150 YEARS OF CELEBRATING THE MAHATMA

सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

GOVERNMENT OF INDIA

CENTRAL PUBLIC WORKS DEPARTMENT

SPECIFICATIONS

(VOL. 1)

2019

CPWD

Director General, CPWD, New Delhi

GOVERNMENT OF INDIA

CENTRAL PUBLIC WORKS DEPARTMENT

SPECIFICATIONS

(VOL. 1)

2019

Published under the Authority of Director General, CPWD, New Delhi

© All rights reserved. No part of this publication may be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording on any information storage and retrieval system, without permission, in writing, from the Director General, CPWD, New Delhi. Photocopying of this book is strictly prohibited.

For feed back and suggestions, please contact SE(TAS), CPWD, Room No. 418, "A" Wing, Nirman Bhawan, New Delhi. Tel. No. 011-23062339, Email: delsetascsq.cpwd@nic.in

A GOVERNMENT OF INDIA PUBLICATION

Published by
DIRECTOR GENERAL
CPWD, Nirman Bhawan, New Delhi - 110011

Printed & Distributed by
JAIN BOOK AGENCY (CENTRAL)
4574/15, 2nd Floor, Padamchand Marg,
Near Happy School, Daryaganj, New Delhi-110002
Phone : 011- 43513689, 43513570
Mob: 9667274446, 9810666810
E-mail : thakur@jainbookagency.com

&

Marketed by

JAIN BOOK AGENCY
Authorised Dealers of Govt. Publications
C-9, Connaught Place, New Delhi-110001
Phones : 011- 44556677, 23416390 upto 94
E-mail : cp@jainbookagency.com
Website : www.jainbookagency.com

JAIN BOOK DEPOT
C - 4, Opp. PVR Plaza, Post Box. No. 51,
Connaught Place, New Delhi-110001 (India)
Phone : 011- 23416101 / 02 / 03
E-mail : sales@jainbookdepot.com

JAIN BOOK AGENCY (SOUTHEND)
1, Aurobindo Place Market,
Hauz Khas, New Delhi-110016
Phone : 011- 41755666
E-mail : sales@jainbookagency.com
Website : www.jainbookagency.com

JAIN BOOK AGENCY (GURGAON)
19, Central Plaza Mall, Sector 53,
Golf Course Road,
Gurgaon 122002 Haryana
Phone : 0124- 4042665
Mobile : 9810666810

JAIN BOOK AGENCY (INTERNATIONAL)
RA- 11, Sector- 126,
Opp. Gate No. 2A of Amity University,
Noida
Mobile. : 9210080580

JAIN BOOK AGENCY (GREATER NOIDA)
11 Jagat farm Complex
Gama Sector Market
Near OBC Bank
Greater Noida
Phone : 0120-4206655

Also available at
All Leading Booksellers & Authorised Govt. Dealers In India

Price : Rs. 2500/- (for both volumes) excluding postage and forwarding charges etc.

PRABHAKAR SINGH
Director General

सत्यमेव जयते
भारत सरकार
Government of India

केन्द्रीय लोक निर्माण विभाग
निर्माण भवन, नई दिल्ली 110011
Central Public Works Department
Nirman Bhawan, New Delhi- 110011
Tel : 23062556 / 1317, Fax : 23061884
E-Mail : cpwd_dgw@nic.in

FOREWORD

The CPWD Specifications being published by CPWD from time to time are very comprehensive and useful in execution of works and are used as guide by a number of Engineering Departments, Public Sector Undertakings, Architects and Builders. These specifications not only give the standards for building materials but also serve as guidelines for execution of works, measurements and rates.

The CPWD Specifications were first compiled in 1950. Subsequently, these specifications have been revised in the years 1962, 1967, 1977, 1996 and 2009

Many new items and construction technologies, which are used in various CPWD works and projects have been incorporated in Delhi Schedule of Rates of CPWD. Some items have become obsolete over a period of time and are not in use. Further, there were no specifications for Rain Water Harvesting & Tubewells, Conservation of Heritage Buildings, Structural Glazing Aluminium Composite Panel and New Technologies & Materials. CPWD Specifications have been accordingly modified/ revised and updated to incorporate the above changes.

The revised/updated specifications are being published in two volumes.

I wish to place on record the effective coordination on the part of **Dr. K. M. Soni, ADG (Tech.) and the technical inputs and the efforts by Sh. M. K. Mallick, CE (CSQ), Sh. Divakar Agrawal, SE(TAS), Sh. Satya Narain Jaiswal, EE(TAS-I), Sh. Moti Lal Prasad (TAS-II), Sh. D.S. Adhikari, AE(QA), Sh. Naveenkumar P, JE and Sh. Chalapaka Ramaraju, JE and all others officers of CSQ in finalizing these specifications.**

I am sure that these Specifications will be useful to all concerned in the building industry in general and CPWD in particular.

(Prabhakar Singh)

Place: New Delhi
Dated: July 2019

DR K.M. SONI
Additional Director General (Tech)

भारत सरकार
Government of India

केन्द्रीय लोक निर्माण विभाग
निर्माण भवन, नई दिल्ली 110011
Central Public Works Department
Nirman Bhawan, New Delhi- 110011

PREFACE

1.0 CPWD Specifications, 2019 are the revised edition of existing CPWD Specifications.

2.0 CPWD Specifications, 2019 is published in two volumes as under:

Volume Number	***Sub-head No.***	***Contents/ Chapters***
1	0.0	General
	1.0	Carriage of Materials
	2.0	Earth Work
	3.0	Mortars
	4.0	Concrete Work
	5.0	Reinforced Cement Concrete Work
	6.0	Masonary work
	7.0	Stone Work
	8.0	Cladding work
	9.0	Wood Work and PVC Work
	10.0	Steel Work
	11.0	Flooring
	12.0	Roofing
2	13.0	Finishing
	14.0	Repairs to Buildings
	15.0	Dismantling and Demolishing
	16.0	Road Work
	17.0	Sanitary Installation
	18.0	Water Supply
	19.0	Drainage
	20.0	Pile Work
	21.0	Aluminium Work
	22.0	Water Proofing

	23.0	Rain Water Harvesting & Tubewells
	24.0	Conservation of Heritage Buildings
	25.0	Structural Glazing Aluminum Composite Panel
	26.0	New Technologies and Materials

3.0 CPWD Specifications, 2019 will replace existing CPWD Specifications, 2009 along with correction slips. The specifications of many items have been updated and improved by making them more comprehensive. Specifications of items, which have become obsolete over a period of time or are not in use, have been deleted. Many new items using new materials and latest technology have also been added.

4.0 Specifications of dry work for speedier construction using prefabricated materials and pre-finished elements are included viz gypsum block walls, calcium silicate and non-asbestos cement board partitions, pre-finished counter tops for kitchen and washbasins, pre-moulded and pre-finished stone work in risers and treads of steps and window sills, dry stone cladding, sub-frames for windows, use of chemical and mechanical fasteners, laying of tiles in flooring and dado with polymer based adhesives etc.

5.0 Specifications of Rain Water Harvesting & Tubewells, Conservation of Heritage Building, Structural Glazing Aluminium Composite Panel and New Technologies & Materials are incorporated for the first time.

6.0 Sub-head wise salient features are as follows:

6.1 Earth Work : Specifications for filling with available fly ash and Earth (excluding rock) have been incorporated. The clause no 2.22 has been deleted.

6.2 Concrete : Specifications of aggregate from other than natural resources shall comply with requirement of IS 383:2016 have been introduced.

6.3 Reinforced Cement Concrete : Specifications of steel reinforcement for R.C.C. work ready to use "Cut and bend rebars, Reinforcement couplers, Precast door & window frames, Expansion joint covering with cement bonded particle board, Expansion joint covering with stainless steel grade 304, RCC for construction of piers, abutment, portal frame, pier caps, bearing pedestals & seismic arresters, RCC diaphragm wall and Expansion joint system for floor, wall & roof joint have been incorporated. Guidelines for multistage centering also introduced in this sub head.

6.4 Masonry Work : Specifications of AAC block masonry have been incorporated. The name of sub head Brick work has been renamed as Masonry work.

6.5 Stone Work : Specifications of stone work in or under water and /or in liquid mud & under foul position have been incorporated. The specification Clause No. 7.7 Shifted to Sub Head 8 (Cladding work) Under Clause No. 8.8, Clause No. 7.11,7.12 & 7.13 are shifted to Sub Head 8 (Cladding work) under clause No. 8.12, 8.13 & 8.14. Figures 7.14, 7.15 & 7.16 shifted to Sub head 8 (cladding work) under Fig. 8.5, 8.6 & 8.7.

6.6 Cladding Work : Specifications of wall lining butch work with Dholpur stone, Kota stone veneering work, Extra for stone work for wall lining, veneered decorative plywood, Air veneer board for general purposes, prelaminated particle board, laminated sandwiched composite panel cladding system and associated works have been incorporated. The name of Sub Head has been renamed as Cladding work from Marble work.

6.7 Wood Work and PVC Work : Specifications for cupboard shutter, lipping in pelmet, teak wood lipping, uPVC casement/sliding window & door and Fire resistant glazed doors, windows & partition have been incorporated. Fig. 9.29 to 9.39 have been added. The specification Clause No. 9.9 shifted to Sub Head 8 (cladding work) under clause No. 8.15. Specification of Nickel plated M.S. Pipe curtain roads, M.S. grills in frames of window, Bamboo Jaffery/ fencing, wooden moulded corner beading, magnetic catchers, powder coated telescopic drawer channel, slidling arrangement in racks/ cupboards/ cabinets shutter, hardware fittings for uPVC door/ windows, pre-laminated medium density fibre board and stainless handles have been incorporated.

6.8 Steel work : Specifications of dash fasteners, stainless steel railing, Fly proof wire gauze, Glass panes with putty and Glazing clips, Angle iron frames for doors, windows and ventilators have been incorporated.

6.9 Flooring : Specifications of pendulum test for skid resistance, Turf paver, Border tiles, Epoxy based grouting for tiles, Italian marble stone flooring and flamed finish granite stone flooring have been incorporated.

6.10 Finishing : Specifications of White cement based polymer modified mortar, 1st quality distemper for new & old works, Deluxe multi surface paint for interior and exterior, Epoxy Paint, Fire Retardant Paint, G.I. metal tiles ceiling, Heat resistant terrace floor, thermal insulations over existing wall with fiber glass wool, calcium silicate tiles false ceiling, calcium silicate board false ceiling, thermal insulation of ceiling, thermal insulation over existing false ceiling, thermal insulation over existing wall and Melamine Polish have been incorporated.

6.11 Repairs to building: Specifications of fixing old wind ties, Brick work in mud mortar, Brass curtain roads, fixing MS round or square bars in wooden frame of window, Wooden karries for roofing, Double Scaffolding system upto seven storey height made with MS tube, Repairs to plaster in patches, Cleaning of water storage tanks, Disconnecting damaged over head/terrace, Replacement of old damaged WC seats, Cutting holes of required size in brick masonry wall, Dismantling of WC pan of all sizes, Hacking of C.C. flooring, Dismantling of 15 mm to 40 mm dia G.I. pipe, Taking out existing wooden door shutter and refixing the same after repairs, Security guard without gun and Security guard with gun have been incorporated. The specification clause no. 14.19, 14.20, 14.21, 14.22, 14.24, 14.25, 14.26, 14.28, 14.29, 14.30 & 14.32 are shifted to Sub Head:- 13 (Finishing) under clause no. 13.14, 13.18, 13.19, 13.21, 13.44, 13.45, 13.46, 13.47, 13.48, 13.35, 13.40 respectively.

6.12 Road Work: Specifications of Granular sub base, Wet Mix Macadam (WMM) sub-base/base, Reflective Pavement Markers (RPM) or road studs and Prime coat over granular base have been incorporated. Specification of tack coat with bitumen emulsion has been modified.

6.13 Sanitary Installations: Specifications of Hubbles centrifugally cast (spun) iron pipes and fittings, Installation of sink, cutting chase in masonry wall, painting synthetic enamel paint on SCI/ centrifugally cast (spun) iron soil, waste and vent Pipe, Repainting SCI/ Centrifugally cast (spun) iron soil, Waste and vent Pipe, Installation of wall mounted water closet (WC) and Installation of floor mounted single piece water closet (WC) have been incorporated.

6.14 Water Supply : Specifications of CP brass bib cock, CP brass long nose bib cock, CP brass long body bib cock, CP brass stop cock, CP brass angle value, CP brass extension nipple, PTMT bib cock, PTMT stop cock, PTMT pillar cock, PTMT push cock, PTMT grating, PTMT ball cock, PTMT angle stop cock, PVC connection pipe, PTMT extension nipple for water tank pipe, Disinfection C.I. water mains by flushing with water and chrome plated brass battery based infrared sensor operated pillar cock have been introduced.

6.15 Drainage: Specifications of dismantling of old S.W. pipes, 6 mm thick plastic encapsulated MS foot rest, Replacement of MS foot rest in manholes, Raising of manhole cover and frame slab, Inspection chamber, Non pressure NP-3 class (medium duty)/NP-4 class (Heavy duty) RCC pipes have been incorporated. Fig 19.19 to Fig. 19.22 have been incorporated.

6.16 Aluminium Work: Specifications of Machine moulded aluminium covering over expansion, Anodized aluminium grill, 12mm thick frameless toughened glass door shutter and Non sag elastomeric polyurethane sealant have been incorporated.

6.17 Water Proofing: Specifications of Water proofing treatment with Integral crystalline admixture, Fibre reinforced elastomeric liquid water proofing membrane having Sun Reflectivity Index (SRI) of 105, Water proofing treatment with integral crystalline water proofing coating/slurry, Flexible cementatious negative side water proofing coating with elastic water proofing polymers, Water proofing treatment with integral crystalline water proofing dry-shake, Crystalline water proofing mortar and Swellable type water stop tape have been incorporated. The specification clause no. 22.12, 22.13 & 22.14 shifted to sub head 14 (Repairs to Buildings) under clause no. 14.49, 14.50 & 14.51 respectively. Fig. 22.11 & 22.12 shifted to sub head 14 (repairs to buildings) under Fig. 14.10 & 14.11 respectively.

6.18 Rain Water Harvesting & Tubewells: New sub head has been introduced and all Specifications kept in this sub head are new specifications.

6.19 Conservation of heritage building: New sub head has been introduced and all specifications kept in this sub head are new specifications.

6.20 Structural glazing aluminium composite panel: New sub head has been introduced and all specifications kept in this sub head are new specifications.

6.21 New Technologies and materials: New sub head has been introduced and all specifications kept in this sub head are new specifications.

7.0. A lot of effort has gone into the preparation of CPWD Specifications, 2019. I convey my deep appreciation and sincere thanks to Sh. M. K. Mallick, CE(CSQ), Sh. Divakar Agrawal, SE(TAS), Sh. Satya Narain Jaiswal, EE(TAS-I), Sh. Moti Lal Prasad, EE(TAS-II), Sh. P. Goyal, EE(TAD), Sh. A. K. Sikka, EE(Con.), Sh. M.C. Singhal, EE(QA), Sh. Shivani Kaushal, EE (M), Sh. D.S. Adhikari, AE(QA), Sh. Patta Madhukumar AE (TAS), Sh. Sanjay Singh, AE(TAS), Sh. Jitender Kumar Tiwari, AE(TAS), Sh. Mohammad Tarik AE(QA), Sh. S. K. Sharma, AE(QA), Sh. N. N. Sharma, AE(QA), Sh. K.R. Meena, AE(Con.), Sh. R. K. Sharma, AE(Con.), Sh. S. K. Roy AE(M), Sh. P.K. Upreti, AE(M), Sh. P.K. Verma, AE(TAS), Sh. Gurmeet Singh, AE(TAD), Sh. Ved Khurana, AE(TLC), Sh. Jai Bhagwan, AE(TAS), Sh. Chalapaka Ramaraju, JE(TAD), Sh. Naveen kumar P., JE(TAS), Sh. Mukesh Verma, Chief Estimator (TAS) and other officers and staff of TAS Unit for sincere efforts made in the preparation of this document in such a short time.

8.0 My sincere thanks to the specifications committee and Sh. Vimal Kumar, CE (NDZ-II), Sh. O.P. Tripathi, CPM IITDPZ & Sh. Sanjay Singh, AE, Sh. Rajeev Singhal, CPM, NDPZ & Sh. Sajal Mitra, EE, Sh. Umesh Bansal, SE, PEC, Sh. V.P. Srivastava, EE, PED, Sh. Manoj Kumar Thakur, AE, PED & Sh. A. K. Grover EE(P), (NDZ)-I, Sh. Anant Kumar, CE (NZ)-V, Sh. Ujjwal Mitra, CE, (NDZ)-III, Sh. Ujjwal Kumar, CE (NDZ)-VI, Sh. Harnam Singh, CPM, (RPZ), Sh. Pradeep Gupta, CE, (ICBRPZ), Sh. Ramesh Chandra, CE, (NDZ)-IV, Sh. Vikas Rana, CE (NDZ)-VII & Sh. Manoj Kumar SE & Sh. Virender Singh, EE, Sh. B. B. Makkar, CPM, SCPZ & Sh. Varun Gupta, AEE & Sh. Savinay Srivastav, AE, Sh. Mohd. Kamal Ahmad, CE, CZ, Bhopal, Sh. L. Dung Dung, CE, (WZ-I), Mumbai, Sh. Manoj Kumar Talreja, CE, ZEZ-II & Surender Kumar Rampal, CE & Sh. Amrender Kumar Jalan EE & Sh. Subhadip Ghosh, AE, Sh. D.Roy Chowdhury, CPM, Sh. K.C.Singh, CE, NZ-I, Sh. N.N.S.Rao, CE, SZ-II & Sh. Mathura Prasad, CE, PWD their teams for great help extended in preparation of this document and graphic cover desigining by Sh. Sachin Sharma, Dy. Architect, Ms. Azra Mahwash, Architect & Ms. Roopanshi Goel, Int. Architect.

9.0 Due care has been taken to print CPWD Specifications, 2019 as correctly as possible. It is, however, possible that some errors might have crept in inadvertently. In case any error or omission is noticed, it may be brought to the notice of the **Superintending Engineer (TAS), CPWD, Room No. 418, A- Wing, Nirman Bhawan, New Delhi**.

Suggestions for improvement are welcome.

(**Dr.K.M.Soni)**
ADG (Tech), CPWD,
Nirman Bhawan, New Delhi

CONTENTS

Vol. 1

SH. No.	*Name of Sub-Head*	*Page No.*
0.0	GENERAL	01 – 08
1.0	CARRIAGE OF MATERIALS	09 – 24
2.0	EARTH WORK	25 – 58
3.0	MORTARS	59 – 80
4.0	CONCRETE WORK	81 – 112
5.0	REINFORCED CEMENT CONCRETE WORK	113 – 226
6.0	MASONRY WORK	227 – 268
7.0	STONE WORK	269 – 300
8.0	CLADDING WORK	301 – 342
9.0	WOOD WORK AND PVC WORK	343 – 468
10.0	STEEL WORK	469 – 524
11.0	FLOORING	525 – 566
12.0	ROOFING	567 – 624

For remaining Sub Heads see Vol.2

SUB HEAD : 0.0

GENERAL

CONTENTS

Clause No.	*Brief Description*	*Page No.*
0.1		
0.2		
0.3	Interpretations	5
0.4	Definitions	5
0.5	Floor and Levels	5
0.6	Foundations and Plinth	6
0.7	Measurements	6
0.8	Materials	6
0.9	Safety in Construction	7
0.10	Abbreviations	7

0.0 GENERAL

0.1 Reference mentioned herein shall be applicable to all sections to the extent the context permits and are intended to supplement the provisions in the particular section. In case of any discrepancy/ deviation, the provisions in the particular section shall take precedence.

0.2 The rates for all items of work unless clearly specified otherwise shall include cost of all labour, materials and other inputs involved in the execution of the items.

0.3 INTERPRETATIONS

0.3.1 The Director General (Works), CPWD shall be the sole deciding authority as to the meaning, interpretation and implications for various provisions of the specifications. His decision in writing shall be final.

0.3.2 Wherever any reference is made to any Indian Standard, it shall be taken as reference to the latest edition with all amendments issued thereto. In the event of any variation between the CPWD specifications and the Indian Standard, the former shall take precedence over the latter.

0.4 DEFINITIONS

The following terms and expressions in the specifications shall have the meaning or implication hereby assigned to them unless otherwise specified elsewhere.

0.4.1 *Contractor:* The Contractor shall mean the individual or firm or company whether incorporated or not undertaking the works and shall include the legal personal representatives of such individual or the persons composing such firm or company, or the successors of such individual or firm or company and the permitted assignees of such individual or firm of company.

0.4.2 *Engineer- in-Charge:* The 'Engineer-in- Charge' means the Engineer officer who shall supervise and be in-charge of the work and who shall sign the contract on behalf of the President.

0.4.3 *Site:* The 'site' shall mean the land/ or other places on, in, into or through which the work is to be executed under the contract or any adjacent land, path or street through which the work is to be executed under the contract, or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.

0.4.4 *Store:* The 'store' shall mean the place of issue of materials included in the appropriate schedule of a contract for issue by the CPWD. In all other cases 'Store' shall mean any CPWD store in the district.

0.4.5 *IS:* The standards, specification and code of practices issued by the Bureau of Indian Standards.

0.4.6 *Best*: The word 'best' when used shall mean that in the opinion of the Engineer-in-Charge, there is no superior material/ article and workmanship obtainable in the market and trade respectively. As far as possible the standard required shall be specified in preference to the word 'best'.

0.4.7 *Department:* 'Department' shall mean Central Public Works Department (CPWD).

0.5 FLOOR AND LEVELS

0.5.1 Building

0.5.1.1 Floor 1 is the lowest floor above the ground level in the building unless otherwise specified in a particular case. The floors above floor 1 shall be numbered in sequence as floor 2, floor 3 and so on. The number shall increase upwards.

0.5.1.2 Floor level: For floor 1, top level of finished floor shall be the floor level and for all other floors above floor 1, top level of the structural slabs shall be the floor level.

0.5.1.3 Plinth level: Floor 1 level or 1.2 m above the ground level whichever is lower shall be the plinth level.

0.5.2 Special Structures

0.5.2.1 For structures like retaining walls, wing walls, chimneys, over head reservoirs/ tanks and other elevated structures, where elevations/ heights above a defined datum level have not been specified and identification of floors cannot be done as in case of building. Level, at 1.2 m above the ground level shall be the floor 1 level as well as plinth level. Level at a height of 3.5 m above floor 1 level will be reckoned as floor 2 level and level at a height of 3.5 m above the floor 2 level will be floor 3 level and so on, where the total height above floor 1 level is not a whole number multiple of 3.5 metre. Top most floor level shall be the next in sequence to the floor level below even if the difference in height between the two upper most floor levels is less than 3.5 metres

0.6 FOUNDATION AND PLINTH

The work in foundation and plinth shall include:

(a) For buildings: All works upto 1.2 metre above ground level or upto floor 1 level whichever is lower:

(b) For abutments, piers and well steining: all works upto 1.2 m above the bed level:

(c) For retaining wall, wing walls, compound walls, chimneys, over head reservoirs/ tanks and other elevated structures: All works upto 1.2 metre above the ground level:

(d) For reservoirs/ tanks (other than overhead reservoirs/ tanks): All works upto 1.2 metre above the ground level:

(e) For basements: All works upto 1.2 m above ground level or upto floor 1 level whichever is lower.

Note: Specific provision shall be made in the estimate for such situations where the foundation level is more than 3 (three) metre depth from the plinth for all types of structures mentioned above.

0.7 MEASUREMENTS

0.7.1 In booking dimensions, the order shall be consistent and in the sequence of length, width and height or depth or thickness.

0.7.2 Rounding off: Rounding off where required shall be done in accordance with IS: 2-1960. The number of significant places rounded in the rounded off value should be as specified.

0.8 MATERIALS

0.8.1 Samples of all materials to be used on the work shall be got approved by the contractor from the Engineer-in-Charge well in time. The approved samples duly authenticated and sealed shall be kept in the custody of the Engineer-in-Charge till the completion of the work. All materials to be provided by the contractor shall be brand new and as per the samples approved by the Engineer-in-Charge.

0.8.2 Materials obtained by the contractor from the sources approved by the Department shall be subjected to the Mandatory tests. Where such materials do not conform to the relevant specifications, the matter shall be taken up by the Engineer-in-Charge for appropriate action against the defaulters. In all such cases, necessary documents in original and proof of payment relating to the procurement of materials shall be made available by the contractor to the Engineer-in-Charge.

0.8.3 Samples, whether submitted for approval to govern bulk supplies or required for testing before use and also the sample of materials bearing 'Standard mark,' if required for testing, shall be provided free of cost by the contractor. All other incidental expenditure to be incurred for testing of samples e.g. packaging, sealing transportation, loading, unloading etc. except testing charges shall be borne by the contractor.

0.8.4 The materials, supplied by the Department shall be deemed to be complying with the specifications.

0.8.5 Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric effects due to rain, sun, wind and moisture to avoid deterioration.

0.8.6 Materials like timber, paints etc. shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials and explosives shall be stored in accordance with the relevant rules and regulations or as approved by Engineer-in-Charge in writing so as to ensure desired safety during storage.

0.8.7 The unit weight of materials unless otherwise specified shall be reckoned as given in IS: 1911-1967.

0.9 SAFETY IN CONSTRUCTION

0.9.1 The contractor shall employ only such methods of construction, tools and plant as are appropriate for the type of work or as approved by Engineer-in-Charge in writing.

0.9.2 The contractor shall take all precautions and measures to ensure safety of works and workman and shall be fully responsible for the same. Safety pertaining to construction works such as excavation, centering and shuttering, trenching, blasting, demolition, electric connections, scaffolds, ladders, working platforms, gangway, mixing of bituminous materials, electric and gas welding, use of hoisting and construction machinery shall be governed by CPWD safety code, relevant safety codes and the direction of Engineer-in-Charge

0.10 ABBREVIATIONS

The following abbreviations wherever they appear in the specifications, shall have the meaning or implication hereby assigned to them:

Mm	Millimetre
Cm	Centimetre
M	Metre
Km	Kilometre
Mm^2/sqmm	Square Milimetre
Cm^2/sqcm	Square centimetre
Dm^2/sqdm	Square decimetre
M^2/sqm	Square metre
Cm^3/ cubic cm	Cubic centimetre
Dm^3/ cubic dm	Cubic decimetre
M^3/cum	Cubic metre
Ml	Millilitre
Kl	Kilolitre
Gm	Gram
Kg	Kilogram
Q	Quintal
T	Tonne
Fps system	Foot pound second system
°C	Degree Celsius temperature
Fig	Figure
Re/Rs	Rupee/ Rupees
No	Number
Dia	Diameter
AC	Asbestos cement
CI	Cast Iron
GC	Galvanised corrugated
GP	Galvanised plain
GI	Galvanised iron
PVC	Polyvenyl chloride
RCC	Reinforced cement concrete
SW	Stone ware
SWG	Standard wire Gauge

SUB HEAD : 1.0

CARRIAGE OF MATERIALS

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Bureau of Indian Standard Codes	13
1.0	General	14
1.1	Responsibility for Loss or Damage	14
1.2	Mode of Carriage	14
1.3	Lead	14
1.4	General Consideration for Stacking and Storage	14
1.5	Protection against Atmospheric Agencies	14
1.6	Protection against fire and other Hazards	14
1.7 to 1.26	Stacking and Storage of Materials	15 - 20
1.27	Measurements	20
1.28	Rate	21
Table 1.1	Storage and Stacking Check List	22
Fig. 1.1	Typical Sketch for Cement Godown	23

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*I. S. No.*	*Subject*
1.	IS 4082	Stacking & storage of construction materials and components at site – Recommendations
2.	IS 1141	Seasoning of Timber – Code of Practice

1.0 CARRIAGE OF MATERIALS

1.0 GENERAL

The carriage and stacking of materials shall be done as directed by the Engineer-in- Charge. Any tools and plants, required for the work shall be arranged by the Contractor. The carriage of materials includes loading within a lead of 50 metres, unloading and stacking within a lead of 50 metres.

1.1 RESPONSIBILITY FOR LOSS OR DAMAGE

Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the materials. In case of any loss or damage, recovery shall be effected from the Contractor at twice the Departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be effected at twice the prevailing market rates as determined by the Engineer-in-Charge.

1.2 MODE OF CARRIAGE

Depending upon the feasibility and economy, the Engineer-in -Charge shall determine the mode of carriage viz. whether by mechanical or animal transport or manual labour.

1.3 LEAD

1.3.1 All distances shall be measured over the shortest practical route and not necessarily the route actually taken. *Route other than shortest practical route may be considered in cases of unavoidable circumstances and as approved by Engineer-in-Charge alongwith reasons in writing.*

1.3.2 Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

1.3.3 Carriage by animal and mechanical transport shall be reckoned in one km unit. Distances of 0.5 km or more shall be taken as 1 km and distance of less than 0.5 km shall be ignored. However, when the total lead is less than 0.5 km, it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km by mechanical/ animal transport.

1.4 GENERAL CONSIDERATION FOR STACKING AND STORAGE

1.4.1 Planning of Storage Layout

For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipments with proper access and proper manoeuvrability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipments at different stages of construction shall be considered. The storage & stacking check list is given in Table 1.1. For further details refer IS- 4082.

1.4.2 Material shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

1.5 PROTECTION AGAINST ATMOSPHERIC AGENCIES

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture to avoid deterioration.

1.6 PROTECTION AGAINST FIRE AND OTHER HAZARDS

1.6.1 Materials like timber, coal, paints, etc. shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in general they shall not be more than 4.5 m in height. The provisions given in IS 13416 (part 5) shall be followed.

1.7 STACKING AND STORAGE OF MATERIALS

1.7.1 Cement

1.7.1.1 In case cement is received in bags. Cement shall be stored at the work site in a building or a shed which is dry, leakproof and as moisture proof as possible. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed as far as possible.

1.7.1.2 Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep about 150 mm to 200 mm clear above the floor. The floor may comprise of lean cement concrete or two layers of dry bricks laid on well consolidated earth. A space of 600 mm minimum shall be left alround between the exterior walls and the stacks (see Fig. 1.1)

In the stacks the cement bags shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on the bottom layer of bags sometimes 'warehouse pack' is developed in these bags. This can be removed easily by rolling the bags when the cement is taken out for use. Lumbed bags, if any should be removed and disposed off.

1.7.1.3 The height of stack shall not be more than 10 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3 metres. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross -wise so as to tie the stacks together and minimize the danger of topping over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received; a lable showing date of receipt of cement shall be put on each stack to know the age of cement.

1.7.1.4 For extra safety during the monsoon, or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a water proofing membrane such as polyethylene, which shall close on the top of the stack. Care shall be taken to see that the waterproofing membrane is not damaged any time during use.

1.7.1.5 Cement in gunny bags, paper bags and polyethylene bags shall be stored separately.

1.7.2 In case cement is received in drums

These shall be stored on plane level ground, as far as possible near the concrete mixing place. After taking out the required quantity of cement, the lid of the drum shall be securely tied to prevent ingress of moisture.

1.7.3 In case cement is received in silos

The silos shall be placed near the concrete batching plant. Proper access shall be provided for the replacement of silos.

1.7.4 Different types of cements shall be stacked and stored separately.

1.8 BRICKS

1.8.1 Bricks shall be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement. These shall not be dumped at site.

1.8.2 Bricks stacks shall be placed close to the site of work so that least effort is required to unload and transport the bricks again by loading on pallets or in barrows. Building bricks shall be loaded or unloaded a pair at a time unless palletized. Unloading of building bricks or handling in any other way likely to damage the corners or edges or other parts of bricks shall not be permitted.

1.8.3 Bricks shall be stacked on dry firm ground. For proper inspection of quality and ease in counting the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack.

1.8.4 Bricks of different types, such as clay bricks, clay fly ash bricks, fly ash lime bricks, sand lime (calcium silicate) bricks, auto-clave bricks etc. shall be stacked separately. Bricks of different classification and size consideration (such as, conventional and modular) shall be stacked separately. Also bricks of different types, such as, solid, hollow and perforated shall be stacked separately.

1.9 BLOCKS

1.9.1 Blocks are available as hollow and solid concrete blocks, hollow and solid light weight concrete blocks, autoclaved aerated concrete blocks, concrete stone masonry blocks and soil based blocks.

1.9.2 Blocks shall be unloaded one at a time and stacked in regular tiers to minimize breakage and defacement. These shall not be dumped at site. The height of the stack shall not be more than 1.2 m. The length of the stack shall not be more than 3.0 m, as far as possible and the width shall be of two or three blocks.

1.9.3 Normally blocks cured for 28 days only should be received at site. In case blocks cured for less than 28 days are received, these shall be stacked separately. All blocks should be water cured for 10 to 14 days and air cured for another 15 days; thus no blocks with less than 28 days curing shall be used in building construction.

1.9.4 Blocks shall be placed close to the site of work so that least effort is required for their transportation.

1.9.5 Blocks manufactured at site shall be stacked at least for required minimum curing period as given in 1.9.3.

1.9.6 The date of manufacture of the blocks shall be suitably marked on the stacks of blocks manufactured at factory or site.

1.10 FLOOR, WALL AND ROOF TILES

1.10.1 Floor, wall and clay roof tiles of different types, such as, cement concrete tiles (plain, coloured and terrazzo) and ceramic tiles (glazed and unglazed) shall be stacked on regular platform as far as possible under cover in proper layers and in tiers and they shall not be dumped in heaps. In the stack, the tiles shall be so placed that the mould surface of one faces that of another. Height of the stack shall not be more than one metre. During unloading, these shall be handled carefully so as to avoid breakage.

1.10.2 Tiles of different quality, size and thickness shall be stacked separately to facilitate easy removal for use in work. Tiles when supplied by manufacturers packed in wooden crates, shall be stored in crates. The crates shall be opened one at a time as and when required for use.

1.10.3 Ceramic tiles and clay roof tiles are generally supplied in cartons which shall be handled with care. It is preferable to transport these at the site on platform trolleys.

1.11 AGGREGATES

1.11.1 Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent contamination with clay, dust, vegetable and other foreign matter.

1.11.2 Stacks of fine and coarse aggregates shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. On a large job, it is desirable to construct dividing walls to give each type of aggregates its own compartment. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum.

1.11.3 Unless specified otherwise or necessitated by site conditions stacking of the aggregates should be carried out in regular stacks. The suggested sizes for stacks are as follows :

Sl. no.	Material	Size of Stack (in m)			
			Length	Breadth	Height
(i)	Soling stone		5.0	2.0	0.50
		Or	5.0	1.0	0.50
(ii)	Coarse aggregates		2.0	2.0	0.50
		Or	5.0	5.0	1.00
		Or	5.0	1.0	0.50
(iii)	Fine aggregates		2.0	2.0	0.50
		Or	5.0	5.0	1.00
		Or	5.0	1.0	0.50

1.12 FLY ASH

Fly ash shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in stack similar to fine aggregates as specified in 1.11 to avoid any intrusion of foreign matter. Fly ash in bags shall be stored in stacks not more than 10 bags high.

1.13 STEEL

1.13.1 For each classification of steel, separate areas shall be earmarked. It is desirable that ends of bars and sections of each class be painted in distinct separate colours.

1.13.2 Steel reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting.

1.13.3 Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths so as to minimize wastage in cutting from standard lengths.

1.13.4 In case of long storage, reinforcement bars shall be stacked above ground level by at lest 150 mm. Also in coastal areas or in case of long storage a coat of cement wash shall be given to prevent scaling and rusting.

1.13.5 Structural steel of different classification, sizes and lengths shall be stored separately. It shall be stored above ground level by at least 150 mm upon platforms, skids or any other suitable supports to avoid distortion of sections. In coastal areas or in case of long storage suitable protective coating of primer paint shall be given to prevent scaling and rusting.

1.14 ALUMINIUM SECTIONS

Aluminium sections of different classification, sizes and lengths shall be stored separately, on a level platform under cover. The aluminium sections shall not be pulled or pushed from the stack nor shall be slided over each other, to protect the anodizing layer.

1.15 DOORS, WINDOWS AND VENTILATORS

1.15.1 General

While unloading, shifting handling and stacking timber or other lignocellulosic material based, metal and plastic door and window frames and shutters, care shall be taken that the material is not dragged one over the other as it may cause damage to the surface of the material particularly in the case of decorative shutters. The material should be lifted and carried preferably flat avoiding damage of corners or sides.

1.15.2 Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level ground preferably on wooden battens and shall not come in contact with dirt and ashes. If received in crates they shall be stacked according to manufacturer's instructions and removed from the crates as and when required for the work.

1.15.3 Metal and plastic frames of doors, windows and ventilators shall be stacked upside down with the kick plates at the top. These shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping.

1.15.4 During the period of storage all metal doors, windows and ventilators shall be protected from loose cement and mortar by suitable covering such as tarpauline. The tarpauline shall be hung loosely on temporary framing to permit circulation of air to prevent condensation.

1.15.5 All timber and other lignocellulosic material based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well ventilated dry rooms. The frames shall be stacked one over the other in vertical stacks with cross battens at regular distances to keep the stack vertical and straight. These cross battens should be of uniform thickness and placed vertically one above the other. The door shutters shall be stacked in the form of clean vertical stacks over the other and at least 80 mm above ground on pallets or suitable beams or rafters. The top of the stack shall be covered by a protecting cover and weighted down by means of scantlings or other suitable weights. The shutter stack shall rest on hard and level ground.

1.15.6 If any timber or other lignocellulosic material based frame or shutter becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air generally following the guidance laid down in IS 1141.

1.15.7 Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material.

1.16 ROOFING SHEETS

1.16.1 Roofing sheets shall be stored and handled in such a manner as not do damage them in any way.

1.16.2 Plain and corrugated asbestos cement sheets shall be stacked horizontally to a height of not more than one meter on a firm and level ground, with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by the winds.

Asbestos cement sheets of same variety and size shall be stacked together. Damage sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

1.16.3 Corrugated galvanized iron sheets and aluminium sheets shall be stacked horizontally to a height of not more than 0.5 m on a firm and level ground, with timber or other packing beneath them. To protect them from dust and rain water, these shall be covered with tarpaulin or polyethylene sheets.

1.16.4 Plastic sheets and glass reinforced plastic (GRP) sheets shall be stacked under a shed to a height of not more than 0.5 m on a firm and level ground with timber or other packing beneath them.

1.17 GYPSUM BOARDS, PLYWOOD, FIBREBOARD, PARTICLE BOARD, BLOCK BOARD, ETC.

1.17.1 These boards shall be stored flat in a covered clean and dry place. Different sizes and types of each of these boards shall be stacked separately.

The board shall be stacked on a flat platform on which a wooden frame shall be constructed with 50 mm x 25 mm battens in such a way that it will give support to all four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping.

The boards shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping wherever necessary.

The boards shall be unloaded and stacked with utmost care avoiding damage to the corners and surface. In case of decorative plywood and decorative boards, the surfaces of which are likely to get damaged by dragging one sheet over another it is advisable that these are lifted as far as possible in pairs facing each other.

1.18 GLASS SHEETS

1.18.1 It is important that all glass sheets whether stored in crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of the glass sheets. In removing glass sheets from crates, great care shall be taken to avoid damages. The glass sheets shall be lifted and stored on its long edges against a vertical wall or other support with the first sheet so placed that its bottom edge is 25 mm from the vertical support. The stacks shall be of not more than 25 panes and shall be supported at two points by fillets of wood at 300 mm from each end. The whole stack shall be as close and as upright as possible.

The glass sheets of different sizes, thickness and type shall be stacked separately. The distance between any two stacks shall be of the order of 400 mm.

1.19 CAST IRON, GALVANIZED IRON AND ASBESTOS CEMENT PIPES AND FITTINGS

1.19.1 The pipes shall be unloaded where they are required when the trenches are ready to receive them.

1.19.2 Storage shall be done on firm, level and clear ground and wedges shall be provided at the bottom layer to keep the stack stable.

1.19.3 The stack shall be in pyramid shape or the pipes length-wise and cross-wise in alternate layers. The pyramid stack is advisable in smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5 m.

1.19.4 Each stack shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible.

1.19.5 Cast iron detachable joints and fittings shall be stacked under cover separately from the asbestos cement pipes and fittings.

1.19.6 Rubber rings shall be kept clean, away from grease, oil heat and light.

1.20 POLYETHYLENE PIPES

1.20.1 Natural polyethylene pipe should be stored under cover and protected from direct sunlight. However, black polyethylene pipes may be stored either under cover or in the open.

1.20.2 Coils may be stored either on edges or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surface.

1.20.3 Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.

1.20.4 Storage of pipes in heated areas exceeding 27^{o} C should be avoided.

1.21 UNPLASTICIZED PVC PIPES

1.21.1 The pipe should be given adequate support at all times. Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. In storage, pipe racks should be avoided. Pipe should not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks.

1.21.1.1 It is recommended not to store pipe inside another pipe.

1.21.1.2 On no account should pipes be stored in a stressed or bent condition or near the sources of heat.

1.21.1.3 Pipes should not be stacked more than 1.5 m high. Pipes of different sizes and classes should be stacked separately.

1.21.2 The ends of pipe should be protected from abrasion particularly those specially prepared for jointing either spigot or socket solvent welded joints or shouldered for use with couplings.

1. 21.3 In tropical conditions, pipes should be stored in shade. In very cold weather, the impact strength of PVC is reduced making it brittle and more care in handling shall be exercised in wintry condition.

1.21.4 If due to unsatisfactory storage of handling a pipe becomes kinked, the damaged portion should be cut out completely. Kinking is likely to occur only on very thin walled pipes.

1.22 BITUMEN, ROAD TAR, ASPHALT, ETC.

1.22.1 All types of bitumen, road tar, asphalt, etc, in drums or containers shall be stacked vertically on their bottoms in up to 3 tiers. Leaky drums shall be segregated. Empty drums shall be stored in pyramidal stacks neatly in rows.

1.23 WATER

1.23.1 Wherever water is to be stored for construction purposes this shall be done in proper storage tanks to prevent any organic impurities getting mixed up with it.

1.24 OIL PAINTS

1.24.1 All containers of paints, thinners and allied materials shall preferably be stored in a separate room on floors with sand cushions. The room shall be well-ventilated and free from excessive heat, sparks of flame and direct rays of sun. The containers of paint shall be kept covered or properly fitted with lid and shall not be kept open except while using. The containers of paints have expiry date marked by the manufacturers, which should be highlighted so as to facilitate use of paint within due period.

1.25 SANITARY APPLIANCES

1.25.1 All sanitary appliances shall be carefully stored under cover to prevent damage. When accepting and storing appliances, advance planning shall be made regarding the sequence of removal from the store to the assembly positions. Supporting brackets shall be so stored as to be readily accessible for use with the appliances.

1.26 OTHER MATERIALS

1.26.1 Small articles like nails, screws, nuts and bolts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings, packing, water supply and sanitary fittings, electrical fittings, insulation board, etc, shall be kept in suitable and properly protected store rooms. Valuable small material such as, copper pipes and fittings shall be kept under lock and key.

1.27 MEASUREMENTS

Length, breadth and height of stacks shall be measured correct to a cm. The quantity shall be worked out in cubic metre correct to two place of decimal. The volume of stacks shall be reduced by percentages as shown against each for looseness in stacking to arrive at the net quantity for payment . No reduction shall be made in respect of articles or materials for which mode of payment is by length or weight or number.

1.27.1 Earth

1.27.1.1 In loose stacks such as cart loads, lorry loads, etc. – 20%

1.27.1.2 In fills consolidated by light mechanical machinery – 10%

1.27.1.3 In fills consolidated by heavy mechanical machinery but not under OMC (Optimum Moisture Content) – 5%

1.27.1.4 In fills consolidated by heavy mechanical machinery at OMC – Nil

1.27.1.5 Consolidated fills in confined situation such as under floors. etc. – Nil

1.27.2 Other Materials

1.27.2.1 Manure or sludge – 8%

1.27.2.2 Moorum, building rubbish Lime and sand – Nil

1.27.2.3 Stone metal, 40 mm nominal size and above – 7.5%

1.27.2.4 Coarse aggregate/ stone metal below 40 mm nominal size – Nil

1.27.2.5 Soling stone/ Boulder 100 mm and above – 15%

1.27.2.6 Excavated rocks – 50%

1.28 RATE

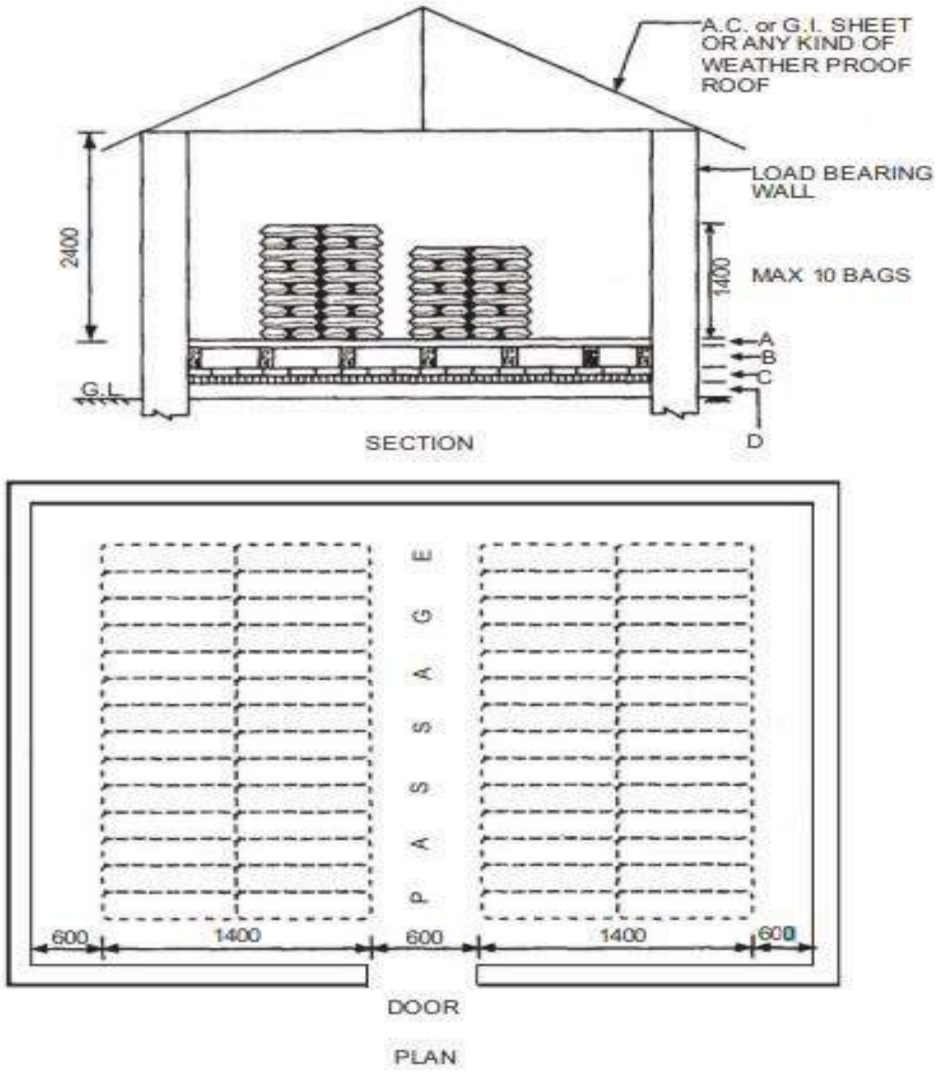
The rate for carriage of materials is inclusive of all the operations described above.

TABLE 1.1
Storage and Stacking Check List
(Clause 1.4.1)

Sl.No.	Material /Component	Base			Stack				Type of Cover		
		Firm Level Ground	Hard Floor	Off Floor	Heaps	Tiers	flat	Vertical	Open	Open but covered	Under shed
1.	Cement			√		√					√
2.	Stone and Aggregates										
(a)	Stones, aggregates, fly ash and cinder	√			√				√		
(b)	Veneering stones	√				√		√	√		
3.	Bricks and Blocks	√				√			√		
4.	Tiles										
(a)	Clay and concrete floor, wall and roof tiles	√				√	√		√		
(b)	Ceramic tiles		√			√	√				√
5.	Steel	√					√		√		
6	Aluminum Sections		√				√				√
7.	Door, windows and Ventilators		√					√			√
8.	Roofing Sheets										
(a)	AC	√				√	√		√		
(b)	GI and Aluminum Sheets	√				√	√			√	
(c)	Plastic Sheets		√			√	√				√
9.	Boards like Plywood, Particle Boards, Fibre Boards, Block boards and Gypsum Board		√			√	√				√
10.	Glass Sheets		√					√			√
11.	CI, GI and AC Pipes & fittings										
(a)	Pipes	√				√	√		√		
(b)	CI and GI fittings		√				√				√
(c)	AC Fittings		√				√		√		
12.	Polyethylene Pipes			√		√	√				√
13.	Unplasticized PVC Pipes	√				√	√		√		
14.	Bitumen, Road Tar, Asphalt, etc in Drums	√				√			√		
15.	Oil Paints		√			√					√
16.	Sanitary Appliances			√			√				√

TYPICAL SKETCH FOR CEMENT GODOWN

Sub Head : Carriage
Clause : 1.7.1.2



A = Planks
B = Wooden Battens
C = 150 Dry Bricks in two Layers or Lean Cement Concrete
D = 150 Consolidated Earth

Drawing not to scale
All Dimensions in millimetres

Fig. 1.1 : Typical Arrangement in Cement Godown

SUB HEAD : 2.0

EARTH WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Bureau of Indian Standard Codes	29
2.0	Definitions	30
2.1	Classification of Soils	30
2.2	Antiquities and Useful Materials	31
2.3	Protections	31
2.4	Site Clearance	31
2.5	Setting out and Making profiles	32
2.6	Blasting	32
2.7	Excavation in All kinds of soils	34
2.8	Excavation in Ordinary/ Hard rock	35
2.9	Earth work by mechanical means	36
2.10	Filling	37
2.11	Measurements	37
2.12	Rates	39
2.13	Surface Excavation	40
2.14	Rough Excavation and Filling	40
2.15	Excavation over Area (All kinds of Soil)	40
2.16	Excavation over Area (Ordinary/Hard rock)	40
2.17	Excavation in Trenches for Foundations and Drains (All kinds of Soil)	41
2.18	Excavation in Trenches for Foundation and Drains (Ordinary/ Hard rock)	41

2.19	Excavation in Trenches for Pipes, Cables etc. and Refilling	41
2.20	Planking and Strutting	42
2.21	Excavation in Water, Mud or Foul position	43
2.22	Deleted	
2.23	Filling in Trenches, Plinth, under Floor etc.	44
2.24	Sand Filling in Plinth	45
2.25	Surface Dressing	45
2.26	Jungle Clearance	45
2.27	Felling Trees	46
2.28	Anti Termite Treatment	47
2.29	Filling with Flyash and Earth	51
Fig. 2.1	The Design for Temporary Site Bench Mark	52
Fig. 2.2	Close and Open Planking and Strutting	53
Fig. 2.3 (i to viii)	Anti-Termite Construction Stage 1 to 8	54 - 57
Fig. 2.4	Anti-Termite Construction – Final Recommendations	58

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*I.S. No.*	*Subject*
1	IS 632	Gamma – BHC (Lindane) emulsifiable concentrates
2	IS 1200 (Pt 1)	Method of measurement of earth work
3	IS 1200 (Pt-27)	Method of measurement of earth work (by Mechanical Appliances)
4	IS 4081	Safety code for Blasting and related drilling operation
5	IS 4988 (Part IV)	Excavators
6	IS 6313 (pt-II)	Anti Termite measures in buildings (pre -constructional)
7	IS 6313(pt.-III)	Anti Termite Measures in Buildings for existing buildings
8	IS 6940	Methods of test for pesticides and their formulations
9	IS 8944	Chlorpyrifos emulsifiable concentrates
10	IS 8963	Chlorpyrifos – Technical specifications
11	IS 12138	Earth moving Equipments

2.0 EARTH WORK

2.0 DEFINITIONS

Deadmen or Tell Tales: Mounds of earth left undisturbed in pits dug out for borrowing earth

Burjis: Short pillars of brick/ stone having top surface finished with cement plaster for marking etc.

Formation or Profile: Final shape of the ground after excavation or filling up.

Foul condition: Filthy and unhygienic conditions where physical movements are hampered such as soil mixed with sewage or night soil.

Lead : All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge along with reasons in writing.

Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

Carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 0.5 km. or more shall be taken as 1 km. and distance of less than 0.5 km. shall be ignored. However, when the total lead is less than 0.5 km., it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km. by mechanical/animal transport.

Lift: The vertical distance for removal with reference to the ground level. The excavation up to 1.5 metres depth below the ground level and depositing the excavated materials upto 1.5 metres above the ground level are included in the rate of earth work. Lifts inherent in the lead due to ground slope shall not be paid for.

Safety rules: Safety rules as laid down by the statutory authority and *as provided in National Building Code (NBC) shall be followed.*

2.1 CLASSIFICATION OF SOILS

2.1.0 The earthwork shall be classified under the following categories and measured separately for each category:

(a) ***All kind of soils:*** Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrifiers, ripper and other manual digging implements.

(b) ***Ordinary rock:*** Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as 'Hard rock'.

(c) ***Hard rock:*** Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

(d) ***Hard rock (blasting prohibited):*** Hard rock requiring blasting as described under (c) but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, use of rock hammers and cutters or any other agreed method.

2.2 ANTIQUITIES AND USEFUL MATERIALS

2.2.1 Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government**.**

2.2.2 Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Government.

2.3 PROTECTIONS

2.3.1 Excavation where directed by the Engineer-in- Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights *and/or written using fluorescent reflective paint as directed by engineer in charge* during the night to avoid accident.

2.3.2 The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.

2.3.3 Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer-in-Charge for which payment shall be made separately.

2.3.4 Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, over head wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

2.4 SITE CLEARANCE

2.4.1 Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one metre above ground level and rubbish removed up to a distance of 50 metres outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

2.4.2 The trees of girth above 30 cm measured at a height of one metre above ground shall be cut only after permission of the Engineer-in-Charge is obtained in writing. The roots of trees shall also be removed as specified in 2.4.1. payment for cutting such trees and removing the roots shall be made separately.

2.4.3 Existing structures and services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer-in-Charge and payment for such diversion/dismantling works shall be made separately.

2.4.4 In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing alround such monuments as per the directions of the Engineer-in -Charge and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

2.4.5 Lead of 50 m mentioned in the 'Schedule Of Quantities' is the average lead for the disposal of excavated earth within the site of work. The actual lead for the lead for the disposal of earth may be more or less than the 50 m for which no cost adjustment shall be made in the rates.

2.4.6 Disposal of Earth shall be disposed off at the specified location or as decided by the Engineer-in-Charge. The contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer-in-Charge.

2.5 SETTING OUT AND MAKING PROFILES

2.5.1 A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be constructed as per Fig. 2.1 and connected with the standard bench mark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or 'Burjis' and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

2.5.2 The ground levels shall be taken at 5 to 15 metres intervals (as directed by the Engineer-in-Charge) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 metres to one cm or any other suitable scale decided by the Engineer -in-Charge. North direction line and position of bench mark shall invariable be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

2.6 BLASTING

2.6.0 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to blasting operation.

Note: In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the Engineer-in-charge, but nothing extra shall be paid for such blasting operations.

The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, 1884 as amended up to date and the Explosive Rules, 1983. The contractor shall purchase the explosives fuses, detonators, etc. only from a licensed dealer. The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer-in -Charge or his authorized representative shall have the right to check the contractor's store and account of explosives. The contractor shall provide necessary facilities for this.

The contractor shall be responsible for any damage arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation.

2.6.1 Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent only), during specified hours as approved in writing by the Engineer-in-Charge. The agent shall be conversant with the rules of blasting. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not

rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular nitch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the nitch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

(a) The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or

(b) The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

Before leaving the site of work, the agent of one shift shall inform the another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

2.6.2 General Precautions

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 metres from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done with in 200 metres of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives drilling and loading of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081, safety code for blasting and related drilling operation.

2.6.3 Precautions against Misfire

The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose.

If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.

The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer-in-Charge or his authorized representative before resuming the blasting or returning the consignment.

2.7 EXCAVATION IN ALL KINDS OF SOILS

2.7.1 All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.

2.7.2 During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

2.7.3 In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal : 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping , sloping or shoring to be done for excavation deeper than 2 metres.

2.7.4 The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.

2.7.5 In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in -Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

2.7.6 While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required is to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.

2.7.7 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.

2.7.8 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on the account shall be done by the contractor at his own cost.

2.7.9 The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

2.8 EXCAVATION IN ORDINARY/HARD ROCK

2.8.1 All excavation operations shall include excavation and 'getting out' the excavated matter. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead.

2.8.2 During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.

2.8.3 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in- Charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified in para 2.6 and chiseling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-in-Charge and nothing extra shall be payable for chiseling.

2.8.4 Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling.

2.8.5 In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting. Blasting shall be done as specified in para 2.6.

2.8.6 If the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge. The excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

2.8.7 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling with earth duly watered, consolidated and rammed.

2.8.8 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost.

2.8.9 Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.

2.8.10 The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

2.9 EARTH WORK BY MECHANICAL MEANS

Earth work by mechanical means involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected.

The earth moving equipment consists of excavating and transporting equipment. Excavating equipments may be further classified as excavators and tractor based equipments.

2.9.1 Excavators

Excavators generally used at site are as follows:

(i) ***Dipper–shovel :*** It is used for excavating against a face or bank consisting of open-top bucket or dipper with a bottom opening door, fixed to an arm or dipper stick which slides and pivots on the jib of the crane. It is suitable for excavating all clay chalk and friable materials and for handling rock and stone. However, it is not suitable for surface excavation for which a skimmer is used.

(ii) ***Backhoe :*** It is similar to face shovel except that the dipper stick pivots on the end of the jib and the dipper or bucket works towards the chassis and normally has no bottom door but is emptied by swinging away from the chassis to invert the bucket. It may be designed to carry both a front –mounted bucket loading mechanism and a rear mounted backhoe. It is mainly used to excavate trenches and occasionally used for the excavation of open areas such as small basements.

In the backhoe mode the bucket lifts, swings and discharges materials while the undercarriage is stationary. When used in the 'loader' mode, the machine loads or excavated through forward motion of the machine, and lifts, transports and discharges materials.

(iii) ***Skimmer :*** This arrangement is similar to the face shovel except that in this case the bucket slides on rollers directly along the jib and thus has a more restricted movement. It is used for surface excavation and levelling in conjunction with transport to haul away the excavated material.

(iv) ***Dragline :*** It is usually fitted with a long slender boom or jib and the bucket, which in operation faces towards the machine and has no door, is supported by cable only as on a crane. It works from the side of the excavation at normal ground level and is used for excavating large open excavations such as basements when the depth is beyond the limit of the boom of a backhoe. It is commonly used for open cast mining operations.

(v) ***Clamshell :*** It consists of two hinged half-buckets or jaws pivoted to a frame which is suspended by cable from a long jib of an excavation. The grab is used for deep excavations of limited area on all types of soil except rock. Crane and Grab is a variant of this type of equipment.

2.9.2 Tractor–based Equipment

It is a self–propelled crawler or wheeled machine used to exert a push or pull force through mounted equipment. It is designed either as attachments to normal tracked or wheeled tractors or as machines in which the earth moving attachments and the tractor are designed as a single integrated unit. A tractor, which is hydraulically operated, can be rigged as :

(i) ***Loaders :*** It is used for loading, light dozing, scraping and grabbing operations, lifting and transporting the materials (loose earth, rubble, sand, gravel aggregate etc) at various sites through forward motion of the machine.

(ii) ***Tractor Shovel :*** This consists of a tipping bucket at the front attached by strong pivoted arms or booms to the frame of the machine. It is used for stripping top soil, excavating against a face, bulldozing and for loading spoil or loose materials. It is similar to crawler dipper-shovel.

(iii) ***Trench Digger :*** It operates on the same principle as a backhoe excavator except that the bucket is controlled by hydraulic rams instead of cables and pulleys.

(iv) ***Scraper :*** Scrapers provide unique capability to excavate, load, haul and dump materials. Scrapers are available in various capacities by a number of manufacturers with options such as self – loading with elevators, twin engines or push-pull capability. They are cost effective where the haul distance is too long for bulldozers, yet too short for trucks. This distance typically ranges from 120 m to 1200 m; however, the economics should be evaluated for each project.

Scraper has an open bowl with a cutting edge positioned between the axles, which cuts, loads, transports, discharges and spreads through forward motion of the machine. Loading through forward motion of the machine can be assisted by a powered mechanism (elevator) fixed to the scraper bowl.

(v) ***Bulldozer and Angle-dozer :*** The most common equipment used for clearing and levelling activities is a bulldozer. The terms bulldozer is used to define a tractor mounted with a dozing blade.

The bulldozer consists of a rectangular steel blade with renewable cutting edge set at right angles (capable of only tilting but not angling) to the direction of travel and attached by steel arms to the side frames of a crawler tractor. It may be used for excavating natural soil or for moving loose soil or debris, which is pushed forward as the tractor forces it ahead.

(vi) ***Angledozer*** is capable of both tilting and angling

2.9.3 Transporting Equipment

This implies horizontal movement primarily but it can involve some vertical movement too.

(i) ***Dumpers :*** These are self-propelled wheeled machines, having an open body. It is designed for the transport of excavated materials and consists of a shallow tipping hopper or skip mounted on a wheeled chassis, such as, power barrow, dumper, multi-skip dumpers, high discharge dumpers, dump truck, etc. These can be rear dump, side dump or bottom dump.

(ii) ***Vibratory Roller :*** It is a single Drum Vibratory Roller for compaction of embankments, etc. The smooth drum version is for compaction of granular and mixed soil. The sheepsfoot Roller consists of a hallow cylindrical steel drum or drums on which projecting feet are mounted. These feet penetrate into the fill as a roller moves forward and cause compaction. The geometry of the foot may be sheep, club pyramid, cone or cylinder foot. Such rollers are employed for compaction (densification) of cohesive and semi-cohesive soils.

2.10 FILLING

2.10.1 The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish.

2. 10.2 Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top must layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metre vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

2.11 MEASUREMENTS

2.11.1 The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5 mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

2.11.1.1 In case of open footings up to the depth of 1.5 metres, alround excavation of 30 cm. beyond the outer dimension of footing shall be measured for payment to make allowances for centering and

shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.11.1.2 In case of open footings/Rafts at a depth of more than 1.5 metre, alround excavation of 75 cm shall be measured for payment to make allowance for centering and shuttering. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.11.2 In case the ground is fairly uniform and where the site is not required to be levelled, the Engineer- in-Charge may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead-men, the position of which shall be fixed by the Engineer-in-Charge, shall be left by the contractor to permit accurate measurements being taken with steel tape on the completion of the work Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and the earth so removed is utilized in the work. In the latter case nothing extra will be paid for their removal as subsequent operation.

2.11.3 Where ordinary rock and hard rock is mixed. The measurement of the excavation shall be made as specified in 2.11.1 and 2.11.2 The two kinds of rock shall be stacked separately and measured in stacks. The net quantity of the two kinds of rocks shall be arrived at by applying deduction of 50% to allow for voids in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity of the excavated material, then the quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of the two types of rocks. If in the opinion of the Engineering- in-charge stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross-sectional measurements.

2.11.4 Where soil, ordinary rock and hard rock are mixed, the measurements for the entire excavation shall be made as specified in 2.11.1 and 2.11.2 Excavated materials comprising hard rock and ordinary rock shall be stacked separately, measured, and each reduced by 50% to allow for voids to arrive at the quantity payable under hard rock and ordinary rock. The difference between the entire excavation and the sum of the quantities payable under hard rock and ordinary rock shall be paid for as excavation in ordinary soil or hard soil as the case may be.

2.11.5 Where it is not possible or convenient to measure the depth of cutting by recording levels as specified in 2.11.1 quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earth work so computed shall be reduced by 10% in case of consolidated fills and by 5% in case the consolidation is done by heavy mechanical machinery to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of consolidation by heavy mechanical machinery at optimum moisture content, or when the consolidated filling is in confined situations such as under floors.

2.11.6. Recording Measurements for Earth Levelling Work

2.11.6.1 ***Level Books:*** In case of levelling operations and earthwork, measurements are required to be recorded in level books in addition to Measurement Books. The Level Books should be numbered, accounted for and handled like Measurement Books.

2.11.6.2 ***Preparatory Works:*** Before starting the earth work, following steps should be taken :

(1) Original ground levels should be recorded in the Level Book in the presence of the contractor or his authorized representative, and should be signed by him and the Department Officer who records the levels. All the local mounds and depressions should be indicated clearly in the drawing and the field Level Book and should be checked by the Assistant Engineer/Executive Engineer before the levelling work is started.

(2) A suitable baseline should be fixed with permanent masonry pillars at distances not exceeding 150 metres to provide a permanent reference line for facilitating check work. The base line (s) should be entered in the Level Book with co-ordinates. These baselines should be maintained till the final payment for the work has been made.

(3) While recording the levels, it should be ensured that the circuit is closed by taking final levels of the starting point or any other point, the R.L. of which was previously determined.
(4) Plans showing initial levels, location of bench marks and reduced levels, should be prepared and signed by both the parties and attached to the agreement before commencement of the work.

2.11.6.3 ***Test Check of the Levels***

(1) The Assistant Engineer should exercise test check at least to the extent of 50%, and the Executive Engineer at least to the extent of 10% where the value of this item of work exceeds 10% of the tender acceptance power of the Assistant Engineer.
(2) The test check of the levels should be carried out independently by each officer, and the readings should be recorded in the prescribed Level Book in red ink against the old levels which should be neatly scored out wherever necessary. If the test check carried out reveals serious mistakes in the original levels, these should be taken or re-taken and re-checked.
(3) The test check carried out by an officer should be as representative as possible for the entire work done.
(4) On completion of work, the levels should again be recorded in the Level Book and the contractor's signatures obtained. These levels should also be test checked by the Assistant Engineer/Executive Engineer to the same extent as indicated in (1) within one month of the date of completion of the earth work, and according to the procedure as laid down in the case of initial levels as indicated above.
(5) The formation levels as per final execution of the work should be compared with the proposed formation levels and the work got rectified within permissible tolerance.

2.11.6.4 ***Payment of Leveling Work***

(1) Every fourth running bill and the final bill should be paid on the basis of levels.
(2) Intermediate payments can, however, be made on the basis of borrow pit measurements. The Executive Engineer should take care that the quantities thus assessed are not in any case more than the actual work done.

2.11.6.5 ***Large Scale Leveling Work***

(1) In case of large scale levelling work involving both cutting and filling, an accurate site plan should be prepared before the work is commenced. The portions requiring cutting and filling shall then be divided into squares and corresponding squares into filling, which are complementary to the squares in cutting given the same number.
(2) A table may be written upon the plan showing leads involved between the various complementary squares. This would form a lead chart for the work to be done.
(3) Before the work of levelling is commenced, the lead chart shall be checked by the Assistant Engineer in the presence of the contractor or his authorized representative, and his signatures shall be obtained on the same. This should form an integral part of the contract and should be duly signed by both the integral parties before commencement of the work.
(4) The quantity payable for earthwork shall be lower of the quantity derived from cutting or filling. The payment for lead shall be based on lead chart prepared in the aforesaid manner.

2.11.6.6 ***Import of Earth:*** In case of earth to be imported, the area from where the earth is to be imported, should be pre-determined wherever possible before the start of the work, and wherever feasible, the average lead should be worked out and stipulated in the tender. After this is determined, initial levels of the area to be filled should be recorded. The levels should be properly checked during the progress of work and on completion.

2.12 RATES

2.12.1 Rates for Earthwork shall include the following:

(a) Excavation and depositing excavated material as specified.
(b) Handing of antiquities and useful material as specified on 2.2.
(c) Protection as specified in 2.3.

(d) Site clearance as specified in 2.4.
(e) Setting out and making profiles as specified in 2.5.
(f) Forming (or leaving) dead – men or 'Tell Tales' in borrow pits and their removal after measurements.
(g) Bailing out or pumping of rain water from excavations.
(h) Initial lead of 50 m and lift of 1.5 m.
(i) Blasting operations for hard rock as specified in 2.6.

2.12.2 No deduction shall be made from the rate if in the opinion of the Engineer- in-charge, operations specified in 2.12.1 (b) to (h) are not required to be carried out on any account whatsoever.

2.13 SURFACE EXCAVATION

2.13.1 Excavations exceeding 1.5 m in width and 10 sqm. on plan but not exceeding 30 cm. in depth in all types of soils and rocks shall be described as surface excavation and shall be done as specified in 2.7 and 2.8.

2.13.2 Measurements

The length and breadth shall be measured with a steel tape correct to the nearest cm. and the area worked out to the nearest two places of decimal in square metres.

2.13.3 Rate shall be as specified in 2.12.

2.14. ROUGH EXCAVATION AND FILLING

2.14.1 Excavation for earth from borrow pits, cutting hill side slopes etc. shall be described as rough excavation and shall be done as specified in 2.7, 2.8 and 2.9.

2.14.2 Wherever filling is to be done, the earth from excavation shall be directly used for filling and no payment for double handling of earth shall be admissible. Filling of excavated earth shall be done as specified in 2.10. In case of hill side cutting, where the excavated materials is thrown down the hill slopes, payment for filling excavated earth shall not be admissible.

2.14.3 Measurements shall be as specified in 2.11.

2.14.4 Rates shall be as specified in 2.12.

2.15 EXCAVATION OVER AREA (ALL KINDS OF SOIL)

2.15.1 This shall comprise**:**
(a) Excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth.
(b) Excavation for basements, water tanks etc.
(c) Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.

2.15.2 Excavation shall be done as specified in 2.7.

2.15.3 Measurements shall be as specified in 2.11.

2.15.4 Rates shall be as specified in 2.12.

2.16 EXCAVATION OVER AREA (ORDINARY/ HARD ROCK)

2.16.1 This shall comprise:
(a) Excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth.
(b) Excavation for basements, water tanks etc.
(c) Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.

2.16.2 Excavation shall be done as specified in 2.8 and 2.9.

2.16.3 Measurements shall be done as specified in 2.11.

2.16.4 Rates shall be as specified in 2.12.

2.17 EXCAVATION IN TRENCHES FOR FOUNDATIONS AND DRAINS (ALL KINDS OF SOIL)
2. 17.1 This shall comprise excavation not exceeding 1.5 m in width or 10 sqm on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

2.17.2 Excavation shall be done as specified in 2.7.

2.17.3 Measurements shall be as specified in 2.11.

2.17.4 Rates shall be as specified in 2.12.

2.18 EXCAVATION IN TRENCHES FOR FOUNDATION AND DRAINS (ORDINARY/ HARD ROCK)
2. 18.1 This shall comprise excavation not exceeding 1.5m in width or 10 sqm. On plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

2.18.2 Excavation shall be done as specified in 2.8. and 2.9.

2.18.3 Measurements shall be as specified in 2.11.

2.18.4 Rates shall be as specified in 2.12.

2.19 EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILLING
2.19.1 This shall comprise excavation not exceeding 1.5 mts in width or 10 sqm in plan and to any depth trenches for pipes. Cables etc. and returning the excavated material to fill the trenches after pipes, cables etc. are laid and their joints tested and passed and disposal of surplus excavated material upto 50 m lead.

2.19.2 Width of Trench

(a) Upto one metre depth the authorized width of trench for excavation shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.
(b) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical upto depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom.
(c) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.
(d) Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding increase in the width of trench. Sloping or shoring to be done for excavation in soft, loose or slushy soils.

2.19.3 Excavation : Shall be done as specified in 2.7, 2.8 and 2.9.

2.19.4 Refilling

Filling in trenches shall be commenced soon after the joints of pipes, cables, conduits etc. have been tested and passed. The space alround the pipes, cables conduits etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/ soft soil, the filling shall be done with earth on the side and top of pipes in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation trenches in ordinary/ hard rock, the filling upto a depth of 30cm above the crown of pipe, cable, conduits etc. shall be done with fine material like earth, moorum or pulverized/ decomposed rock according to the

availability at site. The remaining filling shall be done with boulders of size not exceeding 15cm mixed with fine material like decomposed rock, moorum or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30cm. Excavated material containing deleterious material, salt peter earth etc. shall not be used for filling. Ramming shall be done with iron rammers where feasible and with blunt ends of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, Cables, Conduits etc. laid in the trenches.

2.19.5 Measurements

2.19.5.1 Trenches for pipes, cables, conduits etc. shall be measured in running metre correct to the nearest cm in stages of 1.5 m depth and described separately as under:

(a) Pipes, cables, conduits, etc. not exceeding 80 mm dia.
(b) Pipes, cables, conduits etc. exceeding 80 mm dia but not exceeding 300mm dia.
(c) Pipes, cables, conduits etc. exceeding 300 mm dia.

2.19.5.2 Where two or more categories of each work are involved due to different classification of soil within the same stage of trench depth or where the soil is soft loose or slushy requiring increase in the width of trench or sloping sides or shoring, trenches for pipes, cables, conduits, etc. shall be measured in cubic metres as specified in 2.10. Extra excavation, if any, on account of collar/ socket of pipes shall neither be measured nor paid for separately.

2.19.6 Rates

The rate shall be as specified in 2.12 and shall also include the cost of refilling and all other operations described above.

2.20 PLANKING AND STRUTTING

2.20.1 When the depth of trench in soft/loose soil exceeds 2 metres, stepping, sloping and/ or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken, shall be determined by the Engineer-in-Charge according to the nature of soil.

Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be determined by the Engineer-in-Charge. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches from collapse. Engineer-in-Charge should take guidance from IS: 3764 for designing the shoring and strutting arrangements and specifying the profile of excavation.

2.20.2 Close Planking and Strutting

Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as directed by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs**.** One boards on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench. Typical sketch of close timbering is given in Fig. 2.2.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

2.20.3 Open Planking and Strutting

In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick, shall be spaced sufficiency apart to leave unsupported strips of 50 cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in- Charge. In all other respect, specifications for close planking and strutting shall apply to open planking and strutting. Typical sketch of open planking and strutting is given in fig. 2.2.

2.20.4 Measurements

The dimensions shall be measured correct to the nearest cm and the area of the face supported shall be worked out in square metres correct to two places of decimal.

2.20.4.1 Works shall be grouped according to the following:

(a) Depth not exceeding 1.5 m.
(b) Depth exceeding 1.5m in stages of 1.5 m.

2.20.4.2 Planking and strutting to the following shall be measured separately:

(a) Trenches.
(b) Areas- The description shall include use and waste of raking shores.
(c) Shafts, walls, cesspits, manholes and the like
(d) Where tightly driven close but jointed sheeting is necessary as in case of running sheeting is necessary as in case of running sand the item shall be measured separately and packing of cavities behind sheeting with suitable materials included with the item.
(e) Planking and strutting required to be left permanently in position shall be measured separately.

2.20.5 Rates

Rates shall include use and waste of all necessary timber work as mentioned above including fixing and subsequent removal.

2.21 EXCAVATION IN WATER. MUD OR FOUL POSITION

2.21.1 All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundation trenches or from a sump out side the excavation in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be decided from time to time in consultation with the Engineer-in-Charge.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

2.21.2 Classification

The earth work for various classification of soil shall be categorised as under:

(a) ***Work in or under water and/or liquid mud:*** Excavation, where water is met with from any of the sources specified in 2.21.1 shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the sub-soil water level in that area.

(b) Work in or under foul position: Excavation, where sewage, sewage gases or foul conditions are met with from any source, shall fall in this category. Decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

2.21.3 Measurements

2.21.3.1 The unit, namely, metre depth shall be the depth measured from the level of foul position/ sub-soil water level and upto the centre of gravity of the cross sectional area of excavation actually done in the conditions classified in 2.21.2. Metre depth shall be reckoned correct to 0.1 m, 0.05 m or more shall be taken as 0.1 m and less than 0.05 m ignored. The extra percentage rate is applicable in respect of each item but the measurements shall be limited only to the quantities of earth work actually executed in the conditions classified in 2.21.2.

2.21.3.2 In case earth work in or under foul position is also in or under water and/or liquid mud, extra payment shall be admissible only for the earth work actually executed in or under foul position.

2.21.3.3 Pumping or bailing out water met within excavations from the sources specified in 2.21.1 where envisaged and specifically ordered in writing by the Engineer-in-Charge shall be measured separately and paid. Quantity of water shall be recorded in kilolitres correct to two places of decimal. This payment shall be in addition to the payment under respective items of earthwork and shall be admissible only when pumping or bailing out water has been specifically ordered by the Engineer-in-Charge in writing.

2.21.3.4 Planking and strutting or any other protection work done with the approval of the Engineer- in-Charge to keep the trenches dry and/or to save the foundations against damage by corrosion of rise in water levels shall be measured and paid for separately.

2.21.3.5 Bailing or pumping out water, accumulated in excavation, due to rains is included under respective items of earthwork and is not to be paid separately.

2.21.4 Rates

The rates for respective items described above shall include cost of all the operations as may be applicable.

Note: NIT approving authority may make work specific special conditions considering magnitude of works, soil and water table condition etc.

2.22 DELETED

2.23 FILLING IN TRENCHES, PLINTH, UNDER FLOOR ETC.

2.23.1 Earth

Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling**.**

2.23.2 Filling

The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

2.23.3 Measurements

2.23.3.1 ***Filling Side of Foundations:*** The cubical contents of bed concrete levelling course and masonry/ concrete in foundations upto the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal**.**

2.23.3.2 ***Filling in Plinth and under Floors:*** Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical content worked out in cubic metres correct to two places of decimal.

2.23.4 Rates

The rates include cost of all the operations described above.

2.24 SAND FILLING IN PLINTH

2.24.1 Sand

Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V specified in Section 3 'Mortars'**.**

2.24.2 Filling

Sand filling shall be done in a manner similar to earth filling in plinth specified in 2.23.3.2. except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-Charge has inspected and approved the sand filling.

2.24.3 Measurements

The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal.

2.24.4 Rates

The rates include the cost of material and labour involved in all the operations described above.

2.25 SURFACE DRESSING.

2.25.1 Surface dressing shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level and removal of rubbish and other excavated material upto a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled upto the required level with the excavated earth so as to give an even, neat and tidy look.

2.25.2 Measurements

Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square metres correct to two places of decimal.

2.25.3 Rates

The rates shall include cost of labour involved in all the operations described above.

2.26 JUNGLE CLEARANCE

2.26.0 Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level. Where only clearance of grass is involved it shall be measured and paid for separately**.**

2.26.1 Uprooting of Vegetations

The roots of trees and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and levelled. Trees, shrubs, poles, fences, signs, monuments, pipe lines, cable etc., within or adjacent to the area which are not required to be disturbed during jungle clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

2.26.2 Stacking and Disposal

All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the Engineer -in-Charge. Trunks and branches of trees shall be cleared of limbs and tops and stacked neatly at places indicated by the Engineer-in- Charge. The materials shall be the property of the Government. All unserviceable materials which in the opinion of the Engineer-in-Charge cannot be used or

auctioned shall be removed up to a distance of 50 m outside the periphery of the area under clearance. It shall be ensured by the contractor that unserviceable materials are disposed off in such a manner that there is no likelihood of getting mixed up with the materials meant for construction.

2.26.3 Clearance of Grass

Clearing and grubbing operation involving only the clearance of grass shall be measured and paid for separately and shall include removal of rubbish upto a distance of 50 m outside the periphery of the area under clearance**.**

2.26.4 Measurements

The length and breadth shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

2.26.5 Rates

The rate includes cost of all the operation described above.

Note: Jungle clearance and clearance of grass are not payable separately for the earth work specified in 2.13 to 2.19.

2.27 FELLING TREES

2.27.1 Felling

While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling trees shall include taking out roots upto 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20 cm layers and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-Charge.

2.27.2 Stacking and Disposal

Wood, branches, twigs of trees and other useful material shall be the property of the Government. The serviceable materials shall be stacked in the manner as directed by the Engineer-in-Charge upto a lead of 50m.

All unserviceable material, which in the opinion of Engineer-in-Charge cannot be used or auctioned shall be removed from the area and disposed off as per the directions of the Engineer-in-Charge. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

2.27.3 Measurements

Cutting of trees above 30 cm in girth (measured at a height of one metre above level) shall be measured in numbers according to the sizes given below:

(a) Beyond 30 cm girth, upto and including 60cm girth.
(b) Beyond 60 cm girth, upto and including 120 cm girth.
(c) Beyond 120 cm girth, upto and including 240 cm girth.
(d) Above 240 cm girth.

2.27.4 Rate

The rate includes the cost involved in all the operations described above. The contract unit rate for cutting trees above 30 cm in girth shall include removal of stumps as well.

2.28 ANTI-TERMITE TREATMENT

2.28.0 Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre- constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.28.1 Materials

2.28.1.0 ***Chemicals:*** Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:

(i) Chlorphriphos emulsifiable concentrate of 20%
(ii) Lindane emulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

Engineer -in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer-in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

2.28.1.1 ***Measurements:*** Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.

2.28.1.2 ***Rate:*** The Rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

2.28.2 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.28.3 Anti-Termite Treatment: Constructional Measures

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

(i) Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery. [See Fig. 2.3(i)]

(ii) Brick on edge masonry in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of plinth wall for getting anticipated offset space for coarse sand and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer. [See Fig. 2.3(ii)]

(iii) The dry brick for the anti-termite groove shall be taken out and dense cement concrete 1:3:6 (1 cement : 3 sand : 6 coarse aggregate by volume) sub-floor carpet shall be laid casting the anti-termite groove in position. In case of internal partition walls, the cement concrete sub-floor shall be laid on either side over the dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling. [See Fig. 2.3(iii)]

(iv) Superstructure masonry shall be raised over the dense cement concrete sub floor carpet and over-head jobs completed. [See Fig. 2.3)(iv)]

(v) The dry brick for coarse sand layer shall be removed and graded sand (of size 3 to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling and underneath the partially laid dense cement concrete sub-floor carpet [See Fig. 2.3)(v)]

(vi) Dense cement concrete (1:3:6 mix.) sub-floor at least 75 mm thick shall be laid over the sand filling. Necessary finish may be provided to the cement concrete sub-floor carpet. [See Fig. 2.3)(vi)]

(vii) Dry brick provided for apron floor shall be taken out and 600 mm wide formation of earth in 1:30 slope shall be made. Over the formation, 75 mm thick lime concrete 1:3:6 (1 lime:3 sand: 6 coarse aggregate, by volume) shall be laid. [See Fig. 2.3)(vii)]

(viii) Over the 75 mm thick like concrete bed at least 25 mm thick cement concrete topping 1:2:4 (1 cement: 2 sand: 4 fine aggregate, by volume) shall be laid and 12 mm thick cement plaster shall be applied on foundation and plinth. [See Fig. 2.3)(viii)]

The final recommendations incorporating the constructional details given above (i to viii) are shown in Fig. 2.4.

2.28.4 Anti Termite Treatment : Treatment for Existing Building: Post Construction Treatment

2.28.4.1 *Material*

(i) Chemicals : Any one of the following chemicals conforming to relevant Indian Standards in water emulsion may be used for soil treatment in order to protect a building from termite attack.

Chemical with Percent		Relevant Indian Standards (Active ingredient)	Concentration by weight
Chlorpyrifos	20EC	IS 8944	1.0
Lindane	20EC	IS 632	1.0

These chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemicals

should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration. Oil or kerosene based solution of chlorpyrifos 20 EC or Lindane 20 EC, 1.0 percent (by weight) concentration is useful for treatment of wood. Engineer-in-charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized representative. Chemical shall be kept in the custody of the Engineer-in-charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-charge or his authorized representative.

(ii) *Measurements :* Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.

(iii) *Rate :* The rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

(iv) *Safety Precautions :* Chemical used for antitermite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons carrying out chemical soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in diluted form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

2.28.4.2 *Treatment*

(i) Once the termites have an ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Anti termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall be done as per IS 6313 (Part III). Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized dealers.

(ii) ***Treatment along outside of foundations:*** The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre.

In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sqm. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

(iii) ***Treatment of Soil under Floors :*** The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

(a) At the junction of the floor and walls as result of shrinkage of the concrete;
(b) On the floor surface owing to construction defects;
(c) At construction joints in a concrete floor, cracks in sections; and
(d) Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

(iv) ***Treatment of Voids in Masonry :*** The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plilnth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

(v) ***Treatment at Points of Contact of Wood Work :*** The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a dowonward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

Infested wood work in chaukhats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm centre to centre and should cover in entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

2.28.4.3 *Measurements :* All dimensions shall be measured correct to a cm. The measurements shall be made of the surface actually provided with anti termite treatment. Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below:

(i) *Treatment along outside of foundations :* The measurements shall be made in running metres taking length along the plinth of the building.
(ii) *Treatment of soil under floors :* The measurements shall be made in square metres, inside clear dimensions of rooms, verandah etc. shall be taken.
(iii) *Treatment of voids in masonry :* The measurements shall be made in running metres along the plinth of the building.
(iv) *Treatment of wood work :* The measurements shall be made in running metres for chowkhats, joints, purlins, beams etc.

2.28.4.4 Rates

The rate shall include the cost of labour and all other inputs (except concentrated chemical) involved in all the operations described above including drilling, refilling and making good the holes.

2.28.4.5 Treatment of Electrical Fixtures

If infestation in electrical fixture (like switch boxes in the wall) is noticed, covers of the switch boxes shall be removed and inside of such boxes shall be treated liberally with 5 per cent Malathion dusting powder. The covers of the switch boxes shall be refixed after dusting.

2.29 FILLING WITH FLYASH AND EARTH

2.29.1 Earth

The earth shall be as specified under para 2.23.1.

2.29.2 Flyash

Flyash be procured from nearest local power plant. To prevent dust, it should be kept moist by sprinkling of water.

2.29.3 Filling

The space around the foundation and drains in trenches shall be cleared of all debris, brick bats etc. Filling with available excavated earth and flyash shall be done in regular horizontal layers. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt and of crow bars where rammers can not be used. Intermediate layer of compacted earth not exceeding 15 cm shall be placed after every four layers of compacted depth of flyash (each layer should not exceed 15 cm). The sides and top layer of filling shall be done with earth having minimum compacted thickness of 30 cm. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the tranches. In case of filling in embankment, consolidation of flyash/earth shall be done with power roller to achieve soil density of 98%.

2.29.4 Measurement

2.29.4.1 Filling sides of foundations:-The mode of measurements shall be the same, as specified in para 2.23.3.1.

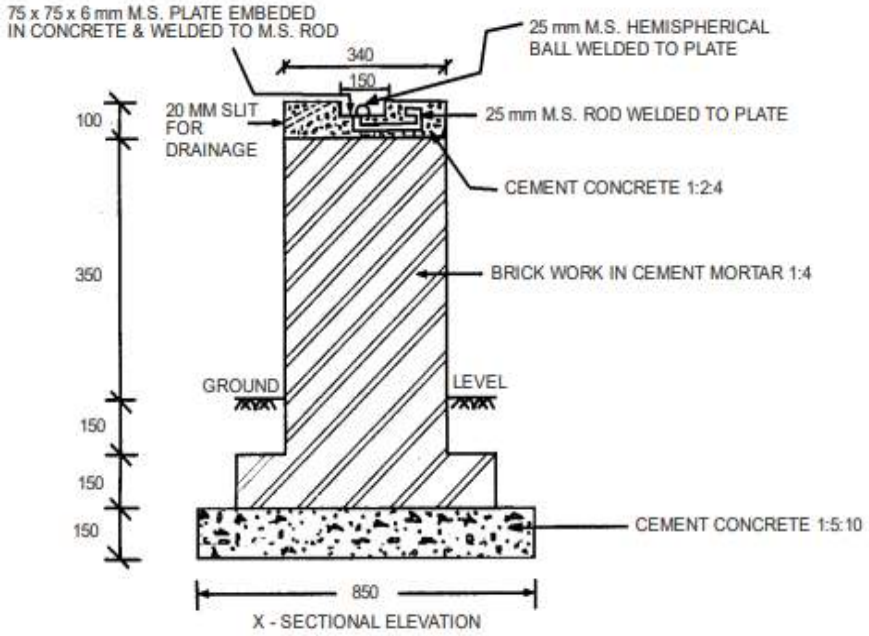
2.29.4.2 Filling in embankment:-Depth of filling shall be the consolidated depth. The length, breadth and depth shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal.

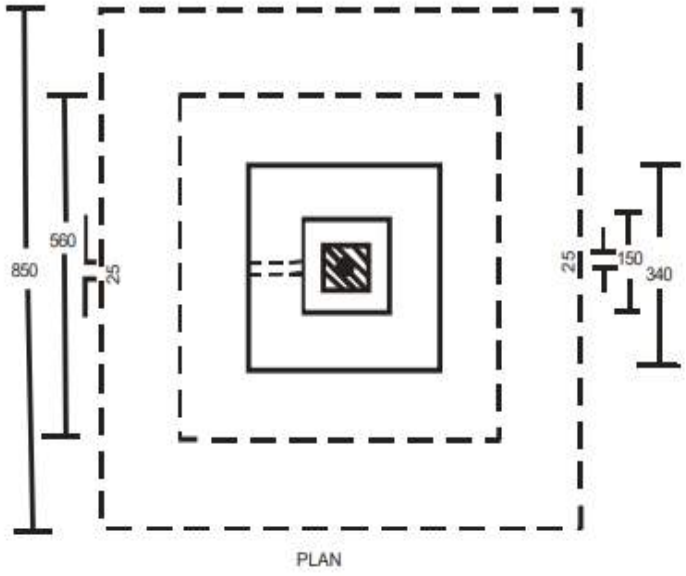
2.29.5 Rates

The rates include the cost of material and labour involved in all the operations described above

THE DESIGN FOR TEMPORARY SITE BENCH MARK

Sub Head : Earthwork
Clause : 2.5.1





DRAWING NOT TO SCALE

ALL DIMENSIONS ARE IN M.M.

Fig. 2.1 : Design for Temporary Site Bench Mark

CLOSE AND OPEN PLANKING AND STRUTTING

Sub Head : Earthwork
Clause : 2.20.2 and 2.20.3

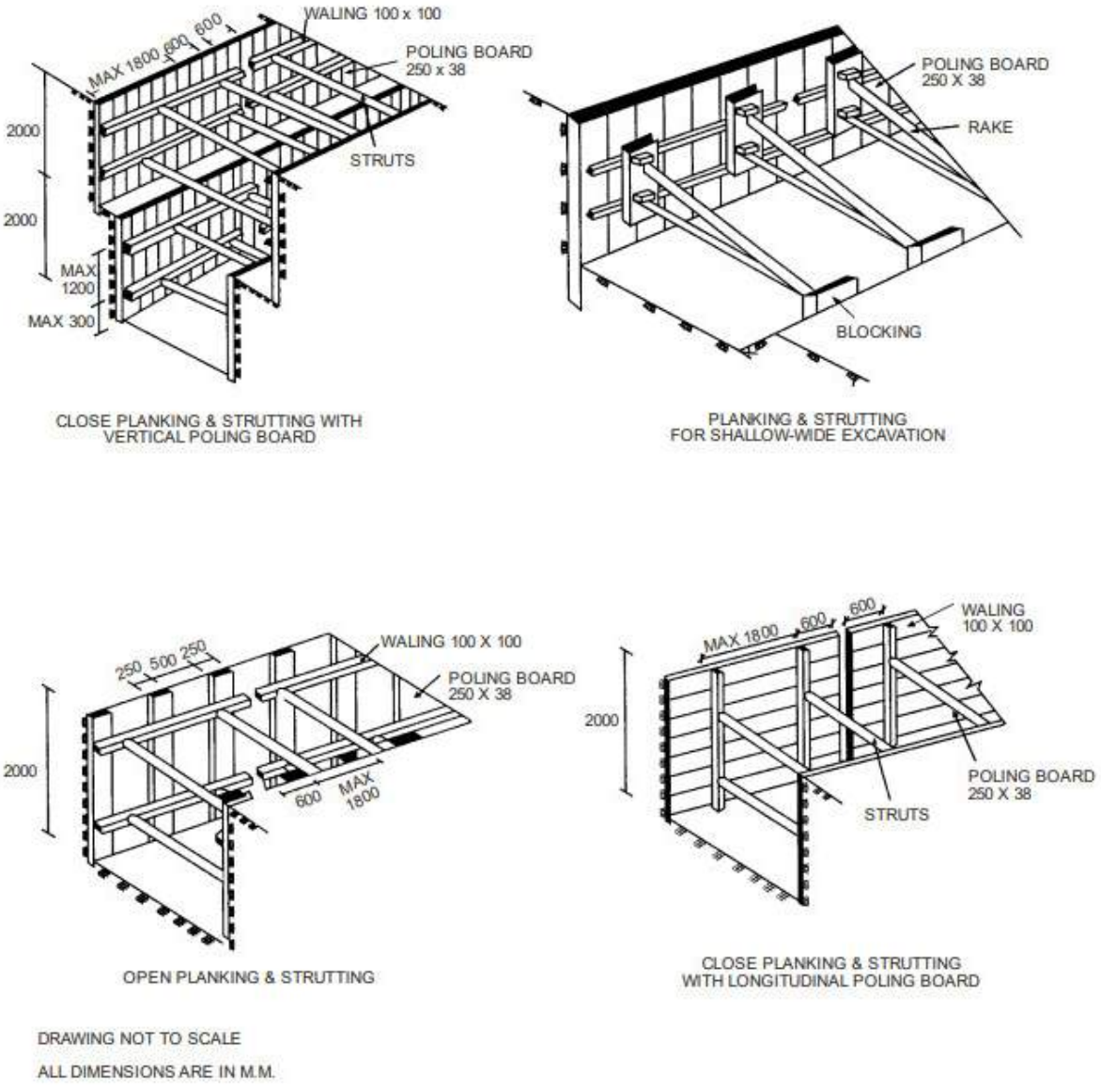
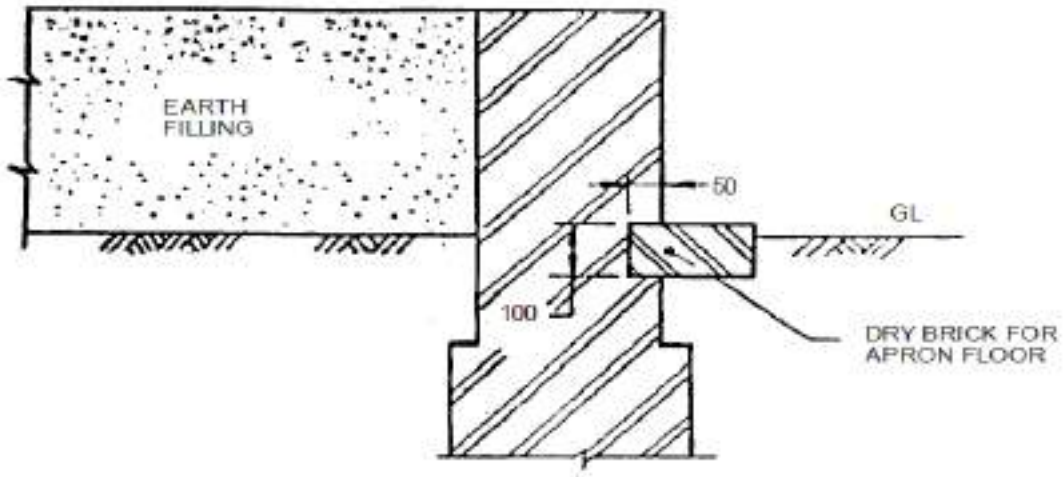


Fig. 2.2 : Close & Open Planking & Strutting

ANTI-TERMITE CONSTRUCTION STAGE -1

Sub Head : Earthwork
Clause : 2.28.3(i)

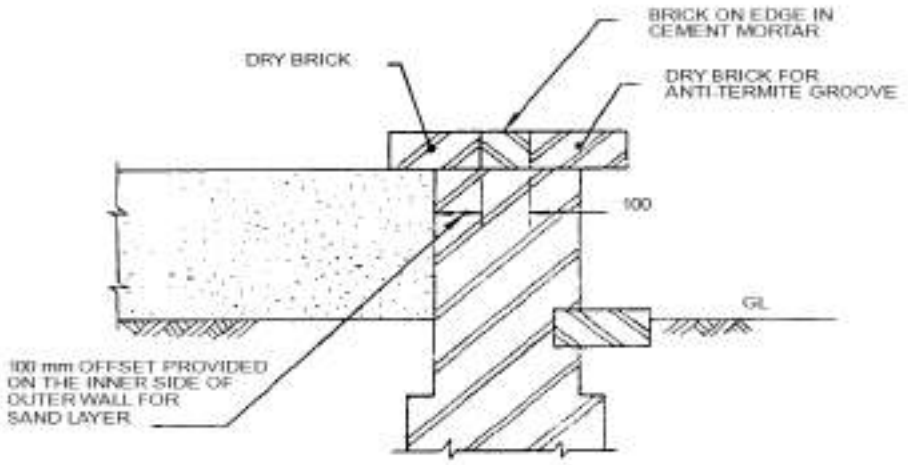


Drawing not to Scale
All dimensions in millimetres

Fig. 2.3(i) : Anti-Termite Construction – Stage 1

ANTI-TERMITE CONSTRUCTION STAGE -2

Sub Head : Earthwork
Clause : 2.28.3(ii)



Drawing not to Scale
All dimensions in millimetres

Fig. 2.3(ii) : Anti-Termite Construction – Stage 2

ANTI-TERMITE CONSTRUCTION STAGE -3

Sub Head : Earthwork
Clause : 2.28.3(iii)

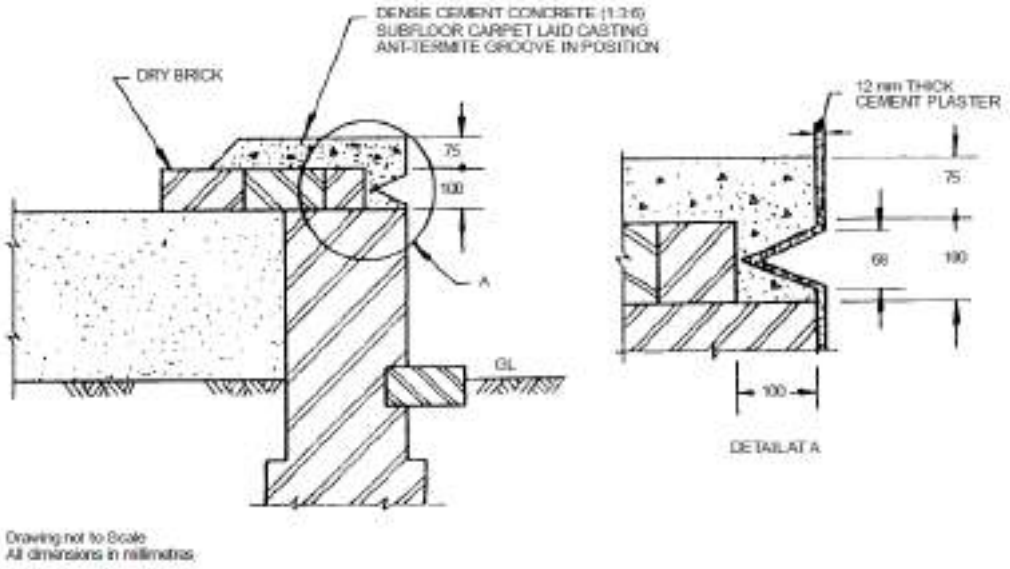


Fig. 2.3(iii) : Anti-Termite Construction – Stage 3

ANTI-TERMITE CONSTRUCTION STAGE -4

Sub Head : Earthwork
Clause : 2.28.3(iv)

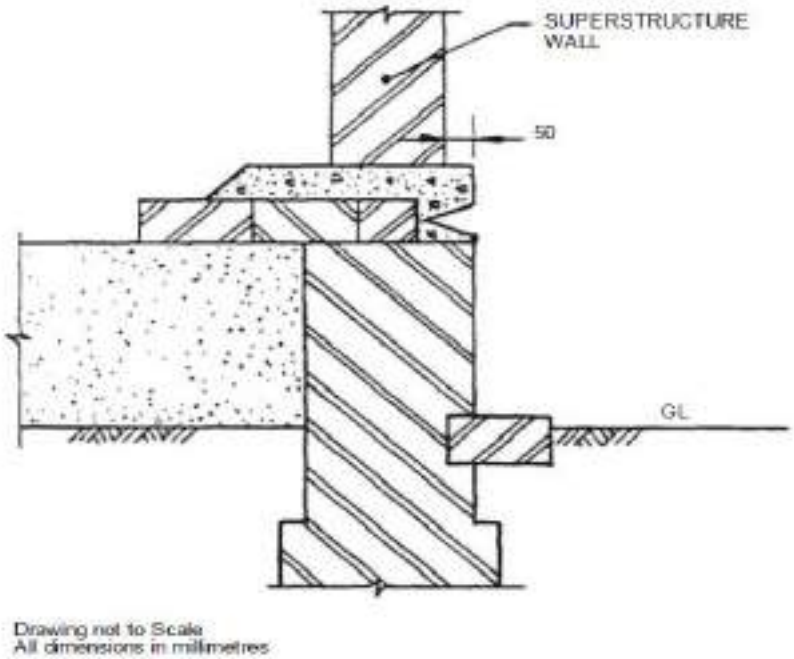


Fig. 2.3(iv) : Anti-Termite Construction – Stage 4

ANTI-TERMITE CONSTRUCTION STAGE -5

Sub Head : Earthwork
Clause : 2.28.3(v)

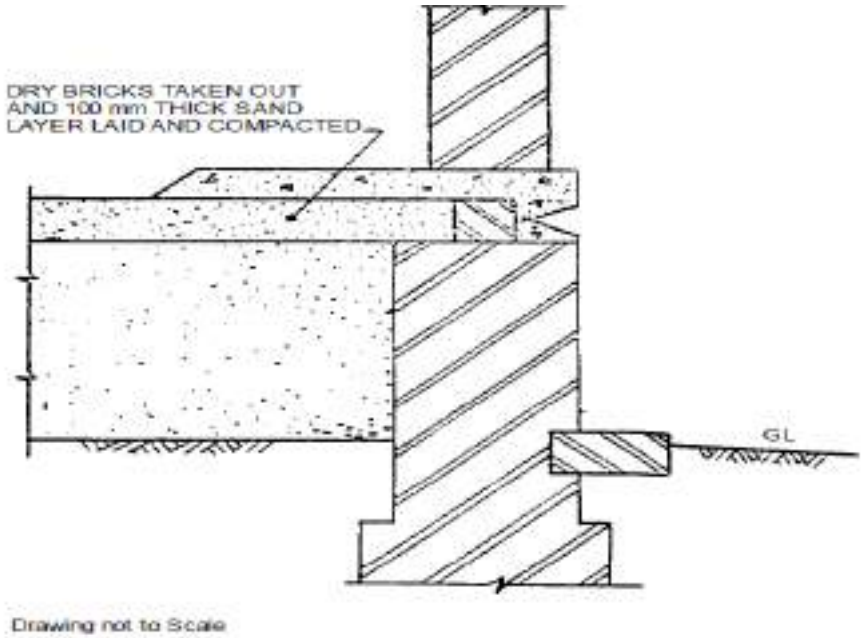


Fig. 2.3(v) : Anti-Termite Construction – Stage 5

ANTI-TERMITE CONSTRUCTION STAGE -6

Sub Head : Earthwork
Clause : 2.28.3(vi)

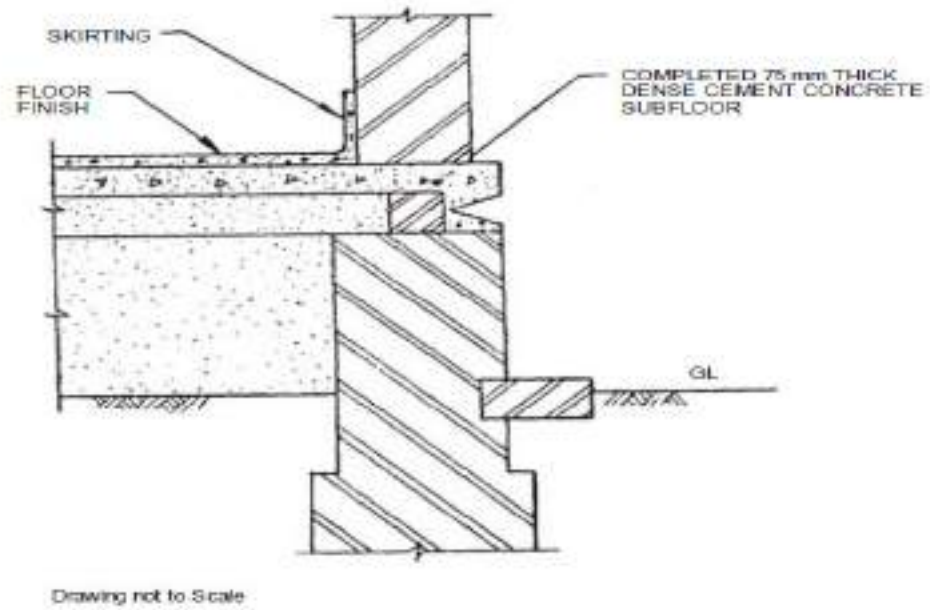
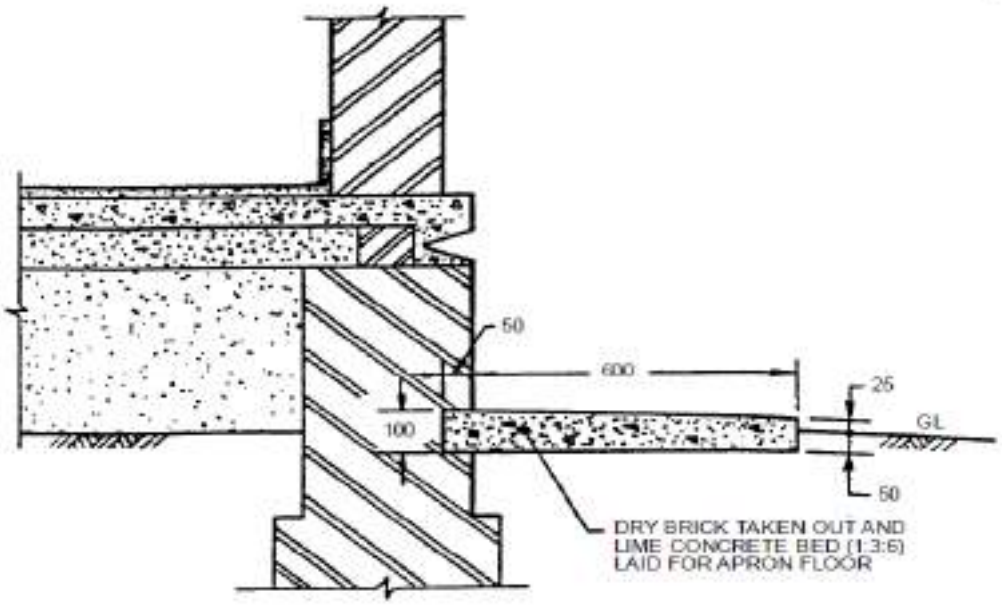


Fig. 2.3(vi) : Anti-Termite Construction – Stage 6

ANTI-TERMITE CONSTRUCTION STAGE -7

Sub Head : Earthwork
Clause : 2.28.3 (vii)

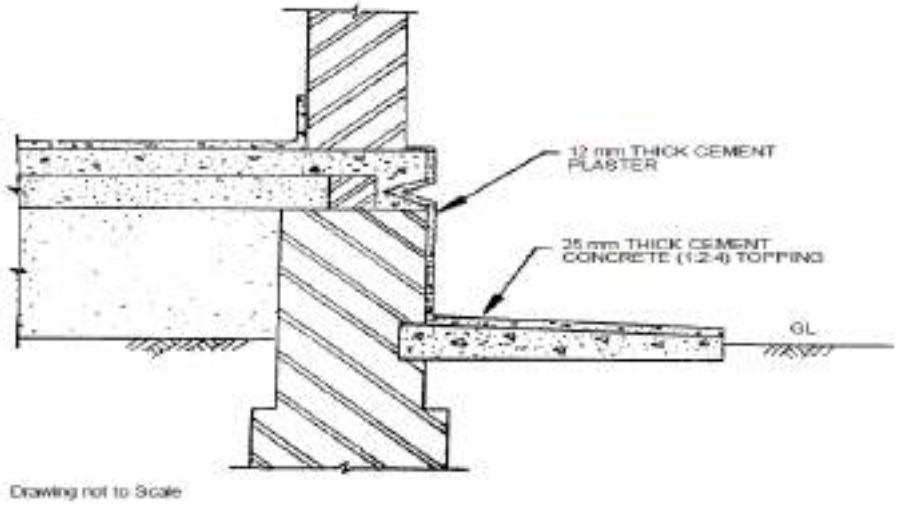


Drawing not to Scale
All dimensions in millimetres

Fig. 2.3(vii) : Anti-Termite Construction – Stage 7

ANTI-TERMITE CONSTRUCTION STAGE -8

Sub Head : Earthwork
Clause : 2.28.3(viii)



Drawing not to Scale

Fig. 2.3(viii) : Anti-Termite Construction – Stage 8

ANTI-TERMITE CONSTRUCTION FINAL RECOMMENDATIONS

Sub Head : Earthwork
Clause : 2.28.3(viii)(a)

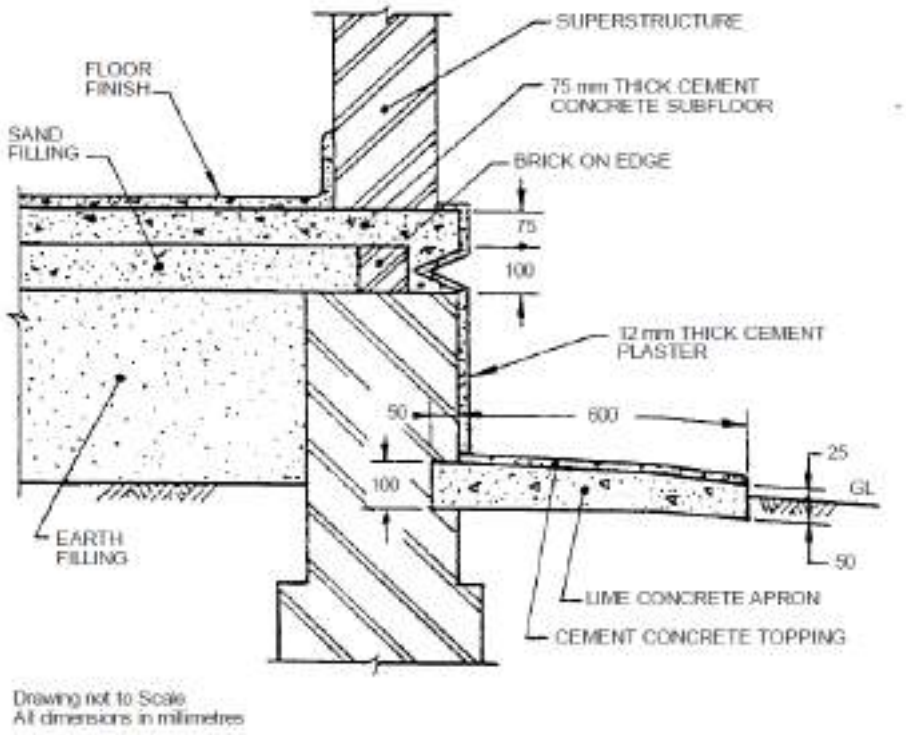


Fig. 2.4 : Anti-Termite Construction – Final Recommendations

SUB HEAD : 3.0

MORTARS

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	63
	List of Bureau of Indian Standard Codes	65
3.0	General	66
3.1	Materials	66
3.2	Preparation of Mortars & its Grade	72
Appendix A	Test for Organic Impurities	74
Appendix B	Test for Particle size (Sieve Analysis)	75
Appendix C	Test for Silt Content	76
Appendix D	Bulking of Fine Aggregates/ Sand (Field Methods)	77
Appendix E	Physical Requirements of Fly Ash	78
Appendix F	Criteria for Selection of Masonry Mortars	79

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ laboratory test*	*Test procedure*	*Min. quantity of material for carrying out the test*	*Frequency of testing*
1	*2*	*3*	*4*	*5*	*6*	*7*
Water	3.1.1	(i) pH Value (ii) Limits of Acidity (iii) Limits of Alkalinity (iv) Percentage of solids (a) Chlorides (b) Suspended matter (c) Sulphates (d) Inorganic solids (e) Organic solids	Lab Lab Lab Lab Lab Lab Lab Lab Lab	IS 3025	-	Water from each source shall be got tested before the commencement of work and thereafter once in every three months till the completion of the work. Water from municipal source need be tested only once in six months. Number of Tests for each source shall be 3
Cement	3.1.2	(a) Physical requirement (i) Fineness (ii) Soundness (iii) Setting time (Initial & Final) (iv) Compressive strength (v) Consistency of standard cement paste	 Lab Lab Lab Lab Lab	 IS 4031 (Part II) IS 4031 (Part III) IS 4031 (Part V) IS 4031 (Part VI) IS 4031 (Part **IV)-1988 (Reaffirm 2014)**	 Each lot	 Every 50 tonnes or part thereof. Each brand of cement brought to site shall be tested as per this frequency.
Sand	3.1.3.1	Organic impurities	Field	Appendix 'A'	20 cum	Every 20 cum or part thereof or more frequently as decided by Engineer-in-Charge.
	3.1.3.2	Silt Content	Field	Appendix C	20 cum	-do-
	3.1.3.4	Particle size distribution	Field or Labor-atory as decided by the Engin-eer-in-charge	Appendix B	40 cum	40 cum or part thereof

1	2	3	4	5	6	7
Sand	3.1.3.5	Bulking of Sand	Field	Appendix D	20 cum	Every 20 cum or part thereof or more frequently as decided by Engineer-in-Charge.
Fly Ash	3.1.5 & 3.1.5.1	Total chloride in percent by mass, max.	Lab	IS 12423	10 cum	Every 10 cum or part thereof or more
		Loss of ignition in percent by mass, max.	Lab	IS 1727	10 cum	Frequency as decided by Engineer-in-charge
		Fineness, specific surface in m^2/kg	Lab/field	Blaine's permeability method	10 cum	-do-
		Compressive strength at 28 days in N/mm^2, Min.	Lab.	-	10 cum	Only in cases when fly ash is used as pozzolana in cement

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*I.S. No.*	*Subject*
1	IS 269	Specification for 33 grade ordinary Portland cement
2	IS 383	Specification for coarse and fine aggregate from natural source for concrete.
3	IS 455	Specification for Portland slag cement.
4	IS 460 (Part I)	Specification for test sieves: wire cloth test sieves.
5	IS 650	Specification for standard sand for testing of cement
6	IS 1269	Specification for 53 grade ordinary Portland cement
7	IS 1344	Specification for calcined clay Pozzolana.
8	IS 1489	Specification for Portland pozzolana cement
9	IS 1542	Specification for sand for plaster
10	IS 1727	Methods of Test for Pozzolanic materials
11	IS 2116	Specification for sand for masonry mortar.
12	IS 2250	Code of practice for preparation and use of masonry Mortar.
13	IS 2386 (Pt-I)	Method of test for aggregate for concrete (Particle size and shape)
14	IS 2386 (Pt-II)	-Do- Estimation of deleterious materials and organic impurities.
15	IS 2386 (Pt-III)	-Do- Specific gravity, density, voids, absorption and bulking.
16	IS 3025	Method of sampling and test for water
17	IS 3406	Specification for masonry cement.
18	IS 3812 (Part I)	Specification for fly ash for use as pozzolana in cement mortar and concrete
19	IS 3812 (Part II)	Specification for flyash for use as admixture in cement mortar and concrete
20	IS 4031 (Part I) to (Part XIII)	Method of Physical test for hydraulic cement
21	IS 4032	Method of chemical analysis of Hydraulic cement.
22	IS 8041	Rapid hardening Portland cement.
23	IS 8042	Specification for white cement
24	IS 8043	Hydrophobic Portland cement
25	IS 8112	Specification for 43 grade ordinary Portland cement
26	IS 11652	Woven HDPE sacks for packing cement
27	IS 11653	Woven polypropylene sacks for packing cement
28	IS 12174	Jute synthetic union bags for packing cement

3.0 MORTARS

3.0 GENERAL

Desirable properties of mortars for use in masonry are:

(a) Workability
(b) Water retentivity
(c) Rate of stiffing
(d) Strength
(e) Resistance to rain penetration
(f) Durability

3.1 MATERIALS

3.1.1 Water

3.1.1.1 Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel. potable water is generally considered satisfactory for mixing. The Ph value of water shall be not less than 6. The following concentrations represent the maximum permissible values: (of deleterious materials in water).

(a) ***Limits of Acidity:*** To **neutralize** 100ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The details of test shall be as given in IS 3025 (part 22).

(b) ***Limits of Alkalinity:*** To **neutralize** 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H_2SO_4. The details of tests shall be as given in IS 3025 (part 23)**-1986 (Reaffirm 2003).**

(c) ***Percentage of Solids:*** Maximum permissible limits of solids when tested in accordance with IS 3025 shall be as under:

Organic	200mg/ litre
Inorganic	3000 mg/ litre
Sulphates	400 mg/ litre
Chlorides	2000 mg/ litre.for concrete not containing embedded steel and 500 mg./ltr.for reinforced concrete work.
Suspended matter	2000 mg/ litre

The physical and chemical properties of ground water shall be tested along with soil investigation and if the water is not found conforming to the requirements of IS 456-2000, the tender documents shall clearly specify that the contractor has to arrange good quality water for construction indicating the source.

3.1.1.2 Water found satisfactory for mixing is also suitable for curing. However, water used for curing shall not produce any objectionable stain or unsightly deposit on the surface.

3.1.1.3 Sea water shall not be used for mixing or curing

3.1.1.4 Water from each source shall be tested before the commencement of the work and thereafter once in every three months till the completion of the work. In case of ground water, testing shall also be done for different points of drawdown. Water from each source shall be got tested during the dry season before monsoon and again after monsoon.

3.1.2 Cement

3.1.2.1 The cement used shall be any of the following grade and the type selected should be appropriate for the intended use.

(a) 33 grade ordinary Portland cement conforming to IS 269**-2013.**
(b) 43 grade ordinary Portland cement conforming to IS 8112**-2013.**
(c) 53 grade ordinary Portland cement conforming to IS 12269**-2013.**
(d) Rapid hardening Portland cement conforming to IS 8041**-1990, Reaffirm Apr 2014**
(e) Portland slag cement conforming to IS 455-**1989, Reaffirm Apr 2014.**
(f) Portland Pozzolana cement (flyash based) conforming to IS 1489 (Part 1**)-1991, Reaffirm Apr 2014.**
(g) Portland Pozzolona cement (calcined clay based) conforming to IS 1489 (part 2**)-1991, Reaffirm Apr 2014.**
(h) Hydrophobic **Portland** cement conforming to IS 8043**-1991, Reaffirm Apr 2014.**
(i) Low heat Portland cement conforming to IS 12600-1989, **Reaffirm Apr 2014.**
(j) Sulphate resisting Portland cement conforming to IS 12330**-1988, Reaffirm Apr 2014.**
(k) White cement conforming to IS 8042-**1989, Reaffirm Apr 2014.**

Different types of cement shall not be mixed together. In case more than one type of cement is used in any work, a record shall be kept showing the location and the types of cement used.

3.1.2.2 ***Caution in Use of Cement Grade 53 in Construction:*** Because of the faster hydration process, the concrete releases heat of hydration at a much faster rate initially and release of heat is the higher in case of Grade. 53. The heat of hydration being higher, the chances of micro-cracking of concrete is much greater. Thus, during initial setting period of concrete, the higher heat of hydration can lead to damaging micro-cracking within the concrete which may not be visible at surface. This cracking is different from shrinkage cracks which occurs due to faster drying of concrete in windy conditions.

The situation can be worse when we tend to increase the quantity of the cement in the concrete with a belief that such increases are better for both strength and durability of concrete. Thus, it is very essential to be forewarned that higher grade cement specially grade 53 should be used only where such use is warranted for making higher strength concrete and also where good Quality Assurance measures are in place, by which proper precaution are taken to relieve the higher heat of hydration through chilling of aggregates or by proper curing of concrete. There are instances where higher grade cement is being used even for low strength concrete, as, mortar or even for plastering. This can lead to unnecessary cracking of concrete/ surfaces.

Another issue to be cautioned against is the tendency of the manufacturers to project Grade 53 cement as stronger cement, whereas Grade 33 or 43 are enough to produce the concrete of desired characteristic strength. The scenario of method of production of cement by various manufacturers should also be kept in mind while ordering various grades of cement. The ability to produce cements of particular fineness get fixed by the machinery installed by the manufacturers, and thus the ability to produce other various grades of cement by a particular manufacturer also gets limited. Whereas tendency today is to supply the consumer what he orders for by the manufacturers by simply stamping such grades on the bags. Thus, it is often observed that cement bags marked as grade 33 or 43 may really be containing cements of much higher grade.

3.1.2.3 ***Compressive Strength :*** Compressive strength requirement of each type of cement for various grades when tested in accordance with IS 4031 (part 6) shall be as under:

Sample	Strength in N/mm^2 not less than for		
Age at testing	Gr. 33	Gr.43	Gr. 53
72 + 1 hr	16	23	27
168 + 2 hrs	22	33	37
672 + 4 hrs	33	43	53

3.1.2.4 ***Setting Time:*** Setting time of cement of any type of any grade when tested by Vicat apparatus method described in IS 4031 **(Part-5)-1988 (Reaffirm-2014)** shall conform to the following requirement:

(a) Initial setting time: Not less than 30 minutes
(b) Final setting time: Not more than 600 minutes

3.1.2.5 ***Supply :*** The cement shall be packed in jute sacking bags conforming to IS 2580, double hessian bituminized (CRI type) or woven HDPE conforming to IS 11652. Woven polypropylene conforming to IS 11653, jute synthetic union conforming to IS: 12174, or any other approved composite bags, bearing the manufacturer's name or his registered trade mark if any, with grade batch no. and type of cement, with date of manufacturing of batch of cement.

Every delivery of cement shall be accompanied by a producer's certificate conforming that the supplied cement conforms to relevant specifications. These certificates shall be endorsed to the Engineer-in-Charge for his record.

Every consignment of cement must have identification marks on packages indicating date of manufacturing grade and type of cement batch no. etc. **Cement** brought to works shall not be more than 6 weeks old from the date of manufacture.

Effective precautionary measures shall be taken to eliminate dust-nuisance during loading or transferring cement.

3.1.2.6 ***Stacking and Storage :*** Cement in bags shall be stored and stacked in a shed which is dry, leakproof and as moisture-proof as possible. Flooring of the shed shall consists of the two layers of dry bricks laid on well consolidated earth to avoid contact of cement bags with the floor. Stacking shall be done about 150 to 200 mm clear above the floor using wooden planks. Cement bags shall be stacked at least 450 mm clear off the walls and in rows of two bags leaving in a space of atleast 600 mm between two consecutive rows. In each row the cement bags shall be kept close together so as to reduce air circulation. Stacking shall not be more than 10 bags high to avoid lumping under pressure. In stacks more than 8 bags high, the cement bags shall be arranged in header and stretcher fashion i.e. alternately lengthwise and crosswise so as to tie the stacks together and minimise the danger of toppling over.

A typical arrangement for storing and stacking of cement is shown in Fig. 1. of sub-head of Carriage of Materials.

