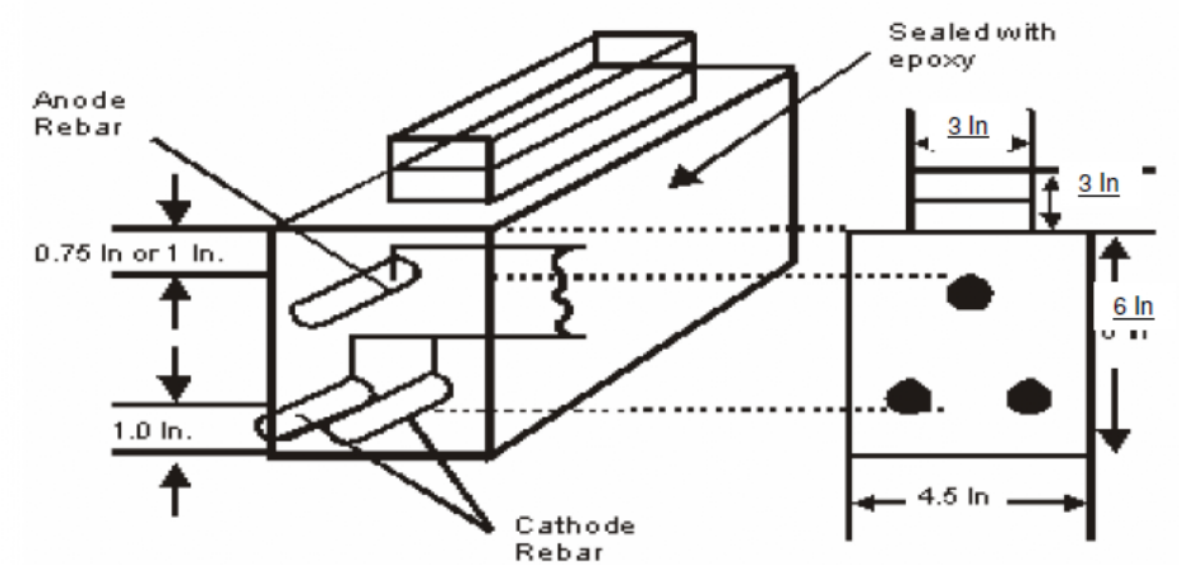
APPENDIX-VII

BRIEF OUTLINES OF LONG TERM CORROSION TEST (AS PER ASTM G 109)

TEST PROCEDURE

Three specimens each of control concrete and that of CPCIA admixed concrete (1% w/w of cement or as recommended by the manufacturer) should be cast as per the size 280mmx150mmx115mm and with placement of three cleaned reinforcement bars conforming to IS 1786 (preferably cleaned by picking in Hydrochloric acid 20% (v/v) approx, till surface shines and washed in running water) of size 12mm and length 375mm as per the details shown in the figure. Admixture shall be added as per manufacturers recommended dosage. All the casted concrete samples shall be moist cured for 28 days.

Ponding of samples with 3% NaCl solution as shown in the figure to be continued and measuring of voltage across 100-ohm resistor to be continued beginning of the second week of ponding. Calculate the current IJ from the measured voltage and record. Also measure the corrosion potential of the bars against reference electrode. The experiment should be continued till the macrocell current reaches a value of 10 µA. After the experiment break the specimens and examine the rebars for extent of corrosion, measure the corroded area and record.



Note - All Measurements in In. (25.4 mm = 1 In.)

Copyright EIL – All rights reserved

APPENDIX-VIII

BRIEF OUTLINES OF RESISTANCE OF CONCRETE TO MIGRATION OF CHLORIDE ION TEST (AS PER AASHTO T259)

Part-A : Chloride Ion Penetration (Salt Ponding Test As per IS 456)

TEST PROCEDURE

Cast three concrete blocks of size 300mmx300mmx75mm each without and with CPCIA 1% (w/w) or as recommended by the manufacturer, by using the concrete mix as under:

S.No.	Material	M30 (Kg)	M40 (Kg)
i)	53 Grade Cement	50	50
ii)	Coarse Sand	104	87
iii)	Aggregate, passes through 20 mm and retained on 10 mesh	160	134
iv)	Water (subject to 55±5 slump)	24	20
v)	CPCIA	0.5*	0.5*
	* as recommended by the manufacturer with each type of cement viz. Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag cement, Sulphate resisting Cement		

AASHTO T259 test (commonly referred to as the salt ponding test) is a long-term test for measuring the penetration of Chloride ions into concrete. Three slabs of 75 mm thick and having a surface area of 300 mm square shall be casted. These slabs are moist cured for 14 days and then stored in drying room at 50 percent relative humidity for 28 days. The sides of the slabs are sealed except for bottom and top face. After the conditioning period, a 3% NaCl solution is ponded on the top surface for 90 days, while the bottom face is left exposed to the drying environment (see figure below).

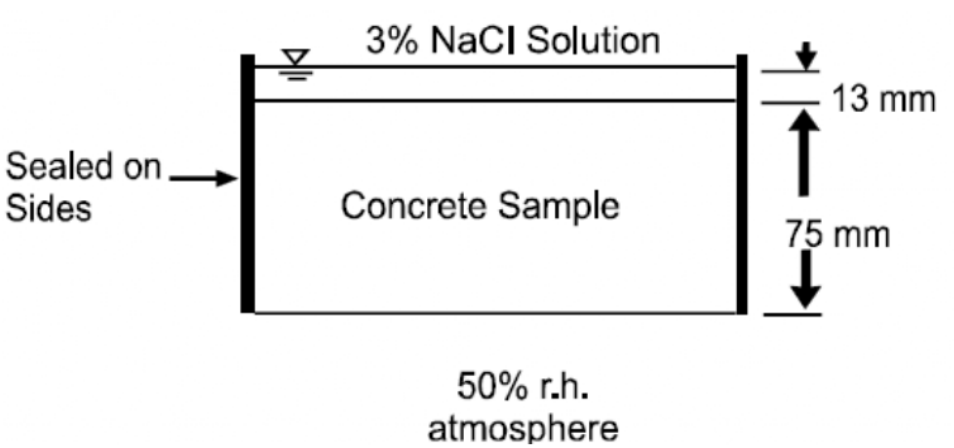


Figure: AASHTO T259 (Salt ponding) test setup

At the end of this time (90 days) the slabs are removed from the drying environment and the Chloride concentration of 10 mm thick slices is then determined (AASHTO T259). Two or three slices are taken at progressive depth. The salt ponding test does provide a crude one-dimensional chloride ion ingress profile. Test results should meet the requirements as stipulated in IS 456.

Copyright EIL – All rights reserved

BRIEF OUTLINES OF RESISTANCE OF CONCRETE TO MIGRATION OF CHLORIDE ION TEST (AS PER AASHTO T259)……Contd.

Part-B : Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (Rapid Chloride Permeability test As per ASTM C-1202)

TEST PROCEDURE

Cast three concrete cylinders of size 50 mm thick, 100 mm diameter without and with CPCIA 1% (w/w) or as recommended by the manufacturer, by using the concrete mix as under:

S.No.	Material	M 30 (Kg)	M 40 (Kg)
i)	53 Grade Cement	50	50
ii)	Coarse Sand	104	87
iii)	Aggregate, passes through 20 mm and retained on 10 mesh	160	134
iv)	Water (subject to 55±5 slump)	24	20
v)	CPCIA	0.5*	0.5*
	* as recommended by the manufacturer with each type of cement viz. Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag cement, Sulphate resisting Cement		

As per ASTM C-1202, water-saturated concrete specimen is subjected to a 60 V applied DC voltage for 6 hrs. using the apparatus shown in Figure below. In one reservoir is a 3.0% NaCl solution and in the other reservoir is a 0.3 M NaOH solution. The total charge passed is determined and this is used to rate the concrete's resistance to chloride ion penetration.

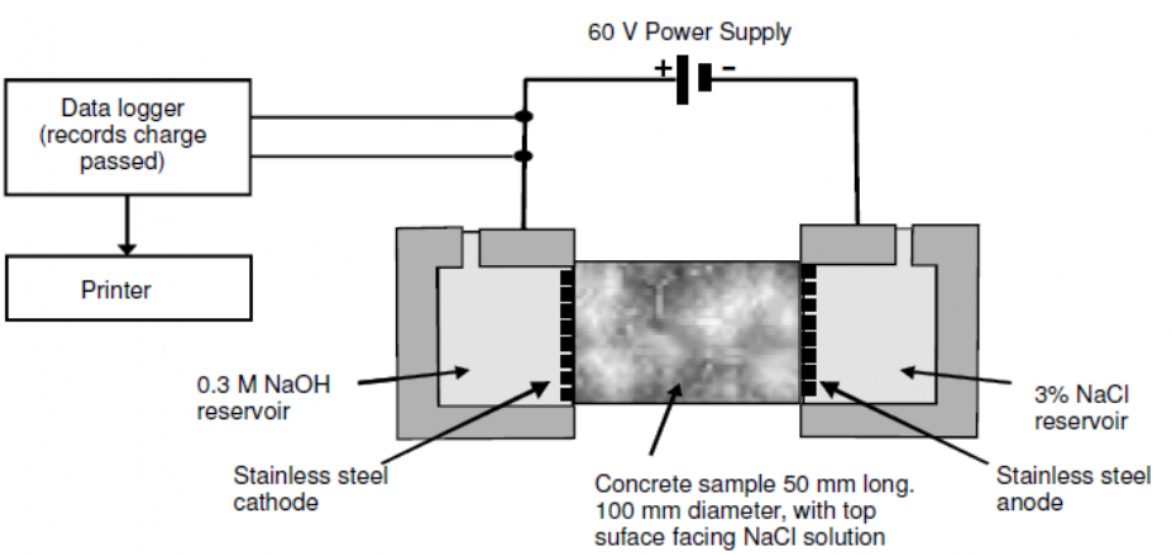


Figure: AASHTO T277 (ASTM C1202) test setup

Copyright EIL – All rights reserved

मानक विनिर्देशन

सिविल संरचना

STANDARD SPECIFICATION
CIVIL - STRUCTURAL

एकमुश्त टर्न-की कार्य

(एल.एस.टी.के. कार्य)

LUMP-SUM TURN-KEY WORKS
(L. S. T. K. WORKS)

सामान्य आवश्यकताएँ

GENERAL REQUIREMENTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	04 07 2019	REVISED AND ISSUED AS SPECIFICATION	AVM	AJS	RS	RKT
0	30 08 2013	ISSUED AS SPECIFICATION	GV	AS / RS	PKM	DM

Copyright EIL – All rights reserved

Abbreviations:

AFC	: Approved for Construction
BIS	: Bureau of Indian Standards
DCI	: Document Control Index
EDB	: Engineering Design Basis
EIL	: Engineers India Limited
GAD	: General Arrangement Drawing
LOI	: Letter of Intent
LSTK	: Lump-sum Turn-key
MTO	: Material Take-off
PC	: Personal Computer
RCC	: Reinforced Cement Concrete
VDMS	: Vendor Document Management System
VDR	: Vendor Document Requirement

Structural Standards Committee:

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 DESIGN & DOCUMENT REVIEW 5

ANNEXURES:

ANNEXURE-1 : General Check List
ANNEXURE-2 : Format for Comment & Compliance Sheet
ANNEXURE-3 : Check List for analysis & Design of Normal foundations
ANNEXURE-4 : Check List for analysis & design of Foundation for Rotating equipments
ANNEXURE-5 : Check List for analysis & design of Liquid Retaining Structures
ANNEXURE-6 : Check List for analysis & design of Concrete buildings
ANNEXURE-7 : Check List for analysis & design of Shed type buildings
ANNEXURE-8 : Check List for analysis & design of Technological/ Process structures
ANNEXURE-9 : Check List for analysis & design of Pipe racks (unit/ offsite)
ANNEXURE-10 : Check List for analysis & design of Tall structures (concrete/ steel)
ANNEXURE-11 : Check List for analysis & design of Conveyor galleries & trestles
ANNEXURE-12 : Check List for analysis & design of Foundation for storage tanks
ANNEXURE-13 : Check List for analysis & design of Foundation for static equipments
ANNEXURE-14 : Check List for analysis & design of Furnace foundations
ANNEXURE-15 : Check List for preparation of Structural drawing

Copyright EIL -- All rights reserved

1.0 GENERAL

1.1 The design considerations given hereunder establish the minimum basic requirements for civil-structural works for LSTK contracts.

This standard specification shall be read in conjunction with the Engineering Design Basis document (EDB) issued for the Job and Standard Specification No. 6-68-0022 for Material & Construction requirements.

All structures shall be designed for satisfactory performance and functions for which the same are to be constructed.

a) Whenever any reference to BIS/ other code is made, the same shall be taken as the latest revision (with all amendments issued there to) on the notified date of submission of tender.

b) Apart from the codes mentioned in particular in the EDB document, all other relevant codes related to the specific job under consideration and/ or referred to in the above-mentioned codes, shall be followed wherever applicable. Reference to some of the codes does not limit or restrict the scope of applicability of other relevant codes.

c) In case of any variation/ contradiction between the provisions of BIS codes and the requirements given in EDB document, the provisions given in EDB document shall have precedence over all others. In absence of relevant BIS codes, reference to corresponding British or American codes may be made (in that order of preference).

All designs, detailing and construction shall strictly conform to the standards, specifications and 'specific requirements' enclosed with the tender. Only if relevant information is not available in these documents, reference to relevant BIS code shall be made.

1.2 A Document Control Index [DCI, i.e. detailed list of drawings/ documents, including specifications, standards, design philosophy (foundation & superstructure), general notes, design calculations, design drawings, Bulk Material Take-off (Bulk MTO), bar bending schedules (for RCC works) and fabrication drawings (for structural steel works)] indicating the document/ drawing category (review or record as applicable) together with the scheduled and actual date of submission of the documents, shall be submitted by the Contractor through the Vendor Document Management System (VDMS) and kept updated at all times in the DCIM for review by Owner/ owner's representative.

1.3 The Bulk MTO document containing Cement, Re-bars (*diameter-wise*) and Structural Steel (*section-wise*) shall be submitted within 45 days from the date of receipt of LOI. The same shall be updated at 50% & 90% stages of the engineering.

1.4 Structure-wise quantity statements (showing anticipated, released and balance quantities of concrete, structural steel and piles) shall be submitted by the Contractor and kept updated at all times in the Vendor Document Management System (VDMS) for review by Owner/ owner's representative. The DCI shall also indicate the document/ drawing category (review or record as applicable) together with the scheduled and actual date of submission of the documents.

1.5 Vendor Document Management System (VDMS) is a web application that lets suppliers/ contractors manage their Document Control Index (DCI) through an interface, submit their documents for review/ record and get the reviewed/ approved documents/ drawings.

Copyright EIL – All rights reserved

2.0 DESIGN & DOCUMENT REVIEW

2.1 Before proceeding with design and drawing preparation, the Contractor shall submit detailed philosophy of design of various parts of (all) the structures and foundations (including equipment foundations) along with explanatory sketches for review by Owner/ owner's representative. Only after the approval (including review and incorporation of comments as offered during the review) of the design philosophy, the Contractor shall submit any design document and/ or drawing for review or record or issue the same for construction.

2.2 The Contractor shall carry out the structural design of all structures and prepare complete set of civil and structural approved for construction (AFC) drawings needed for correct and accurate construction. The design/ drawing shall be strictly in accordance with the approved design philosophy prepared for the structure (including "Design Criteria" given in the EDB) and architectural/ structural general arrangement and shall incorporate all the comments/ suggestions given by Owner/ owner's representative without any extra cost to the Owner and without any implication on the time-schedule for completion of works.

2.3 Design and detailing of the structures and foundations shall fulfill all functional requirements for which the same is intended and it shall be ensured that adequate accesses, clearances, clearing of interferences, provision of cutouts, etc. have been provided to make the structure/ foundation fully operational.

2.4 Construction of units/ structures identified for design/ drawing review (as referred in Vendor Document Requirement (VDR) attached in the bid document or DCI) by Owner/ owner's representative shall not be taken up at the site till these documents are reviewed by Owner/ owner's representative and comments/ suggestions given by Owner/ owner's representative are incorporated along with submission of compliance sheet indicating incorporation of all comments. For all other foundations and structures the Contractor shall directly submit the AFC drawings to Engineer-in-Charge and construction of such works shall be taken up immediately. Design and drawings for such foundations/ structures shall also be simultaneously submitted in VDMS for Owner/ owner's representative's record. In the event Owner/ owner's representative offers any comment on documents/ drawings of record category, it shall be ensured by the Contractor that these comments are duly incorporated in the documents/ drawings and revised set of document/ drawing is issued to site for construction and simultaneously submitted in VDMS for Owner/ owner's representative's record.

2.5 Submission of typical review category documents shall be taken up prior to corresponding record category documents. Owner/ Owner's representative comments on typical review category documents shall be duly taken care in all relevant record category documents as well before issuing them for construction and simultaneously submitted in VDMS for Owner/ owner's representative's record.

Wherever review is carried out the same shall be restricted to following:

a) Conformance of general arrangement of the structure to approved design philosophy and design basis.
b) Overall framing of the building/ conceptual foundation system.
c) Detailed design and drawings including input/ output of computer analysis and design vis-a-vis actual drawing.

Irrespective of the identified structures requiring review, the Contractor shall submit complete set of design and drawings of all structure/ foundation systems.

Copyright EIL – All rights reserved

2.6 To facilitate an overall systematic review, the Contractor shall ensure the following:

a) Structural design/ drawings for any structure/ foundation are submitted for review only if referenced input (e.g. architectural drawing, equipment layout, piping general arrangement drawing (GAD), equipment data sheet, vendor drawing, etc.) have been reviewed by the concerned Owner's specialist in approval/ review Code-2 or Code-1 and are available in the VDMS on or before the date of submission of structural design/ drawings.

b) Complete set of design and drawings of each independent building/ structure are submitted simultaneously

c) Relevant checklist(s) duly filled-up, signed (by the approver of civil-structural design/ drawing) & stamped, shall accompany each deliverable of civil-structural document/ drawing submitted by the contractor. The checklist(s) are to be used as a guide while performing the related activities. The same are attached as annexure. All points listed therein are mandatory check point. Other points/ observations/ comments may be added based on need and judicious discretion depending on the importance of activity/ deliverables.

d) Soft copy of files created as input for computer analysis/ design are also part of the respective design documents.

e) All re-submissions are accompanied with a compliance statement (a document stating point-wise compliance to all comments by Owner/ owner's representative on previous submission)

2.7 In case the referenced input (e.g. geotechnical recommendations, architectural drawing, equipment layout, piping general arrangement drawing (GAD), equipment data sheet, vendor drawing, etc.) as applicable, reviewed by the concerned Owner's specialist in approval/ review Code-2 or Code-1 are not available in the VDMS on or before the date of submission of structural design/ drawings for any structure/ foundation, the date of submission of structural design/ drawings shall deemed to be considered as the date of submission of approved reference drawing.

2.8 To ensure accuracy, correctness and completeness of documents before submission to Owner/ owner's representative, the Contractor shall ensure that all such submitted designs and drawings are complete in all respects, thoroughly checked, stamped APPROVED FOR CONSTRUCTION, and signed APPROVED by the Contractor's own responsible civil/ structural graduate (minimum) engineer (irrespective of the fact that the same are prepared in the Contractor's own design office or by an approved agency/ sub-contractor).

Incomplete, unchecked, unsigned and unstamped design documents/ drawings shall not be reviewed/ accepted for construction and shall be deemed to be considered as void/ withdrawn.

2.9 The accuracy/ correctness of all designs and drawings shall be the sole responsibility of the Contractor and any delay/ loss/ damage to the Owner in respect of any mistake/ discrepancy/ anomaly in such designs and drawings shall be entirely borne by the Contractor.

2.10 Owner/ owner's representative reserves the right to review any/ all or none of the designs and drawings. Review by Owner/ owner's representative shall not relieve the Contractor of his responsibility for correct design and execution of the works.

2.11 Revision of any design/ drawing/ detailing shall not be permitted unless the same is necessitated due to comments on review of such documents by Owner/ owner's representative. Such revisions shall be restricted to incorporation of these comments only and no new details shall be added in the drawings unless called for by comments during review. All revised portion shall be clearly marked and clouded on the respective drawing for easy

Copyright EIL – All rights reserved

identification. Subsequent review of such revised documents, if required shall be limited to revision as clouded.

2.12 All fabrication/ erection drawings and bar bending schedules shall be prepared by the Contractor and shall be directly issued through VDMS for construction to the work. Such drawings together with design calculations for all splices, joints and gusset plates shall simultaneously be reviewed by Owner/ owner's representative at site (Resident Construction Manager). The Owner/ owner's representative at site at his discretion may review all or some or none of these designs & drawings.

Wherever such review is carried out the same shall be restricted to the following:

a) Structural layouts, orientation, elevation of structural members.
b) Section/ size of members.
c) Adequacy of few critical connections and joints for their required strength.

2.13 For analysis and design of structures, latest version of internationally accepted commercial software viz. STAAD.PRO or equivalent are permitted.

In case software packages (commercially available or in-house developed) other than above are intended to be used for analysis and design, the same shall be informed in writing to Owner/ owner's representative. A validation report consisting of calculations and relevant computer files containing input and detailed output (also refer clause 2.14) shall be submitted by the Contractor through VDMS. Only after getting written approval from Owner/ owner's representative, to this effect, such intended software be put to use for detailed analysis and design.

2.14 The following minimum documentation shall be submitted through VDMS for computer aided analysis and design as a part of structural analysis & design document:

a) Complete input and output files in native format.
b) Relevant sketches of structure geometry with node and member numbering, loading, bending moment, shear force, deflected shape diagrams, etc.
c) Summary of member end forces, support reactions, stress ratio, deflections, etc.

2.15 Contractor shall depute the concerned Civil-Structural design engineer to the review office of Owner/ owner's representative as and when required for review of contractor's documents. During such reviews involving computer aided analysis/ design/ drafting of structures, the contractor shall make his own arrangement of Personal Computer (PC) in the form of Lap-top in the premises of review office of Owner/ owner's representative. This is required to expeditiously resolve all the comments including those involving the use of PC by contractor in his submission. The contractor shall ensure that these PC's are fully operational along with necessary software already loaded including the input/ output/ drawing files of the structures being reviewed. The contractor shall revise and re-submit the analysis/ design and drawings as required during review, through VDMS.

Reviewing of designs/ drawings is not obligatory on the part of Owner/ owner's representative and complete correctness/ soundness of the designs/ drawings and their execution at the site shall be the sole responsibility of the Contractor irrespective of the fact whether the same has been reviewed by Owner/ owner's representative or not. Any defect observed during construction or till the defect liability period of works' shall be rectified and removed by the Contractor. The Contractor shall carry out whatever modification or reconstruction is needed for the purpose, to the entire satisfaction of the Engineer-in-Charge/ Owner without any extra cost and/ or time implication to the Owner.

Copyright EIL – All rights reserved

Filled-up, signed (by the approver of civil-structural design/ drawing) & stamped checklist shall accompany each submission of civil-structural document/ drawing by the contractor:

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

Sl. No.	PMC Requirement	Contractor's Response	Remarks
1.	The submission is as per submission schedule as per approved DCI.	□ Yes	
2.	The submission is as per submission sequence as per approved DCI.	□ Yes	
3.	Basic documents prepared by the contractor (e.g. design philosophy, specifications, standards, general notes, etc.) are already approved.	□ Yes	
4.	Bulk MTO has been submitted.	□ Yes	
5.	All the referenced input (e.g. geotechnical recommendations, architectural drawing, equipment layout, piping general arrangement drawing (GAD), equipment data sheet, vendor drawing, etc.) as applicable have been reviewed by the concerned Owner's specialist in approval/ review Code-2 or Code-1 and are available in the DCIM on or before the date of submission of structural design/ drawings.	□ Yes	
6.	The design calculations being submitted herewith are complete in all respects, thoroughly checked and confirm to approved engineering design basis, relevant approved input documents and applicable codes & standards, stamped APPROVED FOR CONSTRUCTION, and signed APPROVED by the Contractor's own responsible civil/ structural graduate (minimum) engineer (irrespective of the fact that the same are prepared in the Contractor's own design office or by an approved agency/ sub-contractor).	□ Yes	
7.	The drawings being submitted herewith are complete in all respects, thoroughly checked and confirm to approved design calculations, approved general arrangement, stamped APPROVED FOR CONSTRUCTION, and signed APPROVED by the Contractor's own responsible civil/ structural graduate (minimum) engineer (irrespective of the fact that the same are prepared in the Contractor's own design office or by an approved agency/ sub-contractor).	□ Yes	
8.	The documents/ drawing being submitted are complete with respect to the whole structure.	□ Yes	
9.	In case this submission is for drawings only, the related analysis & design have already been submitted.	□ Yes	
10.	Structure-wise quantity statements (showing anticipated, released and balance quantities of concrete, structural steel and piles) are updated & submitted.	□ Yes	
11.	In case this submission is of record category document/ drawing, similar review category documents/ drawings have already been submitted.	□ Yes	

Copyright EIL – All rights reserved

Sl. No.	PMC Requirement	Contractor's Response	Remarks
13.	In case this submission is of record category document/ drawing, the submitted document/ drawing incorporates comments on the similar review category document/ drawing.	☐ Yes	
14.	The accuracy/ correctness of all designs and drawings shall be the sole responsibility of the Contractor and any delay/ loss/ damage to the Owner in respect of any mistake/ discrepancy/ anomaly in such designs and drawings shall be entirely borne by the Contractor. Review by Owner/ owner's representative shall not relieve the Contractor of his responsibility for correct design and execution of the works	☐ Yes	

Date: Name & Signature

Note:

Contractor to check & confirm that the submission meets the above requirements of PMC and categorically tick ☑ mark in the "☐ Yes" response.

Copyright EIL – All rights reserved

Filled-up, signed & stamped compliance sheet shall accompany each re-submission of civil-structural document/ drawing by the contractor:

Document No. :

Rev. No.:

Date of Submission:

Date of Review:

Review Code: □ 1 □ 2 □ 3 □ R □ V

Sl. No.	Reference Clause	PMC Comments	Contractor's Response
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

Review Code Legend:

Code 1	:	No comments.
Code 2	:	Proceed with manufacture/ fabrication as per commented document. Revised document required.
Code 3	:	Document does not confirm to basic requirement as marked. Resubmit for review.
R	:	Retained for Records.
V	:	Void.

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Founding level/ depth of foundation with respect to HPP/ FGL/ NGL/ EGL/ FFL (strike out whichever is not applicable).	
2	Requirement & Level of plinth/ tie beams.	
3	Type, Shape & Dimensions of footing.	
4	Adequacy of loading for foundation.	
5	Correctness of the design forces as per analysis.	
6	Selection of critical loading cases/ combinations.	
7	Long/ short column effect for pedestal.	
8	Size of pedestal: a) type of anchor bolts b) bolt spacing (with respect to clearance between the bolts) c) edge distance of anchor bolts d) depth of embedment of anchor bolts	
9	Location co-ordinates & Orientation with respect to North direction.	
10	Conformance to Geotechnical recommendations: a) check for SBC at founding depth (w.r.t. settlement/ shear) b) consideration of ground water table. c) check for FOS against overturning, sliding d) increase in SBC (limited to 25% for wind or seismic/ 100% for blast) e) spacing of piles (within group & inter-group) f) pile cut-off level g) load check conforming to pile capacity h) increase in pile capacities (limited to 50% for vertical & 25% for lateral for wind/ seismic/ 50% for blast)	
11	Projection of foundation outside battery limit is co-ordinated with Civil Department for under-ground piping, etc.	
12	Ductile detailing requirements for reinforcement, wherever applicable.	
13	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK

✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Approved (at least review code 2) inputs available.	
2	Complete loading data: a) reference line of machine, base frame dimensions and suction side & discharge side (for pumps) b) size of block/ deck, pedestal above HPP c) static/dynamic loads (or dynamic load factor) & their location of application (as per vendor) d) permissible limiting values of vibration parameters e) pocket dimensions, locations f) grout type & thickness g) whether anti-vibration pads are provided	
3	Founding level/ depth of foundation w.r.t. HPP/ FGL/ NGL/ EGL/ FFL	
4	Value of C_u & net SBC from soil recommendations. For pile foundations, the pile stiffness value.	
5	Amplitude of vibration and resonance check in required modes.	
6	No fouling with adjacent foundation as per equipment layout.	
7	Check for limiting size of element(s).	
8	Check for critical speed, whether the machine is variable speed or fixed speed? If variable speed motor is used, whether amplitude has been checked considering the machine speed same as the natural frequency of the foundation system.	
9	Minimum reinforcement requirement as per IS:2974.	
10	Specified number of construction joints & their details.	
11	Note for single pour.	
12	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL -- All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Design method (cracked or un-cracked) to be identified for each element.	
2	Check for stability & uplift as per respective structure/ pit/ tank w.r.t. water table at various stages of construction.	
3	Requirement of minimum thickness & reinforcement.	
4	Reinforcement provided on both faces (for slab & walls).	
5	Treatment to be given on surfaces in contact with earth.	
6	Anti-corrosive treatment for structures storing corrosive liquids.	
7	Requirement of joints, water stops, puddle flanges, giving notes for execution sequences.	
8	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1.0	**Availability of Inputs**	
1.1	Approved Architecture drawings of building	
1.2	Approved Plot Plan	
1.3	Approved related Area Drawings	
1.4	Contour plan	
1.5	Approved Geotechnical Recommendation	
1.6	Approved Electrical Drawings for Substation Building	
1.7	Approved Instrumentation Drawings for Control Room Building	
1.8	Vendor Inputs for: a) Air Conditioning Equipments b) Transformers etc. c) Lift	
2.0	**Correctness of Inputs**	
2.1	With respect to Architecture Drawings: a) Framing arrangement. b) Level & Location: i) Co-ordinate of building ii) Finished Ground Level iii) Finished Floor Level iv) Approach Road Level c) Brickwork arrangement i) Length/ height of brickwork. ii) Stability check for brickwork with Steel frame. iii) Flushing of Brickwork with frame structure. iv) Brick supporting arrangement for Rain water Pipe encasing. d) Requirement of expansion joints as per codal provisions. e) Arrangement & levels of false flooring & false ceiling. f) Clear height of floors. g) Cross-checking of elevations at FFLs of Ground Floor, Upper Floors, Roof etc., w.r.t. FGL, Approach Road Level. h) Monorail location & extent of monorail beam for Substation building.	
2.2	With respect to Mechanical Drawings: a) Lift Pit Size and loading available in Approved Mechanical/ Vendor Drawing. b) Machine Room Details available in Approved Mechanical/ Vendor Drawing. c) Cut-out details for duct in AC Plant room/ AHU rooms in Approved Mechanical/ Vendor Drawing. d) Details of pedestals for AC Plant/ AHU in Approved Mechanical/ Vendor drawing. e) Monorail location & Capacity as per Approved Mechanical drawing.	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
2.3	With respect to Electrical Drawings: a) Transformer details. b) LT-HT Switch gear panel location. c) Cable trench layout.	
2.4	With respect to Instrumentation Drawings: a) Panel resting arrangements. b) Cable tray details. c) Pipe sleeves details. d) MCT location. e) Cable tray in superstructure. f) Cable trench layout.	
2.5	With respect to General Civil Area Drawings: a) Co-ordinates of building b) Orientation of building with respect to North direction. c) Approach Road level/ Finished Ground Level. d) Contour for NGL from Plot Plan. e) Fouling with existing/ proposed facilities from Area/ Foundation drawing. f) Underground facilities from Area Drawing.	
2.6	With respect to Geotechnical Recommendation: a) Type of foundation (Shallow or Pile). b) Depth of foundation. c) Net Allowable SBC for foundation from Geotechnical Report. d) Pile Capacity from Geotechnical Report. e) Diameter of Pile & Spacing of Piles from Geotechnical Report. f) Specification of Piling. g) Drawing of Pile.	
3.0	**Design Aspects**	
3.1	Structure is analysed as 3D Framed Structure.	
3.2	Uses of Codes as per approved EDB: a) For Concrete (IS:456/ IS:13920) b) For Steel (IS:800)	
3.3	Grade of Material as per approved EDB: a) Concrete b) Reinforcement c) Structural Steel	
3.4	Covers as per approved EDB: a) Foundation b) Column c) Beam d) Slab e) Wall	
3.5	Checking of Minimum thickness as per approved EDB: a) Foundation b) Column c) Beam d) Slab e) Wall	
3.6	**Loadings**	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
3.6.1	Dead Load: a) Self weight b) Slab load c) Brick load d) Gutter/ Parapet load	
3.6.2	Live/ Imposed load as per approved EDB for panels, ducts, cables etc. on floor, roof canopy, passage, lobby & stair case: a) Office Building b) Administrative building c) Substation building d) Control room	
3.6.3	Seismic Load as per approved EDB: a) Method of Seismic Analysis (Seismic Coefficient/ Response Spectra). b) Importance factor (Mention Value). c) Response reduction factor accordingly consideration of ductile detailing (Mention Value). d) Damping factor (Mention Value). e) Type of soil. f) Type of structure. g) Time period for frame structure as per IS:1893.	
3.6.4	Wind load for Shed type Building a) Basic Wind Speed (Mention Value). b) Probability Factor (k_1) (Mention Value). c) Terrain, Height, Structure Size Factor (k_2) (Mention Value). d) Topography Factor (k_3) (Mention Value).	
3.6.5	Blast load for Control Room shall be as per RRA report (Mention Blast Pressure).	
3.6.6	Load combination shall be as per approved EDB:	
3.7	Design of concrete member of building shall be as per IS:456/ IS:13920.	
3.8	Ductile detailing requirements for Reinforcement, wherever applicable.	
3.9	Slenderness check for design of columns.	
3.10	Crack width of beam/ slab.	
3.11	Deflection of slab/ staircase.	
3.12	**Foundation design.**	
3.12.1	Fouling of under-ground cable trench with foundations/ plinth beams etc.	
3.12.2	Alignment of plinth beams with brick walls.	
3.12.3	Factor of safety against overturning & Sliding as per approved EDB.	
3.12.4	Checking of SBC/ pile capacity as per approved Geotechnical Recommendation.	
3.12.5	Maximum allowable settlement of soil as per approved EDB	
3.12.6	Checking of modified pressure calculation in case of tension occurred.	
3.12.7	Increase in stress shall be as per Geotechnical Recommendation.	
3.12.8	Minimum percentage of reinforcement as per approved EDB	
3.12.9	Minimum spacing of reinforcement bar as per approved EDB.	
4.0	Internal coordination with other departments.	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
5.0	MTO for super structure & Substructure a) Area of building b) Concrete in foundation c) Concrete in superstructure d) Reinforcement in foundation e) Reinforcement in superstructure f) Reinforcement per Cu. M. of Concrete for foundation g) Reinforcement per Cu. M. of Concrete for superstructure	

Date:

Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
A	**SUB-STRUCTURE**	
1	Refer separate checklist for foundation.	
2	Check fouling with machine/equipment foundation.	
B	**SUPER-STRUCTURE**	
1	Check the clear gap for isolation of rotating machine foundation.	
2	Requirement of roof monitor, extent of side cladding & height of parapet wall.	
3	Identification of braced bay & maintenance bay.	
4	Whether provision of extension of shed by one bay considered (for future).	
5	Live loads & superimposed loads at various locations, including crane loading & centerline distance between rails	
6	Check the critical load combination for design.	
7	Check the horizontal (transverse & longitudinal) deflections.	
8	Check flooring details conforming to likely superimposed load.	
9	Compatibility between pedestal level & anchor bolts with base plate details.	
10	Check whether correct limiting values of slenderness ratios for structural elements (columns, beams, bracings, etc.) used in design.	
11	Check whether correct effective lengths of structural elements (columns, beams, bracings, etc.) used in design.	
12	Check whether minimum 90% mass participation achieved (in both horizontal directions) for calculating seismic forces.	
13	Check over-all compliance to approved Architectural drawings.	
14	Internal co-ordination with all concerned departments.	

Date:

Name & Signature

Legend :

✓ : Check carried out and found OK

✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
A	**SUB-STRUCTURE**	
1	Refer separate checklist for foundation.	
2	Check fouling with equipment foundation.	
B	**SUPER-STRUCTURE**	
1	Material of construction as per engineering design basis of the project and departmental guidelines.	
2	Check the application of equipment load (correction, magnitude & location).	
3	Live load/ superimposed load considered for respective level/ floor, air-coolers, fire proofing load, etc. where applicable.	
4	Whether loading due to one extra floor considered (for future expansion).	
5	Check the estimation of seismic/ wind force to be applied at respective level/ floor.	
6	Check whether critical design forces from various likely load combinations have been considered for the design of structural element/ foundation.	
7	Identify critical areas where limiting beam sizes need to be provided for avoiding any fouling.	
8	Location of braced bay, co-ordinated with Piping. Bracing angle is within 30° & 60°. Plan bracing considered.	
9	Check the horizontal (transverse & longitudinal) deflections.	
10	Check the capacity of overhead mono-rails & its location with extent (in & outside plan dimensions) w.r.t. the respective equipment.	
11	Verify whether all vertical & horizontal piping loads have been correctly & completely taken care.	
12	Equipment supporting arrangement - check fouling with bottom nozzle or hood.	
13	Arrangement of intermediate/ secondary beams to clear opening requirements.	
14	Inter-connection with pipe rack.	
15	Compatibility between pedestal level & anchor bolts with base plate details.	
16	Joint details: a) reference standard no. is furnished b) details for connections not available in standard are furnished	
17	Compatibility between member sizes in General Arrangement & Reinforcement Details (in drawing).	
18	Whether integrated analysis done with equipment/ piping.	
19	Check whether correct limiting values of slenderness ratios for structural elements (columns, beams, bracings, etc.) used in design.	
20	Check whether correct effective lengths of structural elements (columns, beams, bracings, etc.) used in design.	
21	Check whether minimum 90% mass participation achieved (in both horizontal directions) for calculating seismic forces.	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
22	Check requirement of ductile detailing for reinforcement (for concrete elements).	
23	Summation of applied forces matched with reactions.	
24	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
A	**FOUNDATION**	
1	Refer separate checklist for foundation.	
B	**SUPER-STRUCTURE**	
1	Layout and configuration of pipe rack conforming to piping inputs/ approved equipment layout.	
2	Levels of pipe rack/ tiers conforming to piping inputs/ approved equipment layout.	
3	Whether load due to one extra tier considered (for future expansion) to be confirmed by Piping/ PMC.	
4	Location of expansion joints and braced bays coordinated with Piping department.	
5	Material of construction as per engineering design basis of the project, including fire-proofing requirements.	
6	Check the loading considered given by piping conforming to the requirement of design basis, including for fire proofing where applicable.	
7	Check consideration of friction/ anchor/ guide loads as per design basis and as forwarded by piping.	
8	Check the layout & loading of Air-coolers including supports required for inlet & outlet piping.	
9	Check the routing of electrical cable trays & instrument duct to be supported on the pipe rack and their respective loading as per design basis.	
10	Check the horizontal & vertical clearances at road/ railway crossings.	
11	Location and arrangement of vertical & horizontal bracing fulfilling design requirements and confirmed by piping	
12	Check whether additional load due to extra length of pipes have been considered or not at the location where pipes are rising or getting dropped.	
13	Check the level at top of grout w.r.t. actual profile of ground levels for off-site pipe rack.	
14	Local design checks at junction locations	
15	Whether any two-phase flow lines are there? If yes, have these been taken care as per the Design basis.	
16	Compatibility between pedestal level & anchor bolts with base plate details.	
17	Joint details: a) reference standard no. is furnished b) details for connections not available in standard are furnished	
18	Compatibility between member sizes in General Arrangement & Reinforcement Details (in drawing).	
19	Transverse beams are designed for horizontal bending.	
20	Tray support members are provided as per electrical guidelines.	
21	Battery Limit platform & approach for the same.	
22	Bracing angle is within 30° & 60°.	
23	Inter-connection with technological structures.	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
24	Fouling of vertical bracing with anchor bolt in pedestal (in drawing).	
25	Check whether correct limiting values of slenderness ratios for structural elements (columns, beams, bracings, etc.) used in design.	
26	Check whether correct effective lengths of structural elements (columns, beams, bracings, etc.) used in design.	
27	Check whether minimum 90% mass participation achieved (in both horizontal directions) for calculating seismic forces.	
28	Check requirement of ductile detailing for reinforcement (for concrete elements).	
29	Internal co-ordination with all concerned departments.	

Date:

Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
A	**SUB-STRUCTURE**	
1	Refer separate checklist for foundation.	
B	**SUPER-STRUCTURE**	
1	Check wind & seismic parameters considered.	
2	Check estimation of wind forces.	
3	Check estimation of seismic loads.	
4	Check structural configuration and bracing system (vertical & horizontal).	
5	Check analysis corresponding to critical wind/ seismic direction.	
6	Check whether correct limiting values of slenderness ratios for structural elements (columns, beams, bracings, etc.) used in design.	
7	Check whether correct effective lengths of structural elements (columns, beams, bracings, etc.) used in design.	
8	Check whether critical maximum design forces have been considered from various load combinations for the design of respective elements.	
9	Check for permissible horizontal (transverse & longitudinal) deflections.	
10	Internal co-ordination with all concerned departments.	

Date:

Name & Signature

Legend :

✓ : Check carried out and found OK

✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
A	**SUB-STRUCTURE**	
1	Refer separate checklist for foundation.	
B	**SUPER-STRUCTURE**	
1	Check the system stability & dynamic analysis as per design basis/Job specification.	
2	Check the correctness in estimation of wind pressure corresponding to right shape factor for exposed members.	
3	Check the lateral load transfer from gallery to top of trestle.	
4	Check the supporting arrangement of gallery for keeping proper provision for expansion, check limiting vertical deflection.	
5	The analysis & design shall conform to the erection scheme being adopted.	
6	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Check equality of bottom pressure below ring wall and intermediate compacted soil mass.	
2	Check the detailing/ arrangement of ring wall w.r.t. anchor bolts and clean out drain, requirement of minimum edge clearance for Anchor Bolt.	
3	Check the thickness, size, shape and spacing of piers with protective coating/ lining for tanks storing corrosive liquid.	
4	Check the special requirements/ consideration (size, solid concrete slab below bottom plate, anchorage, counter weights etc.) for storage tanks storing liquids at high pressure and/ or high/ low temperature.	
5	Location co-ordinates & Orientation w.r.t. North direction.	
6	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Design loads as per approved data sheet.	
2	Check the input files for: a) depth of foundation b) depth of water table c) wind/ seismic load as per Design Basis d) support details as per data sheet	
3	Check the out-put file for: a) SBC conforming to Geo-Tech Recommendations b) FOS against overturning c) size restriction for likely fouling	
4	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	Loading as per approved data sheet of equipment	
2	Additional load due to supported ducts/ lining	
3	Check for SBC at founding level and FOS against overturning	
4	Size limitations if any to avoid fouling	
5	Internal co-ordination with all concerned departments.	

Date: Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

Project:		Job No.:	
Document No.:		Rev. No.:	
Document Title:			

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
1	**GENERAL**	
a	Drawing number is as per approved DCI	
b	Electronic file number is as per approved DCI	
c	Draughting is as per design requirements	
d	North line/ orientation as per input data	
e	Notes comply with Job Specifications and General Notes	
f	Field notes for specific instructions/ scope of work defined	
g	Layout of grids and spacing/ dimensions/ equipment location, support, orientation etc. as per input data	
h	Referenced Drawings specified	
i	Referenced Standards specified	
j	If not adequately clear in General Notes, grade of concrete and grade of reinforcement bars specified	
k	Bill of materials furnished (for the detailed portion)	
l	Necessary internal co-ordination done with relevant departments as per requirements	
m	Resolution/ incorporation of comments received	
2	**FOUNDATIONS**	
a	Coordinates/ location is as per input data, suction side & discharge side (for pump foundations) as per layout drawing	
b	Referenced level and elevations specified are as per approved General Civil/ Architectural drawings/ Piping GAD (viz. NGL/ FGL/ HPP)	
c	Elevation/ depth of foundation bottom furnished	
d	Fouling with surrounding foundations/ services cleared	
e	Any extra cover for rebar required and specified	
f	Any extra minimum cement content required and specified	
g	Thickness, projection and grade of lean concrete specified	
h	Anchor bolt location and orientation specified	
i	Adequacy of foundation depth checked to accommodate anchor bolt assemblies	
j	Anchor bolt description (as per standard) specified	
k	Depth of pockets specified	
l	Minimum cover on anchor bolts/ pockets checked	
m	Fouling between anchor bolt assembly and pedestal rebar checked	
n	Grout thickness specified	
o	Reinforcement provided as per design/ codal requirements	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
p	Links and ties detailed	
q	Dowel lengths for column rebars staggered and specified	
r	Depth of machine foundations with respect to building foundations checked	
s	Separation detail for machine foundations and pouring sequence given	
t	Requirement of water bars at construction joints for liquid retaining structures furnished	
u	Requirement of protective painting	
v	Field note for sequence of construction, if adjoining foundations are at different level	
w	For pump foundations, following field note shall compulsorily be added in foundation drawings: "The pump discharge nozzle is facing towards North/East/West/South". (appropriate direction shall be selected as per layout drawing, in case discharge is upwards, direction of suction nozzle shall be specified)	
3	**SUPER STRUCTURE Reinforced Cement Concrete**	
a	Layout is as per approved Piping GAD/ Architectural drawings	
b	Requirement of expansion/ separation joints checked	
c	Anchor bolt location and orientation specified	
d	Anchor bolt description (as per standard) specified	
e	Pockets for bolts located/oriented and specified	
f	Depth of pockets/ length of bolts in RCC members checked	
g	Minimum cover on anchor bolts/ pockets checked	
h	Fouling between anchor bolt assembly and rebar checked	
i	Grout thickness specified	
j	Reinforcement provided as per design/ codal requirements	
k	Cut-outs as per requirement provided with edge protection	
l	Slope has been provided over RCC roof	
m	Curb around all openings	
n	Insert plates & pipe sleeves provided wherever required	
o	Extra reinforcement around cut-outs & openings	
p	Dowel bars for lap length & anchorage length	
q	Nominal links in column, stirrups for beams & their arrangement	
4	**SUPER STRUCTURE Structural steel**	
a	Layout is as per approved Piping GAD/ input drawings	
b	Requirement of expansion/ separation joints checked	
c	Bolting details for equipments specified	
d	Member sizing and connection details furnished	
e	Grating/ chequered plate requirements with supporting members furnished	
f	Welding requirements furnished	
g	Fire-proofing requirements furnished	

Copyright EIL – All rights reserved

SR. NO.	CHECK/ CONTROL POINTS	Tick Mark as per Legend
h	Requirement of removable floor/ handrails checked	
i	Requirement of grouting holes in base plates specified	
j	Vertical & Horizontal bracings provided as per piping clearance	
k	Splicing location has been proposed/ suggested	
l	Approach staircase/ ladder provided with proper landing at entry point	
m	Toe plate around openings	
n	Stiffness/ diaphragm plates have been suitably provided	
o	Vertical clearance below monorail beam checked	
p	Capacity of monorail specified & structurally stable cantilever projection given	
5	Drawing issued through DCIM (Document Control Index Module)	

Date:

Name & Signature

Legend :

✓ : Check carried out and found OK
✓ NA : Check carried out and found not applicable

Copyright EIL – All rights reserved

मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL - STRUCTURAL

लंप–सम टर्न–की कार्य
(एल.एस.टी.के. कार्य)

LUMP-SUM TURN-KEY WORKS
(L. S. T. K. WORKS)

समाग्री एवं निर्माण
MATERIAL & CONSTRUCTION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	13-03-2025	REVISED AND REISSUED	AM	AH	AS	MN
1	27.08.2018	REVISED AND ISSUED AS STANDARD SPECIFICATION	AV	AS	RS	RKT
0	26.07.2013	ISSUED AS STANDARD SPECIFICATION	AS	RS	PKM	DM

Copyright EIL – All rights reserved

Abbreviations:

BIS	: Bureau of Indian Standards
CPCIA	: Concrete Penetrating Corrosion Inhibiting Admixture
C&D Waste	: Construction and Demolition Waste
EIL	: Engineers India Limited
HSFG	: High Strength Friction Grip
IS	: Indian Standard
LSTK	: Lump-sum Turn-key
OISD	: Oil Industry Safety Directorate
PCC	: Plain Cement Concrete
PVC	: Polyvinyl Chloride
RA	: Recycled aggregate
RCA	: Recycled concrete aggregate
RCC	: Reinforced Cement Concrete
STD	: Standard
TMT	: Thermo-mechanically Treated

Structural Standards Committee

Convenor: **Mr. Anurag Sinha**

Members:
Mr Virender Goel
Mr Deepak Agrawal
Ms Alpana Srivastava
Dr Sudip Paul
Mr Prasenjit Saha *
Mr Charanjit Singh
Mr Ravindra Kumar

*** For Fireproofing Specifications**

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 REFERENCED CODES, STANDARDS & PUBLICATIONS 4

3.0 MATERIAL REQUIREMENTS 4

3.1 General 4

3.2 Water 4

3.3 Aggregate (for Concrete) 5

3.4 Sand (for Masonry & Filling) 7

3.5 Cement 8

3.6 Steel 8

3.7 Brick 10

3.8 Stone 11

3.9 Admixtures 12

3.10 Water Bars (Water Stops) 13

3.11 Bitumen/Bituminous Materials 13

3.12 PVC Pipes 14

3.13 Wood/ Timber 14

3.14 Concrete Blocks Masonry 15

3.15 Autoclaved Cellular (Aerated) Concrete Blocks (AAC Block Masonry) 15

3.16 Anti-termite Compounds 15

3.17 Poly-sulphide Sealants 15

4.0 CONSTRUCTION REQUIREMENTS 15

4.1 Construction 15

4.2 Tolerances 16

4.3 Hanger Scaffolding for Pipe Rack 18

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 The material and construction considerations given hereunder establish the minimum basic requirements for reinforced cement concrete (RCC), structural steel and masonry structures/ works.

This specification shall be read in conjunction with the Engineering Design Basis (EDB) for the Job and Standard Specification No. 6-68-0021 for General requirements.

Project specific civil-structural requirements as mentioned in the Engineering Design Basis (EDB) shall supersede the any such requirements given in this standard specification.

1.2 All codes referred in this document pertain to BIS (Bureau of Indian Standards) publications and bear prefix IS.

1.3 Whenever any reference to BIS code is made, the same shall be taken as the latest revision (with all amendments issued there to) on the notified date of submission of tender.

1.4 Apart from the BIS codes mentioned in particular in the various clauses of this document, all other relevant codes related to the specific job under consideration and/ or referred to in the above-mentioned codes, shall be followed wherever applicable. Reference to some of the codes in the various clauses of this document does not limit or restrict the scope of applicability of other relevant codes.

1.5 In case of any variation/ contradiction between the provisions of BIS codes and the requirements given hereunder, the provisions given in this document shall have precedence over all others. In absence of relevant BIS codes, reference to corresponding British or American codes may be made (in that order of preference).

All material and construction shall strictly conform to the enclosed standards, specifications and 'specific requirements. Only if relevant information is not available in these documents, reference to relevant BIS code shall be made.

2.0 REFERENCED CODES, STANDARDS & PUBLICATIONS

For list of applicable codes, standards & publications, reference to Engineering Design Basis (EDB) shall be made.

3.0 MATERIAL REQUIREMENTS

3.1 General

The minimum requirements of various materials to be used in Civil and Structural works are as below:

3.2 Water

a) Water used in construction for all Civil & Structural works shall be clean and free from injurious amounts of oil, acids, alkalies, organic matters and/ or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall not be less than 6. Potable water will be considered satisfactory. All requirements of IS 456 have to be met.

b) Tests on water samples shall be carried out in accordance with IS 3025 and these shall fulfil all the guidelines and requirements given in IS 456.

Copyright EIL – All rights reserved

c) The Engineer-in-Charge may require the Contractor to prove, that the concrete prepared with water, proposed to be used, shall have average 28 days compressive strength not lower than 90% of the strength of concrete prepared with distilled water.

d) The Engineer-in-Charge may require the Contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/ organic matter or an excess of acid, alkalies or any injurious amount of salts etc., beyond the permissible maximum limits given in IS 456, the Engineer-in-Charge may refuse to permit its use. In case the water is supplied by the owner, contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements.

e) Water for curing shall be of the same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/reinforced concrete and masonry works. Sea water shall not be used for hydrotesting.

3.3 Aggregate (for Concrete)

3.3.1 General

Coarse and Fine aggregates for Civil and Structural Works shall conform in all respects to IS 383 (Specification for Coarse and Fine Aggregates from Natural Sources for Concrete). Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof. These shall be chemically inert, hard, strong, dense, durable, clean and free from veins, adherent coatings, injurious amounts of alkalies, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc. Naturally occurring aggregates shall be obtained from an approved source known to produce the same satisfactorily.

Manufactured aggregates shall consist of Iron and Steel slag aggregates, Copper slag aggregates or aggregates made from Construction & Demolition (C&D) waste such as Recycled Aggregates (RA) and Recycled Concrete Aggregates (RCA). RA shall comprise of waste from concrete, brick, tiles, stone, etc. and RCA shall be derived from concrete after requisite processing. Extent of utilization of manufactured aggregates in RCC and PCC works shall be as per Table-1 of IS 383.

Source and type of aggregates shall be got approved by the Engineer-in-Charge prior to procurement. Change in source and type of aggregates, at later stage, shall not be generally permitted; but under specific circumstances, Engineer-in-Charge can allow a change in source and type of aggregate. Contractor shall produce necessary test certificates from approved laboratories regarding the quality and suitability of the proposed aggregates and submit fresh mix design for approval of the Engineer-in-Charge. Any such change, if permitted by the Engineer-in-Charge, shall be without any time and cost implication to the owner.

Aggregates which may chemically react with alkalies of cement or might cause corrosion of the reinforcement shall not be used.

The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS 2386 - Part II (Methods of Test for aggregates for concrete), shall not exceed the limits defined in IS 383. No special test is required to prove the absence of such deleterious matters if the aggregates are from a known source with satisfactory prior data on the properties of concrete made with them. In case of newly developed quarry sites, the contractor shall submit necessary test results as per IS 383

Copyright EIL – All rights reserved

and IS 2386 to the Engineer-in-Charge prior to his acceptance and approval. The method of Sampling shall be in accordance with the requirements given in IS 2430.

Coarse and fine aggregates shall be batched separately. All-in-aggregate shall be used only where specifically permitted by the Engineer-in-Charge.

Separate sieve analysis and grading curves shall be prepared by the Contractor for any/ all batches of coarse and fine aggregates, and submitted to the Engineer-in-Charge, whenever asked for, to ensure conformity with those submitted along with the mix design.

Whenever required by Engineer-in-Charge, the aggregates (coarse/ fine) shall be washed and/ or sieved by the contractor before use in the works to obtain clean and graded aggregate at no extra cost to the owner

Aggregates not in conformity with the specifications shall be rejected and the Contractor shall immediately remove them from the site of work.

3.3.2 Coarse Aggregates

a) Coarse aggregates are the aggregates, which are retained on 4.75 mm IS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).

The grading of the aggregates shall be as per IS 383 or as required by the mix design, to obtain densest possible concrete. For this purpose, the contractor shall submit to the Engineer-in-Charge at least three sets of mix design and test results, each with different gradings of coarse aggregates, proposed to be used. The Engineer-in-Charge may allow "All-in-aggregates" to be used provided they satisfy the requirements of IS 383.

b) Coarse aggregates may be obtained from

(1) Uncrushed gravel or stone which results from natural disintegration of rock

(2) Crushed gravel or stone which results from crushing of gravel or hard stone.

(3) Partially crushed gravel or stone which results from blending of (1) and (2) above.
(4) Manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured coarse aggregate may be RCA or RA processed from C&D waste and may be supplied as single sized or graded.

3.3.3 Fine Aggregates

a) Fine aggregates are the aggregates which pass through 4.75 mm IS sieve but not more than ten percent (10%) pass through 150 micron IS sieve. These shall comply with the requirements of grading zones I, II and III of IS 383. Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.

Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

b) Fine aggregates shall consist of

Natural Sand: Fine aggregate resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies. This may also be called as uncrushed sand.

Crushed Sand –

i) Crushed Stone Sand: Fine aggregate produced by crushing hard stone
ii) Crushed Gravel Sand: Fine aggregate produced by crushing natural gravel

Copyright EIL – All rights reserved

Mixed Sand: Fine aggregate produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

c) Manufactured Fine Aggregate: Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured fine aggregate may be RCA processed from C&D waste

3.3.4 Sampling and Testing

The Contractor shall carry out all tests including mix designs of concrete, at the start of work as well as during any stage of construction as per the requirement. Tests shall be carried out in accordance with IS 516 (Methods of Test for Strength of Concrete) and IS 2386 (Methods of Test For Aggregates for Concrete). The method of sampling shall be in accordance with the requirements given in IS 2430.

3.3.5 Storage of Aggregates

a) Storage of all types of aggregates at the site of work shall be as specified in IS 4082. Aggregates shall in no case be stored near excavated earth or directly over ground surface.

b) The Contractor shall maintain sufficient quantities of aggregates, near to the place of work, required for the continuity of the work. Each type and grade of aggregate shall be stored separately on hard, firm surface having adequate slope for drainage of water.

c) Aggregates delivered at the site in wet condition or becoming wet due to rain or any other means, shall not be used for at least 24 hours. For the use of such aggregates the contractor shall adjust the water content in accordance with IS 2386 to achieve the desired mix. In the absence of test results, and to allow variation in mass of aggregates and water content on account of moisture content, the contractor can make suitable adjustment in the masses as per IS 456, for preparation of nominal mix concrete only.

3.4 Sand (for Masonry & Filling)

3.4.1 Sand for Masonry Mortars

a) The sand shall consist of natural sand, crushed stone sand or crushed gravel sand, or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS 2116.

b) The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.

c) The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS 2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand or manufactured sand. For organic impurities, when determined in accordance with IS 2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS 2386.

3.4.2 Grading of Sand

a) The particle size grading of sand for use in mortars shall be within the limits as specified below:

IS Sieve Designation (IS 460 Part-1)	Percentage Passing (by mass)	Reference to method (IS 2386 Part-1)
4.75 mm	100	

Copyright EIL – All rights reserved

IS Sieve Designation (IS 460 Part-1)	Percentage Passing (by mass)	Reference to method (IS 2386 Part-1)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600 micron	40 to 100	
300 micron	5 to 70	
150 micron	0 to 15	

b) In case of sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/ or blending with required quantities of suitable sizes of natural sand particles or crushed stone screening which are by themselves unsuitable. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

3.4.3 Sampling and Testing

a) The method of sampling shall be in accordance with IS 2430. The amount of material required for each test shall be as specified in relevant parts of IS 2386. All tests shall be carried out in accordance with the relevant parts of IS 2386.

b) If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) may be made in accordance with IS 2250 using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

3.4.4 Sand for Filling

Sand for filling shall meet the requirements of IS 383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Sand obtained from sea shores, creeks or river banks affected by tides shall not be used for filling. Fine aggregates suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS 383 shall be allowed for filling.

3.5 Cement

Cement shall be as specified in the Engineering Design Basis.

Cement to be used for civil and structural works shall be one of the following. Specific requirement for the type of cement to be used shall be as shown in the drawings or as specified in the contract or as directed by the Engineer-in-Charge.

- Specification for 33/43/53 grade ordinary Portland cement — IS 269
- Specification for Portland slag cement — IS 455
- Specification for Portland pozzolana cement (fly ash based) — IS 1489 Pt.1
- Specification for Portland pozzolana cement (calcined clay based) — IS 1489 Pt.2
- Specification for Masonry Cement — IS 3466
- Specification for high alumina cement for structural use — IS 6452
- Specification for rapid hardening Portland cement — IS 8041
- Specification for Sulphate Resisting Portland cement — IS 12330

3.6 Steel

3.6.1 General

All steel bars, sections, plates, and other miscellaneous steel materials, etc. shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials,

Copyright EIL – All rights reserved

construction specifications such as dimensions, shape, weight, tolerances, testing etc, for all materials covered under this section, shall conform to respective BIS codes.

3.6.2 Reinforcement Bars

Reinforcement shall be TMT (Thermo-mechanically treated) bars of minimum Grade Fe500D (unless specified otherwise in the EDB/ Job Specifications), conforming to IS 1786 and bearing standard mark of the Bureau of Indian Standards.

Corrosion protection to reinforcement bars, if any shall be as specified in the EDB/ Job Specification.

3.6.3 Structural Steel

Structural Steel shall be of minimum Grade E250A/BR/B0 (unless specified otherwise in the EDB/ Job Specifications) conforming to IS 2062 and bearing standard mark of the Bureau of Indian Standards, excluding bars and rods of diameter/ thickness less than 6 mm and structural (angle) below ISA 50x50x6.

Hollow Sections shall be of minimum Grade YSt 310 (unless specified otherwise in the EDB/ Job Specifications) conforming to IS 4923 (for SHS/RHS) and IS 1161 (for CHS) and bearing standard mark of the Bureau of Indian Standards.

