 1:4:8 cement concrete.

4.7 Condition of Equipment

All equipment used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

4.8 Finishing of Surfaces

For a surface which is to be subsequently plastered or pointed the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

5.0 Weep Holes

In case of abutment retaining walls and wing walls, weep holes as shown on the drawings or directed by the Engineer shall be provided in the masonry to drain moisture from the backfilling. Weep holes shall be 8 cm wide, 15 cm high and shall extend through the full width of the masonry with slope of about 1 vertical to 20 horizontal towards the draining face.

The spacing of weep holes shall be as shown on the drawings with the lowest one at about 15 cm above the low water level or ground level whichever is higher or as directed by the Engineer.

6.2 The scope under this item shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the satisfactory completion of the work as described herein above and as shown on the drawings and including the following.

(i) dewatering required for completing this item and till the mortar of masonry pointing & plastering is properly set

(ii) watering the masonry and

(iii) cleaning the site round the brickwork so as to restore the area to its original condition.

(iv) For using specially moulded bricks on the face of walls with batter and provision of weep holes.

7.0 All other specifications under Brick Work for Construction and Measurements will be applicable.

Block Work Relevant Indian Standards

The Standards to be followed are:

IS 264 Specification for Ordinary and Low heat Portland Cement

IS 383 Specification for Course and Fine Aggregate for Cement

IS 455 Specifications for Portland Slag Cement

IS 456 Code of Practice for Plain and Reinforced Cement Concrete

IS 2185 Specification for Cement Concrete Block

IS 2572 Code of practice for Construction of Concrete Walls

IS 9103 Specification for Admixture of Concrete

Concrete blocks (hollow or solid) shall generally conform to IS:2185. Blocks shall be regular in size and shape and shall be of specified strength. Blocks shall be properly cured before they are brought to site. Half or three quarter size blocks are to be used wherever required to make up length of wall and broken blocks shall not be used. The texture of the blocks shall be such that plaster will adhere to it. They shall be sound, free from cracks, honeycombing, broken edges and other flaws. They shall have plane rectangular faces with parallel sides and sharp straight angled edges. They shall have a fine, compact, uniform texture and thoroughly dried.

The sub-Contractor shall supply samples for approval. Blocks supplied shall conform to approved samples.

1.1 **Dimensions**

The size of blocks shall be as specified in the item of work. The maximum variation in dimensions shall not be more than +1.5mm in ht. and breadth and +/- 3mm in length.

1.2 **Handling And Storage**

The Contractor is responsible for transporting concrete blocks in such a manner that the units are adequately protected during transportation. The units shall be handled in a manner which will prevent soiling, chipping or damage of any kind. Broken, chipped or otherwise damaged units will be rejected and shall not be used in the work. The blocks shall be stored in next piles free from contact with ground, which shall be located to avoid being disturbed or damage by construction activities.

1.3 **Sampling**

A sample of 20 blocks shall be taken from every consignment of 5000 blocks of the same size, batch and manufacturer for conducting tests.

All 20 blocks shall be checked for dimension and inspected for visual defects. Out of the 20 blocks, 3 blocks shall be subjected to test for block density, 8 blocks for compressive strength, 3 blocks for test of water absorption, 3 blocks for drying shrinkage and rest for moisture movement. Block shall be approved if requirement of conditions mentioned in 11.2 to 11.5 of IS:2185 Part 1 are satisfied.

All Block work to be painted or plastered or to remain exposed in the finish shall be equal to the approved samples.

1.4 **Tolerances in Blockwork**

Maximum variation in the dimensions shall not vary by 5% in length and 3% in width and height.

1.5 **Preparatory Work** Wetting of blocks

The blocks need not be wetted before or during laying in the walls. In case the climatic conditions so require, the top and the sides of the blocks may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

1.6 **Laying Concrete Block Masonry**

Each block shall be set with bedding joints and vertical joints filled thoroughly. The wall shall be taken up truly plumb. All courses shall be laid truly horizontal and vertical joints truly vertical. Vertical joints in alternate courses shall come directly over the other. Thickness of the block courses shall be kept uniform.

Necessary tools comprising of wooden straight edge, mason’s spirit level, square, foot rule, plumb line and pins etc. shall be frequently and fully used by the masons to ensure that the walls are taken up true to plumb line and levels. All the connecting block masonry work shall

be carried out at nearly one level and no portion of work shall be raised more than 1m above the rest of work. Any dislodged block shall be removed and reset in fresh mortar.

The construction of walls may be started either at the corners first, or started from one end and proceeding in the other direction. If the corners of the walls are built first, they shall be built four or fine courses higher than the centre of the walls. As each course is prelaid at the corner, it shall be checked for alignment, level and for being plumb to ensure truly straight and vertical walls. Each course in building shall be stepped back by half block and the horizontal spacing of the block shall be checked by placing a mason's level diagonally across the corners of the block, the mason's line shall be stretched from corner to corner for each course and the top outside edge of each block shall be laid to this line. Handling or gripping the block shall be such as to position the block properly with minimum adjustment. Mortar shall not be spread too far ahead of actual laying of the block that it tends to stiffen and lose its plasticity.

1.7 **Closure Block**

When installing the closure block, all edges of the opening and all four vertical edges of the closure block shall be buttered with mortar the closure block shall be carefully lowered into place. If any of the mortar falls out leaving an open joint the closure block shall be removed, fresh mortar applied and the operation.

1.8 **Joints**

Horizontal (bedding) joints

Mortar shall be spread over the entire top surface of the block including front and rear shall as well as the webs to a uniform layer of 10mm thickness.

When filling in the wall between the corners Vertical (cross) joints for vertical joints, mortar shall be applied on the vertical edges of the front and rear shall the blocks. The mortar shall be applied on the edges of the succeeding unit when it is standing vertically and then placing it horizontally well pressed against the previously laid unit so as to provide well compacted vertical joints. In the case of two cell blocks, depression on either vertical sides shall also be filled with mortar.

The thickness of both horizontal and vertical joint shall be not more than 10mm. All face shall be raked to a minimum depth of 10mm by raking tool when the mortar is still green. Where pointing or plastering is not required to be done, the joints can be struck flush and finish at the time of laying, such decision lying solely with the Project Manager. The face of concrete block masonry shall be kept cleaned and all mortar droppings removed promptly.

Provision for doors and windows frames. A course of solid concrete block masonry shall be provided under doors and window openings or a 10cm tick precast concrete sill-block under windows. The solid course shall extend for atleast 20cm beyond the opening on either side. For jabs of doors and windows, either solid concrete blocks shall be provided or if hollow units are used, the hollows shall be filed with cement concrete 1:2:4

All block work shall be plumb, square and properly bonded. The joints shall be broken. The thickness of the courses shall be uniform with courses horizontal. All connected work shall be carried out at nearly one level and no portion of the work shall be left more than one course lower than the adjacent work.

Blocks shall be full height and no cut pieces shall be allowed.

Where blocks are to be used for load bearing walls, the uppermost layer of the blocks supporting slab or other structural members, shall be solid or treated as directed by the Project Manager.

Precast concrete screen blocks or 'jali' work may be used for decorative purposes. The sub-Contractor shall furnish samples for approval.

Fire Stop: Has to be provided for top of partition and duct penetration.

1.9 **Scaffolding**

Independent double scaffolding free of the masonry work shall be provided. It shall be tied back in both directions. Planks shall be provided all around. Railing to outside faces shall be provided. Scaffolding must be strong & easy to maintain. Holes in masonry to support scaffolding will not be permitted.

1.10 **Protection**

Maintain protection against entry of moisture into blockwork when stored and whenever work is interrupted.

Exposed ledges are to be protected. External corners must be protected which may be damaged by construction activities.

1.11 **Cleaning and Pointing:**

Smooth finished block work to be cleaned by means of scrapes or stoning. Acids should not be used for cleaning.

Any loose or open joints are to be pointed as required. Replace finishes and materials that cannot be satisfactorily cleaned.

1.12 **Measurements:**

Solid Cement Concrete block work shall be measured in square meters for specified width. Rates for items shall include the following:

- Material and labour for the completion of items as specified including any centering, shuttering, curing etc.
- Raking out joints
- Preparing tops and sides
- Forming and preparing expansion joints, construction joints, Contraction joints
- Making holes, openings etc for outlets, embedding pipes and finishes exposed surfaces as instructed by the Project Manager.
- Deductions such as lintels and openings shall be measured for net sizes of all such openings and recesses for 0.1 square meter and over.

TECHNICAL SPECIFICATIONS – 2.5

TECHNICAL SPECIFICATIONS FOR FLOOR FINISHES

FLOOR FINISHES

1.0 Scope

These specifications cover the use of plain cement tiles, marble mosaic tiles, Kotah stone flooring, ceramic flooring, granolithic flooring, PVC flooring, acid resistant flooring and white glazed tiles.

2.0 General

The provision of the latest revisions of the following IS Codes shall form a part of this specification to the extent they are relevant:

IS: 269 Specification for ordinary, rapid hardening and low heat Portland cement.

IS: 383 Specification for coarse and fine aggregate from natural sources for concrete.

IS: 777 Specification for glazed earthenware tiles.

IS: 1200 Method of measurements for Building and

Part XI Civil Engg. Works, paving, floor finishes, dado & skirting.

IS: 1237 Specification for cement concrete flooring tiles.

IS: 1443 Code of practice for laying and finishing of cement concrete flooring tiles.

IS: 2541 Code of practice for use of lime concrete in buildings.

IS: 2571 Code of practice for laying in situ cement concrete flooring.

IS: 10067 Material Constants in Building Work

Other IS Codes not specifically mentioned here, but pertaining to Floor Finishes form part of these specifications.

3.0 Plain Cement Tiles

3.1 Materials

Plain Cement tiles shall generally conform to standard laid down in IS: 1237.

3.2 Workmanship

(a) General

Tiles shall be laid on a sub-grade of concrete or the RCC slab.

(b) Bedding

Bedding shall either be in cement mortar 1:6 (1 cement: 6 coarse sand) in which case the amount of water added shall be minimum required for sufficient plasticity and workability or in lime mortar where the ingredients shall be thoroughly mixed dry, hard

lumps removed and water added to give a good workability.

(c) Laying

The base shall be cleaned of all dust, dirt and scum properly wetted without allowing water pools. For bedding of cement mortar, the mortar shall be then spread evenly over the base for two rows of tiles and three to five metres of length. The top shall be kept rough so that cement slurry can be absorbed. The thickness of the bedding shall not be less than 10 mm at any place. Where lime mortar is used, the mortar spread over shall be levelled with a screed batten to a rough surface. Screeds properly levelled shall be fixed at a correct height to suit the thickness of screed bed. The area of bedding shall be as much as can be covered with tiles the next day.

The actual laying of tiles shall be commenced the next day when the surface will provide a rigid cushion to the tiles. Neat cement slurry of honey like consistency shall be spread over the mortar bed over an area sufficient to receive about 20 tiles. The tiles shall then be fixed in this grout one after the other each tile being gently tapped and properly bedded in line and level with the adjoining tiles. The joints shall be as narrow as possible and normally shall not exceed 1.5 mm. After the day's work, the excess cement slurry on top shall be cleaned as also the joints with a broom stick and washed before the slurry sets hard. Next day the joints shall be filled with the cement grout of the same shade as the matrix of the tile.

Tiles which are fixed in the floor adjoining the wall shall go a minimum of 10 mm under the wall plaster, skirting or dado. For the purpose, plaster etc., may be left unfinished by about 50 mm above the proposed finished level of the floor. The unfinished strip shall be plastered after laying the floor tiles. Where a full tile cannot be used, tile shall be cut to the size and used. In order to avoid optical illusion of a depression, the central portion shall be raised by about 10 mm.

(d) Curing

The floor shall be kept wet for a minimum of seven days so that bedding and joints set properly.

(e) Grinding and Polishing

Grinding shall be commenced after 14 days of laying the tiles. Except for skirting or small areas, machine shall be used for the purpose.

First grinding shall be done with carborundum stones of 48 to 60 grade grit fitted in the machine. Water shall be properly used during grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water baring all pin holes. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the tile. Pin holes, if any, shall thus be filled. This grout shall be kept moist for a week. Thereafter second grinding shall be started with carborundum of 120 grit. Grouting and curing shall follow again. Final grinding shall be done when other works are finished. The machine shall be fitted with carborundum of grit 220 to 350 using water in abundance. The floor shall then be washed clean with water. Oxalic acid powder shall then be dusted at 33 grams per square metre on the surface rubbed with machine fitted with Hessian bobs or rubbed

hard with pad of woolen rags. The floor shall then be washed clean and dried with a soft cloth or linen. The finished floor shall not sound hollow when tapped with a mallet.

If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointly and polished.

3.3 Plain Cement Tiles for Dado and Skirting

After preparing the wall to be plastered, plastering shall be done as indicated in IS:1443. Fixing, curing, polishing and cleaning, shall be done entirely as per IS:1443. Polishing may be done by hand. But a smooth surface and fine polish shall be obtained. Jointing shall be done in neat cement slurry. The plaster at the upper edge of the dado shall be finished neatly as directed by the Project manager.

4.0 Marble Mosaic Tiles

(a) Materials

Marble mosaic tiles shall generally conform to IS:1237.

(b) Workmanship

This will be as per 3.2

(c) Marble Mosaic Tiles for Dado and Skirting

This be as per 3.3.

5.0 Indian Patent Stone Flooring

(a) Materials

Cement concrete: The cement concrete shall generally conform to specifications for ordinary concrete. The coarse aggregates shall be carefully selected, sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximately cubical shape affording good interlocking. The maximum size of coarse aggregate shall be 12 mm. The fine aggregate shall consist of properly graded particles. The proportion of mix shall be M15. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

(b) Workmanship:

The sub-grade in all cases shall be formed to proper levels and slopes, well compacted and cured. The top surface shall be kept slightly rough.

The surface of the sub-grade shall be cleaned off all loose materials and moistened immediately before laying the concrete floor. The concrete flooring shall be laid in alternate bays not exceeding 6.25 sq.m (about 64 sf.ft) each. The edge of each panel into which the floor is divided should be supported by flat bars of steel or wood duly oiled to prevent sticking. Their depth shall be the same as that proposed for the finished floor as mentioned in the item. The bars should be removed before filling in the adjoining panels. At least 48 hours shall elapse before the concreting in the adjacent bays is commenced.

The concrete shall be laid immediately after mixing. While being placed the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternating with small lateral shifts. While concreting the adjacent bays care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping.

Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction made up by adding or removing the concrete. After striking off the surfaces to the required grade concrete shall be compacted with a wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming. The floating shall be followed by steel trowelling after the concrete has hardened sufficiently to prevent excess of fine material from working to the surface. The finish shall be brought to a smooth and even surface free from defects and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix. After the concrete has been thoroughly rammed and has dried sufficiently to allow rendering to be worked up, surface shall be rendered with a thin coat of 1:1 cement mortar with fine sand and uniformly floated. If so directed by the Project manager, approved mineral colour pigment shall be added to the cement mortar to give the required colour and shade to the flooring. When the cement mortar rendering is sufficiently stiff, lines shall be marked on it with strings or by any other device to give the appearance of tiles 30 x 30 cm or of any other size laid diagonally or square as directed by the Project manager. The junctions of floor and walls shall be rounded off if so directed, without any extra payment.

After the concrete in the bays has set, the joints of the panels shall be filled with cement cream or with suitable bitumastic compound as shown on the drawings or directed by the Project manager. Vertical edge of the bays shall be neatly marked on the surface of the concrete with a pointed trowel after filling the joints.

Finishing: When the rendering is somewhat stiff, neat cement may be sprinkled on sparingly through a paper pot on the surface and rubbed lightly to give smooth polished ordinary cement coloured surface. If coloured flooring is required by the Project manager the approved coloured cement shall be used. Surface shall be protected from direct sun when it is green.

Curing: Curing shall start on the next day after finishing and shall be continued for 14 days.

6.0 In-Situ Granolithic Concrete Floor-Topping & Skirting

6.1 Material and Workmanship

The requirements of materials and workmanship shall be all as per clause 18.19 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be !:1:2 (cement:sand:coarse aggregates) by volume.

The minimum thickness of granolithic floor topping on hardened concrete base shall be

40 mm.

6.2 Floor Hardener Topping

(a) Materials & Workmanship

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

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

For monolithic application with the floor finish/slab the thickness of the layer shall be 15 mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 18.19.2. After the surface has hardened sufficiently, it shall be kept continmously moist for atleast 10 days.

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

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

(b) Skirting

After preparing the wall with the plastering as indicated in IS: 1443, the skirting shall be fixed, cured, cleaned & polished**.** The polishing may be done by hand to get the smooth surface and fine finish. Jointing shall be done with cement slurry. The upper edge of the dado shall be finished neatly as directed by the Project manager. The height of skirting shall be minimum 125 mm.

6.3 **PVC Sheet, Tile Flooring & Skirting**

(a) Materials

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

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

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

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

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor.

The skirting shall be done on the cement concrete finish as a base layer upto the minimum height of 125 mm.

(b) **Workmanship**

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

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

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

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

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

PVC Sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets ARE FORMED. It shall then be pressed with a suitable roller to develop proper contact.

The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferable, commencing from the center of the area. Tiles should be lowered in position and pressed firmly on to the

adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5 kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

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

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

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

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

6.4 Acid Proof Flooring.

(a) General:

This specification relates to the supply and application of acid-proof flooring, skirting, dadoing or any other such work.

The finishing as specified below shall be applied on the surface to be finished, i.e. RCC floor slab, PCC layer in ground floor or masonry wall, depending on the conditions.

Reference to Standard Specifications:

IS: 1195 : Bitumen mastic for flooring.

IS: 3384 : Bitumen primer for use in waterproofing and damp proofing.

IS: 4832 : Acid resistant mortars -silicate type.

(Part-I)

IS: 4832 : Acid resistant mortars -resin type.

(Part-2)

IS: 4457 : Ceramic unglazed vitreous acid resisting tiles.

(b) Materials

The following materials shall be used.

1. BITROK Primer or equivalent conforming to IS:3384

2. B!!ROK Mastic or equivalent conforming to IS:1195.

3. KERA SINTERED acid-proof tiles or equivalent conforming to IS:4457.

4. VICRON silicate based acid-proof cement mortar or equivalent conforming to IS:4832 (Part-I).

5. RESILAX acid-proof cement mortar or equivalent conforming to IS:4832

(Part-2). 10.1

(c) Laying the flooring:

The flooring shall be laid over the clean, green surface. Before laying the primer I10. coats, the sub-base shall be cleaned off all dirt, scum or laitance, and of loose materials. The surface shall be left rough by suitable means.

Above the prepared surface, two coats of bitrok primer as specified shall be applied. Above it a layer of acid resistant Bikrock mastic shall be laid. The thickness shall be

10 6mm. This layer shall be allowed to dry for sufficient time. A bed of silicate based acid proof cement mortar 6mm shall then be laid.

Over this surface 100mm x 200mm size acid-proof tiles as per Cl.12.3 shall be laid correct to line and alignment. The thickness of tiles shall be 20mm. The dimensions shall be varied if so required in the Bill of quantities.

The joints of the tiles thus laid shall be pointed using acid-proof mortar .The surface shall be rendered smooth to suit the best serviable conditions.

Similar operations shall be carried out in skirting and dadoing. The surface shall be kept wet for 7 days.

7.0 Water Proofing

7.1 Impregnation external treatment to the Basement and Underground Water Tank structure:

The underground structure shall be treated with the above treatment during the initial state of construction to ensure 100% water tightness.

The impregnation layers shall be laid over the evenly laid bedding course of concrete after cleaning the surface. Rough stone slabs are then laid side by side leaving a gap of about 15mm to 20 mm between them. These joints thus left are raked open and cement slurry admixed with chemicals is grouted in these joints. A protective layer of about 25 mm thickness of cement mortar 1:5 (1 cement : 5 coarse sand) with stone chips embedded at random is put over the stone layer. The total thickness of the water proofing layer shall be minimum of 75 mm. The treatment is extended 150 mm beyond the external face of the R.C.C raft slab and where side walls are laid the treatment shall be carried over to the side walls.

7.2 The impregnation treatment shall be continued to the external sides of the walls and upto 300 mm above ground level. The procedure shall be as follows:

Rough stone slabs of thickness 12 mm to 18 mm shall be with the help of cement paste applied on the internal face of the vertical joints of the stones, leaving a gap of about 18

mm between the external face of R.C.C wall and internal face of the rough stones. The stones are fixed side by side without leaving any gap between the edges. In order to fix the bottom most layer of stones a groove about 25 mm deep is made in the bottom R.C.C slab and the stones fixed in it to ensure the water tightness at the junctions of the walls and raft if the raft is projecting beyond the external face of walls. Maximum of two to three horizontal layers of rough stones are laid at a time. A layer of very rough cement plaster 1:5 (1 cement : 5 coarse sand) is applied to the external face of rough stones. After the layer is set, the gap between the walls and the stone layer is filled with a grout mix made up of cement slurry and acrylic based chemicals, which on gellation forms an impermeable monolithic layer. The treatment is then continued upto 300 mm above G.L. in stages.

8.0 Cuddapah Stone for Treads:

The method of laying, bedding etc. for Cuddapah stone shall be similar to that for Kotah Stone. Nosing of the treads shall be rounded as directed. Final polishing may be done by hand.

9.0 Vitrified Tiles in Flooring

9.1 Material

Vitrified Tiles including specials shall be of the approved make,colour, size and quality and shall conform to relevant IS standards in all respects. Samples of tiles shall be got approved by the Project manager, who will keep them in his office for verification as to whether the material brought for use conform to the approved samples.

Cement Mortar 1:4 to be used along with White Cement of approved quality and make.

Workmanship

9.3 Mortar Bedding

The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in the preparation of mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed, the base shall be cleaned of all dirt, scum or laitance and loose materials and then well wetted without forming any pools of water on the surface. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens to proper level or slope. The thickness of the bedding shall not be less than 12 mm (about 1/2") or more than 20 mm (about 3/4") in any one place. The tiles shall be laid on bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles.

9.4 Fixing Tiles

Tiles which are fixed in the floor adjoining the wall shall be so arranged that the surface

of the round edge tiles shall correspond to the skirting or dado. Tiles shall be laid to the required slope wherever required. Neat cement grout of honey like consistency shall be spread over the bedding mortar just to cover so much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight lines. The joints between the tiles shall not exceed 0.5 mm wide. The joints shall be grouted with a slurry of white cement. After fixing the tiles finally in an even plane, the flooring shall be covered with wet saw dust and allowed to mature undisturbed for 14 days.

9.5 Cleaning

After the tiles have been laid in a room or the day's fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. Once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust which shall be removed only after completion of the construction work and just before the floor is occupied.

9.6 Vitrified Tiles in Dado

(a) Materials

Vitrified tiles including specials shall be of the approved make, colour, size and quality and shall conform to IS: 777 in all respects. Samples of tiles shall be got approved by the Project manager. Materials brought for use shall conform to the approved samples.

(b) Workmanship

(i) Plastering

Cement plaster of about 12/15 mm thickness shall be applied to the part of the wall where dado or skirting is to be fixed. The proportion of mortar shall be as mentioned in the item.

(ii) Fixing of Tiles

Dado or skirting work shall be done only after fixing tiles on the floor. The white glazed tiles shall be soaked in water for at least 2 hours before being used for skirting or dado work. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff. The back of tiles shall be covered with a thin layer of neat cement paste and the tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the bed or joints. Each tile shall be fixed as close as possible to the one adjoining. The tiles shall be joined with cement slurry. Any difference in the thickness of tiles shall be evened out in cushioning mortar so that all tile faces are in one vertical plane. The joints between the tiles shall not exceed 1.5 mm in width and they shall be

uniform. After fixing the dado, they shall be kept continuously wet for 14 days.

(iii) Cleaning

After the tiles have been fixed the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting work shall be washed thoroughly clean.

10.0 Kotah Stone Flooring

10.1 Materials

(a) Rough Paving Slabs

At its thinnest part, no stone shall be thinner than 25 mm. The flag stones shall be hard, sound, durable and water resistant. Uniformity of size shall generally be maintained for the flags used in any one room. The stone flags shall be without any soft veins, cracks or flaws and shall have a uniform colour. They shall have even natural surfaces free from broken flakes on top and shall be chiselled on edges to half its depth, true and square to ensure uniform width of joint. The evenness of the surface and edges of the slab shall not be marked by careless dressing of slabs and no patching up shall be allowed for the slabs. The edges shall be quite straight. The under face may be left as quarried. Samples of stone slabs to be used and their dressing shall be got approved by the Project manager and the slabs to be used shall conform to approved sample.

(b) Bedding

The base of cement or lime concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and level. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and a satisfactory bedding. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, scum or laitance and of loose material and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be spread over so much area as will be covered with slabs within half an hour. The thickness of the mortar bedding shall not be less than 12 mm and not more than 25 mm.

(c) Fixing Stone Slab

Before laying, the stone flags shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much areas as could be covered with the slabs within half an hour. Each flag shall be gently tapped with a wooden mallet till it is firmly and properly bedded. If there is hollow sound on gentle tapping of the slabs, such slabs shall be removed and reset properly. The joints shall be 6 mm thick and filled solidly with mortar for their full depth. The flags shall be laid so as to give continuous parallel long joints with cross joints at right angles to them. The edges of the adjoining slabs shall be in one plane. Where the slabs cover open edges, of floor or window sills the edges shall be neatly rounded off.

(d) Pointing

When pointing to be done, the joints shall be pointed with cement mortar of specified

proportion. When pointing is not specified, joints shall be struck.

(e) Curing

The floor shall be kept well wetted with damp sand or water for fourteen days.

(f) Cleaning

All flooring shall be thoroughly cleaned and handed over clean and free from any mortar stains, etc.

(g) Machine Polished Kotah Stone Flooring

Same as for Item Rough paving slabs as stated above except that:

i) All the stone slabs shall be square in shape. The dimensions shall be 600 x 600 mm and below upto 300 x 300 mm and 25 mm thick. Tolerance in thickness shall be ±3 mm.

ii) The exposed surface of the specified stone flags shall be machine polished to a smooth, even and true plane and the edges machine cut square and to the required shape when necessary. Samples shall be got by the Project manager who will keep them in his office for reference.

iii) The thickness of the joint shall not exceed 1.5 mm.

iv) Joints shall be grouted with matching pigment and neat cement slurry.

v) When the bedding and joints of the flooring have completely set, the surface shall be machine polished to give a smooth, even and true plane to the floor and thoroughly clean.

(h) Skirting or Dado of Polished Kotah Stone

The backing for skirting shall be lime or cement plastering mentioned in the item 12 mm to 20 mm thick and this plastering shall be done in a single coat. Thickness of joints shall not exceed 1.5 mm. Final polishing may be done by rubbing. The top of skirting or dado shall be jointed neatly with the plaster above as directed. The joints between the two slabs shall be filled with neat cement grout of appropriate consistency.

(i) Heavy Duty Abrasion Resistant Flooring

The type, quality, size, thickness, colour, etc., of the tile for flooring and skirting work shall be of the best quality approved by the Employer's Representative. For this purpose, the Contractor shall provide the Employer's Representative with necessary samples for this selection. Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases.

12.0 The Epoxy Lining Work

(a) Materials

The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS: 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure.

i) Hydrochloric acid upto 30% concentration

ii) Sodium hydroxide upto 50% concentration

iii) Liquid temperature upto 60 deg.

iv) Ultraviolet radiation

v) Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS:383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/ Aromatic Amine the Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish text certificates for satisfying the requirements of the epoxy formulation if so directed by the Employer's Representative.

b) Workmanship

The minimum thickness of epoxy lining shall be as per the manufacturer's specification & as per the requirement. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water all or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC / stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

11.0. **SPECIFICATIONS FOR CEMENT CONCRETE FLOORING**

11.1 Cement concrete - Cement concrete of specified mix shall be used and it shall generally conform to the specifications.

11.2 Base concrete

Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah courtyard kitchens & baths shall have slope ranging from 1 48 to 1 60 depending upon location and as decided by the engineer. Floors in water closet portion shall have slope of 130 or as decided by the engineer to drain off washing water. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it. If the base consists of lime concrete, it shall be allowed to set for seven days and the flooring shall be laid within the next three days.

If the base is of lean cement concrete, the flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

11.3 Thickness - The thickness of floor shall be as specified in the description of the item.

11.4 Laying

11.5 Panels - Flooring of specified thickness shall be laid in the pattern including the border/ or as given in the drawings or as directed by the engineer. The border panels shall not exceed 450 mm in width and the joints in the border in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm.

11.6 Laying of flooring with strips - Normally cement concrete flooring shall be laid in one operation using glass / plain asbestos / aluminium/ PVC / brass strips or any other strips as required as per drawing or instructions of the engineer, at the junction of two panels. This method ensures uniformly in colour of all the panels and straightness at the junctions of the panels. 4 mm thick glass strips or 5 mm thick plain asbestos sheet, 2 mm PVC strips or 2 mm aluminium or brass strips, shall be fixed with their tops at proper level, giving required slopes. Cost of providing and fixing strips shall be paid for separately.

Concreting - Cement concrete shall be placed in the panels and be leveled with the help of straight edge and trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge and made true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

11.7 Laying of flooring without strips

Laying of cement concrete flooring in alternate panels may be allowed by the engineer in case strips are not to be provided.

11.8 Shuttering - The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

11.9 Concreting - The concreting shall be done in the manner as described. The angle iron / flats used for shuttering shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1:2 and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

11.10 Finishing

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form thick slurry and spread at the rate of 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edges of sunk floors shall be finished and rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

11.11 Curing - The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

11.12 Precautions - Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good. During cold weather, concreting shall not be done when the temperature falls below 4 degree C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall

be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38 degree C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the engineer. To facilitate rounding of junction of skirting, dado and floor, the skirting / dado shall be laid along with the border or adjacent panels of floor.

12.0 **Providing and Laying Granite in Flooring, Skirting and Dado**

The approved quality of acid and alkali preventive primer shall be applied uniformly in two coats over the slab or the concrete surface. The acid-alkali proof powder shall be mixed with the cement in the proportion 2:1 (2 cement: 1 powder) or as per the manufacturer's specification. The cement-powder mix and the sand shall be mixed in the ratio 1:3 and the mortar shall be prepared. The stones shall be laid on the mortar bed in level and line with even thickness of 6mm to 10mm joints all around. The joints shall be raked to 12-19mm deep and filled with epoxy based resin. The resin is mixed with quick drier and acid-alkali proof powder. As the resin is an atmospheric hardening agent, it does not require curing. The work place shall be kept dry for the joint filling operation. The stones shall be either hand polished or machine polished cleaned with oxalic acid and then wax polished.

13. Granite slab over counter:

Granite slab shall be of jet black shade and of approved quality. They shall be of 18mm thick machine cut and mirror polished. They shall be laid over RCC slab. The angles shall be right angles and all edges shall be straight and true. Joints shall be permitted when the length is more than 2m. Number of joints in each direction shall not be more than one number for every 2m length beyond the initial 2m. No joints shall be permitted in the direction of width. Mortar bed shall be of cement mortar. The mortar will be of ratio 1:4 (1cement and 4coarse sand). After properly cleaning and wetting the base, the mortar shall be evenly and smoothly spread over the base by the use of screed battens. The average thickness of the mortar bed shall be 20mm. The granite slab shall be wetted before placing in position and leveled. The joints shall be paper thin joint. Joints shall be treated with white cement mixed with matching pigment. The exposed edges of the granite slab shall be rounded / edge polished.

14. Ceramic Tiles Flooring

Tiles shall be of approved make and confirm to IS: 13630 / 1992 all parts. They shall be flat and true to shape and free from blisters, crazing, chips, welts, crawling or other imperfections detracting from their appearances. The tiles shall be square in shape and nominal size 300 X 300mm. Thickness of tiles shall be 8mm. Permissible deviations in length, squareness, straightness of sides and surface flatness shall not be more than + 0.5% and that is thickness of + 5.0%. For other types of ceramic tiles manufacturers specifications may be referred.

TECHNICAL SPECIFICATIONS – 2.6

SPECIFICATIONS FOR PLASTERING AND POINTING

PLASTERING AND POINTING

1.0 SCOPE

These specifications cover the use of plastering for masonry and RCC work, pointing for brick and stone masonry work.

2.0 APPLICABLE INDIAN STANDARDS

The provision of the latest revisions of the following IS codes shall form a part of this specification to the extent they are relevant.

IS: 269 Specification for ordinary rapid hardening and low heat Portland cement

IS: 712 Building Lines

IS: 1200 Method of measurement of building and Part XII Civil Engg. Works - Plastering & Pointing

IS: 1542 Specification for sand for plaster

IS: 1630 Mason's Tools for Plaster work and pointing work.

IS: 1661 Code of practice for application of cement lime plaster finishes.

IS: 10067 Material Constants for Building Works

Other I.S. Codes, not specifically mentioned here, but pertaining to plastering work, form part of these specifications.

3.0 GENERAL

3.1 Cement Mortar

Cement mortar shall have the proportion of cement to sand and water content as specified and shall comply with relevant clauses of concrete specifications IS:1661 and codal provisions.

3.2 Scaffolding

Scaffolding will be double and shall be erected with steel sections or pipes of adequate strength so as to be safe for construction operations. The contractor shall take all measures to ensure the safety of the work and working people. Any instructions of the Engineer in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to properly or injury to persons resulting from ill erected scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be allowed.

3.3 Tools and Accessories

Tools and accessories used in plaster work shall conform to IS: 1630. All tools shall be cleaned by scrapping and washing at the end of each day's work or after use. Metal tools shall be cleaned after each operation. All tools shall be examined to see that they are thoroughly cleaned before plastering is begun.

3.4 Programme of work in relation to plastering

The programme of other building operations before, during and after plastering shall be according to the instructions contained in clause 9 of IS: 1661.

3.5 General Precaution in plastering

All general precautions as specified in IS: 1661, Clause 9, shall be taken and preparation of the background shall be done as laid down in IS: 1661, Clause 13. Care shall be taken to see that other parts of the work or adjacent works are not damaged while plastering.

3.6 Preparatory work

All joints in the face work that is to be plastered shall be raked out to depth equal to not less than the width of the joints or as directed by the Engineer. The raking shall be done taking care not to allow by chipping of masonry. In new work the raking out shall be done when the mortar in the joints is still green. Smooth surfaces of concrete, old plaster, etc. must be suitably roughened to provide necessary bond for the plaster. All dirt, soot, oil paint or any other material that might interfere with satisfactory bond shall be removed. In the case of stone masonry, scrubbing on the walls to receive the plaster shall not be more than 12 mm (1/2"). The surface to be plastered shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to plastering. It shall be kept damp during the progress of the work. The plastering shall not be commenced unless the preparatory work is passed in writing by the Engineer.

3.7 Gauges

Patches of plaster 15 cm x 15 cm shall be put on about 1.5 m apart as gauges to ensure even plastering in one plane.

3.8 Workmanship

Plastering:

In all plaster work the mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joints and on the surface and rubbed and levelled with a flat wooden rule to give required thickness. Long straight edges shall be freely used to give perfectly plane and even surface. All corners must be finished to their true angles or rounded as directed by the Engineer. The surface shall be finished to plane or curved surface as shown on the plan or directed by the Engineer, and shall present a neat appearance. The mortar shall adhere to the masonry surface intimately when set and there should be no hollow sound when struck. Cement plastering should be done in squares or strips as directed. Plastering shall be done from top downward.

First or Backing Cost

The first cost of the specified thickness shall be applied as described above. The subsequent coat shall be applied after this cost has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

3.9 Plastering to Ceiling

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surface shall be poke marked with a pointed tool at spacing of not more than 50 mm centres, the pokes being made not less than 3 mm deep, to ensure a proper key for the plaster. The mortar shall be washed off and surface cleaned of all oil, grease etc., and well wetted before the plaster is applied.

4.0 SAND FACES PLASTER IN CEMENT MORTAR

4.1 Base Coat:

The base coat plaster shall be of cement mortar 1:4. Waterproofing compound of approved make like Sika, Accoproof shall be added according to the makers' instructions to make the mortar water-proof.

The plaster with this mortar shall be laid as specified above with a thickness of not more than 12 mm for brick work and concrete surfaces, and 15 mm for rubble stone masonry. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still pastic. The base coat shall be cured for not less than 2 days.

4.2 Sand Faced Treatment

The cement mortar for sand faced plaster shall have washed Kharasalis or similar type of approved sand with slightly larger proportion of coarse material. The proportion of cement to sand shall be 1:3. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 7 mm. After application, the surface should be finished with a wooden flat, lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened, the surface shall be kept moist continuously for 14 days.

5.0 ROUGH COAT CEMENT PLASTER WITH CEMENT MORTAR

5.1 Base Coat

The first coat of plaster shall be of cement mortar of 1:4 mix and applied according to the relevant provisions of IS: 1661 Clause 14.1. The finished thickness of the first coat shall be 12 mm for brick masonry or concrete surface and 15 mm for rubble stone masonry. The plaster shall be laid by throwing the mortar (by using a strong whipping motion) on the prepared surface with a trowel in a uniform layer, and pressed to form a good bond. The surface shall be roughened.

5.2 Second Coat

The second coat shall be the rough coat mixture consisting of aggregate which may vary in size from 5 to 8 mm and may consist of specially graded mixture mixed with fine sand and cement. The proportion of cement to sand and aggregate shall be 1:1½:3. It shall be flung upon the first coat with large trowels to form an even protective coat. The second coat must be applied while the first coat is still soft and plastic. The work shall generally conform to clause 16.5 of IS: 1661. The thickness of the coat shall be about 12 mm.

7.0 POINTING

7.1 General

When the type of pointing is not mentioned in the item, sunk pointing is described below shall be carried out.

7.2 Raking Out Joints

Where the joints have not been raked out when the mortar is green, the joint shall be chipped (without damaging the masonry) to such a depth that the minimum depth of new mortar measured from either the sunk surface of the finished surface of the finished pointing or from the edge of the brick shall not be less than 12 mm, thoroughly cleaned off all loose particles with a stiff brush and thoroughly wetted.

7.3 Pointing

The mortar shall be pressed into the raked out joints with a pointing trowel. The mortar shall not spread over the corners, edges or the surface of the masonry. With a pointing tool, the mortar shall be neatly pressed back to about 3 mm or as directed. The vertical joints shall be pressed back similarly to match the horizontal joints. The surface of masonry shall be cleaned of all mortar.

7.4 Curing

The pointed face shall be kept continuously wet for 7 days suitably protected from all damage.

8.0 SCOPE

The scope under this item shall include erecting and removal of scaffolding all labour, materials, equipment, plants, tools and all incidental expenses to complete plastering pointing rubbing out joints, cleaning, wetting, filling with cement mortar, trowelling etc. and making of drip moulds, grooves, etc.

TECHNICAL SPECIFICATIONS – 2.7

SPECIFICATIONS FOR PAINTING

SPECIFICATIONS FOR PAINTING

1.0 SCOPE

These specifications cover the use of paints for the plastered and concrete surfaces. It also includes the painting of wood and metal surfaces.

2.0 GENERAL

The provisions of the latest revisions of the following IS: Codes shall form a part of this specification.

IS: 63	Whiting for Paints Ready mixed paint, brushing, grey filler, for Enamels, for use over primers.
IS: 426	Specification for paste filler for colour coats.
IS: 428	Specification for Distemper, Oil Emulsion, colour as required.
IS: 710	Marine Plywood
IS: 1200	Method of Measurement of Building & Civil Engg Works -
Part XIII	White Washing, colour washing, distempering & other finishes.
IS: 1477	Code of practice for painting of ferrous metals in buildings
(Part I)	Pretreatment
IS: 1477	Code of practice for finishing of ferrous metals in buildings.
Part II	Painting
IS: 2338	Code of practice for finishing of wood and wood based materials
Part I	Operations and workmanship for finishing.
IS: 2338	Code of practice for finishing of wood and wood based materials,
Part II :	Schedule
IS: 2395	Code of practice for painting concrete masonry and plaster
Part I :	surfaces. Operation & workmanship
IS: 2395	Code of practice for painting concrete, masonry and plaster
Part II :	surfaces. Schedule
IS: 2524	Code of practice for painting of non-ferrous metal in
Part I :	buildings Pretreatment

IS: 2524 Code of practice for painting of non-ferrous metal in buildings

Part II: Painting

IS: 5410 Specification for cement paints, colour as required.

Other IS Codes not specifically mentioned here, but pertaining to painting form part of these specifications.

3.0 MATERIALS

Materials shall strictly conform to the relevant IS: Specifications.

4.0 PLASTERED OR CONCRETE SURFACES

4.1 General

Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be painted. A properly secured and well tied suspended platforms (JHOOLA) may be used for painting. Where ladders are used, pieces of old gunny bags shall be tied at top and cotton to prevent scratches to the walls and floors. For painting of ceilings, proper stage scaffolding shall be erected, where necessary.

Preparation of surfaces:

The surface shall be thoroughly cleaned off all dirt, dust, mortar dropping and other foreign matter, before paint is to be applied. New plaster surfaces shall be allowed to dry for at least 2 months, before applying paint. All unnecessary nails shall be removed. Pitting in plaster shall be made good with putty. The surface shall then be rubbed down again with a fine grade sand paper and made smooth.

The surface shall be allowed to dry thoroughly before the regular coat of paint is allowed.

The surface affected by moulds moss, fungi, algaelicnens, efflorescence shall be treated in accordance with IS 2395 (Part I) before applying paint.

4.2 Oil-Bound Distempering

Preparation of Surfaces:

Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

Primer Coat:

The primer where used as on undercoated surfaces shall be alkali resistance primer or distemper primer as specified in the item. These shall be of the same manufacture as of oil bound distemper. If the wall surface plaster has not dried completely alkali resistance primer shall be applied before distempering the walls. But if the distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Application:

Primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil bound distemper or paint is applied.

Preparation of oil bound distemper:

The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for days work shall be prepared.

Application of distemper coat:

After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed to immediately by vertical which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit the proper drying of the preceding coat.

The finished surface shall be even and uniform without patches, brush marks, distemper, drops, etc.

Sufficient quantity of distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

15 cm. double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

4.3 Emulsion Paint

Emulsion paint and primer of approved brand manufacture and shade shall be used.

Applications:

The priming and the number of coats to be applied shall be as specified in the bill of quantities and shall be as per the manufacturers specification. The surface on finishing shall present a flat velvety smooth finish.

Precautions:

A) Old brushes if they are to be used with emulsion paints, should be completely dried of turpentine or oil paints by washing in warm soap water. Brushes should be quickly

washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

B) In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes, etc.

C) Splashes on floors etc, shall be cleaned out without delay as they will be difficult to remove after hardening.

4.4 **Water Proof Cement Paint**

Preparation of Surfaces:

The surfaces shall be thoroughly wetted with clean water before the water proof cement paint is applied.

Preparation of Paint :

Portland cement paints are made readily by adding paint powder to water and stirring to obtain a thick paste which shall then be diluted to a brushable consistency. Generally equal volumes of paint powder and water make a satisfactory paint. In all cases the manufacturer's instructions shall be followed. The paint shall be mixed in such quantities as can be used up within an hour of mixing as otherwise the mixture will set and thicken, affecting flow and finish.

The lids of cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly becomes air set due to its hydroscopic qualities.

Application of Paint:

No painting shall be done when the paint is likely to be exposed to a temperature of below 7 degree within 48 hours after application.

When weather conditions are such as to cause the paint to dry rapidly, work shall be carried out in the shed as far as possible. This helps the proper hardening of the paint film by keeping the surface moist for a longer period.

To maintain a uniform mixture and to prevent segregation the paint shall be stirred frequently in the bucket.

For undecorated surfaces, the surface shall be treated with minimum two coats of water-proof cement paint. Not less than 24 hours shall be allowed between two coats and the second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather the preceding coat shall be slightly moistured before applying the subsequent coat.