Different types of cement shall be stacked and stored separately.

Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

For extra safety during monsoon, or when cement is expected to be stored for an unusually long period, each stack shall be completely enclosed by a water proofing membrane, such as polyethylene, which shall cover the top of the stack. Care shall be taken to see that the water proofing membrane is not damaged at any time during use.

Storage of cement at the work site shall be at the contractor's expense and risk. Any damage occurring to cement due to faulty storage in contractor's shed or on account of negligence on his part shall be the liability of the contractor.

3.1.3 Fine Aggregate

3.1.3.1 Aggregate most of which passes through 4.75 mm IS sieve is known as fine aggregate. Fine aggregate shall consist of natural sand, crushed stone sand, crushed gravel sand stone dust or marble dust, fly ash and broken brick (Burnt clay) . It shall be hard, durable, chemically inert, clean and free from adherent coatings, organic matter etc. and shall not contain any appreciable amount of clay balls or pellets and harmful impurities e.g. iron pyrites, alkalies, salts, coal, mica, shale or similar laminated materials

in such form or in such quantities as to cause corrosion of metal or affect adversely the hardening, the strength, the durability or the appearance of mortar, plaster or concrete. The sum of the percentages of all deleterious material shall not exceed 5%. Fine aggregate must be checked for organic impurities such as decayed vegetation humps, coal dust etc. in accordance with the procedure prescribed in Appendix 'A' of Chapter 3.

3.1.3.2 ***Silt Content :*** The maximum quantity of silt in sand as determined by the method prescribed in Appendix 'C' of Chapter 3 shall not exceed 8%.

Fine aggregate containing more than allowable percentage of silt shall be washed as many times as directed by Engineer-in-charge so as to bring the silt content within allowable limits for which nothing extra shall be paid.

3.1.3.3 ***Grading :*** On the basis of particle size, fine aggregate is graded in to four zones. The grading when determined in accordance with the procedure prescribed in Appendix 'B' of Chapter 3 shall be within the limits given in Table 3.1 below. Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron IS sieve, by a total amount not exceeding 5 per cent, it shall be regarded as falling within that grading zone.

TABLE 3.1
Fine Aggregates
(Clause 3.1.3)

IS Sieve	*Percentage passing for*			
	Grading Zone I	*Grading Zone II*	*Grading Zone III*	*Grading Zone IV*
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100
300 microns	5-20	8-30	12-40	15-50
150 microns	0-10	0-10	0-10	0-15

Note 1: For crushed stone sands, the permissible limit on 150 micron sieve is increased to 20 per cent. This does not affect the 5 per cent allowance permitted in 3.1.3.4 (e) (1) applying to other sieves.

Note 2: Allowance of 5% permitted in 3.1.3.4 (e) (1) can be split up, for example it could be 1% on each of three sieves and 2% on another or 4% on one sieve and 1% on another.

Note 3: Fine aggregate conforming to Grading Zone IV shall not be used in reinforced cement concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

Note 4: Sand requiring use for mortar for plaster work shall conform to IS 1542 and for masonry work shall conform to IS 2116.

3.1.3.4 Type and grading of fine aggregate to be used shall be specified. Use of sea sand shall not be allowed, unless otherwise specified. **Fine aggregate may further be sub-divided into following parts:-**

(a) Coarse sand shall be either river sand, pit sand, **crushed stone sand, crushed gravel sand** or a combination of these. It shall be clean, sharp, angular, gritty to touch and composed of hard siliceous material. Its grading shall fall within the limits of grading zone I, II, III of Table 3.1. Grading of sand shall conform to IS 2116 -1980 (Reaffirm-2012) for use in Masonry work.

(b) Fine sand shall be either river sand or pit sand or a combination of the two. Its grading shall fall within the limits of Grading zone IV of Table 3.1. As a guideline, fine sand conforming to grading Zone IV can be generally obtained in Delhi by mixing one part of Badarpur sand and two parts of jamuna Sand (by volume). Grading of sand shall conform to IS 1542 for use in plaster work.

(c) Stone dust/**Gravel dust** shall be obtained by crushing hard stones or gravel. Its grading shall fall within the limits of grading Zone, I, II, III **or IV** of Table 3.1.

(d) Marble dust shall be obtained by crushing marble. Its grading shall fall within the limits of Grading Zone IV of Table 3.1. Grading of Marble dust for use in Mortar shall be as per following table.

Grading of Marble Dust

IS Sieve	*Percentage Passing*
10 mm	100
4.75 mm	95-100
2.36 mm	95-100
1.18 mm	90-100
600 micron	80-100
300 micron	15-50
150 micron	0-15

(e) *Sand for Masonry Mortar and for Plaster-* Sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. Sand shall be hard durable, clean and free from adherent coating and organic matter and shall not contain the amount of clay, silt and fine dust more than specified as under.

Deleterious Material: 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 shale in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand / Marble dust shall not exceed the following limits:

(1)	Clay, fine silt and fine dust when determined in accordance within IS 2386 (Part II). In natural sand or crushed gravel sand & crushed stone sand	Not more than 5% by mass
(2)	Organic impurities when determined in accordance with IS 2386 (Part II)	Colour of the liquid shall be lighter than that indicated by the standard specified in IS 2386 (Part II).

Grading of sand for use in masonry mortar shall be conforming to IS: **2116 -1980 (Reaffirm-2012)** (Table 3.2 below).

Grading of sand for use in plaster shall be conforming to IS 1542 (Table 3.2 below):

TABLE 3.2
Grading of Sand for use in Masonry Mortar and Plaster

Grading of sand for use in masonry mortar		*Grading of sand for use in plaster*	
IS Sieve Designation	*Percentage passing by mass*	*IS Sieve Designation*	*Pecentage passing by mass*
10 mm	100	10 mm	100
4.75 mm	100	4.75 mm	95 to 100
2.36 mm	90 to 100	2.36 mm	95 to 100

Grading of sand for use in masonry mortar		*Grading of sand for use in plaster*	
IS Sieve Designation	*Pecentage passing by mass*	*IS Sieve Designation*	*Pecentage passing by mass*
1.18 mm	70 to 100	1.18 mm	90 to 100
600 micron	40 to 100	600 micron	80 to 100
300 micron	5 to 70	300 micron	20 to 65
150 micron	0 to 15	150 micron	0 to **15**

Note: For crushed stone sands, the permissible limit on 150 micron IS Sieve is increased to 20%, this does not affect the 5% allowance as per IS 2386 (Part 1).

3.1.3.5 ***Bulking****:* Fine aggregate, when dry or saturated, has almost the same Volume but dampness causes increase in volume. In case fine aggregate is damp at the time of proportioning the ingredients for mortar or concrete, its quantity shall be increased suitably to allow for bulkage, which shall be determined by the method prescribed in Appendix 'D' of Chapter 3.0 Table 3.3 gives the relation between moisture content and percentage of bulking for guidance only.

TABLE 3.3

Moisture content % age	*Bulking % age (by volume)*
2	15
3	20
4	25
5	30

3.1.3.6 ***Stacking:*** Fine aggregate shall be so stacked as to prevent dust and foreign matter getting mixed up with it as far as practically possible. Marble dust in dry condition shall be collected in bags and properly staked so as not to form lumps, suitable arrangements shall be made to protect it from moisture similar to those adopted for stacking of cement bags.

3.1.3.7 ***Measurements:*** As the fine aggregate bulks to a substantial extent when partially wet, measurements shall be taken when the stacks are dry or appropriate allowance made for bulking.

3.1.4 Broken Brick (Burnt Clay) Fine Aggregate

3.1.4.1 Broken Brick (Burnt Clay) Fine Aggregate, also known as Surkhi, shall be made by grinding well burnt (but not under or over burnt) broken bricks as specified in IS **3182-1986 (Reaffirm-2014)**. It shall not contain any harmful impurities, such as iron pyrites, salts, coal, mica, shale or similar laminated or other materials in such form of quantity as to adversely affect hardening, strength, durability or appearance of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in surkhi (all taken together) shall not exceed five per cent by weight. The particle size grading of surkhi for use in lime mortars shall be within the limits specified in Table 3.4.

TABLE 3.4

IS Sieve Designation	*Percentage passing (by wt)*
4.75 mm	100
2.36 mm	90-100
1.18 mm	70-100
600 microns	40-100
300 microns	5-70
150 microns	0-15
75 microns	**nil**

3. 1.4.2 *Stacking:* Surkhi shall be stacked on a hard surface or platform so as to prevent the admixture of clay, dust, vegetation and other foreign matter. It shall be also protected form rain and dampness and kept under adequate coverings.

3.1.4.3 *Measurements:* Surkhi shall be measured in regular stacks in cubic metres. Alternatively it may be measured by weight when supplied in bags.

3.1.5 Fly Ash

Fly ash is finely divided residue resulting from the combustion of pulverized coal in boilers. Fly ash is the pulverized fuel ash extracted from the flue gases by any suitable process such as cyclone separation or electrostatic precipitation. The ash collected from the bottom of boilers is termed as bottom ash. Fly ash is finer than bottom ash. Siliceous fly ash (ASTM Class F) containing calcium oxide less than 10% by mass is normally produced from burning anthracite or bituminous coal and possesses pozzolanic properties. Calcareous fly ash (ASTM Class C) is **produced** by burning lignite or sub-bituminous coal and contains calcium **oxide** more than 10% by mass; the content could be as high as 25%. This fly ash has both hydraulic and pozzolanic properties. It shall be clean and free from any contamination of bottom ash, grit or small pieces of pebbles. It is obligatory on the part of supplier/ manufacture that the fly ash conforms to the requirements if mutually agreed upon & shall furnish a certificate to this effect to the purchaser or his representative.

3.1.5.1 *Characteristics:* The physical requirements of fly- ash shall be as specified in Annexure 'E' of Chapter 3. The chemical properties of fly ash shall be as per IS 3812 (part 1 & 2) depending on the usage.

3.1.5.2 *Stacking:* Fly ash shall be protected from dirt collecting on it.

3.1.5.3 *Measurements:* Fly ash shall be measured in regular stacks in cubic metres. Alternatively it may be measured by weight when supplied in bags.

3.2 PREPARTATION OF MORTARS AND ITS GRADE

3.2.0 Grade of Masonry Mortar

The grade of masonry mortar will be defined by its compressive strength in N/mm^2 at the age of 28 days as determined by the standard procedure detailed in IS 2250.

3.2.0.1 For proportioning the ingredients by volume, the conversion of weight into volume shall be made on the following basis:

(a) Burnt Clay Pozzolana	860 Kg/cum
(b) Coarse Sand (dry)	1280 kg/cum
(c) Fine sand (dry)	1600 kg/ cum
(d) Fly Ash	590 kg/ cum

For details of grades and criteria for selection of Masonry mortars see Appendix 'F' of chapter-3.

3.2.1 Cement Mortar

3.2.1.1 This shall be prepared by mixing cement and sand with or without the addition of pozzolana in specified proportions as per Appendix 'F'.

3.2.1.2 *Proportioning:* Proportioning on weight basis shall be preferred taking into account specific gravity of sand and moisture content . Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 x 35 x 25 cm. Sand shall be measured on the basis of its dry volume in the case of volumetric proportioning.

3.2.1.3 *Mixing*

3.2.1.3.1 The mixing of mortar shall be done in mechanical mixers operated manually or by power as decided by Engineer-in-Charge. The Engineer-in-Charge may, however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In cases, where mechanical mixers are not to be used, The contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

(a) *Mechanical Mixing:* Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least three minutes. only the required quantity of water shall be added which will produce mortar of workable consistency but not stiff paste. Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time before suspending the work.

(b) *Hand Mixing:* The measured quantity of sand shall be leveled on a clean masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff paste of necessary working consistency.

3.2.1.4 *Precautions:* mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

3.2.2 Cement Flyash Sand Mortar

3.2.2.1 This shall be prepared by mixing cement, flyash and sand in specified proportions as per Appendix G. Mixing shall be done in a mechanical mixer (operated manually or by power) unless otherwise permitted by the Engineer-in-Charge in writing. The Engineer-in-Charge may, however, permit hand mixing at his discretion, taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixer or where items involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In case, where mechanical mixer is not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

3.2.2.2 *Proportioning:* Proportioning on weight basis shall be preferred taking into account specific gravity of Fly Ash, sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in the specified proportions shall be measured using boxes of suitable sizes. Sand and flyash shall be measured on the basis of their dry volume in the case of volumetric proportioning.

3.2.2.3 *Mixing*

(a) *Mechanical Mixing:* Sand and flyash in the specified proportions shall be mixed dry in a mixer and then the specified quantity of cement shall be added and mixed dry thoroughly. Water shall then be added gradually and wet mixing continued for atleast one minute. Water shall be just sufficient to bring the mortar to the consistency of a workable paste. Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time.

(b) *Hand Mixing:* The measured quantity of sand and flyash shall be mixed dry on a clean masonry platform before adding specified quantity of cement to it. The resulting mixture of cement, sand and flyash shall then be mixed thoroughly being turned over and over, backward several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a clean watertight masonry trough with just sufficient quantity of water, to bring the mortar to a stiff paste of necessary working consistency.

3.2.2.4 *Precautions:* Shall be same as specified in 3.2.1.4.

APPENDIX 'A'

TEST FOR ORGANIC IMPURITIES

(Clause 3.1.3.1)

The aggregate must also be checked for organic impurities such as decayed vegetation humus, coal dust etc.

What is called the colour test is reliable indicator of the presence of harmful organic matter in aggregate, except in the area where there are deposits of lignite.

Fill a 350 ml clear glass medicine bottle upto 70 ml mark with a 3% solution of caustic soda or sodium hydroxide. The sand is next added gradually until the volume measured by the sandy layer is 125 ml. The volume is then made upto 200 ml by addition of more of solution. The bottle is then stoppered and shaken vigorously and allowed to stand for 24 hours. At the end of this period, the colour of the liquid will indicate whether the sand contains a dangerous amount of matter. A colourless liquid indicates a clean sand free from organic matter. A straw coloured solution indicates some organic matter but not enough to be seriously objectionable. Darker colour means that the sand contains injurious amounts and should not be used unless it is washed, and a retest shows that it is satisfactory.

Add 2.5 ml of two per cent solution of tannic acid in 10 per cent alcohol, to 97.5 ml of three per cent sodium hydroxide solution. Place in a 350 ml bottle, fix the stopper, shake vigorously and allow to stand for 24 hours before comparison with the solution above the sand.

Note: A three per cent solution of caustic soda is made by dissolving 3 g of sodium hydroxide in 100 ml of water, preferably distilled. The solution should be kept in a glass of bottle tightly closed with a rubber stopper. Handling sodium hydroxide with moist hands may result in serious burns. Care should be taken not to spill the solution for it is highly injurious to clothing, leather, and other materials.

APPENDIX 'B'

TEST FOR PARTICLE SIZE (SIEVE ANALYSIS)
(Clause 3.1.3.3)

Apparatus: Perforated plate sieves of designation 10 mm, 4.75 mm and fine mesh sieve of designation 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron should be used.

The balance or scale shall be such that it is readable and accurate to 0.1 per cent of the weight of the test sample.

Sample: The weight of sample available shall not be less than the weight given in the table below. The sample of sieving shall be prepared from the larger sample either by quartering or by means of a sample divider.

TABLE SHOWING MINIMUM WEIGHTS FOR SAMPLING

Maximum size present in substantial proportions (mm)	Minimum weight of sample for sieving (Kg)
10	0.5
4.75	0.2
2.36	0.1

Test Procedure: The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100 degree to 110 degree centigrade. The air dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.

Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case for a period of not less than two minutes. The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions. Materials shall not be forced through the sieve by hand pressure, but on sieves coarser than 20 mm, placing of particles is permitted, Lumps of fine material, if present may be broken by gentle pressure with fingers against the side of the sieve. Light brushing of under side of the sieve with a soft brush may be used to clear the sieve openings.

Light brushing with a fine camel hair brush may be used on the 150 micron IS sieve to prevent segregation of powder and blinding of apertures. Stiff or worn out brushes shall not be used for this purpose and pressure shall not be applied to the surface of the sieve to force particles through the mesh.

On completion of sieving the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Reporting of Results: The results shall be calculated and reported as:

(a) The cumulative percentage by weight of the total sample passing each of the sieves, to the nearest whole number:
or

(b) The percentage by weight of the total sample passing one sieve and retained on the next smaller sieve, to the nearest 0.1 percent.

APPENDIX 'C'

TEST FOR SILT CONTENT

(Clause 3.1.3.2)

The sand shall not contain more than 8% of silt as determined by field test with measuring cylinder. The method of determining silt contents by field test is given below:

A sample of sand to be tested shall be placed without drying in a 200 ml measuring cylinder. The volume of the sample shall be such that it fills the cylinder upto 100 ml mark

Clean water shall be added upto 150 ml mark. Dissolve a little salt in the water in the proportion one tea spoon to half a litre. The mixture shall be shaken vigorously, the last few shakes being sidewise direction to level off the sand and the contents allowed to settle for three hours.

The height of the silt visible as settled layer above the sand shall be expressed as a percentage of the height of sand below. The sand containing more than the above allowable percentage of silt, shall be washed so as to bring the silt contents within allowable limits.

APPENDIX 'D'

BULKING OF FINE AGGREGATES/SAND (FIELD METHODS)

(Clause 3.1.3.5)

Two methods are suggested for determining the bulking of sand/fine aggregate. The procedure may be suitably varied, if necessary. Both depend on the fact that the volume of inundated sand/fine aggregate is the same if the sand/fine aggregate were dry.

Method -1: Put sufficient quantity of sand loosely into a container until it is about two -third full. Level off the top of the sand and push a steel rule vertically down through the sand at the middle to bottom, measure the height. Suppose this is 'X' cm.

Empty the sand out of the container into another container where none of it is lost. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder and level the top surface of the inundated sand. Measure its depth at the middle with the steel rule. Suppose this is 'Y' cm.

The percentage of bulking of the sand due to moisture shall be calculated from the formula:

Percentage bulking = (X/Y -1) X 100

Method -2: In a 250 ml measuring cylinder, pour the damp sand, consolidate it by staking until it reached the 200 ml mark.

Then fill the cylinder with the water and stir the sand well (the water shall be sufficient to submerge the sand completely). It will be seen that the sand surface is now below its original level. Suppose the surface is at the mark of Yml, the percentage of bulking of sand due to moisture shall be calculated from the formula.

Percentage bulking= (200/Y – 1) x 100

APPENDIX 'E'

PHYSICAL REQUIREMENTS OF FLY ASH
(Clause 3.1.5 & 3.1.5.1)

Sl. No	*Characteristics*	*Requirement of Fly Ash*	
		For use as Pozzolana	*For use as admixture in Cement Mortar and concrete*
1	2	*3*	*4*
(i)	Fineness- Specific surface in m^2/kg by Blaine's permeability method, min	320	200
(ii)	Lime reactivity -average compressive strength in N/mm^2 Min	4.5	-
(iii)	Compressive strength at 28 days in N/ mm^2	Not less than 80 per cent of the strength of corresponding mortar cubes.	-
(iv)	Soundness of autoclave test expansion of specimens, per cent, max	0.8	0.8
(v)	Particles retained on 45 micron IS sieve (wet sieving) in percent, maximum	34	50

APPENDIX 'F'

CRITERIA FOR SELECTION OF MASONRY MORTARS

(Clauses 3.2.0, 3.2.0.1, 3.2.1.1)

(a) The selection of masonry mortars from durability consideration will have to cover both the loading and exposure condition of the masonry. The masonry mortar shall generally be as specified below in (b) to (g).

(b) In case of masonry exposed frequent to rain and where there is further protection by way of plastering or rendering or other finishes, the grade of mortar shall not be less than 0.7 MM but shall preferably be of grade MM2. Where no protection is provided, the grade of mortar for external wall shall not be less than MM2.

(c) In case of load bearing internal walls, the grade of mortar shall preferably be MM 0.702 or more for high durability but in no case less than MM 0.5.

(d) In the case of masonry work in foundations laid below damp proof course, the grade of mortar for use in masonry shall be as specified below.
   (i) Where soil has little moisture, masonry mortar of grade not less than MM 0.7 shall be used.
   (ii) Where soil is very damp, masonry mortar of grade preferably MM 2 or more shall be used. But in no case shall the grade of mortar be less than MM 2.

(e) For masonry in building subject to vibration of machinery, the grade of mortar shall not be less than MM 3.

(f) For parapets, where the height is greater than thrice the thickness, the grade of masonry mortar shall not be less than MM3. In case of low parapets the grade of mortar shall be the same as used in the wall masonry.

(g) The grade of mortar for bedding joints in masonry with large concrete blocks shall not be less than MM 3.

(h) The compressive strength shall be determined in accordance with the procedure given in IS 2250.

(i) While mixing the pozzolanic material like fly ash in mortars Ordinary Portland cement only shall be use.

Grade of Masonry Mortar (IS 2250)
(Clause 3.2.0)

Sl. No.	*Grade*	*Compressive strength at 28 days in N/mm^2*	*Cement*	*Pozzolana (Fly Ash)*	*Sand*
1	MM 0.7	0.7 to 1.5	1	---	8
2			1	0.4*	10
3	MM 1.5	1.5 to 2.0	1	---	7
4			1	0.4*	8.75
5	MM 3	3.0 to 5.0	1	---	6
6			1**	0.21	4.2
7			1	0.4*	7.5
8	MM 5	5.0 to 7.5	1	---	5
9			1	0.4	6.25
10			1	0.4	5
11	MM 7.5	7.5 & above	1	---	4
12			1**	0.2*	2.1
13			1	---	3
14			1	0.4	3.75

Note:

* Pozzolana of minimum lime reactivity of 4 N/MM^2

** This ratio by volume correspondence approximately to cement pozzolana ratio of 0.8:0.2 by weight. In this case, only ordinary portland cement is to be used (see IS 269). Specifications for ordinary rapid hardening and low heat Portland Cement (Third revision).

Note : Compressive strength shall be determined in accordance with the Appendix –A-IS 2550.

SUB HEAD : 4.0

CONCRETE WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	85
	List of Bureau of Indian Standard Codes	87
4.1	Material	88
4.1.1	Coarse Aggregate	88
4.1.2	Chemical Admixtures	90
4.2	Cement Concrete	91
4.2.1	Grades of Cement Concrete	91
4.2.2	Workability of Concrete	93
4.2.3	Concrete Mix Proportioning	93
4.2.4	Batching	94
4.2.5	Mixing	96
4.2.6	Placing	98
4.2.7	Compaction	98
4.2.8	Construction Joints	98
4.2.9	Concreting under Special Conditions	99
4.2.10	Curing	99
4.2.11	Testing of Concrete	100
4.2.12	Form Work	100
4.2.13	Finishes	100
4.2.14	Durability of Concrete	100
4.2.15	Measurements	104
4.2.16	Rate	106

4.3	Cement Fly Ash Concrete	106
4.4	Damp Proof Course	107
4.4.1	Cement Concrete Layer	107
4.4.2	Curing	107
4.4.3	Application of Hot Bitumen	107
4.4.4	Water Proofing Materials	107
4.4.5	Measurements	107
4.4.6	Rate	107
Appendix A	Determination of Particle Size	108
Appendix B	Test for Surface Moisture	108
Appendix C	Determination of Ten Per cent Fine Value	109
Appendix D	Slump Test	111

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory*	*Test procedure*	*Min. qty of Material for Carrying out test*	*Frequency of Testing*
1	2	3	4	5	6	7
Stone aggregate	4.1.2.2	(a) Percentage of soft or deleterious material	Field or Laboratory - Test as required	IS 2386-Part II	As required By Engineer in-Charge	For all quantities
	4.1.2.3	Particle size	Field/ Lab	Appendix 'A'	45 cum	For every 45 cum or part thereof for RCC Work only. For rest of items as decided by Engineer-in Charge
	4.1.2.5	(a) Estimation of organic impurities	Field/ Lab	IS 2386-Part II	10 cum	For every 40 cum or part thereof
		(b) Surface moisture	Field/ Lab	IS 2386	10 cum	-do-
		(c) Determination of 10% fine value	Field/ Lab	IS 2386	10 cum	-do-
		(d) Specific gravity	Field/ Lab	IS 2386	10 cum	-do-
		(e) Bulk density	Field/ Lab	IS 2386	10 cum	-do-
		(f) Aggregate crushing strength	Field/ Lab	IS 2386	10 cum	-do-
		(g) Aggregate impact value	Field/ Lab	IS 2386	10 cum	-do-
Concrete	4.2.2	Slump test	Field	Appendix 'D'	10 cum	15 cum or part thereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	*I. S. No.*	*Subject*
1.	IS 383	Specification for coarse and fine aggregate from natural sources for concrete.
2.	IS 456	Plain and reinforced concrete - Code of practice
3.	IS 516	Method of test for strength of concrete
4.	IS 1199	Method of sampling and analysis of concrete
5.	IS 1200 (Part II)	Method of measurement of building and civil engineering work (concrete work)
6.	IS 1322	Specification for bitumen felt for water proofing and damp proofing.
7.	IS 1791	General requirements for batch type conrete mixers
8.	IS 2386	Method of test for aggregates for concrete
		(a) Part I - Particle size and shape
		(b) Part II - Estimation of deleterious materials and organic impurities
		(c) Part III - Specific gravity, density, voids absorption and bulking.
		(d) Part IV - Mechanical properties.
		(e) Part V – Soundness
9.	IS 2505	General requirements for concrete vibrators - immersion type.
10.	IS 2506	General requirements for concrete vibrators - screed board concrete vibrators
11.	IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
12.	IS 3068	Specification for broken brick (burnt clay) coarse aggregate for use in concrete.
13.	IS 3812	Specification for flyash for use as pozzolana and admixture in cement mortar and concrete.
14.	IS 4656	Specification for form vibrators for concrete.
15.	IS 7861 (Part-I)	Code of practice for extreme weather concreting (Part-I) recommended practice for hot weather concreting.
16.	IS 7861 (Part–II)	Code of practice for extreme weather concreting (Part-II) recommended.
17.	IS 9103	Specification for concrete admixtures

4.0 CONCRETE WORK

4.1. MATERIAL

Water, cement, fine aggregate or sand, surkhi, and fly ash shall be as specified in Chapter 3.0 – Mortar.

4.1.1 Coarse Aggregate

4.1.1.1 ***General:*** Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved/ authorized sources.

(a) *Stone Aggregate:* It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. **Aggregates from other than natural resources shall comply with the requirements of IS 383.**

(b) *Gravel:* It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coating, alkali, vegetable matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall conform to IS 383 unless otherwise specified.

(c) *Brick Aggregate:* Brick aggregate shall be obtained by breaking well burnt or overburnt dense brick/ brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil, vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete. It shall conform to IS 306 unless otherwise specified.

(d) Light weight aggregate such as sintered fly ash aggregate may also be used provided the Engineer-in-Charge is satisfied with the data on the proportion of concrete made with them.

4.1.1.2 ***Deleterious Material:*** Coarse aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalies of cement shall not be used. The maximum quantity of deleterious material shall not be more than five percent of the weight of coarse aggregate when determined in accordance with IS 2386.

4.1.1.3 ***Size and Grading***

(i) *Stone aggregate and gravel:* It shall be either graded or single sized as specified. Nominal size and grading shall be as under:-

(a) Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by the method prescribed in Appendix 'A' of Chapter 4 shall be in accordance with Table 4.1.

TABLE 4.1
Graded Stone Aggregate or Gravel

IS Sieve Designation	*Percentage passing (by weight) for nominal size of*			
	40 mm	*20 mm*	*16 mm*	*12.5 mm*
80 mm	100	-	-	-
63 mm	-	-	-	-
40 mm	95 to 100	100	-	-
20 mm	30 to 70	95 to 100	100	100
16 mm	-	-	90 to 100	-
12.5 mm	-	-	-	90 to 100
10 mm	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10

(b) Nominal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal size, the proportion of other sizes as determined by the method prescribed in Appendix 'A' of Chapter 4 shall be in accordance with Table 4.2.

TABLE 4.2
Single Sized (Ungraded) Stone Aggregate or Gravel

IS Sieve Designation	*Percentage passing (by weight) for nominal size of*					
	63 mm	*40 mm*	*20 mm*	*16 mm*	*12.5 mm*	*10 mm*
80 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
40 mm	0-30	85-100	100	-	-	-
20 mm	0- 5	0-20	85-100	100	-	-
16 mm	-	-	-	85-100	100	-
12.5 mm	-	-	-	-	85-100	100
10 mm	0-5	0-5	0-20	0-30	0-45	85-100
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

(c) When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sized aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate as determined by method prescribed in Appendix 'A' of Chapter 4 shall be in accordance with Table 4.1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 4.3.

TABLE 4.3
Single Sized (Ungraded) Stone Aggregate or Gravel

Cement concrete	*Nominal size of graded aggregate required*	*Parts of single size aggregate of size*				
		50 mm	*40 mm*	*20 mm*	*12.5 mm*	*10 mm*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1:6:12	63	9	-	3	-	-
1:6:12	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-

(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
1:5:10	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
1:4:8	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5	-	-
1:3:6	40	-	4.5	1.5	-	-
1:3:6	20	-	-	4.5	-	1.5
1:2:4	40	-	2.5	1	-	1.5
1:2:4	20	-	-	3	-	1
1:2:4	12.5	-	-	-	3	1
1:1 ½:3	20	0	0	2	-	1

Note:

(i) The proportions indicated in Table 4.3 above are by volume when considered necessary, these proportions may be varied marginally by Engineer-in-Charge after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the Engineer-in-Charge. If single size coarse aggregate are not premixed at site to obtain the graded coarse aggregate required for the mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.

(ii) *Brick Aggregate:* Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in Table 4.4 when tested for sieve analysis for the method prescribed in Appendix 'A' of Chapter 4.0.

TABLE 4.4
Brick Aggregate

IS Sieve Designation	*Percentage passing (by weight)*
75 mm	100
37.5 mm	95-100
20.0 mm	45-100
4.75 mm	0.50

4.1.1.4 ***Stacking:*** Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

4.1.1.5 ***Testing:*** Coarse aggregate shall be tested for the followings (as per IS 2386)

(a) Determination of particle size and shape (Appendix 'A' of Chapter 4)
(b) Estimation of organic impurities (as per IS 2386 - Part II)
(c) Surface moisture (Appendix 'B' of Chapter 4)
(d) Determination of 10% fine value (Appendix 'C' of Chapter 4)

4.1.1.6 ***Measurements:*** The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregate of nominal size below 40 mm.

4.1.2 Chemical Admixtures

When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS 9103 and as specified in Chapter 5 - R.C.C.

4.1.2.1 Admixtures may be any one of the following classes for use in concrete:-

(a) Water Reducing Admixtures
(b) Retarding Admixtures
(c) Accelerating Admixtures.
(d) Water Reducing and Retarding Admixtures.
(e) Water Reducing and Accelerating Admixtures.
(f) Permeability Reducing (water proofing) Admixtures.

4.1.2.2 ***Liquid Admixtures:*** Admixtures introduced into the concrete as liquids generally fall into the following categories.

(a) Air Entraining.
(b) Water Reducing.
(c) Water Reducing Retarders.
(d) Retarders.
(e) Water Reducing Accelerators.
(f) Accelerators.

4.1.2.3 Dosage of these admixtures may vary according to manufacturers specification.

4.1.2.4 Two or more admixtures may not be compatible in the same solution. It is therefore mandatory that when two admixtures manufactured by the same manufacturers is being used simultaneously, the manufacturer shall certify their compatibility. In case the two or more admixtures are produces by different manufacturers, then, before their use in concrete, test shall be performed by the manufacturer to establish their compatibility, all such test reports shall be furnished to the Engineer-in-Charge for his approval before their use in concrete.

4.1.2.5 Some admixture may be in the form of powder, particle or high concentration liquids which may require mixing with water prior to dosing. Under these conditions water in solution shall be considered as part of total water content in the batch in order to maintain the water-cement ratio.

4.1.2.6 Admixture manufacturer's recommendation shall be carefully followed so as to ensure complete solution of the product or to prepare a standard solution of uniform strength for easier use.

4.1.2.7 Certain admixtures may contain significant amounts of finely divided insoluble materials or active ingredients which may or may not be readily soluble. It is essential for such admixtures that precautions be taken to ensure that these constituents be kept in a state of uniform suspension before actual batching. When relatively small amounts of powered admixtures are to be used directly, these shall be pre-blended with cement.

4.1.2.8 Admixtures are sold under various trade names and may be in the form of liquids or powders. The proprietary name and the net quantity of content shall be clearly indicated in each package or container of admixtures. The admixtures shall be uniform within each batch and uniform between all batches.

4.1.2.9 No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS 9103 and the test results are approved by the Engineer-in-Charge.

4.2. CEMENT CONCRETE

4.2.1 Grades of Cement Concrete

The concrete shall be in grade designated as under:

TABLE 4.5
Grades of Concrete

Group	*Grade Designation*	*Specified characteristic compressive strength of 150 mm Cube at 28 Days in N/mm^2*
(1)	(2)	(3)
Ordinary Concrete	M10	10
	M15	15
	M20	20
Standard Concrete	M25	25
	M30	30
	M35	35
	M40	40
	M45	45
	M50	50
	M55	55
	M60	**60**
High Strength Concrete	**M65**	**65**
	M70	**70**
	M75	**75**
	M80	**80**
	M 85	**85**
	M 90	**90**
	M 95	**95**
	M 100	**100**

Notes :

1. In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm^2.
2. For concrete of compressive strength greater than **M60,** design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

4.2.1.1 The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall.

TABLE 4.6
Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal; Maximum Size
(Clause 4.2.1.1)

Sl. No.	*Exposure*	*Plain Concrete*			*Reinforced Concrete*		
		Minimum Cement Content kg/m^3	*Maximum Free Water Cement Ratio*	*Minimum Grade of Concrete*	*Minimum Cement Content kg/m^3*	*Maximum Free Water-Cement Ratio*	*Minimum Grade of Concrete*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
(i)	Mild	220	0.60	-	300	0.55	M20
(ii)	Moderate	240	0.60	M15	300	0.50	M25
(iii)	Severe	250	0.50	M20	320	0.45	M30
(iv)	Very Severe	260	0.45	M20	340	0.45	M35
(v)	Extreme	280	0.40	M25	360	0.40	M40

Notes:

1. Cement content prescribed in this Table is irrespective of the grades **and types** of cement **and inclusive of mineral admixtures mentioned in 5.9.1.3.** The additions such as fly **ash** or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio, if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively. **Beyond which these additions through permitted, shall not be considered for these purpose.**
2. Minimum grade for plain concrete under mild exposure condition is not specified.
3. **The minimum cement content, maximum free water cement ratio and minimum grade of concrete are individually related to exposure.**

The minimum grade of concrete for plain and reinforced concrete shall be as per Table 4.6.

4.2.1.2 Concrete of grades lower than those given in Table 4.6 may be used for lean concrete, foundation for masonry walls or temporary reinforced concrete construction.

4.2.2 Workability of Concrete

4.2.2.1 The concrete mix proportion chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

Placing Conditions	*Degree of Workability*	*Slump (mm)*
(1)	(2)	(3)
Blinding concrete: shallow sections: Pavements using pavers	Very low	See 4.2.2.2
Mass concrete: Lightly reinforced sections in slabs, beams, wall, columns, : floors	Low	25-75
Hand placed pavements: canal lining; Strip footing	Medium	50-100
Heavily reinforced sections in slabs, beams, walls, columns:		
Slip form work: Pumped concrete	Medium	75-100
Trench fill	High	100-150
Tremie concrete	Very High	See 4.2.2.3

Note:- For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used (see also 4.2.7)

4.2.2.2 In the 'very low' category of workability where strict control is necessary, for example, pavement quality concrete, measurement of workability be determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

4.2.2.3 In the 'very high' category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

4.2.3 Concrete Mix Proportioning

4.2.3.1 The determination of the proportion of cement, aggregate and water to attain the required strength shall be made as follows:

(a) *By designing the concrete mix:* such concrete shall be called 'Design mix concrete', for details reference may be made to RCC Chapter.
(b) *By adopting nominal concrete mix:* such concrete shall be called 'Nominal mix concrete'.

Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of Engineer-in-Charge, which, however, is likely to involve a higher cement content.

4.2.3.2 ***Nominal Mix Concrete:*** Nominal Mix Concrete may be used for concrete of M20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table 4.7.

The cement content of the mix specified in Table 4.7 for any nominal mix shall be proportionately increased if the quantity of water in the mix has to be increased to overcome the difficulty or placement and compaction, so that the water cement ratio as specified is not exceeded.

TABLE 4.7
Proportions for Nominal Mix Concrete
(Clause 4.2.3.2)

Grade of Concrete	*Total Quantity of Dry Aggregates by Mass per 50 kg of cement, to be taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, Kg. Max*	*Proportion of Fine Aggregate to Coarse Aggregate (by Mass)*	*Quantity of Water per 50 kg of Cement, max Ltr.*
(1)	(2)	(3)	(4)
M5	800	Generally 1:2 but subject to an upper limit of 1: 1 ½ and a lower limit of 1:2 ½	60
M7.5	625		45
M10	480		34
M15	330		32
M20	250		30

Note : - The proportion of the fine to coarse aggregate should be adjusted from upper limit progressively as the grading of fine aggregate becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Note : - Quantity of water required from durability point of view may be less than the value given above.

Example

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½ , 1:2 and 1:2 ½ for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

4.2.4 Batching

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixed on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass: liquid admixture may however be measured in volume or mass: water shall be weighed or measured by volume in a calibrated tank (see also IS 4925). **For projects having sanctioned more than 100 Crores, the concrete shall be sourced from ready mixed concrete plant or from captive on site or off site automatic batching and mixing plants. The concrete produced and supplied by ready mixed concrete plants shall be in accordance with IS 4926. In case of concrete from captive on site or off site automatic batching and mixing plants, similar quality control shall be followed.**

Ready- mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926).

4.2.4.1 In case of batch mixing plant at site the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in right proportions, the different sizes being stocked in separate stock piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the specified grading is maintained.

4.2.4.2 The accuracy of the measuring equipment shall be within ± 2 percent of the quantity of cement **and mineral admixtures** being measured and within ± 3 percent of the quantity of aggregate, **chemical** admixtures and water being measured. **In a batching plant, the concrete production equipment shall be calibrated initially at the time of installation or reconditioning of the equipment and subsequently at the following intervals:**
a) Mechanical/knife edge system: At least once every two months
b) Electrical/load cell system: At least once every three months

4.2.4.3 All ingredients of concrete shall be used by mass except water and chemical admixtures which may be by volume.

4.2.4.4 Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bilking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-Charge to ensure that the specified grading is maintained.

4.2.4.5 It is important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass for aggregate due to variations in their moisture content, suitable adjustments in the masses of aggregates shall be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 4.8.

TABLE 4.8
Surface Water Carried by Aggregate
(Clause 4.2.4.5)

Sl No	*Aggregate*	*Approximate Percent by mass*	*Quantity of Surface Water l/m3*
(1)	*(2)*	*(3)*	*(4)*
(i)	Very wet sand	7.5	120
(ii)	Moderately wet sand	5.0	80
(iii)	Moist sand	2.5	40
(iv)	[1)] Moist gravel or crushed rock	1.25-2.5	20-40

[1)] Coarser the aggregate, less the water it will carry.

4.2.4.6 No substitutions in materials used on the work or alteration in the established proportions, except as permitted in 4.2.4.4 and 4.2.4.5 shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

4.2.5 Mixing

Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the Engineer-in-Charge in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be $1^1/_2$ to 2 minutes, for hydrophobic cement it may be taken as $2^1/_2$ to 3 minutes.

4.2.5.1 ***Power Loader:*** Mixer will be fitted with a power loader complying with the following requirements.

(a) The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note: In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

(b) The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 4.9.

TABLE 4.9

Nominal size of mixer (T, NT or R).litre	*Minimum inside width of hopper feeding edge*
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

T = Tilting; NT = Non-tilting; R = Reverse

(c) The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the centre line of the chute plate of the hopper when in discharge position, is at an angle of not less than 50º to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of centre line of the chute plate of the hopper when in discharge position, should be as larger as practicable, preferably not less than 40º to horizontal.

(d) When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, these should be at least one and a half drums of rope on the drum.

(e) Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

(f) The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

(g) Safety device shall be provided to secure the hopper in raised position when not in use.

4.2.5.2 ***Mixing Efficiency:*** The mixer shall be tested under normal working conditions in accordance with the method specified in IS 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete.

The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halve of the batch shall not be more than the following limits:

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

4.2.5.3 ***Machine Mixing:*** The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for atleast four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the Engineer- in-Charge. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for atleast two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed.

The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed cleaned with water.

4.2.5.4 ***Hand Mixing:*** When hand mixing has been specifically permitted in exceptional circumstances by the Engineer-in-Charge in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured

quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by showlling and turning till the coarse aggregate gets evenly distributed the cement sand mixture. Three quarters of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

4.2.5.5 ***Transportation and Handling :*** Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

During hot or cold weather, concrete shall be transported in deep containers, other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

4.2.6 Placing

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains. As a general guidance, the maximum free fall of concrete may be taken as 1.5 metre.

4.2.7 Compaction

Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS 2505, IS 2506, IS 2514 and IS 4656. To prevent segregation, over vibration shall be avoided.

Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the Engineer-in- Charge in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

4.2.8 Construction Joints

Concreting shall be carried out continuously upto construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the Engineer-in-Charge. Number of such joints shall be kept minimum. Joints shall be kept as straight as possible. Construction joints should comply with IS 11817.

4.2.8.1 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2 kgs of cement per sqm shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete.

4.2.8.2 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work particular attention being paid to corners and close spots; work, thereafter, shall proceed in the normal way.

4.2.9 Concreting under Special Conditions

4.2.9.1 ***Work in Extreme Weather Conditions:*** During hot and cold weather, the concreting shall be done as per the procedure set out in IS 7861 (Part–I)-1975 and IS 7861 (Part II)-1981 respectively. Concreting shall not be done when the temperature falls below 4.5ºC. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38ºC.

4.2.9.2 ***Under Water Concreting:*** Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the Engineer-in-Charge before the work is started.

Under-water concrete should have a slump recommended in 4.2.2. The water- cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be atleast 350 kg/m^3 of concrete.

4. 2.9.3 ***Concrete in Sea Water:*** Concrete in sea-water or exposed directly along the sea-coast shall be at least M20 Grade in the case of plain concrete and M30 in case of reinforced concrete. The use of slag or pozzolana cement is advantageous under such conditions.

(i) Special attention shall be given to the design of the mix to obtain the densest possible concrete: slag, broken brick, soft lime stone, soft sandstone, or other porous or weak aggregates shall not be used.

(ii) As far as possible, preference shall be given to precast members unreinforced, well-cured and hardened, without sharp corners, and having trowel-smooth finished surfaces free from crazing, cracks or other defect; plastering should be avoided.

(iii) No construction joints shall be allowed within 600 mm below low water-level or within 60 mm of the upper and lower planes of wave action. Where unusually severe conditions or abrasion are anticipated, such parts of the work shall be protected by bituminous or silico-fluoride coatings or stone facing bedded with bitumen.

(iv) In reinforced concrete structures, care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods.

4.2.10 Curing

Curing is the process of preventing loss of moisture from the concrete. The following methods shall be employed for effecting curing.

4.2.10.1 ***Moist Curing :*** Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

4.2.10.2 ***Membrane Curing*** *:* Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in- Charge. Such compound shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membrane such as polythene sheet covering the concrete surface may also be used to provide effective barrier against the evaporation.

4.2.10.3 Freshly laid concrete shall be protected from rain by suitable covering.

4.2.10.4 Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at east 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

4.2.11 Testing of Concrete

Testing of concrete shall be done as described in chapter of R.C.C.

4.2.12 Form Work

Form work shall be as specified in R.C.C. chapter and shall be paid for separately unless otherwise specified.

4.2.13 Finishes

Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

4.2.14 Durability of Concrete

A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service **life**. The materials and mix proportions shall be such as to maintain its intergrity and, if applicable, to protect reinforcement from corrosion.

The factors influencing durability include:

(a) The environment;

(b) The cover to embedded steel;

(c) The type and quality of constituent materials;

(d) The cement content and water/ cement ratio of the concrete;

(e) Workmanship, to obtain full compaction and efficient curing; and

(f) The shape and size of the member.

4.2.14.1 *Requirements for Durability*

4.2.14.1.1 *General Evironment :* The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 4.10.

TABLE 4.10
Environmental Exposure Conditions

Sl. No	*Environment*	*Exposure Conditions*
(1)	*(2)*	*(3)*
(i)	Mild	Concrete surfaces protected against weather or aggressive conditions,except those situated in coastal area.
(ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wetConcrete exposed to condensation and rainConcrete continuously under waterConcrete in contact or buried under non-aggressive soil/ ground waterConcrete surfaces sheltered from saturated salt air in coastal area
(iii)	Severe	Concrete surfaces exposed to severe rain, alternate weting and dryingor occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water.Concrete exposed to coastal environment.
(iv)	Very severe	Concrete surface exposed to sea water spray, corrosive fumes orsevere freezing conditions whilts wet.Concrete in contact with or buried under aggressive sub-soil/ groundwater.
(v)	Extreme	Surface of members in tidal zone.Members in direct contact with liquid/ solid aggressive chemicals.

Note: For the purpose of determining exposure conditions, all places within a distance of 10 kms. of coastal line, sea front would be treated as coastal area.

4.2.14.1.2 *Freezing and Thawing :* Where freezing and thawing actions under wet conditions exist, enhanced durability can be obtained by the use of suitable air entraining admixtures. When concrete lower than grade M50 is used under these conditions, the mean total air content by volume of the fresh concrete at the time of delivery into the construction should be:

Nominal Maximum Size Aggregate (mm)	*Entrained Air Percentage*
20	5 ± 1
40	4 ± 1

4.2.14.1.3 *Exposure to Sulphate Attack :* For the very high sulphate concentration in Class 5 conditions given in Table 4.11, some form of lining such as polyethylene or polychloroprene sheet: or surface coating based on asphalt, chlorinated rubber, epoxy; or polyurethane materials should also be used to prevent access by the sulphate solution.

4.2.14.1.4 *Chlorides in Concrete :* The total amount of chlorides content (as CI) in the concrete at the time of placing shall be as under :

SI. No.	*Type of Use of Concrete*	*Maximum Total Acid Soluble Chloride Content expressed as kg/ m^3 of Concrete*
(1)	(2)	(3)
(i)	Concrete containing metal and steam cured atelevated temperature and pre-stressed concrete	0.4
(ii)	Reinforced concrete or plain concrete containing embedded metal	0.6
(iii)	Concrete not containing embedded metal or anymaterial requiring protection from chloride	3.0

4.2.14.1.5 *Sulphates in Concrete :* The total water-soluble sulphate content of the concrete mix, expressed as SO_3 should not exceed 4 per cent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix. The 4 per cent limit does not apply to concrete made with supersulphate cement complying with IS 6909.

TABLE 4.11
Requirements for Concrete Exposed to Sulphate Attack
(Clause 4.2.14.1.3)

Sl No.	*Class*	*Concentration of sulphates, Expresed as SO3 Concrete.*			*Type of Cement*	*Dense, Fully compacted made with 20 mm nominal maximum size Aggregates complying with IS 383*	
		In Soil		*In Ground Water (g/l)*		*Minimum Cement Content kg/m3*	*Maximum Free Water-Cement Ratio*
		Total SO3 (%)	*SO3 in 2:1 (Water: Soil Extract) (g/l)*				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	1	Traces (<0.2)	Less than 1.0	Less than 0.3	Ordinary Portland cement or Portland slag cement or Portland - pozzolana cement	280	0.55
(ii)	2	0.2 to 0.5	1.0 to 1.9	0.3 to 1.2	Ordianry Portland cement or Portland slag cement or Portland pozzolana cement	330	0.50
					Supersulphated cement or sulphate resisting Portland cement	310	0.50
(iii)	3	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	Supersulphated cement or sulphate resisting Portland cement	330	0.50
					Portland Pozzolana cement or Portland slag cement	350	0.45
(iv)	4	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	Supersulphated or sulphate resisting Portland cement	370	0.45
(v)	5	More than 2.0	More than 5.0	More than 5.0	Sulphate resisting Portland cement or supersulphated cement with protective coatings	400	0.40

Notes

1. Cement content given in this Table is irrespective of grades of cement.
2. Use of supersulphated cement is generally restricted where the prevailing temperature is above 40°C.
3. Supersulphated cement gives an acceptable life provided that the concrete is dense and prepared with a water-cement ratio of 0.4 or less, in mineral acids, down to pH 3.5.
4. The cement contents given in col. 7 of this Table are the minimum recommended. For SO_3 contents near the upper limit of any class, cement contents above these minimum are advised.

5. For severe conditions, such as thin sections under hydrostatic pressure on one side only and sections partly immersed, considerations should be given to a further reduction of water-cement ratio.

6. Portland slag cement conforming to IS 455 with slag content more than 50 per cent exhibits better sulphate resisting properties.

7. Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C_3A content from 5 to 8 per cent shall be desirable to be used in concrete, instead of suplhate resisting cement. Alternatively, Portland slag cement conforming to IS 455 having more than 50 per cent slag or a blend of ordinary Portland cement and slag may be used provided sufficient information is available on performance of such blended cements in these conditions.

4.2.15 Measurements

4.2.15.1 Dimensions of length, breadth and thickness shall be measured correct to nearest cm. except for the thickness of slab and partition which shall be measured to nearest 5 mm. Areas shall be worked out to nearest 0.01 sq.m and the cubic contents of consolidated concrete shall be worked out to nearest 0.01 cum. Any work done in excess over the specified dimension or sections shown in the drawing shall be ignored.

4.2.15.2 Concrete work executed in the following conditions shall be measured separately:

(a) Work in or under water
(b) Work in liquid mud
(c) Work in or under foul positions

4.2.15.3 ***Cast-in -situ concrete*** and or precast concrete work shall be measured in stages described in the item of work, such as:

(a) At or near the ground level
(b) Upto specified floor level
(c) Between two specified floor levels
(d) Upto specified height above or depth below plinth level/ defined datum level.
(e) Between tow specified heights or depths with reference to plinth/defined datum level.

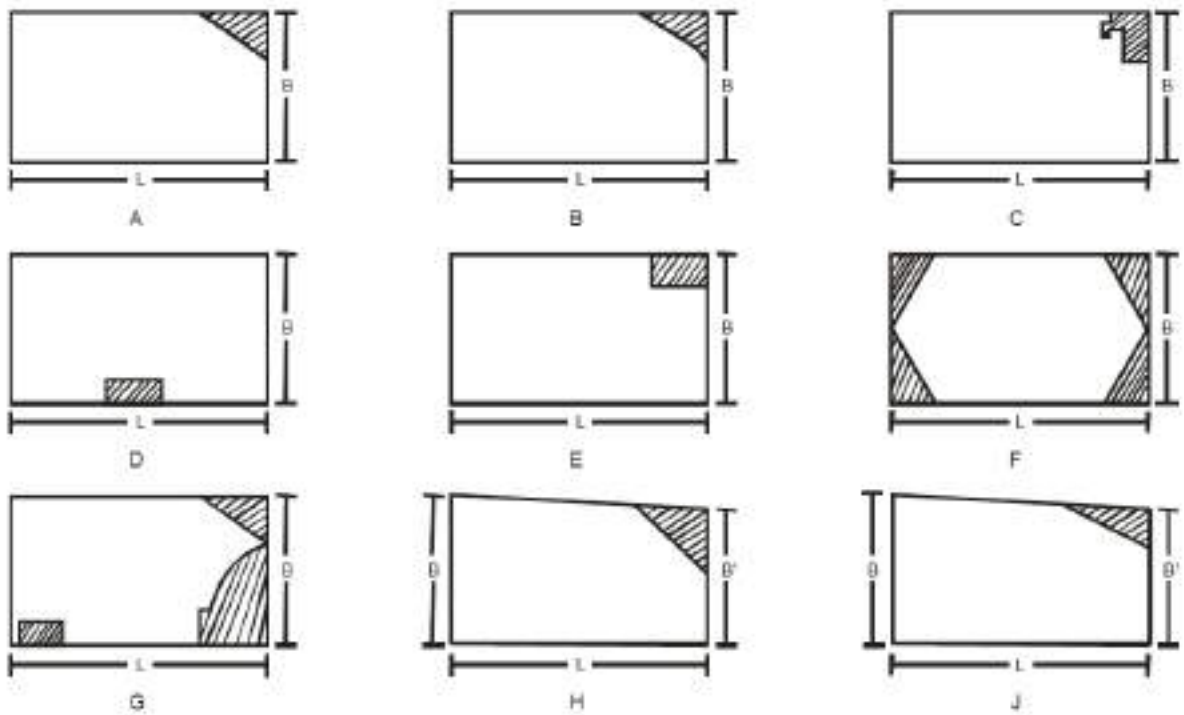
4.2.15.4 No deduction shall be made for the following:

(a) Ends of dissimilar materials for example beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sq cm in cross sections.
(b) Opening upto 0.1 sq metre (1000 sq.cm)
(c) Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq cm each in cross sectional areas.
(d) Small voids such as shaded portions in Figure A to J below when these do not exceed 40 sq cm each in cross section.

Note: In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

Area of Fig. A to G shall be = L x B

Area of Fig. H & J shall be = L x {Average of B and B'}



4.2.15.5 Cast-in-situ and precast concrete work shall be measured sperately.

4.2.15.6 Cast-in-situ concrete shall be classified and measured as follows:

(a) Foundation, footings, bases for columns
(b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
(c) Shelves
(d) Slabs
(e) Chajjas including portions bearing on the wall
(f) Lintels, beams and bressummers
(g) Columns, piers abutments, pillars, post and struts
(h) Stair case including stringer beams but excluding landings.
(i) Balustrades, newels and sailing
(j) Spiral staircase (including landings)
(k) Arches
(l) Domes, vaults
(m) Shell roof, arch ribs and folded piates
(n) Chimneys and shaft.
(o) Breast walls, retaining, walls, return walls
(p) Concrete filling to precast components
(q) Kerbs, steps and the like
(r) String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like
(s) Cornices and moulded windows sills.
(t) Louvers, fins, facia.

4.2.15.7 Precast cement concrete solid article shall be measured separately and shall include use of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement : 2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under:

Sl.No.	*Classifications*	*Method of measurement*
(i)	String or lacing courses, coping, bed plates, plain windows sills, shelves, louvers, steps etc.	In square meters stating the thickness.
(ii)	Kerbs, edgings etc.	In cubic meters.
(iii)	Solid block work	In cubic metres.
(iv)	Hollow block work	In square metres stating the thickness or in cubic meters.
(v)	Light weight partitions	In square metres stating the thickness or in cubic metres.
(vi)	Light weight partitions	In square metres stating the partition's thickness.

4.2.16 Rate

The rate is inclusive of the cost of labour and materials involved in all the operations described above.

4.3 CEMENT- FLY ASH CONCRETE

4.3.0 Fly ash concrete shall be prepared by mixing graded coarse aggregate of nominal size as specified with fine aggregate, ordinary Portland cement and fly ash in specified proportions with required quantity of water. The recommended composition of cement fly ash concrete are as under:

TABLE 4.12
Fly Ash Concrete Mixes

Composition (Dry Volume)	*Proportion (Dry Volume)*	*Compressive Strength at seven days*
Lean Concrete (1:5:10)		28 kg/cm^2
Cement (Ordinary Portland)	1.0	
Fly ash	2.5	
Sand	4.0	
Stone aggregate	11.0	
Lean Concrete (1:4:8)		37 kg/cm^2
Cement (Ordinary Portland)	1.0	
Fly ash	2.0	
Sand	3.5	
Stone aggregate	9.0	

Note: No fly ash is to be added to Portland Puzzolona cement in any case which itself contains fly ash.

4.3.1 Proportioning

Proportioning shall be done by volume. Boxes of suitable size shall be used for measuring fly ash, sand and aggregate. The internal dimensions of the boxes shall be generally 35x25x40 cm. deep or as otherwise approved by the Engineer -in-charge. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulkage shall be made as given in the chapter for mortar.

4.3.2 Mixing shall be as specified in 4.2.5 except that the fly ash shall be placed in the hopper before cement in case of machine mixing.

4.3.3 Placing and compaction shall be as specified in 4.2.6 and 4.2.7.

4.3.4 Curing shall be as specified in 4.2.10.

4.3.5 Form work shall be as specified in 4.2.12.

4.3.6 Measurements shall be as specified in 4.2.15.

4.3.7 Rate

Rate shall include the cost of materials and labour involved in all the operations described above.

4.4 DAMP PROOF COURSE

4.4.1 Cement Concrete Layer

This shall consist of cement concrete of specified proportions and thickness. The surface of brick or stone masonry work shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honey-coming. Continuity shall be maintained while laying the cement concrete layer and laying shall be terminated only at the predetermined location where damp proof course is to be discontinued. There shall be no construction joints in the Damp Proof Course.

4.4.2 Curing

Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

4.4.3 Application of Hot Bitumen

Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete, properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Bitumen of penetration A 90 or equivalent where used shall be heated to a temperature of $160^{o} \pm 5^{o}C$. The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere. It will be paid for separately.

4.4.4 Water Proofing Materials

Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer's specification stating the quantity of water proofing material in litres or kg per 50 kg or cement and will be paid for separately.

4.4.5 Measurements

The length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

4.4.6 Rate

The rate is inclusive of the cost of materials and labour involved in all the operations described above except for the applications of a coat of hot bitumen and addition of water proofing materials which shall be paid for separately, unless otherwise specified.

APPENDIX A

DETERMINATION OF PARTICLE SIZE

(Clause 4.1.2.3 & 4.1.2.5)

The apparatus, sample size and test procedure shall be same as specified in sub-head 'MORTARS'.

In order that the sieves shall not be overloaded, care must be taken to ensure that the maximum sieve loads shown in Table A-4.1 (below) are not exceeded at the completion of sieving.

TABLE A-4.1

I.S. Sieve Designation	*Maximum weight for*	
	45 cm dia sieve kg	*30 cm dia sieve kg*
45 mm	10	4.5
40 mm	8	3.5
31.5 mm or 22.1 mm	6	2.5
20 mm	4	2.0
16 mm or 12.5 mm	3	1.5
10 mm	2	1.0
5.6 mm	1.5	0.75
4.75 mm	1.0	0.50
3.35 mm	-	0.30

The sample weight taken will thus normally require several operations on each sieve. Each sieve should be taken separately over a clean tray or receiver until no more than a trace passes, but in any case for not less than two minutes. Materials should not be forced through the apertures but hand placing is permitted. A light brush should be used with fine sieves. The cumulative weight passing each sieve should be calculated as percentage of the total sample weight to the nearest whole number.

APPENDIX B

TEST FOR SURFACE MOISTURE

(Clause 4.1.1.5)

Take a sample of wet aggregate and weigh it (A). Then place it in a frying pan and gently apply heat, meanwhile stirring with a glass rod until the surface moisture disappears. This is apparent when the aggregate loses its shining wet appearance and becomes dull, or when it just attains a free funning condition. The saturated surface dry material is then weighed (B). Continue the heating thereafter until the moisture is evaporated and weigh the dry sample (C). The surface moisture is then calculated as follows:

$$\text{Surface moisture} = 100 \times \frac{A-B}{C}$$

It is expressed as a percentage of dry aggregate.

APPENDIX C

DETERMINATION OF TEN PER CENT FINE VALUE

(Clause 4.1.1.5)

Apparatus: The apparatus for the standard test shall consist of the following:

(a) A 15 cm diameter open-ended steel cylinder, with plunger and base-plate, as shown in Fig. in the end of this appendix. The surfaces in contact with the aggregate shall be machined and case hardened or otherwise treated so as to have a diamond (VH) pyramid hardness number of not less than 650 VH.

(b) A straight metal tamping rod of circular cross-section 16 mm in diameter and 45 to 60 cm long, rounded at one end.

(c) A balance of capacity 3 Kg, readable and accurate to one gram.

(d) I.S. Sieve of sizes 12.5, 10 and 2.36 mm.

(e) A compression testing machine capable of applying a load of 50 tonnes and which can be operated to give a uniform rate of loading so that the maximum load in any test is reached in 10 minutes. This load may vary from 0.5 to 50 tonnes.

(f) For measuring the sample, a cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions:

Diameter	11.5 cm
Height	18.0 cm

(g) Means of measuring the reduction in the distance between the plates of the testing machine to the nearest one millimetre during the test (for example, dial gauge).

Test Sample: Material for the test shall consist of aggregate passing a 12.5 mm I.S. Sieve and retained on a 10 mm I.S. Sieve. The aggregate shall be tested in a surface dry condition. If dries by heating the period of drying shall not exceed four hours, the temperature shall be 100ºC to 110ºC and the aggregate shall be cooled to room temperature before testing.

The quantity of aggregate shall be such that the depth of material in the cylinder, after tamping as described below, shall be 10 cm.

The weight of material comprising the test sample shall be determined (weight A) and the same weight of sample shall be taken for the repeat test.

Note: About 6.5 kg of natural aggregate is required to provide the two test samoles. Less of light weight aggregate is required.

The measuring cylinder is filled in three layers of approximately equal depth with aggregate passing a 12.5 mm I.S. Sieve and retained on 10 mm I.S. Sieve. Each layer is subjected to 25 strokes from the tamping rod (16 mm dia and 45 to 60 cm long) rounded to one end, care being taken in case of weak materials not to break the particles. The surface of the aggregate shall be carefully levelled and the plunger inserted so that it rests horizontally on this surface.

Test Procedure: The apparatus, with the test sample and plunger in position, shall then be placed in the compression testing machine. The load shall be applied at a uniform rate so as to cause a total penetration of a plunger in 10 minutes of about: 15.0 mm for rounded or partially rounded aggregates (for example uncrushed gravel) 20 mm for nominal crushed aggregate & 24 mm for honey combed aggregate (for example expanded shales and slags). These figures may be varied according to the extent of the rounding or honey combing.

After reaching the required maximum penetration, the load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The fines passing the sieve shall be weighed, and this weight expressed as a percentage of the weight of the test sample. Normally, this percentage will fall within the range 7.5 to 12.5, but if it does not, a further test shall be made at a load adjusted appropriately, to bring the percentage fines within the range of 7.5 to 12.5.

A repeat test shall be made at the load that gives as percentage fines within the range 7.5 to 12.5.

Calculations: The mean percentage fines from the two tests at this load shall be used in the following formula to calculate the load required to give 10 percentage fines.

Load required for 10 percent fines = $\frac{14+X}{Y+4}$

Where X = Load in tonnes and
Y= mean percentage fines from two test at X tonnes load.

Reporting of Results: The load required to produce 10 percent fines shall be reported to the nearest whole number for loads of 10 tonnes or more, the nearest 0.5 tonne for loads of less than 10 tonnes.

The value expressed to the nearest 0.5 tonne should be as follows:
(a) For normal concrete, not less than 5 tonnes.
(b) For wearing surfaces, not less than 10 tonnes.
(c) For granolithic concrete, not less than 15 tonnes.

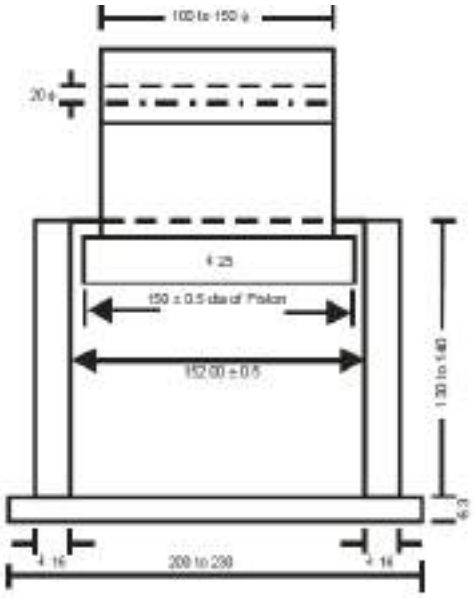


Fig. C-4.1 : Apparatus for Determination of Ten per cent Fine Value

APPENDIX D

SLUMP TEST

(Clause 4.2.2)

Apparatus: Mould shall consist of a metal frustum of cone having the following internal dimensions:

Bottom diameter……..20 cm

Top diameter……10 cm

Height……30 cm

The mould shall be of a metal other than brass and aluminium of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used.

Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

Procedure: The internal surface of the mould shall be thoroughly cleaned and free form superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid and non- absorbent surface viz. levelled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of mould. Each layer shall be tamped with twenty five strikes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the under-lying layer. The bottom layer shall be tamped through out its depth. After the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould is exactly filled. Any mortar which shall leak out between the mould and the base plate shall be cleaned away. The mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The moulded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.

The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

Result: The slump shall be recorded in terms of millimeters of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally give incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.

SUB HEAD : 5.0

REINFORCED CEMENT CONCRETE WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	123
	List of Bureau of Indian Standard Codes	127
5.0	General	128
5.1	Materials	128
5.1.1	Water, Cement, Fine and Coarse Aggregate	128
5.1.2	Fly Ash Admixed Cement Concrete (FACC) and Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures	128
5.1.3	Steel for Reinforcement	129
5.1.4	Stacking & Storage	131
5.1.5	Identification	132
5.2	Form Work (Centring & Shuttering)	132
5.2.1	Form Work	132
5.2.2	Design & Tolerance in Construction	132
5.2.3	General Requirement	132
5.2.4	Surface Treatment	134
5.2.5	Inspection of Form Work	135
5.2.5.1	Erection of Form Work (Centering and shuttering)	135
5.2.5.2	Guidelines for Multistage Centering	136
5.2.6	Measurements	136
5.2.7	Rate	138
5.3	Reinforcements	138
5.3.1	General Requirements	138
5.3.2	Welding of Bars	139

5.3.3	Placing in Position	139
5.3.4	Measurements	140
5.3.5	Rate	140
5.3A	Steel for Reinforcement ready to use "Cut & Bend"	141
5.3A.7	Assembly of Rebars	143
5.3A.8	Wlding of Bars	143
5.3A.9	Placing in Position	143
5.3A.10	Measurement	144
5.3A.11	Rate	144
5.3B	Reinforcement couples	145
5.3B.1	General requirement of material	145
5.3B.2	Performance requirement	145
5.3B.3	Sampling and criteria for conformity	145
5.3B.4	Installation procedure/instructions	145
5.3B.5	Measurements	145
5.3B.6	Rate	145
5.4	Concreting	145
5.4.1	Consistency	145
5.4.2	Placing of Concrete	145
5.4.3	Compaction	146
5.4.4	Construction Joints	147
5.4.5	Expansion Joints	147
5.4.6	Curing	147

5.4.7	Rectification of Surface Defects of Minor nature	147
5.4.8	Strength of Concrete	148
5.4.9	Testing of Concrete	149
5.4.10	Standard of Acceptance for Nominal Mix	149
5.4.11	Measurements	152
5.4.12	Tolerances	154
5.4.13	Rate	154
5.5	Encasing Rolled Steel Sections	155
5.5.1	General Requirements	155
5.5.2	Wrapping	155
5.5.3	Form Work	156
5.5.4	Concreting	156
5.5.5	Measurements	156
5.5.6	Rate	156
5.6	Precast Reinforced Concrete	156
5.6.1 to 5.6.4	General Requirements	156
5.6.5 to 5.6.6	Curing	157
5.6.7 to 5.6.8	Marking	157
5.6A	Precast door & window frames	157
5.6.A.1	Materials	157
5.6.A.2	Manufacture	158
5.6.A.3	Hinges	158
5.6.A.4	Other hardware fixing	159

5.6.A.5	Finishing	159
5.6.A.6	Fixing	159
5.6.A.7	Measurements	159
5.6.A.8	Rate	159
5.7	Precast Cement Concrete Jali	159
5.7.1	Fixing	159
5.7.2	Measurements	159
5.7.3	Rate	159
5.7A	Expansion joint covering with cement bonded particle board	159
5.7A.1	Materials	159
5.7A.2	Physical requirement	160
5.7A.3	Measurement	160
5.7A.4	Rate	160
5.7B	Expansion joint covering with stainless steel grade 304	160
5.7B.1	Materials	160
5.7.B.2	Chemical composition	160
5.7B.3	Tolerances	160
5.7B.4	Mechanical properties	160
5.7B.5	Frequency of sampling	160
5.7B.6	Measurement	160
5.7B.7	Rate	160
5.8	Design Mix	161
5.8.0	Definition	161

5.8.1	Mix Design and Proportioning	161
5.8.2	Standard Deviation	161
5.8.3	Acceptance Criteria for Design Mix	161
5.8.4	Cement Content of Concrete	162
5.8.5	Water Cement Ratio and Slump	162
5.8.6	Approval of Design Mix	163
5.8A	RCC for construction of piers, abutments, portal, frames, pier caps and bearing pedestals and seismic arresters	163
5.8A.1	General	163
5.8A.2	Materials	163
5.8A.3	Steel for reinforcement	163
5.8A.4	Concreting	164
5.8A.5	Self compacting concrete	164
5.8A.6	Laying of RMC concrete	167
5.8A.7	Specifications for pier, abutment, pier/abutment cap. (IRC 78-2014)	167
5.8A.8	Measurement	168
5.8A.9	Rate	169
5.8B	RCC diaphragm wall	169
5.8B.1	General	169
5.8B.2	Materials	169
5.8B.3	Steel for reinforcement	170
5.8B.4	Concreting	170
5.8B.5	Self compacting concrete	170

5.8B.6	Specifications for Diaphragm Wall	173
5.8B.7	Records	175
5.8B.8	Measurement	175
5.8B.9	Rate	175
5.9	Ready Mixed Concrete (As per IS 4926)	175
5.9.1	Materials	175
5.9.2	General Requirements	176
5.9.3	Sampling and Testing of Ready - Mixed Concrete	177
5.9.4	Information to be Supplied by the Purchaser	178
5.9.5	Information to be Supplied by the Producer	178
5.9.6	Production and Delivery	179
5.9.7	Quality Control	181
5.9.8	Order Processing	183
5.9.9	Records	183
5.10	Placing Concrete by Pumping	183
5.10.1	General	183
5.10.2	Pumping Equipments	183
5.11	Guidelines for Field Practice	185
5.11.1	General Precautions	185
5.11.2	Submittals	187
5.11.3	Sampling and Testing (Materials)	187
5.11.4	Sampling and Testing for Quality Control of Fresh Concrete	190
5.11.5	Sampling and Testing for Quality Control of Hardened Concrete	192

5.12	Expansion joint system	194
5.12.1	Floor joint	194
5.12.1.1	General requirement of material	194
5.12.1.2	Performance requirement	194
5.12.1.3	Approval of expansion joint system	194
5.12.1.4	Installation of expansion joint system	194
5.12.1.5	Measurement	194
5.12.1.6	Rate	194
5.12.2	Wall joint	194
5.12.2.1	General requirement of material	194
5.12.2.2	Performance requirement	195
5.12.2.3	Approval of expansion joint system	195
5.12.2.4	Installation of expansion joint system	195
5.12.2.5	Measurement	195
5.12.2.6	Rate	195
5.12.3	Roof joint	195
5.12.3.1	General requirement of material	195
5.12.3.2	Performance requirement	195
5.12.3.3	Approval of expansion joint system	195
5.12.3.4	Installation of expansion joint system	195
5.12.3.5	Measurement	195
5.12.3.6	Rate	195
Appendix A	Cube Test for Compressive Strength of Concrete - Mandatory Lab Test	196

Appendix B	Additional Tests for Concrete	199
Appendix C	Register of Work Test of Concrete	203
Appendix D	List of Equipments required for Site Laboratory	205
	Annexure A- Sampling of concrete	207
	Annexure B- Concret mix information to be supplied by the purchaser	207
	Annexure C- Calibration and weighing equipment accuracy	208
	Annexure D- Delivery ticket information	209
Fig. 5.1, 5.2 & 5.3	Typical set up of Steel Wall Form Work and Ties	210 – 212
Fig. 5.4 & 5.5	Typical Standard Units and Components of Form Work	213 – 214
Fig. 5.6 & 5.7	Typical Arrangements of Column Form Work.	215
Fig. 5.8	Typical details of Beam Head and Stiffener	217
Fig. 5.9	Typical details of Multi-Stage Shuttering	218
Fig. 5.10 to 5.23	Details of Expansion Joints	219 – 223
Fig. 5.24 & 5.25	Seismic Separation Joints, Details at Floor and Roof Level	224
Fig. 5.26	Construction Joints	225
Fig. 5.27 & 5.28	Encasing Rolling Steel Sections	226

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ laboratory test*	*Test procedure*	*Min, quantity of material for carrying out the test*	*Frequency of testing*
1	2	3	4	5	6	7
Reinforced cement concrete (Nominal Mix)	5.4.1	(a) Slump test	Field/Lab	Appendix 'D' of Chapter 4	(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected columns (iii) 20 cum for other R.C.C. work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineerin - Charge	(ii) Every 20 cum or part thereof (i) Every 5 cum of part thereof (iii) -Do-
	5.4.9.1	(b) Cube Test	Lab	Appendix 'A'	(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected Columns (iii) 20 cum for other R.C.C.work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineerin-Charge	(i) Every 5 cum or part thereof (ii) Every 20cum or part thereof (iii) -Do

1	2	3	4	5	6	7
Reinforced Cement Concrete (Design Mix)	Coarse Aggregates				50 cum or part thereof & also on each change of source	
	Fine Aggregates				50 cum or part thereof & also on each change of source	
	Cement				50 MT or on each change of source	
	Fresh Concrete	(a) Slump test	Field	Appendix 'D' of Chapter 4	10 cum	50 cum for R.C.C. work including in all other small location. R.C.C.done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge
	Fresh Concrete	(b) Cube Test	Lab	Appendix 'A'	10 cum or part thereof	50 cum or 10 batches of 5-7 cum each for R.C.C. work in all location taken together. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge
Reinforced Cement Concrete (Ready Mix)	Coarse Aggregates				50 cum or part thereof & also on each change of source	
	Fine Aggregates				50 cum or part thereof & also on each change of source	
	Cement				50 MT or on each change of source	
	Fresh Concrete	(a) Slump test	Field/Lab	Appendix 'D' of Chapter 4	10 cum	50 cum for R.C.C. work including in all other small location. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineer-in-Charge

1	2	3	4	5	6	7	
	Fresh Concrete	(b) Cube Test	Lab	Appendix 'A'	10 cum or part thereof	50 cum or 10 batches of 5-7 cum each for R.C.C. work in all location – taken together. R.C.C. done in a day is less than 50 cum test may be carried out as required by Engineerin-Charge	
Steel for Reinforced cement concrete	5.1.3	(A) Physical Test and chemical tests				(a) For consignment below 100 tonnes (i) under 10 mm dia, one Sample for each 25 tonnes or part thereof (ii) 10 mm to 16 mm dia one sample for each 35 tonnes or part thereof (iii) over 16 mm dia one sample for each 45 tonnes or part thereof	(b) For consignment over 100 tonnes (i) Under 10 mm dia, one sample For each 40 tonnes or part thereof (ii) 10 mm to 16 mm, one sample for each 45 (iii) over 16 mm dia, one sample for each 50 tonnes or part thereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	*I.S. No.*	*Subject*
1.	IS 226	Structural Steel
2.	IS 2285	Methods for chemical analysis of steel (Issues in various parts)
3.	IS 432 (Part I)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-I mild steel and medium tensile steel bars.
4.	IS 432 (Part II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement – Part-II hard drawn steel wire.
5.	IS 456	Code of Practices for plain and Reinforced concrete.
6.	IS 516	Method of test for strength of concrete.
7.	IS 716	Specification for pentachlorophenol
8.	IS 1199	Method of sampling and analysis of concrete.
9.	IS 1200 (Part II)	Method of measurement of building and civil engineering work – concrete work
10.	IS 1200 (Part V)	Method of measurement of building and civil engineering work – concrete work (Part 5- Form work)
11.	IS 1566	Specification for hard drawn steel wire fabric for concrete requirement.
12.	IS 1599	Method for bend test
13.	IS 1343	Code of Practice for Prestressed Concrete
14.	IS 1387:1993	General requirements for the supply of metallurgical materials
15.	IS 14687	Guidelines for falsework for concrete structures
16.	IS 1608	Method for tensile testing of steel products
17.	IS 1786	Specification for high strength deformed steel and wires for concrete reinforcement.
18.	IS 1791	Specification for batch type concrete mixes
19.	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
20.	IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
21.	IS 4925	Batch plants specification for concrete batching and mixing plant
22.	IS 4926	Ready – Mixed Concrete
23.	IS 5522:2014	Specification for Indian Standard Stainless Steel sheet and strips for utensils
24.	IS 6523	Specification for precast reinforced concrete door, window frames
25.	IS 10262	Recommended guidelines for concrete mix design
26.	IS 13311 (Part I)	Indian standard for non-destructive testing of concrete. Method of test for ultrasonic pulse velocity
27.	IS 13311 (Part II)	Indian standard for non-destructive testing of concrete. Method of testing by rebound hammer.
28.	IS 14276:1995	Indian standard for Cement bonded particle boards
29.	IS 16172:2014	Specification for Reinforcement couplers for mechanical splices of bars in concrete

5.0 REINFORCED CEMENT CONCRETE WORK

5.0 GENERAL

Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

(a) Form work (Centering and Shuttering)

(b) Reinforcement

(c) Concreting: (1– Cast-in-situ), (2 – Precast)

5.1 MATERIALS

5.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 mortars and chapter 04 concrete work as applicable.

5.1.2 Fly Ash admixed cement concrete (FACC) and fly ash Blended cements in Cement Concrete (PPCC) in RCC structures.

5.1.2.0 Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below :

5.1.2.1 ***General***

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under :
   (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
   (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

(ii) Minimum M -25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.

(iii) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.

(iv) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture.
If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and /or PPC received from different sources shall be ensured by trials.

(v) In environment subjected to aggressive chloride or sulphate attach in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, fly ash substitution/content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

(vi) Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

5.1.2.2 ***Use of Fly ash Admixed Cement Concrete (FACC) in RCC structures***

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

(i) Fly ash shall have its chemical characteristics and physical requirements etc. conforming to IS 3812 (part I & II) and shall be duly certified.

(ii) To ensure uniform blending of fly ash with cement in conformity with IS 456, a specific facility needs to be created at site with complete computerized automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.

(iii) As per IS 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS 3812 (Part –I) and same is reiterated.

(iv) Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

5.1.2.3 ***Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures***

(i) Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.

(ii) Till the time, BIS makes it mandatory to print the %age of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.

(iii) While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.

5.1.3 Steel for Reinforcement

5.1.3.1 The steel used for reinforcement shall be any of the following types:

(a) Mild steel and medium tensile bars conforming to IS 432 (Part I)

(b) High strength deformed steel bars conforming to IS 1786

(c) Hard drawn steel wire fabric conforming to IS 1566

(d) Structural steel conforming to Grade A of IS 2062

(e) Thermo-mechanically treated (TMT) Bars.

5.1.3.2 Elongation percent on gauge length is $5.65\sqrt{A}$ where A is the cross sectional areas of the test piece.

5.1.3.3 Mild steel is not recommended for the use in structures located in earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

5.1.3.4 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.

Nominal mass/weight : The tolerance on mass/ weight for round and square bars shall be the percentage given in Table 5.1 of the mass/ weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7.85 kg/ cm^3 or 0.00785 kg/mm^3.

TABLE 5.1
Tolerance on Nominal Mass

Nominal size in mm	*Tolerance on the Nominal Mass per cent*		
	Batch	*Individual sample +*	*Individual sample for coil (x)*
(a) Upto and including 10	±7	-8	±8
(b) Over 10, upto and including 16	±5	-6	±6
Over 16	±3	-4	±4

\+ for individual sample plus tolerance is not specified
(x) for coil batch tolerance is not applicable
Tolerance shall be determined in accordance with method given in IS 1786.

5.1.3.5 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.2.

TABLE 5.2

Sl. No	*Property*	*Fe 415*	*Fe 415 D*	*Fe 500 D*	*Fe 550 D*
(i)	0.2 Per cent Proof stress/ yield stress, Min, N/mm^2	415.0	415.0	500.0	550.0
(ii)	Elongation, per cent, Min. on gauge length 5.65 √A, where A is the corss-sectional area of the test piece.	14.5	18.0	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 485.0 N/mm^2	12 Per cent more than the actual 0.2 percent proof stress/yield stress but not less than 500.0 N/mm^2	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 565.0 N/mm^2	8 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 600.0 N/mm^2
(iv)	Total elongation at maximum force, percent, Min on gauge length 5.65 √A, where A is the cross-sectional area of the test piece.	-	5	5	5

Tests: Selection and preparation of Test sample. All the tests pieces shall be selected by the Engineer-in-Charge or his authorized representative either-

(a) From cutting of bars
Or

(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation –
This shall be done as per IS 1608, read in conjunction with IS 226.

RE- test: This shall be done as per IS 1786.

Rebend test: This shall be done as per IS 1786.

5.1.3.6 Chemical composition of reinforcement bars shall be as per Table 5.3 as follows:-

TABLE 5.3

Constituent	*Maximum Per cent*			
	Fe 415	*Fe 415 D*	*Fe 500 D*	*Fe 550 D*
Carbon	0.30	0.25	0.25	0.25
Sulphur	0.060	0.045	0.040	0.040
Phosphorus	0.060	0.045	0.040	0.040
Sulphur and Phosphorus	0.110	0.085	0.075	0.075

5.1.3.7 Thermo Mechanically treated reinforcement bars:

(a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.

(b) The TMT bars are being produced under valid licence from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licences to various producers to produce TMT Bars.

(c) The TMT bars shall conform to IS 1786 pertaining to Fe 415 D or Fe 500 D or Fe grade of steel as specified.

(d) In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermo mechanical treatment process of grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5. % and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

5.1.4 Stacking and Storage

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

5.1.5 Identification

Care shall also be taken to properly identify these bars at site. The staff shall be specially trained for looking for identification marks on these bars given by the manufacturers which are generally given colour code. It will be advisable to see that only one type/grade of bars are brought to site and used in the project after conducting tests for each lot.

5.2 FORM WORK (CENTRING & SHUTTERING)

5.2.1 Form Work

Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

5.2.2 Design & Tolerance in Construction

Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.

(a)	Deviation from specified dimension of cross section of columns and beams	**+10 mm** **-5 mm**
(b)	Deviation from dimensions of footings	
	(i) Dimension in Plan	(+ 50 mm (**-10 mm**
	(ii) Eccentricity in plan	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
	(iii) Thickness	**+50mm** **Or** **± 0.05 times the specified thickness** **Whichever is less**

(**Note**- These tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

5.2.3 General Requirement

It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

5.2.3.1 ***Material for Form Work***

(a) *Propping and Centering* : All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

5.2.3.2 (a) ***Centering/Staging :*** Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made form rolled structural steel sections.

(b) In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

(c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

5.2.3.3 ***Shuttering:*** Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used or concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

(a) *Runner Joists:* RSJ, MS Channel or any other suitable section of the required size shall be used as runners.

(b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

(c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.

5.2.3.4 Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 metres, the prop may be provided in multi-stages. A typical detail of multistage shuttering is given in Fig. 5.9.

5.2.3.5 ***Camber:*** Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the Engineer-in- Charge, so as to offset the subsequent deflection, For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

5.2.3.5.1 Typical arrangement of form work for 'beams, columns and walls' are shown in Figures 5.1 to 5.8 and form secured by wall ties is shown in Fig. 5.3.

5.2.3.6 ***Walls :*** The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig. 5.1, 5.2 & 5.3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs, some of the accessories used for wall form are shown in Fig. 5.3.

5.2.3.7 ***Removal of Form work (Stripping Time) :*** In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods:

Type of Form work	*Minimum period Before Striking Form work for OPC 33 grade*	*Minimum period Before Striking Form work for OPC 43 grade*	*Minimum period Before Striking Form work for PPC*
(a) Vertical form work to columns, walls, beams	16-24 h	16-24 h	24-36 h

Type of Form work	*Minimum period Before Striking Form work for OPC 33 grade*	*Minimum period Before Striking Form work for OPC 43 grade*	*Minimum period Before Striking Form work for PPC*
(b) Soffit form work to slabs (Props to be refixed immediately after removal of formwork)	3 days	3 days	4 days
(c) Soffit form work to beams (Props to be refixed immediately after removal of formwork	7 days	7 days	10 days
(d) Props to slabs: (1) Spanning upto 4.5m (2) Spanning over 4.5m	 7 days 14 days	 7 days 14 days	 10 days 20 days
(e) Props to beams and arches: (1) Spanning upto 6m (2) Spanning over 6m	 14 days 21 days	 14 days 21 days	 20 days 30 days

Note 1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally If Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

Note 3: For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6: Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

5.2.4 Surface Treatment

5.2.4.1 ***Oiling the Surface*** **:** Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.

A typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use.

The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

5.2.4.2 The design of form work shall conform to sound Engineering practices and relevant IS codes.

5.2.5 Inspection of Form Work

The completed form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position.

Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge.

Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

5.2.5.1 ***Erection of Form Work (Centering and shuttering):*** Following points shall be borne in mind while checking during erection.

(a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.

(b) Material used should be checked to ensure that, wrong items/ rejects are not used.

(c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

(d) (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
(ii) Sole plates shall be properly seated on their bearing pads or sleepers.
(iii) The bearing plates of steel props shall not be distorted.
(iv) The steel parts on the bearing members shall have adequate bearing areas.

(e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

(f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.

(g) The stacked materials shall be placed as catered for, in the design.

(h) When adjustable steel props are used. They should:
1. be undamaged and not visibly bent.
2. have the steel pins provided by the manufacturers for use.
3. be restrained laterally near each end.
4. have means for centralizing beams placed in the forkheads.

(i) Screw adjustment of adjustable props shall not be over extended.

(j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/ clamped down after adjustment to prevent shifting.

(k) No member shall be eccentric upon vertical member.

(l) The number of nuts and bolts shall be adequate.

(m) All provisions of the design and/or drawings shall be complied with.

(n) Cantilever supports shall be adequate.

(o) Props shall be directly under one another in multistage constructions as far as possible.

(p) Guy ropes or stays shall be tensioned properly.

(q) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.

(r) Required camber shall be provided over long spans.

(s) Supports shall be adequate, and in plumb within the specified tolerances.

5.2.5.2 Guidelines for Multistage Certering: The proper handling the situation of multistage centering in buildings or where height of casting of concrete is higher than normal height of 3.5 M or where higher loadings are coming during casting of concrete or large span structures and in situations of casting of some special structures like Domes, Vaults etc.

In all situations, centering/scaffolding/staging for casting of these structures should be properly designed by a qualified and experienced person/agency having past experience in design of false work (centering) for concrete structures and should be proof checked by similar experienced person/ agency and it should be properly approved and issued to contractor by Engineer-In-Charge. The provisions of clause 7 of IS:14687 may be referred for design of false work (centering).

A method statement for erection and dismantling of the centering/scaffolding/staging and process of concreting shall be prepared by contractor and submitted to Engineer-in-Charge for approval and the work shall be commenced only after approval of method statement by Engineer-in-Charge. The provisions of clause 9 of IS:14687 may be referred for erection of false work (centering), safety precautions and other site operations, pertaining to false work (centering).

Experienced form watcher shall be engaged during erection, concreting and dismantling for early detection of any movement or instability in the system. The field engineers shall ensure that CPWD specifications and provisions of BIS codes are strictly followed.

A detailed programme of field safety inspection of centering/scaffolding/form work of such structures during different stages should be chalked out and strictly followed.
Provision of safety net, fall arresting system including other safety gears, for workers, working over these structures shall be made in contract and should be followed strictly.

5.2.6 MEASUREMENTS

5.2.6.1 ***General*** **:** The form work shall include the following:

(a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.

(b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.

(c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.

(d) Working scaffolds, ladders, gangways, and similar items.

(e) Filleting to form stop chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.

(f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.

(g) Dressing with oil to prevent adhesion and

(h) Raking or circular cutting

5.2.6.2 ***Classification of Measurements:*** Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following.

(a) Foundations, footings, bases of columns etc. and for mass concrete

(b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.

(c) Suspended floors, roofs, landings, shelves and their supports and balconies.

(d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.

(e) Columns, pillars, piers, abutments posts and struts.

(f) Stairs (excluding landings) except spiral staircase.

(g) Spiral staircases (including landings).

(h) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates

(i) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped

(j) Chimneys and shafts.

(k) Well steining.

(l) Vertical and horizontal fins individually or forming box, louvers and bands.facias and eaves board

(m) Waffle or ribbed slabs.

(n) Edges of slabs and breaks in floors and walls (to be measured in running metres where below 200 mm in width or thickness).

(o) Cornices and mouldings.

(p) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.

(q) Chullah hoods, weather shades, chajjas, corbels etc. including edges and

(r) Elevated water reservoirs.

5.2.6.3 Centering, and shuttering where exceeding 3.5 metre height in one floor shall be measured and paid for separately.

5.2.6.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

5.2.6.5 No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0.4 square metre. Nothing extra shall be paid for forming such openings.

5.2.6.6 Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well steining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.

5.2.6.7 Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However, there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

5.2.7 Rate

The rate of the form work includes the cost of labour and materials required for all the operations described above.

5.3 REINFORCEMENTS

5.3.1 General Requirements

Steel conforming to para 5.1.3 for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

5.3.1.1 ***Assembly of Reinforcement :*** Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer- in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or $1^1/_4$ times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

5.3.1.2 ***Bonds and Hooks Forming End Anchorages:*** Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

(a) U-Type Hook

In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter equal to four times the diameter of the bar.

Note: In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

(b) Bends

Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

5.3.1.3 ***Anchoring Bars in Tension :*** Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.

5.3.1.4 ***Anchoring Bars in Compression :*** The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

5.3.1.5 ***Binders, stirrups, links etc. :*** In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times **the** nominal size of bar.

5.3.2 Welding of Bars

Wherever facility for electric **arc** welding **or gas pressure welding** is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-Charge. Welding shall be as per IS 2751 and 9417.

5.3.3 Placing in Position

5.3.3.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer -in -charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-Charge.

5.3.3.2 The bars shall be kept in correct position by the following methods:

(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.

(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 mere or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them: or with clock of cement mortar 1:2 (1 cement: 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.

(d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

5.3.3.3 ***Tolerance on Placing of Reinforcement*****:** Unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:

	Tolerance in spacing
(a) For effective depth, 200 mm or less	+10 mm
(b) For effective depth, more than 200 mm	+ 15 mm

5.3.3.4 ***Bending at Construction Joints*** **:** Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameter for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

5.3.3.5 ***Cover :*** The minimum nominal cover to meet durability requirements shall be as under:-

Exposure	*Nominal Concrete cover in mm not less than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.
3. For exposure condition 'severe' and 'very severe' reduction of 5 mm may be made, where concrete grade is M35 and above.
4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

5.3.4 Measurement

Reinforcement including authorized spacer bars and lappages shall be measured in length of different diametre, as actually (not more than as specified in the drawings.) used in the work nearest to a centimetre and their weight calculated on the basis of standard weight given in Table 5.4 below. In case actual unit weight of the bars is less than standard unit weight, but within variation, in such cases weight of reinforcement shall be calculated on the basis of actual unit weight. Wastage and unauthorized overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement.

Where tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the Engineer-in-Charge and measured separately and paid for.

TABLE 5.4
Cross Sections Area and Mass of Steel Bar

Nominal Size mm	*Cross sectional Area Sq.mm*	*Mass per metre Run Kg.*
6	28.3	0.222
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
20	314.3	2.47
25	491.1	3.85
28	615.8	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.86

Note: These are as per clause 6.2 of IS 1786.

5.3.5 Rate

The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking bending,

binding, placing in position etc. as required or directed including tack welding on crossing of bars in lieu of binding with wires.

5.3A STEEL FOR REINFORCEMENT READY TO USE "CUT & BEND"

5.3A.1 Cut and bend rebars are customised reinforced steel bars required at construction sites. These shall be made from specialized machinery ensuring exact precision, ready to use pre-cut and pre-bent as per approval drawings. The steel used for reinforcement shall be the following types.

(a) Thermo-mechanically treated (TMT) Bars.

5.3A.2 Elongation percent on gauge length is 5.65A, where A is the cross sectional area of the test piece.

5.3A.3 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirement of IS 2751.

Nominal mass/weight:- The tolerance on mass/weight for round and square bars shall be the percentage given in Table 5.4A of the mass/weight calculated on the basis that the masses of the bar/wire of nominal diameter and of density 7.85 Kg/cm^3 or 0.00785 kg/mm^3.

TABLE 5.4A
Tolerance on Nominal Mass

Nominal size in mm	Tolerance on the Nominal Mass per cent		
	Batch	Individual sample+	Individual sample for coil (x)
(a) Upto and including 10	±7	-8	±8
(b) Over 10, upto and including 16	±5	-6	±6
(c) Over 16	±3	-4	±4

\+ for individual sample plus tolerance is not specified
(x) for coil batch tolerance is not applicable
Tolerance shall be determined in accordance with method given in IS 1786.

5.3A.4 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.4B.

TABLE 5.4B

Sl. No.	Property	Fe 500 D	Fe 550 D
(i)	0.2 Per cent Proof stress/yield stress, Min, N/mm^2	500.0	550.0
(ii)	Elongation per cent, Min. on gauge length 5.65 √A, where A is the cross-sectional area of the test piece.	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 565.0 N/mm^2.	8 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 600.0 N/mm^2.
(iv)	Total elongation at maximum force, percent, Min on gauge length 5.65 √A, where A is the cross-sectional area of the test piece.	5	5

Tests:-Selection and preparation of Test sample. All the tests piece shall be selected by the Engineer-in-charge or his authorized representative either-

(a) From cutting of bars
Or

(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-charge or his authorized representative.

The test piece obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation-
This shall be done as per IS 1608, read in conjunction with IS 226.

RE-test:- This shall be done as per IS 1786.

Rebend test:- This shall be done as per IS 1786.

5.3A.5 Chemical composition of reinforcement bars shall be as per Table 5.4C as follows:-

TABLE 5.4C

Constituent	Maximum Per cent	
	Fe 500 D	Fe 550 D
Carbon	0.25	0.25
Sulphur	0.040	0.040
Phosphorus	0.040	0.040
Sulphur and Phosphorus	0.075	0.075

5.3A.6 Thermo Mechanically treated reinforcement bars:

(a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.

(b) The TMT bars are being produced under valid licence from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licences to various producers to produce TMT Bars.

(c) The TMT bars shall conform to IS 1786 pertaining to Fe 500 D or Fe grade of steel as specified.

(d) In design and construction of reinforcement concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermomechanical treatment process of grade Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

5.3A.7 Assembly of Rebars

5.3A.7.1 The rebars shall be bend correctly and precisely to the size and shape as shown in the detailed drawing or as directed by Engineer-in-charge. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or 1¼ times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted light. The overlaps/splices shall be staggered as per direction of the Engineer-in-charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

5.3A.7.2 Bonds and Hooks Forming End Anchorages:-Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement.

5.3A.7.3 Anchorages Bars in Tension:-Deformed bars may be used without end anchorages Development length of bars will be determined as per IS: 456.

5.3A.7.4 Anchorages Bars in Compression:-The anchorages length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of bend and straight length beyond bend, if provided for a bar in compression, shall be considered for development length.

5.3A.7.5 Binders, stirrups, link etc:-In case of binders, stirrups, link etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

5.3A.8 Welding of Bars.

Wherever facility for electric arc welding or gas pressure welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-charge. Welding shall be as per IS 2751 and 9417.

5.3A.9 Placing in Position

5.3A.9.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-charge.

5.3A.9.2 The bars shall be kept in correct position by the following methods:

(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.

(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them or with block of cement mortar 1:2 (1 cement : 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.

(d) In case of other R.C.C. structure such as arches, domes, shells, storage tank etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-charge.

5.3A.9.3 Tolerance on Placing of Reinforcement:-Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances.

	Tolerance in spacing
(a) For effective depth, 200 mm or less	+ 10 mm
(b) For effective depth, more than 200 mm	+ 15 mm

5.3A.9.4 Bending at Construction Joints:-Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 6 bars diameter. Care should also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

5.3A.9.5 Cover:-The minimum nominal cover to meet durability requirements shall be as under:-

Exposure	Nominal Concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Note : 1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.

3. For exposure condition ‘severe’ and ‘very severe’ reduction of 5 mm may be made, where concrete grade is M 35 and above.

4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

5.3A.10 Measurement

The Measurement shall be as specified under para 5.3.4

5.3A.11 Rate

The Measurement shall be as specified under para 5.3.5

5.3B REINFORCEMENT COUPLERS

5.3B.1 General requirement of material

Reinforcement coupler shall have adequate strength, length and internal threads as per manufacturer's design to be able to meet the performance requirement as per IS Code. All reinforcement coupler shall be finished smooth and shall be free from burrs, cracks and other manufacturing defects. The threads shall be clearly formed and shall be free from imperfections. The nominal sizes of reinforcement couplers based on their internal diameter shall correspond to the size of bars covered under IS Code 1786. Each coupler should be identifiable by marks/ brands which indicate name of manufacture or their brand name, class designation, nominal size and grade of reinforcement for which it is intended and BIS standard mark.

5.3B.2 Performance Requirement: All reinforcement couplers shall meet the performance requirements as per IS Code 16172:2014 clause 9.2, 9.3, 9.4 and 9.5.1. Class H couplers in addition to above shall also meet requirement of clause 9.5.2 of IS Code 16172:2014.
The static tensile test shall constitute acceptance test.

5.3B.3 Sampling and criteria for conformity: Sampling and criteria for conformity shall be as per Annexure 'F' of IS Code 16172:2014

5.3B.4 Installation procedure/ instructions: The manufacturer/ supplier shall provide written installation instructions. The installation instructions shall be clear and understandable. The described installation procedure of reinforcement coupler shall be repeatable and able to achieve its performance under different job site circumstances.

5.3B.5 Measurement : The reinforcement couplers shall be measured in numbers.

5.3B.6 Rate : The rate shall be inclusive of all materials &labour involved in fixing parallel threaded couplers to reinforcement bars.

5.4 CONCRETING

5.4.0 The concrete shall be as specified under chapter 4 concrete work. The proportion by volume or by the weight of ingredients shall be as specified.

5.4.1 Consistency

The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated on or hand tamped, it shall be determined by slump test as prescribed in sub-head "concrete" under workability – requirement.

5.4.2 Placing of Concrete

5.4.2.1 Concreting shall be commenced only after Engineer-in-Charge has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shavings, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed in 5.2.4.

5.4.2.2 In case of concreting of slab and beams, wooden plank or cat walks of chequerred MS plated or bamboo chalies or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

5.4.2.3 In case of columns and wall, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction, shall be restricted to one metre per hour.

5.4.2.4 The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the Engineer-in-Charge. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 metres at a time.

5.4.2.5 During cold weather, concreting shall not be done when the temperature falls below 4.5^{0}C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

5.4.2.6 During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38ºC. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

5.4.2.7 It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

5.4.3 Compaction

It shall be as specified in sub-head of Concrete Work of this specification.

5.4.3.1 Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations complying with IS 2505, IS 2506, IS 2514 and IS 4656. The Engineer- in- Charge may however relax this condition at his discretion for certain items depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation; such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

5.4.3.2 Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibration. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. with 30 minutes of addition of water to the dry mixture.

5.4.3.3 In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. Sprinkling of dry cement while finishing shall not be resorted to.

5.4.4 Construction joints

5. 4.4.1 Joints are a common source of weakness and, therefore, it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be indicated in Fig 5.26 or as directed by Engineer-in-Charge.

5.4.4.2 In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

5.4.4.3 When stopping the concrete on a vertical plane in slabs and beams, and approved stop board (see Fig. 26C) shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

5.4.4.4 When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square metre shall then be applied on the roughened surface before fresh concrete is laid.

5.4.5 Expansion Joints

Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 5.10 to 5.25 or as directed by Engineer-in-Charge, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running metre. The measurement shall be taken two places of decimal stating the depth and width of joint.

5.4.6 Curing

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the Engineer-in-Charge. After 24 hours of laying of concrete, the surface shall be cured by ponding with water for a minimum period of 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather condition.

5.4.7 Rectification of Surface defects of Minor nature

Immediately on removal of forms, the R.C.C. work shall be examined by the Engineer-in-Charge, before any defects are made good.

(a) The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given in para 5.4.9.4 for visual inspection test.

(b) Surface defects of minor nature may be accepted. On acceptance of such a work by the Engineer-in-Charge, the same shall be rectified as follows:

1. Surface defects which require repair when forms are removed, usually consist of bulged due to movement of forms, ridges at form joints, honey-combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly under cut to provide a key at the edge of the patch.

2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.

4. Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.

6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.

7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

(c) **Whenever required**, The exposed surface of R.C.C. work shall be plastered with cement mortar 1:3 (1 cement : 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure, shall be considered exposed surfaced for the purpose of this specification.

(d) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster.

RCC work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6 mm.

(e) The surface of RCC slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

5.4.8 Strength of Concrete

The compressive strength on the work tests for different mixed shall be as given in Table 5.5 below:-

TABLE 5.5

Concrete Mix (Nominal Mix on Volume basis)	*Compressive Strength in (Kg/ sq cm)*	
	7 days'	*28 days'*
1:1:2	210	315

1:1.5:3	175	265
1:2:4	140	210

5.4.9 Testing of Concrete

5.4.9.0 Regular mandatory tests on the workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

(a) Mandatory Lab, Test
(b) Mandatory Field Test

Results of Mandatory Field Test will prevail over mandatory Lab. Test.

5.4.9.1 ***Cube Test for Compressive Strength of Concrete - Mandatory Lab Test :*** Mandatory tests shall be carried out as prescribed in Appendix A of Chapter 5.

5.4.9.2 ***Additional Test*** *:* Additional test, if required, shall be carried out as prescribed in Appendix B of Chapter 5.

5.4.9.3 ***Slump Test :*** This test shall be carried out as prescribed in sub-head 4 of concrete.

5.4.9.4 ***Visual Inspection Test :*** The concrete will be inspected after removal of the form work as described in para 5.4.7.2 The question of carrying out mandatory test or other tests described in Appendix A and B (para 5.4.9.1 and 5.4.9.2) will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected if:

(i) It is porous or honeycombed as per para 5.4.7.2 (a).
(ii) Its placing has been interrupted without providing a proper construction joint.
(iii) The reinforcement has been displaced beyond tolerance specified or construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge at the risk and cost of the contractor.

5.4.10 Standard of Acceptance – for Nominal Mix

5.4.10.1 ***Mandatory Lab. Test :*** For concrete sampled and tested as prescribed in Appendix A of Chapter 5, the following requirement shall apply.

5.4.10.2 Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days.

5.4.10.3 ***7 days' Tests***

Sampling: The average of the strength of three specimen shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than $\pm$ 15% of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimens. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days' test shall have to be carried out.

Strength: If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength upto $\pm$15% then strength of the concrete shall be considered in order.

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days' test shall have to be carried out to determine the compressive strength of concrete cubes.

5.4.10.4 ***28 days' Test***

(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-Charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge (see para 5.4.13.2).

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests (See Appendix B of Chapter 5) to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

5.4.10.5 ***Acceptance Criteria of Field Test (Additional Test – Not Mandatory)***

(A) Preparation of Standard Test Cubes for calibration of Rebound Hammer at site

(a) In the beginning the standard test cubes of the specified mix shall be prepared by field units before undertaking any concrete work in each project.

(b) At least 18 standard cubes necessary for formation of one specimen of specified mix, shall be cast by site staff well in advance. From these 18 cubes any 3 cubes may be selected at random to be tested for crushing strength of 7 days. The crushing strength obtained should satisfy the specified strength for the mix as per specification or agreement. If the strength is satisfactory then the remaining cube will form the standard samples for calibration of rebound hammer. In case of failure, the site staff should totally reject the samples and remove them also and then make another set of samples by fresh mixing or alternatively, out of the remaining 15 cubes, 3 cubes will be tested on 28 days. If the 28 days' tests are found satisfactory then remaining 12 cubes will form the standard sample for calibration at 28 days' strength otherwise all samples shall be rejected and whole procedure repeated to form a fresh specimen. All the results shall be recorded in a register.

(c) No concreting will be allowed unless the standard specimen cubes are obtained.

The criteria for acceptance and calibration of hammer will be 28 days' strength. The 7 days' strength is only to facilitate the work to start.

(d) No work (for the concrete cast between 8th and 28th day) shall be allowed to be paid unless 28 days' cube strength is obtained. For the concrete cast between 8th and 28th day, the decision to make the payment may be taken by the Engineer-in-charge on the basis of existing criteria. Concrete work will be rejected if 28 days' strength falls short as per acceptance criteria. No further work will be allowed till the acceptable standard cubes are obtained.

(e) *Frequency*: it will be once in each quarter or as per the direction and discretion of Engineer-in-Charge. Whenever the acceptance criteria is changed or concrete mix or type of cement is changed or Engineer-in-Charge feels it necessary for recorded reasons with the approval of the authority according to technical sanction, fresh specimen shall be prepared.

(B) Calibration of Hammer

(a) Simultaneously, same three cubes to be tested on 28 days as referred in para A (b) above shall be used to correlate the compressive strength of their concrete with rebound number as per procedure described in para 5.2 of the IS 13311 (Part 2) "Indian standard for non-destructive testing of concrete Method of test by rebound hammer which is given below in para B (b). The average of values of the rebound number (minimum readings) obtained in respect of same three cubes passing on 28 days' work test shall form the datum reference for remaining cubes for the strength of cubes.

(b) The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound hammer taken and then compressive strength determined as per IS 516. The fixed load required is of the order of 7 N/mm^2 when the impact energy of the hammer is about 2.2 NM.

If the specimen are wet cured, they should be removed from wet storage & kept in the laboratory atmosphere for about 24 hours before testing.

Only the vertical faces of the cubes as cast should be tested for rebound number. At least nine readings should be taken on each of the three vertical faces accessible in the compression testing machine when using rebound hammers. The points of impact in the specimen must not be nearer than 20 mm from the edge & should not be less than 20 mm from each other. The same points must not be impacted more than once.

(c) The rebound number of hammer will be determined on each of the remaining (18-3-3=12) cubes. Whenever the rebound number of hammer of any individual cube varies by more than +25% form the datum readings referred to in para B (a) above, that cube will be excluded and will not be considered for standard specimen cubes for calibration. It must be ensured that at least 8 cubes out of 12 that is 66.67% are within the permissible range of variation of rebound number i.e. +25% or otherwise whole procedure shall have to be repeated and fresh specimen prepared.

These 8 cubes will form one standard sample in the beginning before commencement of work and shall be kept carefully for the visiting officers who will calibrate their hammers on these cubes.

(d) This calibration will be done by field staff with their hammer and then chart of calibration giving the details of the average readings, date & month of casting, mix of the concrete etc. shall be prepared and signed by Engineer-in-Charge and will be duly preserved for future reference as and when required.

(C) Preservation of Cubes at site

Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the officers of QCTA/CTE or any other senior departmental officer, during their inspection of the work. They will calibrate their hammer on these cubes if required.

(D) Testing at Site

(D-1) Testing Equipments

(D-2) Testing will be done generally by non-destructive methods like rebound hammers etc. Each field Division/ Sub Division/ Unit will purchase rebound hammers and keep them in working order at work site. The testing will be done only by hammers which are duly calibrated.

(D-3) The relative strength of actual field work will be tested with reference to strength of these standard cubes and calibration charts of a hammer for determining the rebound number on the field work. The hammer will be used as per manufacturer's guidelines at various locations chosen at random. The number of location/reading on each wall, beam or column etc. shall not be less than 12. All the readings should be within the +25% range of values prescribed in calibration chart normally. However, reading indicating good strength will be when it is at per with calibrated value or between 100% & 125% and very good if more than 125% any value between 100% & 75% of calibrated value shall be considered satisfactory. Values from 75% to 50% shall be considered for payment at rates reduced on prorate basis. The concrete indicating rebound number less than 50% of calibrated value shall be rejected and not paid for.

(E) Acceptance of Field Tests and Strength

If the relative strength of actual field work is found satisfactory considering the calibration charts with reference to the standard cube test kept at site, the representative work will be considered satisfactory. If the work is considered below satisfactory, the same will be dealt as stated in para D-3 above.

(F) 7 days' Strength in Rare Cases only

Normally cube crushing strength on 28 days' test shall form the basis of acceptance. However in rare cases of time bound projects/ urgent repairs 7 days' cube test strength criteria may be adopted on similar lines using 7 days' standard test cubes and calibration graphs/ curves/ charts for 7 days' in lieu of 28 days' and testing work done at 7 days'.

(G) Precautions

(G-1) The testing shall be done generally as per guidelines of manufacture of the apparatus and strictly in accordance with the procedure laid down in clause 6 of IS 13311 (Part 2): Indian Standard for Non-Destructive Testing of Concrete - Method of Test by Rebound Hammer.

(G-2) The rebound hammers are influenced by number of factor like type of cement aggregate, surface conditions, moisture content, age of concrete & extent of calibration of concrete etc. hence care shall be taken to compare the cement, aggregate etc. and tested under the similar surface conditions having more or less same moisture content and age. However effect of age can be ignored for concrete between 3 days & 3 months old.

5.4.11 Measurements

5.4.11.1 Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm. The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic metre.

5.4.11.2 Reinforced cement concrete whether cast-in-situ or pre cast shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns and mass concrete etc. all work up to plinth level, column up to plinth level, plinth beams.

(b) Wall (any thickness) including attached pilasters, buttresses plinth and string course, fillets, column, pillars, piers, abutments, post and struts etc.

(c) Suspended floors, roofs, landings and balconies.

(d) Shelves

(e) Chajjas

(f) Lintel, beams and bressummers.

(g) Columns, pillars, piers, abutments, posts and struts.

(h) Stair-cases including waist or waist less slab but excluding landing except in (i) below.

(i) Spiral stair-case (including landing).

(j) Arches, arch ribs, domes and vaults.

(k) Chimneys and shafts.

(l) Well steining.

(m) Vertical and horizontal fins individually or forming box, louvers and facias.

(n) Kerbs, steps and the like.

(o) String courses, bands, coping, bed plates, anchor blocks, plain window sills and the like.

(p) Mouldings as in cornices, window sills etc.

(q) Shell, dome and folded plates.

(r) Extra for shuttering in circular work in plan.

5.4.11.3 Work under the following categories shall be measured separately.

(a) Rafts, footings, bases of columns etc. and mass concrete.

(b) All other items upto floor two level.

(c) From floor two level to floor three level and so on.

(d) R.C.C. above roof level shall be measured along with R.C.C. Work in floor just below.

5.4.11.4 No deduction shall be made for the following:

(a) Ends of dis-similar materials (e.g. Joists, beams, post, girders, rafter, purlins, trusses, corbels steps etc.) upto 500 sq cm in cross-section.

(b) Opening upto 0.1. sqm.

Note: In calculating area of openings upto 0.1 sqm the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.

(c) The volume occupied by reinforcement.

(d) The volume occupied by water pipes, conduits etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

5.4.11.5 Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

(a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.

(b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.

(c) The columns measurements shall be taken through.

(d) Chajjas along with its bearing on wall shall be measured in cubic metre nearest to two places of decimal. When chajjas is combined with lintel, slab or beam, the projecting portion shall be measured as chajjas, built in bearing shall be measured as per item of lintel, slab or beam in which chajja bears.

(e) Where the band and lintels are of the same height and the band serves as lintel the portion of the band to be measured as lintel shall be for clear length of opening plus twice the over all depth of band.

5.4.12 Tolerances

Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C. members shall be as specified in the drawings by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the Engineer-in-Charge after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurement shall apply.

(a) If the actual dimension of R.C.C. members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurement.

(b) If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.

(c) If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.

(d) For acceptance of RCC members whose dimensions are not exactly as per design dimensions, the decision of Engineer-in-Charge shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply.

5.4.13 Rate

5.4.13.1 The rate included the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering, **finishing & reinforcement**.

5.4.13.2 On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to specified compressive strength.

Example:

1. Average compressive strength in 80% of specified strength. Rate payable shall be 80% of agreement rate.
2. In case average compressive strength is less than 70% of the specified strength, the work represented by the sample shall be rejected.
3. However, on the basis of mandatory field tests, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength shall be worked out as per para 5.4.10.5 (D-3) above. In addition, Engineer-in-charge may order for additional tests (see Appendix 'B' of chapter 5) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples had been used, can be retained on the basis of these tests. Engineer-in-Charge may take further remedial measured as necessary to retain the structure at the risk and cost of the contractor.

5.4.13.3 Where throating or plaster drip or moulding is not required to be provided in RCC chajjas, deduction for not providing throating or plaster drip or moulding shall be made from the item of R.C.C. in chajjas. The measurement for deduction item shall be made in running metres correct to a cm of the edge of chajja.

5.4.13.4 No extra payment for richer mix which projects into any member from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawings. The payment for work done under items of different mixed shall be limited strictly to what is indicated in the structural drawings.

5.5 ENCASING ROLLED STEEL SECTIONS

5.5.1 General Requirements

Before concrete work is started, the Engineer-in-Charge shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust/ scales etc. Where so specified, ungalvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them shall be wrapped round the section to be encased and paid for separately.

5.5.2 Wrapping

5.5.2.1 In case of columns, the wrapping shall be arranged as illustrated in Fig. 5.27 to pass through the centre of the concrete covering. The wrapping of the entire length of the columns be carried out in stages and no stage shall cover more than 1.5 metre of height of columns. Successive wrappings shall be carried out only after the immediate adjacent wrapping has been encased in concrete. The surface and edges of the flanges of the steel columns shall have a concrete cover of not less than 50mm. The wrappings of the successive stages shall be tied together.

5.5.2.2 In the case of beams and grillages, the wire mesh or expanded metal shall be wrapped round the lower flange of the beam as illustrated in Fig. 5.28 and the wrapping shall be suspended by wire hangers 5 mm diameter placed at about 1.2 metres centres. The surfaces and edges of the steel sections shall have a concrete cover of not less than 50mm. The wrapping shall pass through the centre of the concrete covering at the edges and soffits of the flanges.

5.5.3 Form Work shall be as prescribed in 5.2.

5.5.4 Concreting

Concrete shall consist of a mix of 1:2:4 (1 cement : 2 coarse and : 4 graded stone aggregate of 12.5 mm nominal size) unless a richer mix is specified. The mix shall be poured solidly around the steel sections and around the wrapping by vibrating the concrete into position. Consistency of concrete, Placing of concrete and its compaction, curing, finishing and strength of concrete shall be as described in 5.4.

5.5.5 Measurements

The length shall be measured correct to one cm and other dimensions correct of 0.5 cm. The cement concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of plaster. No deduction shall be made for the volume of steel sections, expanded metal, mesh or any other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion only shall be deducted.

Fabric reinforcement such as expanded metal shall be measured separately in square metres stating the mesh and size of strands.

The description shall include the bending of the fabric as necessary, Racking or circular cutting and waste shall be included in the description.

5.5.6 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the cost of fabric reinforcement. The cost of providing and erecting steel section and wire hangers shall be paid for separately.

5.6 PRECAST REINFORCED CONCRETE

5.6.1 General Requirements

Precast reinforced concrete units such as columns, fencing posts, door and window frames, lintels, chajjas, copings, sills , shelves, slabs, louvers etc. shall be of grade of mix as specified and cast in forms or moulds. The forms/ moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be cast in one operation.

5.6.2 Concrete used for precasting the units should be well proportioned, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honey combing.

5.6.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have not cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angle of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.

5.6.4 The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric posts where the minimum cover shall be 25 mm.

5.6.5 Curing

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

5.6.6 The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled.

5.6.7 Marking

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

5.6.8 Precast units shall be stored, transported and placed in position in such as manner that they will not be overstressed or damaged.

5.6A PRECAST DOOR AND WINDOW FRAMES

5.6A.1 MATERIALS

5.6A.1.1 Factory Made Precast Reinforced Concrete Door and Window Frame- The frame shall be manufactured from M 40 grade reinforced cement concrete of specified thickness confirming to IS:4021. The ingredients of RCC for the manufacture of precast reinforced concrete door and window frames shall comply with the requirements given in Table 1 of IS:6523.

5.6A.1.2 Aggregates - The aggregates shall consist of well-graded mixture of clean coarse and fine aggregates. The nominal maximum size of coarse aggregates shall not exceed 10 mm.

5.6A.1.3 Concrete - The mix proportion of the concrete shall be determined by the manufacturer and shall be such as to produce a dense concrete not weaker than grade M 40.

5.6A.1.4 Reinforcement - Steel reinforcement shall be minimum of 3 nos. 6 mm dia M.S. bars tied with 3 mm dia mild steel wire placed @ 200 mm c/c. The reinforcement bars and wires shall confirm to IS432 (Part-I & II).

Reinforcement shall be clean and free from loose millscale, loose rust, mud, oil, grease or any other coating which may reduce the bond between the concrete and steel.

5.6A.1.5 Cement Concrete Block – Cement Concrete Block of minimum size 15 cm x 10 cm x 10 cm, shall be of nominal mix concrete 1:3:6 and hold fast shall be embedded in the Block.

5.6A.1.6 High Strength Polymer Block–High Strength Polymer Block for securing hinges, tower bolts, sliding bolts shall be confirming to IS3395.

5.6A.1.7 Mild Steel Galvanised Sleeves& Bolts -Mild Steel Galvanised Sleeves& Boltsshall be confirming to IS806, IS 1363 and IS 4736.

5.6A.1.8 Hinges– Bright finished or black enamelled mild Steel butthinges shall be confirming to IS1341.

5.6A.2 MANUFACTURE

5.6A.2.1 Construction and Finish

5.6A.2.1.1 Each frame shall be made of concrete proportioned, mixed, placed and compacted by vibration/pressing to give a dense concrete free from voids and honeycombing.

Compaction by vibration may be done using a vibrating table or a shutter vibrator. A good finish may generally be obtained by using smooth surface moulds and proper vibration of concrete. Any small surface defects shall be rectified by rubbing with Carborundum stone before erection of the frame. Plastering or touching shall not be done under any circumstances.

5.6A.2.1.2 Each member of the frame shall have a dense surface finish showing no coarse aggregate and shall have no crevices likely to assist in the disintegration of concrete or rusting of steel by the action of natural agencies.

5.6A.2.1.3 The specification of M 40 grade concrete shall be according to Sub Head:5.0of CPWD Specification 2019 Vol-I.

5.6A.2.1.4 The RCC door/window frames shall be cast in rubber / PUmoulds / shuttering having proper shape and dimension with smooth finish.

5.6A.2.1.5 Rubber / PU moulds/ shuttering for RCC door/window frames are casted suitably on the vibrating table having good quality vibration facility to achieve adequate compaction and smooth finish without blow holes or crisis.

5.6A.2.1.6 Curing shall be done as per Section 4.2.10 of CPWD Specification 2019 Vol.-1.

5.6A.2.2 Positioning of Reinforcement - The vertical as well as the horizontal members of the frame shall be reinforced with longitudinal bars. The longitudinal reinforcement for each of the vertical or horizontal member shall be in one piece. The longitudinal bar shall be firmly held by means of at least 3 mm dia steel ties spaced at not more than 200 mm centre to centre.

5.6A.2.2.1 Cover - The longitudinal reinforcement shall have a minimum clear cover of 12 mm or twice the diameter of the main bar, whichever is more.

5.6A.2.2.2 Casting-The entire frame may be cast complete in one piece.

5.6A.3 Hinges – Bright finished or black enamelled mild steel butt hinges of minimum size 100 mm shall be used. For door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for door frames above 80 cm wide, four hinges shall rigidly fixed to one jamb, if it is single shutter, where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof the additional height. In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distances from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not fixed to the frame shall have four counter sunk holes to take cross recessed head screws.

5.6A.4 Other Hardware fixing- RCC frames shall be provided with high strength polymer blocks at the appropriate locations for fixing hinges of adequate sizeon the vertical members. The Hinge blocks shall be of minimum size 120 mm x 25 mm x 25 mm with the provision to pass one longitudinal reinforcement bar through the Hinge block, to ensure proper anchoring with the concrete. Screw holding capacity of Hinge blocks should not be less than 200 kg per screw. Blocks shall not get cracked on hammering a nail or screw and should be soft enough to drill a hole to drive a screw easily. Such blocks shall also be provided at appropriate locations for fixing latches, tower bolts, mortise locks and cylindrical locks, etc.Specially designed M.S. galvanized sleeves shall also be provided for accommodating 6 mm dia fully threaded bolts for fixing holdfasts on vertical members.

5.6A.5 Finishing- The surface of door frame shall be thoroughly cleaned, free of rust, mill scale, dirt, oil etc. After pre-treatment two coats of paints as directed by the Engineer-in-charge shall be applied to the exposed surface.

5.6A.6 Fixing-Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing orduring construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame. Three lugs shall be provided on each jamb with spacing not more than 75 cm. The temporary struts should not be removed till the masonry behind the frame is set.Fixing door, window or clerestory window chowkhats in existing opening shall be done as per section 14.2 of CPWD Specification 2019 Vol-II.

5.6A.7 Measurements -The length shall be measured in running metre correct to a cm along the centre line of the frames.

5.6A.8 Rate -The rate shall include the cost of labour and material involved in all the operation described above.

5.7 PRECAST CEMENT CONCRETE JALI

5.7.0 The jali shall be of cement concrete 1:2:4 (1 cement 2 coarse sand:4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

5.7.1 Fixing

The jali shall be set in position true to plumb and level before the joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

5.7.2 Measurements

The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

5.7.3 Rate

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering.

5.7A EXPANSION JOINT COVERING WITH CEMENT BONDED PARTICLE BOARD

5.7A.1 Materials :

Species of wood which do not hinder the process of setting of cement shall be used. Suitable additives such as sodium silicate conforming to IS 381:1995 and aluminum sulphate conforming

IS260:2001 shall be used to prevent inhibitive effect of setting & cement when other services are used. Also cement conforming to IS 8112:2013 shall be used.

Tolerance in thickness

(i) Un-sanded boards
6mm to 12mm: ± 1mm

(ii) Sanded boards
(For all thickness) : ± 0.3mm

5.7A.2 Physical Requirements :

5.7A.2.1 Workability: The boards shall not crack or split when drilled, sawed or nailed perpendicular to surface. For nailing perpendicular to surface a pre-bore of 0.8 times the diameter of the nail shall be made. Other requirements shall be as stated in Table 1 (i.e. requirement of physical and mechanical properties of cement bonded particle boards) of IS 14276: 1995.

5.7A.2.2 Sampling and Inspection: In any consignment, all the boards of the same dimensions and manufactured under similar condition of product shall be grouped together to constitute a lot. The number of boards to be selected from a lot , method of selection ,test specimen and number of specimen shall be in accordance withIS Code : 14276 : 1995

5.7A.2.3 Criteria for conformity: A lot shall be considered as conforming to the requirement of the specification if the sample and test specimen pass the requirements prescribed in clause 10 of IS Code 14276:1995. In case of failure, double the number of samples shall be taken from the lot for testing. The lot shall be considered to have passed if all these samples conform to the requirement as specified in clause 10 of IS Code:14276: 1995.

5.7A.3 Measurement : The length of sheet shall be measured correct to a cm.

5.7A.4 Rate : The rate shall be inclusive of all materials and labour involved in fixing cement bonded wood particle board over expansion joints.

5.7B EXPANSION JOINT COVERING WITH STAINLESS STEEL GRADE 304

5.7B.1 Material:

General requirement to the supply of material shall conform to IS 1387:1993

Stainless steel sheets and strips shall be free from harmful defects such as scale, rust, blisters, laminations, cracked edges and seams.