3.6.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall conform to the following BIS codes:

a) Specification for Expanded Metal Steel Sheets for General Purposes	IS 412
b) Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement	IS 432
c) Hexagon Head Bolts, Screws and Nuts of Product Grade 'C' - Part 1: Hexagon Head Bolts	IS 1363
d) Cold formed light gauge structural steel sections.	IS 811
e) Technical supply conditions for threaded steel fasteners.	IS 1367
f) Plain washers	IS 2016
g) Steel wire ropes for general engineering purposes	IS 2266
h) Thimbles for wire ropes.	IS 2315
i) Bulldog grips	IS 2361
j) Mild Steel Tubes, tubular and other wrought steel fillings	IS 1239
k) Drop forged sockets for wire ropes for general engineering purposes	IS 2485
l) Steel chequered plates.	IS 3502
m) High Strength Structural Nuts	IS 6623
n) Washers for High Strength Structural Bolts & Nuts	IS 6649

3.6.5 Connection Bolts

Connection bolts shall be High Strength Hot-dip Galvanised Structural bolts of minimum Property Class 8.8, material and installation shall comply to requirements of IS 3757 and IS 4000 respectively. The acceptable methods of tightening the bolts in order of preference are listed below:

a) "Automatic Torque Control" where tightening is by a torque control impact wrench with automatic cut-off, calibrated to shut off at the desired bolts tension.

b) "Stall Torque Control" where tightening is by a standard impact wrench, calibrated by regulation of air pressure to "stall" at the desired bolt tension.

c) "Turn-of Nut" where tightening is by a standard impact wrench, by turning the nut ½ to ¾ turn beyond the "snug" position. The snug position is that position where the wrench begins to impact.

Copyright EIL – All rights reserved

d) "Manual Torque Control" where tightening is by hand wrench equipped with a torque indicator and calibrated for the desired bolt tension.

All the bolts in a joint shall be tightened to a minimum tension value as per Table 3 of IS 4000.

Properties of Bolt Class 4.6 wherever specified shall conform to IS 1367. Black hexagonal nuts and washers wherever specified shall be as per IS 1363.

3.6.6 Anchor Bolts

Material for Anchor Bolts such as bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS codes mentioned in the EDB.

3.7 Brick

3.7.1 General

All Bricks used for masonry works shall conform to the requirements of following BIS Codes:

- Common Burnt Clay Bricks- Specifications IS 1077
- Pulverized Fuel Ash Cement Bricks- Specifications IS 16720
- Pulverized Fuel Lime Ash Bricks- Specifications IS 12894
- Burnt Clay Fly Ash Bricks- Specifications IS 13757

3.7.2 Common Burnt Clay Bricks

Bricks for masonry works shall conform to IS 1077 - Specification for common burnt clay building bricks and shall be of class 5.0 (with minimum compressive strength of 5.0 N/mm^2). Specific requirement for any other class of bricks shall be as shown in drawings or as described in the contract for a particular site or type of work. Physical requirements, quality, dimensions, tolerances etc. of common burnt clay building bricks shall conform to the requirements of IS 1077.
Bricks shall be hand - moulded or machine moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

3.7.3 Pulverized Fuel Ash Cement Bricks

Pulverized fuel ash-cement bricks shall conform to IS 16720. The bricks shall be sound, free from visible cracks and uniform in shape and colour. The brick shall have total pulverized fuel ash content not less than 35 percent of the mass of bricks. Pulverized fuel ash shall conform to IS 3812 (Part 1) or IS 3812 (Part 2).

3.7.4 Fly Ash Lime Bricks (FALG Bricks)

The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. Fly ash shall conform to IS 3812.

3.7.5 Burnt Clay Fly Ash Bricks

The burnt clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

Copyright EIL – All rights reserved

3.7.6 Mechanized Autoclave Fly Ash Lime Brick

These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

3.7.7 Tests after Delivery

The Contractor shall take samples of each type of brick as directed by the Engineer-in-Charge as per the requirements of IS 5454 and tests shall be carried out as per IS 3495. The cost for carrying out any or all the tests, shall be borne by the Contractor. The bricks, when tested, as per IS 3495 shall have a minimum average compressive strength, as given in the Code, for a particular class of brick. Water absorption shall not be more than 20% by its dry weight, when soaked in cold water for 24 hours.
Brick samples so approved, shall be deposited with the Engineer-in-Charge. All subsequent deliveries shall be upto the standards of the approved samples.

3.7.8 Local Bricks/ Class 3.5 Bricks.

Where shown on drawings, locally available bricks of non modular size (230 mm x 110 mm x 70 mm) in place of bricks of modular size (190 mm x 90 mm x 90 mm) can be used in case the bricks satisfy the other requirements of respective BIS codes. Minimum compressive strength of these bricks shall not be less than 3.5 N/mm^2.

All external brick masonry walls shall be of minimum 230 mm thickness (except for fire walls).

3.8 Stone

3.8.1 General

All Stones used for masonry works shall conform to the requirements of following BIS codes:

a)	Method of identification of natural building stones	IS 1123
b)	Recommendations for dimensions and workmanship of natural building stones for masonry work	IS 1127
c)	Recommendations for dressing of natural building stones	IS 1129

3.8.2 Quality of Stones

a) Stones shall be hard, dense, strong, sound, durable, clean and uniform in colour. These shall also be free from veins, adherent coatings, injurious amounts of alkalies, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea shells etc. As far as possible, stones from one single quarry shall be used for any one work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS 1905, taking into account the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS 1124, shall not exceed 5%.

b) The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150 mm and in no case exceed ¾th thickness of the wall. Height of the stone shall not be more than 300 mm.

Copyright EIL – All rights reserved

3.9 Admixtures

3.9.1 General Requirements

a) All concrete admixtures shall comply with the following Indian standards:

i. Specification for integral cement water proofing compounds IS 2645

ii. Specification for other admixtures for concrete IS 9103

Generally, admixtures shall have ISI certification marks. However, even in case of BIS certified admixtures, Engineer-in-Charge may require the Contractor to carry out and submit any or all the tests (as specified in relevant BIS Codes), from BIS approved laboratories, over and above the manufacturer's test certificate, before giving his final approval.

In case, admixtures certified by BIS are not available, the contractor shall submit to the Engineer-in-Charge the type and/or proprietary brand of the admixture from only reputed manufacturers along with necessary test certificates from BIS recognized/ BIS approved laboratories or any other document directed by Engineer-in-Charge for the latter's final approval. In such cases, names of at least two manufacturers shall be submitted to the Engineer-in-Charge for his selection. In case, both the names are rejected, the contractor shall submit a fresh list of two manufacturers for approval by the Engineer-in-Charge.

The Engineer-in-Charge may direct the contractor to submit test results as required by IS 2645 or IS 9103 for any admixture proposed to be used in the concrete in any approved laboratory at his discretion at any stage of the work. The cost of any/all tests required to satisfy compliance with this specification shall be borne by the Contractor.

In case of non-availability of any BIS code for testing and acceptability criteria, relevant American, British or German Code shall be applicable.

The suitability and effectiveness of any admixture shall be verified by trial with the designed concrete mixes using cement, aggregates together with any other materials to be actually used in the works as per the direction of Engineer-in-Charge. If two or more admixtures are to be used simultaneously in the same concrete mix, the Contractor must submit necessary test results from an approved laboratory to show their interaction and compatibility. Any/all tests specified in BIS Codes shall be carried out only with the type of material and mix design, to be actually used in the work site.

b) No admixture shall impair the durability of the concrete nor combine with the ingredients to form harmful compounds, nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixtures has been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.

c) The chloride contents in admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement.

d) Admixtures which do not meet the requirements stipulated in this document shall not be used.

3.9.2 Corrosion Inhibiting Admixtures

Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA) shall be added to the concrete matrix for protection of embedded steel in concrete against corrosion.

Copyright EIL – All rights reserved

The CPCIA shall be concrete penetrating type which upon addition into the concrete matrix inhibits the corrosion process. It need not be in direct contact with the steel. Its vapour penetrates through fissures, honeycomb structure of concrete, pure water solution added in concrete and seals steel reinforcement at both anodic & cathodic sites, for inhibition. This is due to the bipolar mechanism property of the system.

Non-concrete penetrating, nitrite & nitrate corrosion inhibitors shall not be used.

The dosage shall be 1% by weight of cement or as recommended by the manufacturer.

In case the product is not as per the Suppliers List, the same shall be got approved by the Owner/ Owner's representative.

3.9.3 Water Proofing Compounds (Crystalline/ Non-crystalline)

Water proofing compounds shall be mixed with cement only.

a) The permeability of the specimen with the admixture shall be less than half of the permeability with a similar specimen without the use of these compounds. These compounds shall be used in such proportion as recommended by manufacturer but in no case, it shall exceed 3% by weight of cement.

b) The initial setting time of the cement with the use of these compounds shall not be less than 30 minutes and final setting time shall not be more than 10 hours. Tests shall be carried out in accordance with IS 4031.

c) Compressive strength of the specimen at 3 days shall not be less than 160 kg/cm^2 nor 80% of the 3 days compressive strength of mortar cubes prepared with same cement and sand only, whichever is higher. Similarly compressive strength at 7 days shall not be less than 220 kg/cm^2 nor less than 80% of the 7 days compressive strength prepared with the same cement and sand only, whichever is higher. The test to determine the compressive strength shall conform to IS 4031.

3.10 Water Bars (Water Stops)

a) PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. These shall be preformed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/ displacements at joints arising due to variation of temperatures or settlement of foundations.

b) Performance requirements of PVC water bars shall meet the requirements of IS 12200. These shall be of an approved make and of ribbed/ serrated/ plain type with a bulb at the centre. The thickness and width of water bars shall in no case be less than 5 mm and 150 mm respectively. However, for concrete sections greater than 300 mm thick, the width of water bars shall not be less than 230 mm.

3.11 Bitumen/ Bituminous Materials

Bitumen to be used for various types of work shall meet all the requirements of relevant BIS codes as given below:

i.	Specification of Paving Bitumen	IS 73
ii.	Specification for bitumen mastic for flooring. (Grade IV)	IS 1195
iii.	Specification for Bitumen felts for water proofing and damp proofing	IS 1322
iv.	Specification for Bituminous compounds for water proofing and caulking purposes	IS 1834

Copyright EIL – All rights reserved

v.	Specification for preformed fillers for expansion joint in concrete pavements and structures	IS 1838
vi.	Specification for bitumen mastic for use in water proofing of roofs	IS 3037
vii	Specification for bitumen primer for use in water proofing and damp proofing	IS 3384
vii	Specification for Bitumen Mastic for Tanking and Damp proofing	IS 5871
ix.	Specification for Glass fibre base coal tar pitch & bitumen felts	IS 7193
x.	Code of practice for damp proofing using bitumen mastic	IS 7198
xi.	Specification for bitumen Mastic, Anti Static and electrically conducting grade	IS 8374

Tests and acceptable criteria shall be as per relevant BIS codes.

3.12 PVC Pipes

PVC Pipes shall conform to the requirements of IS 4985.

3.13 Wood/ Timber

a) Wood recommended for platforms of cold vessels or below cold vessels/ exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7 N/mm^2 in compression, perpendicular to grains on outside location as per IS 883. General characteristics like durability, treatability etc. shall conform to IS 883 and IS 3629.

b) Timber required to be used for form work shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/ Timber shall be as per the requirements of IS 4082.

c) For proper identification and selection of suitable timber for form work, following codes shall be referred.

i.	Classification of commercial timbers & their zonal distribution	IS 399
ii.	Specification for ballies for general purposes	IS 3337
iii.	Specification for Ply wood for concrete shuttering work	IS 4990

3.14 Concrete Block Masonry

Grade of solid and hollow concrete block masonry shall be as follows:

a) Solid concrete blocks : Grade C (5.0).
b) Hollow concrete blocks : Grade A (5.5) closed cavity.

The nominal dimensions (length, height & width), density, compressive strength of solid & hollow concrete block masonry units shall be in conformance to IS 2185 (Part-1) corresponding to the above-mentioned grades.

Concrete block masonry of following thicknesses shall preferably be used:

a)	100 mm thickness	: Solid concrete block masonry.
b)	200 mm thickness	: Hollow concrete block (closed cavity) masonry.
c)	400 mm thickness (fire walls)	: Hollow concrete block (closed cavity) masonry.

Copyright EIL – All rights reserved

3.15 Autoclaved Cellular (Aerated) Concrete Blocks (AAC Block Masonry)

AAC Block masonry units shall be in conformance to IS 2185 (Part-3).

3.16 Anti-termite Compounds

Following chemicals as per IS 6313 (Part 2 and 3) shall be used for treatment of soil for protection of buildings against attack by subterranean termites.

S.No.	Chemical	Relevant Standard	Dosage* (Chemical Emulsion)
1	Chlorpyrifos 20% Emulsifiable Concentrate (EC)	IS 8944	250ml in 5 litre water 50ml in 1 litre water
2	Imidacloprid 30.5% Suspension Concentrate (SC)	IS 16131	10.5ml in 5 litre water 2.1ml in 1 litre water
3	Bifenthrin 2.5% Emulsifiable Concentrate (EC)	IS 15936	100ml in 5 litre water 20ml in 1 litre water

3.17 Poly-sulphide Sealants

All Poly-sulphide Sealants shall conform to IS 12118. Test conditions and requirements shall be as given in the above referred BIS code.

4.0 CONSTRUCTION REQUIREMENTS

4.1 Construction

4.1.1 All concrete works shall be carried out as per the provisions of IS 456, IS 3370, IS 2974 and other relevant BIS Codes. Concrete mix proportioning and design mix; sampling and strength test of concrete, production and control of concrete, tolerances and placing of reinforcement and for cover; transporting, placing, compacting and curing etc, inspection and testing of structure (including requirement of non-destructive testing) shall be as specified in IS 456.

4.1.2 Continuous concreting shall be done for structures supporting dynamic equipment as per the provisions of IS 2974.

4.1.3 The damp proof course shall be laid in two layers of equal thickness and each layer given two coats of hot bitumen on top (grade VG-10 conforming to IS 73) at the rate of 1.7 kg/m^2. Dry sharp sand shall be sprinkled evenly over the top layer of bitumen before hardening.

4.1.4 Form work and stripping of form work shall be as per the provisions of IS 456.

4.1.5 Only steel shuttering shall be used for civil construction.

4.1.6 Assembly of reinforcement in RCC structures shall conform to IS 456.

4.1.7 Fabrication of all structural steel works shall be carried out as per the provisions of IS 800/ IS 801/ IS 802/ IS 806 and other relevant BIS codes. Fabrication shall include cleaning, straightening, cutting, bending, holding, bolting, welding, machining, painting, marking, assembling, erecting, inspecting and testing etc. Welding procedure and welder qualification shall be as per IS 800 and/ or referenced BIS codes only.

4.1.8 Erection of all structural steel works including supply of plant & equipment, storing and handling, setting out, field connections, field welding and security during erection shall conform to IS 800/ IS 801/ IS 802/ IS 806.

Copyright EIL – All rights reserved

4.1.9 All masonry works shall be carried out as per the provisions of IS 1597/ IS 2185/ IS 2212/ IS 4326 and other relevant BIS codes.

4.1.10 Construction of all other items of works shall conform to relevant Indian Standards and sound engineering practices.

4.1.11 The Contractor shall be responsible for the complete safety pertaining to all construction works.

4.2 Tolerances

4.2.1 The limits of dimensional tolerances for Plain and Reinforced Cement Concrete Structures shall be as follows:

a. Deviation from specified dimensions of cross section of columns and beams — -6 mm to +12 mm

b. Deviation from dimensions of footings (refer note below)

i. Dimensions in plan	-12 mm to +50 mm
ii. Eccentricity	0.02 times the width of footing in the direction of deviation but not more than 50 mm
iii. Thickness	±0.05 times the specified thickness

Note: *Tolerances apply to cast-in-situ concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.*

c. Deviation in length (major dimension of single unit)

i. Up to 3.0m	± 6 mm
ii. 3.0m to 4.5m	± 9 mm
iii. 4.5m to 6.0m	±12 mm
iv. additional deviation for every subsequent 6m	± 6 mm

d. Deviation in straightness or bow (deviation from specified line) for a single or continuous member), e.g, beam, column or slab edge:

i. Up to 3.0m	6 mm
ii. 3.0m to 4.5m	9 mm
iii. 4.5m to 6.0m	12 mm
iv. additional deviation for every subsequent 6m	6 mm

e. Deviation in squareness shall be measured taking the longer of two adjacent sides as the base line. The shorter side shall not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions exceeds 6mm. For this purpose, any error due to lack of straightness shall be ignored. Squareness shall be checked with respect to the straight lines that are most nearly parallel with the features being checked. When the nominal angle is other than 90 degrees, the included angle between check lines shall be varied accordingly.

f. Deviation in twists shall be within a limit such that any corner shall not be more than the limit given below from the plane containing other three corners:

i. Up to 600mm wide and up to 6m in length : 6 mm
ii. over 600mm wide and for any length : 12 mm

Copyright EIL – All rights reserved

g. Maximum deviation in flatness from a 1.5 m straight edge placed in any position on a nominally plain surface shall not exceed 6mm.

4.2.2 The limits of dimensional tolerances for Steel Structures shall be as follows:

4.2.2.1 For columns and tower-type structures:

a.	Deviation of column axes at foundation top level with respect to true axes	
	i. In longitudinal direction	±5 mm
	ii. In lateral direction	±5 mm
b.	Deviation in the level of bearing surface of columns at foundation top with respect to true level	±5 mm
c.	Out of plumb (verticality) of column axis from true vertical axis, as measured at top	
	i. Up to and including 30m height	lesser of ±H/1000 or ±25mm
	ii. Over 30m height	lesser of ±H/1200 or ±35mm
d.	Deviation in straightness in longitudinal & transverse planes of column at any point along the height	lesser of ±H/1000 or ±10mm
e.	Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/ beams with respect to true distance	±5 mm
f.	Deviation in any bearing or seating level with respect to true level Up to 600mm wide and up to 6m in length	±5 mm
g.	Deviation in difference in bearing levels of a member on adjacent pair of columns both across & along the building	±5mm

Notes:

1. *Tolerance specified for out-of-plumbness should be read in conjunction with 'Deviation in straightness....' & 'Difference in the erected positions....'.*
2. *'H' is the column height in mm.*
3. *Tolerance limits as given under clause 4.2.2.1 above for steel structures are applicable to concrete columns/ pedestals also.*

4.2.2.2 Trusses

a.	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	±1/250 of height of truss in mm at centre of span or ±15 mm, whichever is less
b.	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	±1/1500 of span of truss in mm or ±10 mm, whichever is less
c.	Lateral shift in location of truss from its true position	±10 mm
d.	Lateral shift in location of purlin from true position	±5 mm
e.	Deviation in difference of bearing levels of truss from the true level	±1/1200 of span of truss in mm or 20mm, whichever is less

4.2.2.3 Gantry girders and Rails

a.	Shift in the centre line of crane rail with respect to centre line of web of gantry girder	± [web thickness of girder(mm)+2mm] / 2
b.	Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point	±5mm

Copyright EIL – All rights reserved

c.	Deviation in crane track gauge with respect to true gauge	
	i. For track gauge up-to and including 15m	±5 mm
	ii. For track gauge more than 15m	±[5+0.25(S-15)] subject to maximum ±10 mm, where S in metres is true gauge
d.	Difference in level between crane track rails (across the bay) at	
	i. Supports of gantry girders	15 mm
	ii. Mid span of gantry girders	20 mm
e.	Relative shift of crane rail surfaces (at joint) in plan and elevation	2 mm

4.3 Hanger Scaffolding for Pipe Rack

Hanger scaffolding (fixed/ movable) shall be provided in the pipe rack to facilitate mechanical works over the first tier & above. The same shall provide protection from falling material as well as act as a safe working platform. This shall be provided about one meter below the entire pipe rack first tier elevation.

The scaffolding shall be light weight, easy to remove when the work is complete. The deck planks may be perforated sheets suitably folded at the ends and open web ladder type of beams may be used to support them. These beams shall be supported on the hangers provided from the beams of the pipe rack.

The design load under the working condition shall be 120 kg/m^2 and that for the limit state of collapse shall be twice the same. However individual panel shall be designed for the concentrated loads of 120 kg at spacing of 1 m and double that load for the limit state of collapse.

Deflection of individual planks shall be maximum span/100. For the beam, the deflection shall be controlled as per IS 800:2007.

The design shall be supported by the properly testing of the checking for the specified loads.

After completion of work over the pipe rack, the contractor shall remove the hanging scaffolding from the pipe rack and take back the scaffolding material.

Copyright EIL – All rights reserved

मानक विनिर्देशन
सिविल एवं संरचना

STANDARD SPECIFICATION
CIVIL - STRUCTURAL

एकमुश्त टर्न-की कार्य
(एल.एस.टी.के कार्य)

LUMP-SUM TURN-KEY WORKS
(L. S. T. K. WORKS)

विक्रेता डेटा आवश्यकताएं
VENDOR DATA REQUIREMENTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	10.02.2025	ISSUED AS STANDARD SPECIFICATION	HKV	RM	AS	MN
A	06.02.2025	ISSUED FOR COMMENTS	HKV	RM	AS	MN

Copyright EIL – All rights reserved

Abbreviations:

BIS	: Bureau of Indian Standards
DCI	: Document Control Index
EIL	: Engineers India Limited
EPC	: Engineering Procurement & Construction
IS	: Indian Standard
LSTK	: Lump-sum Turn-key
MTO	: Material Take off
PCC	: Plain Cement Concrete
RCC	: Reinforced Cement Concrete
STD	: Standard
TMT	: Thermo-mechanically Treated
VDMS	: Vendor Document Management System

Structural Standards Committee:

Convener: Mr. Anurag Sinha

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms Alpana Srivastava
Dr. Sudip Paul
Mr. Prasenjit Saha (SMMS)
Mr. Charanjit Singh (Project)
Mr. Indrajit Neog (Construction)
Ms Papia Mandal
Mr. Vikram Kumar Gupta

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

ANNEXURE-IA : Load Summary for Structure
ANNEXURE-IB : MTO format for individual structure
ANNEXURE-II : Bulk MTO format for entire scope of package
ANNEXURE-III : Detailed MTO format for entire scope of package (Structural, Geotechnical & Architectural)
ANNEXURE-IV : Format for MTO of Rebars
ANNEXURE-V : Format for MTO of Structural Steel

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This specification establishes and defines the requirements of various data from contractors for Civil and Structural works under the EPC & LSTK contracts.

1.2 Vendor Document Management System (VDMS) is a web application that lets contactors/ vendors manage their Document Control Index (DCI) through an interface, submit their documents/drawings for review/ record and get the reviewed documents/ drawings.

1.3 A Document Control Index [DCI, i.e. detailed list of documents/ drawings, including specifications, standards, design philosophy (foundation & superstructure), general notes, design calculations, design drawings, Bulk Material Take-off (Bulk MTO), bar bending schedules (for RCC works) and fabrication drawings (for structural steel works)] indicating the document/ drawing category (review or record as applicable) together with the scheduled and actual date of submission of the documents, shall be submitted by the Contractor through the Vendor Document Management System (VDMS) and kept updated at all times in the VDMS for review by Owner/ owner's representative. The DCI shall also indicate the document/ drawing category (review or record as applicable) together with the scheduled and actual date of submission of the documents.

Incomplete, unchecked, unsigned and unstamped design documents/ drawings shall not be reviewed/ accepted and shall be deemed to be considered as void/ withdrawn.

1.4 Annexure IA & IB shall be submitted along with design calculation for all individual structures/ buildings/ foundations as defined in the Vendor Data Requirement document.

1.5 Detailed MTO (Annexure-II) & Bulk MTO (Annexure-III) shall be submitted by the contractor for entire scope of the Package/Tender.

1.6 Bulk MTO (Annexure-III) (showing anticipated, released and balance quantities) shall also be submitted by the Contractor at 30%, 60% & 90% stages of engineering and kept updated at all times in the Vendor Document Management System (VDMS) for review by Owner/ Owner's representative.

ANNEXURES

ANNEXURE-IA	: Load Summary for Structure
ANNEXURE-IB	: MTO format for individual structure
ANNEXURE-II	: Bulk MTO format for entire scope of package
ANNEXURE-III	: Detailed MTO format for entire scope of package (Structural, Geotechnical & Architectural)
ANNEXURE-IV	: Format for MTO of Rebars
ANNEXURE-V	: Format for MTO of Structural Steel

Copyright EIL – All rights reserved

ANNEXURE-IA

(LOAD SUMMARY FOR_____)

Job No.:
Package Name:
Structute / Building / Foundation Name:
Type of Structure: Concrete / Steel / Hybrid / Precast / Modular
Project:
Client:
Contractor:
Location:
PO No. & Date:

SL. NO.	TYPE OF LOAD	DIRECTION OF LOAD		
		X (HORZ.)	Y (VERT.)	Z (HORZ.)
A.	Dead Load (DL)	-		-
A1	Self Weight (SW)			
A2	Masonary Load	-		-
A3	Non-modelled elements of structure	-		-
A4	Non-Structural (Equipment, Elect. Panel, AHU equipment etc.)			
B.	Imposed Load (IL)			
B1	Live Load			
C.	Wind Load (WL)		-	
D.	Seismic Base Shear			
D1	Mass Participation (%)			
	Any Other			

Notes:
1. To be submitted along with each design calculations.

Copyrights EIL – All rights reserved

ANNEXURE-IB

Job No.:

Package Name:

Structute / Building / Foundation Name:

Type of Structure: Concrete / Steel / Hybrid / Precast / Modular

Project:

Client:

Contractor:

Location:

PO No. & Date:

SL. NO.	NAME OF STRUCTURE / BUILDING/ FOUNDATION	DOCUMENT/ DRAWING NUMBERS	LENGTH (M)	WIDTH (M)	HEIGHT (M)	PORTAL SPACING (ONLY FOR PIPE RACK)	NO. OF TIERS (ONLY FOR PIPE RACK)	SEISMIC ZONE	BASIC WIND SPEED (m/s)	PILE CAPACITY / SBC (MT/T/Sq.m)	NO. OF PILES (NOS.)	PCC / RCC			TOTAL REBAR (REFER NOTE-2)		STRUCTURAL STEEL (REFER NOTE-3)		GRATING (Sq. M)	HANDRAIL (RM)
												PCC (Cu.M)	RCC SUB-STRUCTURE (Cu.M)	RCC SUPER-STRUCTURE (Cu.M)	SUB-STRUCTURE (MT)	SUPER-STRUCTURE (MT)	UPTO 20 M HEIGHT (MT)	ABOVE 20 M HEIGHT (MT)		

Notes:

1. To be submitted along with each design calculations.
2. Diameter-wise breakup shall be provided for Rebars
3. Section-wise breakup shall be provided for Structural Steel

Copyrights EIL – All rights reserved

Page 4265 of 5436 ; C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 ; Rev. A

ANNEXURE-II

Job No.:

Package Name:

Structute / Building / Foundation Name:

Type of Structure: Concrete / Steel / Hybrid / Precast / Modular

Project:

Client:

Contractor:

Location:

PO No. & Date:

SL. NO.	NAME OF STRUCTURE / BUILDING / FOUNDATION	TYPE OF STRUCTURE (Concrete Steel / Hybrid / Precast / Modular)	DRAWING NUMBERS	LENGTH (M)	WIDTH (M)	HEIGHT (M)	PORTAL SPACING (ONLY FOR PIPE RACK)	NO. OF TIERS (ONLY FOR PIPE RACK)	SEISMIC ZONE	BASIC WIND SPEED (m/s)	PILE CAPACITY / SBC	NO. OF PILES (NOS.)	RCC/PCC			TOTAL REBAR (REFER NOTE-2)		STRUCTURAL STEEL (REFER NOTE-3)		GRATING (Sq. M)	HANDRAIL (RM)
													PCC (Cu.M)	RCC SUB-STRUCTURE (Cu.M)	RCC SUPER STRUCTURE (Cu.M)	SUB-STRUCTURE (MT)	SUPER-STRUCTURE (MT)	UPTO 20M HEIGHT (MT)	ABOVE 20 M HEIGHT (MT)		
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
	TOTAL																				

Notes:

1. To be submitted for the entire scope of each package.
2. Diameter-wise breakup shall be provided for Rebars
3. Section-wise breakup shall be provided for Structural Steel
4. Rows can be added as per requirement.

Copyrights EIL – All rights reserved

Page 4266 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

ANNEXURE-III

Job No.:
Package Name:
Plot Size:
Project:
Client:
Location:
PO No. & Date:
Time Schedule:

MTO FORMAT (STRUCTURAL, GEOTECHNICAL & ARCHITECTURAL)			
SL. NO.	**DESCRIPTION**	**UNITS**	**Quantity**
1	EARTH WORK IN EXCAVATION (SOIL)	CUM	
2	EARTH WORK IN EXCAVATION (ROCK)	CUM	
3	BACKFILLING	CUM	
4	BACKFILLING WITH BORROW EARTH	CUM	
5	TRANSPORTATION & DISPOSAL OF SURPLUS EARTH / ROCK	CUM	
6	PCC (WITH GRADE)	CUM	
7	RCC IN SUB-STRUCTURE (WITH GRADE)	CUM	
8	RCC IN SUPER-STRUCTURE (WITH GRADE)	CUM	
9	PRECAST RCC (WITH GRADE)	CUM	
10	REINFORCEMENT BARS (WITH GRADE) * REFER NOTE-2	MT	
11	CENTRING AND SHUTTERING IN SUB-STRUCTURE	SQM	
12	CENTRING AND SHUTTERING IN SUPER-STRUCTURE	SQM	
13	STRUCTURAL STEEL (WITH GRADE) * REFER NOTE-3	MT	
13.1	STRUCTURAL STEEL (UPTO 20 M HEIGHT)	MT	
13.2	STRUCTURAL STEEL (ABOVE 20 M HEIGHT)	MT	
14	FLOOR GRATING & CHEQUERED PLATE	MT	
15	HAND RAILING	RM	
16	MASONRY (WITH TYPE & GRADE)	CUM	
17	SAND FILLING	CUM	
18	VERMICULITE IN FIRE PROOFING	SQM	
19	PILING WITH CONCRETE & REINFORCEMENT GRADE		
19.1	TYPE (BCIS/DCIS/PRECAST/STEEL)		
19.2	DIAMETER	mm	
19.3	QUANTITY	Nos.	
19.4	LENGTH	M	
19.5	PILING CONCRETE QUANTITY	CUM	
19.6	PILING REINFORCEMENT QUANTITY	MT	
20	PILE CAPACITY (MT) / SBC (T/SQ.M)	MT/SQ.M	
21	GROUND IMPROVEMENT (SAND-GRAVEL MIX / SAND / CNS MATERIAL / BOULDER SOLING, IF APPLICABLE)	CUM	
22	STONE COLUMNS	Nos.	
22.1	LENGTH OF STONE COLUMNS	M	
22.2	DIAMETER OF STONE COLUMNS	mm	
23	BUILDINGS (BLAST RESISTANT / NON-BLAST RESISTANT)	Nos.	
23.1	TYPE OF CONSTRUCTION (Concrete / Steel / Hybrid / Precast / Modular)		
23.2	SIZE (L, B & H)	M	
23.3	NO. OF FLOORS	Nos.	
23.3	TOTAL FLOOR AREA	SQM	
24	ANY OTHER INFORMATION		

NOTE:

1. Summary to be submitted for the entire scope of each package.
2. Diameter-wise breakup shall be provided for Rebars as per Annexure-IV.
3. Section-wise breakup shall be provided for Structural Steel as per Annexure-V.

Copyrights EIL – All rights reserved

ANNEXURE-IV

Job No.:
Package Name:
Plot Size:
Project:
Client:
Location:
PO No. & Date:
Time Schedule:

FORMAT FOR MTO OF REBARS				
SL. NO.	**NOMINAL SIZE OF REBARS (MM)**	**GRADE OF REBARS**	**WEIGHT (MT)**	**PERCENTAGE (%) (OF GRAND TOTAL)**
1	8			
2	10			
3	12			
4	16			
5	20			
6	25			
7	28			
8	32			
9	36			
10	40			
11	ANY OTHER INFORMATION			
	GRAND TOTAL			**100.00**

NOTE:

1. Summary to be submitted for the entire scope of each package.

Copyrights EIL – All rights reserved

ANNEXURE-V

Job No.:
Package Name:
Plot Size:
Project:
Client:
Location:
PO No. & Date:
Time Schedule:

FORMAT FOR MTO OF STRUCTURAL STEEL				
SL. NO.	SECTION SIZES	GRADE OF STEEL	WEIGHT (MT)	PERCENTAGE (%) (OF GRAND TOTAL)
	GRAND TOTAL			100.00

NOTE:

1. Summary to be submitted for the entire scope of each package.
2. Section sizes shall contain Beams, Channels, Angles, Plates, Flats, including Plate Fabricated Sections (if any).

Copyrights EIL – All rights reserved

मानक विनिर्देश

सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION CIVIL & STRUCTURAL WORKS

कंक्रीट की भूमिगत संरचनाओं का जल-रोधन

WATER-PROOFING OF UNDERGROUND CONCRETE STRUCTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
1	26.02.21	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	TK	AJS	AS	SM
0	15.01.15	ISSUED AS STANDARD SPECIFICATION	SP	AS	PKM	SC

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
DIN	:	Deutsches Institut für Normung (German Institute for Standardization)
EIL	:	Engineers India Limited
EN	:	European Standard
FGL	:	Finished Ground Level
FPO	:	Fully-bonded Poly Olefin
HDPE	:	High Density Poly Ethylene
IS	:	Indian Standard
ISO	:	International Organisation for Standardisation
PCC	:	Plain Cement Concrete
PVC	:	Polyvinyl Chloride
RCC	:	Reinforced Cement Concrete
SBR	:	Styrene Butadiene Rubber
UEAtc	:	Union Européenne pour l'Agrément technique dans la construction (European Union for technical approval)

Structural Standards Committee

Convener : Mr. Anurag Sinha

Members:
Mr. C Damodaran
Mr. V.K.Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Projects)
Mr. Ravindra Kumar (Constn.)

Copyright EIL – All rights reserved

TABLE OF CONTENTS

1.0 SCOPE 4
2.0 GENERAL REQUIREMENTS 4
3.0 REFERENCES 4
4.0 TERMINOLOGY 4
5.0 WATER-PROOFING PROTECTION SYSTEMS 6
6.0 GENERAL CONSTRUCTION ISSUES 12
7.0 TYPE A (BARRIER) PROTECTION 13
8.0 TYPE B (STRUCTURALLY INTEGRAL) PROTECTION 22
9.0 TYPE C (DRAINED) PROTECTION 25
10.0 REMEDIAL MEASURES 28
11.0 TESTING 30
12.0 GUARANTEE 31
13.0 PAYMENT 31

Copyright EIL – All rights reserved

1.0 SCOPE

This specification covers the requirements of water-proofing of under-ground concrete structures such as basements, tunnels, ducts, trenches, pits etc., designed as per IS:456 for effectively preventing the infiltration of water from the surrounding soil into the structure and flow of water from inside the structure to outside, by using the following types of water-proofing systems:

a) Waterproofing barrier system/ materials applied to the structure,
b) Structurally integral watertight system; and
c) Drained cavity system/ internal water management system.

This specification shall also be applicable for under-ground structures designed as per IS:3370, in case shown on drawings.

Structures are generally characterized as "deep" if they have more than one storey below ground level, or "shallow" if they have only a single storey below ground. This specification is applicable to both.

This specification does not cover design philosophies, site evaluations of groundwater conditions, risk assessment and options for drainage outside the structure.

2.0 GENERAL REQUIREMENTS

2.1 The materials, constructional and performance requirements for water proofing treatment on concrete structures and any special requirements as shown or noted on the drawing(s) shall govern over the provisions of this specification.

2.2 The work shall be done in accordance with this specification. In case of conflict between the clauses mentioned in this specification and those in the Indian Standards, this specification shall govern.

3.0 REFERENCES

3.1 BIS Codes

IS:456, IS:800, IS:1322, IS:1343, IS:2314, IS:2645, IS:3370, IS:3384, IS:4911, IS:5871, IS:6461 (Part 7), IS:6494, IS:12027.

3.1 Other Codes & Standards

Various international ISO, EN, ASTM, DIN standards as mentioned.

4.0 TERMINOLOGY

For the purpose of this specification, the following definitions shall apply in addition to those given in IS:4911 and IS:6461 (Part 7), listed in alphabetical order:

4.1 **Cavity drain membrane** – Dimpled, flexible, high-density polymer sheet, which can be placed against the internal face of a structure after construction and is designed to intercept water penetrating the structure and direct it to a drainage system.

4.2 **Cut-off wall** – Embedded retaining wall designed to surround and seal-off an area, to inhibit water inflow from the surrounding area.

4.3 **Damp area** – Area which, when touched, might leave a light film of moisture on the hand but no droplets of water (that is beading).

Copyright EIL – All rights reserved

4.4 **Embedded retaining wall** – Wall used to support the sides of an excavation, installed in advance and penetrating below the lowest level of the below ground construction. Within this specification the principal forms considered constitute the primary permanent wall for the below ground construction, and are taken as diaphragm walls, contiguous or secant piles (which may be installed in different configurations) or steel sheet piles.

4.5 **Ground barrier** – Impermeable barrier between the structure and the ground intended to prevent or impede the ingress of water, dampness, radon, methane and other ground gases and contaminants.

4.6 **Loading coat** – Layer of material designed to hold a Type A waterproofing material in place when resisting water pressure.

4.7 **Perched water table** – Reservoir of water in the ground maintained permanently or temporarily above the standing water level in the ground below it, and is caused by the presence of an impervious soil or a stratum of low permeability.

4.8 **Seepage** – Slow transmission of water through discrete pathways of a structure.

4.9 **Tanking** – Application of an appropriate waterproofing barrier to the walls, the base slab and, where relevant, the roof of a below ground structure, such that the entire envelope of the structure below ground is protected against water ingress. A cavity drain membrane is not considered to constitute tanking.

4.10 **Type A (barrier) protection** – Protection against water ingress which is dependent on a separate barrier system applied to the structure.

4.11 **Type B (structurally integral) protection** – Protection against water ingress which is provided by the structure.

4.12 **Type C (drained) protection** – Protection against water ingress into usable spaces which is provided by the incorporation of an appropriate internal water management system.

4.13 **Vapour check** – Membrane or other element that restricts the transmission of water vapour.

4.14 **Water-proof** – Impervious to water, also known as water-tight.

4.15 **Water-proofing** – Application of water-proof/ water-resisting materials.

4.16 **Waterproofing barrier** – Material that does not permit the transmission of free water, but might allow some water vapour permeability.

4.17 **Water-proofing system** – Materials and methods used to protect a structure from water ingress and might also provide resistance to the diffusion of water vapour.

4.18 **Water resistance** – Ability of a material to resist water penetration.

4.19 **Water Bar/ Waterstop** – Material designed to inhibit the transmission of water through joints in the structure.

4.20 **Water vapour** – Water in its gaseous state.

4.21 **Water vapour resistance** – Ability of a material to resist water vapour penetration.

Copyright EIL – All rights reserved

5.0 WATER-PROOFING PROTECTION SYSTEMS

5.1 Types of Water-Proofing Protection Systems

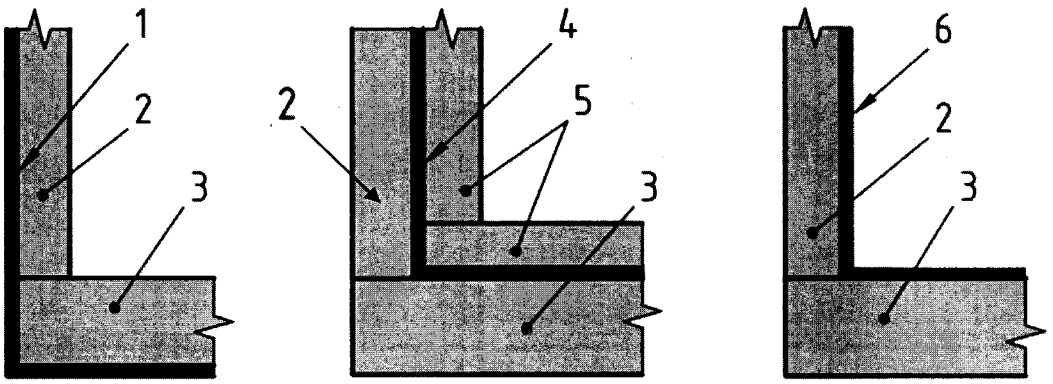
One, or a combination, of the following types of water-proofing protection systems should be selected:

a) Type A (barrier) protection;
b) Type B (structurally integral) protection;
c) Type C (drained) protection.

When making this selection, consideration should be given to:

1) the need for combined protection (see clause 5.4);
2) the water table classification and required performance level (see Table 1 & Table 2);
3) the need for continuity in the protection (see clause 5.6).

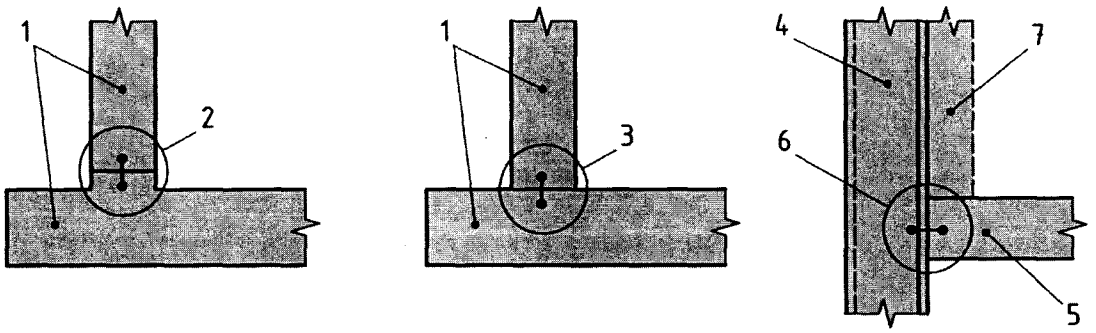
Examples of the three types of water-proofing protection systems are given in Figures 1a, 1b & 1c below:



Key to numbers:
1. External waterproofing
2. Concrete wall
3. Concrete floor slab
4. Sandwiched waterproofing
5. Loading coat
6. Internal waterproofing

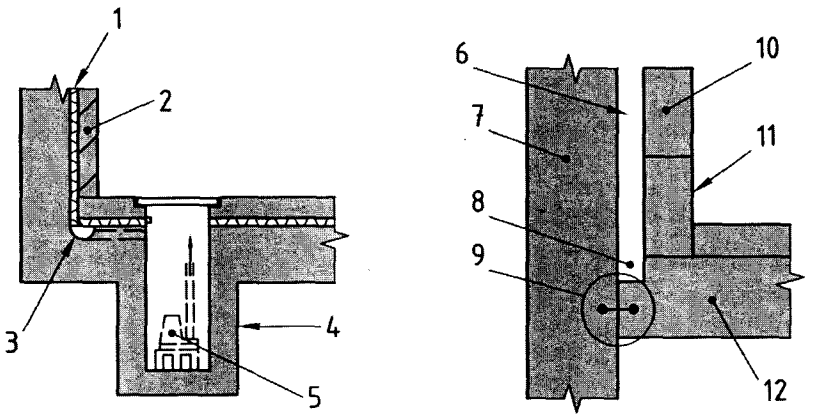
Figure 1a : Type A (barrier) protection

Copyright EIL – All rights reserved



Key to numbers:
1. Water resistant reinforced concrete wall and slab
2. External or internal (within wall) waterstop, as required
3. Waterstop required at junction between wall and slab and at all construction joints
4. Concrete/steel piled wall
5. Water-resistant reinforced concrete floor slab or slab with added barrier
6. Waterstop at junction to follow profile of wall
7. Piled wall might need to be faced to achieve desired water resistance (see Table 1)

Figure 1b : Type B (structurally integral) protection



Key to numbers:
1. Cavity drain membrane
2. Inner skin (render, drylining or walling, depending on system)
3. Maintainable drainage channel with pipe connection to suitable discharge point
4. Sump formed in-situ or preformed
5. Pump
6. Wall cavity
7. Reinforced concrete/steel pile or diaphragm wall
8. Drainage channel
9. Waterstop at junction to follow wall profile
10. Internal block wall
11. Access point(s) to drainage
12. Floor slab with integral protection and/or added membrane (internal or external)

Figure 1c : Type C (drained) protection

5.2 Range of Water-Proofing Systems

There is a range of waterproofing systems that can be incorporated in each type of waterproofing protection system and these should be assessed in accordance with clause 7, 8 and 9, as appropriate, and relevant manufacturers' data sheets to confirm that the system selected is suitable for the structure to which it is to be applied. It is noted that the

Copyright EIL – All rights reserved

manufacturer's recommendations for installation, including provision of protection, should always be followed. Similarly, recommendations for fixings where proprietary products are used should be followed.

5.3 Water-proofing Systems for Existing Structures

For existing structures, the following types of waterproofing systems should be considered, subject to their suitability for application and their ability to be repaired:

a) an internal Type A waterproofing barrier on a structure of suitable strength and stiffness, built of concrete or masonry (subject to the condition of the surface) (see Figure 1a);
b) a drained cavity to the walls and floor, using a Type C cavity drain system (see Figure 1c).

5.4 Combined Protection

Consideration should be given to the use of combined protection (i.e. Type A & Type B, Type A & Type C or Type B & Type C) where in a single system:

a) the assessed risks are deemed to be high;
b) the consequences of failure to achieve the required internal environment are too high; or
c) additional vapour checks are necessary for a system where unacceptable water vapour transmission can occur.

Although structures with Type B protection are designed to be water-resistant, additional Water-proofing systems may be applied internally or externally to control water vapour movement, where appropriate. An in-situ "liner" wall designed to provide Type B protection can be cast inside an embedded retaining wall to provide combined protection. In some cases, a fully bonded barrier might also be provided between the two elements.

Although structures with Type C protection are designed to control and manage seepage into a structure, where this is unacceptably high the water resistance of the structure should be improved prior to the installation of the Type C protection, by the application of either Type A or Type B protection.

When combining types of protection, the compatibility of the different protection types should be assessed in order to minimize the risks and negate the need for remedial measures.

5.5 Water Table Classification and Grades of Water-proofing Protection

Where assessment of the water table is undertaken, this should be classed into the following three categories, which can then be used to determine the suitability of different types of waterproofing protection (see clause 5.1).

a) High – where the water table or perched water table is assessed to be permanently above the underside of the base slab.
b) Low – where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free-draining strata.
c) Variable – where the water table fluctuates.

In certain ground conditions, external drainage systems can be used to convert the "high" and "variable" water tables to the "low" condition (see also clause 5.7)

When selecting a type of waterproofing protection system, Table 1 and Table 2 should be taken into account, in conjunction with the following:

Copyright EIL – All rights reserved

a) During the life of the structure, some degree of groundwater pressure is likely to build up against the chosen waterproofing system.
b) Cracking or defective construction joints can provide a potential path for water ingress.
c) Water ingress can occur where there is groundwater pressure. If this is not consistent with the required performance level (see Table 2):
   1) consideration should be given to the form and feasibility of remedial work;
   2) if remedial work is not possible, the design should be altered.
d) There are a number of risks associated with not carrying out planned maintenance for structures with Type C protection, e.g. pump failure (see clause 9.3).

The following should also be taken into account while selecting the type of waterproofing protection system:

1) initial capital costs compared with costs for future maintenance and any necessary upgrades;
2) the scope for testing during installation;
3) the risks associated with aggressive groundwater and other ground contaminants, which might require the use of a specific protection barrier;
4) the need or ability to provide heating and/or ventilation and the consequences arising in terms of water vapour.
5) the type of structure, i.e. building, basement, sump, etc.

Table 1 : Selection of type of Water-proofing based on Water Table Classification

<table>
<tr><td rowspan="3">Risk associated with water table</td><td rowspan="3">Water table classification (see note)</td><td colspan="4">Water-proofing protection type</td></tr>
<tr><td rowspan="2">Type A (barrier)</td><td colspan="2">Type B (structurally integral)</td><td rowspan="2">Type C (drained)</td></tr>
<tr><td>Piled Wall</td><td>Reinforced Concrete Wall</td></tr>
<tr><td rowspan="3">Low
↕
High</td><td>Low</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td>Variable</td><td>Acceptable if the variable classification is due to surface water.</td><td rowspan="2">Acceptable where:
a) The piled wall is directly accessible for repair and maintenance from inside the structure; or
b) The piled wall is combined with a fully bonded waterproofing barrier; or
c) The piled wall is faced internally with a concrete wall.</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td>High</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td rowspan="6">Measure to reduce risk</td><td colspan="5">Use combined protection</td></tr>
<tr><td colspan="5">Incorporate appropriately designed sub-surface drainage and ensure that it is maintained</td></tr>
<tr><td colspan="5">Use a fully bonded waterproofing barrier</td></tr>
<tr><td colspan="5">Lower the permeability of the main structure wall</td></tr>
<tr><td colspan="5">Use concrete with a waterproofing admixture</td></tr>
<tr><td colspan="5">Ensure that discharge systems, e.g. pumps are maintained so that the system remains effective</td></tr>
</table>

NOTE – The water table classifications are defined as follows (see also clause 5.5)
1) Low – where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free drainage strata.
2) Variable – where water table fluctuates.

Copyright EIL – All rights reserved

3) High – where the water table or perched water table is assessed to be permanently above the underside of the base slab.
4) Ground permeability might affect risk under a low or variable water table (see clause 5.5)

Table 2 : Grades of Waterproofing Protection

Grade	Example of use of structure	Performance level
1	Car parking, plant rooms (excluding electrical equipments).	Some seepage and damp areas tolerable, depending on the intended use *.
2	Car parking, plant rooms (utilities) and workshops requiring a drier environment (than Grade 1), storage areas.	No water penetration acceptable. Damp areas tolerable, ventilation might be required.
3	Ventilated residential and commercial areas, including offices, restaurants, retails shops, leisure centres, Car parking etc.	No water penetration acceptable. Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use.
4	Industrial plant areas like cable cellar, sumps in pump houses, sumps having equipments, panel rooms, etc.	No water penetration acceptable.
* Seepage and damp areas for some forms of construction can be quantified by reference to available Industry Standards.		

5.6 Continuity of Water-proofing Protection

The need for continuity in the waterproofing protection should also be considered when selecting a type of protection. In most circumstances, the protection should be continuous. In certain situations, for example, where a drained cavity is combined with an underslab membrane, discontinuity with respect to waterproofing can be acceptable subject to careful detailing and an appropriate assessment of risk. Any build up of water should be permanently controlled by a water management system.

The proposed type of foundation and its suitability for providing continuity of waterproofing (where so required) should be assessed.

Continuity can be provided in situations where the surface or structure of the wall and foundation provides uninterrupted positioning of the waterproofing measures.

In existing structures, assessment of any direct or potential discontinuity should be undertaken in order to determine the need for special waterproofing details, for example to overcome the effects of future movement.

Discontinuity of waterproofing protection might not be acceptable if there is a need to manage radon, methane and other ground gases and contaminants (see clause 5.9).

5.7 Exclusion of Surface Water

Where practicable, provision should be made to prevent or reduce percolation of rainwater into the ground. Burst water mains and leaky sewers can provide additional sources of surface water. These can affect perched water tables. The drainage behind the wall needs to be able to cope with the highest inflow rates, e.g. the burst water main, which might not be practicable in coarse-grained soils.

5.8 Sub-surface drainage

Where sub-surface drainage is deemed necessary to lower the potential for hydrostatic pressure on the waterproofing system and lessen the risk of water ingress through defects, it should be provided by one of the following methods:

Copyright EIL – All rights reserved

a) permeable granular fill;
b) no-fines or hollow block work;
c) geosynthetic drainage composite;
d) underslab drainage.

Figure 3 gives examples of the positioning of land drains, drainage channels and sub-surface drainage.

Such provisions should be made maintainable where they are used to control the level of water in a structure that does not in itself provide adequate water resistance.

Where practicable, water should be kept from prolonged contact with perimeter structure walls or base slabs by porous or open jointed land drains, combined with a geosynthetic drainage composite installed to the full height of the earth-retaining wall and laid to proper falls around the perimeter of the structure, adjacent to the wall footing and, where appropriate, beneath the slab itself.

The sub-surface system should be graded to an open outlet below the level of the lowest slab, such as to a stormwater drain protected by a pumped surcharge device or to a pumped sump, and can also provide a suitable outfall for any sub-floor drainage.

Perimeter drainage at floor level is likely to lower the groundwater table to a degree that varies with the permeability of the subsoil and the possible consequences of this (such as permanent lowering of the water table in the surrounding area) should be taken into account. Any existing system of land drains should be tested, checked and only retained if both appropriate and maintainable. Any local diversions necessary should retain the existing geometry so far as practicable with new and easily maintainable pipework.

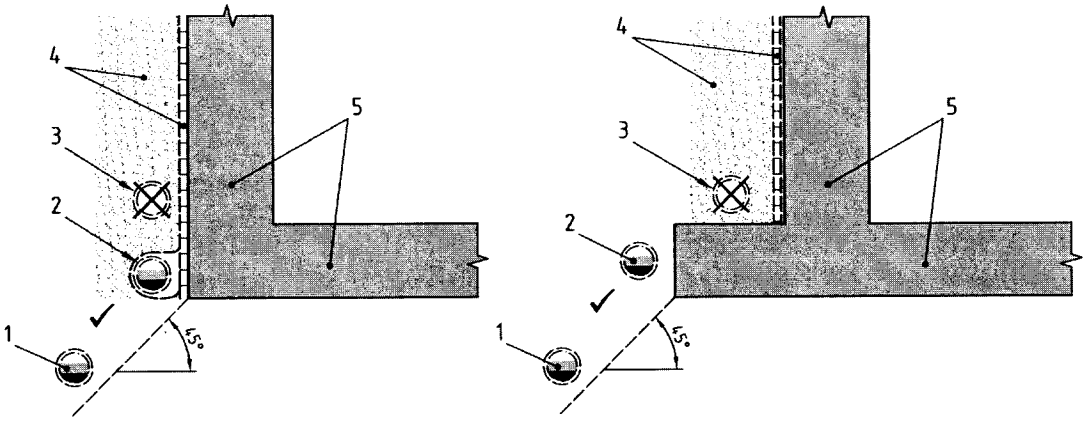
Care should be taken so that no damage is caused in nearby structures. Where deep structures are contemplated in built-up areas, groundwater lowering should not be undertaken without careful investigation in conjunction with a groundwater specialist. Perimeter walls providing a cut-off into an impervious layer or stabilization of granular subsoils by grout injection or similar alternative treatments may be considered instead.

For structures in coarse-grained soil, with variable and high water tables (see clause 5.5), the flow rates are likely to make it impracticable to pump for the design life of the structure. In these cases, a hydraulic cut-off wall into fine-grained soils is required to isolate the ground below the base slab. This enables an underslab drainage system to relieve the water pressure below the base slab.

For structures in fine-grained soil, with variable and high water tables (see clause 5.5), the flow rates are more likely to make it practical to pump for the design life of the structure. A drainage system may be provided outside the retaining wall to control the water pressures. An underslab drainage system may also be provided below the base slab to control the water pressures.

Cut-off walls are formed from diaphragm walls, secant piles or steel piles. Over the excavated wall depth remedial works can be carried out on leaky walls. This is not feasible for the length of wall below formation. Therefore, specified tolerances should be such that there is adequate intersection between piles or provision of continuous water bars at diaphragm wall panel joints and particular attention should be given to workmanship. In inter-bedded soils, relief wells may be used below formation level. The cut-off wall may also be used to reduce the flow rate and control the drawdown outside the site.

Copyright EIL – All rights reserved



a) Construction without a toe

b) Construction with a toe

Key to numbers:

1. Maintainable land drain (see clause 5.8) not to be positioned closer than a line of 45° from the underside of the slab/ blinding or with an invert above the upper surface of the floor slab
2. Measures to control water vapour might be necessary where the invert of the land drain is above the underside of the floor slab
3. Incorrect position of land drain, which can cause hydrostatic pressure on barrier leading to water ingress, if defects are present.
4. Subsoil drainage layer, where appropriate (see clause 5.8)
5. Structural wall slab and foundation slab

Figure 2 : Sub-surface drainage positioning

5.9 Ground Gases

The insertion of a ground barrier for the prevention of radon, methane and other ground gases and contaminants from entering a structure should be considered in the design, choice of the materials and installation of any waterproofing system.

6.0 GENERAL CONSTRUCTION ISSUES

6.1 Site De-watering

Where appropriate, the site should be de-watered at least until such time as the below ground structure and waterproofing is completed. On open sites, where any adjacent structures are sufficiently remote to be unaffected by groundwater lowering, de-watering or pumping from carefully arranged sumps with appropriate drainage channels should be continuous while the laying of any waterproofing barrier materials is in progress and until all loading coats have hardened and the structure has developed sufficient strength to resist the full water pressure.

6.2 Structural Elements

Forms of construction to receive below ground waterproofing protection may include the following:

a) Walls – constructed from:

i) masonry (plain or reinforced brick or block);
ii) precast concrete;
iii) in-situ concrete, either cast in form (plain, reinforced or prestressed) or embedded walls; or
iv) steel or concrete piles in embedded walls.

Copyright EIL – All rights reserved

b) Base slab – constructed from concrete cast in situ, plain or reinforced, raft or other form.
c) Roof, where applicable – constructed from reinforced in-situ concrete, precast concrete with an in-situ topping, or a steel composite slab, as appropriate.

7.0 TYPE A (BARRIER) PROTECTION

7.1 Structural Aspects

Schematic illustrations of Type A protection are given in Figure 1a.

7.2 General

Barrier protection design should be based on an evaluation of:

a) the nature of the substrate(s);
b) the likely overall and local movements that might cause distress in the waterproofing barrier;
c) the ability of the barrier system to accommodate these movements;
d) the essential characteristics of the waterproofing system, e.g. bonded/ unbonded, pre-applied/ post-applied, liquid-applied or pre-formed;
e) the need for external or internal application; and
f) the effects of environmental contaminants.

7.3 Differential Movement and Cracking

Barrier-specific properties should also be evaluated, allowing for any predicted cracking from the structure. The waterproofing barrier should be capable of providing the appropriate protection against water and water vapour without disruption or decay.

Although some barrier materials accept local strains and can accommodate a crack opening in the supporting structure, it should be noted that others might be damaged by differential movement or cracking (see Figure 3).

Care should be taken so that a load-bearing substrate is capable of supporting the barrier material, even under sustained water pressure, particularly around openings or service penetrations. A levelling or smoothing layer should be applied to masonry structures, as required.

Note – There are two issues in regard to the possible influence of cracks on barrier performance. One relates to cracks pre-existing at the time of application and the ability of the selected system to initially bridge the crack. Decisions based on the specific properties of the barrier material would be needed before deciding whether any such cracks require pre-treatment. The second issue is the ability of the selected system to accommodate cracks that might form after application.

Remedial measures to fill significant voids or openings should be undertaken as the effect of sustained water pressure forcing the barrier material into them might create a risk of failure.

7.4 Continuity of Water-proofing Barrier

The water-proofing barrier should, in most instances, be continuous around the structure. In order to maintain the continuity of the barrier, penetrations through walls or floors that are to be protected (e.g. openings for services, pipes, cables) should be avoided, wherever possible. Where it is essential to provide such openings, special treatment around the penetration should be provided and reference should be made to the manufacturer's instructions and specialist

Copyright EIL – All rights reserved

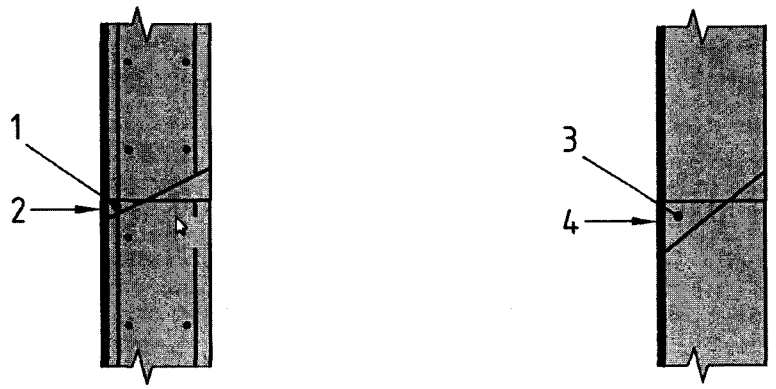
advice. Similarly, where fixings through the barrier are necessary, the manufacturer's instructions should be followed. Movement joints below ground should not be used unless unavoidable; in such cases these should be waterproofed in accordance with the manufacturer's instructions.

Where a water-proofing barrier is required for a structure supported on piled foundations, special consideration should be given to the detailing so that structural continuity is not compromised (*see* Figure 4) and reference should be made to the manufacturer's instructions.

7.5 Materials Water-proofing Barrier

The water-proofing barrier used to provide Type A protection should be installed in one of the following locations, depending on the material(s) from which it is formed:

a) On the exterior face of walls or slabs (external waterproofing);
b) On some external source of support (reverse waterproofing);
c) Within the structure (sandwiched waterproofing);
d) On the interior face of perimeter walls (internal waterproofing).



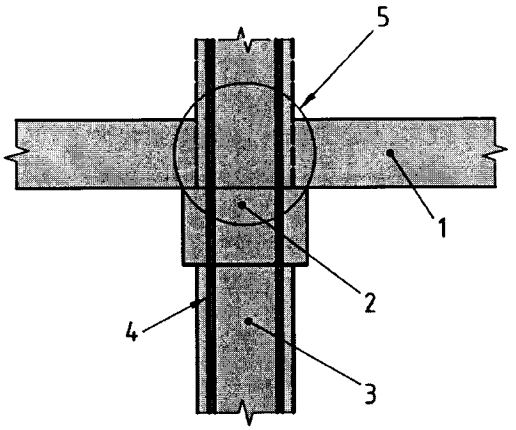
a) Reinforced (in-situ) concrete wall

b) Un-reinforced or nominally reinforced (in-situ) concrete wall

Key to numbers:
1. Stress and crack width reduced by reinforcement
2. Likely to be compatible with most waterproofing barriers
3. Stress and crack width increased by lack of reinforcement
4. Might exceed strain capacity of some water proofing barriers if wall cracks

Figure 3 : Effect of structure on applied waterproofing barrier

Copyright EIL – All rights reserved



Key to numbers:
1. Floor slab
2. Pile cap, as appropriate
3. Pile
4. Pile reinforcement
5. Slab/ pile/ pile cap to have integral protection and/or added internal or external membrane

Figure 4 : Pile to floor slab junction

Table 3 should be considered when selecting the appropriate waterproofing barrier for use. All barriers should be installed strictly in accordance with the manufacturer's instructions, including any recommendations regarding:

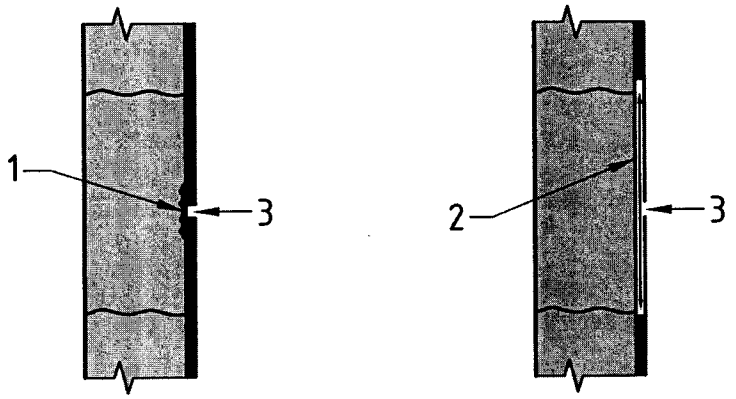
1) protection from damage, following application and curing, where the barrier is applied externally;
2) penetrations through the barrier;
3) fixings, where these are necessary;
4) application over joints in the substrate.