The finished surface shall be even and uniform in shade without patches, brush marks, paint drops, etc.

Cement paints shall be applied with a brush with relatively short stiff hog or fibre bristles. The paint shall be brushed in uniform thickness and shall be free of excessively heavy brush marks. The laps shall be well brushed out.

Curing

Painted surfaces shall be sprinkled with water two or three times a day. This shall done between coats and for at least two days following the final coat. The curing shall be started as soon as the paint has hardened so as not to be damaged by the sprinkling of water say about 12 hours after its application.

5.0 PAINTING OF WOOD AND METAL SURFACES

5.1 General Requirement:

The materials required for the execution of painting work shall be obtained directly from approved manufacturers and brought to the site in maker's drums, with seals unbroken. All paints shall not be inferior to relevant Indian Standards as mentioned under sub-head "Material".

All materials not in actual use shall be kept properly protected. Lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer turpentine to prevent formation of skin. Materials which have become stale or fat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in the smaller container. No left over paint shall be put back into stock tins. When not in use, the containers shall be kept properly closed.

If for any reason thinning is necessary, in case of ready mixed paint, the brand of thinner recommended by manufacturer shall be used.

Painting except the priming coat shall generally be taken in hand after all other builder's work is practically finished. The rooms shall be thoroughly swept out and the entire building cleaned up at least one day in advance of the paint work being started. The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt scales, smoke and grease shall be thoroughly removed before painting is started.

No painting on exterior or other exposed parts of the work shall be carried out in wet, humid or otherwise unfavourable weather and all the surfaces must be thoroughly dry before painting work is started.

Brushing of Paint:

The brushing operations are to be adjusted to the spreading capacity advised by the manufacturers of the particular paint. The painting shall be applied evenly and smoothly by means of crossing and laying off, the later in the direction of the grain of wood. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively in the opposite directions two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

During painting, every time after the paint has been worked out of the brush bristles or after the brush has been unloaded, the bristles of the brush (which are down together due to the high surface tension) shall be opened up by striking the brush against a

portion of the unpainted surface with the end of the bristles held at right angles to the surface, so that bristles thereafter will collect the correct amount of paint when dipped again into the paint container.

Spraying :

Where so stipulated, the painting shall be done with spray. Spray machine used may be (a) high pressure (small air aperture) type or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry conditions prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application with the minimum wastage of paint. The air pressure shall not be kept too high as otherwise the paint will log up and will be wasted.

At the end of the job, the spray-gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand paper and loose particles brushed off before next cast is applied. Each coat shall vary slightly in shade and shall be got approved from the Project manager before next coat is started.

Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is applied.

No hair marks from the brush or clogging of paint puddles in the corner panels, angles of moulding, etc. shall be left on the works. In painting doors and windows, the putty round the glass panes shall also be painted but care shall be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting.

In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be according to the detailed specifications under the respective headings.

Brushes and containers:

After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. After cleaning, the brushes are wrapped in heavy paper or water proof paper for storage. It is to be used the next day, it shall be hung in a thinner or linseed oil in a container. On no account shall brushes be made to stand on bristles. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers, when not in use, shall be kept closed and free from air so that paint does not thicken and also shall be kept guarded from dust. When the paint has been

used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, before they can be used again.

5.2 Steel and other Metal Surfaces

Preparation of Surfaces:

The surface before painting shall be cleaned of all rust, scale, dirt and other foreign matter sticking to it with wire brushes, steel wool, scrappers, sand papers etc. The surfaces shall then be wiped finally with mineral turpentine which shall also remove grease and perspiration of hand marks. The surface shall then be allowed to dry.

Preparation of Surfaces

The surface shall be treated with Mordant Solution (5 litres for about 190 sq.m) by rubbing the solution generously, with a brush or bundle of rags on a stick. After about half an hour, the surface will turn grey and parts remaining bright shall be retouched and the extra surface washed down thoroughly with clean cold water and allowed to dry.

Application of primers and paints:

After preparation of the surface, the priming coat shall be applied immediately. The specifications for application shall conform to Para 5.1 above.

External Steel Works

a) All the external steel works shall be painted with two coats of approved anti-corrosive paint with two coats of compatible primer.

b) Anti-corrosive primers shall be of lead free types.

c) All the materials shall be of the best quality from and approved manufacturer. The Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

d) Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling and shall be from the same manufacturer for each painting system.

5.3 Wood and wood Based Materials:

Preparation of Surface:

All wood work shall be dry and free from any foreign matter, incidental to building operation. Nails shall be punched well below the surface to provide a firm key for stopping. Moulding shall be carefully smoothened with abrasive paper and projecting fibres shall be removed. Flat portions shall be smoothened off with abrasive paper used across the grain prior to painting. Any knots, resinous, streaks or bluish sap wood that are large not enough to justify cutting out shall be treated with two coats of pure

shellac knotting, applied thinly and extended about 25 mm beyond the actual area requiring treatment.

Plywood and block board:

This shall be treated as for solid wood, described above.

Hard Boards:

The surface shall be dusted off and painted with a coat of plastic emulsion paint thinned with water or with a coat of shellac varnish as specified. The surface shall then be rubbed down with fine grade abrasive paper and followed with required under coating and finishing coat as for soiled wood.

Particle Board :

The surface shall be filled with a thin brushable filler and finished as for solid wood.

Insulation Boards :

Two thin coats of water based paints shall be applied by spraying.

Priming Coat :

The dirt or any other extraneous material shall be removed from the surface to be painted. In case the surface is already finished with primer coat but unsatisfactory, it shall be rubbed down to bare wood and surface reprimed. Primer shall be applied by brushing.

Application for transparent wood filler:

The filler shall be applied with brush or rag in such a way that it fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours and it shall then be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

Stopping:

All holes, cracks, crevices, etc. shall be stopped carefully to true and level surface with putty before the main undercoat is applied and after the application of the priming coat, stopping shall be prepared as below:

Bees wax, resin and lac (orange in colour) in the proportion of 1:1:16 by weight shall be melted down together in a suitable pot using slow heat, the mix being kept well stirred. Colouring materials to produce the required shade shall be added into molten mixture and stirred. Stopping shall on cooling be rolled into stick forms for use.

Application of Paints:

This shall conform to specifications under Para 5.1

Applying wood preservatives:

The preservatives of specified quality shall be applied in two coats. On new wood work, it shall be applied liberally with a stout brush and not doubled with rags or cotton

waste. The first coat shall be allowed at least 24 hours to soak in before the second coat is applied. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

6.0 MEASUREMENT

Painting on plastered or concrete surface shall be measured as for plastering.

Painting on wooden or metal surfaces shall not be measured separately and is deemed to be included in the respective items.

WHITEWASHING

General

The item refers to white-washing over old and new concrete, stone masonry brick plastered surfaces.

White wash shall be prepared from fresh burnt white stone lime or shell lime. This lime shall be of class C type as per IS: 712. Surkhi lime or lime of equivalent quality may be used. The lime shall be dissolved in a tub with sufficient quality of water (about 4.5 litres/Kg. of lime) and the whole shall be thoroughly mixed and stirred until it attains the consistency of thin cream. The wash shall be taken out in small quantities and strained through a clear course cloth. Alternatively with IS: 63 may also be used. Clean gum dissolved in hot water shall then be added in suitable proportion of 2 gm of gum arabic to a litre of lime or whiting to prevent the white-wash coming off easily when rubbed. Rice may be used instead of gum.

Scaffolding:

This may be double or single according to requirements. If ladders are used, pieces of old gunny bags or cloth rags shall be tied on their tops to avoid damage or scratches to the wall. Proper stage scaffolding shall be created when white-washing ceiling. The contractor shall be responsible for accidents if any taken place.

Preparation of Surface:

The surface shall be prepared by removing all mortar dropping and foreign matter and thoroughly cleaned with wire or fibre brush or other means as may be ordered by the Engineer to produce an approved clean and even surface. All loose pieces and the scales shall be scraped off and holes stopped with mortar. In case where the surface have been previously coloured-washed, the old colour wash must be entirely removed before the white-wash is applied. In the case of surface which have once been white-washed, the old loose white-wash shall be broomed down. In case, the loose white-wash cannot be removed by brooming, the Engineer may order scraping of the surface.

After cleaning the surface as specified above, the unwanted nails shall be removed and all nail holes, cracks and crevices stopped with mortar similar in composition to the surface to be stopped. The mortar should be cured.

Application of white-wash:

On the surface so prepared, the white-wash shall be laid. Each coat shall be laid on with a brush. The first stroke of the brush shall be from the top downwards, another from bottom upwards over the first stroke, and similarly, one stroke from the right and another from the left over the first brush before it dries. This will form one coat. Each coat must be allowed to dry and shall be subject to inspection before the next coat is applied. When dry, the surface shall show no signs of cracking. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with a finger.

No portion in the surface shall be left out initially, to be patched up later on.

For new work, the white washed surface shall present a smooth and uniform finish.

For old work, patches and repairs shall be white washed first. Thereafter, the whole surface shall be white washed with the required number of coats.

Doors, windows, floors and other articles of furniture, etc., shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed and the surfaces cleaned.

Preparing the surface for white wash including the scaffolding.

Applying the white wash in required number of coats as specified above and prior white washing of repaired patched.

TECHNICAL SPECIFICATIONS – 2.8

SPECIFICATIONS FOR ALUMINIUM DOORS AND WINDOWS

1.0 ALUMINIUM DOORS & WINDOWS

1.1 All aluminum doors and windows to be used in the work shall be manufactured using suitable gauge Aluminium extruded sections (Indal, Jindal or equivalent) oxidized to natural matt finish or electro colour. Considering varying profiles of Aluminium sections being extruded by approved manufacturers the contractor shall prepare detailed shop drawings of proposal using sections based on architectural design drawings and adequate to meet the performance and other specifications - parameters laid down for the work. The sections, profile, weight and suitability to meet the requirements/specifications as proposed by the manufacturer and detailed shop drawings shall be got approved by the contractor from the architects who should be satisfied that it fully meets their design.

1.2 All aluminium works shall include in various items complete work including sub frames and fittings, fixture, stays, locks, handles, special hinges, floor springs, neoprene/rubber lining, gaskets, bushes, rollers, sealant, etc. as directed and approved by the architects.

1.3 All windows, glazing, door etc. shall be made completely waterproof to the satisfaction of the architects and necessary silicon/polysulphide sealant etc. shall be provided. No payment shall be made for providing necessary silicon/polysulphide, to items under this sub-head.

1.4 The items of aluminium glazing doors and windows etc. work shall include the provision of mullions, coupling bars as required to join various units of glazing windows and doors etc. to form larger glazing windows or doors cum windows/glazing area as required as per Architects drawings. The glass shall conform to the provisions of IS:2835 and relevant codal provisions.

1.5 The aluminium extruded sections shall conform to IS designation HE9 WP alloy with chemical composition and mechanical properties as per IS: 733. Hollow section shall conform to IS HV 9 WP of IS: 1285.

1.6 All joints shall be accurately fabricated and be hairline in appearance. The finished surface shall be free from visible defects.

1.7 The aluminium sections shall be brushed and anodised to natural matt finish or electro colour anodised to any shade of bronze as per IS: 1868 - 1968 and IS: 6012 - 1970. For general interior and exterior use the anodising shall be average 12 to 15 microns. For highly corrosive environment anodising shall be average 18 to 20 microns.

1.8 The anodic coating shall be properly sealed by steam or boiling in deionised water as per IS: 1868 - 1968 and or IS: 6057. Sealing quality shall be tested in accordance with DIN 50949 or similar standards.

1.9 Doors, windows or fixed glazing etc. shall be fixed to subframe, concrete or brick wall with suitable metal fasteners. Each door, window, fixed glazing etc. shall be tailor made as per openings at site. No cutting and making good of subframes concrete surface etc. shall be permitted.

1.10 A thick layer of clear transparent lacquer, based on methacrylates or cellulose Butyrate shall be applied on the anodised glazing before they are brought on site. The lacquer shall be removed on completion of erection.

1.11 All screws shall be stainless steel. Screw threads of machine screws shall conform to IS 4218 or otherwise approved by architects. Gaskets for retaining glass shall be approved heavy duty extruded neoprene.

1.12 The requirements, provisions, for all anodised aluminium work shall conform to requirements and specifications, given in the tender, Architects drawings and instructions and shall conform to relevant IS codes relating to materials, workmanship, fabrication, finishing, erection, installation etc. In this connection IS codes IS: 1868 - 1968, IS: 733 - 1983, IS: 1948 - 1961, IS: 7088 - 1973, IS: 6012 - 1970, IS: 1285 - 1975, IS: 740 - 1974 as deemed applicable shall be considered. Other IS codes not specifically mentioned above but pertaining to aluminium doors, windows and ventilators also form part of these specifications.

1.13 For use in Anodised aluminium items like doors, windows, ventilators etc. the sections used should have weights not less than as mentioned below but not restricted to these values;

1) Fixed and openable glazing frames 0.9 Kg/metre

2) Side hung windows including beads 1.2 Kg/metre.

3) Doors 1.4 kg to 2.8 kg per meter.

However, suitable sections with lighter/heavier weight as may be required and as approved by Architects shall be provided. No variation in quoted rates shall be made for change in section or weights given above as a guide.

1.14 Unless specified otherwise the amount quoted for all items shall include the following:

The Contractor shall attach a schedule of various sections used in the assembly with accessories indicating the weight per running meter of the section. The sourcing of the material to be specified. Actual weight of Aluminium for each item of work to be specified.

The shop drawings for approval shall be prepared by the Contractor and submitted to the Consultant/Engineer in Charge. The drawings approved by the Consultant/ Engineer in Charge will be issued to the Contractor for the execution of work and the procurement of materials accordingly.

The quoted amount shall include the cost of supplying, fabricating and fixing of Aluminium subframes of rectangular Aluminium tubes of required sizes/section, weighing not less than 0.367 Kg/mtr.

The quoted amount are to be inclusive of delivery of materials to site and installation charges.

Tower Bolts, Aldrops, Handles, Door stopper, Locking arrangements, etc., of approved make, type and required numbers to be provided.

EPDM Rubber gaskets to be used for all glazing applications.

Sliding doors and windows should have approved bearings for trouble free operation of shutters.

The amount should be inclusive of scaffolding for erection at site.

The Contractor shall be responsible for safe storage and safe custody of the materials.

Side/Top hung window shutters should have IMEX or approved equivalent hinges brass chromium plated type 250 mm or of approved sizes.

Caulking shall be done using Silicone sealant to provide water tight seal between the windows and adjoining construction both inside and outside.

The amount quoted to include at all heights, depths and levels.

Exhaust fan opening to be provided as directed.

The aluminium frame shall be fixed only before the final coat of painting.

The sub frame has to be fixed properly before plastering the sills, jams .

1.15 DOORS

Material: Heavy duty made from Aluminium extruded section HE-9-WP of I.S. 733.

Frame: Outer frame including intermediate vertical and horizontal members shall be rectangular extruded section having in-built grooves to receive glazing.

Shutter: Shutter horizontal and vertical section provision for snap on glazing. Vertical section have mullion groove for weather shipping.

Glazing: Screwless snap on square aluminium above beading with PVC glazing gasket, - 5.5 mm thick clear glass.

Section: Outer frames including intermediate, horizontal and vertical members - Size 101.6 x 44.5 x 3.18 mm.

Shutter Vertical	47.62 x 44.45 x 3.18 mm
Shutter Top	47.62 x 44.45 x 3.18 mm
Shutter Bottom	114.3 x 44.5 x 3.18 mm
Shutter Middle	47.62x 44.45x3.18 mm

Hardware:

a) Lever lock, brass body, key operating from both sides.

b) Standard push and pull horizontal full length.

c) Double action hydraulic floor spring of approved make & quality with G.I. Pivot for top and bottom for each shutter.

Construction

Frame: Frame shall be mechanically jointed with 3 mm thick aluminium cleat.

Shutters: Mechanically jointed with plated self tapping screws and aluminium safety plates, blind rivets and nickel plated self tapping screws for joints and fittings.

Anodising: Shall be average 18 to 20 micron and gummed paper tape provided to sections as protective coating.

1.16 HEAVY DUTY SLIDING WINDOWS

Aluminium windows and doors to be used in the work shall be manufactured using suitable heavy gauge (3.2 mm) Aluminium extruded sections of Indal or Jindal anodised to approved finish for 18 to 20 micron. For any work whose purpose made steel windows are specified, the same shall be obtained from Alumilite or Jindal or any other approved manufacturer. The Engineers and the Architect's approval for windows to be supplied by non-specified manufacturer shall be obtained in writing on the contractor furnishing him at his own cost a sample of each window or door type. Only then a firm order shall be placed with the approved manufacturer. All windows and doors shall conform to the samples so approved.

Materials: Heavy duty sliding windows shall be made from extruded aluminium sections of alloy HE-9-WP of IS:733-1956.

Frames: Frames shall be 2 or 3 track as required having in-built grooves to accept weather strip for weather sealing.

Shutters: The shutter vertical, interlock sections shall be hollow sections and horizontal sections shall be non-hollow and suitable for glazing with PVC/EPDM gaskets. Interlock section shall have in-built grooves for weather stripping.

Gutter and valves: In heavy rainfall areas, the sill member shall be hollow section with special gutter section clipped on to the bottom track so as to have hollow chamber of minimum cross-sectional area of 1000 sq.mm. for 2 track and 1500 sq.mm. for 3 track. The slots of size 75 x 5 mm shall be provided in the bottom track and gutter sections for vertical drainage of rain water. PVC valves shall be provided in the gutter sections acting as pressure equalization cum non-return valves.

Sections: Size of the sections shall be as follows:

Item	Size
Frame-2 track on the sides, top and bottom	61.85 x 31.75 x 1.5 mm
Shutter – vertical	40 x 18 x 1.25 mm

and horizontals

Shutter – Interlock 40 x 26.7 x 1.10 mm

Glazing gaskets: Soft PVC/EPDM glazing gaskets shall be used for glazing the shutters. Rubber gaskets shall not be allowed. 4mm thick clear glass to be provided.

Weather strips: Soft PVC/EPDM weather strips shall be provided in the in-built grooves of the sections and rubber weather strips shall not be allowed. Use of pile weather strips in lieu of PVC is optional.

Hardware: The sliding shutters shall be provided with:

(a) Needle bearing nylon rollers, encased in plated M.S. brackets.

(b) Flush type handle-cum-lock having aluminium body and stainless steel spring/ receiving latch.

(c) Nylon and cover-cum-guide on the top and bottom of the shutters.

(d) Nylon anti-lift with pile insert to prevent lifting and tilting of the shutters.

Construction: The frames shall be mechanically jointed with 3 mm thick aluminium angle cleats. The shutters shall be mechanically jointed with plated self tapping screws and aluminium safety plate or aluminium alloy blind rivets and nickel plated self tapping screws shall be used for the joints and fittings.

Anodising: The aluminium sections shall be brushed and anodised to natural matte finish or electro colour anodised to any shade of bronze as per IS:1868-1968. The anodising shall be average 18 to 20 microns. Gummed paper tapes shall be provided on the exposed surface of the sections as protective coating.

1.17 OPENABLE LOUVERED WINDOWS

Material	:	Heavy duty made from Aluminium extruded section HE-9-WP of IS. 733.
Frame	:	40 x 18 x 1.45 MM in-built grooves top and bottom repeated sections 40 x 23 x 1.2 mm.
Coupling	:	Coupling bar panel shape 12.5 x 6 x 2 mm Bar
Louver blade		
Clip	:	One piece 18 gauge above sheets riveted to jambs by 89 mm c/c., after fixing the blade from inside and attached to coupling bar.
Ground Glass	:	4 mm thick for louver upto width of 760 mm and 5.5 mm thick for louver above 760 mm.
Weather Strip	:	Soft P.V.C. Weather strip
Hardware	:	Louver window with self locking type handle.

Construction &

Anodising : Shall be average 18 to 20 micron and gum paper tape provided to sections as protective coating.

1.18 MEDIUM RANGE OPENABLE AND FIXED WINDOWS

Material: Heavy duty made from Aluminium extruded section HE-9-WP of I.S. 733.

Frame: Frames shall have in-built grooves to accept the weather strip for weather sealing.

Shutters: Vertical interlock will be hollow section Horizontal shall non-hollow suitable for glazing with suitable gaskets.

Sections :

Frame:	Equal Log	63.5 x 43.0 x 1.6 mm
Shutter:	Hollow Section	57.4 x 40.0 x 1.6 mm
Mullion:	Hollow Section	62.0 x 40.0 x 1.6 mm
Glazing :	Beading	30.0 x19.0 x 1.1 mm,
		4 mm thick clear glass.

Hardware: (Openable Shutter)

a) Heavy duty alum butt hinges having stainless steel pins, dowels and P.C. Washers.

b) Peg Stay - Aluminium extruded section.

c) Aluminium fasteners angle with nylons striking plate.

Construction &

Anodising : Same as General Specifications for Sliding Windows

TECHNICAL SPECIFICATIONS – 2.9

SPECIFICATIONS FOR METAL DOORS, WINDOWS AND VENTILATORS

1.11.1.1 METAL DOORS, WINDOWS AND VENTILATORS

1.0 Applicable Codes:

The provisions of the largest Indian Standards mentioned below shall form a part of these specifications:

IS: 1956 Glossary of terms relating to iron and steel.

IS:814 Specifications for covered electrodes for metal arc welding of

(Part I) structural steel.

IS: 814 1) For welding products other than sheets. Specifications for covered electrodes for metal arc welding of structural steel.

(Part II) 2) For welding sheets

IS: 815 Classification and coding of covered electrodes for metal arc welding of structural steel.

IS: 818 Code of practice for safety and health requirements in electric and gas welding and cutting operations.

IS: 1948 Aluminium doors, windows & ventilators.

IS: 6227 Code of Practice for use of metal arc welding in tubular structure.

IS: 6248 Specifications for metal rolling shutters and rolling grill.

IS: 1081 Code of Practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

IS: 2062 Weldable Structural Steel

IS: 1361 Specifications for steel windows for Industrial Buildings.

IS: 1200 Measurements for steel work and iron work.

(Part VIII)

IS:2835 Flat transparent sheet glass

IS: 1038 Specifications for steel doors, windows and ventilators.

IS: 226 Specifications for structural steel (Standard quality)

IS: 823 Code of procedure for manual metal arc welding of metal steel.

IS: 1363 For black hexagon bolts, nut and lock nuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm)

IS: 813 Scheme of symbols for welding.

Other IS Codes not specifically mentioned here but pertaining to Metal Doors, Windows & Ventilators form part of these specifications.

2.0 MATERIALS

2.1 Structural Steel :

Standard quality mild steel of various varieties and designations shall be used for different works as mentioned below:

St 42 - S: This variety of steel (standard quality) shall conform to specifications given in IS: 2062 (latest) and shall be used for (i) Riveted steel work (ii) bolted steel work (iii) steel work where welding is employed for fabrication provided that the thickness of material does not exceed 20 mm. When material conforming to this standard is over 20 mm thick special precautions may be required in case the material is to be welded (see IS: 823 - latest).

St 30 - 0: This variety of steel (ordinary quality) shall conform to specifications given in IS: 1977 and is intended for general purposes such as door and window frames, window bars, grills steel gates, hand railing, builder's hardware, fencing post, tie bars, etc. All finished steel material shall be properly and neatly rolled to dimensions, sections and weights as specified. The finished material shall be free from visible as well as hidden defects and excessive rusting. The ends of the tubes shall be cut square, unless otherwise specified.

Steel sections and tubes shall be well protected and kept free from excessive rust and scaling. In this regard, decision of Project manager shall be final and binding on the contractor.

2.2 Black Bolts :

Also known as machine bolts, these bolts shall be made from rods and they come from the rolling mills and are not finished to exact size. A lower working stress is taken for these types of bolts than those of rivets and 'turned fitted bolts'.

2.3 Rolling Grills :

The grills shall conform to specifications given in IS: 6248. Rolling grills shall be supplied in the following alternative types as specified. The grills shall be complete with accessories. The fixing arrangement shall be as per the drawing with regard to whether it shall be fixed on the inside or outside between jamb of opening on or below the lintel etc.

(a) Gear operated type (push and pull type or manually operated type): It shall be used upto a maximum of about 8 sq.m clear area without ball bearings and upto a clear area of about 12 sq.m with ball bearings.

(b) Gear Operated Type (Mechanical Type): It shall be fitted with ball bearings. It shall be used upto a maximum of about 25 sq.m clear area, if the rolling grill is operated by a bevel gear box and crank handle, and upto a maximum of about 35 sq.m clear area, if the rolling grill is operated by chair wheel and hand chain, mounted directly on the work shaft.

Grills shall be manufactured out of 8 mm dia. mild steel round bars. Rolling grills shall be of mid bar type or of any other approved design.

The guide channels shall be of mild steel deep channel section and of rolled pressed or built up (fabricated) jointless construction. The thickness of sheet used shall not be less than 3.15 mm. Hood covers shall be made of mild steel sheet not less than 0.90 mm thick. For grills having width 3.5m and above thickness of M.S. sheet for the hood cover shall be not less than 1.25 mm.

Rolling Grills :

The springs shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong mild steel or malleable cast iron brackets. Brackets shall be fixed on the or under the lintel as specified with raw plugs, and screw bolts, etc.

Both the side guides and bottom rail shall be jointless and of single piece of pressed steel.

Grill shall be laid on ground and the side-guide channels shall be bound with it with ropes, etc. The shutter shall then be placed in position and top fixed with suspension shaft with bolts and nuts. The side guide channels and the cover frame shall then be fixed to the walls through the plate-welded to the guides. These plates and bracket shall be fixed by means of screw bolts, end rawl plugs drilled in the wall. The plates and screw bolts shall be concealed in plaster to make their location invisible. Fixing shall be done accurately in a workman like manner so as to ensure easy and smooth operation of the grill.

Rolling Shutter

Same as above for Rolling Grills but with 18 gauge x 65 mm steel laths of deep convex corrugation. The rolling steel shutters shall be of approved make and design.

2.4 Steel Doors, Windows and Ventilators:

Steel doors, windows and ventilators and sashes shall be manufactured from fusion welding quality steel (St.42 W) sections conforming to specifications given in IS: 2062.

In case of composite units consisting of a combination of two or more units of doors, windows and ventilators, etc. as the case may be, different units shall be coupled by using coupling sections made from M S Sheet 3.15 mm thick as per IS: 1038 Para 5.2. The weight of different rolled steel sections used for manufacture of doors, windows and ventilators shall be as per those specified in IS: 1038, unless otherwise specified.

Painting : Approved quality paint conforming to relevant codal provisions shall be used.

2.5 Welding Equipment:

The welding plant and equipment shall be of modern design and shall be got approved by the Project manager.

The electrodes required for metal arc welding shall be 'covered electrodes' and shall conform to IS: 814 (Part I) for welding products other than sheets and IS: 814 (Part II) for welding sheets.

The type of covering shall be as per IS: 815 for classification and coding of covered electrodes for metal arc welding of structural sheets.

2.6 WORKMANSHIP

2.7 Structural Steel Work

The steel sections as specified or required shall be out, square and to correct lengths, as per drawing and design. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member, except as indicated in the drawings or directed by the Project manager. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permitted.

All holes shall be generally drilled to the required size and at the required position. Sub-puching shall be permitted, provided it is done 3 mm less in diameter and reamed thereafter to the required size.

Holes for rivets and black bolts shall be larger by 0.4 to 0.6 mm than the nominal diameter of the rivets of black-bolts depending upon the dia of rivets.

Holes for counter-sunk bolts shall be made in such a manner that their heads fit flush with the surface after fixing.

All bolt heads and nuts shall be hexagonal and of equal size, unless specified otherwise. The screwed threads shall conform to IS: 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project two clear threads beyond the nuts when fixed in position and these shall fit in the bolts without any shake. The nuts shall fit in the threaded ends of bolts properly. Tapered washers shall be provided for all heads and nuts bearing and levelled surfaces. The threaded portion of the bolt shall not be within the thickness of the parts bolted together. The faces of bolt heads and nuts shutting against steel members shall be machine finished.

Welding shall generally be done by electric process. The electric arc method being economical, is usually adopted. Where public electricity is not available a suitable generator shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Project manager.

Types of welding: Welds used for joining structural members are generally of the following two types as under:

(i) Fillet weld: The cross section of fillet weld is triangular and it is used to join two surfaces normally at right angles to each other. This type of weld is used more frequently in structural connections than any other type, and is usually in the

form of isosceles triangle. The fillet welds shall be continuous or in intermittent as specified in the design.

(ii) Butt welds: These are classified according to the method of grooving or preparing of the base metal. The metal pieces shall be filled or chiselled to the required shape for butt welding at the throat for which no extra payment shall be made.

Fillet and Butt welds shall conform to IS: 816. Special type of welds as slot-welds shall be used where so specified. Either direct or alternating current (but not both types) may be used throughout the whole work. An ammeter shall be provided to each arc and so situated that the Project manager can easily check the current being used by the operator. Each welder shall be supplied with a portable current regulator to enable him to adjust the welding current within the approved limits without leaving his work. Only qualified operators shall be employed for welding and they shall have been trained and shall be tested after every three months as per provisions of IS: 817 for "Code of Practice for training and testing of Metal Arc Welders".

In welded structure holes are necessary for service bolts required during erection. These holes shall be made as specified above. The holes in the various sections shall be filled with punches and welded properly to form a composite section.

Surfaces which are to be welded together shall be free from loose mill-scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without displacement.

All operators connected with welding and cutting equipment conform to the safety requirement given in IS: 818 for "Safety and Health Requirements in Electric and Gas Welding and Cutting Operations".

The following points shall be borne in mind during the process of welding:

(a) Welds shall be made in the flat position, wherever applicable.

(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.

(c) The sequence of welding shall be such that where possible the members which offer the least resistance to compression are welded first.

Processor Welding :

The electrode manipulation during welding shall be such as to ensure that :

(i) The base metal is in a fused state when the filler metal makes contact with it.

(ii) The filler metal does not overflow upon any unfused based metal.

(iii) The base metal is not under-cut along the weld edges.

(iv) The flowing metal floats the slags, the oxides, and the gas bubbles to the

surface behind the advancing pool.

In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed. Each time the arc is started, the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run the arc shall be restarted ahead of the previous deposit and then moved back to fill the crater, or such alternative technique shall be used as will ensure complete filling of the crater or complete fusion between the new and old deposits and the base metal at the point of junction and result in continuity of weld. Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary and the deposited and adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers but also to successive beats, and to the overlapping area whatever a junction is made on starting a new electrode:

(v) The welds shall be free from cracks, discontinuity in welding and other defects such as

(a) under size

(b) over size

(c) undercutting

(d) overcutting

In case of fillet welds and defects (b), (c) and (d) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and re-welded.

Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed, welds and adjacent parts shall be painted after the same are approved by the Project manager.

Inspection and testing of welds:

The method of inspection and testing shall be as under:

(a) Visual Inspection: The following factors shall be considered during the visual inspection:

(i) Dimensions of weld deposit: The size of the weld shall be as specified and it may be slightly over but not under.

(ii) Shape of profile: The profile of the weld is affected by the position of the joint, but it shall be uniform. In the case of butt and corner welds, the profile shall be slightly convex and in the case fillet welds it shall be usually slightly concave.

(iii) Uniformity of Surface: The height and spacing of the ripple shall be uniform;

these being indicative of workmanship.

(iv) Degree of under cut: Undercutting is undesirable. The weld joint shall be free from undercut but slight intermittent occurrences may be disregarded.

(v) Smoothness of joints: The joints in the weld run where welding has been adopted, shall be as uniform and smooth as possible and shall show no pronounced bump or crater in the weld surface.

(vi) Freedom from surface defects: The surface of the weld shall be free from porosity, cavities and burnt on scale.

(vii) Penetration bead in Butt Welds: A slight penetration bead shall be present and it should be reasonably uniform in width and appearance. Intermittent occurrences of lack of penetration bead may be disregarded.

(viii) Degree of fusion: Fusion shall be complete over the whole area of the joint surface.

(ix) Degree of Root Penetration: These defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effects in reducing the strength of the weld. A close examination of the root shall, therefore, be made. In butt-welds, the penetration should extend to the underside of the plates producing a penetration bead of the right size. In fillet welds with good root penetration, the weld metal should reach the corner.

Note: 1

In case of fusion welding or non-fusion weld and fillet welds will appear in joint, fillets being at the cretches.

Note: 2

In case of non-fusion welding of cast iron the joints shall show satisfactory penetration and adhesion.

(x) Gas Cavities and Flux Entrapments : Unless they are caused by the use of unsuitable material, they are attributable to the quality of workmanship, the desired result being to achieve uniform appearance and freedom from cavities and flux entrapments (where flux is used). In fusion welding of mild steel, cast iron and aluminium where neutral flame is used, and in fusion welding of brass or braze welding of cast iron where oxidising flame is used, current welding technique may result in rough, porous, discoloured and lusterless appearance in the fracture.

Note

(a) In case of fusion welding or non-fusion welding of cast iron isolated blow holes or concentration of pinholes in the weld metal shall be regarded as grounds for rejection but isolated pinholes shall not be so regarded.

(b) Bending Testing (for ductility): The elongation shall be not less than 30 percent for stress relieved welds and not less than 25 percent for non-stress relieved welds.

(c) Tensile Testing: (Reduced Section Tensile Testing): The tensile strength shall be not less than minimum of the specified tensile range of the parent metal.

(d) Radiographic Examination : This shall be done as given in IS: 6227.

Steel Doors, Windows and Ventilators:

General: The type, over all sizes, side opening position of steel doors, windows and ventilators, shall be specified as per details given in IS : 1038, Specifications for steel doors, windows and ventilators.

Fabrication: Both the fixed and opening frames shall be constructed of sections which have been cut to length and mitered. The corners of fixed and opening frames shall be electrically flash butt welded to form a solid and true right angle and all frames shall be square and flat.

Sub-dividing bars of the units shall be tenoned and riveted into the frame. No face welding at the joint of sub-dividing bars and frame is required. The horizontal glazing bars shall pass through the vertical bars and the joints closed by hydraulic pressure.

The sizes of door, windows or ventilators frames shall not be more than +1.3 mm.

The size of opening of steel doors, windows and ventilators will be on a 10 cm module, i.e. the width as well as height will be in multiple to 10 cm.

Side-hung shutter windows: Window shutters shall be hung on projecting type hinges (not less than 65 mm and not more than 75 mm wide). One leaf of the hinge shall be welded into a slot in the outer frame and the other leaf of the hinge riveted to the opening shutters. Friction hinges may be provided for side-hung shutter windows in which case peg-stay may not be required. In cases where non-friction type hinges are provided, the windows shall be fitted with peg-stays which shall be either of hot pressed brass, aluminium or steel protected against rusting and shall be 100 mm long with steel peg and locking bracket. The peg stay shall have three holes to open the side hung casements in three different angles.

The handle for side hung shutters shall be of hot pressed brass, aluminium or steel protected against rusting and shall be mounted on a steel or aluminium handle plate moulded, screwed or riveted to the opening frame in such a manner that it could be fixed before the shutter is glazed and may not be removed after glazing. The handle shall have a two point nose, which shall engage with a brass or aluminium striking plate on the fixed frame in a slightly open position as well as in a fast position.

Ventilator

(a) Top Hung Ventilator: The steel butt hinges for top hung ventilators shall be riveted to the fixed frame or welded to it after cutting a slot in it. Hinges to the opening frame shall be riveted or welded and cleaned off. Top hung casements shall be provided with a peg stay three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frames or to the window.

(b) Center Hung Ventilator: This shall be hung on two pairs of brass or aluminium cup pivots riveted to the inner and outer frames of the ventilator to permit it to swing to an angle of approximately 85 Degree. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather conditions.

A brass or aluminium spring catch shall be fitted in the centre of the top bar of the ventilator. A brass or aluminium cord pulley wheel in galvanised mild steel on malleable iron bracket shall be fitted at the sill of the ventilator with mild steel screws or alternatively welded together with a mild steel or malleable iron cord eye riveted or welded to the bottom inner frame bar of the ventilator in a position corresponding to that of the pulley.

Position of Holes, fixing Screws and Lugs:

Outer frames shall be provided with fixing holes, screws and lugs centrally in the web of the section as directed.

Fixing of Steel Doors, Windows and Ventilators:

General Steel doors and windows shall be stacked in upright position on level ground, preferably on wooden battens to keep them in true shape without damage.

Steel work opening shall be so designed that the outer flange of the door, window or ventilator from section overlaps the steel surface by 10 mm.

Fixing Procedure - 1 Masonry Opening:

(a) Fixing with Lugs : Doors, Windows and ventilator units shall not be 'built-in' as the work proceeds but opening shall be left out and frames fitted afterwards so that the minimum specified clearance between opening and unit frame shall be left all round. The size of opening shall first be checked and cleared for obstructions, if any.

The position of the unit and fixing holes shall be on the jamb. Necessary holes shall be made in the masonry and lugs/screws etc. fixed in cement concrete blocks. The frames of units shall be set in the opening by using wooden wedges at the jamb, head and sill (wedges shall preferably be placed near the points where a glazing bar meets the frame) and be plumbed in position. In case of the flush openings which are rendered smooth, wedges shall be removed and gap between the unit and the jamb shall be filled with cement mortar.

In case of flush jambs with external 'fair-faced' finish the gap between the opening and frame shall be filled with mastic from inside till it oozes out on external face. The oozing mastic shall be cleared and flush pointed. The internal gap shall be filled with mastic to about 1/3rd depth and the rest 2/3rd with cement mortar.

In case of rebated jambs and jambs finished 'fair-faced' externally the mastic shall be freely applied to the inside 'channel of frame' jamb and sill, so as to ensure a water tight joint. After the unit is firmly fixed in position, surplus mastic shall be cleaned and flush pointed.

(b) Fixing with screws and plugs : The R C C work, where lugs cannot be embedded due to reinforcement bars, etc., wooden plugs shall be fixed in RCC at proper position while laying concrete. Alternatively rawl plugs may be fixed in proper position and frames fixed to them with wooden screws.

Composite Unit: Composite units are to be assembled at site, using coupling sections. Wherever the ventilators, windows, and doors shall be coupled with a coupling section, mastic cement shall be applied between the junction to make the joint water tight. The fixing procedure for composite units shall be generally as described under Para fixing procedure except that:

(a) Where large units shall be bound by coupling individual units together (with coupling sections) the mullions and transoms shall be bedded in mastic to ensure water tightness. Mastic shall be applied liberally to the channels of the outside frame sections before assembling and other coupling. All oozing mastic shall be trimmed out neatly.

(b) MULLIONS normally project 2.5 cm at head and sills are fixed in pockets made into the masonry timber or steel with opening. But where it is at cross joint with a transom the shorter coupling unit shall run through unbroken and other coupling until shall be cut square to form a butt joint with other members.

Finish

Doors, windows or composite units shall be either hot dip galvanised or painted. All the steel surfaces shall be thoroughly cleaned free of rust, mill-scale, dirt, oil, etc., either by mechanical means e.g., grit / shot blasting(within an enclosure) or by chemical means e.g., pickling and then painted or hot-dip galvanised as given in IS: 1038. Final finishing coats shall be given after the doors, windows and ventilators are erected and fixed in final position. Non-ferrous parts and working parts such as handles, stays, catches handle pins, hinge-pins, etc. shall not be painted.

Precautions: Steel doors, windows, etc. shall not be used for centering etc. scaffolding shall not be rested on the steel door and window frames or glazing bars.

All fittings and hinges shall be covered with Hessian cloth etc. so that these may not be damaged during construction.

The doors, windows and ventilators shall be measured in square metres of finished opening and item shall include painting, glazing and all necessary fixtures and fittings.

2.8 WELD MESH

The welded mesh shall be of 10 gauge of standard wire products or equivalent. The measurements of weld mesh shall be taken from inside of MS angle and shall be in square meters. The method of fixing will be either by tackwelding or by using a MS strip which shall then be welded. The weight of MS strip/angle etc. used shall be measured and paid for separately in the MS structural item.

M S Fabricated Gates and Wicket Gate

M S fabricated gates etc. will be as per the design and drawings and shall include all hold fasts, hinges (either roller bearing or otherwise) of any type, locking arrangements as specified, strap and stoppers, guide wheels and embedded runners for guide wheels all as specified. It shall include all necessary costs for fixing in position to RCC columns including all necessary temporary supports etc. and involve for one coat of primer and two coats of synthetic enamel paint of approved makes quality and shade.

TECHNICAL SPECIFICATIONS – 2.10

STRUCTURAL STEEL WORKS

STRUCTURAL STEEL WORKS

1.0 SCOPE

These specifications cover the requirements of material, workmanship, protective measures etc., of structural steel work in general. Specifications for special items of work used in structural steel construction are given separately.

2.0 GENERAL

The provisions of the latest Indian Standards listed below, but not restricted to, form part of these specifications:

IS: 104 - Ready mixed paint, brushing, zinc chrome, priming

IS: 123 - Ready mixed paint, brushing, finishing, semi-gloss, for general purposes, to Indian Standard Colours and red oxide (Colour unspecified)

No. 445 Venetian Red

No.449 Light Purple brown

No.446 Red Oxide

No. 451 Chocolate

No.448 Deep Indian Red

No.473 Gulf Red and Red

Oxide (Colour Unspecified)

IS: 226 - Structural Steel (Standard Quality)

IS: 800 - Code of practice for use of structural steel in general building construction.

IS: 813 - Scheme for symbols for welding.

IS: 814 - Covered electrodes for metal are welding of structural steel (Part I & II).

IS: 815 - Classification and coding of covered electrodes for metal are welding of structural steels.

IS: 816 - Code of practice for use of metal are welding for general construction in mild steel.

IS: 817 - Code of practice for training and testing of metal are welders.

IS: 822 - Code of procedures for inspection of welds.

IS: 823 - Code of procedure for manual metal are welding of mild steel.

IS: 961 - Structural steel (high tensile).

IS: 1024 - Code of practice for use of welding in bridges.

IS: 1148 - Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes.

IS: 1387 - General requirements for the supply of metallurgical material.

IS: 1477 - Part I, Code of practice for painting of ferrous metals in buildings - pretreatment.

IS: 1599 - Method for bend test for steel products other than sheets, strip, wire and tube.

IS: 1608 - Method for tensile testing of steel products.

IS: 1731 - Dimensions for steel flats for structural and general engineering purposes.

IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products.

IS: 1915 - Code of practice for steel bridges.

IS: 2074 - Ready Mixed paint, air drying red-oxide-zinc chrome, priming.

IS: 2102 - Allowable deviations for dimensions without specified tolerances.

IS: 3757 - High tensile friction grip bolts.

IS: 4000 - Code of practice for assembly of structural joints using high tensile friction grip fasteners.

IS: 7318 - Part I Fusion welding of steel.

Other I.S. Codes and I.R.C. codes pertaining to the items of structural steel not specifically listed shall also be deemed to come under the purview of this clause.

Specification for pin and pinned connections:

Pin Material:

Rolled steel pins and rollers, including those made from slabs shall comply with the requirements of IS:226 - Specification and structural steel and IS:2062 - Specification for structural steel (fusion welding quality) or IS:961 - Specification for high tensile structural steel.

Forged steel pins shall have a tensile strength of 44 to 50 kg/Sq.m or 57 to 63 kg/sq.m to conform to IS:1875 - Specification for carbon steel billets, blooms and slabs for forging, Steel casting for cast steel pins shall conform to grade 1 or 3 of IS:1030.

Pin Holes:

Pin holes shall be bored true to gauge, smooth, straight, at right angle with the axis of the member and parallel with each other, unless otherwise required, in built up

members the boring shall be done after the members have been welded. The specified diameter of pin shall be its minimum diameter. Hole diameter can be maximum + 0.5 mm more than pin diameter.

Pins:

The pins shall be parallel throughout and shall have a smooth surface free from flaws. At ends of pins there shall be slot to facilitate in driving the pin.