5.7B.2 Chemical composition: It shall be as given in table 1 of IS 5522 : 2014 with permissible variations between specified analysis and check analysis as per table 2 of IS 5522 : 2014 when the analysis of steel carried out according to IS :228 and its relevant parts.

5.7B.3 Tolerances: The tolerances for thickness shall be as per clause 10.1 of IS 1387 : 1993

5.7B.4 Mechanical properties: The mechanical properties of the material shall be as per Table-3 of IS 1387 : 1993

5.7B.5 Frequency of sampling: One test shall be made on each coil and for every 100 sheets for each size of the same cast.

5.7B.6 Measurement : The length of sheet shall be measured, correct to a cm.

5.7B.7 Rate : The rate shall be inclusive of all material and labour involved in fixing stainless steel plate over expansion joints.

5.8 DESIGN MIX

5.8.0 Definition

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

5.8.1 Mix Design and Proportioning

5.8.1.1 Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

5.8.1.2 Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

5.8.1.3 As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23. Reference may also be made to ACI 211.1-77 for guidance.

5.8.1.4 Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-Charge.

5.8.1.5 All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

5.8.1.6 Before using an admixture in concrete, its performance shall be evaluated by comparing the properties of concrete with the admixture and concrete without any admixture. Chloride content of admixture should be declared by the manufacturer of admixture and shall be within limits stipulated by IS:9103.

5.8.2 Standard Deviation

5.8.2.1 Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with IS 456.

5.8.3 Acceptance Criteria for Design Mix

5.8.3.1 ***Compressive Strength :*** The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

(a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 5.6.

(b) Any individual test result complies with the appropriate limits in col. 3 of Table 5.6.

5.8.3.2 ***Flexural Strength :*** When both the following conditions are met, the concrete complies with the specified flexural strength.

(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2.

(b) The strength determined from any test result is not less than the specified characteristic strength/ 0.3 N/mm^2.

5.8.3.3 ***Quantity of Concrete Represented by Strength Test Results :*** The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col 3 of Table 5.6 or in item (b) of 5.8.3.2. Only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m^3.

5.8.3.4 If the concrete is deemed not to comply pursuant to 5.8.3 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

5.8.3.5 Concrete of each grade shall be assessed separately.

5.8.3.6 Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measured to the satisfaction of the Engineer-in-Charge.

5.8.4 Cement Content of Concrete

5.8.4.1 For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 330 kg per cubic metre of concrete. Also, irrespective of the grade of concrete the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.

5.8.4.2 Actual cement content in each grade of concrete for various conditions of variable shall be established by design mixes within the limits specified in para 5.8.4.1 above.

5.8.5 Water Cement Ratio and Slump

5.8.5.1 In proportioning a particular mix, the manufacturer/ producer/ contractor shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

5.8.5.2 Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with IS 1199.

TABLE 5.6
Characteristic Compressive Strength Compliance Requirement
(Clause 5.8.3.1 and 5.8.3.3)

Specified Grade	*Mean of the Group of 4 Non- Overlapping Consecutive Test Results in N/mm³*	*Individual Test Results in N/mm³*
(1)	*(2)*	*(3)*
M15 and above	$\geq f_{ck}$ + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2) or f_{ck} + 3 N/mm^2 whichever is greater	$\geq f_{ck}$-3 N/mm^2

NOTE –

1. In the absence of established value of standard deviation, the values given in Table may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

2. **For concrete of quantity up to 30 m^3 (where the number of samples to be taken is less than four as per frequency of sampling given in 5.11.5(d), the mean of test results of all such samples shall be f_{ck} + 4 N/mm^2, minimum**

5.8.6 Approval of Design Mix

5.8.6.1 The producer/ manufacturer/ contractor of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-in-Charge for his comments and approval. Concrete of any particular design mix and grade shall be produced/ manufactured for works only on obtaining written approval of the Engineer-in-Charge.

5.8.6.2 For any change in quality/ quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again.

5.8A R.C.C FOR PIERS, ABUTMENTS, POTAL FRAMES, PIER CAPS AND BEARING PEDESTALS AND SEISMIC ARRESTERS

5.8A.1 GENERAL

Reinforced cement concrete work shall be cast-in-situ as directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid collectively or separately as per the description of the item of work.

(a) Reinforcement
(b) Self compacting design mix concrete of minimum grade M50/M60by using admixure Retarder / Plasticizer and micro silica as per design mix.

5.8A.2 MATERIALS

5.8A.2.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 of mortars, chapter 04 of concrete work and chapter 20 of Pile Work as applicable.

5.8A.2.2 General

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:
  (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
  (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

(ii) Self-compacting concrete of grade M-50/M-60 shall be used in all structural elements.
If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with OPC, received from different sources shall be ensured by trials.

(v) In cases, where structural concrete is exposed to excessive magnesium sulphate, flyash substitution/content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

(vi) Curing as per provision in IS 456:2000 (with amendment). Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

5.8A.3 Steel for reinforcement

Steel shall be thermo mechanically treated bar Fe-500D as per IS1786-2008 (with amendments) or more as per as per clause 5.1.3 of CPWD Specification Vol.I, 2019 with upto date correction slips.

5.8A.3.1 Cover

Cover as per IS456:2000 (with amendment) and clause 5.3.3.5 of CPWD Specification Vol.I, 2019.

5.8A.4 Concreting

Self-compacting concrete of grade M-50/M-60 for construction of piers, abutments, portal frames, pier caps and bearing pedestals and seismic arresters over pier/ abutment caps at all locations with specified grade using Ordinary Portland Cement (conforming to strength requirement of IS:8112).

5.8A.4.1 Strength of concrete

As per IS 456:2000 with amendments.

5.8A.5 Self Compacting Concrete

Self-compacting concrete shall be able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, whilst maintaining homogeny.

5.8A.5.1 Guiding Technical specification for Self compacting concrete.

The specification, performance and conformity requirements for structural concrete are given in IS 456-2000 Annex - J. Test methods. The filling ability and stability of self-compacting concrete in the fresh state shall be defined by four key characteristics like flow ability viscosity, passing ability & Segregation resistance. Each characteristic shall be addressed by one or more test methods:

Grade	*M30 & above*
Cementitious content	*400 – 600kg / m3*
Admixtures	*PCE based & Viscosity Modifiers or as per design mix*
Flow	*550 – 850 mm*
T 50 time	*Time of 2-5 seconds*
V-Funnel	*Time Max 25 seconds*
L – Box ratio	*0.8 – 1.0*
Compressive Strength	*As per Specification of IS 456.*

Characteristic	**Preferred test method(s)**
Flow ability	Slump-flow test
Viscosity (assessed by rate of flow)	T500 Slump-flow test or V-funnel test
Passing ability	L-box test

5.8A.5.1.1 Slump - flow

Slump-flow value describes the flow ability of a fresh mix in unconfined conditions. It is a sensitive test that will normally be specified for all SCC, as the primary check that the fresh concrete consistence meets the specification. Visual observations during the test and/or measurement of the T_{500} time can give additional information on the segregation resistance and uniformity of each delivery.

The following are typical slump-flow classes for a range of applications:

SF1 (550 - 650 mm) is appropriate for:

- Unreinforced or slightly reinforced concrete structures that are cast from the top with free displacement from the delivery point (e.g. housing slabs)
- Casting by a pump injection system (e.g. tunnel linings)
- Sections that are small enough to prevent long horizontal flow (e.g. piles and some deep foundations).

SF2 (660 - 750 mm) is suitable for many normal applications (e.g. walls, columns)

SF3 (760 – 850 mm) is typically produced with a small maximum size of aggregates (less than 16 mm) and is used for vertical applications in very congested structures, structures with complex shapes, or for filling under formwork. SF3 will often give better surface finish than SF 2 for normal vertical applications but segregation resistance is more difficult to control.

Target values higher than 850 mm may be specified in some special cases but great care should be taken regarding segregation and the maximum size of aggregate should normally be lower than 12 mm.

Class	Slump – Flow in mm	Conformity criteria
SF 1	550 to 650	>520 & <700
SF 2	660 to 750	>640 & <800
SF 3	760 to 850	>740 & <900

Picture above shows Slump flow test

5.8A.5.1.2 Viscosity

Viscosity can be assessed by the T_{500} time during the slump-flow test or assessed by the V-funnel flow time. The time value obtained does not measure the viscosity of SCC but is related to it by describing the rate of flow. Concrete with a low viscosity will have a very quick initial flow and then stop. Concrete with a high viscosity may continue to creep forward over an extended time.

Viscosity (low or high) should be specified only in special cases such as those given below. It can be useful during mix development and it may be helpful to measure and record the T_{500} time while doing the slump-flow test as a way of confirming uniformity of the SCC from batch to batch.

VS1/VF1 has good filling ability even with congested reinforcement. It is capable of self-levelling and generally has the best surface finish. However, it is more likely to suffer from bleeding and segregation.

VS2/VF2 has no upper class limit but with increasing flow time it is more likely to exhibit thixotropic effects, which may be helpful in limiting the formwork pressure (see Clause 10.5) or improving segregation resistance. Negative effects may be experienced regarding surface finish (blow holes) and sensitivity to stoppages or delays between successive lifts.

Class	V-Funnel Time in Seconds	Conformity criteria
VF 1	≤ 9	± 3
VF 2	10 to 25	± 3

5.8A.5.1.3 Passing ability

Passing ability describes the capacity of the fresh mix to flow through confined spaces and narrow openings such as areas of congested reinforcement without segregation, loss of uniformity or causing blocking. In defining the passing ability, it is necessary to consider the geometry and density of the reinforcement, the flowability/filling ability and the maximum aggregate size.

The defining dimension is the smallest gap (confinement gap) through which SCC has to continuously flow to fill the formwork. This gap is usually but not always related to the reinforcement spacing. Unless the reinforcement is very congested, the space between reinforcement and formwork cover is not normally taken into account as SCC can surround the bars and does not need to continuously flow through these spaces.

Examples of passing ability specifications are given below:

PA 1 structures with a gap of 80 mm to 100 mm, (e.g. housing, vertical structures)
PA 2 structures with a gap of 60 mm to 80 mm, (e.g. civil engineering structures)

For thin slabs where the gap is greater than 80 mm and other structures where the gap is greater than 100 mm no specified passing ability is required.
For complex structures with a gap less than 60 mm, specific mock-up trials may be necessary.

Class	Passing Ability	Conformity criteria
PA 1	≥ 0.8 with 2 bars	≥ 0.75
PA 2	≥ 0.8 with 3 bars	≥ 0.75

5.8A.5.1.4 Segregation resistance

Segregation resistance is fundamental for SCC in-situ homogeneity and quality. SCC can suffer from segregation during placing and also after placing but before stiffening. Segregation which occurs after placing will be most detrimental in tall elements but even in thin slabs, it can lead to surface defects such as cracking or a weak surface.

In the absence of relevant experience, the following general guidance on segregation resistance classes is given:

Segregation resistance becomes an important parameter with higher slump-flow classes and/or the lower viscosity class, or if placing conditions promote segregation. If none of these apply, it is usually not necessary to specify a segregation resistance class.

SR1 is generally applicable for thin slabs and for vertical applications with a flow distance of less than 5 metres and a confinement gap greater than 80 mm.

SR2 is preferred in vertical applications if the flow distance is more than 5 metres with a confinement gap greater than 80 mm in order to take care of segregation during flow.

SR2 may also be used for tall vertical applications with a confinement gap of less than 80 mm if the flow distance is less than 5 metres but if the flow is more than 5 metres a target SR value of less than 10% is recommended.

SR2 or a target value may be specified if the strength and quality of the top surface is particularly critical.

5.8A.6 Laying of RMC concrete

All Ready Mixed Designed concrete from plant shall be laid with the help of concrete pump of adequate capacity for which nothing extra shall be paid over and above the quoted rates in relevant items. However, small quantity can be allowed without pump with prior written approval of Engineer-in-charge as per site requirement.

NOTE :- In case cement content as per the approved design mix is more or less than the cement contents for cubic metre of concrete specified in the nomenclature of the item, financial adjustment by way of extra payment or such recovery for more or less cement content shall be effected at the rate provided in BOQ with applicable quoted percentage.

5.8A.7 Specifications for pier, abutment, pier/abutment cap. (IRC 78-2014)

(i) Thickness of the wall of hollow concrete pier should not be 300mm.

(ii) Pier shall be designed to withstand the load enforced from the superstructure and the load enforces on the pier itself, apart from the effect of itself weight in general, pier may be solid, hollow or framed structure.

(iii) In case of pier consisting of 2 or more columns, the horizontal forces at the bearing be distributed on columns as required by appropriate analysis.

(iv) The lateral reinforcement of the walls of hollow circular RCC pier shall not be less than 0.3% of the sectional area of the walls of pier. This lateral reinforcement shall be distributed 60% on outer face and 40% in inner face.

5.8A.7.1 Abutments

(i) The abutment will carry superstructure from one side, it should be designed/dimensioned to retain earth from the approach embankment.

(ii) The embankment to should be design to be withstand earth pressure in normal condition in addition to load enforces transferred from superstructure. In addition, any load acting on the embankment, including self-weight is to be considered.

(iii) All abutments and abutment columns shall be designed for a live load surcharge equivalent to 1.2m height of earth fill. The effective width of the columns need not be increased as in clause 710.4.3 for surcharge effect when spill through abutment is adopted.

(iv) Abutment should also be designed for water current forces during 'scour all round' condition.

(v) The Weight of earth filling material on heel may be considered. In case of toe, the weight may be considered if the bed is protected.

(vi) In case of abutments having counterfort, the minimum thickness of the front wall should not be less than 200mm and the thickness of the counterfort should not be less than 250mm.

(vii) In case of box type abutments, weep holes shall be provided similar to hollow piers as per clause 710.2.9.

5.8A.7.2 Pier and abutment cap.

The width of the abutment and pier cap shall be sufficient to accommodate:

(i) The bearing living an offset 150mm beyond them.

(ii) The blast wall

(iii) The space for jacks to lift the super structure for repair/replacement of bearing, etc.

(iv) The equipment for pre-restrain operation where necessary, over and above space for end block in cast in situ cases.

(v) The drainage arrangement for water on the cap.

(vi) Seismic arrestor if provided.

(vii) To accommodate inspection ladders.

5.8A.7.2.1 The thickness of cap over the hollow pier or column type of abutment should not be less than 250mm but in case of solid plain or reinforced concrete pier and abutment, the thickness can be reduced to 200mm.

5.8A.7.2.2 Pier/abutment caps should be suitably designed and reinforced to take care of concentrated point loads dispersing in pier/abutment. Caps cantilevering out from the supports or resting on two or more columns shall be designed to cater for the lifting of superstructure on jacks for repair/ replacement of bearings. The locations of jacks shall be predetermined and permanently marked on the caps.

5.8A.7.2.3 In case of bearing are placed centrally over the columns and the width of bearing/pedestal is located within half the depth of cap from any external face of column, the load from bearing will be considered to have been directly transferred to columns and the cap been need not be designed for flexure.

5.8A.7.2.4 Reinforcement in pier and abutment cap where the bearing satisfied the square root formula stated in clause 307.1 of IRC 21, the pier cap shall be reinforced with total minimum of 1% steel assuming a cap thickness of 225mm. the total steel shall be distributed equally and provided both at top and bottom in two directions. The reinforcement in the direction of length of the pier shall extend from and end to end of the pier cap while the reinforcement at right angle shall extend for the full width of the pier cap and be in form of stirrups. In addition, two layers of mass reinforcement one at 20mm from top and the other at 100mm centers in both directions shall be provided directly under the bearing.

5.8A.8 Measurement

Quantity of concrete in cum of pier, abutment, pier caps, bearing pedestal and seismic arrestor over pier/abutment cap shall be measured. “Excess/less cement used for design mix including the extra cement required under water concreting is payable/recoverable separately”.

5.8A.9 Rate

The rate include cost of steel, centering and shuttering etc. complete including testing of material etc. for casting pier and pier cap in one/two stage, necessary tools, plants, machinery and all related operations as required to complete the work as per drawing and specification with all leads, lifts and depth true to level and position but excluding the cost of providing reinforcement. Reinforcement shall be measured and paid separately.

5.8B R.C.C. DIRPHRAGM WALL

5.8B.1 GENERAL

Reinforced cement concrete work shall be cast-in-situ as directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid collectively as per the description of the item of work. Form work shall be paid separately.

(a) Reinforcement
(b) Self compacting design mix concrete of minimum grade M30 with suitable Retarder / Plasticizer: (Cast-in-situ) with tremie controlled pipe
(c) Bentonite slurry
(d) Concrete mix 1:2:4 for guide walls.

5.8B.2 MATERIALS

5.8B.2.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 of mortars, chapter 04 of concretework and chapter 20 of Pile Work as applicable.

5.8B.2.2 Fly Ash admixed cement concrete (FACC) and fly ash blended cements in Cement Concrete (PPCC) in RCC structures.

5.8B.2.2.1 Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below:

5.8B.2.2.2 General

(i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:

(a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9of IS 456 mentioned above.

(b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456covering quality assurance measures both technical and organizational, which shall alsonecessarily require a qualified Concrete Technologist to be available during manufacture ofconcrete for certification of quality of concrete.

(ii) Minimum M-30 grade of concrete shall be used in all structural elements.

(iii) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage offly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to besignificantly different and their values are to be taken same as those used for concrete made with OPC.

(iv) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closelymonitored during concrete manufacture.

If necessitated due to low water/binder ratio, required workability shall be achieved by use ofchloride free chemical admixtures conforming to IS 9103. The compatibility of

chemicaladmixtures and super plasticizers with each set OPC, fly ash and /or PPC received from differentsources shall be ensured by trials.

(v) In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ashadmixed or PPC based concrete is recommended. In cases, where structural concrete isexposed to excessive magnesium sulphate, flyash substitution/content shall be limited to 18% byweight. Special type of cement with low C3A content may also be alternatively used. Durabilitycriteria like minimum binder content and maximum water /binder ratio also need to be given dueconsideration in such environment.

(vi) Curing as per provision in IS 456:2000 (with amendment). Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & aridregions, the minimum curing period shall be 14 days or its equivalent.

5.8B.3 Steel for reinforcement

Steel shall be thermo mechanically treated bar Fe-500D as perIS1786-2008 (with amendments) or more as per as per clause 5.1.3 of CPWD Specification Vol.I, 2019 with upto date correction slips.

5.8B.3.1 Cover

Cover as per IS456:2000 (with amendment) and clause 5.3.3.5 of CPWD Specification Vol.I, 2019

5.8B.4 Concreting

Constructing cast-in situ RCC diaphragm wall by providing and laying machine batched, machine mixed, self-compacting, ready mix reinforced cement concrete, tremie controlled.

5.8B.4.1 Strength of concrete

As per IS 456:2000 with amendments.

5.8B.5 SELF COMPACTING CONCRETE

Self-compacting concrete shall be able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, whilst maintaining homogeny.

5.8B.5.1 Guiding Technical specification for Self compacting concrete.

The specification, performance and conformity requirements for structural concrete are given in IS 456-2000 Annex - J. Test methods. The filling ability and stability of self-compacting concrete in the fresh state shall be defined by four key characteristics like flow ability viscosity, passing ability &Segregation resistance. Each characteristic shall be addressed by one or more test methods:

Grade	M30 & above
Cementitious content	400 – 600kg / m^3
Admixtures	PCE based & Viscosity Modifiers or as per design mix
Flow	550 – 850 mm
T 50 time	Time of 2-5 seconds
V-Funnel	Time Max 25 seconds
L – Box ratio	0.8 – 1.0
Compressive Strength	As per Specification of IS 456.

Characteristic	**Preferred test method(s)**
Flow ability	Slump-flow test
Viscosity (assessed by rate of flow)	T500 Slump-flow test or V-funnel test
Passing ability	L-box test

5.8B.5.2 Slump-flow

Slump-flow value describes the flow ability of a fresh mix in unconfined conditions. It is a sensitive test that will normally be specified for all SCC, as the primary check that the fresh concrete consistence meets the specification. Visual observations during the test and/or measurement of the T_{500} time can give additional information on the segregation resistance and uniformity of each delivery.

The following are typical slump-flow classes for a range of applications:

SF1 (550 - 650 mm) is appropriate for:

- Unreinforced or slightly reinforced concrete structures that are cast from the top with free displacement from the delivery point (e.g. housing slabs)
- Casting by a pump injection system (e.g. tunnel linings)
- Sections that are small enough to prevent long horizontal flow (e.g. piles and some deep foundations).

SF2 (660 - 750 mm) is suitable for many normal applications (e.g. walls, columns)

SF3 (760 – 850 mm) is typically produced with a small maximum size of aggregates (less than 16 mm) and is used for vertical applications in very congested structures, structures with complex shapes, or for filling under formwork. SF3 will often give better surface finish than SF 2 for normal vertical applications but segregation resistance is more difficult to control.

Target values higher than 850 mm may be specified in some special cases but great care should be taken regarding segregation and the maximum size of aggregate should normally be lower than 12 mm.

Class	Slump – Flow in mm	Conformity criteria
SF 1	550 to 650	>520 & <700
SF 2	660 to 750	>640 & <800
SF 3	760 to 850	>740 & <900

5.8B.5.3 Viscosity

Viscosity can be assessed by the T_{500} time during the slump-flow test or assessed by the V-funnel flow time. The time value obtained does not measure the viscosity of SCC but is related to it by describing the rate of flow. Concrete with a low viscosity will have a very quick initial flow and then stop. Concrete with a high viscosity may continue to creep forward over an extended time.

Viscosity (low or high) should be specified only in special cases such as those given below. It can be useful during mix development and it may be helpful to measure and record the T_{500} time while doing the slump-flow test as a way of confirming uniformity of the SCC from batch to batch.

VS1/VF1 has good filling ability even with congested reinforcement. It is capable of self-levelling and generally has the best surface finish. However, it is more likely to suffer from bleeding and segregation.

VS2/VF2 has no upper class limit but with increasing flow time it is more likely to exhibit thixotropic effects, which may be helpful in limiting the formwork pressure (see Clause 10.5) or improving segregation resistance. Negative effects may be experienced regarding surface finish (blow holes) and sensitivity to stoppages or delays between successive lifts.

Class	V-Funnel Time in Seconds	Conformity criteria
VF 1	≤ 9	± 3
VF 2	10 to 25	± 3

5.8B.5.4 Passing ability

Passing ability describes the capacity of the fresh mix to flow through confined spaces and narrow openings such as areas of congested reinforcement without segregation, loss of uniformity or causing blocking. In defining the passing ability, it is necessary to consider the geometry and density of the reinforcement, the flowability/filling ability and the maximum aggregate size.

The defining dimension is the smallest gap (confinement gap) through which SCC has to continuously flow to fill the formwork. This gap is usually but not always related to the reinforcement spacing. Unless the reinforcement is very congested, the space between reinforcement and formwork cover is not normally taken into account as SCC can surround the bars and does not need to continuously flow through these spaces.

Examples of passing ability specifications are given below:

PA 1 structures with a gap of 80 mm to 100 mm, (e.g. housing, vertical structures)
PA 2 structures with a gap of 60 mm to 80 mm, (e.g. civil engineering structures)

For thin slabs where the gap is greater than 80 mm and other structures where the gap is greater than 100 mm no specified passing ability is required.

For complex structures with a gap less than 60 mm, specific mock-up trials may be necessary.

Class	Passing Ability	Conformity criteria
PA 1	≥ 0.8 with 2 bars	≥ 0.75
PA 2	≥ 0.8 with 3 bars	≥ 0.75

5.8B.5.5 Segregation resistance

Segregation resistance is fundamental for SCC in-situ homogeneity and quality. SCC can suffer from segregation during placing and also after placing but before stiffening. Segregation which occurs after placing will be most detrimental in tall elements but even in thin slabs, it can lead to surface defects such as cracking or a weak surface.

In the absence of relevant experience, the following general guidance on segregation resistance classes is given:

Segregation resistance becomes an important parameter with higher slump-flow classes and/or the lower viscosity class, or if placing conditions promote segregation. If none of these apply, it is usually not necessary to specify a segregation resistance class.

SR1 is generally applicable for thin slabs and for vertical applications with a flow distance of less than 5 metres and a confinement gap greater than 80 mm.

SR2 is preferred in vertical applications if the flow distance is more than 5 metres with a confinement gap greater than 80 mm in order to take care of segregation during flow.

SR2 may also be used for tall vertical applications with a confinement gap of less than 80 mm if the flow distance is less than 5 metres but if the flow is more than 5 metres a target SR value of less than 10% is recommended.

SR2 or a target value may be specified if the strength and quality of the top surface is particularly critical.

5.8B.5.6 Laying of RMC concrete

All Ready Mixed Designed concrete from plant shall be laid with the help of concrete pump of adequate capacity for which nothing extra shall be paid over and above the quoted rates in relevant items. However, small quantity can be allowed without pump with prior written approval of Engineer-in-charge as per site requirement.

NOTE :- In case cement content as per the approved design mix is more or less than the cement contents for cubic metre of concrete specified in the nomenclature of the item, financial adjustment by way of extra payment or such recovery for more or less cement content shall be effected at the rate provided in BOQ with applicable quoted percentage.

5.8B.6 Specifications for diaphragm wall

(i) Cast-in-situ RCC diaphragm wall shall be as per IS14344:1996.

(ii) Rigid type of diaphragm wall or plastic concrete diaphragm wall shall be constructed by resorting to either successive panel method or alternate panel method. For cement bentonite slurry trench diaphragm wall, alternate panel method of construction is suitable in view of the time that is require to achieve hardness of the mix put in the trench.

5.8B.6.1 Tolerance:

(i) Guide walls:
Finished faces of the guide wall toward the trench shall be vertical. There shall be no rigid or abrupt change of the guide wall and variation from a straight line or a specified profile shall not exceed 25mm in 3 meter.

(ii) Diaphragm wall:
Verticality
Face of the wall and ends of panel shall be vertical within a tolerance of 1:80.
In positioning of reinforcement longitudinal tolerance of cage head at top of the guide wall measured along the trench, shall be 75mm and vertical tolerance at caged head in relation to top of guide wall shall be 50mm.

(iii) Testing
Testing of material to be used for the work shall be done in a laboratory to confirm their usability as per applicable IS Standard.

Mix for rigid concrete, plastic concrete and cement bentonite slurry shall be design in a laboratory and testing shall be done to ascertain various parameters like compressive and tensile strength, permeability, modulus of elasticity, erodibility, PH value, etc. to be confirm that the mix design satisfies the design parameter.

Sample of mix at the time of placing shall be collected and kept in air tight sealed molds of specified size till due dates of various tests. Important test to be perform are as under: -

(a) Compressive strength: Test shall be carried out at 7, 28 and 90 days.

(b) Triaxial compressive strength test shall be carried out on filling material like plastic concrete, cement, bentonite etc. to determine stress strain characteristic, modulus of elasticity and shear parameters, test shall be carried out at 7, 28 and 90 days in consolidated undrained conditions.

(c) Permeability test on sample shall be conducted after 28 days in membrane permeameter.

5.8B.6.2 Instrumentation:

(i) Placement of instruments simultaneously with casting of panel is difficult, as there is a possibility of damaging the instruments, wires etc., or losing their sensitivity due to vibrations generated during placement of concrete. It is, therefore, preferable to install the instrument outside the completed diaphragm wall to measure in-situ performance.

5.8B.6.2.1 Deformation of the structure

For the purpose of measuring deformation behavior of the diaphragm, inclinometers at various location shall be installed close to the diaphragm wall.

5.8B.6.2.2 Settlement gauge

Settlement gauged may be installed at selected locations to measured vertical displacement. Gauges shall not have an error of more than 1mm.

5.8B.6.2.3 Piezometric levels:

To judge the efficiency in water tightness of the diaphragm wall, residual discharge collected downstream of the cut off wall is the essential measurement. This can be determined by a double network of Piezometers placed on either side of the wall and well protected by filters. Chemical and physical analysis water may be useful to pinpointed its source. Observations frequency shall not be more than 15 days.

5.8B.6.2.4 Permeability

100mm diameter tubes extending to random depths, shall be placed at the center of the thickness of the diaphragm panel at randomly chosen locations. After a period of 28 days bore holes may be drilled into the diaphragm below the tubes and permeability test by pumping in method carried out. The in-situ permeability of the diaphragm shall be compared with the specified limit as per requirement.

5.8B.7 Records

Following records shall be maintained in a manner approved by the Engineer-in-charge.

(i) Name of Project/work.

(ii) Panel No. & reference drawing no.

(iii) Date of commencement and completion of excavation

(iv) Date of concreting of panel

(v) Length of panel

(vi) Thickness of panel

(vii) Top of guide wall level

(viii) Depth of guide wall

(ix) Top level of wall as cast, in relation to top of guide wall at the edges and at the center.

(x) Depth of panel from base of top of guide wall

(xi) Strata encountered

(xii) Volume of panel and volume of concrete used, slump, water cement ratio.

(xiii) Cube taken and their result.

(xiv) Details of reinforcement (cage type)

(xv) Detail of any obstructions/ peculiar conditions encountered and time spent and measures taken in overcoming them.

(xvi) Type and proportion of any additives used and reason for use.

5.8B.8 Measurement

Actual area of diaphragm wall correct to two places of decimal, from design bottom level to the design cut off level (including portion incurred in the rock upto the design bottom level) only shall be measured for payment. "Excess/less cement used for design mix including the extra cement required under water concreting is payable/recoverable separately".

5.8B.9 Rate

The rate include cost of all inputs of labour, material and T&P, cost of handling, lifting and placing in position the reinforcement cage in the trench, including cost of reinforcement bar, welding, etc. involved in the work and all other incidental expenditure for completing the work as directed by the Engineer-in-charge shall include the cost of labour and material involved in all the operation describedabove.

5.9 READY MIXED CONCRETE (as per IS 4926)

5.9.1 Materials

5.9.1.1 ***Selection and Approval of Materials*** **:** Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

5.9.1.2 ***Cement*** : Cement used for concrete shall be in accordance with the requirements of IS 456.

5.9.1.3 ***Mineral Admixtures :*** Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

5.9.1.4 ***Aggregates :*** Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given IS 4926.

5.9.1.5 ***Chemical Admixtures***

(i) Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.

(ii) It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and the determine the dosage required to give the desired effect.

(iii) Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.

(iv) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

(v) The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

5.9.1.6 ***Water :*** Water used shall be in accordance with the requirement of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex A.

The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the build up of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.

The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck -mixer, drivers shall be made aware of the appropriate responses to variations in concrete consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

5.9.2 General Requirements

5.9.2.1 ***Basis of Supply :*** Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

5. 9.2.2 ***Transport of Concrete :*** Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re- handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The

purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site.

Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

5.9.2.3 ***Time in Transport :*** The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

5.9.3 Sampling and Testing of Ready-Mixed Concrete

5.9.3.1 ***Point and Time of Sampling*** **:** For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex A).

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

5.9.3.2 ***Workability :*** The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate:

Slump ± 25 mm or 1/3 of the specified value, whichever is less.

Compacting factor : ± 0.03, where the specified value is 0.90 or greater,
± 0.04, where the specified value is less than 0.90 but more than 0.80,
± 0.05, where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103) Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

5.9.3.3 ***Specified Strength***

(i) Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his sampling and testing or may enter into an arrangement with the producer to provide his testing requirements.

(ii) Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready- mixed concrete industry method of production control should be one sample for every 50 m^3 of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).

In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 ± 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

(iii) The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m^3 or 50 batches, whichever is the greater frequency.

5.9.3.4 ***Additional Compliance Criteria*** *:* Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.

5.9.3.5 ***Non-Compliance :*** The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

5.9.4 Information to be Supplied by the Purchaser

5.9.4.1 The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters such as notice to be given prior to delivery, delivery rate, the name of the purchasers authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training, etc.

5.9.4.2 ***Designed Mixes :*** Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in Annex B may be completed and forwarded to the producer at the time of enquiry.

5.9.4.3 ***Prescribed Mixes :*** The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex B may be followed with suitable modifications as applicable to prescribed mixes.

5.9.5 Information to be Supplied by the Producer

When requested, the producer shall provide the purchaser with the following information before any concretes is supplied:

(a) Nature and source of each constituent material,

(b) Source of supply of cement,

(c) Proposed proportions or quantity of each constituent/ m^3 of fresh concrete.

(d) Generic type(s) of the main active constituent(s) in the admixture;

(e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture;

(f) Where more than one admixture is used, confirmation of their compatibility and

(g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

5.9.6 Production and Delivery

5.9.6.1 *Materials Storage and Handling*

(i) *Cement :* Separate storage for Different types and grades of cement shall be provided. Containers may be used to store cement of different types provided these are emptied before loading new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. Each silo or compartment of a silo shall be completely separate and fitted with a filter or alternative method of dust control. Each filter or dust control system shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained and prevent undue emission of cement dust and prevent interference with weighing accuracy by build up of pressure. Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them and where cement can be stored and retrieved without undue damage to the bags. The bags are to be protected from becoming damp either from the ground or the weather. The cement is to be used in the order it is delivered (see also IS 4082).

In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard.

(ii) *Dry Pulverized Fuel Ash and Other Mineral Admixtures :* Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.

(iii) *Aggregates (Coarse and Fine) :* Stockpiles shall be free draining and arranged to avoid contamination and to prevent intermingling with adjustment material. Handling procedures for loading and unloading aggregates shall be such as to reduce segregation to a minimum. Provision shall be made for separate storage for each nominal size and type of aggregate and the method of loading of storage bins shall be such as to prevent intermingling of different sizes and types. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum (see also IS 4082 and IS 456).

(iv) *Water :* An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risk of contamination.

(v) *Chemical Admixtures :* Tanks or drums containing liquid admixtures shall be clearly labeled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixture, which are not stable solutions.

5.9.6.2 *Batching Plants and Batching Equipment :* Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances specified in Annex C. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant mixing cycle is less than 2.0 m^3, additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently and prevent the build up of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust.

Vibrator or other attachment, where fitted, shall not affect the accuracy of weighing. There shall be sufficient protection to cement and aggregate weigh hoppers and weighing mechanisms to prevent interference with weighing accuracy by weather conditions or external build-up of materials.

Where chemical admixture dispensers are used, they shall be capable of measurement within the tolerance in annex C and calibrated container or weigh scales shall be provided to check the accuracy of measurement at least once a month.

Where a continuous mixer with ribbon loading is used the batching procedure specified by the manufacture of the plant shall be followed.

Each control on the batching console and weigh-dial or display shall be clearly labeled with its function and where concerned with the batching of materials, the materials type.

When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from on type of cement to another.

When more than one type or grade of cement is being used, the weighing devised and discharge screw or other parts of the transfer system shall be empty before changing from on type of cement to another.

When pulverized fuel ash and other mineral admixtures are batched through the cement weigh system, the weighing device and discharge screw or other parts of the transfer system shall be empty when the weighing system has returned to zero reading or completed the batch.

Where a back weigh system is utilized to weigh materials a system shall be in place so as to prevent materials being loaded during the process of weighing.

5.9.6.3 ***Measurement of Materials :*** Cement and mineral admixture materials shall be measured by mass in a hopper or compartment separate from those used for other materials and on a scale of appropriate sensitivity, measurement being taken from a zero reading. Aggregates shall be measured by mass, allowance being made for the free moisture content of the aggregates. The added water shall be measured by volume or by mass. Any liquid chemical admixture (or paste) shall be measured by volume or by mass and any solid admixture by mass. When weighing materials any build up in the hopper during the day must be tared out or allowed for in the batch weights. After measurement all materials shall be discharged into the mixer without loss.

The accuracy of the measuring equipment shall be within $\pm$ 2 percent of the quantity of cement and mineral admixtures being measured and within $\pm$ 3 percent of the quantity of aggregate, chemical admixture and water being measured. The plant operator shall be provided with a clear display of the quantities of materials to be batched for each mix and batch size with information identifying the display to be selected for each designed and prescribed mix to be produced. Analogue scale displays for the weighing of cement, mineral admixtures, aggregates and water shall be readily discernable from the operating position. For digital readouts the numerals shall be readily discernable from the operating position .

Fully automatic production systems shall be fitted with control equipment to allow the correct operation of the plant to be monitored during weighing and batching. Automatic control systems on batching plants shall not commence batching until all hoppers have been emptied and /or tared and the scales zeroed unless such systems are designed to take account of build up in their programming.

All scales shall be tested and calibrated as per Annex C.

5.9.6.4 *Mixing*

(i) *Washing Out Water :* Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.

(ii) *Stationary or Central Mixers :* Stationary mixers shall not be loaded in excess of the manufacturer's rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.

(iii) *Truck Mixers :* When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer.

Truck or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant.

When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and remixed at the site for at least 2 min so that the concrete is of the required uniformity.

Where water is added to the concrete in the truck mixer through the truck mixer water meter and when such water is being accounted for in the total water within the mix, it shall be ensured that the truck mixer water meter is in operational condition and properly calibrated. Where a water meter is not available, water must be measured in a suitable container before being added to the truck mixer.

(iv) *Condition of Mixers :* Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes.

5.9.6.5 *Delivery Ticket :* Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing as per Annex D.

5.9.7 Quality Control

Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

5.9.7.1 *Forward control :* Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.

(i) Control of purchased material Quality

(ii) Control of Materials storage

(iii) Mix design and mix design modification

(iv) *Transfer and Weighing Equipment :* The producer shall be able to demonstrate that a documented calibration procedure is in place. The use of elector-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc, is preferable over purely mechanical system, that is, knife edge and lever systems.

(v) Plant mixers where present and truck mixers used shall be in an operational condition.

5.9.7.2 ***Immediate Control :*** Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

(i) *Production Control :* The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the producer and purchaser.

Each load of mixed concrete shall be inspected before dispatch and prior to discharge.

The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.
For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

(ii) *Product Control :* Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (see IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

5.9.7.3 ***Retrospective Control :*** Retrospective control is concerned with those factors that influence the control of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not property which can be measured ahead of, or at the time of, manufacture.

5.9.7.4 ***Mix Performance :*** The producer shall be responsible for ensuring that suitable control procedures are in place ensure the following.

(i) *Design Mixes :* A quality control system shall be operated to control the strength of design mixes to the levels required as per IS 456 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actual with target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

(ii) *Prescribed Mixes :* Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

5.9.7.5 ***Stock Control of Materials :*** The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

5.9.7.6 ***Complaints :*** The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

5.9.8 Order Processing

A competent person to interpret the specified requirements and relate these to mix design criteria shall systematically review specification and orders supplied by the purchaser. These shall be formally recorded together with any modification to the specification resulting from subsequent agreed documentation to ensure that the plant operator is given the correct instructions for batching and mixing. When mixes or materials are offered as alternatives to requested mixes or where there is no specification supplied by the purchaser, orders whether received verbally or in writing, shall be agreed with the purchaser and the fact recorded. Alternatives to the mix description or compliance requirements in the purchaser's specification shall be clearly identified in the quotation.

5.9.9 Records

Records shall be maintained by the producer to provide confirmation of the quality and quantity and quantity of concrete produced. The records shall be retained for the purposes of these requirements for a period of at least one year. They shall cover the following aspect:

(a) Production and delivery:
  (i) Batching instruction
  (ii) Batching Records,
  (iii) Delivery tickets, and
  (iv) Equipment calibration and plant maintenance.

(b) Materials and production control:
  (i) Concrete production and materials purchase, usage and stocks, and
  (ii) Certificates or test results for materials.

(c) Production quality Contol: Control test results.

5.10 PLACING CONCRETE BY PUMPING

5.10.1 General

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below:-

(A) Piston type pumps
(B) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

5.10.2 Pumping Equipments

5.10.2.1 ***Piston Pumps*** : Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin-piston pump.

The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipe line to maintain a reasonably steady flow of concrete. Single piston pumps shall not be acceptable.

Inlet and outlet valve shall be any one of the following types:-

- Rotating plug type
- Sliding plate type
- Guided plunger type
- Swing type
- Flapper type

- Or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete.

The primary power for pumps may be supplied by gasoline, diesel, or electric motors.

The primary power unit and the pump unit may be truck, trailer or skid mounted.

5.10.2.2 ***Squeeze Pressure Pumps :*** Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum.

The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers., which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

5.10.2.3 ***Effective Range and Discharge of Pumps :*** Effective range of pumps to be used in the work shall be decided after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres.

Selection of pumps bases on discharge capacity shall be decided after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer-in-Charge. As a guide line figure the contractor may assume a discharge capacity of 15 cubic metre/hour/pump.

5.10.2.4 ***Pipe Lines :*** All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Engineer-in-Charge.

(i) ***Rigid Line/ Hard Line/ Slick line :*** Such lines shall be made either of steel or plastic. Aluminum alloy pipes shall not be used.

Minimum pipeline diameter shall be 100 millimeters and shall have normal maximum length of 3 metre in each section connected through couplers.

(ii) ***Flexible Pipe Line*** *:* Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 metre length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no links in the pipeline, which is a normal tendency with these pipes having diameter 100 mm and above.

5.10.2.5 ***Couplers :*** Couplers to be used for connecting pipe line sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipe lines etc.

For horizontal runs of pipes and for vertical run upto 30 metre height the couplers shall be rated for a minimum pressure of 35 kg/ cm square. Couplers used for rising runs between 30 metre and 50 metre heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These

shall provide for the full internal cross section. These shall provide for the full internal cross section with no constructions or service. Which may disrupt the smooth flow of concrete. For pipelines of size 150mm and above, double togged type coupler with a thick rubber gasket and secondary wedge-take-up is recommended. Types of couplers that may be used shall be any of the following:-

- Grooved end coupler
- One piece extended lever swing type couplers
- And full flow oil line type couplers.

5.10.2.6 ***Other Accessories :*** Other accessories which shall be catered for, are as under:-

(a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications

(b) Curved sections of rigid pipes

(c) Swivel joints and rotary distributors

(d) Pin and gate valves to prevent back flow in pipe lines

(e) Switch valves to direct the flow into another pipe line

(f) Connection devices to fill forms from the bottom up

(g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel and form and to provide lifting and lashing points in the pipe line.

(h) Transitions for connecting different sizes of pipe sections

(i) Air vents for downward pumping.

(j) Clean out equipment.

For concreting of columns, walls and scattered small placement, recommendation is made for special cranes or power controlled booms carrying pipe lines with a pendant type concrete delivery hose.

5.10.2.7 Lubricating of Pipe Line

Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line, for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements.

The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in -Charge, this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted.

Lubrication shall be maintained as long as the pumping of concrete continues.

5.11 GUIDELINES FOR FIELD PRACTICE

5.11.1 *General Precautions*

(i) Proper planning of concrete supply, pump locations, line layout, placing sequence and the entire pumping operation will result in savings of time and expense.

(ii) The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Engineer-in-Charge.

(iii) Pipe lines from the pump to the placing area shall be laid with minimum number of bend. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without re-handling of pipelines. The pipeline shall be firmly supported.

(iv) If more than one size of pipe must be used, the smaller diameter pipe shall be placed at the pump end and the larger diameter at the discharge end.

(v) When pumping downwards, an air release valve shall be provided at the middle of the top bend to prevent vacuum or air buildup. Similarly, while pumping upwards, a no-return valve shall be provided near the pump to prevent the reverse flow of concrete.

(vi) It is essential that direct radio/telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between the pump operator and the batching-plant is also essential. The placing rate shall be estimated by the pump operator so that concrete can be ordered at an appropriate delivery rate.

(vii) The pump shall be started for a check run and operated without concrete to ensure that all moving parts are in operation properly. Before placing concrete, the pump shall be run with some grout/mortar for lubricating the line.

(viii) When concrete is received in the hopper, the pump shall be run slowly until the lines are completely full and the concrete is steadily moving. A continuous pumping must be ensured, because, if the pump is stopped, concrete in the line may be difficult to move again.

(ix) When a delay occurs because of concrete delivery or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line back to the pump so that concrete can be re-circulated during long delays.

(x) If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and requires cleaning. The pump operator who know such details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

(xi) When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a “go devil” inserted at the appropriate time so that concrete ahead of the go-devil shall be forced completion of the work. The go-devil shall be forced through the pipeline to clean it out. Use of water pressure is a safer method. The go-devil shall be stopped at the discharge end to ensure that water does not spill on the placement area, if air pressure is used, extreme care shall be taken and the pressure must be carefully regulated. A trap shall be installed at the end of the line to prevent the go-devil being ejected as a dangerous projectile. An air release valve shall also be installed in the line to prevent air pressure build up.

(xii) It is essential to clean the line after concrete placing operation is complete. Cleaning shall be done in the reverse direction from the form work end to the pump-end where the concrete in the
line can be dumped in bucket. After removal of all concrete, all pipe lines and other equipments shall be cleaned thoroughly and made ready for the next use.

5.11.2 Submittals

Along with their bid the contractors shall be required to submit the following information regarding the equipments proposed to be used by them:-

(i) Type, number, capacity, range, mounting, nature of primary power used and the operating weight of pump and mounting.

(ii) Manufacturer's specifications for pipe lines giving pressure ratings, sizes and material for straight and curved sections.

(iv) Manufacturer's certificates.

5.11.3 Sampling and Testing (Materials)

5.11.3.1 *Aggregates*

(i) Supplier of aggregates shall furnish the following information before the material is delivered to site:-
- Precise location of source from where the material is to be supplied.
- Trade group of principal rock type as per table 5.7 below :
- Presence or reactive minerals

TABLE 5.7

Trade group name of Aggregates to be used for concrete	: Granite, Gabbro, : Dolerite, Rhyolite, Basalt, Quartzite, Gneiss.

(ii) The supplier shall also furnish reports on test results giving the following information for approval to Engineer-in-Charge before delivery of material at site:-
Specific gravity Bulk
density Moisture
content Absorption
Value Aggregate
crushing strength
Aggregate impact
value Abrasion value
Flakiness index
Elongation index
Limits of deleterious substances in the aggregate
Soundness of aggregate
Potential reactivity of aggregates.

All tests shall be conducted in accordance with IS 2386 (Part-I to VIII).

(iii) Change in quality of aggregate as per trade group name shall not be acceptable in the work. Change in source of aggregates shall also not be acceptable under normal circumstances, even if the aggregate belong to the same trade group. Engineer-in-Charge may with his discretion allow a change in the source. But, in that case, all test mentioned in para 5.8.9.1.2 above shall have to be repeated for the aggregates form the changed source and

the test results submitted to Engineer-in-Charge for his approval before the delivery of material at site.

(iv) In addition to above, the following tests have to be performed on representative samples from every lot of aggregate after delivery at site. These test results are to be submitted to the Engineer-in-Charge for his approval. Acceptance criteria for aggregates shall be based on the
results of this set of tests only. If in the opinion of the Engineer-in-Charge, the test results are not with in permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.

Mandatory tests on Aggregates at site

Tests	*Nos. of test on each 50 cum of Material or part thereof*
1. Specific gravity	3
2. Bulk density	3
3. Aggregate crushing strength	3
4. Limits of deleterious substances	3
5. Aggregate impact value	3

Mean value of the results from above test shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures and computations for test results shall be as per IS 2386.

(v) All other tests in para iv being in compliance with requirements set in specifications, if only the limits of deleterious substances do not meet the requirements, and attempt may be made to wash the aggregate to bring the limits within permissible values. Under such circumstances, moisture content check shall be made and allowance made before batching.

(vi) Apart from mandatory tests specified above, the Engineer-in-Charge may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such test shall be done in accordance with IS 2430 and IS 2386 as applicable.

5.11.3.2 ***Cement*** *:* Supplier of cement shall furnish the following documents before the cement is delivered to site:-

(i) Certificate confirming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.

(ii) Certificate confirming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.

(iii) If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.

(iv) Each 1000 bags or part thereof the cement or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site before cement is accepted.

(v) Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and the 2% value shall be rounded off to the next higher integer.

For bulk cement, sampling shall be done with the help of slotted sampler to be as per IS 3535.

(vi) Results of test conducted on samples drawn shall be submitted to the Engineer-in-Charge for his approval. If in the opinion of the Engineer-in-Charge, the test results are not within permissible limits, the lot of cement from which samples have been obtained from testing shall stand rejected and the material shall be removed from site.

(vii) Following tests shall be conducted at site on each lot of cement delivered:-

Mandatory tests	*Number of test per lot*
1. Consistency of standard cement paste	5
2. Initial and final setting time	5 each
3. Compressive strength test	10

Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these test. All test procedures and computation of test results shall be as per IS 4031.

(viii) Apart from mandatory tests specified above, the Engineer-in-Charge may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot and testing and computation of test results shall be done as per IS 4031.

5.11.3.3 *Water*

(i) Water to be used in manufacturing and curing of concrete shall be tested before use. All such test results shall be submitted to the Engineer-in-Charge for his approval before water is used.

(ii) Manufacturer/ Contractor responsible for curing concrete shall identify and inform the Engineer-in-Charge, precisely the location of source of water intended to be used. Each such source of water shall be separately tested. In the event of a change in the source of water all tests specified herein shall have to be repeated.

(iii) In the event water is drawn from tube wells or open-wells, water samples shall be tested for seasonal fluctuations in water table or at intervals to be directed by the Engineer-in-charge.

(iv) Water sample from each source shall be tested as under:-

Test	*Number of test for each source*
Acidity	3
Alkalinity	3
Presence of solids	3

Mean values of the above test shall be taken as the representative value and the acceptance criteria shall be based on these test results. All testing procedure and computation of test results shall conform to IS 3025.

5.11.3.4 *Admixtures*

(i) Suppliers of Admixtures for concrete shall supply the following before any admixtures is approved by the Engineer-in-Charge for their used:-

Certificate confirming that the use of a particular brand of admixture shall not be harmful to concrete in any way.

Certificate confirming the exact dosage of admixture of a particular brand. Certificate stating the specific purpose for which the admixture is to be used.

Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture.

Certificate confirming that the admixture conforms to specifications of IS 9103 or to ASTM-C260, ASTM – C10, ASTM – C 595 or to ASTM- C 618.

(ii) Engineer-in-Charge at his discretion may require tests to be performed to reconfirm the characteristic properties of any admixture. All such tests shall be done in accordance with IS: 9103.

(iii) All tests described in paras 5.4.8 to 5.4.10 above shall be done at the site laboratory or at a laboratory to be identified by the Engineer-in-Charge depending on the test to be conducted.

(iv) All test shall be done in the presence of a representative nominated by the Engineer-in-Charge and a representative of the concrete Manufacturer/ Contractor when tests are performed at the site laboratory. All observation and reports of test shall be jointly signed by the two representatives before the test results are submitted to the Engineer-in-Charge.

(v) Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the concrete Manufacturer/ Contractor.

(vi) Rate of concrete is inclusive of cost of admixtures. The contractor shall not be paid anything extra for admixtures required for achieving direct workability without any change in specified water cement ration for RCC/CC work.

5.11.4 Sampling and Testing for Quality Control of Fresh Concrete

Fresh concrete shall be tested for

(a) Slump

(b) Compacting Factor/ Workability

(c) Consistency

(d) Weight per cubic metre, cement factor and air content

5.11.4.1 *Slump*

(i) For concrete totally mixed in a central plant, slump shall be checked at:-

(a) Immediately during loading of trucks

(b) Point of discharge from the delivery truck

(c) Final placement location

(d) At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer. Placement contractor shall transport concrete from truck discharge point to actual placement location within 10 minutes of delivery, before the final slump reading is taken at placement location.

(ii) For concrete entirely mixed in transit or for shrink mix concrete, slump reading shall be taken at:-

(a) Point of discharge from delivery trucks

(b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump. The placement contractor shall be responsible for transporting concrete from delivery truck discharge point to final placement location within 10 minutes. However, in this case, the truck shall discharge the concrete within 1 hour and 30 minutes from the time cement is added in the mixer and slump measured at point of discharge immediately on delivery. Manufacturer of concrete shall ensure that the final slump measurement corresponds to the ordered slump.

(iii) For measuring concrete slump at point of discharge from delivery trucks, samples shall be taken from concrete omitting the first and the last 15% of the load. For concrete delivery of placed by pumping, sampling shall be similar to those specified for delivery trucks.

(iv) Slump measurements of ready mix concrete transported by buckets shall be at locations specified in para 5.11.4.1 with same limits on time. Sampling from buckets shall be such that the buckets containing discharge from mixer for the last 15% are omitted.

(v) At placement locations, samples for checking slump shall be collected from every 20 cum of concrete or part thereof placed at location for each type to concrete.

(vi) For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.

(vii) Slump checks for concrete in the laboratory shall be carried out as and when required by the manufacturer of concrete during the mix design stage and during the progress of work for control on field results.

(viii) Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump test shall be carried out in accordance with IS 1199.

5.11.4.2 ***Compacting Factor***

(i) For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at both field and central batch plant in addition to slump tests mentioned above.

(ii) Compacting factor check shall be done in field only at placement location, and shall also be conducted at central batch plant if concrete is totally mixed in plant.

(iii) For this test, sampling shall be done as for slump measurements in field and within the same frame as for slump test.

(iv) Only one compaction factor test shall be conducted for every 20 cum of concrete or part thereof placed at location for each type of concrete. Since the test is sensitive, every care shall be taken to conduct this test totally in compliance with procedure mentioned in IS 1199.

(v) Laboratory tests for determining compacting factor of concrete shall be done as per manufacturer's requirements for establishing and controlling the design mix of concrete.

(vi) Compacting factor test shall not be taken as an acceptance criteria and shall be treated only as a guideline to workability of concrete.

5.11.4.3 ***Consistency of Concrete :*** This test shall be performed only at the batching plant laboratory using a Vee -Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee - Degrees between 1.6 and 4.5 for concrete transported and placed by normal method and between 0.8 and 3.5 for concrete transported and placed by pumping methods.

5.11.4.4 ***Weight, Cement Factor and Air contents Test*** *:* Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete. Frequency and number of test shall be finalized by the manufacturer of concrete in consultation with the Engineer-in-Charge for his requirement of the mode of measurement of concrete produced.

The Engineer-in-Charge may at his discretion require further tests over and above those specified above in para 5.11.4.1 to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

5.11.5 Sampling and Testing for Quality Control of Hardened Concrete

(i) Test on cube crushing strength of concrete in accordance and compliance with IS 456 and IS 516 shall done as under:-

(a) Sample of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.

(b) Test on specimens made form samples collected at placement location shall be considered as field test specimens and results therefrom shall be the criterion of concrete strength. Test in specimens made from samples at the batch plant shall only be taken as guidelines test. Only in the case of doubtful result, the Engineer-in-Charge may refer to such guideline results for deciding on the quality of concrete.

(c) For truck mix concrete and shrink mix concrete guideline test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose first and last 15% of the load shall be omitted while collecting samples.

(d) Frequency of sampling shall be as given below in Table 5.8 for each grade of concrete of different workability's and for each type of specimens (field test specimens and guideline test specimens) for conducting 28 days crushing strength tests.

TABLE 5.8

Quantity of concrete Delivered (cum)	*Number of samples*
Less than 5	1
6 to 15	2
31 to 50	3
51 and above sample for each	4 plus one additional 50 cum or part thereof

Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made test of the sample in accordance with IS 516.

(e) All test specimens shall be made compacted cured and tested in compliance with IS 516 and test result interpreted in accordance with IS 456 for acceptance of concrete strength, field specimens test results shall not be less than values given in Table 5.6.

(f) In addition to 28 day crushing strength test on specimens made at frequencies specified in para 4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guideline test specimens. Frequency of sampling for this set of test shall also be same as those specified in Table 5.8 above. 7 day strength shall conform to values given in Table 5.5. But these test results even if conforming to specified values shall only be taken a guideline values for projecting concrete strength and shall not be construed as conforming to specifications.

(g) For each grade of concrete and for all workability conditions with different water – cement ratios and compositions of admixtures, preliminary test shall be conducted for crushing strength on finalization to design mix for each type of concrete. Such test shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7 days test and six test specimens shall be made for 28 days test.

Average of the six test results of different periods shall not be less than those specified in Table 5.5.

(h) Crushing strengths on cubes shall also be conducted during the process of finalization of concrete design mix. Frequency and number of such tests shall be as per Mix of requirements of concrete manufacturer.

(i) All test specimens for conducting crushing strength shall be properly labeled for identification indicating:-

(i) Date of making specimen

(ii) Grade of concrete

(iii) Placement location exact

(iv) Purchasers order number

(j) In addition to crushing strength test on concrete, the Engineer-in-Charge may call for other tests on hardend concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

(ii) Non-destructive Tests

(a) When the 28 days crushing values on field specimens and/ or specimens and/or specimens made for guideline test fall short of specified values, or in case of doubtful placement of concrete, the Engineer-in-Charge shall call for non-destruction tests on the structure. Such tests may be any one or a combination of the following:-

- Rebound hammer test
- Windsor Penetration Probe test
- Pulse velocity (sonic or Ultrasonic) test
- Core test
- Load test

(b) Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Engineer-in-Charge.

(c) Core test, if ordered by the Engineer-in-Charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in-Charge and such samples shall be collected in compliance with IS:1199.

(d) If felt necessary, the Engineer-in-Charge may instruct load testing for any part of the structure based on doubtful concrete strengths. Such test shall be carried out as per details to be provided by the Engineer-in-Charge in consultation with the structural consultants.

(e) The concrete manufacturer/ concrete placement contractor shall arrange for all test to be conducted in accordance with these specifications, including all necessary tools, plants, equipment and material, and shall be responsible for conducting all test at his cost.

(f) All test conducted at the filed laboratory shall be carried out by qualified technicians employed by the concrete manufacturer/ concrete placement contractor, in presence of authorized representative of the Engineer-in-Charge. All test reports and observation reports shall be jointly signed by the Engineer-in-Charge authorized representative and the technician conducting such test.

(g) Engineer-in-Charge shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the field laboratory and such instructions shall be followed without claiming extra charges on this account.

(h) The Concrete Manufacturer/ Placement contractor shall set up a laboratory at this own expense which shall have facilities, for conducting all necessary field test on materials and field and laboratory test on concrete. The laboratory shall be staffed by the concrete Manufacturer/ Placement Contractor with qualified and experienced scientists and technicians.

5.12 EXPANSION JOINT SYSTEM

5.12.1 FLOOR JOINT

5.12.1.1 General requirement of material

The expansion joint system will be of extruded aluminum base members, self aligning /self centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor/ floor to wall expansion control system for various vertical locations in load application areas that accommodate multi directional seismic movement without stress to its components. The system shall consist of metal profiles with universal aluminum base member designed to accommodate various project conditions and finish floor treatments. The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self centering arrangement that freely rotates/ moves in all directions. The self-centering arrangements shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement. Provision of moisture barrier membrane in the joint system to have water tight joint is mandatory requirement. The scope of work includes all labour, materials, equipments and services and perform all operations required for complete installation of expansion joint system.

5.12.1.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.1.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.1.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.1.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.1.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

5.12.2 WALL JOINT

5.12.2.1 General requirement of material

The expansion joint system related with wall joint (internal/ external) shall be of extruded aluminum base members, self aligning / centering arrangement and support plates as per ASTM B221-02. The material shall be such that it provides an Expansion joints systems suitable for vertical wall to wall/ wall to corner application, both new and existing construction in office buildings & complexes with no slipping down tendency amongst the components of the joint system. The Joint System shall utilize light weight aluminum profiles exhibiting minimal exposed aluminum surfaces mechanically snap locking the multicellular to facilitate movement. (Material shall confirm to ASTM 6063)

5.12.2.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.2.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.2.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.2.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.2.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

5.12.3 ROOF JOINT

5.12.3.1 General requirement of material

Theexpansion joint system for various roof locations shall be of extruded aluminum base members with, self aligning and self centering arrangement support plates as per ASTM B221-02. The system shall be such that provides that is capable to accommodating multidirectional seismic movement without stress to its components. System shall consist of metal profile that incorporates a universal aluminum base member designed to accommodate various project conditions and roof treatments. The cover plate shall be designed of width and thickness required to satisfy movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self-centering arrangement that freely rotates/ moves in all directions. The self centering arrangement shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexures in all directions including vertical displacement. The joint system shall resists damage or deterioration from the impact of allying ice, exposure to UV, airborne contaminants and occasional foot traffic from maintenance personnel. Provision of moisture barrier membrane in the joint system to have water tight joint is mandatory requirement.

5.12.3.2 Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

5.12.3.3 Approval of expansion joint system : Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

5.12.3.4 Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

5.12.3.5 Measurement : The length of expansion joint shall be measured, correct to a cm.

5.12.3.6 Rate : The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

CUBE TEST FOR COMPRESSIVE STRENGTH OF CONCRETE - MANDATORY LAB TEST
(Clause 5.4.9.1)

A-0 One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof concrete work ignoring any part less than 5cum or as often as considered necessary by the Engineer-in-Charge. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site of work in Appendix C. The casting of cubes, concrete used for cubes and all other incidental charge, such are curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

A-1 Test Procedure

A-1.1 *Mould*

The mould shall be of size 15 cmx15 cmx15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm size of mould shall be specified by the Engineer- in-charge, keeping in view the fact that the length of size of mould should be about four times the size of aggregate.

The moulds for test specimens shall be made of non- absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one percent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5mm thick or plain metal not less than 12mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

Note: Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized.

A-1.2 *Sample of Concrete*

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by Engineer-in-Charge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should be spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of moulding of the specimen to counteract segregation. The concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete this sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen. The sampling shall be spread as evenly as possible throughout the day. When wide changes occur during concreting, additional sample shall be taken if so desired by the Engineer-in -Charge.

A-1.3 *Preparation of Test Specimens*

The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained as described under the test specimen shall be immediately moulded by one of the following methods as indicated below:-

When the job concrete is compacted by manual methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge do the mould as the concrete there sided from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded through its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of moulding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or over flow from the top of the mould.

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rolling as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall only be used when the concrete is required to be compacted in layers. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for top extent that there will be no mortar loss during vibrations. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then the struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water-cement ratio of the concrete by loss of water, either by leakage for the bottom or over flow from the top of the mould.

A-1.4 *Curing and Storage of Test Specimen*

In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22ºC to 33ºC. Other suitable means which provide such a temperature and moisture conditions may be used.

Note:- It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24ºC to 30ºC until the time of test. If storage in water is desired, a saturated lime solution shall be used.

A-1.5 *Testing*

The specimens shall be tested in accordance with procedure as described below:

(a) The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.

(b) Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

(c) The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

(d) The load shall be applied axially without shock at the rate of approximately 140 kg. per sq.cm. per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq. cm. using the area computed from the measured dimension of the test specimen. The type of failure and Appearance of the concrete shall be noted.

APPENDIX B

ADDITIONAL TESTS FOR CONCRETE
(Clause 5.4.9.2)

B-0 In case the concrete fails when tested as per the method prescribed in Appendix A, one or more of the following check tests may be carried out at the discretion of Engineer-in-Charge to satisfy the strength of the concrete laid. All testing expenditure shall be borne by the contractor, the number of additional tests to be carried out shall be determined by the Engineer-in-Charge. He shall be the final authority for interpreting the results of additional test and shall decide upon the acceptance or otherwise. His decision in this regard shall be final and binding. For the purpose of payment, the Hammering test results only shall be the criteria. Some of the tests are outlined below:-

B-1 REBOUND HAMMER TEST

If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS 13311 (part II) and a continuously maintained individual charts are kept showing a large number of reading and the relation between the reading and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure for element. If calibration charts are available from manufactures, it can be used. When making rebound hammer test each result should be the average of at least 12 readings. Reading should not be taken within 20mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a trowled face and those on a moulded face. When making the tests on a precast unit, special care should be taken to bed them firmly against the impact of the hammer.

B-2 CUTTING CORES

This method involves drilling and testing cores from the concrete for determination of compressive strength. In suitable circumstances, the compressive strength of the concrete in the structure may be assessed by drilling cores from the concrete and testing. The procedure used shall comply with the requirements of IS 1199 and IS 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least three cores shall be obtained and tested. If the average of the strength of all cores cut from the structure is less than the specified strength, the concrete represented by the cores shall be liable to rejection and shall be rejected if a static load test (B-5) either cannot be carried out or is not permitted by the Engineer-in-Charge.

B-3 ULTRASONIC TEST

If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS 13311 (part I) and continuously maintained individual charts are kept showing a large number of readings & the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structures. In cases of suspected lack of compaction or low cube strength the results obtained from the ultrasonic test results on adjacent acceptable section of the structures may be used for the purpose of assessing the strength of concrete in the suspected portion.

B- 4 LOAD TESTS ON INDIVIDUAL PRECAST UNITS

The load tests described in this clause are intended as check on the quality of the units and should not be used as substitute for normal design procedure. Where members require special testing. Such special testing procedures shall be in a accordance with the specification. Test loads shall be applied and removed incrementally.

B-4.1 Non Destructive Tests

The unit shall be supported at its designed point of support and loaded for five minutes with a load equal to the sum of the characteristic dead load plus one and a quarter time the characteristic imposed load. The deflection is then recorded. The maximum deflection after application of the load shall be in accordance with

the requirements defined by the Engineer-in-Charge. The recovery is measured five minutes after the removal of the load and the load then reimposed. The percentage recovery after the second loading shall be not less than that after the first loading nor less than 90% of the deflection recorded during the second loading. At no time during the tests, shall the unit show any sign of weakness or faulty construction as defined by the Engineer-in-Charge in the light of reasonable interpretation of relevant data.

B-4.2 Destructive Tests

The unit is loaded while supported at its design point of support and must not fail at its design load for collapse, within 15 minutes of time when the test load becomes operative. A deflection exceeding 1/40 of the test span is regarded as failure of the unit.

B-4.3 Special Tests

For very large units or units not readily amenable to the above test e.g. columns, the precast parts of composite beams and members designed for continuity or fixity, the testing arrangements shall be agreed upon before such units are cast.

B-5 Load Test of Structures or Parts of Structures

The test described in this clause are intended as a check where there is a doubt regarding structural strength. Test loads are to be applied and removed incrementally.

B-5.1 Age at Tests

The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt, the test may be carried out earlier, provided that the concrete has already reached its specified characteristic strength.

B-5.2 Test Load

The test loads to be applied for the limit state of deflection and local damage are the appropriate design loads i.e., the characteristic dead and superimposed loads. When the limit state of collapse is being considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained or a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the members being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

B-5.3 Measurement During Tests

Measurements of deflection and crack width shall be taken immediately after applications of the load and, in the case of 24 hour sustained load test, at the end of 24 hour loaded period, after removal of the load and after 24 hour recovery period. Sufficient measurements shall be taken to enable side effect to be taken in account. Temperature and weather conditions shall be recorded during the tests.

B-5.4 Assessment of Results

In assessing the strength of a structure or a part of the structure following a loading test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met:

(a) The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than 2/3 of the value of the appropriate limit state requirement.

(b) For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than 1/500 of the effective span limits shall be agreed upon before testing cantilevered portions of structure.

(c) If maximum deflection in mm shown during 24 hour under load is less than $40L^2/D$ where L is effective span in mm and D is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirement (D) does not apply, and

(d) If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 hour under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

B-6 DETERMINATION OF WATER SOLUBLE AND ACID SOLUBLE CHLORIDES IN CONCRETE

Determination of water soluble and acid soluble chlorides in Concrete shall be done as per method of test given in IS 14959 (Part 1) which covers volumetric method of test as described below :

(a) Quality of Reagents
Unless otherwise specified, pure chemicals of analytical reagent grade and distilled water (see IS 1070) shall be used in the test.

(b) Nitric Acid (HNO_3) Concentrated (Specific Gravity 1.42)
Prepare the solution, (6N (approximately), by diluting 38ml of concentrated Nitric acid to 100 ml with distilled water.

(c) Ferric Alum($FeNH_4 (SO_4)_2$ 12 H_2O)
Dissolve 10 g of ferric alum in 100 ml of distilled water and add 1 ml of Nitric acid.

(d) Potassium Chromate 5% Solution
Dissolve 5 g of potassium chromate ($K_2 CrO_4$) 100 ml of distilled water to form 5% Solution.

(e) Nirabenzene

(f) Silver Nitrate ($AgNO_3$)Solution, 0.02 N
Weigh 1.7 g of silver nitrate, dissolve in distilled water and dilute to 500 ml in a volumetric flask. Standardize the silver nitrate solution against 0.02 N sodium chloride solution using potassium chromate solution as indicator (5 percent *m/v*) in accordance with the procedure given in IS 3025 (Part 32).

(g) Ammonium thiocyanate (NH_4 SCN) Solution
Weigh 1.7 g of ammonium thiocyanate (NH_4 SCN) and dissolve in one litre of distilled water in a volumetric flask. Shake well and standardize by titrating with 0.02 N silver nitrate solution using ferric alum solution as an indicator. Adjust the normality exactly to 0.02 N.

(h) Sodium chloride (NaCl) 0.02N
Weigh 1.1692 g of sodium chloride (NaCl) dried at 105 +/- 2ºC, dissolve in distilled water and make upto 1000 ml in a volumetric flask.

(i) Use of Filter Paper

(j) In the methods prescribed in this standard, relative numbers of Watman filter paper only have been prescribed since these are commonly used. However, any other suitable brand of filter papers with equivalent porosity may be used.

(k) Procedure for Water Soluble Chloride
Weigh 1 000+/-5 g of fresh mortar or concrete sample in a 2 litre capacity beaker and add 500 ml of distilled water (chloride free). Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution

into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Watman filter paper No.1 and collect the filtrate.

Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add 5 ml of 6 N Nitric acid. Add a known volume (X), preferably 25 ml of nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0.02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.

(l) Procedure for Acid Soluble Chloride

Weigh about 1000 +/- 5 g of the fresh mortar or concrete sample in a 2 litre capacity beaker and add 50 ml of 6 N nitric acid and 450 ml of distilled water (chloride free) after stirring for few Minutes. Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Watman filter paper No.1 and collect the filterate.

Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add 5 ml of 6 N nitric acid. Add a known volume (X) preferably 25 ml of standard silver nitrate solution. Add 1 ml ferric alum and 5 ml of nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0.02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.

(m) Calculation

Calculate the percentage of chloride(acid soluble/water soluble) by mass of mortar or concrete as follows:

Chloride, percent = 0.0007 1 (X – Y),

Where

X = volume of silver nitrate added, in ml; and

Y = volume of 0.02 N ammonium thiocyanate consumed.

Note: Interference of silver chloride particles (which are generated in situ) in titration by reacting with thiocyanants can be avoided by the addition of nitrobenzenes which forms a film on silver chloride particles.

APPENDIX C

REGISTER OF WORK TEST OF CONCRETE (NOMINAL MIX)

(Clause A-O of Appendix A)

(a)	Name of work	Concrete mix, (by volume)	Compressive strength in kg/cm^2 on 7 days
(b)	Name of Contractor	1:1:2	210
(c)	Agreement No.	1:1.5:3	175
(d)	Sample No.	1:2:4	140
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/ grade of concrete		

7 Days' Test

(Clause 5.4.10.3)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	(a) Minimum strength	
	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Difference between 3a and 3b	
	(e) Difference in % age in terms of average strength i.e $\frac{3b-3a}{3c}$ x 100	
(4)	Specified compressive strength of concrete mix used	
(5)	(a) If 3(e) is more than 30%	Sample is not acceptable, then 28 days strength test shall be carried out.
	(b) If 3(e) is equal to or less than 30% then proceed as below:-	
	(i) Difference between column 4 specified compressive strength and column 3 (c) i.e., actual average is higher, it will be denoted (+) and (-) if it is less.	
	(ii) Difference in column 5(b) (i) terms of	$\frac{3c-(4)}{4}$ x 100
	(iii) If the difference in column 5(b) (i) is +ve and the same in terms of % age of specified strength (4) i.e., value of col. 5(b) (ii) is within (+15% range)	Acceptable & strength is considered in order

JE AE/AEE EE

REGISTER OF WORK TEST FOR CONCRETE (NOMINAL MIX)

(a)	Name of Work	Concrete mix, (By volume)	Compressive strength kg/cm^2 in 28 days
(b)	Name of contractor	1:1:2	315
(c)	Agreement No	1:1.5:3	265
(d)	Sample No.	1:2:4	210
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/Grade of concrete		

28 Days' Test
(Clause 5.4.10.4)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	Actual compressive strength of cubes (min. no. of cubes to be tested –three)	
	(a) Minimum strength	
	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Specified compressive strength of concrete mix used	
	(e) 70% specified strength	i.e. 70% of 3(d)
	(f) 130% of specified strength	i.e. 130% of 3(d)
(4)	If 3(b) = 3(f) and 3(a) > 3(e)	Value of 3(c) shall be compressive strength of sample
(5)	If 3 (c) is more than 3(f)	EE may order further investigation
(6)	If any test value exceeds 3(f)	It should be restricted to 3(f) for computation of strength
(7)	If 3 (c) > 3(d) but < 3(f)	Strength is in order and concrete accepted at full rates.
(8)	If 3 (c) < 3(d) and > 3(e)	Concrete may be accepted at reduced rates in accordance with para 5.4.13.2
(9)	If 3(c) < 3(e)	Work represented by this sample shall be rejected and action taken as prescribed in clause 5.4.10.4

APPENDIX D

LIST OF EQUIPMENTS REQUIRED FOR SITE LABORATORY

I. Aggregate Testing

ITEMS		*QUANTITY*
1. Aggregate Testing	1. STANDARD SIEVES (INDIAN STANDARD)	
	(a) Set of coarse sieves 30 cm dia (GI sheet frames) with aperture size. (40 mm, 25 mm, 20 mm, 16 mm, 17.5 mm, 10 mm, 4.75 mm all with lid and pan)	1 set
	(a-1) Motorised sieve shaker for the above sieves	1 No.
	(b) Set of fine sieves 20 cm dia of brass with aperture size (4.75 mm, 2.36 mm, 1.18 mm,600 mic, 300 mic, 150 mic, 75 mic all with lid and Pan)	1 set
	(b-1) Motorised sieve shaker for the above sieves.	1 No.
2. Flakiness & Elongation index screen		1 No.
3. Riffle sample divider slot width 25mm		1 No.
4. 1 Los Angeles abrasion Testing Machine		1 No.
5. Bulk Density and voids of Aggregates cylindrical metal measures with capacity (3 ltr, 10 ltr, 15 ltr or 20 ltr)		1 No. each
6. Density basket of galvanized wire height 20 cm		1 No.
7. Pycrometer 1000 ml capacity with Brass		1 No.
8. Hot – Air Blower (Hair Dryer)		1 No.
9. Aggregate impact value apparatus with automatic blow counter		
10. Hot – plate 1000 to 2000 wells with regulator cum switch		1 No.
11. Drying pans (Frying pans)		2 Nos..
12. China clay dishes with dia 10 cm & 15 cm		2 Nos./each
13. Watch glasses for above 10 cm & 15 cm		2 Nos./each

II. Concrete Testing

1.	Sieve Brushes	2 Nos.
2.	Concrete cube moulds 15x15x15cm	3. Ultrasonic Test Equipment 1
3.	Ultrasonic Test Equipment	1 No.
4.	Pruning Rods 2 Kg weight length 40 cm and ramming face 25 mm2	4 Nos.
5.	Extra Bottom plates for 15 cm cube mould	6 Nos.
6.	Standard Vibration Table for gauging the cubes	2 Nos.
7.	Compression Testing Machine with Electricity cum manually operated tamping unit with pressure guage preferable 30 cm dia, 0-150 tonne in 1 tonne divisions. Sensitivity 0.5 tonne.	1 No.
8.	1 Air content measuring apparatus	1 No.
9.	Slump test Apparatus complete	3 Nos.
10.	Pocket concrete pernetrometer 0 to 50kg/ sq.cm	1 No.
11.	Baby Mixer Machine	1 No.
12.	G.I. Tray approx 1mx1m with sides 10 cm high for hand mixing of concrete	2 Nos.
13.	Concrete temperature measuring thermometer with Brass protection sheath 0-100 degree centigrade	2 Nos.

III. Cement Testing

1.	Mortar Cube Moulds 7.07x7.07x7.07 cm	10 Nos.
2.	Standard sand Grade I,II,III	50 kgs./each
3.	Mortar Cube vibrator	1 No.
4.	Vicate needle apparatus Computer	1 No.
5.	Blaine's Apparatus	1 No.

IV. Weighing Equipment

1.	Physical Balance Capacity 200 gms with weight pony	1 No.
2.	Dial type spring balance preferable with zero correction knob capacity 100 kgs reading to ½ kg.	2 Nos.
3.	Counter scale capacity 1 kg and 10 kg	1 No./ each
4.	Weighing platform capacity 100 kg	1 No
5.	Iron Weight of 5 kg, 2 kg, 1 kg, 500 gm, 200 gm, 100 gm	2 No./each
6.	Brass Weight of 50 gm, 20 gm, 10 gm, 5 gm, 2 gm, 1 gm	2 No./each

V. Water Measuring

1.	5 litres, 2 litres, 1 litre, ½ litre	5 Nos./each

VI. Glass and Plastic Ware

1.	Measuring cylinder TPX or Poly propylene capacity 100 ml, 500 ml, 250 ml, 100 ml	2 Nos./each
2.	Pyrex, corning or Borosil beakers with cover capacity 500 ml, 200 ml, 50 ml	2 Nos./each
3.	Wash Bottles capacity 500 ml	2 Nos./each
4.	Thermometers 1-100 degree centigrades/ max. and Min/ Dry and wet with table	1 No.

VII. Laboratory Tools

1.	Set of box spanner ratchet	2 Nos.
2.	Hammer 1lb	2 Nos.
3.	Rubber Hammer	2 Nos.
4.	Hacksaw with 6 blades	1 Nos.
5.	Measuring tape 2 mtr	2 Nos.
6.	Depth gauge 20cm	2 Nos.
7.	Steel Foot Plate	2 Nos.
8.	Vernier Calliper	2 Nos.

VIII. Miscellaneous Items

1.	Trowels made from saw blade, 3 mm thick 16x10cm wooden handle	6 Nos.
2.	Showels & Spade	6 Nos./each
3.	Steel plates 5 mm thick 75x75 cm	2 Nos.
4.	Plastic or G.I. Buckets 15 ltr, 10 ltr, 5 ltr	2 Nos.
5.	Wheel Barrow	3 Nos.
6.	Floor Brushes, hair dusters, scrappers, wire brush, paint brushes, shutter steel plat oil, kerosene with stove etc.	3 Nos.

ANNEXURE – A
(Clause 5.9.3)

SAMPLING OF CONCRETE

After the truck mixer has re-mixed its delivery on site, allow at least the first one-third of a m^3 of concrete to be discharged prior to taking any samples. Take at least 4 incremental samples from the remainder of the load avoiding sampling the last cubic metre of concrete. Thoroughly re-mix this composite sample either on a mixing tray or in the sampling bucket and proceed with the required testing.

ANNEXURE – B
(Clauses 5.9.4.2 & 5.9.4.3)

CONCRETE MIX INFORMATION TO BE SUPPLIED BY THE PURCHASER

RMC : ……..

Contractor : ……

Site : ……

MIX CODE						
Grade (N/mm^2) (Characteristic strength)						
Minimum Cement Content (kg/m^3)						
Mineral Additives (Pulverized fuel ash/Slag/Others) (kg/m^3)						
Maximum Free water Cement Ratio						
Nominal Maximum Aggregate size						
Cement Type and Grade (if preferred)						
Target workability (Slump) (mm)						
Target workability at site						
Maximum Temperature of Concrete at the time of placing						
Class of sulphate Resistance (if applicable)						
Exposure condition (if applicable)						
Class of finish (if applicable)						
Mix Application						
Method of Placing						
Any other requirements (early strength workability retention, permeability testing, chloride content restriction, maximum cement content, etc.)						
Concrete Testing (Frequency)						
Material's Testing (any non-routine requirements)						
Alternatives to be offered: Yes/No						
Method of Curing to be used by contractor						
Quantity (m^3)						

Note : Additional proforma for further information may be used, such as for specific test rates to be achieved for concrete or raw materials, exact method statements of the contractors proposed site practice.

ANNEXURE – C
(Clauses 5.9.6.2 and 5.9.6.3)

CALIBRATION AND WEIGHING EQUIPMENT ACCURACY

C-1. The following limits shall apply to all ready-mixed concrete plants :

(a) The accuracy, sensitivity and arrangement of the weighing devices shall be such as to enable the materials to be batched within the following tolerances :

(1)	Cement, mineral Admixtures	:	Within $\pm$ 2 percent of the quantity of the constituent being measured.
(2)	Aggregate, chemical admixtures and water	:	Within $\pm$ 3 percent of the quantity of the constituent being measured.

(b) Analogue scales shall have scale increments not exceeding 5 kg. for cement and mineral admixtures, 25 kg. for aggregate and 2 kg. for water.

(c) Preset controls shall be calibrated in increments not exceeding 5 kg. for cement and mineral admixtures, 10 kg. for aggregate and 2 kg. for water.

(d) For continuous mixer plants calibration shall be in increments not exceeding 10 kg./m^3 for cement and mineral admixtures, 25 kg./m^3 for aggregates and 10 l/m^3 for water.

(e) Digital readous shall have a scale increments not exceeding 2 kg. for cement and mineral admixtures, 10 kg. for aggregate and 10 for water.

(f) At the time of installation, or reconditional the accuracy of the indicated mass at any point on the scale shall be within 0.25 percent of the full scale reading.

(g) Any other time during the masonry operation the accuracy shall be within 0.50 percent of the full scale reading.

(h) Chemical Admixture dispensers shall have scale increment for exceeding.

Ranger of scale in kg/l	*Scale increment in Kg/l*
0.1 – 0.5	0.01
0.5 - 1.0	0.02
1.0 – 10.0	0.2
more than 10.0	0.4

(i) All weighing and measuring equipment shall be tested and calibrated over its full working range at the following intervals :

(1) Mechanical /knife edge systems : At least once every two month

(2) Electrical /load cell systems : At least once every three months

Adequate and identified facilities shall be provided for the application of the test loads.

(j) In the case of batch weighing systems testing and calibration shall be based on the application test loads to the weigh hoppers.

(k) Checks on continuous weigh systems shall be based on comparison of preset quantities with those actually produced.

(l) To achieve the required accuracy of calibration, a minimum of 500 kg. of stamped weights required, except that for low capacity scale an acceptable limit on the total mass of calibr weight would be 20 percent of the scale capacity.

(m) When calibration of weighing equipment is carried out all personnel involved should competent and fully trained, the procedures should be fully documented, and special atte should be paid to the health and safety aspects of the procedure.

ANNEXURE – D

DELIVERY TICKET INFORMATION

(Clause 5.9.6.5)

D-1 The following information shall be included in the delivery ticket to accompany the load to the purchaser :

(a) Name or number of the ready-mixed concrete depot
(b) Serial number of the ticket
(c) Date
(d) Truck number
(e) Name of the Purchaser
(f) Name and location of site
(g) Grade or mix description of the concrete
(h) Specified target workability
(i) Minimum cement content (if specified)
(j) Type of cement and grade (if specified)
(k) Maximum free water-cement ratio (if specified)
(l) Nominal maximum size of aggregate
(m) Generic Type or name of any chemical and mineral admixtures included.
(n) Quantity of concrete in m^3
(o) Time of loading
(p) Signature of the plant operator
(q) A statement warning the purchaser of the precautions needed to be taken when working with cement and wet concrete.

D-2 On site the following information will be added. :

(a) Time of arrival on site.
(b) Time when discharge was completed.
(c) Any water/admixture added by the supplier to meet the specified workability.
(d) Any extra water /admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
(e) Pouring location.
(f) Signature of the purchaser or his representative conforming discharge of the load.

TYPICAL SET UP OF STEEL WALL FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6

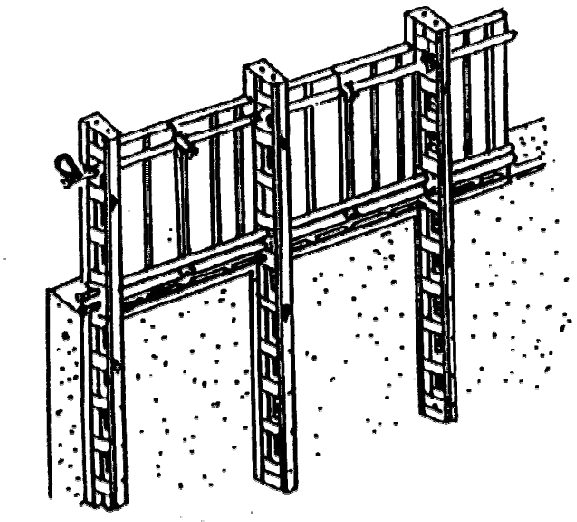


Fig. 5.1A : Single Sided Wall Form (Adjustable)

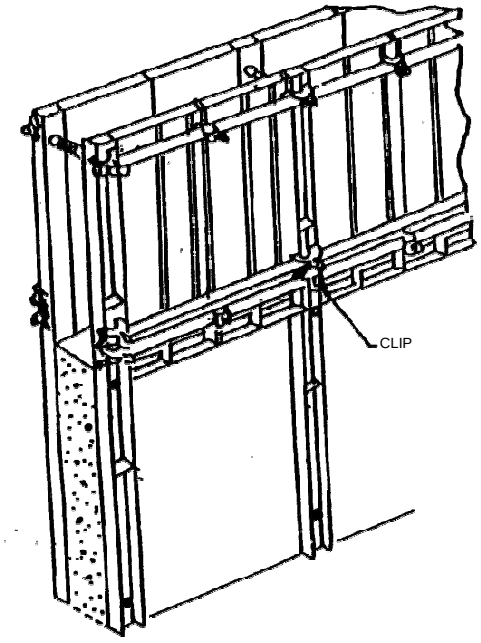


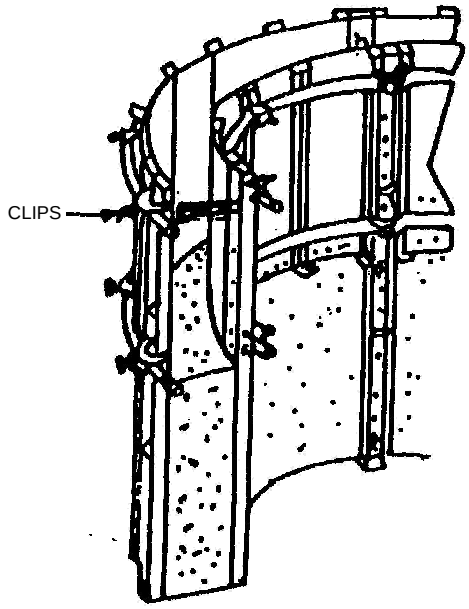
Fig. 5.1B : Double Sided Wall Form

All Members are of Steel

Fig. 5.1 : Typical Set Up of Steel Wall Form Work

WALL FORM

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6



All Members are of Steel

Fig. 5.2 : Adjustable Curved Wall Form (Double Sided)

TYPICAL FIXING DETAILS OF WALL TIES

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.6.

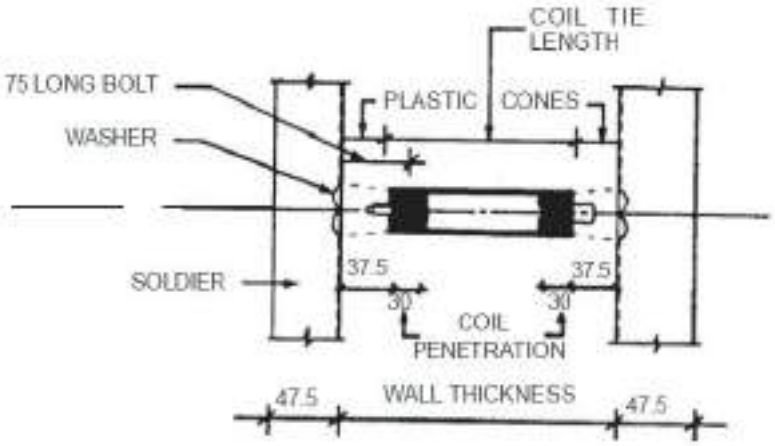


Fig. 5.3A : Wall Tie for Two Sided Shuttering

All Members are of Steel

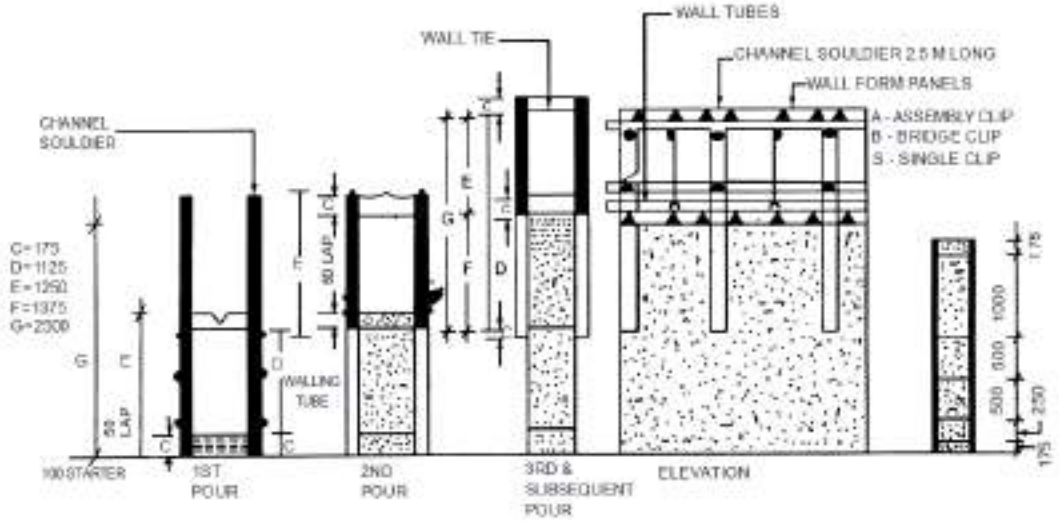


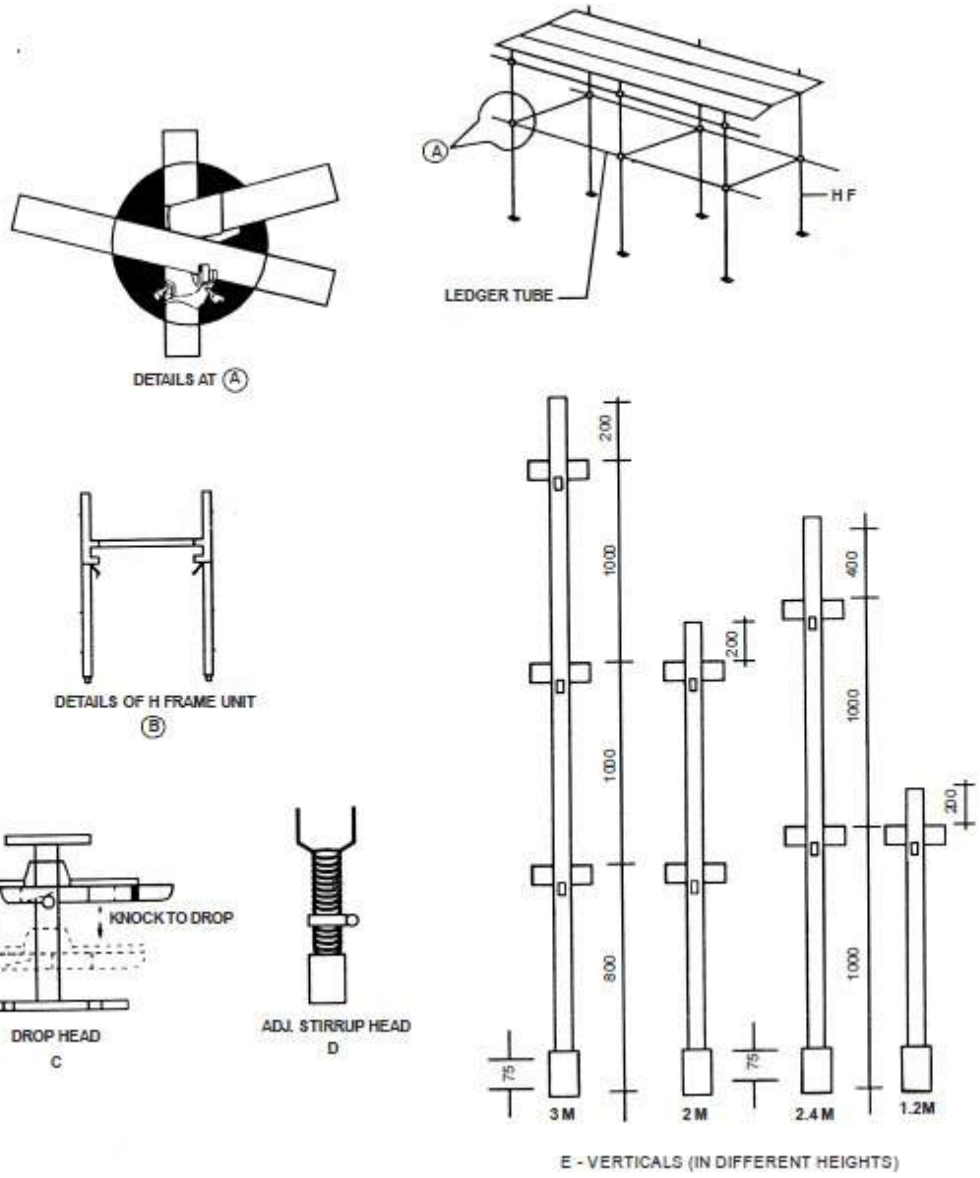
Fig. 5.3B : Position of Wall Ties & Walling Tubes
(Shuttering for 1st Pour should be properly Strutted by Rakers)

Drawing not to scale All dimensions are in MM

Fig. 5.3 : Typical Fixing Details of Wall Ties

TYPICAL STANDARD UNITS OF FORM WORK (CENTRING & SHUTTERING)

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3



All Members are of Steel
All dimensions are in MM
Drawing not to scale

Fig. 5.4 : Typical Standard Units of Form Work

TYPICAL COMPONENTS OF FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

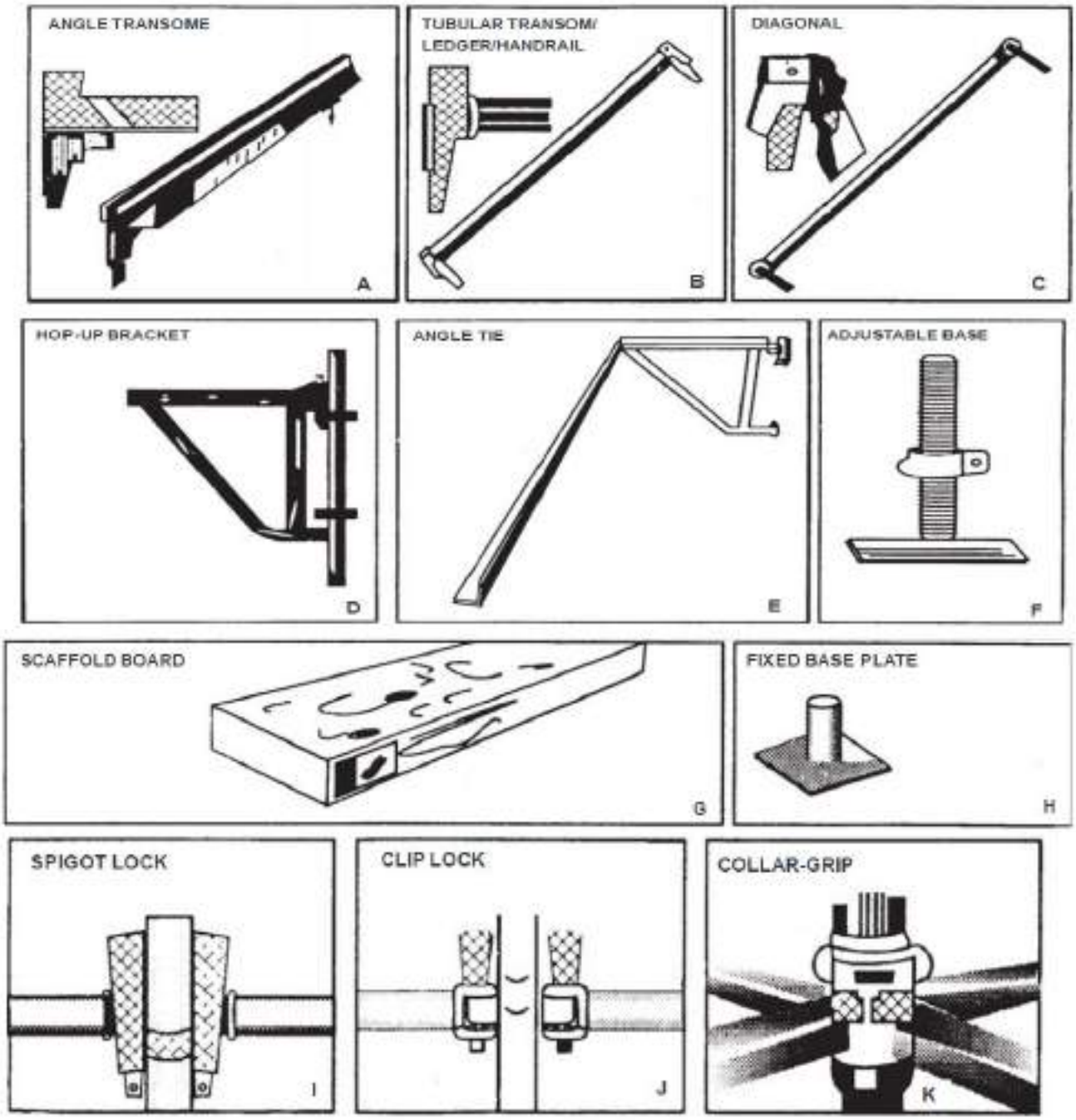


Fig. 5.5 : Typical Components of Form Work

TYPICAL ARRANGEMENT OF COLUMN FORM WORK

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

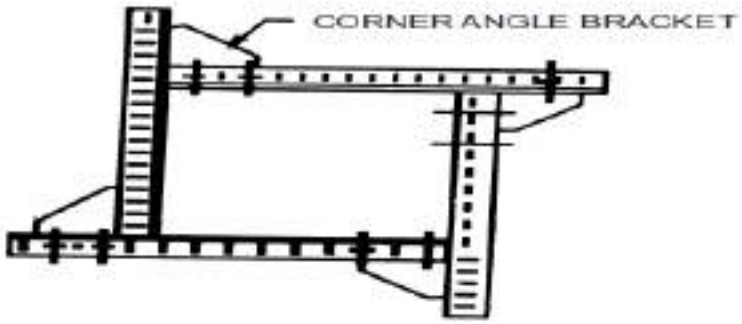


Fig. 5.6A : Four Sides Adjustable Column Form

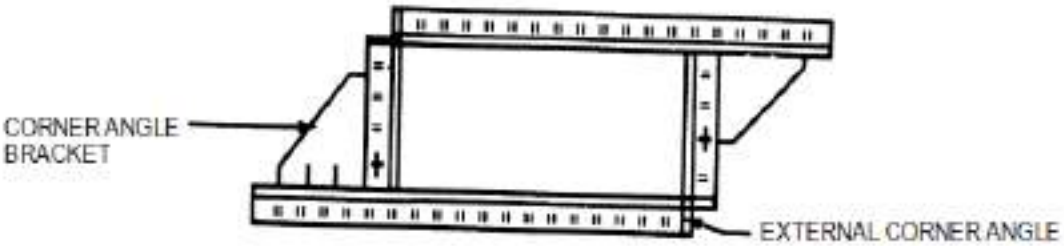


Fig. 5.6B : Two Sides Adjustable Column Form

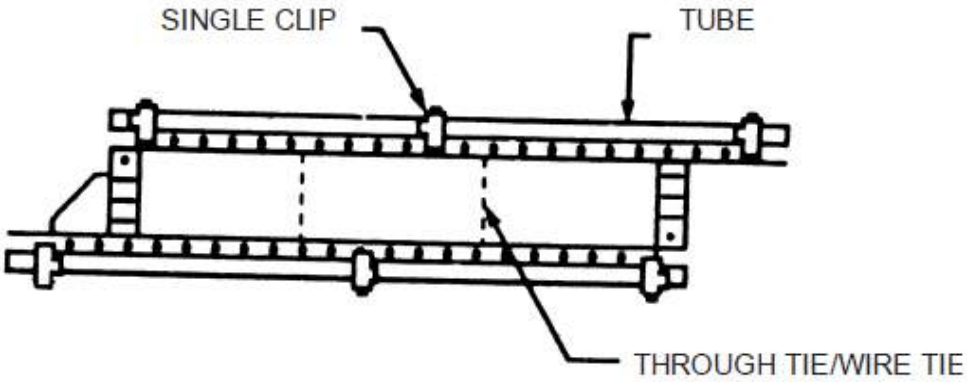


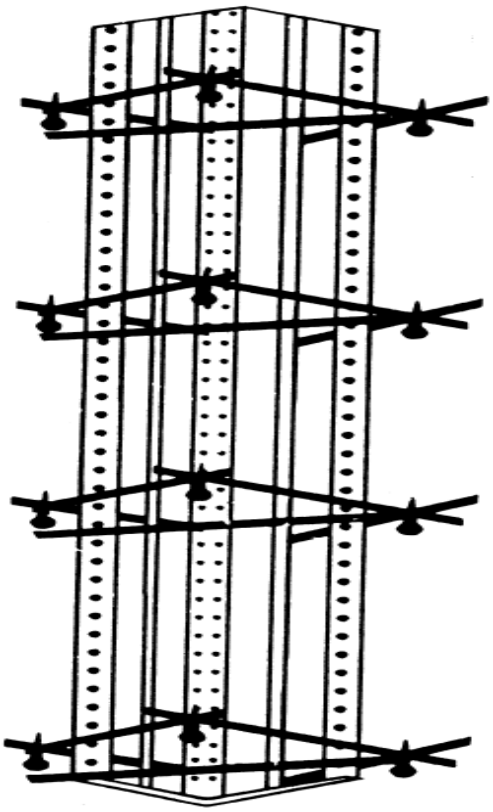
Fig. 5.6C : Column Form with Adjustable Shuttering Wall Form Type Panels

All Members are of Steel

Fig. 5.6 : Typical Arrangement of Column Form Work

TYPICAL COLUMN SHUTTERING

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.2

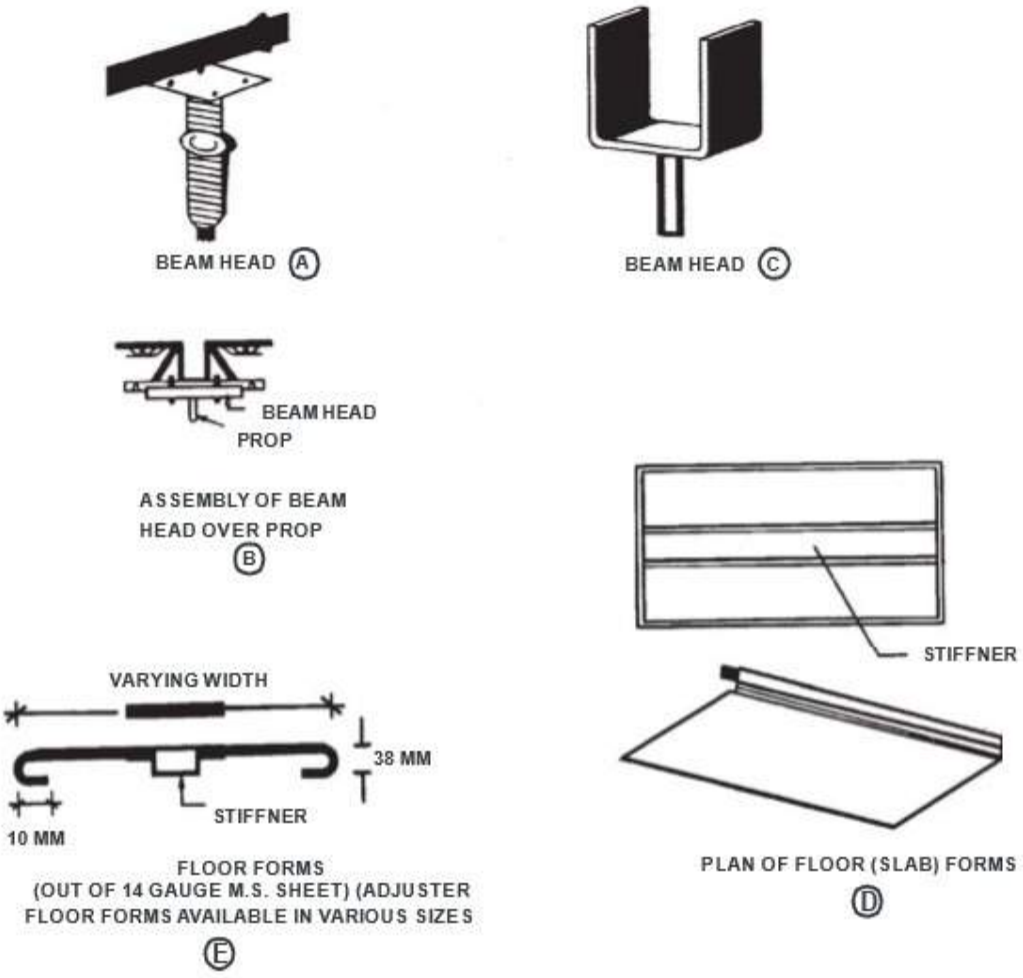


All Members are of Steel

Fig. 5.7 : Typical Column Shuttering

TYPICAL DETAIL OF BEAM HEAD AND STIFFNER

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.3

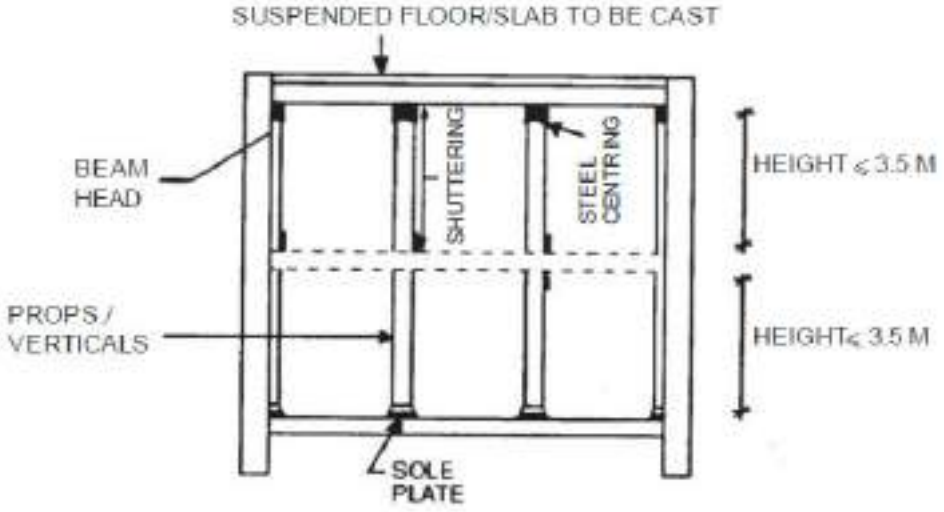


All Members are of Steel

Fig. 5.8 : Typical Detail of Beam Head and Stiffner

TYPICAL DETAILS OF MULTI STAGE SHUTTERING

Sub Head : R.C.C. (Form Work)
Clause : 5.2.3.4



All Members are of Steel

Fig. 5.9A : Suspended Floor – Multi Stage Shuttering (Vertical Section)

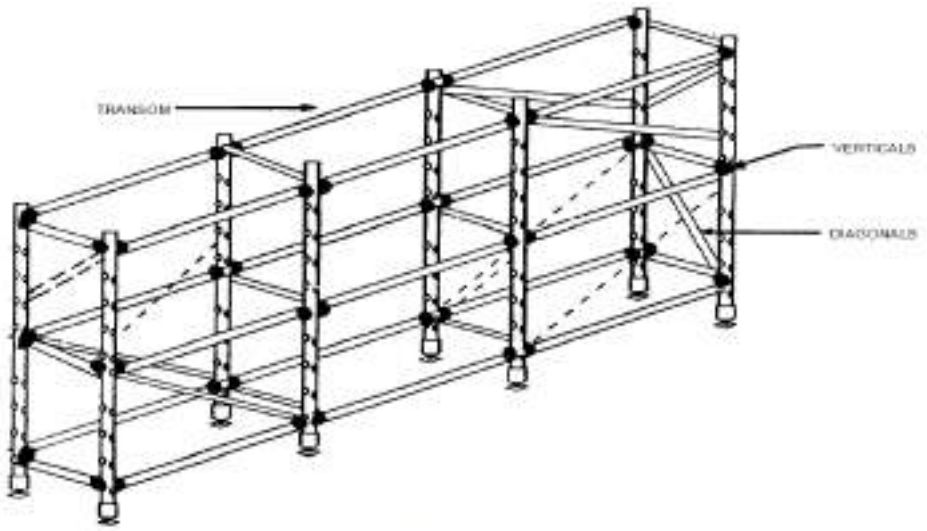


Fig. 5.9B

Fig. 5.9 : Typical Details of Multi-State Shuttering

DETAILS OF EXPANSION JOINTS (IN VARIOUS LOCATIONS)

Sub Head: R.C.C.
Clause : 5.4.5

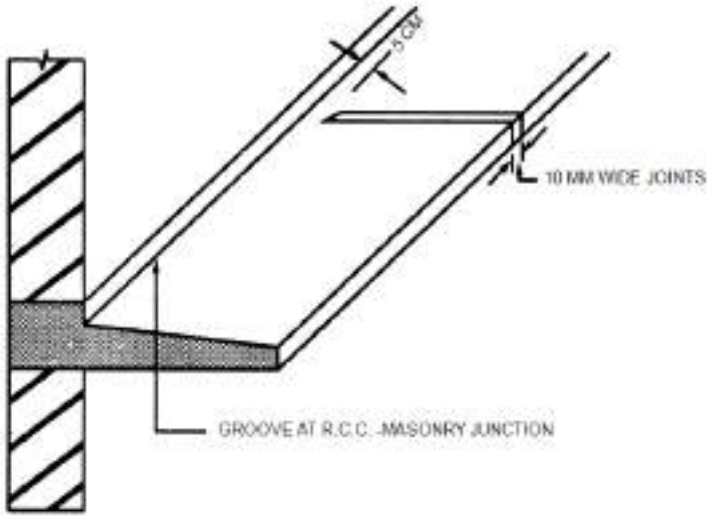


Fig. 5.10 : Expansion Joints in Long Sun Shade

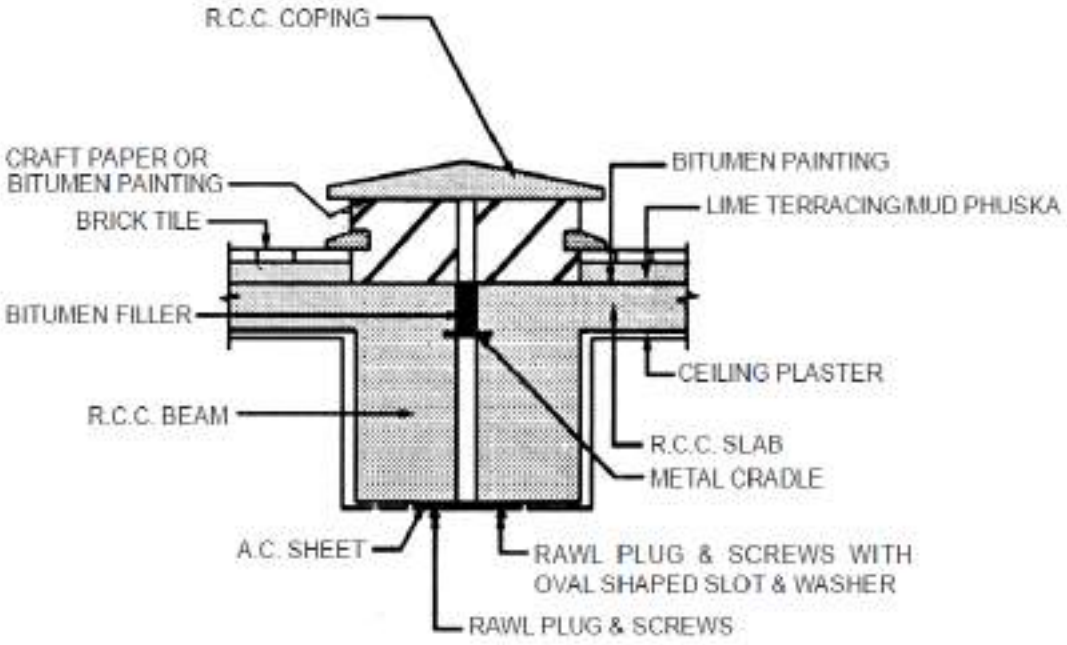


Fig. 5.11 : Details of Raised Type Expansion Joint at Roof

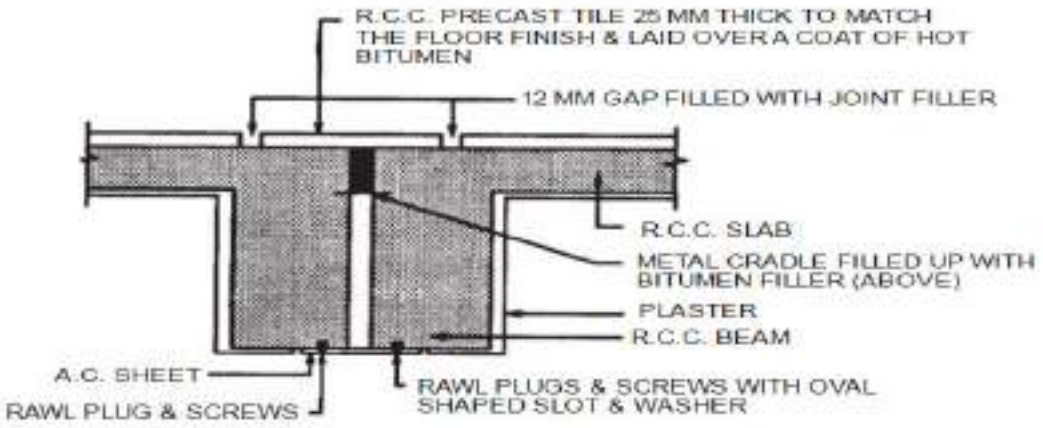


Fig. 5.12 : Typical Details of Expansion Joint at Floor

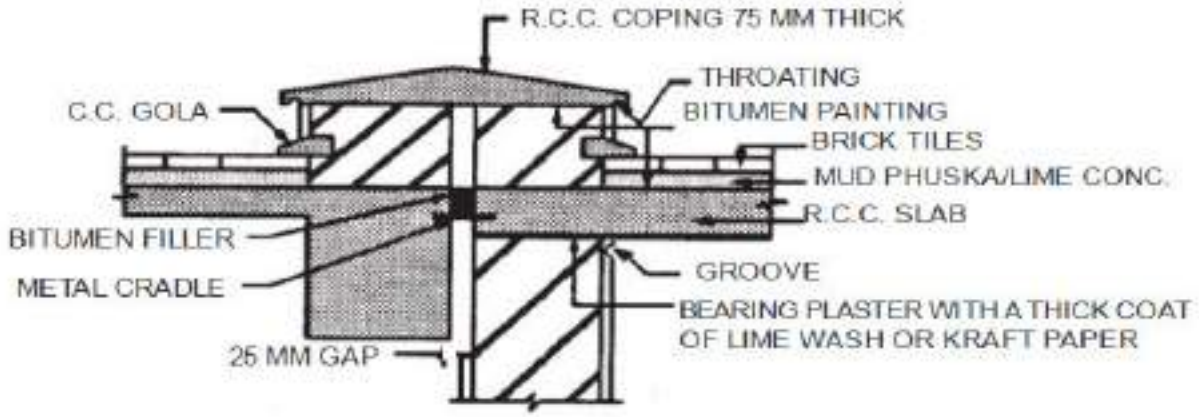


Fig. 5.13 : Typical Details of Expansion Joint at Wall & Beam Junction

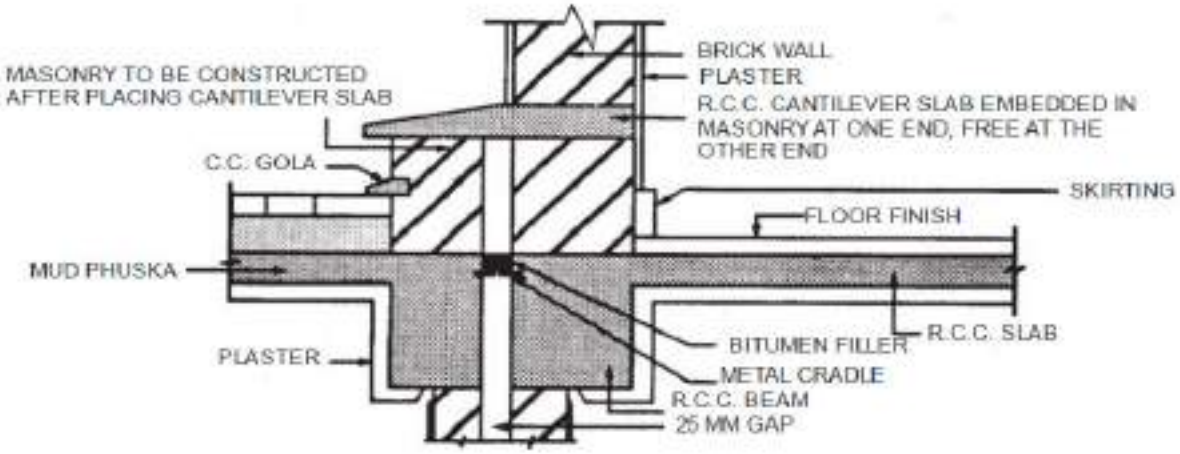


Fig. 5.14 : Typical Details of Expansion Joint at Roof & Floor Junction

EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.
Clause : 5.4.5

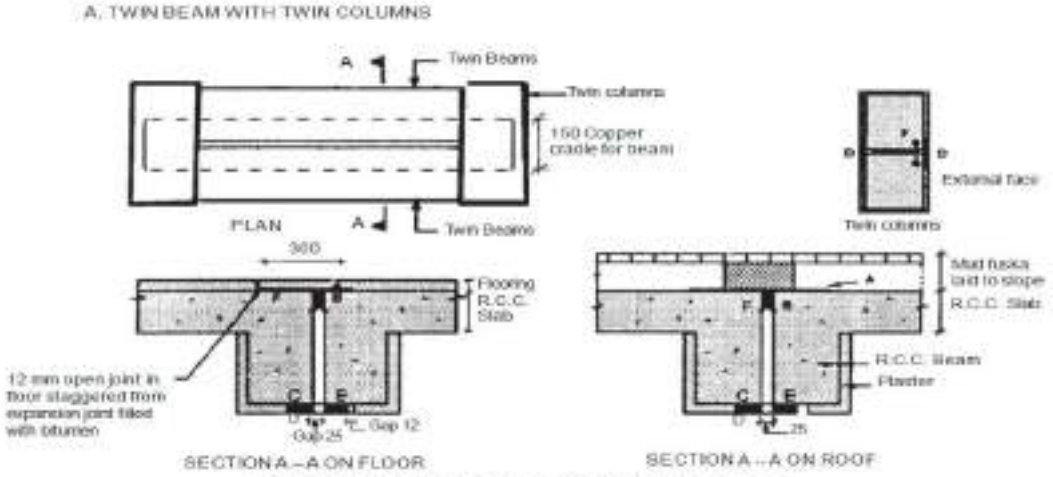


Fig. 5.15 : Twin Beam with Twin Columns

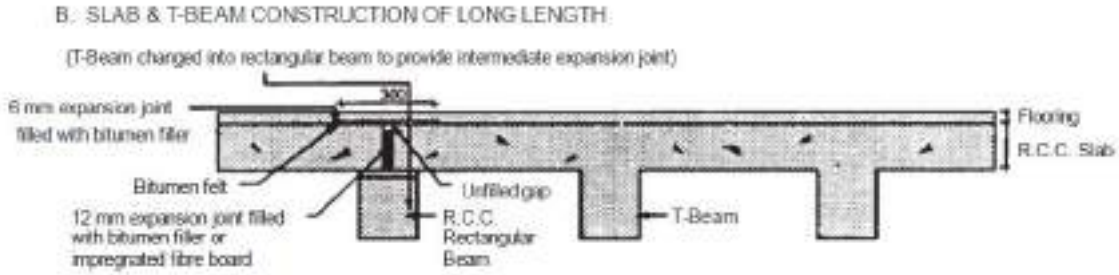


Fig. 5.16 : Slab & T-Beam Construction of Long Length

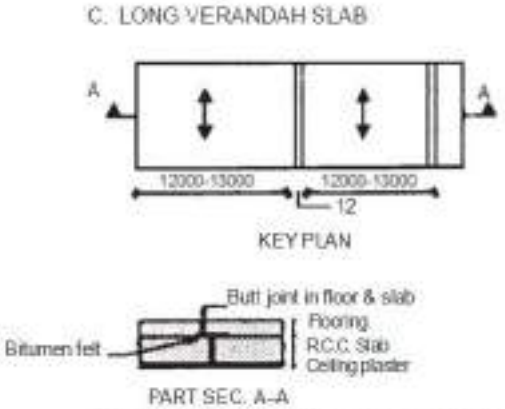


Fig. 5.17 : Long Verandah Slab

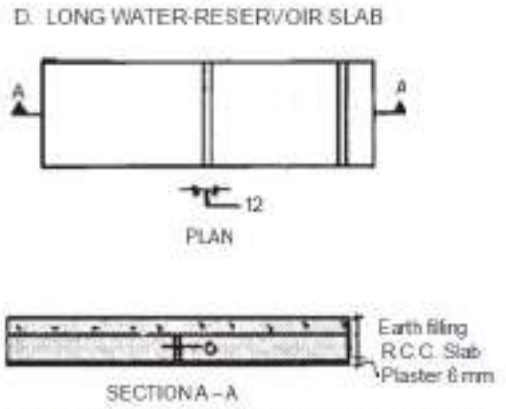


Fig. 5.18 : Long Water Reservoir Slab

A Hot bitumen painting @ 1.7 k.g/sqm.
B Bitumen filler
C Rawl plugs & 50 mm screws @ 300 mm c/c
D Asbestos sheet 150 mm wide or P.V.C. sheet
E Rawl plugs & screws with oval shaped slot & washers @ 300 mm c/c
F Copper cradle

Drawing not to scale
All dimensions are in mm

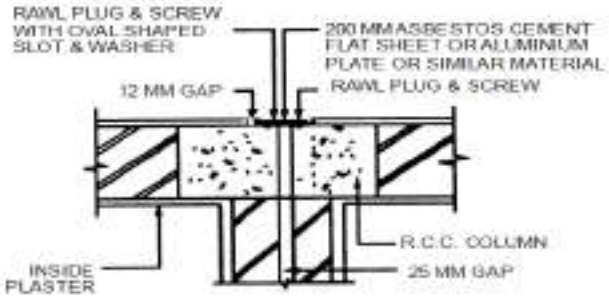


Fig. 5.19 : Typical Details of Expansion Joint Covering on Outer Face of Columns (Plan)

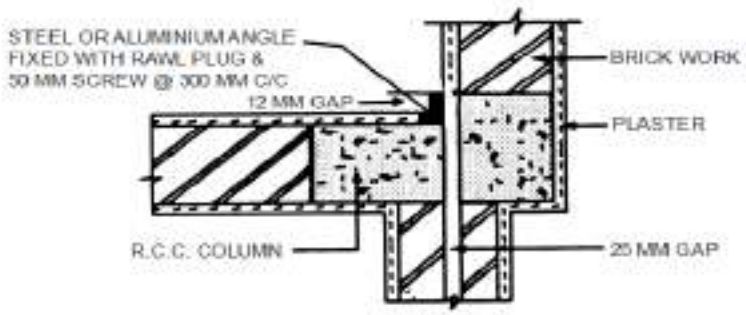


Fig. 5.20 : Typical Details of Expansion Joints at Corner Column

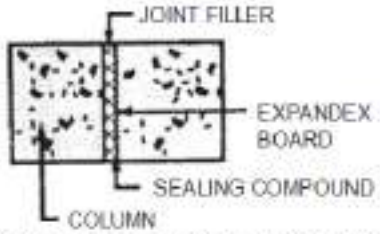


Fig. 5.21 : Typical Details of Expansion Joint at Isolated Twin Columns

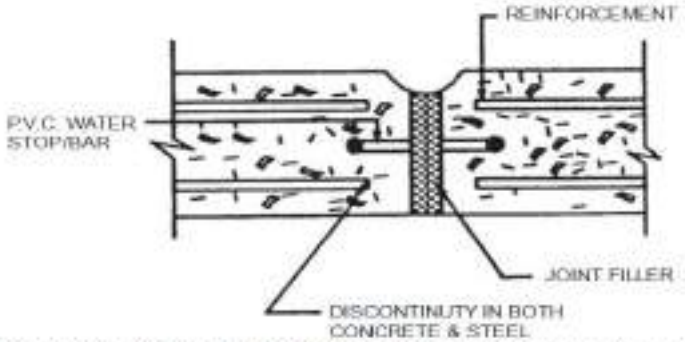
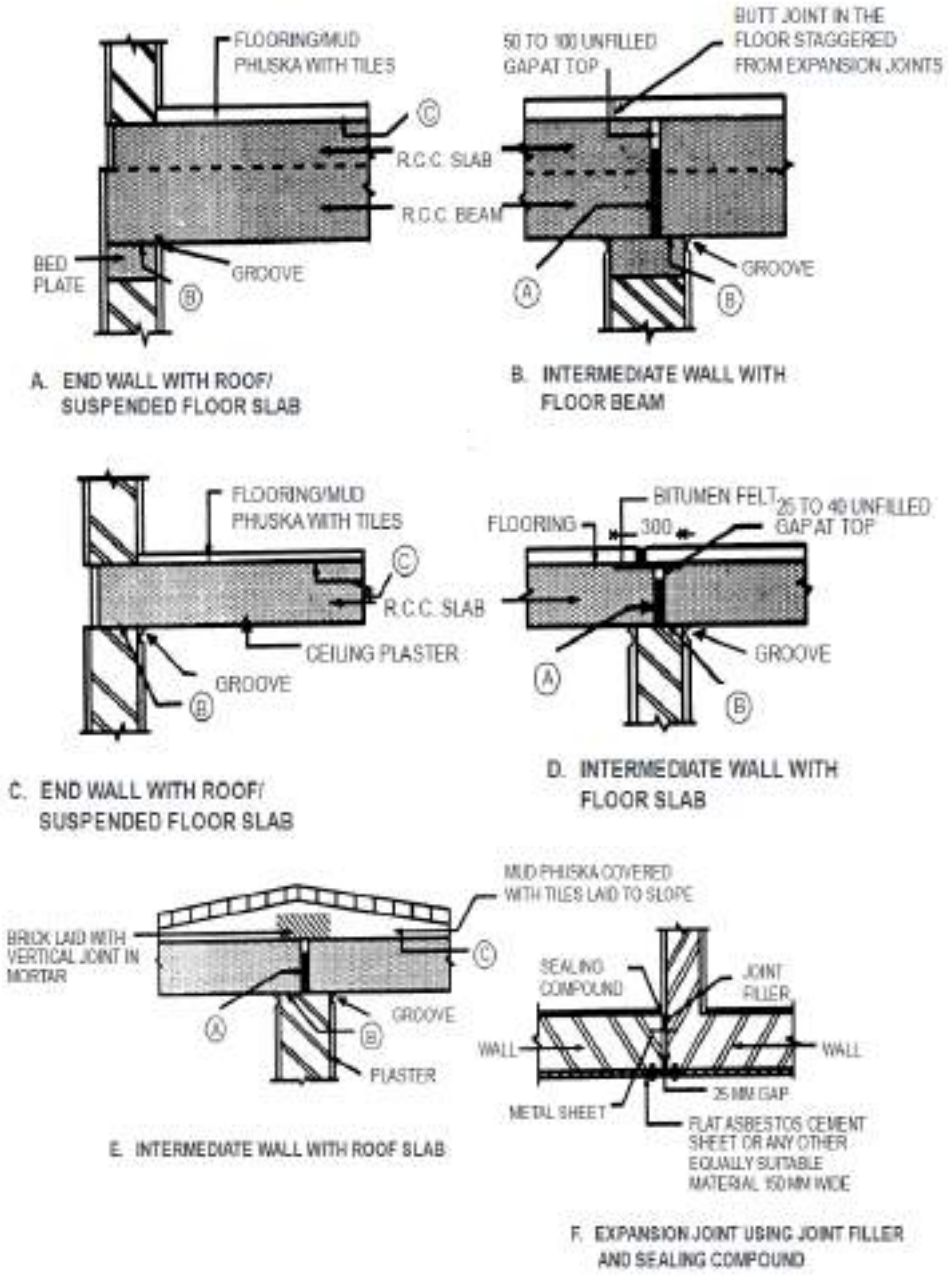


Fig. 5.22 : Expansion Joint Subjected to Water Pressure (For water Tanks)

EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.
Clause : 5.4.5



A 12 MM EXPANSION JOINTS FILLED WITH BITUMEN FILLER OR IMPREGNATED FIBRE BOARD
B 6 MM CEMENT PLASTER 1:3 (1C : 3F. SAND) FINISHED WITH A FLOATING COAT OF NEAT CEMENT AND A THICK LAID WITH KRAFT PAPER BRICK LAID WITH VERTICAL JOINT IN MORTAR FLAT ASBESTOS CEMENT SHEET OR ANY OTHER EQUALLY SUITABLE MATERIAL 150 MM WIDE COAT OF LIME WASH OR LAID WITH KRAFT PAPER
C HOT BITUMEN PAINTING @ 1.7 K.G./SQM. IN CASE OF ROOF SLAB/BEAM
C HOT BITUMEN PAINTING @ 1.7 KG./SQM. BELOW BRICK WALL ONLY ON SUSPENDED FLOOR BEAM/SLAB

Drawing not to scale
All dimensions are in mm

Fig. 5.23 : Expansion Joint (Contd.)