Table 3 : Categories of barrier materials

Sl.	Type of Barrier	Description	Application
1.	Bonded sheet membranes (see clause 7.5.1)	Pre-applied composite sheet membranes comprising HDPE/ FPO based carrier film, synthetic adhesives and protective layer that bond to concrete poured against them.	Applied before concreting of structural slabs and confined walls. Can be applied externally or sandwiched.
		Synthetic or Bitumen based sheet membrane can be either: a) Flexible, cold applied (self adhesive); or b) Hot applied (torch-on, or bonded using a hot melt bitumen adhesive) generally applied in multiple layers	Can be applied externally or sandwiched. Does not provide bonded membrane protection below slabs.
2.	Unbonded sheet membranes (see clause 7.5.2)	Flexible, synthetic sheet co-extruded membranes generally made of plasticized PVC with a signal layer in case of damage	Can be applied externally or sandwiched. Requires separation layers and protection screed below slab.
3.	Liquid applied membranes (see clause 7.5.3)	There are many types of liquid applied membranes, which included one or two part systems.	Can be applied externally or sandwiched
4.	Geosynthetic clay liners (see clause 7.5.4)	These comprise Bentonite with a single or dual carrier material, typically of Geotextile or HDPE. There are two principal forms; dry Bentonite and pre hydrated Bentonite.	Can be applied externally or sandwiched. Vulnerable to wet/dry cycling and must remain confined to be watertight.

Copyright EIL – All rights reserved

Sl.	Type of Barrier	Description	Application
5.	Cementitious crystallization slurries and powders (see clause 7.5.5)	These are applied as coating to surface of concrete walls and slabs or a solution or powder added to concrete.	Can be applied internally or externally
6.	Cementitious multi-coat renders, topping and coatings (see clause 7.5.6)	These are generally applied in multicoats or slurries and are resistant to liquid water but allow some water vapour penetration.	Can be applied internally or externally



Key to numbers:

1. Bonded barrier preventing water from tracking from a defect in the membrane to a crack/ joint in the supporting concrete wall (if the defect is coincident with a crack, the crack can be repaired with crack injection)
2. Partially bonded or un-bonded barrier allowing water to track from a defect
3. Defect in barrier

Figure 5 : Effect of bonded and un-bonded barriers

7.5.1 Bonded Sheet Membranes

Bonded sheet membranes may be pre-applied or post-applied to the structure.

Pre-applied membranes are initially attached to enabling works in a reverse waterproofing application; they subsequently become bonded to poured concrete walls and slabs using synthetic adhesive layers.

Pre-applied bonded sheet membranes shall confirm to EN 13967 "*Flexible sheets for waterproofing. Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characteristics*" and shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Water-tightness to liquid water	EN 1928	Pass
2.	Durability of water-tightness against ageing	EN 1286/ EN 1928	Pass
3.	Water vapour transmission	EN 1931	0.50 to 0.75 g/sqm
4.	Tensile strength	EN 12311	$\geq$ 8 N/sqmm
5.	Joint strength	EN 12317-2	$\geq$ 220 N
6.	Mass (per unit area)	EN 1848/ EN 1849	1.5 g/sqm
7.	Straightness	EN 1848-2	$\leq$ 75 mm per 10 m
8.	Visible defects	EN 1848-2	Pass

Copyright EIL – All rights reserved

Sl.	Property	Code/ Standard	Result
9.	Resistance to static load	EN 10730 B	≥ 15 kg
10.	Resistance to impact	EN 12691	≥ 350 mm
11.	Resistance to tear (nail shank)	EN 12310-1	≥ 600 N
12.	Resistance to fire	EN ISO 11925-2	Pass

Post-applied membranes are either cold-applied (flexible self adhesive type) or hot-applied (torch-on or bonded type).

Cold-applied (flexible self adhesive type) bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	ASTM D638	≥ 39 N/sqmm
2.	Elongation of membrane	ASTM D638	≥ 200%
3.	Elongation of compound	ASTM D412	≥ 2000%
4.	Tear resistance	ASTM D146	250 N/mm
5.	Adhesion to concrete	ASTM D1000	2.2 N/sqmm
6.	Adhesion to self	ASTM D1000	3.5 N/sqmm
7.	Puncture resistance	ASTM E154	< 300 N
8.	Water absorption @ 24 hours	ASTM D540	< 0.02%
9.	Water permeability	ASTM D638	Nil
10.	Resistance to hydrostatic head	ASTM D5385	60 m
11.	Crack bridging	ASTM C836	1.5 mm
12.	Tape strength	ASTM D638	4.3 N/sqmm

Hot-applied (torch-on or bonded type) bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	UEAtc	730 N/ 5 cm
2.	Elongation of membrane	UEAtc	65%
3.	Tear resistance	ASTM D4073	180 N
4.	Puncture Resistance	UEAtc	1.4
5.	Water absorption	ASTM D5147	< 0.15%
6.	Water vapour transmission	ASTM E96	< 0.50 g/sqmm/24h

7.5.1.1 General

A bonded sheet membrane should be firmly supported by a load-bearing structure so that external ground and water pressures are adequately resisted.

It is important that the substructure provides a satisfactory base on which to apply the membrane, and therefore concrete should be free from ridges and indentions and finished to a true and even surface, preferably with a wood float finish. Brickwork and block work should have flush joints. In all cases the manufacturer's instructions shall be closely followed regarding, substrate preparation, detailing and lap sealing.

For hot applied materials, care needs to be taken to ensure the adhesive is melted for the whole area to avoid only partial bonding of the membrane and associated risks of water tracking (see Figure 5). Cold applied materials are increasingly preferred due to ease of installation and to avoid the high risk of fire and injury.

7.5.1.2 Horizontal applications

Copyright EIL – All rights reserved

Membrane applications below foundations slabs are all effectively reverse waterproofing applications and should therefore use only a pre-applied bonded membrane slab (see Figure 5). Protective screeds, fabrics or boards should be avoided as they act as a de-bonding layer between the membrane and structural concrete and provide a path for water migration.

7.5.1.3 Vertical applications (pre-applied)

For protection of walls on confined sites against temporary works or piled walls, a pre-applied membrane that subsequently becomes bonded to the poured concrete should be mechanically fixed to the vertical substrate to provide a fully bonded application.

7.5.1.4 Vertical applications (post-applied)

For walls with external working space that allows the waterproofing to be applied after the concrete wall is poured, post-applied self adhesive membranes shall be used. Walls shall be prepared in accordance with membrane manufacturer's instructions. Careful attention needs to be paid to the compatibility and sealing of the junction between the exposed external face of the pre-applied slab membrane and the post-applied membrane.

7.5.1.5 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.2 **Un-bonded Sheet Membranes**

Un-bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Thickness	EN 1849-2	2 mm
2.	Tensile strength	ASTM D412	$\geq$ 15 N/sqmm
3.	Tear resistance	ASTM D624	$\geq$ 600 N
4.	Elongation	ASTM D412	$\geq$ 300%
5.	Puncture resistance	ASTM E154	$\geq$ 2.5 kN
6.	Water impermeability	BS EN 12393	Nil (@ 5 bar)

7.5.2.1 General

Generally made from plasticised PVC to a minimum of 2 mm thick, sheets are co-extruded in two colours to provide a signal layer to show damage for visual inspection. As the membrane is unbonded utmost care should be taken to avoid any damage. All substrates should be as smooth as possible, free from debris, and other irregularities that may puncture the waterproofing layers.

7.5.2.2 Horizontal applications

The membrane is loose laid sandwiched between layers of geotextile; the first layer is an adjustment layer to compensate for surface irregularities, the second is a separation layer from subsequent minimum 50 mm screed protection. The engineer should note that on piled foundations, the unbonded membrane is separated from the structure and will fall away in case of ground settlement leaving the membrane unsupported against water pressure.

7.5.2.3 Vertical applications

For walls the same sandwich layers are required. The membrane must be attached to the walls using mechanical fixings recommended by the manufacture to which the membrane can be spot welded. Protection to be provided by boards or masonry walls.

Copyright EIL – All rights reserved

7.5.2.4 Lap seam welding

For all applications, watertightness of unbonded membranes relies totally on lap seam welding. Adjacent membranes are joined together using specialist equipment to provide a double seam weld that allows pressure testing of joints. The pressure testing is to check the integrity of the welds for watertightness and strength and must be completed before subsequent layers are applied.

7.5.2.5 Compartmenting

To prevent water tracking as described in Figure 5, un-bonded membranes require a compartmenting system to enable the membrane to be divided into sectors and limit the free movement of water ingress around the structure. This is achieved using waterstops profiles of the same material double welded to the waterproof layer. These welds should also be pressure tested for integrity. Future repair operations can be carried out by injection of water reactive resins. For these repairs to be effective and the source of leaks readily identified, compartment sizes should be limited to no more than 150 sqm.

7.5.2.6 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.3 **Liquid Applied Membranes**

Liquid Applied membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	ASTM D412	$\geq$ 0.3 N/sqmm
2.	Elongation	ASTM D412	$\geq$ 600%
3.	Tack free time	-	15 hours
4.	Time to full cure	-	7 days
5.	Water permeability	ASTM E96	Negligible
6.	Water vapour (moisture) permeability	ASTM E96	< 25 g/sqmm/24h

7.5.3.1 General

Details on the preparation of the substrate, application rate, method and curing requirements should be sought from the manufacturer. Liquid membrane (such as for silicone based water repellents in IS:12027) performance is dependent on the applied thickness and correct mixing of components. Particular attention should therefore be paid to site quality control of mixing and application, both wet and dry film thicknesses to avoid thin patches and unmixed material.

7.5.3.2 Sandwich applications

When applied to the internal face of the structure, the membrane might need to be restrained against the effects of water pressure; in such cases, the restraining element should be firm against the applied liquid membrane. Suitable protection to the membrane should be provided.

7.5.3.3 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.4 **Geosynthetic Clay Liners**

Copyright EIL – All rights reserved

Bentonite is a natural clay mineral, which has the capacity to expand when in contact with water forming a barrier to the transmission of water and other liquids. Sodium bentonite is held between two geosynthetic (geotextile) layers. The bentonite forms an impervious seal providing it remains hydrated and fully confined. The geosynthetic layers attach to the poured concrete.

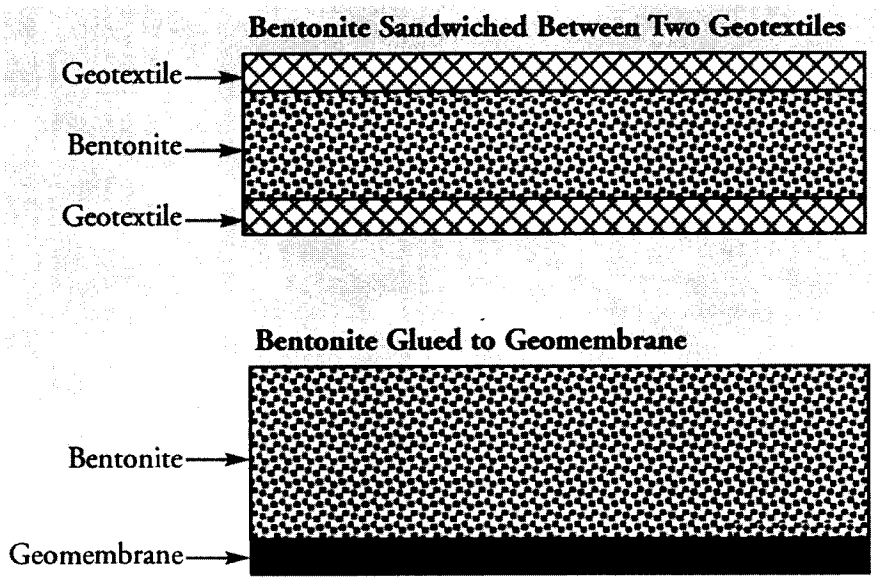


Figure 6 : Geosynthetic Clay Liners

Geosynthetic clay liners are available in two forms. Dry bentonite liners rely on activation taking place on site from the absorption of the groundwater once installed. Pre-hydrated bentonite liners are manufactured by vacuum extrusion and do not need to be hydrated on site.

Geosynthetic clay liners are generally used in environmental containment applications, e.g. solid waste landfills, mining, liquid effluent ponds, etc.

7.5.4.1 General

Bentonite-based waterproofing should only be used where the liner remains confined between two surfaces. For this reason, bentonite membranes are generally not suitable for use below slabs where ground settlement is likely, e.g. on piled foundations. The materials are suitable for new-build and refurbishment applications.

7.5.4.2 Horizontal applications

Geosynthetic clay liners can be laid onto compacted sub-base or blinding concrete. The surface can be damp, but the liner should not be laid into standing water and should be protected from wet weather to avoid premature hydration. Prematurely hydrated material should be replaced prior to concreting. The manufacturer's advice should be sought on surface preparation requirements.

The manufacturer should also be consulted regarding the continuity of the horizontal liner with the vertical liner as different options exist depending on the type of vertical application, i.e. pre-applied or post-applied.

7.5.4.3 Vertical applications (pre-applied)

Copyright EIL – All rights reserved

When pre-applied, the liner should be fixed to formwork or to secant, contiguous or steel piles or diaphragm walls and the concrete should be poured directly, confining the liner.

7.5.4.4 Vertical applications (post-applied)

When post-applied, the liner should be nailed to the reinforced concrete structure. Minimal substrate preparation is required. As the waterproofing performance relies on full confinement for the life of the structure, as soon as possible after the vertical bentonite sheeting has been applied to the walls, backfilling should take place in accordance with the manufacturer's instructions and to avoid the risk of premature hydration.

7.5.4.5 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.5 **Cementitious Crystallization Slurries and Powders**

Cementitious crystallization barriers (such as IS:2645) are blends of Portland cement, treated quartz sands and active chemicals. They are supplied in powder form and can be applied:

a) mixed with water to form slurry, which is then applied directly to the prepared concrete surface using brush, roller or spray (@ ~ 1.2 kg/sqm per coat), or
b) added to concrete mixer (@ ~1% w/w cement), or
c) dry shake over freshly laid PCC (@ ~ 2 kg/sqm)

The active chemicals combine with free lime and moisture present in the capillary tracts to form insoluble crystalline complexes which prevent water ingress.

7.5.5.1 General

Cementitious crystallization barriers should be applied to either internal or external surfaces of the concrete structure by brush, roller or spray. They are suitable for use on both new and existing structures, and do not require a loading coat.

Surfaces should be prepared (in accordance with the manufacturer's instructions) so as to have a capillary open structure prior to the application of the barrier. A capillary open structure refers to the intrinsic fine capillary tracts (pore structure) of a concrete matrix.

7.5.5.2 Horizontal applications

Cementitious crystallization barriers can be applied as single coat slurry to hardened concrete or dry sprinkle and trowel-applied to fresh concrete. They can also be applied to concrete blinding immediately prior to the placing of overlaying concrete.

7.5.5.3 Vertical applications

The barrier should be applied in a two-coat application to all vertical surfaces. Vertical surfaces should be prepared in accordance with the manufacturer's instructions. The rate and final depth of the crystals growing into the capillary channels depends on the concentration of active elements in the product, the concrete quality, the presence of free lime, temperature and humidity. All these are variable factors and change over the life of the concrete particularly as free lime is no longer available.

7.5.5.4 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

Copyright EIL – All rights reserved

7.5.6 **Cementitious Multi-coat Renders, Mortars and Coatings**

The installation of cementitious or acrylic polymer modified or elastomeric multi-coat renders, mortars and coatings should, unless otherwise advised by the manufacturer, be left until as much as practicable of the structure's dead load has been applied. The substrate should be prepared in accordance with the manufacturer's instructions prior to the application of the system.

Details on the application method and rate, mixing, number of layers/ coats and curing requirements should be sought from the manufacturer.

Existing substrates and structural elements should be assessed for suitability to withstand any increase in applied loads from water pressure.

7.5.6.1 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

8.0 TYPE B (STRUCTURALLY INTEGRAL) PROTECTION

8.1 General

For water and water vapour resistance, Type B protection relies upon the design and the materials incorporated into the external shell of the structure itself. Schematic illustrations of Type B protection are given in Figure 1b.

Concrete structures containing a waterproof admixture should be considered as having a lower degree of water/vapour transmission when the design of the concrete mix and casting of the structure is adequately supervised and the admixture is assessed and certified (see clause 8.2.1.3). Service entries are particularly vulnerable to water penetration; where they cannot be avoided, they should be carefully detailed, incorporating sealing, to minimize the risk of water ingress.

8.2 Materials for Structurally Integral Protection

8.2.1 Concrete

8.2.1.1 General

Reinforced concrete structures may be designed and detailed specifically to minimize water ingress with no additional protective measures. Concretes meeting minimum design requirements for structural use and durability in the ground, and properly placed and compacted, are likely to have good resistance to the transmission of water in liquid form. A degree of resistance to water vapour transmission is also achieved dependent on section thickness. The pattern of any seepage encountered is often associated with poor joints, cracks or other discontinuities such as service penetrations.

The following factors are considered as being of particular importance in achieving a water-resistant concrete structure and thus should be taken into account:

a) the design of the structure (general and detailed), and the specification of materials;
b) the quality of workmanship in preparing and placing concrete;
c) curing;
d) site organization;
e) the condition of the formation, i.e. the formation should be clean with no running water; material storage;

Copyright EIL – All rights reserved

f) the close-fitting of formwork, the fixing of reinforcement(s) and the preparation of joints.

Crack widths in concrete should be controlled by using the appropriate design, mix specification, detailing, construction supervision and curing (especially in relation to temperature).

The effects of residual moisture ingress (water or water vapour) may be minimized by the provision of appropriate internal environmental design and control mechanisms.

When selecting applied internal finishes, advice should be sought from the manufacturer. Moisture content and relative humidity should also be considered.

8.2.1.2 Reinforced and prestressed concrete (in-situ or precast)

Structures in reinforced or prestressed concrete should be designed and constructed in accordance with IS:456 and IS:1343.

8.2.1.3 Concrete containing waterproofing admixtures

Water-proofing admixture shall confirm to IS:2645. Manufacturers should be consulted as to the performance of a specific waterproofing admixture in reducing the risk of water penetration through a crack, possibly under considerable hydrostatic pressure. Potential seepage locations, such as penetrations and joints, would typically be addressed by design (for example waterstops; see clause 8.2.1.4).

Waterproofing admixtures should preferably be used in conjunction with other waterproofing components supplied by the same manufacturer, e.g. waterstops, sealants.

8.2.1.4 Water bars/ Waterstops

The principal types of waterstops can be classified as the following:

a) Passive sections:

   1) Rubber or flexible polyvinyl chloride (PVC) extruded profiles cast into the concrete on both sides of the joint, either at the concrete surface or mid-depth of the concrete section, to form a physical obstruction to water transmission;
   2) Steel water bar strips placed mid-depth of the concrete section to form a physical obstruction to water transmission.

b) Active or hydrophilic strips or crystallization slurries:

   1) Preformed profiles of materials or sealant composition applied to the concrete joint at depth in the section. The materials swell or give rise to crystal growth on contact with water providing an enhanced obstruction. They can used as a sole material or in a composite product with passive waterstop sections;
   2) Post-injected systems.

c) Permeable hose or other sections that are fixed to the construction joint surface before casting the second pour, to facilitate the injection of a specialist sealing resin into the joint, when required.

Waterstops should be used to provide enhanced resistance to water transmission at joints in the concrete structure, e.g. at construction or day-work joints, services or other penetrations (see Figure 1). The positioning of the waterstop(s) (external and/ or internal) should be appropriate

Copyright EIL – All rights reserved

for the method of construction and the level of risk. Particular attention should be given to the use of waterstops at movement joints (see clause 7.4).

The specifier should be satisfied that waterstops have been tested and certified for the application, service conditions and groundwater chemistry proposed.

Where centre-bulb waterstops are used, robust methods of fixing should be used to keep the components in place during concreting operations. Correct orientation should be provided to facilitate adequate compaction of the concrete around any internal components and to avoid creating paths for subsequent water ingress.

8.2.2 Steel

Steel piles in either sheet (IS:2314) or tubular form may be used as the permanent structural wall in cases where the pile clutch interlock system between individual sections can be adequately sealed. Soldier piles formed from H or I sections may also be used with suitable lagging. Steel structures should be designed and constructed in accordance with IS:800.

8.3 Embedded Retaining Walls

8.3.1 General

Construction for deep structures may be either top-down or bottom-up, or a combination thereof. The construction method should, as dictated by the ground conditions and site constraints (including the proximity of buildings on adjacent sites), determine the use and type of embedded piled walls, which may be of concrete or steel pile, or diaphragm walls.

For all types of embedded retaining wall, the requirements for water resistance should be clearly specified. In particular, the acceptability of running or dripping water (seepage) and the extent to which any damp areas are tolerable should be considered and specified, as appropriate for the required grade of waterproofing protection.

For all embedded retaining walls, whether concrete or steel, the joint between the base slab and the wall should be precisely detailed to achieve structural continuity consistent with the design. This junction should be viewed as a three-dimensional arrangement, such that all potential water paths can be identified and detailed. The joint should be carefully detailed and waterstops should be attached to, and follow, the profile of the wall in accordance with the manufacturer's instructions.

Grouting tubes may also be installed within a clean flush joint so that remedial grouting can be undertaken, if necessary. Attempts to install grout tubes that maintain intimate contact with convoluted joints might be unsuccessful; in this situation, a hydrophilic strip bonded to the joint with adhesive might be more suitable (see also clause 5.5)

8.3.2 Concrete Retaining Walls

Piled and diaphragm retaining walls should conform to the general requirements. The water penetration through well-formed walls using these techniques is normally limited to, and controlled by, the vertical joints rather than the flow through the concrete elements and there is thus little benefit in designing concrete piled and diaphragm walls in accordance with the higher tightness classes specified.

Where secant pile retaining walls are used, specialist advice should be obtained as to the appropriate system and construction method for the project. The joints between diaphragm wall panels can be enhanced by the incorporation of water bars, where the performance requirements justify it. Such water bars can be effective at restricting water ingress via

Copyright EIL – All rights reserved

transverse flow through the wall section but further attention might be necessary to deal with water flowing up the wall joints inboard of the water bar location.

8.3.3 Steel Retaining Walls

The performance level of water tightness should be specified. This may be achieved by the application of an appropriate sealing system(s) to the clutch interlocks, using one of the following systems:

a) active (hydrophilic) systems, pre-applied or, if essential, applied under shelter and tightly controlled conditions on site; or
b) passive (hot-installed bituminous product) systems; or
c) welded clutches.

The system selected should be able to provide the specified performance and be consistent with the method of installing the piles. The manufacturer's instructions should be followed to achieve the necessary resistance to seepage.
In some instances, welded clutches might be used in addition to the systems specified in a) and b).

For integral protection, sheet pile interlocks should be welded or sealed with a hydrophilic material.

Sealing welds along the interlock should be capable of accommodating any movement that might take place. The welding process should be selected to suit the environment to which the welds are exposed and the site conditions in which welding occurs.

Steel sheet pile interlocks can be seal-welded after installation to provide watertight structural walls.

The connection to the base slab should cater for any uplift forces in addition to providing a robust barrier to water ingress. Horizontal sealants should be provided at the junction between the base slab and the perimeter wall using active or passive methods.

Where possible, sheet piles should be shop-welded and subsequently driven in sets of two or three, thus reducing the extent of site welding required. If welding is undertaken on site, only the exposed length of the sheet piles is treated. Appropriate working conditions need to be provided and the piles should be driven within acceptable deviations to form the joint.

Failure to prepare the surfaces appropriately increases the risk of porosity in the welds, with reduction in the degree of water resistance over time.

9.0 TYPE C (DRAINED) PROTECTION

Type C waterproofing protection manages water that penetrates the external shell of a structure, by collecting it in a cavity formed between the external wall and an internal lining/ wall. There is permanent reliance on this cavity to collect groundwater seepage and direct it to a suitable discharge point, for example, drains or a sump for removal by gravity drainage or mechanical pumping.

New construction generally incorporates a cavity drain membrane. However, the use of other products and techniques, such as drained voids constructed in masonry, can also be considered. Traditionally, the cavity in floor construction has been formed by the use of either no-fines concrete or ceramic tile systems. These are rarely used in new construction, but might be encountered when refurbishing existing structures. Schematic illustrations of Type C protection are given in Figure 1c.

Copyright EIL – All rights reserved

9.1 Structural Aspects

The outer leaf of the exterior wall should be capable of controlling the quantity of water that can pass through it, in order not to exceed the drainage capacity of the system. Water entering a drained cavity system is regulated by the structure, so defects that might result in unacceptable leaks should be remedied before the system is installed.

9.2 Cavity Drain Systems

Cavity drain systems do not change the loadings due to water on an existing structure, other than where remedial measures are taken to control water ingress.

9.2.1 Cavity Drain Systems with Membranes

9.2.1.1 Cavity drain membranes

Where cavity drain membranes are used, the membrane forms a permanent cavity between the external elements of the structure and the internal wall/ floor finishes. Such cavities vary in width, depending on the stud height or profile of the membrane, but are usually up to 20 mm.

Cavity drain membranes should be used in accordance with the manufacturer's instructions. In particular, the stud height or profile of the membrane should be selected in conjunction with the manufacturer's data and after considering the external hydrostatic pressure, the porosity of the structure and the predicted rates of water ingress though the structure's external fabric. Cavity drain membranes can be used on surfaces that have been contaminated with impurities. However, in these situations, consultation should be undertaken with the local environmental agency regarding discharge from the system.

Before a cavity drain membrane is laid or fitted on walls and floors constructed of new concrete, the concrete surface should be treated to reduce the risk of leaching of free lime or mineral salts and to avoid the obstruction of the drainage system.

9.2.1.2 Floor cavities

Where the floor cavity incorporates perimeter channels that discharge into a sump(s), both the channels and the sump(s) should be cleaned before, during and after installation of the membrane to allow uninterrupted drainage (see also clause 9.3). Before the cavity drain membrane is laid:

a) the floor should be flood tested to confirm that all water runs freely to the points of collection; and
b) the base slab should be cleaned to remove all debris that might cause blockages.

Sections of the membrane(s) laid across the floor should be jointed and sealed. Once laid, the membrane should be protected against damage caused by following trades. The membrane should be inspected for damage and any defects should be remedied before floor finishes are applied.

The cavity drain membrane may be covered with a variety of floor finishes dependent on the design requirements of the structure.

9.2.1.3 Wall cavities

The wall cavity should be constructed so that it remains free draining at all times.

Copyright EIL – All rights reserved

Where the wall cavity incorporates perimeter channels that work in conjunction with a drained floor cavity, the drainage, which is common to walls and floors, should conform to 9.2.1.2.

Before the cavity drain membrane is fitted, in situations where the cavity is to be constructed or installed over existing walls, all wall coverings that might decay, or become loose or friable, should be removed.

If they are not removed, such wall coverings can cause the blockage of the cavity or drainage channels and impede free drainage. Sections of the membrane(s) fitted to the walls should be jointed and sealed ensuring adequate laps.

The cavity drain membrane may be covered with a variety of wall finishes dependent on the design requirements of the structure.

9.2.2 Cavity Drain Systems without Membranes

Where a drained cavity is formed by a masonry cavity wall, the inner leaf should be either built off a concrete upstand, constructed integrally with the slab, or built of engineering bricks to a minimum of 150 mm above channel level. Materials should be selected which are appropriate to the environment on both faces. Where the cavity is constructed against an embedded retaining wall, allowance should be made for the permitted construction tolerances, in order to maintain the necessary channel width. Care should be taken during construction to keep the cavity clear of debris and mortar droppings.

In order to allow free drainage from the channel and access for maintenance, it is recommended that this channel is laid nominally level but with adequate access points for maintenance through the inner leaf of the cavity wall. Where possible, the drainage channel should be formed within the depth of the slab. Where this cannot be achieved, the detailing should be such that water cannot migrate from the cavity across the slab.

A drained cavity to the roof should be considered either as part of the base construction or, where necessary, as part of the remedial measures.

9.2.3 Cavity Ventilation

It is not usually advisable to ventilate the cavity; however, it might be necessary in certain circumstances, such as where there is a potential for radon, methane or other ground gases and contaminants to be present. In these circumstances, specialist advice should be sought during the design phase.

9.3 Maintenance and Commissioning

9.3.1 Design

In order to maximize the long-term integrity and effectiveness of a waterproofing system incorporating Type C protection, the waterproofing system should be designed to be maintainable. Access points that allow routine maintenance of channels and outlets should be incorporated into the design of the waterproofing system.

9.3.2 Installation and Inspection

Immediately after the installation of a cavity drain system, drainage channels and sumps should be cleared out and tested. Pumping devices should be checked, tested and fully commissioned in accordance with the manufacturer's instructions.

Copyright EIL – All rights reserved

In circumstances where pumps are running for long periods of time, or where the system is subject to silting or the deposition of free lime, more frequent servicing might be necessary.

The servicing requirements for the waterproofing system should be clearly set out in the documentation supplied by the designer to the client, including the need for regular planned maintenance of the drainage and/or pumping systems not less than once a year. The client should be informed that any failure to adhere to the maintenance schedule could result in a failure of the waterproofing system.

10.0 REMEDIAL MEASURES

10.1 General

There are many causes of seepage in new and existing structures, principally poor design and/or specification, defective materials, defective workmanship, deterioration of the structure, or a change in the external environment (for example, rising groundwater or locally leaking sewers or water mains). Adjacent construction works can also affect the pattern of groundwater flow and surface water run-off. A number of these factors can also combine to cause problems.

Before any remedial action is taken, defects should be diagnosed to determine the cause and extent of failure. The correct diagnosis of the fault is of vital importance, to establish whether faults exist with the system as a whole, or whether faults are localized (*see* also clause 4.2). Where remedial work is required, the following measures should be considered:

a) the installation of a tanking system or a drained cavity;
b) the installation of external drainage; or
c) localized works to the fabric of the structure, such as:
   1) pressure or vacuum grouting (see clause 10.2);
   2) crack sealing with resin or cementitious mortar (see clause 10.3);
   3) crack filling by pressure or vacuum injection (see clause 10.4);
   4) the replacement of locally defective material (see clause 10.5).

These should be considered irrespective of whether planned remedial treatment has been included as a contingency measure in new construction or for maintaining or improving the internal environment of an existing structure.

If the location of a defect in an existing external membrane can be established, it is possible in some instances, where access is not a problem, to expose the membrane and carry out repairs by excavating locally, adjacent to the walls of the structure.

Where the internal membrane is fully bonded to the substrate, the defect is generally located at the position where dampness or seepage occurs. Once the internal finish has been removed to reveal the defect, the membrane can be locally repaired using compatible materials.

Where the internal membrane is only partially bonded to the substrate, the defect might be more difficult to locate. Even if the defect can be found, further migration to other defects can follow. In such cases, consideration needs to be given to removing and replacing the entire membrane with a new bonded system.

Locating defects in a sandwich system can be particularly problematic and localized repair is seldom viable. Where access is not feasible, grouting in accordance with 10.2 and 10.4 ought to be considered.

10.2 Pressure or Vacuum Grouting

Copyright EIL – All rights reserved

Grouting to cut off seepage might repair isolated defects. However, it should be noted that, where a large number of defects occur, it is more effective to prevent water ingress by other methods. There are a number of grouting materials available for use based on:

a) cement;
b) bentonite;
c) chemical (example, acrylic);
d) resin (example, epoxide, polyester and non-expansive polyurethane);
e) expansive polyurethane;
f) modified rubber latex.

Holes should be drilled through the walls and floor of the structure adjacent to the defect (sometimes inclined to intersect seepage paths) and the pressure or vacuum grout should be driven into the material behind to gel and seal the leak. As grout selection and application are specialized techniques, advice should be sought from manufacturers and experienced applicators prior to use.

Often more than one phase of grouting is needed as the seepage might be moved to defects elsewhere in the structure or higher up in the walls.

Care should be taken when grouting larger areas to avoid blocking any external drainage systems.

10.3 Crack Sealing with Resin or Cementitious Mortar

Where structural continuity is not required and there is no hydrostatic pressure against the adhesion of the repair, cement grout, neat cement grout or low viscosity latex emulsion should be brushed into cracks and porous areas to seal them against water ingress. Suitable materials include:

a) cementitious slurry;
b) cement/silica-fume slurry;
c) polymer-modified cementitious slurry;
d) polymer resin;
e) cementitious crystallization systems;
f) epoxide putty.

10.4 Crack Filling by Pressure or Vacuum Injection

Pressure or vacuum injection can be used to fill and seal cracks and joints, particularly at kickers where a waterstop has become displaced and cutting out and replacement is not practical.

Porous areas of concrete can sometimes be injected successfully, but severe honeycombing might require the defect to be cut out and replaced.

Injection techniques have been used to seal very fine cracks.

The selection of grout systems should take into account:

a) the likelihood of structural movement;
b) the nature and size of the defect;
c) the moisture content of the substrate;
d) the temperature of the structure;
e) the injection method to be used.

Copyright EIL – All rights reserved

Where the wall or floor is expected to remain damp, a water-tolerant grout should be used. Suitable materials include:

1) epoxy resin;
2) polyurethane resin;
3) acrylic resin;
4) polyester resin;
5) styrene-butadiene rubber (SBR) and acrylic emulsions;
6) polymer-modified cementitious grouts.

10.5 Replacement of Locally Defective Material

Where a relatively small number of well-separated defects in the walls or floors result in seepage (e.g. poorly compacted concrete), adequate repairs can be achieved by cutting out and replacing the defective area. Achieving a water-resistant joint between the substrate concrete and the repair material is the most critical feature of this method. The installation of temporary drainage points, in the area to be repaired, might be necessary in some situations to control the seepage. However, some repair materials are formulated for application where running water is present.

Surface preparation and the compatibility of the physical and chemical properties of the repair material are important. Many types of repair materials are available, including:

a) concrete compatible with that used in the original construction;
b) polymer-modified cementitious mortars and concrete;
c) polymer-based mortars;
d) sprayed concrete.

The properties of the repair material should be selected to match the substrate as closely as possible, particularly the shrinkage and thermal behaviour. Specialist advice should be obtained to select the most suitable concrete repair system and to specify the required performance of the material to suit the size, depth and location of the area to be repaired.

Where proprietary mortars or concretes are used, they should be applied in accordance with the manufacturer's instructions, and any repair should be undertaken by experienced contractors.

11.0 TESTING

11.1 Liquid retaining structures shall be tested strictly in accordance with IS:3370 for water tightmess in addition to the structural tests as mentioned in EIL Standard Specification No. 6-68-0004. The total maximum drop in water surface level shall not exceed 6 mm in 24 hours in case of covered reservoirs and 12 mm in 24 hours in case of open reservoirs.

11.2 If the test proves that the structure is defective, the contractor shall rectify/ repair the same at his own cost as per the approved scheme as agreed to by Engineer-in-charge. The required structure shall again be tested as per clause 10.1 above. If the structure is still not found to satisfy the acceptance criteria, the same shall be dismantled and rebuilt.

11.3 All testing after construction and remedial treatments shall confirm to the provision of IS:6494.

11.4 Backfilling around underground structures shall be allowed only after the test results are found satisfactory by the engineer-in-charge.

Copyright EIL – All rights reserved

12.0 GUARANTEE

The Contractor shall guarantee the water tightness of the structure for a period of 10 (ten) years after the certified completion and handing over of the same. The water-proofing application work shall be executed by a firm of specialists in the trade, approved by the Engineer-in-charge.

13.0 PAYMENT

This clause shall apply to item rate tender only.

13.1 Payment for water-proofing treatment shall be based on actual surface area in square metres to be water-proofed. The contractor shall include in his rate all allied works viz. cleaning, preparing the surfaces, cutting groves and filling with cement mortar, rendering, scaffolding, drying etc. with all labour and materials complete.

13.2 No separate payment shall be made for testing and report making which is deemed to be included in the quoted concrete rate including cost of tests, all appliances and rectifications, if any.

13.3 If the test proves that the structure is defective, the contractor shall develop and execute with the approval of Engineer-in-charge, suitable methods for making the structure, water-tight/ leak-proof at his own cost. Even after this if the test fails, the contractor shall have to dismantle and rebuild the structure within the specified time schedule at his own cost.

13.4 Cost of initial and subsequent testing, inclusive of cost of water, shall be borne by the Contractor. The Contractor shall make his own arrangement for filling as well as emptying the reservoir after the completion of test and no payment shall be made on this account.

Copyright EIL – All rights reserved

वास्तुकला कार्या- के लिए मानक विनिर्देश सामान्य टिप्पणियाँ

STANDARD SPECIFICATIONS FOR ARCHITECTURAL WORKS (GENERAL)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
7	08.02.22	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	20.03.17	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	PD	JS/ JKB	R. SRIVASTAVA	R.NANDA
5	15.03.12	REVISED AND ISSUED AS STANDARD SPECIFICATION	PD	SD	JKB	D. MALHOTRA
4	21.03.07	RENAMED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVE
3	11.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
BIS	:	Bureau of Indian Standards

Structural Standards Committee

Convener: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 DEFINITIONS 4
3.0 CODES & SPECIFICATIONS 4
4.0 MANUFACTURER 4
5.0 CONFLICTS & CONTRADICTIONS 5
6.0 MATERIALS 5
7.0 WORKMANSHIP 6
8.0 PACKAGING, SHIPPING, DELIVERY & STORAGE 6
9.0 SUBMITTALS 6
10.0 MEASUREMENT 7

Copyright EIL – All rights reserved

1.0 GENERAL

This specification establishes and defines various aspects of specifications of Architectural works such as codes, references, manufacturer, conflicts and contradictions, materials, workmanship, packaging, shipping, delivery and storage, testing, submittals and measurement etc. and shall be applicable for all the Architectural specifications.

2.0 DEFINITIONS

2.1 Contractor

The party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of the Project. Contractor includes its approved Manufacturers, Vendors, Suppliers, and subcontractor's. Requirements of this specification shall be enforced at all levels of the Contractor's design, engineering, procurement, construction process.

2.2 Subcontractor

The party which is engaged by the "Contractor" and carries out all or part of the design, engineering, procurement, construction of the system (s).

2.3 Manufacturer/ Supplier/ Vendor

The party which manufactures and/or supplies equipment, materials, technical documents/ drawings and services to perform the duties specified by the "Contractor".

2.4 Shall

Indicates a mandatory requirement.

2.5 Should

Indicates a strong recommendation to comply with the requirements of this document.

3.0 CODES & SPECIFICATIONS

3.1 Codes and standards as indicated in the specifications form a part of specifications. When an edition date is not indicated for a code or standard, the latest edition and addendum or amendment in force at time of contract award shall apply.

3.2 Alternate codes and standards meeting the requirements of the referenced codes and standards may be used with the approval of the competent authority.

3.3 It shall be Contractor's responsibility to be, or to become, knowledgeable of the requirements of any referenced codes and standards.

4.0 MANUFACTURER

4.1 Name of the Manufacturers of products included in the tender documents are the acceptable Manufacturers for the particular product provided the products meet the requirements specified in the tender documents. Products by other Manufacturers which are of equal quality and performance and meet the specified requirements may be considered for approval upon review of information as required and submitted to the competent authority. However the contractor to ensure that the time schedule is adhered to in any case.

Copyright EIL – All rights reserved

4.2 Product data sheet, specifications, performance data, installation instructions and other recommendations of such approved Manufacturers also form part of the specifications provided that these are not in contradiction with other specified requirements.

4.3 Materials, installation method and other requirements for execution of any item if required by Manufacturer's installation instructions, recommendations and requirements shall also form part of the specifications whether specified or not.

4.4 In case, name of particular Manufacturers are mentioned in specification/ drawing/ item descriptions etc. the purpose is to set example of desired quality of the product. Product of other manufacturers having similar quality (in the opinion of Engineer- in- Charge) may also be considered.

5.0 CONFLICTS & CONTRADICTIONS

5.1 Specifications, Scope of Work, Schedule of rates and drawings for a particular Tender shall be read in conjunction with each other. In case of conflicts/ contradictions amongst them, the clarification shall be obtained from the Engineer-In-Charge whose decision shall be final & binding. Following procedure shall be followed for the necessary clarification.

5.2 Item description shall prevail over specifications for item rate tenders when provisions therein are different from those in specifications. Whenever any requirement is not covered in item description but are covered in specifications, the specifications shall be followed in addition to the requirements of item description .No extra payment shall be made to the Contractor for executing such item as per specification.

5.3 Whenever drawings call for requirements different from or additional to those in item description and specification, the decision of the Engineer-In-Charge shall be obtained in writing. However no extra payment shall be made to the Contractor for executing any work incorporating requirements additional to those in item description and specification but covered in applicable drawings or standards attached to the tender.

5.4 Any conflict between drawing, item description, specification etc. shall be got resolved by the Contractor from the Engineer-In- charge in writing before execution.

6.0 MATERIALS

6.1 All materials shall be of standard quality conforming to the specifications and other requirements of tender document and shall be obtained from the approved Manufacturer.

6.2 The Contractor shall get the samples of materials approved by the Engineer-In-Charge before ordering & procurement. Such approved samples shall be properly marked/ identified as approved sample and shall be kept as record for future reference.

6.3 Contractor shall arrange the samples along with necessary documentation, test certificates etc. so that the compliance with the specifications etc. can be ascertained.

6.4 Contractor shall arrange mock-ups if asked by the Engineer-In- Charge to facilitate approval of the samples.

6.5 Samples shall be approved subjected to compliance with specifications etc. Finishing, colour, texture and other aesthetic aspects shall also be considered for finishing/ interior items.

6.6 Contractor shall get the materials tested from approved test house if and as asked by the Engineers-In-Charge & submit the test certificate at his own cost for which no extra payment shall be made to him.

Copyright EIL – All rights reserved

6.7 The Engineer-In-Charge shall have the right to reject all or any of the materials intended to be used and such materials shall be immediately removed from the site by the Contractor at his own cost without any claim for compensation etc. due to such rejection.

7.0 WORKMANSHIP

7.1 Workmanship shall be in accordance with relevant codes or in accordance with Manufacturer's recommendations as approved by the Engineer-in-charge if not specified otherwise.

7.2 All work shall be executed to the complete satisfaction of the Engineer-in-charge. Necessary rectification etc. shall be done by the Contractor at no extra cost for works not accepted by the Engineer-in-charge until the work is accepted by him.

7.3 All works shall be done by qualified Contractors who have adequate equipment and skilled workers. All specialized items of work (e.g. Aluminium Doors and Windows, Waterproofing, Underdeck and Overdeck Insulation, roof sheeting/ cladding, False ceiling, False Flooring, Partitioning and Panelling, Expansion joint sealing, Fire Check Doors, Structural Glazing, Aluminium Composite Panels etc.) shall be got executed by the Contractor only through authorised applicators/ sub contractors of approved Manufacturer/ vendor or as approved by the Engineer-In-Charge.

7.4 All precaution and protection shall be taken during & after completion of work to prevent damages to work being done and other works. Any damages done shall be rectified by the Contractor at no extra cost.

7.5 Work area shall be cleaned after completion of each work and shall be kept clean and protected till final acceptance by the competent authority.

8.0 PACKAGING, SHIPPING, DELIVERY & STORAGE

8.1 All material shall be delivered in Manufacturer's original package bearing the name of the Manufacturer, product colour and pattern name, identification number and other related information.

8.2 All materials shall be stored, preserved and protected to safeguard against all adverse environments such as humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray and sea water.

8.3 Specific requirement of packaging, shipping, storage and preservation and safety of materials/ items if any as per Manufacturer's recommendation shall also be ensured by Contractor.

8.4 Materials damaged in handling and storage shall not be used. In the event that any material for use deteriorates and become unusable due to inadequate and poor storage they shall be removed from site as instructed by Engineer-in-charge and replaced at the Contractor's expenses.

9.0 SUBMITTALS

If not mentioned otherwise, Contractor shall submit the following.

9.1 Samples

9.1.1 Samples of materials, components, accessories and complete range of finishing/ shades/ colours for verification as well as acceptance of pattern, colour and finish as applicable.

Copyright EIL – All rights reserved

9.1.2 Samples shall be re-submitted until approved. Approved samples shall be retained as mentioned in clause 6.0

9.2 Test and BIS Certificates

9.2.1 All applicable tests shall be conducted by the Contractor at no extra cost. Test Certificates shall be submitted for review/ approval of the Engineer-in-charge.

9.3 Shop/ fabrication Drawings

9.3.1 Shop or fabrication drawings indicating large scale details, lay-out, connections, anchoring, fastening, bracing, finishes etc. as applicable for review/ approval.

9.3.2 These drawings shall be prepared to achieve the desired design and quality of work expressed in design, drawings and specifications etc..

9.4 Product Information and Manuals

A. Product information (Technical).
B. Manufacturer's recommended installation instructions.

9.5 List of applicators/ Sub contractors

Contractor shall submit list of applicators/ sub contractors of specialized items of works along with there past track report for review/ approval before execution of such items.

9.6 Maintenance manuals

In case of specialized items, contractor shall submit the Operation & maintenance manual including guarantee/warranty card and its validity document.

9.7 Deviations

9.7.1 Deviations if any shall be raised and processed in accordance with conditions mentioned in the tender document.

9.7.2 Deviations shall be submitted before procurement and execution. Procurement, execution and other related works shall be taken up only after the deviation is accepted by the Engineer-In-Charge. Post facto approval of deviation shall not be entertained and Contractor himself shall be responsible for any procurement/ execution of any work or any action which are deviations and for whose, prior approval is not obtained.

9.8 Sample mock-up work

Contractor shall prepare mock-up work of specialized items or systems as specified or asked by the Engineer-In- Charge. Mock-up shall include the complete item or system with all associated items.

10.0 MEASUREMENT

Mode of measurement is generally specified in each Specification. Whenever mode of measurement is not specified, IS: 1200 shall be applicable.

Copyright EIL – All rights reserved

फ़र्श के परिष्करण के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR FLOOR FINISHING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	GM (E)	Standards Bureau Chairman
					Approved by		
7	01.06.20	REVISED & ISSUED AS STANDARD SPECIFICATION	Anish Mahala	Samir Das	Rajanji Srivastava		Sunil Kumar Saxena
6	03.03.15	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	SD	JKB	PKM (Addn GM)	S CHANDA
5	06.07.10	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS	JKB	VK	N. DUARI
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR		V. CHATURVEDI
3	12.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ		AS
2	16.03.94	REVISED & ISSUED AS STANDARD SPECIFICATION	JS	JS	AKG		AS

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
IS	:	Indian Standards
PVC	:	Polyvinyl Chloride

Structural Standards Committee

Convener: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 CEMENT CONCRETE FLOORING 5
3.0 HEAVY DUTY CEMENT CONCRETE FLOORING 6
4.0 CEMENT PLASTER SKIRTING 6
5.0 CERAMIC & VITRIFIED TILE FLOORING 7
6.0 ACID OR ALKALI RESISTANT TILES 9
7.0 MARBLE STONE FINISH 10
8.0 KOTA STONE FINISH 12
9.0 GRANITE STONE FINISH 15
10.0 PVC FINISH 17
11.0 ABRASION RESISTANT EPOXY FLOOR COATING SYSTEM 18
12.0 ABRASION & IMPACT RESISTANT POLYURETHANE CONCRETE FLOOR COATING SYSTEM 20
13.0 CHEMICAL RESISTANT NOVOLAC EPOXY FLOOR COATING SYSTEM 23
14.0 CHEMICAL RESISTANT NOVOLAC EPOXY WALL COATING SYSTEM 26
15.0 MEASUREMENTS 28

Copyright EIL – All rights reserved

1.0 GENERAL

This specification covers technical specification of various kind of floor finishes/ floorings to be used in building works.

1.1 Standards

Reference shall be made to the following Indian Standards for any further information etc. not covered in this specification.

IS: 2571	Code of practice for laying in situ cement concrete flooring.
IS: 3461	Specification for PVC asbestos floor tiles.
IS: 3462	Specification for unbaked flexible PVC flooring.
IS: 4441	Code of practice for use of resin type chemical resistant mortars.
IS: 4443	Code of practice for use of resin type chemical resistant mortars.
IS: 4457	Acid and/or alkali Resistant tiles.
IS: 4631	Code of practice for laying of epoxy resin floor toppings.
IS: 5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS: 5491	Code of practice for laying of in-situ granolithic concrete floor topping.
IS: 13630 (Part-1 to 15)	Methods of Testing of ceramic tiles, methods of test, sampling and basis for acceptance
IS 13712	Specification for ceramic tiles; definition, classification characteristic and marking.
IS 15622	Pressed ceramic tile - specification

Note: Wherever, codes other than IS codes are mentioned, equivalent IS codes are also acceptable.

1.2 Base/ sub base for floor finishing

Floor finishing shall be provided over base/ sub base of cement concrete or reinforced cement concrete (RCC) floor slab. In case of ground floor, the floor slab i.e. base/ sub base for floor finish shall be as per standard no. 7-67-0011 or as specified or as mentioned in drawings. For other upper floors, the floor slabs shall be the base/ sub base for floor finish.

1.3 Slope/ levelling of floor finishing

1.3.1 Finished floor shall be in slope towards drainage out-lets. Slope shall be ranging from 1: 48 to 60 or as directed by Engineer-In-Charge in Verandahs, Courtyards, Kitchen, Bath and other wet areas. Slope in Indian type water closet areas shall be 1:30 or as directed by Engineer-In-Charge. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6mm to 10mm will also be provided to avoid spread of water.

1.3.2 Necessary margin to accommodate these slopes and drops shall preferably be made in base/ sub base or base course of finishing layer.

1.3.3 Excepting above and if not mentioned specifically otherwise, top of floor finish of all areas/ rooms/ spaces in any particular floor shall be same throughout. If further filling on base floor slab is required for this purpose, the filling shall be done with cement concrete (1 cement: 2

Copyright EIL – All rights reserved

coarse sand: 4 graded stone aggregate, 20mm nominal size which shall be carried out in accordance with workmanship mentioned in the specification of cement concrete flooring for base course of cement concrete flooring) or cement mortar (1 cement: 3 coarse sand) as directed by Engineer-In-Charge.

1.4 Skirting

Skirting shall be provided with floor finish. If not mentioned otherwise skirting shall be of same finish as that of the flooring.

2.0 CEMENT CONCRETE FLOORING

2.1 General

Cement concrete flooring shall consist of a base course of cement concrete (laid over sub base/ base concrete floor) and a finishing layer.

2.2 Base course

Base course shall be of 40mm thick cement concrete (1 cement: 2 coarse sand: 4 graded stone aggregate, 20mm nominal size).

2.3 Finishing layer

Finishing layer shall be a floating coat of neat cement, including cement slurry (@ 2 kg of cement for area of one square metre).

2.4 Workmanship

2.4.1 The surface of floor slab shall be roughened with steel wire brushes without disturbing the concrete, cleaned, and the laitance shall be removed. Immediately before laying the floor finish, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one square metre so as to get a good bond between the floor slab and base course.

2.4.2 Floor finish of specified thickness shall be laid in the pattern including the border as given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450mm in width and the joints in the border shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 metre and the area of a panel shall not be more than 2 square metre. The joints of borders at corners shall be mitred for provision of strips.

2.4.3 Cement concrete floor finish shall be laid in one operation using glass/ aluminium/ PVC/ brass / stainless steel or any other strips (as specified or as per instructions of the Engineer-in-Charge) at the junction of two panels to ensure uniformity in colour of all the panels and straightness at the junction of the panels. The strips shall be fixed with their tops at proper level, giving required slopes.

If, type of strip is not specified anywhere, minimum 3mm thick PVC strips shall be provided.

2.4.4 Base course of cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's 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. Surface of flooring shall be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed. The tops of strips shall be visible clearly after finishing with cement slurry.

Copyright EIL – All rights reserved

2.4.5 The finishing layer of the floor finish 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 stiffening the concrete to 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 @ 2 kg of cement over an area of 1 sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

2.4.6 The junctions of floor with wall plaster, dado or skirting shall be rounded off.

2.4.7 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 bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

3.0 HEAVY DUTY CEMENT CONCRETE FLOORING

3.1 General

Heavy duty cement concrete flooring shall consist of a base course of cement concrete (laid over sub base/ base concrete floor) and a finishing layer.

3.2 Base Course

Base course shall be of 40mm thick cement concrete (1 cement: 2 coarse sand: 4 graded stone aggregate, 20mm nominal size).

3.3 Finishing layer

Finishing layer shall be of 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix: 2 graded stone aggregate 6mm nominal size) by volume laid over the base course.

Hardener/ hardening compound shall be mixed @ 2 litre per 50 kg of cement or as per Manufacturer's specifications.

3.4 Workmanship

3.4.1 Base course shall be laid in accordance with clause nos 2.4.1, 2.4.2, 2.4.3 & 2.4.4

3.4.2 The top surface of base course shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12mm over the concrete surface, to receive finishing layer.

3.4.3 The topping shall be laid on base course within 2 to 4 hours of its laying, true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete so as to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

3.4.4 The junctions of floor with wall plaster, dado or skirting shall be rounded off.

3.4.4 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 bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

4.0 CEMENT PLASTER SKIRTING

4.1 General

Copyright EIL – All rights reserved

Cement plaster skirting shall be provided in cases of all types of cement concrete floorings if not mentioned otherwise.

Cement plaster skirting shall be with cement mortar 1:3 (1 cement: 3 coarse sand) finished with floating coat/ slurry of neat cement. The cement to be applied in the form of slurry for smooth finishing shall be at the rate of 2 kg of cement per litre of water applied over an area of 1 sqm.

Average thickness of cement plaster skirting shall not be less than 18mm.

If not mentioned otherwise, height of the skirting shall be 125mm.

4.2 Workmanship

4.2.1 The surface on which the skirting is to be applied shall be prepared for laying skirting. The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete walls, the surfaces shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

4.2.2 Skirting shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be kept true and straight in continuation of the line of joints in borders or adjacent panels. The skirting shall be finished smooth with top truly horizontal and joints truly vertical except where otherwise indicated.

4.2.3 The finishing of surface shall be done simultaneously with the borders or the adjacent panels of floor. Where skirting is flush with plaster, a groove 10mm wide and upto 5mm deep shall be provided in plaster at the junction of skirting with plaster.

4.2.4 Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

5.0 CERAMIC & VITRIFIED TILE FLOORING

5.1 Ceramic Tile

5.1.1 Ceramic Tiles shall conform to IS 15622 and shall be of 1st quality, flat, true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance.

5.1.2 Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

5.1.3 The tiles shall be tested as per IS 13630.

5.1.4 The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).

5.1.5 The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges.

5.1.6 The tiles shall be non-slip type for flooring application in wet areas and of colour and pattern as specified in drawings, Item descriptions, job specification, design basis or approved by Engineer-in-Charge.

Copyright EIL – All rights reserved

5.1.7 If not mentioned elsewhere i.e. drawings, Item descriptions, job specification, design basis etc. sizes of the tiles shall be:

Flooring : 300mm x 300mm
Dado : 300mm x 450mm
Thickness : As specified by the Manufacturer.

5.2 Vitrified Tiles

5.2.1 Specification of vitrified tiles shall be similar to 5.1 excepting following specifications which vitrified tiles shall conform.

5.2.2 The tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption less than 0.08 per cent, Group BIa).

5.2.3 Sizes of the tiles shall be as per drawings/ Item descriptions/ job specification/ design basis etc. as directed by Engineer-In-Charge. Thickness shall be as specified by the Manufacturer.

5.2.4 If not mentioned elsewhere i.e. drawings, Item descriptions, job specification, design basis etc. 600mm x 600mm glazed tiles finished with digital printing shall be used.

5.3 Workmanship

The finished surface shall not sound hollow when tapped with a wooden mallet.

The tiles shall be laid in pattern as per drawing.

5.3.1 Base concrete or the RCC slab or plastered wall surface on which the tiles are to be laid shall be cleaned, wetted and mopped.

5.3.2 The tiles shall be laid over a coating of polymer modified, thin set, quick set tile adhesive conforming to IS 15477. The adhesive shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used within 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Average thickness of adhesive shall be 3mm. The adhesive so spreaded shall be combed using suitable trowel. Tiles shall be pressed firmly in to the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.

5.3.3 The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

5.3.4 The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/ verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

5.3.5 For vertical surfaces, the tiles shall be corrected to proper planes with joints truly vertical in required pattern and butt jointed. The fixing shall be done from bottom upward. The top of skirting and dado shall be truly horizontal.

5.3.6 If not mentioned specifically elsewhere such as design basis, item description, drawings, job specifications etc. the joints of tiles shall be cleaned off to a depth of 2-3mm and all dust, loose particles shall be removed and joints shall then be flush pointed with white cement added with pigment to match the colour of tiles.

Copyright EIL – All rights reserved

5.3.7 If mentioned specifically elsewhere such as design basis, item description, drawings, job specifications etc. tiles shall be laid with 3mm thick PVC spacers at joints. When the laid tiles have set, the spacers shall be removed and the joints shall be filled and finished with approved quality food grade, stain & chemical resistant coloured epoxy grout matching with the colour of tiles.

5.3.8 The tiled floor shall then be kept wet for 7 days. After curing, the tiled surfaces shall be washed and finished clean

6.0 ACID OR ALKALI RESISTANT TILES

6.1 The Acid or Alkali Resistant tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100 deg C and above and shall be kept unglazed. The finished, tile, shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to slope, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall conform to IS 4457.

The tiles shall be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity shall be as per IS 4457.

The tiles shall be 10mm thick (tolerance: + 2 percent). The depth of the grooves on the underside of the tile shall not exceed 3mm.

The tiles shall be of required colour.

6.2 Workmanship

The finished surface shall not sound hollow when tapped with a wooden mallet.

6.2.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped.

6.2.2 The bedding for the tile shall be with acid/alkali resistant cement mortar 1:4 (1acid/alkali resistant cement: 4 coarse sand).

6.2.3 The average thickness of the bedding shall be 10mm for flooring and 12mm for skirting/ Dado while the thickness under any portion of the tiles shall not be less than 10mm.

6.2.4 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

6.2.5 Over this mortar bedding neat grey acid/alkali resistant cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area up to one square metre.

6.2.6 Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

Copyright EIL – All rights reserved

6.2.7 For vertical surfaces, the tiles shall be corrected to proper planes with joints truly vertical in required pattern and butt jointed. The fixing shall be done from bottom upward. The top of skirting and dado shall be truly horizontal.

6.2.8 The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope.

6.2.9 Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

6.2.10 After tiles have been laid surplus cement slurry shall be cleaned off. The joints shall be cleaned off the cement slurry with wire/coir brush or trowel to a depth of 2mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with acid/alkali resistant cement added with pigment if required to match the colour of tiles.

6.2.11 The tiled floor shall then be kept wet for 7 days. After curing, the tiled surfaces shall be washed and finished clean.

7.0 MARBLE STONE FINISH

7.1 Marble Stone Slabs

The marble slabs shall be of specified size, thickness, type, grade and colour. The marble from which the slabs are made shall be of selected quality, hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes. The sample of marble stone slabs shall be got approved from the Engineer-in-Charge.

Marble stone shall be laid in desired pattern using stones of desired color.

If not mentioned elsewhere i.e. item description, drawings, job specifications etc. marble stone slab shall be second quality Makrana white.

This specification does not cover Marble stone wall cladding and veneering.

Dimensions:

Except for dimensions shown in drawing or cut sizes required to cover the balance areas along peripheries, dimensions of slabs shall be 600mm to 2500mm in length and 600mm to 1000mm in width as per drawing and as directed by Engineer-In-Charge.

Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of + 2% shall be allowed.

If not mentioned elsewhere i.e. i.e. item description, drawings, job specifications design basis etc. thickness shall be as below.

1. Thickness of stone slab in flooring and horizontal surfaces: 18mm.
2. Thickness of stone slab in skirting, dado and vertical surfaces: 12mm.

Marble stone in riser, tread of staircases, counter tops shall be of single piece upto 2000mm length. Nosing shall be provided in the treads &counter tops.

Physical properties:

Physical properties of Marble and method of testing shall be as follows:

Physical Property	Requirement	Method of test
Moisture absorption After 24 hours	Maximum 0.4%	IS: 1124

Copyright EIL – All rights reserved

Immersion in cold water		
Hardness	Minimum 3	Mhos scale
Specific Gravity	Minimum 2.5	IS: 1122

7.2 Workmanship

The slabs shall be washed clean before laying. Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/ streaks or as directed by the Engineer-In-Charge.

The finished surface shall not sound hollow when tapped with a wooden mallet.