Pins more than 175 mm in length or diameter shall be forged and annealed. Coffer pins shall be provided on both sides of the pin.

3.0 FABRICATION:

3.1 Materials, Inspection & Testing:

All supplies of structural steel and other materials specified shall be supported by manufacturers test certificates showing that the materials meet the requirements of these specifications.

The Project manager may require to get further samples tested and all the cost of taking samples and testing the same by the approved agency shall be borne by the Contractor.

3.2 Fabrication Drawings and Approval:

The fabrication drawings shall be prepared on the basis of design drawings supplied by the designer. The fabrication drawings showing details of connection are required to be supported by the calculations showing adequacy of the connections. The fabrication drawings and calculations shall be prepared by qualified Consulting Engineer and fabricators. All charges required to be made by the Project manager shall be incorporated at no extra cost.

3.3 Workmanship:

Workmanship shall be equal to the best general practice in current fabrication practice. The methods followed in cutting, straightening, finishing and shaping, bindings of members and holing for rivets, bolts or pins etc., and any other operations shall be performed in such a way as not to adversely affect the structural members in any way. The machinery and equipment as well as the method of working, shall be approved by the Project manager.

The fabrication work shall be carried out by the qualified fabricators and sample work done by qualified fabricators shall be test it and approved by BESCOM representative at tenderers cost.

Required equipments/instruments shall be arranged for quality control inspection. The welding

4.0 STORAGE AND PROTECTIVE PAINTING-TEMPORARY AND PERMANENT:

a) No dragging of steel shall be permitted. All steel shall be stored 30 cm above ground on suitable packing to avoid damage during the monsoons. Steel shall

be stored in the order of erection with erection marks visible. Storage areas shall be prepared and maintained by the Contractor. Any steel stored near excavations shall be removed immediately to a safe distance to avoid burial under debris.

b) Adequate handling facilities shall be available at Storage place. The temporary protective paint shall not be damaged and if so damaged shall be immediately made good.

c) The rates quoted by the Contractor shall include the following:

i) Applying one coat of zinc phosphate grey primer paint to all surfaces of steel that are scratched in transit or unloading prior to storage before erection.

ii) Applying one coat zinc phosphate grey primer paint and two coats of finishing paint as specified in schedule to all surfaces which will be inaccessible after erection, except surfaces coming in contact with concrete. It should be noted that all steel work such as Trusses, Purlins etc., are considered inaccessible.

iii) After steel has been erected, all burrs and abraded spots scratched surfaces, field welds, bolt heads and nuts shall receive one coat of primer paint. Before the paint is applied the surface shall be dry and free from dust, dirt, scale and grease. No paint shall be applied to bolt or field welds until these bolts or field welds have been approved by the Engineer.

iv) All steel material except surfaces coming in contact with concrete shall receive one coat of primer paint after erection after having been thoroughly cleansed of dust and foreign matter. No paint shall be applied when humidity is such as to cause condensation on the surfaces to be painted. Paint shall be stirred frequently to keep the pigment in suspension.

d) All the external structural steel works shall be painted with two coats of approved anti-corrosive paint with two coats of compatible primer.

Anti-corrosive primers shall be lead free types.

All the materials shall be of the best quality from and approved manufacturer. The Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling and shall be from the same manufacturer for each painting system.

e) <u>Final Paint:</u>

The final painting of structural steel shall be as specified by the Project

Manager.

f) Materials supplied by the Engineer:

After materials have been accepted by the Contractor as being in proper condition, he shall be responsible for their safety and protection from loss or damage of any nature until the completion of work. The contractor shall be similarly responsible for surplus materials until they are returned and accepted by the Engineer.

5.0 **ERECTION**:

5.1 Preliminaries:

a) The Contractor shall complete all preliminary works at site, well before the arrival of structural steel, such as keeping in readiness electrical winches, mobile cranes, gin poles, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches etc. and work that may be necessary so as to start erection immediately after the arrival of steel at site.

b) The Contractor shall furnish at his own expenses, the necessary non-inflammable staging and hoisting or equipment required for the erection work and shall remove and take them away after the completion of the job. The contractor shall also provide necessary passage ways, fences, safe belts, helmets, lights and other fittings to the satisfaction of the Engineer and for protection of his men and materials.

5.2 Approval of Erection Scheme:

All structures shall be erected as shown on drawings. The contractor shall carry out all erection work in the sequence required by the Engineer. The method of erection and complete erection scheme shall be subject to the approval of the Engineer and shall be modified as required by the Engineer. This, however, will not relieve the contractor of the responsibility for safe and expeditious completion of the work, its quality and accuracy.

5.3 Workmanship:

a) Unless specified herein, all erection work will be carried out in accordance with the latest edition of Indian Standard code of practice for use of structural steel in General Building Construction IS: 800 and AISC code wherever applicable.

b) Drifts should be used only for drawing the work into position and must not be used to such an extent so as to destroy the holes. Drifts of a larger size than the nominal diameter of the holes or burrs must be rectified to the satisfaction of the Engineer.

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from field rivets, if any, shall be considered as a part of erection. Any error in shop work which prevents proper fit on a moderate amount of reaming and slight chipping or cutting shall be immediately reported to the

Engineer. The contractor's work shall also include straightening and repairing of materials slightly damaged and drilling some holes in members where required. This shall all be included in the unit rate quoted.

c) Structural steel frames shall be erected plumb and true to tolerances indicated elsewhere in these specifications. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected including erection equipment and the operation thereof. Such bracing shall be left in place as long as may be required for safety. Proper size steel cables, slings etc., shall be used to avoid any damage due to accidents.

d) As erection progresses, the work shall be securely bolted to take care of all dead load, wind and erection stresses. No final welding or bolting shall be done until the structure has been properly aligned and approved by the Engineer.

e) The Engineer shall be immediately informed of any errors observed/found in the fabricated steel which prevents proper assembling and fitting up of parts in field by a moderate amount of repairing.

f) The contractor shall protect all existing plants, embedded parts, all piping, conduits, equipment and facilities against damage during erection. The contractor shall perform his work in a manner which in no way endangers the operations of any existing plant or structures or hinders other construction activities.

g) Holes may be required to be drilled at site for installing equipment or steel furnished by other manufacturers or other contractors. The information for this will be supplied to the Contractor by the engineer before or after erection of the steel.

h) In case of any faulty erection, all such dismantling and re-erection required will be at Contractor's cost.

i) Shim stock of mild steel plates required for erection will be set, levelled and prepared for grouting. Where flat bearing beams occur, bearing plates shall be set, levelled and prepared for grouting.

5.4 Tolerance:

The erection shall be carried out to the requirements stated in Section 7 (h) of AISC Code Standard practice, except that Structural Steel members be erected plumb with a tolerance not exceeding in 1000. Column splices and other compression joints which depend upon contact bearing, upon completion, shall bear with respect to the centroid of the contact area.

At least 65% of the entire contact area shall be in full bearing and the separation of any remaining portion shall not exceed 0.5 mm except locally at toes of flanges where a 50% greater separation is permissible. Otherwise corrective measures as specified by

the Engineer shall be taken.

5.5 Connections:

a) H.S.F.G. Bolts:

The Contractor shall obtain the prior written approval of the engineer for the method proposed to be adopted for tightening the High Strength Friction Grip bolts. For preliminary assembly and before use of these bolts he shall use his own erection bolts.

b) Bolting/Riveting:

In general bolts and rivets will conform to the relevant Indian Standards. The methods of establishing connections use of equipment, etc., shall be as approved by the Project manager.

c) Welding:

Welding where specified shall be performed by the shielded electric arc, gas or other approved methods, using coated electrodes and/or low hydrogen electrode conforming to IS: 814. The welding process and the qualification of the welding operators shall conform to IS: 817 and IS: 823 and shall be got approved before commencement of any work of welding.

Welding shall generally be done by electric process. The electric arc method being economical, is usually adopted. Where public electricity is not available a suitable generator shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Project manager.

Types of welding: Welds used for joining structural members are generally of the following two types as under:

(i) Fillet weld: The cross section of fillet weld is triangular and it is used to join two surfaces normally at right angles to each other. This type of weld is used more frequently in structural connections than any other type, and is usually in the form of isosceles triangle. The fillet welds shall be continuous or in intermittent as specified in the design.

(ii) Butt welds: These are classified according to the method of grooving or preparing of the base metal. The metal pieces shall be filled or chiselled to the required shape for butt welding at the throat for which no extra payment shall be made.

Fillet and Butt welds shall conform to IS: 816. Special type of welds as slot-welds shall be used where so specified. Either direct or alternating current (but not both types) may be used throughout the whole work. An ammeter shall be provided to each arc and so situated that the Project manager can easily check the current being used by the operator. Each welder shall be supplied with a portable current regulator to enable him to adjust the welding current within the approved limits without leaving his work. Only qualified operators shall be employed for welding and they shall have been trained and shall be tested after every three months as per provisions of IS: 817 for "Code of

Practice for training and testing of Metal Arc Welders".

In welded structure holes are necessary for service bolts required during erection. These holes shall be made as specified above. The holes in the various sections shall be filled with punches and welded properly to form a composite section.

Surfaces which are to be welded together, shall be free from loose mill-scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without displacement.

All operators connected with welding and cutting equipment conform to the safety requirement given in IS: 818 for "Safety and Health Requirements in Electric and Gas Welding and Cutting Operations".

The following points shall be borne in mind during the process of welding:

(a) Welds shall be made in the flat position, wherever applicable.

(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.

(c) The sequence of welding shall be such that where possible the members which offer the least resistance to compression are welded first.

Processor Welding :

The electrode manipulation during welding shall be such as to ensure that :

(i) The base metal is in a fused state when the filler metal makes contact with it.

(ii) The filler metal does not overflow upon any unfused based metal.

(iii) The base metal is not under-cut along the weld edges.

(iv) The flowing metal floats the slags, the oxides, and the gas bubbles to the surface behind the advancing pool.

In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed. Each time the arc is started, the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run the arc shall be restarted ahead of the previous deposit and then moved back to fill the crater, or such alternative technique shall be used as will ensure complete filling of the crater or complete fusion between the new and old deposits and the base metal at the point of junction and result in continuity of weld. Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary and the deposited and adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive

layers but also to successive beats, and to the overlapping area whatever a junction is made on starting a new electrode:

(v) The welds shall be free from cracks, discontinuity in welding and other defects such as

(a) under size

(b) over size

(c) undercutting

(d) overcutting

In case of fillet welds and defects (b), (c) and (d) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and re-welded.

Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed, welds and adjacent parts shall be painted after the same are approved by the Project manager.

Inspection and testing of welds:

The method of inspection and testing shall be as under:

(a) Visual Inspection: The following factors shall be considered during the visual inspection:

(i) Dimensions of weld deposit: The size of the weld shall be as specified and it may be slightly over but not under.

(ii) Shape of profile: The profile of the weld is affected by the position of the joint, but it shall be uniform. In the case of butt and corner welds, the profile shall be slightly convex and in the case fillet welds it shall be usually slightly concave.

(iii) Uniformity of Surface: The height and spacing of the ripple shall be uniform; these being indicative of workmanship.

(iv) Degree of under cut: Undercutting is undesirable. The weld joint shall be free from undercut but slight intermittent occurrences may be disregarded.

(v) Smoothness of joints: The joints in the weld run where welding has been adopted, shall be as uniform and smooth as possible and shall show no pronounced bump or crater in the weld surface.

(vi) Freedom from surface defects: The surface of the weld shall be free from porosity, cavities and burnt on scale.

(vii) Penetration bead in Butt Welds: A slight penetration bead shall be present and it should be reasonably uniform in width and appearance. Intermittent occurrences of lack of penetration bead may be disregarded.

(viii) Degree of fusion: Fusion shall be complete over the whole area of the joint

surface.

(ix) Degree of Root Penetration: These defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effects in reducing the strength of the weld. A close examination of the root shall, therefore, be made. In butt-welds, the penetration should extend to the underside of the plates producing a penetration bead of the right size. In fillet welds with good root penetration, the weld metal should reach the corner.

Note: 1

In case of fusion welding or non-fusion weld and fillet welds will appear in joint, fillets being at the cretches.

Note: 2

In case of non-fusion welding of cast iron the joints shall show satisfactory penetration and adhesion.

(a) Gas Cavities and Flux Entrapments : Unless they are caused by the use of unsuitable material, they are attributable to the quality of workmanship, the desired result being to achieve uniform appearance and freedom from cavities and flux entrapments (where flux is used). In fusion welding of mild steel, cast iron and aluminium where neutral flame is used, and in fusion welding of brass or braze welding of cast iron where oxidising flame is used, current welding technique may result in rough, porous, discoloured and lusterless appearance in the fracture.

Note

(a) In case of fusion welding or non-fusion welding of cast iron isolated blow holes or concentration of pinholes in the weld metal shall be regarded as grounds for rejection but isolated pinholes shall not be so regarded.

(b) Bending Testing (for ductility): The elongation shall be not less than 30 percent for stress relieved welds and not less than 25 percent for non-stress relieved welds.

(c) Tensile Testing: (Reduced Section Tensile Testing): The tensile strength shall be not less than minimum of the specified tensile range of the parent metal.

(d) Radiographic Examination : This shall be done as given in IS: 6227.

All field assembly and welding shall be executed in accordance with the requirements for shop fabrications excepting which manifestly apply to shop conditions only. Where the steel has been delivered, painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints. All welds should be free from defects like blow holes, lack of penetration, slag intrusion etc. All welds shall be cleaned of slag or flux and shall show uniform smoothness of weld metal, feather edges without overlap and free from porosity. Where a thick weld is required the weld metal shall be deposited in successive layers. Each layer except the last, shall be

preened moderately before the next layer is applied. The contractor shall be responsible for the quality of the work performed by his welding group.

If required, the engineer may test the welds by non-destructive tests. Any defective welds shall be made good by the Contractor at no extra cost and the cost of non-destructive testing for such defective welds shall be borne by the Contractor.

6.0 **SCOPE:**

The scope under this item shall including cost of all materials, labour, supervision, tools and plant, apparatus, conveying equipment, incidental expenses, painting as specified, nuts, bolts and washers etc

TECHNICAL SPECIFICATIONS – 2.11

SPECIFICATION FOR WATER PROOFING

WATER PROOFING

(a) Terrace

The terrace water proofing shall be of cement based water proofing treatment as per the specification / literatures of approved water proofing agency including making necessary slopes for the drainage using bricks / brick bats fixed on the Cement Mortar 1:3 mixed with approved water proofing compound including surface preparation. The top surface shall be finished with a floating coat of approved pigmented cement with approved waterproofing compound as per specification. The surface shall be kept wet for a minimum of 14 days

The approved water proofing contractor shall guarantee for a period of 10 years for water treatment.

(b) Toilet water proofing.

All the sunken slabs, sun-shade and porches covered all round with masonry or RCC structures shall be plastered in Cement Mortar 1:3 with approved water proofing compound. After the treatment the treated area shall be tested for the water tightness. In the toilet areas, the level difference shall be filled with brick jelly lime concrete using well burnt broken brick jelly of 25 mm size and mixed with burnt lime 1:3 (1 part of burnt lime and 3 part of brick jelly) including the surface preparation and mixing, laying and beating the laid concrete. The top surface shall be smoothly plastered and finished to the required slopes in Cement Mortar 1:3 mixed with approved water proofing compound. The surface shall be kept wet for minimum 14 days.

(c) Liquid Retaining Structure

All the liquid retaining structures shall be water tight. All the liquid retaining structure shall not be plastered or given any treatment for the water tightness. The tenderer can add approved water proofing compound during the concreting. The hydro-testing has to be carried out as per IS: 3370.

(d) Treatment for Liquid Retaining Structure.

The treatment for the liquid retaining structure shall be carried out after successful completion of hydro-testing of the structure.

The treatment shall be compatible to the liquid retained in the structure. The treatment shall be of Non-Toxic epoxy based or any other approved methods. The Tenderer has to specify the method of treatment for all the liquid retaining structure.

(e) Surfaces Preparation

Before starting the water proofing treatment, the surfaces shall be cleaned with wire brush and all the dirt to be removed using Air-compressors. All the protruding surfaces shall be either chipped or grinded to bring to the surroundings levels.

TECHNICAL SPECIFICATION – 2.12

JOINTS

1.0 Construction Joints

Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown on approved drawings or as directed by the Project manager. Such joints shall, however, be kept to the minimum.

For a vertical construction joint, a stopping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concrete is compacted against it. Concreting shall be continued right upto the board. The board shall not be removed before the expiry of the specified period for removal of vertical forms.

In all cases, the position and detailed arrangement of all construction joints shall be predetermined and got approved by the Project Manager

These shall be avoided as far as possible and shall be formed whenever absolutely necessary to stop concreting for 30 minutes or longer. Except for emergency stops, construction joints shall be located at regular site of expansion or contraction joints, i.e. if construction joint is at the site of expansion joint, regular edging tool shall be used along the bulk head to make construction joint a well defined line. For steel dowels across the transverse joints on bulkhead, there shall be notches spaced in accordance with the drawing.

When work is resumed, bulkhead shall be removed, care being taken not to disturb rods or concrete. Fresh concrete shall be placed directly against the face of the concrete previously laid and carefully worked around the rods. Face of set concrete shall be applied with a coat of bitumen sealing primer.

PVC water bar shall be used at construction joints of approved brand ,shape and size for horizontal, contraction and , vertical joints.

Joints in Flooring :

(a) **Joints** :

Joints shall be provided in flooring to take care of expansion and contraction due to variations in temperature. In addition, construction joints shall also be provided in case of compulsory break in continuity of slabs due to the close of day's work and the commencement of the same the next day. The location and type of joints provided shall be as shown in the drawing or as directed by Project manager. The edge of the slab at all joints shall be rounded with an edging tool having radius not greater than 6mm. It should be carefully ensured by proper vibration, that concrete at joints is free from honeycomb.

(b) **Transverse Joints** :

Transverse joints shall be expansion, contraction or construction joints and shall be provided as shown in the drawing or as directed by Project manager. They shall be at right angles to longitudinal joint surface of the floor. Contraction and expansion joints shall be continuous from edge to edge.

(c) **Transverse Expansion Joints** :

These joints shall be provided at an interval or spacing of 30 m. They shall be pre moulded type and shall extend the entire width of the pavement and from sub-base to 25mm below the surface of the pavement. The gap width for this type of joint shall be approximately 20 to 25mm. The filler shall be held accurately in place during the placing of the concrete by a metal bulk head, a metal channel cap or other approved method. Load transfer is effected through a system of reinforcement called dowel bar. Dowel bars are embedded and kept fixed in concrete at one end and is kept free to expand or contract by providing a thin coating of bitumen over it. Metal cap is provided at this end to offer a space of about 25mm for movement during expansion.

(d) **Transverse Contraction Joints** :

These joints shall be provided at an interval on spacing of 10 m, depending upon the type of aggregates. They shall be placed as shown in the drawing or as directed by the Project manager. They shall be constructed by forming in the surface of the slab, a slot not less than 6mm wide and having a depth equal to one fourth depth of the concrete slab. This slot may be formed such as by pushing into concrete a flat bar or the web of a 'T' bar and keeping the slot open or any manner approved by the Project Manager. It shall be filled flush with top surface by using approved sealant.

(e) **Longitudinal Joints** :

Longitudinal joints, parallel to longer side of floor slab shall be of plain type and shall be formed by placing the concrete against the faces of the slabs concreted earlier. The faces of the old concrete shall be painted with bitumen before placing fresh concrete.
The bar shall be used at longitudinal joints and they shall be of the dimensions and at spacings as shown in drawing or as directed by the Project manager. Tie bars shall be fairly well supported so as not to be displaced during construction operations.

2.0 Expansion Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.50 m in both right angle directions for walls and rafts. Expansion joints of suitable gap at intervals not more than 30 m shall be provided in walls, floors and roof slabs of water retaining structures.

Expansion joint shall be provided with PVC water stopper of suitable type of 230 mm width and sealed with 12 mm x 25 mm gun grade joint sealant over a backer rod and high performance laminated closed cell polyethylene foam joint filler in sheet foam having a density of 100 Kg / Cum, non staining with less than 1% water absorption, having 97% recovery at compression.

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 stoppers of suitable type of 230 mm width shall be used in all construction joints and joints between wall and base slab.

TECHNICAL SPECIFICATION – 2.13

SPECIFICATIONS FOR STRUCTURAL GLAZING

STRUCTURAL GLAZING

1.0 SCOPE OF WORKS

The scope of works under this contract includes design, supply, installation, protection, guarantees, testing and maintenance upto the defects liability period for Curtain Wall, Doors, Windows, and Louvers.

The work under this section includes all Labour, materials, equipment and services as required for the complete design, engineering, testing, fabrication, assembly, delivery, anchorage, installation, protection and waterproofing of the aluminium curtain wall / structural glazing system, aluminium doors, aluminium windows & louvers and all in accordance with the true intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings or described in the specification provided that the same can be reasonably inferred therefrom. Anchorage includes all primary and secondary anchor assemblies and supportive structural framing as required to secure aluminium structural glazing system, and louvers to the building structure.

The detailed scope of works consists of :-

1. The aluminium structural glazing system, aluminium doors, aluminium windows & louvers described hereafter shall include but will not necessarily be limited to the follows:-
2. Frames, vision panels, spandrels, doors and ventilators.
3. Openable panels where indicated, inclusive of all accessories, fittings etc.
4. Copings, soffit trimmers, and external metal cladding panels for the curtain walling system.
5. Aluminium doors, aluminium windows, aluminium fix glazing, louvers etc. wherever indicated.
6. All caulking, sealing and flashing including sealing at junctions with roof waterproofing and exterior wall, flashing at doorway, raised kerbs and in window surrounds.
7. Sealant within and around the perimeter of all work under this section.
8. Separators, neoprene / EPDM and silicon gaskets, trims etc.
9. All steel structural framing and beam supports, anchors and attachments as required for the complete installation of the whole system, wherever specified.
10. Inserts in concrete, anchor fasteners etc. for the anchorage of all work under this section to the approval of Architect
11. Isolation of all dissimilar metal surfaces as well as moving surfaces similar or dissimilar.
12. Fire-stops, Flashings, Sealing of all interfaces with buildings etc.
13. Protection during storage and construction until handing over.
14 Engineering proposals, drawings and data.
15. Shop drawings, engineering data and structural calculations of all systems including framing, fasteners etc.
16. Scheduling and monitoring of the work.
17. All samples, mock-ups and test units.

18. Co-ordination with work of Main Civil Contractor and other agencies / contractors employed on site.
19. All final exterior and interior cleaning of the aluminium structural glazing system, doors louvers and window etc.
20. Hoisting, staging, scaffolding and temporary services.
21. Specified tests, inclusive of necessary reports.
22. Maintenance manuals.
23. Design and Performance guarantees.
24. Periodic inspection, supervision and advice by the main contractor as well as a back-up guarantee in approved Proforma from the main contractor for the quality and performance of works.
25. Construction monitoring for regular quality control and technical inspection to ensure the work conforms to the shop drawing details (including any modification made during testing) and acceptable standards of quality.
26. AS Built drawings to be provided by main contractor after successful completion & water proof testing

2.0 REFERENCES AND STANDARDS

The provisions of the latest Standards listed below, but not restricted to from part of these specifications:

ANSI	Z97.1.84	Safety Glazing materials used in Buildings
ASTM	C 1036-90	Specification for float glass
ASTM	C 1048-90	Specification for Heat treated Float Glass
ASTM	E 774 –88	Specification for sealed Insulating Glass Units
ASTM	C 1172- 91	Specification for Laminated Architectural Glass
ASTM	C 864 – 90	Specification for compression Seal Gaskets
ASTM	C 1115-89	Specification for Silicon Rubber Gaskets
ASTM	C 920-87	Specification for Sealants
ASTM	C 509-90	Specification for sealing material
CPSC	16 CFR 1201	Specification for Safety of glass
GTA Specification No. 89-1-6		Specification for environment durability for heat strengthened Spandrel Glass with Applied pacifiers.
BSCP	118	Structural use of Aluminium

In general the Contractor may follow any International Standards subject to his satisfying the Architect these specifications are equivalent to latest specifications issued by ASTM, ISO, AAMA, BSS & SSIR.

Copies of all standards & codes proposed to be followed for design, materials, installation and testing shall be submitted to the Architect within two weeks of issue of Works Order.

3.0 Building Regulations

Design of the aluminium structural glazing system shall comply with all Government codes and regulations. For wind design, all calculations shall comply with the requirements of the relevant National Building Code and Indian Standard Code, unless specified otherwise.

4.0 GUARANTEE

The Contractor shall be fully responsible for and shall guarantee proper design and performance of his installed system for a period of 10 (Ten) years from handing over of works.

The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, air pollution, thermal stresses, building movements and the like

In addition specific 10 year guarantees (to be furnished in non-judicial stamp paper of value Rs.100/-) in approved Proforma shall be given for performance of glass, double-glazed units, anodizing, PVDF coating to cladding sheets and sealants. All the Guarantees shall be submitted before Final payment and shall not in any way limit any other rights to correction which the Employer may have under the Contract.

5.0 CONTRACTOR'S RESPONSIBILITIES

The Contractor's responsibilities include but are not necessarily limited to the following items:

The Contractor shall provide and install all supplementary parts necessary to complete all items generally implied in the drawings and in the specifications though not specifically shown or mentioned. This shall include the design and sizing of all sections and anchor assemblies to meet the performance and design requirements, furnishing and installation of all inserts, fasteners, clips, bracing and framework as required for the proper anchorage of the structural glazing system elements to the structure, unless otherwise noted or specified to be furnished / installed by another contractor. Alternate anchorage proposals will be considered, if, in the opinion of the Architect the general design and intent of the drawings and specifications are maintained.

The Contractor's system therefore must perform satisfactorily as a whole.

Design Responsibility:

Drawings and specifications indicate the required basic dimensions, profiles and performance criteria. The Contractor shall have the option of modification and addition of details provided the visual concept and performance requirements are fulfilled. Proposed modifications shall be clearly shown on shop drawings as "Design Modifications" and acceptance of the same will not relieve the Contractor from sole responsibility for performance of the aluminium structural glazing system and cladding. The Contractor shall be solely and fully responsible for due performance of his installation based on his own design and details.

In-plant and job site inspection: The Contractor shall afford the Employer, Architect or their authorised agent full access to plants, shops and assembly points to view and inspect the processes and methods employed in the fabrication, assembly and finishing of the aluminium structural glazing system and cladding for this project.

The Project Manager will have the right to reject any and all aluminium structural curtain wall / structural glazing system and cladding components and assemblies during assembly and erection if the workmanship and intent are not in strict conformity with the approved shop drawings, structural calculations, documentation, certifications, samples and mock-up.

Glass, sealants and other items or materials procured by purchase shall be back to back guaranteed by the manufacturer.

6.0 SHOP DRAWINGS

Within one month form the award of contract, the contractor shall prepare necessary shop drawings based on the preliminary drawings and two (2) copies of all shop drawings shall be submitted to the Architect for review and approval. The Architect's review of all shop drawings will be limited to their conformity to the design concept & specifications. Architect's approval of the shop drawings will not relieve the contractor from any of the responsibilities and requirements as stated drawings and all other related submissions, documentation, certifications, samples and the mock-up for that work have been reviewed and approved by the Architect. On approval of the drawings by Architect, the Contractor shall submit six (6)copies of all drawings to PMC for release to execution / site.

Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections and full size details for all work in this section.

Shop drawings shall indicate the desired dimensional profiles and modules, function, design and performance standards and, in general, delineate the scope of work. The contractor shall verify and co-ordinate these items with all applicable and/or related trades, contract drawings and specifications. Since the dimensions and modular references shown on the drawings are for specific and/or typical detail, the shop drawings shall include a full complete layout of all modular and referenced dimensions for all the aluminium structural glazing, cladding, doors, windows and louvers and their related elements. All dimensions / modules, etc., shall be field checked as required.

The full size details shall show and specify all metal sections, types of finishes; areas to be sealed and sealant materials; gaskets; direction and magnitude of thermal expansion; direction and magnitude of all applicable construction including fasteners and welds; all anchorage assemblies and components; the fabrication and erection tolerances for the work and applicable related works adjoining, attached to or in some way related to the work covered by these specifications. The location of all static and dynamic anchor assemblies, the direction of thermal and other applicable building movements, co-ordination with concrete works and the sequence of installation shall be designated on the applicable plans, elevations and / or sections. All details shall be subject to Architect's approval.

Shop drawings shall indicate the desired profiles, dimensions, details of metal finish and in general delineate the scope of the work. Profile adjustments in the interest of economy, fabrication, erection, weather-ability or ability to satisfy the performance requirements may be made only with the written approval of the Architect, provided that the general design and intent of the drawings and specifications are maintained.

Six (6) copies plus Two (2) reproducible sepia print each of all final approved shop drawings shall be submitted to Architect / PMC.

7.0 STRUCTURAL CALCULATIONS

The Contractor shall employ a competent Design Engineer to design his systems and components. During the design stage, the Contractor shall interact actively with the Architect concerning all aspects of design and shall obtain all the information from them concerning the structure, probable deflections and other building movements etc. The Contractor shall take full account of all possible building movements as well as the movements of his curtain wall and cladding systems in his design. The Contractor shall submit his detailed structural calculations for the systems and each of their components and shall guarantee that his design will ensure the structural safety and integrity of the curtain wall, cladding and glass panels against all natural forces, superimposed loads, environment and consequent movements.

The Contractor shall obtain Architect's approval to his design calculations and to the provisions made in his design for all the building movements, and shall directly pay fees to the Design Engineer for their interaction in a manner such that the Contractor and the Design Engineer shall be jointly responsible to the Employer for the correctness of the fixing and interaction of the curtain wall with the structure so as to ensure that all the movements envisaged between the structure and the curtain wall area fully taken care of. However the Contractor along shall be responsible for the workmanship of fabrication and installation and shall indemnify the Employer against all claims due to defects or non-performance during the specified 10 year Guarantee period. The provisions of this clause shall not in any way limit the Employer's rights under other clauses of the Contract.

The R.C.C. in the building structure is Grade M30. The Contractor shall design anchorages for this grade of concrete with adequate safety factor.

Three (3) sets of approved design calculations which is compatible with R.C.C. and steel structure shall be submitted to Architect.

8.0 DOCUMENTATION AND CERTIFICATION

8.1 Glass and Glazing Documentation:

The applicable glass manufacturer(s) shall submit written certification for Architect's review and approval stating that all glass and glazing requirements as detailed and specified on the shop drawings have been reviewed and approved for use relative to their specific application and / or design parameters, compatibility to adjacent materials and in conformity with all requirements as detailed and specified in the Contract Documents. Certification shall further state that the proposed glass and glazing materials are most appropriately suited for the use or uses intended and recommended for the specific use or the selection of the glass and the glazing materials including compatibility of materials. Test Certificate from approved laboratories for U-values and shading factor claimed by the Manufacturer shall be submitted.

8.2 Sealants Documents:

All sealant applications must be clearly designated on the applicable shop drawing details and referenced to a master sealant schedule specifying materials, special instructions and application procedures. The applicable sealant manufacturer(s) shall submit in writing that all sealant requirements as detailed and specified on the shop drawings have been reviewed and approved for use relative to their specific application and / or design intent, compatibility to adjacent materials and in conformity with all the requirements as detailed and specified in the contract documents. The manufacturer's certification shall specify the optimum life expectancy, in years, for the proposed sealant materials as detailed and specified on the shop drawings and/or master sealant

schedule and shall further state that the proposed materials are most appropriately suited for the use or uses intended and recommended for the specific use or uses.

8.3 Quality Control Documentation:

In-plant and job site quality control procedures shall be documented in writing for Architect's review and approval to ensure the design integrity and performance of the as-built product. Documentation shall include schedule, details, isometric and/or schematic explanatory sketches cross-references to the shop drawings, data sheets, etc., all as required to intelligently witness and assess methods and materials; and to ensure that both the fabrication and installation are in accord with the contract documents.

The Employer / Project Manager shall, if required, be given free access to the plant to inspect fabrication procedures. No fabrication or assembly of job site materials shall commence until the first production unit is inspected and approved by Architect / PMC.

The in-plant quality control procedures shall include but not necessarily be limited to the following items:

Fabrication	:	Tolerances, Joinery, Sleeves, etc.
Finish Match	:	Approved finish controls required for matching the exposed surfaces.
Assembly	:	Welds, fastener, sealants, gaskets, separators, glazing etc.
Protection	:	Handling, protection, shipping etc.

The job site quality control procedures shall include, but not necessarily be limited to the following items:

Anchorage	:	Lines, grades and related building tolerances
Installation	:	Tolerances, finish, match, joinery, sleeves, flashing, welds, fasteners, sealants, etc.
Sealing	:	As recommended by the applicable sealant manufacturer(s)
Protection & Cleaning	:	As recommended by the applicable sealant manufacturer(s)

9.0 SAMPLES AND MANUALS:

Within 3 weeks of issue of Work Order, the following samples of actual job site materials together with detailed technical data / catalogues shall be submitted in duplicate, unless otherwise noted, and in the sizes noted, for Architect's review and approval. Any omission of an item, or items which require the Contractor's compliance with these documents does not relieve him from such responsibility.

(a) Aluminium sheet panel: Each type and thickness; 600 x 600 mm of the specified thickness.

(b) Aluminium extrusions; one only of each section ; 300 mm long of specified thickness.
(c) Glass; each type and kind, 300 x 250 mm of specified thickness and including frame. The U – Value & Shading co-efficient to be pre-approved before doing the mock-up
(d) Glazing gaskets, tapes, separators, glass setting blocks, etc. each section or unit, 300 mm long or unit.
(e) Fasteners and connections devices: Each type and size.
(f) Finish samples: After approval of the final finish coating the Architect is to be provided with six (6) approved samples.
(g) Window and door ironmongery and accessories, as applicable.
(h) Flashings and finish samples.
(i) Cladding.
(j) Samples submitted should be also include assembly of various components forming a typical fixing and details complete with flat sheets, glazing, extrusion, fastener, sealants etc.

9.1 Mock - Up

Before the fabrication and site installation is taken up and within 4 weeks of issue of Work Order, the Contractor shall put up a mock-up of his proposed curtain wall / structural glazing system & aluminium cladding system at least 4.00 m high and 3 modules wide incorporating all types of in-fill panels, fire-stop, flashing, shadowbox, bracketry, hardware and fixtures. A mock-up of 4 panels of cladding shall also be put up. The mock-up are essential for final approval of all materials and installation details by the Architect.

The Contractor shall submit samples and catalogues of door / window elements for approval, as applicable.

9.2 Maintenance Manual:

Submit Maintenance Manuals approved by Architect / PMC in three (3) copies each indicating the detailed procedures for the periodical inspection maintenance and cleaning of all the structural glazing, cladding, doors, windows and louver elements, finishes etc.

10. WORK SCHEDULE:

Immediately on receipt of the Work Order the Contractor shall submit the final programme of work schedule for the completion of the whole of the works including submittals, approvals, fabrication, supply at site & installation. The time schedule shall be got approved from the Project manager.

The time schedule shall be prepared in consultation with Project manager to suit the overall project schedule and shall be updated from time to time to suit prevailing conditions and co-ordination with other Contractors employed on site.

11. INSPECTION OF COMPONENTS:

The Contractor shall submit a schedule of material specification and procedure for inspection of the quality of components of the metal wall cladding / curtain walling and the fabrication in the plant.

The Contractor shall submit fortnightly report on the results of the inspection of the components, in a format approved by the Project manager.

The Contractor shall submit a description of the procedure of delivery, hoisting, storage, handling, fixing, scaffolding, temporary working stage or gondola, protection and cleaning.

12. STORAGE, PROTECTION AND PROGRAMME

The Contractor shall submit a schedule on the procedure for inspection during installation so as to maintain quality control on the job site.

The Contractor shall submit a detailed method statement for the protection of the surface of the aluminium structural glazing & cladding members during delivery and erection, with description as to when the protection can be removed.

The Contractor shall submit weekly reports on the inspection of erection and installation as direction by the Project manager.

Delivery and Storage of Materials: All materials delivered to site shall be stored in allocated spaces where the stored materials will not be exposed to rainwater, moisture or damage, and shall permit easy access to and handling of the materials. Materials shall be stored neatly and properly stacked.

Factory made structural glazing units / Aluminium wall cladding / or their components shall be transported, handled and stored in a manner to preclude damage of any nature.

Accessory materials, required for erection at the site shall be delivered to the site in labeled containers by the manufacturer.

Remove all units or components which are cracked, bent, chipped, scratched or otherwise unsuitable for installation and replace them promptly.

12. PERFORMANCE REQUIREMENTS

All components, assemblies and completed work included in or permit to the work of this section shall conform to or exceed the following performance standards and comply with all applicable and governing building codes and regulations.

12.1 Thermal Movement:

Provide for noiseless contraction and expansion of component materials for an ambient temperature range of +10°C to 70°C and a material temperature range of 100°C without buckling, opening joints, glass breakage, undue stress on fasteners, or other detrimental effects. Make allowance for vertical and horizontal expansion. For fabrication, assembly and erection, procedures shall take into account the ambient temperature range at the time of respective operations.

12.2 Building Movement and Related Building tolerance.

The design and installation of the structural glazing system shall accommodate all inherent building movements and/ or deflections and the fabrication and installation tolerances of all related work not involved in this section without the loss of, or any detrimental effect to, the performance requirements herein specified. The Contractor shall verify and co-ordinate all such movements and / or tolerances with the Project Manager and before designing all the components of structural glazing and aluminium

cladding so that movements and deflections in the structure do not at any time affect the integrity and safety of curtain wall and aluminium cladding and vice versa.

12.3 Thermal property:

All insulation materials, fire-stops and smoke seals shall comply with the current requirements of the local Fire authorities.

12.4 Structural Properties:

The design of curtain wall / structural glazing system and aluminium cladding and all related components shall comply with the requirements of National Building Code I.S.875 and Indian Standard Code I.S.456.

No curtain wall / structural glazing system and aluminium cladding elements including sealants and sealed joints shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure herein specified.

12.5 Deflections:

The specified deflections must be reduced if they are in any way detrimental to the aluminium structural glazing and cladding elements and sealants.

The maximum deflection on design wind pressure shall not exceed 1/240 of height or 15 mm whichever is lesser for mullions.

No vertical deflection shall exceed 1/300 or span of transom / sill / head members.

Under 1.5 times design wind pressure there should be no permanent deflection of framing member exceeding 1/1000 of span length.

Maximum deflection of glass under design wind pressure at centre of any panel shall not exceed 15 mm or as recommended by the manufacturer whichever is less.

12.6 General

a) All braces, supports and connections for the aluminium curtain wall / structural glazing and cladding shall be designed, provided and installed complete as required.

b) Anchors for curtain wall shall be located within a maximum distance of 500 mm above or below the R.C.C. floor slab unless specifically approved otherwise by the Project Manager.

c) Variations from schematic layouts indicated on the drawings may be permitted but only if a proposed revision does not, in the Architect's opinion, deviate from the design intent, cause excessive stress in the structure, cause excessive deflection, inhibit thermal and building movement or conflict with other requirements.

d) Member shapes and / or profiles if schematically shown on the Architect's drawings are not necessarily the exact shapes required or best suited for the particular condition. Final shapes and locations shall be as designed by the contractor and are subject to the Architect's review and approval.

e) The height-from the finished floor level to the top of the window sill shall not be less than as shown in the drawing.
The horizontal or lateral load on such transom / railing (where not backed by an R.C.C. parapet) shall be designed in accordance with the following criteria i.e. a horizontal UDL at 0.74 KN/m run, UDL supplied to the infill of 1.0 KN/m^2 and a point load applied to part of the infill at 0.5 KN.

f) No holes shall be burned, filed or drilled in any structural steel members unless approved by the Project Manager in writing.

g) The contractor shall provide detailed layouts, alignment jigs etc. for the proper and exact placement of all welded anchor studs, anchorage components, embedded anchor assemblies etc.

h) All metal structural glazing and cladding elements and their applicable anchorage assemblies shall be designed to accommodate all thermal and building movements without any harmful effect to the structural glazing and cladding.

i) No field forming, cutting and/or alterations of primary wall elements will be allowed. All framing members shall be shop fabricated and finish coated. No unfinish surfaces will be permitted on exposed surfaces.

12.7 Concrete Tolerances:

a) The contractor shall take into account tolerance in concrete and masonary surfaces to which the structural and glazing framework is fixed.

b) In general, the construction tolerances in the building will be attempted as follows. (The actual tolerances may exceed these figures by 75%):

- Surface level of floor slab, sills and lintels ±10 mm
- Plumb in a storey height ±10 mm
- Plumb in full height of building ±14 mm
- Cross – diagonal distortion between columns ±14 mm
- Max. displacement of any point on External Fascia from its true location ±14 mm

12.8 Lightning protection

The whole of the curtain wall when having insufficient clearance from the lightning protection system shall be bonded as directly as possible to the lightning protection system. At each end of each continuous length of curtain wall, cladding or louvers, provision shall be made at top and bottom for bonding by the electrical contractor engaged by the Employer. The exact locations and details of the bonding points shall be as determined by the Project Manager.

12.9 Fire-stop and Interface with building.

Joints in the curtain wall / structural glazing system between successive floors shall have the required fire resistance of at least 2 (Two) hours and shall comply with requirements of Chief Fire Officer.

A fire-stop-cum-smoke seal shall be provided at each window-head level. In addition the Contractor shall provide an aluminium flashing to approved design at the window sill level and on 2 sides of vision panels.

All interfaces with building structure, and other elements shall be sealed / flashed / provided with expandable gaskets to Architect's approval.

12.10 Sound Control

Provisions shall be made (e.g. capping of all ends of mullions) to prevent sound transmission through the system. Provisions shall also be made to prevent metal to metal rubbing noise due to thermal changes and wind pressure.

MATERIALS

13.0 GENERAL:

Materials and components used shall be of the best quality and suitable for the purpose to Architect's approval and shall have been tried and tested in environments similar to that of Coimbatore.

Aluminium panels shall be of a minimum thickness of 2 mm and of max. 3 mm for solid sheets, and 4 mm for insulated composite units.

All materials shall be free from any defect that may impair the strength, functioning or appearance of the glazing and cladding system or adjacent construction.

Testing by independent testing laboratories or review of data by the Architect shall not relieve the Contractor's responsibility to verify for himself that the work conforms to the intent of the contract documents.

13.1 METALS

In general, metals shall comply with relevant Indian and International Standards.

13.1.1 Aluminium Wall Cladding

The aluminium cladding shall be fabricated with a minimum of 4 mm thick aluminium composite panel of approved make comprising of a thermoplastic resin core sandwiched between two skins of aluminium alloy. The panels shall be PVDF coated to minimum 35 micron thickness in approved metallic colour. The resin content of the PVDF shall be 75% to 80%. The back of the panel shall be chromatised 3-4 mm thick or otherwise protected to Architect's approval. The insulation in-fill of the composite panel shall be non-toxic on burning. The panels shall be acceptable to the Chief Fire Officer.

13.1.2 Fasteners: The type, size, alloy, quantity and spacing of all fasteners and / or anchorage devices shall be as required for the specified performance standards.

a) Bolts, anchors and other fastening devices shall be of approved types as required for the strength of the connections, shall be self-locking, unless otherwise noted, shall be suitable for the conditions encountered, and shall be torque tightened, where required, to achieve the maximum torque tension relationship in the fasteners. Washers, nuts and all accessory items shall be of the same material as fasteners.
b) Fastening devices between aluminium and aluminium shall be AISC, Type 316 stainless steel unless otherwise approved.
c) Fastening devices between aluminium and dissimilar materials shall be 316 series non-magnetic stainless steel unless otherwise approved.
d) Exposed fasteners are subject to Architect's approval and shall be stainless steel.
e) Self-locking fasteners shall be stainless steel with nylon inserts or patches.

14 Extrusions:

All aluminium extrusions shall conform to the system principal's specification for tolerances which shall, in any case, be better than DIN standards. Any section not conforming to the tolerances shall be rejected.