SEISMIC SEPARATION JOINTS

Sub Head : R.C.C.
Clause : 5.4.5

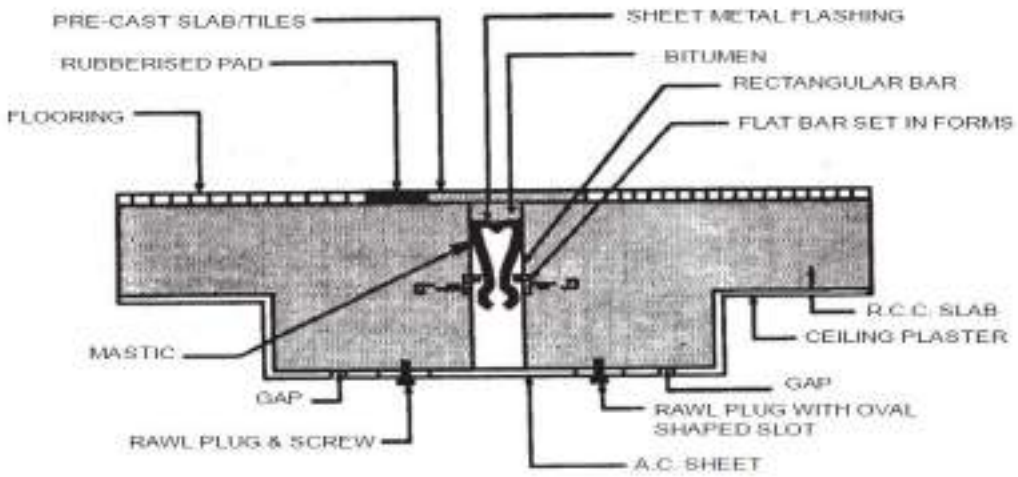


Fig. 5.24: Seismic Separation at Floor Level

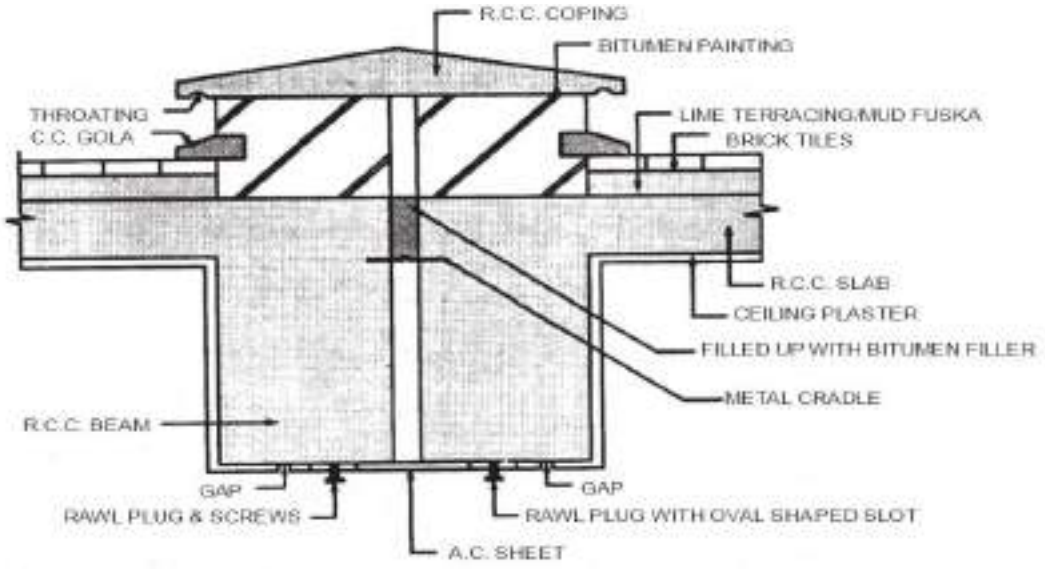
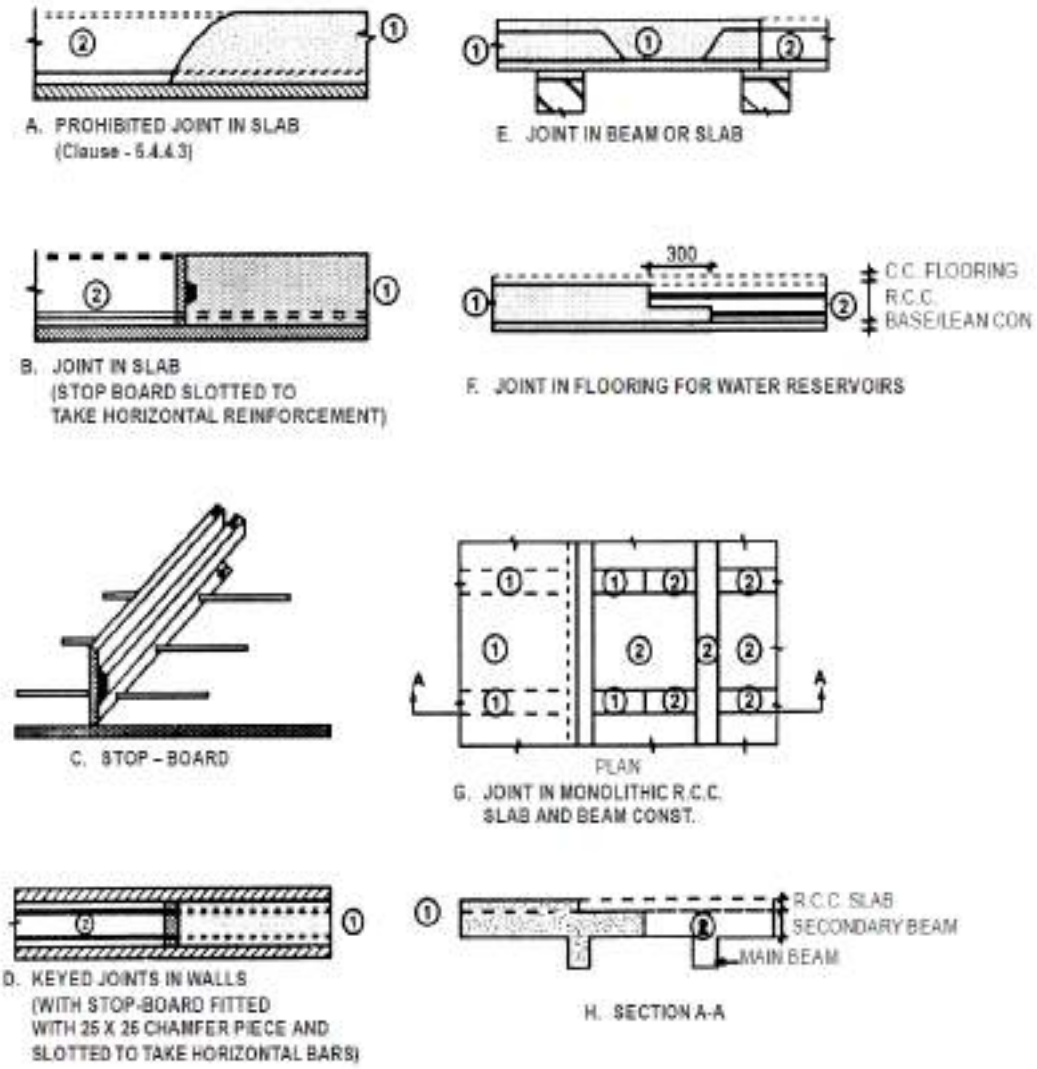


Fig. 5.25 : Seismic Separation Joints Detail at Roof

CONSTRUCTION JOINTS

Sub Head : R.C.C.
Clause : 5.4.4



1. REPRESENTS FIRST PLACING OF CONCRETE
2. REPRESENTS SUBSEQUENT PLACING OF CONCRETE

Drawing not to scale
All dimensions are in mm

Fig. 5.26 : Construction Joints

ENCASING ROLLED STEEL SECTION

Sub Head : R.C.C.
Clause : 5.5.2

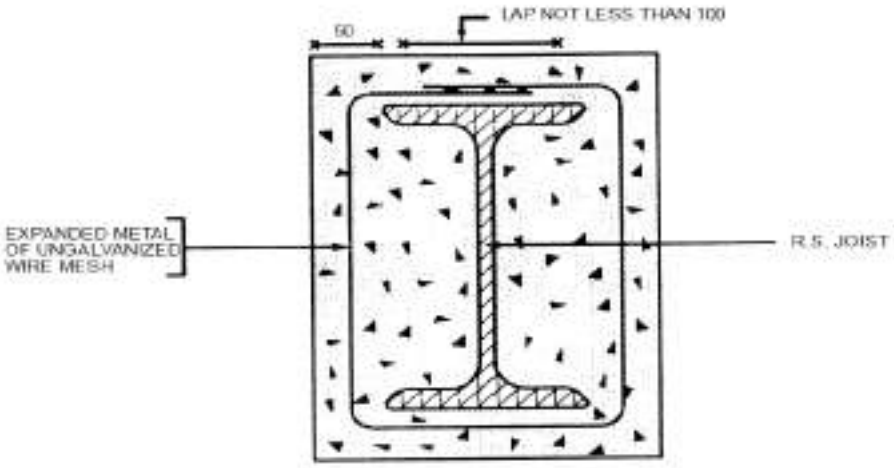


Fig. 5.27 : Steel Column

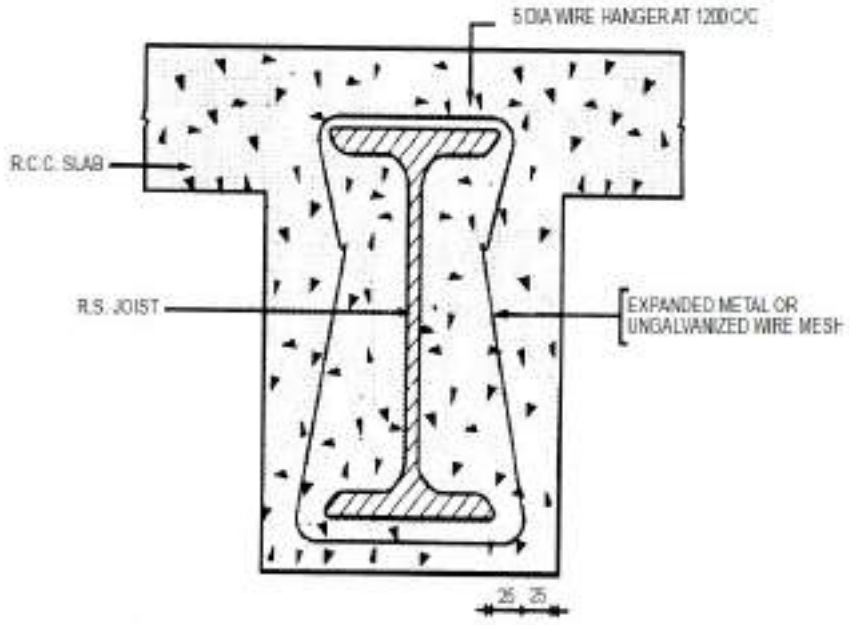


Fig. 5.28 : Steel Beam with slab

Normally Cement Concrete 1 : 2 : 4 (1 Cement : 2 Coarse Sand : 4 Graded Stone Aggregate 12.5 Nominal Size) shall be used.

Drawing not to scale
All dimensions are in mm

SUB HEAD : 6.0

MASONRY WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	231
	List of Bureau of Indian Standard Codes	233
6.0	Terminology	234
6.1	Bricks/ Brick Tiles/ Brick Bats/ Mechanized Autoclave Fly Ash Lime Brick	235
6.2	Brick Work	241
6.3	Brick Work in Arches	246
6.4	Half Brick Work	247
6.5	Brick Tile Work	247
6.6	Honey Comb Brick Work	247
6.7	Joining Old Brick Work with New Brick Work	248
6.8	Moulding and Cornices	248
6.9	Brick Work under Water and Foul Conditions	249
6.10	Exposed Brick Work	249
6.11	Cavity Wall	250
6.12	Gypsum Partition Panels	251
6.13	Brick Edging	251
6.14	Autoclaved Aerated Concrete Block masonry work	252
Appendix A	Test for Dimensional Tolerance	258
Appendix B	Test for Compressive Strength	259
Appendix C	Test for Water Absorption	260
Appendix D	Test for Efflorescence	261

Fig. 6.1	Brick Work	262
Fig. 6.2	Brick Pillars	263
Fig. 6.3 & 6.4	Brick Bonds	264 – 265
Fig. 6.5	Brick Work in Arches.	266
Fig. 6.6	Brick Work in Cavity Walls	267 – 268

LIST OF MANDATORY TESTS

Sl. No.	*Material*	*Clause*	*Test*	*Field/ laboratory Test*	*Test Procedure*	*Minimum Qty. of material for carrying out test*
(i)	Bricks/ Brick Tiles	6.1.3, 6.1.4, 6.1.5	Testing of Bricks/Brick Tiles for dimensions, Compressive strength, Water absorption and efflorescence	Laboratory	Appendix A, B, C & D of Chapter 6	As per Table 6.3 and 6.4
(ii)	Sewer Bricks	6.1.4	Dimensions, Compressive strength, Water absorption and Efflorescence	Laboratory	Appendix A, B, C & D of Chapter 6	As per Table 6.3 and 6.4
(iii)	Burnt clay perforated building bricks	6.1.5	--do--	-- do --	-- do--	-- do--

LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	IS. No.	Subject
1.	IS 269	Specification for Ordinary Portland cement (33 Grade)
2.	IS 383	Specification for coarse and fine aggregate
3.	IS 456	Plain and reinforced concrete - Code of practice
4.	IS 712	Specification for building limes.
5.	IS 1077	Common burnt clay building bricks.
6.	IS 1200 (Part 3)	Method of measurements of brick works
7.	IS 2212	Code of practice for brick work. (1st Revision)
8.	IS 2222	Specification for burnt clay perforated building bricks.
9.	IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
10.	IS 2849	Specification for non load bearing gypsum partition blocks, (Solid and hollow types)
11.	IS 3346:1980	Method of the determination of thermal conductivity of thermal insulation materials
12.	IS 3495	Method of test for burnt clay building bricks.
13.	IS 3812	Specification for fly ash for use as pozzolana and admixture.
14.	IS 4082:1977	Stacking & storage of construction materials and components at site – Recommendations
15.	IS 4139	Specification of calcium silicate bricks
16.	IS 4885	Specification for sewer brick
17.	IS 5454	Methods of sampling of clay building bricks.
18.	IS 6441 (Part-1): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of unit weight or bulk density and moisture content
19.	IS 6441 (Part-2): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of dry shrinkage
20.	IS 6441 (Part-5): 1972	Methods for test for Autoclaved Cellular concrete Products: Determination of compressive strength
21.	IS 9103	Specification for concrete admixtures
22.	IS 12894	Pulverized fuel ash lime bricks specification,
23.	IS 13757	Specification of burnt clay fly ash bricks.

6.0 MASONRY WORK

6.0. TERMINOLOGY

Bond

The arrangement of the bricks in successive courses to tie the brick work together both longitudinally and transversely. The arrangement is usually designed to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is greatest possible amount of lap.

Bed Joint

Horizontal joint in brick work or masonry.

Closer

Any portion of a brick used in constructing a wall, to close up the bond next to the end brick of a course (See Fig. 6.3).

Coping or Weathering

The cover applied over or the geometrical form given to a part of structure to enable it to shed rain water.

Corbel

A cantilever projecting from the face of a wall to form a bearing (see Fig. 6.1D)

Cornice

Horizontal or ornamental feature projecting from the face of a wall (see Fig. 6.1D)

Course

A layer of bricks including bed mortar.

Cross joint

A joint other than a bed joint normal to the wall face.

Efflorescence

A powdery incrustment of salts left by evaporation. This may be visible on the surface or may be below surface. In the latter case, this is termed as crypto Efflorescence.

Header

A brick laid with its length across the wall.

Indenting

The leaving recesses into which future work can be bonded.

Jamb

The part of the wall at the side of an opening.

Joint

A junction of bricks.

Jointing

The operation of finishing joints as the masonry work proceeds.

Pier

A thickened section forming integral part of the wall placed at intervals along the wall primarily to increase the stiffness of the wall or to carry a vertical concentrated load. The thickness of a pier is the over all thickness including the thickness of the wall, or when bonded into one leaf of a cavity wall the thickness obtained by treating this leaf as an independent wall (see Fig. (6.1A, 6.1B)).

Pillar

Pillar means a detached masonry support. This can be rectangular, circular, elliptical etc. In case of rectangular pillar, the breadth shall not exceed three times the thickness and thickness itself shall not exceed more than thrice the length of brick (See Fig. 6.1C).

Quoin

An external corner in brick work, the term may also denote the brick used to form the quoin.

Scaffolding

A temporary erection of timber or steel work used in the construction, alteration, demolition or repairs of a building to support or to attend of the hoisting or lowering of workmen, their tools and materials. Scaffoldings are of two types, namely single and double scaffoldings. Single scaffolding consists of a row of verticals connected to wall by horizontal supported on and tied to the structure. Double scaffolding consists of two rows of verticals secured or leashed together with horizontal and diagonal bracings forming essentially a structure independent of the building. It may also connect to the structure at convenient points for the sake of better stability.

Sill

A brick work forming the lower boundary of door or window opening (see Fig. 6.1D).

Spandrel

The space between the haunches and the road decking of an arch.

Strecher

A brick laid with its length in the direction of the wall.

String course

A horizontal course projecting from a wall usually introduced at every floor level or windows or below parapet for imparting architectural appearance to the structure and also keeping off the rain water. (see Fig. 6.1D).

Templet

A pattern of sheet metal used as a guide for setting out specific section and shape.

Toothing

Bricks left projecting in alternate courses to bond with future work.

Wall joint

A joint parallel to the wall face.

6.1 BRICKS/BRICK TILES/BRICK BATS/MECHANIZED AUTOCLAVE FLY ASH LIME BRICK

Bricks used in the masonry may be of the following type.

(a) The ***Common Burnt Clay Bricks*** shall conform to IS:1077 and shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warpage and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

(b) 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. The bricks shall be solid and with or without frog on one of its flat side.

Fly Ash: Fly ash shall conform to IS 3812.

Note: This item will be operated only for load bearing structure upto 2 storeys and for non-load bearing walls 23 cms thick for multi-storeyed building's.

Bottom ash used as replacement of sand shall not have more than 12% loss on ignition when tested.

Sand: Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime: Lime shall conform to class 'C' hydrated lime of IS 712.

Additives: Any suitable additive considered not detrimental to the durability of bricks may be used.

(c) Clay Fly Ash Bricks: The 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.

(d) Calcium Silicate Bricks: The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape. Bricks shall be free from visible cracks, warpage, organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely grounded sand siliceous rock and lime. In addition limited quantity of fly ash conforming to IS 3812 may be used in the mix. These bricks are also known as Fly Ash Sand Lime bricks in the construction industry.

(e) Tile Brick: The bricks of 4 cm height shall be moulded without frogs. Where modular tiles are not freely available in the market, the tile bricks of F.P.S. thickness 44 mm (1-3/4") shall be used unless otherwise specified.

(f) Brick Bats: Brick bats shall be obtained from well burnt bricks.

(g) 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.

6.1.1 Dimensions

The brick may be modular or non-modular. Sizes for both types of bricks/tiles shall be as per Table 6.1. While use of modular bricks/tiles is recommended, non-modular (FPS) bricks/tiles can also be used where so specified. Non-modular bricks/tiles of sizes other than the sizes mentioned in Table 6.1 may also be used where specified.

TABLE 6.1

Type of Bricks/ Tiles	*Nominal Size mm*	*Actual Size mm*
Modular Bricks	200 × 100 × 100 mm	190 × 90 × 90 mm
Modular tile bricks	200 × 100 × 40 mm	190 × 90 × 40 mm
Non-modular tile bricks	229 × 114 × 44 mm	225 × 111 × 44 mm
Non-modular bricks	229 × 114 × 70 mm	225 × 111 × 70 mm

6.1.2 Classification

Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength as given below :

TABLE 6.2

Class Designation	*Average compressive strength*			
	Not less than		*Less than*	
	N/mm²	*(kgf/cm²)*	*N/mm²*	*(kgf/cm²)*
12.5 (125)	12.5	*125*	*15.0*	*150*
10 (100)	10	100	12.5	125
7.5 (75)	7.5	75	10	100
5 (50)	5	50	7.5	75
3.5 (35)	3.5	35	5.0	50

The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

(**Note:** Upper limits specified in Table 6.2 are for calculating the average compressive strength in accordance with Appendix B of Chapter 6).

6.1.3 Sampling and Tests

Samples of bricks shall be subjected to the following tests :

(a) Dimensional tolerance.

(b) Water absorption.

(c) Efflorescence.

(d) Compressive strength.

6.1.3.1 ***Sampling:*** For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken at random according to the size of lot as given in Table 6.3 below. The sample thus taken shall be stored in a dry place until tests are made. For the purpose of sampling, the following definition shall apply.

(a) Lot: A collection of bricks of same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling a lot shall contain a maximum, of 50,000 bricks.

In case a consignment has bricks more than 50,000 of the same classification and size and manufactured under relatively similar conditions of production, it shall be divided into lots of 50,000 bricks or part thereof.

(b) Sample: A collection of bricks selected for inspection and/or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.

(c) Defective: A brick failing to meet one or more of the specified requirements.

6.1.3.2 The samples shall be taken as below:

(i) Sampling from a Stack: When it is necessary to take a sample from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of bricks drawn from each section. For this purpose bricks in the upper layers of the stack shall be removed to enable units to be sampled from places within the stack.

Note: For other methods of sampling i.e. sampling in motion and sampling from lorries or trucks, IS :5454 may be referred.

Scale of sampling and criteria for conformity for visual and dimensional characteristics:—

Visual characteristics: The bricks shall be selected and inspected for ascertaining their conformity to the requirements of the relevant specification.

The number of bricks to be selected from a lot shall depend on the size of lot and shall be in accordance of Col. 1 and 2 of Table 6.3 for visual characteristics in all cases and dimensional characteristics if specified for individual bricks.

(ii) ***Visual Characteristics:*** All the bricks selected above in accordance with Col. 1 and 2 of Table 6.3 shall be examined for visual characteristics. If the number of defective bricks found in the sample is less than or equal to the corresponding number as specified in Col. 3 of Table 6.3 the lot shall be considered as satisfying the requirements of visual characteristics, otherwise the lot shall be deemed as not having met the visual requirements.

(iii) ***Dimensional Characteristics:*** The number of bricks to be selected for inspecting the dimensions and tolerance shall be in accordance with Col. 1 and 4 of Table 6.3. These bricks will be divided into groups of 20 bricks at random and each of the group of 20 bricks thus formed will be tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerance if none of the groups of bricks inspected fails to meet the specified requirements.

TABLE 6.3
Scale of Sampling and Permissible Number of Defectives for Visual and Dimensional Characteristics

No. of bricks in the lot	*For characteristics specified for individual bricks*		*For dimensional characteristics for group of 20 bricks*
	No. of bricks to be selected	*Permissible no. of defective in the sample*	*No. of bricks to be selected*
(1)	*(2)*	*(3)*	*(4)*
2001—10000	20	1	40
10001—35000	32	2	60
35001—50000	50	3	80

Note: In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

(iv) ***Scale of Sampling and Criteria for Physical Characteristics:*** The lot which has been found satisfactory in respect of visual and dimensional requirements shall be next tested for physical characteristics like compressive strength, water absorption, efflorescence as specified in relevant material specification. The bricks for this purpose shall be taken at random from those already selected above. The number of bricks to be selected for each of these characteristics shall be in accordance with relevant columns of Table 6.4.

TABLE 6.4
Scale of Sampling for Physical Characteristics

Lot size	*Sample size for compressive strength, water absorption and efflorescence*	*Permissible No. of defectives for efflorescence*	*Warpage Sample Size*	*Permissible No of defects*
(1)	*(2)*	*(3)*	*(4)*	*(5)*
2001—10000	5	0	10	0
10001—35000	10	0	20	1
35001—50000	15	1	30	2

Note: In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Engineer-in-Charge.

(v) A lot shall be considered having satisfied the requirements of physical characteristics if the condition stipulated here in are all satisfied.

(a) From the test results for compressive strength, the average shall be calculated and shall satisfy the requirements specified in relevant material specification.

Note: In case any of the test results for compressive strength exceeds the upper limit for the class of bricks, the same shall be limited to the upper limit of the class for the purpose of averaging.

(b) Wherever specified in the material specification, the compressive strength of any individual bricks tested in the sample shall not fall below the minimum average compressive strength specified for the corresponding class of brick by more than 20 per cent.

(c) From the test results for water absorption, the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements specification in material specification.

(d) The number of bricks failing to satisfy the requirements of the efflorescence specified in the relevant specification should not be more than the permissible no. of defectives given in Col. 3 of Table 6.4.

6.1.3.3 ***Dimensional Tolerances:*** The dimensions of, modular bricks when tested as described above as per procedure described in Appendix A of Chapter 6 shall be within the following limits per 20 bricks or locally available size as approved by Engineer-in-charge.

(a) For modular size
Length 7320 to 3880 mm (3800 ± 80 mm)

Width 1760 to 1840 mm (1800 ± 40 mm)

Height 1760 to 1840 mm (1800 ± 40 mm) for 90 mm high bricks

760 to 840 mm (800 ± 40 mm) for 40 mm high bricks

(b) For non modular bricks
Length 4520 to 4680 mm (4600 ± 80 mm)

Width 2240 to 2160 mm (2200 ± 40 cm)

Height 1440 to 1360 mm (1400 ± 40 mm) for 70 mm high bricks

640 to 560 mm (600 ± 40 mm) for 30 mm high bricks

Brick Tiles

760 to 840 mm (800 ± 40 mm) for 40 mm high brick tiles

In case of non-modular bricks, % age tolerance will be ± 2% for group of 20 numbers of class 10 bricks, and ± 4% for other class of bricks.

6.1.3.4 ***Compressive Strength:*** The bricks, when tested in accordance with the procedure laid down in Appendix B of Chapter 6 shall have a minimum average compressive strength for various classes as given in Table 6.2. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified in Table 6.2 for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table 6.2 for the purpose of calculating the average compressive strength.

6.1.3.5 ***Water Absorption:*** The average water absorption of bricks when tested in accordance with the procedure laid down in Appendix C of Chapter 6 shall be not more than 20% by weight.

6.1.3.6 ***Efflorescence:*** The rating of efflorescence of bricks when tested in accordance with the procedure laid down in Appendix D of Chapter 6 shall be not more than moderate.

6.1.4 Sewer Bricks

6.1.4.1 Sewer bricks are intended for the lining of walls, roofs and floors of sewers used for ordinary sanitary (domestic) sewage. The general practice in the country is also to utilize common building bricks in the construction of sewers which is not satisfactory. However, these sewer bricks may not be suitable for sewers dealing with industrial effluent (sewage) for which the use of acid resistant bricks in accordance with IS 4860 may be considered. Sewer bricks shall conform to IS 4885.

6.1.4.2 ***Dimensions and Tolerances***

Dimensions: The standard sizes of the sewer bricks shall be as follows:

Length mm	*Width mm*	*Height mm*
190	90	90
190	90	40

For sewers of special shapes, such as the oval sewers, the bricks may have to be suitable tapered to conform to the radii of curvature of the arches and barrels and sides of sewers.

Tolerance: The permissible tolerance on the dimensions specified in 6.1.4.2 shall be as follows :

Dimensions mm	*Total tolerance for 20 bricks mm*
190	±80
90	±40
40	±40

6.1.4.3 ***Compressive Strength:*** The average compressive strength obtained on a sample of sewer bricks when tested in accordance with the procedure laid down in IS 3495 (Part I) shall be not less than 17. 5 N/mm^2 (175 kgf/cm^2 approximately) and the individual strength of any brick shall be not less than 16 N/mm^2 (160 kgf/cm^2 approximately).

6.1.4.4 ***Water Absorption:*** The average value of water absorption for five bricks after 24 h cold water immersion test when tested in accordance with IS 3495 (Part 2) shall not exceed 10 per cent of the average dry weight of the brick and the absorption for any individual brick shall not exceed 12 per cent.

6.1.4.5 ***Efflorescence:*** When the bricks are tested in accordance with the method laid down in IS 3495 (Part 3), the rating of efflorescence shall not be more than 'slight'.

6.1.5 Burnt Clay Perforated Building Bricks

6.1.5.1 ***General Quality:*** The bricks shall be made of suitable clay and shall be thoroughly burnt at the maturing temperature of clay. They shall be free from cracks, flaws and nodules of free lime. They shall have rectangular face with sharp straight edge at right angle. They shall be of uniform colour and texture. These bricks generally should conform to IS 2222.

6.1.5.2 ***Dimensions and Tolerances:*** The standard size of burnt clay perforated bricks shall be as follows:

Type of Brick	*Length (L) mm*	*Width (W) mm*	*Height (H) mm*
Modular	190	90	90
Non Modular	230	110	70

The permissible tolerances on the dimensions shall be as follows:

Dimension mm	*Tolerance mm*
70, 90	±4
110, 190	± 7
230	± 10

Note: The tolerances specified above shall apply to measurements on individual bricks.

6.1.5.3 ***Perforations:*** The area of perforation shall be between 30% and 45% of the total area of the corresponding face of the bricks.

The perforation shall be uniformly distributed over the surface. In the case of rectangular perforations, the larger dimension shall be parallel to the longer side of the brick. The shorter side of the perforation shall be less than 20 mm incase of rectangular perforations and less than 25 mm diameter in case of circular perforations.

The area of each perforation shall not exceed 500 mm^2.

The thickness of any shell shall not be less then 15 mm and that of any web not less than 10 mm.

6.1.5.4 ***Compressive Strength:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a minimum average compressive strength of 7 N/ mm^2 on net area.

The compressive strength of any individual brick tested shall not fall below the minimum compressive strength specified for the corresponding class of bricks. The lot shall then be checked for next lower class of brick.

6.1.5.5 ***Water Absorption:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4): after immersion in cold water for 24 hours water absorption shall not be more than 20 percent by weight.

6.1.5.6 ***Efflorescence:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a rating of efflorescence not more than 'slight'.

6.1.5.7 ***Warpage:*** The bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4) the average warpage shall not exceed 3%.

6.2 BRICK WORK

6.2.1 Classification

The brick work shall be classified according to the class designation of bricks used.

6.2.2 Mortar

The mortar for the brick work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

6.2.3 Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin -dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I: The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II : If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

6.2.4 Laying

6. 2.4.1 Bricks shall be laid in English Bond (Fig. 6.2, 6.3, 6.4) unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note: Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

6.2.4.2 All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints.

6.2.4.3 The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be pro-perly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

(a) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

(b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(c) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

(d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

(e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

6.2.4.4 All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

6.2.4.5 The brick work shall be built in uniform layers.

No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

6.2.4.6 All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

6.2.4.7 Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be

properly radiated and keyed into position to form cut (maru) corners as shown in Fig 6.4. Where bricks cannot be cut to the required shape to form cut (maru) corners, cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

6.2.4.8 Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

6.2.4.9 In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

6.2.4.10 To facilitate taking service lines later without excessive cutting of completed work, sleeves (to be paid separately) shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

6.2.4.11 Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating (to be paid separately) shall be provided where indicated.

6.2.4.12 Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpoulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

6.2.4.13 Vertical reinforcement in the form of bars (MS or high strength deformed bars or thermo-mechanically treated bars as per direction of Engineer-in- Charge)), considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 (1 cement : 4 coarse sand), or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The dia. of bars shall not be less than 8 mm and concrete grade shall be minimum 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

6.2.4.14 In retaining walls and the like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

Note : Work of providing loose stone will be payable extra.

6.2.4.15 Work of cutting chases, wherever required to be made in the walls for housing G.I. pipe, CI pipe or any other fixtures shall be carried out in various locations as per guidelines given below :

(a) Cutting of chases in one brick thick and above load bearing walls.

(i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

(ii) The depths of vertical chases and horizontal chases shall not exceed one-third and one-sixth of the thickness of the masonry respectively.

(iii) When narrow stretches of masonry (or short length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength bricks in mortar or concrete walls provided, if required.

(iv) Horizontal chases when unavoidable should be located in the upper or lower one-third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

(v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

(vi) Masonry directly above a recess, if wider than 30 cm horizontal dimension) should be supported on lintel. Holes in masonry may be provided upto 30 cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes upto 40 cm in diameter.

(b) Cutting of chases in half brick load bearing walls.
No chase shall be permitted in half brick load bearing walls and as such no reccessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.

(c) Cutting of chases in half brick non-load bearing wall :
Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

6.2.5 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measure as follows:

(i) In case of modular bricks conforming to IS 1077 specification for common burnt clay buildings bricks, equal to 39 cm.

(ii) In case of non-modular bricks, it shall be equal to 31 cm.

Note : Specified thickness of joints shall be of 1 cm. Deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.

6.2.5.1 ***Finishing of Joints:*** The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

6.2.6 Curing

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

6.2.7 Scaffolding

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

6.2.7.1 ***Single Scaffolding:*** Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one metre in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.

6.2.7.2 ***Double Scaffolding:*** Where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

6.2.8 Measurements

6.2.8.1 Brick work shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm.

Areas shall be calculated to the nearest 0.01 sq mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

6.2.8.2 Brick work shall be measured separately in the following stages:

(a) From foundation to floor one level (Plinth level)
(b) Plinth (floor one) level to floor two level
(c) Between two specified floor levels above floor two level

Note : (i) Brick work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

6.2.8.3 No deductions or additions shall be done and no extra payment made for the following :

Note : Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

(a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 m^2 in section;
(b) Opening up to 0.1 m^2 in area (see Note);
(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;
(d) Cement concrete blocks as for hold fasts and holding down bolts;
(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows; and
(f) Chases of section not exceeding 50 cm in girth.
(g) Bearing portion of drip course, bearing of moulding and cornice.

Note : In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

6.2.8.4 Walls half brick thick and less shall each be measured separately in square metres stating thickness.

6.2.8.5 Walls beyond half brick thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of mortar joints. For the sizes of bricks specified in 6.1.1, half brick thickness shall mean 100 mm for modular and 115 mm for non-modular bricks.

Where fractions of half brick occur due to architectural or other reasons, measurement shall be as follows :

(a) upto 1/4th brick-actual measurements and
(b) exceeding 1/4 brick-full half bricks.

6.2.8.6 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

6.2.8.7 Square or rectangular pillars shall be measured separately in cubic metres in multiple of half brick.

6.2.8.8 Circular pillars shall be measured separately in cubic metres as per actual dimensions.

6.2.8.9 Brick work curved on plan shall be measured like the brick work in straight walls and shall include all cutting and wastage of bricks, tapered vertical joints and use of extra mortar, if any. Brick work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for brick work in straight walls. Nothing extra shall be payable if the mean radius of the brick work curved in plan exceeds six metres.

6.2.8.10 Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for brick work in walls.

6.2.8.11 Brick work with brick tiles shall be measured and paid for separately.

6.2.9 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following :

(a) Raking out joints or finishing joints flush as the work proceeds;
(b) Preparing tops of existing walls and the like for raising further new brick work.
(c) Rough cutting and waste for forming gables, splays at eaves and the like.
(d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.
(e) Rough cutting and waste for brick work curved in plan and for backing to stone or other types of facing.
(f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
(g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items and
(h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section.
(i) Brick on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.

6.3 BRICK WORK IN ARCHES (FIG. 6.5)

6.3.0 The detailed specifications for brick work mentioned in 6.2 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussiors. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted.

The bricks of the spandrel wall at their junctions with the extrudes of the arch shall be cut to fit the curvature of the arch.

6.3.1 Circular Arches

These shall be either (a) plain arches, and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels upto the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussoirs shall break joints to the full depth of the arch.

6.3.2 Flat Arches

These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 60° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussoirs breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

6.3.3 Centring and Shuttering

The centring and shuttering for the arch shall be got approved by the Engineer-in- Charge before the arch work is started. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be got approved from the Engineer- in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch loaded.

6.3.4 Measurements

The length of the arch shall be measured as the mean of the extrados and intrados of the arch correct to a cm. The thickness of the arch shall be measured in multiples of the half brick.

The breadth in the direction of the thickness of wall shall be measured as specified.

The cubical contents shall be calculated in cubic metre, correct to two places of decimal.

For arches exceeding 6 m in spans extra payment shall be made on the actual area of the soffit for additional cost of centring including all strutting, bolting, wedging, easing, striking and its removal.

6.3.5 Rate

The rate is inclusive of the cost of the materials and labour required for all the operations described above.

6.4 HALF BRICK WORK

Brick work in half brick walls shall be done in the same manner as described above in 6.2.4 except that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 6 mm dia., shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 (1 cement: 4 coarse sand). Lime mortar shall not be used. Over laps in reinforcement, if any shall not be less than 30 cm.

The mortar interposed between the reinforcement bars and the brick shall not be less than 5 mm.

The mortar covering in the direction of joints shall not be less than 15 mm.

6.4.1 Measurements

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m. where half brick wall is joined to the main walls of one brick or greater thickness and measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

6.4.2 Rate

The rate includes the cost of the materials and labour involved in all the operations described above except reinforcement which is to be paid for separately.

6.5 BRICK TILE WORK

6.5.0 The work shall be done in the same manner as described in 6.2.4 except that brick tile shall be used instead of bricks. The measurement and rate shall be same as specified under 6.2.

6.6 HONEY COMB BRICK WORK

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

6.6.1 Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square metres correct to two places of decimal. Honeycomb openings shall not be deducted.

6.6.2 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

6.7 JOINING OLD BRICK WORK WITH NEW BRICK WORK

6.7.1 In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses. In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

6.7.2 For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement.

6.7.3 Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

6.7.4 Measurement

The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 sqm.

6.7.5 Rate

The rate includes the cost of labour and material involved in all the operations described above.

6.8 MOULDING AND CORNICES

6.8.0 The specifications described under 6.2 shall apply in so far these are applicable. Mouldings and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

6.8.1 Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately.

6.8.2 Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the mouldings shall be finished straight and true with the help of metal templates.

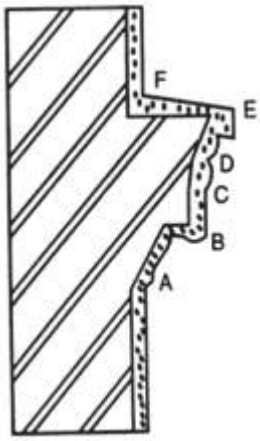
6.8.3 Curing and Protection

The mouldings and cornices shall be cured for at least seven days. These shall be protected from the effects of sun and rain by suitable covering and also from damage during the execution of the work.

6.8.4 Measurements

For the purpose of measurements, the sectional periphery of mouldings and cornices (excluding the portion in contact with wall) shall be measured in centimetres and length in metres (fig. below) .

The girth and length shall be measured correct to a cm. No deduction shall be made from the masonry of wall for the bearing of the moulding and cornices.



Note : 1 The sectional periphery curve ABCDEF.
2. Length FA shall not be measured.

6.8.5 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

6.9 BRICK WORK UNDER WATER OR FOUL CONDITIONS

Brick Work under following conditions :

(i) Work in or under water/or liquid mud;

(ii) Work in or under foul positions

Shall be measured separately for payment of extra rate over and above the quantity measured and paid under para 6.2.8.

6.10 EXPOSED BRICK WORK

6.10.1 Facing Bricks

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

6.10.2 Dimensions and Tolerances

The standard sizes of machine moulded facing bricks shall be as specified in 6.1.1.

6.10.2.1 The permissible tolerances shall be as under:

Dimension mm		*Tolerance (For Machine moulded bricks) mm*
Length	190 or 225	±3
Width	90 or 111	±1.5
Thickness	40 or 44	±1.5

Note: Tolerance and Dimensions for selected hand moulded bricks ± 4 mm in length and ± 3 mm in width and thickness).

6.10.3 Sampling

As per Para 6.1.3 and 6.1.3.2.

6.10.4 Physical Requirements

Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive strength shall not be less than 7.5 N/mm^2, water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down and tolerance in dimensions shall be checked as per the procedure laid down in Appendix A-2.

Mortar, Soaking of Bricks and laying shall be as specified in Para 6.2.2, 6.2.3 and 6.2.4 respectively.

6.10.5 Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per 6.2.5.

6.10.6 Curing and scaffolding shall be as specified in 6.2.6 and 6.2.7 to 6.2.7.2 respectively.

6.10.7 Measurements

Exposed brick work in face using machine moulded bricks and selected hand moulded bricks shall be measured separately and the measurement shall be as specified in 6.2.8.

6.10.8 Rate

The rates shall be as specified in 6.2.9 and shall also include the following :

(a) Labour for selecting bricks and wastage of bricks where use of selected hand moulded brick is specified.

(b) Leaving uniform horizontal and vertical grooves of specified depth and providing joints of required thickness using wooden or steel strips as the work proceeds.

6.11 CAVITY WALL

It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

6.11.1 Metal Ties

These may be of galvanised iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side (For details refer Fig. 6.6 of Chapter 6).

6.11.2 Bonding Units

These shall be preferably precast R.C.C. units having cross-section as per Fig. No. 6.6.

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be 2 × 115 + width of cavity as shown in Fig. 6 of Chapter 6. Precast RCC units shall be provided with 2 no., 6 mm mild steel reinforcement bars tied with 2 no. 3 mm. dia. M.S. wire/hard drawn wire cross bars (As shown in Fig. 6 of Chapter 6) placed in the centre of units.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

6.11.3 Spacing

Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

6.11.4 Restrictions

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

6.11.5 Measurements and Rate

(a) Brick work in cavity walls shall be included and measured with general brick work. The width of the cavity shall not be measured. Skin of cavity wall, half brick thickness shall be measured as and paid as described in para 6.2.8 and 6.4.

(b) The forming of the cavity shall be given in square metres stating the width of the cavity and shall include the metal ties/bonding unit specifying the numbers per square metre.

(c) Labour and material for closing cavities at the jambs, sills and heads of opening shall be as described and measured separately in running metres.

(d) The item shall include use of device for keeping cavity clear and forming the requisite weep and vent holes and nothing extra on this account shall be payable.

6.12 GYPSUM PARTITION PANELS

6.12.1 The material shall conform to IS:2849.

6.12.2 Dimensions

As per the item nomenclature.

6.12.3 Laying

(i) Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.

(ii) The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.

(iii) The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made for conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.

(iv) The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conduiting etc.

(v) The recommended span of walls is maximum 6 meters and maximum height is 4.5 meters.

(vi) Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.

(vii) ***Sanding:*** This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.

(viii) ***Primer Application:*** The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinable primers shall be used only.

6.12.4 Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two place of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

6.12.5 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

6.13 BRICK EDGING

6.13.1 The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 6.1. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in chapter 3.0.

6.13.2 Measurements

The brick edging shall be measured in running metere correct a cm.

6.13.3 Rate

Rate shall include the cost of materials and labour involved in all operations.

6.14 AUTOCLAVED AERATED CONCRETE BLOCK MASONRY WORK

6.14.1 Terminology

For the purpose of, Autoclave Aerated Concrete Block masonry work, the following definitions shall apply

1. **Autoclaved** -Steam curing of concrete Products, sand lime bricks, asbestos cement products, hydrous calcium silicate insulation Products, or cement in an autoclave at maximum ambient temperatures generally between 170^0C to 215^0C.
2. **Block -** A concrete masonry unit, any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS : 3952-1978 and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and Panels, the height of the block shall not exceed either its length or six times its width.
3. **Block Density** - The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses..
4. **Drying Shrinkage** - The difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.
5. **Gross Area**-The total area occupied by a block on its loading face, including areas of the cavities and end recesses.
6. **Height** -The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying
7. **Length** - The horizontal dimension of the exposed face of a block excluding any tongue or other device designed to provide mechanical keying.
8. **Width -**The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

6.14.2 Dimensions & Tolerances:

Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different concrete needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, partition block and concrete floor units.

Autoclave Aerated Concrete Block shall be referred to by its normal dimension the term ‘normal’ means that the dimension includes the thickness of the mortar joints. The actual dimension shall be 10mm short of the normal dimension (or 6mm short in special areas finer joints as specified).

6.14.2.1 The normal dimension of the concrete block shall be as follows:-

Length	:	400, 500 or 600 mm
Height	:	200, 250 or 300 mm
Width	:	100, 150, 200 or 250 mm

In addition, Autoclave Aerated Concrete Block shall be manufactured in half length of 200, 250 or 300 mm correspond to the full lengths.

6.14.2.2 The nominal dimensions of the units are so designed that taking account of the thickness of mortar joints, they will produce wall length sand heights which will conform to the principles of modular co-ordination.

6.14.2.3 Block of sizes other than those specified above, may also be used if so specified in the case of special Autoclave Aerated Concrete Block such as jallie or screen wall and ornamental block ,the specified size may not necessarily apply.

6.14.2.4 The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.

6.14.2.5 The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks.

6.14.2.6 The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so specified.

6.14.3 The autoclaved Autoclave Aerated Concrete Block shall be classified in two grades according to their compressive strength as indicated in table:

S. No.	Density in oven dry condition (Kg/m^2)	Compressive Strength (Min)		Thermal Condition in Air dry condition (W/m.k)
		Grade-I (N/mm^2)	Grade-II (N/mm^2)	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.30
4	751 to 850	6.00	5.00	0.37
5	851 to 1000	7.00	6.00	0.42

6.14.4 Materials

6.14.4.1 Cement complying with any of the Indian Standard may be used as per the direction of the manufacturer.

6.14.4.2 Use of Fly ash conforming to IS 3812-1981 may be permitted to a limit of 20% in cement conforming to IS 269-1976.

6.14.4.3 The lime shall satisfy the requirement for class C lime specified as IS 712-1973.

6.14.4.4 The aggregate used for the manufacture of Autoclave Aerated Concrete Block shall conform to the following requirements

(a) Sand-Conforming to IS 383-1970 except for the grading which may be made to suit the product and silica content shall not be less than 80%.

(b) Fly ash – Conforming to IS 3812-1981 with loss on ignition not more than 6%.

6.14.4.5 The water used in the manufacture of Autoclave Aerated Concrete Block shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the block and shall meet the requirements of IS 456-2000.

6.14.4.6 Additives and Admixtures may be added either as additives to the cement during manufacturing or as additive or admixtures to the concrete mix. Additive or admixtures used in the manufacture of concrete block may be

(a) Accelerating , water reducing and air –entraining admixtures conforming to IS 9103-1979

(b) Water proofing agent conforming to IS 2645-1975

(c) Colouring pigments

6.14.5 Physical requirements

6.14.5.1 All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units, impair the strength or performance of the construction.

6.14.5.2 Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.

6.14.5.3 Dimensions- The overall dimension of the block units when measured shall be in accordance with para 6.14.2.1 subjected to the tolerances mentioned in para 6.14.2.4

6.14.5.4 Block Density - The Block density shall conform to the requirements specified in table of para 6.14.3, when tested accordance with para 6.14.6 (1)

6.14.5.5 Compressive Strength - The min. compressive strength being the average of twelve block units shall be as prescribed in table of para 6.14.3, when tested accordance with para 6.14.6(2)

6.14.5.6 Thermal Conductivity - The thermal conductivity shall be not exceed the values specified in table of para 6.14.3 when tested accordance with para 6.14.6(3)

6.14.5.7 Drying Shrinkage – the drying shrinkage shall be not more than 0 .05% for grade –1 block and 0.10% for grade-2 block when tested accordance with para 6.14.6(4)

6.14.6 Tests

1. Block Density- The block density shall be determined in the manner described in IS 6441 (part-1) -1972

2. Compressive Strength- The compressive strength of block shall be determined in accordance with IS 6441 (part-5) -1972

3. Thermal Conductivity- The thermal conductivity of block shall be determined in accordance with IS 3346 -1980

4. Drying Shrinkages-The drying shrinkage of block shall be determined in the manner described in IS 6441 (part-2) -1972

6.14.7 Sampling

6.14.7.1 **Lot** - In any consignment, all the blocks of the same size and from the same batch of manufacture shall be grouped together into a minimum number of groups of 10000 blocks or less. Each such group shall constitute a lot.

6.14.7.2 From each lot, a sample of 24 blocks shall be selected at random. The required numbers of Blocks shall be taken at regular intervals during the loading of the vehicle or unloading the vehicles depending on whether sample is taken before delivery or after delivery. When this is not practicable,

sample shall be taken from the stack in which case the required number of blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.

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

6.14.8 Number of tests

6.14.8.1 All the 24 Blocks shall be checked for dimensions and inspected for visual defects.

6.14.8.2 Out of the 24 blocks, 12 blocks shall be subjected to the test for compressive strength, 3 blocks to the test for density, 3 blocks to the test for thermal conductivity and 3 blocks to the test for drying shrinkage. The remaining 3 blocks shall be reserved for re-test for drying shrinkage if a need arises.

6.14.8.3 The samples of AAC blocks (each sample consisting of 6 specimen) shall be chosen randomly from the lot procured and tested for various parameters specified in para 6 above. One samples shall be tested for every **100 cum** or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 100 cum. If required, Engineer-in-Charge or his authorized representative shall inspect the factory during production of the material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be payable on this account.

6.14.9– Criteria for conformity

6.14.9.1 The number of blocks with dimensions outside the tolerance limit and or with visual defects, among those inspected, shall not be more than two.

6.14.9.2 For density, the mean value shall be within the range specified in Table of para3

6.14.9.3 For compressive strength, the mean value, say X shall be determined. The test results shall be grouped into groups of 4, individual values of ranges shall be determined, the average range a calculated from these values and shall satisfy the following condition:
$\underline{X}$- 0.6 R> minimum value specified in Table of para3.

6.14.9.4 For thermal conductivity, the mean value shall be equal to or less than the value specified in Table of para3.

6.14.9.5 For drying shrinkage, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.

6.14.10 Manufacturer's Certificate

6.14.10.1 The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.

6.14.11 Independent Tests

6.14.11.1 If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery, at the option of the purchaser or his representative and the tests shall be carried out in accordance with this specification.

6.14.11.2 The manufacturer shall supply free of charge the units required for testing.

6.14.12 Storage

6.14.12.1 General requirements of storage of autoclaved cellular (aerated) concrete blocks shall be as described in IS : 4082-1977*.

6.14.13 Marking

6.14.13.1 Each lot of concrete masonry units manufactured in accordance with this specification shall be suitably marked with information-

(i) The identification of the manufacture

(ii) The grade and block density of the unit

(iii) The month and year of manufacturing

Each block may also be marked with the ISI Certification mark.

6.14.14 The R.C C bend shall be provided on **150mm /230mm/300mm** thick masonry to increase the strength and compatibility . The RCC bend shall be provided at sill level and at lintel level over throughout the wall. This thickness of the bend shall be approved by the Engineer in charge or as specified in drawing. The payment of RCC bend and reinforcement shall be paid separately.

Autoclave Aerated Concrete Block masonry shall be provided with polymer modified adhesive mortar. The polymer modified adhesive mortar shall be provided @ 30 kg per cum or with cement mortar 1:4 (1 cement : 4 coarse sand).

6.14.15. Autoclave Aerated Concrete Block with **100 mm thick** masonry shall be provided with two number 6mm dia reinforcement steel bar at every third course. The payment of reinforcement shall be paid separately.

6.14.16. Autoclaved Aerated Concrete Block confirming the IS Code – 2185 (Part-3) 1984 (Reaffirmed 2005)

6.14.17 Measurements

6.14.17.1 Autoclave Aerated Concrete Block Masonry shall be measured in cubic metres unless otherwise specified.

Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 metre. ie. 1 cm. Areas shall be calculated to the nearest 0.01 sqm and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

Note : (i) Autoclave Aerated Concrete Block work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

6.14.17.2 No deductions or additions shall be done and no extra payment made for the following:

Note: Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

(a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.); up to 0.1 m^2 in section;

(b) Opening up to 0.1 m^2 in area (see Note);

(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

(d) Cement concrete blocks as for hold fasts and holding down bolts;

(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows;

(f) Chases of section not exceeding 50 cm in girth; and

(g) Bearing portion of drip course, bearing of moulding and cornice.

Note: In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

6.14.17.3 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

6.14.17.4 Square or rectangular pillars shall be measured separately in cubic metres

6.14.17.5 Circular pillars shall be measured separately in cubic metres as per actual dimensions.

6.14.17.6 Autoclave Aerated Concrete Block work curved on plan shall be measured like the block work in straight walls and shall include all cutting and wastage of blocks, tapered vertical joints and use of extra mortar, if any. Block work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for block work in straight walls. Nothing extra shall be payable if the mean radius of the block work curved in plan exceeds six metres.

6.14.17.7 Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for block work in walls.

6.14.18 Rate

The rate shall include the cost of materials and labour required for all the operations described. The rate shall also include the following:

(a) Raking out joints or finishing joints flush as the work proceeds;

(b) Preparing tops of existing walls and the like for raising further new block work.

(c) Rough cutting and waste for forming gables, splays at eaves and the like.

(d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.

(e) Rough cutting and waste for block work curved in plan and for backing to stone or other types off acing.

(f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.

(g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items

(h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section; and

(i) Block on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.

TEST FOR DIMENSIONAL TOLERANCE

(Clause 6.1.3.3)

A -1. Sampling

As per para 6.1.3.1 and 6.1.3.2.

A -2. Procedure

All the blisters, loose particles of clay and small projections shall be removed from the surface of bricks. Each specimen of 20 bricks shall then be arranged upon a level surface successively as indicated in Fig. A, B and C of para A-4 below in contact with each other and in straight line. The overall length of the assembled bricks (20 Nos) shall be measured with a steel tape sufficiently long to measure the whole row at one stretch.

A-3. Tolerance

The actual dimensions of bricks when tested as described in A-2 shall be within the following limits per 20 bricks.

Modular Bricks

Length	3720 to 3880 mm (3800 ± 80 mm)
Width	1760 to 1840 mm (1800 ± 40 mm)
Height	1760 to 1840 mm (1800 ± 40 mm) for 90 mm high brick
	760 to 840 mm (800 ± 40 mm) for 40 mm high brick

Non-Modular Bricks

For class 10

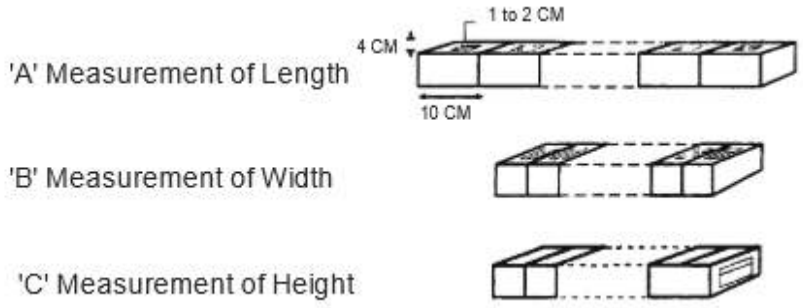
Length	(4520 to 4680) mm (4600 ± 80 mm)
Width	(2240 to 2160) mm (2200 ± 40 mm)
Height	(1440 to 1360) mm (1400 ± 40 mm) for 70 mm high bricks
	(640 to 560) mm (600 ± 40 mm) for 30 mm high bricks

For other classes

Length	(4320 to 4680) mm
Width	(2130 to 2310) mm
Height	(1340 to 1460) mm for 70 mm high bricks
	(840 to 920) mm for 44 mm high bricks

A-4. Criteria for Conformity

A lot shall be considered conforming to the requirements of dimensions and tolerances if all the groups of bricks are tested to meet the specified requirements.



APPENDIX B

TEST FOR COMPRESSIVE STRENGTH

(Clause 6.1.3.4)

B-1. Specimen

Five whole bricks shall be taken from the samples as specimens for this test. Length and width of each specimen shall be measured correct to 1 mm.

B-2. Apparatus

The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which shall coincide with the centre of the plate.

B-3. Procedure

(a) *Pre-conditioning:* The specimen shall be immersed in the water for 24 hours at 25^0C to 29^0C. Any surplus moisture shall be allowed to drain at room temperature. The frog of the bricks should be filled flush with mortar 1:3 (1 cement : 3 clean coarse sand of grade 3 mm and down) and shall be kept under damp jute bags for 24 hours, after that these shall be immersed in clean water for three days.

After removal from water, the bricks shall be wiped out of any traces of moisture.

(b) *Actual Testing:* Specimen shall be placed with flat faces horizontal and mortar filled face upward between three 3 ply plywood sheets each of thickness 3 mm and carefully centred between plates of the testing machine. Plaster of Paris can also be used in place of plywood sheets to ensure a uniform surface.

Load shall be applied carefully axially at uniform rate of 14 N/mm^2 per minute till the failure of the specimen occurs.

B-4. Reporting the Test Results

The compressive strength of each specimen shall be calculated in N/mm^2 as under :

$$\text{Compressive Strength} = \frac{\text{Maximum load at failure (in N)}}{\text{Area of Specimen (in sq mm)}}$$

In case the compressive strength of any individual brick tested exceeds the upper limit of the average compressive strength specified for the corresponding class of brick, the same shall be limited to the upper limit of the class specified in 6.1.2 for the purpose of calculating the average compressive strength. Compressive strength of all the individual bricks comprising the sample shall be averaged and reported.

B-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of average compressive strength if the average compressive strength specified in 6.1.2 for the corresponding class of brick tested is not below the minimum average compressive strength specified for the corresponding class of bricks by more than 20 per cent.

TEST FOR WATER ABSORPTION

(Clause 6.1.3.5)

C-1. No. of Specimen

Five whole bricks shall be taken from samples as specimen for this test.

C-2. Apparatus

A balance required for this test shall be sensitive to weigh 0.1 percent of the weight of the specimen.

C-3. Procedure

(a) *Pre-conditioning:* The specimen shall be allowed to dry in a ventilated oven at a 110°C to 115°C till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours, if the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require four hours for cooling, unless electric fan passes air over them continuously in which case two hours may suffice.

The cooled specimen shall be weigh (W_1) a warm specimen shall not be used for this purpose.

(b) *Actual Testing:* Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of 27°C ± 2°C for 24 hours. Specimen shall be wiped out of the traces of water with a damp cloth after removing from the water and then shall be weighed within three minutes after removing from water (W_2).

C-4. Reporting the Test Results

The water absorption of each specimen shall be calculated as follows and the average of five tests shall be reported.

$$\text{Water Absorption} = \frac{W_2 - W_1}{W_1} \times 100$$

C-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of water absorption if the average water absorption is not more than 20% by weight.

APPENDIX D

TEST FOR EFFLORESCENCE

(Clause 6.1.3.6)

D-1. No. of Specimen

Five whole bricks shall be taken as specimen for this test.

D-2. Apparatus

Apparatus required for this test shall be a shallow flat bottom dish containing distilled water.

D-3. Procedure (actual testing)

The brick shall be placed vertically in the dish with 2.5 cm immersed in the water. The room shall be warm (18ºC to 30ºC) and well ventilated. The bricks should not be removed until it absorbs whole water. When the whole water is absorbed and the brick appears to be dry, place a similar quantity of water in that dish and allow it to evaporate as before. The brick shall be examined after the second evaporation.

D-4. Reporting the Test Results

The rating to efflorescence in ascending order shall be reported as 'NIL', 'SLIGHT', 'MODERATE', 'HEAVY' or 'SERIOUS' in accordance with the following :

(a) *NIL:* When there is no perceptible deposit of efflorescence.

(b) *SLIGHT:* When not more than 10 per cent of the area of the brick is covered with a thin deposit of salts.

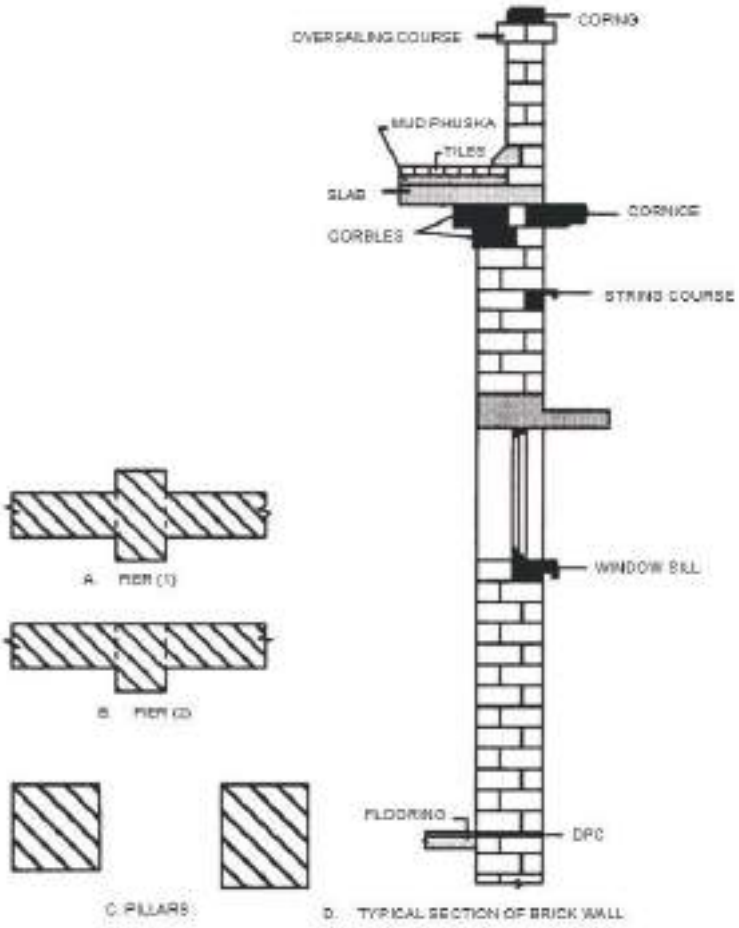
(c) *MODERATE:* When there is heavier deposit and covering upto 50% of the area of the brick surface but unaccompanied by powdering or flaking of the surface.

(d) *HEAVY:* When there is a heavy deposit of salts covering 50% or more of the brick surface but unaccompanied by powdering or flaking of the surface.

(e) *SERIOUS:* When there is heavy deposit of salts, accompanied powdering and/or flaking of the surface and tending to increase in the repeated wetting of the specimen.

D-5. Criteria for Conformity

A lot be considered having satisfied the requirements of efflorescence if for 4 out of the specimen of 5 bricks, the rating of efflorescence is not beyond "Moderate".



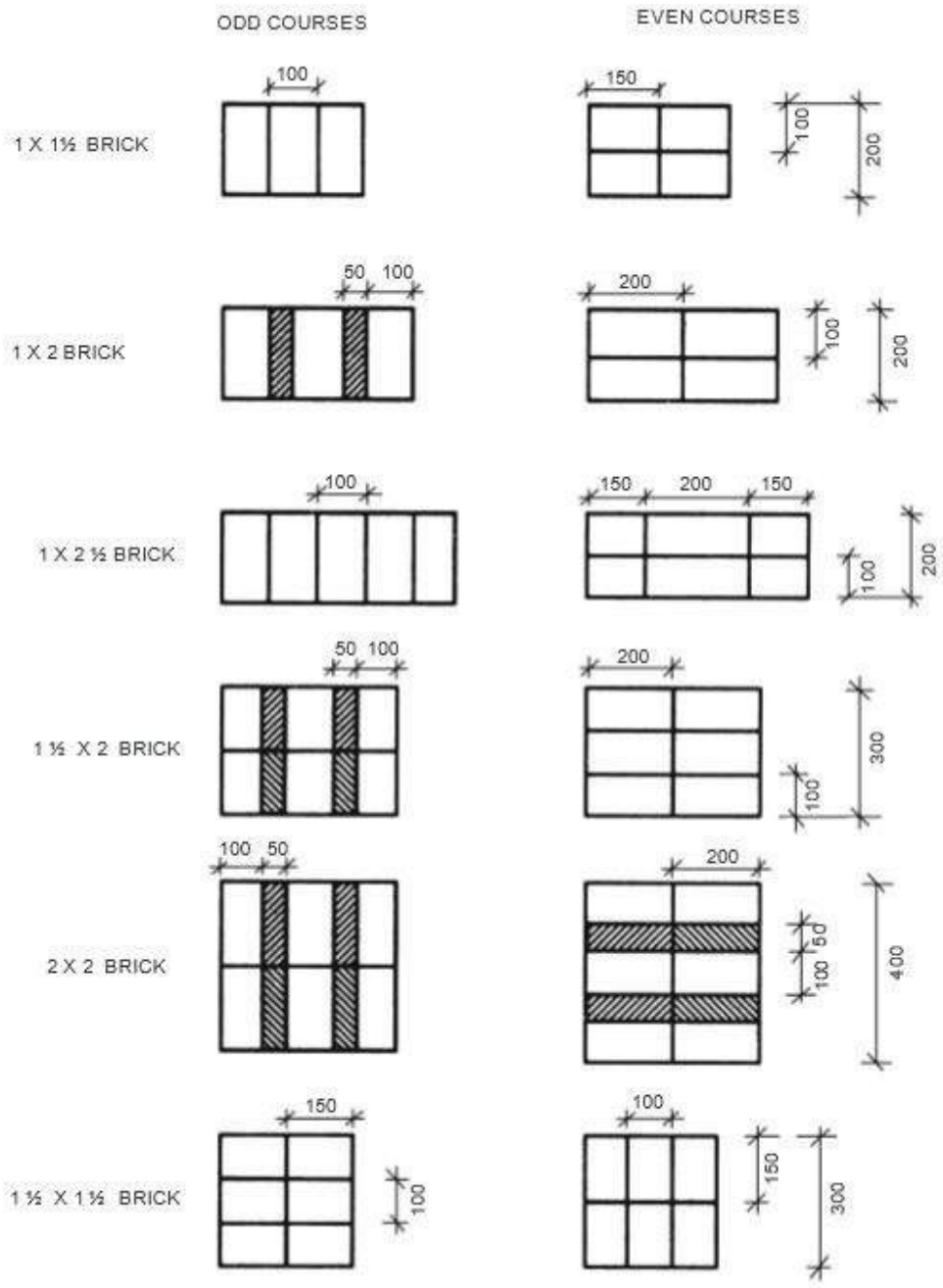
THE BREADTH SHALL NOT EXCEED THREE TIMES THE THICKNESS AND THICKNESS ITSELF SHALL NOT EXCEED MORE THAN THREE BRICKS

Drawing not to scale

Fig. 6.1 : Brick Work

BRICK PILLARS

Sub Head : Brick Work
Clause : 6.2.4.1

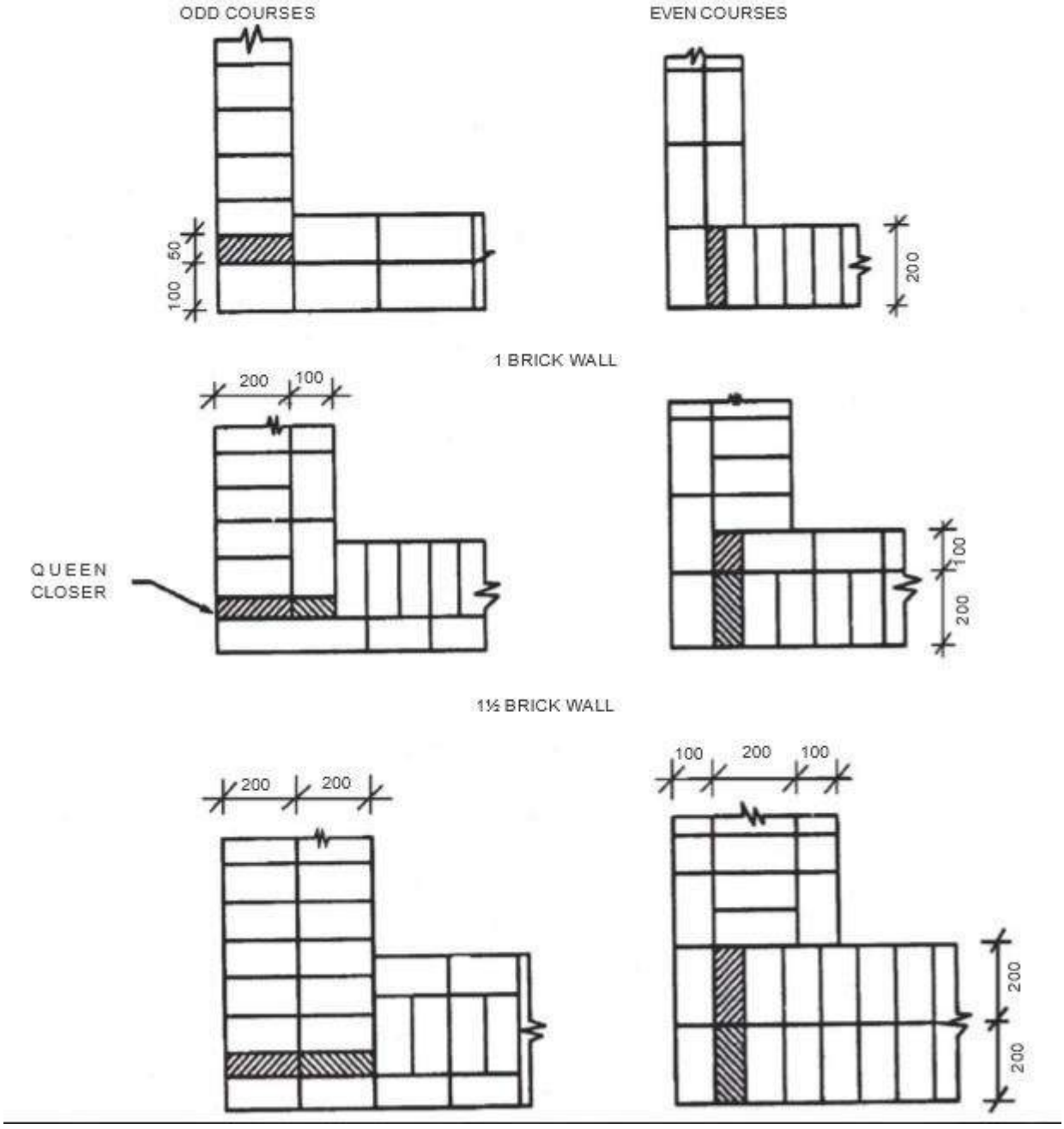


Drawing not to scale
All dimensions are in mm

Fig. 6.2 : English Bond

BRICK BONDS

Sub Head : Brick Work
Clause : 6.2.4.1



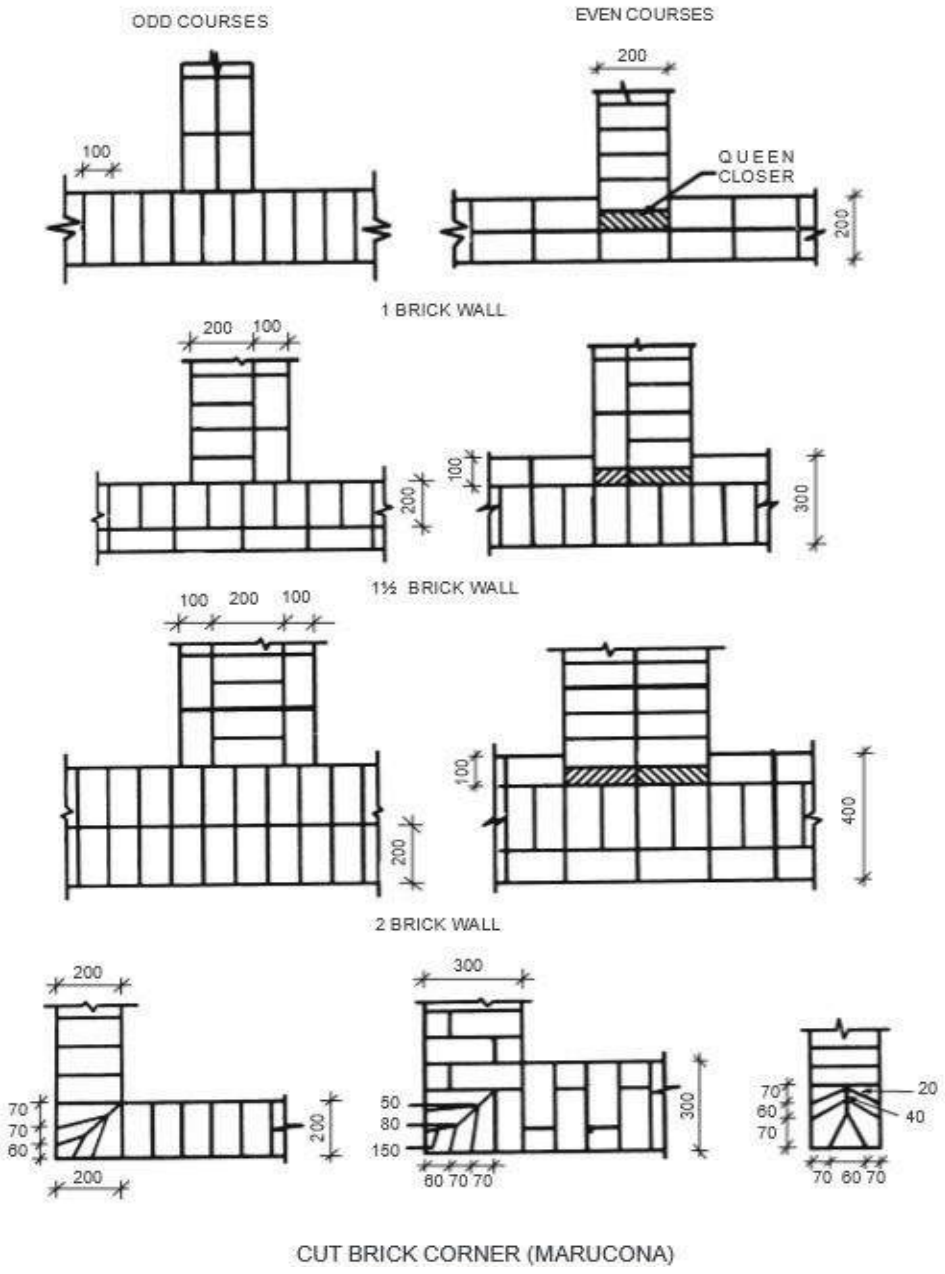
2 BRICK WALL

Drawing not to scale
All dimensions are in mm

Fig. 6.3 : English Bond

BRICK BONDS (Contd.)

Sub Head : Brick Work
Clause : 6.2.4.1

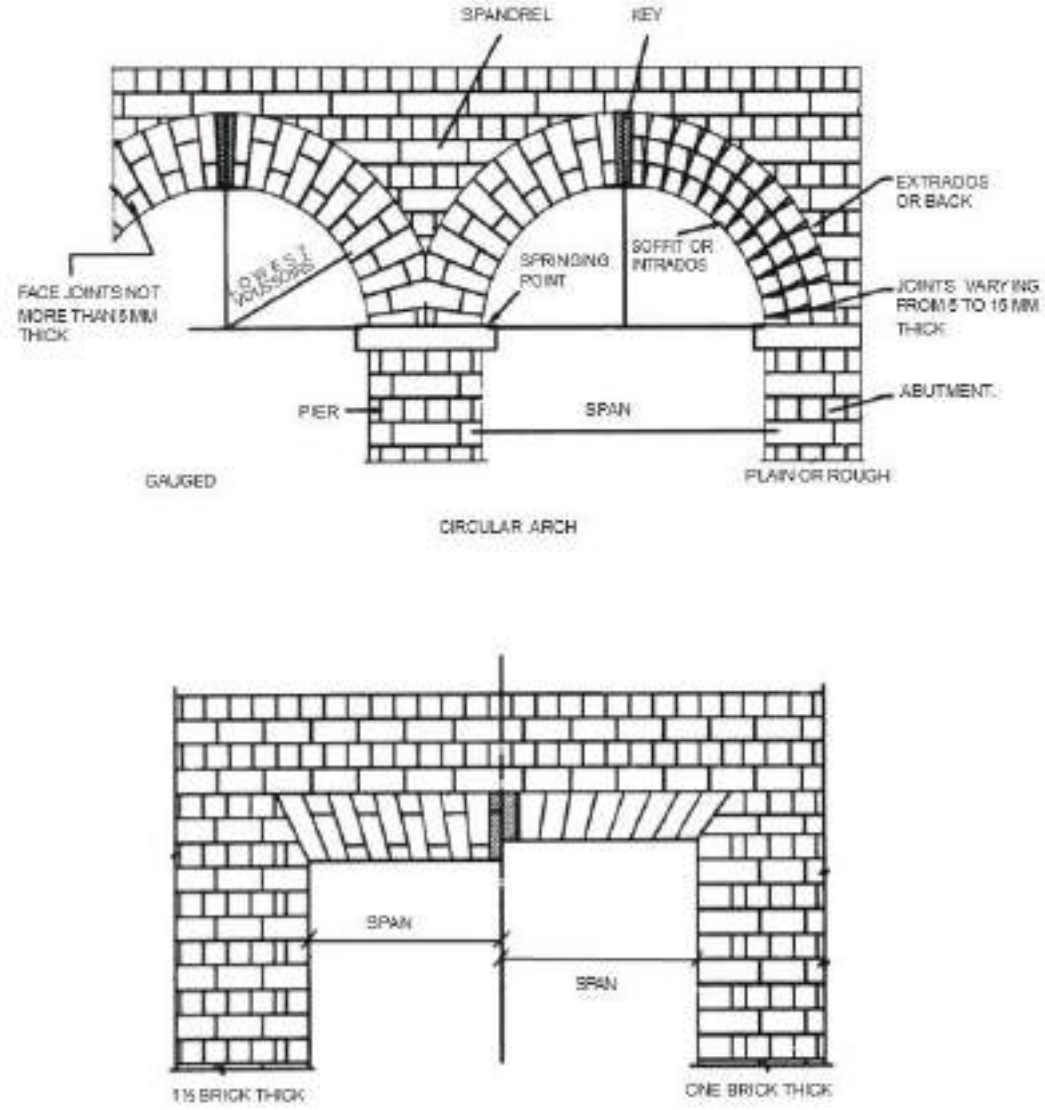


Drawing not to scale
All dimensions are in mm

Fig. 6.4 : English Bond

BRICK WORK IN ARCHES

Sub Head : Brick Work
Clause : 6.3

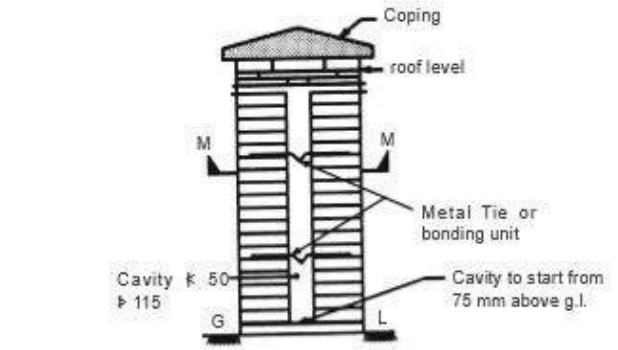


Drawing not to scale

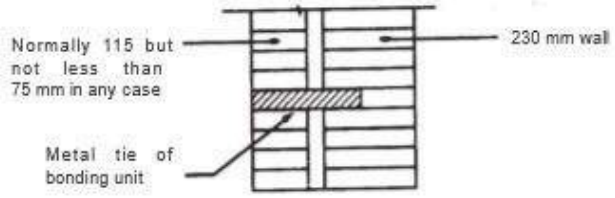
Fig. 6.5 : Brick Work in Arches

BRICK WORK IN CAVITY WALLS

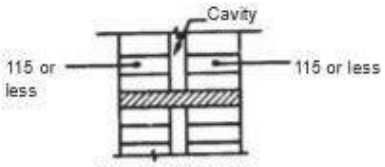
Sub Head : Brick Work
Clause : 6.11.0



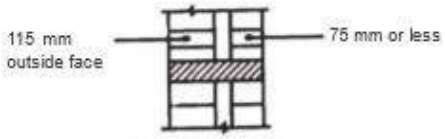
(a) SECTION OF CAVITY WALL



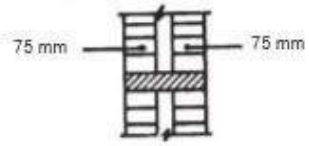
(b) SECTIONAL PLAN - MM



(c) PLAN AT MM



(d) PLAN AT MM



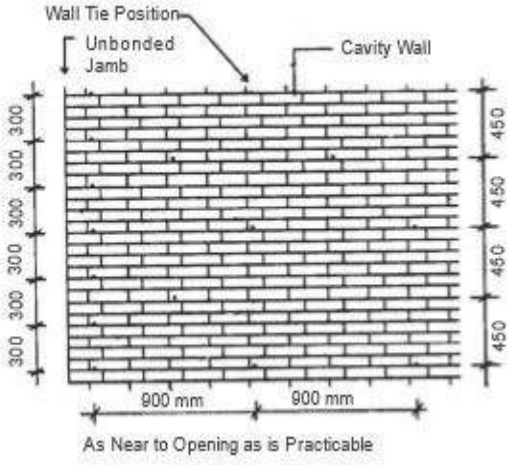
(e) PLAN AT MM

Note :
(1) Only one of the alternative a, b, c, d or e shall be applicable in each case.
(2) Ties shall be placed sloping towards exterior side.

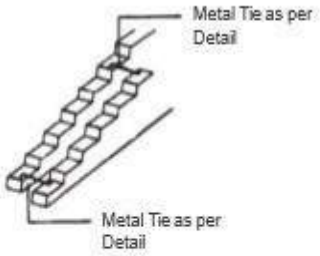
Drawing not to Scale
All dimensions are in mm

Fig. 6.6 : Brick Work in Cavity Walls

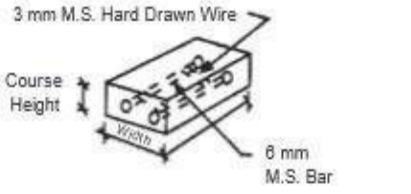
(Fig. 6.6 Contd.)



(f) ELEVATION

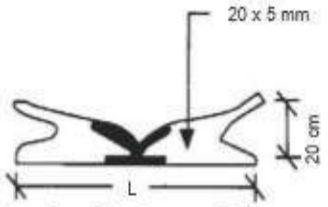


(g) ISOMETRIC VIEW



L = Thickness of Walls + Cavity
≯ 2 x 115 + Cavity (for walls 115 mm or more)

(h) BONDING UNIT
(Preferably Precast R.C.C.)



L = Sum of Two Leaves + Cavity
≯ 2 x 115 + Cavity (for walls 115 mm or more)

(i) METAL TIE

(j) DETAILS OF REINFORCEMENT IN BONDING UNIT

Drawing not to Scale
All dimensions are in mm

Fig. 6.6 (Contd.) : Brick Work in Cavity Walls

SUB HEAD : 7.0

STONE WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	273
	List of Bureau of Indian Standard Codes	275
7.0	Terminology	276
7.1	Random Rubble Stone Masonry	278
7.2	Coursed Rubble Masonry - First Sort	283
7.3	Coursed Rubble Masonry - Second Sort	284
7.4	Plain Ashlar Masonry	284
7.5	Punched Ashlar (Ordinary) Masonry	287
7.6	Moulded, Sunk, Carved Ashlar Masonry	287
7.7	Stone Veneering Work (Shifted to 8.8)	288
7.8	Stone Chajja	288
7.9	Shelves, Coping, Plain, Cornices, String Courses etc.	290
7.10	Stone Jali	290
7.10A	Stone work in or under water and/or in liquid mud & under foul position	291
Fig. 7.1	Stone Work	293
Fig. 7.2 to 7.7	Terminology	294
Fig. 7.8	Random Rubble Masonry	295
Fig. 7.9	Rubble Stone Masonry - Coursed	296
Fig. 7.10	Ashlar Stone Masonry	297
Fig. 7.11	Ashlar Stone Masonry (with Brick Backing)	298
Fig. 7.12	Moulded, Sunk, Carved - Stone Work	299

Fig. 7.13	Stone Work in Arches & Chajjas	300
Fig. 7.14, 7.15	Stone Veneering (Shifted to Fig. 8.5, Fig 8.6)	
Fig. 7.16	General Arrangement of Cramps (Shifted to Fig. 8.7)	

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Requirement*	*Field/ laboratory Test*	*Test Procedure*	*Minimum Qty. of Material For Carrying out test*	*Frequency of Testing*
Stone	7.1.1 7.4 7.8 7.9	(i) Water absorption	Not more than 2.5% by mass for sand stone and as specified in IS 1123 for other stones.	Laboratory	IS 1124	50 sqm. for slabs and 10 cum in Stone masonry	100 sqm/20 cum or part thereof or change of source as per direction of Engineer-in- Charge
		(ii) Transverse strength	Not less than 7 N/mm^2 (70 Kgf/cm^2) for sand stone and as specified in IS 1123 for other stones.	Laboratory	IS 1121 Part II	-do-	-do-
		(iii) Resistance to wear	Not greater than 2 mm on the average and 2.5 mm for any individual specimen for sand stone and as specified in IS 1123 for other stones.	Laboratory	IS 1706	-do-	-do-
		(iv) Durability	Shall not develop signs of spalling, disintegration or cracks for sand stone and as specified in IS 1123 for other stones.	Laboratory	IS 1126	-do-	-do-

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*IS Code No.*	*Subject*
1.	IS 737	Specifications for wrought aluminium and aluminium alloy, steel and strip for general engineering purpose.
2.	IS 1121 - (Pt. I)	Methods of determination of properties and strengths of natural building stones (Part-I compressive strength).
3.	IS 1122	Methods for determination of specific gravity of natural building stone
4.	IS 1123	Methods of identification of natural building stones.
5.	IS 1124	Methods of test of determination of water absorption, apparent, specific gravity and porposity of natural building stones.
6.	IS 1125	Methods of test of determination of weathering of natural building stone
7.	IS 1126	Methods of test for determination of durability of natural building stone
8.	IS 1128	Specification for Lime stone (Slab & Tiles).
9.	IS 1129	Recommendations for dressing of natural building stones.
10.	IS 1200 (Pt. IV)	Methods of measurements of building and Civil engineering works stone Masonry.
11.	IS 1197 (Pt. I)	Code of practice for construction of rubble stone masonry
12.	IS 1597 (Pt. II)	Code of practice for construction of ashlar stone masonry
13.	IS 1805	Glossary of terms relating to stones, quarrying and dressing
14.	IS 3620	Specification for latrite stone block for masonry
15.	IS 3622	Sand stone (Slab & Tiles)
16.	IS 4104 (Pt. I)	Code of practice for external facings and veneers (Part I-Stone facing).
17.	IS 4101 (Part II)	Code of practice for external facing and veneers: (Part II-Cement Concrete facing).

7.0 STONE WORK

7.0 TERMINOLOGY

Ashlar

Stone masonry using dressed square stone blocks of given dimensions having faces perpendicular to each other and laid in courses.

Bed Joint

The joint where one stone presses on another for example, a horizontal joint in a wall or radiating joint between the voussoirs or arch (See Fig. 7.1 and 7.13)

Block

(a) *Hollow (Open and Closed Cavity) Block:* A concrete masonry unit with any one of the external dimension greater than the corresponding dimension of a brick and having one or more large holes or cavities which either pass through the block (open cavity) or do effectively pass through the block (closed cavity) and having the solid material between 50% and 75% of the total volume of the block calculated from the overall dimensions.

(b) *Solid Block:* A concrete masonry unit with external dimensions greater than corresponding dimension of a brick and having solid material not less than 75% of the total volume of the block calculated from over all dimension.

Bond

An interlocking arrangement of structural units in a wall to ensure stability.

Bond Stone (through Stone)

Selected long stone used to hold a wall together transversely (See Fig. 7.8).

Corbel

Stone bonded well into the wall with part of it projecting out of the face of wall to form a bearing surfaces.

Cornice

A horizontal moulded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature (See Fig. 7.1C).

Cramp

A small piece of metal or the hardest or toughtest stone procurable, sunk in mortices and fixed across joints as additional ties. The ends of metal cramps are bent at right angles and stone cramps are dovetailed (See Fig. 7.1B).

Course

A layer of stones in wall including the bed mortar.

Dowels

Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joint or adjacent stones (See Fig. 7.1A).

Jamb

The part of the wall at the side of an opening.

Joggle

A key between the stones by providing a groove in one stone to take a corresponding concealed pro-jection in the edges on the other stone (See Fig. 7.1B).

Natural Bed

The planes of stratification that occurs in a sedimentary rocks.

Parapet

A solid or pierced guard wall for flat stone terrace or balcony (or a bridge) or a curb wall at the lower part of a pitched roof which is exposed to atmosphere on face back and top (See Fig. 7.1C).

Quoin

A quoin is the external angle of wall or building. The term is also applied to stone specially selected and neatly dressed for forming such angle.

Random

Random or irregular size and shapes.

Reveal

The part of the jamb between the frame and the arris.

Rubble Masonry

Masonry built of stones either irregular in shapes as quarried or squared and only hammer dressed and having comparatively thick joints. As far as possible, stones for rubble masonry shall be angular.

Skewback

Sloping surface against which the springing of an arch rests.

Spandrel

Space between the haunches below the decking level.

String Course

A horizontal band, plain or moulded, usually projecting slightly from the face of wall (See Fig. 7.1C).

Surfacing or Dressing of Stones

The stones are dressed to have different surfaces as indicated below.

Template or Bed Block

A block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

Self Faced Surfaces

Surfaces of stone slabs used for roofing, flooring, lintels etc. as obtained from quarry.

Squared Back Surface

Means the surface shall be dressed back at right angles to the face of the stone.

Chisel Drafted Margin

The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted margin shall be punch dressed.

Hammer Dressed Surface

A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic faced. The bushing from the general wall face shall not be more than 40 mm on exposed face and 10 mm on faces to be plastered (Fig. 7.2).

Rock Faced Surface

A rock faced stone shall have a minimum of 25 mm wide chisel drafted margin at the four edges, all the edges being in the same plane (Fig. 7.3).

Rough Tooled Surface

A rough tooled surface shall have a series of bands, made by means of a plane chisel 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45° as directed (Fig. 7.4). The edges and corners shall be square and true. The depth or gap between the surface and straight edge, held against the surface shall not be more than 3 mm (Rough tooled stones are used where fairly regular plane faces are required for masonry work).

Punched Dressed Surface

A rough surface is further dressed by means of punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm (Fig. 7.5). Punched dressed stones are used where even surfaces are required.

Close Picked Surface

A punched stone is further dressed by means of point chisel so as to obtain a finer surface, ridges or chisel marks left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm (Fig. 7.6).

Fine Tooled Surface

Close picked surface is further dressed so that all the projections are removed and fairly smooth surface is obtained. The surfaces shall have 3 to 4 lines per centimetre width depending on the degree of hardness of stone and degree of fineness required (Fig. 7.7). This type of dressing is commonly adopted for ashlar work.

Polished Surface

Surfaces having a high gloss finish. Polishing of stones shall be done by rubbing them with suitable abrasive, wetting the surface where necessary with water. Alternatively polishing of stones shall be done by holding them firmly on the top of revolving table to which some abrasive material like sand or carborundum is fed. The final polishing shall be performed by rubber or felt, using oxide of lime (called by trade name as putty powder) as a polishing medium.

Moulded

Cut to profile of a moulding with punched dressed surfaces, unless otherwise specified.

7.1 RANDOM RUBBLE STONE MASONRY

7.1.0 Material

7.1.1 Stone

The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite, etc. and shall be obtained from the quarries, approved by the Engineer-in-Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stone shall not contain crypst crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc.

Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per Table 7.1 and the percentage of water absorption shall generally not exceed 5% for stones other than specified in Table 7.1. For laterite this percentage is 12%.

TABLE 7.1

Type of stone	*Maximum Water Absorption*	*Minimum Compressive*
	Percentage by weight	*Strength kg./sq.cm.*
Granite	0.5	1000
Basalt	0.5	400
Lime stone (Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite (Block)	12	35

Note 1: Test for compressive strength shall be carried out as laid down in IS 1121 (Part I).

Note 2: Test for water absorption shall be carried out as laid down in IS 1124.

7.1.2 Size of Stones

Normally stones used should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall, or not less than 150 mm. The height of stone for rubble masonry may be upto 300 mm.

The selection and grading of stones for rubble masonry is largely done at site and the smaller stones are used in the hearting of wall.

7.1.3 Random Rubble Masonry shall be uncoursed or brought to courses as specified (Fig. 7.8 and 7.9). Uncoursed random rubble masonry shall be constructed with stones of sizes as referred to in para 7.0 and shapes picked up random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, not be used.

7.1.4 Random rubble masonry brought to the course is similar to uncoursed random rubble masonry except that the courses are roughly levelled at intervals varying from 300 mm to 900 mm in height according to the size of stones used.

7.1.5 Dressing

Each stone shall be hammer dressed on the face, the sides and the beds. Hammer dressing shall enable the stones to be laid close to neighbouring stones such that the bushing in the face shall not project more than 40 mm on the exposed face.

(i) ***Face stone:*** At least 25% stones shall be headers tailing into the work at least 2/3rd the thickness of wall in super structure masonry. Such stones shall not be less than 200 sq. cm in cross sections.

(ii) ***Hearting Stones:*** The hearting or interior filling of a wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

(iii) ***Quoin Stone:*** Quoin stone shall be less than 0.03 cum in volume.

(iv) ***Jamb stones:*** The jambs shall not be made with stones specified for quoins except that the stones which were required to be provided at 1 metre centre to centre on both the exposed faces shall here be provided only on the jamb and the length shall be equal to the thickness of the wall

for wall upto 60 cm and a line of headers shall be provided for walls thicker than 60 cm as specified for bond.

7.1.5 (A) Courses

The masonry shall be carried out in regular courses of height not exceeding 50 cm and masonry on any day will not be raised more than 60 cm in height when using mortars having compressive strength less than 20 kg./sq. cm at 28 days and 100 cm when using mortars exceeding this strength.

7.1.5 (B) Thickness of Joints

The joint thickness shall not exceed 30 mm at any point on the face. Chips of the stone and spalls shall be wedged into seating bed of face stones to avoid excessive bed thickness. No pinning shall be allowed to avoid excessive joint thickness.

7.1.6 Mortar

The mortar used for joining shall be as specified.

7.1.7 Laying

Stone shall be laid on their natural bed and shall be solidly bedded full in mortar with close joints, chips of stone spalls be wedged into the work wherever necessary. No dry work or hollow spaces shall be allowed and every stone whether large or small shall be carefully selected to fit snugly the interstices between the large stones. Masonry shall be built breaking joints in all the three directions. Bond stone and headers shall be properly laid into the work and shall be marked by the contractor with white lead paint. The bond stones shall be provided as specified in para 7.1.8.

The masonry work in wall shall be carried up true to plumb or to specified batter.

Random rubble masonry shall be brought to the level courses at plinth, window sills, lintel and roof levels. Levelling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45°.

7.1.7 (A) Raking out joints

All the joints on the faces to be pointed or plastered shall be racked out with racking tool to a depth of 20mm while the mortar is still green.

7.1.8 Bond Stones

Though bond stones shall be provided in walls upto 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) the bond stone shall extend about two-third into the wall, as through stones in such walls a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 m^2 of the wall surface and shall be provided at 1.5 m to 1.8 m apart clear in every course.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond stones may give rise to dampness. For all thicknesses of such walls a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available pre-cast cement concrete block of 1:3:6 mix (1 cement : 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimeters and length equal to the thickness.

At least one bond stone or a set of bond stones shall be provided at 1.5 m to 1.8 m apart clear in every course. (Bond stones shall be marked suitably with paint as directed by the Engineer-in-Charge).

7.1.9 Quoin and Jamb Stones

The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header and stretcher alternatively.

7.1.10 Joints

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

7.1.11 Scaffolding

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one metre in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1 : 3 : 6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size).

7.1.12 Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

7.1.13 Protection

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

7.1.14 Measurements

7.1.14.1 The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metre nearest to two places of decimal.

7.1.14.2 The work under the following categories shall be measured separately.

(i) From foundation to plinth level (level one) :
  (a) work in or under water and or liquid mud,
  (b) work in or under foul positions.
(ii) Above plinth level and upto floor five level.
(iii) Above floor five level to every floor/floors or part thereof.
(iv) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

7.1.14.3 No deduction shall be made nor extra payment made for the following :

(i) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters purlins, trusses, corbels, steps etc.) upto 0.1 sqm in section.

(ii) Openings each upto 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included alongwith the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded.

(iii) Wall plates and bed plates, and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.
Note: The bearing of floor and roof shall be deducted from wall masonry.

(iv) Drain holes and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.

(v) Building in masonry, iron fixture, pipes upto 300 mm dia, hold fasts of doors and windows etc.

(vi) Forming chases in masonry each upto section of 350 sq cm.

Masonry (excluding fixing brick work) in chimney breasts with smoke of air flues not exceeding 20 sq dm (0.20 sq m) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sq m) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running metres stating size of flues and paid for separately. Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throating.

7.1.14.5 Apertures for fire places shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch to support the opening.

7.1.14.6 ***Square or Rectangular Pillars:*** These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

7.1.14.7 ***Circular Pillars (Columns):*** These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

7.1.14.8 Tapered walls shall be measured net, as per actual dimensions and paid for as other walls.

7.1.14.9 ***Curved Masonry:*** Stone masonry curved on plan to a mean radius exceeding 6 metres shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 metres shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

7.1.15 Rate

The rate shall include the cost of materials and labour required for all the operations described above and shall include the following :

(a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.

(b) Preparing tops and sides of existing walls for raising and extending.

(c) Rough cutting and waste for forming gables cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified.

(d) Bond stones or cement concrete bond blocks.

(e) Leading and making holes for pipes etc.

(f) Bedding and pointing wall plates, lintels, sills etc. in or on walls, bedding roof tiles and corrugated sheets in or on walls.

(g) Building in ends of joists, beams, lintels etc.

7.2 COURSED RUBBLE MASONRY - FIRST SORT (FIG. 7.9)

7.2.1 Stone: Shall be as specified in 7.1.1.
7.2.2 Size of Stone: Shall be as specified in 7.1.2.

7.2.3 Dressing

Face stones shall be hammer dressed on all beds, and joints so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for at least 80 mm back from the face, and side joints for at least 40 mm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joint. The bushing on the face shall not project more than 40 mm as an exposed face and 10 mm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for minimum width of 25 mm along the four edges of the face of the stone, when stone work is exposed.

7.2.4 Mortar

The mortar for jointing shall be as specified.

7.2.5 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up uniformly but where breaks are unavoidable, the joints shall be raked back at angle not steeper than 45°. Toothing shall not be allowed.

7.2.6 Bond Stones

Shall be as specified in 7.1.8 except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

7.2.7 Quoins

The quoins shall be of the same height as the course in which these occur. These shall be at least 450 mm long and shall be laid stretchers and headers alternatively. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 100 mm. In case of exposed work, these stones shall have a minimum of 25 mm wide chisel drafts at four edges, all the edges being in the same plane.

7.2.8 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

7.2.9 Curing, Scaffolding, Measurements and Rates. Shall be as specified under 7.1.

7.3 COURSED RUBBLE MASONRY - SECOND SORT (FIG. 7.9)

7.3.1 Stone : Shall be as specified in 7.1.1.

7.3.2 Size of Stone : Shall be as specified in 7.1.2.

7.3.3 Dressing: Shall be as specified in 7.2.3 except that no portion of dressed surface of joints shall show a depth of gap more than 10 mm from a straight edge placed on it and use of chips shall not exceed 15 per cent of the quantity of stone masonry.

7.3.4 Mortar

The mortar for jointing shall be as specified.

7.3.5 Laying: Shall be as specified in 7.2.5 except that the use of chips shall not exceed 15% of the quantity of stone masonry and stone, in each course need not be of the same height but not more than two stones shall be used in the height of a course.

7.3.6 Bond Stone, Quoins: Shall be as specified in 7.2.6 and 7.2.7 respectively.

7.3.7 Joints

All bed joints shall be horizontal and all side vertical. All joints shall be fully packed with mortar, face joints shall not be more than 20 mm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during progress of work, where the mortar is still green.

7.3.8 Curing, Scaffolding, Measurement and Rates. Shall be as specified under 7.1.

7.4 PLAIN ASHLAR MASONRY (FIG. 7.10)

7.4.1(A) Stone shall be of the type specified. It shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc. before starting the work, the contractor shall get the stones approved by Engineer-in-Charge.

7.4.1(B) Kota Stone for Vineering

Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall be of colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of kota stone approved from the Engineer-in-Charge.

Dressing : Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of ± 2 mm shall be allowed for the thickness.

7.4.1(C) Red Sand Stone & White Sand Stone Ashlar Masonry

The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough, free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

7.4.2 Size of Stone

Normally stones used should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall nor less than 15 cm. The height of stone may be upto 30 cm.

7.4.3 Dressing

Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings.

A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

7.4.4 Mortar

The mortar for jointing shall be as specified.

7.4.5 Laying

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of ashlar work without backing of brick work or coursed rubble masonry, face stone shall be laid headers and stretchers alternately unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 30 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlar facing with backing of brick work or coursed rubble masonry (See Fig. 7.11) face stone shall be laid in alternate courses of headers and stretchers unless otherwise directed. Face stone and bond stone course shall be maintained throughout. All connected masonry in a structure shall be carried up nearly at one uniform level throughout, but where breaks are avoidable, the joint shall be made in good long steps so as to prevent cracks developing between new and old work. Bond stone provided in the masonry shall be payable in the item of Ashlar masonry. Neither any deduction will be made from the brick masonry for embedding the bond stone in the backing nor any extra payment shall be made for any extra labour involved in making holes in brick masonry backing.

When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these into correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before tying chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work.

7.4.6 Bond Stones : Shall be as specified in 7.1.8.

7.4.7 Joints

All joints shall be full of mortar. These shall be not more than 6 mm thick. Face joints shall be uniform throughout and a uniform recess of 20 mm depth from face shall be left with the help of the steel plate during the progress of work.

7.4.8 Pointing

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15 mm.

7.4.9 Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

7.4.10 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

7.4.11 Scaffolding

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.

7.4.12 Measurements

The finished work shall be measured correct to a centimetre in respect of length, breadth and height. The cubical contents shall be calculated in cubic metre nearest to two places of decimal.

7.4.12.1 No deduction nor any extra payment shall be made for the following :

(i) Ends of dissimilar materials (that is joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 0.1 sqm in section.

(ii) Openings upto 0.1 sqm in area. In calculating the area of opening, any separate lintels or sills shall be included alongwith the size of the opening but the end portion of the lintels shall be excluded and extra width of rebated reveals, if any, shall also be excluded.

(iii) Wall plates and bed plates and bearing of chajja and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.
Note : The bearing of floor and roof slabs shall be deducted from wall masonry.

(iv) Drainage holes and recesses left for cement concrete blocks to embed hold-fasts for doors and windows, building in the masonry iron fixture and pipes upto 300 mm diameter.

(v) Stone walling in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.20 sqm in sectional area shall be measured as solid and no extra measurement shall be made for pargetting and coring such flues. Where flues exceed 0.20 sqm in sectional area, deduction shall be made for the same and pargetting and coring flues paid for separately.

7.4.12.2 ***Square, Rectangular or Circular Pillars:*** Shall be measured and paid for as walls, but extra payment shall be allowed for such pillars and columns over the rate for stone work in walls.

Rectangular pillars shall mean a detached masonry support, rectangular in section, such that its breadth shall not exceed two and half times the thickness.

7.4.12.3 *Curved Stone Work:* Stone work curved on a plan to a mean radius exceeding six metres shall be measured net and included with general stone work. Stone work circular on a plan to a mean radius not exceeding six metres shall be measured separately and extra payment shall be allowed and shall include all cutting and waste and templates. It shall be measured as the mean length of wall.

7.4.13 Rate

The rate shall include the cost of materials and labour required for all the operations described above. Stone facing or wall lining upto and not exceeding 8 cm thickness shall be paid for under "Stone work for wall lining etc. (Veneer work)". The stone work of thickness exceeding 8 cm shall be paid under relevant items of work.

7.5 PUNCHED ASHLAR (ORDINARY) MASONRY (FIG. 7.10)

7.5.1 Stone: Shall be as specified in 7.4.1. In case of red or white sand stone, stone shall be red or white as specified in the item. In red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted.

7.5.2 Size of Stone : Shall be as specified in 7.4.2.

7.5.3 Dressing: Shall be as specified in 7.4.3 except that the faces exposed in view shall have a fine dressed chisel draft 2.5 cm wide all round the edges and shall be rough tooled between the drafts, such that the dressed surface shall not be more than 3 mm from a straight edge placed over it.

7.5.4 Other Details

The specifications for mortars, laying and fixing, bond stone, joints, pointing, curing, protections, scaffolding, measurements and rates shall be same as specified in 7.4.

7.6 MOULDED, SUNK, CARVED ASHLAR MASONRY (FIG. 7.12)

7.6.1 Stone : Shall be as specified in 7.4.1.

7.6.2 Dressing

Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial or circular joints with adjoining stones as the case may be. The dressed surface shall not be more than 3 mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, rebated sunk or plain moulded and fine tooled as shown in the working drawings. The joints 6 mm from the face shall also be fine tooled so that straight edge laid along it is in contact with every point. It shall be finest surface which can be given to a stone with the chisel and without rubbing.

In case of sunk or moulded masonry, the corner stone shall be dressed at true right angles or true to the shape as specified. The corners being straight and vertical.

For arch (See Fig. 7.13), dome or circular work (See Fig. 7.12) the stone shall be dressed to require wedge shape so that joints shall be truly radial.

7.6.3 Sample

The full size layout of the moulding etc. shall be prepared on platform from which sheet templates shall be cut and the stone dressed to templates to a uniform and fine finish. All visible angles and edge shall be true square and free from chippings. A sample of dressed stone shall be prepared for approval and it shall be kept as sample after being approved by Engineer-in-Charge.

In case of ashlar moulded and carved columns a full size model of the required moulding, carving etc. shall be prepared in plaster of paris and kept at site of work as sample work after being approved by the Engineer-in-Charge. The stones shall be moulded and carved in accordance with the approved model to a uniform and fine finish.

7.6.4 Other Details: Shall be as specified in 7.4.4., 7.4.5 and 7.4.7 to 7.4.11.

7.6.5 Centering and Shuttering

Centering and shuttering required for arch dome or circular moulded work shall be constructed as directed by the Engineer-in-Charge.

7.6.6 Measurements

The dimensions of the circumscribing rectangles of the dressed stone used in the work shall be measured correct to a cm and cubical contents shall be calculated in cubic metres, nearest to two places of decimal.

7.6.6.1 In case of sunk or moulded work the measurements for the work shall be taken course by course. The plain stone used in conjunction with sunk or moulded stone shall be measured and paid for under the relevant item of stone work.

7.6.6.2 Sunk or moulded work in rectangular, square and circular pillars, moulded cornices and string courses shall be measured under stone work sunk or moulded but extra payment shall be allowed over the general work in each case. No such extra payment shall be allowed for moulded string and plinth courses.

7.6.6.3 In case of arch dome or circular moulded work for arches exceeding six metres in clear span extra payment for additional cost of centering shall be made on the actual area of soffit including strutting, bolting, wedging, easing, striping and removal.

7.6.7 Rate

The rate includes the cost of all materials and labour involved in all the operations described above, including centering and shuttering for arch, dome or circular moulded work.

7.7 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.8

7.8 STONE CHAJJA (FIG. 7.13)

7.8.1 Stone slabs shall be hard, sound and durable. These shall be chisel dressed on all faces which are exposed to view and rough dressed at other surface. Angles shall be true and edge lines straight. The finished thickness shall be as stipulated with permissible tolerance of ± 2 mm. The length of stone slabs in chajja shall not be less than 60 cm and single piece unless otherwise specified.

7.8.2 In case of sloping chajja the stone shall be sloped as specified. It shall have minimum bearing of 20 cm measured horizontally on the wall and the bearing shall also be similarly sloped. Each slab shall have a hole in the centre of the bearing area through which the anchoring M.S. holding down

bolt shall pass. The holding down bolts shall be 12 mm diameter and shall be bent at right angles at its lowest end and burried horizontally for at least 7 cm in a joint 30 cm below the bearing surface. Each holding down bolt shall be secured at top by suitable washer and nut.

7.8.3 The stone chajja shall be provided with red sand stone bracket supports in both ends.. The stone chajja shall be supported on red sand stone brackets which shall be provided with minimum bearing 15 cm in the brick masonry. The bearing of the stone chajja shall be done by making a recess in brick masonry upto 15cm width and size of the recess shall be 40mm large than the thickness of the red sand stone. The red sand stone chajja& support brackets shall be fixed with cement mortar 1:4 (1 Cement : 4 Coarse sand). The stone shall be fixed horizontally with straight outer shape of about 30mm or 40 mm thickness. It shall be min. bearing 15cm on the wall. Thestonechajjashall be provided with single pieces of red or white sand stone and supported on the red or white sand stone bracket at ends.

The chajjas shall be provided with cove supports, where cove is in brick masonry, it shall project out from the wall as under.

45 cm wide chajja, cove projection 15 cm, depth of cove 3 courses.

60 cm wide chajja, cove projection 20 cm, depth of cove 4 courses.

75 cm wide chajja, cove projection 25 cm, depth of cove 5 courses.

90 cm wide chajja, cove projection 30 cm, depth of cove 6 courses.

7.8.4 In case of horizontal chajja, the stone shall be fixed horizontally with a slight outer slope of about 1 cm. It shall have minimum bearing of 15 cm on the wall. Holding down bolts shall be provided, only where so specified.

7.8.5 Pointing

The joints shall be pointed with 1:2 cement mortar (1 cement : 2 stone dust) with an admixture of pigment to match the stone shade, and properly cured.

7.8.6 Other Details

7.8.6.1 Dressing

Every stone shall be cut to the required size and shape chisel dressed on all beds. All angles and edges that one to remain exposed in the final. Position shall be true; square and true from chipping. A sample of dressed stone shall be prepared for approval of Engineer-in-charge. It shall be kept at the work site as a sample after being approval. No piece which has been damaged shall be used in work.

7.8.6.2 Curing

Stone chujja work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of stone chujja with fat lime mortar, curing shall commence two days after laying of stone chujja and shall continue for at least seven days thereafter.

7.8.6.3 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

7.8.6.4 Scaffolding

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.

7.8.7 Measurements

The length and breadth of the finished work shall be measured correct to a cm. The area of chajja projecting beyond the wall shall be calculated in sq m correct to two places of decimal.

In case of sloping chajja, the sloping breadth shall be measured correct to a cm and the area of chajja projecting beyond the wall shall be calculated in sq m correct to two places of decimal.

7.8.8 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Anchoring the coves shall be deemed to be included in the rate, only when it is so stipulated in the description of the item.

7.9 SHELVES, COPING, PLAIN, CORNICES, STRING COURSES ETC.

7.9.1 Stone

Stone shall be of uniform colour and texture and of the kind as stipulated.

7.9.2 Dressing

The exposed faces and sides of shelves shall be chisel dressed such that the dressed surface shall not be more than 3 mm from a straight edge placed on it. All visible angles and edges shall be free from chippings. The surfaces to be burried in the masonry shall be rough dressed.

7.9.3 Laying

These shall be laid in mortar of specified mix and fixed as shown in drawing or as directed by the Engineer-in-Charge.

7.9.4 Other Details

Specifications for pointing, curing, protections and scaffolding shall be as specified under 7.4.

7.9.5 Measurements

7.9.5.1 ***Shelves:*** The length and breadth shall be measured inclusive of bearings correct of a cm. The thickness shall be as specified with permissible tolerance of ± 2 mm. The area shall be calculated in sqm correct to two places of decimal.

7.9.5.2 ***Copings:*** The dimensions of the circumscribing rectangles of the dressed stones as used in work shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cum.

7.9.5.3 ***Plain Cornices, String Courses and Plinth Courses:*** The length, breadth and depth of the stone including bearing shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cu. m.

7.9.5.4 No deduction shall be made from the masonry of wall for the bearing of stone shelves, cornices, string courses.

7.9.6 Rate

The rate shall include the cost of all materials and labour required in all the operations described above.

7.10 STONE JALI

7.10.1 Stone shall be as specified in 7.4.1.

7.10.2 Dressing and Fixing

The stone shall be cut into slabs of required thickness so as to make jali of the specified thickness. The jali shall be cut as per pattern shown on the drawings. All exposed faces shall be fine tooled to a uniform and smooth finish. Fixing shall be done with the adjoining work in grooves, rebates etc., as shown in the drawing or as directed by the Engineer-in-Charge. A tolerance of $\pm$ 2 mm shall be allowed in the specified thickness of the jali.

7.10.3 Stone jalis shall be fixed in grooves/rebates etc. to adjoining Stone work/Brick work/RCC as shown in the drawing or as directed by Engineer-in-Charge. Necessary sample for the same shall be got approved from the Engineer-in-charge before execution. The breakage of stone jail during fixing shall be the responsibilities of the contractor and replacement shall be provided at his risk and cost.

7.10.4 Measurements

The length and breadth of the stone forming the jali including its borders shall be measured correct to a cm and the area shall be calculated in square metres nearest to two places of decimal.

7.10.5 Rate

It includes the cost of labour and materials required for all the operations described above. It also includes the cost of making grooves or rebates in the adjoining work for fixing jali.

7.10A STONE WORK IN OR UNDER WATER AND/OR IN LIQUID MUD & UNDER FOUL POSITION

7.10A.1 All water that may accumulate during the progress of work springs; tidal or river seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and pumping out water from site during the progress of work. Pumping shall be done directly from the site in such a manner as to preclude the possibility of movement of water through and fresh work during laying of stone work and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from the stone work by effective means.

7.10A.2 Capacity and number of pumps; location at which the pumps are to be installed; pumping hours ease shall be decided from time to time in consultation with the Engineer-in-charge.

7.10A.3 Pumping shall be done in such a way as not to cause damage to the work or adjoining properly by subsidence ease. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

7.10A.4 Classifications

The stone work shall be categorised as under:

(a) Work in or under and/or liquid Mud: Stone work where water is met with from any of the sources specified above shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the subsoil water level in that one.

(b) Work in or under foul position: Stone work, where sewage, sewage gases or foul conditions are met with from any source, shall fall in this category. Decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

7.10A.5 DE-WATERING

7.10A.5.1 De-watering shall be done conforming to BIS Code IS: 9759 (guide lines for dewatering during construction) and / or as per the specifications approved by the Engineer-in-Charge. Design of an appropriate and suitable dewatering system shall be the Contractor's responsibility. Such scheme shall be modified / augmented as the work proceeds based on fresh information discovered

during the progress of work, at no extra cost. At all times during the construction work, efficient drainage of the site shall be carried out by the Contractor and especially during the laying of plain cement concrete, taking levels, installing rock anchors etc. The Contractor shall also ensure that there is no danger to the nearby properties and installations on account of such lowering of water table. If needed, suitable precautionary measures shall be taken by the Contractor. Also the scheme of dewatering adopted shall have adequate built in arrangement to serve as stand-bye to attend, to repair of pumps etc. and disruption of power / fuel supply. Nothing extra shall be payable on this account.

7.10A.5.2 De-watering shall be carried out by suitable means with adequate stand-by arrangements of pumps etc. and it shall be ensured that its disposal is carried out as per the regulations of the local bodies. The water / slush / muck etc. shall not be disposed off into the public drainage system of sewer manhole or storm water drain, but shall be pumped off into the creek close to the plot or disposed by any other manner, subject to the approval of the local bodies in this regard. The agencies are, therefore, advised to inspect and acquaint themselves of the site and location of disposal point(s) of water / slush and satisfy themselves as regards method of pumping and disposal required to be adopted. Any default or failure on the part of the Contractor to acquaint him with the aforesaid aspect of work shall not absolve him from his responsibility for the execution / performance of the contract. Also, all permissions in this regard, to be taken from local authorities, shall be obtained by the Contractor. Nothing extra shall be payable on these accounts.

7.10A.5.3 In trenches where surface water is likely to get into cut / trench during monsoons, a ring bund of puddle clay or by any other means shall be formed outside, to the required height, and maintained by the Contractor. Also, suitable steps shall be taken by the Contractor to prevent back flow of pumped water into the trench. Nothing extra shall be payable on this account.

7.10A.5.4 Unless otherwise provided in the item of schedule of quantity, the cost of dewatering or working under water and / or liquid mud for execution of all the items for the work is deemed to be included in quoted rates of the respective items and shall not be measured separately for payment. Nothing extra shall be payable for de-watering in this work, irrespective of whether specified or not, in the item descriptions or in the specifications / conditions in the contract agreement.

7.10A.6 Measurement: - The unit, namely, metre depth shall be the depth measured from the level of foul position/ subsoil water level and upto the centre of gravity of the cross sectional area of excavation actually done for stone work.. Metre depth shall be reckoned correct to 0.1 m, 0.05 m or more shall be taken as 0.1 m and less than 0.05 m ignored.

In case stone work in or under foul position is also in or under water and/or liquid mud; extra payment shall be admissible only for the stone work actually executed in or under foul position.

Pumping or bailing out water met within excavations from source and specifically ordered in writing by the Engineer-in-charge shall be measured separately and paid.