7.2.1 Laying

Laying on floor and horizontal surfaces:

Base slab on which the slabs are to be laid shall be cleaned, wetted and mopped.

Marble slabs shall be laid over average 22mm thick cement mortar 1:4 (1 cement : 4 coarse sand) bedding.

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar shall be allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already laid shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs.

The slab to be laid shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.

Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1mm.

Laying on vertical surfaces i.e skirting/ dado/ risers:

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete surfaces, the surface shall be hacked and roughened with wire brushes. The base surface shall be cleaned thoroughly, washed with water and kept wet before laying is commenced.

In case of skirting, the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

Copyright EIL – All rights reserved

The slabs shall be held in position by suitable temporary measure such as wooden/ bamboo supports, temporary hook etc. as approved by Engineer-In- Charge. The line of the slab shall be at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, The outer face of the slabs shall be checked for plane and plumb and corrected. The joints shall be as fine as possible and shall be filled with neat cement paste/ grout with white cement and pigment to match the colour of the slabs. The joints shall thus be left to harden and then the rear gap between the slabs and backing surface shall be packed with average 12mm thick cement mortar 1:3 (1 cement : 3 coarse sand). Temporary supports shall be removed after the mortar filling in the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1mm. The top line of the skirting/ dado/ risers shall be truly horizontal and joints truly vertical.

7.2.2 Curing, Polishing and Finishing

The surface shall be kept wet for a minimum period of 7 days. The day after the slabs are laid, all joints shall be cleaned of the grout with a wire brush or trowel. The surface shall thereafter be grounded evenly using the following carborundum stones.

1st grinding — coarse grade stone (No. 60)
Second grinding — medium grade (No. 80)
Final grinding — fine grade (No. 120)

If desired appearance of the finished surface is not achieved, the surface shall be further polished using requisite carborundum stones (including finer grade) as directed by Engineer-In-Charge.

Visible top surfaces of skirting/ dado etc. and edges of nosing shall be polished.

Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped.

Each grinding shall be done one day after the previous grinding has been done.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags).

The following day after the last grinding/ polishing, the surface shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any stone is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

In case of pre-polished stones, any damage or unevenness on the surface shall be rectified.

8.0 KOTA STONE FINISH

8.1 Kota stone slabs

The Kota stone slabs shall be of specified size, thickness, selected quality and shade, hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes. These shall be machine cut to the requisite size and thickness and of the colour indicated in the drawings or as instructed by the Engineer-in-Charge. The sample of stone slabs shall be got approved from the Engineer-in-Charge. Kota stone shall be laid in desired pattern.

Copyright EIL – All rights reserved

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified.

All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

Dimensions:

The slabs shall be machine cut to the requisite dimensions.

Except for dimensions shown in drawing or cut sizes required to cover the balance areas along peripheries, dimensions of slabs shall be 600mm to 2500mm in length and 600mm to 1000mm in width as per drawing and as directed by Engineer-In-Charge.

Tolerance of ±2mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 2mm for machine cut slabs shall be allowed.

If not mentioned elsewhere i.e. item description, drawings, job specifications etc. thickness shall be as below.

1. Thickness of stone slab in flooring and horizontal surfaces: 25mm.
2. Thickness of stone slab in skirting, dado and vertical surfaces: 18mm.

Kota stone in riser, tread of staircases, counter tops shall be of single piece up to 2000mm length. Nosing shall be provided in the treads &counter tops.

8.2 Workmanship

The slabs shall be washed clean before laying.

The finished surface shall not sound hollow when tapped with a wooden mallet.

8.2.1 Laying

Laying on floor and horizontal surfaces:

Base slab on which the slabs are to be laid shall be cleaned, wetted and mopped.

Kota stone slabs shall be laid over average 15mm thick cement mortar 1:4 (1 cement: 4 coarse sand) bedding.

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar shall be allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already laid shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs.

The slab to be plaid shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.

Copyright EIL – All rights reserved

Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge.

The edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1mm.

Laying on vertical surfaces i.e skirting/ dado/ risers and vertical surfaces:

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete surfaces, the surface shall be hacked and roughened with wire brushes. The base surface shall be cleaned thoroughly, washed with water and kept wet before laying is commenced.

In case of skirting, the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

The slabs shall be held in position by suitable temporary measure such as wooden/ bamboo supports, temporary hook etc. as approved by Engineer-In- Charge. The line of the slab shall be at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, The outer face of the slabs shall be checked for plane and plumb and corrected. The joints shall be as fine as possible and shall be filled with neat cement paste/ grout with white cement and pigment to match the colour of the slabs. The joints shall thus be left to harden and then the rear gap between the slabs and backing surface shall be packed with average 12mm thick cement mortar 1:3 (1 cement : 3 coarse sand). Temporary supports shall be removed after the mortar filling in the gap has acquired sufficient strength.

The edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be as minimum as possible. In any location, it shall not exceed 1mm. The top line of the skirting/ dado/ risers shall be truly horizontal and joints truly vertical.

8.2.2 Curing, Polishing and Finishing

The surface shall be kept wet for a minimum period of 7 days. The day after the slabs are laid, all joints shall be cleaned of the grout with a wire brush or trowel. The surface shall thereafter be grounded evenly using the following carborundum stones.

First grinding — medium grade (No. 80)
Final grinding — fine grade (No. 120)

If desired appearance of the finished surface is not achieved, the surface shall be further polished using requisite carborundum stones (including finer grade) as directed by Engineer-In-Charge.

Visible top surfaces of skirting/ dado etc. and edges of nosing shall be polished.

Copyright EIL – All rights reserved

Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped.

Each grinding shall be done one day after the previous grinding has been done.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags).

The following day after the last grinding/ polishing, the surface shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any stone is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

In case of pre-polished stones, any damage or unevenness on the surface shall be rectified.

9.0 GRANITE STONE FINISH

The Granite stone shall be of specified size, thickness, type, and colour (such as jet black, cherry red, elite brown, cat eye etc.). They shall be of selected quality, hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes, machine cut and pre-polished/ of flamed finish. The sample of granite stone slabs shall be got approved from the Engineer-in-Charge.

Granite stone shall be laid in desired pattern using stones of desired color.

This specification does not cover Granite stone wall cladding and veneering.

Dimensions:

The slabs shall be machine cut to the requisite dimensions.

Except for dimensions shown in drawing or cut sizes required to cover the balance areas along peripheries, dimensions of slabs shall be 600mm to 2500mm in length and 600mm to 1000mm in width as per drawing and as directed by Engineer-In-Charge.

If not mentioned elsewhere i.e. item description, drawings, job specifications etc 18mm thick Granite slabs shall be provided.

Tolerance of + 1% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of + 2% shall be allowed.

Granite stone in riser, tread of staircases, counter tops shall be of single piece upto 2000mm length. Nosing shall be provided in the treads &counter tops.

Finish:

If not mentioned elsewhere i.e item description, drawings, job specifications, design basis etc Granite stone shall be pre-polished finish.

Physical properties:

Physical properties of Granite and method of testing shall be as follows:

Physical Property	Requirement	Method of test
Moisture absorption After 24 hours	Maximum 0.5%	IS: 1124

Copyright EIL – All rights reserved

Immersion in cold water		
Specific Gravity	Minimum 2.6	IS: 1122

9.2 Workmanship

The slabs shall be washed clean before laying.

The finished surface shall not sound hollow when tapped with a wooden mallet.

9.2.1 Laying

Laying on floor and horizontal surfaces:

Base slab on which the slabs are to be laid shall be cleaned, wetted and mopped.

Granite slabs shall be laid over average 22mm thick cement mortar 1:4 (1 cement: 4 coarse sand) bedding.

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar shall be allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already laid shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the granite slabs.

The slab to be plaid shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.

Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1mm.

Laying on vertical surfaces i.e skirting/ dado/ risers:

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete surfaces, the surface shall be hacked and roughened with wire brushes. The base surface shall be cleaned thoroughly, washed with water and kept wet before laying is commenced.

In case of skirting, the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

The slabs shall be held in position by suitable temporary measure such as wooden/ bamboo supports, temporary hook etc. as approved by Engineer-In- Charge. The line of the slab shall be at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, The outer face of the slabs shall be checked for plane

Copyright EIL – All rights reserved

and plumb and corrected. The joints shall be as fine as possible and shall be filled with neat cement paste/ grout with white cement and pigment to match the colour of the slabs. The joints shall thus be left to harden and then the rear gap between the slabs and backing surface shall be packed with average 12mm thick cement mortar 1:3 (1 cement : 3 coarse sand). Temporary supports shall be removed after the mortar filling in the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1mm The top line of the skirting/ dado/ risers shall be truly horizontal and joints truly vertical.

9.2.2 Curing, Polishing and Finishing

The surface shall be kept wet for a minimum period of 7 days. The day after the slabs are laid, all joints shall be cleaned of the grout with a wire brush or trowel. The surface shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any stone is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

Any damage unevenness of the stone surface shall be rectified.

10.0 PVC FINISH

10.1 PVC Roll/ Tiles

PVC roll/ tiles shall be homogenous, of approved texture, colour, pattern, with polyurethane surface protection and shall be of class-1 category for surface spread of flame when tested in accordance with BS 476, part-7.

PVC rolls shall conform to IS: 3462 and PVC tiles shall conform to IS: 3462.

Antistatic PVC roll/ tiles shall conform to B.S.2050, Table-2.

Thickness of PVC roll/ tiles shall be 2mm.

Size of tiles shall be 600mm x 600mm.

If not mentioned elsewhere i.e item description, drawings, job specifications, design basis etc. PVC floor finish shall be with PVC rolls.

PVC roll/ tiles shall be laid in desired pattern in accordance with drawing or as directed by Engineer-In-Charge.

10.2 Workmanship

The base floor on which PVC finish is to be laid shall be prepared in accordance with PVC tile/roll Manufacturer's recommendation.

The base floor shall be made permanently smooth, firm, free of cracks and dry. If required, suitable leveling compound as recommended and approved by PVC tile/roll manufacturer shall be applied over the base floor.

PVC rolls/tiles shall be brought to the temperature of the area in which it is to be laid and stacked suitably near the site in accordance with manufacturer's recommendation.

Copyright EIL – All rights reserved

Laying of PVC roll/ tile shall be in accordance with manufacturer's recommendation using adhesive (Fevicol SR-505 or other adhesive as recommended by Manufacturer and approved by Engineer-In-Charge).

In case of rolls, minimum possible number of joints shall be provided.

PVC rolls shall be placed in position from one end onwards slowly without creation on any air pockets between roll and the base floor.

PVC rolls/tiles shall be placed only when the adhesive is set sufficiently for laying. After placing, the rolls/tiles shall be pressed suitably with a wooden roller weighing about 5 kg. The joint between adjacent rolls shall be thin hairline type.

PVC rolls in flooring shall he continued for skirting without any joints.

Joints, seams of the PVC flooring shall be sealed by thermo-welding the joints using PVC welding bar of matching colour.

Any excess adhesive squeezing out of the surface shall he wiped off immediately with a wet cloth. In case of such excess adhesive becoming hard, it shall be removed using suitable removing product.

After a minimum period of 24 hours after laying the rolls/tiles, the finished floor shall be cleaned with a wet cloth soaked in warm soap or detergent solution as per approved manufacturer's specifications.

11.0 ABRASION RESISTANT EPOXY FLOOR COATING SYSTEM

Abrasion resistant epoxy floor coating system shall consist of primer coat, levelling/ self smoothening screed and a top finishing coat. All components of the system shall be compatible to it's under and top layer/coat and shall be of single Manufacturer.

11.1 Material

Primer, screed and top coat shall meet the requirements of the table below :

Requirement	Primer	Screed	Top Coat
Material	Solvent free Epoxy resin.	Shall comprise of resin base, resin hardener and fillers and shall be self-smoothening.	Shall comprise of resin base, resin hardener and aggregate/ fillers , shall be self-smoothening and of approved colour.
Dry film Thickness (Minimum)	200 micron	2000 micron	2000 micron
Material coverage	Material shall be applied in quantity worked out considering minimum coverage mentioned in the data sheet (authenticated by the Manufacturer) for intended surface area for specified thickness.		
Tensile strength (Minimum Value) Material shall meet minimum value corresponding to any test method mentioned below.			
ASTM D 638	-	08 MPa at 7 days	51Mpa at 7 days

Copyright EIL – All rights reserved

ASTM C 307	-	-	25 MPa at 7 days
EN ISO 527	-	-	07 MPa at 7 days
BS 6319 Part-7	-	08 MPa at 7 days	10 MPa at 7 days
Compressive strength (Minimum Value) Material shall meet minimum value corresponding to any test method mentioned below.			
ASTM D695	-	40 MPa at 7 days	50 MPa at 7 days
ASTM C 579	-	-	40 MPa at 7 days
EN ISO 604	-	-	50 MPa at 7 days
BS 6319 Part-2	-	50 MPa at 7 days	50 MPa at 7 days
Abrasion resistance (Minimum Value)			
ASTM D 4060	-	-	45 Mg thickness loss/ 1000 cycle of CS 17 wheel
Shore D Hardness (Minimum Value)			
ASTM D 2240	-	75	75
Bond strength to concrete (Minimum Value) Material shall meet minimum value corresponding to any test method mentioned below.			
ASTM D 4541	1.5 MPa concrete failure	-	-
ASTMD 412	1.0 MPa concrete failure	-	-

11.2 Workmanship

The work shall be carried out by Applicator recommended by coating Manufacturer and approved by Engineer-In-Charge.

Waiting time between the coats i.e. primer, screed and top coat should be as recommended by Manufacturer.

Surface preparation:

Base concrete slab shall be grinded thoroughly (minimum upto 150-200 microns) to make the surface suitable for epoxy application and achieve desired surface profile.

Base concrete slab on which epoxy coating is to applied shall be cleaned and made free from oil, grease, foreign particles,dust, dirt, debris, loose epoxy coatings, paint, sealers etc. by using wire brushes or mechanical means.

Cutting of construction & control joints in concrete floor including Isolation joints in perimeter of column, Door & floor joint, Machine foundation should be done within 48 to 72 hours after the concrete floor is laid.

Copyright EIL – All rights reserved

These joints in the concrete floor shall be filled with Poly-Urathane sealant (Having Shore A hardness more than 60 and Movement Accommodation Factor (MAF) more than 10%).

Any damage or pot holes in the concrete floor shall be rectified as directed by Engineer-In-Charge.

Primer coat:

Primer coat shall be applied when the prepared surface is ready for such application.

Primer coat as per specification shall be applied by brush and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

The primer will be left for minimum seven hours or as recommended by manufacturer. to dry before the application of screed.

Screed:

Screed as per specification shall be applied over the primed surface using steel trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment in the screed.

The screed shall be left to get air cured for minimum time as recommended by manufacturer so asto get the floor dry and hard to take care of walking movement. Further it will be cleaned and inspected for pin holes which shall be patched up suitably.

Top coat:

Top coat as per specification and of approved colour shall be applied over the screed using steel trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment.

Any damage or incorrect work/finish shall be suitably rectified.

The finished surface shall be left to dry and cure for minimum 24 hours (for human movement), 72 hours (for light weight movement), 7 days (for heavy movement) or as recommended by manufacturer.

11.3 Submittals by Contractor

Contractor shall submit following:

1. Product Data Sheet authenticated (signed and stamped) by the Manufacturer.
2. Test certificates in support of specified properties/ values.

12.0 ABRASION & IMPACT RESISTANT POLYURETHANE CONCRETE FLOOR COATING SYSTEM

Copyright EIL – All rights reserved

Abrasion & impact resistant Polyurethane (PU) concrete floor coating system shall consist of primer coat, screed or scratch-coat and a top finishing coat. All components of the system shall be compatible to it's under and top layer/coat and shall be of single Manufacturer.

12.1 Material

Primer, screed or scratchcoat and top coat shall meet the requirements of the table below :

Requirement	Primer	Screed or scratch-coat	Top Coat
Material	Waterborne Epoxy resin or other material compatible to other coats of the system.	Shall comprise of Polyurethane Resin base, resin hardener and fillers	Shall comprise of resin base, resin hardener and aggregate/ fillers , shall be self-smoothening, fast setting and of approved colour
Dry Film Thickness (Minimum)	50 micron	1000 micron	3000 micron
Material coverage	Material shall be applied in quantity worked out considering minimum coverage mentioned in the data sheet (authenticated by the Manufacturer) for intended surface area for specified thickness.		
Tensile strength (Minimum Value) Material shall meet minimum value corresponding to of any test method mentioned below.			
ASTM D 638	-	05 MPa at 28 days	05 MPa at 28 days
ASTM C 307	-	06 MPa at 28 days	06 MPa at 28 days
EN ISO R527	-	09 MPa at 28 days	09 MPa at 28 days
BS 6319 Part-7	-	06 MPa at 28 days	06 MPa at 28 days
Compressive strength (Minimum Value) Material shall meet minimum value corresponding to of any test method mentioned below.			
ASTM D695	-	40 MPa at 28 days	40 MPa at 28 days
ASTM C 579	-	40 MPa at 28 days	40 MPa at 28 days
BS 6319 Part-2	-	45 MPa at 28 days	45 MPa at 28 days
Abrasion resistance (Minimum Value)			
ASTM D 4060	-	-	50Mg thickness loss/ 1000 cycle of CS 17 wheel
Bond strength to concrete (minimum value) Material shall meet minimum value corresponding to of any test method mentioned below.			
ASTM D 4541	1.5 MPa concrete failure	-	-
ASTMD 412	1.0 MPa concrete	-	-

Copyright EIL – All rights reserved

	failure		
Impact Resistance (minimum Value)			
ASTM D 2794	-	-	8 Joules for 3mm thickness

12.2 Workmanship

The work shall be carried out by Applicator recommended by coating Manufacturer and approved by Engineer-In-Charge.

Waiting time between the coats i.e. primer, screed and top coat shall be as recommended by Manufacturer.

Surface preparation:

Base concrete slab shall be grinded thoroughly (minimum upto 150-200 microns) to make the surface suitable for epoxy application and achieve desired surface profile.

Base concrete slab on which PU coating is to applied shall be cleaned and made free from oil, grease, foreign particles,dust, dirt, debris, loose epoxy coatings, paint, sealers etc. by using wire brushes or mechanical means.

Cutting of construction & control joints in concrete floor including Isolation joints in perimeter of column, Door & floor joint, Machine foundation should be done within 48 to 72 hours after the concrete floor is laid.

These joints in the concrete floor shall be filled with Poly-Urethane sealant (Having Shore A hardness more than 60 and Movement Accommodation Factor (MAF) more than 10%).

Any damage or pot holes in the concrete floor shall be rectified as directed by Engineer-In-Charge.

Primer coat :

Primer coat shall be applied when the prepared surface is ready for such application.

Primer coat as per specification shall be applied by brush and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

The primer will be left for minimum seven hours or as recommended by manufacturer to dry before the application of screed.

Copyright EIL – All rights reserved

Screed or Scratch coat:

Screed or Scratch-coat shall be applied over the primed surface using notched trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment in the screed.

The screed shall be left to get air cured for 3-4 hours or as recommended by the Manufacturer to get the floor dry and hard to take care of walking movement. Further it will be cleaned and inspected for pin holes which shall be patched up suitably.

Top coat:

Top coat as per specification and of approved colour shall be applied over the screed or scratch coat using notched trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment.

Any damage or incorrect work/finish shall be suitably rectified.

The finished surface shall be left to dry and cure for minimum 24 hours (for human movement), 72 hours (for light weight movement), 7 days (for heavy movement) or as recommended by the Manufacturer.

12.3 Submittals by Contractor

Contractor shall submit following:

1. Product Data Sheet authenticated (signed and stamped) by the Manufacturer.
2. Test certificates in support of specified properties/ values.

13.0 CHEMICAL RESISTANT NOVOLAC EPOXY FLOOR COATING SYSTEM

Chemical resistant Novolac Epoxy floor coating system shall consist of primer coat, levelling screed or scratch coat and chemical resistant top coat. All components of the system shall be compatible to it's under and top layer/coat and shall be of single Manufacturer.

13.1 Material

Primer, screed or scratch coat, coloured coat and final clear coat shall meet the requirements of the table below:

Note:

For chemical resistant top coat, any option (option 1 and option 2) mentioned in the table is acceptable.

Requirement	Primer	Screed or scratch coat	Top coat	
			Option1 – Top coloured coat over clear chemical resistance coat	Option 2 – Coloured chemical Resistance coat

Copyright EIL – All rights reserved

Material	Solvent free Epoxy resin	Shall comprise of resin base, resin hardener and fillers and shall be self-smoothening	Top coloured coat shall comprise of resin base, resin hardener and aggregate/ fillers , shall be self-smoothening and of approved colour Clear chemical resistance coat shall comprise of resin, hardener and shall be self smoothening and shall be solvent free.	Shall comprise of resin, hardener and shall be self smoothening and shall be solvent free and of approved colour.
Dry Film Thickness (Minimum)	200 micron	2000 micron	Total 1000 micron (500 micron for both clear and coloured coat)	500 micron
Material coverage	Material shall be applied in quantity worked out considering minimum coverage mentioned in the data sheet (authenticated by the Manufacturer) for intended surface area for specified thickness.			
Tensile strength (Minimum Value) Material shall meet minimum value corresponding to of any test method mentioned below.				
ASTM D 638	-	08 MPa at 7 days	14 MPa at 7 days	14 MPa at 7 days
ASTM C 307	-	-	-	-
EN ISO 527	-	-	-	-
BS 6319 Part-7	-	08 MPa at 7 days	-	-
Compressive strength (Minimum Value) Material shall meet minimum value corresponding to of any test method mentioned below.				
ASTM D 695	-	40 MPa at 7 days	60 MPa at 28 days/	-
ASTM C 579	-	-	85 Mpa at 28 days	-
EN ISO 604	-	-	-	-
BS 6319 Part-2	-	50 MPa at 7 days	-	-

Copyright EIL – All rights reserved

Abrasion resistance				
ASTM D 4060	-	45 Mg thickness loss/ 1000 cycle of CS 17 wheel	-	60 Mg thickness loss/ 1000 cycle of CS 17 wheel
ASTM D 4060	-	-	-	<0.10 Mg/ cycle of 1 Kg CS10 wheel
Shore D Hardness				
ASTM D 2240	-	70	70	70
Bond strength to concrete Material shall meet minimum value corresponding to any test method mentioned below.				
ASTM D 4541	1.5 MPa Concrete failure	-	-	-
ASTMD 412	1.0 MPa concrete failure	-	-	-

13.2 Workmanship

The work shall be carried out by Applicator recommended by coating Manufacturer and approved by Engineer-In-Charge.

Waiting time between the coats i.e. primer, screed or scratch coat, top coloured coat and top clear coat shall as recommended by Manufacturer.

Surface preparation:

Base concrete slab shall be grinded thoroughly (minimum upto 150-200 microns) to make the surface suitable for epoxy application and achieve desired surface profile.

Base concrete slab on which epoxy coating is to applied shall be cleaned and made free from oil, grease, foreign particles, dust, dirt, debris, loose epoxy coatings, paint, sealers etc. by using wire brushes or mechanical means.

Cutting of construction & control joints in concrete floor including Isolation joints in perimeter of column, Door & floor joint, Machine foundation should be done within 48 to 72 hours after the concrete floor is laid.

These joints in the concrete floor shall be filled with Poly-Urathane sealant (Having Shore A hardness more than 60 and Movement Accommodation Factor (MAF) more than 10%).

Any damage or pot holes in the concrete floor shall be rectified as directed by Engineer-In-Charge.

Primer coat:

Primer coat shall be applied when the prepared surface is ready for such application.

Copyright EIL – All rights reserved

Primer coat as per specification shall be applied by brush and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

The primer will be left for minimum seven hours or as recommended by manufacturer. to dry before the application of screed.

Screed:

Screed as per specification shall be applied over the primed surface using steel trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment in the screed.

The screed shall be left to get air cured for 7 hours or as recommended by the Manufacturer to get the floor dry and hard to take care of walking movement. Further it will be cleaned and inspected for pin holes which shall be patched up suitably.

Top coat:

Top coat as per specification and of approved colour shall be applied over the screed using steel trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Chemical resistance top coat should be immediately applied to the prepared surface ensuring a continuous coating of uniform thickness. Stiff nylon brush or short nap roller is recommended for such application.

Chemical resistant, clear coating (option-1) shall be applied over cured top coloured coat using roller, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment.

Any damage or incorrect work/finish shall be suitably rectified.

The finished surface shall be left to dry and cure for minimum 24 hours (for human movement), 72 hours (for light weight movement), 7 days (for heavy movement) or as recommended by the Manufacturer.

13.3 Submittals by Contractor

Contractor shall submit following:

1. Product Data Sheet authenticated (signed and stamped) by the Manufacturer.
2. Test certificates in support of specified properties/ values.

14.0 CHEMICAL RESISTANT NOVOLAC EPOXY WALL COATING SYSTEM

Chemical resistant Novolac epoxy wall coating system shall consist of primer coat and a top coloured coat All components of the system shall be compatible to it's under and top layer/coat and shall be of single Manufacturer.

14.1 Material

Copyright EIL – All rights reserved

Primer and top coat shall meet the requirements of the table below :

Note :

For chemical resistant top coat, any option (option 1 and option 2) mentioned in the table is acceptable.

Requirement	Primer	Top coat	
		Option 1- Top coloured coat over chemical resistant clear coat	Option 2- Chemical Resistance coloured top coat
Material	Solvent free Epoxy resin	Chemical resistant clear coat shall comprise of resin, hardener and shall be self smoothening. Coloured coat shall comprise of resin base, resin hardener and shall be of approved colour	Shall comprise of resin, hardener and shall be self smoothening of approved colour.
Dry film Thickness (Minimum)	200 micron	Chemical resistant clear coat : 300 micron Coloured coat: 100 micron	400 micron
Material coverage	Material shall be applied in quantity worked out considering minimum coverage mentioned in the data sheet (authenticated by the Manufacturer) for intended surface area for specified thickness.		
Tensile strength (Minimum Value) Material shall meet minimum value corresponding to of any test method mentioned below.			
ASTM D 638	-	10 Mpa at 7 days	30 MPa at 7 days

14.2 Workmanship

The work shall be carried out by Applicator recommended by coating Manufacturer and approved by Engineer-In-Charge.

Waiting time between the coats i.e. primer, screed and top coat shall be as recommended by Manufacturer.

Surface preparation:

Base wall shall be grinded lightly or rubbed with a sand paper thoroughly to make the surface suitable for application and achieve desired surface profile.

Base on which coating is to applied shall be cleaned and made free from oil, grease, foreign particles, dust, dirt, debris, loose epoxy coatings, paint, sealers etc. using wire- brushes or mechanical means.

Putty may be applied to the base wall surface depending upon the exisiting condition of the surface and as directed by Engineer-In-Charge

Copyright EIL – All rights reserved

Any damage or holes or cracks in the wall shall be rectified as directed by Engineer-In-Charge.

Primer coat:

Primer coat shall be applied when the prepared surface is ready for such application.

Primer coat as per specification shall be applied by brush and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

The primer will be left for minimum seven hours or as recommended by manufacturer to dry before the application of screed.

Top coat:

Top coat as per specification and of approved colour shall be applied over the screed using steel trowel, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Chemical resistance top coat should be immediately applied to the prepared surface ensuring a continuous coating of uniform thickness. Stiff nylon brush or short nap roller is recommended for such application.

Chemical resistant, clear coating (option-1) shall be applied over cured top coloured coat using roller, mixing the ingredients in right proportion and in accordance with recommendations by the coating manufacturer to specified thickness and using specified coverage.

Spike Rollers shall be used to remove air entrapment.

Any damage or incorrect work/finish shall be suitably rectified.

14.3 Submittals by Contractor

Contractor shall submit following:

1. Product Data Sheet authenticated (signed and stamped) by the Manufacturer.
2. Test certificates in support of specified properties/ values.

15.0 MEASUREMENTS

For measurement of floor finishing, skirting, wall finishing etc. mentioned in this specification, actual finished surface shall be measured.

No deduction shall be done for cutting or wastage of materials.

Copyright EIL – All rights reserved

स्टील/अलुमिनियम दरवाजे, खिडकियों एवं रोशनदान का मानक विनिर्देशन

STANDARD SPECIFICATION FOR STEEL/ALUMINIUM DOORS, WINDOWS AND VENTILATORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Approved by	Standards Bureau Chairman
8	19.10..23	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	SAMIR DAS		SANJAY MAZUMDAR
7	04.06.18	REVISED & ISSUED AS STANDARD SPECIFICATION	AG	SD	RS		R.K.TRIVEDI
6	03.03.14	REVISED & ISSUED AS STANDARD SPECIFICATION	AG	SD	JKB	S.CHATURVEDI	S.CHANDA
5	03.03.11	REVISED & ISSUED AS STANDARD SPECIFICATION	GJK	SD	JKB	VK	D. MALHOTRA

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing & Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
RCC	:	Reinforced Cement Concrete
VOC	:	Volatile Organic Compounds
ISO	:	International Organization for Standardization
NFPA	:	National Fire Protection Association

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 DOOR,WINDOW AND VENTILATORS 5
4.0 STEEL DOORS 5
5.0 STEEL WINDOW & VENTILATORS 7
6.0 ALUMINIUM DOORS, WINDOWS AND VENTILATORS 9
7.0 STEEL, ALUMINIUM ROLLING SHUTTERS 11
8.0 MEASUREMENT 16

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down the requirements of steel/ aluminium door, window and ventilator and rolling shutter assemblies for buildings.

2.0 REFERENCES

2.1 The codes and standards listed below contains provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Sl.no:	Standards	Document Title
1.	IS 5	Colour for ready mixed paints and enamels.
2.	IS 325	Three phase induction motors
3.	IS 617	Specifications for aluminium and aluminium alloy ingots & castings for general engineering purposes.
4.	IS 733	Specifications for wrought aluminium and aluminium alloy bars, rods & sections for general engineering purposes.
5.	IS 737	Specifications for wrought aluminium and aluminium alloy sheet & strip for general engineering purposes.
6.	IS 1038	Specifications for steel doors, windows and ventilators.
7.	IS 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
8.	IS 1161	Steel Tubes For Structural Purposes - Specification
9.	IS: 1239	Steel tubes, tubulars and other wrought steel fittings — Specification
10.	IS 1285	Specifications for wrought aluminium and aluminium alloy extruded round tube & hollow sections for general engineering purposes.
11.	IS 1361	Specifications for steel windows for Industrial buildings.
12.	IS 1477 Part-2	Code of practice for painting of ferrous metals in buildings
13.	IS 1948	Specifications for Aluminium doors, windows and ventilators.
14.	IS 2062	Standard for hot rolled medium and high tensile structural steel
15.	IS 2074	Specifications for Ready mixed paint, air drying, red oxide zinc chrome, priming specification
16.	IS 2223	Dimensions of flange-mounted AC Induction motors
17.	IS 2253	Designation for types of construction and mounting arrangements of rotating electrical machines
18.	IS 2385	Designation for types of construction and mounting arrangements of rotating electrical machines
19.	IS 2553 Part-1	Safety glass – specification Part 1: General purposes
20.	IS 2835	Flat transparent sheet glass
21.	IS - 2968	Dimensions of slide rails for electrical motors
22.	IS 3548	Code of practice for glazing building

Copyright EIL – All rights reserved

23.	IS 3564	Specification for hydraulically regulated door closer
24.	IS 3614 Part-1	Specification for fire check doors. Part-1: Plate metal cover and rolling type
25.	IS 3614 Part-2	Specification for metallic and non metallic fire check doors. Part-2: Resistance test & performance criteria
26.	IS 4029	Guide for testing of three phase induction motors
27.	IS 4351	Specifications for steel door frames.
28.	IS 4454-part I	Steel wire for mechanical springs — specification
29.	IS 4691	Degree of protection provided by enclosure for rotating electrical machinery
30.	IS 4722	Rotating electrical machines
31.	IS 4889	Method of determination of efficiency of rotating electrical machines
32.	IS 5437	Figured rolled and wired glass
33.	IS 6248	Specifications for metal rolling shutters and rolling grill
34.	IS 6315	Specification for Floor springs (hydraulically regulated) for heavy doors.
35.	IS 6362	Designation of methods of cooling of rotating electrical machines
36.	IS: 7088	Recommended practice for anodizing aluminum and its alloys.
37.	IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators.
38.	IS 12436 (1998)	Specifications for preformed rigid polyurethane (PUR) and polyisocyanurate (PIR) foams for thermal insulation..

3.0 DOOR,WINDOW AND VENTILATORS

3.1 Door, window and ventilator assemblies shall be complete with frames, shutters and required, hardware ensuring stability, safety and smooth operation.

3.2 Type of Door, window and ventilator assemblies shall be as mentioned in job specifications or construction drawings.

4.0 STEEL DOORS

4.1 Steel door assemblies shall have following components. For further details reference shall be made to EIL Standard Nos.7-75-0070, 7-75-0071 and 7-75-0074

Component	Specification
Door frame	Made of 16 SWG galvanized steel pressed and profiled to required size with 3mm thick MS flat spacers welded towards jamb size, 3mm thick MS pad plate and 18 SWG galvanized steel mortar guard welded at all hinge & lock locations. The vertical members shall be provided with 20mm x 20mm x 3mm welded MS angle threshold which shall be embedded in flooring. The hollow frame shall be filled up with concrete or any other approved suitable material.

Copyright EIL – All rights reserved

	Continuous "D" profile EPDM gasket shall be provided in the rebate of the frame in case of air-tight doors.
Door Shutter	Made of 18 SWG galvanized steel pressed and profiled to required size and thickness (minimum thickness – 40mm) with 3mm thick MS flat welded continuously along the perimeter of the shutter, profiled vertical stiffeners made of 18 SWG galvanized steel. The shutter shall be filled up with mineral wool (density – 48 Kg/ cum). Other approved filler material is permissible for large doors/shutters. In case of double shutters, suitable profiling/ rebating shall be done at the junction of meeting shutters for proper closure of the shutters.
Vision Panel	Vision panels shall be provided in the shutters as per project drawings. Glass shall be as mentioned in the drawings. Glass pane shall be fixed by means of 18 SWG galvanized steel "Z" angle welded to the shutter along the periphery of the opening and continuous EPDM gasket. If nothing is specified 350mm x 450mm sized vision panel with 5mm thick toughened glass shall be provided.
Louvers	Louvers shall be provided in the shutters if specified or mentioned in the project drawings. Louvers shall be made of 18 SWG galvanized steel "Z" profiled blades welded to the shutter. Louvers shall not be provided in air conditioned and pressurized area.

4.2 Hardware

Following hardware shall be provided in the steel door assemblies

Hardware	Specification
Hydraulic door closer	1 no. heavy duty hydraulic door closer confirming to IS 3564 for each shutter .
Tower/ Flush bolt	1 no. 10mm dia stainless steel Tower/ Flush Bolt (SS 304 grade, 250mm long upto 2100mm high door and 600mm long upto 2500 mm high door) for each shutter on both sides. For large size door (width- above 2000mm to 3000mm, height- above 2500mm to 3000mm), tower/ flush bolt shall be upto 1400mm long and shall be surface mounted or concealed type.
Aldrop	1 no. 16mm dia stainless steel Aldrop (SS 304 grade, 300mm long) for each shutter on both sides. For large size door (width- above 2000mm to 3000mm, height- above 2500mm to 3000mm), Aldrop shall be 400mm long.
Door Handle	1 no. 18mm dia stainless steel door handle (SS 304 grade, 200mm long) for each shutter on both sides. For large size door (width- above 2000mm to 3000mm, height- above 2500mm to 3000mm), door handles shall be 300mm long.
Door Stopper	1 no. spring loaded heavy duty door stopper for each shutter.
Hinges for shutters	100mm long stainless (SS 304 grade) steel heavy duty ball bearing hinge. Number of hinges shall be : 3 (for upto 2100mm high door)

Copyright EIL – All rights reserved

	4 (for upto 2400mm high door) 5 (for upto 2700mm high door) 6 (for upto 3000mm high door)

4.3 Fabrication & Installation

4.3.1 Doors shall be true to the plumb, size and design and smooth operation shall be ensured.

4.3.2 All metallic components shall be shall be welded or rigidly fixed together by mechanical means. Joints between horizontal and vertical frame members shall be mitred. All welding shall be finished smooth.

4.3.3 The frames shall be fixed to the masonry by means of 200 mm x 25 mm x 6 mm MS hold fast welded to the spacers and grouted with M-20 grade concrete in minimum 250 mm x 100 mm x 100 mm sized hole in the masonry.

4.3.4 In case of concrete, the frames shall be fixed by minimum 100 mm long, 12 mm dia metallic counter sunk type anchor fasteners through the frame and spacers.

4.3.5 Vertical frame member shall be tied together below floor finish by mean of 20mmx20mmx3mm MS Angle welded to both faces of frame.

4.3.6 40mmx150mmx3mm thick MS pad shall be welded to frame at all hinges and lock locations. 18 SWG GI mortar guard shall be provided at the back of hinges and lock.

4.3.7 The metallic surfaces shall be thoroughly cleaned of rust, mill scale, dirt, oil etc. and then finished with painting or powder coating as specified. If not specifically mentioned elsewhere, Finishing of the door assemblies shall be minimum 40 micron powder coating in desired colour. The thickness of powder coating shall be subjected to verification at site (on random basis) as directed by Engineer- in- Charge with appropriate measuring instruments supplied by contractor.

5.0 STEEL WINDOW & VENTILATORS

5.1 Steel window and ventilator assemblies shall have steel frames and shutters (glazed/with wire mesh/ with louvers as specified) with required hardware. For further details reference shall be made to EIL Standard Nos.7-75-0025, 7-75-0027 to 7-75-0032.

5.2 Steel windows and ventilators shall in general conform to IS 1038 and IS 1361.

5.3 Materials/ Assembly components

5.3.1 Frame and shutter shall be made of rolled steel sections conforming to IS: 7452.

5.3.2 Glass for glazed shutters shall be as specified. If nothing is mentioned specifically, minimum 5 mm thick toughened glass shall be provided.

5.3.3 Louvers shall be made of 18 SWG MS steel profiled sheets.

5.3.4 Wire mesh shall be of stainless steel (SS-304 grade) or wire of galvanized steel as specified. If nothing is mentioned specifically, stainless steel wire mesh shall be provided.

Copyright EIL – All rights reserved

5.4 Hardware

5.4.1 All hardware required for smooth operation, durability and safety such as handles, Peg-stays, hinges, closure of shutters etc. shall be provided.

5.5 Fabrication & Installation

5.5.1 Steel window and ventilator assemblies shall be true to the plumb, size and design and smooth operation shall be ensured.

5.5.2 All metallic components shall be shall be welded together. Joints between horizontal and vertical frame members shall be mitred. All welding shall be finished smooth.

5.5.3 Frames shall be fixed in the opening by means of 100mm x 15mm x 6 mm thick MS lugs @ grouted with M-20 grade concrete or with minimum 100 mm long, 12 mm dia metallic counter sunk type anchor fasteners. when fixing to steel work, mastic shall be applied to the sill of the opening and the unit shall be placed on it with the jambs and head buttered with mastic and the unit shall be fixed with special fixing dips or with nuts and bolts.

5.5.4 Where larger units are to be formed by coupling individual units, the mullions, transoms shall be bedded in mastic to ensure weather tightness. Mastic shall be applied liberally to the channels of the outside frame sections before assembly, and the two units being coupled shall be drawn together tight with clamps, the mastic being squeezed out and cut off neatly when the units shall be screwed together tight.

5.5.5 Where fixed glazing units are placed over openable units, a push fit weather bar shall be provided.

5.5.6 Before glazing, all opening parts shall be checked for their operational smoothness. The frame shall be completely cleaned and bedding putty shall be placed in the rebate before glazing. Glass then shall be cushioned into the bedding and shall be fronted with front putty in a manner so as to enable the painting to be done up to the sight line. The back putty oozing out over the glazing rebate shall be cut off square and smoothed down.

5.5.7 For panels exceeding 600 x 300 mm in size, glass shall be secured by special glazing clips inserted in holes already provided in the steel sections, before applying the front putty.

5.5.8 For glazing of very large areas, rust proof steel beading with mitred corners shall be provided with screws @ 10 cm. from each corner and @ 20 cm. apart from each other. Putty shall be provided to the face of the bead in contact with glass, in addition to back putty.

5.5.9 Side hung shutters shall be connected to the frame by means of friction hinges. The handle for side hung shutters shall be of pressed brass mounted on a steel handle plate welded to the opening shutter frame and shall not be removable easily after glazing. The handle shall have a two point nose which shall engage with a brass striking plate on the fixed frame in a slightly open as well as in a fixed position.

5.5.10 Top hung shutters shall be provided with steel butt hinges welded to the fixed frame after cutting a slot in it. Top hung casements shall be provided with peg stay of 3 holes of pressed brass; 300 mm long which when closed shall be held tightly by the locking bracket fitted to the fixed frame or to the window.

Copyright EIL – All rights reserved

5.5.11 All the steel surfaces shall be thoroughly cleaned free of rust, mill scale, dirt, oil etc. by sand and shot blasting and then finished with painting by priming with red oxide zinc chromate primer conforming to IS:2074 and minimum two coats of synthetic enamel paint conforming to IS:1477 (Part II). Putty shall also be provided with painting in a manner so as to seal the putty glass junction. Surfaces not meant for painting shall be cleaned of any strains of paint.

6.0 ALUMINIUM DOORS, WINDOWS AND VENTILATORS

6.1 Aluminium door, window and ventilator assemblies (glazed/with wire mesh/ with louvers as specified) shall have frames and shutters made of extruded profiled tubular Aluminium sections with required hardware. Aluminium window shutters shall be side hung or sliding type as mentioned in the design basis, job specifications or construction drawings. For further details reference shall be made to EIL Standard Nos. 7-75-0014, 7-75-0015, 7-75-0016, 7-75-0017 etc.

6.2 Materials/ Assembly components

6.2.1 Aluminium sections shall be extruded profiled tubular sections of approved Manufacturers having aluminium alloy as per IS: 733 and IS: 1285.

6.2.2 Aluminium sections shall be anodised as per IS: 7088 or electrostatically powder coated to as specified. The thickness of anodizing/ powder coating shall be subjected to verification at site (on random basis) as directed by Engineer- in- Charge with appropriate measuring instruments supplied by contractor.

6.2.3 If not mentioned specifically, the finishing of Aluminium sections shall be of powder coating in approved colour.

6.2.4 Thickness of powder coating shall be as specified. If not specified the minimum thickness shall be 50 micron.

6.2.5 Glass used for glazing shall be as specified. If not mentioned specifically minimum 5 mm thick toughened glass conforming to IS: 2835 shall be provided.

6.2.6 Louvers shall be made of 2 mm thick bend and profiled Aluminium sheets framed suitably and shall be fixed to the door/ window/ ventilator frame. The profiles and spacing of louver blades/ sheets shall ensure prevention of water ingress.

6.2.7 Wire mesh shall be of stainless steel (SS-304 grade) or wire of galvanized steel as specified. If nothing is mentioned specifically, stainless steel wire mesh shall be provided.

6.3 Hardware

6.3.1 If not specifically mentioned, following hardware shall be provided in the Aluminium door assemblies.

Hardware	Specification
Hydraulic door closer	1 no. heavy duty hydraulic door closer confirming to IS 3564 for each shutter .
Tower/ Flush bolt	1 no. 10mm dia aluminium or stainless steel (SS-304 grade), 250mm long upto 2100mm high door and 600mm long upto 2500 mm high door) for each shutter on both sides.

Copyright EIL – All rights reserved

	For large size door (width- above 2000mm to 3000mm, height- above 2500mm to 3000mm), tower/ flush bolt shall be upto 1400mm long and shall be surface mounted or concealed type. Finishing of Aluminium tower/ flush bolts shall be similar to aluminum profiled sections of the door assembly.
Door Handle	1 no. 10mm dia aluminium or stainless steel (SS-304 grade), minimum 250mm long for each shutter on both sides. For large doors, longer door handles shall be provided as mentioned in design basis, job specification or construction drawings. Finishing of Aluminium handles shall be similar to aluminum profiled sections of the door assembly.
Door Stopper	1 no. spring loaded heavy duty door stopper for each shutter.
Double action hydraulic floor spring	1 no for each shutter conforming to IS 6315 with double spring mechanism and pivot.
Lock	Brass body, minimum 4 lever

Note: In case of Aluminum doors, either Double action hydraulic floor spring as per IS 6315 or Hydraulic door closer as per IS 3564 will be applicable.

6.3.2 If not mentioned elsewhere, window/ ventilator assemblies shall be provided with hardware such as hinges, handles, peg-stays, tower/flush bolts, sliding mechanism etc. as required for safety, operation and durability.

6.3.3 If not mentioned elsewhere, visible hardware shall be of Aluminium having finishing similar to aluminum profiled sections of the window/ ventilator assembly.

6.4 Fabrication & Installation

6.4.1 Frames and shutters shall be square and flat, the corner of the frame being fabricated to true right angles. Aluminium sections of frames, shutters etc. shall be mitred and jointed rigidly.Details of construction of frames, shutters etc. shall be as per construction drawings and EIL standards.

6.4.2 In case of composite Door/window/ventilator units, the units shall be coupled as per drawing. Weather bar shall be provided whenever a coupling member is fitted over an external opening shutter.

6.4.3 The Aluminium frames shall be fixed in the openings by means of aluminium lugs fixed to the frame (by counter sunk brass machine screws) and grouted with concrete or by means of anchor fasteners.

6.4.4 Glazing shall be fixed to the extruded sections by means of extruded Aluminium beading. Glass panes shall be provided with EPDM gasket/rubber lining before fixing.

6.4.5 Side hung window shutters shall be fixed to the frame with pivots or hinges.

6.4.6 Gaps at the junction of opening and frame shall be filled up with weather silicon sealant.

Copyright EIL – All rights reserved

7.0 STEEL, ALUMINIUM ROLLING SHUTTERS

7.1 Rolling shutters shall be of steel or Aluminium as specified and shall conform to IS 6248.

7.2 Rolling shutters shall be push or pull type or operated by mechanical means or by electrical motors as specified. However, rolling shutter beyond 10 square metre in area shall not be push and pull type. If nothing is mentioned specifically, rolling shutters shall be electrical motor operated type.

7.4 Steel Rolling Shutters

7.4.1 Rolling shutter components

Components of steel rolling shutters shall have following specification.

1. Shutter

Shutter shall be built-up of inter locking lath section formed from cold rolled steel strips.

The thickness of the steel strips shall not be less than 0.90 mm for shutters upto 3.5 m width.

The lath sections shall have interlocking curls at both the edges and deep corrugation at the centre with a bridge depth of minimum 12 mm.

Each lath section shall be a continuous single piece without any welded joint.

When interlocked, the lath sections shall have a distance of 75mm rolling centers.

Each alternate lath sections shall be fitted with MS clips securely riveted at either ends to prevent lateral movement of the individual lath sections.

2. Guide channels

Guide channels shall be of mild steel . Width shall be minimum 25mm. Minimum depth (shutter clear width wise) shall be as below :

Upto 3.5 metre wide shutter – 65mm
3.5 metre to 8 metres – 75mm
8 metre and above – 100mm

The gap between the two legs of the guide channels shall be sufficient to allow free movement of the shutter and at tthe same time close enough to prevent rattling of the shutter.

3. Roller and brackets

The suspension shaft of the roller shall be heavy duty steel pipe conforming to IS 1161.

For shutter upto 6 metre width and height not exceeding 5 mitre, steel pipe of minimum 50 mm nominal bore shall be used.The shaft shall be supported on MS brackets.

Size of the brackets shall be minimum 375mm x 375mm x 3.15 for shutters upto clear height of 3.5 metre, minimum 500mm x 500mm x 10mm for clear height above 3.5 metre and upto 6.5 metre.

The suspension shaft shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and the pipe shaft shall be connected by means of pretensioned helical

Copyright EIL – All rights reserved

springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5 metre, the pullies shall be interconnected with a cage formed out of MS flats and dummy rings to distribute the torque uniformly. Self aligning two row ball bearing with cast iron casing shall be provided at the extreme pully.

4. Spring

The spring shall be built of coiled type manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454-part I

5. Cover

Top cover shall be of mild steel sheets not less than 0.90mm thick and shall be stiffened with MS angle or flat stiffeners.

6. Hardware

Lock plates with sliding bolts, handles and anchoring rods conforming to IS 6248 shall be provided.

7. Grills

If specifically mentioned, rolling grills shall be provided in the shutter. In general, height of grill portion shall not exceed 500mm. In case of grills at multiple locations, cumulative height of the grill portions shall not exceed 1000mm. Grills shall be made of 8 mm dia MS round bars.

8. Finishing

All metallic parts shall be painted with minimum 2 coats of red oxide zinc chromate primer conforming to IS 2075. Visible parts shall be further painted with minimum two coats of synthetic enamel paint conforming to IS 2933.

7.4.2 Sizes and dimensions of various components mentioned in above clause are for normal conditions. For larger sizes and windy locations, the sizes and dimensions shall be suitably modified as directed by the Engineer-In-Chief.

7.4.3 Mechanically operated rolling shutters shall have suitable gear mechanism for smooth operation.

7.4.4 Motor operated rolling shutters shall be provided with necessary and suitable electrical fittings like motors, switch panel, switches, wires, cables etc. all complete and conforming to India standards.

7.4.5 Installation

Rolling shutters shall be installed true to the plane and fixed in the opening ensuring smooth operation as per IS 6248.

7.5 ALUMINIUM ROLLING SHUTTER

7.5.1 Aluminium Rolling Shutters shall be motorized gear operated and either double walled Insulated type or non- insulated type as specified complete with all accessories.

Copyright EIL – All rights reserved

The Brackets and hood cover shall conform to IS: 6248. The clear opening dimensions shall not exceed 5000 mm x 5000 mm.
The motorised rolling shutters shall be suitable for electrical motor operation (automatic) as well as manual operation with chain-wheel & hand chain. The rolling shutters shall be provided with mechanical reduction / bevel gear box for operation either mechanically or with electrical device.

7.5.2 Rolling shutter components

Components of Aluminium rolling shutters shall have following specification.

1. Shutter curtain

The shutter curtain shall be fabricated using aluminium alloy profiled slats. Aluminium alloy shall have composition of Magnesium 0.4-0.9 %, Silicon 0.3-0.7 %, Manganese 0.3% (maximum) and remaining Aluminium. Aluminium Alloy shall have UTS (Ultimate tensile strength) – 19 Kg/mm2 and Elongation – Min 7%.

The surface of these aluminium alloy shall be micro ribbed with the ends of alternate profiles fitted with end locks to prevent lateral movements of the laths.

The shutter curtains shall have interlocking aluminium alloy slats with integral bottom lock plate.

The non-insulated shutter curtains shall generally be of 80mm x18mm (minimum size) double-walled /skinned slats and the insulated shutter curtains shall be 80mm x 18mm double-walled / skinned slats (minimum size) with thermal PUF (Polyurethane Foam) insulation packing (within the walls).

The PUF packing shall be tight enough so as to fill all irregular voids and at joints. The PUF shall be non-toxic and fire retardant / self-extinguishing. The PUF density shall not be less than 40 kg / cu. meter and its thermal properties & characteristics shall be in accordance with IS-12436

2. Bracket

The bracket shall be made of mild steel conforming to relevant IS having minimum size of 350 mm x 350 mm x 3 mm thick for clear opening dimensions up to 4000 mm x 4000 mm & 350 mm x 350 mm x 4 mm thick for clear opening dimensions beyond 4000 mm x 4000 mm and up to 5000 mm x 5000 mm.

3. Shaft

MS Pipes used for the suspension shaft of the roller shall be heavy duty pipe suitable for mechanical purposes and shall conform to IS: 1239. Minimum diameter shall be 100mm.

4. Side Guides/ Channels

The side guides/ channels shall be joint less (single piece construction) made of aluminium alloy of minimum 3mm thickness. The guide rails shall be provided with PVC / Rubber / Brush seals to ensure silent shutter travel & effective sealing. Size shall be 105mm x 42mm or as required.

Copyright EIL – All rights reserved

5. Bottom Profile

Aluminium Bottom bar / locking plate shall be minimum 100mm high having a special non-degradable neoprene / rubber profile for providing a complete sealing upon closure.

6. Hood & Side-Motor Cover

The covers shall be made of painted GI sheets not less than 0.8 mm thick. They shall be of rectangular or cylindrical contour depending on the contour of the bracket / end plate. The hood cover shall be stiffened with angle or flat stiffeners at top and bottom edges to retain shape. The hood cover shall be fixed to the bracket plate by means of angle cleats and supported at the top at suitable intervals for preventing sagging. The hood & motor/actuator assembly - covering shall be a water-tight arrangement for ensuring no water seeps through to the internal mechanical & electrical components. Adequate slopes & guide-ways are to be provided to avoid any water accumulation on the hood-covers.

7.5.3 Finishing

All components of rolling shutter except springs and inside of guide channel shall be thoroughly cleaned with a mild non-corrosive chemical to free the substrate of rust, mill-scale, dirt, oil, etc.

Aluminium sections and other visible metallic surfaces shall be electrostatically powder coated (approved colour) to minimum 50 microns. The thickness of powder coating shall be subjected to verification at site (on random basis) as directed by Engineer- in- Charge with appropriate measuring instruments supplied by contractor.

All coated surfaces shall be free from flaking / peeling. Each shutter shall be clearly and legibly marked with the Manufacturer's Name or Trade Mark / Shutter Size / Year of Manufacture.

7.5.4 Electrical Operation of Rolling shutter

The rolling shutters shall be operated by electric motor actuators - operating on 415 Volts, 3-phase or 240 Volts, 1-phase - 50 Hz. AC supply.

All associated electrical components for motor control shall be compatible for working at the above mentioned voltage profile. The motor shall be of side-mounted type installed in alignment with the roller shaft inside the shaft-hood or adjacent to the rolling-shutter box. In either case, the rolling shutter motor & actuator assembly enclosure shall have IP-55 (or better) ingress protection against water & dust. The rolling shutter motor shall be rated for intermittent periodic duty (Duty Type – S3) or intermittent periodic duty with starting (Duty Type – S4). Arrangements shall also be made for emergency manual operation of the rolling shutter with mechanical reduction-gear, wheel & hand-chain override assembly - in the event of failure of the electric equipment or electricity.

For buildings in safe area, all electrical equipment's shall be in weatherproof executive with IP-54 protection for direct drive and IP 44 Protection for indirect drive ingress protection.

For buildings in hazardous are, if specified in Tender/MR, following shall be ensured:

Copyright EIL – All rights reserved

1. For hazardous area buildings, all electrical equipment's such as motor, actuators, push button control stations, PDB/Local panels etc. shall be flameproof type Exd suitable for applicable Gas Group and Temperature Class.

2. All hazardous area equipment shall have test certificates issued by recognised independent test house (CIMFR/ERTL/BASEEFA/LCEI/UL/FM/KLP or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by recognised testing agencies. All equipment (indigenous & imported) shall have valid statutory approval (e.g. PESO/DGMS etc.) as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

Make of all hazardous area equipment (for hazardous area building) and weatherproof equipment (for safe area building) shall be approved by owner / Engineer-In-Charge before selection & order placement. The motor shall be heavy duty type & sturdy - suitable for lifting shutters weighing up to 600 kilograms. The motors shall have BIS or equivalent approvals & relevant performance guarantee track records. The motor drive unit for the rolling shutter shall be complete with Drive-Chain / Gear, Plate-Wheel, Bush, Drive-Sprockets, mounting base-plates, integrated safety brakes & limit-switches, etc. Ideally all metallic components of the drive system shall be constructed out of non-corrosive high-grade stainless steel.The motor speed shall be regulated with gear drives such that the speed of the shutter (during up & down movement) for indirect drive shall be up to 0.05 m/s .The motor operating time within the intermittent duty cycle shall be long enough to ensure that the motor does not get heated up excessively, thereby resulting in tripping and / or damaging of motor windings for up to three continuous up & down (full height traverse) operation of the rolling shutter.

The motor shall be automatically protected from thermal overload by internal thermal probes / overload relays. The motor shall be compact and motor operation shall be with minimum of noise & vibration. Ideally, the motor controls (including motor-starter / over-load protections / contactors / etc) shall be placed within the motor-actuator enclosure.

The automation of the shutter shall have local control with a directional push button control station flush-mounted with the wall-surface, with 3 buttons marked UP, DOWN and STOP. The STOP Button must be of Mushroom-head type with lockable arrangement & push to release type. All the push-buttons shall be of latching type (single press & release) – without the need to continuously press the buttons during the traverse time of the shutter. The shutter traversing shall be prohibited if the STOP button is pressed & locked. The push-button unit shall have an enclosure with a minimum degree of IP-44 dust & water protection

7.5.5 Installation

Rolling shutters shall be installed true to the plane and fixed in the opening ensuring smooth operation as per IS 6248.

All fixing / mounting accessories shall be made of stainless steel only.

All necessary control wiring / cabling for the side-motor with the limit switches / controller panel shall be done with 3 / 5 core X 2.5 sq. mm. PVC insulated multi-stranded Copper Conductor armoured and flame retardant Low Smoke (FRLS) cables. All power cabling from PDB to the side motor shall be with 3 core X 4 sq. mm (minimum) Cu conductor, FRLS cable . Only fire rated & PVC insulated cables / wires with multi-stranded copper conductors shall be used for internal wiring of the motor / actuator / push-button. All cabling & wiring shall be concealed type with heavy-duty PVC conduits. Works include termination of the incoming power cable from the owner's Main Power Distribution Board to the motor / actuator /

Copyright EIL – All rights reserved

controller unit & all outgoing power & control cables from the controller panel to individual electrical components with supply & installation of cable glands & copper lugs of adequate sizes.

7.5.6 Mandatory & commissioning spares

The entire consignment of motorized rolling shutters for the shed / buildings shall be supplied with the following mandatory spares for each rolling shutter.

1. One set of the complete motor / actuator drive unit (of each rating) – duly assembled with limit switches, drive-chain / worm-gear, plate-wheels / bush / sprockets & mounting base-plates.
2. One set of motor controller (PCB / Controlling Unit).

8.0 MEASUREMENT

Doors, windows, ventilators and rolling shutters shall be measured in the following manner.

Pressed steel frames for doors	Length (vertical and horizontal members) in Running metres (RM)
Pressed steel door shutter	Actual shutter area in square metre (SqM)
Steel Windows/ ventilators with MS sections	Actual area of window/ ventilator in square metre (SqM)
Aluminium Doors/windows/ventilators	Aluminium sections by weight (Kg) Glazing - Actual area in square metre (SqM)
Rolling shutters	Actual area of Rolling shutter in square metre (SqM)
Loose hardware	In numbers

Copyright EIL – All rights reserved

पलस्तर एवं पॉइन्टिंग का मानक विनिर्देशन

STANDARD SPECIFICATION FOR PLASTERING & POINTING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
7	31.05.23	REVISED & ISSUED AS STANDARD SPECIFICATION	SANDEEP SHARMA	GURSHARAN JEET KAUR	SAMIR DAS	SANJAY MAZUMDAR
6	31.05.17	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AM	JS/ JKB	R. SRIVASTAVA	R. NANDA
5	05.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	SM	JKB	D. MALHOTRA
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V.CHATURVEDI
3	10.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS
2	16.03.94	REVISED & ISSUED STANDARD SPECIFICATION	JS	JS	AKG	AS

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Standards of Testing of Materials
BS	:	British Standards
EN	:	European Standards
IS	:	Indian Standards
ISO	:	International Organization for Standardization
NBC	:	National Building Code of India

Architecture Standards Committee

Convener : Mr. Samir Das

Members : Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Ms. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL....4
2.0 REFERENCES....4
3.0 TYPE AND THICKNESS OF PLASTERING....4
4.0 MATERIALS....5
5.0 PLAIN CENENT PLASTER....7
6.0 CEMENT PLASTER WITH WATER PROOFING COMPOUND....7
7.0 SAND FACE PLASTER....7
8.0 EXPOSED AGGREGATE FINISH....7
9.0 APPLICATION OF PLASTER....8
10.0 GYPSUM PLASTER....10
11.0 READY MIX PLASTER....10
12.0 POINTING....11
13.0 MEASUREMENT....12

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This specification covers requirements of plastering and pointing in civil work, on building or Architectural or structural elements and as interior or exterior finishing or decorations etc.

1.2 Unless otherwise specifically mentioned in design basis, job specification, drawings, item descriptions etc. all masonry, block work, RCC surfaces shall be plastered.

2.0 REFERENCES

The codes and standards listed below contain provisions, which through reference in this specification constitute provisions of this standard specification, if not explicitly mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document Title
IS: 1542	Sand for Plaster - Specification
IS: 1661	Code of Practice for application of cement and cement- lime plaster finishes
IS: 2114	Code of practice for laying in-situ terrazzo floor finish
IS: 2250	Code of Practice for Preparation and Use of Masonry Mortars
IS: 2386 (Part 2)	Methods of test for aggregates for Concrete Part II: Estimation of Deleterious materials and organic impurities
IS: 2402	Code of Practice for External Rendered Finishes
IS: 2542 (Part 1)	Methods of test for Gypsum plaster, Concrete and products, Part I - Plaster and Concrete
IS: 2547 (Part 2)	Specification for Gypsum building plasters, Part II - Premixed lightweight plasters.
IS: 2645	Integral waterproofing compounds for Cement Mortar and Concrete – Specification.
IS: 4031 (Part 1)	Methods of physical tests for hydraulic cement.

3.0 TYPE AND THICKNESS OF PLASTERING

3.1 Plastering shall be of plain cement plastering or plain cement plastering with waterproofing compound or Gypsum plastering or ready-mix plastering as mentioned in design basis, job specification, drawings, item descriptions etc.