In general aluminium alloy for extrusions shall be 6063 T5 or T6 as per B.S.1474. However, the grade and tempering specifications shall be as recommended by the supplier for each application and shall be approved by the system principal.

All aluminium sections shall be either anodised in approved colour to a minimum thickness of 20 microns or coated with PVDF as specified in clause19.0 except for sections concealed from view behind cladding which may be mill-finished.

All surfaces abutting the parent sections and designed to receive sealants shall have adequate sealant contact and adhesion. They shall be finished to match parent sections.

14.1 Aluminium Flashing

Flashings concealed from view shall be made from mill-finished aluminium sheets 1.5 mm thick. Visible flashings (e.g. on periphery of vision panels) shall be 2 mm thick aluminium sheets anodised in approved colour.

14.2 Capping

Top capping shall be from 3 mm stretch-levelled aluminium sheets coated with 35 micron PVDF in approved colour.

14.3 Soffits and Suspended Ceiling System

Soffits and suspended ceiling system if required shall be of similar metal of the aluminium wall cladding with a similar finish. Colour and shape shall be selected by the Project Manager.

14.4 Fire stops – cum – smoke seals.

Fire stops – cum – smoke seals shall be provided at successive floor levels, and shall be two hour fire resistant & approved by CFO.

Metals sections shall be in galvanised steel sections minimum 1.5 mm thick. All details shall be approved by the Architect.

14.5 Protection:

Materials used as permanent or temporary protection for metals shall conform with relevant Indian / International Standards.

14.6 Brackets:

Brackets shall be MS epoxy coated approved by Architect. Slots in brackets shall be pre-drilled / punched and not flame-cut.

14.7 Hardware and Fittings:

All hardware and fittings such as patch fittings, handles, locks, stay-arms, floor springs etc. for doors windows and openable panels shall be to best International standards and to Architect's approval. Hinges for openable panel shall be stainless steel friction hinges / stays selected for specified wind load and dead loads or specifically extruded in-built hinges. All fittings and locks shall be approved by the Architect.

15.0 SEALANTS & GASKETS

15.1 All sealant applications must be clearly designated on the applicable shop drawings details and reference to a master sealant schedule specifying materials, special instructions and application procedures. Provide documentation as per Clause 7.2.

15.2 The compatibility and sequence of installation for all sealants must be carefully considered in all proposals in order to ensure the required cure and optimum performance. Sealants must not degrade and / or fail under all design conditions including, but not limited to thermal movement, water, ultraviolet exposure and / or other adverse environmental conditions. The following sealant materials are specified for performance standards only. All proposals must be equal to or better than the materials herein specified. The designation of sealant types noted on the drawings is

intended for general design guidance. Final selection by the contractor for the sealant types shall be based on their conformity with the Performance Requirements herein specified and conform with the Architect's approval. Maximum precautions shall be taken to prevent failure of sealant.

15.3 Structural sealant:

Structural sealant shall be Dow Corning Silicone sealant 995, GE ultraglaze 4000, or approved equivalent recommended by manufacturer. All exposed and concealed metal to metal (including tight or butt type metal to metal assembly prior to assembly), perimeter metal to concrete joints shall be silicone base sealant, preferably 2 (Two) component, in approved colour, conforming to the manufacturer's recommendations for the specific uses and performance criteria. The manufacturer shall conduct laboratory test for adhesion for each lot of aluminium sections and glass. Laboratory reports shall be submitted to the Architect.

15.4 Weather Sealant:

The grades of sealants for concealed metal to metal and metal to concrete joints such as embedment and lapping of flashings elements are to be installed or embedded in a full bed sealant shall be the best recommended by the manufacturer for the application. (Dow Corning, GE or equivalent).

15.5 Joint fillers and back-up materials shall be non-gaseous polyethylene foam, sponge neoprene as per written recommendations from the applicable sealant manufactures for each specific application. Shape, size, hardness, compatibility and bond breaking requirements are all factors to be considered.

15.6 All sealant must be non-staining and compatible with adjoining sealants, backup materials, substrate materials and their respective finishes and / or applied colour coatings.

15.7 Exposed assembly sealant will not be permitted at any wall area.

15.8 All sealants shall be given 10 (Ten) years Guarantee for materials, workmanship and performance from the date of completion of Contract.

15.9 Caulking compound: Dow Corning 790 or approved equivalent, one part gun grade consistency, colour to match adjacent material or approved by Architect for use around frame or between frame and floor slab.

15.10 GASKETS:

Gaskets and seals shall be extruded EPDM of approved quality, compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets.

Extruded EPDM sections shall have the following properties:

Shore Hardness	70 $\pm$ 5A
Tensile strength	Min. 70 Kg/cm^2
Elongation	300%
Ozone Resistance	No crack at 50 $\pm$ 5 pphm, test temp. of

40 $\pm$ 2°C, test duration of 96 hours and 20% strain.

Extruded neoprene sections if specifically permitted shall have the following properties:

Physical Property	Test Method	Performance
Hardness, Durometer A	ASTM D 2240	60 + 5 points
Tensile strength	ASTM D 412	1800 psi, minimum
Elongation at break	ASTM D 412	25%, minimum
Brittleness temperature	ASTM D 746	40 degree F
Resistance to heat	ASTM D 573	

Change in original properties after 70 Hrs. at 100°C

Hardness	-	+ 10 points, max.
Elongation	-	40% maximum
Tensile Strength	-	15% maximum
Resistance to permanent set – compression set after 70 Hrs. at 100°C	ASTM D 395	25% maximum

16.0 SEPARATORS

Separators between steel and aluminium members and wherever required shall be rigid type, high impact, smooth both side Teflon with a minimum thickness of 0.8 mm or other non-conducting materials as approved by the Architect.

17.0 GLASS

All glass and glazing materials shall be verified and co-ordinated with the applicable performance requirements.

Finish and install glass and glazing work as indicated on the drawings and as specified herein. All glass shall be cut to required sizes and ready for glazing. Any pane which does not fit any section of the curtain wall and shop front will be rejected and a replacement made at the Contractor's expense. All glass shall be of accurate sizes with clear undamaged edges and surfaces which are not disfigured.

Glass shall conform to the quality, thickness and dimensional requirements specified in US Federal specification DD- G 0451 C.

Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm within 260 mm of leading or trailing edge, or 0.076 mm in centre. Direction of ripples shall be consistent and extent shall be acceptable to Architect. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be uni-directional as per Architect's option. Surface compression stress of heat strengthened glass shall be within 320 – 450 Kg/cm^2

Permanent identification marking on glass shall be accomplished by a technique selected by the manufacturer. The location of the marking shall be proposed by the Manufacturer and approved by the Architect. All glass shall be delivered to site with the manufacturer's label of identification attached.

Submit for Architect's approval a complete list of materials to be used, including the sealants proposed and such samples as the Architect may require. All glass and glazing methods and materials including the design and profile dimensions of glazing pockets shall be as approved and recommended in writing by the applicable glass and sealant manufacturers. A sealant substrate test report shall be submitted for each type of sealant for adhesion and compatibility.

Sealants in factory-glazed panels shall be fully cured prior to shipment to projects site and installation.

All glass breakage caused by the Contractor or his sub-contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay to the project completion.

The Contractor shall be responsible to deliver to the Employer without charge replacement for any unit of glass and glazing that fails within the Guarantee period of Ten (10) years from date of completion of Contract.

The glass glazed panels / structural glazing frames for the structural glazing system shall be designed to withstand lateral imposed loads and comply with requirements of local building codes.

Glass thickness should be selected in accordance with AS 1228 – 1989 "Glass in Buildings Selection and Installation" to satisfy design performance requirements and local design codes.

Glass shall be free from defects or impurities detrimental to its performance. Defects such as bubbles, waves, spots, scratches, spalls, discolouration, visibly imperfect coating, chipping, and bubbles or delamination of opacifier film shall be limited in accordance with the Manufacturer's / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass shall be consistent in colour.

Manufacturer's glazing instructions regarding installation, clearance, dimensional tolerance, bite edge clearance etc. shall be followed.

All solar control glass panels shall be stored with particular care and protected against abrasion, sun and moisture prior to installation.

Precautions specified by glass manufacturers to minimise thermal stress must be followed. A thermal stress analysis shall be obtained from glass manufacturer prior to fabrication and their recommendations shall be followed. Allowance shall be made for thermal movements due to an air temperature range of 60°C and a material temperature range of 100°C.

Glass panels shall be selected / rejected on the basis of product quality standards specified by the manufacturer concerning scratches, pinholes, clusters, distortion, colour variations, flaws in coating and other defects.

Each type of glass shall be obtained from only one manufacturer and one lot. Adequate spare quantity shall be ordered to cover for breakage and for replacement during maintenance period.

Double glazed units shall be procured only from approved manufacturers. Quality control tests shall be performed for mixing, curing, adhesion, dewpoint and grammage for molecular sieves and DELTA T. The spacers shall be of black colour. Capillary tubes shall be provided for pressure equalisation during transit. The units shall be guaranteed against condensation and dirt between the panes, failure of seal and damage to internal coating.

Setting blocks for glass shall be extruded neoprene with minimum 80 durometer hardness.

18.0 VISION GLASS PANELS;

Characteristics of each type of glass are given in the performance data sheet.

19.0 SPANDREL GLASS PANELS

Characteristics of each type of glass are also given the performance data sheet.

20.0 GLAZING COMPOUNDS;

Provide documentation as per Item 7.1. All neoprene materials shall be extruded high quality ozone resistant, cured, elastomeric, virgin neoprene compounds with durometer hardness, profiles and design parameters, lengths and locations all as required and recommended in writing by the applicable glass manufacturer (s). All neoprene glazing materials shall have smooth neat exposed surfaces, all flashings and burrs removed and in profiles, including integral locking projections to engage into the parent drawings. Furnish certified test reports to establish conformity with the specified standards.

Setting blocks used to support the dead load of the glass shall be extruded in a neoprene / EPDM compound or silicone material conforming to the design criteria, all as recommended by the glass manufacture.

Jamb shims used to centre and station the glass shall be extruded in a neoprene / EPDM compound or a silicone material conforming to the design

Fixed compression and roll-in glazing gaskets shall be extruded in an EPDM compound as recommended by the glass manufacturer. Gaskets for any one light shall be one piece with injection moulded corners free of all flashings and burrs.

21.0 METAL COATINGS:

Aluminium shall be bronze anodised to minimum 20 microns or powder coated to 40 micron thickness as per colour approved by Architect.

Coatings to aluminium sections and cladding where specified shall be fluoropolymer formulated and will consist of a 3 coat system comprising primer, colour coat and clear anti abrasion top coat. The coating system shall meet or exceed all the requirements of AAMA 605 - Voluntary specification for high performance organic coatings on Architectural extrusions and panels.

The total dry film thickness shall be 35 microns.

After selection of colour by the Architect, the Contractor shall prepare two (2) sets of two (2) samples of each which shall define the colour and gloss range and submit them for approval.

All samples shall be identified and have a full laboratory report attached.

The coating system, including materials and application shall conform to the requirements and recommendations of the paint manufacturer.

Testing and Sampling Procedures

In-process testing shall be performed on test specimens of equal metal thickness pre-treated and finished along with the production metal, specimen shall exhibit a test of at least 75 mm x 300 mm to permit instrument readings. In addition to running in-process

tests to assure high quality production, additional finished extrusions or panels are to be submitted to the coating manufacturer's laboratory for extended exposure testing.

All test samples shall be properly identified with date, batch number and shift indicated.

The following tests shall be conducted at least once per production shift and submitted to the Employer when required.

Dry Film Thickness – evaluated with a Permascope, Isoscope or Dermatron instruction.

Film Hardness.

Dry Cross batch Adhesion

Boiling Water Adhesion Test.

Gloss Measurement

Colour Examination Against Standard

General Appearance – Smoothness, free of blisters, sags, pinholes and other surface imperfections.

Testing reports shall be certified by the testing agency, manufacturer and the Contractor.

22.0 Process :

(i) Dry Film Hardness – The coating shall have a hardness of H minimum when tested with "Eagle Turquoise Pencil"

(ii) Film Adhesion – The coating system shall withstand the following adhesion tests:

DRY: Make ten (10) parallel cuts 1.25 mm apart through film and ten (10) more cuts 90 degrees and crossing first ten cuts. Apply Scotch Transparent #710 Tape, 18mm wide, over area of cuts, pressing down firmly against coating. Pull tape off sharply.

WET: Make ten (10) parallel cuts as above. Immerse samples in boiling water for 5 minutes. Remove sample, dry, cool and tape-test the cross-hatched area as above.

iii) Gloss Measurement – Measure gloss at various locations on painted metal with a 60-"Glossmeter".

iv) Colour Uniformity – Check random samples of painted production metal under a uniform light source, such as natural North daylight against standard panels approved by the Employer.

v) Test for cure of coating using 100 double rubs with several thickness of cheesecloth wet with MEK solvent. Slight dulling of the film is considered normal, but softening shall not be permitted.

23.0 Performance Requirements:

i) Salt Spray resistance – withstand a minimum of 3000 hours exposure to 5% salt solution at 95%.R.H., 37.5^{0}C with no more than 1.25 mm creepage or loss of adhesion from scribed line or cut edges.

ii) Humidity Resistance – Withstand a minimum of 3000 hours exposure to 100% R.H. 37.5^{0}C with no more than a few blisters, size No. 8 (ASTM D 714 – 56).

iii) Abrasion Resistance – Withstand abrasion of sand with an abrasion coefficient value of 65 minimum when evaluated as per ASTM D 968-51 test method.

iv) Mortar Resistance – Withstand wet mortar, 24 hour part test at 100% RH without gaining adhesion or any visual effect on the painted surface of solid colours.

v) Detergent Resistance – Withstand immersion in 3% synthetic detergent solution for 72 hours at 37.5^{0}C with no loss of adhesion no blistering and no visible change.

vi) Colour Retention – Withstand maximum chalk rating of No. 8 for colours and No. 6 for white per test method ASTM D659-44 (1970).

Field Touch-up and Repair – The contractor and coating manufacturer shall supply materials for air dry touch up for spray or brush application as per instruction of manufacturer. Touch up shall be held to an absolute minimum to Architect's approval.

Furnish to Owner a written guarantee warranting all work in connection with organic coating system to be free from defects in materials and workmanship for a period of Ten (10) years from date of completion and to correct promptly any defect free of cost. The following are considered as defects without being limited thereto:

i) Peeling
ii) Cracking
iii) Checking
iv) Blistering
v) Chalking in excess #8 Chalk rating when measured in accordance with ASTM D659-44 (1965).
vi) Fading or colour change in excess of 5 NBS unit when calculated from measurement on a spectrophotometer or colour meter capable of colour measurement by reflectance reading in accordance with ASTM D244-68.

24.0 STRUCTURAL GLAZING AND CLADDING SYSTEMS

The method of assembly, reinforcing and anchorage of the aluminium structural glazing / cladding system, where indicated, is schematic. Locations and method of providing same shall be the Contractor's responsibility, who shall design the assembly, reinforcing and anchorage to suit each specified conditions in an acceptable manner complying with the requirements specified herein after.

Visible joints shall be as shown in the Architect's drawings.

All parts shall be secured by concealed means wherever possible and where exposed to view, screw positions are to be indicated on the preliminary drawings. Exposed screws shall be of the countersunk type coloured in same finish as of aluminium or non magnetic stainless steel and shall be evenly and neatly located in an approved manner.

All components shall be assembled, secured anchored, reinforced, sealed and made weather-tight in a manner not restricting thermal or wind movements of the structural glazing. Sealants shall be concealed wherever possible.

All fastening into or through aluminium shall be non-magnetic stainless steel.

Free and noiseless movement of all the components of the Curtain Walling system due to thermal effect, structural effect, wind pressure, seismic forces, erection or dead loads, shall be achieved without strain to the glass, without buckling of any components and without excessive stress to any members or assemblies.

Aluminium surfaces in contact with mortar, concrete, plaster, masonry, wet application of fire-proofing and absorptive materials shall be coated with an anti-galvanic, moisture barrier material.

25.0 Waterproofing:

a) A complete drainage system must be incorporated into the structural glazing frame work. Water leakage and condensation shall be drained or discharged to exterior face of the wall and all internal spaces vented by acceptable means to ensure air pressure equalization wherever possible.

b) Drainage system will be sealed off at every floor to prevent infiltrated water from leaking to lower floors.

c) Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

26.0 Anchorage System and Building Frame

Each glazed unit shall be fixed to the structural slab at each floor level. All fasteners shall be stainless steel of grade as approved by Architect. The contractor shall also make necessary modifications to the anchor fasteners to suit existing site conditions of steel reinforcement without additional charge.

27.0 Mullions and Transoms

a) The sections of mullions and transoms shall be designed to restrict deflection under wind pressure as specified and shall be rigid enough to support and retain the glass spandrel under all conditions. The mullions shall be designed if required, to act as guide tracks for gondolas to permit its free movement in vertical direction for window washing and to sustain concentrated loading by the gondola cage.

b) Reinforcing members, where used, shall be completely enclosed and if fabricated from steel shall be galvanised and protected with primer and two coats of zinc chromate.

28.0 Window units (Vision Panels)

All windows shall be glazed from inside where possible. All cladding as well as internal glazing beads, if any (unless otherwise specified) shall be in anodised aluminium.

29.0 Spandrel Units

a) Spandrel shall be of glass having equal colour matching with vision areas after using a shadow box or as specified.

b) Structural spandrel beam, structural glazing fasteners and other construction shall not be seen through the glass from the exterior and shall be fully concealed behind the shadow box.

c) A shadow box shall be provided a distance behind the spandrel glass panel. It shall consist of an approved fiberglass non-woven tissue in approved colour stuck on surface #2, 50 mm semi–rigid fibre glass insulation of minimum density of 60 Kg/cum. The periphery shall be properly sealed. Surface #2 shall be adequately protected against damage until spandrel glazing is done.

d) Two hour rating fire stops–cum–smoke seals shall be constructed continuously at the spandrel to the approval of the Chief Fire Officer and other authorities.

30.0 Ventilators, Openable Windows and Doors

a) Ventilators, windows and doors shall be provided at positions as shown on the drawings. The ventilators when in closed position shall remain watertight under all weather conditions and pass the water tightness tests as specified.

b) All hardware and accessories shall be supplied by the contractor and when exposed shall be of stainless steel or approved aluminium alloys in approved finish.

c) Minimum aggregate openable area of the ventilator shall be as given in the Architect's drawings.

d) The detailed system of the ventilators and doors must be proposed by the tenderer keeping the position as shown on the drawings.

31.0 Coping and Soffit Trimmer

a) All coping and soffit panels shall receive frame reinforcement and be fixed rigidly to the structure.

b) All joints between coping / soffit panels and between coping / soffit panels to structural glazing frame and other sections of the work shall be tightly sealed up. Effective drainage system shall be provided to drain out the water that may penetrate through the joints.

32.0 CLADDING

Cladding shall be non-toxic composite aluminium panels (ALPOLIC / ALUCOBOND / ALUCOMAT or approved equivalent) of adequate strength with approved aluminium details. The panels shall be 4 mm thick composite units finished with PVDF coating overall 35 micron thick of approved metallic colour. The resin content of the PVDF coating shall be 75% to 80%. The back of the panel shall be chromatised 3-4 micron thick, compatible with adhesives for stiffeners if any or given a polymer coating.

Alternatively, cladding shall be fabricated in panels from 3 mm stress-levelled aluminium alloy sheets (ALCAN or equivalent) coil-coated with 35 micron PVDF on front face and 3 micron PVDF on reverse in approved colour.

The fabrication and installation of the cladding systems shall be carried out as per manufacturer's instructions with invisible / concealed fastenings, aluminium sub-structure, silicon sealants properly tooled etc.

All cladding panels of one kind shall be obtained in one lot from the manufacturers.

Each panel shall be guaranteed for a minimum flatness of ±1 mm from the true face after installation under no-wind conditions.

Deviations from the true alignment of adjoining panels shall not be cumulative.

Full load deflections shall be kept to the minimum possible. Each panel shall be capable of withstanding 300 Kg/Sq.m wind pressure without any permanent deformation.

The cladding system shall be adequately ventilated. The air-gap between the cladding panels and the concrete / block wall shall be atleast 50 mm to allow proper ventilation of the rainscreen system. The cavity shall be closed by a perforated bird / vermin-proof closer at bottom and by a flashing at top.

The fabrication processes including cutting, grooving, benching, folding, joining, rout-in as well as installation shall be performed as per manufacturer's instructions. The panels shall be backed by approved aluminium supporting framework, fixed to walls with aluminium brackets.

33.0 LOUVERED PANELS

Louvered panels shall be provided at positions as shown on the drawings.

Louvers shall be of approved anodised aluminium with an assumed efficiency of 50% unless otherwise specified and shall be complete with stainless steel bird-proof wire fixed internally.

All hardware and accessories shall be, when exposed, of non-magnetic stainless steel and / or coloured aluminium to match that of structural glazing / cladding wherever possible.

34.0 FABRICATION

General: All assemblies shall be fabricated and assembled in accordance with the drawings and the requirements of these specifications. Deviations of any nature, without approval of the Architect /PMC shall not be permitted.

Tolerances: Furnish a schedule of fabrication tolerances for all major wall cladding components. In addition to the fabrication tolerances, provide for and schedule thermal movement including assembly and installation tolerances for all major and/or applicable wall cladding components and/or assemblies.

Workmanship

1) All work shall be performed by skilled workmen, specially trained and experienced in the applicable trades and in full conformity with the applicable provisions of the listed References and Standards and/or otherwise noted on the drawings or as specified herein.
2) All work shall be carefully fabricated and assembled with proper and approved provisions for thermal expansion and contraction, fabrication and installation tolerances and design criteria.

3) All forming and welding operations shall be done prior to finishing. Unless otherwise noted.
4) All work shall be true to detail with sharp, clean profiles, straight and free from defects, dents, marks, waves or flaws of any nature impairing strength or appearances; fitted with proper joints and intersections and with specified finishes.
5) All work shall be erected true to plumb, level, square to line, securely anchored, in proper alignment and relationship to work of other trades and free from waves, sags or other defects.

Joints in Metal Work

1) All exposed work shall be carefully matched to produce continuity of line, design and finish. Joints in exposed work, unless otherwise shown or required for thermal movement, shall be accurately fitted, rigidly secured with hairline contacts and sealed watertight.
2) Where two or more sections or metals are used in building up members, the surface in contact shall be brought to a smooth, true and even surface and secured together so that the joints shall be absolutely tight without the use of any point materials. Extrusions shall be tolerated to eliminate any edge projection or misalignment at joints.
3) Furnish physical samples of all joinery elements as for comparative appraisal and approval of the production materials. Physical samples of all typical wall intersection assemblies shall be colour coded on surfaces and/or areas to receive sealants.

Shop Assembly

As far as practicable, all fitting and assembly of the work shall be done in the shop. Work that cannot be permanently shop assembled shall be temporarily assembled in the shop and marked, before disassembly to ensure proper assembly later in the building.

Sleeves

Unless otherwise noted, all aluminum sleeves shall be extruded sections designed to accurately interlock with adjacent sections and incorporate serrated surfaces for the secure bedding of sealant between the parent metal and the sleeve.

Fasteners

1) All fasteners shall be of **stainless steel** with self locking devices, unless otherwise specified, and of sufficient size and strength to withstand the applicable design wind load and dead load forces with safety allowance factors as required for the specific materials. The spacing and quantities of fasteners shall be as required to develop the maximum strength of the member they secure or support. Washers and / or other accessory items shall be of the same material as the fastener. Torque tighten all assembly fasteners to achieve the maximum torque tension relationship in the fastener.
2) All fasteners shall be concealed unless otherwise shown or approved. The head style for all exposed fasteners shall be countersunk oval head unless otherwise specified on the drawings. Exposed fasteners shall be finished to match surrounding metal finish.
3) All fasteners including washers and accessory items shall be scheduled and designated on the shop drawings so that anyone can witness and assess the assembled units to ensure that all fasteners conform to the designated and approved type, size, material, spacing. etc. When certain items are not readily

apparent, such as material and alloy or torque tightening requirements, special instructions for the identification and appraisal of such items shall be issued.

Protection of Metals

1) Protection against galvanic action shall be provided wherever dissimilar metals are in contact.
2) Aluminium which is to be in contact with cured concrete, mortar or plaster shall have the contact surfaces protected wherever crevices between the contact surfaces may entrap moisture and corrosive elements. All metals, except stainless steel, which are to be in contact with fresh concrete, mortar or plaster, shall have the contact surfaces protected with epoxy paint.
3) Furnish a schedule of all protective coatings and related items including the designation of area and/or specific locations, materials used, special instruction, specification data sheets, etc.

Welding

1) All welding in aluminum work shall be done by the inert gas shielded arc or fluxless resistant techniques and with electrodes and/or by methods recommended by the suppliers of the metals being welded. Type, size and spacing of welds, shall be as shown on approved shop drawings.
2) Welds in galvanized metal shall be touched up with zinc rich paint.
3) Welds behind finished aluminum surfaces shall be so done as to eliminate distortion and/or discolouration on the finished side. When weld spatter and welding oxides on finished surfaces shall be removed by de-scaling and / or grinding. Provide low heat filled welds using chill bar on finished side to eliminate dimpling, distortion and / or discolouration on the finished or exposed surface. Plug, puddle or spot-welding are not permitted. If weld beads are shown on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal.
4) Structural welds shall be made by certified welders and shall conform to the general recommendations and regulations of A W S Specification D1.0-46.
   a) Dirt grease, lubricant, or other organic material shall be removed by vapour degreasing or suitable solvent.
   b) Joints rejected because of welding defects may be repaired only by rewelding. Defective welds shall be removed by chipping or machining. Flame cutting shall not be used.
5) Wherever welding is done in proximity to glass or finished surfaces, such surfaces shall be protected from damage due to weld sparks, spatter or tramp metal.
6) All welds shall be scheduled and designated on the shop drawings so that anyone can witness and assess the assembled units to ensure that all welds conform to the designated and approved type, size, spacing etc.

Soldering

All soldering and/or brazing shall be done as recommended by the suppliers of the metals involved.

Shop painting of Carbon Steel

Item of carbon steel, unless galvanised or scheduled for other finish, shall be thoroughly cleaned of all loose scale, filings, dirt and other foreign matter and shall be painted with zinc chromate primer.

Factory Application

As much work as possible shall be carried out in the factory. All glazing shall be done in the factory. Gaskets shall be pre-positioned and welded in the factory as far as possible. Site work shall be kept to a minimum.

GENERAL EXECUTION

The drawings supplied by the Architect shall be considered essentially schematic, except of profiles of exposed surfaces which shall be as indicated. If, in the opinion of the contractor, a change of profile is required in order to meet the specifications, he shall consult the Project Manager for a review of the conditions.

The method of assembling, reinforcing and anchorage of the aluminum structural glazing / cladding system, were indicated is schematic. Location and method of providing same shall be the Contractor's responsibility, who shall design, assemble, reinforce and anchor to suit each specified condition in an acceptable manner complying with main building structure. Site work shall be coordinated with the Main Contractor's programme.

Visible joints shall be as shown on the Architect's drawings.

All parts shall be secured by concealed means and screws exposed to view shall not be allowed.

All components shall be assembled, secured, anchored, reinforced, sealed and made weather tight in manner not restricting thermal or wind movement of the metal wall cladding / curtain walling system. Where possible, sealants shall be concealed.

Free and noiseless movement of all components of aluminum structural glazing and cladding system due to thermal, structural, wind pressure, or dead loads shall be achieved without strain to glass, without buckling of any components and without excessive stress to any members or assemblies.

The entire aluminum structural glazing and cladding system shall be assembled and installed so that all leakage and condensation shall be drained and discharged to the exterior face of the wall.

Movement of water behind and on exposed surfaces shall be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapping water.

Measurements:

The measurements given on Architect's drawings shall not be used by the Contractor for preparing his shop drawings and for executing the work. All dimensions shall be actually measured on site and in case of any discrepancy between measurements on site and in drawings, modules shall be decided in consultation with the Architect.

PERFORMANCE TESTING

General

The contractor shall carry out site tests as specified at his own cost. The Contractor shall supply copies of shop drawings and calculations to the Test Laboratory prior to installation of the test units. These drawings shall include:

- Test elevation and sections;
- Full scale typical details of unitized panels (intersections of members);
- Typical support details
- Extent of sealants
- Size and number of pressure equalisation/drainage slots or holes;

- Blanking off details; and,
- Method of installation

Any deviations from the drawings shall be recorded and noted in the final report. After approval of structural calculations and shop drawings for the structural glazing test units for performance testing of the curtain wall shall be constructed by the Contractor at the testing laboratory.

Test Units

1) The test units shall comprise components representative both in size and shape of the facade of the building under examination. The width of the test sample shall be not less than of three typical adjoining wall panels/units. The height of the test sample shall be not less than 2 storey's high and must contain full height modules of the aluminum structural glazing and cladding system. Vertical and horizontal movement joints shall be included in the test sample.
2) Where details of the building facade differ from those in the representative test sample, such as at corners, overhangs and the like, supplementary tests shall be performed on either composite or part sample of the facade.
3) The materials of the test sample (glass, aluminum reinforced concrete, sealant, gaskets etc.) shall be of the sample, type and size and have the same details, methods of construction, flashing and anchorage as the building facade.
4) If not actual on site representative sample of the wall of the building, the test sample shall be mounted and sealed into a simulated building frame in the same manner and by the same fixing which are intended to attach the facade to the building structure. The support frame shall be of equivalent stiffness to the supporting the building to prevent unrealistic deflection of the prototype sample.
5) Simulated floor slabs and spandrel shall be to actual depth if for example in curtain walls the air seal is connected to the slab. The internal finishes and linings shall be installed where they contribute to the air seal of the facade. The air seal of the test sample shall be continued to the air seal of the test chamber.
6) All United panels and other interconnected joints in the facade shall be sealed at the sample boundaries. This is to minimize the effects that the surrounding construction will have on the test performance of the sample. All pressure equalization and drainage slots or holes in the test sample shall be left open.
7) Transparent viewing panels (or other means of observation such as an optical fiber probe) shall be provided so that the performance of the facade in areas that are not readily seen can be determined.

Inspection of test units

1) The Contractor shall allow for the Architect / PMC to inspect the test sample regularly during erection. At this stage the adequacy and stiffness of the support structure shall be assessed. When the installation of the test sample is complete, the Architect / PMC shall inspect the test sample and, if satisfied, shall approve its completeness.
2) Testing shall not commence until this approval has been given.
3) Full time attendance by approved representatives of the contractor shall be provided for the erection of the test unit and all testing of the test units.

1) Test of Wind Pressure

Method : The equivalent load for wind pressure or wind suction shall be given to the test unit as increasing and decreasing the inside pressure of the "Pressure Chamber" at which the test unit is fixed.

Static Wind Pressure : The static pressure shall be increased to a maximum of ± 300 Kg/sq.m. in steps.

Dynamic Wind Pressure: The variation of dynamic pressure shall be approximately sinusoidal with each cycle having a period of 2 seconds.

Observation : Deflection on each observational point of the test unit shall be observed and recorded under the static pressure as described above.

Evaluation : No damage or harmful permanent deformation on any parts shall be found at the maximum design wind pressure as defined in item 14. The deflection of the main structural members in this condition shall be less than L/125 (L = length between support) or less than 15 mm whichever is least. No damage or harmful permanent deformation of any parts excepts sealing materials shall be found at the maximum testing pressure.

The maximum deflection / span ratio of glass shall not exceed 1: 90.

The residual displacement of a member shall not exceed 3.0 mm. The slippage at supports and fixing shall not exceed 1.0 mm.

2) Test Water tightness (Static pressure)

Method : Water shall be sprinkled on the unit under the same condition as under Test on Static Wind Pressure as described above. Pressure shall be maintained continuously for 10 minutes and the pressure of every +50 kg/sq.m shall be added to the preceding pressure upto +100 kg/sq.m. and 150 kg/sq.m. at maximum. The volume of the sprinkling water in one minute shall be 5 litres /sq.m.

Observation : All water leakage and drainage system at the joints and ventilators of the Curtain Walling System shall be observed from the inside of the chamber.

Conduct the test 3 times, in sequence as described below, conforming to the above mentioned conditions:

a) Install the test unit
b) Hold 1st water tightness test
c) Hold test on Wind Pressure as described above.
d) Hold 2nd water tightness test.

e) Cut the compound type sealant if any on purpose.
f) Hold 3rd water tightness test.

Evaluation : Water leakage at all parts of the test unit should not be observed inside during the 1st water tightness test except for ventilator, where water leakage should not be observed at the pressure of 100 kg/sq.m.

If water leakage and splash are observed on the ventilator they should be provided with a proper drainage system.

In case water leakage is observed during the 3rd water tightness test, effective drainage system should be provided.

3) Test of Water tightness (Cycle pressure)

Method : This test shall be performed upon completion of the test for water penetration by static pressure.

Should the cyclic water penetration test not commence within thirty (30) minutes of the static water penetration test, then, immediately prior to the start of the cyclic test the exterior face of the test sample shall be completely sprayed with water at a rate not less than 0.05L/m2/s for five (5) minutes with zero air pressure differential on the facade. Water shall be applied to completely and continuously over the exterior face of the test sample at a rate not less than 0.05L/m2/s while a cycling positive air pressure is applied to the exterior face for a period of not less than five (5) minutes. The applied positive pressure shall be varied between the specified limits with a cycle time of three (3) to five (5) seconds. These each of the steps are shown below:

Step	Minimum	Maximum
1	30 Kg/sq.m	60 kg/sq.m
2.	30% positive permissible stress design pressure	60% positive permissible stress design pressure

The air pressure differential shall be reduced to zero for two (2) minutes between each steep with thee water spray still in operation.

Observation : Observation of the internal face of the facade shall be carried out during the water spray operation and for five (5) minutes after the water spray has

stopped and there is zero air pressure different on thee facade.

Any water appearing on the inside face of the facade shall be recorded, with the extent and, if possible, the source of leakage indicated.

Evaluation : There shall be no leaks at 60% of maximum positive pressure. A leak is considered to occur when

a) Water appears on the inside face of the facade and is visible from an occupied space; or
b) Uncontrolled water appears on the inside face of the facade and is likely to damage insulation or other Architectural fixtures.
c) Uncontrolled water is defined as any leakage that is not contained and drained away within the test duration (including the five (5) minutes observation period)

4) Air infiltration test

Method : The face of the test sample shall be sealed airtight by covering it with an impervious film. If this is not practicable, all joints, peepholes and glazing or sealant lines of the test facade shall be sealed with impervious adhesive tape. Positive and negative test pressures of 7.5 kg/sq.m. shall be applied and the base air infiltration rates through the test apparatus determined by a calibrated flow meter inserted in the air pressure line. The sealing film or tape shall be removed from the test sample and the total air infiltration through the test sample shall be the difference between the base and total readings.

Evaluation : Air infiltration shall not exceed 1.0 L/M2/s.

5) Proof test

Method : The test sample shall be subjected to proof tests. The applied positive and negative pressure shall be 1.5 times the positive and negative permissible stress design pressure as determined from AS 1170 –1983 Part 2. Each proof test pressure shall be maintained on the test sample for a period of one (1) minute.

Evaluation : Under proof test there shall be no collapse shall mean any one or any combination of the followings:

a) Dislodgment of any glass.
b) Dislodgment of any frame, panel or any thereof
c) Failure of any fixings that connect the facade to the building structure, such that the test sample is unstable.
d) Failure of any stop, locking device, fastener or support which would allow an opening light to come open.

Form of Report

Details of the test sample (including an outline of the simulated building frame) and the test apparatus, instrumentation and method shall be clearly given in a report.

The report shall include the following:

a) An identification and general description of the facade and Certificate of Identity from the builder or his nominated contractor.
b) Drawings of the actual test sample showing modifications, if any.
c) Test sequence with pressure used in all tests.
d) Location of all transducers for the structural performance test.
e) Displacements, span/deflection ratios and air infiltration rates.
f) Other pertinent observations.

Record Drawings

1) The testing laboratory shall keep a copy of approved test unit, shop drawings and calculations at testing laboratory accurately and neatly recorded on the above mentioned shop drawings all changes, revisions, modifications, etc. made to test unit, which shall become the record drawings.
2) On completion of testing and after approval of test reports, the testing laboratory shall submit the marked up record drawings to the Project Manager.

Cost of Performance Testing

The testing laboratory shall provide the test chamber and support structure for the test. The Contractor shall allow for the cost of fabrication, erection, corrections to and the demolition of the test unit. The Contractor shall fabricate, erect, correct and demolish the test unit. If the test unit fails to pass the initial testing, the Contractor shall make the necessary corrections to the test unit and shall have the Test unit re-tested by the Testing laboratory until it passes the test. Cost of correction to the test unit and cost of re-testing shall be paid for by the Contractor at no additional cost to the Employer.

Site Tests

The Contractor shall carry out site tests at his own cost to determine resistance to water leakage as per recommendations given in AAMA 501.2-94 for “Field Check of Metal Storefronts, Curtain Walls and Sloped Glazing Systems for Water Leakage”.

The test areas shall be selected by the Project Manager, one for every 600 sq.m. approx. of installed curtain wall and glazing system. Testing will normally be ordered on 1st & 2nd floors but the Project Manager may at his discretion order tests to be carried out on any upper floor. In case of any test failing, the Project Manager shall order more tests to be conducted at the Contractor’s cost.

Each test area shall be:

a) 10 sqm. minimum or
b) 25 m. Run of perimeter of vision and spandrel units
c) 4 entire panels of standard types, whichever is the least.

INSTALLATION

Quality Control : See clause 7.3

Qualification of workmanship

All work shall be performed by skilled workmen, especially trained and experienced in the applicable trades employed and in full conformity with applicable provisions of the listed References and Standards and/or as otherwise noted on the Architect's drawings or as specified herein. The qualification of the Contractor's installation workmen shall first be filled with and approved by the PMC / Architect.

Setting out

Bench marks for elevations and building line offset marks for alignment shall be established on each floor level by the main contractor. Should any error be found in their location, the Contractor shall notify the PMC and the Main Contractor in writing and installation work shall not proceed in the affected area until the errors have been corrected.

Within 2 weeks on the award of the contract, the Contractor shall submit the structural glazing anchorage plan for endorsement by the PMC and approval by the Architect. The Contractor shall co-ordinate his system of anchorage with PMC / Civil Contractor according to site conditions.

Prior Inspection of the Structure

After the setting out has been established and before beginning installation in any area, the Contractor shall examine all parts of the structure on which the curtain walling system / metal wall cladding are to be placed in that area. Should any conditions be found which, in his opinion, will prevent the proper execution of his work or endanger its permanency, he shall report such conditions in writing to the PMC and the Civil Contractor. Installation work shall not proceed in that area until such conditions are corrected or adjusted to the satisfaction of the PMC.

Workmanship

All parts of the aluminum structural glazing and cladding system shall be erected true to plumb and in proper alignment and relation to established setting out, as shown on approved shop drawings.

Erection Tolerances

The installed metal wall cladding/curtain walling system components shall conform to the following erection tolerances under no-wind conditions:

a) Amount of total deviation and/or misalignment in any direction for vertical members: 3 mm maximum in a height of 4 m (non-cumulative) and maximum 7 mm in full-height of cladding/curtain walling.
b) Amount of total deviation and/or misalignment in any direction for horizontal members: 3 mm max. in a length of 7 m. 5 mm in full length
c) Maximum offset from true alignment between two abutting members shall be 1 mm. No edge projection or misalignment will be permitted.
d) Maximum joints, gaps or openings between removable glazing stop and adjacent member shall be 1mm and/or a maximum 1 mm cumulative opening at both ends of removable members (0.5 mm each end).
e) Deviation in spacing of brackets $\pm$ 3 mm.
f) Allowances for the cumulative effect of all tolerances (fabrication, assembly, thermal and erection) must be made to ensure a workmanlike installation. The documentation and distribution of this information to all applicable installation and inspection personnel is essential in order to ensure the standard of quality and workmanship required.

Installation within and / or adjacent to concrete:

Where work is to be installed within and/or adjacent to concrete, no aluminum structural glazing and cladding system components other than built in anchor devices shall be put in place until the concrete work is completed, including the removal of all forms, shoring, etc.

Anchorage : See clause 12.7 and 12.9.

a) Anchorage of the aluminum structural glazing and cladding system to the structure shall be by approved methods and in strict accordance with approved shop drawings. After the aluminum structural glazing and cladding system are properly positioned, all connections so designated on approved shop drawings shall be rigidly fixed by welding or other positive means.

b) All anchorage assemblies and their related components shall be thoroughly scheduled and described on the shop drawings so that anyone can evaluate an installation and ensure its compliance with the contract documents. Designate trades responsible for furnishing and/or installing materials if other than the Sub-Contractor. Descriptive items shall include the access removal movement and tolerances of related building and the aluminum structural glazing and cladding system direction and magnitude of thermal expansion, materials, sizes, quantities and any special instruction as may be required. All primary aluminum structural glazing and cladding, anchorage assemblies inclusive of frame/structural mullion shall receive a 100% inspection.

Welding

All welding shall be done by skilled mechanics qualified or licensed in accordance with local building regulations. Welds and adjoining burnt area in prime coated surfaces shall be thoroughly cleaned and painted with one coat of primer. Welds in galvanised steel shall be coated with one coat of zinc rich paint. Special care shall be taken to protect glass and other furnished surfaces from dame and to prevent causing fires.

Use of sealing materials

a) Sealing materials shall be used in strict accordance with the Manufacturer's printed instructions and shall be applied only by workmen specially trained or experienced in their use. Before applying sealant, all mortar, dirt, dust, moisture and other foreign matter shall be completely removed from surfaces it will contact. Adjoining surfaces shall be masked when required to maintain a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.

b) The manufacturer(s) of the applicable materials shall, when required render, technical assistance prior to the application of any sealant and witness the first applications as well as periodic site inspections thereafter. The contractor shall witness and document all inspections performed by the sealant manufacturer and provide close supervision of all workmen used to apply the sealant.

Coping and soffit trimmer

Installation of coping and soffit panels and field sealing between the copings and other trades shall be performed by the Contractor.

Tensioning of Bolts

All bolts shall be correctly tensioned. The tension shall be specified on shop drawings. At least 10% of bolts shall be mechanically checked for corrected tension.

Sequence of Installation

If so directed by the PMC, installation of the aluminum structural glazing and cladding shall be postponed in areas as designated by the PMC for a specified period of time so as to facilitate moving materials / equipment into and out of the building and installation of M&E (Mechanical & Electrical) fittings during construction. The Contractor's work is to proceed along guidelines and schedule as directed by the PMC.

Removal of Debris

All debris caused by or incidental to the installation work shall be promptly removed from the job site as the work progresses. Weep holes and drainage channels shall be unobstructed and free of dirt, rubbish and sealant.

Protection and Cleaning

a) The Contractor shall adequately protect all aluminum sections, glazing, cladding sheets, components and accessories from damage during shipment, storage, erection and after completion of the work by use of protective film / foil of approved non-staining quality,

b) At such time as may be directed by the PMC, the Contractor shall remove all protective coverings and / or coatings and clean surfaces free of all soil and discoloration. All cleaning agents shall be acceptable to the applicable aluminum, glass and coating manufacturers, and where doubt exists, spot tests shall be made to satisfy the PMC.

DESIGN DATA

• Temperature	:	60°C Ambient 100° C for Materials
• Wind Load	:	As per IS 875
• Deflections:		
• - Mullions	:	Max. L/240 or 15 mm whichever is less
• - Transomes, sills, heads, gutters	:	Max. L/300
• - Permanent deflection in Mullions	:	Max. L/3000 at 300 Kg/sqm. wind pressure
- Permanent deflection in transomes, sills, heads, gutters	:	Nil at 1.5 times dead load
• - Permanent deflection in cladding frame members	:	Nil at 300 kg/sqm. wind pressure.
• - Glass Panels	:	Max. 15mm or as recommended by glass manufacturer for each typical panel, whichever is less.
• R.C.C Grade	:	M30 M30

The following building movements are anticipated by the Architect after the building structure is completed. The Contractor shall adequately allow for these movements in his design.