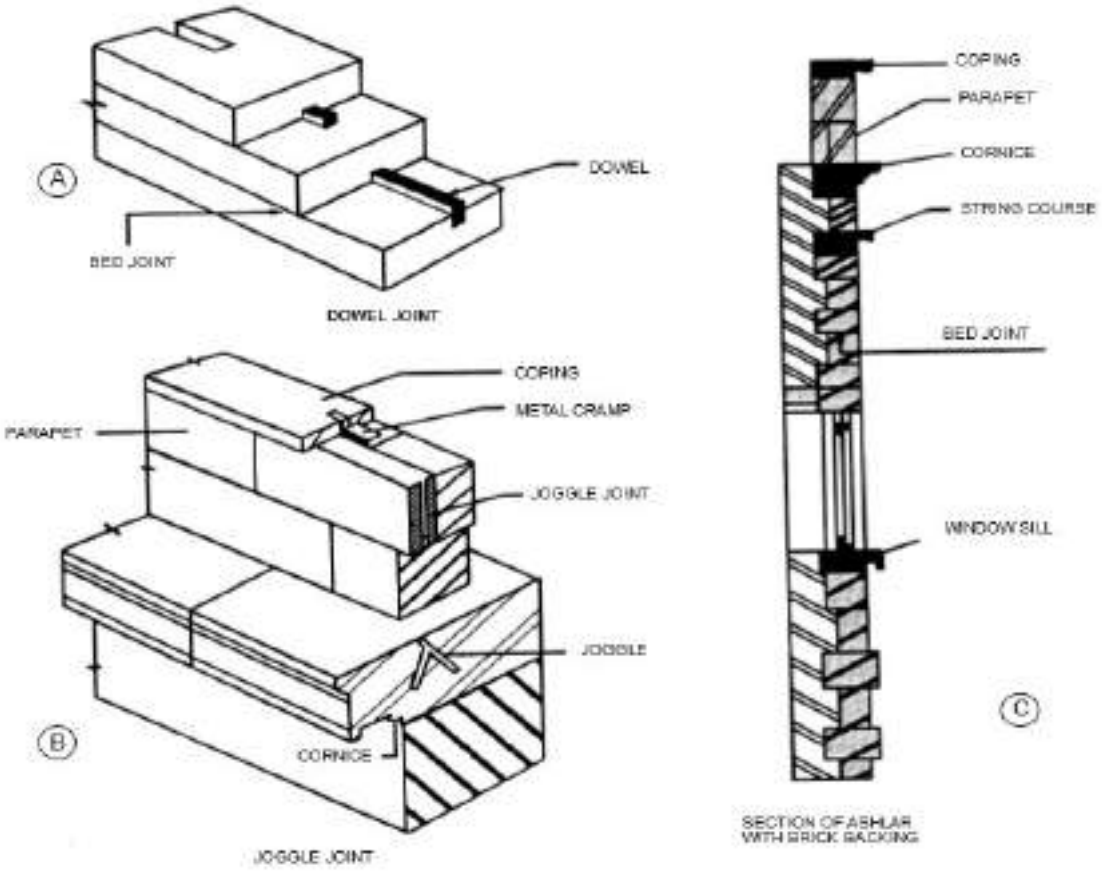
7.11 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.12

7.12 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.13

7.13 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.14

STONE WORK

Sub Head : Stone Work
Clause : 7.0



Drawing not to scale

Fig. 7.1 : Stone Work

STONE WORK
(Terminology)

Sub Head : Stone Work
Clause : 7.0

Fig. 7.2 : Hammer Dressed Stone Surface

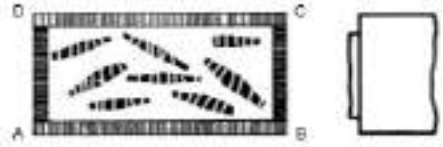


Fig. 7.3 : Rock Faced Stone Surface

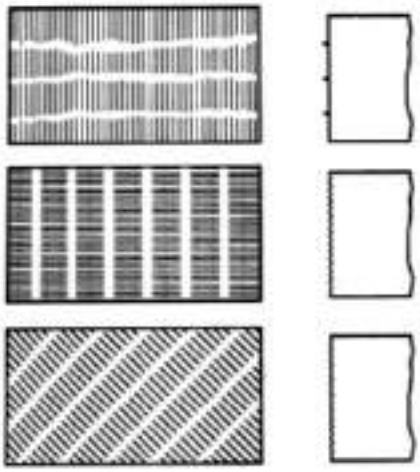


Fig. 7.4 : Rough Tooled Stone Surface

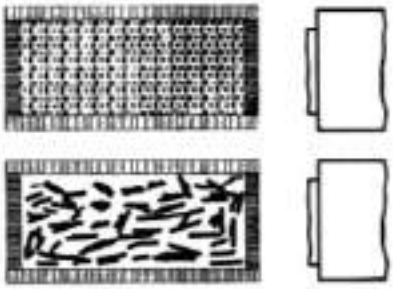


Fig. 7.5 : Punched Stone Face Surface
(Chisel drafted)

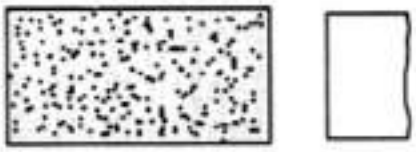


Fig. 7.6 : Closed Picked Stone Surface

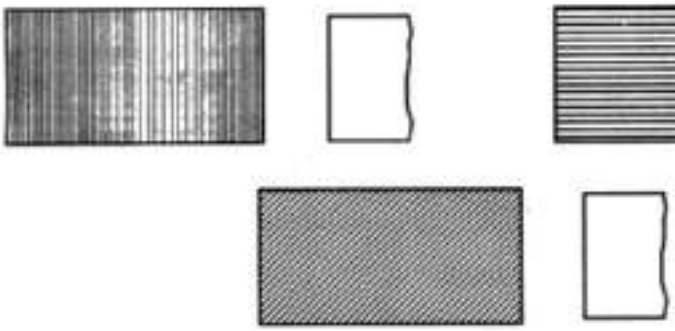
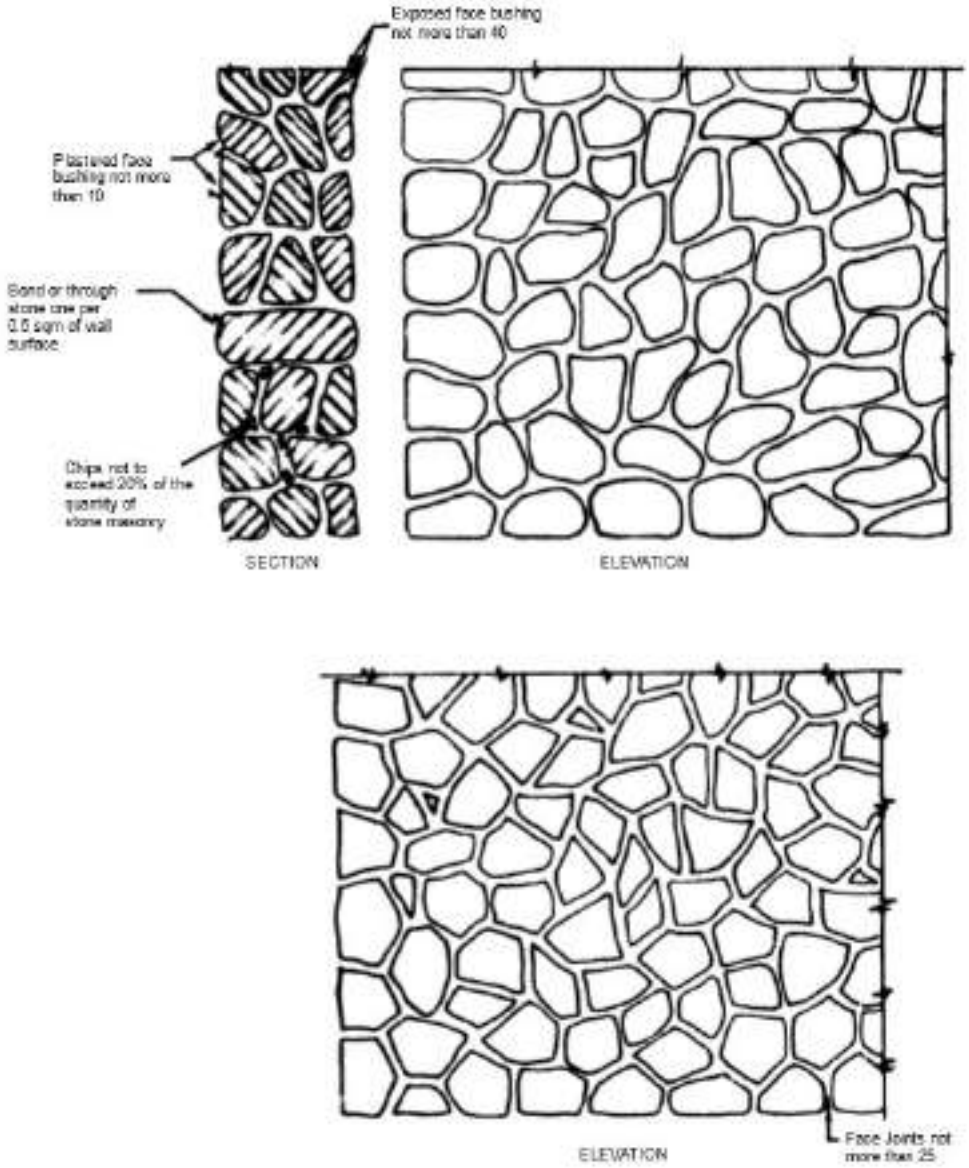


Fig. 7.7 : Fine Tooled Stone Surface

Drawing not to scale

RANDOM RUBBLE MASONRY

Sub Head : Stone Work
Clause : 7.1

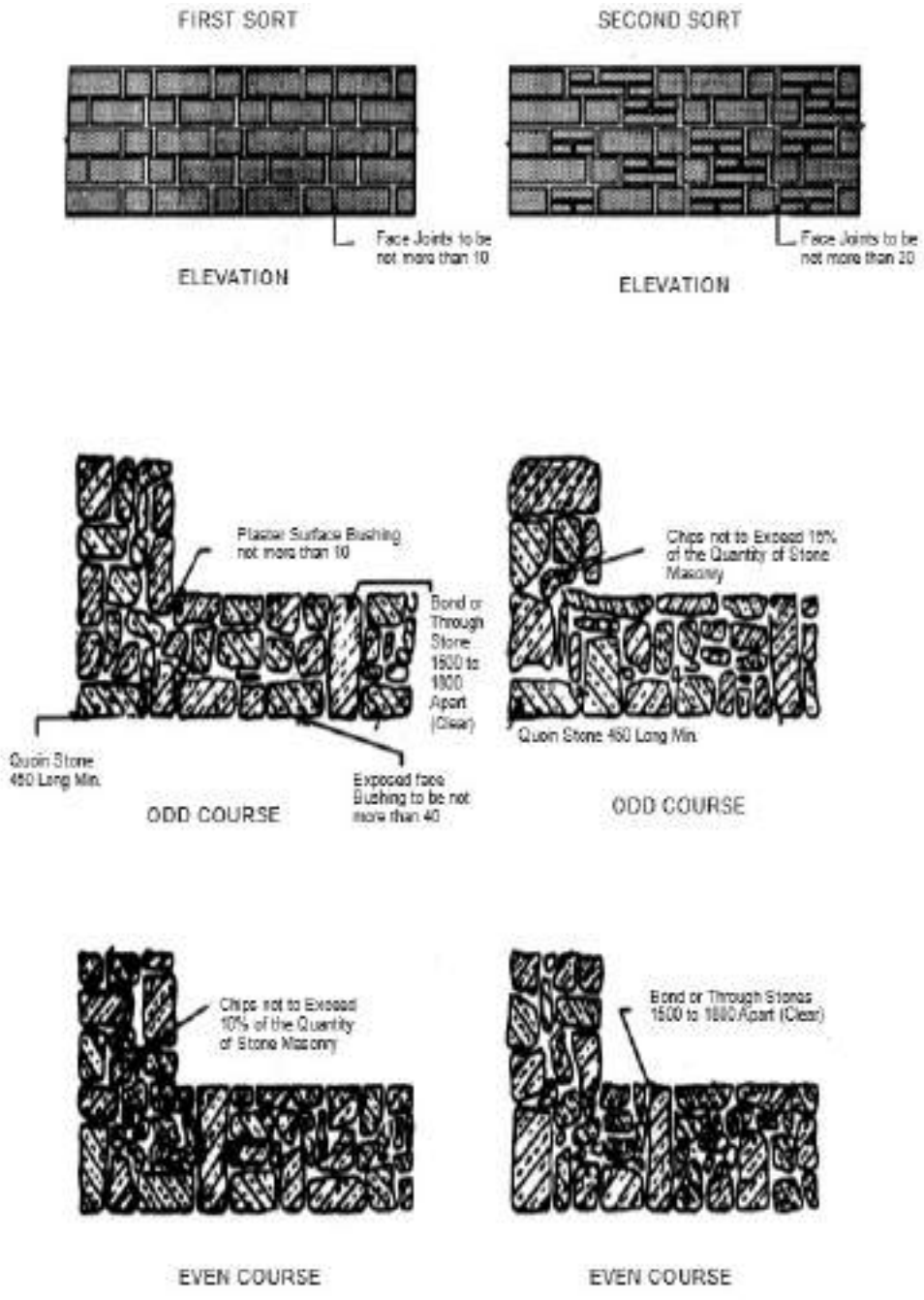


Drawing not to scale
All dimensions are in mm

Fig. 7.8 : Random Rubble Masonry

RUBBLE STONE MASONRY - COURSED

Sub Head : Stone Work
Clause : 7.2 & 7.3

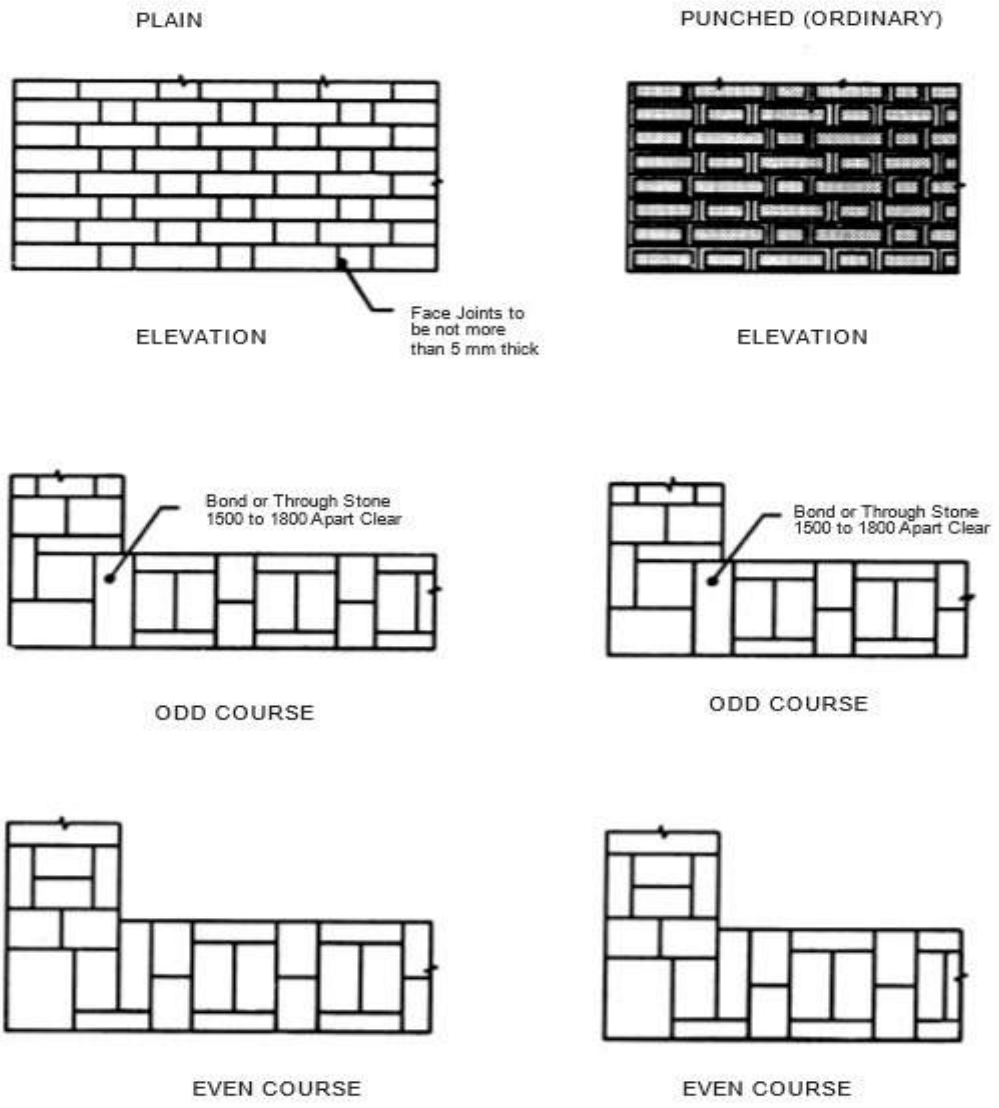


Drawing not to Scale
All dimensions are in mm

Fig. 7.9 : Rubble Stone Masonry – Coursed

ASHLAR STONE MASONRY

Sub Head : Stone Work
Clause : 7.4 & 7.5

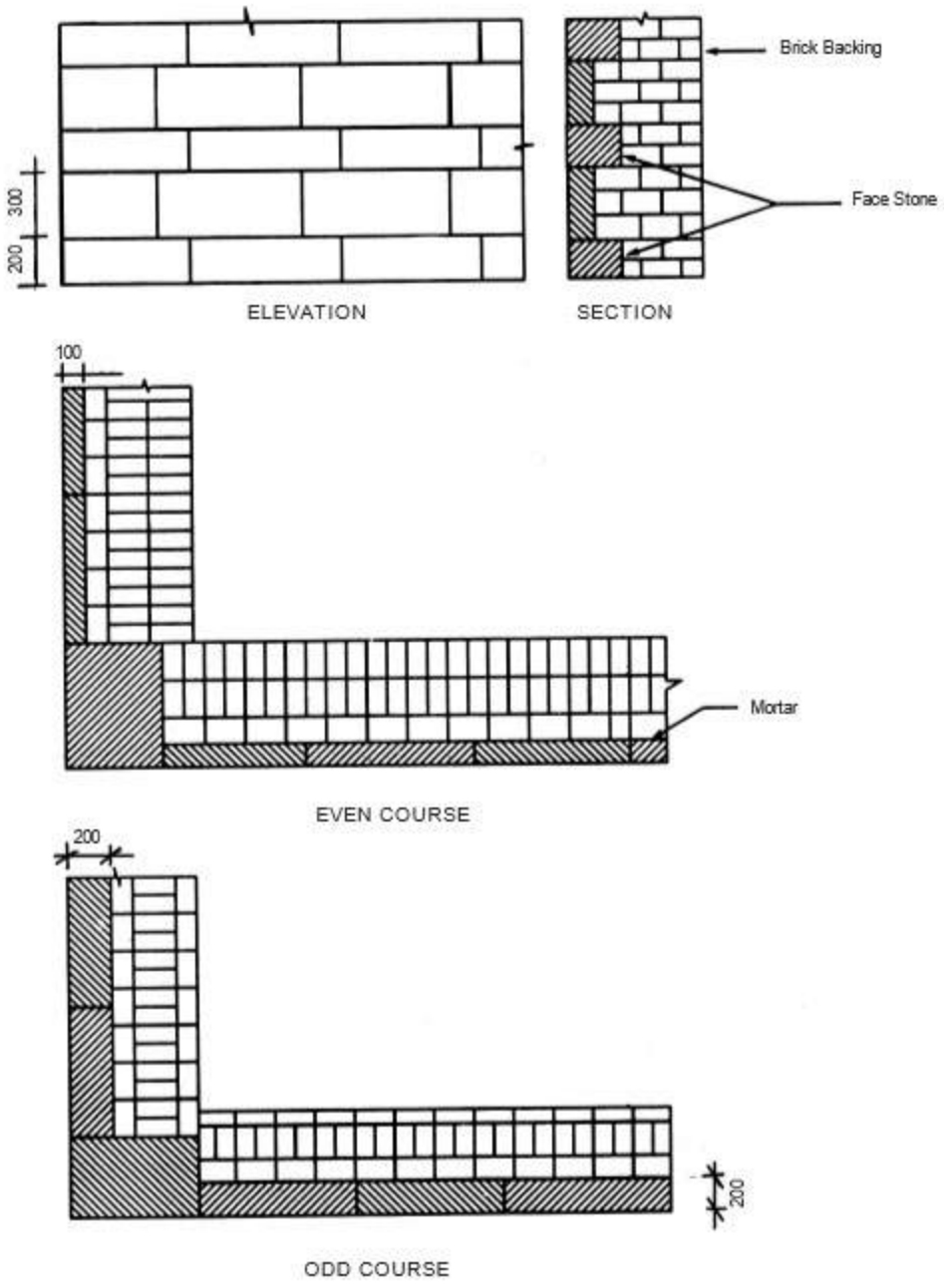


Drawing not to scale
All dimensions are in mm

Fig. 7.10 : Ashlar Stone Masonry

ASHLAR STONE MASONRY (WITH BRICK BACKING)

Sub Head : Stone Work
Clause : 7.4.5

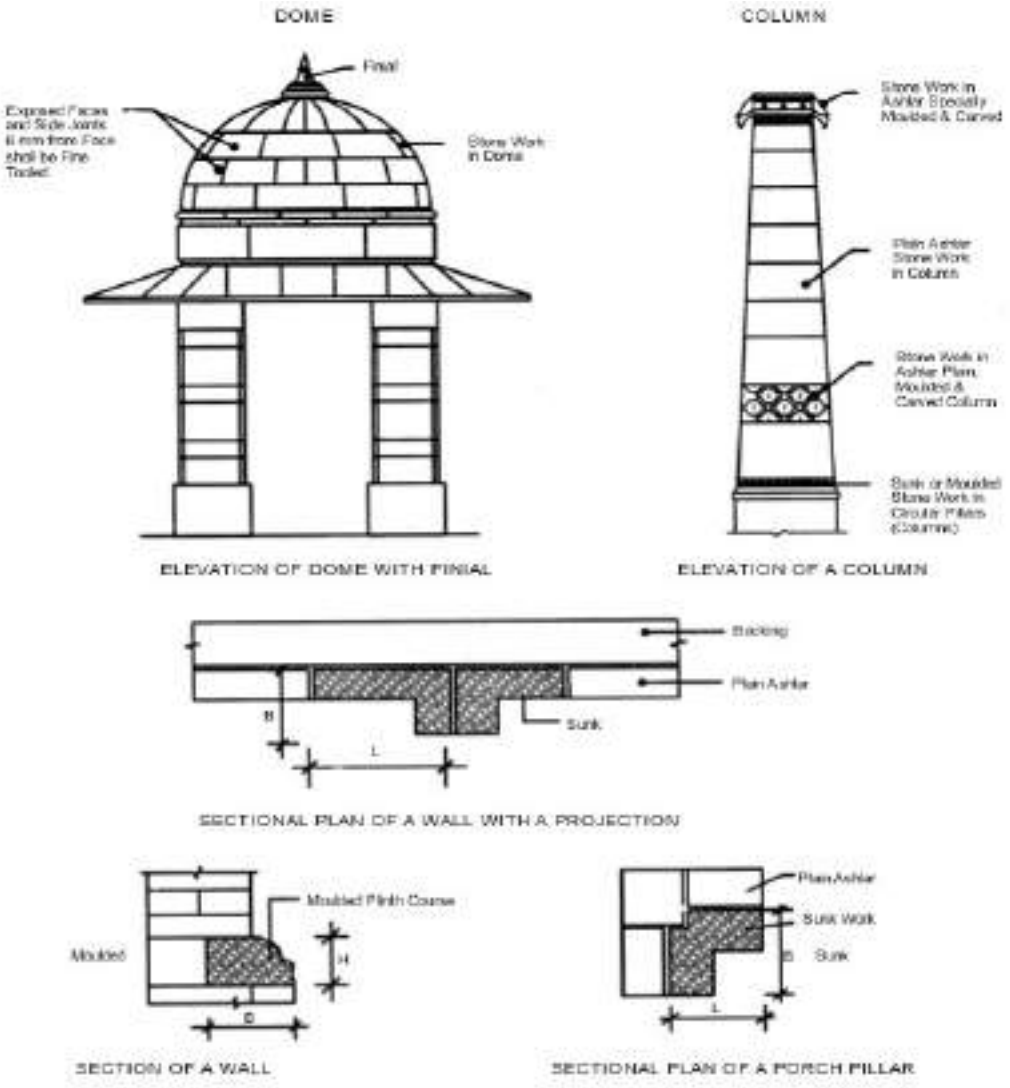


Drawing not to scale
All dimensions are in mm

Fig. 7.11 : Ashlar Stone Masonry (with Brick Backing)

MOULDED, SUNK, CARVED – STONE WORK

Sub Head : Stone Work
Clause : 7.6



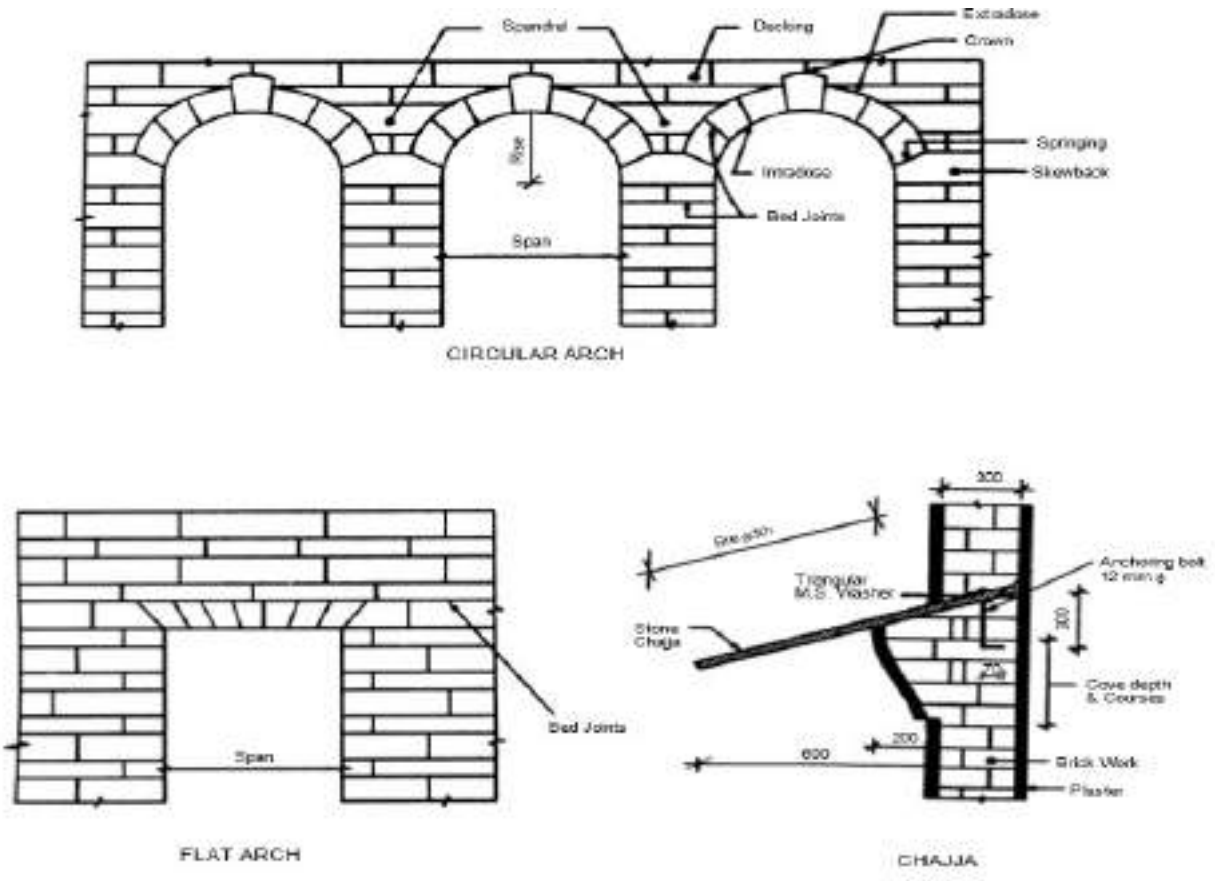
Note : Sunk or Moulded Stone Work shown Shaded, to be measured as l x b x h

Drawing not to scale

Fig. 7.12 : Moulded, Sunk, Carved – Stone Work

STONE WORK IN ARCHES & CHAJJAS

Sub Head : Stone Work
Clause : 7.6 & 7.8



Drawing not to scale
All dimensions are in mm

Fig. 7.13 : Stone Work in Arches & Chajjas

Note: Fig. 7.14, 7.15 & 7.16 shifted to Fig 8.5, 8.6 & 8.7.

SUB HEAD : 8.0

CLADDING WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	305
	List of Bureau of Indian Standard Codes	307
8.0	General	308
8.1	Classification	308
8.2	Sizes and Tolerances	309
8.3	Physical Properties	310
8.4	Sampling	310
8.5	Marble Work - Table Rubbed and Polished (Plain Work)	311
8.6	Wall Lining / Veneer Work	313
8.7	Marble Stone Flooring and Marble Stone in Risers of Steps and Skirting	315
8.8	Stone Veneering work	316
8.9	Wall lining butch work with dholpur stone	318
8.10	Kota Stone Veneering work	320
8.11	Extra for stone work for wall lining	322
8.12	Dry stone cladding	323
8.13	Structural steel frame work for dry stone cladding	324
8.14	Adjustable Stainless steel cramps	325
8.15	Wall lining	325
8.16	Veneered decorative plywood	326
8.17	Coir veneer board for general purposes	327
8.18	Prelaminated particle board	328

8.19	Pressed ceramic tiles in skirting and dado	330
8.20	Laminated sandwiched composite panel cladding system and associated works	331
Fig. 8.1	Marble Stone Veneering (General Fixing Arrangement)	336
Fig. 8.2	Marble Stone Veneering (Typical Fixing Arrangement)	337
Fig. 8.3	General Arrangement of Cramps	338
Fig. 8.4	Marble Slab Urinal Partition	339
Fig. 8.5	Stone Veneering	340
Fig. 8.6	Stone Veneering (Typical Fixing Arrangement)	341
Fig. 8.7	General Arrangement of Cramps	342

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory Test*	*Test*	*Minimum quantity of material/ work for carrying out the test*	*Frequencyof testing*
Marble	8.3 (Table 8.2)	(i) Moisture Absorption	Laboratory	IS 1124	50 Sq.m.	100 sqm. or part thereof.
		(ii) Hardness Test	-do-	Mho's Scale	-do-	-do-
		(iii) Specific Gravity	-do-	IS 1122	-do-	-do-
Granite		(i) Moisture	-do-	IS 1124	-do-	-do-
		(ii) Specific Gravity	-do-	IS 1122	-do-	-do-

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*IS. No.*	*Subject*
1.	IS 848	Specification for synthetic resin adhesives for plywood (Phenolic and Aminoplastic
2.	IS 1122	Method of test for determination of true specific gravity of naturalbuilding stones.
3.	IS 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
4.	IS 1130	Marble (blocks, slabs and tiles).
5.	IS 1328	Specification for Veneered decorative plywood
6.	IS 1734 (Part-1)	Methods of test for plywood
7.	IS 2380	Methods of test for wood particle boards and boards from other lignocellulosic materials
8.	IS 3316	Specifications for structural granite
9.	IS 3734 (Part-1)	Rubber – Tolerance for products
10.	IS 4101 (Part 1)	Code of practice for external facing and veneers: Stone facing.
11.	IS 7638	Wood/Lignocellulosic based panel products – Methods of sampling
12.	IS 12049	Dimensions and tolerances relating to wood based panel materials
13.	IS 12823	Wood products – Prelaminated particle boards - Specification
14.	IS 14223 (Part 1)	Polished Building Stones (Part-1) Granite
15.	IS 14842	Coir Veneer board for general purposes – Specification

8.0 MARBLE WORK

8.0 GENERAL

Marble shall be hard, sound, dense and homogeneous in texture with crystaline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

8.0.1 Marbles are metamorphic rocks capable of taking polish, formed from the re-crystalization of lime stones or dolomitic lime stones and are distinguished from lime stone by even visibly crystalined nature and nonflaggy stratification.

Note : Marble is a product of nature hence it is difficult to guarantee uniformity of colour, veining or other characteristics that may be represented in any sample submitted. A sample will indicate only an average of colour, veining and other general texture and specified finish.

8.1 CLASSIFICATION

The marble blocks, slabs and tiles shall be classified broadly in the following two categories:

8.1.1 White Marble

Raj Nagar (plain white) Marble:

It shall be plain white marble with coarse grains predominantly showing mica particles giving reflection in light.

8.1.2 Coloured Marble

(i) Plain Black Marble

Black marble sawn along veins locally known as 'Peta Pasu sawing' available at Bhainslana.

(ii) Black Zebra Marble

(a) Bhainslana Black Zebra Marble: Black marble having grey or white veins available at Bhainslana.

(b) Kishangarh Black Zebra Marble: Black marble with grey and/or white veins available at Kishangarh.

(c) Abu Black Zebra Marble: Black marble having white patches and streaks available at Abu.

(d) Narnaul Black Zebra Marbles: Black marble with thin white veins available at Narnaul.

(e) Makrana Dhobi Doongri Zebra Marble: Greyish black marble with white flowery pattern available at Dhobi Doongri.

(iii) Green Marble

(a) Baroda Green Marble: Dark green marble with flowery pattern available at Baroda.

(b) Abu Green Marble: Light green marble with green and/or brown streaks on white ground available at Ambaji.

(c) Falna Green Marble: Green marble with prominent yellowish pattern available at Falna.

(d) Bundi Green Marble: Green marble with pinkish shades available at Umar, (Bundi).

(iv) Grey Marble

(a) Kumari Grey Marble: Grey marble having light blue shades available at Makrana.

(b) Bundi Grey Marble: Grey Marble with pink or green or black streaks available at Umar (Bundi).

(v) Brown Marble

(a) Bar Brown Marble/Brown Marble with light and dark brown shades available at Bar.

(b) Narnaul Brown Marble

Brown marble having teak wood shades available at Narnaul.

8.1.3 Granite Stone

It shall be of any colour and size as directed by Engineer-in -Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

8.2 SIZES AND TOLERANCES

The size of marble blocks, slabs and tiles shall be as mentioned in Table 8.1.

TABLE 8.1

Sl.No	Type	*Length*	*Width*	*Thickness*
1.	Blocks	30 to 250	30 to 100	30 to 90
2.	Slabs	70 to 250	30 to 100	2 to 15
3.	Tiles	10 to 60	10 to 60	0.8 to 2.4

(1) All dimensions are in centimetre.

(2) The length and width, of the blocks shall be in multiple of 30 cm.

(3) Length and width of slab shall be in multiple of 10 cm. and thickness in multiple of 1 cm.

(4) Tiles shall be square cut and linear dimensions in multiple of 10 cm.

(5) Only slabs and tiles shall be machine cut and factory made.

(6) For 8 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

Tolerance

The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

Type	**Tolerance**
Blocks	
(a) Length	+ 2 per cent
(b) Width	+ 2 per cent
(c) Thickness	+ 2 per cent
Slabs	
(a) Length	+ 2 per cent
(b) Width	+ 2 per cent
(c) Thickness	+ 3 per cent
Tiles	
(a) Linear dimension	+ 3 per cent
(b) Thickness	+ 1 per cent

The sizes other than those mentioned above may be provided as directed by the Engineer-in-Charge and nothing extra shall be payble on this account.

8.3 PHYSICAL PROPERTIES

8.3.1 The physical properties of marble for blocks, slabs and tiles and method of tests are mentioned in Table 8.2.

TABLE 8.2
Physical Properties of Marble & Granite

Characteristic	Marble		Granite	
(1) Moisture absorp- tion after 24 hrs immersion in cold water	Max. 0.4%	IS 1124	Max. 0.50% by weight	IS 1124
(2) Hardness	Min. 3	Mhos scale	-	-
(3) Specific Gravity	Min. 2.5	IS 1122	Min. 2.6	IS 1122

8.3.2 Approval of Sample

Before starting the work, the contractor shall get samples of marble approved by the Engineer-in-Charge. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

8.4 SAMPLING

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table 8.3.

TABLE 8.3
Sample Size and Criteria for Conformity

Number of Blocks slabs/Tiles in the lot	*Number of blocks slabs/ Tiles to be selected in sample*	*Permissible number of defectives*	*Sub Sample size in no.*
(1)	*(2)*	*(3)*	*(4)*
Up to 25	3	0	2
26 to 100	5	0	2
101 to 200	8	0	3
201 to 500	13	0	4
501 to 1000	20	1	5

Note: The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

Explanation 1 : All the blocks/slabs/tiles, selected in the sample, shall be examined for dimensions workmanship and general requirements.

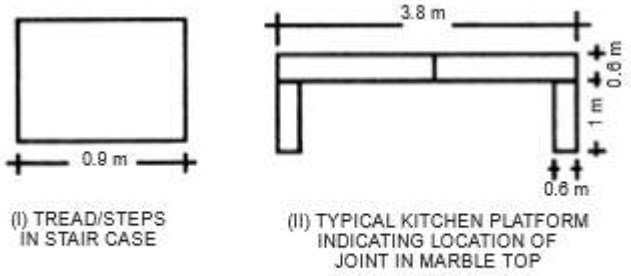
Any block/slab/tile failing in any one or more of the above requirements shall be considered as defective. A lot shall be considered as conforming to these requirements if the number of defectives obtained is not more than permissible no. of defectives given in Col. 3 of table 8.3

Explanation 2 : The lot having been found satisfactory with respect to dimensions, workmanship and general requirement shall be tested for physical properties of the marble. For this purpose a sub sample of the size given in Col. 4 of Table 8.3 shall be selected at random. These blocks/slabs/tiles in the sub sample shall be tested for moisture absorption, hardness and specified gravity. The lot shall be considered having satisfied the requirements of the physical properties if none of the blocks/ slabs/tiles tested for the requirements fails in any of these tests.

8.5 MARBLE WORK - TABLE RUBBED AND POLISHED (PLAIN WORK)

Marble work in steps, jambs, columns and other plain work shall be as specified below:

Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/ length is more than 0.6/2 mtrs. respectively. Number of joints in each direction shall not be more than one number for every 2 mtrs. length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provide judiciously as given in sketch 'A' below.

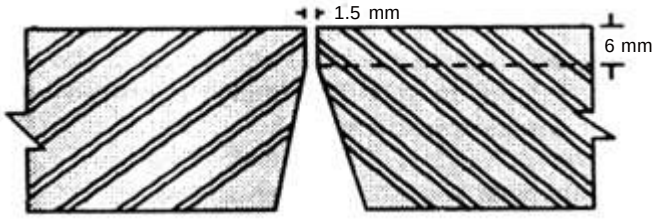


SKETCH (A)

8.5.1 Dressing, Cutting and Rubbing

Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required. The exposed faces and sides of stones forming joints upto 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineer-in-Charge. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape as shown in Fig. below. The surfaces of the stones coming in contact with backing need not be chisel dressed.

EXTERNAL FACE



INVERTED V-SHAPE JOINT

A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer-in Charge.

8.5.2 Mortar

The mortar used for jointing shall be as specified.

8.5.3 Laying

All marble stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truely in plumb or battered as shown in the drawings. All courses shall be laid truely horizontal and all vertical joints shall be truely vertical.

In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified.

For work facing with backing of brick work or coursed rubble masonry, face stone shall be laid in alternate courses of header and stretchers unless otherwise directed. Face stone and bond stone courses shall have break joint on the face of atleast half the height of the standard course and the bond shall be carefully maintained through out. All the connected masonry in a structure shall be carried up nearly at one uniform level throughout but where breaks are unavoidable the joints shall be made in good long steps so as to prevent cracks developing between new and old work.

When necessary jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these in to correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before putting chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work. The matching of grains shall be carried out as directed by the Engineer-in-Charge.

8.5.4 Bond Stone

Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by atleast 15 cm shall be provided in a line from face to back.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-in-Charge.

8.5.5 Joints

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

8.5.6 Curing

The work shall be kept constantly moist on all faces for a period of atleast seven days.

8.5.7 Finishing

After the marble work is cured, it shall be rubbed with carborandum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos.in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

8.5.8 Protection

Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

8.5.9 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

8.5.10 Tolerances

As per para 8.2

Note: The above Para 8.5. also applies to the Ashlar masonry referred in Chapter No. 7.0 - Stone Work.

8.5.11 Measurements

For plain work: Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

8.5.11.1 In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimetre and thickness, correct to 0.5 cm.

The cubical contents shall be calculated in cubic decimetre nearest to two places of decimal.

8.5.11.2 The marble work in arches and domes shall be measured as for plain work, but extra shall be allowed for such work over the rate for plain work.

8. 5.11.3 Sunk or moulded work in marble shall be measured by volume as per plain marble work or work in arches or domes as the case may be on the basis of circumscribed rectangular block of the finished work but extra shall be paid for such work over the rate for plain work for work in arches and domes. For the purpose of extra payment, volume of every stone sunk or moulded shall be considered.

8.5.12 Rate

The rate includes the cost of materials and labour required for all the operations i/c cutting of recesses in wall cutting moulding corners edge rounding finishing & polishing as specified.

8.5.13 Use of Finished Marble Slabs and Tiles

In case such finished tiles are used, these shall be measured and paid for separately.

8.6 WALL LINING/VENEER WORK

8.6.1 Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given in Table 8.1 above.

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible under para 8.2 above. The tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2 mm.

8.6.2 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed.

8.6.2.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

8.6.2.2 The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 × 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members cramps shall be of 25 × 6 mm and length as per requirement made out of gun metal or any other metal specified in para 8.6.2.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape & details of cramps for such backing are as indicated in Fig. 8.2 for general guidance. This can be modified as directed by the Engineer-in-Charge if so, required at site. Cramps shall be spaced not more 60 cm apart horizontally.

Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.1.

8.6.2.3 The adjoining stones shall be secured to each other by means of gun metal cramps or copper pins of the specified size. Cramps may be attached to its sides (see Fig. 8.3A, 8.3B) or top and bottom (See Fig. 8.3C, D, E, F) or sides, top and bottom (see Fig. 8.3G, 8.3H) . The general arrangement of cramps required for fixing facing unit to the wall are illustrated in Fig 8.3. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.6.2.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facings above.

8.6.2.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS 4101 (Part 1).

8.6.2.6 The cramps may be of copper alloyed with zinc, tin, nickel, lead or stainless steel.

8.6.2.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.6.3 Joints

All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and relaid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.

8.6.4 Mortar

The mortar used for jointing slabs shall be as specified.

8.6.5 Curing, Finishing, Protection and Scaffolding

It shall be as specified under 8.5.6, 8.5.7, 8.5.8 and 8.5.9.

8.6.6 Measurements

The length and breadth shall be measured correct to a cm. In case of radially dressed or circular slabs used in the work, the dimensions of the circumscribing rectangles of the dressed stone used in the work, shall be measured & paid for. The area shall be calculated in sqm nearest to two places of decimal.

Marble work in lining upto 4 cm thickness shall be paid by area under veneer work and lining of greater thickness paid by volume under plain marble work.

8.6.7 Rate

The rate includes the cost of materials and labour required for all the operations described above except for the cost of providing and fixing of dowel and cramps which shall be paid for separately, unless otherwise stipulated in the item of work.

When factory made finished slabs and tiles are used, no further finishing as mentioned in para 8.5.7 shall be required nor anything extra shall be payable.

8.7 MARBLE STONE FLOORING AND MARBLE STONE IN RISERS OF STEPS AND SKIRTING

Refer to relevant clause in subhead 11.0 of flooring of CPWD Specifications 2019.

8.7.0 Marble Slab Urinal Partitions

The partitions shall be of marble slab embedded in the wall. The size and shape of the marbles slab shall be as per direction of Engineer-in-Charge. The finished thickness shall be 18 mm. The specifications for marble/granite stone work, in general, shall be as specified. The marble granite stone shall be cut into slabs of required thickness and shall be one piece. (Fig. 8.4).

8.7.1 Finishing

The partition of the slab to be embedded in the masonry shall be rough dressed. Dressing and rubbing of the exposed portion of the slab shall be as described. The dressed slab shall be of the thickness as specified with a tolerance of $\pm$ 1.5mm. The slab shall be got approved from the Engineer-in-Charge before fixing.

8.7.2 Fixing shall be as specified except that the recess shall be 7.5 cm wide. Fixing shall be done by cutting chase with chase cutter/fine tools in a recess of 7.5 cm X 7.5 cm filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6mm nominal size). Fixing can also be done by epoxy grout in a chase of 2.0 X 7.5 cm as per direction of Engineer-in-Charge.

8.7.3 Measurement shall be as per para 8.6.6.

8.7.4 Rate shall include the cost of labour and materials involved in all the operations described above including the leaving/cutting of recess in the wall, moulding, curves, edge rounding, finishing and polishing as specified.

8.8 STONE VENEERING WORK (FIG. 8.5, 8.6 & 8.7)

Stone lining upto 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

8.8.1 Stone : Shall be as specified in 7.4.1.

The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

8.8.2 Dressing: Shall be as specified in 7.4.3 except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of ± 2 mm.

8.8.3 Mortar

Mortar for fixing shall be as specified.

8.8.4 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.8.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

8.8.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of stainless steel or any other metal specified in para 7.7.4.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 7.15 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally.

Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 7.14 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.8.4.3 Cramps may be attached to its sides (see Fig. 7.16A, 7.16B) or top and bottom (see Fig. 7.16C to F) or sides, top and bottom (see Fig. 7.16G & H). The minimum number of cramps required for fixing facing unit to the wall are illustrated in Fig. 7.16. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.8.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.8.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.8.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.

8.8.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.8.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.8.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.8.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand) . All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow groundings are detected by taping the face stones, these shall be taken out and relaid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout.

Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.8.6 Other Details

Specifications for pointing, curing, protections and scaffolding shall be specified under 7.4.

8.8.7 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.8.8 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

Note: Clause 8.8 brought from Sub Head 7 (Stone Work) clause 7.7.

8.9 WALL LINING BUTCH WORK WITH DHOLPUR STONE

8.9.0 Stone lining upto 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

8.9.1 Stone : The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough, free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

8.9.2 Dressing: Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings. A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of ± 2 mm.

8.9.3 Mortar

Mortar for fixing shall be as specified.

8.9.4 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.9.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins75 mm long and 6 mm diameter or as specified.

8.9.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper

alloyed with zinc or nickel or of stainless steel of grade 304. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 8.6 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.5 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.9.4.3 Cramps may be attached to its sides (see Fig. 8.7A, 8.7B) or top and bottom (see Fig. 8.7C to 8.7F) or sides, top and bottom (see Fig. 8.7G & H). The minimum number of cramps required for fixing facing unit to the wall is illustrated in Fig. 8.7. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.9.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.9.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.9.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.

8.9.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.9.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.9.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.9.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding are detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.9.6 Other Details

8.9.6.1 Pointing

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15mm.

8.9.6.2 Curing

Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

8.9.6.3 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

8.9.6.4 Scaffolding

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.

8.9.7 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.9.8 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

8.10 Kota Stone Veneering work

8.10.1 Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall be of colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished/rough chiselled before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of kota stone approved from the Engineer-in- Charge.

8.10.2 Dressing : Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of ± 2 mm shall be allowed for the thickness.

A sample of dressed kota stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

8.10.3 Mortar

Mortar for fixing shall be as specified.

8.10.4 Laying
The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.10.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins75 mm long and 6 mm diameter or as specified.

8.10.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper alloyed with zinc or nickel or of stainless steel of grade 316. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. typical shape and details of cramps for such backing are indicated. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. The adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.10.4.3 The minimum number of cramps required for fixing facing unit to the wall. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

8.10.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

8.10.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

8.10.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 316.

8.10.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.10.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

8.10.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

8.10.5 Joints

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding are detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

8.10.6 Laying

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort. The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All Kota Stone shall be laid truly horizontal and all vertical joints shall be truly vertical. It shall be handled carefully. No piece which has been damaged shall be used in work.

8.10.7 Curing

Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

8.10.8 Protections

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

8.10.9 Scaffolding

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.

8.10.10 Measurements

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

8.10.11 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

8.11 EXTRA FOR STONE WORK FOR WALL LINING

8.11.1 The stone lining work shall be executed at site as per the relevant item. All the specification shall be follows as per relevant items. The exterior stone work at height greater than 10.0 m from average ground level shall be measured separately.

8.11.2 Scaffolding
For all exposed stone work double scaffolding independent of the work 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.

8.11.3 Measurement :-The Exterior stone work at a height greater than 10 .0 meter from ground level shall be measured separately for every additional story height 3.0 meter or part thereof .

The Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres upto two places of decimal. The area of stone work at every additional height of 3.0 m shall be added with the consequent lower story height of 3.0 m means after stone work height at greater than 10.0 m. first area of 3.0 m height (at 13.00 meter) shall be measured one times and second area of next 3.0 m height (16.0 m) shall be measured two times and third area of next 3.0 m height (19.00 meter) shall be measured three times and so on.

8.12 DRY STONE CLADDING

8.12.1 Material
Stone shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified

Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of $\pm$ 2 mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-In-charge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

8.12.2 Stacking and Storing
Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

8.12.3 Scaffolding
As specified in 7.4.11.

8.12.4 Fixing
The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.

Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

8.12.5 ***Jointing:*** Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer -in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

8.12.6 ***Protection:*** Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

8.12.7 ***Measurement:*** The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

8.12.8 Rate: The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

Note: Clause 8.12 brought from Sub Head 7 (Stone Work) clause 7.11.

8.13 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

8.13.1 Fixing of Frame

The properly designed structural frame for withstanding the weight of stone slab are fixed/ supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centring/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

8.13.2 Measurement

The mode of measurement shall be the same, as specified for steel work in built up section except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centring and shuttering and making holes in walls, but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

8.13.3 Rate

The rate shall include the cost of all labour and material involved in all the operation described above.

Note: Clause 8.13 brought from Sub Head 7 (Stone Work) clause 7.12.

8.14 ADJUSTABLE STAINLESS STEEL CRAMPS

The cramps shall be stainless steel of make approved by the Engineer-in-charge.

8.14.1 The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.

8.14.2 Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

8.14.3 Necessary recessed are required to be done in stone slab which is required to be supported by clamps.

8.14.4 The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.

8.14.5 The rate includes cost of materials and other operations mentioned as above.

Note: Clause 8.14 brought from Sub Head 7 (Stone Work) clause 7.13.

8.15 WALL LINING

8.15.0 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided.

8.15.1 Grounds

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement : 3 fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimetres centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

8.15.2 Panelling

8.15.2.1 ***Material :*** This panelling shall be decorative or non -decorative (Paintable) type as per design and thickness specified by the Engineer- in- Charge, of 2nd class teak wood, FPT-1 or graded wood prelaminated particle board or as specified in item.

8.15.2.2 ***Ornamental Work :*** The ornamental wood work shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The ornamental work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The planks for wall lining shall be tongued and grooved, unless otherwise specified.

8.15.2.3 ***Measurements :*** Length and breadth shall be measured correct to a cm. Wall panelling such as teakwood panelling and block panelling, plain lining, and plain skirting each shall be measured separately in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm.

The measurements for ground shall be taken on the basis of cubical contents of battens and paid for separately, unless otherwise specified.

Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

8.15.2.4 ***Rate :*** The rate includes the cost of materials and labour required for all the operation described above.

Note: Clause 8.15 brought from Sub Head 9 (Wood and PVC Work) clause 9.9.

8.16 VENEERED DECORATIVE PLYWOOD

8.16.1 Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1328.

8.16.1.1 Requirement of Type-I Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots decolourisation and sapwood.

(c) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 8.16.1.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

8.16.2 ***Adhesive :***The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

8.16.3 ***Dimensions and Tolerances:***

8.16.3.1 The dimensions of plywood boards shall be as follows:

2400 mm x 1200 mm	2100 mm x 900 mm
2100 mm x 1200 mm	1800 mm x 900 mm
1800 mm x 1200 mm	

8.16.3.2 ***Thickness:*** The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

Note: Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

8.16.3.3 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as follows:

Dimension	*Tolerance*
Length	*+6 mm-0*
Width	*+3 mm-0 mm*
Thickness *(i) Less than 6 mm*	+ 10 per cent
(ii) 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm Or 0.2 per cent
Squareness	2 mm per 1000 mm Or 0.2 per cent

Note: Edge straightness and squareness shall be tested as per Appendix I of CPWD Specifications.

8.16.4 ***Finish :***The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in 8.16.3.3

8.16.5 ***Sampling and Criteria for Conformity :***The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

8.16.6*Tests :*Boards shall be subjected to following tests :

(i) Moisture content: Decorative veneered plywood of either type when tested in accordance with IS1734 (Pt. I) shall have moisture content not less than 5 per cent and not more than 15 percent.

(ii) Water Resistance Test : Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 +2^{0}C for a period of 3 hours and dried for 8 hours at a temperature of 65 + 2^{0}C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

8.16.7 ***Marking :***Each plywood bound shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

(a) Indication of the source of manufacture

(b) Year of manufacture

(c) Batch no.

(d) Type of plywood

(e) Criteria for which the plywood has been labelled as ECO mark

The decorative veneered plywood may also be marked with standard BIS certification mark.

8.16.8 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.16.9 Rates:-The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which shall be paid separately.

8.17 COIR VENEER BOARD FOR GENERAL PURPOSES

8.17.1 Coir veneer board is manufactured with a combination of coconut fibre needled felt, veneer and jute fibres with craft paper coconut fibre. Needled felt can be used as core cross bands or as outer skin formed with jute fibres and craft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needled.

8.17.2 Coir veneer board generally shall conform to IS 14842.

Grades

Coir veneer board for general purposes shall be of two grades:

(a) Boiling water resistant (BWR) grade

(b) Moisture resistant (MR) grade

8.17.3 ***Material***

*(a) Coconut Fibre :*Coconut fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 gm/m^2.

*(b) Jute :*Jute fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 gm/m^2.

*(c) Adhesive :*Adhesive for manufacture of coir veneer board shall be conform to BWR/MR of IS 848for BWR/MR grade boards respectively.

(d) Veneer : Any species of timber may be used for the manufacture of veneers.

*(e) Kraft Paper :*Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 gm/m^2.

8.17.4 Permissible Defects: Gap in cores and cross band shall not be permitted. Splits in cores and cross bands may be permitted to an extent of 2 per core or cross band and overlap shall be permitted in core/cross bands only.

8.17.5 The Dimensions and Tolerances: The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12049.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 18 mm,20 mm and 25 mm.

The following tolerance on nominal thickness shall be permissible.

(a) Less than 6 mm + 10%
(b) 6 mm and above + 5%

8.17.6 Workmanship and Finish: Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The squareness and edge straightness of the board shall be as per para 9 of IS 12842 and Appendix J.

8.17.7 Sampling: The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

8.17.8 Tests: The tests shall be carried out as specified in IS 14842 – Appendix K.

8.17.9 Moisture Content: Coir veneer board when tested in accordance with IS 3734 (Part-I) shall have a moisture content not less than 5 percent and not more than 15 percent.

8.17.10 Marking: Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner.

(a) Identification of source

(b) Year of manufacturing

(c) Batch no.

(d) The grade and type as follows.

(i) Boiling water resistant (BWR) and

(ii) Moisture resistant (MR)

8.17.11 *BIS Certification Marking :* Coir veneer board may also be marked with the standard mark governed by the BIS Act, 1986.

8.17.12 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.17.13 Rates:- The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

8.18 PRELAMINATED PARTICLE BOARDS

8.18.1 Pre-laminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type –I, II, III, IV.

8.18.2 Material

8.18.2.1 Particle Board Pre-laminated particle board Grade-1 (FPT–I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and pre-laminated conforming to IS 12823 Grade-I, type II or I shall be used.

8.18.2.2 *Impregnated Base Paper* : Printed or plain coloured absorbent base paper having a weight of60-140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of particle board.

8.18.2.3 *Impregnant Overlay :*An absorbent tissue paper having a weight of 18-40 gm/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

8.18.3 ***Dimension and Tolerances***

8.18.3.1 Dimensions of pre-laminated particle boards shall be as follows:

Length : The length of pre-laminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1,1.8, 1.5, 1.2, 1.0 and 0.9 metres.

Width : The width of pre-laminated particle boards shall 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and0.45 metres.

Thickness : The thickness of pre-laminated particle boards shall be 6, 9, 12, 15, 20, 25, 30,35, 40 and 45 mm.

8.18.3.2 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	+ 6 mm - 0
Width	+ 3 mm - 0
Thickness	5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per IS 12823.

8.18.4 ***Sampling and Inspection*** **:** The number of pre-laminated particle board to be selected from a lot shall be in accordance with the Table 8.4 given below:

TABLE 8.4

Lot Size	Number of pre-laminated boards to be selected
Upto 50	**2**
51 to 100	**3**
101 to 200	**4**
201 to 300	**5**
301 to 500	**7**
501 and above	**10**

8.18.4.1 The pre-laminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the pre-laminated particle boards in the lot may be arranged in a serial order and every pre-laminated particle board may be selected till the required number is obtained, 'r' being the integral part of N/n, where N is the lot size and n is the sample size.

8.18.4.2 All board selected as given in para 8.18.4.1 shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 8.18.3.2.

8.18.4.3 ***Testing and Number of Tests :*** For each of particle board selected as per para8.18.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

8.18.4.4 ***Criteria for Conformity:*** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 8.18.4 & 8.18.4.3 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be consideredas passed, if all these samples conform to the specified requirement.

8.18.4.5 ***Marking :*** Each pre-laminated particle board shall be legibly and indelibly marked on any of its edges with following :

(a) Indication of source of manufacturer

(b) Grade and type of pre-laminated particle board

(c) Thickness

(d) Batch number and year of manufacture

8.18.5 Measurement:- Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

8.18.6 Rates:-The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

8.19 PRESSED CERAMIC TILES IN SKIRTING AND DADO

8.19.1 The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. 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 free from glaze, however, any glaze if unavoidable shall be permissible on only upto 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

8.19.1 (a) Dimensions and Tolerances

Glazed pressed cramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified. above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cronices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

8.19.2 Preparation of Surfaces

The joints shall be raked out to a depth of at least 15 mm in masonry walls.

In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

8.19.3 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished “surface of wall” by more than the tile thickness, undulations if any shall be adjusted in wall.

8.19.4 Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

8.19.5 Measurements

Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

8.19.6 Rates

The rate shall include the cost of all material and labour involved in all the operations described above, for tiles of sizes upto 0.14 sqm. unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

Note : Clause 8.19 brought from Sub Head 11 (Flooring) clause 11.18

8.20 CURTAIN WALL WITH ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

8.20.1 General

1. All composite aluminum panels shall have a thickness of 4.00mm.
2. The composite cladding panels shall be of cassette type, framed with an extrude aluminum profile.
3. All fasteners shall be concealed within the panel joints. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction. The fixing of these panels shall accommodate the expected structural movements in the building.

4. With a gloss of 30% according to Gardner Scale, the installed composite panel surface shall not have irregularities such as oil canning, waves, buckles, and other irregularities when viewed at any position not less than 15 degrees to the true plane of the panel.
5. All fasteners, anchors, brackets and similar attachments used for the fixing and erection of these panels shall be of aluminum, non-magnetic stainless steel, or hot dip galvanized steel.

8.20.2 Materials

Aluminium Composite Panel (ACP) cladding in pan shape in metallic colour of approved shade, made of Aluminium Composite Material (ACM), made out of 4 mm thick aluminium composite panel consisting of 3 mm thick fire retardant (FR) grade mineral filled thermoplastic inorganic core of grade B1 sandwiched between two thin coil coated aluminium sheets(Top i.e. face # 1& rear i.e. face # 2) of alloy, Grade 3003 and H-16 temper and minimum thickness of 0.5 mm each as specified in the nomenclature of item. The ACPs are used for the external cladding surface like column, wall, jambs, sills, projected area, ceiling, decorative cladding on any surface to any profile and shape (pan shape) at horizontally / vertically / sloped / curved / circular etc.(linear as well as curvilinear shape).

The ACP fire retardant core of B1 grade contain 70% of Non-Combustible Inorganic compound & 30% of virgin LDPE. The main ingredient of the non-combustible compound are Aluminum Oxide (AlO) and Magnesium Oxide (MgO), when this ACP are put on fire at self ignition temperature of 460^{o} C, it can be catched on fire after 5 minutes and when the fire leave the panels, the fire on the wall extinguish after 10 seconds.

The ACP top face (exposed surface) coil should have Kynar 500 PVDF(Polyvinylidene fluoride)/ Lumiflon based fluropolymer resin (high surface energy) coating of approved colour and shade of 30 microns to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM or DIN or EN or BS code.The back face (rear side) of the cladding penal surface facing to the wall shall have polyester based wash (service) coating of 7 microns preferably grey in colour to protect against possible corrosion problems. The finished surface (Top face) shall be protected with a self adhesive peel off film with two layers of white & black tested to with stand local weather conditions without losing the original peel off characteristic or causing stains or other damages.

The weight of the Aluminum Composite Panel (ACP) should not be less than 7.50 Kg/Sqm. The ACP shall confirm to ASTM E84-08 or EN13501-1 or DIN4102 resulting in fire resistant properties.

The complete system shall be designed to with stand the design wind pressure as per relevant IS code or international code (Test pressure shall be 1.5 times of the design wind pressure).

Necessary pull out test of anchor fastener shall be carried out on the masonry wall /RCC structure to check the load carrying capacity of the bolt designed under suction pressure for designing the supporting and anchoring system.

8.20.3 Movement

System shall be designed to accommodate movement due to any force including the movement resulting from the exterior skin temperature ranging from 15°C to 85°C and also to accommodate the horizontal building movement of 10 mm per panel & vertical movement of 20 mm between floors on the aluminium framing system with support brackets, glass, gaskets and fastening devices. System shall be designed to accommodate the size and shape of the Laminated sandwiched composite panel as per the approved drawings including approved modifications as may be required during execution as well as all other incidental forces and stresses likely to be experienced under service conditions, i.e. Lateral force, Dead weight and Thermal expansion due to building movement both vertical and horizontal etc. Grooves shall be designed in such a way to accommodate weather silicon sealant/ Non staining sealant of approved make.

8.20.4 Testing

The mechanical properties of 4mm thick ACP or ACM with core and aluminium coil/sheet shall confirm to the requirement as given in table 8.5 below.

Table 8.5

Specification for Aluminium Composite Material (ACM)

S. No.	Description	Specification for 4mm	
A	**Physical Tests for ACM**	**Standard Test**	**Acceptable Value/Results**
1	Over all thickness of ACM	Measurement	4mm (Tolerance + 0.2mm)
2	Aluminium Skin thickness (each side)	Measurement	0.5mm (Tolerance +/- 0.03mm)
3	Panel weight (ACM)	Measurement	7.5 Kg/m^2 (+ 5%)
B	**Mechanical Properties of ACM**		
1	Peel off strength (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2	Tensile strength	ASTM E8	Min. 40 N/mm^2
3	Yield strength	ASTM E8	Min. 40 N/mm^2
4	Elongation	ASTM E8	Min. 6%
5	Flexural strength	ASTM C393	Min. 130 N/mm^2
6	Shear strength with punch shear test	ASSTM D732	Min. 18 N/mm^2
C	**Properties of Aluminium skin**		
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm^2
2	Modules of elasticity	ASTM E8	Min 70000 N/mm^2
3	Elongation	ASTM E8	Min. 2%
4	0.2% proof stress	ASTM E8	Min. 110 N/mm^2
5	Yield strength	ASTM E8	Min. 124 N/mm^2
6	Sound Transmission loss	ASTM E413	Max. 26 dB

8.20.5 Performance Certificate

Requisite performance certificate from the manufacturer of ACM stating compliance with ACM technical specification as per Table 5 above shall be submitted by the contractor to the Engineer-in-Charge before fixing at site of work.

The contractor shall provide curtain wall with aluminum composite panel cladding, having all the performance characteristics all complete as per the Architectural drawings, as per items description, as specified, as per the approved shop drawings and as directed by the Engineer-in-charge.

8.20.6 Marking

The ACP sheet should have a following laser marking and should be at repeated interval at the rear face of ACP sheet.

1. Total thickness with coil and core materials.
2. Size of ACP sheet.
3. Fire Retardant (FR) grade.
4. Date of manufacturing.
5. Batch number.
6. Make of manufacturer.

8.20.7 Installation

The installation system of ACP as external cladding with tray type (rout and return) panels and sealing joint is one of the most common method and it is available for a wide range of new buildings

and renovation projects. The ACP sheet under this system is first fixed on the substructure i.e. of steel members/RCC structures/brick walls with the help of base aluminium member frame work using necessary clamps, brackets, anchor fasteners, stainless screws, nuts and bolts, weather silicon sealant backer rods etc. as per approved design & drawing at all height and elevation which include all labours, materials, equipment's, handling, transportation, workmanship, design & preparation of working drawings, staging, scaffolding etc. all complete as per specification, drawings and instructions of the Engineer-in-Charge.

8.20.7.1 Frames: Providing and fixing Aluminium extruded members (Box Tube) designed to with stand design wind pressure and movement as specified as continuous member for cladding the Aluminium Composite Panel. Aluminium member shall be fixed into masonry wall / RCC member / steel structures with brackets / clamps and it shall be of chromicised finish aluminium. All fastening straps, nuts & bolts, rivets, washers/other fastening materials shall be of nonmagnetic stainless steel and aluminium brackets shall be considered for ACP cladding with standard dimension and after the site survey if any undulation is observed intern that doesn't allow to fix the aluminium bracket only in these areas the additional support with locally fabricated hot dip galvanized bracket can be considered. The bidder shall include the provision for these brackets also with in the quoted rate for ACP cladding works. Aluminium shim shall be used for level adjustment of bracket but more than 20 mm is not acceptable. If more than 20 mm, bracket shall be designed according to site condition.

Aluminium brackets / clamps shall be fixed with chemical injection technique threaded anchor rods of approved make to the base structure in the case of masonry wall / RCC members and SS anchor bolts in the case of steel structure. Extruded member shall be designed to accommodate laminated sandwiched composite panel as per the approved shop drawings and extruded aluminium member shall be 6063 T6 or 63400 (H9) grade conforming to BS 1467 or IS 8147, finished with transparent electrolytic colour anodic coating AC15 grade conforming to IS 1868.

8.20.7.2 Composite Panel: Aluminium composite panel cladding of approved make as specified in BOQ to be fixed on the framing system described above. Lamination process of Aluminium panel shall only be glue technology and the source of complete composite panel shall only be accepted.

The Laminated sandwiched composite panel suitably stiffened internally on the back side for preventing deformation due to design wind pressure beyond permissible limits by using aluminium flat 25 mm wide, 4 mm thick gloved with double adhesive tape in order to maintain panel flatness and to avoid permanent deformation over a period. Stiffener shall be provided at 600 mm c/c behind ACP panel irrespective of structural check of the panel against stability and deflection. Aluminium flat of size 25 mm wide and 3 mm thick shall be provided to a length 100 mm bent to shape, wherever the inner skin is cut to bend the ACP at the corners and as per approved shop drawing. Methodology of fixing the stiffener/flat in the corner panel shall be established in the drawing or to be glued to ACP on the backside of the panel in such a way the fixing mechanism of stiffener / flat shall not be visible on the elevation of the panel / outside.

8.20.7.3 Sealing: After fixing the ACP on the sub structure, then a suitable sealing materials i.e. Non structural weather silicon sealant/Non staining sealant filled to the joints of panel with baker rod of approved make to ensure water tightness to the panel. Sealing shall be carried out with Non-structural (weather) sealant / Non staining sealant with PE baker rods, wherever the system is interfacing with glazing, cladding groove and any other groove.

8.20.7.4 Flashing: Fixing flashing at terrace level as part of the system made to profile as shown in the approved shop drawings and the profile shall be made out of hot dip galvanized sheet 1.2 mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general, the flashing shall be provided to the entire length of cladding horizontally at terrace level with necessary anchoring system with SS fastening devices of approved make. Also, the flashing shall be provided

at parapet top below the coping to drain the water during any seepage through the sealant joints with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping / flashing joints.

8.20.7.5 Field Test: Conduct field test at site on the installed system as per the criteria set out in the particular specification in the presence of Engineer in charge. Methodology for carrying out the test shall be submitted to Engineer-in Charge for approval prior to testing. Record the results and submit the report to the Engineer-in Charge for approval. If Field test fails, correct the defects revealed to the satisfaction of the performance data as set out in the technical specification with the prior approval of Engineer-in Charge on defects rectification methodology.

8.20.7.6 General Guideline: System design in total, including Aluminium extruded member, type & thickness of Aluminium composite panel, Aluminium sleeves at connections, inserts, Sealant, Supporting system/bracket including fastening and anchoring system & materials specified in the schedule and the system details as shown in the tender drawing are only tentative and is meant to set out a general outline of the proprietary system. Since the cladding system in terms of design, materials, all fixing details, methodology of execution are proprietary in nature, the onus of the design and performance requirements, shop drawing, execution etc. satisfying the design intent, particular specification and site conditions lies solely with the Contractor.

8.20.8 Precautions

1. Do unpacking and repacking of ACP sheet work in a clean place.
2. Remove dust and chips from ACP sheet and the packing paper.
3. Handle ACP sheet on a worktable. Do not handle it on the floor.
4. ACP sheets should always be handled by two people with external face upward to avoid possible rubbing of the ACP surface during handling.
5. Prior to fabrication, clean off the worktable, temporary stand and both side of ACP sheet.
6. Ensure that cutting chips generated from saws, routers and drills are completely removed from the interface between ACP sheet and tools.
7. The arrow should be followed as marked on the rear (back) face coil/ sheet to avoid the variation in colour.
8. Protective film of 75 microns should be removed within 45 days after the installation.
9. Do not use adhesive tapes made of PVC (Polyvinyl Chloride) on the surface of protective film or any time during storage, fabrication or installation.
10. Aluminum composite material (ACM) manufacturer shall provide warranty of ten years for any manufacturing defects.

8.20.9 Measurements

For the purpose of payment, only the actual area on the external face of the curtain wall with Aluminum Composite Panel cladding (including width of groove) shall be measured in square meters upto two places of decimal.

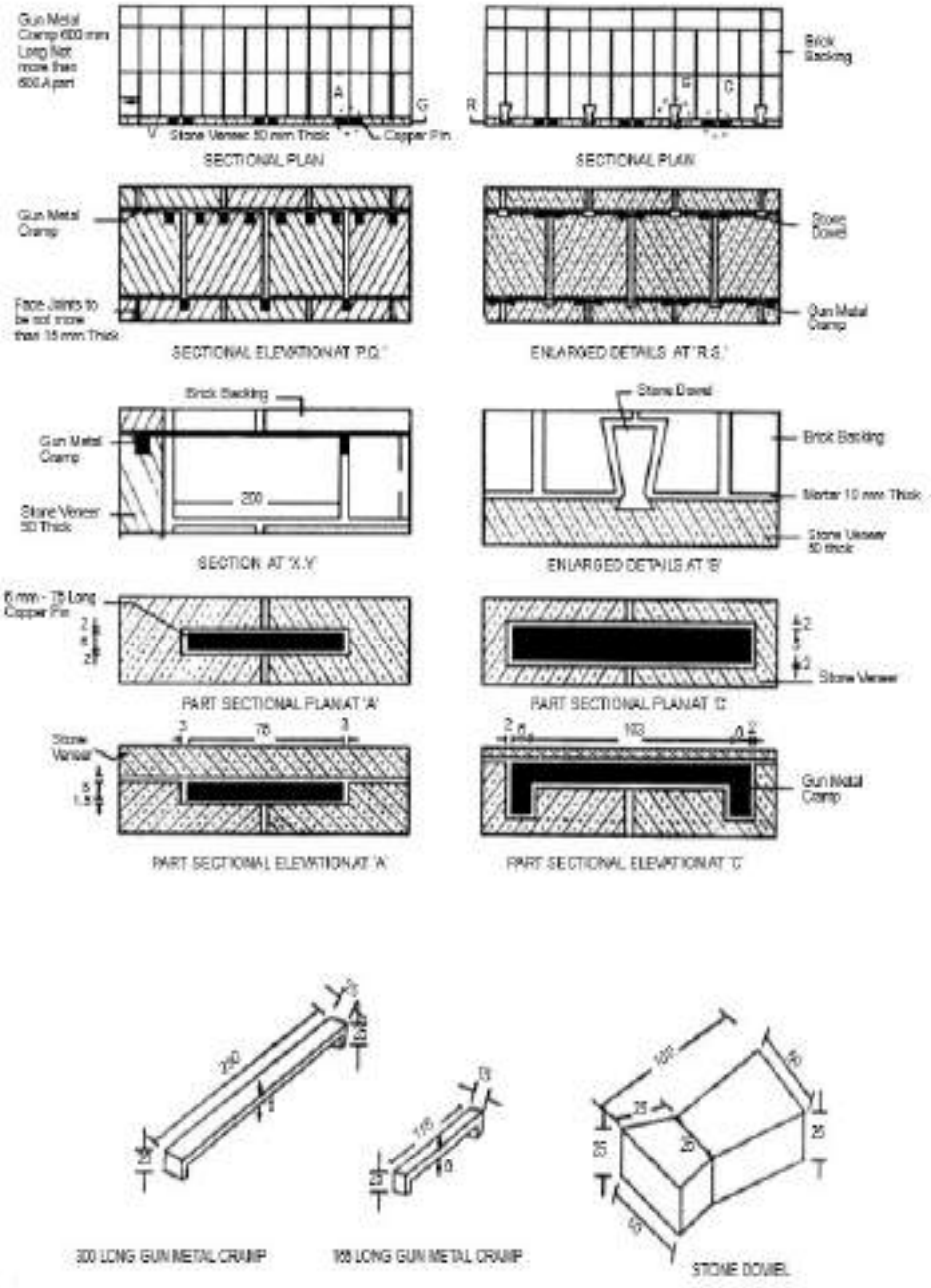
8.20.10 Rate

The rate includes the cost of all materials, labour, equipment's, design, shop drawing, fabricating, installation and fixing in position the curtain wall with Aluminum composite panels cladding for all height and all level etc. in all the operation described above and any other stipulations in the particular specification and agreement. Also, includes the cost of scaffolding, infrastructure facility and all other consumables to execute the work as specified above.

The cost of all mockups at site, testing charges, cost of all sample of the individual components for testing in an approved laboratories, field test on the assembled working curtain wall with aluminum composite panels claddings, cleaning and protection of the curtain wall with aluminum composite panel claddings till the handing over of the building for occupation. Base aluminum members frame work for ACP cladding is payable under the relevant aluminum items.

MARBLE STONE VENEERING

Sub Head : Marble Work
Clause : 8.6.2.2

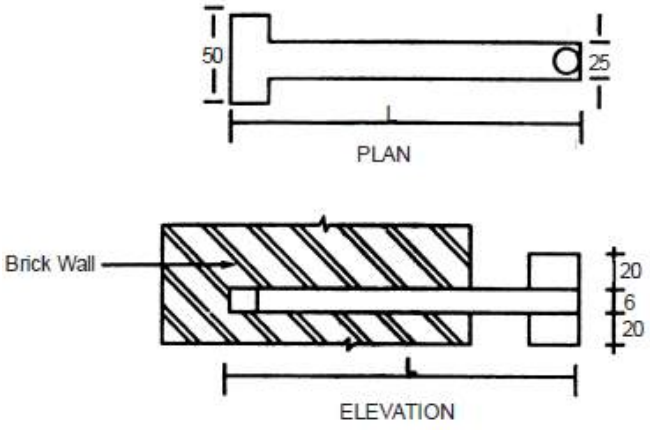


Drawing not to scale
All dimensions are in mm

Fig. 8.1 : Marble Stone Veneering (General Fixing Arrangement)

MARBLE STONE VENEERING
(Typical Fixing Arrangement)

Sub Head : Marble Work
Clause : 8.6.2.2



L=115 mm for half Brick Backing
L=150 mm for full Brick Backing

Fig. 8.2A : Cramp for Brick Backing

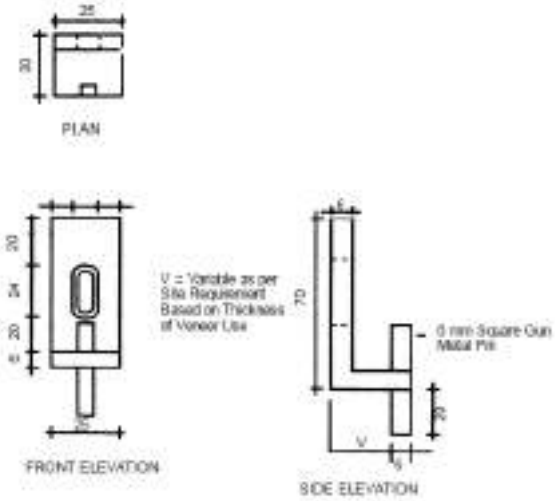


Fig. 8.2B : Cramp for R.C.C. Work Backing

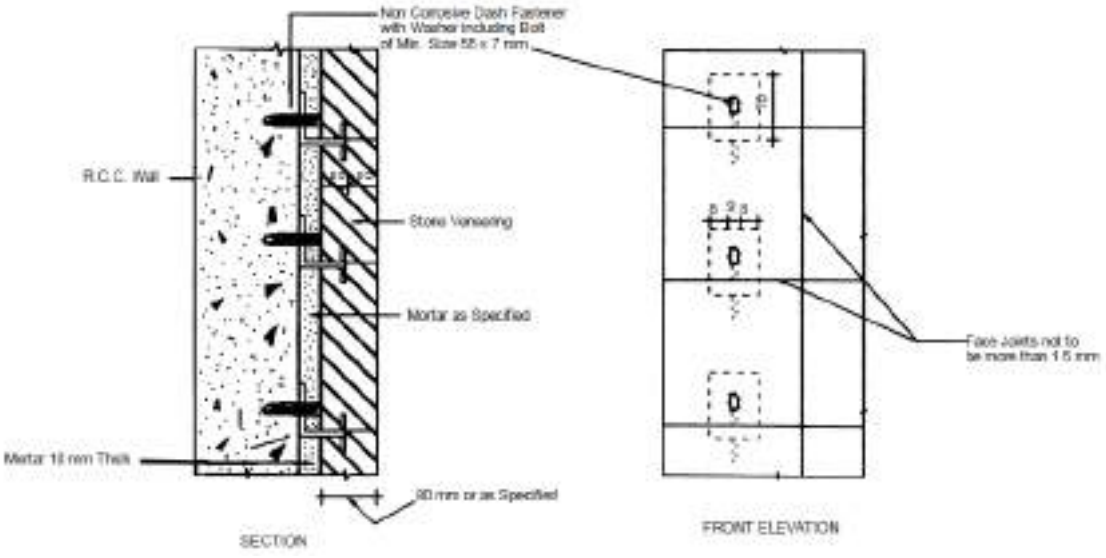


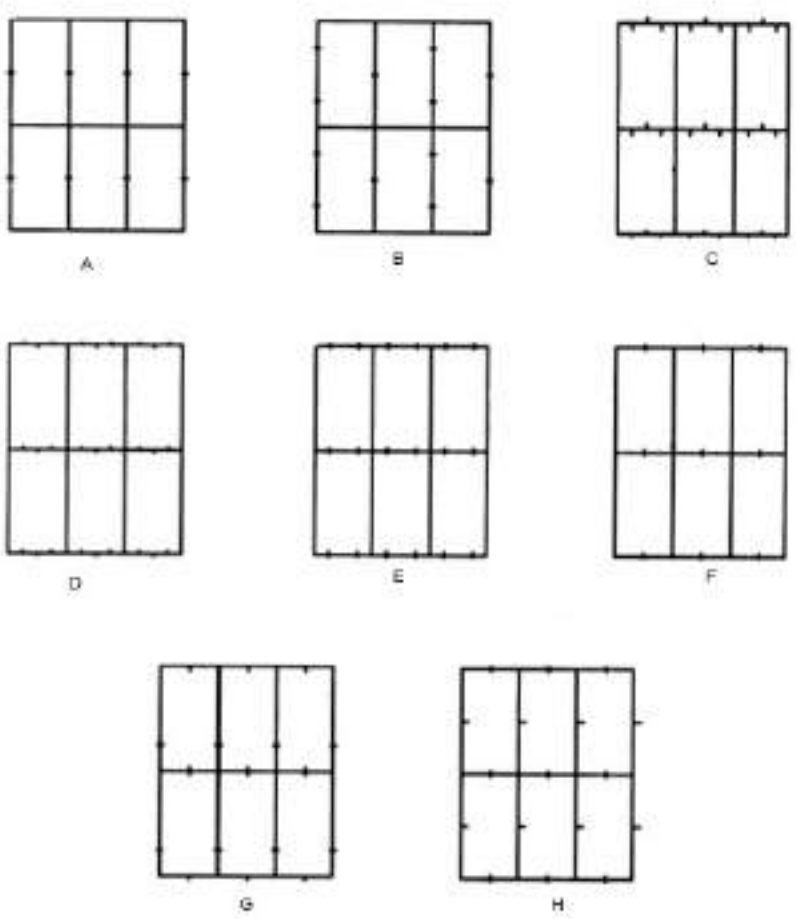
Fig. 8.2C :Typical Details of Cramps for R.C.C. Backing

Drawing not to scale
All dimensions in mm

Fig. 8.2 : Marble Stone Veneering (Typical Fixing Arrangement)

GENERAL ARRANGEMENTS OF CRAMPS

Sub Head : Marble Work
Clause : 8.6.2.3



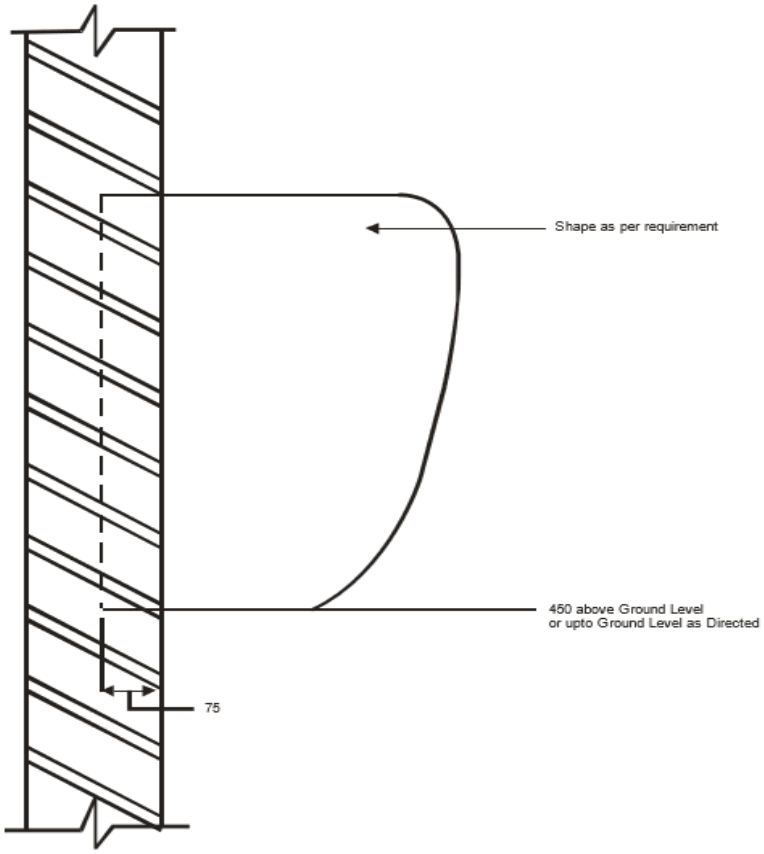
Note : Cramps arrangement is shown above for veneerings with longer sides vertical. For veneering having the longer sides horizontal cramps would be arranged to suit the altered positions.

Drawing not to Scale

Fig. 8.3 : General Arrangements of Cramps

MARBLE SLAB URINAL PARTITION

Sub Head : Marble Work
Clause : 8.7

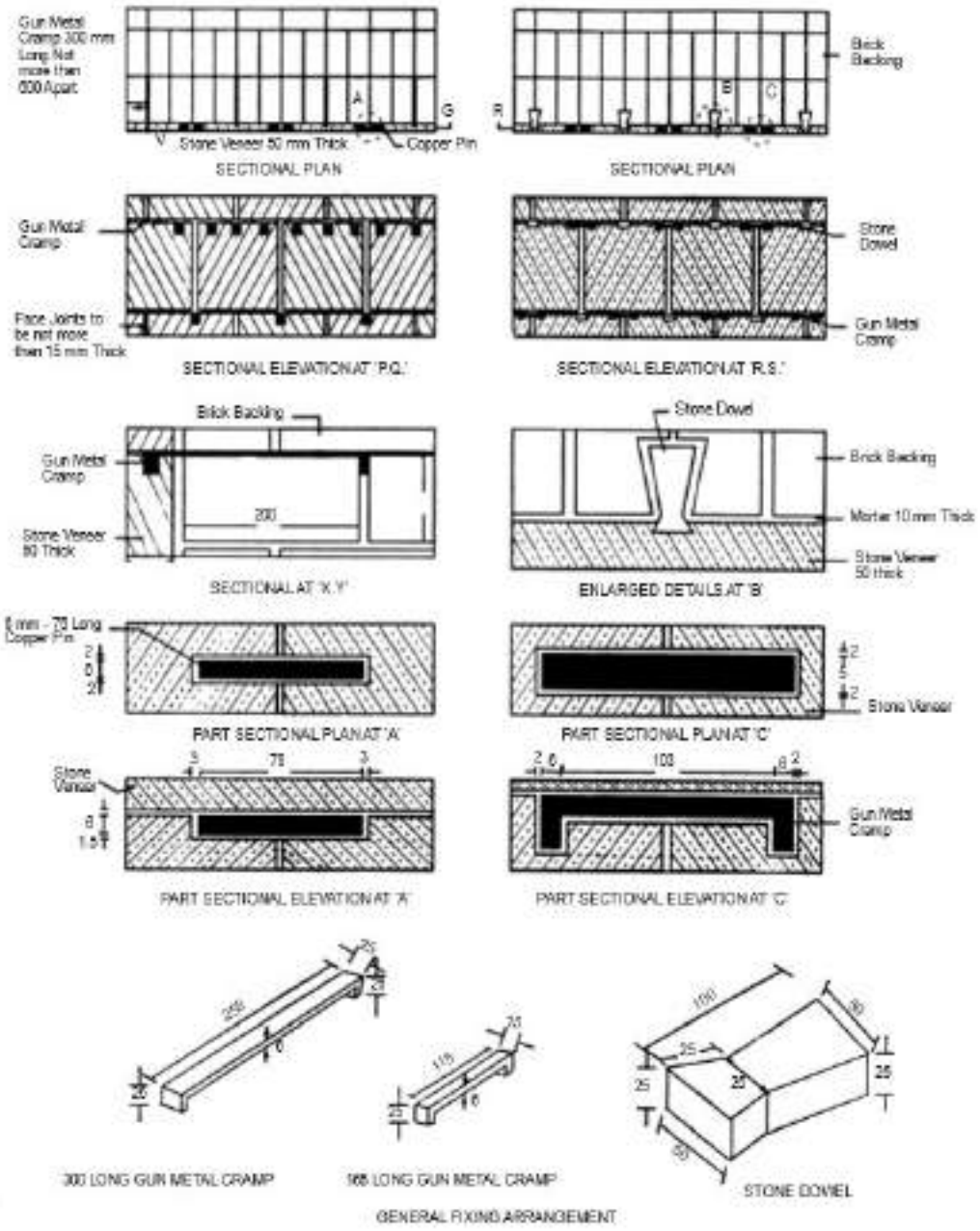


Drawing not to scale
All dimensions are in mm

Fig. 8.4 : Marble Slab Urinal Partition

STONE VENEERING

Sub Head : Stone Work
Clause : 8.8 & 8.8.4.2



Drawing not to scale
All dimensions are in mm

Fig. 8.5 : Stone Veneering

STONE VENEERING (Typical Fixing Arrangement)

Sub Head : Stone Work
Clause : 8.8.4.2 & 8.8.4.6

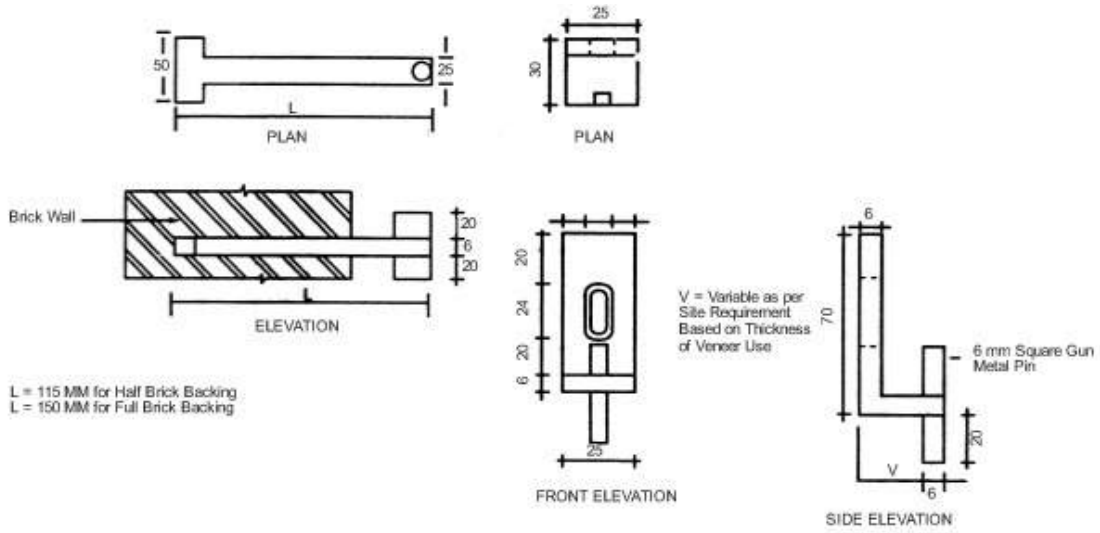


Fig. 7.15A : Cramp for Brick Backing **Fig. 7.15B : Cramp for R.C.C. Work Backing**

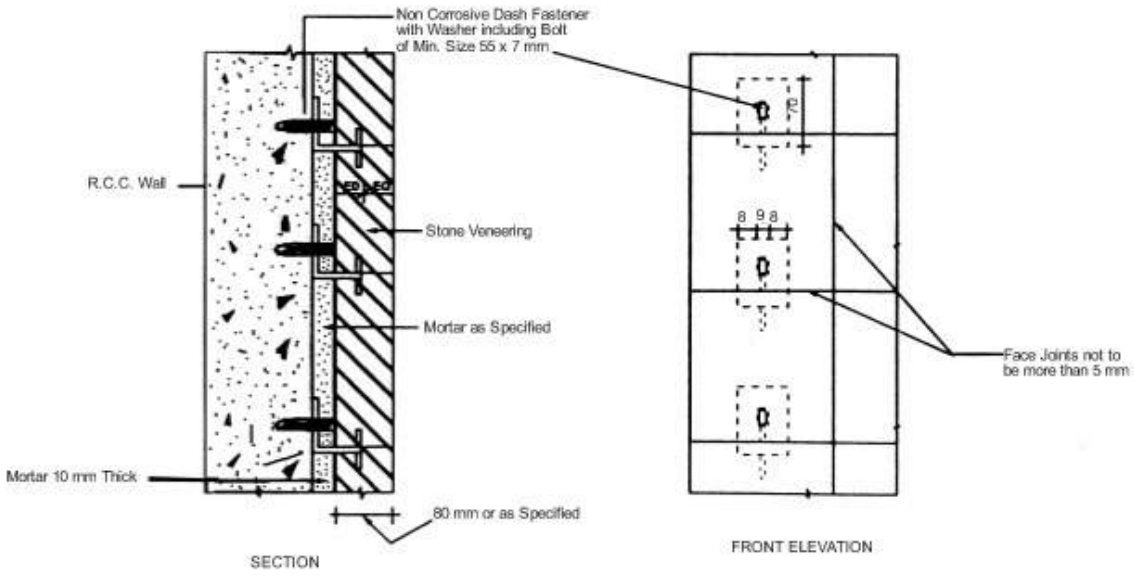
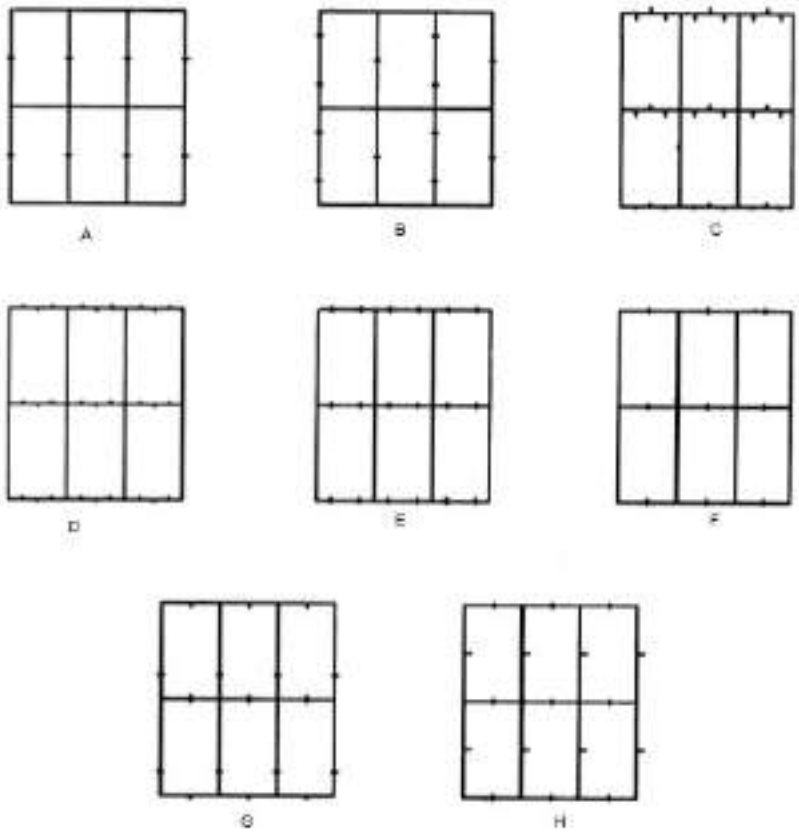


Fig. 8.6 : Stone Veneering (Typical Fixing Arrangement)

GENERAL ARRANGEMENT OF CRAMPS

Sub Head : Stone Work
Clause : 8.8.4.3



Note : Cramps arrangement is shown above for veneerings with longer sides vertical. For veneering having the longer sides horizontal, cramps would be arranged to suit the altered positions.

Drawing not to scale

Fig. 8.7 : General Arrangement of Cramps

Note: Fig. 8.5, 8.6 & 8.7 brought from Fig. 7.14, 7.15 & 7.16

SUB HEAD : 9.0

WOOD WORK AND P.V.C. WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	349
	List of Bureau of Indian Standard Codes	350
9.0	Terminology	353
9.1	Timber	354
9.2	Panelling Material	357
9.2.9A	Pre-Laminated Medium Density Fiber Board	363
9.3	Door, Window and Ventilator Frames	368
9.4	False Ceiling and Partition Frames	369
9.5	Trusses	369
9.6	Panelled Glazed or Panelled and Glazed Shutters	370
9.7	Flush Door Shutters	375
9.7A	Cup board shutter	377
9.8	Wire Gauze Fly Proof Shutters	378
9.9	Wall Lining (Shifted to clause 8.15)	379
9.10	Shelves	379
9.10A	Lipping in Pelmet	379
9.11	Trellis (Jaffri) Work	379
9.12	Pelmets	380
9.13	Hold Fasts	380
9.14	Expanded Metal, Hard Drawn Steel Wire Fabric and Wire Gauze in Wooden Frames	381
9.15	Fittings	381
9.16	Laminated Veneer Lumber (LVL)	394

9.17	Partitions	399
9.17A	Teak wood Lipping	400
9.17B	Skirting	400
9.18	PVC Door Frames	400
9.19	PVC Door Shutters	401
9.20	PVC Door Frame	403
9.21	Panel PVC Door Shutter	404
9.22	Fibre Glass Reinforced Plastic (FRP) Door Frames	404
9.23	Fibre Glass Reinforced Plastic (FRP) Shutters	405
9.24	Solid PVC Foam Profile Doors	406
9.25	Solid PVC Foam Shutters	406
9.26	Factory Made Fibre Glass Reinforced Plastic Chajja	407
9.27	Wall Panelling	407
9.28	uPVC casement/sliding window & door	408
9.28A	Hardware fittings for uPVC Doors & Windows	412
9.29	Fire resistant glazed doors, windows & Partitions	412
9.30	Nickel Plated M.S. Pipe Curtain Rod with Nickel Plated M.S. Brackets	415
9.31	M.S. Grills of required pattern in Frames of Windows etc. with M.S. Flats, Square or Round bars etc. including Priming Coat	416
9.32	Bamboo Jaffery/ Fencing	416
9.33	Wooden Moulded Corner Beading of Triangular Shape	417
9.34	Magnetic Catchers	417
9.35	Powder Coated Telescopic Drawer Channel 300 mm long	418

9.36	Sliding arrangement in Racks/Cup-boards/Cabinet Shutter	418
Appendix A	Permissible Defects for Various Grade of Timbers	419
Appendix B	Different Climatic Zones for Moisture Content of Timber	420
Appendix C	Moisture Content of Timber	421
Appendix D	Physical and Mechanical Properties of Plywood	422
Appendix E	Physical and Mechanical Properties of FPT or Graded Particle Board.	422
Appendix F	Test for Flush Door Shutters	423
Appendix G	Test for Mortice Locks	425
Appendix H	Schedule of Fitting for Doors and Windows	426
Appendix I	Method of Test for Edge Straightness and Squareness of Plywood	427
Appendix J	Method of Test for Edge Straightness and Squareness of Coir Veneer Board	427
Appendix K	Method for Test of Coir Veneer Board for Determination of Glue Shear Strength	428
Fig. 9.1	Joints in Timber	429
Fig. 9.2	Terminology Timber Door, Window and Ventilator Components	431
Fig. 9.3	Wooden Flush Door Shutters	432
Fig. 9.4	Hold Fast	433
Fig. 9.5 to 9.6	Hinges	434 – 435
Fig. 9.7	Sliding Door Bolts	436
Fig. 9.8	Barrel Tower Bolts	437
Fig. 9.9	Pull Bolt Locks	438
Fig. 9.10	Mortice Lock & Latch	439

Fig. 9.11	Mortice Night Latch	440
Fig. 9.12	Handles for Doors & Windows	441
Fig. 9.13	Floor Door Stopper - Cast Type	443
Fig. 9.14	Window Stay & Hooks & Eyes	443
Fig. 9.15	Hasps & Staples	444
Fig. 9.16	LVL Shutter	445
Fig. 9.17	Partitions	446
Fig. 9.18	UPVC Door Frame	447
Fig. 9.19	24 mm Thick PVC Door Shutters	448
Fig. 9.20	30 mm Thick PVC Door Shutters	449
Fig. 9.21	PVC Door Frame	450
Fig. 9.22	30 mm Thick Panel PVC Door Shutter	451
Fig. 9.23	FRP Door Frame	452
Fig. 9.24	Typical Sketch of FRP Door Shutter	453 – 454
Fig. 9.25	Solid PVC Foam Profile Shutter	455
Fig. 9.26	Solid PVC Foam Shutter (28 mm Thick)	456
Fig. 9.27	FRP Chajja	457
Fig. 9.28	Wall Panelling	457
Fig 9.29 to Fig 9.35	uPVC Doors and Windows	458 – 464
Fig. 9.36	uPVC Doors and Windows (Typical casement system)	465
Fig. 9.37	uPVC Doors and Windows (Typical casement with top fixed system)	466
Fig. 9.38	uPVC Doors and Windows (Typical slider system)	467
Fig. 9.39	Fire rated door/window/partition	468

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory Test*	*Test Procedure*	*Min, Quantity of Material for carrying out the test*	*Frequency of Testing*
1	2	3	4	5	6	7
Timber	9.1.6	Moisture content	Field (by moisture meter) laboratory test as required by Engineer-in-Charge	Appendix 'C'	1 cum	Every one cum or part thereof.
Flush door	9.7.10	End immersion Test knife test Adhesion Test	Laboratory	IS 2202 Appendix 'F'	26 shutters	As per sampling and testing specified in clause 9.7.11
Mortice Locks	9.15.13	Testing of spring	Laboratory	IS 2209-Appendix 'G'	50 Nos	100 or part thereof.

LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	IS No.	Subject
1	IS 204 (Part I)	Specification for tower bolts (ferrous bolt)
2	IS 204 (Part II)	Specification for tower bolts (non ferrous metals)
3	IS 205	Specification for non ferrous metal butt hinges
4	IS 206	Specification for Tee and strap hinges
5	IS 207	Specification for Gate and shutter hook and eye
6	IS 208	Specification for door handles
7	IS 277	Galvanized steel sheets (Plain and Corrugated)
8	IS 281	Specification for mild steel door bolts for use with pad locks
9	IS 287	Recommendations for maximum permissible moisture contents of timber used for different purpose
10	IS 303	Specification for plywood for general purposes
11	IS 362	Specification for parliament hinges
12	IS 363	Specification for hasps and stapple
13	IS 364	Specification for fan light catch
14	IS 401	Code of practice for preservation of timber
15	IS 419	Putty for use on window frames
16	IS 451	Technical supply condition for wood screws
17	IS 452	Specification for door spring rat tail type
18	IS 453	Specification for double acting spring hinge
19	IS 707	Glossary of terms applicable to timber technology and utilization
20	IS 710	Specifications for Marine Plywood
21	IS 723	Specification for steel counter sunk head wire nails.
22	IS 729	Specification for drawer lock, cup board lock and box locks
23	IS 848	Specification for synthetic resin adhesive for plywood (phenoic and amino plastic)
24	IS 851	Specification for synthetic resin adhesive for const. work (non structural in wood)
25	IS 852	Specification for animal glue for general wood work purpose
26	IS 875 (Part-3)	Code for practice for design loads (other than Earthquake) for building and structures
27	IS 1003 (Part I)	Specification for timber panelled and glazed shutter Part I (door shutters)
28	IS 1003 (Part II)	Specification for timber panelled and glazed shutter Part II (window and ventilator shutter)
29	IS 1079	Hot rolled carbon steel sheet and strip

30	IS 1141	Specification for code of practice for seasoning of timber
31	IS 1200 Part XIV	Method of measurement of building and civil engg work glazing.
32	IS 1200 Part XII	Wood work and joinery
33	IS 1328	Specification for veneered decorative plywood
34	IS 1341	Specification for steel butt hinges
35	IS 1378	Specification for oxidized copper finishes
36	IS 1566	Specification for hard drawn steel wire fabric
37	IS 1568	Specification for wire cloth for general purpose
38	IS 1658	Specification for hard drawn steel wire fabric
39	IS 1659	Specification for block boards
40	IS 1708 (Part 1 to 18)	Testing of small clear specimen for timber
41	IS 1734	Determination of density and moisture content.
42	IS 1823	Specification for floor door stopper
43	IS 1868	Specification for anodic coating on aluminium and its alloy
44	IS 2046	-do- Decorative thermosetting synthetic resin bonded laminated sheet
45	IS 2095	Specification for gypsum plaster board
46	IS 2096	Specification for asbestos cement flat sheet.
47	IS 2202 (Pt I)	Specification for wooden flush door shutter, solid core type (plywood face panels)
48	IS 2202 (Part II)	-do- (Particle boards and hard board face panels)
49	IS 2209	Specification for mortice lock (Vertical Type)
50	IS 2380	Method of test for wood particle board and board for lignocelluloses material
51	IS 2547	Specification for gypsum plaster
52	IS 2753	Method for estimation of preservatives in treated timber and in treating solutions.
53	IS 2681	Specification for non-ferrous metal sliding door bolts use with pad locks
54	IS 3087	Specification for wood particle boards (Medium density) for general purpose.
55	IS 3097	Specification for veneered particle board
56	IS 3828	Specification for ventilator chain
57	IS 3400 (Part II)	Method of test for Vulcanized rubber (hardness)
58	IS 3400 (Part IV)	Accelerated aging
59	IS 3400 (Part IX)	Density
60	IS 3564	Specification for door closer (hydraulically regulated)

61	IS 3618	Phosphate treatment of iron and steel for protection against corrosion
62.	IS 3813	“C” hooks for use with swivels
63.	IS 3818	Specification for continuous (Piano) hinges
64.	IS 3847	Specification for mortice night latch
65.	IS 4351	Steel Door Frames - Specification
66	IS 4835	Specification for polyvinyl acetate dispersion based adhesive for wood
67.	IS 4948	Specification for welded steel wire fabric for general use
68.	IS 4985:2000	uPVC pipes for potable water supplies
69.	IS 4992	Specification for rebated mortice lock
70.	IS 5187	Specification for flush bolts
71.	IS 5509	Specification for Fire Retardant Plywood
72.	IS 5930	Specification for mortice latch
73.	IS 6318	Specification for plastic wire window fastners
74.	IS 6607	Specification for rebated mortice lock (Vertical type)
	IS 6760	Specification for sloted counter sunk head wood screws.
75.	IS 7196	Specification for hold fast
76.	IS 7534	Specification for sliding locking bolts for use with pad lock
77.	IS 7638	Wood/lignocellulosic based panel products – Method for sampling
78.	IS 8756	Specification for mortice ball catch for use in wooden almirah
79.	IS 9308 (Part II)	Specification for mechanically extracted coir fibres. (Mattress coir fibres)
80.	IS 9308 (Part III)	-do- Decorated coir fibre
81.	IS 11215	Moisture content of timber and timber products method of determination
82.	IS 12049	Dimensions and tolerance relating to wood based panel materials
83.	IS 12406	Specification for medium density fibre board
84.	IS 12817	Specification for stainless steel Butt Hinges
85.	IS 12823	Specification for wood products –Prelaminated particle Boards
86.	IS 14276	Cement Bonded Particle Boards - Specificaion
87.	IS 14616	Specifications for laminated veneer lumber
88.	IS 14842	Specification for coir veneer board for general purposes
89	IS 14856	Specification for glass fibre reinforced plastic (FRP) panel type door
90	IS 14862	Fibre Cement Flat Sheets - Specification
91	IS 14900	Specifications for transparent float glass

9.0 WOOD WORK AND P.V.C. WORK

9.0 TERMINOLOGY

Ballies : Thin round poles usually without bark.

Beam : A structural timber generally long in proportion to its width and thickness and used for supporting load primarily by its internal resistance to bending.

Block Board : A Board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

Core : The inner layers of a composite wood product.

Cross Band : A general term indicating a transverse layer of veneer or veneers in composite wood products.

Decorative Veneers : Veneers having attractive appearance due to figure, colour, grain, lusture, etc.

Hard Wood : A conventional term used to denote the wood obtained from broad-leaved trees. It has no relationship to the physical properties of hardness or strength. On account of the confusion this word might cause, its use is discouraged.

Freeze Rail : Horizontal member, mortised or otherwise secured to the stiles of a door, provided just below the freeze panel usually provided for decorative purposes in the uppermost portion of the door.

Joint : A prepared connection for joining adjacent pieces of wood, veneer, etc.

Dovetail Joint : A joint at the corner of two pieces in such a way that the notches made to one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints for instance, lapped dovetail joint, wedge shaped dovetail joint, etc. joined in a way which will resist withdrawal except in the direction in which it was assembled (Fig. 9.1C).

Mitred Joint : A joint, between two members at an angle which bisects the joining angle usually the joining faces are cut at 45° to form a right angle (Fig. 9.1B).

Mortise and Tenon Joint : A joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member (Fig. 9.1D).

Tongue and Groove Joint : A joint in which a tongue is provided on edge of one member to fit into a corresponding groove on the other (Fig. 9.1A).

Knot : Base of a branch or limb embedded in the tree which becomes visible when it is cut.

Diameter of a Knot : The maximum distance between two points farthest apart on the periphery of a round knot, on the face where it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

Muntin : Small horizontal or vertical dividing bars within basic framework of a window, or door sub-dividing and supporting the glass panes or panels of doors.

Particle Board : A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings, slivers, splinter agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

Particle : Distinct particle or fraction of wood, or other lignocellulose material produced mechanically for use as the aggregate for making a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

Plywood : A board formed of three or more layers of veneers cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

Rebate : A recess along the edge of a piece of timber to receive another piece or a door, sash or a frame.

Sapwood : The outer layers of the log, which in the growing tree contain living cells and feed material.

The sapwood is usually lighter in colour, and is readily attacked by insects and fungi.

Seasoning : A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

Seasoned Timber : Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

Structural Timber : Timber used in framing and load bearing structures or timber used or intended for use in buildings where strength is the primary consideration.

First Class Wood

Individual hard and sound knots shall not be more than 25 mm in diameter and the aggregate area of all the knots shall not exceed one per cent of the area of the piece.

Second Class Wood

Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate of all the knots shall not exceed one and half per cent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed.

9.1 TIMBER

Timber is classified as under :

(i) Teak wood
(ii) Deodar wood
(iii) Non-coniferous timbers other than teak
(iv) Coniferous timber other than deodar.

The timber shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks. The timber shall be graded as first grade and second grade on the basis of the permissible defects in the timber as given in Appendix 'A' of Chapter 9.0. For both the grades, knots should be avoided over a specified limit.

9.1.1 Teak Wood (Tectona Grandis)

It is of outstanding merit in retention of shape and durability. The heart wood is one of the most naturally durable woods of the world. It usually remains immune to white ant attack and insect attack for very long periods. It is, however, not always immune from fungus attack (rot). Taken as a whole, good quality teak is very durable, it is relatively easy to saw and work. It can be furnished to a fare surface and takes polish well. It is generally used for making furniture and all important timber construction.

9.1.1.1 ***Superior Class Teak Wood such as Balarsha, Malabar and Dandeli :*** Individual hard and sound knot shall not be more than 12 mm in diameter and the aggregate area of all the knots shall not exceed one half per cent of the area of the piece. It shall be close grained.

9.1.2 Deodar Wood (Cedrus Deodars)

It is the strongest of the Indian conifers. Its weight and strength is 20% per cent less than teak. It is easy to saw and works to a smooth finish. It is not, however, a suitable wood for polish or paint work as the oil in the wood and especially near knots, always seeps through such finishes and discolours them.

It is used for house building, furniture and other construction work. It is also suitable for beams, floors, boards, posts, window frames and light furniture etc.

9.1.3 Sal Wood (Shoera Robusta)

Sal is about 30 per cent heavier than teak, 50 per cent harder, and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishable and should not be used. Well dried sal is not a really easy wood to saw and work. It is a rough constructional wood than a carpentary timber. No individual hard and sound knot shall exceed 25 mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece.

It can be used for a variety of purposes, such as for beams, rafters, flooring, piles, bridging, tool handles, picker arms and tent pegs, etc.

9.1.4 Kail Wood (Pinus Roxburghie)

Kail Wood is not a very durable wood. But it is easy to saw and work and usually very popular in wokshops. It can be brought to a fine smooth surface, but is more suitable for paint and enamel finishes than for polish work. It is useful for joinery works, constructional work, light furniture and house fitments.

9.1.5 Other Species

The other species of timber as given in Table 9.1 of chapter 9.0 can also be used for various activities of building construction.

TABLE 9.1
Species of Timber

Sl. No.	*Botanical Name*	*Availability*						
		Trade Name	*Average Unit wt Kg/m^3*	*North Zone*	*East Zone*	*Central Zone*	*West Zone*	*South Zone*
1.	Tectone grandis linnf	Teak	640	—	Y	X	X	X
2.	Acacia Catechiu Willd	Khair	1010	X	X	X	Y	Y
3.	Acacia Arabica Willd	Babul	785	X	X	X	Y	Z
4.	Adina Cordifolia Roxb HK. f	Haldu	675	X	—	—	—	X
5.	Cedrus Deodara D Don	Deodar	545	X	—	Y	Y	—
6.	Magnifera Indica Linn	Mango	690	X	X	Y		X
7.	Pinus Roxburghie	Chir	575	X	—	—	—	—
8.	Pinus Excelsa Wall	Kail	515	X	—	—	—	—
9.	Shorea Robusta Gaertn.	Sal (U.P.)	881	X	X	X	—	—
10.	Terminalia Myrioecarpa. Heurcket Muell Arg.	Hollock	610	—	X	—	—	—
11.	Lagerstroemia Lanceolata Wall	Benteak	675	—	—	—	Y	X
12.	Gamelinc Arborea Ronb.	Gamari	515	Y	Y	Y	Z	Y
13.	Terminalia Bellirica Roxb.	Bahora	801	X	X	X	Y	X
14.	Pterocarpus Marsupium Roxb	Bijasal	800	—	X	X	Y	Y

Note : The Average unit wt. is at 12% moisture content.

NORTH ZONE	:	Jammu and Kashmir, Punjab, Himachal Pradesh, Delhi, Uttar Pradesh and Rajasthan.
EAST ZONE	:	Assam, Manipur, Tripura, West Bengal, Bihar, Orissa, Sikkim, Andamans, North East Frontier Agency and Nagaland.
CENTRAL ZONE	:	Madhya Pradesh, Vidharbha areas of Maharashtra State and the North East Part of Andhra Pradesh (Godavari delta area).
WEST ZONE	:	Maharashtra State (Except Vidharbha areas), Gujarat and North West part of Karnataka. Tamil Nadu, Andhra Pradesh (except the Godawari Delta area) Kerala and karnataka (except north west port)
SOUTH ZONE	:	Tamil Nadu, Andhra Pradesh (Except the Godawari delta area) Kerala and Karnataka (except North West part)

The availability of timbers is categorised under three classes as indicated below:

X - Most common, 1415 m^3 (1000 tonnes) and more per year.
Y - Common, 355 m^3 (250 tonnes) to 1415 m^3 (1000 tonnes) per year and
Z - Less common, below 355 m^3 (250 tonnes) per year.

9.1.6 Moisture Content

Control on moisture content of timber is necessary to ensure its proper utility in various climatic conditions. For specifying the permissible limit of moisture content in the timber the country has been divided into four climatic zones as per Appendix B of Chapter 9. In each of the zones, maximum permissible limit of moisture content of timber for different uses, when determined in accordance with the procedure laid down in Appendix 'C' shall be as per Table 9.2 of Chapter 9.

TABLE 9.2
Maximum Permissible Moisture Content of Timber

Sl.No.	*Use*	*Max Moisture Content Percent*			
		Zone I	*Zone II*	*Zone III*	*Zone IV*
1.	Beams, Rafters & Posts	12	14	17	20
2.	Doors and windows				
	(a) 50 mm and above thickness	10	12	14	16
	(b) Thinner than 50 mm	8	10	12	14
3.	Flooring strips	8	10	10	12
4.	Furniture & Cabinet making	10	12	14	15

9.1.6.1 ***Tolerance on Moisture Content :*** Average Moisture content of all the samples from a lot shall be within + 3 per cent and moisture content of individual samples within + 5 per cent of maximum permissible moisture content specified in Table 9.2. These tolerance are the absolute values over the percentage moisture content for Sl. No. 1 & 2 of Table 9.2. No tolerance on moisture content is permitted for Sl. No. 3 & 4 of Table 9.2.

9.1.7 Seasoning of Timber

The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln seasoned and in both cases moisture content of the seasoned timber shall be as specified in Table 9. 2 of Chapter 9 unless otherwise specified, air seasoned timber shall be used. Kiln seasoning of timber, where specified, shall be done as per IS 1141 in a plant approved by Engineer-in-Charge.

9.1.8 Preservation of Timber

Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms. Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planing, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 in a plant approved by the Engineer-in-Charge.

9.2 PANELLING MATERIAL

9.2.1 Timber

Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 square metre in area.

9.2.2 Plywood Boards

9.2.2.1 Plywood shall be of BWP grade or BWR grade as per IS 303.

9.2.2.2 Marine plywood confirming to IS 710.

9.2.2.3 Fire resistant plywood confirming to IS 5509.

9.2.2.4 ***Thickness :***Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be ± 10% for boards upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plys in plywood boards shall be as per Table 9.3.

TABLE 9. 3

Thickness in mm	*No. of ply*	*Thickness in mm*	*No. of ply*
3,4,5,6	3	12,15,16,19	9
5,6,8,9	5	19,22,25	11
9,12,15,16	7		(Above 11 Ply as ordered)

Note : Plywood of 9 mm thick of 5 or 7 ply may be used generally.

9.2.2.5 Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

9.2.2.6 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of plywood boards specified in Appendix D of Chapter 9.

9.2.3 Particle Boards

9.2.3.1 Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

9.2.3.2 ***Adhesives :*** Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.

9.2.3.3 ***Thickness and Tolerance :*** Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards upto and including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

9.2.3.4 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirement of physical and mechanical properties of particle boards specified in Appendix E of Chapter 9.0.

9.2.4 Veneered Particle Boards

9.2.4.1 Veneered Particle Boards with core of FPT-1 or graded board Grade-I particle board (IS 3087) with commercial or general purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives under the influence of heat and pressure.

9.2.4.2 ***Adhesives :*** The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.

9.2.4.3 ***Thickness & Tolerance :*** Veneered particle boards are available in various thickness 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm.

Tolerance in thickness shall be ± 5%.

9.2.4.4 ***Testing :*** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3097. However, testing may not be done if the total requirement of veneered particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of veneered particle boards as under:

1.	Moisture Content	5-15%
2.	Water Absorption	
	(a) 2 hrs. soaking (b) 24 hrs. soaking	Not more than 25% Not more than 50%
3.	Water Resistance	No sign of disintegration or delamination after 3 hrs. boiling in water.
4.	Swelling in Water	
	(a) General absorption for 2 hrs. immersion	Not more than 7%
	(b) Surface absorption for 2 hrs.	Not more than 5%
5.	Adhesion of plies	Knife test

9.2.4.5 Type of face veneers, thickness of veneered particle boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade veneered particle boards with BWP type synthetic resin adhesive shall be used.

9.2.5 Non-Asbestos Fibre Boards

9.2.5.1 Fibre boards shall be of medium density cement board reinforced with wood fibre, produced by fiberizing steamed wood under pressure, blended with adhesive and wax and formed into solid panels under controlled conditions of heat and pressure as per IS 14862.

9.2.5.2 ***Adhesives :*** The adhesive used for bonding shall be BWP type synthetic resin conforming to IS 848.

9.2.5.3 ***Thickness :*** Fibre boards are available in thickness 6, 9, 12, 15, 18, 22, 25, 30, 35 & 40 mm. The tolerance in thickness shall be ± 0.3 mm. Thickness of fibre boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade fibre boards bonded with BWP type synthetic resin adhesive shall be used.

9.2.6 Float Glass, Frosted Glass

Float glass used shall be as specified in sub-head 21.0 of this specifications.

For panel exceeding 0.5 sqm in area, the nominal thickness of the glass to be used shall be as specified.

9.2.7 Wire Cloth (Wire Gauze)

9.2.7.1 Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

9.2.7.2 ***Mesh :*** Average width of aperture and the nominal diameter of the wire shall be as under:

Average width of Aperture mm	*Nominal dia. of wire mm*
1.40	0.63
1.18	0.56
1.00	0.50

9.2.7.3 Width of aperture and dia of wire cloth shall be as specified. Unless otherwise stated, wire cloth of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanized mild steel wire shall be used.

9.2.7.4 Fly-proof wire cloth (aperture 1.40 mm) is generally provided in Kitchen and dining areas while wire cloth of smaller aperture is used in mosquito proof shutters.

9.2.8 Veneered Decorative Plywood

Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1328.

9.2.8.1 Requirement of Type-I Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots discolourisation and sapwood.T

(c) he decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 9.2.8.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

9.2.8.2 ***Adhesive :*** The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

9.2.8.3 ***Dimensions and Tolerances:***

9.2.8.3.1 The dimensions of plywood boards shall be as follows:

2400 mm x 1200 mm 2100 mm x 900 mm
2100 mm x 1200 mm 1800 mm x 900 mm
1800 mm x 1200 mm

9.2.8.3.2 *Thickness:* The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

Note: Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

9.2.8.3.3 ***Tolerances:*** Tolerances on the nominal sizes of finished boards shall be as follows:

Dimension	*Tolerance*
Length	+6 mm - 0
Width	+3 mm -0 mm
Thickness:	
(i) Less than 6 mm	±10 per cent
(ii) 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per Appendix I.

9.2.8.4 ***Finish :*** The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in 9.2.8.3.3.

9.2.8.5 ***Sampling and Criteria for Conformity :*** The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

9.2.8.6 ***Tests :*** Boards shall be subjected to following tests :

(i) *Moisture content:* Decorative veneered plywood of either type when tested in accordance with IS 1734 (Pt. I) shall have a moisture content not less than 5 per cent and not more than 15 per cent.

(ii) *Water Resistance Test* : Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 $\pm 2^{o}$ C for a period of 3 hours and dried for 8 hours at a temperature of 65 $\pm$ 2^{o}C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

9.2.8.7 ***Marking :*** Each plywood bound shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

(a) Indication of the source of manufacture
(b) Year of manufacture
(c) Batch no.
(d) Type of plywood
(e) Criteria for which the plywood has been lablled as ECO mark

The decorative veneered plywood may also be marked with standard BIS certification mark.

9.2.9 Prelaminated Particle Boards

9.2.9.1 Prelaminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type –I, II, III, IV.

9.2.9.2 Material

9.2.9.2.1 Particle Board Prelaminated particle board Grade-1 (FPT–I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and prelaminated conforming to IS 12823 Grade-I, type II or I shall be used.

9.2.9.2.2 *Impregnated Base Paper* : Printed or plain coloured absorbent base paper having a weight of 60 -140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for prelamination on both surfaces of particle board.

9. 2.9.2.3 *Impregnant Overlay :* An absorbent tissue paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

9.2.9.3 ***Dimension and Tolerances***

9.2.9.3.1 Dimensions of prelaminated particle boards shall be as follows:

Length	:	The length of prelaminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, 1.0 and 0.9 metres.
Width	:	The width of prelaminated particle boards shall 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and 0.45 metres.

Thickness : The thickness of prelaminated particle boards shall be 6, 9, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

9.2.9.3.2 ***Tolerances :*** Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	+ 6 mm - 0
Width	+ 3 mm - 0
Thickness	5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note : Edge straightness and squareness shall be tested as per IS 12823.

9.2.9.4 ***Sampling and Inspection*** **:** The number of prelaminated particle board to be selected from a lot shall be in accordance with the Table 9.4 given below:

TABLE 9.4

Lot Size	*Number of prelaminated boards to be selected*
Upto 50	2
51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

9.2.9.4.1 The prelaminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the prelaminated particle boards in the lot may be arranged in a serial order and every rth prelaminated particle board may be selected till the required number is obtained, 'r' being the integral part of N/n, where N is the lot size and n is the sample size.

9.2.9.4.2 All board selected as given in para 9.2.9.4.1 shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 9.2.9.3.2.

9.2.9.5 ***Testing and Number of Tests :*** For each of particle board selected as per para 9.2.9.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

9.2.9.6 ***Criteria for Conformity:*** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 9.2.9.3 & 9.2.9.5 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be considered as passed, if all these samples conform to the specified requirement.

9.2.9.7 ***Marking :*** Each prelaminated particle board shall be legibly and indelibly marked on any of its edges with following :

(a) Indication of source of manufacturer

(b) Grade and type of prelaminated particle board
(c) Thickness
(d) Batch number and year of manufacture

9.2.9A PRE-LAMINATED MEDIUM DENSITY FIBER BOARD

9.2.9A.1 Pre-laminated medium density fiber boards are available in two grades namely Grade I and II as per IS 14587:1998. Each grade is further classified in four types; namely Type –I, II, III, IV.