Copyright EIL – All rights reserved

3.2 Unless otherwise specified in design basis, drawings, item descriptions, job specifications etc, the external surfaces shall be plastered with or plain cement plastering with waterproofing compound and internal surfaces shall be plastered with plain cement plastering.

3.3 Unless otherwise specified in design basis, drawings, item descriptions, job specifications etc, thickness of plastering shall be as per following table.

Type of plaster	Surface	Average thickness
Plain cement Plaster	Plumb surface of the internal masonry/ all block work walls & RCC Columns coming in line (flush) with this side of wall.	12 mm
Plain cement Plaster	Rough side of the internal masonry/ all block work walls & RCC Columns coming in line (flush) with this side of wall.	15mm
Plain cement Plaster with waterproofing compound	External surface	18 mm
Plain cement Plaster	Internal RCC surface	06 mm
Gypsum Plaster	Plumb surface of the internal masonry/ all block work walls & RCC Columns coming in line (flush) with this side of wall.	12 mm
Gypsum Plaster	Rough side of the internal masonry/ all block work walls & RCC Columns coming in line (flush) with this side of wall	12 -15 mm
Gypsum Plaster	Internal RCC surface	06 mm
Ready mix plaster	Similar to Plain cement plaster	Similar to plain cement plaster

Note:
However, if the undulation in the surface is beyond proper finishing with specified thickness of plaster, extra thickness of plaster shall be applied as required for proper finish without any extra cost.

4.0 MATERIALS

4.1 Cement

Cement shall conform to `Standard Specification for Civil and Structural Works- Materials' (Structural Specification no. 6-68-0002)

4.2 Sand

Sand for plaster and pointing shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these and shall conform to IS: 1542. Sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of silt, day bails or pellets. Sand shall not contain harmful impurities such as iron pyrites, coal particles, lignite, mica shale etc in such form or in quantities as to affect adversely the hardening, strength or durability of the mortar.

Copyright EIL – All rights reserved

The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand shall not exceed the following limits:

Clay, fine silt and fine dust when determined in accordance with IS 2386 (Part 2):

a. In natural sand or crushed gravel sand & crushed stone sand: Not more than 5% by mass

b. Organic impurities when determined in accordance with IS 2386 (Part 2): Color of the liquid shall be lighter than that indicated by standard specified in IS 2386 (Part-2)

Grading of sand for use in Plaster shall conform to IS 1542 (as below)

IS sieve designation	**Percentage passing**
10mm	100
4.75mm	95 to 100
2.36mm	95 to 100
1.18mm	90 to 100
600 micron	80 to 100
300 micron	20 to 65
150 micron	0 to 15

4.3 Water

Water for plastering and pointing shall conform to `Standard Specification for Civil and Structural Works- Materials' (Structural Specification no. 6-68-0002)

4.4 Cement Mortar

Cement mortar shall conform to `Standard Specification for Civil and Structural Works- Brick Masonry' (Structural Specification no. 6-68-0009) unless otherwise mentioned.

4.5 Cement Mortar with Waterproofing Compound

Waterproofing compound shall conform to IS: 2645 of approved make.

4.6 Gypsum Plaster

Gypsum plaster shall conform to IS 2542 (Part I) and IS 2547 (Part II). The plaster shall consist of retarded hemihydrate gypsum plaster and light weight aggregate. Other additions may be incorporated to impart desired properties.

4.7 Ready Mix Plaster

Ready Mix Plaster shall be ready mix cement plaster rendered with polymer additives, well graded sand and fillers. Compressive strength of the material shall be minimum 7.5 Mpa in 28 days as per IS: 2250.

Ready Mix Plaster shall be pre packed material requiring only water addition at site.

Copyright EIL – All rights reserved

5.0 PLAIN CEMENT PLASTER

5.1 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster. Proportions of ingredients of cement mortar for various thicknesses of plaster shall be as per following table:

20mm thick plaster	1 cement: 6 sand (by volume), in two layers
18mm thick plaster	1 cement: 6 sand (by volume), in two layers
15mm thick plaster	1 cement: 4 sand (by volume)
12mm thick plaster	1 cement: 4 sand (by volume)
06mm thick plaster	1 cement: 4 sand (by volume)

6.0 CEMENT PLASTER WITH WATERPROOFING COMPOUND

6.1 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used. Proportions of ingredients of cement mortar for various thicknesses of plaster shall be as per clause no 5.1

6.2 Waterproofing compound shall be mixed to cement mortar as recommended by the approved Manufacturer but @ 3% by weight as minimum.

7.0 SAND FACE PLASTER

7.1 Sand face plaster shall be 20mm thick consisting of 13 mm thick under layer and 7 mm thick top layer.

7.2 Under layer shall be 13 mm thick (1 cement: 4 sand, by volume) plain cement plaster.

7.3 Top layer shall be 7 mm thick (1 cement: 2 sand, by volume, granule size 2 to 2.5mm) plain cement plaster.

7.4 The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster.

7.2 Application of sand face plaster shall be as described in `two-layer plaster work' in clause no. 9.7. The surface of the sand face plaster shall be finished rough with sponge or as directed by the Engineer-in-charge.

8.0 EXPOSED AGGREGATE FINISH

8.1 Exposed aggregate finish plaster shall consist of 12 mm thick under layer and 20 mm thick top layer.

8.2 Under layer shall be 12 mm thick plain cement plaster (1 cement: 4 coarse sand, by volume) finished rough. The mortars of specified mix as per the specifications of 'Cement Mortar' (Refer clause 4.4) shall be used for plain cement plaster. The under layer shall be applied in accordance with `One layer plaster work' described in clause no. 9.6.

8.3 Top layer shall be 20 mm thick admixture of white cement and grey cement (mix. ratio 1:1 by volume) mixed with white/colored marble chips/pebbles (as required for desired shade/ colour

Copyright EIL – All rights reserved

of the finished surface) of 6mm to 12mm nominal size. Mix ratio shall be 1 cement: 1 marble chips/pebbles by volume. Marble dust @ 15% by volume with pigment (conforming to IS:2114, as required for obtaining desired colour/ shade of the finished surface) shall be added to the admixture.

The pebbles to be used shall be well washed and drained. The admixture shall be thrown wet on to the under layer while it is still plastic using strong whipping motion at right angles to the face of the wall.

One coat of neat cement slurry @ 2.75 kg cement per square meter of area shall be applied on to the under layer to receive the top layer.

The whole plastering shall be laid in panels of maximum 1200mm x 1200mm size or as per drawing with 12mm x 20mm grooves in between formed by holding removable wooden batons over the under layer.

Loose mortar etc. on the top surface shall be cleaned/removed by brushing/washing/spraying with water jet after initial setting of mortar.

9.0 APPLICATION OF PLASTER

9.1 Finishing

Plastered surface shall be plumb, without any undulations and defects such as cracks etc. Patterns/ grooves etc. shown in the drawing shall be provided. Any cracks, damages, any part of work which sound hollow when tapped or found damaged or defective otherwise shall be cut out in rectangular shape and redone as directed by Engineer-in-charge

9.2 Preparation of Background Surface

9.2.1 The background surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing.

9.2.2 Smooth surfaces shall be roughened by wire brushing or hacking for non-hard and hard surfaces respectively.

9.2.3 Projections on surfaces shall be trimmed wherever necessary to get even surfaces. In case of brick/stone masonry, raking of joints shall be carried out wherever necessary.

9.2.4 The background surface shall be allowed to dry out for sufficient period before carrying out the plaster work. The background surface shall not be soaked but only damped evenly thereafter before applying the plaster.

9.2.5 In case of concrete work, projecting blurs of mortar formed due to the gaps of joints in shuttering shall be removed. Such surface shall be scrubbed clean with wire brushes. The surface shall be pock marked with a pointed tool at spacing of not more than 50 mm centers, the pocks being made not less than 3 mm deep to ensure a proper key for the plaster. The surface shall be washed off and cleaned of all oil, grease etc. and well wetted before the plaster is applied.

Copyright EIL – All rights reserved

9.3 Sequence of Operations

9.3.1 The surfaces to be plastered, shall first be prepared as described in `Preparation of background surface' in clause no 9.2

9.3.2 For external plaster, the plastering operations shall be started from the top floor and carried downwards.

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

9.3.4 After a suitable time interval, the secondary layers if required shall be applied. After a further suitable time interval, the finishing coat shall be applied first to the ceiling and then to the walls.

9.3.5 Plastering of cornices, decorative features, etc. shall be completed before the finishing coat is applied.

9.4 Scaffolding/Staging

Scaffolding/staging for plastering/pointing shall be as per `Standard Specification for Civil and Structural Works- Brick Masonry' (Structural Specification no. 6-68-0009)

9.5 Chicken Wire Mesh

150mm wide, closely knit, 20-gauge chicken wire mesh stretched tight and fixed with G.I. "U" type nails shall be provided at all the masonry/ block work and RCC joints.

9.6 One Layer Plaster Work

9.6.1 To ensure even, specified thickness, plaster of 150 mm x 150 mm shall be first applied horizontally and vertically at not more than 2-meter interval over the entire surface to serve as gauges.

9.6.2 The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time.

9.6.3 Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided.

9.6.4 All corners, arises. angles and junctions shall be truly vertical/ horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc. shall be carried out with proper templates to the size required.

9.6.5 In suspending the work, the plaster shall be left cut clean to line, both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area.

Copyright EIL – All rights reserved

9.6.6 Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

9.7 Two Layer Plaster Work

9.7.1 The first or under layer of the specified thickness shall be applied as described in clause no. 9.6.

9.7.2 Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

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

9.8 Curing of plaster

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages at the contractor's expense by such means as approved by the Engineer-in-charge. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

10.0 GYPSUM PLASTER

10.1 Gypsum plastering shall be done using premixed gypsum plaster and aggregates as mentioned in clause no. 4.6

10.2 Preparation of Gypsum plaster shall be in accordance with approved Manufacturer's standard and recommended practice. The powder (gypsum plaster) shall be mixed with clean water in clean plastic buckets to avoid mixing with impurities, ensuring thorough mixing by help of mixing rod so as to avoid formation of lumps and unmixed residues. The water to plaster ratio should be maintained as per approved manufacturer's specification.

10.3 Application of Gypsum plaster shall be in accordance with clause nos. 9.1 to 9.7

10.4 Curing

There is no requirement of curing. Gypsum plaster dries in 3 days, after which painting can be done directly over the finished surface.

11.0 READY MIX PLASTER

11.1 Ready-mix plastering shall be done using pre packed plaster ingredients as mentioned in clause 4.7

11.2 The powder (ready mix) shall be mixed with clean water, preferably in clean plastic buckets to avoid mixing with impurities, ensuring thorough mixing by help of mixing rod or mechanical

Copyright EIL – All rights reserved

stirring for 2-3 minutes as to avoid formation of lumps and unmixed residues. The water to plaster ratio shall be maintained as per approved manufacturer's specification.

11.3 Application of ready-mix plaster shall be in accordance with clause nos. 9.1 to 9.7. The plaster mix shall be applied within the time (after preparation of the mix) recommended by the approved Manufacturer. Curing shall be done in accordance with clause no 9.8 or as recommended by the approved Manufacturer as approved by the Engineer-In-Charge.

11.4 Curing

Curing shall be done in accordance with clause no 9.8 or as recommended by the approved Manufacturer and as approved by the Engineer-In-Charge.

12.0 POINTING

Pointing shall be of the type specified such as flush, cut or weather struck, raised and cut etc.

12.1 Preparation of Base Surface

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall be less than 20 mm.

12.2 Cement Mortar

Cement Mortar shall be in accordance with the specifications of cement mortar described in clause no. 4.4.

12.3 Application of Mortar and Finishing

The cement mortar (1 cement: 4 sand, by volume) shall be pressed into the raked out joints with a pointing trowel according to the type of pointing specified. The mortar shall be spread over the corner edges or surfaces of the masonry. The pointing shall then be finished with the pointed tool. The superfluous mortar shall be cut off from the edges.

12.4 Flush Pointing

The cement mortar shall be pressed into joints and shall be finished off flush and leveled. The edges shall be neatly trimmed with trowel and straight edges.

12.5 Cut or Weather Struck Pointing

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 15 mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall also be similarly pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles in case of brick & coursed rubble masonry.

Copyright EIL – All rights reserved

12.6 Raised and Cut Pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm and width 10 mm more as directed. The pointing shall be finished to a smooth but hard surface.

12.7 Curing

Curing shall be as described in clause no. 9.8

13.0 MEASUREMENT

13.1 Plastering shall be measured by the area of actual plastered surface.

13.2 Pointing shall be measured by the actual area of the surface on which pointing is done.

Copyright EIL – All rights reserved

छत उपचार का मानक विनिर्देशन

STANDARD SPECIFICATION FOR ROOF TREATMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
7	10.05.22	REVISED AND ISSUED AS STANDARD SPECIFICATION	SANDEEP SHARMA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	12.01.18	REVISED AND ISSUED AS STANDARD SPECIFICATION	SG	JS/SD	RS	R NANDA
5	15.05.12	REVISED AND ISSUED AS STANDARD SPECIFICATION	MKV	SM	JKB	VK D MALHOTRA
4	21.03.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI
3	10.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Standards of Testing of Materials
BS	:	British Standards
EN	:	European Standards
IS	:	Indian Standards
ISO	:	International Organization for Standardization
NBC	:	National building Code
NFPA	:	National Fire Protection Association
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
PUF	:	Polyurethane
CuM	:	Cubic Meter
GSM	:	Grams per square meter
PCC	:	Plain cement concrete
Sq.M	:	Square meter
MPa	:	Mega Pascal

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4

2.0 REFERENCES 4

3.0 ROOF WATERPROOFING SYSTEMS 5

4.0 POLYMER MODIFIED BITUMINOUS ROOF WATER PROOFING 5

5.0 POLYURETHANE (PU) WATERPROOF COATING (SINGLE COMPONENT) 9

6.0 WATERPROOFING CUM INSULATION SYSTEM 14

7.0 DELIVERABLES BY THE CONTRACTOR 17

8.0 WARRANTY 17

9.0 MEASURMENT 17

Copyright EIL – All rights reserved

3.0 ROOF WATER PROOFING SYSTEMS

3.1 General

3.1.1 Roof waterproofing system shall be a complete system including base preparation and top finishing ensuring leak proof, water tight roof/ terrace surface and efficient rain water drainage. Following types of roof waterproofing systems shall be provided as specified in design basis, job specifications, item descriptions, drawings etc.

1. Polymer modified bituminous (APP) roof waterproofing system.
2. Polyurethane (PU) coating (single component) waterproofing system.
3. Waterproofing cum insulation system.

If roof waterproofing system is not mentioned specifically, the roofing treatment system shall be provided as below :

1. Polymer modified bituminous (APP) roof waterproofing system shall be provided in case of buildings which are not centrally air conditioned.
2. For centrally air conditioned buildings, Waterproof cum insulation system shall be provided.

3.1.2 The roof waterproofing system shall be leak-proof, water tight, properly finished and levelled with necessary slope for efficient roof water drainage.

3.1.3 All waterproofing materials of the system shall be from a single approved Manufacturer. Mix of waterproofing materials procured from different Manufacturers shall not be permitted.

3.1.4 The roof waterproofing system shall be laid by agencies approved by Engineer-In-Charge.

4.0 POLYMER MODIFIED BITUMINOUS (APP) ROOF WATER PROOFING SYSTEM

APP (Atactic Polypropylene polymer) roof waterproofing system shall consist of cement concrete screed on prepared base, primer coat, Bituminous (APP) membrane and a top protective finishing layer.

4.1 Materials

4.1.1 Cement concrete screed

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete .Thickness of the screed shall be minimum 50 mm. Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

4.1.2 Primer

Bituminous solvent based primer of approved quality conforming to IS: 3384 or ASTM D41.

4.1.3 Bituminous membrane for waterproofing

Bituminous membrane for waterproofing shall be 4 mm thick prefabricated polymer (APP-Atactic Polypropylene) modified and shall be reinforced with nonwoven Polyester and shall have following properties.

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of water proofing treatment for RCC roofs and terraces of buildings.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
ASTM C165	Standard Test Method for Measuring Compressive Properties of Thermal Insulations
ASTM C177	Standard Test For Measuring the Thermal Conductivity of a Material by Means of a Guarded-hot-plate Apparatus.
ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
ASTM C518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C836	Standard Specification for High Solids Content, Cold Liquid- Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM C1363	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
ASTM D5	Standard Test Method for Penetration of Bituminous Materials
ASTM D36	Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Damp-proofing, and Waterproofing
ASTM D146	Standard Test Methods for Sampling and Testing Bitumen- Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1623	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D1970	Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2842	Standard Test Method for Water Absorption of Rigid Cellular Plastics
ASTM D6226	Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM D7425	Standard Specification for Spray Polyurethane Foam Used for Roofing Applications
IS 3384	Bitumen primer for use in waterproofing and damp-proofing
IS12432 (Part-3)	Indian Standard Application of Spray Applied Insulation - Code of Practice

Copyright EIL – All rights reserved

Property	Value	Testing Method
Thickness	4 mm	ASTM D751
Penetration at 25deg. C, 100g, 5 seconds	25 +/- 5 mm	ASTM D5
Softening point	110 to 155 deg C	ASTM D36
Low Temp. Flexibility	-2 deg C to -10 deg C	ASTM D1970
Tensile strength		
- Longitudinal	> 500 N/ 5cm	ASTM D146
- Transverse	> 450 N/ 5cm	ASTM D146
Elongation		
- Longitudinal	> 40%	ASTM D146
- Transverse	> 40%	ASTM D146
Water absorption	0.12% max.	ASTM D570

4.1.4 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade Concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm.

4.2 Workmanship

4.2.1 The waterproofing system shall be laid in accordance with approved Manufacturer's standard practice as approved by Engineer-In-Charge and following clauses.

4.2.2 In order to avoid damages in the roofing system, the system shall be laid after the pedestals, structures etc. to be placed on the roof/ terrace are done.

4.2.3 Any pipes or openings / protrusions which are required to be provided on the roof shall be provided prior to taking up the base surface preparation.

4.2.4 The system application shall be done at suitable weather condition as mentioned/ recommended in the product data sheet etc. of the materials / system.

4.2.5 Base surface preparation

a. The entire base surface of the roof/ terrace shall be thoroughly cleaned with wire brush or mechanically and all foreign matter including loose concrete etc. shall be removed.

b. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with polymerised mastic or a paste of liquid single component elastomeric waterproofing and fine sand mix or with Polysulphide Sealant.

c. Potholes or depressions shall be filled up after removing weak cement concrete or cement plaster etc. with PCC (1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) or M15 grade concrete laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, to achieve a smooth prepared surface.

d. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate

Copyright EIL – All rights reserved

4.2.6 Screed

a. PCC or M15 grade concrete screed shall be laid over prepared base surface in required slope. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The screed shall be finished and cured to receive the primer coat. The screed layer and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

4.2.7 Primer coat

a. The finished and cured screed shall be cleaned and Bituminous solvent based primer shall be applied over the entire area to be waterproofed including abutting vertical surfaces.

b. If required, the surface of the screed layer shall be prepared in accordance with clause no 4.2.5.

c. Primer coat shall be cold applied. Minimum coverage shall be 0.2 to 0.4 litre per square metre.

d. The primer coat shall be allowed to dry for minimum 24 hours.

4.2.8 Fixing of APP membrane

a. The APP polymer modified bituminous membrane shall be laid over the primer coat by torch welding. The membrane shall be properly pressed during laying to remove any entrapped air.

b. The joints should be sealed properly with necessary side laps of 100 mm and end laps of 150 mm.

c. The membrane shall be continued along the vertical surfaces up to a minimum height of 300mm above the fillet/ coving. The continued membrane shall be terminated in minimum 20 mm x 10 mm chase to be provided in the vertical surface and shall be sealed with approved quality polyurethane sealant. Alternatively, the membrane can be continued over the entire vertical surface and suitably covered by coping at top.

d. After the membrane is laid, water ponding test for leakage shall be done on waterproof treated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 metre x 2 metre and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge

4.2.9 Top protective finishing layer

a. The top protective finishing layer of PCC or M15 grade concrete (minimum 50 mm thick) with chicken wire mesh shall be laid over APP membrane without sprinkling of clean sand. The finished surface shall be in desired slope.

Copyright EIL – All rights reserved

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The PCC or M15 grade concrete shall be laid in panels of maximum 1200 x 1200 mm size.

e. The PCC or M15 grade concrete and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

f. The joints between panels shall be raked out neatly (after stipulated curing period) to a minimum 10mm X 10mm V groove and shall be filled up approved quality polyurethane sealant.

e. Khura (minimum size 450 mm x 450 mm) shall be provided at every rain water outlets.

4.2.10 Finishing of waterproofing treatment over parapets/ vertical surfaces

APP membrane continued over parapets/ vertical surfaces shall be finished with minimum 12 mm thick plaster.

4.2.11 Waterproofing treatment in RCC gutters

a. Water proofing treatment over Parapets/ Vertical surfaces of gutter shall comprise of APP membrane continued over parapets/ vertical surfaces finished with minimum 12 mm thick plaster.

b. Waterproofing treatment on horizontal surface of gutter shall comprise of screed of PCC or approved light weight material such as cinder concrete, APP waterproofing membrane and top finishing layer of plaster or PCC or M15 grade concrete as approved.

c. Base horizontal surface shall be prepared in accordance with clause 4.2.5

d. Necessary slope shall be provided by means of PCC or M15 grade concrete or approved light weight material such as cinder concrete.

e. APP membrane over roof surface shall be continued over the sloped surface and continued on vertical parapet of the gutter and inside the rain water pipes similar to roof application of the APP membrane.

f. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

g. After the membrane is laid, water ponding test for leakage in the gutter shall be done as directed by Engineer-In-Charge by making sand/mud bundhs and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

Copyright EIL – All rights reserved

h. APP membrane shall be finished with minimum 12 mm thick plaster or PCC as approved. PCC or M15 grade concrete shall be laid in accordance with clause 4.2.9

4.3 Testing

Test for leakage shall be done in two stages.

Stage 1:

After the APP membrane is laid, water ponding test for leakage shall be done on waterproof treated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top protective finishing layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.0 POLYURETHANE (PU) COATING (SINGLE COMPONENT) WATERPROOFING SYSTEM

Single component PU waterproofing system shall consist of cement concrete screed on prepared base, primer coat, PU waterproof coating, Geo-textile membrane and a top protective finishing layer.

5.1 Materials

5.1.1 Cement concrete screed

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete. Thickness of the screed shall be minimum 50 mm. Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

5.1.2 Primer

Primer shall be polyurethane primer compatible to single component Polyurethane water proofing coating (which shall be applied over the primer) and shall be as per approved Manufacturer/ system provider's standard specification and as approved by Engineer-In-Charge.

5.1.3 Polyurethane (PU) water proofing coating

Copyright EIL – All rights reserved

Polyurethane water proofing coating/ membrane shall be single component (moisture cured, elastomeric, free from bitumen and tar) viscous liquid containing urethane polymers having following properties:

Property	Value	Testing Method
Solid content	Minimum 85%	ASTM C 836
Elongation	Minimum 400%	ASTM D 412
Tensile Strength	2-3 MPa	ASTM D 412

5.1.4 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm.

5.1.5 Geo-textile membrane

Geo textile membrane shall be of 150 GSM (grams per square meter) as per approved Manufacture/ system provider's specification and as approved by Engineer-In-Charge.

5.2 Workmanship

5.2.1 The waterproofing system shall be laid in accordance with approved Manufacturer's standard practice as approved by Engineer-In-Charge and following clauses.

5.2.2 In order to avoid damages in the roofing system, the system shall be laid after the pedestals, structures etc. to be placed on the roof/ terrace are done.

5.2.3 Any pipes or openings / protrusions which are required to be provided on the roof shall be provided prior to taking up the base surface preparation.

5.2.4 The system application shall be done at suitable weather condition as mentioned/ recommended in the product data sheet etc. of the materials / system.

5.2.5 Base surface preparation

e. The entire base surface of the roof/ terrace shall be thoroughly cleaned with ire brush or mechanically and all foreign matter including loose concrete etc. shall be removed.

f. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with polymerised mastic or a paste of liquid single component elastomeric waterproofing and fine sand mix or with Polysulphide Sealant.

g. Potholes or depressions shall be filled up after removing weak cement concrete or cement plaster etc. with PCC (1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) or M15 grade concrete laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, to achieve a smooth prepared surface.

h. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate

5.2.6 Screed

Copyright EIL – All rights reserved

a. PCC or M15 grade concrete screed shall be laid over prepared base surface in required slope. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

c. The screed shall be finished and cured to receive the primer coat. The screed layer and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

5.2.7 Primer coat

Polyurethane primer shall be brush applied @ 6-8 square meter area/ Litre over the entire prepared roof surface.

5.2.8 Polyurethane (PU) water proofing coating

a. Polyurethane water proofing coating of specified thickness shall be spray or brush applied as directed by Engineer-In-Charge in minimum two layers over primer. If thickness is not mentioned specifically, thickness shall be minimum 1.5 mm DFT (dry film thickness)

b. Scrim cloth reinforcement shall be provided in between the layers. Scrim cloth reinforcement shall also be provided in places where there is a change in surface profile. eg. junction of horizontal and vertical surface of wall, pedestal etc and also near openings for rainwater pipe etc. Scrim cloth to be placed for a distance of 150 mm on either side of junction. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

c. The coating shall be properly cured.

d. After the waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 metre x 2 metre and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.2.9 Top protective finishing layer

a. Geo textile member shall be provided over the cured PU coating as a separation layer for subsequent screed layer after emptying the water used for ponding test for leakage.

b. The top protective finishing layer of PCC or M15 grade concrete (minimum 50 mm thick) with chicken wire mesh shall be laid over Geo textile member. The finished surface shall be in desired slope.

c. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

Copyright EIL – All rights reserved

d. The PCC or M15 grade concrete shall be laid in panels of maximum 1200 x 1200 mm size.

e. The PCC or M15 grade concrete and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

f. The joints between panels shall be raked out neatly (after stipulated curing period) to a minimum 10mm X 10mm V groove and shall be filled up approved quality polyurethane sealant.

g. Khura (minimum size 450 mm x 450 mm) shall be provided at every rain water outlets.

5.2.10 Waterproofing treatment over parapets/ vertical surfaces on roof

Waterproofing treatment over Parapets/ Vertical surfaces shall comprise of Polyurethane water proofing coating (refer clause 5.1.3) over primer coat (refer clause 5.1.2) finished with cement plaster. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

a. Entire surface shall be prepared in accordance with clause 5.2.5

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

c. Polyurethane Primer coat shall be applied over the prepared surface in accordance with clause 5.2.7.

d. The Polyurethane water proofing coating (minimum 1.5mm DFT -Dry Film Thickness) applied on roof shall be continued over parapet/ vertical surface over the primer coat.

e. The Polyurethane water proofing coating shall be continued over vertical surface as per drawing or as directed by Engineer-In-Charge subjected to upto minimum 300 mm height from the finished roof surface.

f. Scrim cloth reinforcement shall be provided in between the layers of the coating and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

g. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

h. The coating shall be properly cured.

5.2.11 Finishing of parapet/ vertical surfaces

Copyright EIL – All rights reserved

a. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

b. Minimum 12mm thick cement plaster (1 cement : 4 sand, with polypropylene fibers @ 125 gms per bag of cement or as per recommended dosage by manufacturer to avoid cracking and disintegration) finishing shall be provided over the Polyurethane water proofing coating.

5.2.12 Roofing treatment in concrete gutters

a. Roofing treatment over Parapets/ Vertical surfaces of gutter shall comprise of Polyurethane water proofing coating over primer coat finished with minimum 12mm thick cement plaster similar to clause 5.2.10 & 5.2.11. The treatment shall be done on entire vertical surfaces/Parapet including gutter facia top.

b. Roofing treatment on horizontal surface of gutter shall comprise of screed of PCC or M15 grade concrete approved light weight material such as cinder concrete, Polyurethane water proofing coating over primer coat, Geotextile membrane and top finishing layer of plaster or PCC as approved.

c. Entire surface shall be prepared similar to the base surface preparation of roof surface.

d. Necessary slope shall be provided by means of PCC or M15 grade concrete or approved light weight material such as cinder concrete.

e. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

f. Polyurethane Primer coat as per clause 5.1.2 shall be applied over the prepared surface in accordance with clause 5.2.7.

g. The Polyurethane water proofing coating (Minimum 1.5mm DFT -Dry Film Thickness) applied over roof shall be continued over horizontal and parapet/ vertical surface of gutter in accordance with clause 5.2.8 over the primer coat.

h. Scrim cloth reinforcement shall be provided in between the layers and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

i. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

j. The coating shall be properly cured.

k. After the waterproofing coating is cured, water ponding test for leakage in the gutter shall be done as directed by Engineer-In-Charge by making sand/mud bundhs and water

Copyright EIL – All rights reserved

ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

l. PU waterproof coating shall be finished with minimum 12 mm thick plaster or Screed as approved. The screed shall be laid in accordance with clause 5.2.9

m. Ponding test for leakage of the finished roof surface shall be done after the top layer has cured in locations as directed by Engineer-In-Charge by making sand / mud bundhs water ponding for 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

5.3 Testing

Test for leakage shall be done in two stages.

Stage 1:

After the waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top protective finishing layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

6.0 WATERPROOFING CUM INSULATION SYSTEM

Waterproofing cum Insulation system shall consist of cement concrete screed on prepared base, primer coat, Polyurethane foam insulation, PU waterproof coating, Geo-textile membrane and a top protective finishing layer as below :

Layer	Material
1st layer	PCC screed over prepared roof surface
2nd layer	Polyurethane primer coat
3rd layer	40 mm thick machine sprayed Polyurethane Foam insulation
4th layer	Minimum 1.5mm DFT (Dry Film Thickness) single component Polyurethane (PU) water proofing coating
5th layer	Geo-textile membrane
6th layer	PCC top protective finishing layer

6.1 Materials

6.1.1 Cement concrete screed

Copyright EIL – All rights reserved

Cement concrete screed shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete. Thickness of the screed shall be minimum 50 mm . Thickness at various locations of the roof/ terrace shall be as required for maintaining required slope to ensure proper roof drainage. If not mentioned specifically otherwise, slope of the finished screed shall be 1: 100.

6.1.2 Primer

Primer shall be polyurethane primer compatible to sprayed Polyurethane Foam insulation or single component Polyurethane water proofing coating as applicable (which shall be applied over the primer) and shall be as per approved Manufacturer/ system provider's standard specification and as approved by Engineer-In-Charge.

6.1.3 Sprayed Polyurethane Foam insulation

Polyurethane Foam insulation shall be CFC (Chlorofluorocarbons) and HCFC (hydro chlorofluorocarbon) free with closed cell structure having following properties. (Reference: Properties for type-1 foam as mentioned in Table-1 of ASTM D 7425.)

Property	Value	Testing Method
Thermal resistance of 25mm thickness	Minimum 0.98 K-sqM/W at mean temperature 24 degree C	ASTM C177, C1363 or C 518
Compressive strength	Minimum 276 KPa at yield or 10% deformation	ASTM C165 or ASTM D 1621
Density	Minimum 40 Kg/CuM	ASTM D 1622
Water absorption	Maximum volume % 5	ASTM D 2842
Tensile Strength	Minimum 276 KPa	ASTM D 1623
Closed cell content	Minimum 90%	ASTM D 6226

6.1.4 Polyurethane (PU) water proofing coating

Polyurethane water proofing coating/ membrane shall be single component (moisture cured, elastomeric, free from bitumen and tar) viscous liquid containing urethane polymers having following properties:

Property	Value	Testing Method
Solid content	Minimum 85%	ASTM C 836
Elongation	Minimum 400%	ASTM D 412
Tensile Strength	2-3 MPa	ASTM D 412

6.1.5 Top protective finishing layer

Top protective layer shall be of PCC (plain cement concrete – 1 cement : 2 coarse sand : 4 aggregate) or M15 grade concrete with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm thick

6.1.6 Geo-textile membrane

Geo textile membrane shall be of 150 GSM (grams per square meter) as per approved Manufacture/ system provider's specification and as approved by Engineer-In-Charge.

Copyright EIL – All rights reserved

6.2 Workmanship

6.2.1 Base Surface Preparation

Surface preparation shall be in accordance with clause 5.2.5

6.2.2 Screed

Screed shall be laid in accordance with clause 5.2.6

6.2.3 Primer coat

Primer coat shall be applied in accordance with clause 5.2.7

6.2.4 Polyurethane Foam insulation

Polyurethane Foam insulation shall be spray applied conforming to IS : 12432, part-3 over the primer coat in layers with compatible spraying machine to form a seamless, crack free and monolithic insulation layer. Public movement shall be restricted over the insulation layer.

6.2.5 Polyurethane (PU) water proofing coating

Polyurethane water proofing coating shall be applied in accordance with clause 5.2.8. Water After the coating is cured, ponding test shall be done in accordance with clause 5.2.8.

6.2.6 Geo-textile membrane

Geo-textile membrane shall be provided over the cured Polyurethane water proofing coating as a separation layer for subsequent PCC layer after emptying the water used for ponding test for leakage.

6.2.7 Top protective finishing layer

Top protective finishing layer of PCC or M15 grade concrete shall be laid in accordance with clause 5.2.9.

6.2.8 Waterproofing treatment over parapets/ vertical surfaces

Waterproofing treatment over parapets/ vertical surfaces on roof shall be done in accordance with clause 5.2.10

6.2.9 Finishing of parapet/ vertical surfaces

Finishing of parapet/ vertical surfaces shall be done in accordance with clause 5.2.11

6.2.10 Roofing treatment in concrete gutter

Roofing treatment in concrete gutter shall be done in accordance with clause 5.2.12

Copyright EIL – All rights reserved

6.3 TESTING

Test for leakage shall be done in two stages.

Stage 1:

After the polyurethane waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours.

Stage 2:

After the top layer is cured, water ponding test for leakage shall be done for finished surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels and water ponding for minimum 72 hours. Smooth roof water drainage through roof water outlets shall also be checked during this stage of testing.

Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

7.0 DELIVERABLES BY THE CONTRACTOR

The Contractor shall furnish product data sheets and test certificates (by Government or NABL approved Laboratories) in support of properties/ performance of specified materials/ systems. Method of tests shall be as mentioned in related standards.

8.0 WARRANTY

Warranty of minimum 10 years shall be provided by the contractor for leak proof roof or any other damage/ defect of the complete roofing system. Any leakage, damage, defect (excepting any leakage, damage caused by 3rd party and causes not attributable to waterproofing contractor) within the warranty period shall be rectified by the contractor at his own cost to the satisfaction of Engineer In charge.

9.0 MEASUREMENT

Measurement of waterproofing treatment shall be the measurement of actual surface area on which waterproofing has been done.

Copyright EIL – All rights reserved

पुताई, रंगीन पुताई, डिस्टेम्परिंग, पैन्टिंग और पालिशिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR WHITE/ COLOUR WASHING, DISTEMPERING, PAINTING AND POLISHING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	11.05.23	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	TUSHAR SRIVASTAVA	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	25.08.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/ JKB	RAJAN SRIVASTAVA	R. NANDA
5	09.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	TS	JS	JKB	D MALHOTRA
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
RCC	:	Reinforced Cement Concrete
VOC	:	Volatile Organic Compounds
ISO	:	International Organization for Standardization
NFPA	:	National Fire Protection Association
POP	:	Plaster Of Paris

Architecture Standards Committee

Convenor : Mr. Samir Das

Members : Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

Contents

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 TYPES OF PAINTS /POLISHING 5
4.0 MATERIALS 5
5.0 WORKMANSHIP 6
6.0 WHITE WASHING 7
7.0 COLOUR WASHING 7
8.0 ACRYLIC DISTEMPER 8
9.0 WATERPROOF CEMENT PAINT 9
10.0 ACRYLIC/ PLASTIC EMULSION PAINTING (For interior surfaces) 10
11.0 ACRYLIC BASED EXTERIOR EMULSION PAINT (For exterior surfaces) 11
12.0 ACRYLIC COPOLYMER AGGREGATE FINISH 12
13.0 SYNTHETIC ENAMEL PAINTING 12
14.0 APPLICATION OF CLEAR FINISHES (Polishing, Varnishing) 13
15.0 MEASUREMENT 15

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of White/ Colour Washing, Distempering, Painting & Polishing on building works as interior or exterior finishing or decorations etc.

1.2 Unless otherwise specifically mentioned in design basis, job specification, drawings, item descriptions etc. all plastered, wooden and bare metal surfaces shall be painted.

1.3 For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
IS 2395	Code of practice for painting concrete, masonry and plaster surfaces.
IS 6278	Code of practice for white washing and colour washing.
IS 712	Specification for building limes
IS 55	Specification for Ultramarine blue for paints.
IS 63	Specification for whiting for paint and putty.
IS 427	Distemper (dry), colour as required.
IS 428	Washable Distemper
IS 15489	Paint, Plastic Emulsion- Specification
IS 2338 Part-1	Code of practice for finishing of wood, and wood based materials. Part-1 : Operations & workmanship
IS 2338 Part-2	Code of practice for finishing of wood, and wood based materials. Part-2 : Schedule
IS 5410	Cement paint, colour as required.
IS 2524 Part-1	Code of practice for painting non-ferrous metals in buildings. Part-1 : Pre-treatment
IS 2524 Part-2	Code of practice for painting non-ferrous metals in buildings. Part-2 : Painting
IS 1477 Part-1	Code of practice for painting ferrous metals in buildings. Part-1 : Pre-treatment
IS 1477 Part-2	Code of practice for painting ferrous metals in buildings. Part-1 : Painting
IS 384	Brushes, paints and varnishes, flat.
IS 486	Brushes, sash, tool, for paints and varnishes.
IS 110	Ready mixed paint, brushing, grey filler enamels for use over primers
IS 3585	Ready mixed paint, aluminium brushing priming water resistant for wood work.
IS 110	Ready mixed paint, brushing, grey filler for enamels for use over primers
IS 2395 Part-1	Painting of concrete, masonry & plastered surface, code of practice. Part-1 : Operations and workmanship
IS 2395 Part-2	Painting of concrete, masonry & plastered surface, code of practice

Copyright EIL – All rights reserved

	Part-2 : Schedule
IS 3536	Ready mixed paint, brushing, wood primer - Specification
IS 109	Specification for ready mixed paint, finishing, priming, plaster, to indian standard colour no. 361 light stone and no. 631 light grey, white and off - White
IS 2074	Ready mixed paint air drying red oxide zinc chrome priming specification

3.0 TYPES OF PAINTS /POLISHING

3.1 Type of Painting/ polishing shall be as mentioned in design basis, job specification, drawings, item descriptions etc.

3.2 Unless otherwise specified in design basis, drawings, item descriptions, job specifications etc, Type of Painting/ polishing shall be as per following table.

Surface	Paint/ polishing type
Internal Masonry/ Block work/ RCC wall and ceiling surface	Interior grade Acrylic Emulsion paint
External Masonry/ block work/ RCC/ plastered surface	Exterior grade Acrylic Emulsion paint
Local/ Hard wood, engineered wood and bare metal surface	Synthetic Emulsion paint
Teak or superior wood surface	French polishing

Note :

For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

4.0 MATERIALS

4.1 All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, bags etc. with seals unbroken.

4.2 In case of ready mixed paints, thinning if necessary, the brand of thinner shall be as per recommendations of the manufacturer.

4.3 Wall putty shall be minimum 2 mm thick and white cement and polymer based wall putty type.

4.4 Primer shall be compatible with the finishing paint.

4.5 The allowable limits of quantity of VOC (Volatile Organic Compounds) in different types of paints and primer shall be as defined in the following parameters:

A. Primer

Type of Primer		**Allowable VOC Content**
Pink & Grey primer on wood	:	< 50 gms/ltr
Ready mix red oxide zinc chromate primer	:	< 250 gms/ltr

Copyright EIL – All rights reserved

Water thinnable cement primer on wall	:	<50 gms/ltr

B. Paints

Type of Paint		Allowable VOC Content
Acrylic Emulsion	:	<50 gms/ltr
Plastic Emulsion	:	<50 gms/ltr
Acrylic Distemper	:	<50 gms/ltr
Synthetic Enamel	:	<150 gms/ltr

5.0 WORKMANSHIP

5.1 Colour/ texture of the wash/ distemper/paint/ polishing shall be as approved by the Engineer-in-charge. Sample painting shall be done as directed by the Engineer-In- charge for approval/ selection of the colour/ texture.

5.2 Washed/ distempered/Painted/ polished surface shall be even and uniform without patches, marks, without any defect and of finish as desired by the Engineer-In-Charge. Any defect or shortcomings in the finishing shall be rectified to the satisfaction of the Engineer –In- Charge.

5.3 Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.

For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For ceiling, proper stage scaffolding shall be erected.

5.4 Surface preparation shall be done as mentioned for various type of wash/ distemper/paint/ polishing. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

5.5 Preparation and application of wash/ distemper/paint/ polishing shall be done as mentioned for various types. However, in case of excessive un-even surfaces, punning with Plaster of Paris shall be done on the surface if and as directed by the Engineer-In-Charge.

5.6 Paint shall be applied by brushing or spraying or by using rollers as directed by the Engineer-In-Charge. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer. During painting, every time after the paint has been worked out of the brush bristles, the bristles shall be opened up by striking the brush suitably.

Spray machine used may be of high pressure type or low pressure depending on the nature and location of work. After work, the brushes shall be completely cleaned of paint and shall be hung in a thinner if intended to be used afterwards. The spray guns shall be cleaned thoroughly after every break in work. The paint/ polish containers, when not used shall be kept close and free from air.

5.7 After the finishing of work, the adjacent surfaces not intended to be washed/ distempered/painted/polished shall be thoroughly cleaned of all paint patches and shall be

Copyright EIL – All rights reserved

finished in accordance with surface finishing of such surfaces. Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned.

5.8 Number of coats of paint as mentioned is the minimum number of coats. Additional coats shall be provided as required for obtaining desired colour and finishing.

5.9 The operation for each coat shall consist of stroke of the brush/ roller from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

5.10 The painting on ceiling should be done prior to that on walls.

6.0 WHITE WASHING

White washing in general shall conform to IS 6278.

6.1 Preparation of Surface

The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before white wash is to be applied. Surfaces already white/colour washed shall be broomed down to remove all dust, dirt, loose scales of lime wash or other foreign matters.

All damaged portions of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the joints in masonry properly. Such portions shall be wetted and allowed to dry before any operation.

All holes, cracks, patches etc. not exceeding 0.1 sq. m. in area shall be made good with material similar to that of the surface. Surfaces affected by efflorescence, moss, fungi, algae, lichen etc. shall be treated in accordance with IS: 2395.

6.2 Preparation of White Wash

The fat lime conforming to IS: 712 shall be slaked at site and shall be mixed and stirred with about 5 litres of water for 1 kg. of unslaked lime to make thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 4 kg of gum dissolved in hot water shall be added to each cubic metre of lime cream. Approved quality ultramarine blue conforming to IS 55 @ 3 gram per kg. of lime shall also be added to the solution. The whole solution shall be stirred thoroughly before use.

6.3 Application

White wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

7.0 COLOUR WASHING

7.1 Preparation of Surface shall be similar to clause no 6.1

Copyright EIL – All rights reserved

7.2 Preparation of colour wash

Sufficient quantity of colour wash enough for the complete job shall be prepared in one operation to avoid any difference in colour. The basic white wash solution shall be prepared in accordance with clause no 6.2. Mineral colours of approved shade and quality not affected by lime shall be added to the white wash solution in proportions as directed by Engg.in-charge. Solid lumps etc. in the colour powder shall be ground to fine powder, sieved and mixed evenly and thoroughly to the white wash solution. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface.

7.3 Application

Colour wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

For new work, a priming coat of white wash with lime or with whiting shall be provided. Three or more coats of colour wash shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface preparation, a coat of colour wash shall be applied over the patches and repairs. Then coats of colour wash shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

8.0 ACRYLIC DISTEMPER

8.1 Preparation of Surface

The surface shall be thoroughly cleaned of dust, old finish by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of Plaster of Paris (POP) mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In case of distempering over existing distempered surface, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster-of-paris mixed with the colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed.

8.2 Priming Coat

The priming coat shall be with distemper primer or cement primer, as required. If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. For old work no primer coat is necessary.

Copyright EIL – All rights reserved

A priming coat of whiting conforming to IS 63 shall be applied over the prepared surface. The priming coat shall be prepared by mixing 2.5 kg. of whiting and one litre of glue solution (prepared by mixing 250 gm. glue conforming to IS: 852 with boiling water) together and placing it in a covered vessel with enough water to cover the mixture which shall be left to cool until it becomes a jelly.

Priming coat shall be applied with "MOONJ" brush or roller to the specified number of coats. Minimum number of coats shall be minimum one. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

8.3 Preparation of Distemper

1st quality Acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used for preparation of distemper. The Acrylic 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 day's work shall be prepared.

8.4 Application of Distemper

For new work, 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. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes or roller in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work, the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

The finished surface shall be even and uniform without patches, marks, distemper drops etc.

9.0 WATERPROOF CEMENT PAINT

9.1 Preparation of Surface

Preparation of Surface shall be similar to clause no 6.1. The surface so prepared shall be thoroughly wetted with clean water before the paint is applied.

9.2 Preparation of Paint

Waterproof cement paint conforming to IS 5410 shall be mixed with water and stirred to obtain a thick paste which shall then be diluted to brushable consistency. The proportion of mixture shall be as per manufacturer's recommendation. The paint shall be mixed in such quantity which can be used up within an hour of mixing to avoid setting and thickening of the paint.

Copyright EIL – All rights reserved

9.3 Application of Paint

The surface shall be treated with waterproof cement paint in minimum three coats maintaining the coverage rate (kg/ square metre) as mentioned in approved Manufacturer's standard literature. No less than 24 hours shall be allowed between two coats and subsequent coats shall be applied only after the preceding coat has become hard to resist marking by subsequent brushing.

9.4 Curing

Curing shall be started after the paint has hardened. Curing shall be done as recommended by the approved Manufacturer and by sprinkling with water two or three times a day. This shall be done between coats and for at least two days following the final coat.

10.0 ACRYLIC/ PLASTIC EMULSION PAINTING (For interior surfaces)

10.1 Acrylic/ plastic emulsion paint (for interior surfaces) shall be of interior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

10.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

First coat of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

Once the surface is dried, second coat of primer shall be applied after sand papering and cleaning the surface.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

In case of already painted surface, old paint and loose particles shall be removed before stating the above mentioned preparation process.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

10.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

10.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to

Copyright EIL – All rights reserved

the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

11.0 ACRYLIC BASED EXTERIOR EMULSION PAINT (For exterior surfaces)

11.1 Acrylic/ plastic emulsion paint (for exterior surfaces) shall be of exterior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

It shall be an acrylic based wall coating for exterior surfaces to form a crack free, flexible, tough, alkali & fungal resistant and UV resistant waterproof coating with silicone additives.

11.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

1-2 coats of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

11.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

11.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

Copyright EIL – All rights reserved

12.0 ACRYLIC COPOLYMER AGGREGATE FINISH

12.1 It shall be an acrylic based textured wall coating system consisting of quartz and silica aggregate, inorganic pigments and other additives to form a crack free, flexible, tough, waterproof coating.

12.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

12.3 Preparation of coating

Preparation of coating using various components shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish.

12.4 Application

Application of the system shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish. Sealing coat, primer etc. as recommended by the approved Manufacturer shall also be provided.

13.0 SYNTHETIC ENAMEL PAINTING

13.1 Synthetic Enamel paint shall conform to IS 2933

13.2 Preparation of surface

A. Preparation of wood surface

The woodwork to be painted shall be dry and free from moisture and any foreign matter. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by griding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used. The surface treated for knotting shall be dry before paint is applied.

Plywood, Block board, Particle board etc. shall be treated in the same manner as for wood work.

Copyright EIL – All rights reserved

B. Preparation of Iron and steel surface

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface if any, shall be removed.

13.3 Priming

The primer shall be ready mixed primer and compatible to the paint.

Primer for wood work shall conform to IS 3536. Primer for Iron and steel shall be Red Oxide Zinc Chromate primer conforming to IS 2074, for cement, concrete and plastered surfaces primer shall conform to IS 109.

Dirt or any other extraneous material on the surface shall be removed and the priming shall be applied in minimum two coats.

13.4 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

13.5 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, smooth finish, even and uniform shade without patches, marks, paint drops etc.

14.0 APPLICATION OF CLEAR FINISHES (Polishing, Varnishing)

14.1 For the application of clear finishes, the following procedures shall generally be adopted in accordance with IS: 2338 (Part-I)

A. Filling
B. Staining
C. Sealing
D. Finishing

14.2 Filling

Fillers shall be applied to prevent the excessive penetration of the finish to the surface for obtaining a smooth finish. Fillers shall be conforming to IS: 345.

Fillers shall be heavily applied to the wood surface by hand, using hessian or jute rag across the grain. It shall be rubbed when still wet to get better penetration. After 5-10 minutes it shall be wiped off by hand across the grain followed by a light wipe with the grain. The filled surface shall be dried preferably over night and smoothened with abrasive paper.

Copyright EIL – All rights reserved

14.3 Staining

A. Spirit Stains

Spirit stains are solutions of spirit soluble dyes in Industrial methylated spirit.

B. Oil Stains

Oil stains are solutions of oil soluble dyes in linseed oil, but, usually consist of insoluble, semi-transparent pigments ground in linseed oil and thinned with turpentine or other solvent.

14.4 Surface Preparation

Surface intended for staining shall be kept scrupulously clean and free from greasy finger marks. It shall be prepared by careful smoothing with fine abrasive paper used in the direction of the grain. Small cracks/nail holes shall be stopped with plastic wood/fine plaster of Paris. The stopping shall be rubbed down with fine abrasive paper when hard and touched with a thinned knotting before staining. In case of oil staining stopping shall be done after staining using tinted putty or wood filler.

14.5 Application of Stains

Stains shall be applied by brushing and wiping or by spraying. The stain shall be so thinned that it can be applied fairly, liberally without over staining and over lapping.

14.6 Sealing

A suitable sealer shall be applied on the filled and sanded surface to prevent absorption by the wood of the succeeding coats of finish and to seal stain and filler and thus preclude their bleeding into the finish coat.

Sealer may be sprayed on taking care not to flood the surface and it shall be allowed to dry hard. When fully dry the surface shall be sanded taking care not to cut through at corners and edges. Dust shall be blown off and surface wiped with a clean rag.

14.7 Finishing

The stained surface shall be varnished, wax-polished or French polished as required after it is dried.

A. Varnishing

Varnishing of wood and wood based material shall be in accordance with IS: 2338 (Part-I).

Surfaces to be varnished shall be prepared to produce a smooth, dry and matt surface and all dust and dirt shall be removed from the surface.

The Varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with short light strokes to avoid frothing. It shall be allowed to flow out while the next section is being laid in. Excess Varnish shall be scraped out of the brush and then the first section be crossed, re- crossed and laid off lightly. The Varnish, once it has begun to set, shall not be retouched. In case of any mistake, the Varnish shall be removed and the work shall be started afresh.

Copyright EIL – All rights reserved

Where two coats of varnish are applied, the first coat shall be a hard drying under coating or flatting varnish which shall be allowed to dry hard and then be flatted down before applying the finishing coat. Sufficient time shall be allowed in between two coats.

When flat varnishing is used for finishing, a preparatory coat of hard drying undercoating of flatting varnish shall first be applied and shall be allowed to harden thoroughly. It shall then be lightly rubbed down before the flat varnish is applied. On larger areas, the flat varnish shall be applied rapidly, and the edges of each patch applied shall not be allowed to set, but shall be followed up whilst in free working conditions.

B. French Polish

French polish shall conform to IS :348. Suitable pigments shall be added to get the required colour.

The surface to be French polished shall be rubbed down to smoothness with sand paper and shall be well dusted. Pores in the surface shall be filled up with fillers.

A pad of woollen cloth covered by a fine cloth shall be used to apply the finish. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles applying the polish sparingly but uniformly over the entire area to give an even surface. A trace of linseed oil may be used on the face of the pad for the purpose. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

15.0 MEASUREMENT

Painting/ polishing shall be measured by the area of actual painted/ polished surface.

Copyright EIL – All rights reserved

छत के कार्यों का मानक विनिर्देश

STANDARD SPECIFICATION FOR ROOFING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	04.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	08.12.15	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	JKB	R. SRIVASTAVA	S. CHANDA
5	06.07.10	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS	JKB	N. DUARI
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI
3	09.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

Copyright EIL – All rights reserved

Abbreviations:

AS	: Australian Standards
ASTM	: American Society for Testing and Materials
BS	: British Standards
BS-EN	: British Standards European Norm
CGI	: Corrugated Galvanized Iron
EN	: European Standards
EPDM	: Ethylene Propylene Diene Monomer
GI	: Galvanized Iron
IS	: Indian Standards
ISO	: International Organization for Standardization
MS	: Mild Steel
NBC	: National building Code
SWG	: Standard Wire Gauge

Architecture Standards Committee
Convenor: Mr. Samir Das

Members: Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL..... 04
2.0 REFERENCES..... 04
3.0 CORRUGATED GALVANISED STEEL SHEET ROOFING..... 04
4.0 ALUMINIUM ALLOY SHEET ROOFING/ CLADDING..... 07
5.0 PRECOATED GALVANIZED STEEL SHEET ROOFING / CLADDING..... 09
6.0 PRECOATED ZINC ALUMINIUM STEEL SHEET ROOFING / CLADDING..... 11
7.0 FIBRE CEMENT CORRUGATED SHEET ROOFING/ CLADDING..... 13
8.0 MEASUREMENTS..... 16

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of sheet roofing/ cladding and associated accessories for buildings and sheds. The specifications of metal sheets (with regards to material) are also applicable for barricades required during construction.

1.2 The roofing and cladding system shall ensure leak-proof enclosure by means lapping of sheets, closure of joints, junctions and gaps etc., efficient roof water drainage system etc. using necessary flashings, accessories and fittings.

1.3 The roofing and cladding system shall also have provisions for natural lighting and ventilation.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS: 277	Galvanized steel strips and sheets (Plain and corrugated)
IS: 513	Cold reduced carbon steel sheet and strip
IS: 737	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes
IS: 1254	Corrugated aluminium sheet
IS: 2676	Dimensions for wrought aluminium and aluminium alloys, sheet and strip
IS: 13592	Unplasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buiildings Including Ventilation and Rainwater System
IS: 14871	Products in fibre reinforced cement - Long corrugated or asymmetrical section sheets and fittings for roofing and cladding - Specification
IS: 15961	Hot dip aluminium - Zinc alloy metallic coated steel strip and sheet (Plain)

3.0 CORRUGATED GALVANISED STEEL SHEET (C.G.S) ROOFING

3.1 Material

3.1.1 C.G.S. Sheets

C.G.S sheet shall conform to IS: 277.

Copyright EIL – All rights reserved

Unless otherwise specified in drawings, item descriptions, job specifications etc. the sheets shall be 1.00 mm thick and with zinc coating (total on both sides) not less than 275 gm/ sqm.

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

3.1.2 Ridges, hips, valley, flashing and gutter of plain galvanised steel sheets

Leakproof roofing system with efficient rain water drainage of the roofing system shall be ensured by providing ridges, hips, valley, flashing and gutter etc. (all bent and fabricated to required shape) made of plain galvanized steel sheets.

Unless otherwise specified in drawings, item descriptions, job specifications etc. thickness and width etc. of these shall be as below:

Item	Thickness (mm)	Minimum overall width (mm)
Ridge	0.8	600
Hip	0.8	600
Valley	1.60	900
Flashing	1.00	400
Gutter	1.00 (minimum)	Profile, dimensions shall be as required for roof drainage

3.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

3.2 Laying and Fixing

3.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

3.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

3.2.3 The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 150 mm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 200 mm. The minimum lap of sheets with ridge, hip and valley shall be 200 mm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Copyright EIL – All rights reserved

3.2.4 Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

3.2.5 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with anticorrosive polymer coated J or L hook bolts and nuts, 8 mm diameter, with polymer cap, seal and thrust washer. J hooks shall be used for fixing sheets on angle iron purlins, and L hooks shall be used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 300 mm. Coach Screws shall not be used for fixing sheets to purlins.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

3.2.6 Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by bolts and nuts 25 × 6 mm size. As the overlap at the sides extends to two corrugations, these bolts shall be placed zig-zag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 600 mm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

3.2.7 Ridges and hips of C.G.S. sheet roofing shall be covered with ridge and hip sections of plain G.S. sheet (properly bent in shape for fitting over roofing sheet) with a minimum lap of 200 mm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 200 mm. They shall be fixed to the perlins with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.8 Valley shall lap with the C.G.S. sheets not less than 250 mm width on other side. The end laps of valley shall also be not less than 250 mm.

3.2.9 Flashings shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

3.2.10 Valley and flashings shall be fixed to roof structural members with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.11 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Hooks/ bolts/ nuts (minimum 6 mm dia) and washers for fixing shall be similar to those used in laying the roofing sheets. Connecting bolts shall be above water line of the gutter.

Copyright EIL – All rights reserved

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of G.S. sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

3.2.12 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

3.2.13 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins.

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

4.0 ALUMINIUM ALLOY SHEET ROOFING/ CLADDING

4.1 Material

4.1.1 Corrugated Aluminium alloy sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of corrugated Aluminium alloy sheet for roofing and cladding shall conform to following specification.

Alloy Grade	31500 B, H4 as specified in IS: 737: 2008
Profile	Profiled/corrugated sheet shall be Industrial troughed sheet Conforming to IS: 1254 -2007
Thickness	20 SWG (0.91mm) for roofing 22 SWG (0.71mm) for wall cladding (Thickness, tolerances shall be as per IS: 2676-1981)
Pitch	125 mm
Crest Height	38 mm

Finishing of the sheets shall be plain mill or stucco embossed finish. Unless otherwise specified in drawings, item descriptions, job specifications etc, the finishing shall be stucco embossed finish in approved colour.

4.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Aluminium alloy sheet of grade 31500 B / H2 conforming to IS: 737.

Unless otherwise specified in drawings, item descriptions, job specifications etc the dimensions and other specifications shall be as mentioned in the following table.

Accessory	Dimension
Ridge piece	0.91 mm thick, minimum 600 mm wide
Apron piece	0.71 mm thick, minimum 150 mm x 150 mm

Copyright EIL – All rights reserved

Eaves piece	0.71 mm thick, minimum150 mm x 150 mm
Corner piece	0.71 mm thick, minimum 150 mm x 150 mm
Gutter	2 mm thick, width as required.

Finishing of accessories shall be similar to that of the roofing/ cladding sheet.

4.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

4.2 Laying and fixing

4.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

4.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

4.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm on roofs and one corrugated for sides lap. If the roof slope is less than 15 degrees, end lap shall be increased to 230 mm. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

4.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with stainless steel (SS 304 grade) or carbon steel or aluminium alloy hex head self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, carbon steel screws shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

4.2.5 Carbon steel screws shall be hex head, self drilling type with multi-layered high density anti-corrosive coating of Aluminium & Zinc (AZ), fitted with AZ150 GSM 0.8mm thick Alu-Zinc coated EPDM bonded washer.

4.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

Copyright EIL – All rights reserved

4.2.7 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

4.2.8 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

4.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

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

5.0 PRECOATED GALVANIZED STEEL SHEET ROOFING / CLADDING

5.1 Material

5.1.1 Pre-coated galvanized steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	Cold rolled steel sheet conforming to IS : 513, galvanized (275 g/SqM total on both side) by hot dip process as per IS : 277.
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.60 mm (+/- 0.03)
Overall coated thickness	0.65 mm
Weight	Minimum 5.80 Kg/ SqM
Finishing – top surface	Regular modified polyester of minimum 20 (+/- 2) microns over primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
Bending test	2-4 T

Copyright EIL – All rights reserved

Salt spray test	750 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 750 hours

The sheets shall be of approved colour.

5.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain pre-coated galvanized steel sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

5.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

5.2 Laying and fixing

5.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

5.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

5.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

5.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

Copyright EIL – All rights reserved

5.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

5.2.6 Gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

5.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

5.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

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

6.0 PRECOATED ZINC ALUMINIUM STEEL SHEET ROOFING / CLADDING

6.1 Material

6.1.1 Pre-coated Zinc- Aluminium steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	The base metal of the roofing shall be cold rolled steel sheet conforming to AS: 1397 or IS : 513. It shall be coated with Al-Zn alloy (55.00% Aluminium, 43.40% Zinc, 1.60% Si) / Zincalume by Hot-dip process as per IS :15961 or AS:1397 or ASTM : A792M. (class AZ 150, having minimum 150 g/SqM AZ coating mass total on both sides).
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.45 mm (+/- 0.03)

Copyright EIL – All rights reserved

Overall coated thickness	0.52 mm
Weight	Minimum 4.50 Kg/ SqM
Finishing – top surface	Super durable polyester of minimum 20 (+/- 2) microns over polyester primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns.
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
T-Bending test	Maximum 5T
Salt spray test	1000 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 1000 hours

6.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Pre-coated Zinc- Aluminium steel sheet sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

6.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

6.2 Laying and fixing

6.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

6.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

6.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

6.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

Copyright EIL – All rights reserved

If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

6.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

6.2.6 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

6.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

6.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

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

7.0 FIBRE CEMENT CORRUGATED SHEET ROOFING/ CLADDING

7.1 Material

7.1.1 Fibre cement corrugated sheet

Fibre cement corrugated sheets shall conform to IS :14871 and following specification.

Composition	The sheets shall be asbestos free and reinforced by organic and /or inorganic synthetic fibres. The product shall be composed essentially of an inorganic hydraulic binder (in case of Portland pozzolana cement Portland slag cement, addition of pozzolanic materials and slag shall not be permitted) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a.