(a) Differential horizontal displacement of building face Between consecutive floors due to wind or earthquake ± 6mm

(b) Differential vertical displacement of building face at any floor 4 mm

(c) Max. Axial compression in columns per floor height 0.8 mm

(d) Differential horizontal displacement between 2 consecutive Steel floor trusses ±12 mm

(e) Expansion/Contraction of RCC fascia per 10 m length Per 10°C temperature difference ±1.2 mm

PERFORMANCE DATA SHEET

FOR

VISION & SPANDREL GLASS PANELS

Outer Lite	6 mm heat strengthened hard coated "STOPSOL Classic Bronze" reflective glass, coated on face #2
Visible light:	
Day light transmission approx. (LT)	21%
Light Reflectance approx. (LR)	11% Ext. 34% Int.
Solar Energy:	
Direct Energy Transmission approx.(DET)	29%
Direct Energy Reflectance approx.(DER)	10%
Energy Absorption approx. (EA)	61%
Solar Factor approx. (SF)	44%
U Value $W/m^2.K$ (Appox)	5.7
Shading coefficient(approx)	0.51

TECHNICAL DATA SHEET

Note: The tenderer shall fill in data in the following format, complete in all respect and attach it to his covering letter. Relevant squares shall be ticked.

The tenderer should offer non preferred items only in case they are not at all able to offer preferred items. Due weightage will be given during evaluation of tenders if preferred items are offered.

CURTAIN WALL SYSTEM

a) Technical Collaborator

Name :

Country :

b) Type : Semi – Unitised System – Give details

Fully unitised 4 side structurally glazed System with subframes – Give details

- ❑ Fully unitised system without sub-frames – Give details

c) Installation :
- ❑ By crane
- ❑ By Cradle (Give details)
- ❑ By scaffolding

- ❑ From Inside
- ❑ From outside

- ❑ Any sequence of installation
- ❑ Continuous sequence of installation

- ❑ Glazed panel installation later
- ❑ Glazed panels installed with framing
- ❑ No silicon bonding on site (PREFERRED)
- ❑ Minimum silicon bonding on site (specify where)

d) Replacement of panels :
- ❑ Pre-fabricated and pre-glazed in factory (PREFERRED)
- ❑ Replacement by cutting gaskets / sealant and by on-site silicon bonding.

e) Elevation :
- ❑ As per Architect's drawings (COMPULSORY)
- ❑ All grooves of equal width (COMPULSORY)
- ❑ Only aluminium visible in grooves
- ❑ No aluminium edge and / or sealant visible on periphery of panels
- ❑ Tapered Aluminium edge and / or sealant visible on periphery of panels
- ❑ Silicon gasket / sealant in grooves (exposed to view)

f) Mechanical Support to glass :
- ❑ No mechanical support
- ❑ Mechanical support

g) Facility available for fabrication and coating (give details) :
- ❑ In own factory
- ❑ Through dedicated fabricators
- ❑ Through outside fabricators

h) Special features :
- ❑ Specify if any

2. ALUMINIUM EXTRUSIONS:

a) Make :

b) Grade & temper

i) For mullions, transomes etc. :

ii) For brackets & structural use :

c) Tolerances : DIN Standard or better (COMPULSORY)- give details

d) Protective coat : PVDF coating 35 Micron D.F.T. in approved colour

Min. 20 micron anodising in approved colour

Min. 40 micron powder coating in approved colour

3. MULLIONS, HEAD/SILL/INTERMEDIATE TRANSOMES, TRIMS AND SUB-FRMAES

a) Weight / metre :

b) Size :

c) Ixx :

d) Zxx :

e) Max. deflection : Mm (to be guaranteed)

f) Details : Give sketches

(Note: Submit data and details for each section separately)

4. OPENABLE PANELS:

a) Section (s) – wt./m :

b) Details : Give sketches

5. FIRE STOP CUM SMOKE SEAL

a) Fire resistance : ❑ Min. 2 Hour or as required by CFO (COMPULSORY)

b) Detail : Give sketch

6. FLASHING & CAPPING:

a) Details : Give sketches for all locations

7. BRACKETS ❑ M.S. Epoxy coated (COMPULSORY)

8. BOLTS, NUTS ETC. Stainless Steel Grade 316 (COMPULSORY)

:

9. SHIMS Same metal as for system component requiring shims of alignment.

:

10. SEPARATORS

(Give details) :

❑ PVC ply
❑ Aluminium both side Teflon – coated

11. GASKETS

:

❑ Silicon (COMPULSORY for exposed gaskets)
❑ EPDM Microwave – cured (PREFERRED)
❑ EPDM steam –cured

a) Details : Give sketches

b) Make :

12. SOUND PROOFING Give details

:

13. EXPANSION / CONTRACTION / BUILDING MOVEMENT

Max movement possible per horizontal and vertical groove:

b) Provision for noiseless movement : Give details

14. SEALANTS

a) Structural Sealant

i) Make :

ii) Grade :

iii) Components : ❑ 2 Component (PREFERRED)

❑ 1 Component

b) Weather Sealant

i) Make :

ii) Grade :

c) 2 Component Equipment : ❑ Available Factory
❑ Not Available

15. SPANDREL GLASS PANELS

i) Make of glass :

ii) Details of glass : Give catalogues with offered items highlighted

iii) Heat Strengthening : Give specs. And surface compression stress

Note: Give details for each type separately.

16. VISION PANELS

i) Make of outer glass :

ii) Construction : Give sketch with details of desiccant, vapour barrier and seal.

iii) Details of glass : Give catalogues with offered items highlighted.

(iv) Name of Manufacturer :

v) Heat Strengthening : Give specs. And extent of strengthening

Note: Give details for each type separately

17. DRAINAGE : ❑ Pressure Equalisation (CUMPULSORY) – (Give details)
❑ Other methods (Give details)

18. FACTORY TESTS ON PERFORMANCE : Give details & results on performance tests carried out on similar curtain wall panels.

1.12 CLADDING

1. Make of composite Units : ❑ ALPOLIC
ALUCOBOND

2.	Details	:	Give catalogues with highlighted items
3.	Coating	:	❑ PVDF (COMPULSORY)
	a) Resin Content	:	
	b) Total Dry film Thickness	:	
	c) Protection of back	:	Give details
4.	Guaranteed flatness after installation under no-wind condition	:	❑ ± 0.5 mm / M ❑ ± 1.0 mm / M
5.	Facility available for fabrication (Give details)	:	❑ In own factory ❑ Through dedicated fabricators Through outside fabricators
6.	Brackets	:	Aluminium (COMPULSORY)
7.	Gaskets	:	❑ Silicon (Compulsory where exposed) ❑ EPDM Microwave cured (PREFERRED) ❑ EPDM Steam cured

1.13 INTERFACES OF CURTAIN WALL AND CLADDING SYSTEMS WITH STRUCTURE

Flashings	:	Provided (COMPULSORY) (Give details)
Sealing	:	❑ Provided (COMPULSORY) (Give details)

1.14 FACILITIES FOR COATINGS (Give full details)

Anodising	:	❑ In own factory ❑ Through dedicated sub-contractors Through outside sub-contractors
PVDF Coating	:	❑ In own factory ❑ Through sub-contractors

TECHNICAL SPECIFICATION – 2.14

SPECIFICATION FOR FALSE CEILING

SPECIFICATION- MINERAL FIBRE TILE FALSE CEILING

False ceiling tiles will be of Fine Fissured type High NRC tiles of size 595 x 595mm and minimum 15mm thick manufactured from high density Glass wool with the visible surface be batch pre painted. The system should have sound Absorption NRC value of 0.7 .Tiles should withstand a permanent ambient RH up to 95% without sagging, The light reflectance of the tiles should not be less than 83%. Providing and fixing Gyp steel pre coated (Exposed portion only) GI T Grid system in 600x600mm module which includes providing and fixing wall angle along the perimeter of the room with help of nylon sleeves and wooden screws at 300mm centers. Then suspending the main tee of size from the soffit with help of soffit Deat , rawl plugs and wire rod with Leveling spring dip at 1200mm c/c. 1200mm Cross Tee is then interlocked into the pre-Cut slots in the main Tees at 600mm centres in direction perpendicular to the main Tee to make a grid of 600x1200mm.Finally 600mm Cross tees are then interlocked into the pre-cut slots in to the 1200mm tess at 1200mm centres and in direction parallel to the main tee. Cross Tees having length more than 600mm is to be supported independently. Tiles of size 595x595mm shall be placed into the grid size of 600x600mm.

SPECIFICATION- GYPSUM BOARD FALSE CEILING

Work shall be done as per IS 2469, IS 2547 (Part 1), IS 2547 (Part 2), IS 2095 (Part 1), IS 2095 (Part 2) and IS 2095 (Part 3) and any other relevant BIS/BS codes.

GENERAL NOTES:

1. Only ‘first’ quality materials shall be used.

2. Client reserves the right to choose any of the approved make /vendors as per the vendors list.

3. In case of products not indicated in the vendor list, only bis marked product shall be used.

4. Specification of manufacturer’s item shall be checked against tender item/specifications before selecting any product or brand name. in case of any discrepancy, tender item/specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even iif it is listed in this vendor list.

5. In case of non availability of any material among approved vendors/makes in a particular site/region, alternatevendor/make conforming to is/bs etc shall be used subject to approval by owner.

6. In case any product neither covered in the vendor list nor having bis specifications, the contractor shall submit the proposed product along with technical literature / specifications (as/bid), test certificates etc. and other credentials of the manufacturer for owner’s approval.

TECHNICAL SPECIFICATION – 2.15

SPECIFICATION FOR GRADED COARSE AGGREGATE

-

SPECIFICATION FOR GRADED COARSE AGGREGATE LAYER BELOW FLOOR

1.0 SCOPE

This specification refers to the surface of graded coarse aggregate to be provided below floor, plinth protection etc.

2.0 GENERAL

a. Graded coarse aggregate layer of thickness specified in the schedule of quantities or shown on the drawings shall be provided after the structural foundations and plinth constructions have been built and the filling in the plinths has been watered and thoroughly consolidated.

b. Materials

The aggregates to be of the quality as specified for concrete elsewhere. The sizes to be used are 50 mm to 40 mm, 40mm to 25 mm and 25mm to 20 mm

Materials like metal and moorum shall be stack measured as per specifications, before laying to ensure adequacy of the materials brought for use in respective items of work.

c. Construction Procedure

The bed on which the graded coarse aggregate layer is to be laid shall be cleared of all loose materials, levelled watered and compacted and got approved by the Engineer before laying the aggregate layer.

The metal shall be mixed thoroughly in a proportion of 2 parts of 50 mm metal, to 1 part of 40 mm and 25 mm each. The mixing shall be done before laying the same at site. It shall be laid in 2 layers of 11.5 cm. thickness and each layer shall boe consolidated to a thickness of 7.5 cm by an 8 to 10 T capacity mechanical roller. While laying, rolling and consolidating precautions shall be taken to ensure that no damage occurs to the masonry or any other portion of the structure. But special care shall be taken for compaction near masonry and concrete structures. Proper manual and vibratory tamping equipment shall be employed for satisfactory compaction in such areas.

After the second layer of graded coarse aggregate has been thoroughly consolidated, moorum to completely fill the interstices shall be applied gradually over the surface and dry rolling shall be done. After the completion of dry rolling, the rolled layer of moorum shall be sprinkled with water, moistened and again rolled over so as to provide an even surface. The maximum thickness of the finished moorum layer shall not exceed 12mm. The quoted rate shall include the moorum layer also.

Compacting shall be done by using an 8 to 10 ton capacity mechanical roller. At places which have no access for mechanical rollers, compaction shall be carried out using hand rollers as approved by the Engineer.

3.0 MEASUREMENT AND PAYMENT

The payment for various thickness of graded coarse aggregate layer shall be made on the basis of unit rate per Sq.m. in plan of the layer in position, limited however to the dimensions indicated in the plan or as directed by the Engineer.

Quoted rate for graded coarse aggregate layer shall include for consolidating the layers and surface finishing with moorum layer not more than 12 mm thick and all other incidental work required to complete the item as per these specifications.

TECHNICAL SPECIFICATION – 2.16

SPECIFICATION FOR READY-MIXED CONCRETE

SPECIFICATION FOR READY-MIXED CONCRETE

1.0 **Ready Mixed Concrete: -** Concrete delivered at site or into the purchaser's vehicle in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

1.1 **Agitation:** - The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation.

1.2 **Agitator:-** Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

1.3 **Truck Mixer** :- A mixer generally mounted on a self-propelled chassis, capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

2.0 **TYPES**

For the purpose of this standard, the ready-mixed concrete shall be one of the two types, according to the method of production and delivery as specified in 2.1 and 2.2

2.1 **Centrally-Mixed Concrete** – Concrete produced by completely mixing cement, aggregates, admixtures, if any and water at a stationary central mixing plant and delivered and the manufacturer, the concrete may be transported without being agitated.

2.2 **Truck-Mixed Concrete:-** Concrete produced by placing cement, aggregates and admixtures, if any, other then those to be added with mixing water, in a truck mixer at the batching plant, the addition of water and admixtures to be added along with mixing water, and the mixing being carried out entirely in the truck mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete commences.

3.0 MATERIALS

3.1 **Cement:-** The cement used shall be ordinary Portland cement or low heat Portland cement conforming to IS:269-1989/ OR 8112-1989/ OR 1226:1987 or Portland slag cement conforming to IS:455-1989 or 'Portland-pozzolana cement conforming to IS:1489,1991 ŧ or rapid hardening Portland cement conforming to IS:8041E-1976 as may be specified by the purchaser at the time of placing the order. If the type is not specified, ordinary Portland cement shall be used.

3.1.1 Fly ash when used for partial replacement of cement, shall conform to the requirements of IS:3812 -1981

3.2 **Aggregates** – Unless otherwise agreed to between the purchaser and the manufacturer, the aggregates shall conform to IS:383-1970 . Fly ash when used as fine aggregate shall conform to the requirements of IS:3812-1981.

3.2.1 Water used for concrete shall conform to the requirements of IS:456-2000.

3.3 **Admixtures –** Admixtures shall only be used when so agreed to between the purchaser and the manufacturer. The admixtures shall conform to the requirements of IS:456-2000, and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete, shall conform to IS:3812-1981.

3.4 **Measurement and Storage of Materials** - Measurement and storage of materials shall be done in accordance with the requirements of IS:456-2000.

4.0 BASIS OF SUPPLY

4.1 Depending upon the agreement between the purchaser and the manufacturer, the ready-mixed concrete shall be manufactured and supplied on either of the following basis:

a) Specified strength based on 28-day compressive strength of 15-cm cubes tested in accordance with IS: 456-2000.

b) Specified mix proportion.

Note: Under special circumstances and subject to the agreement between the purchaser and the supplier, strength of concrete in (a) above may be based on 28-day or 7-day flexural strength of concrete instead of compressive strength of 15-cm cube tested in accordance with IS: 456-2000.

4.1.1 When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements specified in 4.5.7.

4.1.2 When the concrete is manufactured and supplied on the basis of specified mix proportion, the responsibility for the design of the mix shall be that of the purchaser and the concrete shall conform to the requirements specified in 4.5.8.

4.1.3 The general requirements specified in 6 shall apply to the concrete supplied on either of the basis given in (a) or (b) of 4.5.5.1.

4.1.4 Measurement of Ready-Mixed Concrete.

4.1.5 The basis of purchase shall be the cubic meter of plastic concrete as delivered to the purchaser.

4.1.6 The volume of plastic concrete in a given batch shall determine from the total mass of the batch divided by the actual mass per m^3 of concrete. The total mass of the batch shall be calculated either as the sum of the masses of all materials, including water, entering the batch or as the net mass of concrete in the batch as delivered. If the purchaser wishes to verify the total mass, of the batch, this shall be obtained from

the gross and tare masses of the vehicle on a stamped weigh bridge. The mass per m^3 shall be determined in accordance with the method given in IS: 1199-1959.

4.2 GENERAL REQUIREMENTS

4.2.1 In addition to the requirements specified in this standard and subject to such modifications as may be agreed to between the purchaser and the manufacturer at the time of placing order, the ready-mixed concrete shall generally comply with the requirements of IS:456-2000.

4.2.2 Unless otherwise agreed to between the purchaser and the supplier, the minimum quantity of cement and the details regarding proportioning and works control shall be in accordance with IS:456-2000.

4.2.3 When a truck mixer agitator is used for mixing or transportation of concrete, no water from the truck-water system or from elsewhere shall be added after the initial introduction of the mixing water for the batch, except when on arrival at the site of work, the slump of the concrete is less than that specified; such additional water to bring the slump within required limits shall be injected into the mixer under such pressure and direction of flow that the requirements for uniformity specified in Appendix. A are met.

4.2.3.1 Unless otherwise agreed to between the purchaser and the supplier, when a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work and discharge shall be complete within 1½ hour (when the prevailing atmospheric temperature is above 20º C)and within 2 hours (when the prevailing atmospheric temperature is at or below 20º C) of adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the aggregate, whichever is earlier.

4.2.4 Temperature

4.2.4.1 The temperature of the concrete at the place and time of delivery shall be not less than 5º C. Unless otherwise required by the purchaser, no concrete shall be delivered, when the site temperature is less than 2.5º C and the thermometer reading is falling.

4.2.4.2 The temperature of the concrete shall not exceed 5º C above the prevailing shade temperature, when the shade temperature is over 20º C. The temperature of concrete mass on delivery shall not exceed 40º C.

4.2.4.3 Sampling and Testing

4.2.4.4 Adequate facilities shall be provided by the manufacturer for the purchaser to inspect the materials used, the process of manufacture and the methods of delivery of concrete. He shall also adequate facilities for the purchaser to take samples of the materials used.

4.3 **Sampling and Testing** – Unless otherwise agreed to between the purchaser and the supplier, the sampling and testing of concrete shall be done in accordance with the relevant requirements of IS: 456-2000, IS:1199-1959 and IS:516-1959

4.4 **Consisting or Workability** – The tests for consistency or workability shall be carried out in accordance with requirements of IS:1199-1959 or by such other method as may be agreed to between the purchaser and the manufacturer.

4.5 **Strength Test** – The compressive strength, and flexural strength tests shall be carried out in accordance with the requirements of IS:516-1959 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements mentioned below.

4.5.1 Compressive Strength

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

a) The mean strength determined from any group of four consecutive test results compiles with the appropriate limits in col. 2 of Table A.

b) Any individual test result complies with the appropriate limits in col.3 of Table A.

4.5.2 Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2.

b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2.

4.5.3 Quantity of Concrete Represented by Strength Test Results.

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

For the individual test result requirements given in col.2 of Table A or in item (b) of 16.2 only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m^3.

4.5.3.1 If the concrete is deemed not to comply pursuant to 4.5.6.5.4.3, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

4.5.3.2 Concrete of each grade shall be assessed separately.

4.5.3.3 Concrete is liable to be rejected if it is porous or hone-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Project Manager.

Table A
Characteristic Compressive Strength Compliance Requirement

Specified Grade	Mean of Group of 4 Non-Overlapping Consecutive Test Results in N/mm².	Individual Test Results in N/mm².
(1)	(2)	(3)
M15	+0.825 x established standard deviation(rounded off to nearest 0.5 N/mm².	N/mm².
M 20 or above	+ N/mm², whichever is greater + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm²) or +4 N/mm², whichever is greater	N/mm².
Note:- In the absence of established value of standard deviation, the value given in Table 8 of IS:456-2000 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.		

4.5.4 **Cost of Testing** – Unless otherwise agreed to between the purchaser and the manufacturer, the cost of the tests carried out in accordance with the requirements of this specification shall be borne as follows:

a) By the manufacturer if the results show that the concrete does not comply with the requirements of this standard.

b) By the purchaser if the results show that the concrete complies with the requirements of this standard.

4.5.5 Manufacturer's Records and Certificates – The manufacturer shall keep batch records of the quantities by mass of all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required by the purchaser, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

4.6 CONCRETE MANUFACTURED AND SUPPLIED ON THE BASIS OF SPECIFIED STRENGTH

4.6.1 The purchaser shall supply the following information for guidance of the manufacturer :

a) The type of cement to be used;
b) The maximum size and type of the aggregate;
c) The type of admixtures to be used;
d) The minimum acceptable compressive strength of flexural strength or both, determined from samples of plastic concrete taken at the place and time of delivery, in accordance with requirements of IS:456-2000.
e) The slump or compacting factor or both, or other requirements for consistency or workability at the place and time of delivery of the concrete;
f) The ages at which the test cubes or beams are to be tested, and the frequency and the number of tests to be made; and
g) Any other requirements.

4.6.2 Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirement of this standard, if the results of tests where applicable, lie within the tolerances specified in 4.6.1.1 and 4.6.1.2

4.6.1.1 Consistency of workability – The slump (average of two tests) shall not differ from the specified value by ± 10 mm for a specified slump of 75mm or less and ± 25mm when the specified slump is greater than 75m. The compacting factor average of two tests shall be within ± 0.03 of the value specified. If any other method of determining consistency is to be used, a suitable tolerance shall be agreed to between the purchaser and the manufacturer. The test for consistency or workability shall be completed within 15 minutes of the time of receipt of the ready-mixed concrete at the site.

4.6.1.2 Aggregates – When tested in accordance with IS:2386 (Part I) – 1963, the quantity of aggregate larger than the maximum size specified by the purchaser shall not exceed 5 percent of the quantity of coarse aggregate and all such excess shall pass through sieve (conforming to IS:460 (Part 1-3)1985 of the next higher size.

4.7 CONCRETE MANUFACTURED AND SUPPLIED ON THE BASIS OF MIX PROPORTION

4.7.1 The purchaser shall supply the following information for guidance of the manufacturer:

a) The type of the cement to be used;
b) The sizes and types of the aggregate;
c) The type of admixtures to be used;
d) The proportions of the mix including the maximum water cement ration at the place and time of delivery of the concrete;
e) The minimum mixing time after addition of the water; and
f) Any other requirements.

4.7.2 Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirements of this standard, if the result of tests where applicable, lie within the tolerance specified in 4.5.8.2.1 to 4.5.8.2.4.

4.7.2.1 Cement Content – The cement content, as shown by the samples taken, shall be not less than 95 percent of that specified.

4.7.2.2 **Ration of Coarse to Fine Aggregates** – The ratio of coarse to fine aggregates, as indicated by the sample taken, shall neither exceed nor fall below the ration specified by the purchaser by more than 10 percent.

4.7.2.3 **Water/ cement Ration**- ± 5 percent of the specified value.

4.7.2.4 **Consistency or Workability** – The slump shall not differ from the amount specified by ± 10mm for a specified slump of 75 mm or less and ± 25mm when the specified a slump is greater than 75mm. The compacting factor shall be within ± 0.03 of the value specified. If any other method of determining consistency is used, a suitable tolerance shall be agreed to between the purchaser and the supplier.

APPENDIX A
(Clause 4.5.6.3)

CONCRETE UNIFORMITY REQUIREMENT

A-1. TESTS

A-1.1 The variation within a batch as provided in Table I shall determined for each property listed as the difference between the highest value and the lowest value obtained from the different portions of the same batch. For this specification the comparison shall be between two samples, representing the first and last portions of the batch being tested. Test results conforming to the limits of five of the six tests listed in Table I shall indicate uniform concrete within the limits of this specification. Analysis of concrete samples shall be made in accordance with the relevant requirements of IS:1159-1959.

A.2. COARSE AGGREGATE CONTENT

A-2.1 Coarse aggregate content shall be determined using the following equation:

$$P = \frac{c}{b} \times 100$$

Where P= Percentage of coarse aggregate by mass in concrete;

c= saturated surface dry mass in kg of aggregate retained on 4.75 mm IS Sieve, resulting from washing all material finer than this sieve from the fresh concrete; and

b= mass of sample, in kg of fresh concrete in unit mass container.

IS:4926 – 1976

TABLE 1 REQUIREMENTS FOR UNIFORMITY OF CONCRETE
(Clause A.1.1)

	TEST	Requirement expressed as maximum permissible difference in results of tests or samples representing the first and last portions or concrete batch
	2	3
	Mass per cubic metre calculated to an air-free basis	16 kg/m³
	Air-content, percent by volume of concrete	1.0
	Slump:	
	If average slump is 10cm or less	2.5 cm
	If average slump is 10 to 15 cm	3.8 cm
	Coarse aggregate content, percent (portion by mass of each sample retained on 4.75-mm IS Sieve)	6.0
	Unit mass of air-free mortar, percent based on average for all comparative samples tested	1.6
	Average compressive strength at 7 days for each comparative test specimens, percent	7.5

A-3. UNIT MASS OF AIR FREE MORTAR

A-3.1 Unit mass of air free mortar shall be calculated as follows:

$$M = \frac{[b - c]}{\left\{V - \left(\frac{V \times A}{100} + \frac{c}{1000G}\right)\right\}}$$

Where M= Unit mass of air free mortar in Kg/m³

b= mass of concrete sample in unit mass container in kg,

c= saturated-surface-dry mass of aggregate in kg retained on 4.75mm IS Sieve,

V= Volume of unit mass container in m^3

A= air content of concrete in percent measured in accordance with the relevant requirements of IS:1199-1959*, and

G = specific gravity of coarse aggregate.

SECTION - 3

LIST OF APPROVED MANUFACTURERS / SUPPLIERS - CIVIL

Approved Manufacturers/ Suppliers

All materials and products shall conform to the relevant Standard Specification, IS codes and other relevant codes etc. and shall be of approved make and design. The list of approved makes for products and materials is given below. Other equivalent manufacturers can only be considered with prior approval of the Employer subject to testing of the material for equivalent specification and properties.

LIST OF APPROVED MAKES

Sl.No.	Item	Make
A) General Building Materials:		
1	Aluminium Doors and Windows, Curtain walls and Structural Glazing	Indal / Jindal / Bhoruka
2	Cement	Ultratech / Coromandal / ACC / Birla/JK Cement/ Grasim
3	Reinforcement Steel	SAIL / TATA / RINL /Tiscon/Zindal
4	Glass	Modi Guard / Saint Gobain / Asahi / Glaverbel
5	Paint	Asian / Nerolac / Berger / Sherwin Williams
6	Ceramic / Vitrified tiles	RAK / Somany / Spartek / Kajaria
7	Galvalume Roof sheeting / Cladding	Tata Blue Scope Steel / JSW steel / Ispat Industries / Bhushan Power & steel or Approved Equivalent
8	Day lighting Polycarbonate panels	Sabic Innovative Plastics or Approved Equivalent
9	Aluminium Composite panels	Alpolic Fr / Alucobond plus / Reynobond /ALU Bond or Approved Equivalent
10	Self tapping screws for Roofing / Cladding	HILTI / BUILDEX or Approved Equivalent
11	Floor surface hardener	DRIETOP FH / Sika Chapdur / LIQUI-HARD or Approved Equivalent
12	Floor Coating	Sika / Fosroc/BASF or Approved Equivalent
13	EPDM	AMEE /ARDEX/ Approved equivalent

Sl.No.	Item	Make
14	Construction chemicals	Fosroc / Sika / BASF/ARDEX or Approved Equivalent.
15	Structural steel	SAIL / TISCO /Jindal or Approved Equivalent
16	RMC Manufacturers	L & T / RMC INDIA/ Ultratech or Approved Equivalent
17	Formwork suppliers	Pranav / L & T / Maruthi Fab (Pune)
18	Flush Doors	Kutty/Niki/National/Century/Green ply
19	PVC Doors	M/s. Sintex / M/s. Niki/Royal Industry & Trade Co
20	Reinforcement couplers	Usha Ismal / Dextra / BBR / Moment
21	Testing Labs for (Concrete, Soils, Steel etc)	Civil AID / Karnataka test house.
22	Plywood	M/s. Kitply / M/s. Archid ply/ Green Ply/ Osten Ply/ Century/ National

SECTION: E

TECHNICAL SPECIFICATIONS –
ELECTRICAL WORKS

GENERAL

This part outlines the particular requirements for the electrical works. The Contractor shall provide electrical systems as detailed in this part. Unless specified in this section to the contrary the electrical equipments provided by the Contractor and workmanship shall comply with the detailed technical specifications for electrical works.

Definitions

The following abbreviations used in the bill of quantities, specifications and drawings represent:-

IS	: Indian Standard Specifications published by Bureau of Indian Standards
BS	: British Standard.
HRC	: High Rupturing Capacity.
GI	: Galvanised Iron.
MS	: Mild Steel.
CI	: Cast Iron.
APLSTS	: Aluminium Conductor, Paper Insulated Lead, sheathed, Double Steel Tape Armoured and Served.
XLPE	: Cross Linked Polythene.
PVC	: Poly Vinyl Chloride.
HT	: High Tension.
LT	: Low Tension.
AMP	: Ampere.
KV	: Kilo Volts.
PT	: Potential Transformers.
CT	: Current Transformers.
VCB	: Vacuum Circuit Breaker.
ACB	: Air Circuit Breakers.
MCCB	: Moulded Case Circuit Breakers.
ELCB	: Earth Leakage Circuit Breakers.
CFS	: Combination Fuse Switch.
MCC	: Motor Control Cubicle
PMCC	: Power and Motor Control Cubicle.
MCB	: Miniature Circuit Breaker.
FDB	: HRC Fuse Distribution Board.
LDB	: Lighting Distribution Board.
PDB	: Power Distribution Board.
KVA	: Kilo Volts Ampere.
KW	: Kilo Watts.
HP	: Horse Power.
SWG	: Standard Wire Gauge.

Codes, Regulations and Standards

The installation shall conform in all respects to Indian Standard Code of Practice for Electrical Wiring Installation I.S. 732. It shall also be in conformity with the current Indian Electricity Rules Safety Codes and the Regulations and requirements of the Local Electrical Supply Authority. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, this specification shall take precedence over the said regulations and standards. In general, the materials, equipments and workmanship not covered by the above shall conform to the following Indian Standards (latest), unless

otherwise called for. Nothing in the enclosed specification shall be construed to relieve the contractor of his responsibility.

a.	Heavy duty air break switches & composite units of air break switches and fuses for voltages not exceeding 1000 V.	: IS 4047
b.	Specification for enclosed distribution fuses Boards & cut-outs for voltages not exceeding 10000 Volts.	: IS 2675
c.	Installation and maintenance of switchgear.	: IS 3072 (Part I).
d.	HRC cartridge fuse links 650 Volts	: IS 2208.
e.	PVC insulated (Heavy duty) electric cables Part-I For voltage upto 1100 V	: IS 1554.
f.	Specifications for Rigid steel conduits for electrical wiring.	: IS 1653.
g.	Specifications for accessories for rigid steel Conduits for electrical wiring.	: IS 3837.
h.	Specifications for PVC Electrical Conduit pipes	: IS 9537.
i.	Boxes for the enclosures of electrical accessories Part-I, Steel & CI boxes.	: IS 5133 (Part I).
j.	3 pin plugs and socket outlets	: IS 1293
k.	Code of Practice for Earthing	: IS 3043.
l.	Code of Practice for fire safety for buildings (General Electrical Installation)	: IS 1646
m.	Protection of buildings and allied structures against lightning.	: IS 2309.
n.	Current Transformers	: IS 2705 (Part I to III)
o.	Shunt capacitors for power system	: IS 2834
p.	Direct acting electrical indicating instruments.	: IS 1248
q.	Miniature Circuit Breaker.	: IS 8828
r.	Method of measurement of electrical Installation in buildings	: IS 5908
s.	Guide for Safety Procedures and practices in Electrical Work	: IS 5216
t.	Arrangement of bus bars, main connection and auxiliary wiring	: IS 375
u.	AC Electricity Meters	: IS 722
v.	Degree of protection provided by enclosures for Low voltage switch gear and control gear	: IS 2417
w.	Dimensions of panel mounted electrical Indicating and recording instruments	: IS 2417
x.	Circuit breakers	: IS 2516

y.	Air break isolators for voltages not exceeding 1000V	:	IS 2607
z.	Air break switches, air break disconnector and Fuse combination units for voltages not exceeding 1000V AC or 1200V DC	:	IS 4064
aa.	General requirements for switch gear and control gear for voltages not exceeding 1000V	:	IS 4247
bb.	Preferred panel cut-out dimension for electrical relays	:	IS 4483
cc.	Selection of switches (voltages not exceeding 1000V)	:	IS 5987
dd.	Control switches for voltages upto & including 1000V AC and 1200V DC	:	IS 6875
ee.	Factory built assemblies of switch gear and Control gear for voltages upto and including 1000V AC & 1200V DC	:	IS 8623
ff.	Code of practice for electrical wiring installation	:	IS 732
gg.	PVC insulated cables for working voltages upto and including 1100V	:	IS 1554 (PART I)
hh.	PVC insulation and sheath of electric cables	:	IS 5831
ii.	Conductors for insulated electrical cables	:	IS 8130
jj.	Recommended current ratings for PVC Insulated and PVC sheathed heavy duty cables	:	IS 3961
kk.	Galvanised round steel wire	:	IS 3975
ll.	Indian Electricity Rules 32, 61, 67 and 68 of IER 1956 (for Earthing)		

1 TECHNICAL SPECIFICATION FOR 11 KV CABLES

1.1. Scope

The scope of this package, covers the design, manufacture, stage inspection at works, inspection and testing of finished cables at manufacture's works, testing at independent test house, packing, transport and delivery to consignee's address of 6.35/ 11KVThree Core, aluminium conductor, XLPE insulated, screened, underground Cables as per specified construction.

Technical Requirement: Three Core 6.35/ 11KV grade, 900C rating heavy duty power cable with stranded compacted circular aluminium conductor shielded with extruded semi conducting compound, cross linked polyethylene insulated, shielded with extruded semi conducting compound and copper tape, shielded cores laid up with fillers inner sheath of extruded PVC, Galvanized round steel wire Armour and PVCST-2 overall sheath.

The cables should be suitable for use in solidly earthed system.

The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed. The installation of the cables shall be carried out by an approved, qualified and experienced person in the Trade.

Cable shall be laid in cable duct or directly burried details specification shall be under go in the laying of HT cables.

Bidder to consult BESCOM if the cable specification to be as per BESCOM rules & standards, if the specs to be modified the same needs to corrected.

1.2. Standards

The 11KV UG Cables shall, in general, meet the requirements of the latest edition of the Bureau of Indian Standards, (generally referred as IS) IS 7098 (Part-2) 1985. The cables manufactured to and meeting the testing requirements of international standards, like B.S.S. IEC or equivalent standards are also acceptable. The bidders shall enclose a copy of the equivalent international standard, in English Language, along with the Bid.

The cables covered by the specification shall, unless otherwise stated, be designed, manufactured and tested in accordance with the latest revision of relevant India standard.

IS 7098	:	Cross Linked Polyethylene Insulated PVC (Part II) Sheathed cables
IS 3975	:	Mild Steel Wires, strips and tapes for armouring of cables.
IS: 8130	:	Conductor for insulated electric cables and Flexible cords.
IS 5831	:	PVC Insulation and Sheath of Electric Cables.
IS: 10418	:	Specification for drums for electric cables.
IEC 540 & 540 A	:	Test method for insulation and sheath of electric cables and cords.
IS: 10810	:	Methods of tests for cables
IS: 10462	:	Fictitious calculation method for determination of dimensions of Protective coverings of cables.
IS: 10418	:	Specification for drums for electric cables.

1.3. General Technical Particulars:

1) Nominal System Voltage (rms) (u)	-	11 KV
2) Highest System Voltage (rms) (urn)	-	12 KV
3) Phase to Earth Voltage (uo)	-	6.35 KV

4) Number of Phases (for 3 core cables)- 3

5) Frequency - 50 Hz

6) Variation in frequency - ±3%

7) Typeof Earthing - Solidly Earthed

8) Basic impulse level (1.2/50 Micro Second Wave - 75 KV

9) Total relay & circuit break operating time - 15-20 Cycles

10) One minute power frequency withstand voltage - 28 KV

1.4. Conductor:

11 kV HT cables(E) shall be circular, compacted, stranded three core as per Design Criteria, Al. Conductor, XLPE insulated, conductor and insulation screened, extruded PVC ST2 inner sheathed, galvanized steel strip armour, extruded PVC ST2 outer sheathed, conforming to IS 7098 Part 2 (1988). Cables shall be suitable for conductor temperature of 90 º C. for continuous operation and 250 º C. at the end of short circuit.

11 kV 3Core Aluminium Cables shall be from the nearest BESCOM source to the temporary switch yard area.

Stranded aluminium/copper conductor (grade H4, class 2 as per IS: 8130) shall be used as current carrying conductors for cables.

The conductor shall be Aluminium / Copper as specified. The conductor shall be smooth, uniform in quality and free from scale and other defects. The Aluminium conductor shall be stranded and shall be clear and reasonably uniform in size and shape. The conductor shall be circular or sector shaped. The conductor for shall be stranded and shall be clear and reasonably uniform in size and shape. The conductor shall be circular or Sector Shaped. The stranded conductor shall be compacted to reduce dimension and to give smoother profile.

1.5. Conductor Screen

The conductor screen shall be semi conducting compound and shall be extruded in the same operation as the Insulation. The cores shall be screened by extruded semi-conducting compound in combination with non-magnetic metallic tape of copper.

1.6. Insulation

Insulation shall be cross-linked polyethylene and shall be gas cured.

1.7. Insulation Screen

The semi conducting insulation shield shall be strippable and triple extruded thermo set type.

The Insulation shall be screened by extruded semi conducting compound. Metallic screening consisting of annealed copper tape shall be applied over the non-metallic screening.

1.8. Inner Sheath

The inner sheath shall be extruded PVC. Polypropylene filler shall be provided.

Cable shall be provided with extruded PVC inner sheath conforming to type ST-2 (as per IS: 5831) covering all the cores of cable and shall be compatible with insulation provided for the cables.

1.9. Armour

Galvanised steel wire / strips armour shall be provided over the inner sheath for protection against mechanical damage.

The armour coverage shall be more than 95% to achieve better mechanical protection and low armour resistance.

Galvanized steel strip armour shall be provided for the cables conforming to IS 3975.

1.10. Outer Sheath

The outer sheath shall be of an extruded layer of suitable synthetic material compatible with the specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite, and rodent attacks.

The colour of the outer sheath shall be Red.

The FRLS outer sheath shall meet the following requirements:

a. The oxygen index value shall be minimum 29 when tested at 27 ± 2℃ as per ASTM-D-2863-77 and temperature index value shall be minimum 250℃ when tested as per NES 715.
b. The maximum total acid gas generation as determined by titration shall be less than 20 % by weight. The test shall be conducted as per IEC-754-1.
c. The smoke density shall be 60% maximum, when tested as per ASTM-D-2843-77.
d. The finished cable shall pass the flammability test as per IEC-332-1. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475.

1.11. General

The cable shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

1.12. Temperature Rise

The maximum conductor temperature shall not exceed 90 degree C during continuous operation at full rated current. The temperature after short circuit for 1.0 second shall not exceed 250 degree C with initial conductor temperature of 90 degree C.

The Bidder shall give the following information for each conductor cross section specified.

a) Rated continuous current

b) Rated 1.0 second current. Current Rating factor shall be given by the Contractor for the following:

- Variation in ground temperature

- Variation in soil thermal resistivity
- Variation of Ambient temperature
- For the cables laid side by side, at ID spacing and in Tier formation.

The Bidder indicates the percentage overload that the cable can carry and its duration, when operating initially at a conductor temperature of 90 degree C, with final conductor temperature of 130 degree C.

1.13. Cable Drums

Cables shall be supplied on non-returnable drums of sturdy construction as new in condition. All ferrous and other metal parts of drum shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

The length of cable on each drum shall be determined by manufacturer considering the transport limitations from manufacture's works to the site. The manufacturer will advice contractor of drum length before production.

The marking done on the drum shall have the following information:

- Trade name, if any
- Name of the manufacturer
- Number of cores and nominal area of the conductor
- Type of the cable and voltage for which it is suitable
- Length of the cable on the drum
- Direction of rotation of drum (an arrow)

The outer ends of the cables shall be sealed by means of non-hygroscopic sealing materials.

1.14. Cable Jointing

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of jointing of cable. Cable joint boxes of appropriate size, suitable for XLPE insulated 11000 volts ratings shall be used as per manufacturer’s instructions. All cable joints shall be made in suitable, approved cable joint boxes. Jointing of Cables in the joint boxes and the filling in of compound / heat shrink tape insulation shall be done in accordance with the best practices in the trade, in accordance with manufacturer's instructions and in an approved manner utilizing the cable Manufacturers recommended Kits. All straight T- joints shall be done in epoxy mould boxes with epoxy resin and jointing accessories from a reputed and approved manufacturer. All terminal ends of conductors shall be crimped using tinned copper lugs / ferrules.

All cables shall be jointed colour to colour and tested for continuity and insulation resistance before jointing commences. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day

as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and use of spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound being topped as necessary to ensure that the box is properly filled. Heat shrink kits of approved make can be used.

1.15. Cable Terminations

Cable termination shall done utilizing Cable End Termination kits of approved Makes, and as per the Guidelines of the cable Manufacturer.

1.16. Bonding Of Cables

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armoured clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that in the event of ground movement no undue stress is passed on to the cable conductors. The cable gland and armour shall be bonded together using suitable copper clamp and shall be connected to casing on either ends of the cable length.

1.17. Laying Of Cables

HV Cables shall be laid either buried directly underground or in Masonry/ Concrete trenches. The cable buried underground shall be at minimum depth of 1.2 M from the ground level. Sand cushion of not less than 80mm shall be provided both above and below the cable with a protective concrete slab on the top of the sand layer. The cable trench shall be backfilled and compacted.

1.18. Protection Of Cables

The cable shall be protected by placing pre-cast reinforced 50mm, thick (1:2:4) concrete slabs 200mm wide on top layer of sand for the length of the cable. Where more than one cable is running in the same trench, the concrete blocks shall cover all the cables and shall project minimum 80mm on either side of the cables.

Cables under road crossings and any surfaces subjected to heavy traffic shall be protected by running them through RCC Hume pipe of suitable size.

1.19. Excavations and Backfill

All excavations and backfilling including asphalting shall be carried out by the contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150 mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The contractor shall restore all surfaces, roadways, sidewalks curbs, walls or other works cut by excavation to their original condition, satisfactory to the Client/ Consultants.

1.20. Markers and Warning Plates

Approved GI Cable markers shall be provided along the route of the cable at every 30 M distance and at both ends at road crossings, indicating “HT Cables". Special GI cable markers shall be provided at all buried cable joints indicating "Electrical Cable

Joint".

ROUTINE TESTS (To be performed on each drum length)

These shall include, among others normally performed by the manufacturer, the following:

- Conductor D.C. resistance test
- Capacitance
- Partial discharge level measurement at Power frequency
- High voltage test

1.21. Testing Of Cables

Prior to burying cables, following tests shall be carried out:

Insulation between Phases and, between Phase & Earth for each length of cable, before and after jointing.

On completion of cable laying work, the following tests shall be conducted in the presence of the Client.

- Insulation Resistance Test (sectional and overall)
- Continuity resistance test
- Sheathing continuity test
- Earth test

All tests shall be carried out in accordance with relevant Indian Standard Code of Practice (BIS CP) and Electricity Rules. The Contractor shall provide necessary Instruments, Equipment and labour for conducting the above Tests and shall bear all expenses in connection with such tests. All test equipment used for the tests shall bear a calibration seal not more than six months old.

Wherever called for, a hi-pot test in accordance with BIS shall also be performed shortly before commissioning of the HV cable.

Soil Conditions: The knowledge of the soil and environmental conditions helps in selecting type of finish of protective covering of the cable and the route of lying. The knowledge of type of micro biological organizations and termites existing in the soil where the cables are to be stored or installed may also be useful.