9.2.9A.2 Material

9.2.9A.2.1 A medium density fiber board laminated on both surfaces by synthetic resin impregnated base papers conforming to IS 14587:1998 Grade-I, type II or I shall be used.

9.2.9A.2.2 Impregnated Base Paper : Printed or plain coloured absorbent base paper having a weight of 60-140 g/m^2 impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of medium density fiber board.

9.2.9A.2.3 Impregnated Overlay : An absorbent tissue paper having a weight of 18-40 g/m^2 impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

9.2.9A.3 Dimension and Tolerances

9.2.9A.3.1 Dimensions of pre-laminated medium density fiber boards shall be as follows:
Thickness : The thickness of pre-laminated medium density fibre boards shall be 6, 9, 12, 15, 18, 22, 25, 30, 35 and 40 mm.

9.2.9A.3.2 Tolerances : Tolerances on the nominal sizes of finished boards shall be as given below :

Dimension	Tolerance
Length	± 3 mm/metre
Width	± 3 mm/metre
Thickness	± 0.3 mm
Edge straightness	2 mm/metre
Squareness	2 mm/metre

9.2.9A.4 Sampling and Inspection: The number of pre-laminated medium density fibre board to be selected from a lot shall be in accordance with the Table 9.4A given below:

TABLE 9.4A

Lot Size	Number of pre-laminated boards to be selected
Upto 50	2
51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

9.2.9A.5 Marking : Each pre-laminated medium density fibre board shall be legibly and indelibly marked on any of its edges with following :
(a) Name of the manufacturer or trade mark.
(b) Grade and type of pre-laminated medium density fiber board.
(c) Thickness and
(d) Batch number and year of manufacture.

9.2.10 Coir Veneer Board for General Purposes

9.2.10.1 Coir veneer board is manufactured with a combination of coconut fibre needled felt, veneer and jute fibres with kraft paper coconut fibre. Needled felt can be used as core crossbands or as outer skin formed with jute fibres and kraft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needled.

9.2.10.2 Coir veneer board generally shall conform to IS 14842.

Grades

Coir veneer board for general purposes shall be of two grades:

(a) Boiling water resistant (BWR) grade
(b) Moisture resistant (MR) grade

9.2.10.3 ***Material***

(a) *Coconut Fibre :* Coconut fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 g/m^2.

(b) *Jute :* Jute fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 g/m^2.

(c) *Adhesive :* Adhesive for manufacture of coir veneer board shall be conform to BWR/MR of IS 848 for BWR/MR grade boards respectively.

(d) *Veneer* : Any species of timber may be used for the manufacture of veneers.

(e) *Kraft Paper :* Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 g/m^2 .

9.2.10.4 ***Permissible Defects :*** Gap in cores and crossband shall not be permitted. Splits in cores and crossbands may be permitted to an extent of 2 per core or crossband and overlap shall be permitted in core/crossbands only.

9.2.10.5 ***The Dimensions and Tolerances :*** The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12049.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 18 mm, 20 mm and 25 mm.

The following tolerance on nominal thickness shall be permissible.

(a) Less than 6 mm $\pm$ 10%
(b) 6 mm and above $\pm$ 5%

9.2.10.6 ***Workmanship and Finish :*** Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The squareness and edge straightness of the board shall be as per para 9 of IS 12842 and Appendix J.

9.2.10.7 *Sampling :* The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

9.2.10.8 *Tests :* The tests shall be carried out as specified in IS 14842 – Appendix K.

9.2.10.9 *Moisture Content* : Coir veneer board when tested in accordance with IS 3734 (Part I) shall have a moisture content not less than 5 percent and not more than 15 percent.

9.2.10.10 *Marking:* Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner.

(a) Identification of source
(b) Year of manufacturing
(c) Batch no.
(d) The grade and type as follows.
  (i) Boiling water resistant (BWR) and
  (ii) Moisture resistant (MR)

9.2.10.11 *BIS Certification Marking :* Coir veneer board may also be marked with the standard mark governed by the BIS Act, 1986.

9.2.11 Marine Plywood

9.2.11.1 Marine plywood shall be generally conforming to IS 710. Selection of timber species for manufacture of plywood shall be as prescribed in IS 710 and as far as possible a single species of timber shall be used.

9.2.11.2 *Adhesive :* The adhesive used for bonding the veneer shall be of the hot press synthetic resin, phenol formaldehyde type (BWP) and shall conform to IS 848. Extender shall not be added to the adhesive by the plywood manufactures. Fillers, if used, shall not exceed 10 percent by mass of solid content of the glue.

9.2.11.3 *Dimensions*

9.2.11.3.1 The dimensions of plywood boards shall be as stated in para 9.2.10.5.

9.2.11.3.2 The thickness of any board shall not exceed the number of pieces multiplied by 2.5 mm. The two face veneers in finished board shall be of the same nominal thickness.

9.2.11.4 *Tolerances :* The following tolerances in the nominal size of finished boards shall be permitted.

Dimension	*Nominal Size*	*Tolerance*
Length	Upto 120 cm.	+ 3 mm
	Above 120 cm.	+ 6 mm
Width	Upto 90 cm.	+ 3 mm
	Above 90 cm	+ 6 mm
Thickness	Upto 4 mm	±10 per cent
	Above 4 mm	±5 per cent

9.2.11.5 *Sampling :* The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

9.2.11.6 ***Tests :*** Test pieces cut from each of board as specified at para 9.2.11.5 shall be subjected to following tests.

(a) Moisture content
(b) Glue adhesive in dry state
(c) Water resistance test.
(d) Tensile strength
(e) Mycological test
(f) Retension of preservative.

These tests shall be carried out as specified in IS 710.

9.2.11.7 ***Marking :*** Each plywood board shall be legibly and indelibly marked or stamped with following particulars along with such other marks as the purchaser may stipulate at the time of placing order.

(a) Manufacturer's name, initials or recognized trade mark, if any.
(b) Year of manufacturing.
(c) Abreviation indicating the species of timber used in each ply as indicated in col. 3 of Table – 1 and 2 of IS 710.
(d) Batch number

9.2.11.8 ***BIS Certification Marking :*** The plywood board may also be marked with the standard mark, governed by the BIS Act,1986.

9.2.11.9 ***Tender Sample, Inspection and Acceptance:*** Where samples are required to be tendered, three samples each not less than 90 x 60 mm in size shall be submitted by the supplier, and these samples, if the tender is accepted shall constitute the standard as regards the type of timber, quality and finish.

9.2.12 Fire Retardant Plywood

9.2.12.1 Fire retardant plywood shall generally conform to IS 5509. The plywood to be given fire retardant treatment shall conform to BWR grade of IS 303 to be able to stand pressure impregnation. Plywood for treatment shall be clean, free from oil or dirt patches on the surface and at a moisture content not exceeding 15 percent. In case of veneered decorative plywood care shall be taken that colour of the solution does not spoil to decorative surface.

For Eco-mark the plywood shall conform to the requirements of Eco-mark specified in IS 303.

9.2.12.2 ***Fire Retardant Treatment :*** This shall be either pressure impregnation or soaking treatment as per IS 5509.

9.2.12.3 ***Choice of Treatment :*** The choice of treatment may be left to the manufacturer of plywood as per fire resistant requirements prescribed in IS 5509. The purchaser should however, specify whether plywood is to be treated with fire retardants only or with fire retardants and preservatives.

The recommended retention of fire retardant chemicals for different hazards like interior or exterior use not subject to leaching by rain and water is of the order of 50 kg/m^3.

9.2.12.4 ***Conditioning after Treatment :*** The plywood after treatment shall be conditioned to suitable equilibrium moisture content of not more than 20 per cent.

9. 2.12.5 ***Dimension and Tolerances*** shall conform to IS 2049. The tolerance of thickness shall conform to IS 303.

9.2.12.6 ***Sampling :*** The method of drawing representative sample and the criteria of conformity shall be as prescribed in IS 7638.

9.2.12.*7* *Test Specimen and Number of Tests:* From each of fire retardant plywood selected as above para 9.2.12.6, following test specimens shall be cut from portions 150 mm away from the edges for tests specified as under:

(a) *For Flammability :* Six test specimens 125 mm x 125 mm in full thickness of material from each sample.
(b) *For Flame Penetration :* Three test specimens 125 mm x 125 mm in full thickness of material from each sample.
(c) *For Rate of Burning :* Three test specimen 100 mm x 12.5 mm in full thickness of material from each sample.

9.2.12.8 ***Test Requirements and Other Tests***

(i) *Moisture Content :* Shall not exceed 20%.
(ii) *Flammability :* When tested as per IS 1734, time taken for second ignition shall not be less than 30 minutes.
(iii) *Flame Penetration :* When tested as per IS 1734, time taken for flame penetration shall not be less than 15 minutes for every 6 mm thickness.
(iv) *Rate of Burning :* When tested as per IS 1734, the time taken to lose weight from 30 per cent to 70 per cent shall not be less than 20 minutes.

9.2.12.9 ***Marking :*** Each board shall be legibly and indelibly marked near the edge with the following:

(a) Manufacturer's name, his initials or his recognized trade mark, if any.
(b) Year of manufacture
(c) Type of treatment
(d) Criteria for which the plywood has been labeled as ECO mark.

9.2.12.10 ***BIS Marking :*** Each board may also be marked with standard mark governed by the BIS Act, 1986.

9.2.13 Decorative Thermosetting Synthetic Resin Bonded Laminated Sheets

9.2.13.1 ***Scope :*** Decorative thermosetting synthetic resin bonded laminated sheets shall generally conform to IS 2046. This material is intended for interior use and is not intended for load bearing applications.

9.2.13.2 ***Terminology :*** For the purpose of this standard, the definition given under para 2 of IS 1998 shall apply.

9.2.13.3 ***Types :*** The material shall be of two types namely:-

(a) *Type 1*- Having only one side bearing decorative surface the other side being roughened or given an appropriate treatment to promote adhesion to the base. This type shall generally be used, unless specified otherwise.

(b) *Type 2*- Having both sides bearing the decorative surface, the two sides may be different in colour or pattern or both.

9.2.13.4 ***Requirements***

(i) *Appearance :* The types of surface finish of decorative and reverse side, edge finish, colour and pattern shall be as agreed to between the purchaser and the supplier. The sheets shall be reasonably free from local deformation.

Note : Since sheets may vary slightly in colour and appearance, it is recommended that sheets for any one scheme may be matched.

(ii) *Flatness :* For nominal thickness 1.5 mm – when a sheet is tested for flatness in accordance with the method given in Appendix –C of IS 2046, the height above the flat surface at the edge of full manufactured and trimmed width shall nowhere exceed 150 mm.

(iii) *Tolerance to nominal thickness :* The departure from nominal thickness of sheet at any point, shall not exceed the value given below:

Nominal Thickness	Tolerance
Upto 1.5 mm	± 0.25 mm

(iv) Straightness of edges of rectangular finished panels, resistance to dry heat, resistance to boiling water, resistance to staining, gross breaking strength, packing and marking, sampling and criteria for conformity etc. shall be as per IS 2046.

9.3 DOOR, WINDOW AND VENTILATOR FRAMES

9.3.1 Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without any warp or bow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of ± 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

9.3.2 Joints

The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

9.3.3 Fixing of Frames

The frames shall be got approved by the Engineer -in -Charge before being painted, oiled or otherwise treated and before fixing in position. The surface of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with holdfasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be suitably strutted and wedged in order to prevent warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames. In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

9.3.4 Measurements

Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of upto three places of decimal.

9.3.5 Rate

The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

9.4 FALSE CEILING AND PARTITION FRAMES

This work shall be done as specified in 9.3 except that the scantlings need not be planed unless otherwise specified.

9.4.1 All screws shall be of stainless steel minimum grade 304 of required size.

9.4.2 Rate – The rate shall include cost of all materials including SS screws involved in all operations described above except the holdfast or metallic fastness which shall be paid for separately.

9.5 TRUSSES

9.5.0 The work shall be carried out as per detailed drawings and as directed by the Engineer-in-Charge specified timber shall be used. Sawing shall be truly straight and square, and in the direction of the grains. The scantlings shall be accurately planed smooth to the full dimensions and rebate roundings and mouldings shown in the drawings, before the same are framed. Patching or plugging of any kind shall not be permitted. A tolerance of +3 mm and -2 mm shall be allowed in the finished cross sectional dimension.

9.5.1 Joints

Joints shall be simple, neat and strong. All mortise and tenon joints, mitred joints, scarfs etc. shall fit in fully and accurately without wedging or fillings. The joints shall be as per detailed drawings. Holes of correct sizes shall be drilled before inserting screws/bolts. Driving in screws with hammer is prohibited. Holes for bolts shall be of uniform diameter. The screws, bolts and nails shall be dipped in oil before using. The heads of nails and screws shall be sunk and puttied or dealt with as instructed by Engineer-in-Charge. The gauge and length of nails, screws and bolts shall be approved by the Engineer-in-Charge before using on works.

9.5.2 Shaping Form and Cutting

The wood sections, as specified or required, shall be straightened, cut square and to correct lengths. A fine accuracy shall be ensured in the fabrication of various member so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true to shape and free from twist, kinks, buckles or open joints.

9.5.3 Fabrication

As per drawing, a full size truss diagram shall first be drawn on a levelled platform. From this full size diagram, templates of all joints as for tenons, mortises, scarves etc. shall be made for use in the fabrication. The template shall be made to correspond to each member and plate holes for screws and bolts shall be marked accurately on them and drilled. The templates shall be laid on wooden members and the holes for screwing and bolting marked on them. The ends of the wooden members shall also be marked for cutting. The base of columns and the position of anchor bolts shall be carefully set out. Before fabrication of the truss individual members shall be assembled together to ensure close abutting or lapping of the surfaces of the different members and fitted close together as per drawing.

9.5.4 Hoisting and Placing in Position

The trusses shall be hoisted and placed in position carefully, without any damage to itself and other building work and injury to workman. The trusses shall be secured to walls by means of holding down bolts or as directed by the Engineer- in-Charge. The necessary mechanical appliances such as lifting tackel, winch etc. for hoisting the truss shall be used. The trusses shall be stayed temporarily till they are permanently secured in position and connected with each other by means of purlins. Holding down bolts cleats used for purlins and bottom plates used for tie and rafter member shall be paid for separately.

9.5.5 Surface Treatment

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Engineer- in-Charge. All portions of timber built into or against or close to masonry or concrete or burried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved wood primer.

9.5.6 Measurements

Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured over all nearest to a cm, so as to include projections for tenons, scarves or mitres. Width and thickness shall be measured to the nearest mm. Cubical contents can be worked out in units cubic meters upto 3 places of decimal in whole numbers.

9.5.7 Rate

The rate includes the cost of materials and labour involved in all the operations described above. Unless otherwise specified, iron fixtures such as bolts and nuts, M.S. steel plates, holding down bolts and staining, priming, painting or polishing of the work shall be paid for separately.

9.6 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS (FIG. 9.2)

9.6.0 Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutters The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally panelled glazed or panelled and glazed shutter shall conform to IS 1003 (Pt. 1 & 2).

9.6.1 Frame Work

9.6.1.1 Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one- third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

9.6.1.2 ***Gluing of Joints :*** The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS 848 or polyvinyl acetate dispersion based adheshive conforming to IS 4835 and pinned with 8-10 mm dia hardwood dowels or bamboopins or star shaped metal pins; after the frames are put together and pressed in position by means of press.

9.6.1.3 Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

9.6.1.4 ***Door Shutters***

9.6.1.4.1 Finished dimensions and tolerances of components of door shutters has been given in Table 9.5 below.

TABLE 9.5
Dimensions and Tolerances of Components of Door Shutters

Sl.	*Description*	*Width mm*	*Thickness mm*
(a)	Vertical Stile, top and freeze rail	100 ± 3	35 ± 1 or 40 ± 1
(b)	Lock rail	**150 ± 3**	35 ± 1 or 40 ± 1
(c)	Bottom rail	200 ± 3	35 ± 1 or 40 ± 1
(d)	Muntin	100 ± 3	35 ± 1 or 40 ± 1
(e)	Glazing bar	40 ± 3	35 ± 1 or 40 ± 1

9.6.1.4.2 *Size and Types :* Size and types of the timber panels and glazed shutters shall generally conform to modular sizes specified in Table 9.6 below.

TABLE 9.6
Dimension of Door Shutters

Sl. No.	*Designation of Doors*	*Width*	*Height*	
		mm	*mm*	
(1)	*(2)*	*(3)*	*(4)*	
(i)	8DS 20	700	1905	(1945)
(ii)	8DS 21	700	2005	(2045)
(iii)	9DS 20	800	1905	(1945)
(iv)	9DS 21	800	2005	(2045)
(v)	10 DS 20	900	1905	(1945)
(vi)	10 DS 21	900	2005	(2045)
(vii)	12 DT 20	1100[1)]	1905	(1945)
(viii)	12 DT 21	1100[1)]	2005	(2045)

Notes :

(1) The designation refers to modular sizes of door openings. First number stands for width and the last for height in modules (M = 100 mm). Alphabet D refers to doors, 'S' to single and 'T' to double leaf shutter.

(2) Standard sizes of door frames are covered in IS 4021 and IS 4351.

(3) The standard widths and heights for panel doors are arrived at as shown in Fig. 6 of IS 1003 (Pt. 1). In case the modular height is taken from the finished floor level, the height of the door shall be the one given in bracket. In the case of double leave shutters, the rebate in the shutter shall be as given in 6.15 of IS 1003 (Pt. 1).

9.6.1.5 ***Window and Ventilator Shutters :*** Window and ventilator shutters shall conform to IS 1003 (Part 2).

9.6.1.5.1 *Dimensional Sizes and Tolerances :* The finished dimensions and tolerances of different component shall be as given in Table 9.7.

TABLE 9.7
Dimensions and Tolerances of Components of Window and Ventilator Shutters

Description of components	*Window Shutters*		*Ventilator Shutters*	
	Width mm	**Thickness mm**	*Width mm*	**Thickness mm**
Stiles and rails	80 ± 3	25 ± 1	80 ± 3	20 ± 1
		30 ± 1		22.5 ± 1
				25 ± 1
				27.5 ± 1
				30 ± 1
Munting	60 ± 3	25 ± 1	60 ± 3	-do-
		30 ± 1		
Glazing bars	40 ± 1	25 ± 1	40 ± 1	-do-
		30 ± 1		

9.6.1.5.2 *Designation :* Window and ventilator shutters shall be designated by symbols denoting the width, type and height of window and ventilators in following manner.

(a) *Width :* It shall be indicated by the number of modules in the width of opening
(b) It shall be indicated by the following letters of alphabet: W- window, V- Ventilator , S-Single shutter, T-Double shutter
(c) Height : It shall be indicted by the number of modules in the height of opening.

Example : 10 WT 12 would mean a window shutter suitable for a double shutter window of 10 modules width and 12 modules height.

12 V 6 would mean ventilator shutter suitable for a ventilator of 12 modules width and 6 modules height.

9.6.1.5.3 *Sizes :* Sizes of window and ventilator shutters shall generally conform to the modular sizes specified in Tables 9.8 and 9.9 respectively. These sizes are derived after allowing the thickness of the frame and a margin of 5 mm all round based on 100 mm module.

9.6.1.5.4 Tolerances on the overall dimensions of window and ventilator shutter shall be ± 3 mm.

TABLE 9.8
Dimensions of Timber Window Shutters

Designation	*Width mm*	*Height mm*
(1)	*(2)*	*(3)*
6 WS 12	500	1100
10WT 12	460	1100
12 WT 12	560	1100
6 WS 13	500	1200
10 WT 13	460	1200
12 WT 13	560	1200

TABLE 9.9
Dimensions of Timber Ventilator Shutters

Designation	*Width mm*	*Height mm*
(1)	*(2)*	*(3)*
6 V 6	500	500
10 V 6	900	500
12 V 6	1100	500

9.6.2 Mounting and glazing bars where required shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specified the finished dimensions of the components of frame work of shutters shall be as given in Table 9.7. The tolerance on width of styles and rail shall be ± 3 mm. The tolerance in thickness will be ± 1 mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be ± 3 mm.

9.6.3 Rebating

The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the Engineer -in-Charge. In case of double leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebating shall be either splayed or square type as shown in Fig. 9.2.

9.6.4 Panelling

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given in para 9.2 of this sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

9.6.4.1 ***Timber Panels :*** Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

9.6.4.2 ***Plywood Panels :*** Plywood boards used for panelling of shutters shall be BWP type or grade as specified in 9.2.2. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

9.6.4.3 ***Veneered Particle Board Panels :*** Veneered Particle board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 9.2.4.2. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

9.6.4.4 ***Fibre Board Panels :*** Fibre board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive Each fibre board panel shall be a single piece unless otherwise specified.

9.6.4.5 ***Wire Gauze Panels:*** Wire Gauze used for panelling of shutters shall be woven with 0.63 mm dia galvanised mild steel wire to form average aperture size of 1.40 mm as specified in 9.2.7. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face to the required patterns as decided by the Engineer-in-Charge.

9.6.4.6 ***Glass Panels :*** Glass panelling (Glazing) shall be done as specified in 9.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. **For making the glass of frosted look, suitable fill as per direction of the Engineer-in-Charge shall also be accepted and nothing shall be paid extra**. Frosted/ Filmed glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

9.6.4.7 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

9.6.4.8 ***Finish :*** Panels of shutters shall be flat and well sanded to a smooth and level surface.

9.6.5 Beading

Beadings in panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in-Charge. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

9.6.6 Machine/Factory made Shutters

Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

9.6.7 Fixing of Shutters

For side hung shutters of height upto 1.2 m **and width up to 0.9 m** each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m **and width up to 0.9 m** each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. **One additional hinge shall be provided for width exceeding 0.9m for 0.3 m or part thereof.** Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 × 90 × 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

9.6.8 Fittings

Fittings shall be provided as per schedule of fittings as shown in drawings or as decided by Engineer- in-Charge. The schedule of fittings and screws for door & windows contained in Appendix 'H' is for guidance only. All fittings shall be paid for separately. The fittings shall conform to specifications laid down in 9.15. All screws shall be of stainless steel of minimum grade 304.

9.6.9 Wooden Cleats and Blocks

Wooden cleats and blocks shall be fixed to doors and windows as directed by Engineer-in-Charge, as per size and shape approved by him. These are included in the cost of providing and fixing the shutters.

9.6.10 Measurements

Framework and panelling shall be measured separately.

9.6.10.1 ***Framework of Shutters :*** The overall length and width of the framework of the shutters shall be measured nearest to a cm in fixed position (overlaps not to be measured in case of double leaved shutters) and the area calculated in square metres correct to two places of decimal. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labour involved in all operations described above.

9.6.10.2 For panelling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sq.m. The portions of the panel inserts or glazed panel inside the grooves or rebates shall not be measured for payment.

9.6.11 Rate

Rate includes the cost of materials and labour involved in all the operations described above. The framework and panelling of each type or glazed panels shall be paid separately. The rate for framework includes the cost of butt hinges and necessary screws as specified in 9.6.7. However, extra shall be paid for providing moulded beading where specified. Nothing extra shall be paid for plain beading as stated in 9.6.5 when specified in drawing.

9.7 FLUSH DOOR SHUTTERS (Fig. 9.3)

9.7.0 Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.

9.7.1 Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer-in- Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

9.7.2 Core

The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

9.7.3 Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross -bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

9.7.4 Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.7.5 Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

9.7.6 Opening for Glazing

When required by the purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200 mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

9.7.7 Venetian Opening

Where specified the height of the venetian opening shall be 350 mm from the bottom of the shutter. The width of the opening shall be as directed but shall provide for a clear space of 75 mm between the edge of the door and venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or shown in the drawing.

9.7.8 Tolerance

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

9.7.9 Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

9.7.10 Tests

Samples of flush door shutters shall be subjected to the following tests:

(a) End Immersion Test
(b) Knife Test
(c) Glue Adhesion Test

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter. Test shall be done as laid down in Appendix F of Chapter 9.

9.7.11 Sample Size

Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in Table 9.10. If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the discretion of the Engineer-in-Charge and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified in 9.7.10.

For knife test, glue adhesive test, slamming test, the end immersion test, the number of shutters shall be as per col. 4 of Table 9.10.

TABLE 9.10
Sample Size and Criteria for Conformity

Lot Size	*Sample Size*	*Permissible no. of defective*		*Sub. Sample size*
(1)	*(2)*	*(3)*		*(4)*
Upto 26 to 50	8	0		1
51 – 100	13	1		2
101 – 150	20	1		2
151 – 300	32	1		3
301 – 500	50	2		4
501 and above	80	2		5

9.7.12 Criteria for Conformity

All the sample shutters when tested shall satisfy the requirements of the tests laid down in Appendix F of Chapter 9. The lot shall be declared as conforming to the requirements when numbers of defective sample does not exceed the permissible number given in col. 3 of Table 9.10. If the number of sample shutters found unsatisfactory for a test is one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

9.7.13 Fixing

This shall be as specified in 9.6.7.

9.7.14 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured.

All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made for providing venetian opening and opening for glazing.

9.7.15 Rates

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters. Glazing when provided shall be measured & paid for separately as specified in 9.6.10.2.

9.7A CUP BOARD SHUTTER

9.7A.0 Cup Board Shutter shall be with pre-laminated flat pressed three layers particle board or with Veneered particle board.

9.7A.1 Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer in-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of cupboard shutters shall be not more than 12 per cent when tested according to IS 1708.

9.7A.2 Material :- Pre laminated flat presses three layer shall conform to IS 12823. Venereal particleboard shall conform to IS 3087. The boards with BIS Certificate marks shall only be accepted. Nominal thickness of shutter may be 25, 30 or 35 mm thickness and of type of shutter shall be as specified.

9.7A.3 Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.7A.4 Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 20 mm.

9.7A.5 Tolerance

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. Tolerance in respect of Edge straightness and squareness shall be as per relevant BIS standard.

9.7A.6 Tests

All relevant tests as specified India standards shall be done or as directed by Engineer-in-Charge.

9.7A.7 Fixing of Shutter

Continuous (piano) hinges shall be used for fixing cupboard shutter where specified. Only stainless steel of minimum grade 304 shall be used.

9.7A.8 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured.

All work shall be measured net as fixed and area calculated in square meters to nearest two places of decimal.

9.7A.9 Rate

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters.

9.8 WIRE GAUZE FLY PROOF SHUTTERS

9.8.0 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

9.8.1 Stile and Rails

The Specifications shall be as described under 9.6.1.3. The stiles and rails shall be given a rebate to receive the wire gauze which shall form the panels.

9.8.2 Wire Gauze

This shall be unless specified otherwise conform to para 9.2.7 and 9.6.4.5. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at about 75 mm centres, fixed alternately in the two faces of the rebates. Over this, wooden beading shall be fixed with brads or small screws at about 75 mm centres.

The space between the beading and rebates, where the wire gauze is bent, shall be neatly finished with putty, so that the end of the wire gauze may not be visible.

9.8.3 Fixing Fittings, Wooden cleats, blocks and Measurement shall be as specified under 9.6.

9.8.4 Rate

This includes the cost of materials and labour involved in all the operations described above, and as specified under 9.6.

9.9 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.15

9.10 SHELVES

9.10.0 Shelves and vertical partitions of cupboards shall be of timber planks fibre board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece teak wood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-Charge.

9.10.1 Fixing

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. Teakwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be ± 1.5 mm and in thickness 1 mm.

9.10.2 Measurements

Length and width of shelves and vertical partitions shall be measured correct to a cm. separately for each type of board stating its thickness. Area shall be calculated correct to 0.01 sqm.

9.10.3 Rate

It includes the cost of materials and labour required for all the operations described above.

9.10.A Lipping in pelmet –

Lipping shall be provided on all edges of the pelmets. The timber shall be as specified.

9.11 TRELLIS (JAFFRI) WORK

9.11.0 Specified timber shall be sawn/cut in the direction of the grains. Sawing / cutting shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided. **The case of Bamboo Jaffri the bamboo of minimum 25 via shall be of cut in the length dimension.**

9.11.1 Plain Trellis (Jaffri)

This shall consist of wooden strips or laths 35 x 10 mm section unless otherwise specified planed and nailed together at every alternate crossing. The strips shall cross each other at right angle and shall be spaced 35 mm apart, so as to form 35 × 35 mm square opening or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 × 12 mm beading shall be fixed to the frame with screws. The finished work with a tolerance of ± 1 mm may be accepted.

9.11.2 Bamboo Trellis (Jaffri)

This shall consist of half cut bamboos of 25mm (minimum parameter). The bamboo strips shall be fixed with 3 numbers Hollack Wood Scantling of size 50mm x 50 mm and shall be fixed with nails of required size. The finished work with a tolerance of ± 1 mm may be accepted.

9.11.3 Measurements

Width and height of plain trellis work and trellis shutters shall be measured overall correct to a cm.

The area shall be calculated in square metres nearest to two places of decimal.

9.11.4 Rate

It includes the cost of materials and labour required in all the operations described above.

9.12 PELMETS

9.12.0 Planks and curtain rods of specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted.

9.12.1 Sides, front and top of the pelmets shall be of 12 mm planks or boards of specified quality and width unless otherwise stated. These shall project from the wall face by 15 cm or as specified, and shall be securely fixed to walls with wood screws by means of wooden plugs and 10 cm long 25 × 3 mm M.S. flat bent in the form of angle or by any other device approved by the Engineer-in-Charge. The pelmets shall be provided with curtain rods and brackets or curtain rails with rollers, stop ends and brackets wooden, brass or chromium plated brass as specified. Intermediate wooden brackets shall be provided, if the front length of pelmet exceeds 1.5 metres.

9.12.2 Measurements

The pelmets box shall be measured along the sides and front planking correct to a centimetre.

9.12.3 Rate

The rate includes the cost of sides, front and top planking curtain rods with brackets or curtain rails with rollers labour and materials required for all the operations described above.

9.13 HOLD FASTS

9.13.0 These shall be made from mild steel flat 40 × 5 mm size conforming to IS 7196 without any burns or dents. 5 cm length of M.S. flat at one end shall be bent at right angle and one hole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and pluged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of size 30 x 10 x 15 cm of mix 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate, 20 mm nominal size) or as specified (see Fig. 9.4).

9.13.1 Measurements

Measurements for the hold fasts shall be in number.

9.13.2 Rate

It includes the cost of labour and material involved in all the operations described above including fixing bolt and cement concrete blocks.

9.14 EXPANDED METAL, HARD DRAWN STEEL WIRE FABRIC AND WIRE GAUZE IN WOODEN FRAMES

9.14.0 Expanded metal, hard drawn steel wire fabric or wire gauge or weld mesh as described in the item of work shall be fixed to the window frames on the outside or inside as per detailed drawings or as directed by the Engineer-in-Charge. These shall be free from rust and other defects.

Expanded Metal

This shall be in the form of rhombus with its opening diagonals 20 × 60 mm and strands 3.25 mm wide and 1.6 mm thick weighing 3.633 kg/m^2 unless otherwise specified.

Welded Steel Drawn Wire Fabric

This shall conform to IS 4948 and shall have rectangular mesh of 75 × 25 mm size with wires of diameter not less than 5 mm longitudinally and 3.15 mm transversely. Its weight shall be not less than 7.75 kg/m^2 unless otherwise specified.

Wire-Gauze

This shall be as per clause 9.2.7.

9.14.1 Fixing

Expanded metal, hard drawn steel wire fabric and wire gauze shall be cut in one piece to the size of the frame (out to out). Expanded metal and hard drawn steel wire fabric shall be fixed on to the frame with staples, over which wooden beading 60 x 20 mm shall be fixed with wood screws.

9.14.2 Measurements

The length and breadth shall be measured correct to a cm, the area from outside to outside of beading shall be calculated in square metre nearest to two places of decimal.

9.14.3 Rate

It includes the cost of labour and materials required for all the operations described above.

9.15 FITTINGS

9.15.0 Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

(a) **Mild Steel Fittings :** These shall be bright finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.

(b) **Brass Fittings :** These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

(c) **Aluminium Fittings :** These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix H attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with

screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sunking of hinges.

9.15.1 Butt Hinges (Fig. 9.5A)

These shall be of the following types according to the material used.

(a) Mild steel butt hinges (Medium).
(b) Cast brass butt hinges light/ordinary or heavy.
(c) Extruded aluminium alloy butt hinges.

9.15.1.1 ***Mild Steel (Medium) (Fig. 9.5A) :*** These shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

Hinge Pin : Hinge pin shall be made of mild steel wire. It shall fit inside the knuckles firmly and rivetted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge, but shall not cause looseness.

Knuckles : The number of knuckles in the hinges of different sizes shall be as per IS 1341. The size of knuckles shall be straight and at right angle to the flap. The movement of the hinges shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head wood screws and of the specified size for different types, and sizes of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The nos. of screw holes shall as specified in IS 1341.

9.15.1.1.1 *Sampling and Criteria for Conformity :* The number of butt hinges to be selected from a lot shall be depend on size of lot and shall be in accordance with Table 9.11 below. Butt hinges for testing shall be selected at random from at least 10 per cent of the randomly selected packages subjected to minimum of three equal number of hinges being selected from each package. All butt hinges selected shall be checked for dimensions and tolerance requirements. Defects in manufacture and finish shall also be checked and lot shall be considered conforming to the requirement of this specifications, if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.11.

TABLE 9.11
Scale of Sampling and Criteria for Conformity

Sl. No.	*Lot size*	*Sample Size*	*Permissible No. of Defective hinges*
1	*2*	*3*	*4*
1.	Upto 150	5	0
2.	151 to 300	20	1
3.	301 to 500	32	2
4.	501 to 1000	50	3
5.	1001 and above	80	5

9.15.1.2 ***Cast Brass :*** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidised or as specified. These shall generally conform to IS 205.

Hinge Pin : Hinge pin shall be made of brass or of stainless steel. The hinge pins shall be firmly rivetted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

Knuckles : The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be clean and counter sunk and of the specified size for differen types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

9.15.1.3 ***Extruded Aluminium Alloy :*** These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

Hinge Pin : Hinge pin shall be made of mild steel (galvanised or aluminium alloy). The aluminium alloy hinge pin shall be anodised. The hinge pin shall be finally rivetted and shall be properly finished. The movement of hinges shall be free easy and square and shall not have any play or shake.

Knuckles : Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes : The screw holes shall be suitable for counter sunk head wood screws, and of specified sizes for different type of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

9.15.1.4 ***Sampling and Criteria for Conformity :*** The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.12. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.12.

TABLE 9.12
Scale of Sampling and Criteria for Conformity

Sl. No.	*Lot size*	*Sample size*	*Permissible No. of defective hinges*
1	Upto 200	15	0
2	201 to 300	20	1
3	301 to 500	30	2
4	501 to 800	40	2
5	801 and above	55	3

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

9.15.2 Parliament Hinges (Fig. 9.5B)

9.15.2.1 These shall be of mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidised (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidised or as specified.

9.15.2.2 The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanised) in the case of aluminium alloy hinges. The hinge pin shall be firmly rivetted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake.

All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.

9.15.2.3 ***Sampling Criteria for and Conformity :*** The number of parliament hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.13. Parliament hinges for testing shall be taken at random. All hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be

considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.13.

TABLE 9.13

Lot Size	*Sample Size*	*Permissible No. of Defective hinges*
Upto 150	13	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

9.15.3 Spring Hinges (Single or double acting)

9.15.3.1 These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453.

Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ± 0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90º.

The size of spring hinge shall be taken as the length of the plate.

9.15.3.2 These shall be of the following type:

(a) *Mild Steel :* The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and rivetted, or from solid drawn tube of thickness not less than 1.60 mm; or from mild sheet of 1.60 mm thickness pressed to from the two casing and the distance piece. It shall be stove enamelled black or copper oxidized or as specified.

(b) *Cast Brass :* The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickle plated or copper oxidized or as specified.

9.15.3.3 ***Sampling :*** The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table 9.14.

TABLE 9.14

Lot size	*Sample size*	*Permissible No. of defective spring hinges*
Upto 100	13	0
101 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

9.15.4 Rising Hinges

These shall be made of brass, finished bright or chromium plated or oxidised or as specified. Its shape and pattern shall be approved by the Engineer-in-Charge. The size of the rising hinge shall be taken as the length of its plate.

9.15.5 Continuous Piano Hinges (Fig. 9.6B)

9.15.5.1 These shall be made from mild steel or aluminium alloy sheet, these shall generally conform to IS 3818. All screw holes shall be clean and counter sunk. Piano hinges shall be fixed in the entire length of the cup board shutters. Its size will be the width of the two flaps when open.

9.15.5.2 ***M.S. Piano Hinges :*** These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidised finish.

Hinge pin shall be of galvanised mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge, but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy and working shall not have any play and shake.

9.15.5.3 ***Aluminium Piano Hinges :*** These shall be made of aluminium alloy sheet and shall be anodised. The anodic coating shall not be less than the grade AC 15 of IS 1868.

Hinge pin shall be made of aluminium alloy with anodic coating not less than the grade of AC-15 of IS 1868. The hinge pin shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy, and working shall not have any play and shake.

9.15.5.4 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.6 Tee Hinges (Fig. 9.6A)

These shall be made from M.S. sheets and shall be either bright finished or stove enamelled black or as specified. These shall generally conform to IS 206 (Tee hinges shall be well made, free from burrs, flaws, and defects of any kind. The movement shall be square, and the working shall be free and easy without any play or shake. The hole for the hinge shall be central to the bore and shall be square.

The hinge pin shall be firm and rivetted over, so that the heads are well formed. All screw holes shall be clear and counter sunk and shall be suitable for the counter sunk head of wood screws.

9.15.6.1 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.7 Sliding Door Bolts (Aldrops) (Fig. 9.7)

9.15.7.1 These shall be of mild steel, cast brass, aluminium or as specified, and shall be capable of smooth sliding action.

9.15.7.2 ***M.S. Sliding Door Bolts :*** These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S.sliding door bolts shall be copper oxidised (black finish) or as specified.

9.15.7.3 ***Cast Brass Sliding Door Bolts :*** These shall be made from rolled brass and shall generally conform to IS 2681. The hasp shall be of cast brass and secured to the bolt as shown in Fig. 9.7. Alternatively, the hasp and the bolt may be cast in one piece. The fixing and staple bolts shall be cast with 6 mm studs. Bolts shall be finished to shape and have threaded ends and provided with robs washers and nuts of square or hexagon type. All components shall be finished smooth and polished before assembly. Cast brass sliding bolts shall be finished bright or chromium plated or oxidised or as specified.

9.15.7.4 ***Aluminium Sliding Door Bolts :*** These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

9.15.7.5 ***Sampling and Criteria for Conformity :*** The number of sliding door bolt to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.15. For testing shall be taken at random from at least 10 percent of the package subject to a minimum of three, equal number of door bolts being selected from each package. All door bolts selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirement of this specification if the number of defects sliding door bolts among those tested does not exceed the corresponding number given in Table 9.15.

TABLE 9.15

Lot. size	*Sample Size*	*Permissible speed Decorative sliding door bolts*
Upto 150	5	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	81	5

9.15.8 Tower Bolts (Fig. 9.8)

9.15.8.0 These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth.

The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 metre.

9.15.8.1 Tower bolts shall be of the following types:

(a) Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and rivetted at the back.

(b) Brass tower bolts with cast brass barrel and rolled or cast brass bolt.

or

Brass tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt.

The knobs of brass tower bolts shall be cast and the bolt fixed with knob, steel spring and ball shall be provided between the bolt and the barrel.

(c) Mild steel barrel tower bolts with mild steel barrel and mild steel bolt.

or

Mild steel tower bolts with mild steel barrel and cast iron bolts.

The plates and straps after assembly shall be firmly rivetted or spot welded. The rivet head shall be properly formed and the rivet back shall be flush with the plate. These shall be made in one piece.

9.15.8.2 Unless otherwise specified bolt shall have finish as given below :

(a) Mild steel tower bolts (Types 1 and 2) Bolts bright finished or plated as specified and barrel and socket stove enamelled black.

(b) Brass tower bolts (type 3 to 5) Bolt and barrel polished or plated as specified.

(c) Aluminium alloy tower bolts (type 6) Bolt and barrel anodized.

The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

9.15.8.3 ***Sampling and Criteria for Conformity :*** It shall be same as specified in clause 9.15.1.4.

9.15.9 M.S. Locking Bolt with Holes for Pad Locks

9.15.9.1 This shall conform to IS 7534.

9.15.9.2 This shall be of mild steel polished bright or copper oxidised batch electrogalvanised or stove enamelled. In case of stove enamelled locking bolts, the bolt may be finished bright.

9.15.10 Pull Bolt Locks (Fig. 9.9)

9.15.10.1 These shall be of M.S. cast brass or aluminium as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

9.15.10.2 Brass pull bolt locks shall be finished bright, chromium plated or oxidised as specified. Aluminium pull bolt locks shall be anodised and the anodic coating shall not be less than grade. A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

9. 15.10.3 The fixing plate shall have four holes for fixing it to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screwed with lock nuts. The receiving plate shall be of the same width and thickness as the fixing plate and shall have 3 counter sunk holes.

Where the bolt slides into wooden members, like the chowkhat, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws and bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks are given in the drawing. The denominating size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

9.15.11 Door Latch

9.15.11.1 This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch.

9.15.12 Indicating Bolt (Vacant/Engaged*)*

These shall be of cast brass finished bright chromium plated, or oxidized or as specified. The shape and pattern shall be approved by the Engineer-in-Charge.

9.15.13 Mortice Lock and Latch (Fig. 9.10)

9.15.13.0 This should generally conform to IS 2209.

9.15.13.1 The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

9.15.13.2 ***Non-interchangeable Keys :*** Testing of non-interchangeable keys shall be as per IS 2209.

9. 15.13.3 The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be rivetted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2209.

9.15.13.4 Locking bolts, spring and strike plate shall conform to IS 2209.

9.15.13.5 ***Handles :*** These shall conform to IS 4992.

9.15.13.6 ***Keys :*** Each lock shall be provided with two keys.

9.15.13.7 ***Sampling, Criteria for Conformity :*** It shall be the same as specified in clause 9.15.1.4.

9.15.13.8 ***Tests :*** The finally assembled locks shall be tested as prescribed in Appendix 'G' of Chapter 9.

9.15.14 Mortice Latch (with Locking Bolt)

9.15.14.1 These are generally used in doors of bath rooms, WC's and private rooms.

9.15.14.2 Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5930. The material used for the different component parts of the latch shall comply with Tables 1 and 2 of IS 5930, unless otherwise specified.

9.15.14.3 The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

9.15.14.4 The latch shall be of size 10 × 18 mm of shape as shown in Fig. 1 of IS 5930. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5930.

9.15.14.5 The handles provided shall conform to IS 4992.

9.15.14.6 Sampling, criteria for conformity shall be same as per clause 9.15.1.4.

9.15.15 Mortice Lock and Latch (Rebated)

9.15.15.1 These are slightly different from mortice lock described in 9.15.14 and are designed for use in double leaved doors. These should generally conform to IS 6607.

9.15.15.2 ***Handles, Keys, Sampling, Criteria for Conformity and Test :*** These shall be same as specified in clause 9.15.14.

9.15.16 Mortice Night Latch (Fig. 9.11)

9.15.16.1 This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

9.15.16.2 This should generally conform to IS 3847.

9.15.16.3 It shall be cast or sheet brass, cast or sheet aluminium alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidised (black) finish as specified. Nominal size of the latch shall be denoted by the length of the face over the body in milli-metres. These shall have not less than two levers. False (Dummy) levers shall not be allowed.

9.15.16.4 ***Keys :*** Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

9.15.17 Cupboard or Wardrobe Lock

This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm.

These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

9.15.18 Kicking Plates

9.15.18.1 This shall be of brass (finished bright or chromium plated or oxidised) bronze, stainless steel, aluminium or as specified. Aluminium kicking plates shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case of stainless steel. Shape of the plate shall be as specified. This shall have bevelled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in-Charge.

9.15.19 Door Handles (Doors and Windows) (Fig. 9.12)

9.15.19.1 These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

9.15.19.2 Door handles shall be of the following types according to the material used:

(a) ***Cast or Sheet Aluminium Alloy Handles :*** These shall be of aluminium of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6. Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AC 15 - IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.

(b) Cast Brass Handles: These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidised or as specified.

(c) Mild Steel Handles : These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidised (black finish) or stove enamelled black or as specified.

(d) Stainless Steel Handles:- These shall be of stainless steel of specified size, shape and pattern as approved by Engineer-in-Charge for using in doors, windows and kitchen cabinets. Doors handles shall be of 125 mm or 100 mm size and window handles of 75 mm size unless, otherwise specified. Kitchen cabinet handles shall of 125 mm, 100 mm or 75 mm as specified. These shall be fixed with stainless steel screws 20 mm long. Stainless steel handles shall not be less than grade 304. The finish can be bright or matt finish as specified.

9.15.19.3 ***Sampling and Criteria for Conformity :*** The number of handles to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.16. Handles for testing shall be selected at random for at least 10 percent of packages. Subject to a minimum 3, equal number of door handles being selected from each such package. All door handles shall be checked for dimensional requirement and finish. Any door handle which fails to satisfy the requirement of dimensions or finish or both shall be considered as defective.

A lot shall be considered as conforming to requirement of this specification, if the number of defective handles among those tested does not exceed the corresponding number of defectives is greater than or equal to rejection number given in column 4 of Table 9.16, the lot shall be deemed as not meeting the requirements of this specification.

TABLE 9.16

Scale of Sampling and Criteria for Conformity

Lot size	*Sample size*	*Acceptance no.*	*Rejection no.*
(1)	*(2)*	*(3)*	*(4)*
Upto 50	8	0	1
51 to 90	13	1	2
91 to 150	20	1	2
151 to 280	32	2	3
281 to 500	50	3	4
501 to 1200	80	5	6
1201 and above	125	7	8

9.15.20 Floor Door Stopper (Fig. 9.13)

9.15.20.1 The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

9.15.20.2 ***Sampling and Criteria for Conformity :*** The number of floor door stoppers to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These stoppers shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of stoppers being selected from each such package.

All the floor stoppers selected shall be checked for dimensional requirement, material, manufacture and finish. Any of door stopper which fails to satisfy any one or more of these requirement shall be considered as defective door stopper.

A lot shall be considered as conforming to the requirements of this specifications if the number of defective floor door stoppers among these tested does not exceed the corresponding number given in col. 3 of Table 9.17. Otherwise it shall be considered as not conformity to the requirements of this specification.

TABLE 9.17
Scale of Sampling and Criteria for Conformity

Lot Size	*Sample Size*	*Permissible number of Decorative sliding door bolts*
(1)	*(2)*	*(3)*
Upto 100	5	0
101 to 300	0	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

TABLE 9.18
Requirements for Rubber for Use in Floor Door Stoppers

Particulars	*Requirements*	*Testing Procedure*
Relative density Max.	1.3	IS 3400 (Part IX)
Hardness	60 ± 5	IS 3400 (Part II)
Ageing for 24 hours at $100_o \pm 1_oC$	(a) Change in initial hardness (b) Shall not develop brittleness + 5, – 0	IS 3400 (Part II)

9.15.21 Hanging Rubber Door Stopper

9.15.21.1 These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

9.15.22 Universal Hydraulic Door Closer (Exposed Type)

9.15.22.1 These shall be made of cast iron/aluminium alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge.

9.15.22.2 These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564.

9.15.22.3 The door closers may be polished or painted and finished with lacquer to desired colour. Aluminium alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove greese, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618.

9.15.22.4 The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in Table 9.19.

TABLE 9.19
Type and Designation of Door Closers

Designation of closers	*Mass of the door (kg)*	*Width of the door (mm)*	*Remarks*
1.	Upto 35	Upto 700	For light doors such as double leaved and toilet doors.
2.	36 to 60	701 to 850	Interior doors, such as of bed rooms, kitchen and store
3.	61 to 80	851 to 1000	Main doors in a building, such as entrance doors

9.15.22.5 ***Sampling and Criteria for Conformity :*** All the door closer of the same nominal size and shape and from the same batch of manufacture, in one consignment shall constitute a lot. The number of door closers to be taken at random from a lot shall depend upon the size of the lot. (Table 9.20). The sample shall be tested for construction, finish, dimensions, interchangeability of parts and performance in accordance of Table 9.20. Any door closer failing in any one or more of these characteristics shall be considered as defective. If in the first sample, the number of defective door closer is less than or equal to corresponding acceptance number, the lot shall be declared as conforming to the requirement of these characteristics. If the number of defective door closer is greater than or equal to the rejection number, the acceptance number but less than the rejection number, lot shall be deemed as not meeting with requirements of these characteristics. If the number of defectives is greater than the acceptance number, but less than the rejction number, a second sample of the size equivalent to that of the first shall be taken to determine the conformity or otherwise of the lot. The number of defective door closers found in the first and the second sample shall be combined and if the combined number of defective thus obtained is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements of these characteristics.

Endurance Test- Two door closer in case of lot size 280 or less and five door closers in case of lot size more than 280 shall be selected from those already found satisfactory. These door closers shall be tested for the endurance test.

If all the door closers tested for endurance test satisfy the requirement of this standard, the lot shall be deemed as having satisfied the requirements of endurance test, otherwise not.

TABLE 9.20

No. of door closers in the lot	*Sample*	*Sample size*	*Commulative sample size*	*Acceptance Number*	*Rejection Number*
Upto 50	First	8	8	0	2
	Second	8	16	1	2
51 to 90	First	13	13	0	2
		13	26	1	2
91 to 150	Second	20	20	0	3
		20	40	3	4
151 to 280	First	32	32	1	4
		32	64	4	5
281 to 500	Second	50	50	2	5
		50	100	6	7
501 to 1200	First	80	80	3	7
		80	160	8	9
1201 to 3200	Second	125	125	5	9
		125	250	12	13
3201 and above	First	200	200	7	11
		200	400	18	19

9.15.22.6 ***Performance Requirements :*** After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

9.15.23 Casement Brass Stays (Straight Peg Type) (Fig. 9.14)

9.15.23.1 These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised (black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below:

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

9.15.23.2 The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

9.15.24 Quadrant Stays 300 mm

These shall be made of cast brass and finished bright or chromium plated or as specified. The shape and pattern shall be approved by the Engineer-in-Charge. It shall not weigh less than 0.20 kg each.

9.15.25 Hasp and Staple Safety Type (Fig. 9.15)

9.15.25.1 This shall be made of mild steel, cast brass or aluminium as specified. This shall generally conform to IS 363. M.S. Hasp and staples shall be finished black enamelled, or copper oxidised (black finish) or as specified. Brass hasp and staples shall be finished bright chromium plated or oxidised or as specified. Aluminium hasp and staples shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868.

9.15.25.2 M.S. hasp and staples shall be manufactured from M.S. sheet and brass hasp and staples by casting and Aluminium hasp and staples shall be made from dye section. The hinge pin which in all cases shall be of mild steel, shall be firm and its rivetted heads well formed. The movement of hasp shall be free, easy and square and shall not have any play or shake.

The hasp shall fit, in the staple correctly. The size shall be determined by the length of the bigger of the hasp.

9.15.25.3 The staple except in the case of cast one, shall be rivetted properly to its plate. The ends of the hinge pin for the safety type hasp shall be rivetted and properly finished. All screw holes shall be clean and counter sunk to suit counter sunk wood screw. All edges and corners shall be rounded.

9.15.26 P.T.M.T (Polytetra Methyline Tetraphthalate) Fittings

9.15.26.0 PTMT (Polytetra Methylene Tetraphthalate) is an engineering plastic (raw material imported) and have following physical properties:-

(i) Tensile Strength	:	500 Kg/cm²
(ii) Compressive Strength	:	900 Kg/ cm²
(iii) Rockwell hardness L-scale	:	75
(iv) Working temperature	:	-45º to 120ºC.
(v) E Value	:	85000 Kg/cm²
(vi) Density	:	1.3 gm/cc
(vii) Impact Strength	:	No Break

P.T.M.T. fitting shall be in different colours like White, Green, Blue, Derby Brown, Mushroom, Black, Gold, Silver & Broonze or any colours agreed by the manufactures and purchaser.

P.T.M.T. fittings are suitable for internal doors shutters kitchen, bath w.c. & cabinet etc. These shall not be used in external door and where security is concern.

Screws used for fittings shall be counter sunk cross head of chromium plated brass or stainless steel. Sizes of screws shall be of same size as used in case non ferrous material door/window fittings.

9.15.26.1 ***P.T.M.T. Butt Hinges :*** These shall of the material as mentioned in para 9.15.26.0 above. These shall be of required colour/shade ceramic look, glassy smooth surface. These shall be of required size and thickness.

9.15.26.1.1 *Hinge Pin:* Hinge pin shall be made of 5.5 mm dia stainless steel. It shall fit inside the knuckles firmly and riveted head (head covered with same material as of hinge) shall be well formed so as not to allow any play or shake and shall allow easy movement of the hinge, but shall not cause looseness.

9.15.26.1.2 *Knuckles :* The number of the knuckles in hinges shall be as per IS 1341. The shape of knuckles shall be straight and right angle to flap. The movement of the hinge shall be free and easy and working shall not have any play or shake.

9.15.26.1.3 *Screw Holes :* The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head cross head wood screws and of the specified sizes for different type and sizes of hinges. The size of the holes shall be such that when it counter sunk it shall be able to accommodate the full depth of counter sunk of screws.

9.15.26.2 ***P.T.M.T. Door Handles :*** The door handles shall be of material as mentioned in para 9.15.26.0 above moulded to required shape and size. The size & thickness etc. of the handle shall be determined by the inside grip of the handle. These shall be moulded as solid sections. The body of the handle shall not be hollow. Door handles shall be 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood. (Cross head) screws of designation No. 6.

9.15.26.3 ***PTMT Tower Bolt :*** The tower bolt shall be generally barrel type of material as mentioned in para 9.15.26.0 moulded to required shape and size. Size (length, dia, length of rod, number of holes) shall generally confirm to IS 204 PI & P-II. The rod shall be solid. If it in hollow it shall be provided with stainless steel rod of required dia. for its strength protective coat of wood primer, polish or varnish.

9.16 LAMINATED VENEER LUMBER (LVL)

9.16.1 Laminated Veneer Lumber door frames and shutters shall conform to IS 14616.

9.16.2 Material

9.16.2.1 ***Laminated Veneer Lumber (LVL)***

(a) Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued together having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Repture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5 mm.

(b) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects nor cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of $\pm$ 5 percent.

(c) *Adhesives :* Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

(d) *Preservatives :* Veneers used for LVL shall be given suitable perservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall then be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf jointed only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600 mm.

9.16.3 Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

9.16.4 Tests

9.16.4.1 The tests as per Table-1 of IS 14616 shall be carried out by the manufacturer on the LVL (Laminated Veneer Lumber) sections on each batch.

9.16.4.2 The manufacturer shall get the tests done on at least three samples of each batch by the standard method of test to ensure quality and performance of the material as per para 8.2 of IS 14616.

9.16.4.3 The manufacturer shall provide a certificate with the delivery challan indicating that the material conforms to IS 14616 along with the copy of the test report of the relevant batch.

9.16.5 Laminated Veneer Lumber (LVL) Door Shutters (Fig. 9.16)

9.16.5.1 This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

9.16.5.2 The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricator shall take up manufacturing of shutters only if provisions of clause 9.16.4 are fulfilled; failing which, shutters so manufactured are liable for rejection.

9.16.5.*3 Panelling Materials*

9.16.5.3.1 *Plain Particle Board:* Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848. (Ref. para 9.2.3)

9.16.5.3.2 *Pre- laminated Particle Board:* Pre -laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per para 9.2.11 above.

9.16.5.3.3 *Medium Density Fibre Board:* Medium density fibre board used for panels shall conform to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

9.16.5.3.4 *Pre-laminated Medium Density Fibre Board:* Pre-lamination in pre-laminated medium density fiber board shall conform to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fibre board used in pre-laminated medium density fibre board shall be as per para 9.6.11 above.

9.16.5.3.5 *Glass:* Glass for glazing shall conform to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass and coloured glass may also be specified by the Engineer-in-Charge. (Ref.para 9.2.8).

9.16.5.3.6 *Wire Gauze:* Wire gauze shall generally conform to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm. (Ref para 9.2.9)

9.16.6 Construction and Workmanship

9.16.6.1 Laminated Veneer Lumber (LVL) panelled, glazed and panelled and glazed shutter shall be constructed in the form of LVL framework of stiles and rails with panel inserts conforming to para 9.16.5 above of plain or perlaminated particle board, plain or prelaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beading as specified. The stiles, top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints (See Fig. 9.16A). Rails having width of 150 mm or more shall have plain double tenon joints as shown in Fig. 9.16B. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutter complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon & mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping (See Fig. 9.16). Lipping shall be seasoned and chemically treated as per clause 9.16.4. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

9. 16.6.2 All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

9.16.6.3 ***Beading:*** All the panels except glass and wire gauze shall be fixed with grooves (see Fig. 9.16C) but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable headless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

9.16.6.4 Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Mullions and glazing bars shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less.

Two common methods for jointing of panels with stiles/rails are shown in Fig. 9.16C. The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL Shutters shall be manufactured in factories under controlled conditions.

9.16.7 Panelling

9.16.7.1 ***Plain and Prelaminated Particle Board Paneling:*** The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

9.16.7.2 ***Wire Guaze Panelling :*** Wire guaze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

9.16.8 Rebating

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or square type as shown in Fig. 9.16 D as per clause 6.12 of IS 1003 (part-1).

9.16.9 Gluing of Joints

The contact surfaces of tenon and mortice shall be treated before putting together as per clause 6.13 of IS 1003 (Part -I). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

9.16.10 Dimensions, Sizes and Tolerances

9.16.10.1 ***Dimensions of Components and Tolerances:*** The finished dimensions and tolerances of the different components of door shutter shall be as per para 9.6.1.4.1.

Tolerances: Tolerance on the size of door shutter shall be + 3 mm and in thickness + 1.2 mm.

9.16.11 Locations of Fittings and Accessories

9.16.11.1 Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

9.16.11.2 Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described in 9.16.11.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per schedule of fittings decided by the user. The fittings shall conform to specifications as described in clause 9.15.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, sizes and shape of louver or vision panel opening shall be as specified.

9.16.12 Finish

All the four edges of the shutter shall be square. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

9.16.13 Glazing

9.16.13.1 Glazing in the shutters of door and window shall be as per sub head 21.0 In specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

9.16.14 Tests

9.16.14.1 ***Routine Tests:*** The following test shall be carried out by the fabricator on shutters during the process of fabrication in the factory's laboratory to be developed for this specific purpose before dispatch of shutters.

TABLE 9.21

Sl.No.	Name of Test	Acceptability Criteria
1	Dimensions and Defects of Squareness Test	As per IS 4020
2	General Flatness Test	As per IS 4020
3	Local Planeness Test	As per IS 4020
4	Flexure Test	As per IS 4020

9.16.14.2 ***Type Test :*** The manufacturer shall also have the performance of the shutters tested as per IS 4020 by the following tests as given in Table 9.22.

TABLE 9.22

Sl.No.	Name of Test	Acceptability Criteria
1	Impact indentation test	Not more than 0.2 mm
2	Screw withdrawal /Holding power test (a) Face (Min) (b) Edge (Min)	 2700 N 2300 N
3	Edge loading test (a) Deflection (b) Residual Deflection	 Not more than 5 mm Not more than 0.50 mm
4	Shock resistance test (a) Soft & light weight body impact (b) Soft and heavy weight body impact	 No visible damage observed -do-
5	Buckling test (a) Deflection/Deformation (b) Residual Deformation	 Not more than 50 mm Not more than 5 mm
6	Misuse test	Not be any permanent deformation observed
7	Slamming test	No visible damage observed

(i) All the tests to be carried under 9.16.14 shall be got done through approved/reputed lab on at least three samples to ensure the quality and performance of the door shutters on completing manufacturing of 5000 door shutters or once in 12 months whichever is earlier. Record of manufacturing of shutters shall be maintained to ensure the required frequency.

The fabricator shall also provide a certificate of shutters conforming to these specification along with each lot. The fabricator shall also provide test reports carried under para 9.16.14.1 and 9.16.14.2 with each lot of supply.

(ii) Tests to be conducted by field units : The Engineer-in-Charge shall also have options to get any or all other test covered in 9.16.14 done at his own cost. If the shutter fails to satisfy the test, cost will be borne by the supplier and consignment shall be rejected.

9.16.15 Measurement

Length and width of the shutter shall be measured to the nearest centimetre in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of the two shutters shall not be measured. All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made to form panel opening, louver Venetian opening and opening for glazing. No extra payment shall be made for shape, joints and labour involved in operations described above.

9.16.16 Rates

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaf shutters. Fittings described in 9.16.11.2 shall be payable extra. Nothing extra shall be payable for complying with the provisions described in 9.16.14.1 & 9.16.14.2. Cost of tests as described in 9.16.14.2 shall be borne by Deptt. if test reports are found satisfactory. Rate shall include cost of material and labour involved in providing plain beading. Extra shall be paid for providing moulded/plain beading on panels where specified.

9.17 PARTITIONS

9.17.1 Materials

(i) Gypsum plaster Board conforming to IS 2095 (Pt.-I):1996 (Board with BIS Certifiction mark)
(ii) Glass Reinforced Gypsum (GRG) plaster board confirming to IS 2095 (Pt.-3):1996 (Board with BIS Certifiction mark)
(iii) Fiber cement flat sheet conforming to IS 14862-2000 (Reaffirmed 2009)
(iv) Cement bonded particle board confirming to IS 14276-1995 (Reaffirmed 2010)

Tapered Edge Calcium Silicate Board are manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminum or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

9.17.2 Installation

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.17).

9.17.3 Jointing & Finishing

Joints of the boards are finished with specially formulated Jointing compound and fibre tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

9.17.4 Fitting and Fixtures

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

9.17.5 Tolerance

Tolerance in dimensions shall be $\pm$ 5 mm.

9.17.6 Measurements

9.17.6.1 Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

9.17.6.2 For openings exceeding 0.40 sqm. in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such openings.

9.17.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc.

9.17A Teak Wood Lipping

9.17A.0 Materials

2nd class Teak Wood or as specified shall be sawn / cut in the direction of grains to required size of lipping. Sawing / cutting shall be truly straight and shape.

9.17A.1 Fixing

The Lipping shall be fixed with head less nails to the base frame. No joint shall be permitted in one dimension of 2.5 meter or less. The joint shall be mitered in length as well as at corners.

9.17A.2 Measurements

The length of the Lipping shall be measured along the side correct to a centimeter.

9.17A.3 Rate

It includes the cost of labour and material involved in all the operations described above including fixing complete.

9.17B SKIRTING

9.17B.0 Material

Pre-laminated medium fiber density board as per IS 14587:1998

9.17B.1 Installation and joining

The board for skirting shall be cut in such a manner that the grains are in continuation of the grains of attached wall paneling or flooring. The edges of board shall be sealed with PVC edge bending tape 2.00 mm thick and width equal to thickness of board. Fixing shall be as per nomenclature of the item and direction of Engineer-in-Charge.

9.17B.2 Measurements

Length and breath of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 Sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

9.17B.3 Rate

The rate shall include the cost of all materials and labour involved in all operations described above.

9.18 PVC- DOOR FRAMES

9.18.0 Material

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desired proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

9.18.1 PVC Door Frame

PVC door frame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extruded PVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm $\pm$ 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm $\pm$ 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.18).

9.18.2 Fixing of Frames

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

9.18.3 Measurements

The outer length of the vertical and horizontal members of PVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

9.18.4 Rate

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

9.19 PVC DOOR SHUTTERS

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

9.19.1 24 mm thick PVC Door Shutter (Fig. 9.19)

9.19.2 30 mm Thick PVC Door Shutters (Fig. 9.20)

9.19.3 Sampling and Criteria for Conformity

9.19.3.1 *General Precautions*

9.19.3.1.1 The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

9.19.3.1.2 If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

9.19.3.2 *Sampling*

9.19.3.2.1 Sampling criteria for conformity shall be in accordance with IS 4020 (Part –I)

9.19.3.2.2 Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot.

9.19.3.2.3 The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Col. 1 and Col. 2 of Table 9.23.

TABLE 9.23
No. of Sample and Criteria for Conformity

Sl. No.	*Sample size*	*Permissible No. of Defects*
(1)	*(2)*	*(3)*
26 to 50	8	1
51 to 100	13	1
101 to 150	20	1
151 to 300	32	1
301 to 500	50	2
501 and above	80	2

Note : For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-Charge.

Number of Tests : The samples selected as in column 2 of Table 9.23 shall be as agreed to between the manufacturer & Engineer-in-Charge.

9.19.3.2.4 *Criteria for Conformity :* The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

9.19.4 Test

9.19.4.1 The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16).

(a) *Dimension and Squareness Test :* Door shutters when tested in accordance with IS 4020 (Part 2) the dimensions of nominal width and height will be within a limit of $\pm$ 5 mm. The door shutter shall not deviate by more than 1 mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal thickness of the shutter shall be within a limit of $\pm$ 1.5 mm.

(b) *General Flatness Test :* Door shutter, when tested in accordance with IS 4020 (Part 3) the twist, cupping and warping shall not exceed 6 mm.

(c) *Local Planeness Test :* Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

(d) *Impact Indentation Test :* Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

(e) *Edge Loading Test :* Door shutters, when tested in accordance with IS 4020 (Part 7) the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

(f) *Shock Resistance Test :* Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8) , there shall be no visible damage in any part of the door after twenty five blows on each end.

(g) *Buckling Test :* Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any deterioration and any residual deformation more than 5 mm after 15 min. of unloading and the initial deflection also shall not be more than 50 mm.

(h) *Slamming Test :* Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any damage in any part of the door at the end of successive impacts.

Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in part of the door at the end of 100 successive impacts.

(i) *Misuse Test :* Door shutters, when tested in accordance with IS 4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

(j) *Screw Holding Test :* Door shutters, when tested in accordance with IS 4020- Part 16, the load shall not be less than 1000 N.

(k) *End Immersion Test :* Door shutters, when tested in accordance with IS 4020- Part 13, the shutter shall not show any delamination.

(l) *Knife Test :* Door shutter, when tested in accordance with IS 4020 – Part 14, the grading shall be standard & excellent.

(m) *Glue Adhesion Test :* Door shutters shall be tested in accordance with IS 4020 – Part 15. There should be no delamination.

9.19.5 Fixing of Shutters

PVC door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

9.19.6 Tolerance

The tolerance on the width and the height of the door shall be $\pm$ 5 mm and the tolerance on the nominal thickness of the door shall be $\pm$ 2 mm.

9.19.7 Fittings

Fittings shall be provided as per schedule of fittings decided by Engineer-in -Charge. In moisture prone areas M.S. fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

9.19.8 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.19.9 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

9.20 PVC DOOR FRAME

Solid PVC door frame and shutter shall be as per para 9.19.

9.20.1 Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minimum of 1.5 kg./sq. mtr. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be joined to each other using solvent adhesive conforming to IS 14182. A tolerance of $\pm$ 3 mm shall be permitted in the specified dimension of PVC section in the door frames. (Fig. 9.21)

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-charge.

9.20.2 Fixing of Frames

As per clause 9.18.2.

9.20.3 Measurements

As per clause 9.18.3.

9.20.4 Rate

As per clause 9.18.4.

9.21 PANEL PVC DOOR SHUTTER

9.21.1 Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in -Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-charge.

(a) 30 mm thick panel PVC door shutters (Figure 9.22).

9.21.2 Sampling and Criteria for Conformity

As per clause 9.19.3.

9.21.3 Tests

As per clause 9.19.4 except para (k), (l) & (m).

9.21.4 Fixing of Shutters

As per clause 9.19.5. In addition, it may be ensured that while fixing hinges the screws pass through the two opposites surfaces of the M.S. reinforcement.

9.21.5 Tolerance

As per clause 9.19.6.

9.21.6 Fittings

As per clause 9.19.7.

9.21.7 Measurements

As per clause 9.19.8.

9.21.8 Rate

As per clause 9.19.9.

9.22 FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES

9.22.0 Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up or resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./m^2 and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat. (Fig. 9.23).

9.22.1 FRP door shall be manufcturred as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

9.22.2 Tolerance

Tolerance of size of frame to be $\pm$ 2 mm and on size of rebate to be + 1 mm.

9.22.3 Finish

The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

9.22.4 Fixing of Frame

As per clause 9.18.2.

9.22.5 Measurement

As per clause 9.18.3.

9.22.6 Rate

As per clause 9.18.4.

9.23 FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS

9.23.1 F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge. (Fig. 9.24A & 9.24B).

9.23.2 Blocks of any seasoned hardwood of bulk density not less than 450 kg./m^3 at 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

9.23.3 Location of Fittings and Accessories

The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminum.

9.23.4 Sampling & Criteria for Conformity Shall be as per clause 9.19.3.

9.23.5 Finish

As per clause 9.22.3.

9.23.6 Tests

As per para 9.19.4 except clause (j), (k), (l) & (m).

9.23.7 Fixing of Shutter

As per clause 9.19.5.

9.23.8 Tolerance

As per clause 9.19.6.

9.23.9 Measurement

As per clause 9.19.8.

9.23.10 Rate

As per clause 9.19.9.

9.24 SOLID PVC FOAM PROFILE DOORS

9.24.1 Solid PVC Foam Profile Frame

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. (Fig. 9.25). Supporting bar at bottom side of frame shall be provided for maintaining frame in plumb. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-charge. PVC door frame should have shore hardness more than 70.

9.24.2 Fixing of Frames

As per para 9.18.2.

9.24.3 Test in PVC Foam Profiles

Tests on PVC Foam Profiles shall be as per Table 9.24 below:

TABLE 9.24

Sl. No.	*Property*	*Test Method*	*Unit*	*Acceptable Value*
1	Density (at 27°C)	ASTM D 792	gm/cc	0.5-0.7
2	(a) Tensile strength at yield	ASTM D 638	PSI %	2000
	(b) Elongation at Break	ASTM D 638		20
3	Tensile Modulus (Modulus of Elasticity)	ASTM D 638	N/Sq.mm	200
4	Impact strength (charpy Unnotched)	ASTM D 256	ftlb/sq.In	7
5	Durometer Hardness	DIN 53505	Shore D	70
6	Vicat Softening Point (at 10N Load)	ASTM D 1525	C	75
7	Flammability	UL 94		Self Extinguishing

9.24.4 Measurements

As per clause 9.18.3.

9.24.5 Rate

As per clause 9.18.4.

9.25 SOLID PVC FOAM SHUTTERS

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

9.25.1 28 mm Thick Door Shutters

Profile is cut in required length to make vertical & horizontal stile. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffner 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is joined using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicone sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look. (Fig. 9.26)

The fabrication shall be done in factory as per nomenclature of the item and directions of Engineer-in-Charge.

9.25.2 Sampling and Criteria for conformity
As per clause 9.19.3.

9.25.3 Tests
As per clause 9.19.4.

9.25.4 Fixing of Shutters
As per clause 9.19.5.

9.25.5 Tolerance
As per clause 9.19.6.

9.25.6 Fittings
As per clause 9.19.7.

9.24.7 Measurements
As per clause 9.19.8.

9.24.8 Rate
As per clause 9.19.9.

9.26 FACTORY MADE FIBRE GLASS REINFORCED PLASTIC CHAJJA

9.26.1 F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge. (Fig. 9.27).

9.26.2 Material
(1) Glass Fibre (chopped strand mat) shall be as per IS 11551
(2) Unsaturated Polyester Resin shall be as per IS 6746
(3) Surface Burning Characteristics of Building Material – ASTM E 84-77a
(4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
(5) Curing Agents – Cobalt Napthanate and MEKP
(6) Test of products – IS 14425
(7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modulus of elasticity, good textile processing and excellent fiber reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

9.26.3 Tolerance
Tolerance of $\pm$ 10 mm in overall size of FRP chajja is permissible.

9.26.4 Finish
The F.R.P. laminate to be finished with polyurathene based or equivalent paint as final coat or gloss or mat followed by clear lacquer coat to get the shine of required shade.

9.26.5 Tests
Frequency of tests as per direction of Engineer-in-Charge & tests to be conducted as per para 9.19.4.

9.26.6 Measurement and Rate
The width and length to be measured in centimetres and area to be calculated as square metre correct upto two places of decimal. The rate includes cost of all the materials, labour scaffolding, fittings & fixing upto all heights etc. involved in operations described above, but excludes the cost of paint.

9.27 WALL PANELLING (Fig. 9.28)
All specification same as per clauses 9.17.1 to 9.17.7.

9.28 uPVC CASEMENT/SLIDING WINDOW & DOOR

9.28.1 Material

uPVC (un-plasticised polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required uPVC multi-chambered profiles.

The factory made uPVC white colour doors and windows shall be comprising of approved uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of uPVC extruded profile series which are used depending upon the size and design of window/door and wind load consideration and the agency shall also provide wind load calculation sheet duly approved by the Engineer-in-Charge as per IS 875 (Part-3) namely **Small Series** (small depth dimension) having wall thickness of 1.9±0.2 mm and **Big Series** (big depth dimension) having wall thickness of 2.3±0.2 mm of uPVC main profile i.e frame. Depth and width of the profile mentioned in the nomenclature of the item is as following.

(i) Depth of a profile (D)- Dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile.

(ii) Width of a profile (W)-Dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile.

Note :

(i) Profile size mentioned in the Delhi Schedule of Rate are in Depth (Base of Frame) x width format (visible elevation)

(ii) For building it is a must to use big series above 5th floor.

(iii) All uPVC profiles should be got approved by Engineer-in-charge before fixing at site of work.

9.28.1.1 Tolerance in profile dimension

For uPVC frame, sash and mullion extruded profile minus 5 % tolerance in dimension. i.e in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

9.28.2 Terminology

(a) Frame

Non movable or fixed portion of the window/door attached to the wall and to which the sash is assembled.

(b) Sash

Movable part in a window/door.

(c) Glazing Bead

Profile which holds the glass or any other partition materials.

(d) Transom (or Mullion)

Profile used within the frame, vertically or horizontally in a frame and/ or sash.

9.28.3 Marking

uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

(i) The name of the trade mark or brand name of the manufacturer

(ii) Date of manufacturing and profile code

9.28.4 Testing (Criteria for conformity)

The uPVC extruded hollow profiles use in window and doors shall conform to the specification as per **EN 12608** and other standards as mentioned below:

S.No.	Name of the test	Test Method	Specified Parameter
1	Vicat Softening Temperature	EN ISO – 306	Shall not be < 75^0C
2	Charpy Impact Strength	EN ISO – 179-2	Shall not be < 20KJ/m^2
3	Flexural Modulus Elasticity	EN ISO – 178	Shall not be < 2200 N/mm^2
4	Tensile Impact Strength	EN ISO – 8256	Shall not be < 600 KJ/m^2
5	Mean Breaking Stress for welded corner		
	(a) For the tensile bending test	EN – 514	Shall not be < 25 N/mm^2
	(b) For the compression bending test		Shall not be < 30N/mm^2
6	Heat Reversion Test	IS:4985-2000	Shall not be > 2.0 %
7	Surface Spread of flame	BS : 476 - Part 7	Classification 1
8	Ignitability Evaluation	BS : 476 - Part 5	'P' Not easily ignitable
9	Tensile modulus	ASTM D 638	Shall not be < 35 MPa
10	Shear Modulus	ASTM D 732	Shall not be < 220 MPa
11	Tensile Strength	EN ISO 527	Shall not be < 30 MPa

For the determination of the weld ability of profiles, welded corners shall be tested for tests as mentioned above. The sample subjected to weld test shall not be finished by grooving and knifing etc. except for the outside edge of 90 degree angle, which shall be cleaned to permit the sample to sit fully on to the support.

Minimum percentage of **titanium dioxide** content in uPVC profiles shall not be less than **7.00 percent** and **calcium carbonate** content shall not be more than **10.00 percent**.

The uPVC casement / fixed / sliding windows and doors shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorised vendor duly approved by the Engineer - in -charge.

9.28.5 Configuration

Indicative size and configuration of window& door (Casement/ sliding) are given in figure 9.29 to 9.38. In case a new configuration is to be provided, same shall be specified in the item and figure included in the tender document.

9.28.6 Fabrication

(i) According to the drawing, the required dimension and length of uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanised iron section of required length and thickness.

(ii) All frame and sash profiles of door and window shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.

(i) Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.

(iv) The minimum overlap of 6 mm shall be provided on frame and mullion to ensure effective seal between the sash and frame.

(v) The window / door shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the reinforcement chamber. The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

9.28.7 Reinforcement

(i) The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the window/door and it shall confirm to any grade of IS 1079 or IS 513.

(ii) Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanised in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

(iii) The thickness of reinforcement shall be as such that the uPVC window and doors meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.

(iv) Galvanised mild steel reinforcement section is to be inserted in uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to uPVC profile so that it does not move or rattle.

(v) Galvanised mild steel reinforcement section thickness shall be changed according to floor level keeping in consideration of wind load factor and minimum thickness should be as below :

(a)	From ground floor upto floor 5th level	=	1.60±0.2 mm
(b)	From floor 5th level onwards	=	2.20±0.2 mm

9.28.8 Glazing

(i) After fusion welding and cleaning of the corner of the sash prescribed glass panes shall be placed after fitting EPDM gasket and uPVC beading of approved quality and make.

(ii) Window sash shall be made in such a way that glazing or re-glazing is possible at site without the need to remove the outer frame.

(iii) The plastic spacer shall be used to provide to support the glass in sash/frame.

(iv) The following glass thickness shall be used in uPVC windows and doors but in no case less than 4mm.

(a)	For single glazing	-	4 to 6mm
(b)	For double glazing	-	20 mm or 24mm

Glazing supports shall be provided on frame or sash in order to distribute the load of the glass and to place the glass in the frame or sash. Spacers that would provide supports to the glass in the frame or sash shall be installed after the glazing support are installed. The supports and spacers shall be so placed as not block the drainage holes/slots.

9.28.9 Glazing gasket & Weather pile strip/ Wool pile

(i) Material for glazing gaskets shall be of EPDM (Ethylene propylene diene monomer) and shall be used on both side of glass panes in uPVC sash and glazing bead profiles.

(ii) Weather pile strip / Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

9.28.10 Window / Door Hardware and Fittings

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670-1988 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO 9227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 199 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in-Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

9.28.10.1 For Casement windows

Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

9.28.10.2 For Casement doors

Minimum three numbers of approved quality 3D hinges with necessary SS screws shall be provided in the casement door shutter up to 0.90 meter in width and 2.10 meter in height, for more than 2.10 metre height minimum four numbers 3D hinges to be used.

9.28.10.3 For Sliding windows/doors

(i) One pair of zinc alloy body with single nylon roller (weight bearing capacity to be 40 kg) upto 1.50m window height dimension and one pair stainless steel (SS 304 grade) body with adjustable double nylon roller (weight bearing capacity to be 120kg) above 1.50 m window height dimension of approved quality to each shutter of window shall be provided.

(ii) One pair of adjustable double nylon roller of approved quality to each shutter of door shall be provided.

(iii) In case of wire mesh, stainless steel fly proof wire mesh shall be provided as per nomenclature of item of approved make and manufactures duly approved by the Engineer-in-charge before fixing at site of work. SS wire mesh must be in the first track of the three track frame from the interior field of vision and that SS wire mesh must be fixed with EPDM gasket in a sash profile as the glass sash profile.

9.28.11 Tolerance

The tolerance in dimensions of finished window / door in size shall not be more than $\pm$ 5mm from the approved drawing dimension.

9.28.12 Installation

(i) There shall be a maximum gap of 3 to 5mm in between uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.

(ii) To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window**.**

(iii) The uPVC frames are to be fixed in prepared opening in the walls. Window / door frame shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100x8mm fasteners of approved make.

(iv) The gap between uPVC window / door and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mmin width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching colour of uPVC profile shall be applied over backer rod.

9.28.13 Precautions taken before installation of uPVC Window &Door

(i) Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where uPVC window / door to be fixed.

(ii) Aperture shall be smooth in line and level as well as in plumb.

(iii) Flooring (where casement door is to be installed should be complete before installation of door).

(iv) The grill where to be installed in sliding / casement window should be provided after the installation of window.

(a) For sliding window – The grill shall be provided on the outer face of window.

(b) For casement window – The grill shall be provided on the inner face of window.

(v) Installation of uPVC door and window should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. Atleast one coat of paint should be done before installation begins.

(vi) The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the window/door fabricated from the profile, when viewed by the normal vision.

(vii) The uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of uPVC profiles as well as water and air tightness in case of casement uPVC door/window unit.

(viii) uPVC door/windows hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

9.28.14 Mode of Measurement

The length and width of the window / door shall be measured from outer to outer face of the uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

9.28.15 Rate

The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building. The cost of glass panes, wire mesh and silicon sealant shall be paid separately.

9.28A HARDWARE FITTINGS FOR UPVC DOORS & WINDOWS

9.28A.1 Hardware fittings such as zinc alloyed white powder coated casement handles, touch lock, steel roller, steel crescent lock (white powder coated) for uPVC doors/windows shall be of approved brand/make, size and manufacturer as described in nomenclature of item complete as per direction of Engineer-in-Charge.

9.28A.2 Measurement

uPVC doors & windows hardware fittings shall be measured in numbers.

9.28A.3 Rate

Rate shall include all the material and operation as described in the nomenclature of item.

9.29 FIRE RESISTANT GLAZED DOORS, WINDOWS & PARTITIONS

9.29.1 GENERAL

The Fire resistant Glazed Doors (hereinafter termed as FRGD), Fire resistant Glazed windows (hereinafter termed as FRGW) and Fire Resistant Glazed Partition (hereinafter termed as FRGP) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route.

9.29.2 CODES & SPECIFICATIONS

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/ test certificates shall be furnished by the Contractor from the manufacturer before supply of material for approval by Engineer-in-charge. Each Door/Window and Partition shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and details of approved test house. Each Glazing pane shall carry a permanent stamp of the manufacturer.

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1. EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 1: Fire resistance test for door and shutter assemblies and openable windows
2. EN 1364-1	Fire resistance tests for non-load bearing elements – Part 1: Walls
3. EN 410	Determination of luminous and solar characteristics of glazing.
4. EN 12600	Glass in Buildings – Pendulum test – Impact test and classification for flat glass

9.29.3 TESTING AND CERTIFICATION

The FRGD, FRGW & FRGP shall be supplemented with appropriate certification by fire test lab, for applicable or higher dimension with complete description of the architectural components and hardware for FRGD, FRGW and FRGP for which the approval is given. Along with the material tests, the complete system along with the framing shall be tested in accordance with the criteria of EN1634-1 for door/window and EN1364-1 for partition. The installation of the fire rated system shall confirm to requirement of test evidence. The choice of hardware and/or glazed accessories shall be as per test evidence.

9.29.4 Fire Resistant Doors/Windows and Partitions

9.29.4.1 Frame for Fire Resistant Glazed Door / Windows

Frame for Door/Window of 120 min fire rating shall be made of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m^2) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m^3 . The frame will have a provision of G.I. Anchor fastners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter . The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge . (Cost of SS ball bearing hinges is excluded).

9.29.4.2 Frame for Fire Resistant Glazed Partitions

Frame for non load bearing fixed fire resistant glazed Partition for 120 min Fire Rating shall be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanised steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 15 min of insulation (EI15).The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 96kg/m^3. and finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge .

9.29.4.3 Shutter for Fire Resistant Doors/Windows

Glazed fire resistant door shutters 60 mm thick of 120 min Fire Rating shall be confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m^2) duly filled mineral wool insulation having density min 96 kg/m^3 and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge (panelling to be paid for separately).

9.29.4.4 Fire Resistant Glass for Doors/Windows and Partitions

Glazing to be fixed in fire resistant doors/window shutters and fixed Partitions with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m^2) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per direction of Engineer-in-charge. The glass should be clear, toughened, interlayered, non-wired fire resistant having 11 mm minimum thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of more than 35dB and LT of 85%. Glass shall be compliant to class 2B2/1B1 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and

including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer. (Actual glass size is to be measured at site for payments).

The complete assembly shall satisfy the given criteria of fire resistance - stability, fire integrity, radiation control and insulation as per above mentioned rating required.

9.29.5 Vision Panel For FRD

9.29.5.1 Vision Panel for Fire Door

Specifications for glass for Vision panels for Fire Rated Door shall be as per para C above. Minimum size of glass to be used for vision panels shall not be less than 350 mm x 350 mm.

9.29.6 DELIVERABLES BY THE CONTRACTOR

Following documentation/ drawings shall be furnished along with the Doors/window/partition.

(1) Prototype Test Certificate by national/international test house

(2) Shop drawings

(3) Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items intended to be used.

(4) Certificate indicating that design and installation of Doors and hardware conforms to norm laid down by approved national/international test house.

(5) Test report to be attested by Fire rated glass manufacturer.

(6) The Fire rated glass applicator has to be approved by Fire rated Glass Manufacturer has to Submit the approved applicator certificate.

9.29.7 Measurements

9.29.7.1 Measurement of frame for door/window/partition

The outer length of the vertical and horizontal members of fire rated door/window frame shall be measured in running metres including embedded length in floor upto two decimal places.

The outer length of the vertical and horizontal members of fire rated partition frame shall be measured in running metres upto two decimal places.

9.29.7.2 Measurement of shutter for door/window

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.29.8 Rate

The rate of frame includes the cost of the materials and labour involved in all the operations. The cost of SS ball bearing hinges and any other hardware which may be required, shall be paid for separately.

The specified rate for door/window shutter include the cost of the door/window shutter and labour involved in fixing of the shutter. Fittings, fixtures and paneling on the door shutter except hinges & screws shall be paid extra as provided.

9.30 NICKEL PLATED M.S. PIPE CURTAIN ROD WITH NICKEL PLATED M.S. BRACKETS :

9.30.1 20 MM DIA (HEAVY TYPE)

9.30.1.1 Materials

The nickel plated M.S. pipe for curtain rod (20 mm dia) shall be C.R. circular tube confirming to BIS code IS 1161-2014 of outer dia 20 mm, min. 1.25 mm thickness and weighing not less than 0.62 Kg/m. These pipe shall be coated with min. 20 microns nickel plating conforming to IS code 12393-1988.

Brackets for curtain rods are of two types (i) Flat type to be fixed at sideways (if door window opening are in corners) and (ii) Angle type (to be fixed just above openings of door/windows on wall away from corners).

These brackets are made of 1.25 mm thick strip and same grade of nickel plating. The weight of flat bracket shall not be less than 38 gms each piece and the weight of angle bracket shall not be less than 70 gms each.

Tolerances in thickness of CR strips for pipes may be (-) 0.05 mm and tolerance in weights may be specified weight as above (-) 10 gms/meter.

9.30.1.2 Fixing of curtain rods:-

For fixing the curtain rods, M.S. curtain pipe should be cut 30 cm longer than the door/window opening length. The pipe shall be cut and placed 15 cm above the finished soffit line. Positions of bracket holes are marked on lintle top/wall. Drilling the holes, fixing of brackets shall be done with PVC/polystyrene split expendable rawl plugs and 40 mm long fully threaded CSK headed screws.

9.30.1.3 Measurements

The running meter length of M.S. curtain rod only shall be measured correct to a centimeter.

9.30.1.4 Rates

It includes the cost of labour and all materials required for all the operations described above.

9.30.2 25 MM DIA (HEAVY TYPE)

9.30.2.1 Materials

The nickel plated M.S. pipe for curtain rod (25 mm dia) shall be C.R. circular tube confirming to BIS code IS 1161-2014 of outer dia 25 mm, min. 1.25 mm thickness and weighing not less than 0.77 Kg/m. These pipe shall be coated with min. 20 microns nickel plating conforming to IS code 12393-1988.

Brackets for curtain rods are of two types (i) Flat type to be fixed sideways (if door window opening are in corners) and (ii) Angle type (to be fixed just above openings of door/windows on wall away from corners). These brackets are made of 1.25 mm thick strip and same grade of nickel plating. The weight of flat bracket shall not be less than 50 gms each piece and the weight of angle bracket shall not be less than 85 gms each.

Tolerances in thickness of CR strips for pipes may be **(-)** 0.05 mm and tolerance in weights may be specified weight as above (-) 10 gms/meter**.**

9.30.2.2 Fixing of curtain rods:-

For fixing the curtain rods, M.S. curtain pipe should be cut 30 cm longer than the door/window opening length. The pipe shall be cut and placed 15 cm above the finished soffit line. Positions of bracket holes are marked on lintle top/wall. Drilling the holes, fixing of brackets shall be done with PVC/polystyrene split expendable rawl plugs and 40 mm long fully threaded CSK headed screws.

9.30.2.3 Measurements
The running meter length of M.S. curtain rod only shall be measured correct to a centimeter.

9.30.2.4 Rates
It includes the cost of labour and all materials required for all the operations described above.

9.31 M.S. GRILLS OF REQUIRED PATTERN IN FRAMES OF WINDOWS ETC. WITH M.S. FLATS, SQUARE OR ROUND BARS ETC. INCLUDING PRIMING COAT

9.31.1 FIXED TO STEEL WINDOWS BY WELDING.
9.31.1.1 Materials
The M.S. grill of required pattern/ as per drawing is made out of M.S. flats , square bars/ round bars of size as decided by engineer-in-charge or as per drawing by welding. The horizontal or vertical spacing of member should normally be 10 cm c/c or closer as per requirement. The steel including its grading should be as mentioned in 10.1.1 and the tolerances in weight shall be as mentioned in Table 10.3

9.31.1.2 Fabrication
Fabrication of grills shall conform to 10.3.2 (as specified in IS 800).

9.31.1.3 Fixing & installation to the steel window frame
The M.S. grill of require pattern as fabricated shall be properly welded to the sectional steel window frame with minimum 2 cm each weld length @ 10 to 12 cm c/c around the perimeter and on intermediate member of window if any. Priming coat with red oxide primer to grill must be done conforming to specifications of item no. 13.50.3 of CPWD specifications 2019 Vol. II.

9.31.1.4 Measurement
The mode of measurement shall be the same as specified in 10.2.4. The weight of welding materials shall not be added in the weight of members for payments.

9.31.1.5 Rates
The Rate is inclusive of cost of materials and labour i/c welding materials and labour for fixing all complete as described above.

9.31.2 FIXED TO OPENING/WOODEN FRAMES WITH RAWL PLUGS SCREWS ETC.
9.31.2.1 Specifications for this item are same as item No 9.31.1 with the only difference of fixing arrangement. For fixing this type of grill in a bare opening, the grill in opening (for perfectly plum and true level) shall be fixed by making holes of 6 mm dia by drilling in brick/concrete and fixing shall be done using PVC or polystyrene rawl plugs of size 6 mm dia & 50 mm long and with 50 mm size sunken headed steel Screws all complete as per directions of Engineer-in-Charge.

Alternately, if this type of grill is to be fixed to wooden frame of windows using 50 mm size sunken headed steel Screws all complete as per directions of Engineer-in-Charge.

9.31.2.2 Measurement:- Similar to item no. 9.48.1 above.

9.31.2.3 Rates:- Similar to item no. 9.48.1 above.

9.32 BAMBOO JAFFERY/ FENCING
9.32.1 Material
Bamboo sticks of required lengths upto 2.10 mm selected from the bundles, straight with least nos. of knots and average 25 mm dia with brown/dark yellow fully dried (not green soft bamboo) to be sorted out, split into two halfs each and cut to even lengths. Hollock wood battens of X-section 50 x 25 mm out of fully kiln-seasoned sleepers are to be cut out, properly planed and smoothened and sharp edges chamfered. Each 2.10 m high panel of bamboo fencing shall have minimum 3 nos. parallel battens across the height of fencing panel.

9.32.2 Making of bamboo fencing panel

Selected half cut bamboo battens of even length are placed over, 3 nos. hollock wood battens (kiln seasoned and chemically treated) placed equidistant with 20 cm, from the edges of fencing (top & bottom), M.S. nails M-3 size 75 mm long along with 1 mm thick 10 mm dia G.I. washers are hammered in upto bottom face of battens then the whole panel is turned upside down and then again hammering is done on the either side nail tip, once the nail tip ejects out of battens these are bent sideways into battens and to complete neatly as per direction of Engineer-in-Charge.

9.32.3 Priming coat

Pink wood primer shall be applied on either face of Bamboo fencing panel before fixing. (Specification same as that of item no. 13.50.1). This item is payable separately.

9.32.4 Fixing of bamboo fencing panel

Bamboo fencing panel of required height and required width are fixed to pre-existing angle iron posts of G.I. barbed wire/chain link/IRC fabric fencing or M.S. grills by properly tying with G.I. binding wire atleast three ties on each post. Bottom edges of bamboo fencing shall not rest directly on soil bed, but appropriately a minimum 150 mm high brick work base is necessary for longer life of bamboo fencing. (Brick work edging shall be payable separately under respective item.)

9.32.5 Measurement

Visible flat area of bamboo fencing i.e. length and height shall be measured correct to a cm and area shall be calculated up to two places of decimal.

9.32.6 Rates

The Rate includes the cost of materials like half cut bamboo sticks, hollock wood battens, nails with washers and G.I. binding wire and the labour involved in the operations described above.

9.33 WOODEN MOULDED CORNER BEADING OF TRIANGULAR SHAPE.

9.33.1 50X50 MM (BASE AND HEIGHT)

9.33.1.1 Materials

2nd class teak wood or as specified shall be sawn/cut in the direction of the grains to the required size of corner beading of triangular shape. Sawing/ cutting shall be truly straight and in shape.

9.33.1.2 Fixing

The moulded corner beading shall be fixed with headless nails to the base frame. No joint shall be permitted in one dimension of 2.50 meter. The joint shall be mitred in length as well as at corners.

9.33.1.3 Measurements

The length of the beading shall be measured along the side correct to a centimeter.

9.33.1.4 Rate

It includes the cost of labour and materials involved in all the operations described above including fixing complete.

9.34 MAGNETIC CATCHERS

Magnetic catchers for kitchen cabinets and cup-boards can be of slightly different sizes by different manufacturers with varied base materials for housing magnetic plates.

Main body can either be of stainless steel or HDGI steel or 1st grade virgin ABS plastic in which two or three galvanized steel magnetic strips with magnates placed vertically or horizontally in box type body .

Most commonly used magnetic catcher by standard manufacturers are of 1st grade virgin ABS plastic having two/three magnetic strips housed within box type case as described below.

(i) Triple strip magnetic catcher for fixing vertically on the door meeting side of the cabinet/cupboard box of size not less than 70x30x15 mm with three nos. galvanized steel M.S. magnetic strips housed

within the body and its attraction strip/plate of size not less than 60x15 mm . Both fixing of catcher and the alteration plates are to be fixed with 3-M, 15 mm long fully threaded sunken head screws complete.

(ii) Double strip magnetic catcher for fixing horizontally at top or bottom meeting edge of cabinet/cup board box of size not less than 50x30x12 mm with two nos. galvanized steel M.S. magnetic strips housed within the body and its attraction strip/plate of size not less than 50x12 mm. Both the catcher and the alteration plates are to fixed with 3-M, 15 mm long fully threaded sunken headed steel screws complete.

9.34.1 Measurements

It shall be counted in numbers.

9.34.2 Rate

Rate is inclusive of one set of magnetic catcher including its alteration strip and sunken headed steel screws and labour required for proper positioning and fixing in cabinets or cup boards.

9.35 POWDER COATED TELESCOPIC DRAWER CHANNEL 300 MM LONG

Telescopic drawer channels of standard length comprises of four components

(i) Outer fixed channel
(ii) Inner fixed channel
(iii) Intermediate movable channel and
(iv) High carbon high strength stainless steel balls in S.S ball cages.

Both outer and inner fixed channels are punched with holes/slots for fixing to cabinet box and drawer respectively.

The size of drawer channel is defined as length of outer fixed channel which is in this item is 300 mm. The inner fixed channel is of even smaller size in web depth and flange (which is detachable) by way of an ABS plastic clip mechanism and fixed to either sides of drawer wall and slides in the intermediate channel.

The telescopic drawer channels are always fixed in pair i.e. on either side of drawers and fixing to cabinet box using fully threaded M-4, 20 mm long sunken headed screws.

All the three channels are made of die pressed M.S. strips 1.5 mm thick with necessary holes and slots punched/cut and powder coated (minimum 30 microns) black/brown/chocolate color Virgin ABS plastic stopper cleats and clips are also housed/fixed. The standard weight of a pair (one set) of 300 mm long telescopic drawer channel shall not be less than 800 grams.

9.35.1 Measurements

It shall be counted in pair i.e. one set.

9.35.2 Rate

The rate for the item is inclusive of cost of a pair of telescopic drawer channel and sunken headed steel screws and labour for fixing to cabinets/drawer etc complete.

9.36 SLIDING ARRANGEMENT IN RACKS/CUP-BOARDS/CABINET SHUTTER

This sliding clamp is made of chrome plated (minimum 30 microns) M.S. strips to be pressed, cut and bend to form 'U' shaped clamps and 4 nos. 'V' shaped cuts, holes punched and bent inverse to form S.S. roller bearing axis tracks with two nos. S.S. roller bearings in each clamp.

This sliding clamps (1 pair each shutter panel) can be fixed to glass/plywood shutter panel of the cabinet by making inverse U shaped cut at the bottom in the said sliding shutter panel and using EPDM piece of required size & thickness push fixed to form firm grip to ply/glass sliding panel.

9.36.1 Measurements

It shall be counted in numbers.

9.36.2 Rates

The rate for each clamp is inclusive of the cost of clamp and labour charges for making the cuts in shutter panel and fixing of 'C' & E channels etc. all complete as per directions of Engineer-in-Charge.

APPENDIX A

TABLE FOR PERMISSIBLE DEFECTS FOR VARIOUS GRADES OF TIMBERS

(Clause 9.1)

Sl. No.	Defects	First Grade	Second Grade
(i)	Cross-grain	Not steeper than 1 in 15	Not steeper than 1 in 10
(ii)	Sound knots and live knots	(i) Stiles and Rails (a) Short Exposed Face: Not more than 15 mm size and not more than 1 knot/metre (b) Long Exposed Face- Not more than 15 mm size and not more than 1 knot/m. No knot shall occur within 20 mm of the edges (ii) Panels – Not more than 20 mm size and not more than 2 knots/m2 . No knot shall occur on edge of any component of a panel.	(a) Short exposed Face – Not more than 15 mm size and not more than 3 knots per stile and 1 knot per rail (b) Long Exposed Face- Not more than 20 mm size and not more than 3 knots per stile and 1 knot per rail
(iii)	Dead and loose knots (plugged)	(i) Stils and Rails – Not more than 10 mm size – centrally located and not more than 1 knot / m (ii) Panels – Not more than 15 mm size and not more than 2 knots/m2 . No knot shall occur on edges of any component of a panel.	(i) Stiles and Rails – Not more than 10 mm size, centrally located and not more than 3 knots per stile and 1 knot per rail. (ii) Panels – Not more than 15 mm size and not more than 4 knots/m2 . No knot shall occur on edge of any component of a panel.
(iv)	Pitch pockets or streaks	None	Permissible except on exposed edges provided that they are clean and filled up with suitable putty or filler when pitch pockets or streaks are located on the exposed edges of the core, they shall be cut out and filled with piece of wood of similar species with grain running in the same direction. The piece shall be well glued.
(v)	Sapwood	Total not exceeding 5 mm wide and 150 mm long per metre. (This restriction applies only to super group species).	Total not exceeding 10 mm wide and 300 mm long per metre. (This restriction applies only to super group species).
(vi)	Pin holes	Permitted provided they are not in cluster	Permitted.
(vii)	Worm holes	None	Permitted provided they are not more than 10 mm in diameter and not more than one per metre and provided such worm holes are plugged with similar timber in such a manner that the pluging merges with the surrounding area both as to colour and grain.

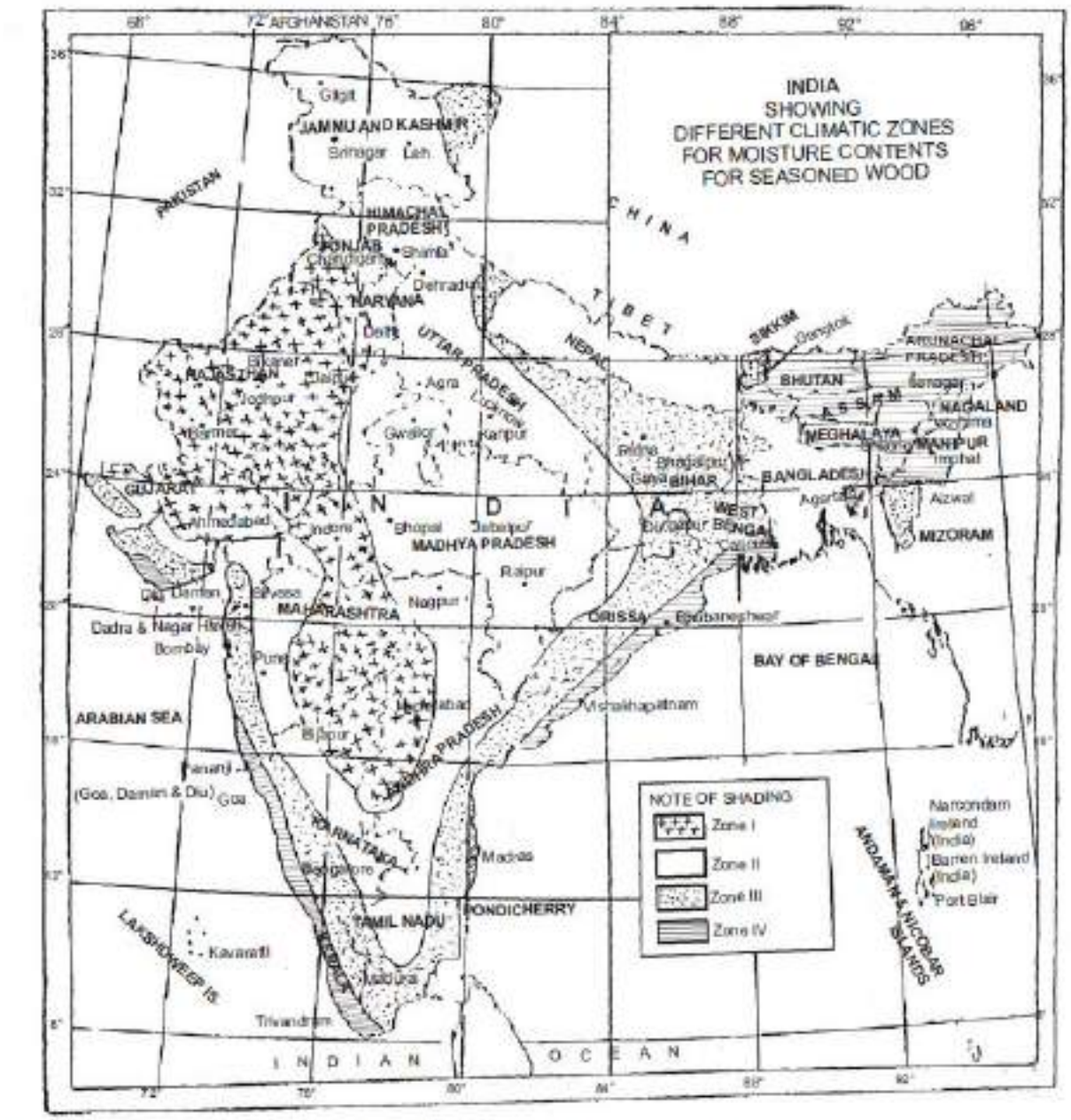
Note :

(i) Dead and loose knots are permitted only if they are suitably plugged.
(ii) Knot shall not occur where hinges or locks are to be fixed.

APPENDIX B

DIFFERENT CLIMATIC ZONES FOR MOISTURE CONTENT OF TIMBER

(Clause 9.1.6)



Note 1 : Based upon Survey of India map with the permission of the Surveyor General of India.
Note 2 : The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
Note 3 : The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Area (Reorganisation) Act, 1971, but has yet to be verified.
Note 4 : The administrative headquarters of Chandigarh, Haryana and Punjab are at Chandigarh.

APPENDIX C

MOISTURE CONTENT OF TIMBER

(Clause 9.1.6)

C-1 Moisture content of timber shall be checked for every 1 cum or part thereof by electrical moisture meters as per IS 287.

C-2 Electrical moisture meters are of resistance type and shall be used when the moisture content is within a range of 8 to 25 per cent. When checking moisture content with electrical moisture meter, it shall be ensured that :

(a) Timber is not hot or surface wet and the moisture gradient is not large due to wet cores.

(b) Electrode probes are of adequate depth (not less than one-fifth the thickness of the timber).

C-3 Sufficient number of reading at different positions are taken on each piece of timber to eliminate localised variations in surface moisture and species corrections are applied for the make of electrical resistance type moisture meter.

C-4 If for any reason, whatsoever, the result of electrical moisture are not to be relied upon the moisture content shall be checked by the oven drying method.

C-5 For checking moisture content by oven drying method, a complete test cross section, 12 to 19 mm long in the direction of timber grain, free from all defects shall be cut from each piece of timber selected for test as follows :

(a) If weighing can be done immediately, the test section shall be cut from a point at least 45 cm from one end of the piece or from its centre.

(b) In case cutting of test section from the piece is not permissible the moisture content in the whole section can also be determined by collecting a boring to a depth of half of the thickness of the piece by means of an auger, in a preweighed weighing bottle which should then be sealed properly.

C-6 The test sections obtained above shall be weighed, immediately after cutting, on a balance the sensitivity of which is not less than 10 mg. They shall be dried in a ventilated, and preferably thermostatically controlled, oven at a temperature of 100°C to 105°C untill the weight is constant. The weight of the test section shall be deemed to have become constant if successive weighing at intervals of 2 to 5 hours do not differ from one another by more than 50 mg. The test weight shall be taken to be the oven dry weight of the test section.

C-7 The percentage moisture content in the test section shall be calculated as follows :

$$\text{Moisture content (Per cent)} = \frac{W_1 - W_O}{W_O} \times 100$$

Where :

W_1 = initial weight of test section and

W_O = oven dry weight of test section

C-8 When moisture content of timber is checked by oven drying method, results of electrical moisture meter shall be ignored.

APPENDIX D

PHYSICAL AND MECHANICAL PROPERTIES OF PLYWOOD

(Clause 9.2.2.6)

D-1 Moisture content

5 to 15 per cent.

D-2 Shear Strength

	Dry State	*Resistance to Moisture*
Average	135	100
Individual	110	80

APPENDIX E

PHYSICAL AND MECHANICAL PROPERTIES OF FPT OR GRADED PARTICLE BOARD

(Clauses 9.2.3.4)

Sl. No.	Properties	Flat pressed Three layer multi layer and graded	
		Grade- I	Grade-II
(i)	Density variation, percent	± 10	± 10
(ii)	Water absorption, percent (a) 2 h soaking (b) 24 h soaking	 10 20	 40 80
(iii)	Linear expansion (swelling in water). 2 h soaking-percent (a) Length (b) Width	 0.5 0.5	 0.5 0.5
(iv)	Thickness, swelling, percent 2 h soaking	8	12
(v)	Swelling in thickness due to surface absorption, percent	6	9
(vi)	Modulus of rupture, N/mm2 (a) Average (b) Minimum	 15 13	 11 10
(vii)	Modulus of elasticity, N/mm2 (a) Average (b) Minimum	 2500 2250	 2000 1800
(viii)	Tensile strength perpendicular to surface, N/mm2 (a) Upto 20 mm thickness (b) Above 20 mm thickness	 0.45 0.40	 0.3 03
(ix)	Tensile strength perpendicular to surface, N/mm2 (a) After cyclic test (b) Accelerated water resistance test2)	 0.2 0.15	 - -
(x)	Screw withdrawal strength, N (a) Face (b) Edge (for thickness >12mm)	 1250 850	 1250 700

1) *Cyclic Test*— Specimen are immersed in water at 27 ± 2°C for a period of 72 h, followed by drying in air at 27 ± 2°C for 24 H and then heating in dry air at 70°C for 72 h. Three such cycles are to be followed and then the specimens are tested for tensile strength perpendicular to surface.

2) *Accelerated Water Resistance Test*— Specimen are immersed in water at 27 ± 2°C and water is brought to boiling and kept at boiling temperature for 2 h. Specimen are then cooled in water to 27 ± 2°C and then tested for tensile strength perpendicular to surface.

APPENDIX F

TESTS FOR FLUSH DOOR SHUTTERS

(Clause 9.7.1 to 9.7.10)

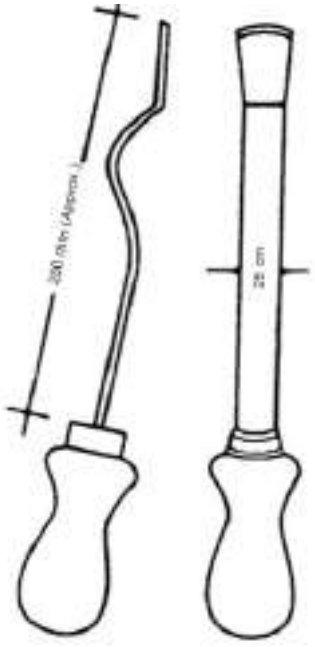
F-1. END IMMERSION TEST

Door shutters shall be tested for resistance of their base to immersion in water as follows :

The door shutter shall be immersed vertically to a height of 30 cm in water at room temperature for 24 hours and then allowed to dry for 24 hours at 27 ± 2°C and relative humidity of 65 ± 5 per cent. The cycle shall be repeated eight times. There shall be no delamination at the end of the test.

F-2. KNIFE TEST

(i) *Apparatus :* The type of knife required to be used in the test is given in Fig. below. It may be made from a 250 x 25 mm file. The cutting edge should be kept chiselsharp. The test shall be carried out on a stout table to which a wooden batten is screwed against which the edge of test piece is placed.



Drawing not to scale

KNIFE FOR TESTING PLYWOOD FOR ADHESION OF PLIES

(ii) *Procedure :* The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible along a glue line and the veneer is prised upwards. A hard and dense specie of plywood requires considerable force to effect entry and to prise and veneer. In a soft timber the knif tends to follow an easy course through the wood and in this case it is essential that the knife be firmly guided along the glue line.

The bond should just pass the requirement, it is judged by the relative amount of wood fibre left on the core veneer, and the area prised off. The grading is assessed chiefly on the appearance of the break. The force needed to effect separation is also an accompanying requirement.

The bond is ‘excellent’, when it is difficult to find the glue line and impossible to keep the tool within it for more than 6 mm without cutting adjacent wood. On prising upwards, the veneer usually breaks off over a width slightly greater than that of the tool.

The bond is ‘poor’ when knife meets little opposition in the glue line and the prise results in the easy removal of almost all the veneers from one side of the test piece. The separated veneers are usually almost free from adherent fibre.

(iii) *Reporting of test results :* The results shall be reported as ‘pass standard’ ‘excellent’ or ‘poor’.

F-3. GLUE ADHESION TEST

Four square sections, 150 x 150 mm shall be cut from the corners of the door. These four corner sections as cut from the door shall be immersed in boiling water for 4 hours, then dried at 27 ± 2°C and relative humidity of 65 ± 5 per cent for 24 hours. At the end of the drying period, the samples shall be examined for delamination. In the case of the glue lines in the plywood, all the four exposed edges of the plywood on both faces of a specimen shall be examined for delamination.

A specimen shall be considered to have passed the test if no delamination has occured in the glue lines in the plywood and if no single delamination more than 50 mm in length and more than 3 mm in depth has occured in the assembly glue lines between the plywood faces and the stile and rail. Delamination at the corner shall be measured continuously around the corner. Delamination at a knot, knot hole, a pitch pocket and worm hole or other permissible wood defects shall not be considered in assessing the sample. A door shall be deemed to have passed this test if three of the four specimens tested pass the test.

APPENDIX G

TEST FOR MORTICE LOCKS

(Clause 9.15.13)

The finally assembled lock shall withstand the test given as below :

The locking bolt shall be first locked in the forward position. A load of 40 kg. shall be applied without shock in the direction perpendicular to securing face as well as on both the locking faces of protruding bolt in turn. Then the load shall be applied by means of a fixed steel board 3 mm thick by rounded edge held in such a position that the centre line is approximately 3 mm from the fore end. A typical arrangement for the purpose of this test is shown in Fig. below :

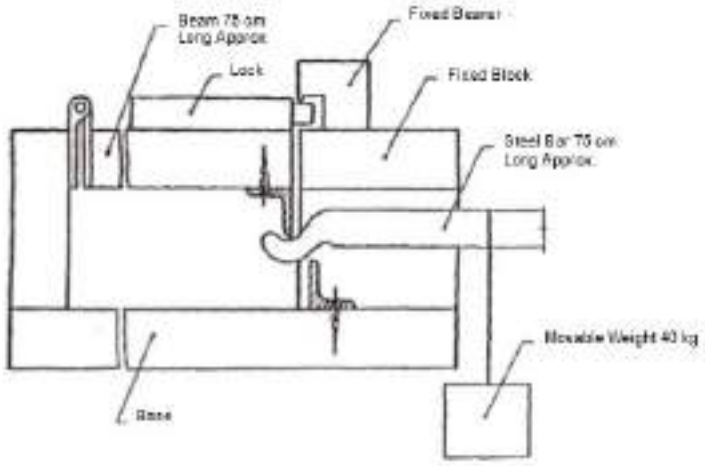


Fig. : Strength Test for Locking Bolt

When the spindle with handle is inserted into hole in the follower and turned, the latch bolt shall draw smoothly into the lock body and shall be within one millimetre from the face of the fore end.

When the latch bolt is pressed in to the lock body by pressure, the action shall be smooth and when fully pressed the latch bolt shall not project more than one millimetre from the face of the fore end.

When a key is inserted in key hole from one side of the lock and turned to withdraw the locking bolt the action shall be smooth and without impediment. When the direction of turn is reversed to lock the locking bolt then also the action shall be smooth and without impediment. In the locked position the locking bolt shall project 12 mm from the face of the fore end, although one millimetre free movement is permissible. In the withdrawn position the locking bolt shall not project more than one millimetre from the face of the fore end. The locking bolt shall be worked by turning key in both the direction 6000 times. At the end of the test, the lock shall continue to work smoothly.

The test shall be repeated with the key inserted from the other side of the lock.

Note : The clearance for levers while in the operating condition shall not exceed 0.25 mm.

When the key is turned to lock the locking bolt at the same time applying a reasonable pressure by finger on it, after completion of the key rotation the locking bolt shall be positively locked in the forward position. This test shall be repeated with the key inserted from the other side of the lock.

APPENDIX H

SCHEDULE OF FITTING FOR DOORS AND WINDOWS

(Clause 9.6.8)

Sl. No.	*Name of Fittings*	*Double leaf doors shutters panelled or glazed*	*Single leaf door shutters external panelled or glazed*	*Single leaf door shutters inter commu-nicating panelled or glazed*	*Single leaf wire guaze door shu-tters*	*Single leaf wardrobe/ cup-board shutters*	*Single leaf window shutters panelled or glazed*	*Fan light/ clear storey window shutters*	*Desi-gna-tion no. of wood screw*	*Length in mm of wood screws IS 6760*	*Remarks*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1.	Butt Hinges 100 mm	6	3	3	3	-	-	-	9	40	
2	Butt Hinges 75 mm	-	-	-	-	-	2	2	8	20	
3	Butt Hinges 50 mm	-	-	-	-	1	1	-	6	20	For fixing wooden cleat
4	Piano Hinges	-	-	-	-	-	-	-	6	20	
5	Tower Bolt 250 mm	3	2	3	2	-	1	-	10	30	
6	Tower Bolt 150 mm	-	-	-	-	-	1	-	8	30	
7	Tower Bolt 100 mm	-	-	-	-	-	-	-	6	30	
8	Sliding door Bolt 300 mm	1	-	-	-	-	-	-	9	35	
9	Sliding door Bolt 250 mm	-	1	-	-	-	-	-	9	35	
10	Floor door stopper	2	1	1	-	1	-	-	9	30	
11	Door handle with plate 100 mm	2	2	2	1	-	-	-	6	25	
12	Window handle with plate 75 mm	-	-	-	-	-	1	-	6	20	
13	Casement stay 300 mm	-	-	-	-	-	1	-	6	30	
14	Helical door spring (Superior quality)	-	-	-	1	-	-	-	6	30	
15	Cupboard /Wardrobe Lock	-	-	-	1	1	-	-	6	20	
16	Fanlight Catch	-	-	-	-	-	-	1	8	30	

Notes :

A : Door Shutters

1. Door of room adjoining the verandah, corridor, lobby or hall, shall be considered as external door.
2. Where the height of the door leaf exceeds 2.15 metres above the floor level, one extra hinge shall be provided for every additional height of 0.50 metre, or part thereof and the length of top bolts shall be increased by the height of the leaf above 2.15 metres from floor level.
3. Single leaf door shutters of more than 0.80 m in width shall be provided with one extra hinge.
4. Fan light shutters of more than 0.80 metre width shall be provided with one extra hinge and extra quadrant stay.
5. In double leaf shutters of doors, two door bolts shall be fixed to the first shutter and one to the closing shutter at the top.
6. In case of single leaf inter communicating, panelled, glazed or panelled door shutter for bath and w.c. one tower bolts will be replaced by a bathroom latch.
7. For shutter exceeding 40 mm thickness, heavy type M.S. butt hinges of 125 x 90 x 4 mm shall be used.
8. In case of external door shutters, instead of sliding door ball mortice lock can be provided where specified.
9. Cupboard and wardrobe shutters will have ball catches where specified.
10. Finger plates shall be provided in case of bath and wc shutters in office buildings.

B : Window Shutters

11. In case of windows with double shutters, two tower bolts shall be fixed to the closing shutters and one tower bolt to the first shutter at the top.
12. In case of window shutters, hooks and eyes may be provided in lieu of casement stays where specified.
13. Where the height of window shutter exceeds 1.20 metres one extra hinge shall be provided and length of top bolts shall be increased by height of the leaf above 2.15 metres from the floor level.
14. Window shutter with steel frames shall be provided with six hinges in case of double leaf shutters and three hinges in case of single leaf shutters, irrespective of height and width of shutters.

C : Fanlight and Clerestory Window or Ventilator

15. Centrally hung and bottom hung CS windows and fan lights, will be provided with chain and hook bamboo pole with hook for opening ventilators shall be provided for each residence or for set of 4 rooms in case of office building.
16. Centrally hung clerestory windows or fan lights will have fan light pivots in lieu of hinges.

APPENDIX I

METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF PLYWOOD

(Clause No. 9.2.8.3)

I.1 PROCEDURE FOR EDGE STRAIGHTNESS

I.1.1 The straightness of the edge and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimeter and recorded.

I.2 PROCEDURE FOR SQUARENESS

I.2.1 The squareness of plywood shall be checked with a 1200 mm x 1200 mm square by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

APPENDIX J

METHOD FOR TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF COIR VENEER BOARD

(Clause 9.2.10.6)

J-1 PROCEDURE FOR EDGE STRAIGHTNESS

J-1.1 The straightness of the edges and ends of coir veneer board shall be verified against a straightedge not less than the full length of the coir veneer board. If the edge on the end of coir veneer board is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straightness and the edge shall be measured to the nearest millimeter and recorded.

J-2 PROCEDURE FOR SQUARENESS

J-2.1 The squareness of coir veneer board shall be checked with a 1200 mm x 1200 mm square, by applying one arm of the square to the coir veneer board. The maximum width of the gap shall be recorded.

APPENDIX K

METHOD OF TEST FOR COIR VENEER BOARD FOR DETERMINATION OF GLUE SHEAR STRENGTH

(Clause 9.2.10.8)

K-1 OBJECT

K-1.1 This test is intended to estimate the tenacity with which the bonding material holds the coir veneer board together.

K-2 TEST SPECIMEN

K-2.1 Six test specimens shall be cut from the coir veneer board from three locations separated by the greatest possible distance from each other.

K-2.2 The test specimens shall be prepared as shown in Fig. 1 below.

K-2.3 The test pieces for 3 ply coir veneer board shall be prepared by gluing an additional 3 ply coir veneer board as shown in Fig. 1A below. The test pieces for 5 ply shall be prepared as shown in Fig. 1B below. The test pieces for 7 ply coir veneer board shall be prepared as shown in Fig. 1C below.

The specimen is glued with room temperature setting epoxy resin and clamped/tied overnight.

Note - This method of preparation of specimen will avoid the failure on notches.

K-2.4 Before test, the specimen shall be conditioned to constant mass at relative humidity of 65 ± 5 per cent and at a temperature of 270^{o} C ± 20^{o}C.

K-3 PROCEDURE

K-3.1 Each test specimen shall be gripped symmetrically at two ends in the jaws of a suitable testing machine, and shall be pulled apart. The distance between the notches on the test specimen and the ends of the gripping jaws of the testing, machine shall be between 10 mm and 20 mm. The pull should be, as far as possible, in the centre line of the central veneer. The grain of the centre ply shall be perpendicular to the direction of application of load. The width of each specimen and distance between the notches shall be measured to nearest 0.025 cm. to determine the shear area.

K-3.2 During the test, the load shall be applied to the test specimens as uniformly as possible, and so adjusted as to have the traverse of the movable head of 1 mm/min.

K-3.3 The maximum load at the time of complete failure of each specimen shall be recorded. Record shall be made regarding the type of failure whether in ply or in glue by visual examination of the area under shear. In case of ply failure, the percentage ply failure shall also be recorded.

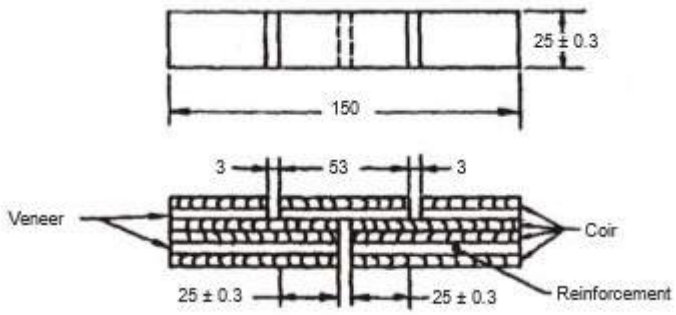
K-4 REPORT

K-4.1 Shear strength of the specimens determined in accordance with K-3 shall be straight averaged.

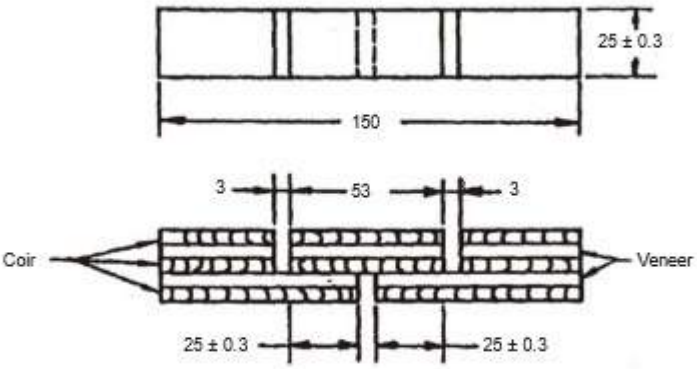
K-4.2 All details shall be recorded under the following sub-heads.