Copyright EIL – All rights reserved

	siliceous (includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced by organic and /or inorganic synthetic fibres. Pozzolanic materials process aids, fillers and pigments which are compatible with the fibre reinforced cement may be added. The inorganic hydraulic binder shall be either ; 33 grade ordinary Portland cement conforming to IS : 269 or 43 grade ordinary Portland cement conforming to IS :8112 or 53 grade ordinary Portland cement conforming to IS :12269 or Portland pozzolona (fly ash based) cement conforming to IS :1489 - part 1 or Portland pozzolona (calcined clay based) cement conforming to IS :1489 - part 2 or Rapid hardening cement conforming to IS :8041 or Portland slag cement conforming to IS :455 Fly ash used shall conform to IS 3812.
Thickness	Unless otherwise specifically mentioned, the thickness shall be 6 mm (tolerance : +/- 10%)
Pitch	146 mm (tolerance : + 6 mm, - 2 mm)
Depth	48 mm (tolerance : + 4 mm, - 5 mm)
Finishing	The sheets shall be free from cracks, chipped edges or corners and other damages. Top exposed surface shall have pre-painted finish with minimum 30 micron thick exterior grade premium quality acrylic emulsion paint. Bottom surface shall have factory finish.

7.1.2 Accessories

Accessories such as adjustable ridges, hips, finishing pieces, eaves filler pieces, north light and ventilator curves, barge boards, expansion joint sheets, "S" type louvers, gutters etc. shall be of the same Manufacturer (unless approved otherwise by Engineer- In- Charge) as the sheet used for roofing/ cladding and as per Manufacturer's standard specification.

7.1.3 In case, sizes of readymade non-metallic gutters by the same Manufacturer of the sheet are not adequate/ suitable for roof drainage, gutters of required size fabricated out of minimum 1 mm thick G.S. sheet (painted in same colour as that of roofing sheet or as approved) shall be provided.

7.1.4 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

7.2 Laying and fixing

Copyright EIL – All rights reserved

7.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

7.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

7.2.3 The sheets shall be laid with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm in cases of roof with a pitch flatter than 1 vertical to 2.5 horizontal. In the cases of very exposed situations, minimum end lap shall be 200 mm. Side lap shall be minimum half a corrugation.

7.2.4 Sheets shall be fixed to the purlins or other roof members by means of 8 mm diameter polymer coated GI J or L hook bolts, nuts and EPDM washers or with self drilling fasteners and EPDM washers. For inserting the bolts/fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown of the sheets. Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

7.2.5 The free overhang of the sheets at the eaves shall not exceed 300mm.

7.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing/cladding sheets)

7.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

7.2.8 Metal sheet gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

7.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

Copyright EIL – All rights reserved

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

8.0 MEASUREMENT

8.1 Measurement of sheets in roofing and cladding shall be the measurement of superficial area of the sheets on the flat without allowance for laps and corrugations. No deductions shall be made for openings upto 0.4 SqM. For opening areas exceeding 0.4 SqM, such areas shall be deducted.

8.2 If not mentioned otherwise, measurement of metal flashings, ridge/hip pieces, corner pieces, gutters (including all fittings and fixtures) etc. shall be the measurement of surface areas of these.

8.3 If not mentioned otherwise, measurement of readymade accessories and fittings (having standard size/profile) of fibre cement sheet shall be the measurement of their lengths.

8.4 If not mentioned otherwise, measurement of rain water pipes (including all fittings and fixtures) shall be the measurement of their actual lengths

Copyright EIL – All rights reserved

सेनिटेरी फिटिंगों और फिक्सचर का मानक विनिर्देश

STANDARD SPECIFICATION FOR SANITARY FITTINGS & FIXTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
7	13.10.23	REVISED & ISSUED AS STANDARD SPECIFICATION	AKHILESH MAURYA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
6	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA
5	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society for Testing & Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
ISO	:	International Organization for Standardization
ABS	:	Acrylonitrile Butadiene Styrene
HDPE	:	High density polyethylene

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0	GENERAL.....	04
2.0	REFERENCES	04
3.0	WATER CLOSET SYSTEM	05
4.0	URINAL SYSTEM.....	08
5.0	WASH BASIN/SINK.....	08
6.0	FITTINGS & FIXTURES.....	10
7.0	INSTALLATION.....	10

Copyright EIL – All rights reserved

1.0 GENERAL

1.1 This Specification covers requirements of sanitary fixtures and fittings such as Water Closets, Wash Basins, Urinals, Water Taps etc.

1.2 In case of Green rated buildings water efficient fixtures shall be used as required to reduce water consumption and for obtaining the green rating. All fixtures installed within the project shall have flow rates at 45 psi or 3.10 bar pressure.

1.3 Other than faucets, which are installed in spaces with water head heights less than 5m/17ft, in a gravity-fed system, flow rates for the fixtures shall not exceed as mentioned in the following table.

Plumbing Fixture	Flow rate
Water Closet (Solid Flush)	6 liter per flush
Water Closet (Liquid Flush)	3 liter per flush
Urinal	3.8 liter per flush
Shower head	10 liter per minute
Lavatory Faucet	8 liter per minute
Kitchen Faucet	8 liter per minute

1.4 The water closets/ cisterns/wash basins/ Urinals shall be of approved colour.

1.5 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

1.6 Associated plumbing works shall be concealed type.

1.7 Sanitary fittings and fixtures shall be procured from Manufacturer approved by the Engineer-In-Charge

2.0 REFERENCES

The codes and standards listed below contain provisions, which through reference in this specification constitute provisions of this standard specification, if not explicitly mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document Title
IS : 2556 Part 1-17	Specification for Vitreous Sanitary appliances (Vitreous China, Part 1-17)
IS : 2267	Specification for Polystyrene Moulding and Extrusion Materials
IS : 407	Specification for Brass Tubes for General Purposes.
1S :774	Specification for Flushing cisterns for water closets and urinals (other than plastic cisterns)

Copyright EIL – All rights reserved

IS: 775	Specification for cast iron brackets and supports for wash basins and sinks
IS :781	Specification for Cast copper alloy screw down bib taps and stop valves for water services
IS : 1300	Specification for Phenolic moulding materials.
IS :2064	Code of Practice for Selection, Installation and Maintenance of Sanitary appliances
IS :2548 Part-1	Specification for Plastic Seats and Covers for water closets Part-1: Thermoset seats and covers
IS :2548 Part-2	Specification for Plastic Seats and Covers for water closets Part-2: Thermoplastic seats and covers
IS :2326	Specification for automatic flushing cistern for urinals (other than plastic cisterns)
IS : 3389	Specification for Urea-formaldehyde Moulding Materials.
IS :7231	Specification for plastic flushing cisterns for water closets and urinals.
IS : 7328	Specification for High Density Polyethylene Materials for Moulding and Extrusion.
IS : 9758	Specification for flush valves and fittings for water closets and urinals.
IS : 13983	Specification for stainless steel sinks for domestic purposes.

3.0 WATER CLOSET SYSTEMS

3.1 General

3.1.1 Water closet Systems shall be a water tight and leakage free system consisting of squatting pans/commodes complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

3.1.2 Flushing and disposal of the waste shall be by means of water either from direct water supply line or from flushing cisterns/ tanks through flush valves as mentioned.

3.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

3.2 Flushing Cisterns/ Tanks

3.2.1 Flushing cisterns shall either be integral with the squatting pan/ commode and shall be open or concealed tank type as mentioned. Connection between cistern and closet shall be made by means of flush pipe/ bend. Flush pipe/ bend shall be firmly fixed with clamps etc. and shall be concealed both in wall and floor.

Copyright EIL – All rights reserved

3.2.2 The cisterns shall be complete with all necessary fittings/ fixtures etc. as required and mentioned in the table below.

Component	Material
Cisterns/ Tanks	Minimum 3 mm thick High density polyethylene (HDPE) conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267. (In case of cisterns integral with wash down type closets, the material shall be vitreous china)
Flush pipe/ bend	40mm dia High density polyethylene pipe conforming to IS 407 or unplasticised PVC plumbing pipe conforming to IS 2501
Siphon/ valve	High density polyethylene (HDPE) Conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267.
Operating mechanism/ lever	Non- ferrous, corrosion resistant material
Float valve	Polyethylene conforming to IS 7328
Coupling nut and lock-nut	Non- ferrous material
Capacity	Minimum 5 litre
Connection pipes/ tubes	Reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.2.3 Flushing cisterns shall be dual valve type with dual pushing button plates. In case of open type of cisterns, the valve shall be integral with the cistern. In case of concealed cistern/ tank, the valve plate (made of non ferrous metal or ABS (Acrylonitrile Butadiene Styrene) and having same finishing of the Faucets, taps etc.) shall be provided on the concealed surface at suitable location. Stop cocks/ valves shall be provided in the system for installation/ maintenance.

3.3 INDIAN WATER CLOSET (IWC)

3.3.1 Squatting Pan shall be of vitreous china and Orissa Pan type conforming to IS: 2556. The closet shall be fixed in the floor with 150 mm thick sand cushion and shall be connected with CI `S' or `P' trap with approximately 50 mm water seal.

3.3.2 Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlets hall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing.

3.3.3 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4 WASH DOWN TYPE EUROPEAN WATER CLOSETS (EWC)

3.4.1 The commode shall be of vitreous china conforming to IS: 2556.

Copyright EIL – All rights reserved

3.4.2 The closets shall be of one piece construction and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with at least 50 mm water seal. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush.

3.4.3 The closets shall be floor or wall mounted with flushing cisterns either integral with the commode or separately mounted on wall or concealed cisterns/tanks connected with flush pipe as mentioned.

3.4.4 The commodes shall be provided with a hinged seat and cover/ lid. The seat and cover made of thermosetting or thermoplastic conforming to IS 2548. Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when it is of urea formaldehyde. The seat and cover shall be fitted with plastic buffers. The cover shall be hydraulically operated type.

3.4.5 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4.6 Superior quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, joint less construction. Water consumption – maximum 2 and 4 litre for partial and full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

3.4.7 Premium quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Fully skirted (Traps not visible), Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, jointless construction. Water consumption – maximum 2 and 4 litre for partial and

Copyright EIL – All rights reserved

	full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

4.0 URINAL SYSTEM

4.1 General

4.1.1 Urinals shall be a water tight and leakage free system consisting of urinals complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

4.1.2 Flushing and disposal of the waste shall be by means of water from direct water supply line if not mentioned otherwise.

4.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

4.1.4 The urinals shall be made of vitreous China and half stall type conforming to IS 2556.

4.1.5 The urinals shall be of one piece construction, full stall type with integral flushing rim and of approved colour.

4.1.6 All pipe, fittings, plumbing of water supply connection to the urinals, drainage/ disposal pipes shall be concealed. Stop cock shall be provided just above the urinal for flushing.

4.1.7 Bottle trap and union fittings shall be provided for waste disposal from the urinals.

4.1.8 Urinal partitions shall be provided in between the urinals. If not mentioned specifically elsewhere, partitions made of polished granite stone shall be provided.

4.2 Sensor operated Urinals

4.2.1 With reference to clause no 4.1, in case of sensor operated urinals, the flushing system shall be by means of concealed type electronic type sensors. The power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In-Charge.

4.2.2 Sensor operated urinals shall have pre-flush facility also.

4.3 Waterless Urinals

4.3.1 Waterless urinals shall be made of vitreous china having antibacterial /germs free ceramic surface, fixed with cartridge having debris catcher and hygiene seal.

5.0 WASH BASINS / SINKS

5.1 General

5.1.1 Wash basins and sinks shall be water tight and leakage free system complete with water supply and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

Copyright EIL – All rights reserved

5.1.2 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

5.1.3 The wash basins shall be made of vitreous China conforming to IS 2556.

5.1.4 The wash basins/sinks shall be of one piece construction and of approved colour with nickel chromium plated brass waste fitting for connecting with waste pipe.

5.1.5 All pipe, fittings, plumbing of water supply connection to the basins/ sinks, drainage/ disposal pipes shall be concealed.

5.1.6 Wash basins/ sinks shall be wall mounted or mounted over/ under counters as mentioned in the tender document or construction drawings. In case of wall mounted fitting, the basin/ sink shall be fixed to wall with metal (painted) brackets.

5.1.7 Shape, design and size of the wash basins/ sinks shall be as approved by the Engineer-In-Charge.

5.1.8 Wash basins shall be provided with taps/ pillar cocks/ faucets of approved design. Mixer type tap/ pillar cock shall be provided in case of hot and cold water supply.

5.1.9 Bottle trap and union fittings shall be provided for waste disposal from the wash basins.

5.1.10 In case of Sinks, taps with long and swinging neck shall be provided so that water reaches in all the areas of the Sink.

5.1.11 Connection pipes/ tubes shall be of flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

5.2 Superior quality Wash Basins and faucets

5.2.1 Superior quality Wash Basins shall be round or oval shaped under counter top type with either electronic sensor operated or pressmatic type faucets as mentioned.

5.2.2 In case of sensor operated basins, power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.2.3 Faucets shall be of brass body, chromium plated of approved design and shall be mounted over the counter or mounted on the basin itself as decided by Engineer-In-Charge.

5.3 Premium quality Wash Basins and faucets

5.3.1 Premium quality Wash Basins shall be over the counter top and thin rim type, of approved shape with electronic sensor electronic sensor operated.

5.3.2 Power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.3.3 Faucets shall be of brass body, chromium plated of approved design and shall be wall mounted or mounted over the counter as decided by Engineer-In-Charge.

5.4 Kitchen/ Pantry/ Laboratory sinks

Kitchen/ Pantry/ Laboratory sinks shall be of stainless steel (304 -18/8) conforming to IS 13983. Nominal thickness of SS sheet shall not be less than 1 mm before forming. Thickness

Copyright EIL – All rights reserved

at any point of the sink, after forming shall not be less than 0.75mm. Depth of the bowl shall not be less than 150 mm. Minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl shall be 380mm x 340 mm for rectangular bowls and 360 mm for round bowls.

6.0 FITTINGS & FIXTURES

6.1 General

6.1.1 Fittings/ fixtures such as Taps/ Valves/ Faucets/Shower roses/ bib, stop, pillar cocks etc shall be of approved design and finish and shall be procured from approved Manufacturer.

6.1.2 Fittings/ fixtures shall be provided as per table below :

WC cubicles	Bib cock or health faucet, Coat/ Robe hook, Toilet paper holder
Shower cubicles	Towel rail, Coat/Robe hook, Soap tray, Shower rose
Wash Basins	Mirror and Faucets for each wash basin, Touch less type Soap dispenser (Tissue paper dispenser in locations decided by the Engineer-In-Charge) and Hand drier near wash basin.

6.1.3 Removable floor trap covers made of stainless steel shall be provided over all floor traps.

6.1.4 Fittings/ fixtures shall be made of non-ferrous anti corrosive metallic materials with chromium plated finish if not mentioned otherwise.

6.2 Specifications of sanitary fittings/ fixtures

6.2.1 Sanitary fittings/ fixtures shall meet the following specifications if not mentioned otherwise specifically in the tender/ bid documents and construction drawings.

Fittings/ fixtures	Specification
Bib Cocks, Stop Cocks, Pillar cocks, Taps, valves, Faucets, mixers etc.	15mm dia, chromium plated Brass body conforming to IS : 781 Faucets for superior and premium quality wash basins shall be as mentioned.
Health Faucets	Chromium plated Brass body with bracket
Shower rose	Chromium plated Brass body conforming to IS : 2064 with adjustable rose and supporting arm.
Toilet paper holder	Chromium plated Brass body or stainless steel (grade – 304)
Liquid soap dispenser	Plastic body
Towel ring/ rail/ rack	Stainless steel (grade – 304)
Mirror	Made of minimum 5mm thick glass with beveled/ rounded edge.
Coat/Robe hook	Stainless steel (grade – 304)

7.0 INSTALLATION

7.1 Sanitary fittings/ fixtures shall be installed by licensed plumber.

7.2 The fixtures/ fittings shall be installed in accordance with the Manufacturer's recommendation and as approved by the Engineer-In-Charge.

7.3 All fittings/ fixtures shall be installed ensuring water tightness using sealers/ gaskets etc. as required.

Copyright EIL – All rights reserved

7.4 All holes/ punctures in walls due to installation shall be concealed by stainless steel round covers matching with the fixture/ fittings.

7.5 Pedestals of WCs/ wash basins etc. in contact with the floor finish shall be suitably sealed.

7.6 All screws for fixing/ fitting etc. shall be of stainless steel fixed with anchor fasteners.

Copyright EIL – All rights reserved

बनावटी छत, बनावटी तल, अंडरडेक इन्सुलेशन और पार्टीशनिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR FALSE CEILING, FALSE FLOORING, UNDERDECK INSULATION & PARTITIONING

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convener	Approved by: Standards Bureau Chairman
8	18.09.25	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	ANISH KUNDU	MAINAK NANDI
7	08.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	22.03.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/JKB	R. SRIVASTAVA	R. NANDA
5	23.11.11	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS/SD	JKB	D. MALHOTRA

Copyright EIL – All rights reserved

Abbreviations:

ASTM	:	American Society of Testing of Materials
BS	:	British Standards
CISCA	:	Ceilings & Interior Systems Construction Association
CRCA	:	Cold Rolled Close Annealed
EN	:	European Standards
GI	:	Galvanized Iron
IS	:	Indian Standards
ISO	:	International Organization for Standardization
MS	:	Mild Steel
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NRC	:	Noise Reduction Coefficients
NBC	:	National Building Code
NFPA	:	National Fire Protection Association
PVC	:	Polyvinyl Chloride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel

Architecture Standards Committee

Convenor: Mr Anish Kundu

Members:
Mr. Sandeep Sharma
Ms Maitrayee Majumdar (Strl)
Mr Charanjit Singh (Projects)
Mr Indrajit Neog (Construction)
Ms Gursharan Jeet Kaur
Mr Atul Gupta
Mr Anish Mahala

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 FALSE CEILING SYSTEMS 4
3.1 GENERAL 4
3.2 MINERAL FIBRE BOARD FALSE CEILING SYSTEM 5
3.3 GYPSUM BOARD SEAMLESS FALSE CEILING SYSTEM 6
3.4 CALCIUM SILICATE BOARD FALSE CEILING SYSTEM 8
3.5 CALCIUM SILICATE TILE FALSE CEILING SYSTEM 9
3.6 ALUMINIUM FALSE CEILING SYSTEM (SQUARE GRID TYPE) 10
3.7 ALUMINIUM FALSE CEILING SYSTEM (LINEAR PLANK TYPE) 11
4.0 UNDERDECK INSULATION SYSTEM 12
4.1 POLY- ISOCYANURATE (PIR) FOAM INSULATION SYSTEM 12
4.2 GLASS WOOL INSULATION SYSTEM 12
5.0 FALSE (RAISED ACCESS) FLOORING SYSTEM 13
6.0 PARTITIONING 16
6.1 GYPSUM BOARD PARTITIONING 16
7.0 MEASUREMENT 17

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of false ceiling, false flooring, under deck insulation, and partitioning system.

2.0 REFERENCES

2.1 The codes and standards listed below contains provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Sr. No.	Standards	Document Title
1	ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
2	ASTM C635	Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
3	ASTM C636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
4	ASTM E1414	Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
5	ASTM E1477	Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
6	BS 476 part 6/7	Fire Test
7	CISCA	The Ceilings & Interior Systems Construction Association Acoustical ceilings: Use and Practice
8	IS 277	Galvanized Steel Sheets (Plain and Corrugated)
9	IS 2095	Gypsum plaster boards
10	IS 2676	Dimension for wrought aluminium and aluminium alloy sheet and strip
11	IS 12436	Specification for. Preformed rigid polyurethane (pur). And polyisocyanurate (pir) foams
12	IS 8183	Bonded mineral wool - specification.

3.0 FALSE CEILING SYSTEMS

3.1 GENERAL

3.1.1 False or suspended ceiling systems shall be complete with supporting frame work / suspension system and ceiling boards/ panels/ tiles. Following types of false ceiling systems (either with only one type or in combination of various types) shall be provided as specified in design basis, job specifications, item descriptions, drawings etc.

1. Mineral Fibre board false ceiling system.
2. Gypsum board seamless false ceiling system.

Copyright EIL – All rights reserved

3. Calcium Silicate board false ceiling system.
4. Calcium Silicate tile false ceiling system.
5. Aluminium false ceiling system. (square grid type)
6. Aluminium false ceiling system. (linear plank type)

If false ceiling type is not mentioned specifically, Mineral Fibre board false ceiling system shall be provided.

3.1.2 False or suspended ceiling systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

3.1.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as lighting, HVAC, Fire-fighting system components, fittings and fixtures of which are accommodated on the ceiling or above and below.

3.1.4 The ceiling system shall be sturdy, finished, levelled and aligned as per approved drawings without any undulations, sagging or other defects. Zig-zag alignment of visible supporting system or ceiling panels/ tiles shall not be permitted.

3.1.5 All components of the ceiling system shall be from the approved Manufacturers of the whole and full system only. Materials / components procured from other Manufacturers shall not be permitted.

3.1.6 The ceiling systems shall be installed by agencies approved by Engineer-In-Charge.

3.2 MINERAL FIBRE BOARD FALSE CEILING SYSTEM

The Mineral Fibre board ceiling system shall be in square grid (exposed) type with tiles having bevelled tegular edges.

3.2.1 Ceiling boards/ panels/ tiles

Ceiling boards/ panels/ tiles shall be standard product of the approved Manufacturer and as per following specification.

Sr. No.	Item/ Property	Specification
1	Base Material	Mineral Fiber
2	Panel Dimensions	600 mm x 600 mm
3	Panel Thickness	16 mm
4	Dimension tolerances	+- 0.5 mm
5	Noise Reduction co-efficient	0.55
6	Fire Properties	Class 0/1 as per BS 476 part 6/7
7	Light Reflectance	85%
8	Humidity Resistance	RH 99%

3.2.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of interlocked main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling panels and shall be standard product of the Manufacturer and as per following specification.

Copyright EIL – All rights reserved

Members of the grid work shall be of galvanised steel (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

The exposed visible surfaces of the suspension system shall be finished with minimum 25 micron pre-painted polyester baked paint.

Mineral Fiber Tile Grid Ceilings Framework Details:

Sl. No.	Ceiling Drop (mm)	Hanger Size (mm)	Distance of hangers in both directions (mm)
1	0 to 1500	Minimum 4mm dia wire rod with level adjuster as per site requirement	1200
2	1500 to 3000	Minimum 6mm Dia Threaded Rod with level adjuster as per site requirement	1200

Note : For ceiling drop exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension framework. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.2.3 Installation

3.2.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.2.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of threaded hanger rod and level adjuster) at 1200 mm maximum. For ceiling drops greater than 3000mm main members shall be placed at a spacing of 1200x1200 mm (both directions) fixed to the structural suspension arrangement.

3.2.3.3 Cross members shall be interlocked between main runners at 600mm to form 1200 mm x 600mm module.

3.2.3.4 Short cross members shall be fixed between main runners at 600mm to form in the 1200 mm x 600 mm modules to form 600 mm x 600 mm modules.

3.2.3.5 Perimeter sections shall be secured to perimeter walls/ partitions.

3.2.3.6 Ceiling panels/ tiles shall be provided in the suspended grid work.

3.3 GYPSUM BOARD SEAMLESS FALSE CEILING SYSTEM

The gypsum board false ceiling system shall be of seamless finish.

3.3.1 Gypsum boards

Gypsum boards shall conform to IS : 2095 and shall have following properties.

Copyright EIL – All rights reserved

Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4
4	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.3.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized steel (120 gsm on both sides as per IS: 277) power pressed to required profile.

Gypsum Ceilings Framework Details:

Table -1

Sl. No.	Ceiling Drop (mm)	Bracing	Hanger Size (mm)	Distance of hangers in both directions (mm)	Distance of Interme diate (mm)
1	0 to1500	Not Required	25x10x0.5	1200	1200
2	1500 to 3000	Bracing with L Angle at every 1500mm in Horizontal direction	25x10x0.5	900	900

Note : For heights exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.3.3 Installation

3.3.3.1 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of cleats and suspension angle member) at 1200 mm maximum.

3.3.3.2 Cross members shall be fixed main runners at the spacing of 450 mm. Additional bracing to be provided as per the ceiling drop from true ceiling as mentioned in the Table No 1.

3.3.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.3.3.4 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

Copyright EIL – All rights reserved

3.3.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

3.4 CALCIUM SILICATE BOARD FALSE CEILING SYSTEM

The Calcium Silicate board false ceiling system shall be of seamless finish by fixing the ceiling boards on the suspension system.

3.4.1 Calcium Silicate ceiling boards

The calcium Silicate ceiling boards shall be with durable tapper edge type board having following specification.

Sr. No.	Item/ Property	Specification
1	Board Thickness	8 mm
2	Dimension tolerances	+- 0.8 mm
3	Fire Properties	Class 0/1, Class A as per BS 476 part 6/7
4	Humidity Resistance	RH 99%
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.4.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

3.4.3 Installation

3.4.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.4.3.2 Main members of grid framework shall be suspended from the soffit @ 1200 mm maximum by means of angle hangers with nuts and bolts, angle hangers being fixed to angle cleats fixed on the soffit by means of dash fasteners.

3.4.3.3 Intermediate members of grid framework shall be fixed to main members @ 450 mm maximum in a direction perpendicular to the main members with connecting clips.

3.4.3.4 Perimeter members shall be fixed on perimeter surfaces.

3.4.3.5 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. Tapered and square edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

3.4.3.6 The ceiling board surfaces shall be finished with paint etc. as specified.

Copyright EIL – All rights reserved

3.5 CALCIUM SILICATE TILE FALSE CEILING SYSTEM

The Calcium Silicate tile false ceiling system shall be of square grid type laid on the suspension system.

3.5.1 Calcium Silicate ceiling tiles

The calcium Silicate ceiling tiles shall be of approved texture having following specification.

Sr.No.	Item/ Property	Specification
1	Tile thickness	8 mm
2	Tile size	595 mm x 595 mm or 610 mm x 610 mm
3	Humidity Resistance	RH 99%
4	Fire Properties	Non combustible as per BS 476, part -4 Class 1 as per BS 476 part 7
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.5.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling tiles and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel.

Visible areas of the frame work shall be pre-painted with polyester paint.

3.5.3 Installation

3.5.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.5.3.2 Main and cross members of grid framework shall be interlocked (as required to form the square grid suitable for the tile size) and suspended from the soffit by means of slotted galvanized steel cleats, adjustable rods fixed to soffit with anchor fasteners in accordance with approved Manufacturer's standard practice.

3.5.3.3 Perimeter members shall be fixed on perimeter surfaces.

3.5.3.4 Ceiling tiles shall be laid in the grid frame work.

3.5.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

Copyright EIL – All rights reserved

3.6 ALUMINIUM FALSE CEILING SYSTEM (SQUARE GRID TYPE)

Aluminium false ceiling system (square grid type) shall be standard product of the approved Manufacturer, clip-in type in square grid consisting of Alumium alloy ceiling panels and suspension system.

3.6.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3003- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Bevel edged, Perforated type with non-woven acoustical fleece
2	Panel dimension	600 mm x 600 mm
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron)
9	Salt spray test	750 hours as per ASTM B 117

3.6.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (90 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.6.3 Installation

3.6.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.6.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod and level adjuster).

3.6.3.3 Cross members shall be interlocked between main runners to form 600 mm x 600 mm grid.

3.6.3.4 Perimeter sections shall be secured to perimeter walls/ partitions.

3.6.3.5 Ceiling panels/ tiles shall be laid in the suspended grid work.

Copyright EIL – All rights reserved

3.7 ALUMINIUM FALSE CEILING SYSTEM (LINEAR PLANK TYPE)

Aluminium false ceiling system (linear plank type) shall be standard product of the approved Manufacturer, single grid type in concealed system consisting of Aluminium alloy ceiling panels and suspension system.

3.7.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3105- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Perforated type with non-woven acoustical fleece with bevel edge and upturn
2	Panel dimension	150 mm (width)
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron) If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.
9	Salt spray test	750 hours as per ASTM B 117

3.7.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (120 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.7.3 Installation

3.7.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.7.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod).

3.7.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.7.3.4 Ceiling panels shall be clipped on to the main members of the suspended grid work.

Copyright EIL – All rights reserved

4.0 UNDERDECK INSULATION SYSTEM

Insulating material of underdeck insulation system shall be of glass wool boards or Polyisocyanurate (PIR) foam boards/slabs as specified in the design basis, item description, job specification drawings etc.

If nothing is mentioned specifically, glass wool boards shall be used.

4.1 POLY- ISOCYANURATE (PIR) FOAM INSULATION SYSTEM

4.1.1 Poly- Isocyanurate (PIR) foam

Poly-Isocyanurate (PIR) foam insulation shall be in the slab form with lining of glass fibre tissue or aluminium foil lining (having 50 mm overlap) on one side.

Poly-Isocyanurate (PIR) foam shall conform to IS: 12436 and shall have following specification.

Sr.No.	Item/ Property	Specification
1	Slab thickness	Minimum 30 mm
2	Density	Not less than 32 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.023 w/mk at 10 degree C
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

4.1.2 Installation

4.1.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.1.2.2 Hot blown bitumen (grade 85/25) over a bituminous priming or approved cold adhesive shall be applied over the soffit and PIR board surface after cleaning the surfaces.

4.1.2.3 PIR slabs shall be pressed in position over the bitumen coat when it is still tacky or over the cold adhesive and shall be fixed to the soffit by means of approved fasteners (at four corners and at the centre of the slabs) without damaging the slabs.

4.1.2.4 Overlaps shall be covered with approved sealing compound.

4.1.2.5 The PIR shall be further secured by chicken wire mesh (24 gauge) fixed to the fasteners and tightened with lacing wire.

4.2 GLASS WOOL INSULATION SYSTEM

4.2.1 Glass wool insulation

Glass wool insulation shall be in rolls or boards and shall be pre-laminated on one side with aluminum foil.

Glass wool insulation shall conform to IS: 8183 and shall have following specification.

Sr. No.	Item/ Property	Specification
1	Thickness	Minimum 75 mm
2	Density	Not less than 24 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.034 w/mk at 25 degree C mean
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

Copyright EIL – All rights reserved

4.2.2 Installation

4.2.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.2.2.2 The insulation boards/roll shall fixed underside soffit with the help of polyamide based long insulation fasteners @ 450 mm c/c.

4.2.2.3 The joints shall be sealed with self-adhesive aluminum foil tape

5.0 FALSE (RAISED ACCESS) FLOORING SYSTEM

False flooring system shall be modular and removable type and shall consist of floor panels and supporting/ understructure system.

The system shall be factory made and the full system including all components shall be sourced from approved single Manufacturer.

The system shall be strong and durable for movement and other operations.

This specification is applicable for false floorings upto 1000 mm high.

The flooring system shall be capable of supporting following loading conditions when tested as per CISCA test procedure.

i. Concentrated load of 675 Kg. with maximum allowable deflection of 2.5mm and a factor of safety of 2.5.
ii. Uniform load of 2025 Kg/ Square meter.

For details reference shall be made to standard no 7-75-0049.

5.1 Floor panels

Sr. No.	Item/ Property	Specification
1	Material	CRCA steel with cementitious core with hemispherical and reverse cones and 1 mm thick epoxy painted CRCA steel sheet on top. The inner empty core shall be injected with light weight fire retardant non combustible cementitious compound.
2	Size	600 mm x 600 mm x 35 mm thick. (Dimensional tolerance : +- 0.8 mm).
3	Finishing	Top sheet shall be finished with 2 mm thick high pressure laminate or 2 mm thick conductive PVC or stone or other type of tiles as specified. If nothing is mentioned specifically, high pressure laminate shall be provided.
4	Edging	All edges of the panels shall have conductive PVC trims
5	Fire resistance/ property	Class 0 & class 1 conforming to BS 476-part-6 (Fire propagation) and BS 476-part-7 (Surface spread of flame).

Copyright EIL – All rights reserved

5.2 Understructure/ supporting system

False floor understructure shall be installed to support the panels and shall be suitable to achieve required cavity height from the existing floor level. The system shall ensure speedy assembly and removal for relocation and maintenance. The system shall also ensure easy adjustment of levelling (±25mm) and accurate alignment of panels in the vertical direction.
False floor understructure shall consist of Base plate, pedestals, pedestal head assembly, stringers and necessary fittings, fixtures and accessories as specified below.

Sr. No.	Item/ Property	Specification
1	Pedestal Base Assembly .	Powder coated. hot dip galvanized (60-80 micron) mild steel base plate with not less than 150mm x 150mm x 4 mm of bearing area, mechanically riveted to a 32mm dia. of 2 mm thick CRCA steel pedestal designed to engage the head assembly
2	Pedestal Head Assembly	Zinc electroplated CRCA steel pedestal head assembly shall be 90mm x 90mm x 4 mm thick profiled head, mechanically riveted to a 19 mm dia. threaded bright rod, fixed to pedestal by specially designed zinc electroplated steel forged adjusting nut for leveling, locking and changing the height setting.
3	Stringers	Stringers shall be of hot dip galvanized (60-80 microns) steel, minimum 20mm x 32mm x 1.20mm thick CRCA steel.

5.3 Installation

5.3.1 False flooring systems shall be installed by agencies approved by Engineer-In-Charge.

5.3.2 False flooring systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

5.3.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as which are accommodated in the cavity of the false flooring.

5.3.4 Installation shall be done in accordance with approved system Manufaturer's standard practice, as directed by the Engineer-In-Charge and as mentioned below:

5.3.5 Installation of under structure

a) The base floor and cavity between false flooring and base floor shall be properly cleaned and made dust free and dry. The base cement concrete floor shall be treated with one component polyurethane based coating.

b) Pedestal base assembly shall be fixed to the base floor by fixing base plates to the base floor by minimum 50mm x 8mm anchor fasteners (4 nos. for each plate).

c) The pedestal stud locations shall ensure the grid work as per flooring pattern which in general shall be of 600 mm x 600 mm dimension. The length of the pedestal studs shall be such that clear cavity between false flooring and base flooring is of desired depth. Additional pedestals as needed to support panels where floor is disrupted by columns, walls and cutouts shall be provided. Perimeter pedestal studs shall be provided along the periphery. Pedestal assemblies including pedestal heads shall be weld-free construction, corrosive resistant and shall provide an adjustment range of ±25mm from the specified finished floor heights.

Copyright EIL – All rights reserved

d) The threaded bright rod with the top head attachments shall be inserted into the studs and shall be adjusted to obtain proper level of the finished floor panels by means of the adjustment nut. The nut shall provide location lugs to engage the pedestal base assembly, such that deliberate action is required to change the height setting. Threaded rod shall provide a specially designed anti-rotation device, such that when the head assembly is engaged in the base assembly, the head cannot freely rotate.

e) The pedestal head shall have an anti vibration PVC cap for panel and stringer location. Stringers shall support each edge of panel. The stringers shall have counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. Stringers shall be individually and rigidly fastened to the pedestal with one machine screw for each end of stringer. Bolts shall provide positive electrical contact between the stringers and pedestals. Stringer grid shall ensure maximum lateral stability in all directions. All the field cut panels shall be installed with an appropriate PVC end cap specially designed to accommodate the stinger and arrest Panel beam movement and will ensure the integrity and stability of the system.

5.3.6 Installation of floor panels

a) Floor panels shall be placed over the stringer channels and bolted to pedestal head. All four edges of panels shall be finished with black conductive 5mm wide PVC edge beadings. These edge beadings are glued and sealed in place to avoid detachment.

Floor panels which are field cut (at ends, Console/ Rack location etc.) shall be marked with positional numbering on the underneath and the adjoining wall. The finished floor panels shall be perfectly levelled and aligned without any gaps in between the panels.

b) All accessories such as outlet boxes and grommets as required, Panel lifters (at least one for each building, one number for every 500 Square meter of access floor area) etc. shall be provided in accordance with approved Manufacturer's recommendations.

c) Each individual panel shall be removable for the purpose of maintenance of the cavity. Panel shall be easily removed by one person with a lifting device and shall be fully transferable and totally inter changeable and replaceable in any of the 4 directions at 90 degrees increments, except where cut for special conditions.

d) Necessary cut-outs shall be made in the panels for cable routing, control panel fixation etc. as per drawing.

e) Necessary ramps, slopes, steps etc. shall be also provided for as per drawing with raised access floor components as per approved manufacturer recommendations.

f) Around a control panel/rack, the residual space left out shall be filled up with cut panels of uniform size as required to fully close the gap between the adjacent full panel and the control panel base channel. In this case the part floor panel shall extend upto the full width of the base channel and the cut size shall be determined accordingly. An additional structural steel framework shall be provided along the cut out on which the edge of the floor panel shall rest and over which the base channel of control panel shall be placed.

g) Earth bonding of the system shall be in accordance with approved Manufacturer's standard practice as approved by the Engineer-In- Charge. After completion of the floor and association services, tests shall be arranged to demonstrate that the floor is electrically continuous and fully earth bonded. Points chosen for testing shall include randomly selected pedestals, stringers tops and bottoms of panels, etc.

Copyright EIL – All rights reserved

6.0 PARTITIONING

Partitioning shall rigid, stable, true to the plumb and in accordance with design and approved drawings for all heights.

6.1 GYPSUM BOARD PARTITIONING

Partitioning shall be of gypsum partition boards fixed on galvanized steel frame work. The partitions shall be rigid and stable.

6.1.1 Gypsum partition boards

Gypsum partition boards shall conform to IS : 2095 and shall have following properties. Overall thickness of the finished partition shall be minimum 75 mm.

Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4

6.1.2 Partition frame

Partition framework shall be in accordance with standard system of the approved Manufacturer and shall consist of profiled floor & ceiling sections and vertical sections of power pressed/ roll formed galvanized steel (minimum 120 gsm, both side inclusive as per IS:277). Minimum thickness of the sections shall be 0.5 mm.

6.1.3 Installation

6.1.3.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's, approved fabrication drawings (prepared by the Contractor) and following specification.

6.1.3.2 Thickness, size, spacing of the frame sections shall be as required for desired height in accordance with recommendations/ standard practice of the approved Manufacturer.

6.1.3.3 Floor and ceiling sections shall be fixed with fasteners of 12.5 mm diameter, 50 mm length @ 600 mm c/c. Vertical sections shall be fixed in the floor and ceiling sections @ 610 mm c/c.

6.1.3.4 Gypsum partition boards shall be fixed on both sides of the framework by drywall screws @ 300 mm c/c.

6.1.3.5 All vertical and horizontal joints of the boards shall be staggered to avoid cracks with provisions of galvanized steel sections fixed to the vertical sections at the horizontal joints of the boards.

6.1.3.6 The jointing and finishing of the boards shall be finished using approved jointing compound, paper tape, metal corner tapes etc. and two coats of primer suitable for the boards.

6.1.3.7 Arrangements of wires/ conduits running through the cavity of the system shall be made. Cut/outs, openings for doors, windows, switches etc. shall be made with necessary framing/ stiffening of the openings.

Copyright EIL – All rights reserved

6.1.3.8 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified. If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour

7.0 MEASUREMENT

7.1 Measurement of false/ suspended ceiling system shall be measurement of actual surface area covered by the ceiling boards/ panels/ tiles.

7.2 Measurement of underdeck insulation system shall be measurement of actual surface area covered by insulation slab/ roll/ board.

7.3 Measurement of false/ raised floor system shall be measurement of actual surface area covered by floor panels.

7.4 Measurement of partitioning system shall be measurement of actual surface area covered by partition boards of one side.

7.5 Area of cut our/ openings for door/ window, various fittings etc. shall be deducted.

Copyright EIL – All rights reserved

अग्निरोधक दरवाजों, खिड़कियों व पार्टीशन के लिए मानक विनिर्देशन

STANDARD SPECIFICATIONS FOR FIRE CHECK/ FIRE RESISTANT DOORS, WINDOWS & PARTITIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	08.02.22	REVISED & ISSUED AS STANDARD SPECIFICATION	SANDEEP SHARMA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
1	14.06.14	REVISED & ISSUED AS STANDARD SPECIFICATION	AM/RH	SD	JKB	DM
0	01.02.12	ISSUED AS STANDARD SPECIFICATION	AM	SM	JKB	DM

Copyright EIL – All rights reserved

Abbreviations:

ASTM	: American Society for Testing and Materials
BS	: British Standards
CBRI	: Central Building Research Institute
EN	: European Standards
IS	: Indian Standard
ISO	: International Organization for Standardization
GI	: Galvanized Iron
NABL	: National Accreditation Board for Testing and Calibration Laboratories
NBC	: National building Code
NFPA	: National Fire Protection Association
PVC	: Polyvinyl Chloride
PUF	: Polyurethane foam
SS	: Stainless Steel
UL	: Underwriters Laboratories
CuM	: Cubic Meter

Architecture Standards Committee
Convenor: Mr. Samir Das

Members: Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumder (Strl)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL 4
2.0 REFERENCES 4
3.0 FIRE CHECK/ RESISTANT/ RATED DOORS, WINDOWS & PARTITIONS 5
4.0 TESTING AND CERTIFICATION 5
5.0 MATERIAL 6
6.0 WOODEN FIRE DOORS 7
7.0 STEEL FIRE DOORS 8
8.0 VISION PANEL 10
9.0 LOUVERS 10
10.0 GLAZED FIRE DOORS 10
11.0 GLAZED FIRE WINDOW 11
12.0 GLAZED FIRE PARTITION 12
13.0 HARDWARE 13
14.0 SOLID TYPE FIRE PARTITION (Calcium Silicate) 14
15.0 SOLID TYPE FIRE PARTITION (Gypsum Plaster Board) 15
16.0 INSTALLATION 16
17.0 DELIVERABLES BY THE CONTRACTOR 17
18.0 GUARANTEE 17
19.0 MEASUREMENT 17

Copyright EIL – All rights reserved

1.0 GENERAL

This standard specification lays down requirements of fire rated/ check/ resistant door, window and partition assemblies intended to provide safety and safe exit from buildings in case of fire.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS 2095, Part-I	Gypsum plaster boards – plain gypsum plaster boards
IS 3614	Fire Doors and Doorsets - Specification
IS 16945	Fire resistance test for glass walls
IS 16947	Fire resistance tests for doors with glass panes, openable glass, glass windows and sliding glass doors
IS 277	Galvanized steel sheets (plain and corrugated)-Specification
IS 287	Permissible moisture content for timber used for different purposes-Recommendations
IS 513	Cold reduced low carbon Steel sheet and strip
IS 8183	Bonded Mineral Wool - Specification
IS 14862	Fibre Cement Flat Sheets — Specification
BS 476, Part- 4	Fire tests on building materials and structures. Non-combustibility test for Materials.
BS 476, Part- 7	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
BS 476, Part- 20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction. (general principles).
BS 476, Part- 22	Fire tests on building materials and structures. Method for determination of the fire resistance of non-load bearing elements of construction.
BS 6206	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
SP-7 (Part-40)	National Building Code of India – part-4 – Fire & life safety
EN-1363-1	Fire resistance tests. General requirements
EN-1364-1	Fire resistance tests for non-load bearing elements. Walls
EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Fire resistance test for door and shutter assemblies and openable windows
EN 10346	Continuously Hot Dip Coated Steel Strip And Sheet Products.
EN 12600	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
ISO 834-1	Fire resistance tests: Elements of Building construction- General requirement.
ISO 3008	Fire resistance tests: Door and shutter assemblies, Part 1: General requirements.
ISO 3009-1	Fire-resistance tests: Elements of building construction: Glazed elements.

Copyright EIL – All rights reserved

3.0 FIRE CHECK/ RESISTANT/ RATED DOORS, WINDOWS & PARTITIONS

3.1 Fire check/ resistant/ rated door, window & partition assemblies (termed as "Fire doors, windows, partitions" hereafter) shall be of fire resistance/ rating and type (wooden/ metallic/ glazed etc.) mentioned in the drawings, job specification, item descriptions etc. and shall be complete assembly with frame, shutter/ leaves, glazing, partition panel, hardware etc.

3.2 If type and fire resistance/ fire rating is not specifically mentioned in the drawings, job specification, item descriptions etc., following types of fire doors/ windows/ partitions shall be provided.

Doors:

Steel fire doors having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 30 minutes for insulation.

Windows:

Fully glazed fire windows having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 20 minutes for insulation.

Partitions:

Solid type fire partitions made of calcium silicate board having fire resistance/ fire rating of two hours (120 minutes) for Integrity and insulation.

3.3 The fire doors, windows and partitions shall be in accordance with test certificate or test validity or evaluation report or assessment report (termed as "test report" hereafter) with regards to fire resistance/ rating, material, design, construction, dimension, sizes etc. and shall be complete assembly with frame, shutter/ leaf, glazing, partition panels and hardware.

3.4 Each Fire door, window & partition shall be provided with appropriate label mentioning name of the Manufacturer, fire rating, and year of Manufacturing/ installation.

4.0 TESTING AND CERTIFICATION

4.0 Prototype/ type test repot shall be submitted for each type (such as wooden, steel, glazed etc.), size range and fire resistance / rating of fire doors, windows and partitions.

4.1 Testing for fire resistance / rating of steel and wooden doors shall be done by subjecting a full size construction to test in accordance with the procedures laid down in ISO 3008 or BS 476: part 22.

4.2 Testing for fire resistance/rating of glazed doors, windows and partitions shall be done by subjecting a full size construction to test in accordance with the procedures laid down in following codes as applicable:

1. EN 1634-1
2. EN-1364-1
3. ISO 3009
4. BS 476 : part 20, part 22
5. IS 16945
6. IS 16947

Copyright EIL – All rights reserved

4.4 Testing for fire resistance / rating of solid type partition shall be done by subjecting a full size construction to test in accordance with the procedures laid down in BS 476 : part 20 and part 22.

4.5 Hardware if not tested with the door/ window/ partition, shall be type tested or shall be certified for use on specified fire rated door/ window/ partitions.

4.6 These prototype/ type test reports shall be issued by CBRI or NABL accredited laboratories or renowned National/ International Laboratories/ Test houses. Certifications of hardware shall be by renowned national/ international certification agencies.

4.7 The prototype/ type test certificate/ certifications etc. shall be valid at the time of submission and shall not be older than five years and shall be submitted by the supplier or manufacturer.

4.8 In case of change in design, material, construction, increase in dimensions (width, breadth, height, overall perimeter) or area of the complete assembly (including frame, shutter/leaves, glazing, partition panels and other individual components) as mentioned in the submitted prototype/ type test report, test reports appropriate to the changes shall be submitted.

4.9 However, refer to specific clauses of this specification pertaining to various type of doors, windows and partitions for allowable changes with respect to clause no 4.8

5.0 MATERIAL

5.1 Timber

Timber and timber boards/ composite material used in the construction of the fire doors shall be of thoroughly seasoned hardwood. The moisture content of any material used in the construction including frame and shutter shall not be more than 15 percent, in accordance with IS 287.

5.2 Calcium Silicate board

Calcium Silicate board shall conform to IS 14862 and shall have following properties:

Density	Not more than 900 kg/ cuM
Material class	Non-combustible, in accordance with BS 476: Part 4
Surface spread of flame	Class 1 in accordance with BS 476: Part 7
Thermal conductivity	K factor - 0.15W/mK
Nominal Mixture content (air-dried)	<15%

5.3 Fire Resistant Gypsum plaster board

Fire Resistant Gypsum Plaster boards shall conform to IS 2095 Part 1 and BS- 1230 (Part-1). Density shall be minimum 960 Kg/cuM (+/- 50).

5.4 Galvanized steel sheet

Galvanized steel sheet shall be zinc coated, alloyed type and shall conform to IS 277. The coating weight shall meet or exceed the minimum requirements for coatings of 120 gram/ square meter, total of both sides.

5.5 Cold rolled low carbon steel sheet

Cold rolled low carbon steel sheets shall conform to IS 513 or EN 10346. Drawing quality shall be DX52D and shall have following properties:

Copyright EIL – All rights reserved

Property	Value
Yield strength	Minimum 255 MPa
Tensile strength	Minimum 350 Mpa
Elongation	Minimum 38.5 %

5.6 Glass

The glass panels shall be clear, non-wired, interlayered and toughened type suitable for required fire rating/ resistance of the door/ window / partition assembly.

Each Glass panel shall carry a non-removable marking with the name of the product & the manufacturer inscribed on it.

Thickness of glass lesser than the thickness mentioned in the test report shall not be permitted.

Increase in width, height and overall area of the glass, when compared to dimensions mentioned in the test report shall also be not permitted.

Make, size and thickness of the glass panels shall be as mentioned in the test report for required assembly (door/ window/ partition) of required fire rating and shall have following properties.

Property	Value
Impact resistance	Minimum 2B2 category (When tested in accordance with EN 12600)
Light transmission ratio	Minimum 85% (When tested in accordance with EN 410)

5.7 Insulation

Insulation or infill material shall be resin bonded like resin bonded honeycomb paper core, mineral wool or ceramic wool as mentioned in the test report. Proprietary material may be used, provided they satisfy the requirement of fire resistance/ rating and is mentioned in the test certificate.

Polyurethane foam (PUF) shall not be permitted as infill or insulation material.

Mineral wool and Rock Wool used for insulation shall conform to IS 8183 and density shall be minimum 48Kg/ CuM. Higher density of insulation is permitted.

5.8 Fire & smoke seal

Fire & smoke seals shall be of the same dimensions and configuration as mentioned in the test report.

6.0 WOODEN FIRE DOORS

6.1 Wooden fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

6.2 Door assembly

6.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

Copyright EIL – All rights reserved

rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

6.2.2 Door frame

Door frames shall be of first grade teakwood and shall be fixed in position by means of anchor fasteners on jambs and head member. Sizes and profiles of the members of the frames shall be as mentioned in the test report. Intumescent fire and smoke seal shall be fitted in the frame in accordance with test certificate.

6.2.3 Door shutter/ leaves

Door shutters/ leaves shall be non-metallic and asbestos free type. They shall be composed of Calcium Silicate boards on both sides and insulation core. Overall thickness of the shutter, thickness of insulation and thickness of calcium silicate boards shall be as mentioned in the test report.

The shutter composition shall have painted/ polished teak wood lipping around the periphery fitted with intumescent fire & smoke seal in accordance with test certificate. The intumescent fire seal may not be required at the bottom of the door leaf.

If not mentioned otherwise, vision panels shall be provided in the door shutters.

6.3 Finishing

The door frames and teak wood lipping around the periphery of the shutters shall be finished with approved quality fire resistant paint conforming to IS 12777 including primer in desired colour.

Both sides of the door shutters/ leaves shall be faced with 3mm thick commercial ply finished with either 1mm thick laminate of approved color, texture and design, or teak ply (finished with fire retardant transparent paint conforming to IS 12777) as mentioned in the drawings, job specification, item descriptions etc.

If finishing of door shutter/ leaf is not specifically mentioned in the drawings, job specification, item descriptions etc., laminate finishing shall be provided.

6.4 Hardware

Reference shall be made to clause no 13.0

6.5 Fire resistance/ rating

If not mentioned otherwise, wooden fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.0 STEEL FIRE DOORS

7.1 Steel fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

7.2 Door assembly

7.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

Copyright EIL – All rights reserved

rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

7.2.2 Door frame

Door frames shall be of galvanized steel sheet press formed to required profile. The minimum sheet thickness for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Dimensions and profile of the door frames shall be as mentioned in the test report. However, increase in sheet thickness and frame profile size (compared to the test certificate) is permitted

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire/ smoke seal shall also be kept in the frame.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

7.2.3 Door Shutter/ leaf

Door shutters shall be minimum 45 mm thick with outer skins made of minimum 1.2 mm (18 gauge) thick galvanized steel sheet with infill/ insulation. Internal construction of the shutter shall be provided with rigid reinforcement in addition to the core/ infill. Rigid reinforcement pads shall be provided for receiving hardware like hinges, locks, door closers etc.

Higher thickness of the outer screens (compared to the test certificate) is permitted.

Double leaf shutters shall be provided with astragals.

Intumescent seals shall be provided on all three sides of the leaves and on the meeting stiles of the double leaf door or as per test certificate. Alternatively, the same can provided on the frame and meeting stile of the double leaf door.

If not mentioned otherwise, vision panels shall be provided in the shutters/ leaves.

Louvers shall be provided in the shutters/ leaves if mentioned specifically and test report of the doors with louver is available.

7.3 Finishing

The frame and the shutters shall be finished with minimum 50 microns powder coating in desired colour.

7.4 Fire resistance/ rating

If not mentioned otherwise, steel fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.5 Hardware

Reference shall be made to clause no 13.0.

Copyright EIL – All rights reserved

8.0 VISION PANEL

Glass for vision panels shall be in accordance with test certificate Maximum area of vision panel shall be 0.06 square meter. Maximum width shall be 200 mm, maximum height shall be 400mm.

In case of change in glass with respect to test report, the changed glass shall be appropriate to the specified fire resistance/ rating and supporting test report of the changed glass shall be submitted.

9.0 LOUVERS

Louvers shall be in accordance with test certificate when tested as a complete assembly on the fire door. Maximum area of the louvers shall not exceed 0.135 square metre. Maximum width and height shall be 300 mm and 450 mm respectively.

10.0 GLAZED FIRE DOORS

10.1 Door assembly

10.1.1 The door assembly including door frame, shutter/ leaf, stiles, rails, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

10.1.2 The glazed fire doors shall be fully glazed type with required frame, shutter/ leaf, stiles, top and bottom rails, insulation, fire & smoke seal, hardware etc. Intermediate middle/ lock rails shall not be provided.

10.1.3 Door Frame

Door frame shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile.

Minimum thickness of galvanized steel sheet for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Minimum thickness of cold rolled low carbon steel sheet for frames shall be 1.5 mm.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Dimensions and profile of the door frames and frame members shall be as mentioned in the test report. Increase or reduction in dimensions and change in profile when compared to the test report shall not be permitted.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire & smoke seal shall also be kept in the frame.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

10.1.4 Door Shutter/ leaf

Copyright EIL – All rights reserved

The shutter/ leaf frame (stiles and rails) shall be shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile. Thickness of steel sheet shall be minimum 1.2 mm.

Dimensions and profile of the stiles and rails shall be as mentioned in the test report. Increase in dimensions and change in profile when compared to the test report shall not be permitted.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Width of the stile and rail shall not exceed 100mm. In case of bottom rail width/ height may be upto 125mm.

Intermediate middle/ lock rails shall not be provided.

Hollow sections of stiles and rails shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screw etc. in accordance with test reports.

10.2 Finishing

The frame and the shutters/ leaves shall be finished with minimum 50 microns powder coating in desired colour.

10.3 Hardware

Reference shall be made to clause no 13.0.

10.4 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

11.0 GLAZED FIRE WINDOW

11.1 Window assembly

11.1.1 The window assembly including frame, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

11.1.2 Specification of window frame shall be similar to the specification of door frame as mentioned in clause 10.0

11.1.3 The glazed fire windows shall be fully glazed type (fixed glazing) with required frame, hardware etc. Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips etc. in accordance with test reports.

Copyright EIL – All rights reserved

11.2 Finishing

The frame shall be finished with minimum 50 microns powder coating in desired colour.

11.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

12.0 GLAZED FIRE PARTITION

12.1 Partition assembly

12.1.1 The partition assembly shall consist of metal framework and glass panels in accordance with approved design and pattern.

12.1.2 The partition assembly including frame, glazing, insulation etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

12.1.3 Glazed fire partitions shall be fully glazed unless otherwise mentioned specifically. Specification of partition frame shall be similar to the specifications of door frame mentioned in clause no 10.0. Specification of glass shall be as mentioned in clause 5.5.

12.1.4 Glass shall be single piece in a panel and increase in glass size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screws etc. in accordance with test reports.

12.1.5 Size of individual glass panels and overall size of the partition shall not exceed the sizes mentioned in the test report.

12.1.6 The partition shall cover the full height and length mentioned in the drawing etc and shall be fixed on top and bottom also. In case, the height and length mentioned in the drawing etc are more when compared to the test report, solid type partition or other construction having fire rating (120 minutes for both integrity and insulation) shall be provided as/ approved design so that dimensions of both glazed and solid partition/ other construction do not exceed the dimensions mentioned in the test report.

12.1.7 Doors provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

12.1.8 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

12.2 Finishing

The partition frame shall be finished with minimum 50 microns powder coating in desired colour.

12.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

Copyright EIL – All rights reserved

13.0 HARDWARE

13.1 Fire Doors, windows and partitions shall be provided with all required hardware for stability, proper operability and safety ensuring the fire resistance / rating.

13.2 All hardware used on Fire doors, windows and partitions shall be fire rated and certified except for hinges, if it is of minimum 100 mm x 75 mm x 3 mm size and in stainless steel of grade 304 and above. Similarly, pull handles may not require specific fire rating if it is in stainless steel of grade SS 304 and above.

13.3 All other hardware like locks, panic devices, lever handles, door closers etc. if not tested with the fire door, window or partition shall be type tested and certified for use on those specific fire rated doors, windows and partitions.

13.4 Tower/ flush bolts, Aldrops, side bolts and chain with padlocks shall not be provided in Fire doors. However, in case of double shutter/ leaf doors without panic bar, tower/ flush bolts shall be provided on inactive leaf.

13.6 Fire doors in exits (component of means of egress which is between the exit access and the exit discharge), doors opening into exits, staircase enclosure, exit access and exit discharge shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's practice.
2	Panic Bar	1. For single leaf door : - Single point panic bar "push to open" push bar, single leaf type – 01 No. 2. For active leaf of double leaf door : - Single point panic bar "push to open" push bar type – 01 No. 3. For inactive leaf of double leaf door Openable locks, trims with handle for panic bars to operate the bar from outside shall also be provided.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	Not required for Doors with Panic Bar, in case of double shutter/ leaf doors without panic bar, SS 304 grade, minimum 300mm long concealed tower/ flush bolts shall be provided on inactive leaf at top and bottom.

13.7 Internal fire doors which are not in the exits and do not open into the exits shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's

Copyright EIL – All rights reserved

		practice.
2	Mortice lock	Heavy duty mortice dead lock and D type (SS 304 grade, minimum length 300mm and 22mm dia) handle on both faces (Offset type handle – For all Glazed fire doors) Note: Instead of door handle with mortice dead lock, SS 304 grade lever handle with mortice sash lock on both faces (Offset type handle – For all Glazed fire doors) may be used.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	SS 304 grade minimum 300mm long concealed flush bolt (in inactive shutter of double shutter Doors) at top and bottom.

14.0 SOLID TYPE FIRE PARTITION (Calcium Silicate)

14.1 Partition assembly

14.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of calcium silicate partition boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

14.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

14.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

14.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

14.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

14.1.6 Minimum thickness of the calcium silicate boards shall be 12mm.

14.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

14.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

14.1.9 Over all thickness of the partition shall not be less than 93 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

14.1.10 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

14.1.11 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

Copyright EIL – All rights reserved

14.2 Finishing

14.2.1 Calcium Silicate partition boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

14.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

14.2.3 The calcium silicate boards shall be jointed and finished with jointing compound, fibre tape etc. so as to have a flush and even look after finishing.

14.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

14.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

15.0 SOLID TYPE FIRE PARTITION (Gypsum Plaster Board)

15.1 Partition assembly

15.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of fire resistant Gypsum plaster boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

15.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

15.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

15.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

15.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

15.1.6 Minimum thickness of the fire resistant Gypsum plaster boards shall be 12.5 mm.

15.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

15.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

15.1.9 Even if insulation in-fill is not mentioned in the test certificate, minimum 50 mm thick insulation of density 48kg/cuM shall be provided in the cavity of the framework.

Copyright EIL – All rights reserved

15.1.10 Over all thickness of the partition shall not be less than 102 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

15.1.11 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

15.1.12 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

15.2 Finishing

15.2.1 Gypsum plaster boards on both sides shall be sealed with paper tape, corner edges with metal corner tape and with three-layers of all purpose jointing compound to reinforce the board joints so as to have a flush and even look.

15.2.2 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

15.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

15.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

15.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

16.0 INSTALLATION

16.1 Shop drawings of the Fire doors, windows and partitions in accordance to the prototype/ type test report and design drawings shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include all details of construction, anchoring, connections, fastenings etc. The fire doors, windows, partitions shall be fabricated in accordance with the approved shop drawings.

16.2 Fire doors, windows, partitions shall be installed by the Manufacturer or agency recommended by the Manufacturer and approved by the Engineer- In-Charge.

16.3 Frames shall be installed plumb, level, rigid and in true alignment and shall be fixed to the adjacent construction so as to retain their position and stability. Fixing of the frames with masonry/ concrete may be done with suitable fasteners. The complete assemblies shall also be installed plumb, level, rigid and in true alignment.

16.4 The maximum allowable gap between the frame and masonry/ concrete work shall not be more than 5-8 mm and shall be sealed with sealant as mentioned in the test certificates/codes & standards or in accordance with the manufacturer's standard practice if not mentioned in the certificates and codes/ standards.

16.5 The door shutters/ leaves, window and partition panels shall be installed and fastened to maintain alignment with frames to achieve maximum operational effectiveness and appearance.

Copyright EIL – All rights reserved

16.6 Installation of hardware shall be in accordance with hardware Manufacturer's recommendations.

16.7 When the smoke/ fire/ intumescent seals are fitted on site, they shall be fitted strictly in accordance with the Manufacturer's recommendations.

17.0 DELIVERABLES BY THE CONTRACTOR

Following documentation/ drawings shall be furnished by the Manufacturer:

1. Prototype/ type Test Certificate of the door, window and partition assembly from test laboratory/ house.
2. Shop drawings.
3. Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items used in the system.
4. Certificate indicating that design and installation of Doors and hardware as per the test reports submitted.
5. Manufacturer's inspection report
6. Manufacturer's Guarantee.

18.0 GUARANTEE

The door/ window/ partition assembly including all hardware shall be guaranteed for a period of 12 months from the date of installation against any manufacturing defect.

In case of any such defect within the guarantee period, the defected part shall be replaced or repaired as required by the Contractor at his own cost.