Chemical Action: The soil may contain such chemicals which are deterring mental to the life of the cable. It is, therefore, advisable that the pH value and the chemical compost ion of the soil to be determined

Electrolytic corrosion: Where the possibility electrolytic corrosion exists for example, adjacent to DC traction system the potential gradient along the pipe line and the cable sheath should be specified

Minimum permissible Bending radii: The cable should not be bent to a sharp radius

minimum recommended bending radii are given below:

Single core	Multi core	Voltage in kV
15 D	15 D	Above 1.1 to 11
20 D	20 D	Above 11

* D is outer radius of the cable

22kV, 33kv rating 1.05 meters.

3.3kV to 11 kV rating 0.9 meters

1.22. Clearances

Power cable to control cable	:	0.2 meter
Power cable to communication cable	:	0.3 meter
Power cable to gas / water mains	:	0.3 meter

Cable laid across the roads, railway tracks and water pipe lines:

Materials to be used for Pipes: Steel cast iron, cement or earth ware ducts are cable ducting blocks. The diameter of the cable conduit should be at least 1.5 times the outer diameter of the cable. The ducts / pipes should be mechanically strong to with stand force due to heavy traffic when they are laid across the road / railway tracks.

- Testing of cables installation
- Measurements Insulation
- Resistances Conductor
- Resistances (DC)
- Capacitances
- High voltage test

1.23. 11kv HT Power Cables

SL.No	DESCRIPTION	TECHNICAL PARTICULARS
1.	System voltage	11 kV, 3 phase, 3 wire
2.	Highest system voltage	12 kV
3.	System neutral	Non- Effectively Grounded
4.	Fault level	
	a) Symmetrical RMS	40 kA (As per BESCOM)
	b) Peak	100 kA Peak
5.	Installation	In Built up trenches, Indoor laid on cable trays

SL.No	DESCRIPTION	TECHNICAL PARTICULARS
6.	Design Ambient temperature	45 deg. C
7.	Ground temperature	40 deg. C
8.	Insulation	XLPE
9.	Conductor material	Aluminium
10.	Armour	Galvanised steel strip/wire
11.	Sheath material	Extruded PVC inner and outer sheath conforming to type ST-2 (as per IS: 5831)
12.	Additional information	
	a) Voltage variation	+10% to –10%
	b) Frequency variation	+5% to –5%
13.	Cable size	
14.	Number of cores	3 Core

2 TECHNICAL SPECIFICATION FOR RMU PANEL WITH 3WAY LBS

2.1. Cubicle

RMU panels shall be generally as per BESCOM standards, below specs if only for reference. Bidder to follow the BESCOM rules for manufacturing the Ring main unit panels.

Each cubicle shall be fully compartmentalized with metallic partitions having separate chambers for main busbars, CTs and cable terminations, switching device, LV chamber for metering, protection and control equipment. The metallic partitions shall be earthed and compartments thus formed shall be dust and vermin proof.

Metal clad switchboard fabricated with CRCA sheet steel having enclosure degree of protection of IP4X without forced ventilation. Separate panels shall be provided for VCBs, Line/Bus PTs.

The switchboard shall be extendible on both sides. Removable bolted end covers shall be provided at both ends to achieve this. Suitable gaskets shall be provided in between adjacent panels to facilitate overall IP4X degree of protection.

No live part of the switchboard shall be accessible from outside during normal operating conditions and at all positions of CB/PT trucks. CB / PT / earthing truck front plates shall be designed to ensure this. Front plates to be suitable for withstanding forces due to full arcing fault inside panel.

Complete isolation shall be ensured between busbar chamber and CB chamber for both service and isolated positions. Safety shutter design shall suit this. Provision for padlocking safety shutters in open & close positions shall be provided.

CB/PT/Bus Link chambers shall be provided with front doors (additional to truck front

plate) with preferably padlocking arrangement at three locations. CB/PT/Bus Link/Earthing trucks in Test Positions shall be fully inside the closed front doors.

Metallic isolation shall be provided between busbar and cable chambers Rear access (separate for busbar chamber and cable chamber) shall be by bolted covers with cross stiffeners on inner side and handles on outer side. Suitable caution symbol to be painted on bus and cable chamber covers. Resettable explosion vents to be provided on busbar chamber, cable chamber and circuit breaker chamber.

Name plates shall be of anodized aluminium. Panel No. and feeder name plates with ratings to be painted on panel front, rear and CB truck front plate CT details shall also be painted on the panel rear. Device identification name plates to be provided beside every equipment by fixing on the panel body.

Additionally, device identification to be painted on the panel body. Maximum operating height of any device will not be more than 1900 mm from the floor level. All meters and switches shall be flush mounted on the Metering/LT chamber door.

Dummy panels provided shall be of full height and depth and shall be provided whenever required, to negotiate floor beams and to terminate bus-ducts .Dummy panel width shall be same as that of associated VCB panel. The final number of dummy panels shall be decided during detail engineering based on actual dimensions of panels offered.

Additional base frames shall be provided.

Pressure relief flaps, which cannot be opened from outside shall be provided to vent upwards in case of arcing faults inside the cubicle. To ensure personnel safety, the following conditions shall be met for internal arcing faults.

i. Correctly secured doors, covers etc., must not open.
ii. Parts, which may cause hazard to personnel, must not fly-off.
iii. Earthing connections must remain effective.

2.2. Busbars

Busbars shall be made of Aluminium. Maximum temperature of busbars, joints at rated current shall not exceed the limits specified in the design criteria. Provision shall be made for taking up changes in length of busbars due to change in temperature.

Bus bar cross-section shall be selected based on the temperature rise indicated. Main busbars shall have same cross sectional area throughout its length and feeder busbars shall be rated correspondingly to breaker rating.

Earth bus bars shall be taken out at both ends of a switchboard and drilled holes shall be provided at both ends of earth bus bar for connection to station earthing. Green/Yellow polyester tapes shall be provided at suitable intervals.

Main & feeder busbars shall be fully insulated and busbar joints shall be provided with removable insulation shrouds. Entire bus work, CT's shall be supported with resin cast insulators of adequate creepage distance.

All phase to phase and phase to earth clearances for 11 kV switchboards to be

suitable for 28 kV RMS and 75 kV peak withstand voltages.

The nominal continuous current ratings shall be such that the installed continuous current ratings of main bus bars at 45℃ in IP4X enclosure without forced cooling and with temperature rise as per IEC 60694 limits, shall not be less than the incoming feeder circuit breaker. The installed current rating of tappings shall not be less than the installed continuous current rating of the corresponding circuit breaker.

Insulation of main busbar shall be of Heat shrunk Raychem sleeving suitable for 12 kV and insulation of busbar joints shall be of FRP shrouds or Raychem sleeving or by means of tape suitable for 12 kV.

Insulation of feeder connections shall be of Raychem Heat Shrunk sleeving or or by means of tape suitable for 12 kV Bus bar support insulator shall be of Epoxy resin cast insulators with creepage distance not be less than 300 mm.

Corners of bus-bars shall be rounded before taping/sleeving. The length of main busbars shall be such that the number of joints within the switchboard is kept to the minimum.

Provision shall be made to allow for thermal expansion of busbar as well as to take care of any expansion in floor slab.

2.3. Load break switch (630A)

Load break switch should have the following:

1. Manually operated 12 KV, 630A Load Break switch and Earthing Switch with making capacity
2. “Live Cable” LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
3. Mechanical ON/OFF/EARTH Indication
4. Anti-reflex operating handle
5. Cable Testing facility without disconnecting the cable terminations, cable joints and terminal protectors on the bushings.
6. Cable terminations
7. Cable boxes suitable for 1 X 3C x 300 sq mm XLPE Cable with right angle Cable
8. Termination Protectors.

2.4. Circuit breaker/ contactors with fuses

The circuit breaker shall be three-pole vacuum break, horizontal draw-out type with stored energy spring charged operating mechanism. The circuit breaker design shall ensure re-strike free operation.

Surge diverter should be provided for capacitor & motor feeders.

The air clearance between phases and between phase to earth at the breaker incoming and outgoing terminals shall not be less than those indicted in the IEC/ British Standards, corresponding to the basic insulation levels of the circuit breaker.

Floor mounted with drawable trucks shall be provided for VCBs/Line / bus PTs/bus Links etc.

The design of the CB trucks shall be such that CB trucks of same rating are only

interchangeable with each other and it shall not be possible to insert a lower rated CB truck in a higher rated panel. All CB/PT/Bus Link trucks shall be provided with suitable mechanical guide to ensure proper alignment of the truck power isolating contacts.

Means shall be provided for contact wear indication for the CB main contact.

The nominal continuous current ratings (open air at 40℃) for circuit breakers shall be so selected that the corresponding installed continuous current ratings at 45℃ in IP4X enclosure without forced cooling and with IEC:60694 temperature rise limits shall not be less than the associated CT primary currents.

ZnO, 15 kV, 10 kA, class-III surge arrestors shall be provided for all incoming and outgoing feeders of 11 kV switchboards. In addition, for motor feeders, R-C type surge arrestors shall also be provided. The surge absorbers shall have polymeric imploding type enclosures and shall be complete with sleeved line side connections as well as earth connection, discharge counters, leakage current detectors.

2.5. Operating mechanism

All circuit breakers shall be provided with motor operated stored energy, manual independent closing and shunt trip mechanism with built in anti-pumping feature and trip operating mechanism conforming to IEC. The shunt trip and closing coil and spring charging motor shall be suitable for AC or DC control supply.

In order to ensure the reliability and long operating life for the mechanism, the mechanism shall be light, with a high mechanical strength and abrasion resistance to avoid high rate of wear and tear and with few components. The number of components in the breaker and operating mechanism shall be kept to a minimum and they shall be designed to be free of undue stresses during normal or short circuit operations. Further they shall ensure a high frequency of operations indicated in technical particulars. All the moving parts of the mechanism requiring inspection, maintenance and lubrication shall be easily accessible.

The life of the operating mechanism shall not be less than 30, 000 operations in case of Vacuum breakers.

The closing and tripping circuits shall be self-opening on completion of their respective functions, irrespective of position of the breaker ON/OFF switch.

Each breaker shall be provided with mechanical trip push button, accessible with door closed.

2.6. Auxiliary contacts

Each circuit breaker shall have required number of auxiliary contacts to control circuit changes for indication, protection, interlocking, supervision, metering viz.,

No. of potential free CB auxiliary contacts / limit switch contacts:

One (1) set of potential free contacts for CB ON/OFF status

One (1) set of potential free contacts for group alarm status

One (1) set of potential free contacts for CB auto trip status

All contacts including spares shall be kept wired upto the terminal strip

All auxiliary contacts shall be positively operated by the main apparatus and all contacts shall be adequate to make, carry and interrupt the currents in their circuits.

Minimum of 4 NO + 4NC auxiliary contacts shall be available for client's exclusive use at site.

Multiplication of breaker auxiliary contacts shall be avoided. However in case of necessity, electrically reset latched relays shall be used. Further these contacts shall be available in both test and service positions.

2.7. Breaker truck/ carriage

The circuit breaker with its control units, operating mechanism, isolating and interlocking gears, auxiliary switches, isolating contacts and wiring shall be carried on a horizontally with drawable, sheet steel dead front truck / carriage on wheels / guide channels. The truck / carriage shall be provided with handles for maneuvering the breaker into position. All Circuit breaker trucks / carriages of same rating shall be identical in all respects and shall be interchangeable at site.

Spring loaded, sliding earth terminals shall be provided on both sides of the truck/ carriage, making positive connection with the earth strip provided with cubicle to ensure that all non- conducting metal parts are securely earthed before moving the breaker truck / carriage to test and service positions. The location of the earth terminal shall be such that, it should be first to make and last to break to ensure personal safety. All the non-conducting metals parts shall be bonded together and connected to the earth terminal by means of a separate connection Bolted connections of the framework of the truck / carriage shall not be used as earth continuity conductors.

Mechanical interlocks shall be provided on each truck/ carriage to prevent mal-operation.

Power isolating contact assembly shall have self-aligning silver faced contacts with replaceable fingers or equivalent construction. The moving contact shall engage with the fixed contacts through opening in the bus bar and current transformer chambers. Each opening shall be covered by vermin proof spring-loaded with automatic safety shutters. With the safety shutter closed, it shall not be possible to introduce even small tools such as screwdrivers and complete protection shall be offered against accidental contact with live terminal, in line with enclosure class of protection.

2.8. Cable Termination

The cubicle shall be suitable for terminating cables or bus turnings as specified. Sufficient space and support arrangements shall be provided for terminating specified no. of power cables with bottom entry as specified.

Required no. of compression type cable glands and tinned copper lugs shall be provided. Where cable terminations are specified, HT cable sealing kits shall form part of cubicle. Where core balance types CT's are specified, the same shall also be enclosed inside the cubicle.

Phase terminals shall be suitable for connection of 11 kV (E) and 11 kV (E),

aluminium conductor, XLPE insulated, armoured cables as per single line diagrams.

Double compression type brass cable glands shall be supplied for LT and control cables of specified type and size. Heavy duty tinned copper lugs of crimping type shall be provided.

2.9. Instrument Transformers

a) Current transformers (CT)

All CTs and PTs shall be cast resin type. The accuracy and VA burdens specified for CTs shall be applicable for the lower taps. CTs shall have Equipotential tap connections on the primary.

The instrument and protection transformers shall be supplied as specified and shall have the ratings, outputs and accessories as specified or required.

i. Separate cores shall be used for metering & protection
ii. All current transformers shall be designed to have over current factors to withstand the fault currents of the associated system as applicable to the switchboard.
iii. Current transformers used for protection shall have an accuracy limit factor of 20. Those used for metering shall have a saturation factor 5.
iv. Provision for connection of 25% additional burden in future shall be considered. The VA burden of the CTs shall be minimum 7.5VA.

b) Voltage transformer (PT)

Voltage transformers shall be built-up of CRGO electrical steel. The voltage transformers shall be resin cast dry type, mounted on draw-out trucks. The PT's shall be single phase or three-phase type as specified. When 3 phase PT's are offered they shall be star/ star/star or star/star/open delta type as specified, fully insulated with neutral points brought out for earthing on both sides.

i. The PTs shall be provided with suitable protective HRC fuse on the primary.
ii. The PTs shall have 25% additional VA capacity over and above the requirement for motors, relays and instrument connect to it. The VA burden of the PTs shall be minimum 100VA.

3 OIL FILLED TRANSFORMER

i) SCOPE:

This specification covers design, manufacture, test at manufacturer's works, and transport to site, unload, installation, testing, commissioning and hand over 11kV/433V, 50Hz, outdoor oil filled type Transformer. The scope shall cover Supply, Testing, Supervision and Commissioning of transformer.

ii) GENERAL INFORMATION:

a) Transformer shall be designed, manufactured and equipped with accessories, in accordance with this specification and the applicable standards indicated below.

b) The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life.

c) Transformers shall be suitable for the following ambient conditions

- Maximum Ambient Temperature..... 40 Deg. C
- Design ambient temperature..... 50 Deg. C
- Maximum humidity..... 100 %

iii) CODE AND STANDARDS:

a) The transformers shall confirm to the requirement of the latest revisions of the following codes and standards: IS: 1886: Installation and maintenance of: transformers, code of practice.

IS: 2026 : Power Transformers. (Part I to IV)

IS: 3639 : Power Transformers, fitting and accessories.

IS: 335 : Specification for new insulating: oils for transformers and switchgear.

IS: 2099 : Bushing for alternating voltage: above 1000 V

IS: 5 : Colours for ready mixed paints and enamels.

IS: 648 : Non-oriented electrical steel sheets for magnetic circuits.

IS: 1866 : Code of practice for maintenance.

IS: 2166 : Guide for insulation co-ordination.

IS: 6600 : Guide for loading of oil-immersed Transformers.

IS: 1666 : Copper conductor for transformer winding.

IS: 8642 : ON Load Tap Changer.

b) Wherever Indian Standards are not available, the transformer shall conform to relevant international standard.

iv) DESIGN CRITERIA:

a) The transformer shall be oil filled type and designed for natural cooling.

b) The transformer impendence shall be as specified to limit the fault Level on the LV side. The neutral of the low voltage winding will be solidly grounded.

c) Impedance shall not exceed 6.25% and variation in impedance of the ultimate finished product shall be with +/- 5% of the nominal impedance value.

d) Flux density should not be more than 1.55 Tesla at the rated voltage and frequency. Transformer core should be designed in such a way that it will not get saturated for any value of V/f (Voltage/frequency) ratio to the extent of 112.5% of rated value of V/f ratio (11000/50). Actual core design along with calculations in support of it should be submitted for approval.

e) The transformers with all accessories shall be capable of withstanding the thermal and mechanical effects of shorts circuit at the terminals of any winding without adverse effect.

f) Account shall be taken of the different forms of system fault that can arise in service, such as line to earth faults and line faults associated with the relevant system and

transformer earthing conditions. The Short circuit levels will be as specified in the data sheet.

g) The transformer shall be Capable of continuous operation at its rated output without exceeding the temperature limits as below (over 50 Deg.C ambient temperature).

a) In top oil by thermometer..... 50 Deg. C. (122 Deg F)

b) In winding by resistance..... 55 Deg. C. (131 Deg F)

h) Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under this condition, no limitations by terminal bushings on load tap changers or other auxiliary equipment shall apply.

i) The transformers shall be capable of continuous operation at its output under the following conditions.

a) Voltage varying by +/- 10%.

b) Frequency varying by +/- 3%.

j) The transformer shall be designed and constructed so as not to cause any undesirable interference in radio or communication circuits.

k) Steel bolts and nuts exposed to the atmosphere shall be either galvanised or zinc passivated.

l) Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.

m) Transformer design shall take care of protection against surge voltage.

n) Internal design of transformer shall ensure that air is not trapped in any location.

o) The neutral terminal of windings shall be designed for the highest over current that can flow through these winding.

p) The design of transformer shall be such as to reduce noise and vibration to the level obtained in good modern practice. Audible sound levels (decibels) at rated voltage and frequency for liquid immersed transformers shall be as per NEMA Standard (62db).

q) All rated quantities such as voltage ratios, impedance, load losses and no load losses subject to the supplier's guarantees shall be within the tolerances given in applicable standards.

v) TRANSFORMER TANK:

a) The tank shall be of electrically welded construction and fabricated from sheet steel of adequate thickness. Tanks shall be hydraulically tested to ensure that they are leak proof and subjected to vacuum test.

b) The tank shall have adequate strength to withstand without any deformation (i) mechanical shock during transportation and (ii) oil filling by vacuum test.

c) The tank shall also be provided with two nos. grounding pads for earthing.

d) The transformer tank shall be provided with 2 sets of bidirectional flat wheels for rolling the transformer parallel to either centre lines.

e) Jacking pads, lifting eyes and pulling lugs shall be provided to facilitate lifting and movement of the transformer, filled with oil. All heavy removable parts shall be provided with eye bolt for case of handling.

f) The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. If necessary the surface of the cover shall be suitably sloped so that it does not retain rain water.

g) Adequate space shall be provided at the bottom of the tank for collection of sediments.

h) The transformer base shall be designed to permit skidding of the complete transformer unit in any direction. Pulling eyes shall be provided for moving the transformer in either direction.

i) The material for gaskets shall be Nitrile Rubber or approved equivalent. Gasket Ted joints for the and the manhole covers bushings and other bolted attachments shall be oil tight and so designed that the gasket will not be exposed to the weather.

j) Tank shall be provided with a pressure release device which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rain proof after blowing and shall be provided with a device visible from the ground to indicate operation. An equivalent pipe connecting the pressure relief device to the conservator shall be supplied.

k) Materials in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanised or cadmium plated.

l) Inspection covers of manholes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings and taps.

m) Oil sampling taps shall be provided with valve at top and bottom to collect sample of oil from the tank for testing.

n) To facilitate the oil filtration by streamline filter, suitable inlet and outlet taps with valves at the bottom and at the top of the tank on diagonally opposite corners shall be provided. The valve at the bottom may be used as drain valve.

o) Thermometer pocket for top oil temperature measurement by liquid thermometer shall be provided.

p) Marshalling kiosk boxes, etc. shall be weatherproof having a degree of protection to IP 54.

q) Cooling tubes or radiators shall permit every part of the cooling surface to be cleaned by hand and shall be suitably braced to protect them from mechanical shock. Each radiator bank shall be of detachable type and provided with oil isolating valves at either sides.

r) The transformer tank shall be fitted with a double diaphragm type of explosion relief vent at the top with equalizer pipe connection to oil conservator.

s) Explosion relief vent should be located on the top cover and directed in such a way that on bursting of diaphragm the oil forced out will not fall in any of the auxiliary equipment of the transformer and the other electrical equipment in the vicinity.

vi) CORE AND COIL:

a) The core shall be built up of high quality, low loss, non-ageing, high permeability, grain oriented, cold rolled silicon steel lamination with very low magnetisation losses and annealed to relieve stresses and develop excellent magnetic properties.

b) The core clamping frame shall be provided with lifting eyes for the purpose of taking and inspecting the core with windings mounted thereon and shall have ample strength to take the full weight of the core and winding assembly. The core assembly shall be electrically connected to the transformer tank for effective core earthing.

c) All insulating material shall be of proven design. Coils shall be so insulated that the voltage stresses are minimum.

d) The windings shall be from electrolytic copper conductor of high conductivity with suitable class 'B' insulation. The windings shall be duly sectionalised. Similar coils shall be connected by accessible joints braced or welded and finished smoothly.

e) Coil assembly shall be secularly positioned with spacers, pressed board cylinders, barriers and shall be arranged as per to allow free circulation of the coil.

f) All leads from the windings shall be suitably supported to prevent damage from vibration or short circuit stresses.

g) The core and coil assembly shall be rigidly braced and fixed on to the tank so that no shifting or deformation occurs during transport and installation or during short circuits.

h) The finally assembled core with all the clamping structure shall be free from deformation and shall not vibrate during operation.

i) The core clamping structure shall be designed to minimise eddy current losses.

j) The end turns on the high voltage windings shall have reinforced insulation to withstand any of the voltage surges likely to occur switching or any other abnormal system conditions.

vii) INTERNAL EARTHING:

a) All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.

b) The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be also earthed.

c) The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of top cover of the transformer tank through a suitably rated bushing. A disconnecting link shall be provided on transformer tank to facilitate disconnections from the ground for IR measurement purpose.

viii) TAPPINGS:

a) OFF LOAD circuit taps as specified shall be provided on the high voltage winding.

b) The transformer shall be capable of delivering its rated output at any tap position.

c) The winding including tapping arrangement shall be designed to preserve the electromagnetic balance between HV and LV winding at all voltage ratios.

ix) INSULATING OIL:

a) The insulating oil shall be confirmed to the latest revision of the IS: 335 / BS 148 properly inhibited for prevention of sluding.

b) Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 2.5 X1012 ohm-cm at 27 ℃ when tested as per IS 6103.

c) The necessary first filling of oil shall be supplied for the transformer. 10% excess oil shall also be provided (to take care of wastages) in non- returnable containers suitable for outdoor storing.

d) Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

x) NEUTRAL TERMINAL:

a) The size of the neutral bushings shall be as that of phase bushings. On the LT side two bushings shall be provided for neutral, one through top side wall bushings to the LV terminating box through the disconnecting chamber and the other brought to a box mounted outside on the top of the transformer for earthing. The box is meant for housing one number loose CT to be provided for transformer restricted earth fault relay protection. Box shall be weather proof design (IP 54)

b) Earth protection of the cable end box shall be provided with 2 Nos. grounding pads suitable for purchaser's 50 X 6 mm M.S. flat.

xi) TEMPERATURE INDICATION:

One set of dial type thermometers with a pointer to register the highest temperature attained for oil temperature indication/winding temperature indication shall be supplied and fitted inside the marshalling box.

xii) BUILT ON RADIATORS:

The following accessories shall be provided for radiator:

- Top and bottom shut off valves and blanking plates on each radiator.
- Lifting lugs.
- Top oil filling plug.
- Air release plug at top.
- Oil drain plug at bottom.

xiii) CONSERVATOR TANK

- The conservator tank shall be connected with the main tank by a pipe.
- The conservator tank shall be provided with oil level indicator visible from ground level.
- A weather proof dehydrating breather shall be provided with silica gel as the dehydrating agent.

xiv) MARSHALLING BOX

A dust and weather proof marshalling box suitable for outdoor use shall be provided. The box shall contain terminal blocks meant for buyer's control cable connections and all auxiliary devices. The marshalling box shall be provided with a blank detachable

plate for mounting the control cable glands. The control cable glands are not within the scope of this specification. NOTE: - The transformers supplied with "BUCHHOLZ" relay if the transformer rating exceeds more than 1000KVA and for the entire transformer in case supplied with OFTC.

xv) LOSSES

a) The bidder shall guarantee individually the no-load loss and load loss without any positive tolerance. The bidder shall also guarantee the total losses at 50%,75% and 100% load condition (at rated voltage and frequency and at 75 ℃)

b) The maximum allowable losses at rated voltage and frequency and at 75 ℃ shall be as below:-

Load	Efficiency	
	UPF	0.8 PF
100%	98.85%	98.5%
75%	99.00%	98.80%
50%	99.25%	99.00%

xvi) TERMINAL MARKINGS

High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral terminal is to be brought out and connected to local grounding terminal by an earthing strip.

xvii) TESTS:

a) The transformer offered shall be fully type tested by the manufacturer as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design during the last five years at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer.

b) The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid.

c) The procedure for testing shall be in accordance with IS1180/2026 as the case may be except for temperature rise test.

d) Before despatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

ROUTINE TESTS:

- Ratio, polarity, phase sequence and vector group.
- No Load current and losses at service voltage and normal frequency.
- Load losses at rated current and normal frequency.
- Impedance voltage test.
- Resistance of windings at each tap, cold (at or near the test bed temperature).
- Insulation resistance.
- Induced over voltage withstand test.
- Separate source voltage withstand test.

- Neutral current measurement-The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.
- Oil samples (one sample per lot) to comply with IS 1866.
- Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
- Pressure and vacuum test for checking the deflection of Transformer tank.

TYPE TESTS:

In addition to the tests mentioned above, the contractor shall submit the following type test certificates conducted on a transformer of the same design during the last five years

Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.

- Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 95 kV peak instead of 75 kV
- Short circuit withstand test: Thermal and dynamic ability.
- Air Pressure Test: As per IS – 1180.
- Magnetic Balance Test.
- Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- Noise-level measurement.
- Measurement of zero-phase sequence impedance.
- Measurement of Harmonics of no-load current.

Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour.

DATA SHEET

1.	Application / Designation	:	Distribution transformer - Step Down
2.	Installation	:	Outdoor
3.	Rating	:	As per SLD
4.	Percentage impedance	:	As per IS
5.	Base kVA for impedance	:	As per IS
6.	Tolerance on above impedance	:	No negative tolerance
7.	Rated primary voltage	:	11000Volts
8.	Rated no load secondary voltage at centre tap	:	As per SLD
9.	Vector group	:	Dyn11

10. Frequency	:	50Hz
11. No. of phases	:	3
12. Type of cooling	:	ONAN, Hermetically sealed
13. Fault level HV system	:	25kA
14. Neutral Earthing	:	Solidly Earthed
15. Impulse voltage	:	75kV
16. Tap changing gear	:	OFF Load
17. Taps required	:	7
18. Tappings on windings	:	HV (11000 V)
19. Total tapping range	:	+5% to -10%
20. Steps	:	2.5%
21. Windings insulation	:	Uniformly insulated
22. Finish 631 of	:	Painted with battle ship grey paint shade IS-5
23. Protection	:	Dial type thermometer with alarm and trip Contacts for oil temperature monitoring. Resistance thermometer type winding temp indicator with alarm and trip contacts Digital protection relay Sudden pressure relay (with trip contact)

24. Terminal connection

HV side : Outer cone plug in bushings suitable for cable termination

LV side : Aluminium Cables

Technical Data Sheet to be filled by Contractor separately for the transformer

SL.NO	DESCRIPTION	UNITS	REMARKS
a)	General		
b)	Make of transformer		
c)	Standards	IS / IEC	
d)	Installation	In	
e)	Design		
f)	Rating	kVA	
g)	Vector Group		
h)	No of phases & rated frequency	Ph / Hz	
i)	Winding		
	i) Material		
	ii) Rated voltage		
	x HV winding		
	x LV winding		
	iii) Vector group, YNd5, Dyn5	Symbol	
j)	Cooling		
	i) Type		
	ii) No of radiator banks	no	
	iii) No of fans / bank	no	
	iv) Rating of fan motor	kW	
k)	On load tap charger		
	i) Tapping range	%	
	ii) No of steps	no	
	iii) Tapping on		
	iv) Each step	%	
l)	Impedance voltage AT 75°C		
	i) at principal tap	%	
	ii) at Maximum tap	%	
	iii) at Minimum tap	%	
m)	Reactance at rated current & frequency	%	
n)	Resistance at rated current at 75°C		
	i) HV winding	Ohms/ph	
	ii) LV winding	Ohms/ph	
o)	Zero sequence reactance	%	
p)	Zero sequence capacitance of HV winding	µF	
q)	Performance		
r)	Temperature rise above 50°C		
	i) Top of oil by thermo meter	°C	
	ii) hot spot temp in winding	°C	
s)	Guaranteed losses (at 75°C at principal tap)		
	i) Maximum no load loss at rated voltage & frequency	kW	
	ii) Maximum load loss at rated current (ON AN)	kW	
	iii) total loss at maximum rated power	kW	
t)	Efficiency at 75°C & 0.9pf		
	i) at full load (ON AN / ON AF)	%	
	ii) at 75% full load (ON AN)	%	
	iii) at 50% full load (ON AN)	%	
u)	Load & pf at which maximum efficiency	%	
	occurs	pf	
v)	Maximum efficiency	%	

SL.NO	DESCRIPTION	UNITS	REMARKS
w)	Regulation at full load 75℃		
	i) at upf	%	
	ii) at 0.8 pf lag	%	
x)	No load current on HV side		
	i) at 90% rated volts	%	

4 L.V. CABLES AND CABLE TRAYS

4.1 SCOPE

This section covers the supply, installation storing, laying, fixing, jointing / termination, testing and commissioning of Low Voltage XLPE/PVC insulated PVC Sheathed armoured copper/ aluminium conductor cables laid in built up trenches or directly buried underground or on cable trays or in pipes or clamped directly to wall or structures etc. as called for in the drawing. The contractor shall provide all materials, labour, equipments, scaffoldings etc., as required for the completion of L.V. Cables, Cable Trays etc.

4.2 STANDARDS

a. The following standards and rules shall be applicable.

IS 1554-88 PVC insulated (heavy duty) electric cables Part I for working voltages up-to and including 1100V.

IS 8130-84 Conductors for insulated electric cables and flexible cords.

IS 3961-67 Recommended current ratings for cables: (Part 2): PVC insulated PVC sheathed heavy duty cables.

IS 5831-84 PVC insulation and sheath of electric cables.

IS 7098-89 Cross linked polyethylene insulated PVC sheathed cables.

b. The individual cores shall have continuous numbering of the core all along its length and also be provided with identification ferrules at both ends. Individual control cables shall have 20% spare cores.

c. FRLS cables shall be used to prevent flame propagation, smoke reduction and to avoid toxic gas emission in the event of a fire. FRLS compound shall be tested rigorously for oxygen index as per ASTM D2863,acid gas generation to IEC 754-1, smoke density to ASTM D 2843 and flammability to SS 424 1475 class F3, IEEE 383 and IEC 332-1.

d. Manufacturer's name, ISI Mark, cable size and type shall be clearly embossed at regular intervals on all cables.

4.3 GENERAL REQUIREMENTS:

a. Power cables shall comply of the following

- LV cables - 1100 V grade with stranded copper/aluminium conductors Colour coded insulation
- PVC inner and outer sheathing applied for extrusion & FRLS
- Steel armouring between inner and outer sheathing for outdoor cables.

- The XLPE cables shall be with chemically cross linked polythene of natural unfilled compound

4.4 TYPE AND QUALITY

a. Low voltage cables shall be circular, multi-core annealed copper conductor, XLPE/PVC insulated, PVC sheathed and steel wire armoured or steel tape armoured construction or enamoured. The conductors of cable shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq.mm. Size and above. The cables shall conform to IS: 1554 part-I in all respects.

b. L.V power cables shall have 1, 3, 3.5 or 4 cores, as required and shall have conductors made from electrical purity copper/ aluminium conductors conforming to IS 191.

c. Conductors shall be insulated with high quality PVC/XLPE base compound. Insulation and outer sheathing compounds shall conform to IS. 5831 - 84.

d. A common covering shall be applied over the laid-up cores by an extruded sheath of un-vulcanised rubber compound.

e. Armouring of galvanised round steel wires or galvanised flat steel strips shall be provided over the inner sheath

f. Outer sheath of PVC shall be extruded over the armouring. Cables shall be manufactured and tested in accordance with IS 1554.

g. Unless otherwise specified, all control cables shall be multi-core, 1100V grade PVC insulated, armoured and overall PVC sheathed with stranded copper conductors of 2.5 sum, conforming to IS 1554. Cores shall be identified by colour scheme of PVC insulation.

4.5 RATING

a. The cables shall be rated for a voltage of 1100 Volts.

b. Core Identifications:

Cores shall be provided with the following colour scheme of PVC insulation:

a) Single Core: Green yellow for earthing.
b) Two Core: Red and Black, Blue and Black, Yellow and Black
c) Three Cores: Red, Yellow and Blue
d) Four Core: Red, Yellow, Blue and Black

4.6 INSPECTION

a. All cables shall be tested inspected at manufacturer's works. However upon receipt at site cables shall be checked for physical damages during transit.

4.7 JOINTS IN CABLES

a. The cable joints are strictly not allowed.

b. The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoidance of straight cable jointing. This apportioning shall be got approved by the Construction Manager before the cables are cut to lengths.

c. Where straight joints in cable are unavoidable, the use and location of such straight joints shall be got approved by Construction Manager.

4.8 JOINTING BOXES FOR CABLES

a. Cable joint boxes shall be of appropriate size, suitable for XLPE insulated armoured cables of particular voltage rating.

4.9 JOINTING CABLES

a. All cable joints shall be of heat shrinkable / push on type with all cable jointing accessories ensuring electrical continuity and mechanical strength and the filling in of compound, jointing etc shall be done in accordance with manufacturer's instructions, good practice in trade and in an approved manner. All straight joints shall be done in epoxy mould boxes with epoxy resin only of makes/types as indicated in the list of approved makes. All terminal leads of conductors shall be heavy soldered upto atleast 50 mm lengths.

b. All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commences. The seals of cables shall not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound and taped so as to ensure that the box is properly filled.

c. Epoxy compound shall be filled as follows:

Equal quantities of resin and hardener shall be mixed thoroughly by hand until the mixture is free from white patches and has uniform colour. No water, oil or any other liquid shall be added to the mixture to make it soft as is will affect the properties of the compound. The mixture shall be used within 30-40 minutes of mixing. The on which epoxy compound is to be used, shall be free from dust, rust, oil, grease and shall be dry. The joint neither be disturbed nor moved till the epoxy compound is completely hardened. A smooth surface can be made by rubbing a damp cloth smoothly on the compound before it sets. The joints shall be painted after they have completely hardened.

d. Alternatively, ready mix of epoxy cable jointing compound may also be used. In all cases manufacturer's recommendations shall be strictly adhered to.

4.10 CABLE MARKERS

a. All underground cables and cable joints shall be marked on the surface by markers generally manufactured and tested to the requirements of relevant Bureau of Indian Standards. Approved CI cable markers shall be provided at every 30m along the route of the cables and at both ends of road crossing, indicating cable joints and cables as applicable. Special CI markers shall be provided at all buried cable joints indicating "Electrical Cable Joints". CI plates duly engraved with the size of the cable and the place it serves shall be tied to the cable at regular intervals of 5m for easy identification of cables.

4.11 TERMINATION OF CABLES

a. Cable termination shall be done in terminal box or cable end box or distribution boards or apparatus/equipments. Terminations are to be made with mechanical and glands be tinned / nickel plated, anti corrosive, three piece improved pattern which is to grip inner and outer PVC sheaths as well as the armour of the cable. The cable ends or the core conductor are to be connected by solder less lugs or sockets using crimping tool of approved make for all cables.

b. All terminations of cable conductors and base conductors shall be mechanically and electrically sound and shall comply with the requirements of IEE regulations.

c. The connectors or connecting sockets are to have such dimensions so as to limit temperature rise.

d. When required the water tightness of the terminal boxes may be obtained by filling with a compound preferably plastic flame-retarding and non-dripping type within the normal range of temperatures.

e. When the cable is cut during the course of installation the open ends are to be sealed immediately by means of self-adhesive non-hygroscopic tape over a wax water seal to make an air and watertight joint.

4.12 INSTALLATION OF CABLES

a. Cable shall be laid in a manner as indicated on the drawings. Generally cables are laid in the following manner.

   a) In the underground masonry trench.
   b) On the cable tray/or on cable ladders.
   c) Buried underground.
   d) Through pipe sleeves.

b. Various installation methods are discussed in the following paragraphs.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before

unwinding the cable. The cable drums shall be rotated in the direction as indicated by the manufacturer. Care shall be exercised inlaying cables to avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding two (2) meters.

a) General

i) All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

ii) When cables pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edges.

iii) In every vertical cable ladder, channel, duct, trunking or cable trench containing cables and exceeding three meters in length, internal barriers shall be provided so as to prevent the air at the top of the unit from attaining an excessively high temperature. In every vertical cable shaft, cable trench or any passage of cable through wall, ceiling, floor barriers against spread of fire and smoke shall be provided for compliance with IEEE regulations.

iv) Where cable passes through walls, ceiling, floor, it shall run through sleeves of GI Conduits of adequate diameter. After pulling the cable through sleeves, both the ends of the sleeves shall be sealed water tight with fire-resistant material to prevent spread of fire and seepage of water.

v) Generally along each cable route either in trench or in cable trays/ladders or in pipe separate Two Nos. of earth strips/wires shall run exposed.

vi) Where an installation comprises Low voltage cables as well as extra low voltage circuits, precaution shall be taken in accordance with IEEE regulations and shall be physically separated by minimum of 300mm distance.

vii) Metal sheaths and armour of all cables, metal conduits, ducts, trunking, and bare earth continuity conductors associated with such cables, which might otherwise come into fortuitous contact with other fixed metal work shall be effectively bonded there to earth so as to prevent appreciable potential difference at such possible points of contact.

viii) If it is necessary to install cables in a situation where flammable and/or explosive dust, flammable volatile liquid/vapour/gas is likely to be present or where explosive materials are handled or stored, the cabling shall be as per IEEE regulations.

b) Underground Installations

i) The cables shall be laid in an excavated trench. The depth of the trench shall be minimum 750mm, below the final ground level but shall be decided on the number of cables to be laid in the trench so that the vertical distance between two adjacent layers of cables shall not be less than 350mm. The width of the trench shall be decided on the number of cables to be laid in the trench so that the distance between two adjacent cables shall not be less than one cable diameter.

ii) Before laying cables the bottom of the trench shall be well compacted

and the cables shall be laid on a 100mm fine sand bedding. The second layer of 150mm of fine sand then be spread over the cable and shall be further covered by 150mm of compacted soil. For the second layer of the cable same procedure shall be repeated.

iii) The cables shall be protected by placing pre-cast concrete tiles or burnt bricks over the cables on top layer of sand and for the full length of underground cables. Cable caution tape to be provided all along the underground cable trench. Where more than one cable is running in the same trench, the concrete tiles/bricks shall cover all the cables and shall project a minimum of 80mm on either side of the cables.

iv) In any case the top layer of the cables shall be minimum 750mm below the finished level of the ground.

v) The top of the cable trench shall be well compacted till the finished level of the ground and shall be approved by the Construction Manager. If required a laboratory compaction test shall be carried out in presence of the Construction Manager.

vii) Cables under road crossings and any surfaces (paved areas) subjected to heavy traffic shall be protected by running them through hume/HDPE pipes of suitable size.

viii) The relative position of the cables laid in the same trench shall be preserved and the cables shall not cross each other as far as possible. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius of bend not less than 15 times the diameter of the cable. Minimum 3 meters long loop shall be provided at both sides of every straight joint and 5 meters at each end of the cable. Distinguishing marks shall be made at the cable ends for identification.

ix) Insulation tapes of appropriate voltage and in red, yellow, and blue colours shall be wrapped just below the sockets for phase identification

x) All the excavation and back fill including timbering, shoring, and pumping required for the installation of the cables shall be carried out as indicated on the drawing and as per requirements laid down elsewhere or as per Construction Manager's direction. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150mm. At each layer compaction test shall be carried out in presence of Construction Manager. Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, side walls, curbs, walls, landscaping or other works cut for excavation to their original condition, the satisfaction of the Construction Manager. Suitable approved type cable markers shall be installed along the cable route and where change of direction takes place.

c) Cables Installed inside the Building

i) The cables inside the building shall be installed in one of the following manner, as indicated in the drawing and approved by the Construction Manager.

d) Installed In Built-Up Trench

i) The cables laid on the bottom of the structural trenches shall not lie freely upon the trench bottom. They shall be raised to prevent the possibility of their coming into contact with deleterious materials.

ii) The cables laid in the trench shall be laid on angle iron brackets/cable tray/cable ladder/cable troughs/cable racks as indicated on the drawings, and as approved by the Construction Manager. Where cables are clamped to the wall a minimum clearance of 100mm shall be maintained between wall and cable and minimum 150mm vertical clearance shall be maintained between two cables. Where cables are laid on brackets the brackets shall not be fixed more than 500mm apart to avoid sag in the cables, where the cables are laid on cable tray/ladder/troughs/racks, minimum 300mm distance shall be observed between adjacent tier of tray/ladder/ troughs/racks, and cable shall be fixed minimum 25mm away from the wall, and minimum of one cable diameter distance shall be observed between two adjacent cables. Cables shall be properly fixed with the tray/ladder/troughs/racks with cable tie or saddles or straps.

e) Cables on Cable Trays/Ladders under the Ceiling or on Wall

i) Where cables are installed under/above suspended ceiling or below ceiling or on wall, they shall be laid on a perforated G.I. cable tray/ladder type cable tray and shall be run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or other fixtures.

ii) The cable tray/ladder shall be properly fixed with tie rod to the ceiling. The concrete inserts for fixing the tie of shall be put in place while casting the slab. If insert plates are not placed in position, Anchor fasteners shall be fastened to support cable trays. The cable tray route shall be coordinated with other services to avoid crisscross of all the services.

iii) While laying the cables on the tray minimum one cable diameter distance shall be observed between two adjacent cables. 25% space shall be kept spare for any future installation

iv) The trays shall be made of 16 SWG/12 SWG G.I. perforated sheet having minimum 50mm depth. The width of perforation shall be maximum 10mm spaced at maximum 20mm distance. The width of the cable tray shall be selected so as to accommodate required number of cables to be laid on it, with minimum separation of minimum one cable diameter between two adjacent cables. The cables shall be tied with the cable tray with nylon strip.

f) Cables Installed in the Mechanical Room

i) The cable reaching the motors in the mechanical room or plant room or machines room or service area shall be laid on cable tray except where indicated in masonry underground trenches.

ii) The cable reaching the motors shall be protected by rigid galvanized conduits up to a height of 300mm above the floor.

iii) Above that height, the cable shall be protected by means of oil tight flexible metallic G.I. conduits to the terminal box of the motor. The connection between the rigid conduit and the flexible conduit shall be done by a rewitt coupling of an approved type.

iv) The flexible conduit shall be properly fixed with the terminal box of the

motor by means of double hexagonal check nut.