(a) Name of the manufacturer/source from whom the coir veneer board is procured
(b) Type and grade of coir veneer board
(c) Adhesive used
(d) End use of coir veneer board
(e) Specimen No. /Ref.
(f) Area of cross-section of bonding surface under shear
(g) Maximum load and
(h) Percentage failure of glue/ply

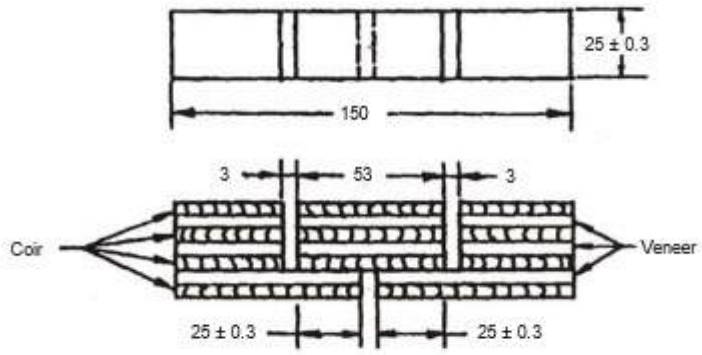
contd.....



1A : 3-ply Test Specimen



1B : 5-ply Test Specimen



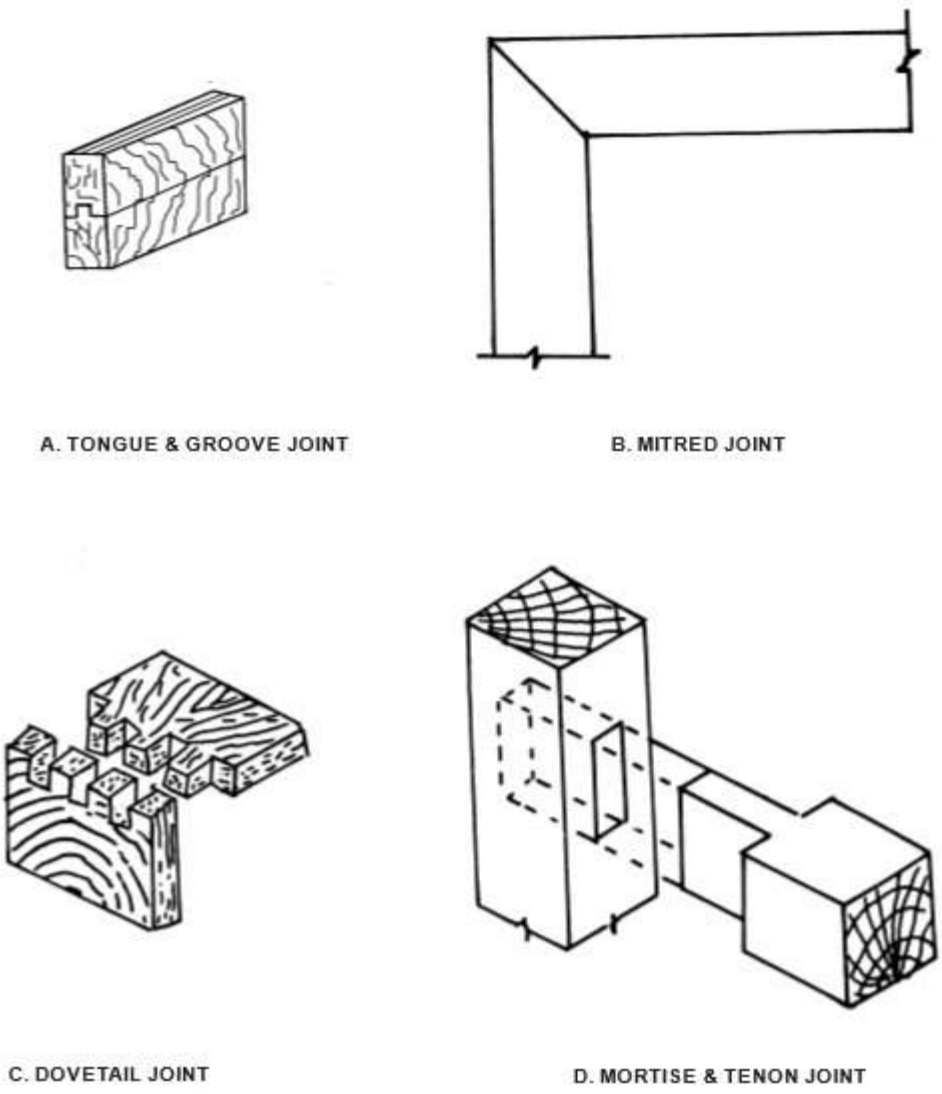
1C : 7-ply Test Specimen

Drawing not to scale
All dimensions are in mm

Fig. 1 : Test Specimen for Glue Adhesion Test

JOINTS IN TIMBER

Sub Head : Wood Work and PVC Work
Clause : 9.0

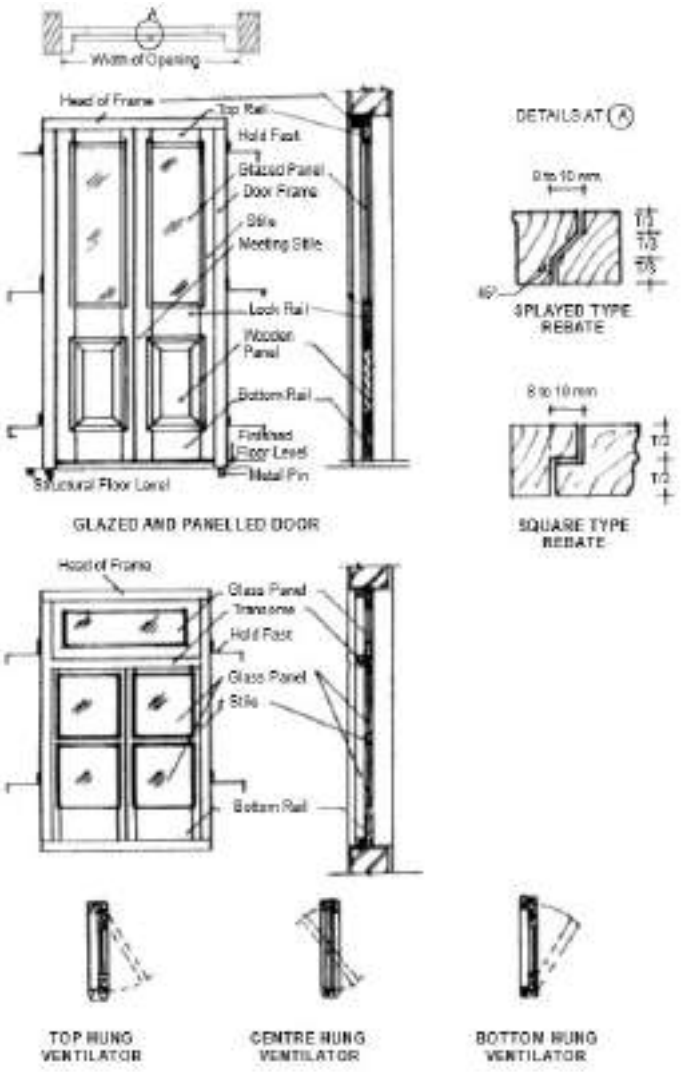


Drawing not to Scale

Fig. 9.1 : Joints in Timber

TERMINOLOGY TIMBER DOOR, WINDOW & VENTILATOR COMPONENTS

Sub Head : Wood Work and PVC Work
Clause : 9.6



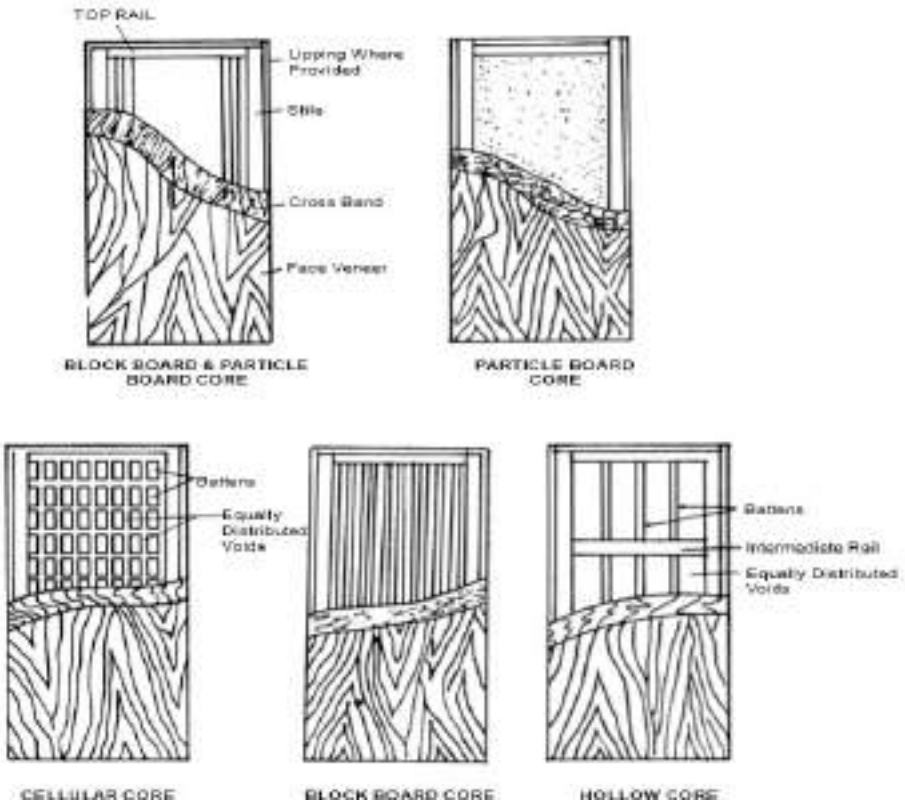
WINDOWS AND VENTILATORS

Drawing not to Scale
All dimensions are in mm

Fig. 9.2 : Terminology Timber Door, Window & Ventilator Components

WOODEN FLUSH DOORS SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.7

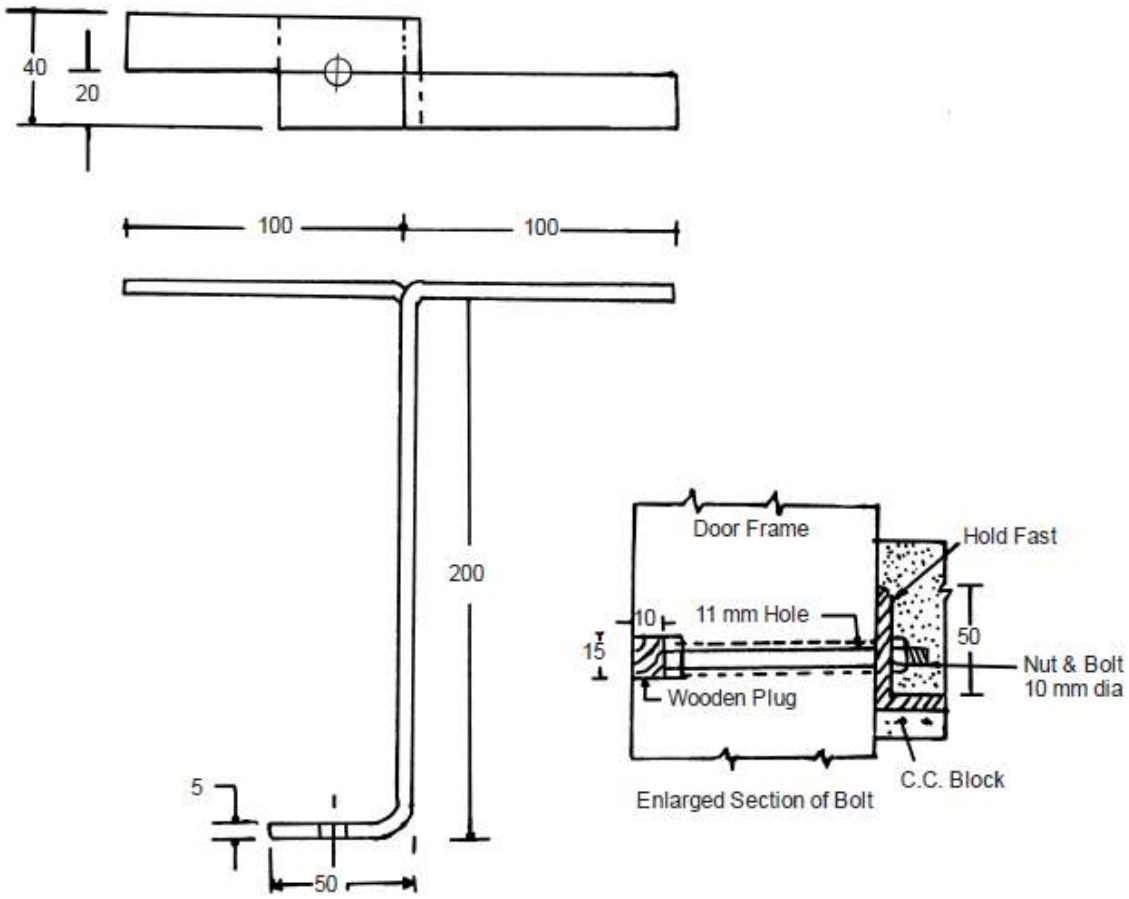


Drawing not to Scale

Fig. 9.3 : Wooden Flush Doors Shutters

HOLD FAST

Sub Head : Wood Work and PVC
Clause : 9.13

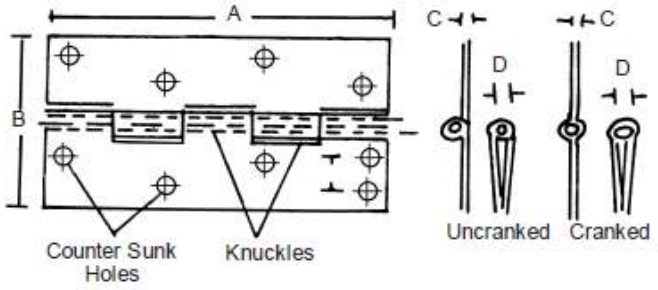


Drawing not to Scale
All dimensions are in mm

Fig. 9.4 : Hold Fast

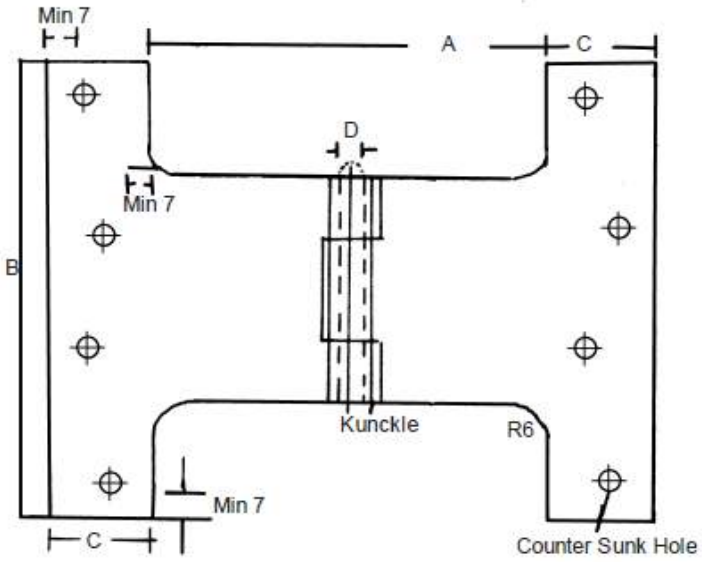
HINGES

Sub Head : Wood Work and PVC Work
Clause : 9.15.1 to 9.15.2



A. DIMENSION OF MEDIUM WT. MILD STEEL BUTT HINGES

Size of Hinge	Length (A)	Breadth (B)	Thickness of Flap (C)	Dai of Hinge Pin (D)	No. of Knuckles	No. of Holes	Holes for Screw No
1	2	3	4	5	6	7	8
50	50±0.5	37±1	1.50±0.06	3.15±0.008	3	4	6
75	75 ± 0.5	47 ± 1	1.70 ± 0.06	4.00 ± 0.08	5	6	8
100	100 ± 0.5	58 ± 1	1.90 ± 0.06	5.60 ± 0.08	5	8	10



B. PARLIAMENT HINGES

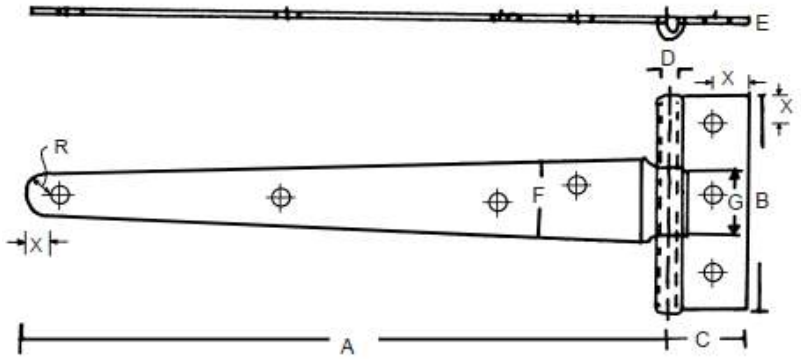
Drawing not to Scale
All dimensions are in mm

Fig. 9.5 : Hinges

HINGES

Sub Head : Wood Work and PVC Work
Clause : 9.15.5, 9.15.6

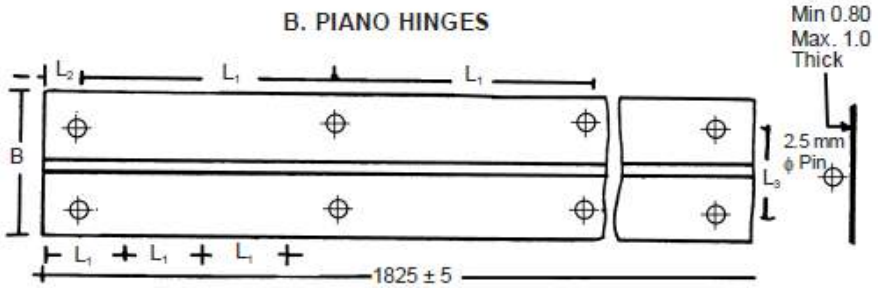
A. TEE HINGES



DIMENSIONS

Size	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*R*	*Screw Desig-nation No.*	*No. of Holes in Strap*	*No. of Holes in Tee*
250	250 ±3	100 ±2	30 ±15	5.6 ±0.10	2.24±0.10	45 ±2	40 ±1	8 ±1	9	5	3
300	300 ±3	115 ±2	30 ±1.5	6.30±0.10	2.26 ±0.10	50 ± 2	50 ±1	8±1	9	5	3

B. PIANO HINGES



DIMENSIONS

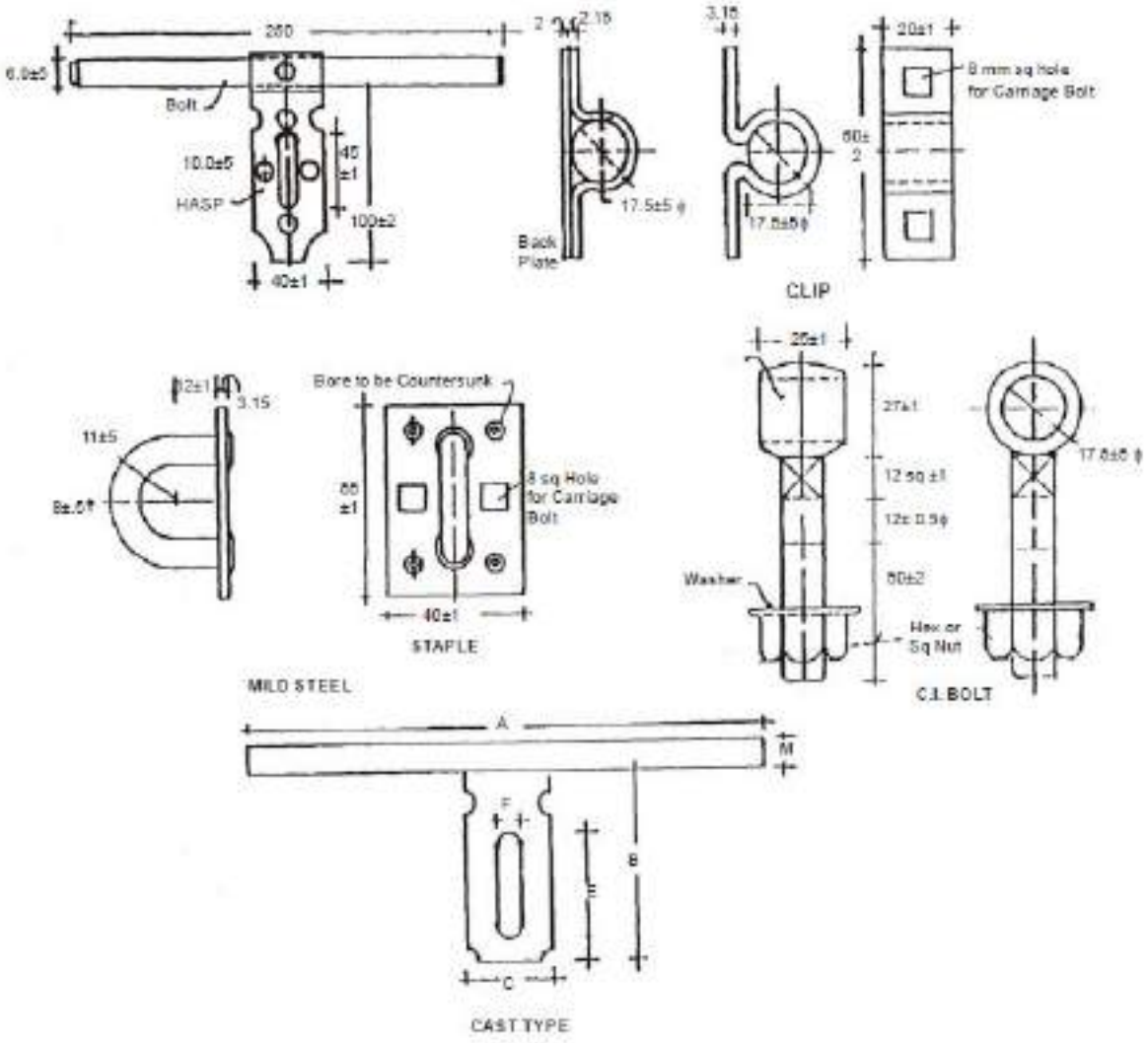
Nominal Size	B	L1	L2	L3
40	40 ± 1	25 ± 2	25 ± 1	20 ± 1
30	30 ±1	75 ± 2	25 ± 1	15 ± 1

Drawing not to Scale
All dimensions are in mm

Fig. 9.6 : Hinges

SLIDING DOOR BOLTS

Sub Head : Wood Work and PVC Work
Clause : 9.15.7



DIMENSIONS

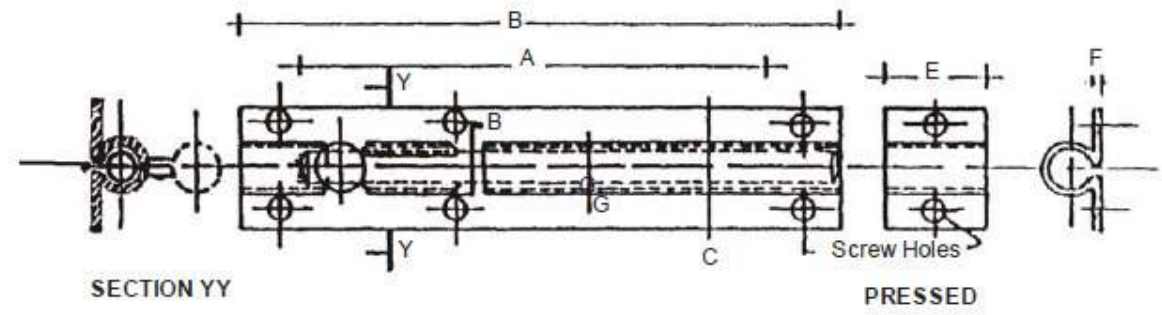
Size	A	B	C	E	F	M	Screw Designation No.
250	250 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9
300	300 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9

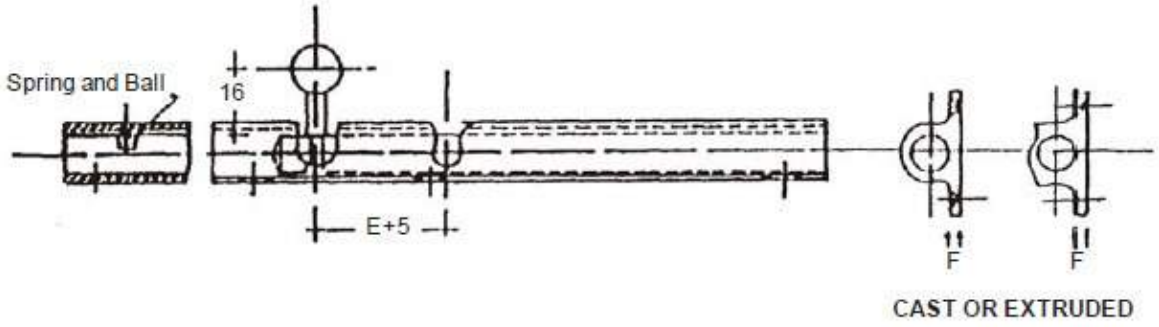
Drawing not to Scale
All dimensions are in mm

Fig. 9.7 : Sliding Door Bolts

BARREL TOWER BOLTS

Sub Head : Wood Work and PVC Work
Clause : 9.15.8





DIMENSIONS

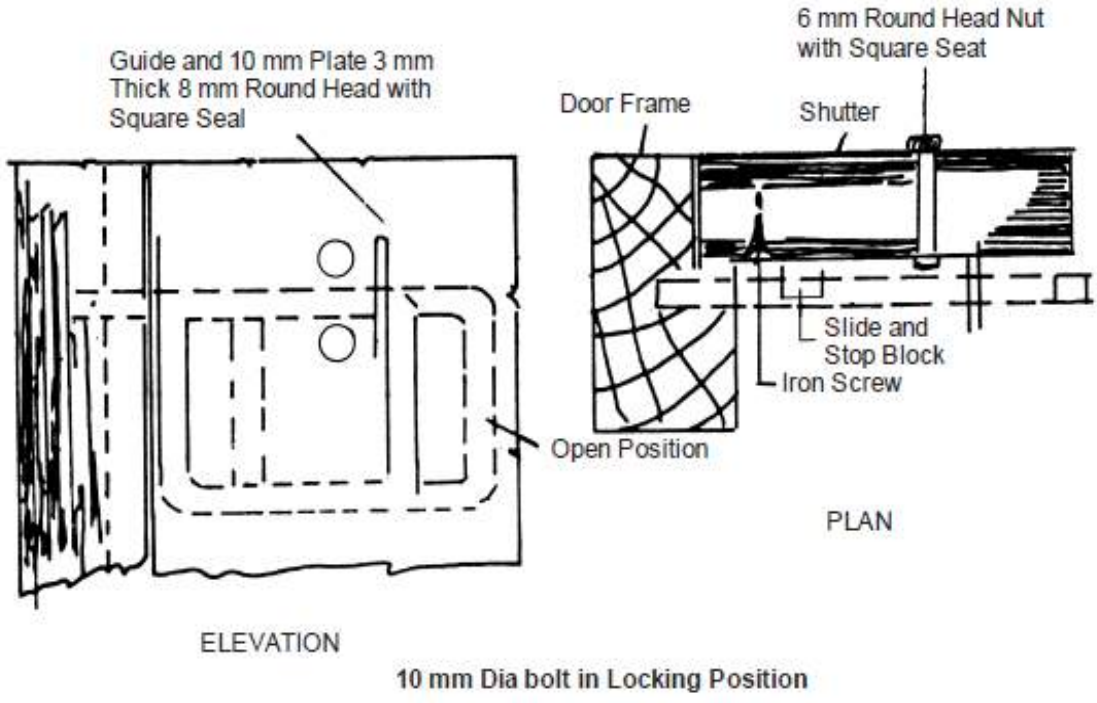
Size	A	B	Width of Barrel C When D=10.0	Width of Barrel C When D=12.00	D	E	Thickness of Metal of Barrel Sheet F Brass or Zinc Alloy	F Aluminium Alloy When D=10.0	F Aluminium Alloy When D=12.0	F Sheet Mild Steel or Brass	G	Screw Designation No.
150	150+3 -1	170 + 3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.60 ±10.33	2.40 ±0.36	1.25 mm ±0.15	1 to 1.5 more than dia of bolt	8
200	200+3 -1	220+3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.60 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		8
250	250+3 -1	270+3 -1	32+3 -1	38+3 -1	10 or 12 ±0.5	25±1	2.0 +0.5 -0.2	1.60 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		10

Drawing not to Scale
All dimensions are in mm

Fig. 9.8 : Barrel Tower Bolts

PULL BOLT LOCKS

Sub Head : Wood Work and PVC Work
Clause : 9.15.10

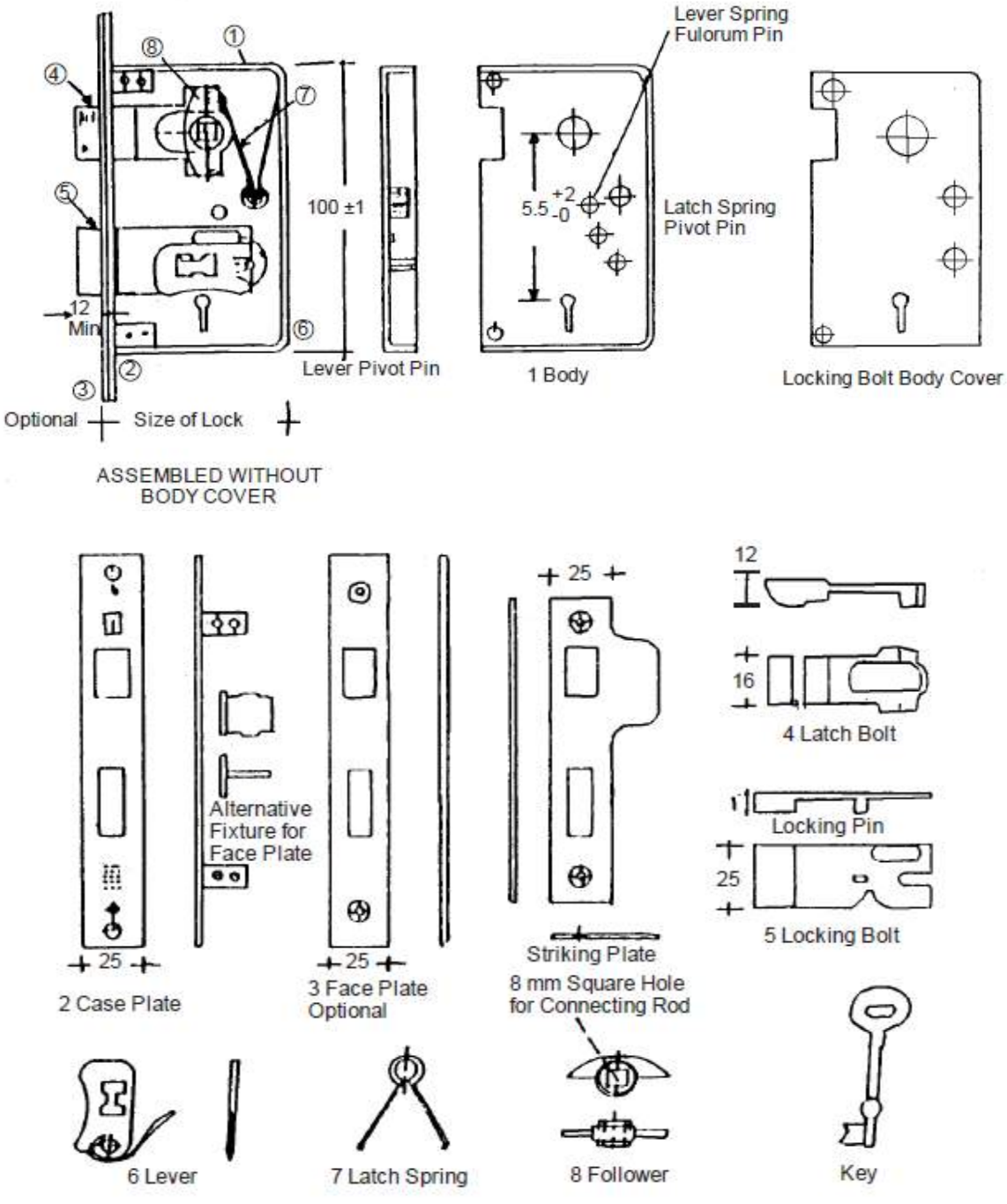


Drawing not to Scale

Fig. 9.9 : Pull Bolt Locks

MORTICE LOCK & LATCH

Sub Head : Wood Work and PVC Work
Clause : 9.15.13
Locking Bolt Guide Pin

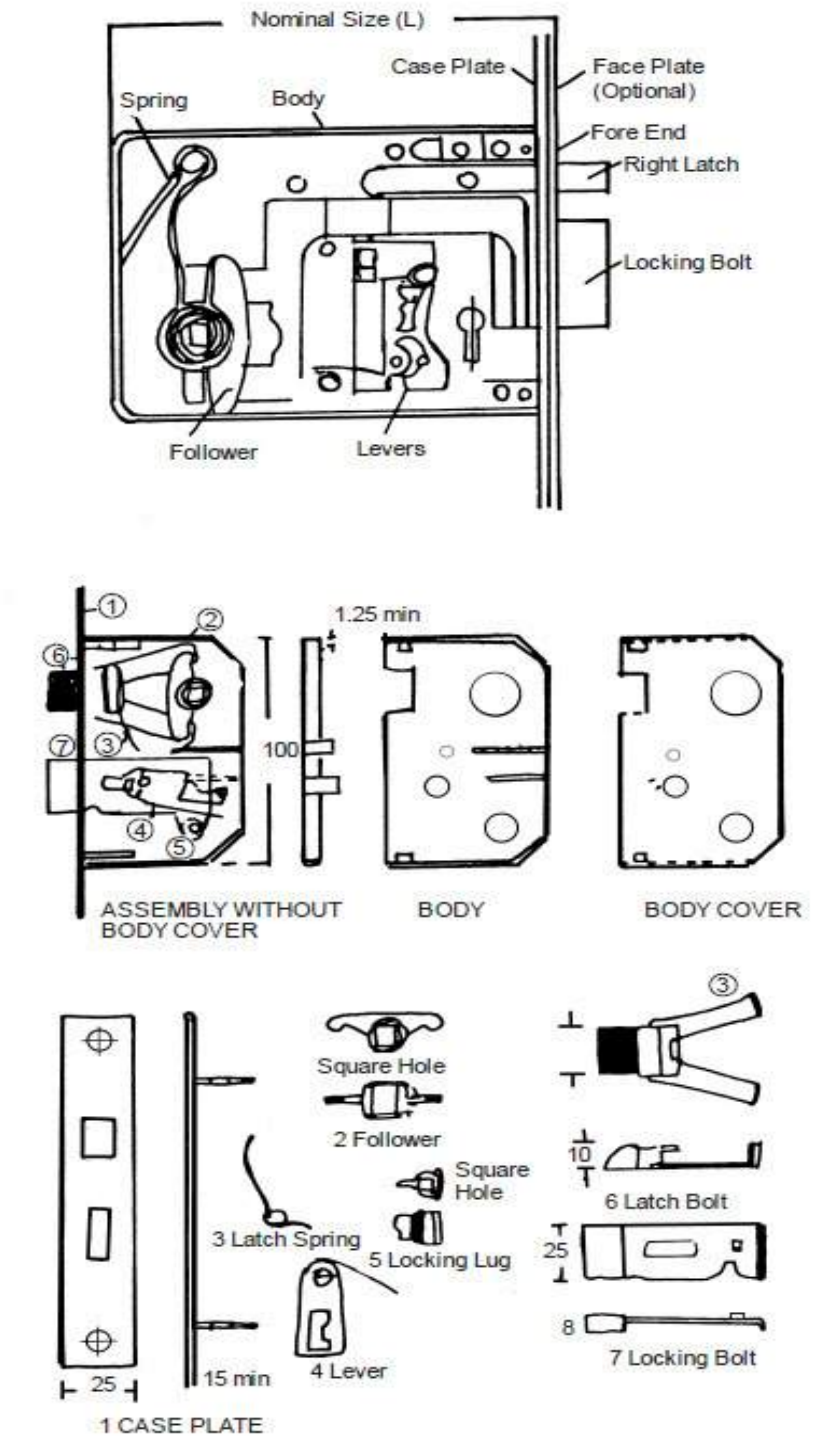


Drawing not to Scale
All dimensions are in mm

Fig. 9.10 : Mortice Lock & Latch

MORTICE NIGHT LATCH

Sub Head : Wood Work and PVC Work
Clause : 9.15.16



Drawing not to Scale
All dimensions are in mm

Fig. 9.11 : Mortice Night Latch

HANDLES FOR DOORS AND WINDOWS

Sub Head : Wood Work and PVC Work
Clause : 9.15.19

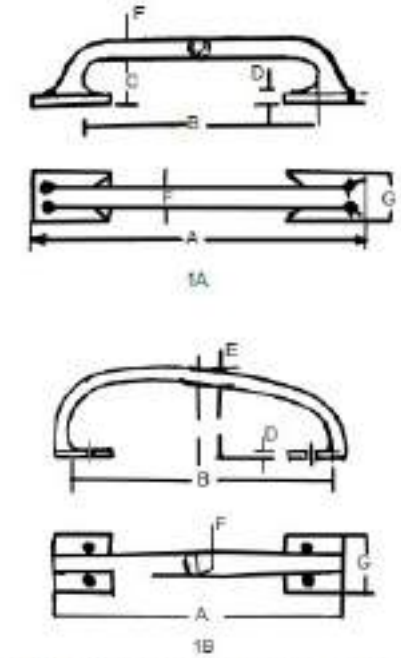


Fig. 9.12.1 : Typical Door Handle (Type 1)

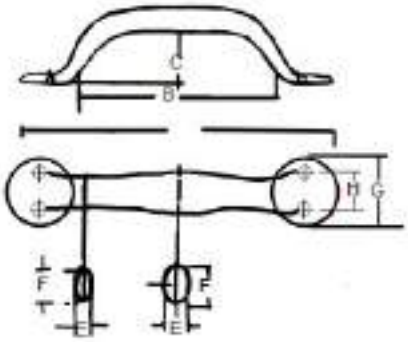


Fig. 9.12.2 : Typical Door Handle (Type 2)

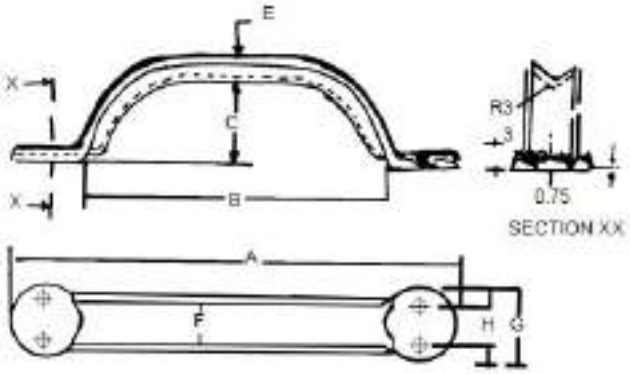


Fig. 9.12.3 : Typical Door Handle (Type 3)

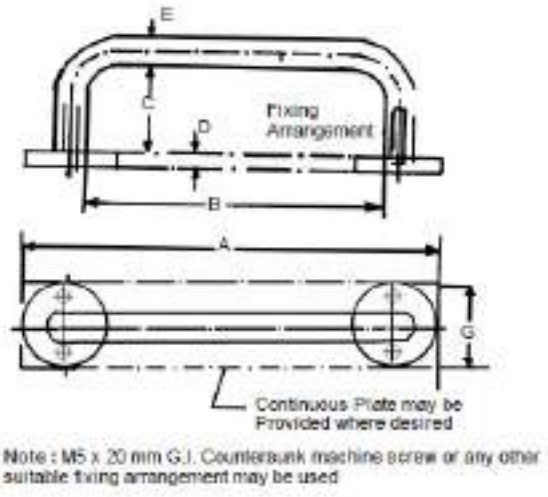


Fig. 9.12.4 : Typical Door Handle (Type 4)

Drawing not to Scale
All dimensions are in mm

Fig. 9.12 : Handles for Doors and Windows

TABLE 2A DIMENSIONS OF DOOR HANDLES

(Fig. 9.12.1 to 9.12.3)

All dimensions in millimetres

Type of Head	Ref to. Fig.	Sizes	A	B	C	D	E	F	G	H	I	Screw Holes*	
			Min	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*No. in Each Lug*	*Size Designation of Counter-sunk Head Wood Screw (see IS 6760-1972#)*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*
1.	*9.12.1A*	*75*	*125*	*75*	*20*	*2.5*	*5*	*8*	*15*	*-*	*-*	*2*	*6*
		100	*150*	*100*	*25*	*3.0*	*8*	*10*	*20*	*-*	*-*	*2*	*6*
		125	*190*	*125*	*25*	*4.0*	*10*	*12*	*22*	*-*	*-*	*2*	*6*
		150	*215*	*150*	*30*	*1.5*	*12*	*15*	*25*	*-*	*-*	*2*	*8*
	9.12.1B	*75*	*85*	*75*	*20*	*2.5*	*5*	*8*	*15*	*-*	*-*	*2*	*6*
		100	*110*	*100*	*25*	*3.0*	*5*	*10*	*20*	*-*	*-*	*2*	*6*
		125	*140*	*125*	*25*	*3.0*	*7.5*	*12*	*22*	*-*	*-*	*2*	*6*
		150	*165*	*150*	*30*	*4.0*	*7.5*	*15*	*25*	*-*	*-*	*2*	*8*
2.	9.12.2	*75*	*125*	*75*	*20*	*-*	*10*	*16*	*32*	*20*	*1.0*	*2*	*6*
		100	*150*	*100*	*25*	*-*	*11*	*19*	*38*	*20*	*1.0*	*2*	*6*
		115	*175*	*115*	*28*	*-*	*13*	*22*	*45*	*25*	*1.0*	*3*	*8*
		135	*200*	*135*	*30*	*-*	*14*	*25*	*50*	*32*	*1.25*	*3*	*8*
3	9.12.3	*75*	*100*	*75*	*20*	*-*	*5*	*14*	*16*	*8*	*1.25*	*1*	*6*
		90	*125*	*90*	*25*	*-*	*6*	*16*	*20*	*10*	*1.25*	*2*	*6*
		100	*150*	*100*	*28*	*-*	*7*	*18*	*25*	*12*	*1.60*	*2*	*6*

TABLE 2B DIMENSIONS OF DOOR HANDLES

All dimensions in millimetres.

Type	*Ref to Fig.*	*Sizes*	*A*	*B*	*C*	*D*	*E#*	*G*	*Screw Holes***		
			Min		*Min*			*Dia*	*No. in Each Lug*	*No. in a plate when a continuous Plate is used*	*Size Designation of Counter-sunk Head Wood Screws (see IS : 6760-1972$)*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
4	9.12.4	75	115	75	25	5 ± 0.5	10 ± 0.5	30 +0 −1	2	4	6
		100	140	100	30	5 ± 0.5	10 ± 0.5	30 +0 −1	2	4	6
		125	175	125	35	5 ± 0.5	12 ± 0.5	38 +0 −1	3	6	6
		150	200	150	35	5 ± 0.5	12 ± 0.5	38 +0 −1	3	6	6

In case a continuous base plate is used, the thickness may be reduced to 3 mm.

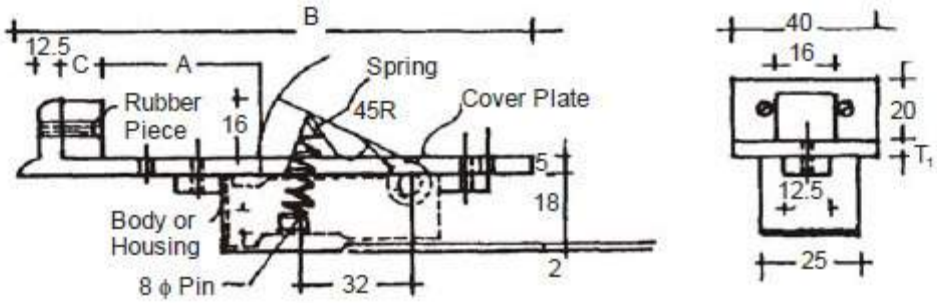
\# Hexagonal or round.

** More evenly placed screw holes may be provided, if so required by the purchaser.

$ Specification for slotted countersunk head wood screws.

FLOOR DOOR STOPPER - CAST TYPE

Sub Head : Wood Work and PVC Work
Clause : 9.15.20



DIMENSION

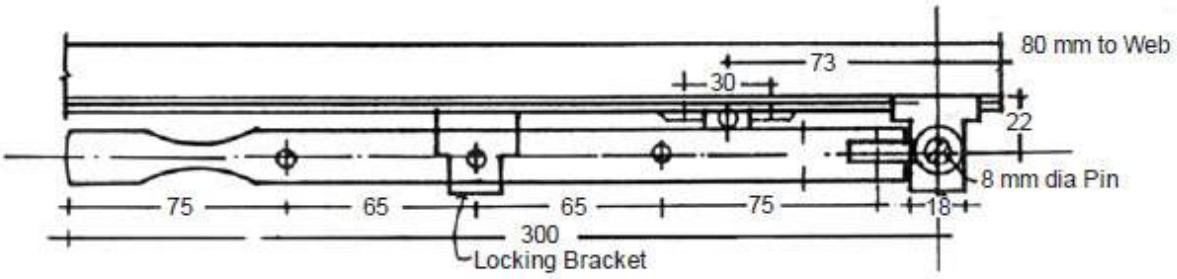
Thickness of Door Shutter	A	B	C	Casting T_1	Screw Designation No.	No. of Holes for T_1
30	35.0 ± 0.5	140.0 ± 0.5	13	4.5 +0.3 -0	9	4
35	40.0 ± 0.5	140.0 ± 0.5	8	4.5 ± 0.3 -0	9	4
40	45.0 ± 0.5	150.0 ± 0.5	13	4.5 +0.3 -0	9	4
45	50.0 ± 0.5	150.0 ± 0.5	8	4.5 +0.3 -0	9	4

Drawing not to Scale
All dimensions are in mm

Fig. 9.13 : Floor Door Stopper – Cast Type

WINDOW STAY

Sub Head : Wood Work and PVC Work
Clause : 9.15.23

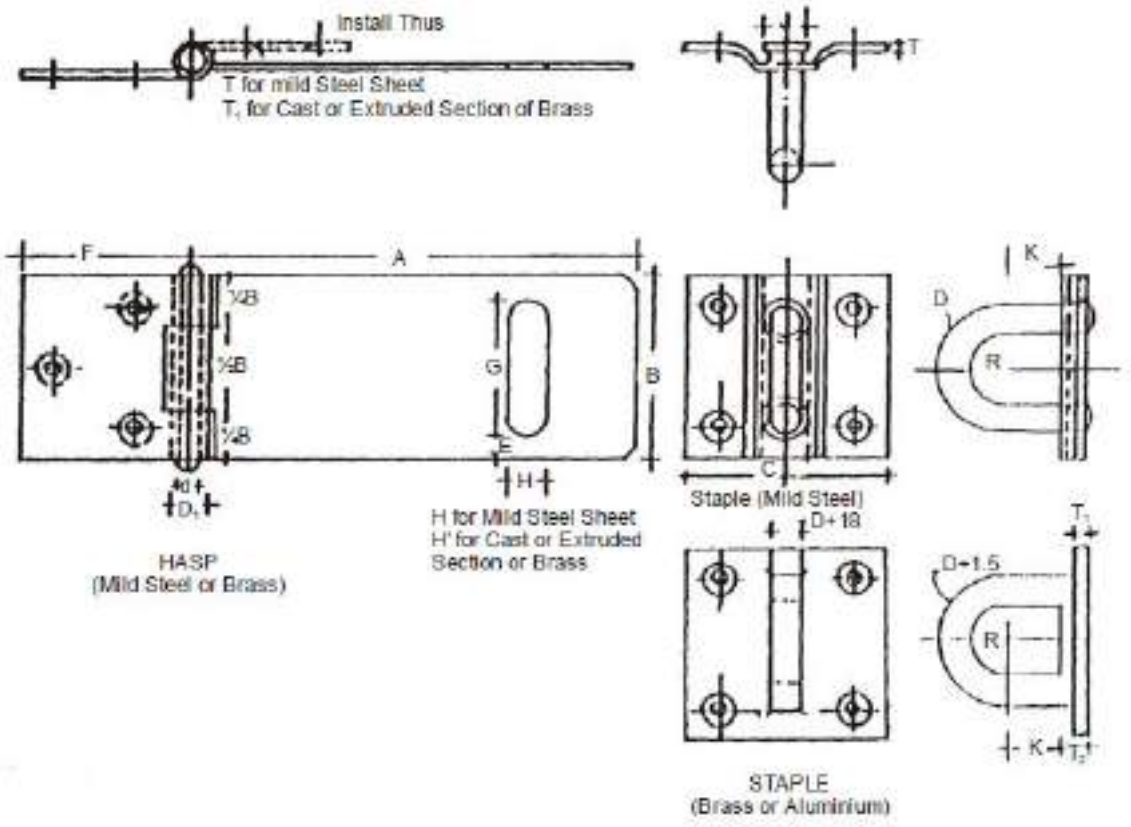


Drawing not to Scale
All dimensions are in mm

Fig. 9.14 : Window Stay

HASP & STAPLES

Sub Head : Wood Work and PVC Work
Clause : 9.15.25



MILD STEEL

Size	A	B	C	D	E	F	G	H	J	K	R	Thickness of Sheet T	Dia of Hinge Pin d	Screw Holes No. on Hasp	Screw Holes No. on Staple	Screw Designation No.
90	90±2	38±1.5	46±2	5.0±.10	5.0±.5	35±1.5	28±1.5	8±.5	12±1	8±1	8±.5	2±.10	4±.10	3	4	8
115	115±2	38±1.5	46±2	5.0±.10	5.0±.5	55±1.5	28±1.5	8±.5	12±1	8±1	8±.5	2±.10	4±.10	3	4	8
150	150±2	45±1.5	60±2	6.30±.10	6.0±.5	65±1.5	38±.5	10±.5	15±1	14±1	8±.5	2.24±.10	5±.10	4	4	10

BRASS CAST OR EXTRUDED

Size	A	B	C	D	E	F	G	H	K	R	Thickness T_1	Thickness T_2	Dia of Hinge Pin d	Dia of Butt D_1	Screw Holes No. on Hasp	Screw Holes No. on Staple	Screw Designation No.
90	90±2	40±1.5	42±1.5	6±.25	6±.5	35±1	28±.5	10±.5	8±1	8.5±.5	2±.25	3±.25	3.15±.10	6±.2	3	4	6
115	115±2	40±1.5	42±1.5	5±.25	6±.5	45±1	28±.5	10±.5	11±1	6.5±.5	2±.25	3±.25	3.15±.10	6±.2	3	4	8
150	150±2	40±1.5	48±1.5	6±.25	7±.5	65±1	32±.5	11±.5	14±1	7.0±.5	3±.25	4±.25	4±.10	8±.2	4	4	0

Drawing not to Scale
All dimensions are in mm

Fig. 9.15 : Hasp & Staples

LVL SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.16.6

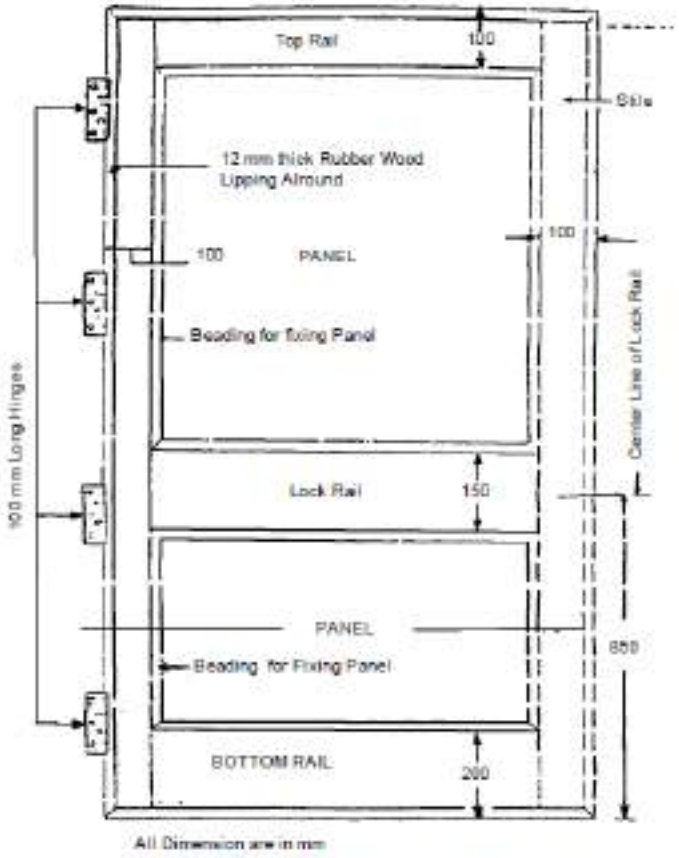


Fig. 9.16 : Typical Illustratino of Panelled LVL Door Shutter

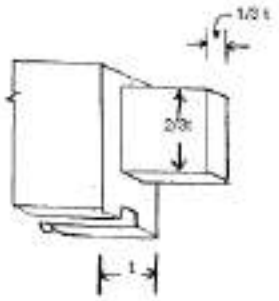


Fig. 9.16A : Single Tenon Joint

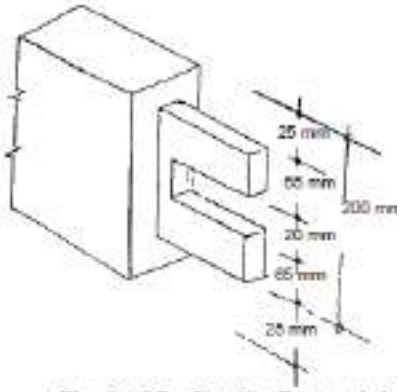


Fig. 9.16B : Double Tenon Joir

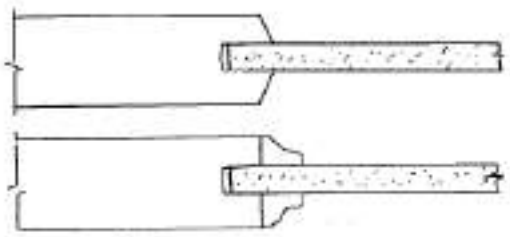


Fig. 9.16C : Common Methods of Joining Panel with Stiles and Rails with/ without Beading

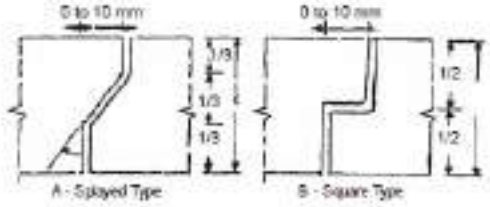
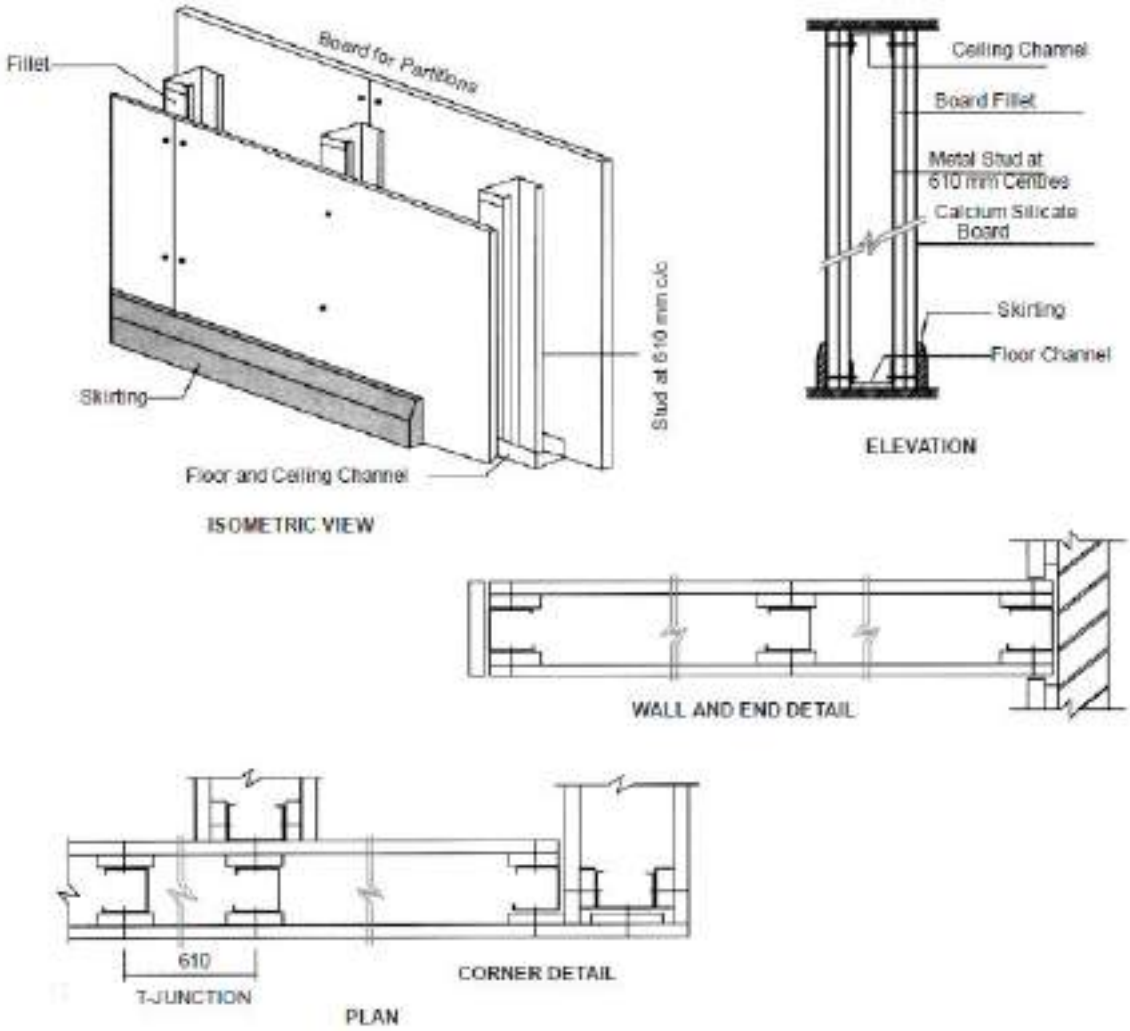


Fig. 9.16D : Meeting of Stiles for Double Leaved Door Shutters

Fig. 9.16 : LVL Shutter

PARTITIONS

Sub Head : Wood Work and PVC Work
Clause : 9.17.2



DETAILS		
Board 8 / 10 / 12 mm	Thick	One layer board on each side of studs
Board Fillets	60 / 100 mm	On each side of all studs and channels
Floor/Ceiling Channel	50 x 32 x 32 x 0.55 mm	Top and bottom perimeter of the partition
Stud	48 x 50 x 48 x 0.55 mm	Vertically at 610 mm c/c
Bracing Member	45 x 15 x 15 x 0.9 mm	At horizontal board joint on both side
Screws (C/S head)	25 & 35 mm long, self drilling with under head cutter	12 mm from the edge & 40 mm from the corner of the board at 200 mm c/c

Fig. 9.17 : Partitions

UPVC DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.18.1

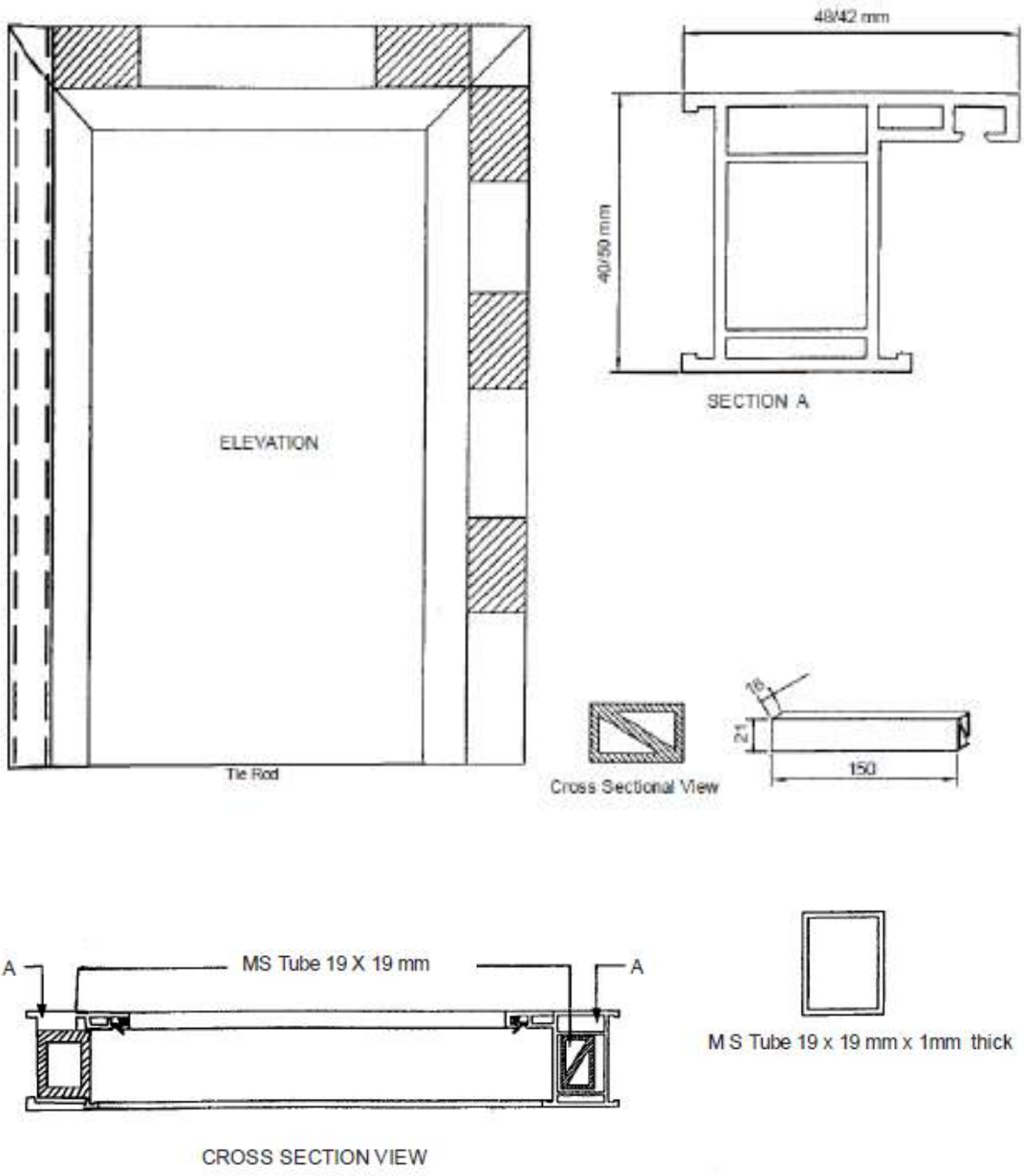


Fig. 9.18 : UPVC Door Frame

24 MM THICK PVC DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.19.1

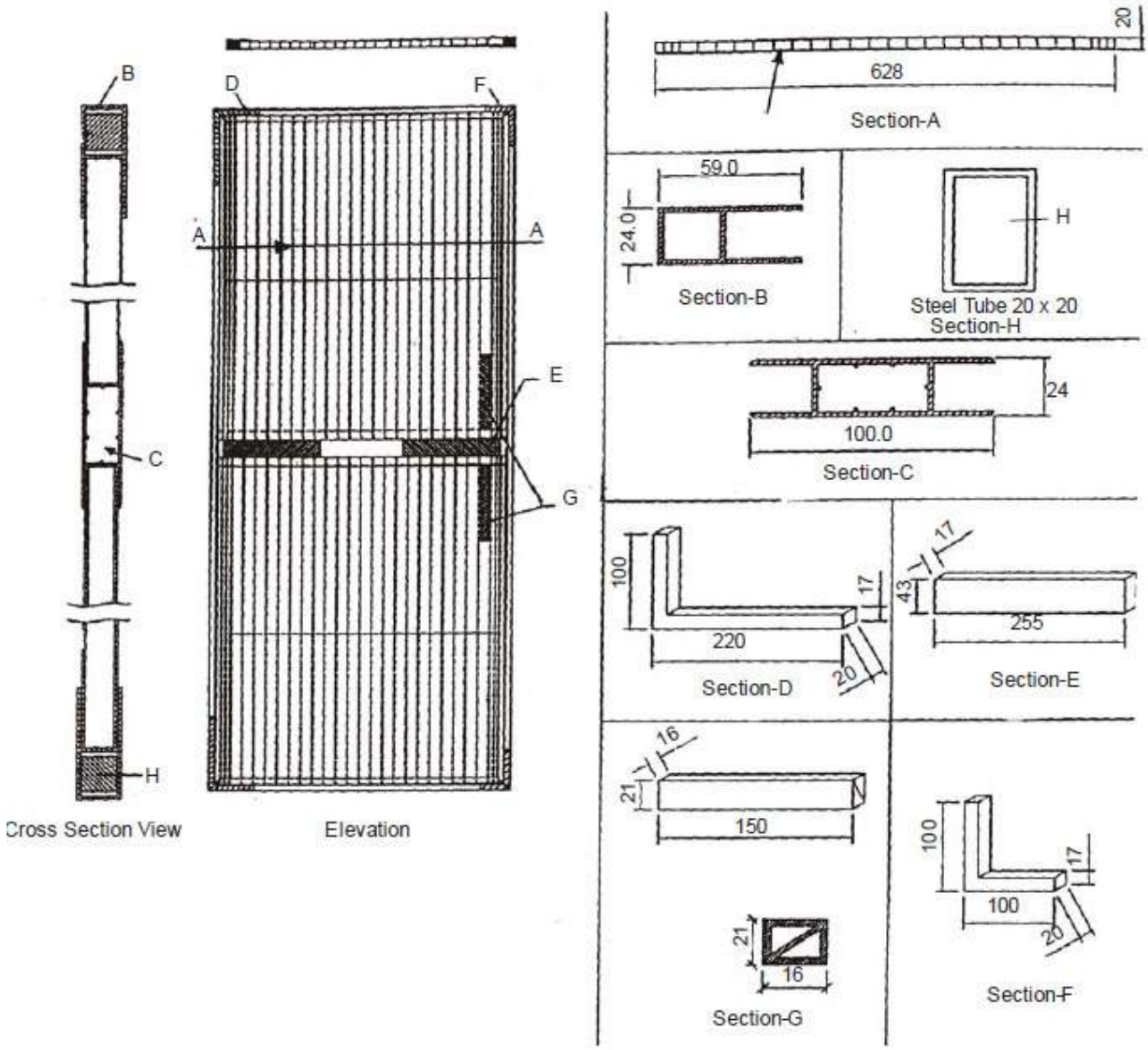


Fig. 9.19 : 24 mm Thick PVC Door Shutters

30 MM THICK PVC DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.19.2

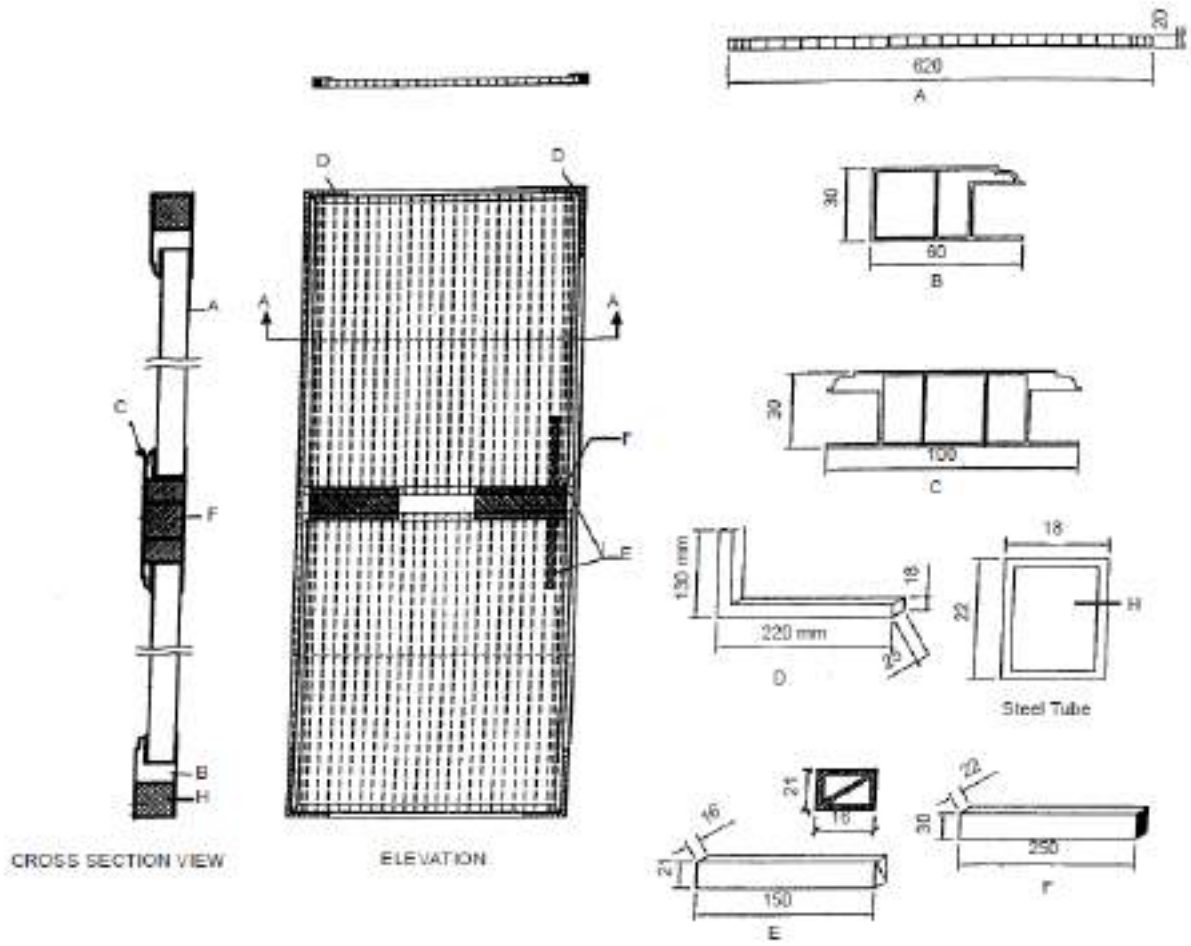


Fig. 9.20 : 30 mm Thick PVC Door Shutters

PVC DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.20.1

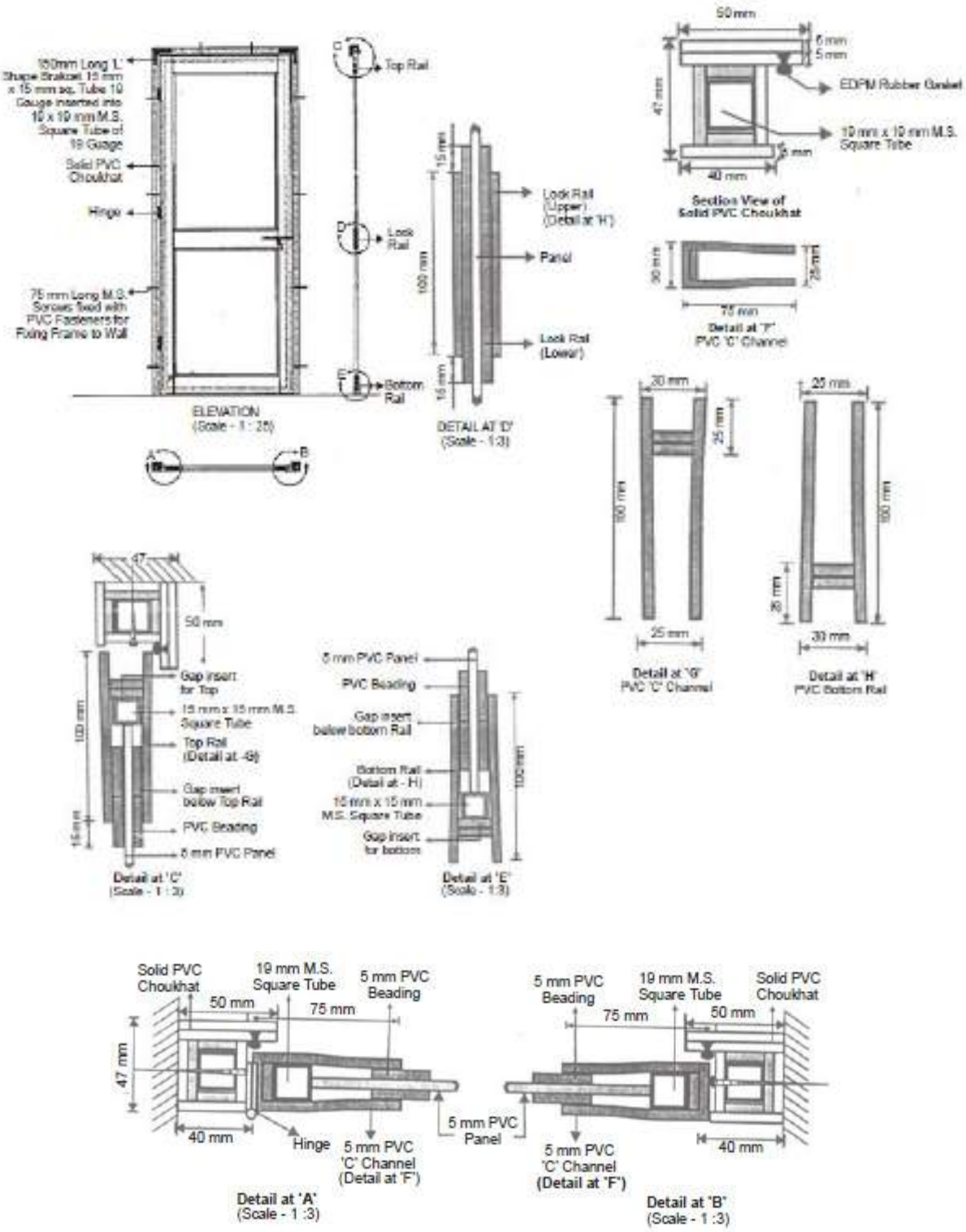


Fig. 9.21 : PVC Door Frame

30 mm THICK PANEL PVC DOOR SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.21.1(a)

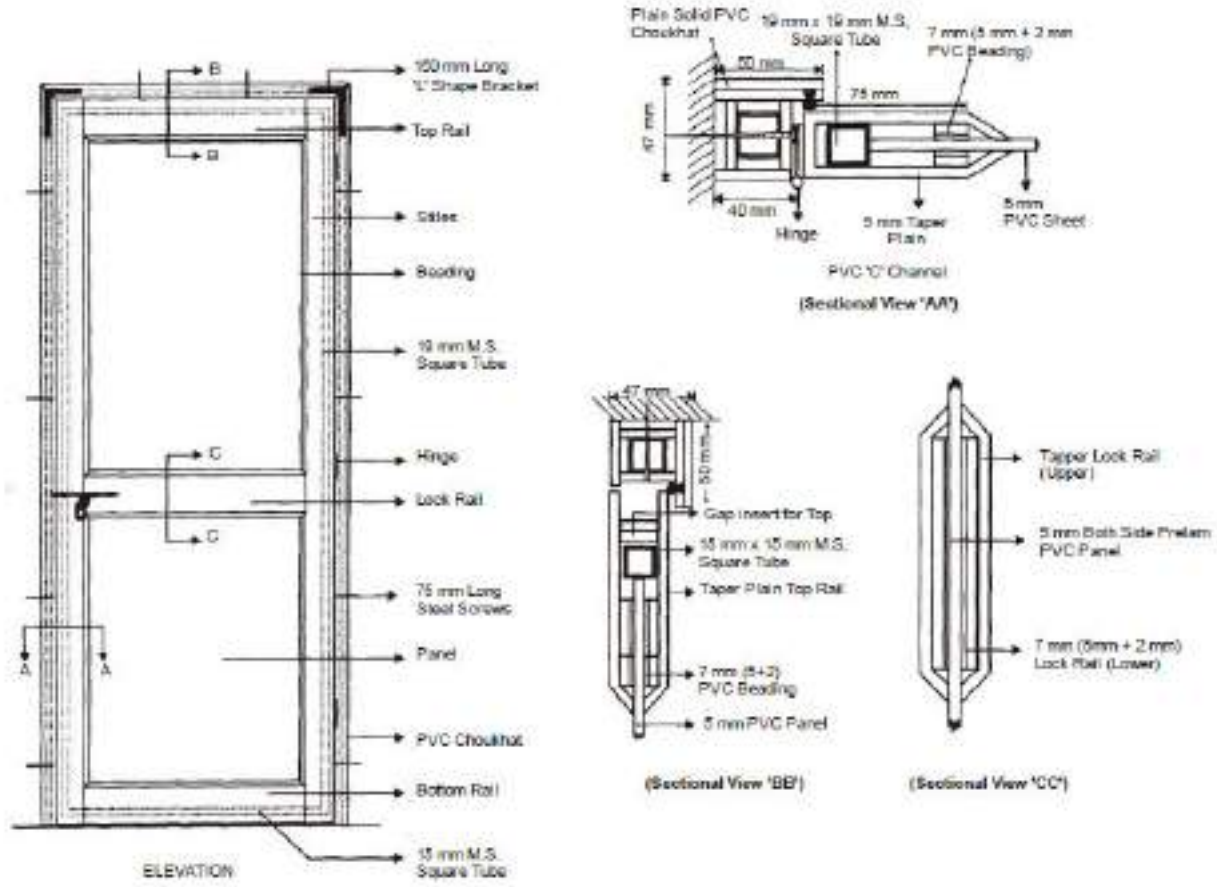


Fig. 9.22 : 30 mm Thick Panel PVC Door Shutter

FRP DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.22.0

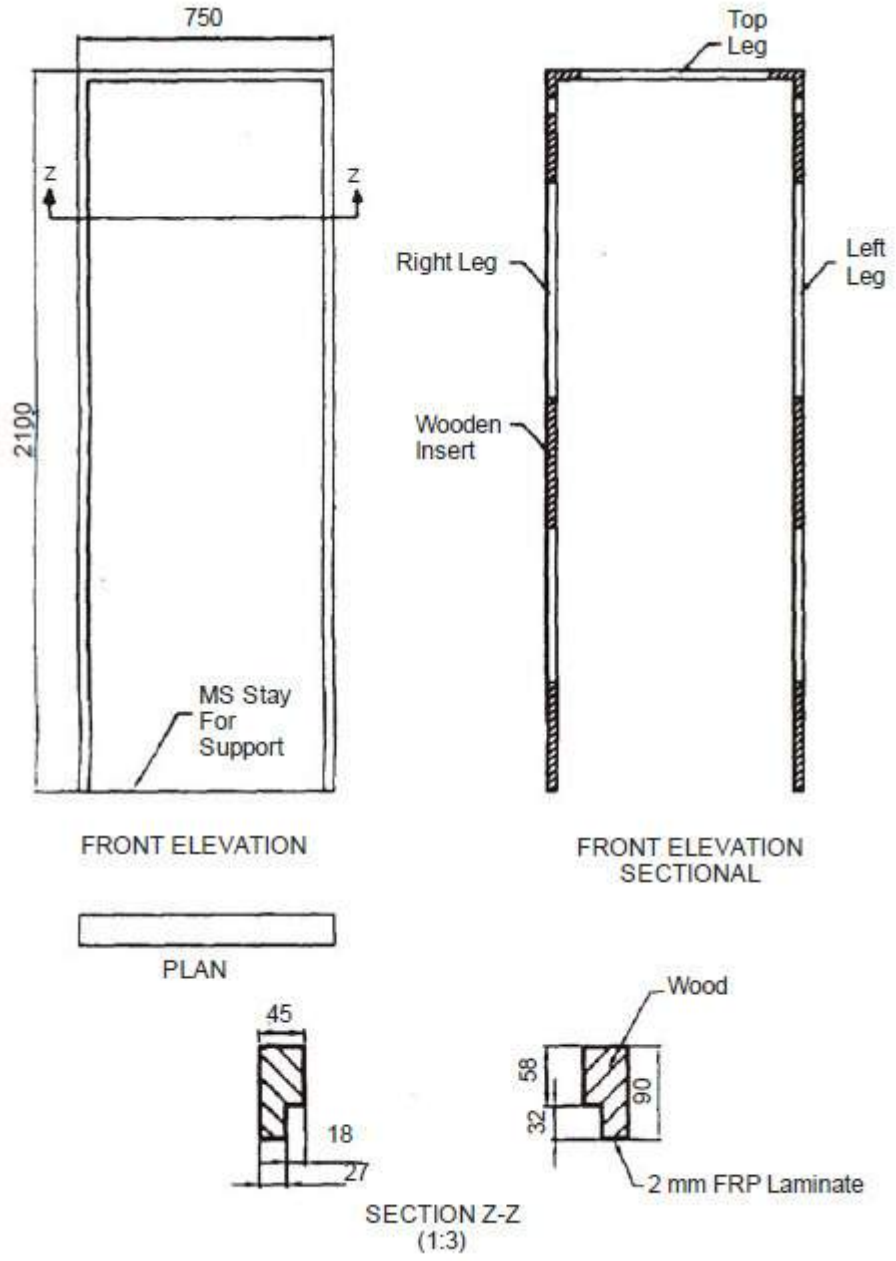
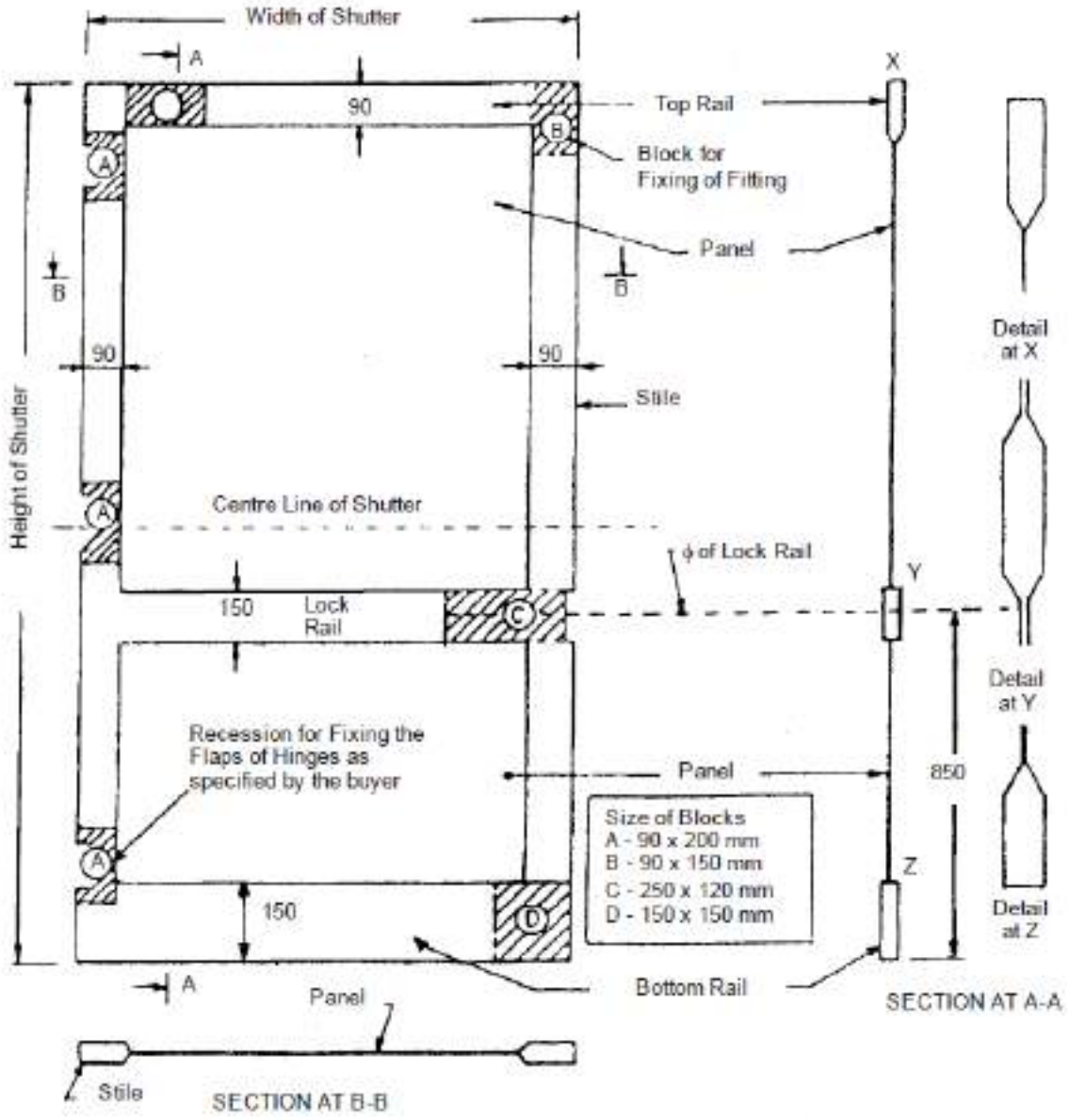


Fig. 9.23 : FRP Door Frame

TYPICAL SKETCH OF FRP DOOR SHUTTERS

Sub Head : Wood Work and PVC Work
Clause : 9.23.1



All dimensions in mm

Fig. 9.24A : Typical Sketch of FRP Door Shutters

SKETCH ILLUSTRATING DIMENSIONS OF SHUTTER

Sub Head : Wood Work and PVC Work
Clause : 9.23.1

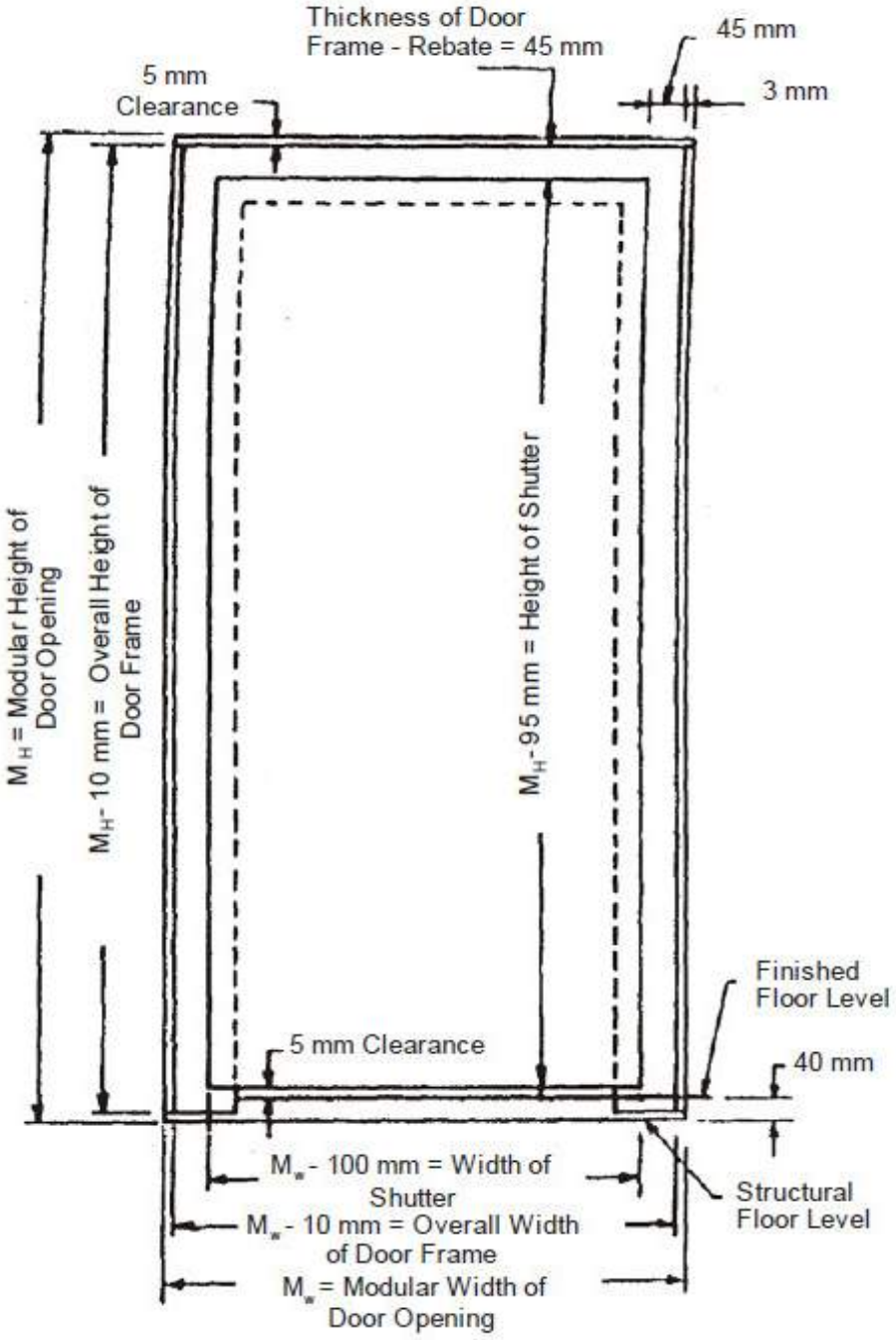
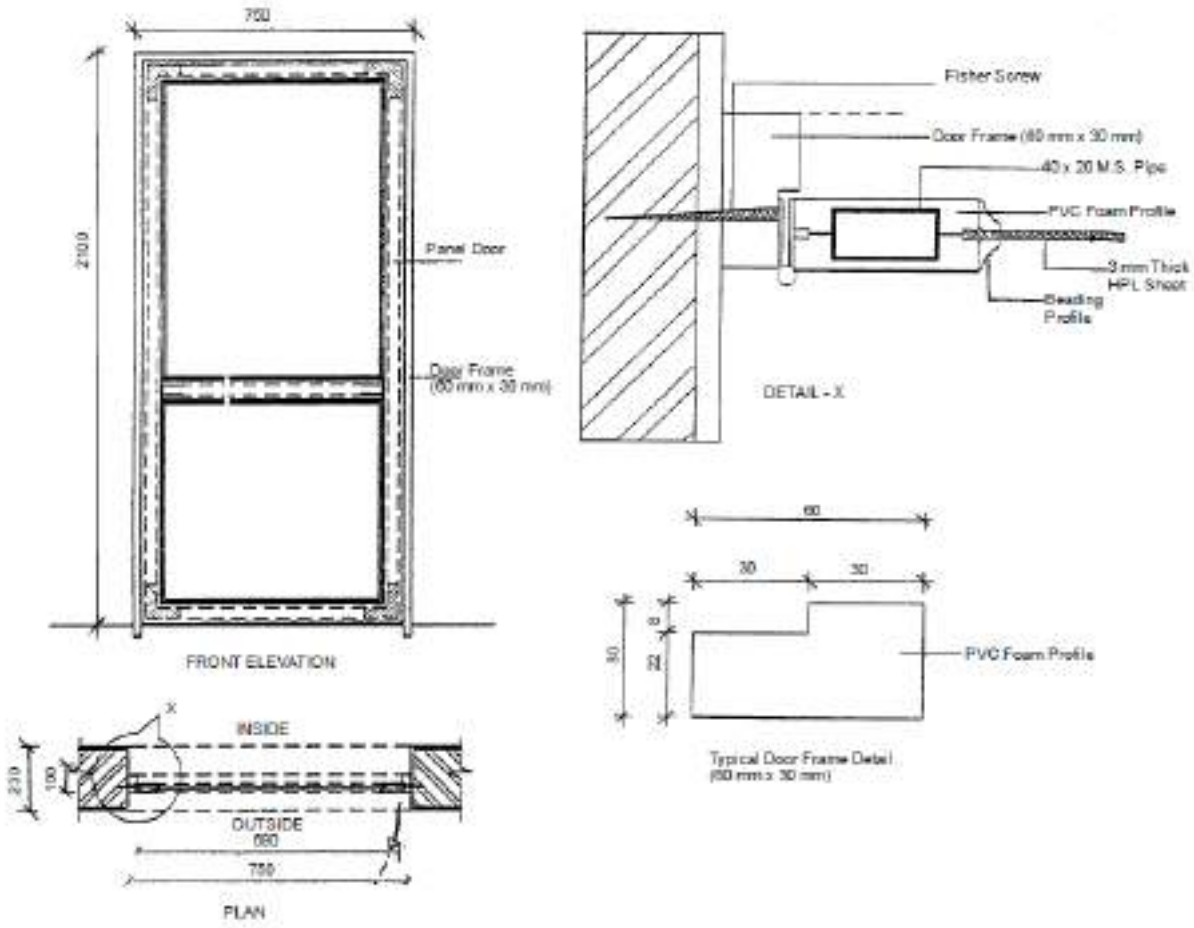


Fig. 9.24B : Sketch Illustrating Dimensions of Shutter

SINGLE REBATE DOOR FRAME

Sub Head : Wood Work and PVC Work
Clause : 9.24.1



Drawing not to scale
Al dimensions are in mm

Fig. 9.25 : Solid PVC Foam Profile Frame

DOOR SHUTTER DETAIL (28 MM THK - FABRICATION DETAIL)

Sub Head : Wood Work and PVC Work
Clause : 9.25.1

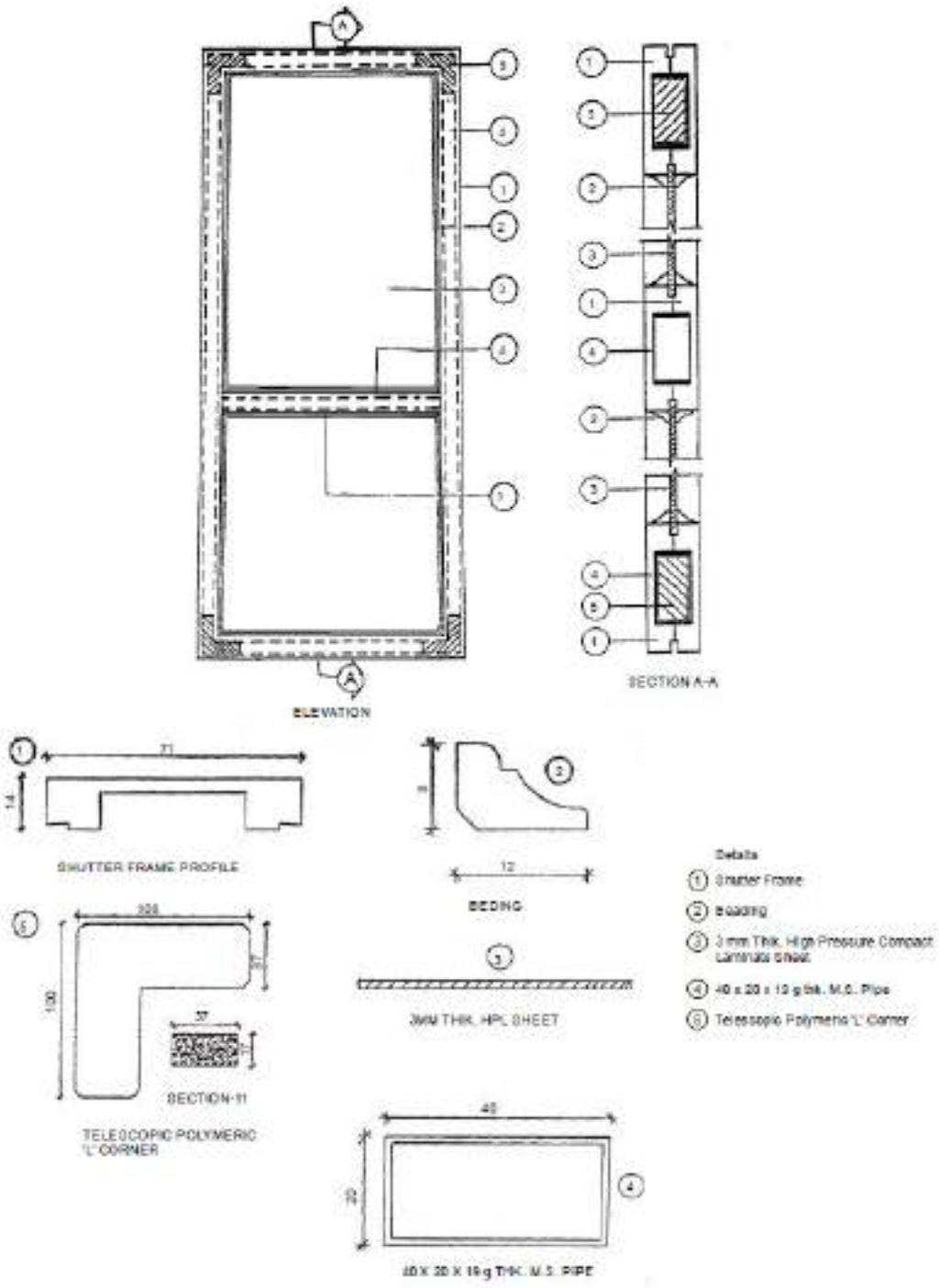


Fig. 9.26 : Solid PVC Foam Shutter (28 mm Thick - Fabrication Detail)

F.R.P. CHAJJA

Sub Head : Wood Work and PVC Work
Clause : 9.26

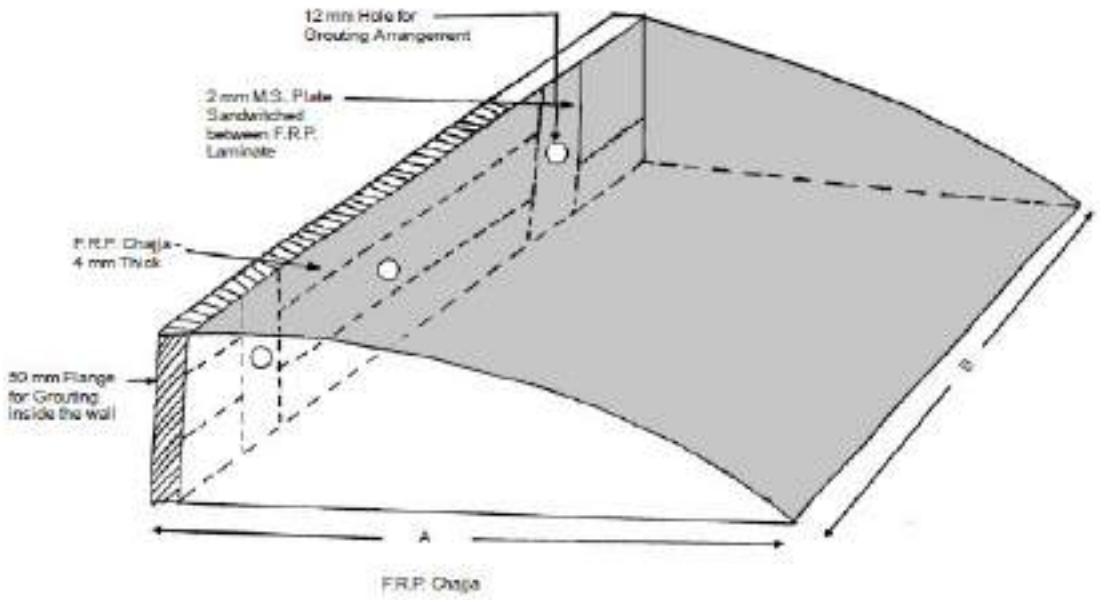


Fig. 9.27 : F.R.P. Chajja

WALL PANELLING

Sub Head : Wood Work and PVC Work
Clause : 9.27

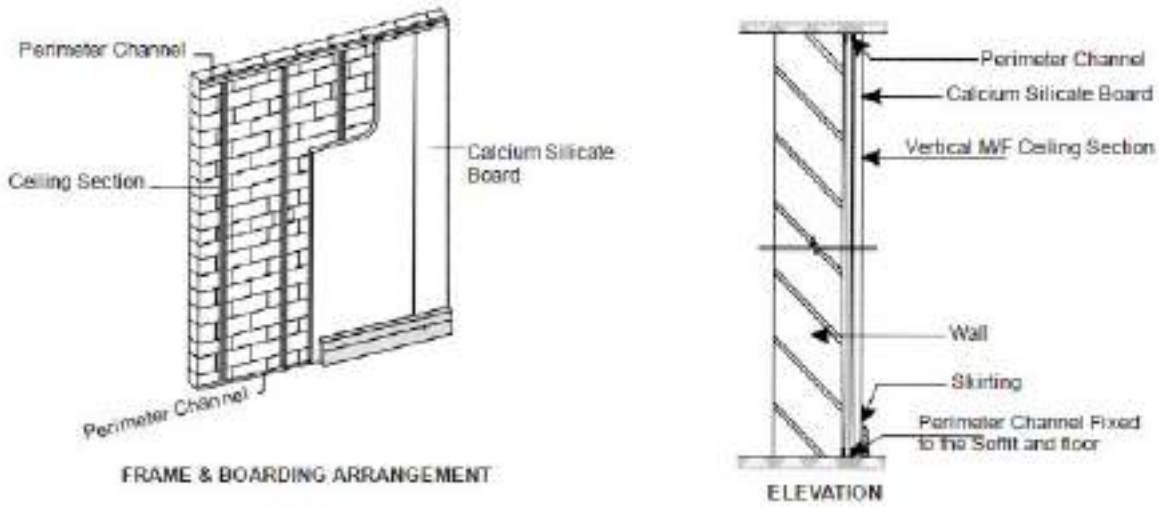


Fig. 9.28 : Wall Panelling

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

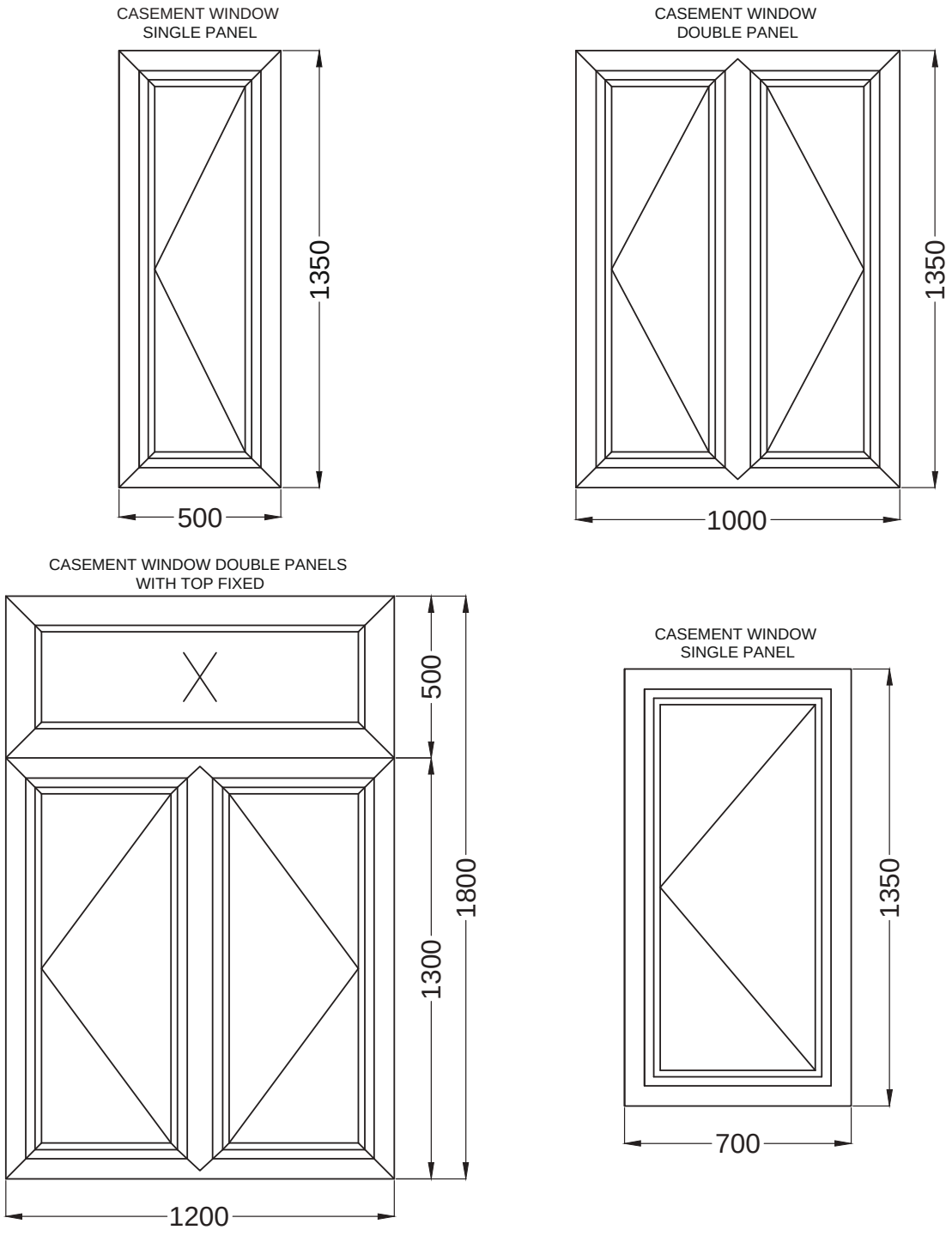
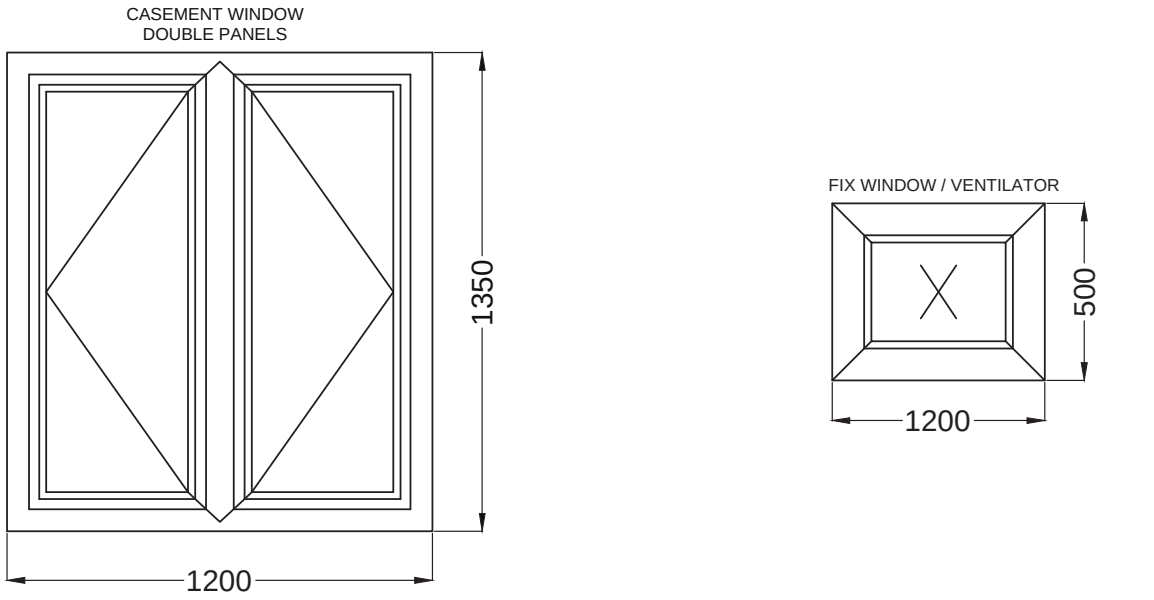


Fig. 9.29: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28



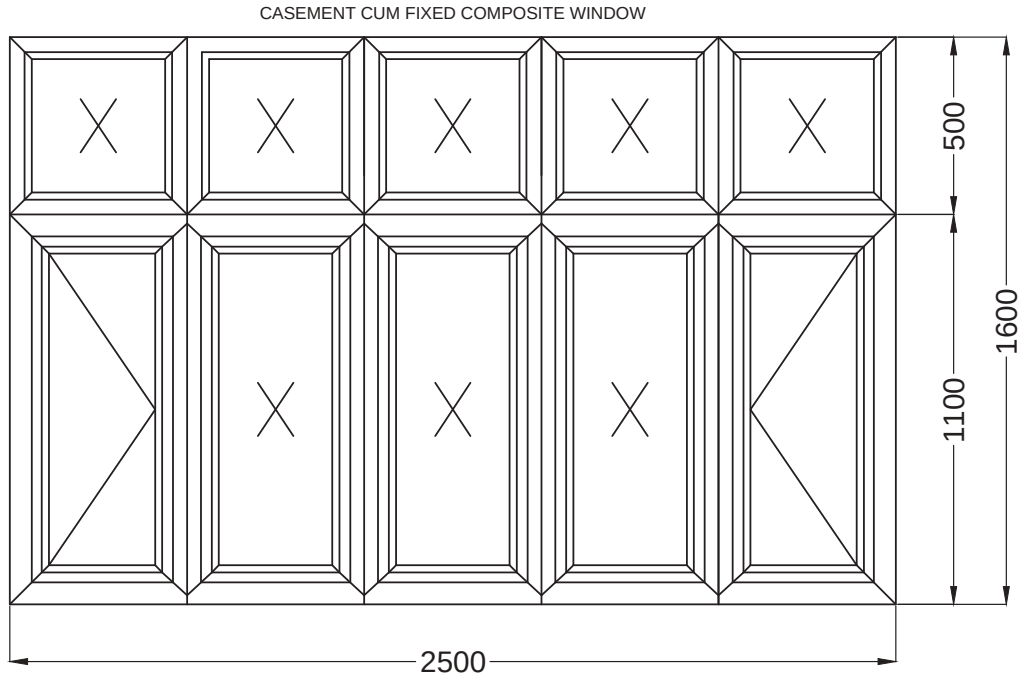


Fig. 9.30: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

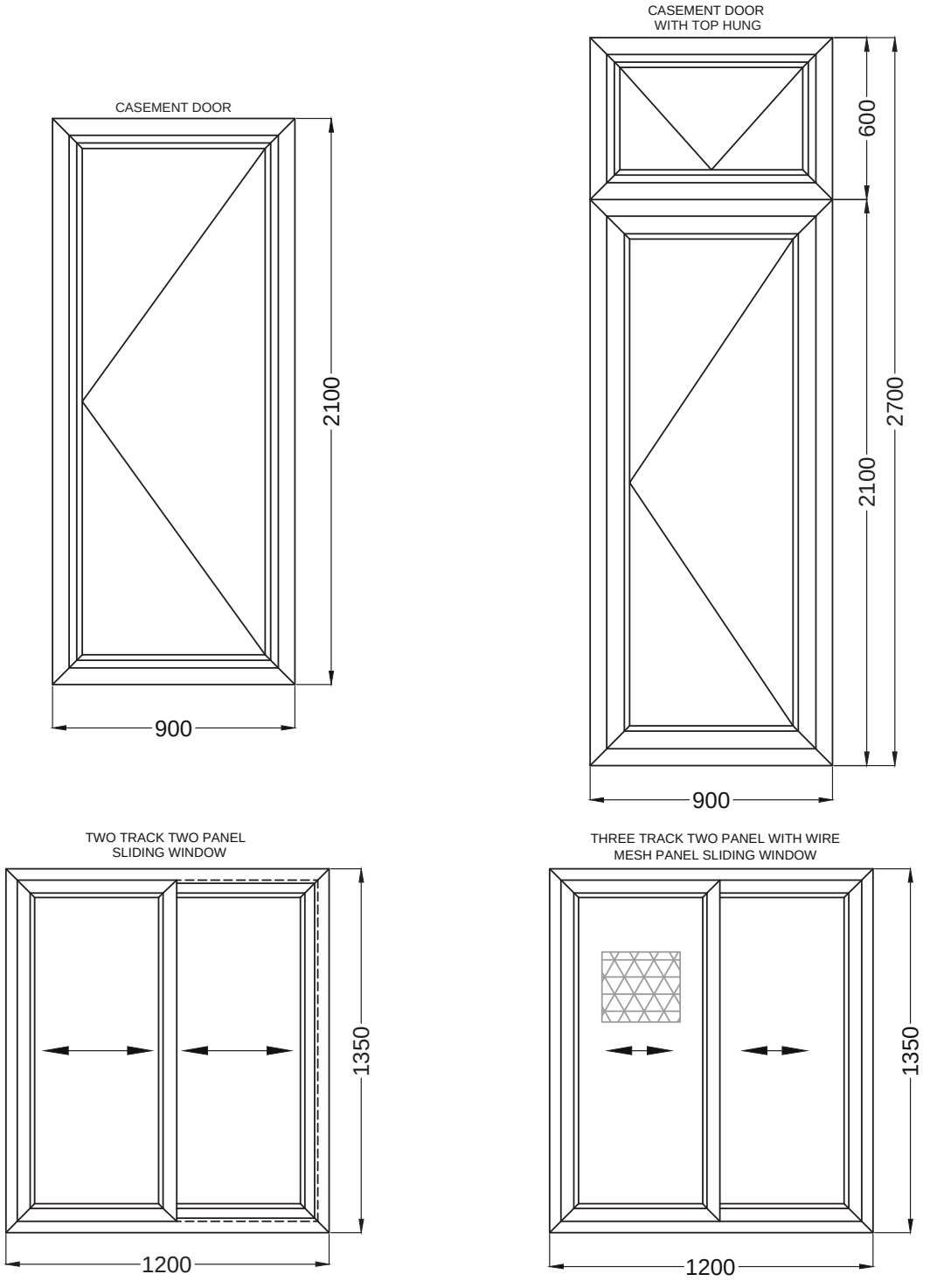


Fig. 9.31: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

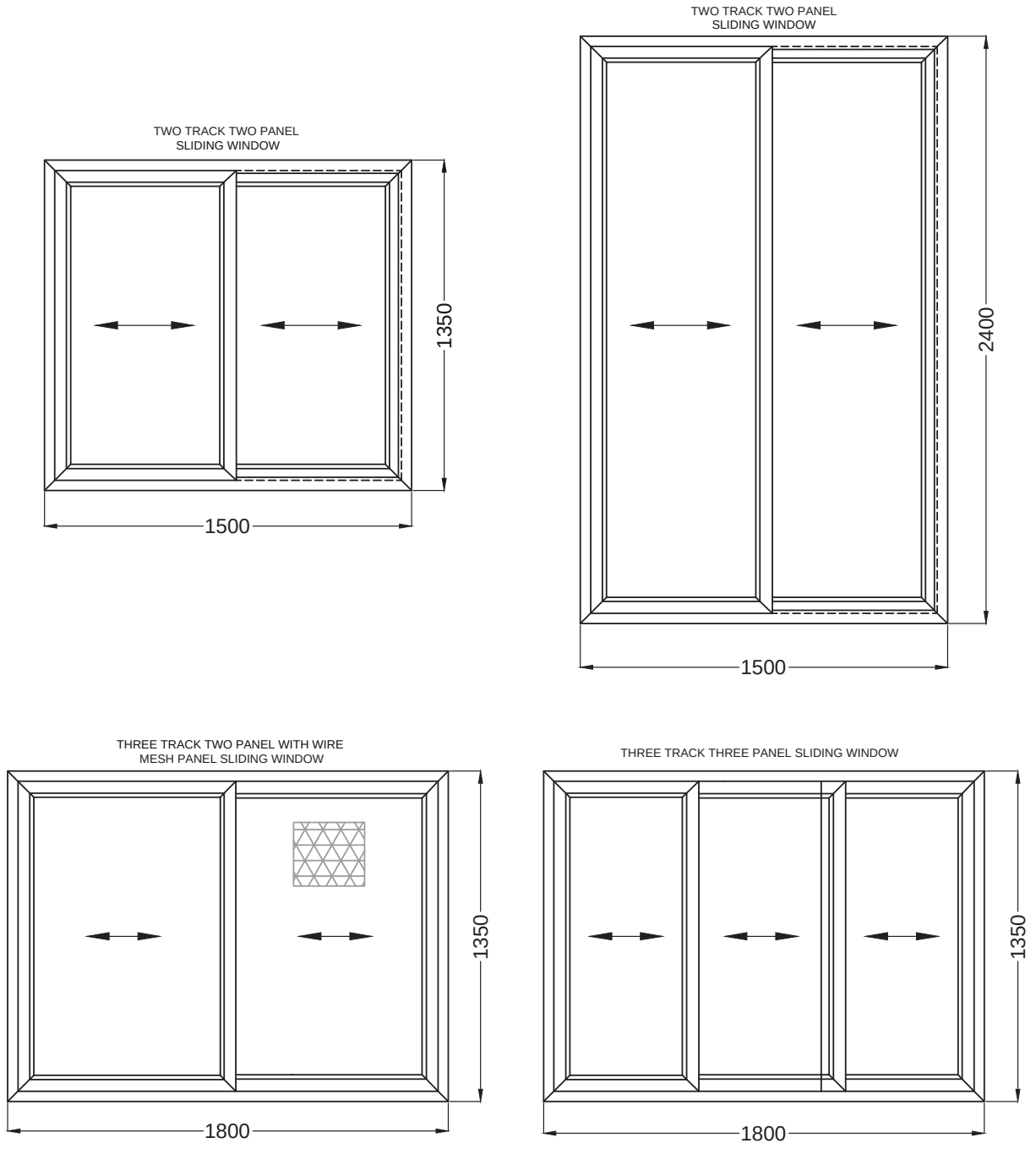


Fig. 9.32: uPVC Doors and Windows

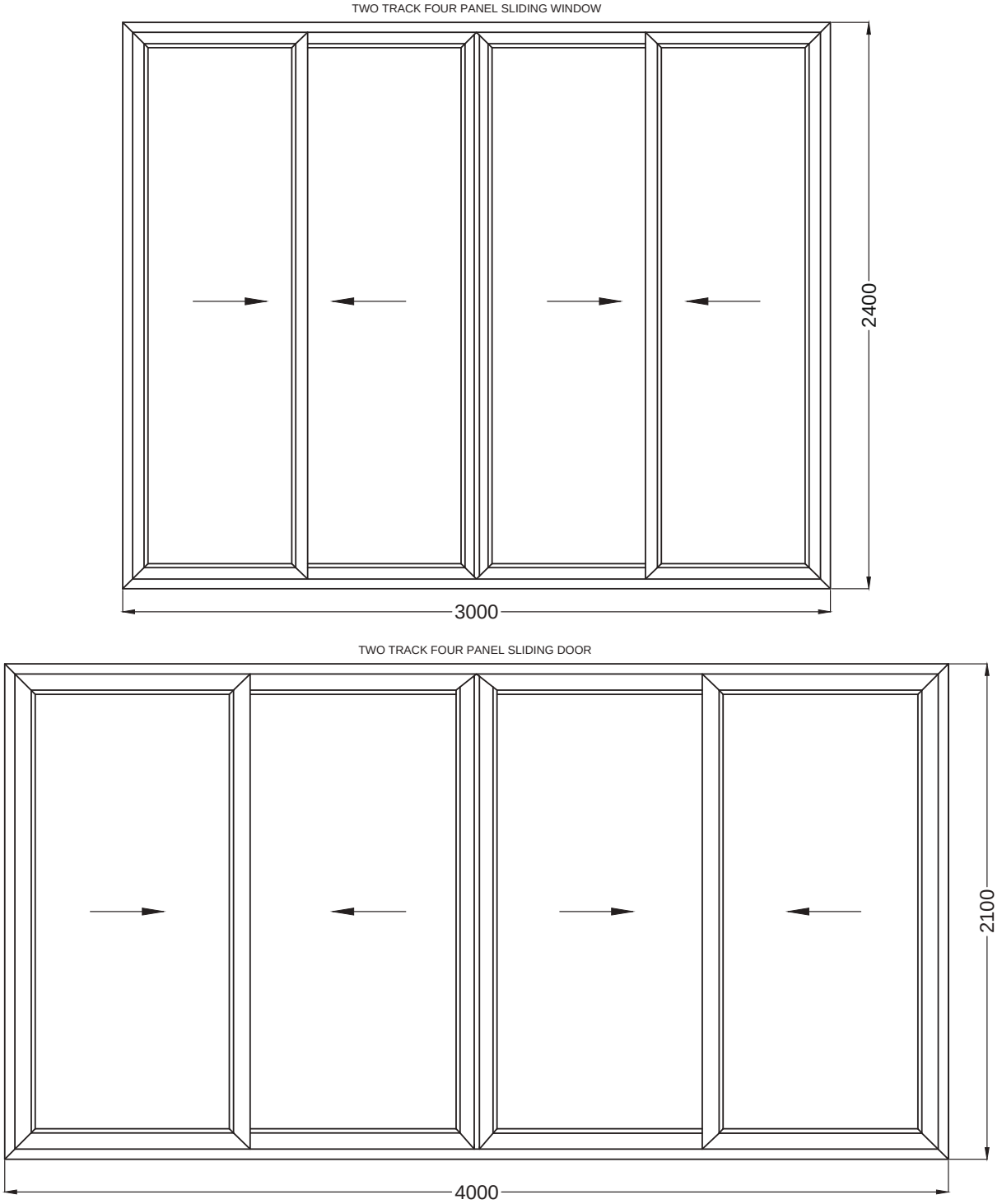


Fig. 9.33: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

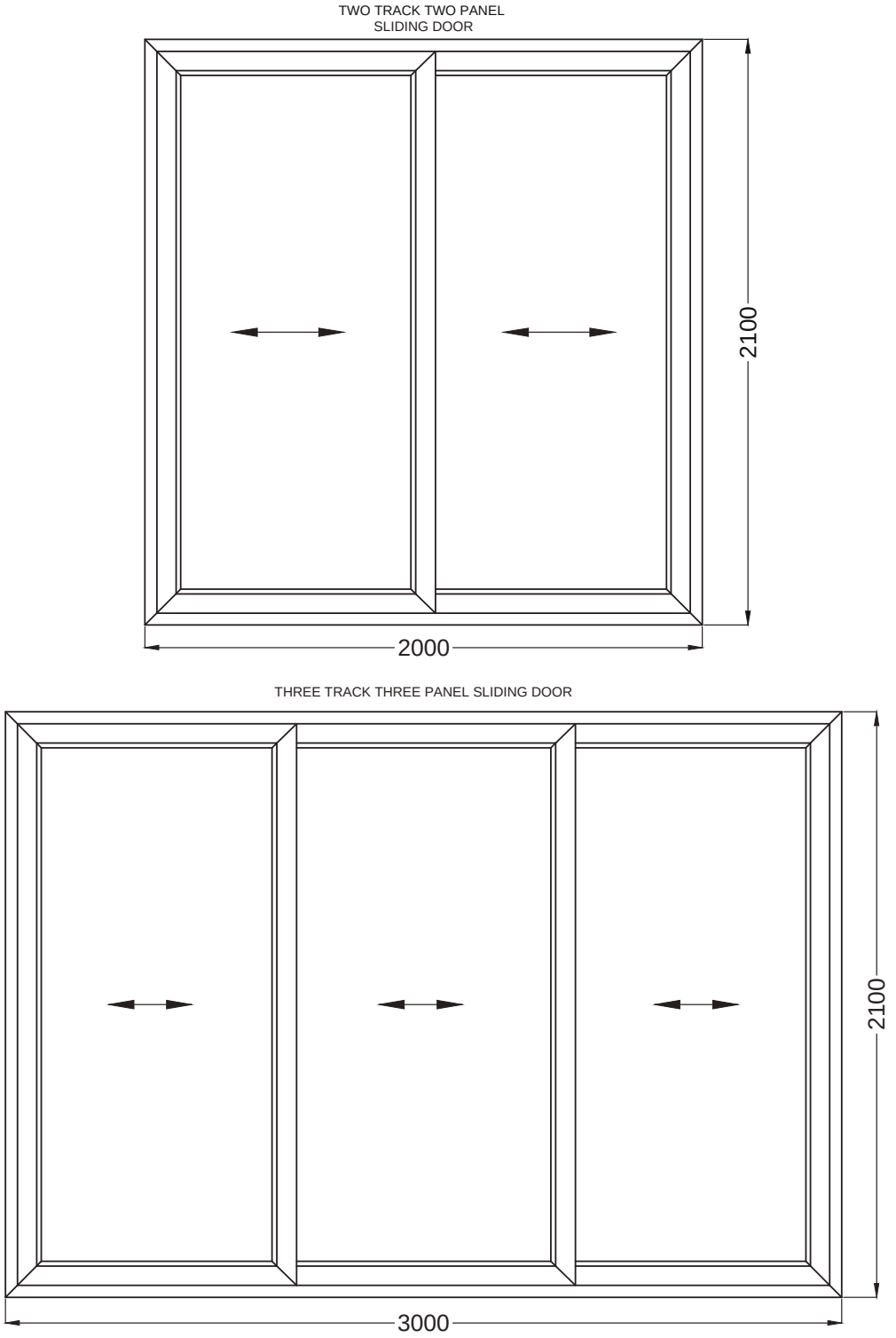


Fig. 9.34: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

THREE TRACK TWO PANEL WITH
WIRE MESH PANEL SLIDING DOOR

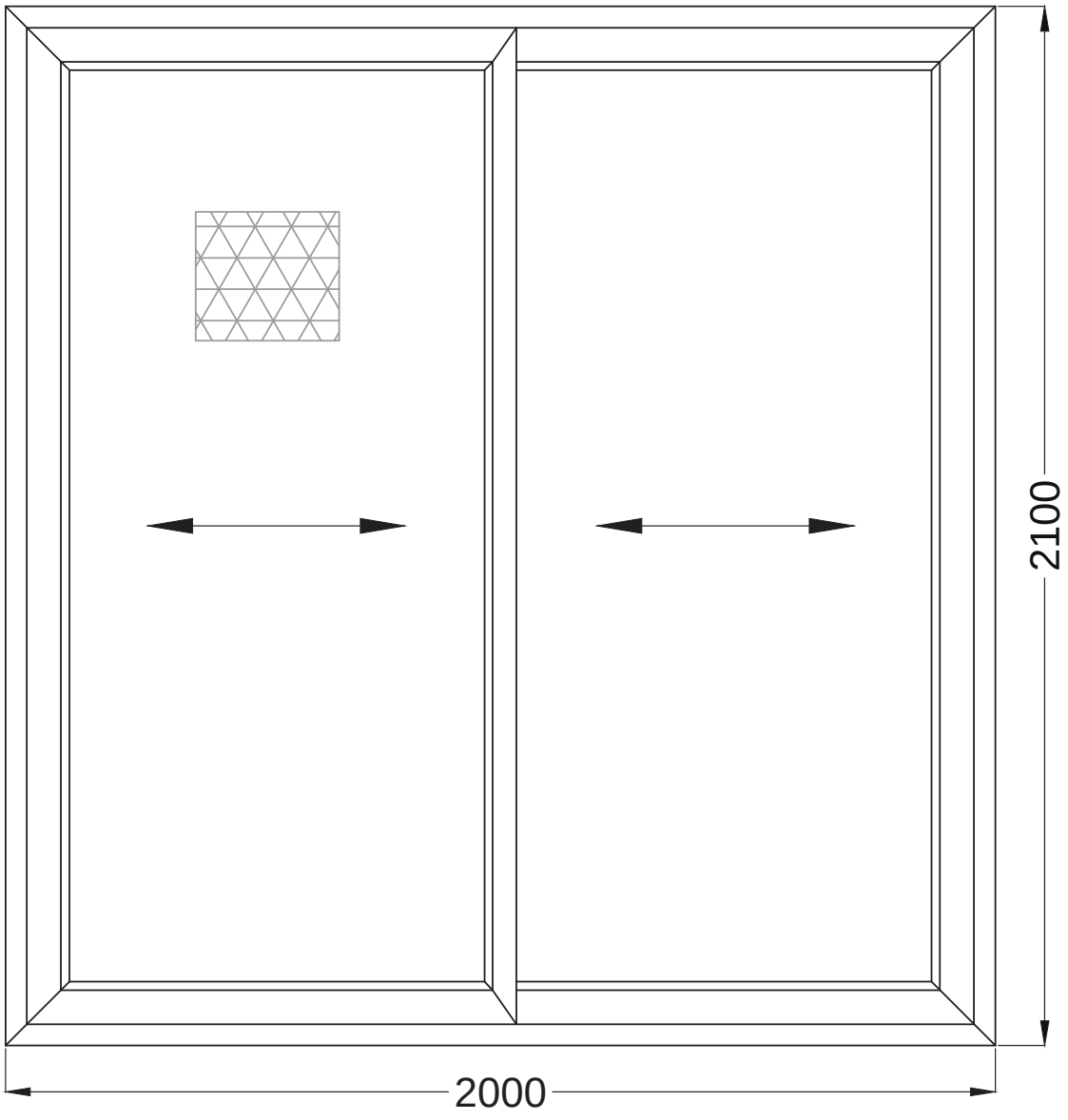


Fig. 9.35: uPVC Doors and Windows

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

TYPICAL CASEMENT SYSTEM

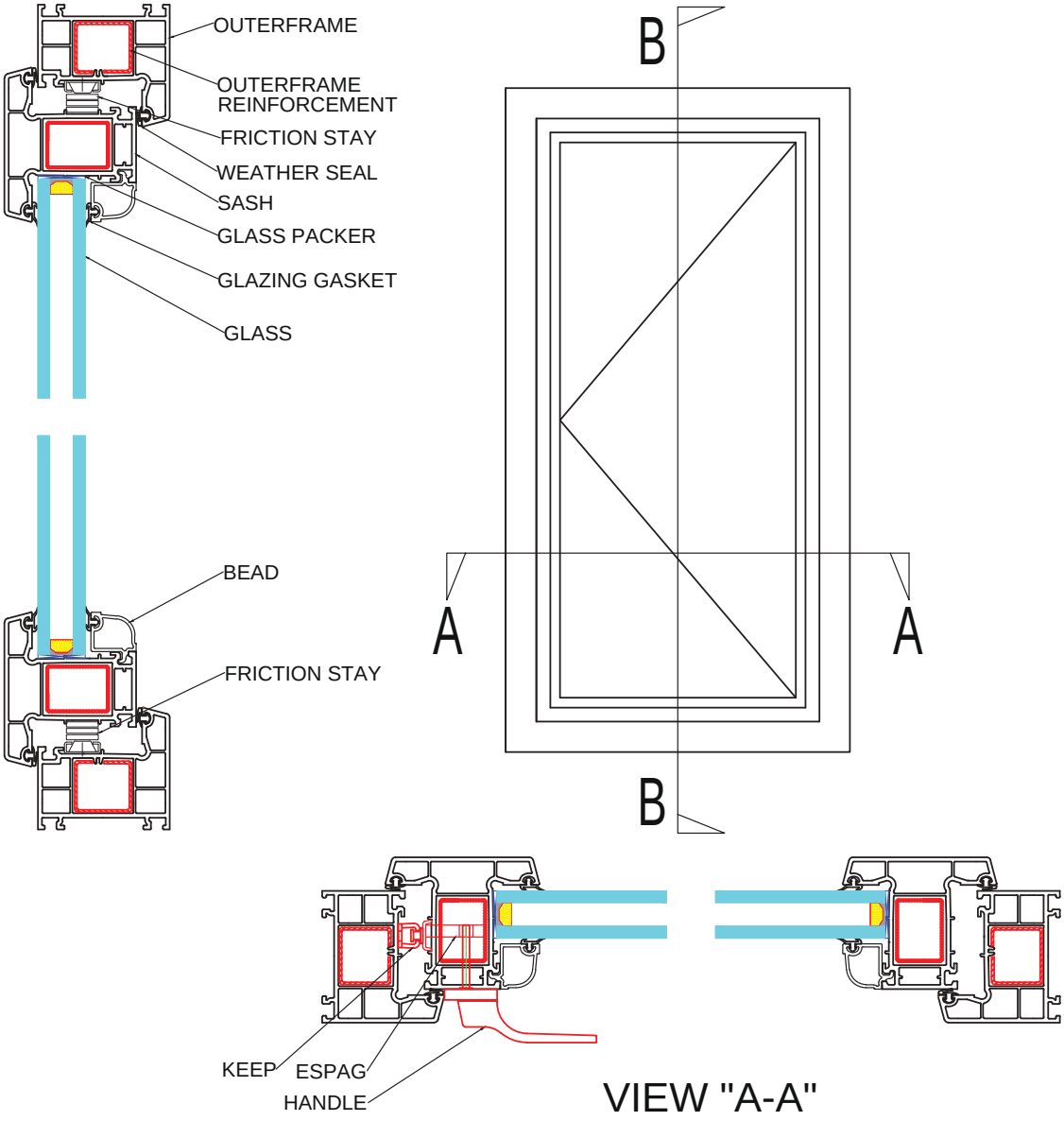


Fig. 9.36: uPVC Doors and Windows (Typical casement system)