19.0 MEASUREMENT

Unless otherwise mentioned, measurement of fire doors, windows and partition shall be as below:

19.1 Fire rated doors shall be measured by area of the doors (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.2 Fire rated windows shall be measured by area of the windows (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.3 Fire rated partition shall be measured by area of the partitions (only one side, inclusive of the frames, partition panels, fixing arrangement, glazing and all fittings. Area of doors, windows and other openings shall be deducted).

19.4 Hardware such as door closer, door stopper, locks and trims, panic bar etc., shall be measured in numbers.

Copyright EIL – All rights reserved

उपस्कर एवं यंत्रों की स्थापना हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	30.03.2019	Reaffirmed & Reissued	RJ	MI	RP	RKT
3	21.01.2013	Revised & Reissued	MA	RS	VK	DM
2	03.09.2008	Revised & Reissued	DM	PKR	AA	VC
1	30.05.2008	Revised & Reissued	DM	PKR	AA	VC
0	25.04.2001	Issued as Standard Specification	DM	AM	MR	MI

Copyright EIL – All rights reserved

Abbreviations:

ASME	:	American Society of Mechanical Engineers
EC	:	Erection Contractor
EIC	:	Engineer-in-charge
ELCB	:	Earth Leakage Circuit Breaker
GAD	:	General Arrangement Drawing
IS	:	Indian Standard
NDT	:	Non Destructive Testing
SS	:	Stainless Steel

General Engineering Standards Committee

Convenor : Ms R Priyamvada

Members : Mr BR Bhogal (Elect.)
Mr Rajan Srivastava (Strl.)
Mr RB Bhutda (EWS)
Mr Amrendra Kumar (Piping)
Ms NP Guha (Projects)
Mr Amit Prakash (FEM)
Mr KJ Harinarayanan (SME)
Mr VK Tonger (Process-1)
Mr Satyabrata Biswas (Process-2)

Copyright EIL – All rights reserved

CONTENTS

1.0 SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY 4

2.0 ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC. 5

3.0 ERECTION OF MECHANICAL EQUIPMENT 8

4.0 HEAT AND MASS TRANSFER EQUIPMENT 10

5.0 ERECTION OF ROTATING EQUIPMENT 16

6.0 EQUIPMENT GROUTING 19

7.0 REFERENCE EIL STANDARDS/ SPECIFICATIONS 22

Copyright EIL – All rights reserved

1.0 SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

1.1 Scope

This specification covers technical requirements for erection of all static and rotating equipment by erection contractor at site. This specification is applicable for all the erection tenders operated by EIL.

1.2 General

1.2.1 All necessary handling equipments, tools, tackles and precision instruments for carrying out the works as specified shall be provided by the Erection Contractor (EC) at his cost. EC must provide all tools and gauges for erection and alignment. Special tools, if any, received as part of machinery, will be given to EC for erection purposes, which shall be returned in good condition after use. Suitable deductions will be made by the Engineer-in-Charge (EIC) in case of loss or damage of the special tools. The value of such loss or damage will be decided by the EIC and EC shall be bound by such a decision.

1.2.2 Equipment Manufacturer's recommendations regarding preservation during storage at site and detailed specifications for the installation alongwith layout drawings, general arrangement/equipment outline drawings and sub-assembly drawings of the various equipment and machinery will be provided to EC during the performance of work. The requirements stipulated in these shall be fulfilled by EC in addition to what is stated in this specification. Erection shall be carried out as per the instructions and supervision of Machinery manufacturer's representative, wherever such supervisory services are applicable.

1.2.3 All the items of work covered in the tender shall be carried out as per this Specification and other details to be furnished to EC. However, EIC reserves the right to give additional/alternative specifications and instructions, at any time, for execution of any particular work and EC shall execute such works in accordance with such additional/alternative specifications and instructions of the EIC. Such a step taken by the EIC shall not constitute a breach of the contract.

1.3 Preparation for Erection

1.3.1 EC shall be responsible for organising the lifting of the equipment in the proper sequence, so that orderly progress of the work is ensured and access routes for erecting the other equipment are kept open.

Rigging procedure for all the major lifts (above 10 MT) and at maximum crane capacity shall be submitted by EC for the approval of EIC. However, approval to rigging procedure proposed by EC shall not relieve EC from his responsibility in following the proper lifting/erection methods on ensuring orderly.

1.3.2 Orientation of all foundations, elevations, length and disposition of anchor bolts and diameter of holes in the supports saddles shall be checked by EC, well in advance. Minor rectifications including chipping of foundations as the case may be, shall be carried out by EC after obtaining prior approval of EIC. EC shall also be provided with the necessary structural drawings and piping layouts etc. wherever required for reference. EC shall crosscheck such piping and structural drawings with actual construction at site and in case of any mismatch inform the EIC before taking up the erection.

Copyright EIL – All rights reserved

1.3.3 During the performance of the work, EC shall keep structures, materials or equipments adequately braced by guys, struts or otherwise approved means which shall be supplied and installed by EC as required till the installation work is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc. shall not interfere with the work of other agencies and shall not damage or cause distortion to other works executed by him or other agencies.

2.0 ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC.

2.1 Scope of work of Erection Contractor

(a) Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.

(b) Withdrawal of equipments from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores of work site including unloading etc.

(c) Erection on foundations furnished by Owner including aligning, levelling and grouting.

(d) Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.

(e) Filling of Columns, Reactors, Vessels/ Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.

(f) Welding of washers for equipments, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.

(g) Assembly & erection of Agitator (Mixer) along with drive unit (Motor) including all accessories for vessels/drums/reactors (wherever indicated) as per specification drawings & instructions of EIC.

(h) Flushing, cleaning and drying of Columns, Vessels/Drums etc.

(i) Completing the equipments in all respects for commissioning the plant as per drawings, specifications & instructions of EIC.

(j) Any modification in the erected Columns, Reactors, Vessels/Drums to the complete satisfaction of EIC.

2.2 General Conditions of Erection

2.2.1 Unless otherwise specified Columns, Vessels, Drums etc. will be generally supplied to the Erection Contractor in single piece and EC will not be required to carry out any assembly or welding. In case column is supplied in multiple pieces and erection of the equipment is not possible in single piece, EC shall be responsible for lifting the pieces, for aligning, welding and hydrotest etc. in vertical position under the supervision of column Supplier (Fabricator). However, EIC shall be responsible for coordination between Erection Contractor & Fabricator. The schedule of quantities (SOQ) for equipment erection enclosed with the tender document outlines details of each equipment such as diameter, overall height, type of support (saddle/skirt/leg/bracket), position (horizontal or vertical) and approximate erection weight etc. However the erection elevation and location of equipment shall be as per the piping layout drawing enclosed with the tender.

Copyright EIL – All rights reserved

2.2.2 Rigging procedures and erection schemes for all the heavy lifts weighing 10 MT & above shall be prepared by EC and got approved by EIC. Approval by EIC shall not relieve EC of his responsibilities. The details to be submitted will include the location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipments etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by EIC, erection of such equipments shall not be undertaken in any case by EC.

2.2.3 Before starting the erection of Columns, Vessels etc., top surface of the foundations is to be cleared/chipped, roughened to obtain proper bond, while grouting. Also the sleeves are to be cleaned before erecting the equipments. Line (orientation) and levels are to be marked on all the foundations to facilitate checking of alignment.

EC shall also check the correct elevation and orientation of civil, structural foundations, before proceeding with the erection work. Discrepancy, if any, shall be brought to the notice of EIC. However, minor rectifications and chipping of foundations upto a thickness of 15 mm in foundation height shall be carried out at no extra cost, by the EC. EC shall be responsible for supply of levelling plates, (if required) and shall carry out levelling of equipment under the directions of EIC.

2.2.4 While handling, transporting or erecting the equipments, care shall be taken not to damage the nozzles, instrument connections, structural clips etc. EC shall also take care of the orientation of the nozzles and other connections of the equipments while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.

2.2.5 Verticality of the Columns, Reactors/Vessels shall be checked with theodolites. After erection the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.

2.2.6 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by EC at his cost, as and when required by EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.

2.2.7 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings, molecular sieves, intalax saddles packing and other types of tower packings such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of Vessels, Columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packings except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packings, shall be done only after flushing and cleaning of Columns/Vessels and completed to the satisfaction of EIC.

Copyright EIL – All rights reserved

2.2.8 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.

2.2.9 EC shall execute erection of wooden pillow for saddle support for cold horizontal vessels wherever necessary as indicated on the drawings/ EIL STD 7-12-0003 and as per the instructions of EIC.

2.2.10 EC shall execute assembly & erection of agitator/mixer along with drive unit including all accessories as per supplier's instructions, specification drawings & instructions of EIC.

2.3 Flushing & Cleaning of Columns, Vessels, Drums etc.

2.3.1 After the erection, alignment and grouting of these equipments are complete, flushing and cleaning shall be carried out by EC as per specifications and instructions of EIC.

2.3.2 After flushing, cleaning and draining, equipments shall be dried by compressed air at the pressure and for duration decided by the EIC. The Vessel interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC.

2.4 Inspection and Acceptance Limits for Level and Alignment

2.4.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

2.4.2 Before equipments are placed on foundations, orientations shall be checked with respect to piping drawings.

2.4.3 When equipments are firmly bolted down but prior to grouting, verticality of all the Columns, vertical vessels etc. shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 15 mm unless otherwise stated on the drawings.

2.4.4 Horizontal Vessels shall be checked for level across machined face of nozzle flanges with precision level.

2.5 Additional requirements for Underground buried vessels

2.5.1 **Underground vessels for operating temp upto 60°C**

The vessels shall be supplied at site with one coat of inorganic zinc silicate primer duly applied on its external surfaces as per Spec. 6-79-0020. All other works such as application of coaltar enamel, as per EIL Spec. 6-79-0020 and wrapping and coating as per EIL Spec. 6-79-0011 shall be carried out by EC. This shall include necessary materials, tools and tackles to complete the Job in all respect as per the instructions of EIC.

2.5.2 **Underground Vessels for operating temp. Above 60°C and upto 300°C**

The vessels shall be supplied at site with one coat of inorganic zinc silicate primer as per Spec. 6-79-0020 duly applied on its external surfaces. EC shall be required to carryout touch-up and repair of outside primer before erection of equipment.

Copyright EIL – All rights reserved

2.5.3 EC shall do the necessary excavation, backfilling and removal of surplus earth at the site as per the directions of the EIC. EC's rate shall include the excavation, blast cleaning, painting, wrapping by kraft paper, placing and fixing of Vessels, backfilling and removal of excess earth.

3.0 ERECTION OF MECHANICAL EQUIPMENT

3.1 Scope of Work of Erection Contractor

The scope of EC shall consist of withdrawal and transportation of equipments and accessories from Owner's stores to site, assembly of loose supplied components/parts erection of equipment on foundations, levelling, aligning and grouting, preparation of equipments for trial runs and hand over in fit condition for the start up of the plant as per instructions of EIC.

3.2 Details of Owner Supplied Equipments

Equipments to be erected shall be supplied by the owner. Equipments may be supplied in any of the following conditions.

- Single equipment such as filter, static mixer, silencer etc.
- Skid mounted equipment, fully assembled.
- Skid mounted equipment with some items supplied loose or as subassemblies involving interconnections also.
- System comprising of many equipments, skids with interconnected piping & hook up.

3.3 Technical Requirements

3.3.1 All equipment/machinery erection shall be done by experienced fitters. For this purpose EC shall employ an experienced erection supervisor and crew who have done similar jobs.

3.3.2 EC shall study the layout drawings, for the machineries and equipments with their auxiliaries, controls defining scope of supply.

3.3.3 Equipments shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the EIC. Rectification of defects shall be carried out in accordance with approved procedure.

3.3.4 Correct procedures for handling of equipment & installation on the foundation shall be followed as given in the manufacturer's manual. In case of non-availability of such procedures, EC shall develop & submit handling procedures for all equipment weighing more than 10 metric tonnes. The handling procedure shall be approved by the EIC.

3.3.5 EC shall check the correctness of equipment foundations or supporting structures as per the drawings. Equipment/Skid foot print dimensions shall be verified to match with the foundation. Minor chipping of foundation, pockets if required shall be carried out by EC.

3.3.6 All accessories like pressure gauges, seal oil, cooling water & Lube oil headers etc., shall be tagged and separately kept in Contractor's stores till erection. All flanged connections and openings shall be kept blanked with dummies, plugs to prevent entry of foreign particles.

3.3.7 Equipments shall be installed on the foundations in proper sequence. Incase the equipments are delivered in subassemblies, EC shall do the assembly work as per manufacturer's instructions.

3.3.8 Equipments shall be installed in the correct orientation and alignment.

Copyright EIL – All rights reserved

3.3.9 After installation and levelling the equipment shall be grouted with the specified grouting applied to the baseplate and support.

3.3.10 EC shall remove all the packing and protective devices used during transport and handling from the equipment such as shock absorbent materials from machined faces, blocking of shafts or rolling bearings & restraining devices from instruments, safety devices and protective equipments.

3.3.11 After the grouting is set & cured, the foundation bolts shall be checked to make sure that they are in straight and vertical position and properly tightened. Shims, if used, shall be on either side of the foundation bolts.

3.3.12 Desiccant, catalyst where supplied loose shall be loaded on to the respective vessels in specified quantities as per the suppliers instructions.

3.3.13 Internals, where supplied loose shall be assembled as per the drawings and manufacturer's instructions.

3.3.14 Unless otherwise specified, all the instruments such as pressure gauges, sight glasses temperature recorders etc. including instrument panels, if any, supplied along with the equipment with necessary connections, shall be installed by EC as part of Equipment erection.

3.3.15 Equipments shall be checked for final cleanliness before boxing up.

3.3.16 Any interconnected piping & ducting shall be properly installed and supported. EC shall connect the gas, steam, air, utility piping, instruments, oil piping etc. as per manufacturer's drawings, specifications and instructions of the EIC.

3.3.17 Safety devices shall be correctly installed.

3.3.18 Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.

3.3.19 Field welding, where specified shall be in accordance with the specified procedures and NDT tests where specified shall be carried out. Results of NDT tests shall be recorded.

3.3.20 Equipment alignment & couplings shall comply with tolerances specified in manufacturer's drawings and manuals. Provisions of dowel pins or similar arrangements for retaining the alignment shall be carried out.

3.3.21 After the piping has been connected, the alignment shall be checked by EC again, to ensure that piping connections do not induce any undue stresses on the Equipments. After making necessary corrections on the piping, if any, realignment shall be done by EC to ensure that no undue stresses are induced on the equipment.

3.3.22 Painting, insulation & fireproofing where specified shall be carried out in accordance with the applicable specifications attached in the tender document.

3.3.23 Any alterations, deviations made during equipment erection with respect to manufacturer's drawings or instructions shall be duly recorded and approval shall be taken from the EIC.

3.3.24 Any special tools, tackles supplied along with the equipment and used during installation shall be returned to the stores through the EIC.

3.3.25 Any protection of the equipment after installation, if required shall be carried out in accordance of the instructions of the EIC.

Copyright EIL – All rights reserved

3.4 Trial Runs

3.4.1 Wherever specified, Machinery & Equipment erected & installed by EC under the supervision of Machinery/Equipment supplier shall be subjected to trial runs in accordance with clause 5.4 of this specification. Job specific trial run procedure, if specified, supersedes the trial run procedure as described in clause 5.4.

3.5 System Start-up

During this phase of work, EC shall provide as part of his work necessary skilled personnel as per requirement of EIC. Any defects noticed in the Equipment shall be made good by EC at his cost if such defects are attributable to him.

4.0 HEAT AND MASS TRANSFER EQUIPMENT

This section covers the minimum requirements for erection of the following equipment by the EC.

- Deaerator
- Trays/ Tower Internals and Tower Packings
- Separators and Internals
- Shell and Tube Heat Exchangers
- Double Pipe Exchangers
- Electric Heaters
- Plate Exchangers
- Plate Fin Exchangers
- Sulphur Recovery Unit Equipment like Combustion Chambers, Waste Heat Boilers, Sulphur Condensers, Incinerators, Burners, Etc.
- Waste Heat Recovery Units
- Desalters
- Vacuum Ejectors
- Ejector Condensers

4.1 Scope of Work of Erection Contractor

4.1.1 Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.

4.1.2 Withdrawal of equipment from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores and work site including unloading etc.

4.1.3 Preparation of foundation by chipping & installation of base plates for foundations. Minor rectifications & chipping of foundations up to a thickness of 15 mm due to error in foundation height, shall be carried out by the EC at no extra cost

4.1.4 Before starting the erection, top surface of the foundations are to be cleaned/chipped/roughened to obtain proper bond while grouting. Line (Orientation) & Levels are also to be marked on the respective foundations prior to erection to facilitate checking of alignment.

4.1.5 Supply of necessary shims, levelling plates, wedges, sliding base plate.

4.1.6 Erection on foundations furnished by Owner including aligning, levelling and grouting.

Copyright EIL – All rights reserved

4.1.7 Assembly and fixing of trays, tower internals (distributor, bed limiter, support plate, chimney trays, vapour distributor etc.), demisters, grids, internal distributors and other internal fittings in columns, vessels etc.

4.1.8 Installation of transformers on desalters and their electrical connection to electrode grid etc.

4.1.9 Welding of chimney trays, lattice girders, beams etc. wherever required.

4.1.10 Carrying out minor adjustments, modifications, seal welding of seal plates etc. wherever necessary during installation.

4.1.11 Checking of installed trays & tower internals and filling of installation formats as referred in 6-14-0016.

4.1.12 Filling of columns, vessels/drums etc. with Raschig rings/Pall rings/ Structured packing, as required.

4.1.13 Welding of washers for equipment, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.

4.1.14 Hydrotesting of shell and tube heat exchangers if the time gap between last hydrotest is more than six months or in case it is found to be necessary by EIC. Procedure is given in para 4.3 & 4.4 below. EC to note that any equipment which are refractory lined at shop shall not be hydrotested.

4.1.15 Flushing, cleaning and drying of equipment using compressed air and blinding to prevent ingress of rain, dust etc.

4.1.16 Installation of refractory lining, brick lining, ceramic boards etc., as per specifications, recommendations of manufacturer and instructions of EIC.

4.1.17 Mounting of instruments like safety valves, rupture disks, sight glasses etc as required.

4.1.18 Completing the equipment in all respects for the commissioning of the plant as per drawings, specifications & instructions of EIC.

4.1.19 Any modification in the equipment to the complete satisfaction of EIC.

4.1.20 In addition to the above EC may be called upon to do other jobs like rectification of defects etc. as per instructions of EIC.

4.2 General Conditions of Erection

4.2.1 All carbon steel components of trays/tower internals shall be cleaned to remove rust preventive coating.

4.2.2 All welding shall be done by qualified welders only. The electrodes/filler material to be used shall be compatible with the metallurgy of component and shall be used only after prior approval of EIC.

4.2.3 A proposed Welding Procedure Specification (WPS) shall be submitted to EIL/ Owner's Inspector for his approval. On approval, a Procedure Qualification Test (PQT) shall be conducted which shall be witnessed by EIL/Owner's Inspector. On acceptance of all tests as per ASME Section IX, a final WPS along with Procedure Qualification Record (PQR) shall be submitted. Production welding shall start only after approval of final WPS/PQR and

Copyright EIL – All rights reserved

qualification of welders as per ASME Section IX. EIL/Owner's Inspector may accept previously qualified WPS/PQR at his sole discretion.

4.2.4 Lattice girders wherever provided for supporting tray & tower internals have been designed in such a way that various components pass through column manway. Components/parts of lattice girders are to be welded inside the column as per respective drawings. EC shall also ensure that all parts of lattice girder are properly welded & levelness of the lattice girder shall be checked before & after the welding. The limits of levelness as mentioned in GA drawings shall be adhered to.

4.2.5 The rigging procedure shall include the following as a minimum:

Location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipment etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by the EIC, erection of equipment shall not be undertaken in any case by the EC.

4.2.6 While handling, transporting or erecting the equipment, care shall be taken not to damage the nozzles, instrument connections, structural clips, refractory lining etc. EC shall also take care of the orientation of the nozzles and other connections of the equipment while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.

4.2.7 After erection, the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.

4.2.8 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by the EC at his cost, as and when required by the EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.

4.2.9 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings/Pall rings/Structured packing, molecular sieves, intalox saddles packing and other types of tower packing such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of vessels, columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packing except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packing, shall be done only after flushing and cleaning of columns/vessels and completed to the satisfaction of EIC.

4.2.10 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.

4.2.11 EC shall install base plate over the sliding end foundation before erection of shell and tube exchangers.

Copyright EIL – All rights reserved

4.2.12 Levelling and plumbness shall be approved by EIC and shall be checked using theodolite before grouting and final finishing of the foundations. The record of the same shall be maintained.

4.2.13 EC to ensure that shell and tube exchangers shall be firmly bolted down to foundations at the fixed end. Further EC to ensure that foundation bolts at the sliding saddle end are at the centre of slotted holes & nuts at sliding end are only hand tightened. Projected bolt threads shall be properly protected by application of grease etc. to avoid rusting and for facilitating free movement of nuts.

4.2.14 EC shall ensure that no equipment is subjected to any corrosion during any stage during his period of work till handling over to EIC/Client.

4.2.15 Instruments, as required, shall be mounted by EC. On instructions of EIC, EC shall also remove and hand over the instruments to EIC for calibrations. During this period, EC shall cover all openings to protect the equipment.

4.2.16 Before transportation to site, EC shall check and report to EIC on the condition of equipment, specifically highlighting the nitrogen pressure indicated in the nitrogen gauges and the absence of blinds on any of the nozzles.

4.2.17 In case the shell and tube exchangers are to be stacked, but have been stored as single shells at the store, then EC shall erect the bottom most shell, then erect other shell(s) sequentially using the nozzle gaskets/bolting and saddle bolting supplied by owner. Additional shims, if necessary, shall be supplied by EC. If the exchangers do not have interconnecting nozzles, then nozzle elevations shall be maintained as per piping GAD.

4.2.18 All equipment, consumable and other accessories required for completion of the job shall be arranged by the EC. This would include but not limited to cranes, tools and tackles, manpower etc; machinery for cutting, grinding , drilling etc. of base plates; instruments like dumpy level, plumb lines, Engineer's levels, precision levels, theodolite, straight edges etc. for checking the alignment/erection accuracy, hydrostatic testing pumps, potable water for hydrotesting, necessary materials including making the arrangements for hydro-testing, hoses, compressed air supply, pressure gauge, sealing taps, blinds, shims and wedges for alignment etc.

4.2.19 EC shall execute the erection of wooden pillows for saddle supports for cold equipment as indicated in schedule of quantities, EIL standard 7-12-002 and instructions of EIC.

4.2.20 For bought out items like plate exchangers, plate fin exchangers, electric heater, etc. vendor's instructions shall be followed.

4.2.21 For erection of piping of ejector system, EC shall follow relevant erection specification of piping for the project.

4.2.22 EC shall check the health of the equipment refractory lined at shop on receipt and shall report any defect or damage in the same to EIC. During installation all precautions shall be taken to avoid any damage to refractory lining. Any damage to refractory during erection shall be repaired by EC at his own cost without loss of time.

4.2.23 Wherever equipment with refractory are bolted or welded at the girth joints, the gaps between the refractory shall be suitably filled with ceramic fiber of suitable grade as given in the drawings or other relevant documents of the equipment.

4.2.24 Refer section 1.0 (General) for additional requirements.

Copyright EIL – All rights reserved

4.3 Hydrotesting of Shell and Tube Exchangers including Condensers

4.3.1 These shall hydrotested at site using potable water. Hydrotesting of both shell and tube sides shall be carried out as per procedure given below or as per instructions of EIC. For exchangers fitted with SS bellow or SS part, potable water with max. 25 ppm chlorides shall be used for hydrotesting.

4.3.2 Suitable pump set, piping, test pressure gauges and other instruments, water-hoses, temporary gaskets, metallic blinds, bolts, nuts, consumable and other temporary arrangements and equipment for testing shall be provided by the EC at his cost. Test pressure gauges shall be calibrated by the EC and got approved from EIC.

4.3.3 Stacked exchangers shall be hydrotested in stacked conditions.

4.3.4 Test pressure shall be as indicated in the name plates mounted on each exchangers. Duration of hydrotest shall be at least one hour. Test pressures and duration of hydrotest may be reduced by EIC. Minimum test water temperature shall be 20°C.

4.3.5 Any defects noticed during hydrotesting shall be repaired by EC as per the procedure approved by EIC. Cost for rectifying defects, not attributable to the EC shall be paid separately.

4.3.6 No equipment shall in general form part of the piping loop during hydrotesting and shall be blinded off, except when instructed otherwise by EIC.

4.3.7 EC to take adequate care during pressurising & depressurising the equipment. EC shall also take care of any instruction given regarding hydrotest in the exchanger drawing.

4.4 Hydrotesting Procedure

4.4.1 Shell side & tube side shall be hydrotested separately, unless specified otherwise. If both sides are to be tested together, a warning plate would be fixed to the exchanger, and the instructions given therein are to be followed.

4.4.2 The side, shell or tube which ever to be tested at higher pressure shall be taken first.

4.4.3 During hydrotest all gasket joints should be checked for any leakage. In case of leakage from any gasket joint, bolting at that joint shall be further tightened following proper tightening sequence (bolts should not be overtightened or tightened by hammering). In case it is not possible to stop leakage by bolt tightening, drain the water in exchanger & replace gasket at that joint by new gasket (gasket will be supplied by owner). After replacing gasket exchanger must be again hydrotested with same procedure to ensure leak tightness.

4.4.4 In case of floating head heat exchangers, if it is found during hydrotest that the pressure is dropping, while the external gasketed joints are not leaking, this could be due to floating head gasket joint leakage. This shall be further investigated, by removing shell cover & pressurising tube side to check the floating head gasket joint leakage. In case of leakage observed at floating head flange joint, replace floating head gasket by new gasket. After replacing gasket exchanger must be again hydrotested first on tube side & then on shell side with same procedure to ensure leak tightness of gasket joints.

In case of heat exchangers with shell side hydrotest pressure higher than tube side, it is possible that above procedure (with tube side hydrotest to detect floating head gasket leakage) may not help. Absence of leakage during this test is not conclusive in such a case, as the shell side pressure was dropping during hydrotest. In such a case, floating head gasket shall in any case be replaced and then equipment retested to ensure leak tightness.

Copyright EIL – All rights reserved

4.4.5 When hydrotested as per above procedure after floating head gasket replacement, if it is observed that test pressure is still dropping, this could mean leakage from tube to tubesheet joint. For such cases matter shall be reported to EIC for further investigations/instructions.

4.5 Flushing & Cleaning

4.5.1 After the erection, alignment and grouting of these equipment are complete, and after hydrotest if any, flushing and cleaning shall be carried out by EC as per specifications and instructions of the EIC.

4.5.2 After flushing, cleaning and draining, equipment shall be dried by compressed air at the pressure and for duration decided by EIC. The equipment interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC at his cost.

4.6 Inspection and Acceptance Limits for Level & Alignment

4.6.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

4.6.2 Before equipment are placed on foundations, orientations shall be checked with respect to piping drawings.

4.6.3 When equipment are firmly bolted down but prior to grouting, verticality of all equipment shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 6 mm.

4.6.4 Horizontal equipment shall be checked for level across machined face of nozzle flanges with precision level.

4.6.5 Difference in elevation of centerline from one end to the other end shall not be more than 1 mm per meter and limited to ± 3 mm maximum. Further elevation difference shall be such as to ensure complete draining of equipment.

4.6.6 Survey of column inside and checking the levelness of support rings, location of bolting bars to ensure that the same are as per column drawings and within tolerances specified in standard 7-14-0001. In case these are not within permissible tolerances, the same shall be reported to EIC for necessary rectification/modification.

4.7 Safety, Health & Environment

EC shall install an exhaust fan for exhaling welding/ cutting fumes etc. and to maintain adequate oxygen level, before any work is started inside confined spaces (i.e. columns). Adequate ventilation shall be maintained at all times. Gas/LPG cylinders shall not be taken inside confined space. When a worker/supervisor enters a confined space, it shall be mandatory to have a second man as standby. Safety belts shall be worn while entering columns, if there is a danger of falling. All ladders/stair cases shall be in place before any item is offered to owner's inspectors. Rope ladders/scaffolding shall be provided inside the column in case tower internals are not easily approachable from column manhole. Low voltage (24 V) lamps equipped with guards shall be used to prevent accidental contact with bulb. All electrical connections shall be through ELCB's and proper earthing shall be ensured. Acids and other materials used for pickling shall be disposed off to a designated place as directed by owner/EIL. All statutory Regulations and owner's safety, health and environment requirements

Copyright EIL – All rights reserved

shall be complied with. Inspection aids for carrying out the inspection of internals shall also be provided.

5.0 ERECTION OF ROTATING EQUIPMENT

5.1 Scope of Work of Erection Contractor

The scope of work shall consist of transportation of Rotating Equipments and accessories from Owner's stores to site, assembly of sub-assemblies/parts, erection of Rotating Equipments on foundations, levelling, aligning and grouting, preparation of Rotating Equipments for trial runs, carrying out no load/trial runs, return of any unused material to the owners stores and hand over in fit condition for the start- up of the Plant, as per instructions of EIC.

Defects due to EC's fault noticed during trial runs shall be rectified by him. Schedule of Quantities, indicate estimated numbers, dimensions and weights of the Rotating Equipments. The actual data on dimensions and weights will be in the vendor data manuals.

The term 'Rotating Equipment' includes all pumps, compressors, steam & gas turbines, fans and blowers, diesel engine/steam turbine/gas turbine generator sets along with drivers accessories & auxiliary systems.

5.2 General Conditions of Erection

5.2.1 All Rotating Equipment erection shall be done by experienced fitters. For this purpose EC shall employ experienced and suitably qualified erection supervisor and crew who have done similar jobs.

5.2.2 The Rotating Equipment manufacturer's instructions as available regarding installation and trial runs will be passed on to EC during the course of work. The requirements prescribed therein shall be met in addition to what is stated in this specification. Erection shall be carried out as per instructions of the Rotating Equipment manufacturer's representative and under their supervision whenever the manufacturer is present at site. In all other cases instructions of the EIC, regarding procedure/sequence of erection shall be binding on EC.

5.2.3 For all Rotating Equipment, EC shall follow the proper sequence for assembly and erection. For Rotating Equipment received along with driver in coupled condition, the coupling bolts shall be dismantled by EC, and alignment shall be rechecked. Realignment, if required, shall be done before recoupling.

Where drivers and couplings are provided separately, drilling and tapping of holes in the base plates for fixing drivers, fixing of couplings on shafts, after enlarging the pilot bores to the correct size with key way etc. and dowelling including provision of dowel pins, alignment screws, jack-up screws or similar arrangements for retaining the alignment shall be carried out by EC as part of erection work. Shims & wedges as required for alignment shall be supplied by EC.

5.2.4 Process and utility (such as cooling water, steam flushing, quenching, lubricating oil, sealing etc.) connections connected with rotating equipment and its auxiliaries shall be fabricated and/or installed by EC from materials supplied by the Owner as per drawings, specifications and instructions of the EIC.

5.2.5 Piping and accessories supplied with the rotating equipment such as seal oil/Gas system, cooling water system & Lube oil system etc. shall be tagged separately and kept in EC's stores till erection. All flanged connections and openings shall be kept blanked with dummies/plugs to prevent entry of foreign matter.

Copyright EIL – All rights reserved

5.2.6 The local mounted instruments such as pressure gauges, sight glasses, temperature gauges etc. and Local instrument panels, if any, with necessary connections, shall be installed by EC as part of rotating equipment erection.

5.2.7 After initial alignment, the Rotating Equipments shall be properly grouted. Grouting shall be carried out as per this specification. Wherever grout holes are provides in the base plates, grout shall be filled through them also.

Epoxy grout where recommended by the rotating equipment manufacturer, shall be provided by EC and shall be as specified in this standard.

5.2.8 Alignment between the Driver and driven equipment shall be done without connecting the equipment nozzles to respective piping. After completion of alignment, the equipment shall be connected to Piping. After the piping has been connected, the alignment shall be re-checked by EC, to ensure that piping connections do not induce any undue stresses on the Rotating Equipments. After making necessary corrections on the piping, if any, re-alignment shall be done by EC and he will ensure that no undue stresses are induced on the Rotating Equipment.

5.3 Special Instructions

EC in addition to general instructions for erection as out lined in para 5.2 above, shall also follow the following special instructions.

5.3.1 Pumps

Depending upon the size of equipment, Pump train will be supplied for erection in any of the following modes :

(a) Pumps with drivers and accessories fully assembled on a common skid (Base plate).

(b) Pumps mounted on base plate and couplings and driver supplied loose in separate packs.

(c) Various major components such as pump, drivers, couplings, gear boxes & base plates auxiliary systems like lube, seal flush equipment in separate packs.

5.3.2 Reciprocating Type Compressors

5.3.2.1 Reciprocating compressors may be supplied for erection in knocked down condition in multiple packaged subassemblies such as frame assembly, distance pieces, fly wheels, cylinder block assemblies, valve assemblies etc. and other accessories such as, drivers, couplings, gear boxes (if any), control panels, gauge boards, coolers, lube oil systems, cooling water systems, etc. would be in separate packages.

Besides the above there would be other packages for loose supplied items such as instruments, pre-fabricated piping, and piping/tubing in commercial lengths.

Lifting devices for erection shall be arranged by EC depending on the weight of packages and elevation of installation.

5.3.2.2 In case of Rotating Equipments received in knocked down condition, the various parts shall be assembled as per instructions of the EIC and as per manufacturer's instructions. All parts of the Compressor shall be thoroughly cleaned with solvents to remove protective compounds if any, before assembly.

Copyright EIL – All rights reserved

5.3.2.3 The compressor, driver and other accessories shall be erected on their respective foundations and the compressor, couplings, gear box and driver shall be aligned and grouted as per the manufacturer's instructions and instructions of EIC and the manufacturers supervisor (when present). There-after all process and utility, drain & vent connections shall be completed as per the relevant drawings/instructions of equipment manufacturer and advice of EIC.

5.3.2.4 Final alignment shall be done after all the piping connections such as water, steam, drains and connection to coolers etc. are made. Tolerances for alignment shall be maintained as specified in the Manufacturer's Instruction Manual. To ensure that piping connections do not induce any undue stresses on the Rotating Equipment, the alignment shall be checked once again by EC after the piping has been connected. Any correction necessary for proper alignment shall be done by EC.

5.3.2.5 EC shall carefully study the vendor drawings, manuals and other data before start of the job to ensure correct erection, alignment and commissioning.

5.3.3 **Centrifugal Compressors & Expanders**

5.3.3.1 Centrifugal Compressors are supplied for erection in multiple packages such as,

- Compressor casings
- Drivers (Electrical motors, Steam/Gas turbines -♦)
  {♦ : Steam/Gas turbines would be further supplied in multiple packages}
- Base plates (or skids)
- Lube oil/control oil systems
- Sealing systems
- Air filters (for gas turbines & compressors for air service)
- Temporary strainers
- Couplings
- Gear boxes
- Coolers
- Gauge boards
- Control panels
- Lube & Seal Oil tanks
- Fire systems (for gas turbines)
- Condensers (for steam turbines)
- Condensate systems (for steam turbines)
- Loose supply items
- Pre-fabricated & Commercial lengths piping, tubing.
- Other miscellaneous packages

5.3.3.2 Other requirements shall be same as defined in para's 5.3.2.2 to 5.3.2.5 above.

5.4 Trial Runs of Machinery

5.4.1 Any construction defects shall be intimated to EIC before start-up. All protective and safety guards shall be installed and rotating equipment shall be checked for free movement by manual barring over. All foundation bolts and alignment shall be checked before starting the trial runs, if damaged, rotating equipment may have to be opened and repaired as directed by EIC. Prior to carrying out the trial runs, the rotating equipment will be subjected to necessary checks by the EIC and the trial runs shall be commenced only after the approval of the EIC.

Copyright EIL – All rights reserved

5.4.2 Unless otherwise specified, all the rotating equipment will be subjected to trial runs for a continuous operation of 72 hours. In case of motor driven rotating equipments, motors shall be decoupled and turned over to other agencies doing electrical work for testing and no load running of motors. After the no load runs of motors are satisfactorily completed, EC shall recouple the motors to the rotating equipment and recheck the alignment. The trial run of the rotating equipment shall be started only after the above is completed. EC shall provide, as part of his work, necessary skilled personnel (excluding the operating personnel) for conducting the trial runs round the clock during the trial runs period. The duration of trial run may be extended if it is considered necessary in the opinion of EIC and EC shall provide personnel for such extended period also. Final inspection of bearing etc. shall be carried out by EC after the Machinery had gone through the trial run and defects, if any, shall be made good for rendering the rotating equipment ready for start up.

5.4.3 During the trial runs, readings of bearing temperature, cooling water inlet and outlet temperatures, lube oil inlet/outlet temperature and pressure, rotating equipment discharge pressure and temperature, starting in current, no load/full load current etc. shall be recorded, wherever necessary, by EC. Trial reports shall be prepared in the approved proforma by EC containing all the above details and submitted to the EIC as part of completion documents.

5.4.4 EC shall also provide necessary improvised fencing and watch & ward personnel as safety measures during trial runs.

5.5 System Start up

During start-up, EC shall provide necessary skilled personnel as per requirement of EIC, to rectify defects noticed in the rotating equipment, if such defects are attributed to him.

6.0 EQUIPMENT GROUTING

All anchor bolt sleeves/pockets and space under Base plates/machine base frames/shoe plates, etc. shall be grouted with either free flow non shrink cementitious or epoxy grout as per the following categorisation:

Sr. No.	Type of Grout	Application
1	Non shrink cementitious grout	All static and rotating equipments, unless covered in 2) below, viz Static equipments like tall columns, vertical silo, blender etc. and horizontal vessel, drum, sphere, bullets, filter, heat exchangers, coolers etc. and other similar equipments, steel stack/chimney, furnace etc. Low frequency, medium frequency, high frequency rotating machines like compressors (centrifugal, reciprocating, diaphram, screw, gear type etc.). Induced draft fan, forced draft fan, air blowers, pumps (centrifugal, reciprocating, diaphram, gear type etc.), expanders, turbine, generator, diesel generator, air coolers (fin fan cooler) and other similar equipment. Machine like screen vibrator, extractor, centrifuge pulverizer, dryer, drop hammer, ball mill, crushers, bagging machine and general workshop equipment.
2	Epoxy grout	Specifically if requested by the Machine Vendor.

Copyright EIL – All rights reserved

6.1 Grout (Material)

All material used for grout shall be in EC's scope. Only approved grout material shall be used. EC shall submit details of grout materials for prior approval of EIC.

6.1.1 Non-Shrink Grout

Non-shrink grout shall be premix type of cementitious (cement pregraded fibre and additive) non-shrink, ready to use grout in dry powder form. It shall have free flow property when mixed with required quantity of water. It shall have initial setting time of 30 minutes.

It shall have the following features:

- Non corrosive to anchor bolts, base plate/saddle/frame, sliding plate.
- Not harmful to concrete and reinforcing steel.
- Non toxic
- Frost, oil and fire resistant
- Require normal curing
- Suitable to use under restraints and grout thickness required
- Expansive to counteract initial shrinkage
- Ensure high early strength without surface crack.
- Suitable for temperature of above 0 deg.C to 200 deg.C.
- Maximum flow distance is compatible to the dimensions of base plate/ saddle/frame.
- It should be resisted to the chemicals, gases etc. being handled in equipment/machines.

It should have the following physical properties:

-	Min. Compressive strength at	3 days	25 N/mm^2
		7 days	30 N/mm^2
		28 days	40 N/mm^2
-	Min. Tensile strength at	28 days	3.5 N/mm^2
-	Min. Bond strength at	7 days	12 N/mm^2
-	Max. Onstrained Expansion in	2 hours	4%
-	Min. Density		2000 kg/m^3

6.1.2 Epoxy Grout

Epoxy grout shall consist of epoxy resin base, hardener and filler component like graded and blended aggregate. Components of epoxy grout shall be of desired grade and mixed in proportion recommended by manufacturer such that it is injectable under base plate/frame/saddle etc., has low viscosity to meet the flow distances according to dimensions of base plate saddle/frame, it is suitable for the desired thickness, it is homogenous, free from segregation, attains high early and high final strength. It shall have minimum Pot life of 30 minutes. It shall have all the features as specified in clause 6.1.1 except for expansive properties.

It should have the following physical properties :

-	Min. compressive strength at	1 day	75 N/mm^2
		7 days	85 N/mm^2
-	Min. Flexural strength	7 days	25 N/mm^2

Copyright EIL – All rights reserved

6.2 Grouting (Placement)

6.2.1 Surface Preparation

Prior to positioning of equipment/machine etc. over concrete pedestal, foundation, slab, beam, etc. all laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surface shall be sufficiently levelled, hacked with flat chisels to make it rough, clean (using compressed air). Additional chipping, if required, to suit level of base plate and/or minimum thickness of grout shall also be done. In case of use of cementitious grout surface shall be thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned. Any excess water shall be removed. In case of use of epoxy grout, it shall be ensured that surface/pocket to receive grout is totally dry. After erection, alignment/plumbing of equipment/machine in required level, orientation and plumb and installation of sliding plate. Forms shall be constructed around and joints made tight to prevent leakage of the grout.

6.2.2 Preparation of Grout

6.2.2.1 In case of premix type of grout water shall be added in required quantity as specified by supplier and/or EIC. Any specific instruction of manufacturer will be strictly followed.

6.2.2.2 In case of epoxy grout required quantity of all constituents shall be mixed in proportion recommended by manufacturer/supplier and/or EIC. All specific requirements of manufacturer/ supplier shall be strictly followed.

6.2.2.3 Required quantity of grout shall be made considering initial setting/pot life of grout. Any grout not used within initial setting time/pot life shall be rejected and in no case used for grouting.

6.2.3 Placement of Grout

6.2.3.1 Placing of grout shall be taken up only after level, orientation, alignment of equipment/machine has been approved by EIC and anchor bolts are placed in pocket.

6.2.3.2 In case of epoxy grout EC shall give details of grouting scheme and get approval of EIC.

6.2.3.3 The grout mixture shall be poured/injected continuously (without interruption till completion) by grouting pump/injecting gun from one side of base plate and spread uniformly with flexible steel strip and rammed with rods till the space is filled solidly and grout mixture carried to the other side of base plate and fill all pockets. Any specific requirement of manufacturer/ supplier shall be strictly followed. Epoxy grout shall be done by or under supervision of manufacturer/supplier and/or agency having adequate experience in this field as per direction of EIC.

Total work shall be done under supervision and direction of EIC and care shall be taken that alignment of equipment/machine is not disturbed.

6.2.3.4 Grout mixture shall be allowed to harden for a period of minimum 7 days or as required by manufacturer/supplier of grout and/or as decided by EIC. At the end of this period, the shims/edges/pack plate may be removed and anchor bolts tightened uniformly. Alignment of equipment/machine shall be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plate (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting is done after making appropriate correction of alignment.

6.2.3.5 Minimum thickness of grout shall be 25mm for all types of grout and maximum thickness shall be 40mm for non-shrink grout. For epoxy grout the maximum thickness shall be as per manufacturer's recommendation and/or as specified in drawing.

Copyright EIL – All rights reserved

7.0 REFERENCE EIL STANDARDS/ SPECIFICATIONS

6-14-0003	Installation Procedure for Trays & Tower Internals
6-14-0011	Specification for Packing the Column
6-14-0016	Standard Specification for Review of Site Installation of Column Internals.
6-79-0011	Standard Specification for Corrosion Protection Tape Coating for Underground Steel Piping.
6-79-0020	Standard Specification for Surface Preparation and Protective Coating (New Construction)
7-12-0001	Vessel Tolerances.
7-12-0002	Support for Horizontal Vessel
7-12-0003	Wooden Pillow for Saddle Support
7-12-0004	Skirt Base Details
7-12-0024	Lifting Lug Top Head Type
7-14-0001	Construction Tolerance for Welded Supports for Tray / Tower Internals

Copyright EIL – All rights reserved

फ्लैंज जोड़ों के लिए बल-आघूर्ण (टॉर्क) तथा हाइड्रोलिक बोल्ट टेंशन के अनुप्रयोग हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR APPLICATION OF TORQUE AND HYDRAULIC BOLT TENSION FOR FLANGE JOINTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	30-06-2021	Revised and reissued for Implementation	PVK	PG	VM	SM
2	04-05-2016	Issued for Implementation	PG	SVRS	RP	RN
1	26-05-2008	Issued for Implementation	PG	KPS	AA	VC
0	15-05-2003	Issued for Implementation	PG	KPS	VC	SKG

Copyright EIL – All rights reserved

Abbreviations:

ASME	American Society of Mechanical Engineers
PMS	Piping Material Specification

General Engineering Standards Committee

Convenor : Mr. Vinod Mahajan

Members :
Mr. Harish Kumar
Mr. Amit Prakash
Mr. VK Tonger
Mr. Satyabrata Biswas
Mr. Shishupal Choudhary
Mr. Vinay Sonker
Mr. Deepak Agrawal
Mr. Ankul Mondal
Mr. Sachin Joshi
Mr. Bharat Bhushan Shukla
Mr. Surojit K Gayen

Copyrights EIL – All rights reserved

CONTENTS

1.0	PURPOSE	4
2.0	SCOPE	4
3.0	REFERENCES	4
4.0	DEFINITIONS	4
5.0	METHODOLOGY AND CONTROL	4
6.0	RESPONSIBILITIES / APPROVALS	11
7.0	DOCUMENTATION	11
	ANNEXURE-I	34
	ANNEXURE-II	35

Copyrights EIL – All rights reserved

1.0 PURPOSE

The purpose of this specification is to describe the methodology for preparation of bolted flange joints by controlled bolt tightening during construction and commissioning stage of process plant piping. This specification shall be used in conjunction with the other process/project specific requirements and the licensor/vendor recommendations.

2.0 SCOPE

This specification covers ASME B16.5 and ASME B16.47 Series B bolted flanged joints, involving identical pair of flanges, which are tightened by means of either hydraulic bolt tensioning or calibrated torque wrenches.

3.0 REFERENCES

EIL Spec no. 6-44-0005 Rev 7	-	Standard Piping Material Specification
ASME B16.5	-	Pipe Flanges and Flanged Fittings (1/2" to 24" NPS)
ASME B16.47 Series B	-	Pipe Flanges and Flanged Fittings (26" to 60" NPS)
ASME B31.3	-	Process Piping
BP RP 42-2	-	British Petroleum Recommended Practice: Bolting for flange joints
ASME Section VIII Division 1 and Division 2	-	Boiler and Pressure Vessel Code

4.0 DEFINITIONS

None.

5.0 METHODOLOGIES AND CONTROL

5.1 Identification of joints for controlled bolt tightening

Controlled bolt tightening can be done either by application of calculated bolt tension with hydraulic tensioner or by application of calculated bolt torque with calibrated torque wrenches. The criteria for selection of joints for these two application procedure are given below.

5.1.1 Hydraulic Bolt tensioning

Hydraulic bolt tensioning shall be applied for all joints where the bolt sizes match the criteria outlined in Table 1, except those in the category 'D' services. Category 'D' service is defined in ASME B31.3.

Copyrights EIL – All rights reserved

**Table 1: Criteria for Bolt Tensioning –
Not applicable for flange joints in category 'D' services**

Nominal Bolt diameter	Condition	Remarks
All	When specified by the Process licensor/ vendor / project specifications	
50 mm and above	All joints	
38 mm and above, but less than 50 mm	Class 600 and above	
	Hydrogen service	(See Note-1 below)
	Category 'M' fluid services	Refer ASME B31.3
	Joints with leakage potential	(See Note-2 below)
	Critical joints with equipments	(See Note-3 below)
25 mm and above, but less than 38 mm	Joints with leakage potential	(See Note-2 below)
	Critical joints with equipments	(See Note-3 below)

Note-1: Hydrogen Service

In absence of project specific definition, Hydrogen service may be defined as service in contact with Hydrogen or gaseous mixtures containing Hydrogen in which the partial pressure of Hydrogen is 7 bar (100 psi) abs. or more.

Note-2: Joints with leakage potential shall include

a) Joints involving tapped holes.
b) Joints not subjected to hydro test e.g. joints for equipment manholes, equipment mounted temperature, pressure and level instruments, line mounted temperature connections, on line instrument joints like control valves and safety valves, compressor volume bottles.
c) Items involving two sets of gaskets with one set of bolt e.g. orifice flange joint, joints with spectacle blind, spacer, flangeless wafer check valve, wafer type butterfly valves.
d) Tie-in joints with other contractors and package vendors.
e) High temperature (above 371°C) joints in hydrocarbon services.

Note-3: Critical joints with the equipments shall include the inlet and the outlet flanges of pumps, compressors and turbines.

5.1.2 Application of torque

Controlled bolt torque, with calculated torque values, shall be applied using calibrated torque wrench. Joints those qualify for hydraulic bolt tensioning per 5.1.1 shall not be considered for torque application. Controlled bolt torque should be applied for the joints meeting the criteria given in Table 2. Joints fulfilling the criteria for Hydraulic bolt tensioning need not be checked for these criteria

Table 2: Criteria for Bolt Torque application

Service	Joints
Hydrogen service	All joints (Note-1)
Category 'M' services	All joints (Note-1)
Other services	Class 600 and above

Note-1: Joints, those qualify for hydraulic bolt tensioning as per cl. 5.1.1, shall not be considered for torque application.

Copyrights EIL – All rights reserved

5.2 Pre-bolting Operations

5.2.1 Design

a) Flange connection with bolting of nominal diameter 25 mm and above shall have sufficient clearances and access to allow the use of hydraulic tensioning equipment (wherever hydraulic bolt tensioning is being used).

b) Stud bolts shall be longer by one diameter to suit the bolt tensioners for hydraulic bolt tensioning. Excess threads shall be protected by using nut, threaded cap etc. On bolts at ambient temperature duty the cap should have a grease nipple.

c) All flanges on hydrogen service must be left exposed unless otherwise agreed.

d) Interface joints shall be system pressure tested as per the relevant code to ensure their integrity.

5.2.2 General

a) Use of right type of gasket, fasteners etc. conforming to the specifications as per design and drawings should be ensured.

b) The Vickers hardness number of ring joint gaskets should be 30 to 40 less than that of the mating face of the flange.

c) All non-ring joint gaskets shall be replaced with the new ones whenever an opened joint is to be re-closed during construction and commissioning stage. Ring joint gaskets normally can be re-used provided they are inspected and are free from any damage

d) Shop tested flange joints should not be disturbed at site. In case the joint is opened, the Contractor shall be responsible for final hook-up joints including bolt tensioning if applicable.

5.2.3 Visual inspection

a) Condition of flange faces should be checked. Those shall be free from dirt, scale, remnant gasket, and protrusions. Faces with pitting, indentations or radial tool marks, or scratches are not desirable. Surface finish should conform to specifications.

b) Flanges should be aligned properly. Flange faces shall be parallel and boltholes shall match so that the studs can be inserted freely.

c) Visual examination of gaskets should be carried out prior to installation to ensure that these are free of any defects such as bends, crease or loose spiral windings etc.

d) Gasket position should be checked.

e) Studs and nuts shall be free from dirt, nicks, burrs and chips. Studs shall be straight and nuts shall turn freely on the stud.

f) No external load shall be used to align the flanges.

Copyrights EIL – All rights reserved

5.2.4 Corrective measures

a) Faces with pitting, indentations or radial tool marks, or scratches that form leakage paths or with the surface finish not in accordance with design requirements shall be replaced or re-machined to specified surface finish.

b) If necessary, gasket seating face should be cleaned using wire brush (SS bristles on alloy components) and/or suitable solvent.

c) Damaged gaskets shall be replaced.

d) If holding gasket in place after installation is a problem, a thin adhesive tape should be used along the outside edge of gasket.

5.2.5 Lubrication/anti-seize compound

a) Threads and nuts to flange contact face should be lubricated with suitable lubricant. Thread compound or lubricant, suitable for line temperature, may be used.

b) Gaskets should not be lubricated.

c) Lubricant shall not be applied on bolts, used in oxygen services.

d) Some of the types of lubricants used are as follows:

Molybdenum Lead oxide (graphite based)
Molykote G-n plus
Molykote P37
Molykote HSC Plus / Never Seez nickel special
API SA2
Molykote 1000
Machine oil
Graphite grease

5.2.6 Assembly

a) Suitable lubricant (refer cl. 5.2.5) to be applied to the threads and the face of the nut that contacts the flange.

b) Four studs should be placed in positions 1, 2, 3 and 4 according to "Stud Tightening Pattern" in Fig.1, as centring guides for the gasket.

c) Balance studs should be inserted next.

d) Nuts should be run down by hand in such a way that an equal number of threads project at each end.

5.2.7 Torque/tension calculation

a) Bolting load calculation and stress analysis used for computation of the listed tightening torque and tension values primarily follow the procedures outlined in ASME Section VIII Division 1/ Division 2.

b) Basic formulae used for torque calculation takes care of friction between bolt threads and nut threads as well as that between nut and back face of flange.

Copyrights EIL – All rights reserved

c) A frictional co-efficient of 0.15 is assumed for calculation of torque values for the lubricant - graphite grease. When a lubricant with different co-efficient of friction (μ) is used, the calculated values get multiplied by the ratio μ/0.15. The approximate μ values of some of the lubricants are as follows:

Type of Lubricant	Co-efficient of friction (μ)
Molybdenum lead oxide + graphite based	0.085
Molykote G-n plus	0.09
Molykote P37	0.10
Molykote HSC Plus / Never Seez nickel special	0.11
API SA2	0.117
Molykote 1000	0.13
Graphite grease / Machine oil	0.15

However, it is advisable to obtain the appropriate co-efficient of friction (μ) value from the lubricant manufacturer.

5.2.8 The PMS classes included in this specification are given in Table 3.

Table 3: PMS classes included in this specification

Sl. no	Piping class	Sl. no	Piping class	Sl. no	Piping class	Sl. no	Piping class
From Standard PMS (6-44-0005 rev 7)							
1	A1A	26	B1A	51	B6N	76	F2D
2	A2A	27	B2A	52	D1A	77	F2G
3	A4A	28	B4A	53	D2A	78	G2G
4	A6A	29	B5A	54	D4A		
5	A7A	30	B6A	55	D5A		
6	A8A	31	B9A	56	D9A		
7	A9A	32	B13A	57	D16A		
8	A11A	33	B16A	58	D19A		
9	A13A	34	B19A	59	D1D		
10	A15A	35	B32A	60	D2D		
11	A16A	36	B1D	61	D5D		
12	A19A	37	B5D	62	D5E		
13	A20A	38	B1E	63	D1K		
14	A32A	39	B3F	64	D2K		
15	A33A	40	B4F	65	E1A		
16	A4F	41	B4G	66	E2A		
17	A4G	42	B1K	67	E5A		
18	A1K	43	B2K	68	E9A		
19	A2K	44	B4K	69	E19A		
20	A6K	45	B5K	70	E5E		
21	A11K	46	B6K	71	F1A		
22	A1M	47	B1M	72	F2A		
23	A1N	48	B3M	73	F5A		
24	A4Y	49	B5M	74	F9A		
25	A33Y	50	B1N	75	F19A		

Copyrights EIL – All rights reserved

5.2.9 Torque and tension values

Table 4 contains the tension and torque values to be used for bolt tightening of each bolt using hydraulic bolt tensioner and torque wrench respectively. These values are listed PMS class and flange size wise. The tension values specified are the target load per bolt intended after the bolt tensioning operation is complete. This means any allowance inherent in bolt tensioning equipment (viz. backlash etc.) shall also to be taken care of as recommended by the equipment manufacturer.

5.2.10 Notes to Torque and tension values in Table 4

a) The **maximum allowed** design pressure & temperature combination and test pressure values are listed in Table 4. These values corresponds to PMS rating table values, except as stated in c) below. **Recalculation** of torque and tension is necessary if the design condition exceeds these limits.

b) Values in the table are **not** valid if the design condition for pipe wall thickness calculation is lower than 80% of the class rating condition. **Recalculation** of torque and tension is necessary in such cases.

c) It may be noted that for the sizes above 24" and rating class above 150 (except Lists B-1 and B-2), the calculations are carried out for 80% of the pressure used for sizes up to 24".

d) Torque / tension computation of sizes and pipe thickness, which are not covered in the respective classes of the standard PMS, are carried out based on approximate calculated pipe thickness for the specified pressure and temperature condition.

e) The "Flange Std" column of table 4 is the standard rating class followed by a suffix. Suffixes to the rating class numbers denote the flange dimensional standard and are as follows:

S - ASME B16.5 B - ASME B16.47 Series B

f) The values in the tables are not valid for non-standard flanges or flanges conforming to any other dimensional standards, e.g., ASME B16.47 Series A, AWWA (American Water Works association) etc.

g) All pressure values are in kg/cm^2 (g) and all temperature values are in °C

h) Bolt tightening torque or tension values at equipment interface flanges, if specified by the equipment vendor, shall be used.

5.3 Bolting Operation

5.3.1 General

a) Categorisation of joints for tension or torque application shall be as per cl. 5.1.

b) Bolt tightening tension or torque value shall be as per cl. 5.2.9.

c) Guidelines and safety requirements provided by the manufacturer bolt tightening equipment should be followed.

Copyrights EIL – All rights reserved

5.3.2 Hydraulic bolt tension application

a) Hydraulic pressure adequate to get the target bolt load can be calculated dividing the bolt load by the load cell hydraulic seal area. This pressure should be applied simultaneously to all load cells.

b) 4 load cells equally spaced should be used.

c) Nuts should be run down to flange surface manually.

d) Load cells should be shifted following the Criss-cross Pattern shown in Fig. 1 but in-groups of 4 bolts each (i.e. 1-2-3-4, 5-6-7-8, 9-10-11-12 etc.) and the tensioning of all bolts should be completed.

e) Tensioning operations should be repeated once again applying the same pressure.

5.3.3 Stud bolt torque application

a) Bolt torque application sequence shall be in accordance with "Criss-cross Stud Tightening Pattern" (Fig. 1).

b) Properly calibrated torque wrenches should be used.

c) Torque wrench should be held perpendicular to the axis of the bolt and if hydraulic wrench is used, it has to be ensured that it reacts against a rigid support parallel to the axis of bolt.

d) Torque should be applied using a minimum of following five steps:

i. All the nuts should be made snug tight with a short wrench (Criss-cross Pattern – Fig.1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

ii. Tightening to 30% of the final torque value (Criss-cross Pattern – Fig. 1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

iii. Tightening to 60% of the final torque value (Criss-cross Pattern – Fig.1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

iv. Tightening to the final torque value (Criss-cross Pattern – Fig. 1).

Flange should be bearing uniformly on the gasket (Distance between mating flanges shall be uniform).

v. Tightening should be continued with the final torque in a clockwise manner (bolt to bolt) until no further rotation is observed.

e) In the event of nut seizure, the nut should be backed off and additional lubricant should be applied or the nut or/and bolt should be replaced, if necessary.

Copyrights EIL – All rights reserved

5.3.4 Testing of joints

Checking up of the individual joints for any leak during system pressure testing should be carried out using special tapes, soap solutions.

6.0 RESPONSIBILITIES / APPROVALS

6.1 All procedures/documents to be used during Construction should be submitted by the Contractor to Engineer-in-charge at site in advance.

6.2 The equipment supplier shall be subjected to EIL/Owner approval.

6.3 The details of hydraulic tensioner equipment to be used for tightening shall be intimated to Engineer-in-charge before application.

6.4 Boxing up and tightening of flange joints shall be done by skilled technicians, qualified and approved by Contractor and EIL/Owner.

6.5 Any conflict between the requirements of this standard specification and applicable codes, licensor specification, standards, data sheets, drawings, requisitions etc. shall be referred to client/ consultant. Agency carrying out bolt tightening shall list and describe all the deviations from this standard specification and the related reference documents.

7.0 DOCUMENTATION

7.1 History sheet for flange joints shall be maintained as per Annexure-I.

7.2 Sequence of the activities involved for reopening/ making/ blinding/ de-blinding/ wedge opening of flange joints shall be as per Annexure-II.

7.3 All joints shall be boxed-up and the record shall be maintained of salient points and names of the persons involved in the execution/inspection of boxing-up operation.

7.4 All critical joints shall be boxed-up under the supervision of the Contractor's representative and EIL's Engineer-in-charge or his representative and separate records shall be maintained for such joints.

7.5 Box up records of interface joints and on-line instrument joints, like control valves, safety valves, turbine flow meters etc., which are not subjected to hydro test shall be maintained separately.

7.6 If mentioned in project specification, complete set of Bolt Tensioning Equipment/ Torque Wrenches shall be supplied by Contractor to the Owner, after commissioning of the plant, as mandatory spares.