4.13 CABLE TRAY/LADDER

a. GI Cable tray shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

b. Cable trays shall be of steel as per IS 226 and galvanised and the thickness of galvanisation shall be not less than 110 microns. All bolts nuts and washers shall also be galvanised and shall conform to IS 1363- 60 for quality, threading and dimensions before galvanising. Hot dip galvanising shall conform to IS 2633.

c. Galvanising of each member shall be carried out in one complete immersion. The galvanising shall be uniform, clear, smooth, continuous and free from acid spots. Quality of zinc used for galvanising shall be of 98.8% purity.

d. Cable trays shall generally be of the following type:

a) For power cables of medium - ladder type voltage and high voltage with slotted angles.

b) For control cables and - perforated sheet extra low voltage cables steel slotted angle type.

e. Perforated cable trays shall be generally of channel type and the perforations in the trays shall be either 8 x 15mm or 10 x 20mm oval holes. Control cables, extra low voltage cables and instrument cables shall be laid on perforated cable trays.

a) For 600mm & above:

Ladder type cable trays shall be made out of 50 x 50 x 6mm slotted M.S. angles for the rungs and channels for the side rails. Pitch of the rungs shall be not more than 250mm centre to centre. Rungs shall be welded to the side rails. This has to be envisaged to the cable trays of size 600mm and above.

b) Upto 600mm or below 600mm:

Cable trays upto 600mm or below 600mm should be with Sheet Steel factory made type with 25mm x 3mm MS flats at not more than 300mm centre to centre.

f. Cable trays shall be of standard sizes:

Length 2500mmWidth 300/450/600/800/1000mm as required.

Flange of perforated tray 75/100mm

Height of side rail (ladder type) 75mm

Thickness of sheet steel - 2.0mm to 3.0mm as per width of tray.

and The flange and width of the cable trays shall be decided based on the diameter the number of cables running through each section of the cable tray.

g. Accessories for Cable Trays

Following accessories of cable trays, as required, shall be supplied with the cable tray.

a) Coupler plates
b) 90 deg bends - Horizontal and Vertical.

c) Tees - Horizontal and Vertical.
d) Reducers
e) 4-way cross
f) Tray covers
g) Fasteners.

Accessories also shall be hot dip galvanised, thickness of galvanising being not less than 110 microns.

4.14 TESTING

Prior to laying cables, and prior to energizing the cables, following tests shall be carried out:-

a) Insulation Resistance test between phases and phase to neutral and phase to earth.

b) Continuity test of all the phases, neutral and earth continuity conductor.

c) Sheathing continuity test.

d) Earth resistance test of all the phases and neutral.

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Construction Manager and results shall be recorded in the prescribed forms.

4.15 STORING

All the cables shall be supplied in drums. On receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drum in vertical position. The end of the cable shall be sealed for water tightness.

5 LT PANELS, FEEDER PILLARS & DISTRIBUTION BOARDS:

5.1 Scope

This specification covers the requirement of design, fabrication, testing at manufacturer's works, supply, erection testing and commissioning of low voltage (upto 415 C AC) switchboards like power control centre (PCC), motor control centre (MCC) etc, including the switchgear / components within.

5.2 Standards

Switchgear assembly and its accessories shall conform to latest applicable Indian Standard specifications / Codes of Practice and in particular, with;

IS 375	- Arrangement of busbars, connections, wiring, marking
IS 722	- AC Electrical meters
IS 1248	- Indicating instruments
IS 2147	- Degree of protection provided by enclosure for low voltage switchgear and Control gear.
IS 2208	- HRC cartridge fuse links
IS 2705	- Current transformers
IS 2834	- Capacitors

IS 3156 - Voltage transformers
IS 3231 - Electrical relays for power system protection.
IS 4064 - Normal duty air break switches and switch fuse units
IS 4237 - General requirement for switchgear and control gear.
IS 5578 - Factory built assemblies of switchgear and control gear.
IS 5082 - Aluminium for electrical purposes
IS 6005 - Code of practice for phosphating iron and steel
IS 6875 - Control switches and push buttons
IS 8623 - Factory built assemblies of switchgear and control gear.
IS 11353 - Factory built assemblies of switchgear and control gear
IS 13118 - Air circuit breaker
IS 13703(Part 1, 2)- HRC Fuse links
IS 13947 (Part 1) - General requirement for switchgear and control gear
IS 13947(Part 2) - Air circuit breaker
IS 13947 - Fuse switch and switch fuse units (Part 3, 4, 5)

Distribution boards shall be made of Robust and rigid construction and of totally enclosed dead front safety type. The enclosures shall be made of MS sheet of not less than 16 SWG. The Distributions boards shall have protection of IP55 for outdoor& IP23 for Indoor. The sheet steel shall be treated with a rigorous rust inhibition procedure before fabrication, followed by two coats of red oxide primer and two coats of synthetic enamel paint of approved shade. The distribution boards shall comprise of MCB/MCCB as incoming and required number of circuit breakers as outgoing.

The main switch and outgoing shall have rating as specified in the drawings and schedule. The boards shall be designed to have adequate cabling space for either top or bottom entry of both incoming and outgoing cables earthing sockets should be fitted to the casing of D.B.

Main LT Panel/Feeder pillar panel shall be suitable for 415 V, 3 phase, 4 wire, 50 Hz supply and shall be outdoor type with canopy and shall be free standing floor type mounted on steel or concrete pedestal. NFP shall be provided with incoming & outgoing MCCB / MCB of appropriate rating and in desired quantity depending on total no. of circuits in use. Outgoing shall have at least 20% of spare circuit all the time. Major switchgears shall have potential free terminals for communication. The incomer MCCB to have short circuit, overload & earth leakage relay ELR along with electronic energy meter with RS485 port for communication.

Main LT Panel/Feeder pillar panel shall be made up of CRCA sheet steel and shall be dust and vermin proof providing a degree of protection of IP 55. The thickness of sheet steel enclosures shall be 2 mm minimum for load bearing and 1.6 mm for other members.

Busbars will be made up of Aluminium, colour coded for easy identification and of appropriate size.

Doors shall be provided with all round neoprene gaskets. The incomer switchgear shall have interlocking mechanism so as to prevent opening of the door when the switch is ON and to prevent closing of the switch when the door is not fully closed. However, a device for bypassing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination / maintenance. The outer doors of panels to have locking facility.

All panels shall have LED type 'SUPPLY ON" indicating lamps. Indicating lamps shall be of the clustered LED type and low watt consumption. Lamps shall be provided with series resistors.

Earth bus with adequate size of GI flat with zinc plated bolts and nuts shall be provided in the bottom of the panel.

The panels shall be provided with individual labels with equipment designation / rating. Also the boards shall be provided on the front with a label engraved with the designation of the respective panles as per SLD. Labels shall be made of non-rusting metal or 3 ply lamicoid or engraved PVC.

Internal wiring of the panel shall be done using flexible copper cables of appropriate sizes. All the wires shall be numbered and ferrules shall be provided for easy identification.

Inside the door of lighting panels a single line circuit diagram / description shall be fixed for ready reference.

Painting: All sheet steel enclosures of panels will be chemically cleaned rinsed, phosphated & dried. After the treatment steel surfaces will be given two coats of primer & finished grey enamel paint or powder coating of shade 631 of IS - 5. Coating thickness shall be minimum 50 microns.

5.3 Power Connections

Interconnections between the main busbars and individual units shall be made by using Cu or Al busbar strips of adequate rating. These interconnections and terminals shall be fully shrouded.

For outgoing feeders above 100 A, provision shall be made by suitable bus link from switchgear terminals so that required number cables could be connected to these links.

5.4 Circuit Breaker Compartment

Circuit breaker (CB) compartment shall be fully drawout type. Suitable guides shall be provided to facilitate easy withdrawal of trolley. It shall be possible to withdraw the trolley without having to unbolt / unscrew any connections. Spring actuated and gravity operated shutters shall be provided for covering the busbars and other live parts when the CB is completely withdrawn.

There shall be three positions for the drawout trolley as below;

- Service Position: In this position both power and control circuits shall be connected and this is normal operating position of the CB.
- Test Position: The power contacts shall be disconnected, but control connections shall not be disturbed. It shall be possible to trip / close the CB in this position.
- Fully Drawout Position: The power and control circuits shall be disconnected. It shall be possible to close the cubicle door in this position.

Compartment door shall be interlocked against opening of door in ON condition. It shall not be possible to either push in or withdraw the trolley when the breaker is in closed condition.

CB shall be of air break, drawout type and shall be provided with series trip for overload and shunt trip for various other protections. It shall have mechanical tripping device on front part of the panel.

CB position shall be indicated by indicating lamps as below;

a) Breaker close - Red
b) Breaker open - Green
c) Breaker trip - Amber
d) Breaker test position - Blue

CB's open / close position should also be indicated mechanically. Such indication shall also be available with manual operating mechanism.

5.5 Moulded Case Circuit Breakers (MCCB)

The MCCB shall be a single unit of triple pole or 4 pole as required

Operating mechanism shall be quick make, quick break and trip free type. It shall not be possible to close the breaker under short circuit condition.

The ON, OFF and TRIP positions of the MCCB shall be clear and visible to the operator when mounted as in service. Front of board operating handle shall be provided.

MCCBs shall be provided with inverse-time-current tripping characteristic for sustained over load and instantaneous tripping characteristic for short circuit conditions. These shall be microprocessor type built in facility.

Under voltage release and any other features shall be provided when called for. Maximum tripping time under short circuit conditions shall be 20 milli seconds.

5.6 Switches

All switches shall be of heavy duty, air break type with quick make / break manual operating mechanisms. The operating handles shall be mounted on door of compartment having the switch. Switches should be rated to carry the designed load without overheating.

Barriers shall be provided to prevent inter-phasing arcing and live terminals shrouded to avoid accidental contact.

Rating of SFU shall be of AC 23 with minimum 25 short circuit capacity

5.7 Contactors, Relays, Pushbuttons

The contactors shall be air break type, equipped with three main contacts and minimum 2 NO + 2 NC auxiliary contacts. The main contacts shall be rated for AC 23 operations. The auxiliary contacts shall be rated for 5A at 240V AC.

The coil of contactor shall be suitable for operation on 240V AC. The drop off voltage of contactor coil shall be between 15% to 65% of rated coil voltage.

Auxiliary relays / contactors shall be used for interlocking and multiplying the signals. Their ratings must not be less than 5A for 240V AC at PF of 0.8 to 1.0.

Thermal overload relays shall be of three elements, positive acting, ambient temperature compensated with adjustable range. Relays shall be of manually reset type. Relays shall be provided with minimum 1 NO + 1 NC contracts having a rating of 5A at 240V AC.

Door mounted over load relays / earth fault relays shall be of back connected, drawout type, suitable for flush mounting and fitted with dust tight covers. The relay cases shall have provision for inserting of test plug at the front for testing and calibration. It shall be possible to test relays without connection of wirings. It should be provided with hand reset type built in flag indicators to reset the flag without opening the relay case.

In case single phasing preventor is used, it shall be of current operated type and shall operate on the principle of sensing negative sequence component of current. SPP used shall be suitable for protection of non-reversing and reversing motors. The relay operation shall be independent of loading and RPM of the motor prior to occurance of single phasing.

Timers used for star delta starters shall be of electronic type and shall have adjusting time of 0 - 60 secs.

Push buttons used shall follow following colour codes;

a. Emergency Stop / Stop : Red
b. Start / Close : Green

5.8 BUS BARS

Suitable colour coded bus bars made of high conductivity aluminium strips and mounted on non-hygroscopic insulating supports shall be provided. Neutral bus bars shall be same the size of phase bus bar. The earth bus shall be also provided of copper material and size as required.

5.9 MINIATURE CIRCUIT BREAKERS

Miniature circuit breakers shall have a minimum breaking capacity of 9 KA. Circuits breakers shall be equipped with individual insulated, braced and protected connectors. The front face of all the breakers shall be flush with each other. The breakers shall have 'quick break trip free' mechanism with current limiting and overload and short circuit tripping characteristics. The mechanism shall be such that the circuit cannot be held closed when a fault occurs or persists.

The contacts shall be silver tungsten or other suitable material to give long contact life. Multiple units shall have an interrupting mechanism thereby ensuring complete isolation in the circuit in the event of an overload or fault in anyone of the phases. The connectors shall

be suitably shrouded.

5.10 PLANT MOTOR CONTROL CENTERS

The Contractor shall provide motor control centers (MCCs) / MLTP at one point in the electrical room only

Multidata electronic meter with communication port for SCADA. Shall be provided in the panel. The meter shall read voltages, currents, power factor, frequency etc.

Mechanical and Electrical interlocking shall be provided between the incomers and the bus section MCCB or breaker to prevent parallel operation of main switchgear feeders. MLTP / MCC be housed within buildings segregated from the injurious effects of process fluids and gases. Cable ductwork or trenches shall not directly interconnect MCCs with areas where process fluids or gases are present.

Cabling shall enter and leave the MCC via floor trenches. The trenches shall be sized to permit cabling to be clipped to the walls of the trench or to be accommodated on cable tray or ladder racking fixed within the trench.

5.11 Motor Control Systems

This section outlines the particular requirements for the motor control systems. Unless specified in this section, to the contrary motor control plant provided by the contractor and workmanship shall comply with the technical specifications of these requirements.

I. General

Motor control centers (MCCs) shall be provided for housing starters for groups of motors. These shall be floor mounted and shall be designed for front access and bottom/Top cable entry. The panels shall be environmentally protected to IP: 52. Each starter enclosure shall be segregated from its neighbour to permit safe access to any drive starter without having to isolate the whole panel or any other starter.

Motor control systems shall recover fully after a power failure without manual intervention to await automatic or manual starting as required by the plant control philosophy.

II. Motor Starter Types

Motor starters shall either be of the direct - on - line (DOL) or star - delta or soft starter type. As a guide, motors of Upto 7.5HP shall be with DOL starter and from 7.5 upto 25HP shall be with star - delta starting & above 25 HP shall be with Soft starter type (OR) as per SLD. However, the contractor shall determine the suitability of the starting method in each case taking into consideration inter alia the system fault level and the permissible voltage drop on starting. For motors higher than 25Hp only soft starters shall be adopted.

III. Switchgear components for motor feeders shall be as per type-2 coordination.

The major components of each starter shall comprise;

- Door interlocked MCCB
- Contactor
- Motor overload
- Start and stop push buttons
- Local / remote selector switch (where appropriate)
- Manual / off automatic selector switch (where appropriate)
- Ammeter for drives > 20hp
- Indicator lights for
- Running
- Tripped
- Emergency stop operated
- Power on
- Run dry protection operated (where appropriate)
- Other hard wired protection devices (where appropriate)
- Remote mode selected

Note:

1 Thermal overloads shall be used for motors up to 15 KW, electronic overloads shall be used for larger motors providing protection against overload, earth fault and phase currents out of balance.

2 For drives 20KW and above facilities shall be provided to measure the current in all phases.

3 The contactors selected shall be 25% more than the full load current of the associated motor. The contactors shall be AC 3 rated for unidirectional and AC 4 for bi-directional.

5.12 Motor Control Facilities

I. General

Each motor shall be provided with a local switch. Where a drive is required to be locally controlled for operational purposes a local start / stop station shall be provided. In this case the stop button shall be mushroom lockable type.

Valve actuator motors shall have local switch and local manual open / close controls integral with the valve actuator assembly. the stop button shall be mushroom lockable type

II. Rotating Arm Drives

Rotating arm drives shall be provided with the following additional protection;

- Motion detectors
- Over torque detectors

III. Valve Actuator Drives

Valve actuator drives shall be provided with the following additional protection:

- Over torque detectors

5.13 Specific Requirements

I. Construction

The switchgear shall be outdoor / indoor, metal-clad, floor mounted, draw-out type. Design and construction shall be such as to allow extension at either end.

The switchgear enclosure shall confirm to the degree of protection IP: 55 for out-door and IP: 42 for indoor application. The minimum thickness of sheet steel used shall be 2 mm.

The switchgear assembly shall comprise a continuous, dead-front, line-up of freestanding vertical cubicles. Each cubicle shall have a front hinged door with latches and a removable back cover. All covers and door shall be provided with neoprene gaskets.

Switchgear cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to test position. The working zone shall be restricted within 750 mm to 1800 mm from floor level.

Circuit breakers, instrument transformers, bus-bars, cable compartment etc., shall be housed in separate compartments within the cubicle. The design shall be such that failure of one equipment shall not affect the adjacent units.

All relays, meters, switches and lamps shall be flush mounted on the respective cubicle door or on a control cabinet built on the front of the cubicle.

II. Bus and Bus Tape

The main buses and connections shall be of high conductivity copper, sized for specific current ratings with maximum temperature limited to 85 °C (i.e. 35 °C rise over 50 °C ambient).

All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and lock nuts.

Busbars and connection shall be fully insulated for working voltage with adequate phase / ground clearances. Insulating sleeves for busbars and cast-resin shrouds for joints shall be provided.

All buses and connection shall be supported and braced to withstand stresses due to maximum short circuit current and also to take care of any thermal expansion.

Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly.

The busbar chamber shall be provided with inter panel barrier with epoxy case seal-off bushings which the buses will pass through so as to prevent fire from one panel to another.

III. Current Transformer

Current transformers shall generally conform to IS: 2705. The CTs shall be mounted on the switchgear stationary parts. The CTs shall be of cast resin, bar-primary type and of Class E or better insulation.

All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

Accuracy class of the Current Transformer shall be;

- Class PS for differential relaying
- Class SP20 for other relaying
- Class 1.0 m and ISF < 5 for metering

Core balance CT and associated relay combination shall be such as to ensure a pick up sensitivity of 10A primary ground fault current.

Facilities for easy shorting and grounding the terminals shall be provided at the terminal block.

All terminal blocks shall be of stud type with marking strip.

IV. Voltage Transformer

Voltage transformer shall generally conform to IS: 3156. Voltage transformer shall be cast-resin, draw-out type and shall have an accuracy Class of 1.0. Voltage Transformer mounted on breaker carriage is not acceptable.

High voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energised.

Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energised.

Fuse failure relay shall be provided on the secondary side of all voltage transformers to monitor failure of HV or LV fuses. The relay shall initiate alarm and block the tripping etc. which will operate in case of VT fuse failure.

R.Y.B phase indication shall be provided in Bus PT panels.

V. Relays

Relays shall be of draw-out design and built-in testing facilities. Small auxiliary relays may be in non-draw-out execution and mounted within the cubicle with plug ins

Relays shall be rated for operation on 110 V VT secondary voltage and 1 or 5 A CT secondary current. Number and rating of relay contacts shall suit the job requirements.

The Contractor shall furnish, install and co-ordinate all relays to suit the requirements of protection, interlock. Auto / Manual change over schemes shall be provided for Unit and Station switchgears.

VI. Control / Selector Switches

All control switches shall be rotary type having a cam operated contact mechanism. Phosphor bronze contacts shall be used on the control switches. Unless otherwise stated, circuit breaker control switches shall be 3 - position spring return to “neutral” from both

close and trip positions. They shall have “Pistol Grip” handle.

Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have four positions, three for reading three phase currents and the fourth as off position. The voltmeter selector shall measure phase to phase voltages.

The contacts shall be of silver plated, air break type. The continuous current and breaking capacity of the contacts shall be adequate for the duty involved.

VII. Meters

Indicating instruments (96 x 96 mm) shall be switchboard type, with 240 °C, anti-glare glass and accuracy class of ± 2% full scale. Each meter shall have zero adjuster on the front.

Motor ammeter shall have extended suppressed end-scale range to indicate starting current (6 - 8 times full load).

Watt-hour meter shall be provided in draw out cases with built-in test facilities. Alternatively, they may have test block to facilitate testing of meter without disturbing CT or VT secondary connections.

VIII. Secondary Wiring

The switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and inter locking schemes.

Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired upto terminal blocks.

Wiring shall be done with FRLS flexible, 650V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 mm2 for current circuits and 2.5 mm2 for voltage circuits.

Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor’s wiring Diagrams.

Wire termination shall be made with crimp in type connectors with insulating sleeves. Wires shall not be spliced between terminals.

All external cable terminations shall be accessible while the breaker is in service position.

IX. Terminal Blocks

Terminal blocks shall be 660V grade box-clamp type with marking strips ELMEX - 10mm2 or equal. Terminals for CT secondary leads shall have provision for shorting.

Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of and external cable can be connected to consecutive terminals.

X. Cable Termination

Switchgear shall be designed for cable entry from the top/bottom. Sufficient space shall be provided for ease of termination and connection.

All provision and accessories shall be furnished for termination and connection of cables including removable gland plates, cables supports, crimp type tinned copper / aluminium lugs, brass compression glands with tapered washer (power cables only) and terminal blocks.

The gland plates shall be minimum 4 mm thick. The gland plate and supporting arrangement for I / C Power cables shall be such as to minimise flow of eddy current.

Sufficient space shall be provided between the power cable termination (end-boxes) and gland plate. Core balance CTs wherever specified, shall be accommodated within the space.

XI. Ground Bus

A ground bus, rated to carry maximum fault current, shall extend full length of the switchgear.

The ground bus shall be provided with two-bolt drilling with G.I bolts and nuts at each end to receive 50 x 6 mm G.I. flat.

Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and draw-out VT unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

Wherever a definite ground is provided at the switchgear, a single wire for each circuit thus grounded shall be ran independently to the ground bus and connected thereto.

CT and PT secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.

XII. Name plates

Name plates of approved design shall be furnished at each cubicle and at each instruments and device mounted on or inside the cubicle.

The material shall be lamicoid or approved equal, 3 mm thick with white letter on the black back ground.

The material shall be held by self-tapping screws. Nameplate size shall be minimum 20 X 75 mm for instrument, device and 40 X 150 mm for panels.

Caution notice of suitable metal plate shall be affixed at the back of each vertical panel.

XIII. Space Heaters and Plug Sockets

Each cubicle shall be provided with thermostat controlled space heaters suitable for operation from 240 V, single phase AC supply and 5A, 3 pin plug socket. The space heater shall be located at the bottom of each switchgear compartment.

In addition, motor feeder cubicle shall be wired-up for feeding the motor space heater through suitable rated breaker auxiliary NC contact and / or contactor.

Cubicle heater, motor heater, plug / socket circuits shall have individual switch fuse units.

XIV. AC / DC Power Supply

The following power supplies shall be made available to each switchgear:panel:

- AC supply : Single incomer EB with DG
- DC supply : Double incomer EB with 2-DG

Isolating switch fuse units of adequate rating shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for AC and 2 pole double throw for DC.

Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units of adequate rating shall be provided at each cubicle for AC / DC supplies.

AC load shall be so distributed as to present a balance loading on three-phase supply system.

XV. Accessories

The following accessories shall be furnished along with the Switchgear;

- Earthing equipment suitable for earthing the bus, outgoing cable.
- Device for slow opening and closing of breaker.
- Test cabinet with coupling cables for testing the breaker in draw-out position.

5.14 Protections

I. Transformer Protection

The protection consists of a three inverse time O / C relays (51) with high set instantaneous units (50) for phase faults and one instantaneous over current relay (50 N) for earth faults. Buch-holz relay for gas.

5.15 Cleaning and Painting

The inside and outside of the equipment shall be thoroughly cleaned of all foreign matter, excessive oxide, weld spatter and flux. All fabricating scars and rough edges shall be repaired by welding and / or grinding.

No paint of filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed, but shall be applied prior to shipment.

All surfaces shall be sand blasted, pickled and ground as required to producer a smooth, clean surface free of scale, grease and rust.

After cleaning, the surface shall be given zinc chromate coating (yellow) followed by two coats of high quality primer and stoved after each coat.

The switchgear shall be finished in two coats of synthetic enamel paint of shade 631 of IS: 5.

5.16 Testing and Inspection

I. Shop Test

All equipments upon completion of manufacture shall be routine tested as stipulated in relevant Indian Standard. In case where Indian Standards are not available / applicable such equipment shall be routine tested in line with equivalent reference standard.

Ten (10) copies of test certificates shall be submitted for approval prior to dispatch of equipment from works.

Only type tested equipment shall be acceptable. Type test certificates for all items shall be furnished along with the Tender. In case identical design of similar or higher rated equipment as offered has not been type tested for all the tests, this shall be clearly indicated in the Tender. All such type tests which have not been conducted so far shall be conducted during the tenure of contract by the Contractor without any cost and time implications.

Oscillographic test results for closing and tripping timings of breaker shall be furnished.

II. Routine Tests:

- HV Test: To test high voltage withstand capacity of the current carrying parts.
- Megger Test: To check the insulation resistance.
- Phase Sequence: To check the phases configuration
- Functional Tests
- Coat meter: To check the painting thickness of the sheet steel fabrication.
- Gauge meter: To check the gauge of the fabricated steel.
- Heat run test kit: To check the adequacy of size of current carrying conductors.
- Secondary injection Test set: To check the protection relay for its correctness.
- Millivolt test Equipment: To check millivolt drop at any point of joint.

III. Type test certificates shall be produced for:

- Short circuit withstand capacity from Central Power Research Institute, Bangalore.
- Dust / vermin / weather - proof test (i.e. IP: 54, IP: 55 etc. as per IS: 2147) from Central Power Research Institute, Bangalore.

5.17 SAFETY & INTERLOCKS

All the live parts are shrouded such that accidental contacts with live parts are totally avoided. Distribution boards shall be provided with a front hinged door. Distribution boards interior assembly shall be dead front with the front cover removed. Main lugs shall be shrouded. Suitable insulating barrier made of arc resistant material shall be provided for phase separation. Ends of the bus structures shall also be shrouded.

6 EARTHING SYSTEM

6.1 SCOPE

This section covers the requirements for providing "Earthing" connection to metal parts of equipment etc., The contractor shall supply all materials, labour, tools, etc., and

everything necessary for the complete Earthing installation".

6.2 STANDARDS

The following standards shall be applicable:

IS 3043 -Code of practice for earthing.
IEEE - 80:86.
IEEE - 142:92.

6.3 GENERAL

All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043. All equipment, metal conduits, rising main, cable armour, switchgear, distribution boards, meters, all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 of IER 1956.

6.4 G.I.PIPE EARTH STATION

Electrodes shall be made of G.I. pipe of internal diameter as indicated in the Drawing. The pipe electrode shall be as far as practicable embedded below permanent moisture level. The length of the pipe electrode shall not be less than 2.5 m. except where rock is encountered.

The electrode may be buried inclined to the vertical and the inclinations not more than 30 deg C from the vertical. The pipe electrode shall be made of one piece. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the pipe electrode with brass bolts, nuts and washers. GI pipe shall be terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of450mm x450mm dimensions.

The chamber shall be provided with C.I. frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS: 3043latest edition. The soil around the earthing electrode shall be treated to reduce the resistivity of the soil by filling the complete depth of electrode with alternative layers of charcoal and salt.

6.5 PLATE EARTH STATION

Plate electrodes shall be made of copper (CU) plate of 3mm thick and 600 x600mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 meters to the top of the plate, the plate being encased in charcoal to a thickness of 300mm all round. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers. A GI pipe of not less than 40mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of450mm x450mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earthstation shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS: 3043.

6.6 EARTHING CONDUCTORS

a) All earthing conductors shall be of high conductivity copper and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel, conduits and cables by using suitable clamps.
b) Main earth bus shall be taken from the main medium voltage panel to the earth

electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net work.

c) Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switch boards, distribution boards and isolators disconnect switches shall be connected to the earth, bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

d) All conduits cable armouring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/protective device or a circuit breaker and shall not exceed 2 ohms.

6.7 PRECAUTIONS

a) Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after subjection to fault currents.

b) The contractor shall take care to see that the earth conductors are installed in such a manner as to ensure maximum utilisation and avoidance of straight run jointing.

c) Joints shall be tinned, soldered and/or double riveted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

d) Wherever required joints of the earth strip shall be welded as per IS standard and painted with bitumen to protect against corrosion.

6.8 TESTING

a) On the completion of the entire installation, the following tests shall be conducted:

- Earth resistance of electrodes
- Impedance of earth continuity conductors as per is 3043.
- Effectiveness of earthing as per is 3043

b) All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in the prescribed tabulated form in triplicate to the consultants for approval.

6.9 CHEMICAL EARTHING:

a. Earth Rod

The Earth Rod shall be mentioned in earthing schematic. Length of copper bonded steel rod shall be 3Mtrs. The minimum copper bonding thickness is 250 microns. Copper bonding on the steel rod is through Nickel interface. Gives lowest possible resistance to ground also resist to corrosion.

It shall be molecularly bonded with copper to high strength steel cores. The life of the earth rod shall be minimum 20 years. Earth resistance of < 3Ω shall be achieved at farthest point for normal earthing &<1Ω shall be achieved at farthest point for clean earthing.

b. Ground enhancing material

Necessary amount of GEM shall be used as soil tests as per site requirement & approval engineers.

c. Earth strips / wires

The earthing conductor (protective conductor from earth electrode up to the main

earthing terminal/earth bus, as the case may be) shall be of copper / Al. of at least 98% conductivity confirming to I.S. 3043, and in the form of wire or strip as specified.

The size & material of earthing conductor and nos. of earth pits are as specified in drg. Though contractor shall confirm the same as per local CEIG dept. requirements & any changes required for the same is within scope of contractor.

d. **Shop drawings / execution**

The contractor shall be responsible to prepare shop drawings for routes of complete system along with necessary calculations before execution for approvals along with location of pits as per site condition. The drawings given by consultant are indicative and it shall be contractor's responsibility to achieve the necessary values for earthing. Contractor shall also incorporate necessary requirements as per local codes / approving authorities.

Following activities shall be carried out for the earthing station Minimum 2 mtr. center to center distance between two earth pits. The bore should be minimum 10ft deep. All earth pits of same category shall be interlinked with insulated cable.

The earth conductors (Cu. / Al.) inside the building shall be properly clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm below the finished ground level or as per site condition as approved by engineer.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

For termination / connectors for the earth strip / wires; factory fabricated connectors shall be used. Braising and other local means for joining shall be not carried out. The connectors shall be tested as per BS EN 50164 : 2000.

e. **Mode of Measurement**

Earthing stations shall be measured in units whereas earthing strips and wires shall be measured in rmt.

7 LIGHT FITTINGS, Street light & Highmast poles

7.1 SCOPE

Scope of work under this section shall include inspection at suppliers/manufacturer's premises, receiving at site, safe storage, transportation from point of storage to point of erection and erection of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting as required. The contractor shall supply all materials and accessories (other than those supplied by the owner), labour, tools, transportation, scaffolding etc., required for the completion of above work in all respects.

7.2 STANDARDS

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

IS – 1913	Electric light fittings General and safety requirement.

IS – 1777	Industrial lighting fittings with metal reflectors
IS – 5077	Decorative lighting outposts
IS – 1947	Flood Lights
IS – 2149	Luminaries for street lighting
IS – 1258	Bayonet lamp holders
IS – 6616	Ballast for HP MV lamps
IS – 2215	Capacitors for use in fluorescent, HPMV & LPsodium Vapour lamps circuits
IS - 9974 (Part I)	High pressure sodium vapour lamps

7.3 LIGHT FITTINGS - GENERAL REQUIREMENTS:

a) Fittings shall be designed for continuous trouble free operation under atmospheric conditions, without deterioration of materials, internal wiring, and lamp life. Outdoor fittings shall be weather - proof and rain proof.

b) Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps / starters etc.

c) All fittings shall be supplied complete with lamps. Outdoor type fittings shall be provided with weatherproof boxes.

d) LED lamp fittings shall be complete with all accessories likeballasts, power factor improvement capacitors, starter's capacitors for correction of stroboscopic effect.

e) Each fitting shall have a terminal block suitable for loop-out connection by 1100V PVC insulated copper conductor wires upto 4sq.mm. The internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

f) All hardware used in the fitting shall be suitably plated or anodised and passivated for use in industrial plants.

g) Earthing: Each light fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earth terminal so as to ensure satisfactory earthing continuity throughout the fixture.

h) Painting Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burrs.

i) The housing shall be stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.

7.4 DECORATIVE TYPE FITTINGS

Decorative fluorescent fittings shall be provided with mounting / housing channel cum reflectors of CRCA sheet steel. Stove enamelled diffusers or louvers shall be translucent white polystyrene.

7.5 ACCESSORIES FOR LIGHT FITTINGS REFLECTORS

The reflectors shall be made of CRCA sheet steel / aluminium silvered glass / Chromium plated sheet as required. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enamelled / vitreous enamelled / epoxy coating finish. Aluminium used for reflectors shall be anodised / epoxy stove enamelled / mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches, blisters and shall have a smooth and glossy surface having no premium light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and

maintenance without use of tools.

7.6 LAMP / STARTERS HOLDERS

Lamp holders shall have low contact resistance, shall be resistant to wear. They shall hold lamps in position under normal conditions of shock and vibration prevalent in an industrial atmosphere. Lamp holders for fluorescent lamps shall be of spring loaded, Bi-pin rotary type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after the lamp has been taken out.
Lamp holders for mercury vapour lamps shall be bayonet type up to 100 W and Edison screw type for higher wattage. Starter holders for fluorescent lamps shall be so designed that they are mechanically robust and shall be capable of withstanding shocks during transit, installation and use.

7.7 BALLASTS:

The ballasts shall be electronic type, designed for long life and low power loss. They shall be mounted using self-locking, anti –vibration fixtures and shall be easy to remove without demounting the fittings. The enclosures shall be dust tight and non-combustible. Ballasts shall be inductive, heavy duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage. The ballast wiring shall be of copper and they shall be free from dust.

Separate ballast shall be provided in case of multiple fittings, except incase of 2 x 20 W fittings. Starters shall have bi-metal electrodes of high mechanical strength. Starters shall be replaceable without disturbing the reflector of lamps and without use of any tool. Starters shall have brass contacts and radio interference suppression capacitor.

7.8 CAPACITORS:

The Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits. The capacitor shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to 0.95 lag or better. Capacitor shall be hermetically sealed preferably in a metal enclosure to prevent seepage of imp regnant and ingress of moisture.

7.9 LAMPS:

Fluorescent lamps shall be "day-light colour (4100K)" type unless otherwise specified and shall be provided with features to avoid blackening of lamp ends. Mercury vapour lamps shall be of high pressure, colour corrected type. Lamps shall be capable of withstanding vibrations prevalent in an industrial atmosphere; the filament/electrodes shall not break under such circumstances. Metal Halide lamps shall be with high colour rendering index and less hot restrike time. Halogen lamps for building illumination shall be high intensity discharge type.

PL Lamps shall be energy effective compact single ended light sources in9 to 11W ratings consisting of two narrow glass tubes welded together.
The lamp shall be complete with integral glow switch starter and capacitor and two pin electrical connections the lamp shall be colour rendered to give warm colour impression. The compact lamp shall have along life and shall be energy efficient.

7.10 INSTALLATION:

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Construction Manager. Pendent fixtures specified with overall stem lengths are subject to change and shall be checked with conditions on the job and installed as directed. All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and the approval of the Construction Manager. Fixtures shall be suspended true to alignment, plumb, level and capable of resisting all lateral and vertical

forces and shall be fixed as required.

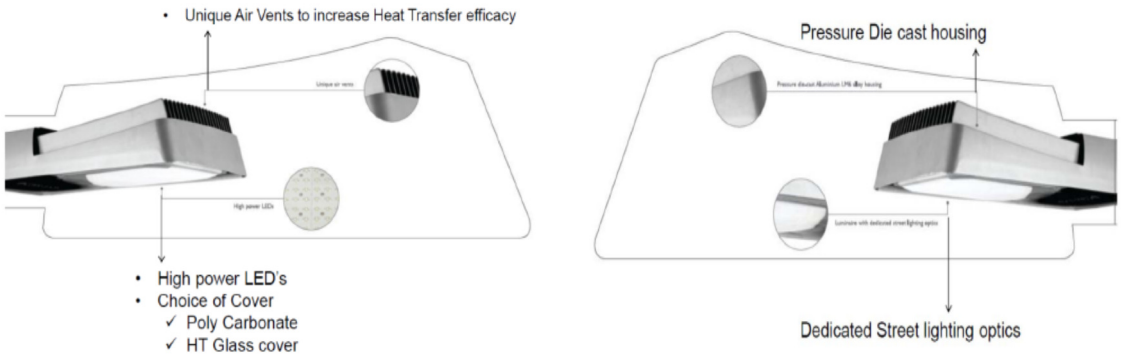
All suspended light fixtures, fans etc, shall be provided with concealed suspension arrangement in the concrete slab / roof members. It is the duty of the Contractor to make these provisions at the appropriate stage of construction. Exhaust fans shall be fixed at location shown on drawings. They shall be wired to a plug socket outlet at a convenient location near the fan. All switch and outlet boxes, for fans and light fittings shall be bonded to earth.

The recessed type fixtures shall not be supported into the false ceiling frame work. This shall have independent support from the socket of ceiling using G.I. conduit down rods /chromium Plated steel chain with provision for adjusting the level of fitting. Wires shall be connected to all fixtures through connector blocks. Wires brought out from junction boxes shall be encased in flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be check-nuted to the junction box with a brass bush and double-check nut at the fixture. Flexible pipes, wherever used shall be of best make and quality, approved by the Construction Manager/Consultant.

7.11 STREETLIGHT LUMINARIES

Street light luminaire shall be outdoor weatherproof integral type suitable for dusty and high traffic density roads. The luminiare shall be epoxy powder coated made up of single piece die-cast aluminium housing for lamp, control gear accessories. The luminiare shall have electrochemically brightened, polished finish computer aided potoptic aluminium reflector. The luminaire shall have heat resistant toughened clear glass, rubber gasket with SS toggles & SS hardware. The luminaire shall have easy access to control gear by top opening for maintenance purpose.

Degree of protection: Lamp housing compartment – IP 66; Control gear accessories
housing compartment – IP 54. Lamps: 150/250/400 Watts SON-T plus lamps having higher lumens delivery. The
Light Source shall be of LED module with system efficiency of >100Lumens/Watt, Voltage range shall be of 120-277Volts, Average lifetime of the lamp shall be more than 50,000 burning hours.



7.12 HIGHBAY / STREET LIGHT FITTINGS :

i. High bay/street light fittings shall be with LED Lamps as specified in the schedule.
ii. Rates quoted against light fittings shall include for the complete light fittings, control gear, bulb etc. all complete in factory wired and assembled condition. Locally assembled fittings and control gear shall not be accepted. Rate shall also include for

fixing arrangement for the fittings and control gear. Fixing arrangements shall have prior approval from Engineer-in-charge.

iii. In case of street light fittings, rates quoted against fittings will be excluded from the arm over the pole, but will include for lead wire from pole mounting box and all other hardware necessary to complete the work.

iv. Sample of the pole shall be submitted and approval of Engineer-in-charge obtained in writing before order is placed for the full quantity.

v. Poles shall be erected absolutely vertical.

vi. All buried portions of the poles shall be given a primer coat and two coats of bituminous paint. All exposed portions shall be given one primer coat and two coats of aluminium paint before erection. In addition, one more coat of aluminium paint shall be given after the fittings are erected and work completed.

7.13 DATA SHEET OF SOLAR STREET LIGHT:

Specification	**specification limit**
Open Circuit voltage	44V DC
Short circuit current	12A
Voltage at max power	36V DC
Current at Max. power	11A
Maximum solar panel capacity	400Watts peak
Minimum solar panel capacity	120Watts peak
output load (W)-Max	68 watts or equivalent
Battery type support	Lead acid
Battery nominal voltage	24V (Lead acid / Gel)
Battery capacity	40Ah-150Ah/24V (Parallel LA/GEL) or 25.6V(single battery)
MPPT Charge controller efficiency (Dynamic & Static)	>97%
Charge controller efficiency	Electronic efficiency >94%
Driver efficiency	>92%
Dusk voltage	<16V DC
Dawn voltage	>20V DC
4 stage battery charging algorithm	To be provided
Dimming steps	Optional
no load current	20mA
Ingress protection of Combo CC	IP66
Connector	IP67
LED Indications	Green/Orange for charging & Red for deep discharging
Humidity range	Up to 95% RH
Charger Dimension(LXWXH) in mm	To be provided
PV terminal lead wire	Yellow & Blue
Battery terminal lead wire	Red & Black
PV terminal reverse	To be provided
Battery terminal reverse	To be provided
Short circuit protection	To be provided
open circuit protection	To be provided
LED driver terminal short	To be provided

LED driver terminal open	To be provided
LED indication for charging & deep discharging	To be provided
working Temperature	0C-45C
Standards Compliance	IEC62109-1, IEC 61547, CISPR 15, IEC62093, IEC61347-2-13, EN50530, IEC62384, IEC61683,

7.14 TECHNICAL SPECIFICATION FOR OCTAGONAL STREET LIGHTING POLES

Scope:

This specification cover the design; manufacture assembly and testing of Conical /Octagonal Uniform tapered flanged type poles to be fixed on the foundation bolts with base plate arrangement as per approved drawing and design.

Bidder shall note that all the street light poles shall be of aesthetic poles considering the architectural features and same needs to get it approved by Client/Consultants before procurement.

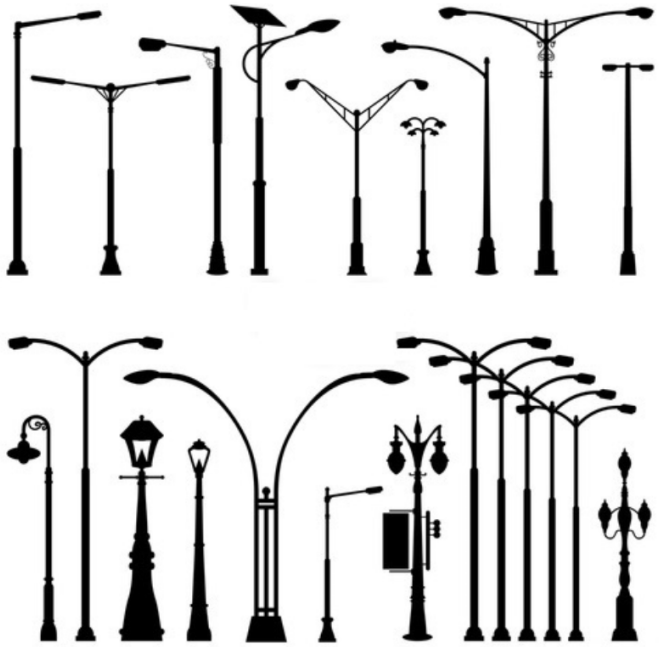
General Standard:

I. The Octagonal Poles and bracket shall comply with the requirement as per latest Indian standard.
II. The material used shall comply with BSEN 10025 with yield strength of 355 MP for Conical / Octagonal Pole shaft.
III. Hot Dip Galvanizing shall be in accordance with IS 2629 or latest IS specification.

7.15 Design:

I. The Octagonal Poles and brackets shall be suitable for use in climatic conditions found in Bangalore.
II. They shall be designed and fabricated from such material and provided withsuch finish so as to withstand atmospheric conditions.
III. Calculation of wind pressure shall be as per IS 875 PART-III.
IV. The Octagonal Poles shall be designed as per the procedures. The safety factor for the loads shall be as per the standards. Force and moments on Octagonal Poles shall be as
per calculations
V. Deflection: The maximum horizontal deflection of the top point of the Conical /Octagonal
VI. Poles. When subject to two thirds of the design wind speed shall not exceed 1/40 of the length above the ground.
VII. Safety Factor: Safety factor, which is defined, as ratio of yield stress to allowable stress must be allowed as 1.25 in the design.

Sample poles for reference:



Bidder shall also evaluate the design of equivalent poles which are feasible to the proposed infrastructure and same may be presented to client/consultant for review/approval.

Material:

The steel used for the manufacture of Octagonal Pole shall be as per BSEN 10025 Grade 355 J or equivalent and the material for the base plate, bracket, flange plates, shall be equivalent to or better than IS 2062.
The Steel used shall be Weldable, aging resistant and suitable for hot dip galvanizing which should be in accordance to IS 2629 or upgraded IS specification.

Galvanising:

All components of the pole and brackets shall be hot dip galvanized after completion of fabrication No further touching up finalizing or modification shall be done after galvanizing. It is recommended that the overall length of each section bracket is immersed in one dipping operation to ensure smooth and aesthetic finish.

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.

Design recommendations:

I. The Octagonal pole shall be evenly tapered from base to top.
II. The Octagonal pole shall preferably be fabricated in section.
III. There shall be no circumferential welded joint in Octagonal Poles.
IV. All welds shall ensure no fissures inside or outside or outsides surfaces, and no blowholes.
V. Fixing of poles shall be on foundation bolts with base plate arrangement.
VI. Suitable size sq. mm of Copper/Aluminium Ar. cable shall be used for loop in/loop out wiring between street light poles.

VII. Lugs of appropriate size of proper quality suitable for size sq. mm cables should be used to terminate cable on terminals.
VIII. Wiring between terminals, MCB and the light fittings shall be with 3 core copper wire of 2.5sqmm.
IX. Octagonal poles shall be in single length of 9.0 m as required or as specified in the BOQ/Dwg.
X. The double arm bracket shall be at a tilt angle of degree for poles of height 9m.
XI. Sample of street light pole complete in every respect shall be got installed at site for testing purpose and got approved from Engineer in-charge.
XII. Octagonal poles should be designed to mount the street light luminaries.
XIII. The Octagonal poles should be Hot Dip Galvanized to give average thickness of galvanization as per IS 4759 / BSEN 1461 standards – 65 microns.
XIV. The Octagonal poles are to be designed for maximum wind speed of 50 m/s (180 km /hr). (IS 875 Part-III)

7.16 TECHNICAL SPECIFICATION FOR HIGH MAST POLE

DATA SHEET OF HIGH MAST

Height of mast	:	16 Meter
No. of sections	:	Three
Material construction	:	355 grade as per BS-EN10 025
Base dia. and top diameter (A/F)	:	Top : 150mm, Bottom : 460 mm
Plate thickness & section Length	:	Top : 3 mm Middle : 4 mm Bottom : 5 mm
Cross section of Mast	:	20 side polygon
Standard for of galvanisation	:	As per BS EN ISO 1461
Size of opening and door at base	:	1200 x 250 mm
Diameter of base plate	:	670 mm
Lightning protection finial	:	G.I single spike of length 1200 mm
Max.wind speed	:	50,47m/s
Number of foundation bolts	:	
PCD of foundation bolts	:	
Type / diameter / length of foundation bolts	:	
LUMINAIRES CARRIAGE		
Material of construction	:	50 NB ERW Class A - M. S. Tube
Diameter of carriage ring (mm)	:	710 mm (ID)
Construction	:	6 Arm, Welded, 2 sections
Load carrying capacity	:	16 Luminaire
TRAILING CABLE	:	
Conductor	:	Copper, 5 core, 4 sq mm
Insulation	:	XLPE Insulated & sheathed
No. of circuits per mast	:	One

8 WIRING SYSTEM

8.1 SCOPE

The scope of work under this section generally covers internal wiring for lights, power sockets, Signage's& Advertisement Boards etc., The contractor shall provide all materials, labour, equipment, scaffoldings, etc., as required for the completion of wiring installation called for. The wiring shall generally be done using FRLS PVC insulated copper conductor wires in G.I conduit as called for including providing switches, sockets, plug tops, etc.

8.2 STANDARDS

The applicable standards for above work shall be as listed below:

IS: 732 Code of practice for electrical wiring installation (System voltage not exceeding 650 V).
IS: 1646 Code of practice for fire safety of buildings (General Electrical installation)
IS: 2667 Fittings for rigid steel conduits for electrical wiring.
IS: 3480 Flexible steel conduits for Electrical wiring.
IS: 3837 Accessories for rigid steel conduit for electrical wiring.
IS: 694 FRLS PVC insulated cables.
IS: 2509 Rigid - non-metallic conduits for electrical wiring.
IS: 946 Flexible (Pliable) non-metallic conduits for electrical installation.
IS: 1293 3 Pin plugs and sockets.
IS: 8130 Specifications for conduits for electrical installation.
IS: 3854 Switches for domestic purpose.
IS: 3415 Fittings for rigid non-metallic conduits.
IS: 4648 Guide for electrical layout in residential building.
IS: 9537 Conduits for electrical installation.
IS: 302 General and safety requirements for household and similar electrical appliances.
IS: 3043 Code of practice for earthing.
IS: 5216 Guide for safety procedures and practices in electrical work.
Indian Electricity Act and Rules.

Regulations for the electrical equipment in buildings issued by the Mumbai Regional Council of Insurance association of India, CEIG Karnataka, BESCOM.

All standards and codes mean the latest.

8.3 POINT WIRING FOR LIGHTS, CONVENIENCE SOCKETS, SIGNAGES & ETC.,

a. A point wiring shall consist of the branch wiring from the distribution board together with a switch as required, including providing conduit and accessories with suitable termination. Point wiring shall include, in addition, the earth continuity conductor / wire from the distribution board to the earth pin / stud of the outlet / switch box and to the outlet points.

The point wiring shall be carried out in the under mentioned manner:

a. Supply, installation, fixing of conduits and GI pull wire with necessary accessories, junction / pull / inspection / switch boxes and outlet boxes etc. Switches, switch plates and switch boxes are not required for the lights which are controlled directly from the MCB DB's, along with the daylight integration control.
b. Supplying and drawing of FRLS PVC insulated wires of required size including earth continuity wire.

c. Supply, installation and connection of flush type switches, sockets, cover plates, switch plates, and lamp holder etc.,
d. The point shall be complete with the branch wiring from the distribution board to the outlet point, through switch board, conduit with accessories, junction, pull, inspection boxes, control switch, socket, outlets boxes, lamp holder, connector, extension cord wire, flexible conduits etc.,

b. **POINT RATE**

For purposes of measurements and payments the rate for point wiring for lights etc., is divided into two parts.

a) Circuit Main for Light Point

The circuit main for lights / fan /6A sockets (where 6A sockets connected to light circuit) shall include the wiring from the MCB distributionboards up to the first switch / light point / fan point. This is measured in linear meter. The scope of work under this section shall include
i) Supply and wiring in concealed / surface conduit from DB's to first switch / light point.
ii) Providing and installing FRLS ZH PVC insulated copper conductor earth wire.
iii) Providing and installing GI fish wire (pull wire) in the conduit.
iv) Termination of wires in DB's and switches using proper tinned copper lugs of crimping type.
v) Providing and installing necessary pull / junction boxes where necessary.

b) Point Wiring

The rate for point shall include supply, installation, and connection, testing and commissioning of point wiring in conduit. The points shall be measured in No. / sets for the set / group of lights controlled as mentioned.

The exact scope of work included in the point wiring for the purposes of measurement is enumerated as stated below

i. Wiring starting from the first switch / light point, where the circuit main is terminated to the various lights , sockets(where 6A sockets connected to light circuit loop), and then looping between the switches / lights / 6A sockets etc.,

ii. Providing and installing all necessary switches, switch plates, sockets, pull / junction / etc. as called for.

iii. Providing and installing insulated earth continuity wire in each conduit along with the wiring system.
iv. Providing and installing G.I. fish wire (pull wire) in the conduits.
v. Providing and installing ceiling roses, lamp holders where necessary.

vi. Providing and installing FRLS PVC insulated, sheathed flexible three core 2.5 sq.mm extension cords including flexible conduits from light / fan outlet points mounted at ceiling point to the light /fan outlet.

Wiring for 6A Sockets, 16A Power Sockets for Equipment Wiring except where 6A sockets connected to the lighting loop

8.4 SYSTEM OF WIRING

a. Unless otherwise mentioned on the drawings, the system of internal wiring shall be as follows:

The system of wiring shall consist of single core, FRLS ZH PVC insulated, 650 / 1100 Volt grade, stranded copper conductor wires /cables laid through concealed or exposed GI conduits as mentioned elsewhere or as directed by owner / consultant.

b. GENERAL: Prior to laying and fixing of conduits and light outlet boxes, contractor shall carefully examine the layout drawings and prepare detailed shop drawings, indicating the exact location of light outlets, with distances marked, conduit routing, with sizes, number of wires run-in each conduit, control switch location etc., The contractor shall obtain the approval of all shop drawings by the owner / consultant prior to the installation of conduits. Any discrepancy noticed in the design drawings shall be brought to the notice of the owner/ consultant. Any suggestions or modification suggested by the contractor shall have approval of Client/Consultant before execution.

8.5 MATERIALS:

a. CONDUITS

Type of Conduit

All conduits for lighting, power sockets irrespective of surface or concealed shall be of GI conduits. Each conduit shall bear the relevant ISI Mark. The conduit internal surface shall be smooth. Only approved quality factory made bends /accessories shall be used. Minimum size of conduits shall be 20mmdiameter.

b. CONDUIT ACCESSORIES

CONDUIT BENDS & COLLARS

The conduit bends & collars shall be of heavy duty and preferably of the same make as of conduit. This shall conform to relevant standards with ISI Mark. Where necessary bends or diversion may be achieved by means of using bends and or circular inspection boxes with adequate and suitable inlet and outlet termination. In case of recessed installation system, the bends shall be properly secured &flush with the finished wall surface. Elbows shall not be used. No bends shall have radius less than 2 1/2 times the outside diameter of the conduit.

c. INSPECTION / JUNCTION / PULL BOXES

The Inspection / pull box / junction box, where used, with relevantGI conduit installation shall be of heavy gauge and conform to IS specification and shall match with the conduit sizes. The box shall be round / square rectangular with conduit stub projection for termination of conduit. The box shall be of minimum 50mm deep and the size of box shall be suitable to pull / make necessary joints of wires inside the boxes. Extra deep boxes are preferred. The boxes shall have flush type cover. The colour of plate shall match the colour of paint of the surface where installed. The boxes shall have concealed screwed socket for fixing the ceiling rose.

d. SWITCH OUTLET & SOCKET OUTLET BOXES

CONCEALED TYPE OUTLET BOXES

The concealed outlet boxes for switches, sockets, power outlets, telephone outlet, fan regulator etc., shall be of standard factory made and to match the exact requirement of combination of outlets. The boxes shall be fabricated out of heavy gauge CRCA cold rolled carbon alloy sheet steel with zinc plating (G.I). The size of boxes shall match the type of outlet / switch plate to be mounted on the box. Adequate No. and size of knockout holes shall be provided to terminate the conduits in the box.

These boxes shall be of standard factory made product and of same make as of switch plates and sockets. Separate screwed earth terminal shall be provided in the box for earthing.

The outlet box shall be of minimum depth of 50mm.Boxes shall be suitable for grid mounting type of accessories. Long screw shall be provided to take care of the extra plaster thickness to mount the switch plates. Provision shall be made in the box and switch plate to have the minor adjustment of alignment of switch plate to plumb level.

SURFACE TYPE BOXES

The boxes for mounting switches, sockets and other wiring devices shall be heavy gauge CRCA sheet steel painted to match the colour of wall. The box shall be suitable to terminate the G.I / M.S. surface conduit into the box. The size and shape of box shall match the exact type and combination of switch plates, receptacles and wiring devices. Deep boxes shall be used to facilitate easy termination of conduit and wires /cables. Separate screwed earth terminal shall be provided in the box for earthing.

LIGHT OUTLET BOXES:

For concealed PVC / MS conduit installation the light outlet box shall bimetallic round / square with knock-out holes. Conduit projection shall be suitable to terminate the conduit to the box. The box shall be made of heavy gauge CRCA and the sample to have the approval of Construction Manager before use. The boxes shall have concealed screwed socket to fix the ceiling rose. The boxes shall be minimum 50mm deep.

For surface conduit installation the light outlet box shall be of G.I / black enamelled M.S. boxes. The boxes shall have threaded stub projection having internal threading to terminate the conduits of different sizes.

The boxes shall have concealed screwed socket for fixing the ceiling rose. The boxes shall be minimum 50mm deep.

SWITCHES

Switches shall conform to IS: 3854, and IS: 4615. Switches shall be single pole, single or two ways as shown on the drawings. They shall be of the moulded type rated for 250V, 6/16A. They shall be provided with insulated covers.

The switches shall be rocker operated with a quiet operating mechanism with bounce-free, snap acting mechanism in an arc resistant chamber.

The switches shall have pure silver and silver cadmium contacts. The switches shall be of approved make as indicated in the `List of Approved Makes'. Switches installed outdoors shall be industrial, metal clad type, and shall be provided in weather-proof enclosure, complete with weatherproof gasket covers.

COVER PLATES FOR SWITCHES & OUTLETS

Switches / sockets / wiring devices plates shall be of the same make as of switches / sockets / wiring devices. These shall be of best quality. Moulded plastic grid mounting type device plates / frames shall be used and these shall match with the type of

switches / sockets and boxes.

COVER PLATES FOR INSPECTION / JUNCTION / PULL BOXES

The cover plate for FRLS PVC boxes shall be with minimum 3mm thick Perspex / Formica sheet cover and for the G.I / M.S. boxes shall be of G.I / black enamelled M.S. plates. In the factory only MS plates shall be used. The shape of the plate shall match with that of the box.

RECEPTACLES

The sockets shall conform to IS 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type rated for 250 volts and of 6 A or 16 A capacity as mentioned on the drawings. The 16 Amps sockets shall be multi pin (6 pin) automatic shutter type suitable for plugging 6 A/16 A plugs. The shutter shall open when the earth pin of the plug is inserted in the socket. Where called for, the 16 A socket shall have indicating lamp. The socket outlets and switches shall be of grid mounting type. Where called for sockets shall be provided with three pin plug top suitable to the socket and of the same make as of socket. The plug shall conform to IS 6538. The socket outlets installed outside the building / open to sky or in damp / wet areas shall be of weather-proof, water-tight type.

e. **CONDUCTORS:**

All FRLS PVC insulated copper conductor wires shall conform in all respects to standards as listed under sub-head 'Regulations and Standards' and shall be of 650/1100V Grade. FRLS PVC INSULATED WIRES (FOR LIGHT & SMALL POWERIRING)

The FRLS PVC cables shall conform to IS: 696/1977. For all internal wiring FRLS PVC insulated cables of 650V grade, single core shall be used. The wires shall have the approval of Tariff Advisory Committee.

The conductors shall be plain, circular stranded annealed copper conductors complying with BS: 6360.
The minimum number and diameter of wires for circular stranded conductor shall meet the requirements set out in the relevant British Standards.

The insulation shall be FRLS PVC compound complying with the requirements of BS: 6746. It shall be applied by an extrusion process and shall form a compact homogeneous body. The FRLS ZH PVC compound shall comply with the requirements of IS 5831-84.

The cores of all cables shall be identified by colours in accordance with the following sequence as per IS.

Single phase	-	Red
Three phase	-	Red, Yellow, Blue
Neutral	-	Black
Earth	-	Green or Green / Yellow.

A means of identifying the manufacturer shall be provided throughout the length of cable.
Unless otherwise specified in the drawings, the sizes of the cables /wires used for internal wiring shall be as follows:

In case of circuit wiring for lights, exhaust fans, ceiling fans, bells, convenience socket outlet points:-
2.5 Sq.mm - For Lights / 6A socket wiring from DB's upto the outlet points including

control wiring where the circuit length from the DB's to1st outlet is less than 40 m.

In case of power socket outlet circuit.
6.0 Sq.mm - From DB's to 20 / 32 A Industrial type sockets.
4.0 Sq.mm - From DBs to 16 A sockets.

The earth continuity conductor size as indicated in the drawing / shall be drawn through conduit along with other circuit cables / wires.

The size of the earth continuity conductor shall be as follows:-
Unless otherwise specified minimum size of earth continuity conductor wires not forming part of the same cable as the associated circuit conductor / as per IS.

Nominal cross sectional area of largest associated copper circuit conductor in sq.mm.	Nominal cross sectional area of earth continuity conductor in sq.mm (FRLS PVC insulated green colour wire)
10.0	6.0
16.0	10.0
25.0	10.0
35.0	16.0
50.0	25.0

Separate circuits shall run for each water heater, pantry / kitchen equipment, window air conditioner, and similar outlets at locations as shown on drawings.

8.6 INSTALLATION OF CONDUIT

a. CONCEALED CONDUIT SYSTEM

Unless otherwise specified, all wiring shall be embedded in wall or ceiling and concealed in the false ceiling. The size of the conduit shall be selected in conformity with I.S. code and as specified in the table given below.
Factory made conduit bends and accessories shall be used. The conduit in ceiling slab shall be straight as far as possible.

Before the conduits are laid in the ceiling, the position of the outlet points, controls, and junction boxes shall be set out clearly as per the dimensions and to minimise off-sets and bends.

Before the reinforcement rods are kept in position electrical contractor shall mark in paint the position of outlet points and conduit drop on the shuttering. When the outlet boxes are kept in position and before pouring the concrete, all outlet boxes shall be filled with paper to avoid entry of concrete into the box.

Conduits in ceiling shall be bonded to the reinforcement rods with G.I. bonding wire at intervals not more than 1000mm, to secure them in position. Metallic deep light outlet/ pull boxes shall be provided as required.

The conduit in ceiling slab shall be laid above the first layer of reinforcement rods to avoid cracks in the ceiling surface. In general the conduit shall not be laid directly on the shuttering surface to avoid cracks in the ceiling surface.

Conduits concealed in the wall shall be secured rigidly by means of steel hooks / staples at min. 750 mm intervals.

Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper required dimensions using electrically operated groove cutting tools to accommodate number of conduits. The outlet boxes for control switches, inspection and draw boxes shall be fixed as and when conduits are being fixed. The recessing of

conduits in walls shall be so arranged as to allow at least 12mm plaster cover on the same.

All grooves, chases etc. shall be refilled with 1:4 cement mortars and finished upto wall surface before plastering of walls is taken up by the general civil contractor. Horizontal chases in walls are not allowed.

Where unavoidable, prior permission of owner/ consultant shall be obtained before making any chasing. Where conduits pass through expansion joints in the building, adequate expansion fitting or other approved devices shall be used to take care of the relative movement. Whenever the conduits terminate into control boxes, distribution boards etc. conduits shall be rigidly connected to the boxes/boards with check nuts on either side of the entry.

After conduits, junction boxes, outlet boxes etc. are fixed in position, their outlets shall be properly plugged with metallic stoppers, so that water, mortar, vermin or any other foreign materials do not enter into the conduit system. All conduit ends terminating into an outlet shall be provided with metallic bushes after the conduit ends are properly filed to remove burrs and sharp edges.

Necessary G.I. pull wires shall be inserted into the conduit for drawing wires before concreting. Insulated earth wires shall be run in each conduit originating from the panel board up-to the Light, Socket and Switch boxes. If the Electrical Contractor forgets to install any conduit/boxes etc., before the plastering / painting work is done by other agencies, he may be permitted to install the same with prior permission of client/ consultant and he shall be liable to make good the wall, floor, ceiling etc. at his own cost.

Conduits shall be so arranged as to facilitate easy drawing of wires through them. Entire conduit layout shall be done in such a way as to avoid additional junction boxes other than light points. The wiring shall be done in a looping manner. All the looping shall be done in either switch boxes or outlet boxes. Joints in junction or pull boxes are strictly not allowed. Where conduits cross building expansion joints, adequate expansion fittings or other approved devices shall be used to take care of any relative movement.

All conduits shall be installed so as to avoid touching of steam and hot water pipes.

Conduits shall be installed in such a way that the junction and pull boxes shall always be accessible for repairs and maintenance work. The location of junction / pull boxes shall be marked on the shop drawings and approved by the owner/consultant.

A minimum separation of 200mm shall be maintained between electrical conduits and hot water lines in the building.

No run of conduit shall exceed ten meters between adjacent draw-in points nor shall it contain more than two right angle bends, or other deviation from the straight line.

The entire conduit system including boxes shall be thoroughly cleaned after completion of installations and before drawing of wires. Conduit system shall be erect and straight as far as possible. Traps where water may accumulate from condensation are to be avoided and if unavoidable, suitable provision for draining the water shall be made.

All jointing methods shall be subject to the approval of the owner /consultant.

Separate conduits shall be provided for the following system.

- Lighting wiring
    - 16 Amp power outlets.
    - 6 Amp outlets and lighting system.
    - CCTV
    - Signages
- Computer data cabling system.
- Equipment wiring.

b. **CONDUIT JOINTS**

Conduits shall be joined by means of plain couplers. Where there are long runs of straight conduits, pull / inspection boxes shall be provided at intervals, as approved by the owner/consultant / construction manager. The conduits shall be thoroughly cleaned before making the joints. Incase of plain coupler joints, proper jointing material as recommended by the manufacturer shall be used.

c. **BENDS IN CONDUIT**

Wherever necessary, long bends or diversions may be achieved by bending the conduits or by employing normal bends. No bends shall have radius less than 2.5 times outside diameter of the conduit. Heat may be used to soften the conduit for bending, but while applying heat to the conduit, the conduit shall be filled with sand to avoid any damage to the conduit. Kinks in the conduit bends shall not be acceptable.

8.7 **BUNCHING OF CABLES**

Cables of AC supply of different phases shall be bunched in separate conduits. The number of insulated wires/cables that may be drawn into the conduits shall be as per the following table. In this table, the space factor does not exceed 40%. However, in any case conduits having less than 20mm diameter shall not be used.

Wires carrying current shall be so bunched in the conduit that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit.

8.8 **WIRING:**

All final branch circuits for lighting and appliances shall be single conductor cables run inside conduits. Branch circuit conductor sizes shall be as shown in the load analysis of drawing and conforming to the requirements of the I.E. Regulations and I.S. Code.

Home runs indicated on the drawings for the final branch circuits shall be kept in a separate conduit upto the panel board via switches wherever called for. No other wiring shall be bunched in the conduit unless the other circuit main of same phase runs in the same conduit.

For each lot of wire supply, Contractor shall supply a certificate issued by the Manufacturer stating its origin, date of manufacture, constitution and standards to which it complies and the test certificates.

Looping system of wiring shall be used. Wires shall not be jointed inside the conduit or pull boxes. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of owner/consultant.

Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in galvanized steel boxes. Chromium plated screws shall be used.
Power wiring shall be distinctly separate from lighting wiring.

Each circuit phase wire from the distribution boards should be followed with a separate neutral wire of the same size as the circuit wire.

a. **BUNCHING OF WIRES:**

Wires carrying current shall be bunched so that the outgoing and the return wires are drawn in the same conduit. Wires originating from two different phases shall not run in the same conduit.

b. **DRAWING CONDUCTORS:**

The drawing and jointing of FRLS PVC insulated copper conductor wires and cables shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp bends.

Insulation shall be shaved off like sharpening of a pencil and it shall note removed by cutting it square.

FRLS PVC insulated copper conductor wire ends shall be soldered (at least 20 mm length).

Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and shall be soldered. Connecting brass screws shall have flat ends. All looped joints shall be soldered and connected through block / connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors of all sizes shall always be terminated using cable sockets. At all bolted terminals, brass flat washers of large area and approved steel spring washers shall be used.

Brass nuts and bolts shall be used for all connections. Only certified wiremen and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing. For all internal wiring, FRLS PVC insulated wires of 650/1100 volts grade shall be used.
The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the use of joint connections is unavoidable due to any specific reason, prior permission, in writing, shall be obtained from the owner/consultant.

No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of wire. Before the wires are drawn into the conduits, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits. The minimum size of FRLS PVC insulated conductor wires for all sub-circuit wiring for light points shall be 2.5 sq.mm.

c. **JOINTS:**

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to outlet.

8.9 **MAINS AND SUB-MAINS:**

Mains and sub-mains cables or wires where called for shall be of the rated capacity and approved make. Every main and sub-main wire shall be drawn through an independent adequate size conduit. An independent earth wire of the proper rating shall be provided

for every single phase sub main. For every 3-phase sub main, 2 nos. earth wires of proper rating shall be provided along with the sub main. The earth wires shall be drawn inside the conduits along with the circuit main. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cables shall be provided to facilitate easy connections and maintenance.

8.10 **LOAD BALANCING :**

Load balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

a. **COLOUR CODE OF CONDUCTORS:**

Colour code shall be maintained for the entire wiring installation: red, yellow, blue for three phases, black for neutral, green / yellow green for earthing as per relevant IS standard.

The control wire from light control switches to the light / fan points shall be the same colour as that of the phase / circuit wires feeding that particular loop.

8.11 **EARTHING**

All grounding system shall be in accordance with IS 3043 - 1985 Code of practice for Earthing.
The type and size of earthing wire shall be as specified under the heading of cables.

Each conduit originating from the DB to various outlets shall have one earth wire (FRLS ZH PVC insulated green colour wire).

a. **TESTING OF INSTALLATION**

Before a completed installation is put into service, the following tests shall be complied with:

b. **INSULATION RESISTANCE**

The insulation resistance shall be measured by using 500 Volt megger with all fuses in place, circuit breaker and all switches closed.

The insulation resistance in mega ohms of an installation measured shall not be less than 50 mega ohms divided by the number of points in the circuit.

The insulation resistance shall be measured between

Earth to Phase
Earth to Neutral
Phase to Neutral

c. **EARTH CONTINUITY PATH**

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

d. **POLARITY OF SINGLE POLE SWITCHES**

A test shall be made to verify that every non-linked, single pole switch is connected to one of the phases of the supply system.

8.12 COMPLETION CERTIFICATES

All the above tests shall be carried out in presence of Construction Manager and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result forms shall be submitted to the owner/consultant.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

8.13 MEASUREMENTS

Mode of measurement is as follows:
For purposes of measurement the point wiring for lights / fans / 6Asockets (where 6A sockets are connected to lighting circuit loop) is divided into two parts.

a) POINT WIRING
The wiring for light / 6A socket (where 6A sockets are connected to lighting circuit loop) point starting from first light /switch and looping between switches/ sockets etc., shall be measured either in `Number' or `Set'.
One light point controlled by one switch is measured in Number (No.)
Set of Two or more light points controlled by one switch is measured in `Sets'.6A socket wiring where connected to the lighting circuit loop is measured in Number (No.)

b) CIRCUIT MAIN
The length of circuit main including conduit starting from MCB DB to first switch / light / fan shall be measured separately in `Linear Metres' (Rm). (Further wiring is measured in point wiring).

Circuit main for wiring 6A sockets, 16A sockets and power outlets shall be measured as under ;

Length of circuit wire including conduit starting from MCB DB to outlets and looping between outlets shall be measured in linear metres (Rm).

The commercial type socket outlet with outlet box and cover plate shall be measured in numbers (No.)

The Industrial type socket outlet including MCB, plug top, outlet box and cover plate shall be measured in numbers (No.)
The plug tops where called for shall be measured in numbers (No.)

9 UPS AND UPS BATTERIES

I. SCOPE

The specification call for design, manufacturing, supply, installation, testing and commissioning of three / single phase UPS including batteries with battery back up of 30min. The supply of batteries is included in the scope of this tender. The scope shall include the complete power and control wiring between the battery terminals to UPS system with all other items like cable trays / conduits etc as required complete as per good installation practice.
Apart from carrying out pre-commissioning checks and tests, the work includes elaborate site tests for operation and performance and heat run test at full load. All guaranteed parameters and performance figures shall be verified through tests before handing over of the UPS to the Employer.

The loads which are connected to the UPS shall be

a) Lighting : 15% of overall lighting
b) workstation : Full load workstation(if any) shall be under UPS
c) PLC system : Full Load

The offer shall include a list of start-up and essential spare with prices, such of those spares available at site after successful commissioning will be treated as Employer's Property.
Contractor shall furnish a list of recommended spares with prices and quantities. Justification for holding each of the spares shall be furnished.

II. UPS CONFIGURATION

The UPS shall be of the online type with static and manual by-pass.
The design shall be IGBT, transformer less, on line static, double conversion type.
Adequately sized, anti-harmonic filters shall be incorporated in the UPS to prevent harmonics being transferred on to the mains. The THD shall be limited to 5% and the input power factor shall not be less than 0.95 at rated full load.

III. OPERATION

The UPS will be working independently supplying its respective loads. During failure of any one of the inverter, the UPS will shift to the static by pass mode.

IV. EMERGENCY MODE

Upon loss of primary AC source, the UPS loads shall be continued to be supplied by inverter(s), which, without interruption shall obtain its power from the battery, for the period specified in the UPS data sheets.

V. RECHARGE MODE

Upon restoration of the primary source the rectifier/changer shall draw power to the inverter and simultaneously recharge the battery.
The rate of re-charge of the battery shall be such as to restore it, within the specified time, to a capacity that will enable it to fulfil the discharge performance requirements; this shall be all automatic function causing no interruption of power to the load. In addition boost charging facility shall be provided for start-up and or for the situations, where the battery is fully drained.

VI. STATIC BYPASS MODE.

In the event of failure of any one unit, the healthy unit shall supply the full load. During this situation should the other unit also fail, the load on both unit shall be transferred to the static by pass without interruption.
In the event of a fault on the load side, same will be cleared through the outgoing feeder breaker, the static by pass capacity to feed the fault current being higher. When the fault is cleared there will be an auto-reverse changeover.

VII. MANUAL BYPASS MODE

During planned maintenance the UPS load receives supply from manual by pass. Switchover to the manual by pass is done manually after transfer of load to the static by pass.
If the battery is taken out of service for maintenance, the UPS will continue to operate and meet all specified preference criteria except for the reserve time capacity.

VIII. BATTERY MAINTENANCE (ELIMINATOR) MODE

If only the battery is taken out of service for maintenance, the UPS shall continue to operate and meet all specified performance except for the reserve time capacity.

IX. SPECIFIC REQUIREMENTS

i. Codes and Standards

i) All equipment shall be designed, manufactured and tested in accordance with the applicable sections of the IEC & IS codes and standards listed in Appendix A1. The latest edition shall always be used.

ii) Equipment manufactured in India shall be designed manufactured and tested in accordance with IEC or IS codes and standards.

iii) Conflicts between referenced documents shall be identified to the Employer in writing for resolution. In general the order of precedence is:

Data Sheets(s)

Single Line Diagram(s), whenever furnished

This specification

Reference standards

ii. Service Conditions

i) Electrical equipment, materials and installation shall be suitable for operation under service conditions as stated under Site conditions.

ii) Design temperature for all equipment and accessories shall be as in Datasheet.

iii) All equipment and accessories shall have a design life of at least 10 years.

iv) Electrical equipment intended for indoor installation shall have minimum protection to IP31 (in accordance with IEC 529).

v) The possibility of condensation, as experienced during large temperature variation in 95% humid atmosphere, shall be taken into account.

iii. Electrical System

i) The electrical arrangement of the system shall be as indicated in UPS configuration drawing.

ii) All components shall be rated for the electrical system characteristics, voltage and frequency variations as stated on the data sheets(s).

X. ALARMS & ANNUNCIATIONS

The UPS system shall include an Annunciation and Alarm system covering all events on LCD menu with messages. The Events on the LCD panel menu shall broadly include but not limited to the following:

i) Test run

ii) Test start fault

iii) Charger fault

iv) Battery connection fault

v) Battery not connected

vi) Battery start OK

vii) Battery test failed

viii) Battery discharged

ix) Battery running down

x) Battery switch open

xi) Battery test ok

xii) Battery voltage high

xiii) By pass

xiv) Communication

xv) Configuration

xvi) EPROM failure

xvii) Emergency power failure

xviii) PCB failures

xix) Frequency control errors

xx) DC link faults

xxi) Inverters failure

xxii) Load control Failure

xxiii) Main by pass failure

xxiv) Output error

xxv) Synchro fault/check

xxvi) Temperatures

xxvii) Capacitors

xxviii) Watchdog alarm levels 1, 2, 3 etc.

The display function includes prior warning for any component/device failure, self diagnostic result messages and failure annunciation and alarm.

XI. CONSTRUCTION

The UPS units shall be entirely built and tested in the works of the manufacturer where regular assembly of similar systems takes place.

Each UPS unit shall include all components shown on the data sheet(s) and/or Single Line Diagram(s) attached to the material requisition, and all other circuit protective devices, regulators, filters, instrumentation, and related components required to ensure the integrity and reliability of the system. Equipment shall be arranged in a logical manner.

Where practicable, enclosure shall be compartmentalized to prevent faults in one section spreading to other sections.

The UPS unit shall be metal enclosed for indoor service, vermin proof, free standing, dead front, with hinged lift off doors for front access and bolted covers for rear access.

The enclosure shall accommodate top cable entry. The interior shall be designed to allow all normal maintenance to be performed from the front hinged door and rear bolted covers shall be provided for further access to components.

Door locking by a central pad lockable handle with top and bottom 'shot bolts 'shall be provided. Equipment isolating facilities with panel door interlocks where logical and practical, shall be provided to ensure equipment within each panel may be de-energised for safe working by maintenance personnel.

The degree of protection (type of enclosure) shall be as stated on the data sheets(s).

Self tapping screws shall not be used in the construction of the equipment.

The UPS room is provided with air-conditioning through centralized system.

Undrilled removable gland plate(s) shall be provided and adequately sized for all external cables. The plates shall be located to provide ease of access for terminating cables.

Bus bars shall be manufactured from HDHC Copper mounted on resin cast insulators Bus bars shall be covered with PVC sleeves. Power supply terminals and terminals powered from outside sources shall be shrouded (guarded).

Internal cubicle wiring shall be insulated stranded copper conductor. All wiring shall be adequately designed to meet the load and short circuit currents.
Wiring shall run in wire ways with ample spare capacity. Each wire end shall have plastic sleeve type permanently embossed markers or have number printed on insulation to match wiring diagrams and/or terminal numbers. For control wiring, pre-insulated crimped terminals shall be used and for power wiring crimped lugs with PVC shrouds shall be used, shielding behind transparent panel(s) is an acceptable alternative. For ribbon cables associated with electronic circuits, numbers shall be provided on terminals/connectors.

Flexible cable shall be used for connections to door mounted equipment. Wiring shall be wrapped inflexible PVC conduit and be firmly clamped at both ends to prevent movement at terminations.

Wring terminations at different voltages and of different signal levels shall be segregated and clearly marked.

All terminal blocks shall have 10% spare terminals. The minimum terminal size shall be 2.5 sq. mm.

A copper earth bar, sized according to equipment rating, shall run through the equipment full length, with all non-current carrying metal parts and cable gland plates connected to it, and shall have an external connecting stud for terminating the plant earth

All doors shall be bonded to the main structure by means of flexible copper connection arranged, so that it cannot be trapped as the door is opened or closed.

Where redundant systems are specified, all components of one system shall be mechanically and electrically separated from other parallel systems. (In separate isolated enclosures)
Suitable rated, 240 V AC anti condensation heaters shall be provided to prevent the formation of harmful condensation inside the enclosure. The heater shall be supplied complete with thermostat and ON / OFF switch.

All insulation materials shall be non hygroscopic.

The equipment shall allow the removal of components without special tools.

The design shall be such as to facilitate rapid repair / replacement.

10 VARIABLE FREQUENCY DRIVE

The Variable Frequency Drive shall be a Clean Power voltage source, advanced Pulse-Width Modulated, space vector technology motor controller which utilizes the latest IGBT technology and surface mount construction to afford efficient use of available space, prudent energy consumption and reliability.

The Variable Frequency Drive(s) shall not induce excessive power losses in the motor. Worst case Root Mean Square (RMS) motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

All Variable Frequency Drive(s) shall be supplied with an input AC line reactor of minimum 2.5% impedance.

Input (AC) Line Reactor shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the VFD input power devices.
Input (AC) Line Reactor shall be factory mounted and wired within the VFD enclosure.
The Variable Frequency Drive(s) shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt/microseconds, or when other VFD's are operated from the same bus.

Individual or simultaneous operation of the VFD's shall not add more than 5% total harmonic voltage distortion to the normal bus, nor more than 10% while operating from standby generator bus, To meet or exceed IEEE 519, 1992.

The Variable Frequency Drive shall maintain a displaced power factor of .95 or better, at all speeds without external correction capacitors, and shall have a continuous output current rating of 110% of nameplate current.

Suitable Variable Frequency Drive(s) shall utilize advanced Pulse Width Modulation (PWM) strategy which can be of the space vector type, implemented within a

microprocessor, which generates a sine-coded output voltage—such as the Robicon 454 GT Series VFD designed & manufactured by ASI Robicon, or the owner's Pre-approved equal, meeting the detailed requirements of these specifications.

All Variable Frequency Drive(s) shall be supplied by one manufacturer and all Microprocessor systems must be products of the same manufacturer as the Variable Frequency Drive (to assure single source responsibility, availability of service and access to spare parts).

Distributor or package modifications to a third-party standard product will not be allowed.

I. BASIC FEATURES

All Variable Frequency Drives (VFD's) shall have the following basic features:

- The keypad of each VFD shall include a "POWER ON" light
- a VFD fault light
- a VFD run light
- manual stop push-button
- manual start push-button
- a fault reset push-button
- An "AUTOMATIC" push-button and increase/decrease pushbuttons.

The VFD's shall be software programmable to provide automatic restart after any individual trip and/or condition resulting from either over current, over voltage, under voltage, or over temperature.
For safety, the variable frequency drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

A speed droop feature shall be included which reduces the speed of the VFD on transient overloads. The drive is to return to set speed after transient is removed.

If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent VFD trip.

Automatic restart after drive trip and/or utility failure. Automatic or Manual restart after VFD trip and/or utility failure shall be Software selectable.

Speed profile: Individual adjustable settings for start, stop entry, slope, and minimum and maximum speed points.

Process Signal Inverter: Software selectable to allow speed of VFD to vary inversely with input signal.

A critical speed avoidance circuit: will be included for selection of two critical speeds with a rejection band centered on that speed. The VFD will ignore any speed signals requiring drive operation within the rejection band.

Proportional and Integral set point process controller with menu driven selection and programming via door-mounted keypad.

The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping. The VFD shall be able to successfully Pick Up a spinning load.

A door-mounted membrane keypad with integral 2-line, 24-character LCD display shall be furnished, which is capable of controlling the VFD and setting drive parameters, and shall include at a minimum the following features:

The digital display must present all diagnostic message and parameter values in plain English engineering units when accessed, without the use of codes. The keypad module shall contain a "self-test" software program which can be activated to verify proper keypad operations. The digital keypad shall allow the operator to enter exact numerical settings in plain English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting, (rather than codes). Drive parameters shall be factory set in EEPROM and resettable in the field through the keypad.

II. SERVICE CONDITIONS

The controller shall be designed and constructed to operate within the following service conditions:

- Elevation to 3,300 feet
- Ambient temperature range: 0℃ to 40℃
- Atmosphere: Non-Condensing relative humidity up to 95%
- AC Line voltage variation: -10% to +10%
- AC Line frequency variation: ±3 Hertz

III. ENCLOSURE

The manufacturer's illustrated operating instructions and parts list shall be mounted within the Variable Frequency Drive enclosure door.

Provide an Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power.

The bypass cabinet shall include a door-interlocked input circuit breaker, a VFD output contactor, and a full-voltage starting contactor (both contactors electrically interlocked), a thermal overload relay to provide motor protection, and a control power transformer to afford continued operation of the motor, in the event the Variable Frequency Drive malfunctions.

For units 100 Horsepower and larger, a door-mounted RS232C/RS422 port for connection of the furnished printer, for each VFD, is to be provided. Units 3 - 30 Horsepower must be supplied with a printer and a RS232C/RS422 port available on the microprocessor board.

Mounted on the cabinet door shall be the bypass selector switch, motor fault light, power "ON" light, motor "ON" VFD light and motor "ON LINE" light.

Door-mounted meters shall be provided on all units 100 Horsepower and larger:

- Analog ammeter (0 - 110%)
- Analog speed/frequency meter (0-110% speed as well as Hertz)
- Analog voltmeter (0-600 VAC)

- Analog kW meter (0-110%)
- 5-digit elapsed time

All Variable Frequency Drive components shall be factory mounted and wired on a dead front, grounded, NEMA-1 enclosure suitable for bottom or top conduit entry.

IV. G. PROTECTIVE FEATURES AND CIRCUITS

- All Variable Frequency Drive(s) shall include the following protective features:
- Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.
- Static instantaneous over current and over voltage trip with inverse over current protection.
- Static over speed (over frequency) protection.
- Line or fuse loss and under voltage protection.
- VFD over temperature protection.
- Electronic motor overload protection.
- Responsive action to motor winding temperature detectors or thermostatic switches.
- LED monitor lamps for each inverter stage.
- LED status indicators on regulator, and printed circuit board face plates.
- Isolated operator controls.
- Input line fuses.
- Be insensitive to incoming power phase sequence.
- Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.
- Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.
- Input line noise suppression with line reactor.
- Individual transistor over current protection.

V. SYSTEM OPERATION

With the manual start push-button selected, the VFD shall be controlled by the front panel increase/decrease pushbuttons on the VFD keypad. With the automatic push-button selected, the VFD shall start when a remote signal is received and its speed shall be controlled by a 4-20mA, internally isolated (or 0-10VDC non-isolated) signal from a remote source.

11 LIST OF APPROVED MAKES

	DESCRIPTION	MAKES
I	**HT SIDE:**	
1	11kV HT XLPE CABLES	UNIVERSAL/KEC/HAVELLS
2	HT CABLE TERMINATION KIT	RAYCHEM / BIRLA-3M / SAFEKIT
3	OIL FILLED TRANSFORMER	VOLT-AMP/KIRLOSKAR/UNIVERSAL
4	CURRENT TRANSFORMER	KAPPA / AE / PRAGATHI
5	VOLTAGE TRANSFORMER	KAPPA / AE / PRAGATHI
6	11KV HT VCB PANELS/ RMU	LOAD CONTROLS/ DYNAM CONTROLS/ SHRI SIDDHALINGESHWAR POWER GEARS
I	**LT SIDE:**	
1	ACB / MCCB	ABB / SCHNEIDER/SEIMENS
2	LT PANELS	LOAD CONTROLS/ DYNAM CONTROLS/ SHRI SIDDHALINGESHWAR POWER GEARS
3	1.1kV LT CABLES	UNIVERSAL/ KEC / HAVELLS

4	CABLE GLANDS	USHA / CROMPTON / COMET
5	CABLE LUGS	DOWELL/3M/ RAYCHEM
6	LT CABLE TERMINATION KIT	RAYCHEM / SAFE KIT
7	MCB / MCB - DBs FOR LIGHTING / POWER / EMERGENCY / UPS	ABB / SCHNEIDER /LEGRAND
8	CABLE TRAYS	PROFAB / INDIANA / RICO STEEL
9	CABLE MANAGEMENT SYSTEM	SCHNEIDER / MK / L&T/OBO BETTERMANN
10	DISTRIBUTION BOARDS	HAVELLS/LEGRAND/INDOASIAN
11	VFD	ABB / SEIMENS / SCHNEIDER
12	UPS	EMERSON/SCHNEIDER/EATON
III	**METERS / SWITCHES / RELAYS:**	
1	TIMERS	ABB / LEGRAND / TELEMECHANIC
2	CAPACITORS	UNIVERSAL / MEHER / EPCOS
3	SELECTOR SWITCHES	SIEMENS / L&T / KAYCEE
4	INDICATING METERS	CONZERV / AE / MECO
5	ENERGY METER	CONZERV / AE / MECO
6	VOLTMETER/AMMETER	RISHAB/SCHNEIDER/
7	PUSH BUTTONS	SIEMENS / L&T / TEKNIC
8	INDICATING LAMPS	SIEMENS / ALSTOM / VAISHNO / BINAY
9	PROTECTIVE RELAYS	C&S / ABB / SIEMENS / ALSTOM / EASUN
IV	**LIGHT FIXTURES / CONDUITS**	
1	LIGHT FIXTURES	PHILIPS / CG / BAJAJ
2	SOLAR STREET LIGHT	PHILIPS / CG / BAJAJ
3	STREET LIGHT/ HIGH MAST POLES	SHUBHAM / BAJAJ / VALMONT
4	METAL CONDUITS	TATA / BHARATH / BEC
5	FRLS WIRES-1100V GRADE	RR KABELS / ANCHOR / FINOLEX / HAVELLS
6	LIGHT SWITCHES	ANCHOR ROMA / TRESA / MDS MOSAIC