Copyrights EIL – All rights reserved

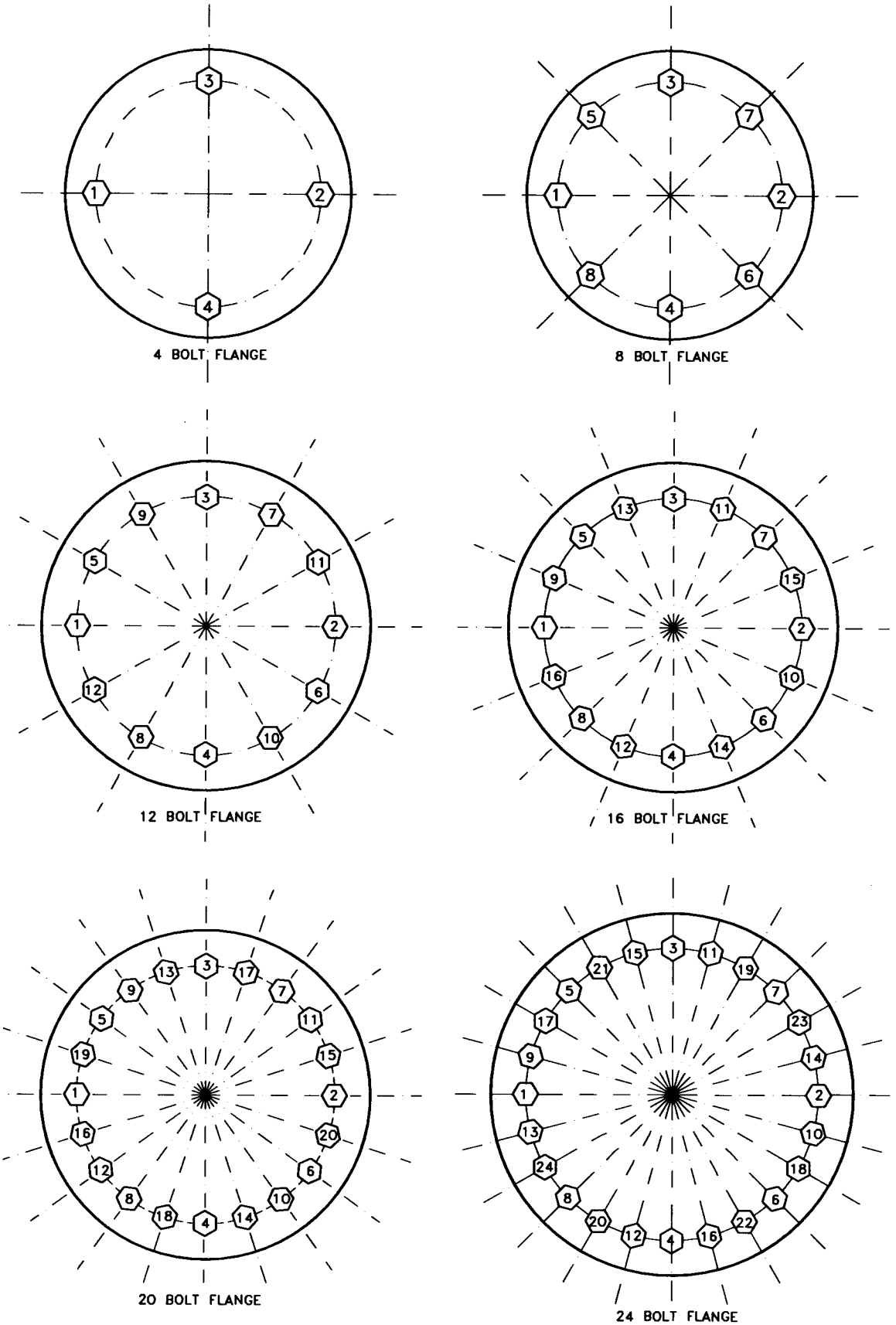


Figure 1 Typical "Criss-cross" Bolt tightening/Torque application pattern

Copyrights EIL – All rights reserved

Page 4491 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

Table 4: Bolt Tension and Torque Values

Refer cl. 5.2.8, 5.2.9 and 5.2.10 for applicability of these values

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST A-1													
A1A	PMS rated Temperature / Pressure		371 / 7.73	Up to 48"	7.73	371	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	3/4	1/2	4	855	2.6
				A672 Gr. B60	7.73	371	30.05	150S	1	1/2	4	1027	3.1
A2A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150S	1-1/2	1/2	4	1597	4.8
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	2	5/8	4	2562	9.4
				A672 Gr. B60	7.73	371	30.05	150S	3	5/8	4	3020	11.1
A6A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	4	5/8	8	2471	9.1
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	6	3/4	8	3972	17.2
				A672 Gr. B60	7.73	371	30.05	150S	8	3/4	8	4931	21.3
A7A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	10	7/8	12	5135	25.5
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	12	7/8	12	5326	26.5
				A672 Gr. B60	7.73	371	30.05	150S	14	1	12	6249	35.2
A9A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150S	16	1	16	5999	33.8
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	18	1-1/8	16	8583	53.7
				A672 Gr. B60	7.73	371	30.05	150S	20	1-1/8	20	8583	53.7
A11A	PMS rated Temperature / Pressure		371 / 7.5	Up to 48"	7.73	371	30.05	150S	24	1-1/4	20	11379	78.3
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	26	3/4	36	4111	17.7
				A672 Gr. B60	7.73	371	30.05	150B	28	3/4	40	4111	17.7
A13A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150B	30	3/4	44	4385	18.9
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	32	3/4	48	4522	19.5
				A672 Gr. B60	7.73	371	30.05	150B	34	7/8	40	6274	31.2
A19A	PMS rated Temperature / Pressure		371 / 7.73	Up to 36"	7.73	371	30.05	150B	36	7/8	44	6274	31.2
	A105	A193 Gr. B7	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150B	38	1	40	7750	43.7
				A 672 Gr.B 60 Cl.22	7.73	371	30.05	150B	40	1	44	7750	43.7
					7.73	371	30.05	150B	42	1	48	7750	43.7
					7.73	371	30.05	150B	44	1	52	7750	43.7
					7.73	371	30.05	150B	46	1-1/8	40	11230	70.3
					7.73	371	30.05	150B	48	1-1/8	44	10570	66.2

Copyrights EIL – All rights reserved

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	30.05	150B	**50**	1-1/8	48	**10570**	**66.2**
					7.73	371	30.05	150B	**52**	1-1/8	52	**10240**	**64.1**
					7.73	371	30.05	150B	**54**	1-1/8	56	**10240**	**64.1**
					7.73	371	30.05	150B	**56**	1-1/8	60	**10240**	**64.1**
					7.73	371	30.05	150B	**58**	1-1/4	48	**13488**	**92.8**
					7.73	371	30.05	150B	**60**	1-1/4	52	**13488**	**92.8**
LIST A-2													
	PMS rated Temperature / Pressure		50 / 10.55	Up to 12"	10.55	186	15.80	150S	**1/2**	1/2	4	**684**	**2.1**
A4Y	A105	A307 GR.B	BUTYL RUBBER	API 5L GR.B PSL1	10.55	186	15.80	150S	**3/4**	1/2	4	**855**	**2.6**
					10.55	186	15.80	150S	**1**	1/2	4	**1027**	**3.1**
					10.55	186	15.80	150S	**1-1/2**	1/2	4	**1255**	**3.8**
					10.55	186	15.80	150S	**2**	5/8	4	**2013**	**7.4**
					10.55	186	15.80	150S	**3**	5/8	4	**2013**	**7.4**
					10.55	186	15.80	150S	**4**	5/8	8	**2013**	**7.4**
					10.55	186	15.80	150S	**6**	3/4	8	**3014**	**13.0**
					10.55	186	15.80	150S	**8**	3/4	8	**3014**	**13.0**
					10.55	186	15.80	150S	**10**	7/8	12	**4184**	**20.8**
					10.55	186	15.80	150S	**12**	7/8	12	**4184**	**20.8**
					10.55	186	15.80	150S	**14**	1	12	**5499**	**31.0**
					10.55	186	15.80	150S	**16**	1	16	**5499**	**31.0**
					10.55	186	15.80	150S	**18**	1-1/8	16	**7263**	**45.5**
					10.55	186	15.80	150S	**20**	1-1/8	20	**7263**	**45.5**
					10.55	186	15.80	150S	**24**	1-1/4	20	**9272**	**63.8**
LIST A-3													
	PMS rated Temperature / Pressure		204 / 14.06	Up to 48"	14.06	204	27.95	150S	**1/2**	1/2	4	**684**	**2.1**
A4A	A 350 GR.LF2 CL.1	A320 GR.L7	Spiral wound SS	A 333 GR.6	14.06	204	27.95	150S	**3/4**	1/2	4	**855**	**2.6**
				A 671 GR.CC60 CL.32	14.06	204	27.95	150S	**1**	1/2	4	**1027**	**3.1**
					14.06	204	27.95	150S	**1-1/2**	1/2	4	**1597**	**4.8**
					14.06	204	27.95	150S	**2**	5/8	4	**2562**	**9.4**
					14.06	204	27.95	150S	**3**	5/8	4	**3020**	**11.1**
					14.06	204	27.95	150S	**4**	5/8	8	**2471**	**9.1**
					14.06	204	27.95	150S	**6**	3/4	8	**3972**	**17.2**
					14.06	204	27.95	150S	**8**	3/4	8	**4931**	**21.3**

Copyrights EIL – All rights reserved

Page 4492 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

Page 4493 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					14.06	204	27.95	150S	10	7/8	12	5135	25.5
					14.06	204	27.95	150S	12	7/8	12	5326	26.5
					14.06	204	27.95	150S	14	1	12	6249	35.2
					14.06	204	27.95	150S	16	1	16	5999	33.8
					14.06	204	27.95	150S	18	1-1/8	16	8583	53.7
					14.06	204	27.95	150S	20	1-1/8	20	8583	53.7
					14.06	204	27.95	150S	24	1-1/4	20	11379	78.3
					14.06	204	27.95	150B	26	3/4	36	4111	17.7
					14.06	204	27.95	150B	28	3/4	40	4111	17.7
					14.06	204	27.95	150B	30	3/4	44	4385	18.9
					14.06	204	27.95	150B	32	3/4	48	4522	19.5
					14.06	204	27.95	150B	34	7/8	40	6274	31.2
					14.06	204	27.95	150B	36	7/8	44	6274	31.2
					14.06	204	27.95	150B	38	1	40	7750	43.7
					14.06	204	27.95	150B	40	1	44	7750	43.7
					14.06	204	27.95	150B	42	1	48	7750	43.7
					14.06	204	27.95	150B	44	1	52	7750	43.7
					14.06	204	27.95	150B	46	1-1/8	40	11230	70.3
					14.06	204	27.95	150B	48	1-1/8	44	10570	66.2
LIST A-4													
A8A	PMS rated Temperature / Pressure		65 / 19.17	Up to 6"	8.78	343	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	3/4	1/2	4	855	2.6
					8.78	343	30.05	150S	1	1/2	4	1027	3.1
A15A	PMS rated Temperature / Pressure		343 / 8.78	Up to 16"	8.78	343	30.05	150S	1-1/2	1/2	4	1597	4.8
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	2	5/8	4	2562	9.4
				A672 Gr. B60	8.78	343	30.05	150S	3	5/8	4	3020	11.1
A20A	PMS rated Temperature / Pressure		343 / 8.78	Up to 18"	8.78	343	30.05	150S	4	5/8	8	2471	9.1
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	6	3/4	8	3972	17.2
				A672 Gr. B60	8.78	343	30.05	150S	8	3/4	8	4931	21.3
A32A	PMS rated Temperature / Pressure		280 / 11.19	Up to 3"	8.78	343	30.05	150S	10	7/8	12	5135	25.5
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	12	7/8	12	5326	26.5
					8.78	343	30.05	150S	14	1	12	6249	35.2

Copyrights EIL – All rights reserved

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
A33A	PMS rated Temperature / Pressure		65 / 18.9	Up to 48"	8.78	343	30.05	150S	16	1	16	5999	33.8
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150S	18	1-1/8	16	8583	53.7
				IS-3589 GR.410	8.78	343	30.05	150S	20	1-1/8	20	8583	53.7
A33Y	PMS rated Temperature / Pressure		65 / 18.9	Up to 48"	8.78	343	30.05	150S	24	1-1/4	20	11379	78.3
	A105	A193 GR.B7	BS7531 GR X	A 106 GR.B	8.78	343	30.05	150B	26	3/4	36	4111	17.7
				IS-3589 GR.410	8.78	343	30.05	150B	28	3/4	40	4111	17.7
					8.78	343	30.05	150B	30	3/4	44	4385	18.9
					8.78	343	30.05	150B	32	3/4	48	4522	19.5
					8.78	343	30.05	150B	34	7/8	40	6274	31.2
					8.78	343	30.05	150B	36	7/8	44	6274	31.2
					8.78	343	30.05	150B	38	1	40	7750	43.7
					8.78	343	30.05	150B	40	1	44	7750	43.7
					8.78	343	30.05	150B	42	1	48	7750	43.7
					8.78	343	30.05	150B	44	1	52	7750	43.7
					8.78	343	30.05	150B	46	1-1/8	40	11230	70.3
					8.78	343	30.05	150B	48	1-1/8	44	10570	66.2
					8.78	343	30.05	150B	50	1-1/8	48	10570	66.2
					8.78	343	30.05	150B	52	1-1/8	52	10240	64.1
					8.78	343	30.05	150B	54	1-1/8	56	10240	64.1
					8.78	343	30.05	150B	56	1-1/8	60	10240	64.1
					8.78	343	30.05	150B	58	1-1/4	48	13488	92.8
					8.78	343	30.05	150B	60	1-1/4	52	13488	92.8
LIST A-5													
A16A	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.05	150S	1/2	1/2	4	684	2.1
	A105	A193 Gr. B7M	Spiral wound SS	A106 Gr. B	7.73	371	30.05	150S	3/4	1/2	4	855	2.6
				A672 Gr. B60	7.73	371	30.05	150S	1	1/2	4	1027	3.1
					7.73	371	30.05	150S	1-1/2	1/2	4	1597	4.8
					7.73	371	30.05	150S	2	5/8	4	2562	9.4
					7.73	371	30.05	150S	3	5/8	4	3020	11.1
					7.73	371	30.05	150S	4	5/8	8	2471	9.1
					7.73	371	30.05	150S	6	3/4	8	3972	17.2
					7.73	371	30.05	150S	8	3/4	8	4931	21.3
					7.73	371	30.05	150S	10	7/8	12	5135	25.5

Copyrights EIL – All rights reserved

Page 4494 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	30.05	150S	12	7/8	12	5326	26.5
					7.73	371	30.05	150S	14	1	12	6249	35.2
					7.73	371	30.05	150S	16	1	16	5999	33.8
					7.73	371	30.05	150S	18	1-1/8	16	8583	53.7
					7.73	371	30.05	150S	20	1-1/8	20	8583	53.7
					7.73	371	30.05	150S	24	1-1/4	20	11379	78.3
LIST A-6													
A4F	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.57	150S	1/2	1/2	4	798	2.4
	A182 Gr.F5	A193 Gr.B16	Spiral wound SS	A 335 GR.P5	7.73	371	30.57	150S	3/4	1/2	4	970	2.9
				A 691 GR.5Cr CL.42	7.73	371	30.57	150S	1	1/2	4	1141	3.4
					7.73	371	30.57	150S	1-1/2	1/2	4	1540	4.6
					7.73	371	30.57	150S	2	5/8	4	2745	10.1
					7.73	371	30.57	150S	3	5/8	4	3020	11.1
					7.73	371	30.57	150S	4	5/8	8	3020	11.1
					7.73	371	30.57	150S	6	3/4	8	5205	22.5
					7.73	371	30.57	150S	8	3/4	8	5274	22.8
					7.73	371	30.57	150S	10	7/8	12	6277	31.2
					7.73	371	30.57	150S	12	7/8	12	6277	31.2
					7.73	371	30.57	150S	14	1	12	8249	46.5
					7.73	371	30.57	150S	16	1	16	7249	40.9
					7.73	371	30.57	150S	18	1-1/8	16	11885	74.4
					7.73	371	30.57	150S	20	1-1/8	20	11554	72.4
					7.73	371	30.57	150S	24	1-1/4	20	14751	101.5
					7.73	371	30.57	150B	26	3/4	36	4109	17.7
					7.73	371	30.57	150B	28	3/4	40	4383	18.9
					7.73	371	30.57	150B	30	3/4	44	4520	19.5
					7.73	371	30.57	150B	32	3/4	48	4794	20.7
					7.73	371	30.57	150B	34	7/8	40	6847	34.0
					7.73	371	30.57	150B	36	7/8	44	7037	35.0
					7.73	371	30.57	150B	38	1	40	8748	49.3
					7.73	371	30.57	150B	40	1	44	8748	49.3
					7.73	371	30.57	150B	42	1	48	8498	47.9

Copyrights EIL – All rights reserved

Page 4495 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST A-7													
A4G	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	30.57	150S	1/2	1/2	4	798	2.4
	A182 Gr.F9	A193 Gr.B16	Spiral wound SS	A 335 GR.P9	7.73	371	30.57	150S	3/4	1/2	4	970	2.9
				A 691 GR.9Cr CL.42	7.73	371	30.57	150S	1	1/2	4	1255	3.8
					7.73	371	30.57	150S	1-1/2	1/2	4	1825	5.5
					7.73	371	30.57	150S	2	5/8	4	3203	11.8
					7.73	371	30.57	150S	3	5/8	4	3386	12.4
					7.73	371	30.57	150S	4	5/8	8	3386	12.4
					7.73	371	30.57	150S	6	3/4	8	5342	23.1
					7.73	371	30.57	150S	8	3/4	8	5342	23.1
					7.73	371	30.57	150S	10	7/8	12	7037	35.0
					7.73	371	30.57	150S	12	7/8	12	6847	34.0
					7.73	371	30.57	150S	14	1	12	8748	49.3
					7.73	371	30.57	150S	16	1	16	7999	45.1
					7.73	371	30.57	150S	18	1-1/8	16	12215	76.5
					7.73	371	30.57	150S	20	1-1/8	20	11885	74.4
					7.73	371	30.57	150S	24	1-1/4	20	15594	107.3
					7.73	371	30.57	150B	26	3/4	36	4383	18.9
					7.73	371	30.57	150B	28	3/4	40	4589	19.8
					7.73	371	30.57	150B	30	3/4	44	4726	20.4
					7.73	371	30.57	150B	32	3/4	48	5137	22.2
					7.73	371	30.57	150B	34	7/8	40	7132	35.5
					7.73	371	30.57	150B	36	7/8	44	7132	35.5
					7.73	371	30.57	150B	38	1	40	9123	51.4
					7.73	371	30.57	150B	40	1	44	9123	51.4
					7.73	371	30.57	150B	42	1	48	8998	50.7
LIST A-8													
A2K	PMS rated Temperature / Pressure		120 / 15.32	Up to 24"	15.32	120	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	15.32	120	29.00	150S	3/4	1/2	4	855	2.6
				A 358 GR.304	15.32	120	29.00	150S	1	1/2	4	1141	3.4
					15.32	120	29.00	150S	1-1/2	1/2	4	1597	4.8
					15.32	120	29.00	150S	2	5/8	4	2379	8.7
					15.32	120	29.00	150S	3	5/8	4	3203	11.8

Copyrights EIL – All rights reserved

Page 4496 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					15.32	120	29.00	150S	4	5/8	8	2837	10.4
					15.32	120	29.00	150S	6	3/4	8	4383	18.9
					15.32	120	29.00	150S	8	3/4	8	5068	21.9
					15.32	120	29.00	150S	10	7/8	12	5516	27.4
					15.32	120	29.00	150S	12	7/8	12	5896	29.3
					15.32	120	29.00	150S	14	1	12	7499	42.3
					15.32	120	29.00	150S	16	1	16	6749	38.1
					15.32	120	29.00	150S	18	1-1/8	16	9574	59.9
					15.32	120	29.00	150S	20	1-1/8	20	9574	59.9
					15.32	120	29.00	150S	24	1-1/4	20	12644	87.0
					15.32	120	29.00	150B	26	3/4	36	4109	17.7
					15.32	120	29.00	150B	28	3/4	40	4246	18.3
					15.32	120	29.00	150B	30	3/4	44	4383	18.9
					15.32	120	29.00	150B	32	3/4	48	4520	19.5
					15.32	120	29.00	150B	34	7/8	40	5896	29.3
					15.32	120	29.00	150B	36	7/8	44	5991	29.8
LIST A-9													
A1K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	7.73	371	29.00	150S	3/4	1/2	4	798	2.4
				A 358 GR.304	7.73	371	29.00	150S	1	1/2	4	913	2.7
A6K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1-1/2	1/2	4	1141	3.4
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	7.73	371	29.00	150S	2	5/8	4	2562	9.4
				A 358 GR.304L	7.73	371	29.00	150S	3	5/8	4	3020	11.1
A11K	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	4	5/8	8	2471	9.1
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	7.73	371	29.00	150S	6	3/4	8	3972	17.2
				A 358 GR.304L	7.73	371	29.00	150S	8	3/4	8	4931	21.3
					7.73	371	29.00	150S	10	7/8	12	5135	25.5
					7.73	371	29.00	150S	12	7/8	12	5326	26.5
					7.73	371	29.00	150S	14	1	12	6249	35.2
					7.73	371	29.00	150S	16	1	16	5999	33.8
					7.73	371	29.00	150S	18	1-1/8	16	8583	53.7
					7.73	371	29.00	150S	20	1-1/8	20	8583	53.7
					7.73	371	29.00	150S	24	1-1/4	20	11379	78.3

Copyrights EIL – All rights reserved

Page 4497 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

Page 4498 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST A-10													
A1M	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	29.00	150S	1/2	1/2	4	570	1.7
	A 182 GR.F316	A193 GR.B7	Spiral wound SS	A 312 TP316	7.73	371	29.00	150S	3/4	1/2	4	798	2.4
				A 358 GR.316	7.73	371	29.00	150S	1	1/2	4	913	2.7
					7.73	371	29.00	150S	1-1/2	1/2	4	1141	3.4
					7.73	371	29.00	150S	2	5/8	4	2562	9.4
					7.73	371	29.00	150S	3	5/8	4	3020	11.1
					7.73	371	29.00	150S	4	5/8	8	2471	9.1
					7.73	371	29.00	150S	6	3/4	8	3972	17.2
					7.73	371	29.00	150S	8	3/4	8	4931	21.3
					7.73	371	29.00	150S	10	7/8	12	5135	25.5
					7.73	371	29.00	150S	12	7/8	12	5326	26.5
					7.73	371	29.00	150S	14	1	12	6249	35.2
					7.73	371	29.00	150S	16	1	16	5999	33.8
					7.73	371	29.00	150S	18	1-1/8	16	8583	53.7
					7.73	371	29.00	150S	20	1-1/8	20	8583	53.7
					7.73	371	29.00	150S	24	1-1/4	20	11379	78.3
LIST A-11													
A1N	PMS rated Temperature / Pressure		371 / 7.73	Up to 24"	7.73	371	24.26	150S	1/2	1/2	4	570	1.7
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	7.73	371	24.26	150S	3/4	1/2	4	798	2.4
				A 358 GR.316L	7.73	371	24.26	150S	1	1/2	4	913	2.7
					7.73	371	24.26	150S	1-1/2	1/2	4	1426	4.3
					7.73	371	24.26	150S	2	5/8	4	2562	9.4
					7.73	371	24.26	150S	3	5/8	4	3020	11.1
					7.73	371	24.26	150S	4	5/8	8	2471	9.1
					7.73	371	24.26	150S	6	3/4	8	3972	17.2
					7.73	371	24.26	150S	8	3/4	8	4931	21.3
					7.73	371	24.26	150S	10	7/8	12	5135	25.5
					7.73	371	24.26	150S	12	7/8	12	5326	26.5
					7.73	371	24.26	150S	14	1	12	6249	35.2
					7.73	371	24.26	150S	16	1	16	5999	33.8
					7.73	371	24.26	150S	18	1-1/8	16	8583	53.7
					7.73	371	24.26	150S	20	1-1/8	20	8583	53.7

Copyrights EIL – All rights reserved

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					7.73	371	24.26	150S	24	1-1/4	20	11379	78.3
LIST B-1													
B1A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1/2	1/2	4	741	2.2
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	3/4	5/8	4	1373	5.0
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	1	5/8	4	1647	6.0
B2A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1-1/2	3/4	4	2740	11.8
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	2	5/8	8	2105	7.7
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	3	3/4	8	3972	17.2
B5A	PMS rated Temperature / Pressure		230 / 43.66	Up to 24"	28.82	427	79.10	300S	4	3/4	8	5205	22.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	6	3/4	12	5205	22.5
				A 672 GR.B60 CL.32	28.82	427	79.10	300S	8	7/8	12	7608	37.8
B6A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	10	1	16	8748	49.3
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	12	1-1/8	16	11554	72.4
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	14	1-1/8	20	8913	55.8
B9A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	16	1-1/4	20	10958	75.4
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300S	18	1-1/4	24	11801	81.2
				A 672 GR.B60 CL.12	28.82	427	79.10	300S	20	1-1/4	24	14330	98.6
B13A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	24	1-1/2	24	17849	144.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	26	1-1/4	32	13065	89.9
				A 672 GR.B60 CL.12	28.82	427	79.10	300B	28	1-1/4	36	13065	89.9
B19A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300B	30	1-3/8	36	15197	114.0
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	32	1-1/2	32	18487	150.1
				A 672 GR.B60 CL.22	28.82	427	79.10	300B	34	1-1/2	36	18168	147.5
B32A	PMS rated Temperature / Pressure		427 / 28.82	Up to 3"	28.82	427	79.10	300B	36	1-5/8	32	23630	206.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	28.82	427	79.10	300B	38	1-5/8	36	25154	219.9
				A 672 GR.B60 CL.12	28.82	427	79.10	300B	40	1-5/8	40	24392	213.2
					28.82	427	79.10	300B	42	1-3/4	36	29631	277.5
LIST B-2													
B4A	PMS rated Temperature / Pressure		204 / 43.23	Up to 24"	28.82	427	79.10	300S	1/2	1/2	4	741	2.2
	A350 Gr.LF2 CL.1	A320 Gr.L7	Spiral wound SS	A333 Gr.6	28.82	427	79.10	300S	3/4	5/8	4	1373	5.0
				A671 Gr.CC60 CL.32	28.82	427	79.10	300S	1	5/8	4	1647	6.0
B16A	PMS rated Temperature / Pressure		427 / 28.82	Up to 24"	28.82	427	79.10	300S	1-1/2	3/4	4	2740	11.8
	A105	A193 Gr.B7M	Spiral wound SS	A106 Gr.B	28.82	427	79.10	300S	2	5/8	8	2105	7.7

Copyrights EIL – All rights reserved

Page 4499 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
				A672 Gr.B60 CL.22	28.82	427	79.10	300S	3	3/4	8	3972	17.2
					28.82	427	79.10	300S	4	3/4	8	5205	22.5
					28.82	427	79.10	300S	6	3/4	12	5205	22.5
					28.82	427	79.10	300S	8	7/8	12	7608	37.8
					28.82	427	79.10	300S	10	1	16	8748	49.3
					28.82	427	79.10	300S	12	1-1/8	16	11554	72.4
					28.82	427	79.10	300S	14	1-1/8	20	8913	55.8
					28.82	427	79.10	300S	16	1-1/4	20	10958	75.4
					28.82	427	79.10	300S	18	1-1/4	24	11801	81.2
					28.82	427	79.10	300S	20	1-1/4	24	14330	98.6
					28.82	427	79.10	300S	24	1-1/2	24	17849	144.9
					28.82	427	79.10	300B	26	1-1/4	32	13065	89.9
					28.82	427	79.10	300B	28	1-1/4	36	13065	89.9
					28.82	427	79.10	300B	30	1-3/8	36	15197	114.0
LIST B-3													
B1D	PMS rated Temperature / Pressure		538 / 15.11	Up to 24"	15.11	538	79.10	300S	1/2	1/2	4	741	2.2
	A182 Gr. F11 Cl. 2	A193 Gr. B16	Spiral wound SS	A335 Gr. P11	15.11	538	79.10	300S	3/4	5/8	4	1007	3.7
				A691 Gr.1.25Cr Cl.42	15.11	538	79.10	300S	1	5/8	4	1647	6.0
B5D	PMS rated Temperature / Pressure		538 / 15.11	Up to 24"	15.11	538	79.10	300S	1-1/2	3/4	4	3014	13.0
	A182 Gr. F11 Cl. 2	A193 Gr. B16	Spiral wound SS	A335 Gr. P11	15.11	538	79.10	300S	2	5/8	8	2196	8.1
				A691 Gr.1.25Cr Cl.42	15.11	538	79.10	300S	3	3/4	8	4794	20.7
B3F	PMS rated Temperature / Pressure		538 / 14.06	Up to 24"	15.11	538	79.10	300S	4	3/4	8	5205	22.5
	A 182 GR.F5	A193 GR.B16	Spiral wound SS	A 335 GR.P5	15.11	538	79.10	300S	6	3/4	12	5205	22.5
				A 691 GR5CR CL.42	15.11	538	79.10	300S	8	7/8	12	7228	35.9
B4F	PMS rated Temperature / Pressure		538 / 14.06	Up to 24"	15.11	538	79.10	300S	10	1	16	9498	53.6
	A 182 GR.F5	A193 GR.B16	Spiral wound SS	A 335 GR.P5	15.11	538	79.10	300S	12	1-1/8	16	11885	74.4
				A 691 Gr. 5CR CL.42	15.11	538	79.10	300S	14	1-1/8	20	9574	59.9
					15.11	538	79.10	300S	16	1-1/4	20	11801	81.2
					15.11	538	79.10	300S	18	1-1/4	24	12222	84.1
					15.11	538	79.10	300S	20	1-1/4	24	14751	101.5
					15.11	538	79.10	300S	24	1-1/2	24	17849	144.9
					12.09	538	63.28	300B	26	1-1/4	32	10958	75.4
					12.09	538	63.28	300B	28	1-1/4	36	10958	75.4

Copyrights EIL – All rights reserved

Page 4500 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					12.09	538	63.28	300B	30	1-3/8	36	12577	94.3
					12.09	538	63.28	300B	32	1-1/2	32	15937	129.4
					12.09	538	63.28	300B	34	1-1/2	36	15299	124.2
					12.09	538	63.28	300B	36	1-5/8	32	19819	173.2
					12.09	538	63.28	300B	38	1-5/8	36	22105	193.2
					12.09	538	63.28	300B	40	1-5/8	40	21343	186.5
					12.09	538	63.28	300B	42	1-3/4	36	26937	252.3
LIST B-4													
B1E	PMS rated Temperature / Pressure		538 / 18.63	Up to 24"	18.63	538	79.10	300S	1/2	1/2	4	855	2.6
	A 182 GR.F22 CL.3	A193 Gr. B16	Spiral wound SS	A335 Gr. P22	18.63	538	79.10	300S	3/4	5/8	4	1098	4.0
				A691 Gr.2.25Cr Cl.42	18.63	538	79.10	300S	1	5/8	4	1830	6.7
B4G	PMS rated Temperature / Pressure		538 / 17,92	Up to 24"	18.63	538	79.10	300S	1-1/2	3/4	4	3287	14.2
	A 182 GR.F9	A193 GR.B16	Spiral wound SS	A 335 GR.P9	18.63	538	79.10	300S	2	5/8	8	2288	8.4
				A 691 GR9CR CL.42	18.63	538	79.10	300S	3	3/4	8	4931	21.3
					18.63	538	79.10	300S	4	3/4	8	5342	23.1
					18.63	538	79.10	300S	6	3/4	12	5342	23.1
					18.63	538	79.10	300S	8	7/8	12	7418	36.9
					18.63	538	79.10	300S	10	1	16	9748	55.0
					18.63	538	79.10	300S	12	1-1/8	16	12215	76.5
					18.63	538	79.10	300S	14	1-1/8	20	10234	64.1
					18.63	538	79.10	300S	16	1-1/4	20	12644	87.0
					18.63	538	79.10	300S	18	1-1/4	24	13065	89.9
					18.63	538	79.10	300S	20	1-1/4	24	15173	104.4
					18.63	538	79.10	300S	24	1-1/2	24	18487	150.1
					14.90	538	63.28	300B	26	1-1/4	32	11801	81.2
					14.90	538	63.28	300B	28	1-1/4	36	11801	81.2
					14.90	538	63.28	300B	30	1-3/8	36	13625	102.2
					14.90	538	63.28	300B	32	1-1/2	32	17212	139.8
					14.90	538	63.28	300B	34	1-1/2	36	16574	134.6
					14.90	538	63.28	300B	36	1-5/8	32	21343	186.5
					14.90	538	63.28	300B	38	1-5/8	36	23630	206.5
					14.90	538	63.28	300B	40	1-5/8	40	22868	199.9
					14.90	538	63.28	300B	42	1-3/4	36	28733	269.1

Copyrights EIL – All rights reserved

Page 4501 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

Page 4502 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST B-5													
B6K	PMS rated Temperature / Pressure		427 / 24.25	Up to 24"	24.25	427	63.27	300S	1/2	1/2	4	570	1.7
	A 182 GR.F304L	A193 GR.B7	Spiral wound SS	A 312 TP304L	24.25	427	63.27	300S	3/4	5/8	4	915	3.4
				A 358 TP304L CL.1	24.25	427	63.27	300S	1	5/8	4	1281	4.7
					24.25	427	63.27	300S	1-1/2	3/4	4	2192	9.5
					24.25	427	63.27	300S	2	5/8	8	1464	5.4
					24.25	427	63.27	300S	3	3/4	8	2466	10.6
					24.25	427	63.27	300S	4	3/4	8	2740	11.8
					24.25	427	63.27	300S	6	3/4	12	3150	13.6
					24.25	427	63.27	300S	8	7/8	12	4945	24.6
					24.25	427	63.27	300S	10	1	16	5249	29.6
					24.25	427	63.27	300S	12	1-1/8	16	7263	45.5
					24.25	427	63.27	300S	14	1-1/8	20	6933	43.4
					24.25	427	63.27	300S	16	1-1/4	20	8851	60.9
					24.25	427	63.27	300S	18	1-1/4	24	9694	66.7
					24.25	427	63.27	300S	20	1-1/4	24	11379	78.3
					24.25	427	63.27	300S	24	1-1/2	24	14662	119.1
LIST B-6													
B1K	PMS rated Temperature / Pressure		454 / 27.77	Up to 24"	5.97	704	75.93	300S	1/2	1/2	4	798	2.4
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	5.97	704	75.93	300S	3/4	5/8	4	1281	4.7
				A 358 TP304 CL.1	5.97	704	75.93	300S	1	5/8	4	1464	5.4
B2K	PMS rated Temperature / Pressure		120 / 40.14	Up to 24"	5.97	704	75.93	300S	1-1/2	3/4	4	2740	11.8
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	5.97	704	75.93	300S	2	5/8	8	2105	7.7
				A 358 TP316L CL.1	5.97	704	75.93	300S	3	3/4	8	3561	15.4
B4K	PMS rated Temperature / Pressure		704 /8.08	Up to 24"	5.97	704	75.93	300S	4	3/4	8	3972	17.2
	A 182 GR.F304H	A453 GR.660CL.A	Spiral wound SS	A 312 TP304H	5.97	704	75.93	300S	6	3/4	12	4109	17.7
					5.97	704	75.93	300S	8	7/8	12	6086	30.3
B5K	PMS rated Temperature / Pressure		704/8.08	Up to 24"	5.97	704	75.93	300S	10	1	16	7499	42.3
	A 182 GR.F304H	A453 GR.660CL.A	Spiral wound SS	A 312 TP304H	5.97	704	75.93	300S	12	1-1/8	16	9574	59.9
					5.97	704	75.93	300S	14	1-1/8	20	8253	51.7
					5.97	704	75.93	300S	16	1-1/4	20	10537	72.5
					5.97	704	75.93	300S	18	1-1/4	24	11379	78.3
					5.97	704	75.93	300S	20	1-1/4	24	12644	87.0

Copyrights EIL – All rights reserved

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					5.97	704	75.93	300S	24	1-1/2	24	15937	129.4
					4.78	704	60.74	300B	26	1-1/4	32	10537	72.5
					4.78	704	60.74	300B	28	1-1/4	36	11801	81.2
					4.78	704	60.74	300B	30	1-3/8	36	12577	94.3
					4.78	704	60.74	300B	32	1-1/2	32	15937	129.4
					4.78	704	60.74	300B	34	1-1/2	36	15937	129.4
					4.78	704	60.74	300B	36	1-5/8	32	19819	173.2
					4.78	704	60.74	300B	38	1-5/8	36	20581	179.9
					4.78	704	60.74	300B	40	1-5/8	40	19819	173.2
					4.78	704	60.74	300B	42	1-3/4	36	25142	235.5
LIST B-7													
B1M	PMS rated Temperature / Pressure		427 / 29.52	Up to 24"	26.66	538	75.95	300S	1/2	1/2	4	570	1.7
	A 182 GR.F316	A193 GR.B7	Spiral wound SS	A 312 TP316	26.66	538	75.95	300S	3/4	5/8	4	1373	5.0
				A 358 TP316 CL.1	26.66	538	75.95	300S	1	5/8	4	1373	5.0
B3M	PMS rated Temperature / Pressure		538 / 25.66	Up to 24"	26.66	538	75.95	300S	1-1/2	3/4	4	2192	9.5
	A 182 GR.F321	A453 GR.660CL.A	Spiral wound SS	A 312 TP321	26.66	538	75.95	300S	2	5/8	8	1556	5.7
				A 358 TP321 CL.1	26.66	538	75.95	300S	3	3/4	8	2603	11.2
B5M	PMS rated Temperature / Pressure		538 / 24.60	Up to 24"	26.66	538	75.95	300S	4	3/4	8	3972	17.2
	A 182 GR.F316H	A453 GR.660CL.A	Spiral wound SS	A 312 TP316H	26.66	538	75.95	300S	6	3/4	12	3972	17.2
					26.66	538	75.95	300S	8	7/8	12	5706	28.4
					26.66	538	75.95	300S	10	1	16	6999	39.5
					26.66	538	75.95	300S	12	1-1/8	16	8253	51.7
					26.66	538	75.95	300S	14	1-1/8	20	7593	47.5
					26.66	538	75.95	300S	16	1-1/4	20	9694	66.7
					26.66	538	75.95	300S	18	1-1/4	24	10537	72.5
					26.66	538	75.95	300S	20	1-1/4	24	12222	84.1
					26.66	538	75.95	300S	24	1-1/2	24	16256	132.0
					20.53	538	60.82	300B	26	1-1/4	32	10537	72.5
					20.53	538	60.82	300B	28	1-1/4	36	10537	72.5
					20.53	538	60.82	300B	30	1-3/8	36	11791	88.4
					20.53	538	60.82	300B	32	1-1/2	32	14981	121.6
					20.53	538	60.82	300B	34	1-1/2	36	14343	116.5
					20.53	538	60.82	300B	36	1-5/8	32	17913	156.6

Copyrights EIL – All rights reserved

Page 4503 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					20.53	538	60.82	300B	38	1-5/8	36	19056	166.6
					20.53	538	60.82	300B	40	1-5/8	40	18294	159.9
					20.53	538	60.82	300B	42	1-3/4	36	22897	214.4
LIST B-8													
B1N	PMS rated Temperature / Pressure		454 / 23.90	Up to 24"	23.90	454	63.27	300S	1/2	1/2	4	570	1.7
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	23.90	454	63.27	300S	3/4	5/8	4	915	3.4
				A 358 TP 316L CL.1	23.90	454	63.27	300S	1	5/8	4	1281	4.7
B6N	PMS rated Temperature / Pressure		427 / 24.25	Up to 24"	23.90	454	63.27	300S	1-1/2	3/4	4	2192	9.5
	A 182 GR.F316L	A193 GR.B7	Spiral wound SS	A 312 TP316L	23.90	454	63.27	300S	2	5/8	8	1464	5.4
				A 358 TP 316L CL.1	23.90	454	63.27	300S	3	3/4	8	2466	10.6
					23.90	454	63.27	300S	4	3/4	8	2740	11.8
					23.90	454	63.27	300S	6	3/4	12	3150	13.6
					23.90	454	63.27	300S	8	7/8	12	4945	24.6
					23.90	454	63.27	300S	10	1	16	5249	29.6
					23.90	454	63.27	300S	12	1-1/8	16	7263	45.5
					23.90	454	63.27	300S	14	1-1/8	20	6933	43.4
					23.90	454	63.27	300S	16	1-1/4	20	8851	60.9
					23.90	454	63.27	300S	18	1-1/4	24	9694	66.7
					23.90	454	63.27	300S	20	1-1/4	24	11379	78.3
					23.90	454	63.27	300S	24	1-1/2	24	14662	119.1
LIST D-1													
D1A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	1/2	1/2	4	970	2.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	3/4	5/8	4	1373	5.0
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	1	5/8	4	2013	7.4
D2A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	1-1/2	3/4	4	4520	19.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	2	5/8	8	3112	11.4
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	3	3/4	8	5205	22.5
D5A	PMS rated Temperature / Pressure		230 / 86.96	Up to 24"	58.00	427	156.08	600S	4	7/8	8	7228	35.9
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	6	1	12	8998	50.7
				A 672 GR.B60 CL.32	58.00	427	156.08	600S	8	1-1/8	12	12875	80.6
D9A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	10	1-1/4	16	14751	101.5
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	12	1-1/4	20	14751	101.5
				A 672 GR.B60 CL.12	58.00	427	156.08	600S	14	1-3/8	20	17294	129.7

Copyrights EIL – All rights reserved

Page 4504 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
D16A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	16	1-1/2	20	21037	170.8
	A105	A193 GR.B7M	Spiral wound SS	A 106 GR.B	58.00	427	156.08	600S	18	1-5/8	20	27441	239.8
				A 672 GR.B60 CL.22	58.00	427	156.08	600S	20	1-5/8	24	26679	233.2
D19A	PMS rated Temperature / Pressure		427 / 58.00	Up to 24"	58.00	427	156.08	600S	24	1-7/8	24	34482	343.7
	A105	A193 GR.B7	Spiral wound SS	A 106 GR.B	46.40	427	124.90	600B	26	1-5/8	28	25917	226.5
				A 672 GR.B60 CL.22	46.40	427	124.90	600B	28	1-3/4	28	28733	269.1
					46.40	427	124.90	600B	30	1-7/8	28	35527	354.2
					46.40	427	124.90	600B	32	2	28	39708	420.7
					46.40	427	124.90	600B	34	2-1/4	24	55895	661.6
					46.40	427	124.90	600B	36	2-1/4	28	49684	588.1
					46.40	427	124.90	600B	38	2-1/4	28	54342	643.2
					46.40	427	124.90	600B	40	2-1/4	32	51237	606.4
					46.40	427	124.90	600B	42	2-1/2	28	66195	865.9
LIST D-2													
D4A	PMS rated Temperature / Pressure		204 / 86.47	Up to 24"	86.47	204	147.05	600S	1/2	1/2	4	970	2.9
	A 350 GR.LF2 CL.1	A320 GR.L7	Spiral wound SS	A 333 GR.6	86.47	204	147.05	600S	3/4	5/8	4	1373	5.0
				A 671 GR.CC60 CL.32	86.47	204	147.05	600S	1	5/8	4	2013	7.4
					86.47	204	147.05	600S	1-1/2	3/4	4	4520	19.5
					86.47	204	147.05	600S	2	5/8	8	3112	11.4
					86.47	204	147.05	600S	3	3/4	8	5205	22.5
					86.47	204	147.05	600S	4	7/8	8	7228	35.9
					86.47	204	147.05	600S	6	1	12	8998	50.7
					86.47	204	147.05	600S	8	1-1/8	12	12875	80.6
					86.47	204	147.05	600S	10	1-1/4	16	14751	101.5
					86.47	204	147.05	600S	12	1-1/4	20	14751	101.5
					86.47	204	147.05	600S	14	1-3/8	20	17294	129.7
					86.47	204	147.05	600S	16	1-1/2	20	21037	170.8
					86.47	204	147.05	600S	18	1-5/8	20	27441	239.8
					86.47	204	147.05	600S	20	1-5/8	24	26679	233.2
					86.47	204	147.05	600S	24	1-7/8	24	34482	343.7

Copyrights EIL – All rights reserved

Page 4505 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST D-3													
D1D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	1/2	1/2	4	1084	3.3
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	3/4	5/8	4	1373	5.0
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	1	5/8	4	2196	8.1
D2D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	1-1/2	3/4	4	4246	18.3
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	2	5/8	8	3295	12.1
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	3	3/4	8	5342	23.1
D5D	PMS rated Temperature / Pressure		538 / 30.23	Up to 24"	30.23	538	158.20	600S	4	7/8	8	7798	38.8
	A 182 GR.F11 CL.2	A193 GR.B16	Spiral wound SS	A 335 GR.P11	30.23	538	158.20	600S	6	1	12	9498	53.6
				A 691 GR.1.25Cr CL.42	30.23	538	158.20	600S	8	1-1/8	12	13535	84.8
					30.23	538	158.20	600S	10	1-1/4	16	16016	110.2
					30.23	538	158.20	600S	12	1-1/4	20	15594	107.3
					30.23	538	158.20	600S	14	1-3/8	20	18342	137.6
					30.23	538	158.20	600S	16	1-1/2	20	21674	176.0
					30.23	538	158.20	600S	18	1-5/8	20	28966	253.2
					30.23	538	158.20	600S	20	1-5/8	24	28203	246.5
					30.23	538	158.20	600S	24	1-7/8	24	36572	364.6
					24.19	538	126.56	600B	26	1-5/8	28	26679	233.2
					24.19	538	126.56	600B	28	1-3/4	28	30529	285.9
					24.19	538	126.56	600B	30	1-7/8	28	35527	354.2
					24.19	538	126.56	600B	32	2	28	40911	433.4
					24.19	538	126.56	600B	34	2-1/4	24	55895	661.6
					24.19	538	126.56	600B	36	2-1/4	28	49684	588.1
LIST D-4													
D5E	PMS rated Temperature / Pressure		538 / 37.61	Up to 24"	37.61	538	158.20	600S	1/2	1/2	4	1255	3.8
	A182 Gr. F22 Cl. 3	A193 Gr. B16	Spiral wound SS	A335 Gr. P22	37.61	538	158.20	600S	3/4	5/8	4	1556	5.7
				A 691 GR2.25CR CL.42	37.61	538	158.20	600S	1	5/8	4	2471	9.1
					37.61	538	158.20	600S	1-1/2	3/4	4	4657	20.1
					37.61	538	158.20	600S	2	5/8	8	3478	12.8
					37.61	538	158.20	600S	3	3/4	8	5479	23.7
					37.61	538	158.20	600S	4	7/8	8	7798	38.8
					37.61	538	158.20	600S	6	1	12	9748	55.0
					37.61	538	158.20	600S	8	1-1/8	12	13535	84.8

Copyrights EIL – All rights reserved

Page 4506 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					37.61	538	158.20	600S	10	1-1/4	16	16437	113.1
					37.61	538	158.20	600S	12	1-1/4	20	16437	113.1
					37.61	538	158.20	600S	14	1-3/8	20	19914	149.3
					37.61	538	158.20	600S	16	1-1/2	20	22949	186.3
					37.61	538	158.20	600S	18	1-5/8	20	29728	259.8
					37.61	538	158.20	600S	20	1-5/8	24	28966	253.2
					37.61	538	158.20	600S	24	1-7/8	24	38662	385.4
					30.09	538	126.60	600B	26	1-5/8	28	28203	246.5
					30.09	538	126.60	600B	28	1-3/4	28	32325	302.7
					30.09	538	126.60	600B	30	1-7/8	28	37617	375.0
					30.09	538	126.60	600B	32	2	28	43318	458.9
					30.09	538	126.60	600B	34	2-1/4	24	59000	698.3
					30.09	538	126.60	600B	36	2-1/4	28	52789	624.8
LIST D-5													
D1K	PMS rated Temperature / Pressure		454 / 55.54	Up to 24"	55.54	454	114.00	600S	1/2	1/2	4	627	1.9
	A 182 GR.F304	A193 GR.B7	Spiral wound SS	A 312 TP304	55.54	454	114.00	600S	3/4	5/8	4	915	3.4
				A 358 TP304 CL.1	55.54	454	114.00	600S	1	5/8	4	1281	4.7
D2K	PMS rated Temperature / Pressure		120 / 80.12	Up to 24"	55.54	454	114.00	600S	1-1/2	3/4	4	2466	10.6
	A 182 GR.F304	A320 GR.B8CL.2	Spiral wound SS	A 312 TP304	55.54	454	114.00	600S	2	5/8	8	1647	6.0
				A 358 TP304 CL.1	55.54	454	114.00	600S	3	3/4	8	3150	13.6
					55.54	454	114.00	600S	4	7/8	8	5135	25.5
					55.54	454	114.00	600S	6	1	12	6249	35.2
					55.54	454	114.00	600S	8	1-1/8	12	8913	55.8
					55.54	454	114.00	600S	10	1-1/4	16	9272	63.8
					55.54	454	114.00	600S	12	1-1/4	20	10115	69.6
					55.54	454	114.00	600S	14	1-3/8	20	12053	90.4
					55.54	454	114.00	600S	16	1-1/2	20	15299	124.2
					55.54	454	114.00	600S	18	1-5/8	20	19056	166.6
					55.54	454	114.00	600S	20	1-5/8	24	19056	166.6
					55.54	454	114.00	600S	24	1-7/8	24	25078	250.0
					44.44	454	91.20	600B	26	1-5/8	28	18294	159.9
					44.44	454	91.20	600B	28	1-3/4	28	20652	193.4
					44.44	454	91.20	600B	30	1-7/8	28	24033	239.6

Copyrights EIL – All rights reserved

Page 4507 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
LIST E-1													
E1A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	1/2	3/4	4	2877	11.9
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	3/4	3/4	4	3698	15.3
				A 672 GR.B60 CL. 12	86.83	427	234.12	900S	1	7/8	4	4565	21.7
E2A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	1-1/2	1	4	6999	37.7
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	2	7/8	8	5135	24.4
				A 672 GR.B60 CL. 12	86.83	427	234.12	900S	3	7/8	8	6847	32.6
E5A	PMS rated Temperature / Pressure		230 / 130.63	Up to 24"	86.83	427	234.12	900S	4	1-1/8	8	8583	51.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	6	1-1/8	12	10234	61.3
				A 672 GR.B60 CL. 32	86.83	427	234.12	900S	8	1-3/8	12	15197	109.0
E9A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	10	1-3/8	16	16245	116.5
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	12	1-3/8	20	17294	124.1
				A 672 GR.B60 CL. 22	86.83	427	234.12	900S	14	1-1/2	20	21674	168.3
E19A	PMS rated Temperature / Pressure		427 / 86.83	Up to 24"	86.83	427	234.12	900S	16	1-5/8	20	26679	223.0
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	86.83	427	234.12	900S	18	1-7/8	20	35527	338.8
				A 672 GR.B60 CL. 22	86.83	427	234.12	900S	20	2	20	40911	414.6
					86.83	427	234.12	900S	24	2-1/2	20	62301	779.5
					69.47	427	187.30	900B	26	2-1/2	20	60354	755.2
					69.47	427	187.30	900B	28	2-3/4	20	66799	915.6
					69.47	427	187.30	900B	30	3	20	77472	1152.8
LIST E-2													
E5E	PMS rated Temperature / Pressure		538 / 56.24	Up to 24"	56.24	538	237.28	900S	1/2	3/4	4	3150	13.0
	A182 Gr. F22 Cl. 3	A193 Gr. B16	RTJ - 5Cr-0.5Mo	A335 Gr. P22	56.24	538	237.28	900S	3/4	3/4	4	3835	15.8
				A 691 GR2.25CR CL.42	56.24	538	237.28	900S	1	7/8	4	5326	25.3
					56.24	538	237.28	900S	1-1/2	1	4	7749	41.8
					56.24	538	237.28	900S	2	7/8	8	5896	28.0
					56.24	538	237.28	900S	3	7/8	8	6467	30.7
					56.24	538	237.28	900S	4	1-1/8	8	9904	59.3
					56.24	538	237.28	900S	6	1-1/8	12	10894	65.3
					56.24	538	237.28	900S	8	1-3/8	12	16245	116.5
					56.24	538	237.28	900S	10	1-3/8	16	16770	120.3
					56.24	538	237.28	900S	12	1-3/8	20	17818	127.8
					56.24	538	237.28	900S	14	1-1/2	20	22949	178.2

Copyrights EIL – All rights reserved

Page 4508 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					56.24	538	237.28	900S	16	1-5/8	20	28203	235.8
					56.24	538	237.28	900S	18	1-7/8	20	36572	348.7
					56.24	538	237.28	900S	20	2	20	44521	451.1
					56.24	538	237.28	900S	24	2-1/2	20	68142	852.6
					56.24	538	189.83	900B	26	2-1/2	20	64248	803.9
					56.24	538	189.83	900B	28	2-3/4	20	73956	1013.8
					56.24	538	189.83	900B	30	3	20	83211	1238.2
LIST F-1													
F1A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	1/2	3/4	4	3014	12.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	3/4	3/4	4	3972	16.4
				A 672 GR.B60 CL.12	144.83	427	390.74	1500S	1	7/8	4	4945	23.5
F2A	PMS rated Temperature / Pressure		427 / 144.46	Up to 24"	144.83	427	390.74	1500S	1-1/2	1	4	7499	40.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	2	7/8	8	6467	30.7
				A 672 GR.B60 CL.22	144.83	427	390.74	1500S	3	1-1/8	8	12215	73.2
F5A	PMS rated Temperature / Pressure		230 / 217.79	Up to 24"	144.83	427	390.74	1500S	4	1-1/4	8	16016	105.4
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	6	1-3/8	12	19914	142.8
				A672 Gr. B60 Cl. 22	144.83	427	390.74	1500S	8	1-5/8	12	29728	248.5
F9A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	10	1-7/8	12	41797	398.5
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	12	2	16	43318	439.0
				A 672 GR.B60 CL.12	144.83	427	390.74	1500S	14	2-1/4	16	55895	632.8
F19A	PMS rated Temperature / Pressure		427 / 144.83	Up to 24"	144.83	427	390.74	1500S	16	2-1/2	16	70089	877.0
	A105	A193 GR.B7	RTJ - Soft Iron	A 106 GR.B	144.83	427	390.74	1500S	18	2-3/4	16	85884	1177.3
				A672 Gr. B60 Cl. 22	144.83	427	390.74	1500S	20	3	16	103296	1537.0
					144.83	427	390.74	1500S	24	3-1/2	16	142889	2467.4
LIST F-2													
F2D	PMS rated Temperature / Pressure		538 / 75.93	Up to 24"	75.93	538	395.48	1500S	1/2	3/4	4	3972	16.4
	A 182 GR.F11 CL.2	A193 GR.B16	RTJ - 5Cr-0.5Mo	A 335 GR.P11	75.93	538	395.48	1500S	3/4	3/4	4	4931	20.4
				A 691 GR.1.25Cr CL.42	75.93	538	395.48	1500S	1	7/8	4	6277	29.8
					75.93	538	395.48	1500S	1-1/2	1	4	9248	49.9
					75.93	538	395.48	1500S	2	7/8	8	7037	33.5
					75.93	538	395.48	1500S	3	1-1/8	8	13205	79.1
					75.93	538	395.48	1500S	4	1-1/4	8	16858	110.9
					75.93	538	395.48	1500S	6	1-3/8	12	20962	150.4

Copyrights EIL – All rights reserved

Page 4509 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure kg/cm²(g)	Des Temp. °C	Test Pressure kg/cm²(g)	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					75.93	538	395.48	1500S	8	1-5/8	12	30490	254.9
					75.93	538	395.48	1500S	10	1-7/8	12	41797	398.5
					75.93	538	395.48	1500S	12	2	16	46927	475.5
					75.93	538	395.48	1500S	14	2-1/4	16	55895	632.8
					75.93	538	395.48	1500S	16	2-1/2	16	72036	901.3
					75.93	538	395.48	1500S	18	2-3/4	16	88270	1210.0
					75.93	538	395.48	1500S	20	3	16	106165	1579.7
					75.93	538	395.48	1500S	24	3-1/2	16	146858	2535.9
LIST F-3													
F2G	PMS rated Temperature / Pressure		538 / 127.95	Up to 24"	127.95	538	395.48	1500S	1/2	3/4	4	3972	16.4
	A182 Gr. F91	A193 GR.B16	RTJ - 9Cr-1Mo	A 335 GR.P91	127.95	538	395.48	1500S	3/4	3/4	4	4931	20.4
				A 691 GR.P91 CL.42	127.95	538	395.48	1500S	1	7/8	4	6277	29.8
					127.95	538	395.48	1500S	1-1/2	1	4	9248	49.9
					127.95	538	395.48	1500S	2	7/8	8	7037	33.5
					127.95	538	395.48	1500S	3	1-1/8	8	13205	79.1
					127.95	538	395.48	1500S	4	1-1/4	8	16858	110.9
					127.95	538	395.48	1500S	6	1-3/8	12	20962	150.4
					127.95	538	395.48	1500S	8	1-5/8	12	30490	254.9
					127.95	538	395.48	1500S	10	1-7/8	12	41797	398.5
					127.95	538	395.48	1500S	12	2	16	46927	475.5
					127.95	538	395.48	1500S	14	2-1/4	16	55895	632.8
					127.95	538	395.48	1500S	16	2-1/2	16	72036	901.3
					127.95	538	395.48	1500S	18	2-3/4	16	88270	1210.0
					127.95	538	395.48	1500S	20	3	16	106165	1579.7
					127.95	538	395.48	1500S	24	3-1/2	16	146858	2535.9
LIST G-1													
G2G	PMS rated Temperature / Pressure		538 / 213.02	Up to 12"	213.02	538	510.00	2500S	1/2	3/4	4	5068	20.9
	A182 Gr. F91	A193 GR.B16	RTJ - 5Cr-0.5Mo	A 335 GR.P91	213.02	538	510.00	2500S	3/4	3/4	4	5479	22.6
				A 691 GR.P91 CL.42	213.02	538	510.00	2500S	1	7/8	4	7228	34.4
					213.02	538	510.00	2500S	1-1/2	1-1/8	4	13535	81.1
					213.02	538	510.00	2500S	2	1	8	9748	52.6
					213.02	538	510.00	2500S	3	1-1/4	8	15594	102.6
					213.02	538	510.00	2500S	4	1-1/2	8	24224	188.1

Copyrights EIL – All rights reserved

Page 4510 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

PMS class data					Calculation Data								
Piping Class	Temperature, pressure, materials and size range				Des Pressure $kg/cm^2(g)$	Des Temp. °C	Test Pressure $kg/cm^2(g)$	Flange Std	Flange size inch	Bolt Dia inch	No. of Bolts	Tension kg	Torque kg-m
	Flange	Bolt	Gasket	Pipe									
					213.02	538	510.00	2500S	6	2	8	46927	475.5
					213.02	538	510.00	2500S	8	2	12	46927	475.5
					213.02	538	510.00	2500S	10	2-1/2	12	70089	877.0
					213.02	538	510.00	2500S	12	2-3/4	12	95426	1308.1

Copyrights EIL – All rights reserved

Page 4511 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

Page 4512 of 5436 : C050-TENDER DOC-C050-1U68-81-45-PB-T-8010 : Rev. A

HISTORY SHEET FOR FLANGE JOINTS

Annexure - I

Project : _____
Unit : _____
System/Sub System Description : _____
Line No. : _____

Test loop No. : _____
ISO Drawing No.: _____
Connected P & ID No.: _____

Flange Joint No.	Flange Parallelity OK/Not OK		Flange Dia & Rating	Gasket		Studs *				Nuts		Torque Value	Bolt Tension Value	Flange joint Acceptance	
	Upstream	Down Stream		Spec.	OK/ Not OK	Size	Spec	Total Nos.	Accepted/ Nos Accepted	Spec.	Nos Accepted			Contractor	Owner/ EIL

* Special Care to be taken for tapped hole and it is to be certified by Contractor that full engagement of stud is there to the tapped hole. Contractor to carry out 100% verification

Acceptance by Licensor/Owner.

1. Pre-commissioning .....
   (Signature with Name and Date)
2. Commissioning .....
   (Signature with Name and Date)

Copyrights EIL – All rights reserved

Annexure - II

SEQUENCE OF ACTIVITIES INVOLVED FOR REOPENING / MAKING / BLINDING / DEBLINDING / WEDGE OPENING OF FLANGE JOINTS

Sl. No.	Activity	Checked by Contractor (Signature)
1	Compliance of all check points.	
2	Availability and use of recommended tools i.e. Standard tools / Non-sparking tools/Pneumatic of Hydraulic torque wrench with suitable sockets and other accessories / Hydraulic bolt tensioner etc depending upon service pressure temperature rating of the line on which job is to be carried out.	
3	Skilled manpower with protective clothing, safety shoes etc.	
4	Proper access to flange joints for all bolts, proper scaffolding etc if required.	
5	Proper escape route	
6	Readiness of proper type, size & rating of blinds/gaskets/wedges & fasteners etc	
7	Loosening of the flange joints, starting from 6 '0' clock position (vertical joints)	
8	Check for leakage of any hot water / gas / steam / hydrocarbon etc and wait for depressurization of line, if any product leakage is observed.	
9	Complete opening of flange joint with recommended tools	
10	Removal of gasket / blind / wedge etc. and checking of old gaskets for improper loading from marking on gasket surface.	
11	Checking of old fasteners for proper metallurgy, sizing, length etc and ensure replacement of fasteners based on observations during final box up and also ensure that all fasteners to be of same size for uniform loading.	
12	Making gap in flange joints with proper tools (flange spreader etc.) For proper observations of gasket sitting area. Ensure proper cleaning of gasket seating surface with suitable non-sparking tools and inspection of gasket face.	
13	Ensure use of recommended gaskets of proper type and size for blinding / final box up	
14	Placing of fasteners in bottom half of flange joint (vertical joints).	
15	In case of blinding ensure that tail of the blind is vertically upward and blind is of proper size and not interfering with studs movement.	
16	Ensure proper placement of gasket on raised face/ring groove/serrated area.	
17	Ensuring slight tightening of studs in random in bottom half vertical joint(s) for holding of gasket in proper position	
18	Fixing all fasteners in position and tightening of nuts by hand to ensure uniform stud length on both sides.	
19	Tightening of all studs as per tightening sequence by recommended tools.	

ACCEPTANCE BY

OWNER / EIL

Signature Not Verified

Digitally signed by MD MAZHER ALI
Date: 2026.04.09 18:05:19 IST
Location: eProcure-EPROC

Copyrights EIL – All rights reserved