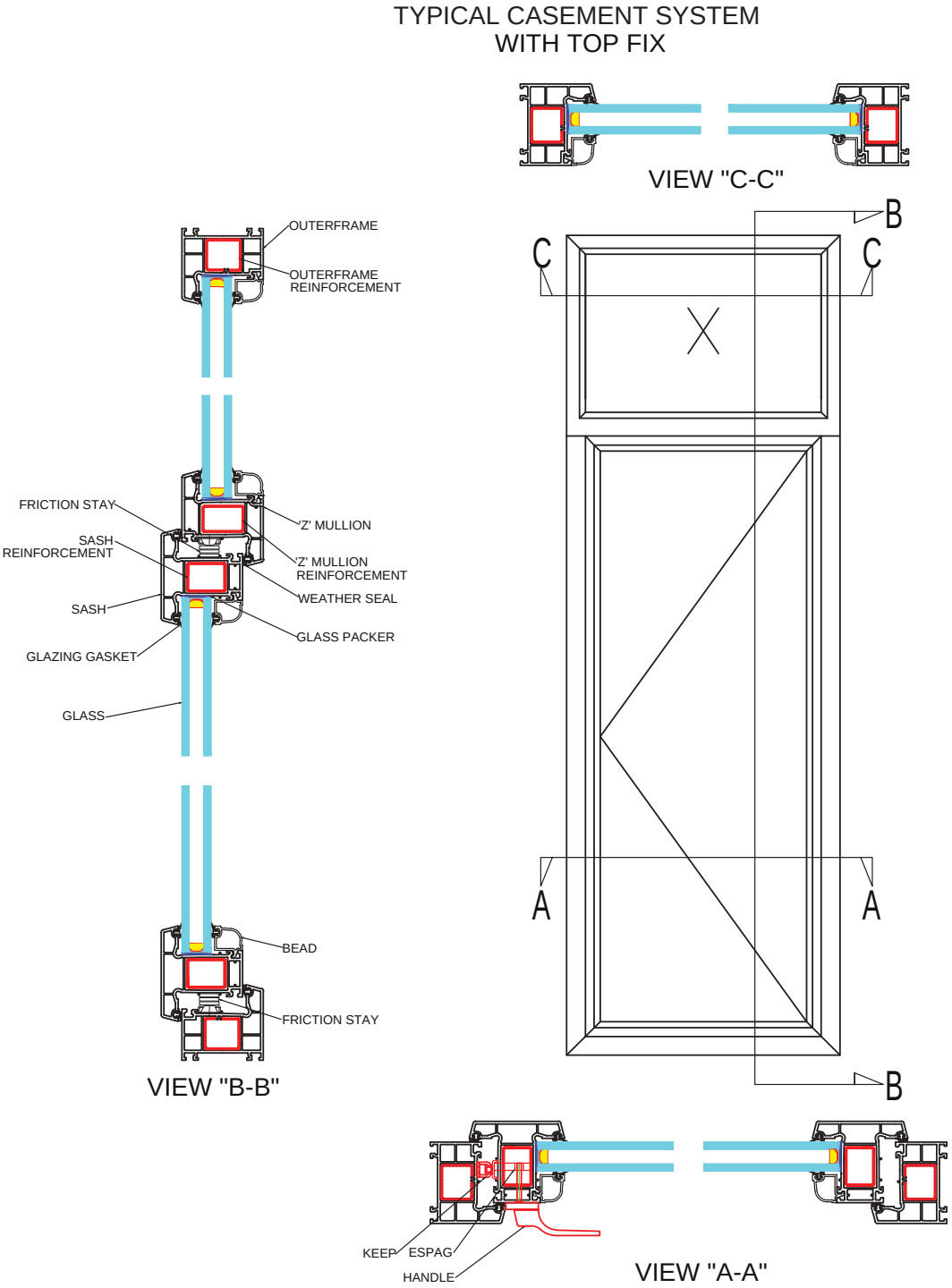


Fig. 9.37: uPVC Doors and Windows (Typical casement with top fixed system)

uPVC DOOR AND WINDOWS

SUB HEAD : WOOD WORK & PVC WORK
CLAUSE : 9.28

TYPICAL SLIDER SYSTEM

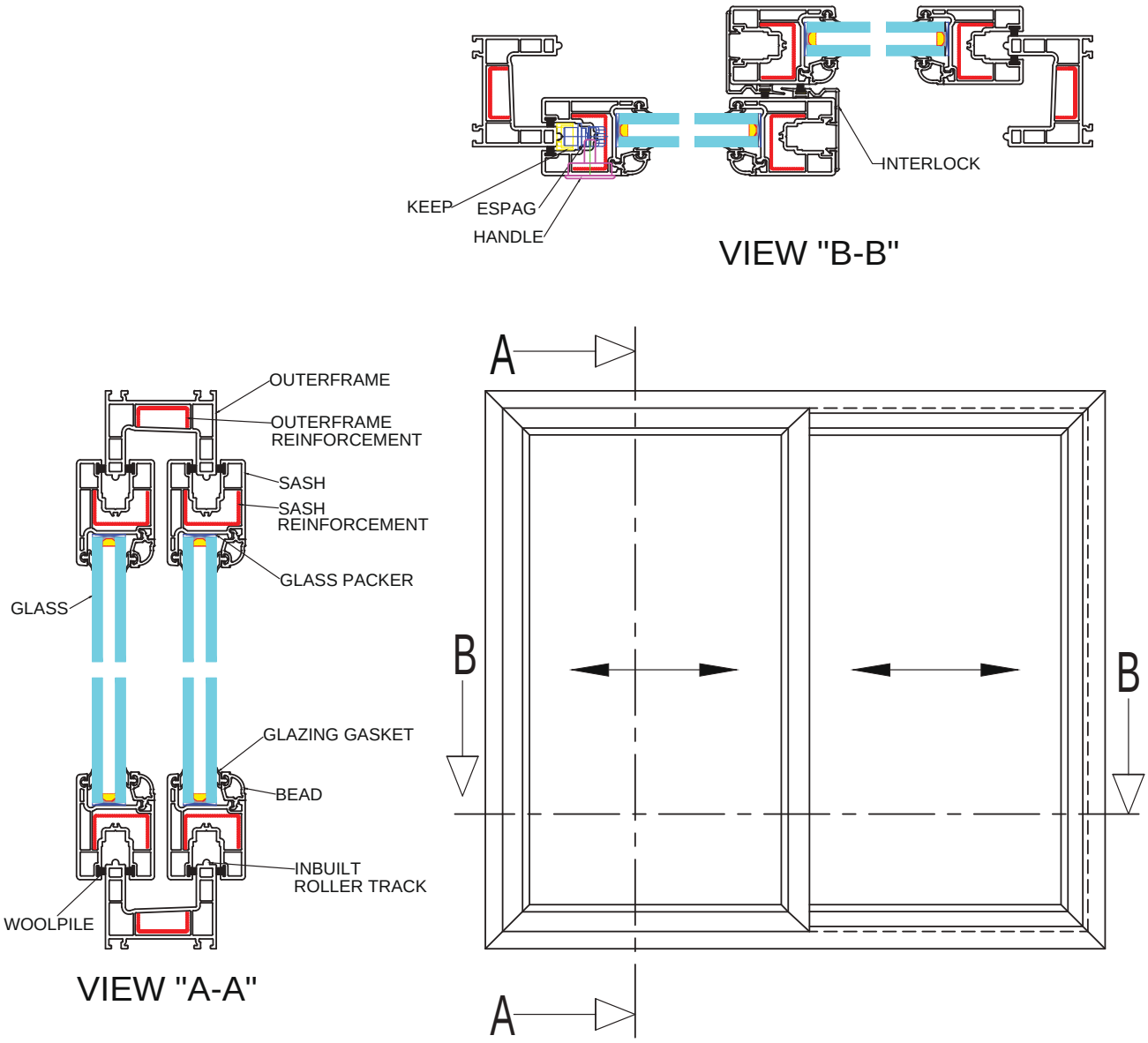
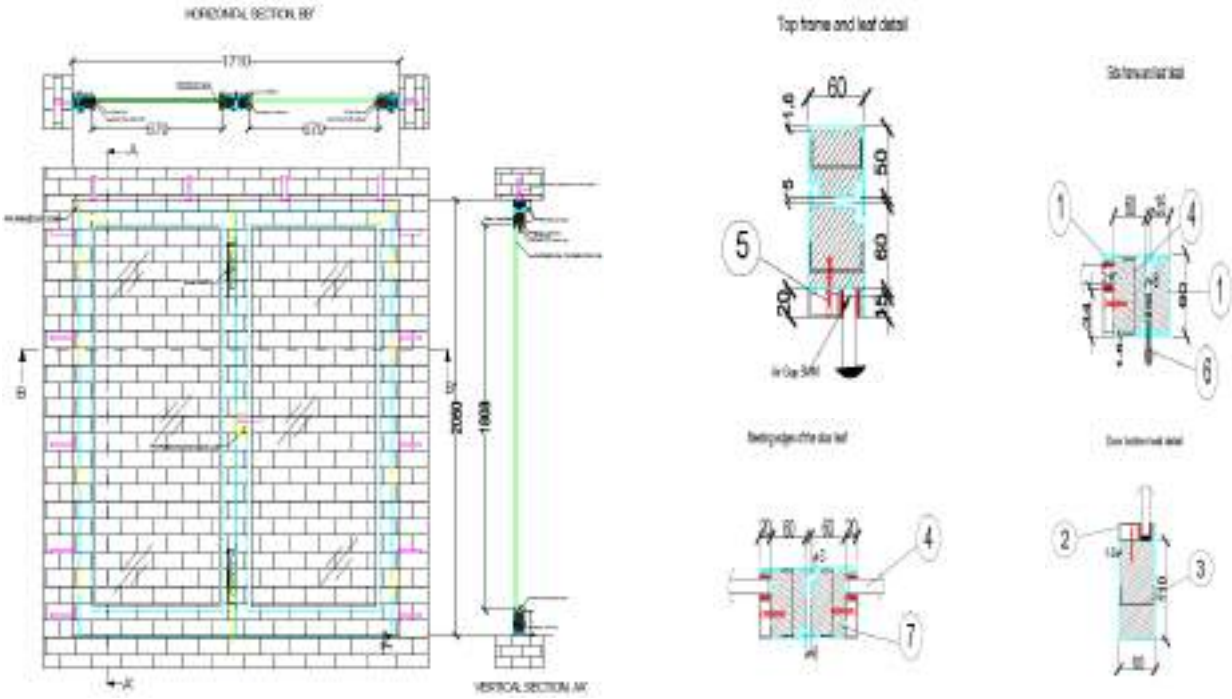


Fig. 9.38: uPVC Doors and Windows (Typical slider system)

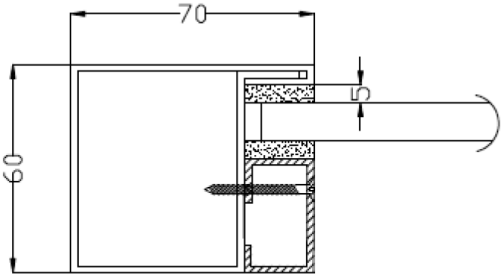
FIRE RATED DOOR/WINDOW/PARTITION

Sub Head: Wood work and PVC Work
Clause: 9.29



Glass					
Sl. No	Type	Glass	Thickness	Size	Quantity
1	Double leaf door	Clear toughened interlayer fire rated glass	11 mm	679mmx1808mm	2

Partition section



1. Door frames and leaf: 1.6 mm thick GI sheet.
2. Glazing bead: 1.6 mm thick GI sheet.
3. Stiffeners: 1.6 mm thick GI sheet.
4. Glass: Clear toughened interlayer fire rated glass.
5. Beading screw: M4x35 mm @ 150mm (approx) C/C.
6. SS ball bearing butt hinges 100x89x3 mm.
   Ceramic wool infill (Density – 96 kg/m^3)

Fig. 9.39 Detail of Fire rated Door/Window/Partition

SUB HEAD : 10.0

STEEL WORK

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	473
	List of Bureau of Indian Standards Codes	475
10.0	Definitions/Terminology	477
10.1	Materials	477
10.2	Steel Work in Single Section Fixed Independently with Connecting Plate	479
10.3	Steel Work in Built up Section (Riveted and Bolted)	480
10.4	Steel Work in Built up Section (Welded)	483
10.5	Collapsible Steel Gates	485
10.6	M.S. Sheet Sliding Shutter	485
10.7	M.S. Sheet Shutters	486
10.8	Rolling Shutters	487
10.9	Rolling Grills -Shutters	489
10.10	Steel Doors, Windows, Ventilators & Composite Units	489
10.11	T-Iron Doors, Windows & Ventilators Frames	494
10.12	Pressed Steel Door Frames	495
10.13	Tubular Hollow Section Trusses	497
10.14	Fan Clamps	498
10.15	M.S. Hollow Rectangular Door Frames (I-Type Section)	499
10.16	Factory Made Glazed Steel Doors, Windows and Ventilators	500
10.17	Steel Work for Staircases, Chequred Plate, Grating, Ladder, Railings, Bracket and Gate etc.	501

10.18	Steel Work for Hand Rails	501
10.19	Dash fasteners	501
10.20	Stainless Steel Railing	502
10.21	Fly proof wire gauze	502
10.22	Glass panes with putty and Glazing clips	503
10.23	Angle iron frames for doors, windows and ventillators	504
Appendix A	Mechanical Properties and Chemical Composition of Steel	506
Appendix B	Welding Process	509
Appendix C	Steel Tubes for Structural Purposes	510
Appendix D	Shapes, Weights and Designation of M S Rolled Steel Section	511
Fig. 10.1	Welds and Rivets	514
Fig. 10.2	Collapsible Steel Gate	515
Fig. 10.3	Typical M.S. Sheet Shutters	516
Fig. 10.4, 10.5 & 10.6	Doors, Windows and Ventilators	517 – 519
Fig. 10.7	Fixing Butt Hinges to T-Iron Frame with M.S. Flat Welded to Frame	520
Fig. 10.8	Pressed Steel Door & Window Frames	521
Fig. 10.9	Fan Clamps	523

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ laboratory test*	*Test procedure*	*Min. quantity of material for carrying out the test*	*Frequency of testing*
1	*2*	*3*	*4*	*5*	*6*	*7*
Steel if arranged by the contractor	10.1.1	(a) Tensile strength (b) Bend test	Laboratory	IS 1599	20 tonne	Every 20 tonne or part thereof.
Steel tubular pipes	10.13	(a) Tensile Test (b) Bend Test (c) Flattening Test	Laboratory	IS 1608 IS 2329 IS 2328	Every 8 tonne or part thereof	Every 8 tonne or part thereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	*Code No.*	*Subject*
1	IS 63	Whiting for paints and putty
2	IS 198	Varnish gold size
3	IS 228	Structural steel (Standard quality)
4	IS 277	Specification for galvanized steel sheets (Plain and corrugated)
5	IS 419	Putty for use on window frames
6	IS 800	Code of practice for use of structural steel in general in steel construction
7.	IS 806	Code of practice for use of steel Tubes in general building construction
8.	IS 808	Dimensions for Hot rolled steel beams, columns, channel and angle sections
9.	IS 812	Glossary of terms relating to welding and cutting metals
10	IS 813	Scheme of symbols for welding
11	IS 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
12	IS 816	Code of practice for use of metal arc welding for general construction in mild steel
13	IS 817	Code of practice for training and testing of metal arc welders
14	IS 818	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations
15	IS 822	Code of procedure for inspection of welds
16	IS 823	Manual for metal arc welding in mild steel
17	IS 1038	Steel doors, windows and ventilators
18	IS 1081	Code of practice for fixing and glazing of metal (Steel and aluminium) doors, windows and ventilators
19	IS 1148	Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes
20	IS 1161	Steel tubes for structural purposes
21	IS 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
22	IS 1200- (Pt. VIII)	Method of measurements of steel work and iron works
23	IS 1363 Part I	Haxagon head bolts, screws, and nuts of product grade C (Hexagon Head bolt)
24	IS 1363 Part II	Haxagon Head Bolts, screws and nuts of product Grade 'C'

25	IS 1363 Part-III	HaxaganM Head Bolts, screws and Nuts of product grade ‘C’
26	IS 1367	Technical supply conditions for threaded steel fasteners
27	IS 1568	Wire cloth for general purposes
28	IS 1599	Method for bend test
29	IS 1608	Metallic materials – Tensile Testing at Ambient Temperature.
30	IS 1730	Dimensions for stainless steel plates, sheets strips and flats for general engineering purposes
31	IS 1821	Dimensions for clearance holes for bolts and screws
32	IS 1852	Rolling and cutting tolerance for hot rolled steel products
33	IS 1894	Method for tensile testing of steel tubes
34	IS 1977	Structural steel (ordinary quality)
35	IS 2062	Hot Rolled low, medium and high tensile structural steel
36	IS 2074	Ready mixed paint, air drying redoxide zinc chrome priming
37	IS 4351	Specification for steel door frames
38	IS 4454 (Part I)	Steel wires for mechanical springs. Cold drawn unalloyed steel wire.
39	IS 4711	Methods for sampling of steel pipes, tube and fittings.
40	IS 4736	Hot – dip zinc coating on mild steel tubes
41	IS 4923	Hollow Steel Sections for Structural Use - Specification
42	IS 6248	Metal rolling shutters and rolling grills
43	IS 6911:2017	Stainless steel plate, sheet and strip
44	IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators.

10.0 STEEL WORK

10.0 DEFINITIONS/ TERMINOLOGY

Bead

A single run of weld metal deposited on surface.

Butt Weld

A weld in which the weld metal lies substantially within the extension of the planes arc the surfaces *on* the parts joined.

Crater

A depression left in weld metal where the *arc* was broken or the flame was removed.

End Crater

A crater at the end of a weld or at the end of a joint.

Fillet Weld

A weld of approximately triangular cross-section joining two surfaces approximately at the right angles to each other in a lap joint, tee joint or corner joint. It is of two types:

(1) Continuous
(2) Intermittent.

Fusion Welding

Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

Non- fusion Welding

A term applied to the deposition, by the Oxy-Acetylene process of filler metal on parent metal without fusion of the latter.

Oxy-Acetylene Pressure Welding

Pressure welding in which any Oxy-Acetylene flame is used to make the surface to be united plastic. No filler metal is used.

Run

The metal deposited during one passage of the electrode or blow pipe in the making of a joint.

Throat thickness

See Fig. 10.1.

Weld

A union between two pieces of metal at faces rendered plastic or liquid by heat or pressure, or both, Filler metal may be used to effect the union.

10.1 MATERIALS

Micro-Alloying Elements

Elements such as niobium, boron, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio and better toughness, formability and weldability as compared to unalloyed steel of similar strength level.

Weldability

A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

Controlled Rolling

A hot rolling process in which the temperature of the steel and its reduction ratio are controlled, particularly during the final rolling passes, in order to achieve fine grain micro structure and optimum mechanical properties.

Normalizing Rolling

A hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

10.1.1 Steel

10.1.1.1 ***Supply of Material*** **:** General requirements relating to supply of structural steel shall conform to IS 8910.

10. 1.1.2 ***Grades :*** There shall be nine grades of steel as given in Tables 10.1 and 10.2. While placing the order the steel should be designated by 'Designation' (See Table 10.1 and 10.2).

10.1.1.3 ***Manufacture :*** The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/ supplier.

10.1.1.4 ***Freedom from Defects***

10.1.1.4.1 All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects.

10. 1.1.4.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the purchaser and manufacturer/supplier.

10.1.1.4.3 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in 10.1.1.4.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that :

(a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20 percent at any place.
(b) Welding is carried out by procedure APPROVED by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness; and
(c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's discretion.

10.1.1.4.4 Welding as mentioned in 10.1.1.4.3 is not permissible for grade designation E 250 material.

10. 1.1.5 ***Chemical Composition :*** Ladle Analysis the ladle analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established instrumental /chemical method, shall be as given in Table 10.1. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

10.1.2 Rivets

Rivets shall be made from rivet bars of mild steel as per IS 1148.

10.1.3 Bolts

These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367 – Technical supply conditions for threaded steel fasteners.

10.1.4 Electrodes

The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

10.2 STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE

10.2.0 The steel work in single section of R.S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

10.2.1 Fabrication

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

10.2.2 Painting

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

10.2.3 Erection

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-charge.

10.2.4 Measurements

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separaters, diaphgram gussets (taking overall square dimension) fish plates, etc. shall

be added to the weight of respective items. In riveted work allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.

No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts).

Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 Kg/m^2 for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

10.2.5 Rate

Rate includes the cost of labour and materials required for all the operations described above.

10.3 STEEL WORK IN BUILT UP SECTIONS (RIVETED AND BOLTED)

The steel work in built up section (Riveted and bolted) such as trusses, framed work etc. is specified in this clause.

10.3.1 Laying Out

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

10.3.2 Fabrication

Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

10.3.2.1 The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No tow pieces shall be welded or joined to make up for the required length of member.

10.3.2.2 ***Making Holes :*** Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

Rivet Holes

The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25 mm" and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

10.3.2.3 ***Assembly :*** Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members *requiring c* ontact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

10.3.2.4 ***Riveting :*** Rivets shall be used, where slip under load has to be avoided.

Preliminaries before Rivetings:- Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

Process of Riveting

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in -charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly.

All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets.

All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

10. 3.2.5 ***Bolting :*** The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the

screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-charge.

10.3.3 Erection

10.3.3.0 Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

10.3.3.1 The work of erection may be done in suitable units as may be directed by the Engineer-in-charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means.

During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

10.3.3.2 Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

10.3.3.3 Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

10.3.3.4 Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base

plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

10.3.3.5 ***Bedding of Column, Stanchions etc*****.:-** Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoreyed buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts.

With small columns, if permitted by the Engineer-in-charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

10.3.4 Painting

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified in 10.2.2.

10.3.5 Measurements

The work as fixed in position shall be measured in running metres correct to a millimeter and their weight calculated on the basis of standard tables correct to the nearest kilogram.

The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerenace in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m^2.

The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m^2 for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

10.3.6 Rate

The rate shall include the cost of all materials and labour involved in all the operation described above.

10.4 STEEL WORK IN BUILT UP SECTION (WELDED)

10.4.0 The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

10.4.1 Laying out

It shall be as specified in 10.3.1.

10.4.2 Fabrication

10.4.2.1 Straightening, shaping to form, cutting and assembling, shall be as per 10.3.2 as far as applicable, except that the words “riveted or bolted” shall be read as “welded” and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

10.4.2.2 ***Welding :*** Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only by resorted to using oxyacetylene flame with specific approval of the Engineer-in- charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813.

As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

10.4.2.3 ***Precautions :*** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

10.4.2.4 Operation, Workmanship and process of Welding is described in Appendix B,

10.4.2.5 Inspection and testing of welds shall be as per IS 822.

10.4.2.6 ***Assembly :*** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

10.4.2.7 ***Erection :*** The specification shall be as described in 10.3.3 except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

10.4.2.8 ***Painting :*** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified in para 10.2.2.

10.4.3 Measurements

The mode of measurements shall be the same as specified in 10.2.4 except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

10.4.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

10.5 COLLAPSIBLE STEEL GATES

10.5.0 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

10.5.1 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

10.5.2 Fixing

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centres alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T -iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee -section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

10.5.3 Painting

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

10.5.4 Measurements

The height and breadth shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square metres, correct to two places of decimal.

10.5.5 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

10.6 M.S. SHEET SLIDING SHUTTER

10.6.0 These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheets.

10.6.1 The shutters shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted / welded together with 3mm gusset plate at junction to form a rigid frame. M.S. sheet of 1 mm thickness or as specified shall be fixed to the frame with rivets/welds as approved by the Engineer- in-charge. These shall also be provided with top and bottom guide rails of specified size angles or T- irons and 25 mm diameter pulley or with 25 mm diameter ball bearing at the bottom and guide block with steel

pulleys at the top. The shutters shall also be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of the item.

The guide rails shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can rest against the walls, giving full opening when so required.

10.6.2 Fixing

The guide rails shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitable fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

All the adjoining work damaged in fixing shall be made good to match the existing work.

10.6.3 Painting

All members of the sliding shutters including fittings shall be thoroughly cleaned of rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red oxide zinc chrome primer conforming to IS 2074 before fixing them in position.

10.6.4 Measurements

The height and width shall be measured correct to a cm and its area for payment shall be calculated in square metres correct to two places of decimal. The height of the shutter shall be measured from outside to outside of the guide rail and width out side to out side of the shutter including the vertical position channels in sides, when shutter closed.

10.6.5 Rate

The rate shall include the cost of materials and labour involved in all the operation described above. It also includes the cost of the full length of guide rails.

10.7 M.S. SHEET SHUTTERS

10.7.0 These shall be manufactured as per drawing and specification. These shall be fabricated from mild steel sheets and angle iron.

10.7.1 The doors shall be provided as double leaf shutters unless otherwise specified . The shutters shall be fabricated with frame of M.S. angle 40 x 40 x 6 mm @ 3.5 kg/ metre and two diagonal braces of the same section as shown in Fig. 3 unless otherwise specified. The frame shall be riveted and/ or welded at the junctions. Wherever riveting shall be done 3.15 mm (10 G) thick gusset plate shall be provided at the junction. M.S. sheet of 1 mm thickness or as specified, shall be fixed to the frame with rivets or welds as approved by the Engineer-in-charge.

Alternatively the diagonal bracing may be replaced by one horizontal and two cross flats 30 x 6 mm as shown in Fig. 10.3 unless otherwise specified.

The outer frame shall be provided with cleats made of section 40 x 10 mm and bent in the shape of angle cleats with one arm 150 mm long and the other arm 50 mm long and fixed to the angle iron frame of the door with two 12 mm dia bolts and nuts. For doors upto 2.40 m height, two angles cleats per door shall be provided.

The cleat shall have a vertical leg of 150 mm which shall be fixed with frame and horizontal leg of about 50 mm which shall be provided with a hole of 24 mm dia and fixed in the projected pin of the pin clamp.

10.7.2 Fittings and Fixtures

The shutters shall be fixed to the wall masonry with four pin clamps (pintles) where the height of the shutter is upto 2.4 m. Each pin clamp shall consist of 50 x 6 mm flat iron 45 cm long bent and forked at one end and provided with 20 mm diameter M.S. pin on the other. The pin shall be firmly riveted or welded to the pin clamp, the other end of which shall be embedded in masonry by means of cement

concrete block 40 x 23 x 20 cm of 1:3:6 mix (1 cement :3 coarse sand:6 graded stone aggregate 20 mm nominal size). It shall be so placed that bottom pin shall face upwards and “top pin downward”in order that the gate may not be removed by lifting over pins.

One hook with eye 45 cm long of 10 mm diameter shall be provided for each shutter to keep it fixed in open position. The hook shall be fixed in wall masonry with wooden block and the eye shall be fixed on 6 mm thick M.S. plate as staple and fixed in the shutter frame with rivet or weld.

A cement concrete block 15 x 10 x 20 cm in 1:2:4 (1 cement:2 coarse sand:4 grades stone aggregate of 20 mm nominal size) mix shall be embedded in the floor or at junction of two shutters so that door shutter open only on the outside and not on the inside.

The shutters shall also be provided with locking arrangement and two handles of the shape and pattern as approved by the Engineer-in-charge.

10.7.3 Painting

All the members of the door including angle iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red Oxide/ Zinc chrome primer confirming to IS 2074 before fixing them in position.

10.7.4 Measurements

The width and height of shutters shall be measured to the nearest cm. The area shall be calculated in square metre correct to two places of decimal.

10.7.5 Rate

The rate shall include the cost of materials and labour involved in all the operation described above. Nothing extra shall be paid for cement concrete block or wooden blocks nor anything deducted for these from the measurement of the masonry wall.

10.8 ROLLING SHUTTERS

10.8.1 Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters upto 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

10.8.1.1 ***Shutter :*** The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90 mm for the shutters upto 3.5 m width. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

10.8.1.2 ***Spring :*** The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I .

10.8.1.3 ***Roller and Brackets :*** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 metre width and height not exceeding 5 metre, steel pipes of 50 mm nominal bore shall be used. The shaft shall be supported on mild steel

brackets of size 375 x 375 x 3.15 mm for shutters upto a clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5 m and upto 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

10.8.1.4 When the width of the opening is greater than 3.5 mtr. The cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

10.8.1.5 In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

10.8.1.6 ***Guide Channel :*** The width of guide channel shall be 25 mm the minimum depth of guide channels shall be as follows:

Clear width of shutters	*Depth of guide channel*
Upto 3.5 m	65 mm
3.5 m upto 8 m	75 mm
8 m and above	100 mm

10.8.1.7 The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

10.8.1.8 Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

10.8.1.9 The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

10.8.1.10 ***Cover :*** Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

10.8.1.11 Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

10.8.2 Fixing

The arrangement for fixing in different situations in the opening shall be as per IS 6248.

10.8.2.1 Brackets shall be fixed on the lintel or under the lintel as specified with rawl. Plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

10.8.2.2 The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen like manner that the operation of the shutter is easy and smooth.

10.8.3 Measurements

Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

10.8.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

10.9 ROLLING GRILLS – SHUTTERS

10.9.0 Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter- cum-grill shall not exceed 1.0 m and the height of the grill portion in any individual segment shall not be more than 0.5 m.

10. 9.1 Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 10.8 shall be applicable to rolling grills shuters except in respect of the shutter portion, and shall conform to IS 6248.

10.9.2 Shutters

Rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150 mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120 mm and the depth of corrugation is 80 to 100 mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughs of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

10.9.3 Measurement & Rate

The measurement and rate shall be as specified in 10.8.3 and 10.8.4 respectively. In case of Rolling Shutter-cum-Grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

10.10 STEEL DOORS, WINDOWS, VENTILATORS AND COMPOSITE UNITS (Fig. 10.4)

Hot rolled steel sections for fabrication of steel doors, windows, ventilators and fixed lights shall conform to IS 7452. Shapes weights and designations of hot rolled sections shall be as per IS 7452. Appendix 'D' indicates the purpose or the situation where the sections are normally used. Tolerance in thickness of the sections shall be + 0.2 mm. The fabricated steel doors, windows, ventilators and composite units shall confirm to IS 1038 with up-to-date amendments and shall be IS marked (IS 1038).

10.10.1 The steel doors and windows shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening. The actual sizes of doors, windows and ventilators shall not vary by more than + 1.5 mm from those given in the drawing.

10.10.2 Fabrication

10. 10.2.1.1 *Frames :* Both the fixed and openable frames shall be made of sections which have been cut to length and mitred. The corner of fixed and openable frames shall be welded to form a solid fused welded joint conforming the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flush but welding or can be any other process as agreed to between the supplier and the purchaser which shall fulfil the requirements given in clause 6.1.1 of IS 1038, metal arc welding or any other suitable method. The section for glazing shall be tennoned and riveted into the frames and where they intersect the vertical tie shall be broached and horizontal tee threads through it, and the intersection closed by hydraulic pressure.

10.10.2.1.2 *Requirements of Welded Joints*

(i) **Visual Inspection Test:** When two opposite corners of the frame are cut, paint removed and inspected, the joint shall conform to the following:-
   (a) Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.
   (b) Welds should have been properly grounded and
   (c) Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

(ii) **Micro and Macro Examinations:** From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and cavity and reasonably free from under cutting overlaps, gross porosity and entrapped slag.

(iii) **Fillet Weld Test:** The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

10.10.2.2 ***Doors :*** The hinges shall be of 50 mm projecting type, Non projecting type hinges may also be used, if approved by Engineer-in -Charge. The hinge pin shall be of electro -galvanized steel or aluminum alloy of suitable thickness and size. Door handles shall be approved by the Engineer-in-Charge. A suitable latch lock for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have a concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double leaf shutter door may be provided with a three way bolting device. Where the device is provided in the case of double leaf shutters, concealed brass or steel bolts shall not be provided.

10.10.2.3 ***Windows***

(a) For fixed windows, the frames shall be fabricated as per 10.10.2.1.1.
(b) Side hung windows.

For fixing steel hinges, slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type with thickness not less than 3.15 mm and length not less than 65 mm and width not more than 25 mm. Non projecting type hinges may also be allowed if approved by the Engineer- in-Charge. The diameter of hinge pins shall not be less than 6 mm. The hinge pin and washer shall be of galvanized steel or aluminum alloy of suitable thickness.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned, or the holes made in the inside frame and hinge riveted.

The handle of side hung shutters shall be pressed brass, cast brass, aluminium or steel protected against rusting and shall be mounted on a steel plate. Thickness of handle shall not be less than 3 mm in case of steel or brass and 3.5 mm in case of aluminium. The handle plate shall be welded, screwed and/ or revitted to the opening frame in such a manner that it should be fixed before the shutter is glazed and should not be easily removable after glazing.

The handle shall have a two point nose which shall engage with a brass or aluminium alloy striking plate on the fixed frame in a slightly opened position as well as closed position. The boss of handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin.

The height of the handle plate in each type of standards windows will be as specified, otherwise it shall be at a height of 3/8 of the height of shutter, from its bottom. The strike plate shall be so designed and fixed in such a position in relation to the handle that with the later bearing against its stop, there shall be adequately tight fit between the casement and outer frames.

In case where no friction type hinges are provided, the windows shall be fitted with peg stays which shall be either of black oxidised steel, pressed or cast brass or as specified, 300 mm long or as specified with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles. The peg stay shall be of minimum thickness 2 mm in case of brass or aluminium and 1.25 mm in case of steel. Where specified friction hinges shall be provided. Side hung shutters fitted with friction hinges shall not be provided with a peg stay.

If specified, side hung shutters may be fitted with an internal removable fly proof screen in a 1.25 mm thick sheet steel frame to the outer frame of the shutter by brass turn buckles at the jambs, and brass studs at the sill to allow the screen being readily removed. The windows with removable fly proof screen shall be fitted with a through – the screen level operator at the sill level to permit the operation of the shutter through an angle of 90° without having to remove the fly proof screen. The lever shall permit keeping the shutter open in minimum three different positions.

10.10.2.4 *Ventilators*

(a) Top Hung Ventilators

The steel butt hinges for top hung ventilators shall be riveted to the fixed frame or welded to it at the back after cutting a slot in it. Hinges to the opening frame shall be riveted or welded.

Top hung ventilators shall be provided with a peg stay with three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frames or to the window.

(b) Centre Hung Ventilators

Central hung ventilators shall be hung on two pairs of brass or aluminium cup pivots as specified, riveted to the inner and outer frames of ventilators to permit the ventilator shutter to swing to angle of approx 85°. The opening portion of the ventilators shall be so balanced that it remains open at any desired angle under normal weather conditions.

10.10.2.4.1 A black oxidised steel spring catch approved by the Engineer-in-Charge shall be fitted in the centre of the top of the centre hung ventilator, for the operation of ventilators. The spring catch shall be secured to the frame with M.S. screws and shall close into a mild steel or malleable iron catch plate riveted, screwed or welded to the outside of the outer window frame bar.

10.10.2.4.2 A black oxidised cord pulley wheel in galvanized mild steel brackets shall be fitted at sill of the centre hung window with mild steel screws or alternatively welded together with mild steel or malleable iron cord-eye riveted or welded to the bottom inner frame bar of the window in a position corresponding to that of pulley.

Removable fly-proof screen may be provided as specified in 10.10.2.3 (b). This shall be fitted with a through – the screen operator to enable operating and keeping the shutter open in minimum three different positions.

10.10.2.5 ***Composite Units :*** Composite Units consist of a combination of two or more units of doors, windows and ventilators etc. as the case may be. The different units shall be coupled by using coupling sections K-11B or K-12B (Ref. Appendix D) as the case may be.

Wherever the ventilators, windows and doors shall be coupled with a coupling sections, mastic cement shall be applied between the junction to make the joint water tight.

10.10.3 Glazing

10.10.3.1 Specifications described in para 9.6.4.6 shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows and clerestory windows of bath, WC and lavatories frosted glass panes shall be used which shall weight not less than 10.00 kg/m^2.

10.10.3.2 Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS 419 shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done upto the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/ metre of glass perimetre. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.

Note: Putty may be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to the 18 kg paste.

10.10.3.3 Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

10.10.3.4 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading. Size of M.S. beading shall be 10 x 10 mm box section manufactured from 1.6 mm thick sheet unless otherwise specified in the item. Where metal beading is specified, extra payment shall be made on this account.

10.10.4 Finishing

All steel surfaces shall be thoroughly cleaned of rust, scale and dirt. Where so specified. The steel surface shall be treated for rust proofing by the hot dip, zinc spray or electro galvanizing process. A priming coat of approved steel primer i.e. red oxide/ zinc chromate perimer conforming to IS 2074 shall be given. The fabricated steel door, windows, ventilators and composite units shall be inspected in the factory and approved by the Engineer-in-charge before priming coat is applied.

Final finishing coat shall be given to the doors, windows and ventilators after they are erected and fixed in final position. The rate shall be exclusive of final finishing coats but shall include the priming coat.

10.10.5 Fixing

10.10.5.1 Steel, doors and windows shall be so stacked as to keep them in true shape without damage. Doors, windows and ventilators shall be fixed as described below.

10.10.5.2 Opening may be flush or rebated as shown in the drawing. The opening may have rendered finish or a "fair faced" finish (i.e. without rendering as in case of marble or stone facing). Where openings are flush and with a rendered finish a clearance of 1.25 cm shall be provided between the steel frame and opening (See Fig. 10.6) . In case of external masonry finish "fair faced" and with rebated jambs, a minimum 1.25 cm clearance between frame and opening shall provided (See Fig. 10.6) opening in steel work shall be so designed that the outer flange of the door, windows, or ventilator frame section overlaps the steel surface by 10 mm (see Fig. 10.6)

Note : The sizes of Indian Standard doors, windows and ventilators, are designed for modular opening 1.25 cm larger all round than the doors, windows etc. This gap of 1.25 cm is for the purpose of fixing of doors, windows etc. In masonry opening, the gap is filled up with mastic cement and plaster after the door or windows is fixed in position. In the case of steel or timber modular opening, extra steel or timber fillets will be necessary to cover this gap of 1.25 cm.

10.10.5.3 ***Fixing in Masonry Openings***

(a) *Fixing with Lugs*

(i) Doors, windows and ventilators unit, shall not be "built in" as the work proceeds but opening shall be left out and frames fitted afterwards so that the minimum specified clearance between opening and unit frame is left alround. The size of the opening shall first be checked and cleared of obstruction, if any. The position of the unit and fixing holes shall be marked on the jamb. Necessary holes shall be made in the masonry and lugs not less than 10 cm long 15 x 3 mm size M.S flat fixed in cement concrete blocks 15 x 10 x 10 cm size of 1:3:6 mix (1 cement : 3 coarse sand:6 graded stone aggregate 20mm nominal size). The frames of units shall be set in the opening by using wooden wedges at the jamb, head and sill, (wedges shall preferably be placed near the points where a glazing bar meets the frames and be plumbed in position).

(ii) After, the frame shall be fixed with the lugs with 20 mm long and 6.3 mm dia. G.I. counter sunk machine screws and nuts. In case of flush opening which are rendered smooth, wedges shall be removed and gap between unit and the jambs shall be filled with cement mortar (Fig. 10.6)

(iii) In case of flush jamb with external "fair faced" finish the gap between the opening and frame shall be filled with mastic from inside till it oozed out on eternal face. The oozing mastic shall be cleaned and flush pointed. The internal gap shall be filled with mastic to about 1/3rd depth the rest with cement mortar (Fig. 10.6).

(iv) In case of rebated jambs and jambs finished "fair faced" externally, the mastic shall be freely applied to the inside channel of frame, jamb and sill, so as to ensure a watertight joint. After the units is firmly fixed in position surplus mastic shall be cleaned and flush pointed, as shown in Fig. 10.6.

(b) *Fixing with Screws and Plugs:* In R. C. C. work where lugs cannot be embedded due to reinforcement bars etc. rawl plugs or other approved metallic fasteners may be fixed in proper position and frame fixed to them with 60 mm galvanized cross recessed head wood screws of designation 10.

10.10.5.4 ***Fixing in Wood Work Opening :*** Opening in wood work are normally rebated and approved mastic or rubber linings shall be applied to jambs, sill and channel before fixing in position, the frame shall be set in opening using wooden wedges as specified in 10.10.5.3 and fixed to the opening with 60 mm galvanized wood screws of designation 10. Extra timber fillets of hard wood to match the adjoining work shall also be provided around the frame to close the extra gap between opening and frame (Fig. 10.6).

10.10.5.5 ***Fixing in Steel Work Opening :*** Before placing the unit frame in position approved mastic shall be applied as specified in 10.10.5.3 (a) (iv) and a mild steel or hard wood fillet shall be provided around the frame to close the extra gap between opening and frame. The unit shall then be fixed to the opening with fixing clips or with nuts and bolts as shown in the drawings or as directed by the Engineer-in-Charge (Fig. 10.6)

10.10.5.6 ***Fixing of Composite Units :*** The fixing procedure for composite units shall generally be as described under 10.10.5.1 to 10.10.5.5 except that:

Where large units shall be formed by coupling individual units together (with coupling sections), the mullions and transom shall be bedded in mastic to ensure water tightness. Mastic shall be applied liberally to the channels of the outside frame section before assembly and after coupling. All oozing out mastic shall be cut out neatly.

10.10.6 Precautions

Care shall be taken that steel doors and windows etc. are not deformed/ damaged during subsequent constructions. Particular care shall be taken that scaffolding do not rest on the steel door window frames or glazing bars.

All fittings and hinges (projecting hinges) shall be protected, preferably with alkathene sheets so that these may not be damaged during execution of work.

10.10.7 Measurement

The weight of finished section door/windows of different sizes, inclusive of all fixed /welded fittings i.e. hinges pivots, lugs, brackets striking plates etc,. shall be worked out before fixing of windows (exclusive of weight of glass panes, glazing clips, putty etc.). Sectional weight of steel members only shall be measured without weight of glass panes etc. Any loose fittings such as casement stays/fastners etc. shall be enumerated and paid for separately.

10.10.8 Rate

Rate shall include the cost of materials and labour involved in all the operations described above excluding two coats of painting but including cost of glazing and priming including the cost of projecting hinges in case of side hung doors/windows, plain hinges in case of top/ bottom hung windows / ventilators and pivots for centre hung windows/ ventilators.

Metal beading and other fittings such as peg stay and casement window fasteners etc. shall be enumerated and paid for separately.

10.11 T-IRON DOORS, WINDOWS AND VENTILATORS FRAMES.

10.11.0 T-iron doors, windows and ventilators frames shall be manufactured from uniform mild steel Tee section. The steel shall be of the grade as provided in 10.1.1 The frames shall be got fabricated in approved workshop as approved by the Chief Engineer.

10.11.1 The sizes of doors, windows and ventilator frames shall be as per drawing or as decided by the Engineer-in- Charge. MS tie bar of 10 mm dia shall be welded at bottom of the frame. The size of doors, window and ventilators shall be calculated so as to allow 12.5 mm clearance on all sides to allow an easy fittings in opening. The actual size of doors, windows and ventilator shall not vary by more than $\pm$ 2 mm than those shown in the drawings.

The size of T section used for manufacture of doors, windows and ventilators shall not be less than those specified in IS 1038 (see Fig. 10.5) unless otherwise directed by the Engineer-in-charge.

10.11.2 Fabrications

The frame shall be constructed in section which has been cut to length and mitred. The corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat meeting the requirements stated under para 10.10.2.1.1.

The T Sections shall be mitre joined and continuously butt welded all along. The requirement of welded joints shall be as specified under para 10.10.2.1.2.

10.11.3 Fittings

Requisite number of holes shall be made in the frame for fixing of fitting. Detailed arrangement of fixing fittings shall be as shown in Fig. 10.7. All fitting shall be fillet welded to T iron frame all along the periphery of contact.

Butt hinges shall be fixed to the frame as below:

(i) MS flat of size 100 mm x 25 mm x 6 mm will be welded with fillet weld all along the periphery of contact on the rear side of the web of T iron to receive the hinges. Requisite number of holes shall be made in T iron frame and MS flat for fixing of hinges with counter sunk steel screws as shown in Fig. 10.7.

(ii) An alternate method of fixing butt hinges can be adopted by fillet welding the hinge to the T iron frame on three sided. No welding shall be done along the hinge pin to allow free movement of butt hinges as shown in Fig. 10.7.

10.11.4 Fixing Procedure

Fixing procedure for T iron doors, windows and ventilator frames in masonry opening shall be as described in 10.10.5. Fixing arrangements of shutters to such frames is shown in Fig. 10.5.

10.11.5 Measurements

T- iron door windows and ventilator frames shall be measured in running metre, along the centre line of the frame correct to a 1mm and weight calculated on the basis of standard tables. No deduction or extra payment shall be made for making holes and making arrangement for fixing fittings including packing wherever necessary. No deduction will be made for not providing tie bars in case of windows and ventilators.

10.11.6 Rate

The rate includes cost of materials and labour involved in all the operation described above. It shall include the necessary butt hinges and screws for fixing the same with frame or as specified. But it does not include the cost of other door, window and ventilator fittings.

10.12 PRESSED STEEL DOOR FRAMES (Fig. 10.8)

10.12.1 Materials

Steel door frames shall be manufactured from commercial mild steel sheet of specified thickness, conforming to IS 2062 and 4351.

Steel door frames with or without fan light shall be made in the profiles indicated in Fig. 10.8 which may be manufactured to suit doors of either type opening inwards or outwards as directed by the Engineer-in-Charge.

10.12.2 Construction

Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold (see Fig. 10.8.) These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be of pressed mild steel 1.25 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable , or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames.

10.12.3 Fabrication

The pressed steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

10.12.3.1 ***Fixing Lugs (Fig. 10.8) :*** There shall be three adjustable lugs with split end tail to each jamb without fan light, and four for jamb with fan light.

The head of the fixing lug shall be of one of the following lengths:

(a) 98 mm long for use with profile A
(b) 120 mm long for use with profile B
(c) 160 mm long for use with profile C

The head shall be made from flat steel strip 25 mm wide and not less than 1.60 mm thick

The tail of the lugs shall be 200mm long and shall be made of steel strip not less than 40 mm wide and not less than 1 mm thick.

10.12.3.2 ***Hinges (Fig. 10.8)*** : 100 mm mild steel butt hinges shall be used. For door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for door frames above 80 cm wide, four hinges shall rigidly fixed to one jamb, if it is single shutter, where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof the additional height.

In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distances from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take No. 10 cross recessed head wood screws.

10.12.3.3 ***Mortar Guards :*** Mortar guards of thickness of main frame sheet shall be provided in accordance to provisions of IS 4351 and as instructed by Engineer-in-charge shall be provided. These shall be welded to the frame at the head of the frame for double shutter doors to make provision for bolts. These shall also be provided to the frame behind the hinges, mortice locks and latches, slots, aldrop and sliding /tower bolts.

10.12.3.4 ***Lock – Strike Plate :*** There shall be an adjustable lock- strike plate of steel complete with mortar guard to make provision for locks or latches complying with the relevant Indian Standards. (IS 4351) Lock-strike plates shall be of galvanized mild steel and fixed at 95 cm from the head of the frame.

10.12.3.5 ***Shock Absorbers :*** For side hung door there shall not be less than three buffers or rubber or other suitable material inserted in holes in the rebate. one shall be located at the centre of the lock jamb and the other two shall be at 30 cm. from top and bottom of the frame. For double leaf shutter door, two buffers shall be provided.

10.12.4 Finishing

The surface of door frame shall be thoroughly cleaned, free of rust, mill-scale dirt oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-charge shall be applied to the exposed surface.

10.12.5 Fixing

Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm. The temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface, one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

10.12.6 Measurements

The length shall be measured in running metre correct to a cm along the centre line of the frames.

10.12.7 Rate

The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

10.13 TUBULAR / HOLLOW SECTION TRUSSES

10.13.1 Structural Steel Tube

These shall be of:

1. Hot finished welded (HFW) type, or
2. Hot finished seamless (HFS) type, or
3. Electric resistance or induction butt welded (ERW), having carbon content less than 0.03 percent, yield stress of 21.5 kg/mm^2 (YST 210) type.

Conforming to the requirement of IS 1161. The steel tubes when analysed in accordance with the method specified in IS 228 shall show not more than 0.06 percent sulphur, and not more than 0.06 per cent phosphorous.

Tubes shall be designated by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. The standard size and weights of tubes are listed in Appendix C. Hollow sections shall be as per IS 4923.

Tubes shall be clean finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.

10.13.2 Minimum Thickness of Metals

Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

10.13.3 Fabrication

10.13.3.1 The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

10.13.3.2 ***Straightening :*** All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist.

10. 13.3.3 ***Bolting :*** Washers shall be specially shaped where necessary, or other means, used to give the nuts and the heads of bolts a satisfactory bearing.

In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

10.13.3.4 ***Welding :*** Where welding is adopted, it shall be as per IS 816.

10.13.3.5 ***Caps and Bases for Columns :*** The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

10.13.3.6 ***Sealing of Tubes :*** When the end of a tube is not automatically sealed by virtue of its connection be welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

10.13.3.7 ***Flatened Ends :*** In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded. Riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

10.13.4 Hoisting and Erection

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman.

The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

10.13.5 Measurements

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified.

Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diapharam gussests (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

10.13.6 Rate

The rate shall include the cost of labour and materials involved in all the operations described above including application of one coat of approved steel primer, i.e. red oxide zinc chrome primer conforming to IS 2074.

10.14 FAN CLAMPS (Fig. 10.9)

10.14.1 The fan clamps shall be of the following types:

(a) Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I, as shown in (Fig. 10.9) This shall be made of 16 mm M.S. bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of slab.

(b) Fan clamps for beams shall be of type II as shown in (Fig. 10.9). It shall be similar to fan clamp, type I, except that its height shall be greater depending on the depth of the beam rib.

(c) In case low ceiling heights, circular cast iron box for ceiling fan clamp shall be fixed during the laying of R.C.C. slab and shall be as shown in (Fig. 10.9). The size of cast iron box shall be 140 mm internal dia with 73 mm height, the thickness of cast iron rim shall be 4.5 mm bottom and top lid shall be of 1.5 mm thick M.S. sheet, with its top surface hacked so as to ensure proper bonding with the concrete. The lids shall be screwed into the cast iron box by means of 3.3 mm dia round head screws one each at the corners. The box can be of M.S. sheet, the

thickness of side walls can be reduced to 3 mm without effecting inner dia of the box. The fan clamp shall be made of 12mm dia M.S. bar bent to shape with its ends bent as per drawing.

10.14.2 Fixing

Holes for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer-in-charge shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the under-side of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of M.S. bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed.

The exposed portion of loops of the clamps shall be given two or more coats of paint, including priming coat, of approved steel primer as ordered by the Engineer-in-charge.

10.14.3 Measurements

Clamps of type I and 3 shall be counted in numbers. Fan clamps type II, shall be counted and paid for under fan clamps type I, but they shall in addition be paid for their extra height as determined by the depth of the beam.

10.14.4 Rate

The rate per fan clamps shall include the cost of labour and materials involved in all the operations described above. In the case of type I and 3 clamps, the rate shall apply irrespective of the thickness of the slabs.

10.15 M.S. HOLLOW RECTANGULAR DOOR FRAMES (I-TYPE SECTION*)*

10.15.1 Materials

Steel door frames shall be manufactured from commercial mild steel sheet of 1.60 mm thickness, conforming to IS 2062 and 4351.

Steel door frames shall be made in the profiles as per drawings and/or as directed by the Engineer-in-charge.

10.15.2 Construction

Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold. These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be pressed mild steel 1.60 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable, or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames.

10.15.3 Fabrication

The M.S hollow rectangular steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

10.15.3.1 ***Fixing Lugs :*** There shall be three adjustable lugs with split end tail to each jamb.

The head of the fixing lug shall be 120 mm long and made up flat steel strip 25 mm wide and 1.60 mm thick.

10.15.3.2 Hinges 100 mm mild steel butt hinges shall be used. Floor door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for frames of door above 80 cm wide, four higes shall be rigidly fixed to one jamb, if it is single shutter. Where the height of door shutter exceeds 2.15 metres, one additional hinge shall be provided for every 0.5 m or part thereof of the additional height.

In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distance from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take Number-10 cross recessed head wood screws.

10.15.3.3 ***Aldrops, Sliding Bolts and Tower Bolts :*** Provisions shall be made for aldrops, sliding bolts and tower bolts in the frames as per the positions given by the purchaser. Necessary mortar guards/metallic or nylon bushes shall be provided inside the frames for aldrops, sliding bolts and tower bolts.

10.15.3.4 ***Lock Strike Plate :*** Provision shall be made to fix lock stricke plates of mortise locks or latches, complying with the relevant Indian Standards. A slot suitable for lock stricke plate shall be pierced into the rebate of the frame and necessary fixing arrangement and mortar guard from the inside of the frame shall be provided.

10.15.3.5 ***Shock Absorbers :*** For side- hung door there shall be not less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located at the centre of the lock jamb of frame and other two shall be 300 mm from top and bottom of the frame. For double leaf doors two buffers shall be provided.

10.15.4 Finishing

The surface of door frame shall be thoroughly cleaned, free of rust, mill –scale dirt, oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-Charge shall be applied to the exposed surface.

10.15.5 Fixing

Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm the temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

10.15.6 Measurements

The length shall be measured in running metre correct to a cm. along the centre line of the frames.

10.15.7 Rate

The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

10.16 FACTORY MADE GLAZED STEEL DOORS, WINDOWS AND VENTILATORS

10.16.0 Specifications for this item to be same as for standard steel glazed doors, windows and ventilators as mentioned in para 10.10, except that Doors, windows and ventilators to be manufactured in a workshop, approved by the Chief engineer. Also owner of the workshop shall have a valid ISI license for manufacture of doors, windows and ventilators.

10.17 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL

(A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequred Plate wherever required

(B) In Grating, Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

10.17.1 General specifications for these items to be same as for steel work welded in built-up sections as mentioned in para 10.4 except that steel used for fabrication of these items to be of type used for structural use/purposes.

10.17.2 Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

10.18 STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR/ ERW TUBULAR PIPES AND G.I. PIPES

10.18.1 General specifications to be same as for steel work welded in built-up section as mentioned in para 10.4.

10.18.2.1 Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.

10.18.2.2 G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. GI pipes to be screwed and socketed type and of required nominal bore.

10.18.2.3 Galvanising of GI pipes shall conform to IS 4736.

10.18.2.4 All screwed tubes and socket of GI pipes shall have pipe threads conforming to the requirements of IS 554.

10.18.2.5 The fittings for GI pipes to be conforming to IS 1239 (Part-II).

10.8.3 Measurement of Hand Rail of M.S. Tubular/E.R.W Tubular Pipes

The work as fixed in place shall be measured in running metres correct to a centimeter and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.

10.19 DASH FASTENERS

These dash fasteners shall be of approved manufacture and shall be fabricated from the carbon steel.

10.19.1 The Grade 6.8 means:

(a) The first figure indicates the 1/100 of nominal tensile strength in N/mm^2.

(b) The second figure indicates 10 times the ratio between lower yield stress and nominal tensile strength.

The yield strength 480 N/mm^2 means the 6.8 grade shall have the tensile strength of 600 N/mm^2.

The lead of a thread is the distance travelled parallel to the axis in one rotation of a part in relation to a fixed mating part. In single threads, the lead is equal to the pitch. A double thread, it has two ridges starting 180Ú apart. The lead is twice the pitch. A triple thread, it has three ridges starting 120Ú apart. The lead is three times the pitch.

10.19.2 Fixing

According to the size (diameter & length) of the dash fasteners, the holes shall be done with precise location for fixing in frame, Masonry/concrete etc. The minimum distance between holes not less than 2.5 times diameter of the fastener.

10.19.3 Measurements

Dash fasteners of each size shall be counted in numbers.

10.19.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for drilling of hole in frame, Masonry/concrete etc. nor anything deducted for these from the measurement of frame, Masonry/concrete etc.

10.20 STAINLESS STEEL RAILING

The stainless steel of 304 grade of as per IS 6911 : 2017 shall be used for further fabrication of railing as per Architectural Design.

10.20.1

(a) Stainless steel of 304 grade is most common in 300 series of Austenitic stainless steel.

(b) It is still sometimes referred to by its old name 18/8 which is derived from the nominal composition of type 304 being 18% chromium and 8% nickel.

(c) Fabrication of all stainless steel sections should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolour the surface of the fabricated product. Some specific hints are as under:

  (i) Remove all moisture by blowing with dry air or heating with a torch.

  (ii) Eliminate organic contaminates like oil, paints, anti-spatter compounds, grease, pencil marks, cutting compounds, adhesive from protective paper, soap used for leak testing etc.

  (iii) Stainless steels cannot be flame cut with a torch. Acceptable results are achieved with an arch plasma cutter.

  (iv) Be particularly careful to avoid zinc contamination. Do not use brushes or tools previously used on galvanized steel.

  (v) Use only stainless steel wire brushes and use these brushes only on stainless steel.

10.20.2 Fixing

Fixing with railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc. of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge.

10.20.3 Measurements

Only weight of stainless steel members shall be considered in kg, excluding fixing accessories such as nuts, bolts, fasteners etc.

10.20.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangements i.e. drilling, nut & bolts etc.

10.21 FLY PROOF WIRE GAUZE

Wire gauze/Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

The following wire gauze shall be used :

(i) Galvanised mild steel wire gauze of 1.40mm average aperture width woven with 0.63mm nominal dia shall be used.

(ii) Stainless steel (Grade 304) gauze of 0.5 mm dia wire and 1.4mm aperture on both sides.

The wire gauze shall be bent at right angles in the inner face of steel frame of stiles and rails, turned back and fixed tight with blue tacks at about 75mm centres, fixed alternately in the two faces of the inner face of frame. Over this, M.S. Flat of size 15x3 mm with nuts & bolts fixed alternately in the two faces of the frame at about 75mm centres.

10.21.1 Measurement

The length and breadth of finished wire gauze on inner face of frame shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

10.21.2 Rates

The rate includes cost of all operation described above.

10.22 GLASS PANES WITH PUTTY AND GLAZING CLIPS

Glazing in the steel door, windows, clerestory windows shall be provided with glass weight of which shall be not less than density 10 kg/sqm or 13.5 kg/sqm for the specific thickness 4.0 mm or 5.5 mm respectively. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and beading.

10.22.1 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been finished.

10.22.2 Panels of shutters shall be flat and well sanded to a smooth and level surface.

Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

10.22.3 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufactures shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

Size of M.S. beading shall be 10 x 10 mm box section manufactured from 1.6mmthick sheet unless otherwise specified in the item.

Where metal beading is specified, extra payment shall be made on this account.

10.22.4 Measurement

The length and breadth of glass pane shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

10.22.5 Rate

The rate includes cost of all the operation described above.

10.23 ANGLE IRON FRAMES FOR DOORS, WINDOWS AND VENTILATORS

Mild steel equal angle sections 35 x 35x 5 mm for fabrication of steel doors, windows and ventilators shall conform to IS 808. The MS Flat of size 35 x 5 mm if used for fabrication shall confirm to IS 1730.

10.23.1 The steel doors, windows and ventilators shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening, The actual sizes of doors, windows and ventilators shall not vary by more than +1.5mm from those given in the drawing.

10.23.2 Fabrication

Frames shall be made of sections which have been cut to length and mitred. The corner of frames shall be welded to form a solid fused welded joint conforming the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flush but welding or can be any other process as agreed to between the supplier and the purchaser which shall fulfil the requirements given in clause 6.1.1 of IS 1038, metal arc welding or any other suitable method.

10.23.3 Requirements of Welded Joints

(i) Visual Inspection Test : When two opposite corners of the frame are cut, paint removed and inspected the joint shall conform to the following:-

(a) Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.

(b) Welds should have been properly grounded and

(c) Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

(d) Micro and Macro Examinations:

From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and cavity and reasonably free from under cutting overlaps, gross porosity and entrapped slag.

(ii) Fillet Weld Test : The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

10.23.4 Priming Coat

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before fixing.

10.23.5 Fixing

Frame places in position carefully without any damage to itself and other building work and injury to workmen. The frame shall be fixed to existing T-Iron frame or to wall with help of Dash fastener upto the satisfaction of the Engineer-in-charge.

10.23.6 Measurements

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable.

10.23.7 Rate

Rate includes the cost of labour and materials required for all the operations described above except the dash fastener paid separately if frame is directly fixed to wall by dash fasteners. It shall include the necessary butt hinges and screws for fixing the same with frame or as specified.

APPENDIX A

MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION OF STEEL

TABLE 10.1
Chemical Composition
(Clause 10.1.1)

Grade Designation	*Quality*	*Ladle analysis, Percent, Max*					*Carbon Equivalent (CE), Max*	*Method of Dexodiation*[1]
		C	*Mn.*	*S*	*P*	*Si*		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
E 165 (Fe 290)	-	0.25	1.25	0.045	0.045	-	-	Semi-killed or killed
E 250 (Fe 410 W)	A	0.23	1.50	0.045	0.045	0.40	0.42	Semi-killed or killed
E 250 (Fe 410 W)	B	0.22	1.50	0.045	0.045	0.40	0.41	Killed
E 250 (Fe 410 W)	C	0.20	1.50	0.040	0.040	0.40	0.39	Killed
E 300 (Fe 440)	-	0.20	1.30	0.045	0.045	0.45	0.40	Semi-killed or killed
E 350 (Fe 490)	-	0.20	1.50	0.045	0.045	0.45	0.42	Semi-killed or killed
E 410(Fe 540)	-	0.20	1.60	0.045	0.045	0.45	0.44	Semi-killed or killed
E 450 (Fe 570)	D	0.22	1.60	0.045	0.045	0.45	0.46	Semi killed or killed
E 450 (Fe 590)	E	0.22	1.80	0.045	0.045	0.45	0.48	Semi killed or killed

Notes:

1. Carbon equivalent (CE) based on ladle analysis = $\frac{Mn}{C+6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$
2. When the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 per cent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 per cent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.30 per cent and total aluminium content shall not be less than 0.01 per cent.
3. Microalloying element like Nb, V, Ti and B shall be added singly or in combination. Total microalloying element shall not be more than 0.25.
4. New grades designation system based on yield stress has been adopted, simultaneously old designations have also been given in parentheses.
5. Steel of qualities A, B and C are generally suitable for welding processes. The weldability increases from quality A to C.
6. Copper may be present between 0.20 to 0.35 per cent as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example, E 250 Cu. In case of product analysis the copper content shall be between 0.17 and 0.38 per cent.
7. Nitrogen content of steel shall not exceed 0.012 per cent which shall be ensured by the manufacturer by occasional check analysis. For micro alloyed steel this is to be reduced to 0.009 per cent.
8. The steel, if required may be treated with rare earth element for better formability.
9. Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.
10. Incidental element-Elements not quoted in Table 1 shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture of such elements which affect the hardenability, mechanical properties and applicability.

---

1. "To be supplied subject to the agreement between the purchaser and the manufacturer".

TABLE 10.2
Mechanical Properties
(Clause 10.1.1)

Grade Designation	*Quality*	*Tensile strength Min. MPa*	*Yield stress, ReH Min. MPa*			*Percentage elongation at Guage length Lo 5.65 √SO Min.*	*Internal Bend Diameter Min.)*		*Charpy V-Notch Impact Energy Min. J*	
			<20	*20-40*	*>40*		*≤ 25*	*>25*	*at Room Temp.*	*At 20°C*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
E 165 (Fe 290)	-	290	165			23	2t	-	-	-
E 250 (Fe 410 W)	A	410	250	240	230	23	3t	2t	-	-
E 250 (Fe 410 W)	B	410	250	240	230	23	2t	3t	27 (See Note 3)	
E 250 (Fe 410 W)	C	410	250	240	230	23	2t	3t	27 (See Note 3)	
E 300 (Fe 440)	-	440	300	290	280	22	2t	3t	50	30
E 350 (Fe 490)	-	490	350	330	320	22	2t	3t	50	25
E 410 (Fe 540)	-	540	410	390	380	20	2t	3t	50	25
E450 (Fe 570)	D	570	450	430	420	20	2t	3t	45	20
E 450 (Fe 590)	E	590	450	430	420	20	2t	3t	45	20

1 1 MPa= 1MN/m^2= 0.102 kgf/mm^2=144.4 psi
2 Temperature of Charpy impact values will be subject to mutual agreement.
3 The more stringent requirements than those given above may be as agreed to between the purchaser and the manufacturer**.**

TABLE 10.3
(Clause 10.2.4 &10.3.5)

Sl. No.	*Steel Section*	*Tolerance in weight per meter percentage*		*Standard weight as per IS*
		Plus Side	*Minus Side*	
(i)	Beams and columns (RS joists)	(a) Beams ≤ 200 mm (+) 4	(-) 1	IS 808
		(b) > 200 mm 2.5	2.5	
(ii)	Channels	2.5	2.5	IS 808
(iii)	Equal and unequal leg Angles			
	(a) upto 3 mm thickness	5	5	IS 808
	(b) Over 3 mm thickness	5	3	
(iv)	Tee bars			
	(a) Web thickness upto 3 mm	5	5	IS 1173
	(b) Web thickness above 3 mm	2.5	2.5	
(v)	Bulb angles	2.5	2.5	IS 1252
(vi)	Bars in straight length			
	Upto and including 10 mm	7	7	IS 1732
	Over 10 mm and upto and including 16 mm	5	5	
	Over 16 mm	3	3	
(vii)	Bars in coils	Weight tolerance is not applicable		
(viii)	Flats			
	Upto 3 mm thickness	5	5	
	Over 3 mm thickness	5	3	
(ix)	Plates	5	2.5	IS 1730
(x)	Strips	10	10	IS 1730
	Consignment in straight length			
	(i) upto 5 tons	7	7	IS 1730
	(ii) Above 5 tons	5	5	
(xi)	Sheets			
	Thickness			
	Over in mm	Upto and including in mm	Tolerance on calculated weight (Percent)	IS 1730
	-	1.25 mm	± 9	
	1.25 mm	1.60	+ 8	
	1.6	4.00	+ 7	

APPENDIX B

WELDING PROCESS

(Clause 10.4.2.4)

(a) The work shall be positioned for downward welding wherever possible.
(b) Arc length voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work. The welding current and electrode sizes for different types of joints shall be as per IS 9595.
(c) The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.

Process of Welding

The electrode manipulation during welding shall be such as to ensure that:

(1) The parent metal is in a fused stage when the filler metal makes contact with it.

(2) The weld metal does not overflow upon any unfused parent metal forming overlapping.

(3) The parent metal is not under-cut along the weld toes.

(4) The flowing metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed.

Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then move back to fill the crater or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposit and the base metal at the point of junction, and result in continuity of weld, Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary, and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also to successive beads, and to the over lapping area wherever a junction is made on starting a new electrode.

(5) The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and rewelded.

In case of welded butt joints in steel of thickness upto 50mm the weld joint shall be subjected to radiographic examination as described in IS 1182.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.

APPENDIX C

STEEL TUBES FOR STRUCTURAL PURPOSES

(Clause 10.13.1)

Nominal Bore (mm)	*Outside Diameter (mm)*	*Class*	*Wall Thickness (mm)*	*Weight (kg/m)*
15	21.3	H	3.2	1.44
20	26.9	H	3.2	1.87
25	33.7	M	3.2	2.41
		H	4.0	2.93
32	42.4	L	2.60	2.54
		M	3.2	3.10
		H	4.00	3.79
40	48.3	L	2.90	3.23
		M	3.2	3.56
		H	4.0	4.37
50	60.3	L-1	2.9	4.08
		M	3.6	5.03
		H	4.5	6.19
65	76.1	L	3.2	5.71
		M	3.6	6.42
		H	4.50	7.93
80	88.9	L	3.2	6.72
		M	4.00	8.36
		H	4.8	9.9
90	101.6	L	3.6	8.7
		M	4.0	9.63
		H	4.8	11.50
100	114.3	L	3.6	9.75
		M	4.5	12.2
		H	5.4	14.5
110	127.0	L	4.5	13.6
		M	4.8	14.50
		H	5.4	16.2
125	139.7	L	4.50	15.00
		M	4.8	15.90
		H	5.4	17.90
135	152.4	L	4.50	16.40
		M	4.8	17.50
		H	5.40	19.60
150	165.1	L	4.50	17.80
		M	4.8	18.90
		H	5.40	21.30
150	168.3	L	4.50	18.20
		M	4.8	19.40
		H-1	5.40	21.70
		H-2	6.3	25.20
175	193.7	L	4.8	22.40
		M	5.40	25.10
		H	5.9	27.30
200	219.1	L	4.8	25.40
		M	5.60	29.50
		H	5.90	31.00
225	244.5	H	5.90	34.70
250	273	H	5.90	38.90
300	323.90	H	6.30	49.30
350	355.60	H	8.00	68.60

L means Light M means Medium H means Heavy

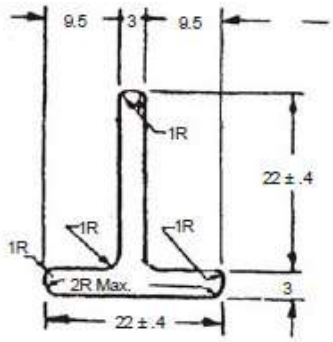
APPENDIX D

SHAPES, WEIGHTS AND DESIGNATION OF MS ROLLED STEEL SECTION

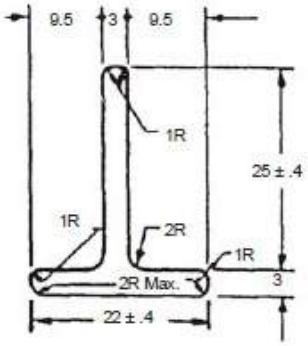
Designation	*Wt kg/m*	*Situation of Use of Section*
T2	1.036	Vertical and horizontal glazing bars for doors and shashes : windows, ventilators glazing bars for door side lights sub dividing bars for fixed length, sash bars for doors, windows and ventilators wheel steel aluminium or wooden beading is used for fixing glasses.
T3	1.14	Vertical glazing bar for FZ 7 frame
T6	0.839	Vertical and horizontal glazing bar for standard windows and ventilators.
F2	1.46	Inner frames for open-in windows.
F3	2.28	Outer frames for open-in windows.
F5	1.55	(a) Inner and middle frames in centre-hung ventilators
		(b) F5 is some times used as inner frames for open-out windows. Also used as inner frame for bottom hung ventilators
		(c) F8 is also used as outer frame for bottom hung ventilators.
F4B	2.28	Central mullion (meeting bar for shutters) for windows and ventilators using F7D as inner frames, outer frames for open-in windows in rainy areas, subdividing bars for openable windows and top-hung ventilators.
F7D	1.419	Inner and outer frames for windows and top hung ventilators, for inner frames for centre-hung ventilators and outer frames for door sidelights.
FX6	2.52	Inner frame for doors
FZ7	1.90	Used as outer frame for industrial shashes. Also used for outer frame for wooden doors
FX8	2.31	Outer frames for doors
FZ5	2.52	Inner frames for doors
K11B	1.80	(a) Vertical coupling mullion for standard windows
		(b) Can be used as horizontal coupling bar when openable windows are to be coupled above fixed ones or between two fixed windows.
		(c) Can also be used as horizontal coupling mullion where windows are not exposed to weather.
K12 B	2.30	Horizontal coupling mullion, also known as weather bar, Especially used when the coupled unit is exposed to rain.

APPENDIX D

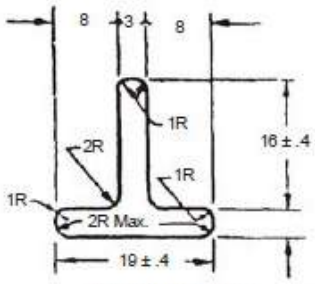
SHAPES



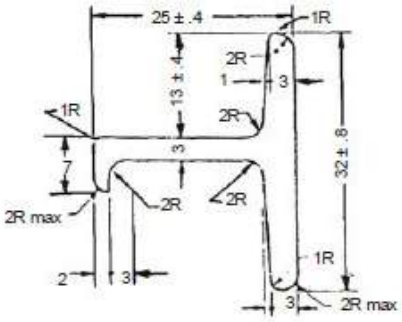
WEIGHT 1.038 Kg/m
T2



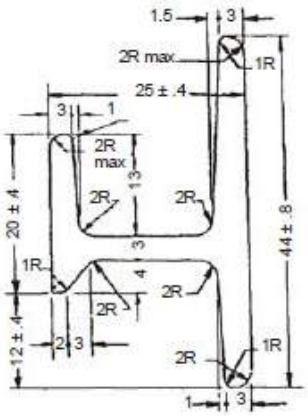
WEIGHT 1.14 Kg/m
T3



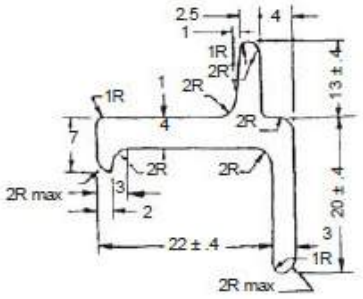
WEIGHT 0.839 Kg/m
T6
All dimensions in millimetres



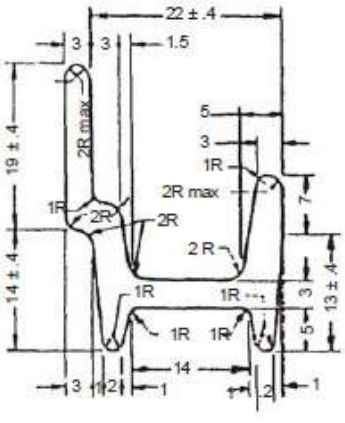
WEIGHT 1.46 Kg/m
F2



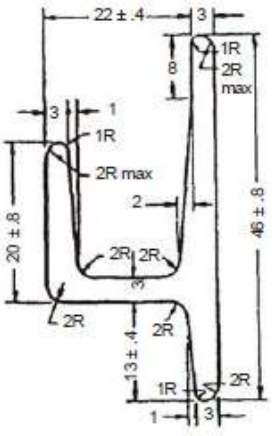
WEIGHT 2.28 kg/m
F3
All dimensions in millimetres



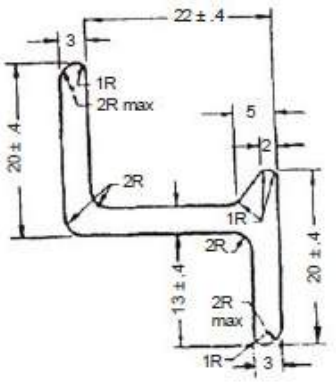
WEIGHT 1.55 kg/m
F5



WEIGHT 1.92 kg/m
F 8
All dimensions in millimetres



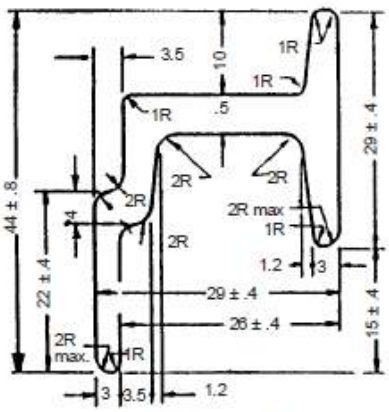
WEIGHT 2.28 kg/m
F4B



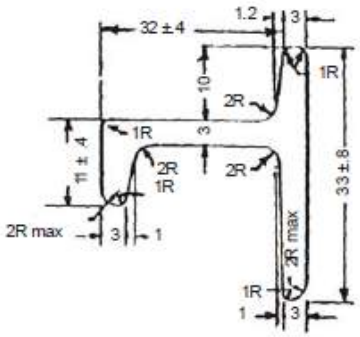
WEIGHT 1.419 kg/m
F7D
All dimensions in millimetres

APPENDIX D

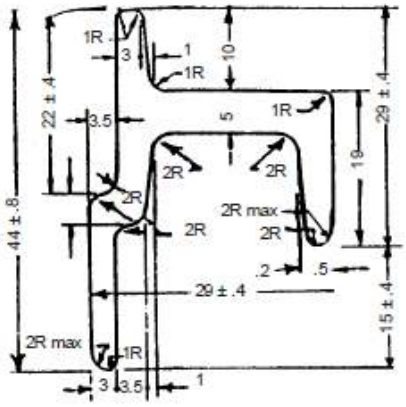
SHAPES



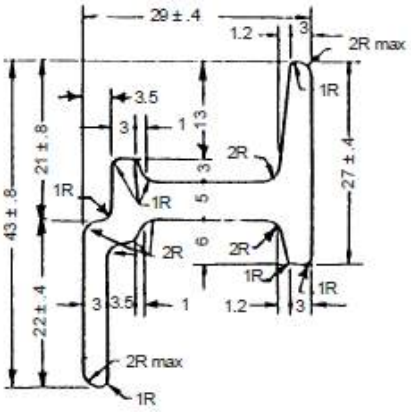
WEIGHT 2.52 kg/m
FX6



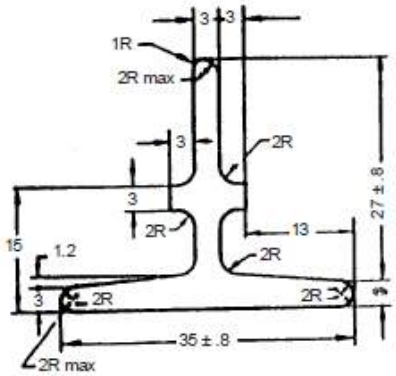
WEIGHT 1.90 kg/m
FZ7
All dimensions in millimetres



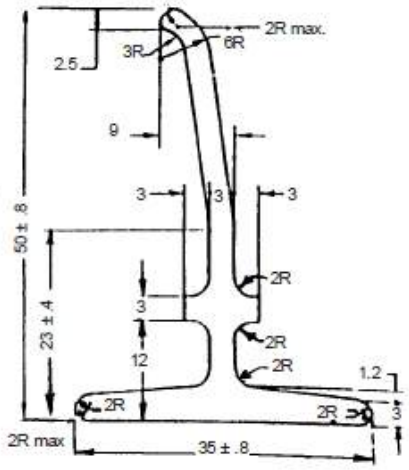
WEIGHT 2.52 kg/m
FZ5
All dimensions in millimetres



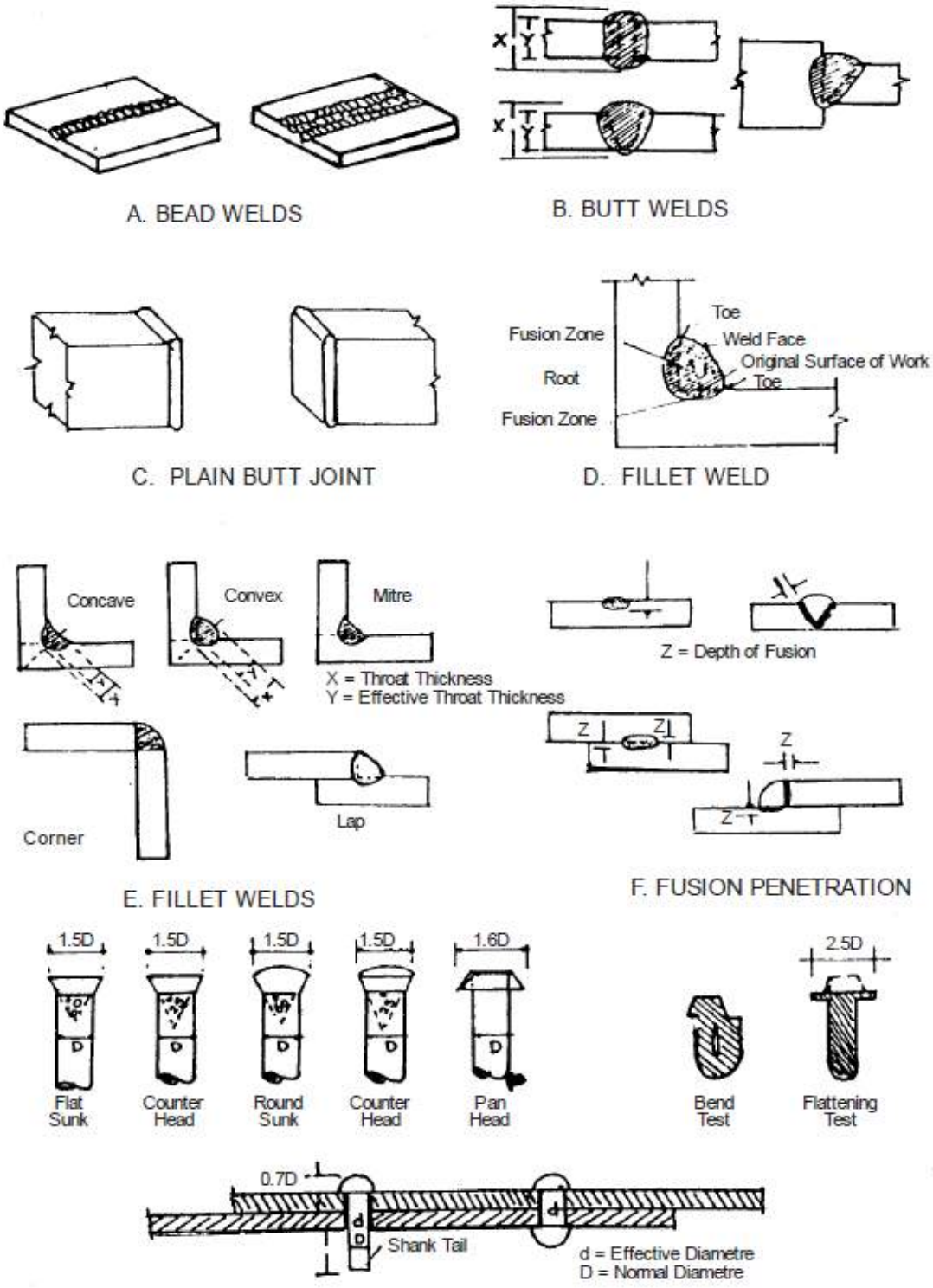
WEIGHT 2.31 kg/m
FX8



WEIGHT 1.80 kg/m
K11B



WEIGHT 2.30 kg/m K12B

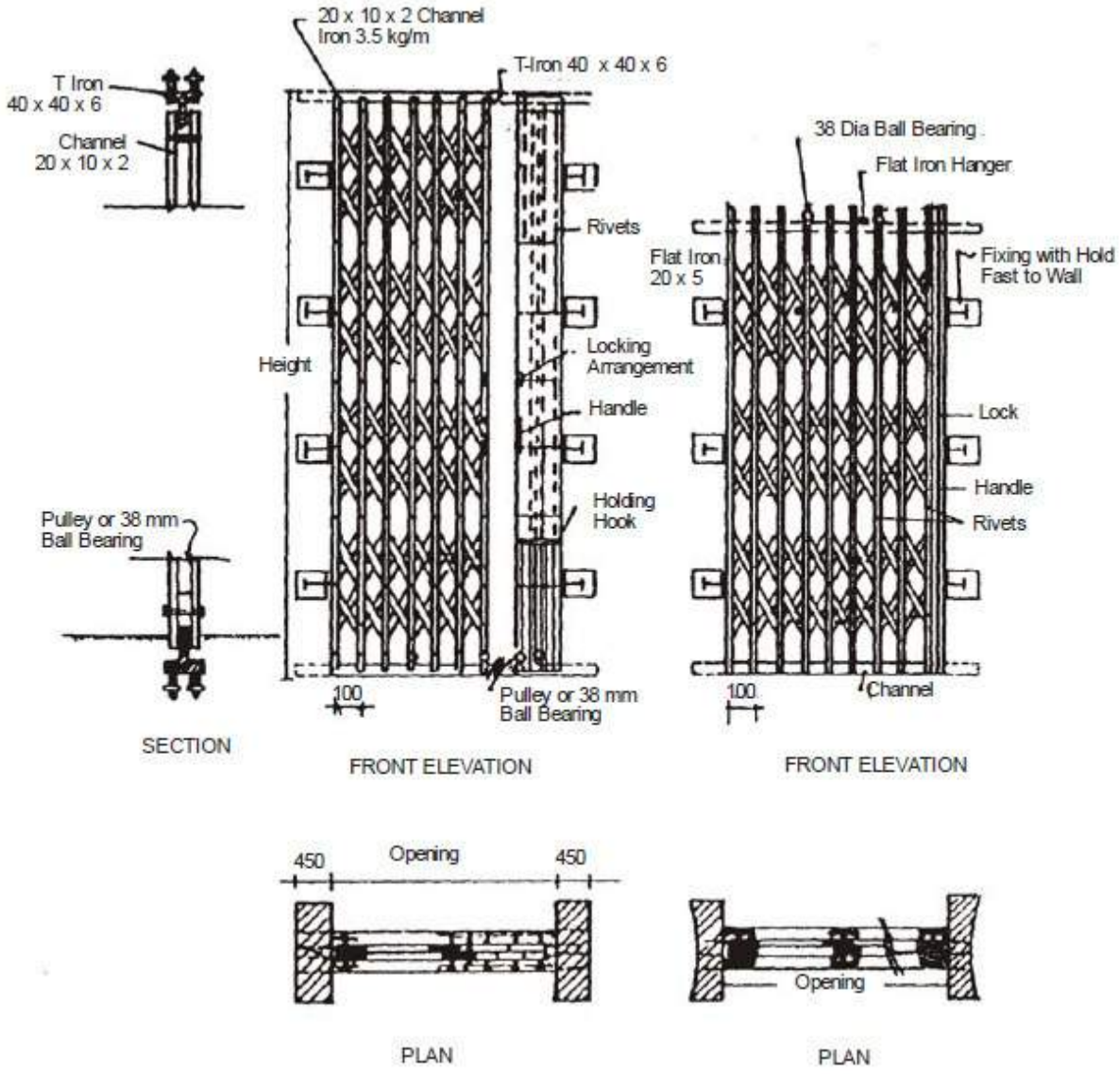


Drawing not to Scale

Fig. 10.1 : Welds and Rivets

COLLAPSIBLE STEEL GATE

Sub Head : Steel Work
Clause : 10.5

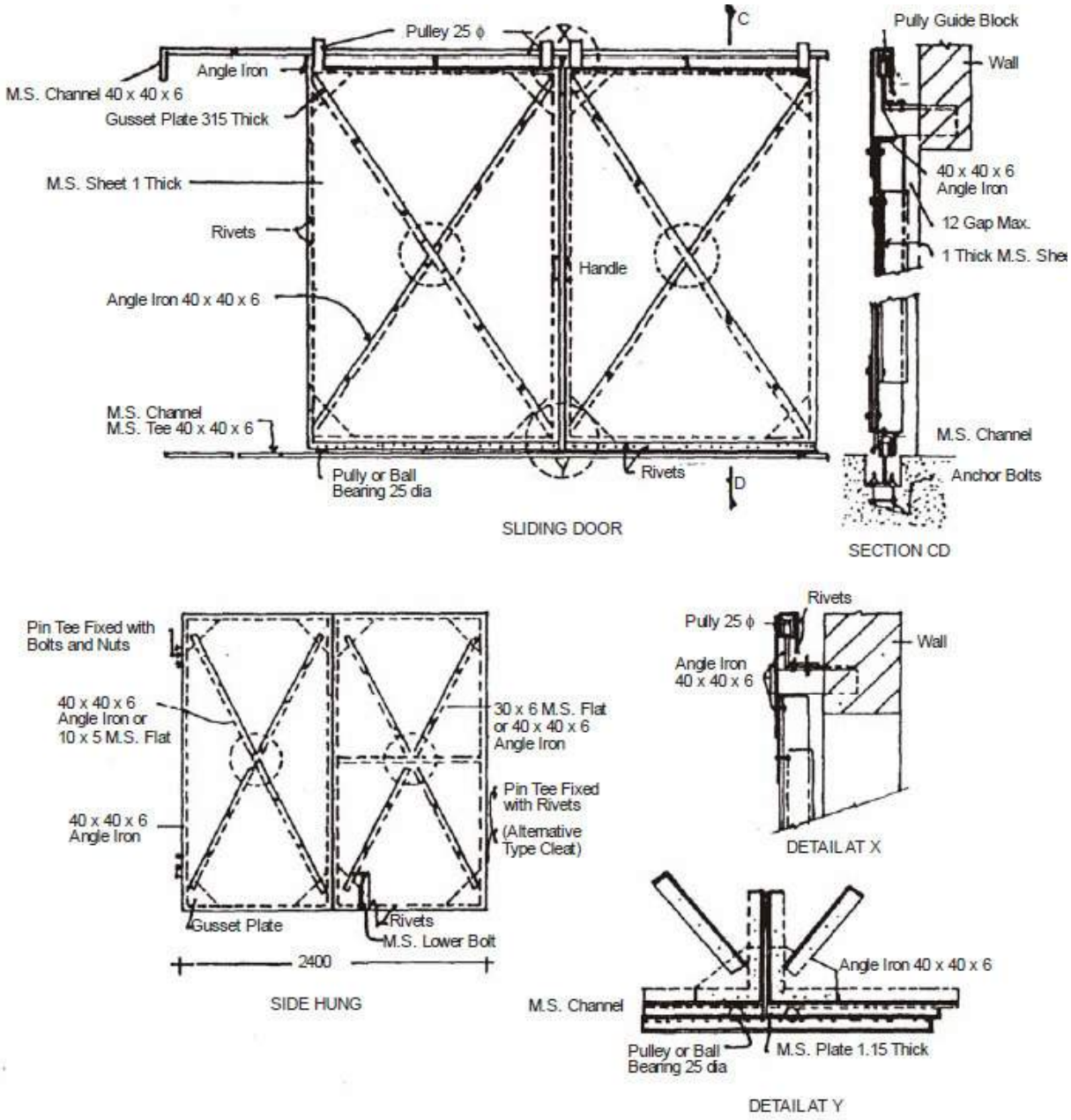


Drawing not to Scale
All dimensions are in mm

Fig. 10.2 : Collapsible Steel Gate

TYPICAL M.S. SHEET SHUTTERS

Sub Head : Steel Work
Clause : 10.6 & 10.7

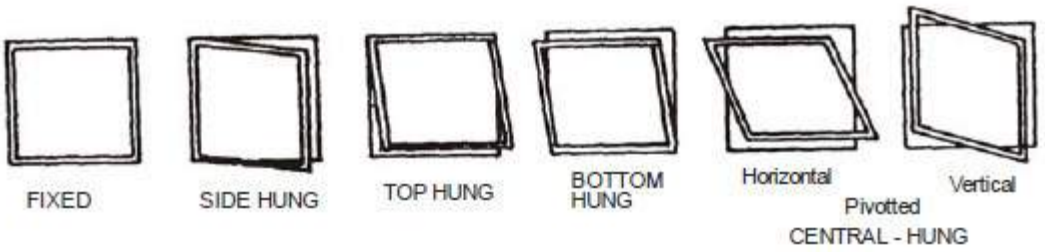


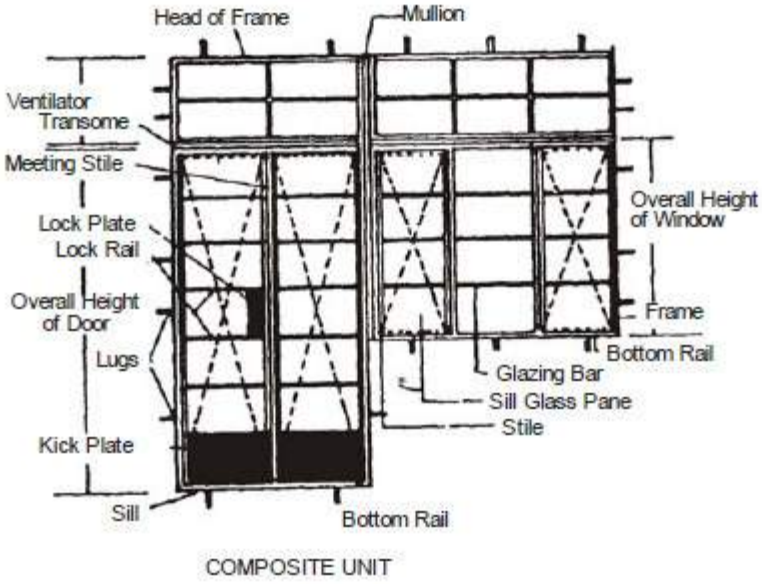
Drawing not to Scale
All dimensions are in mm

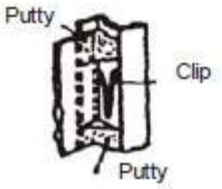
Fig. 10.3 : Typical M.S. Sheet Shutters

STEEL DOORS, WINDOWS AND VENTILATORS

Sub Head : Steel Work
Clause : 10.10







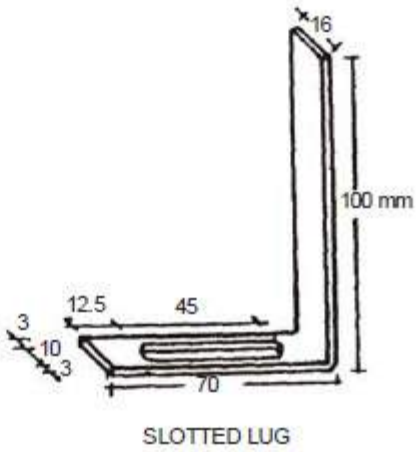
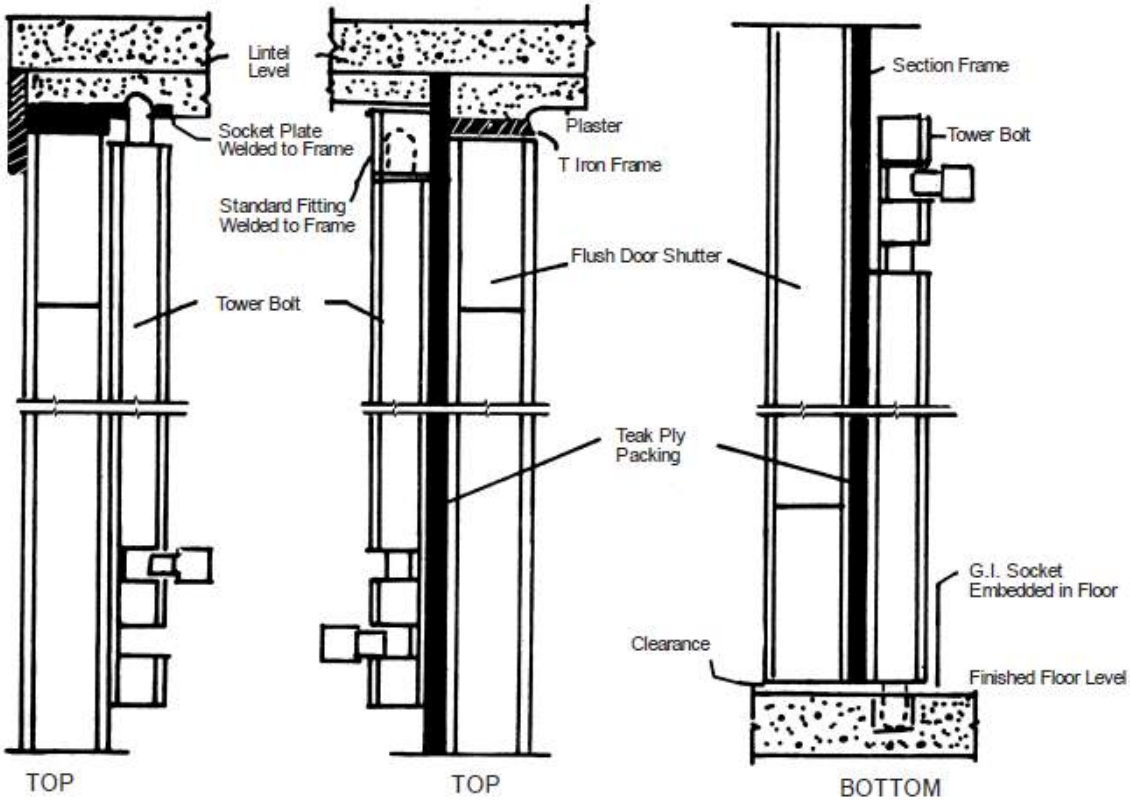


Fig. 10.4 : Steel Doors, Windows and Ventilators

T-IRON DOOR, WINDOW FRAMES

Sub Head : Steel Work
Clause : 10.11

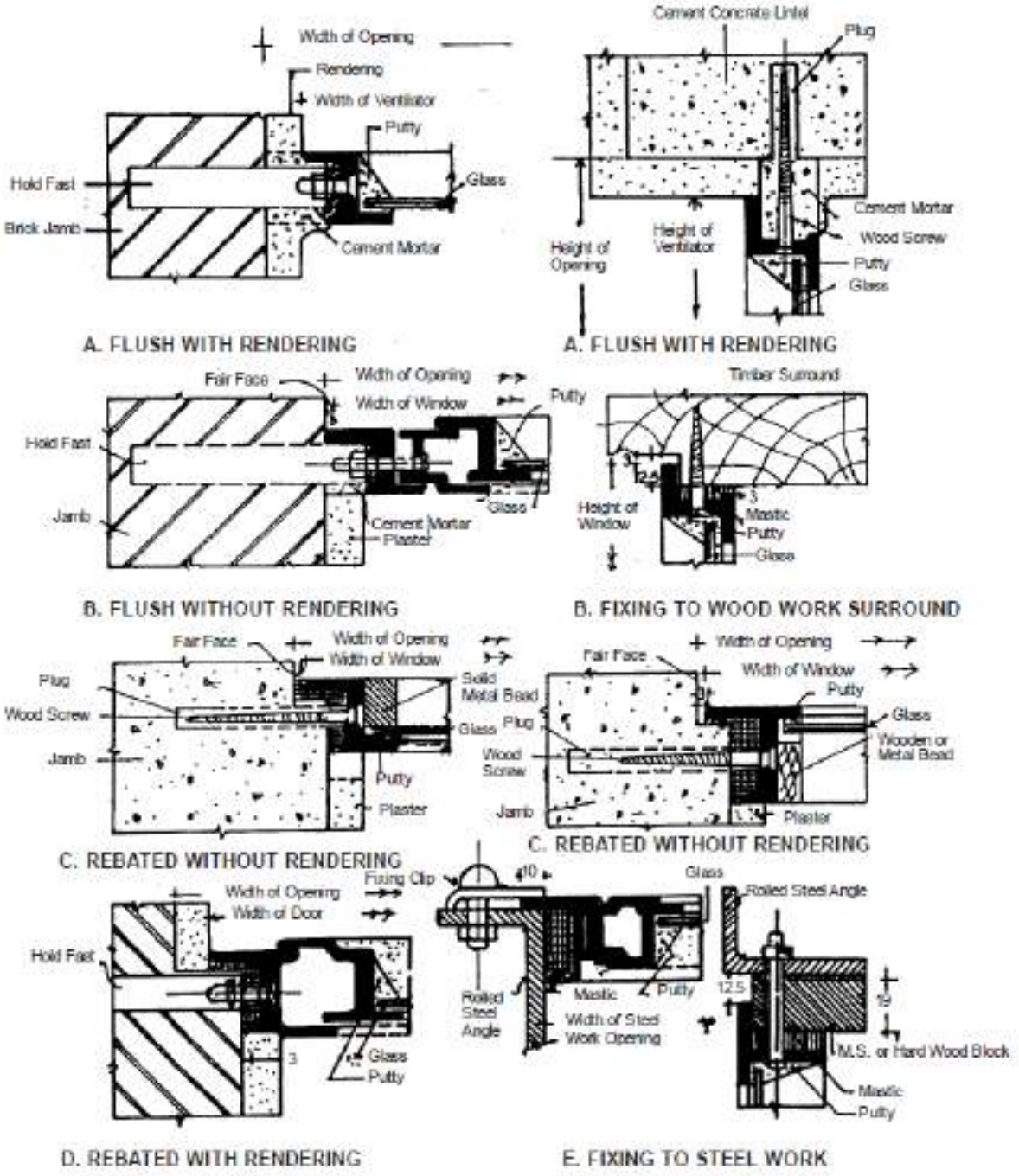


Drawing not to Scale

Fig. 10.5 : T-Iron Door, Window Frames

STEEL DOORS, WINDOWS & VENTILATORS

Sub Head : Steel Work
Clause : 10.10

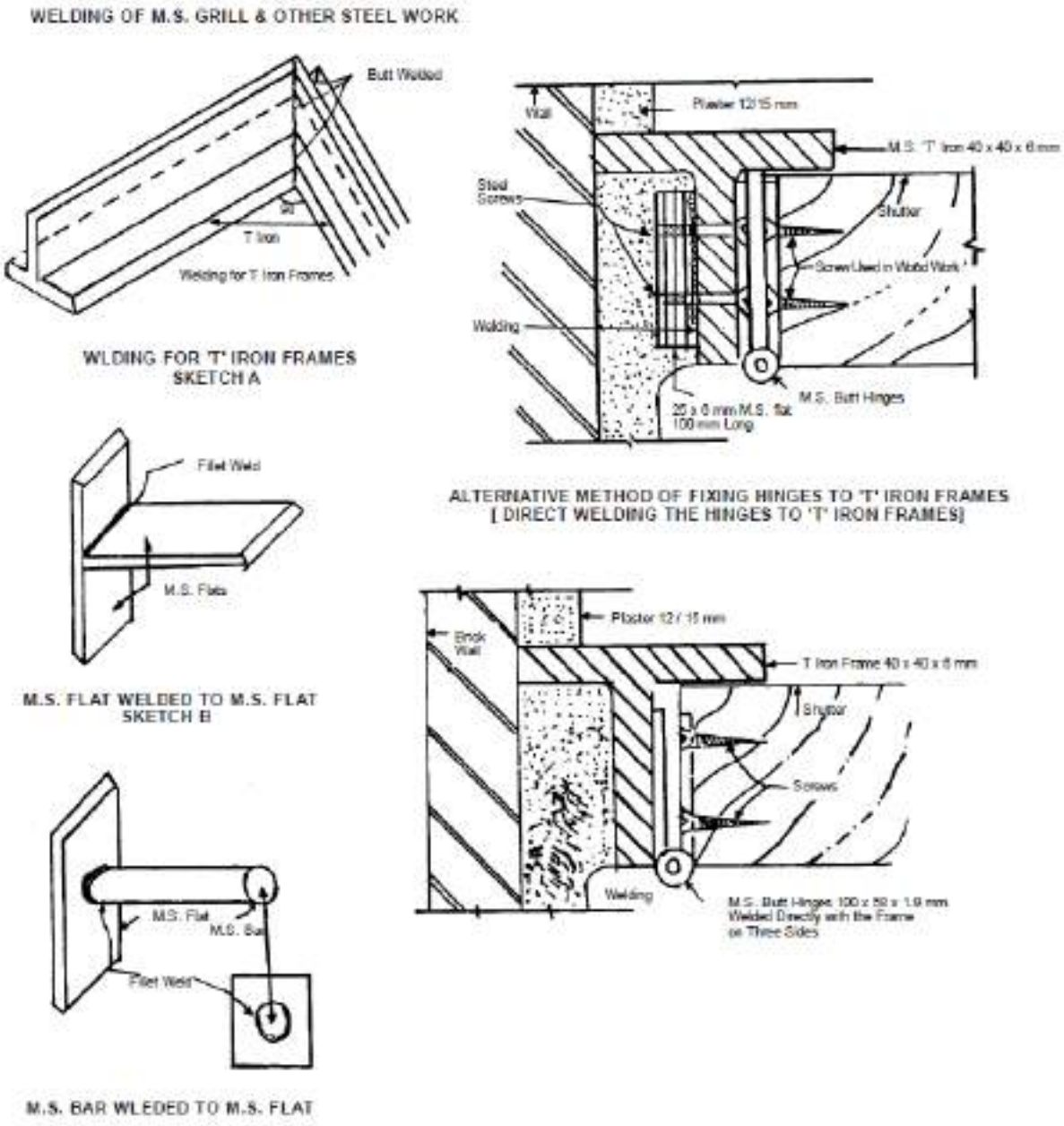


Drawing not to Scale

Fig. 10.6 : Steel Doors, Windows & Ventilators

FIXING BUTT HINGES TO T-IRON FRAME WITH M.S. FLAT WELDED TO FRAME

Sub Head : Steel Work
Clause : 10.11

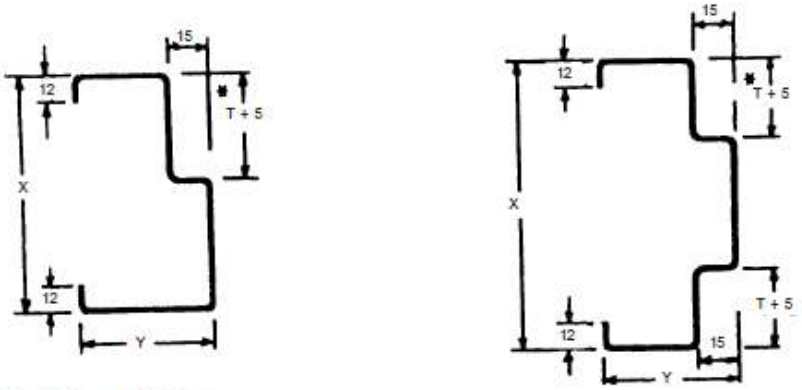


Drawing not to Scale

Fig. 10.7 : Fixing Butt Hinges to T-Iron Frame with M.S. Flat Welded to Frame

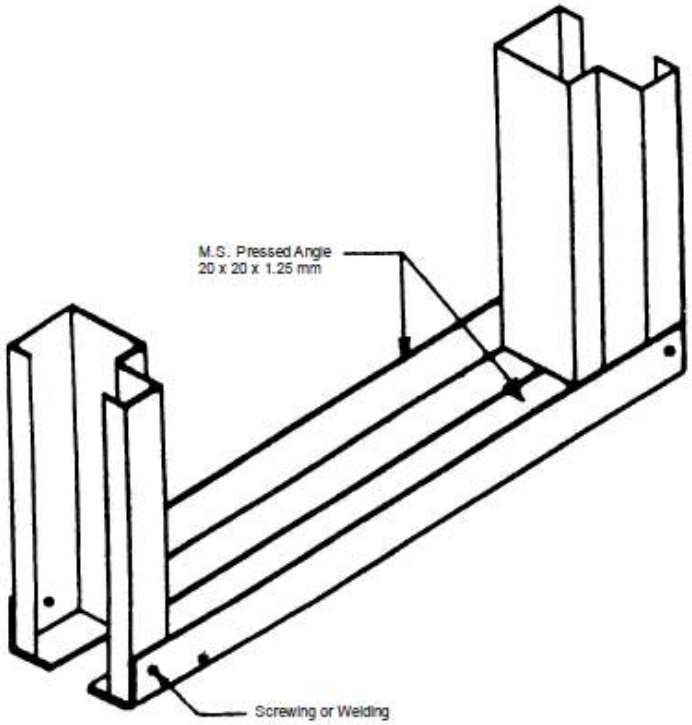
PRESSED STEEL DOOR & WINDOW FRAMES

Sub Head : Steel Work
Clause : 10.12



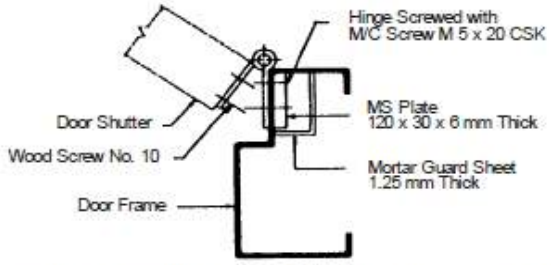
Note : (1) *T is the thickness of the Shutter.
(2) X and Y are as per Table 2 of I.S. Code 4351.
(3) All dimensions in millimetres.

PROFILES OF PRESSED STEEL DOOR FRAMES

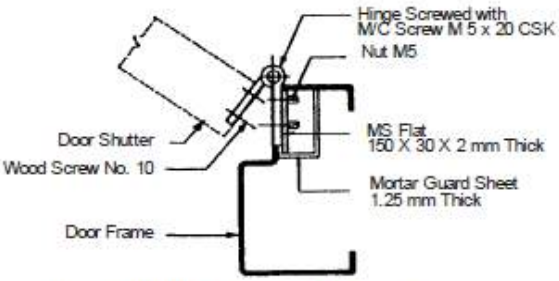


ARRANGEMENT AT BASE OF DOOR FRAME

Fig. 10.8 : Pressed Steel Door & Window Frames

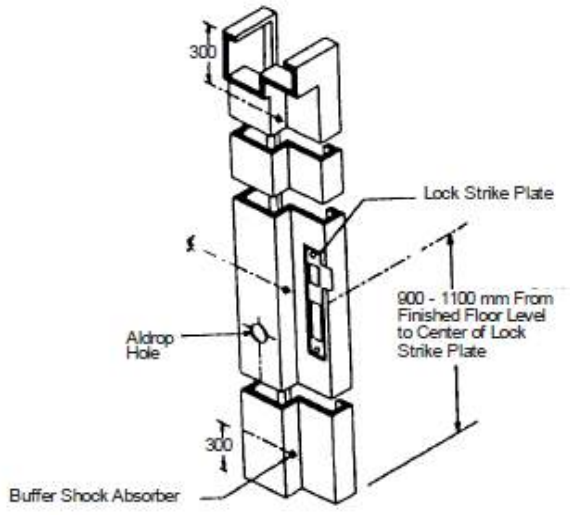


FIXING OF HINGE TO THE FRAME - SCREWED TO THE M.S. FLAT

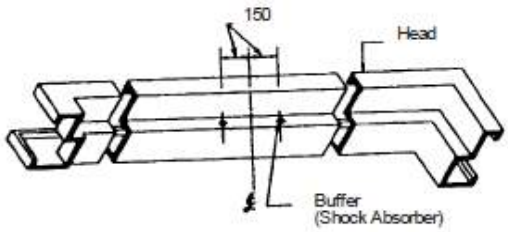


FIXING OF HINGE TO THE FRAME - SCREWED TO THE NUT

FIXING OF HINGE TO THE FRAME



SIDE HUNG DOOR FRAME



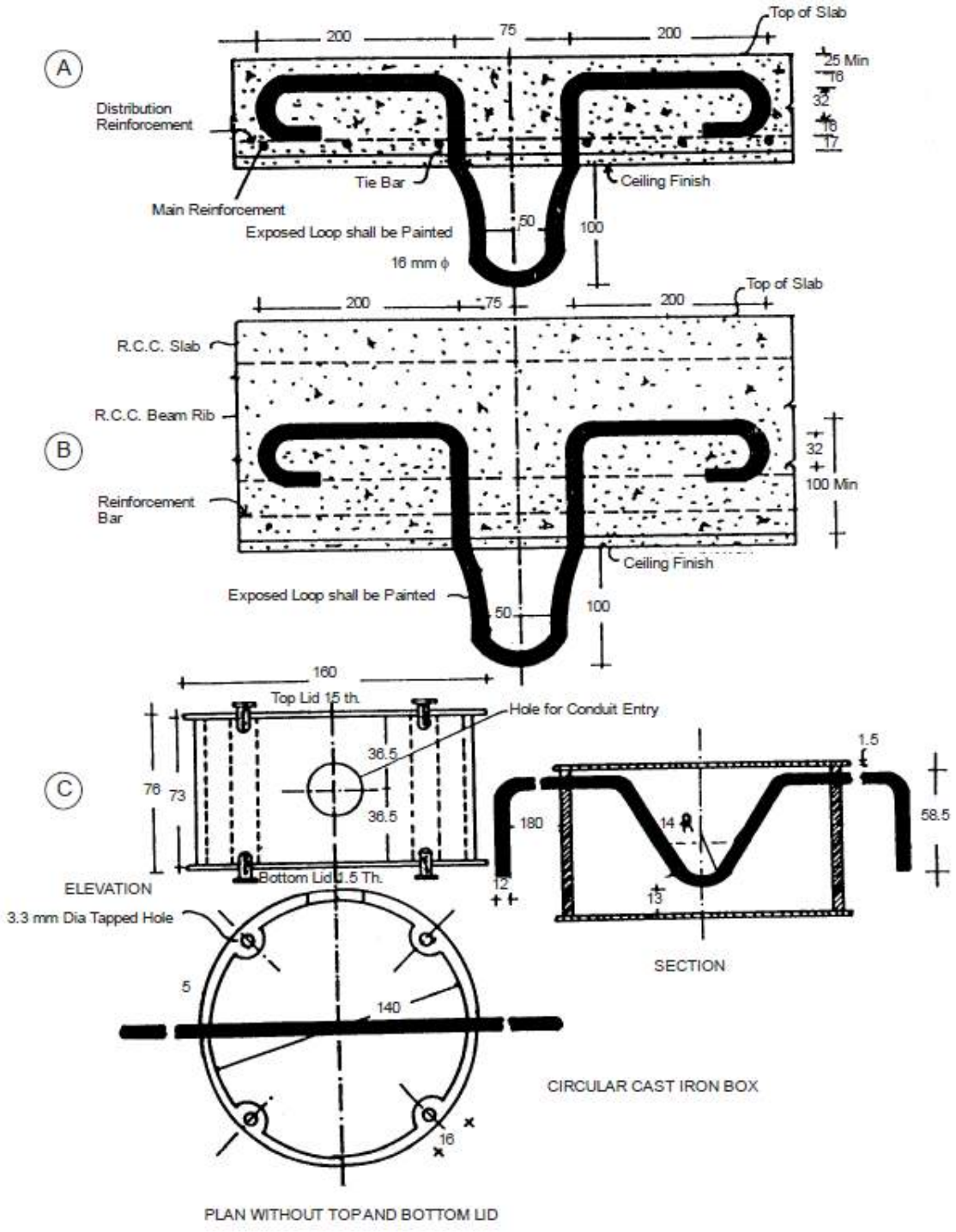
DOUBLE LEAF DOOR FRAME

Drawing not to Scale
All dimensions in millimeters

Fig. 10.8 (Contd.) : Location of Shock Absorbers, Lock-Strike Plate and Aldrop

FAN CLAMPS

Sub Head : Steel Work
Clause : 10.14



Drawing not to Scale
All dimensions in millimeters

Fig. 10.9 : Fan Clamps

SUB HEAD : 11.0

FLOORING

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Mandatory Tests	529
	List of Bureau of Indian Standards Codes	531
11.1	Brick on Edge Flooring	533
11.2	Cement Concrete Flooring	534
11.3	Cement Concrete Flooring with Metallic Hardner Topping	536
11.4	Cement Plaster in Risers of Steps, Skirting & Dado	537
11.5	Cement Concrete Pavement in Courtyard and Terrace, etc.	538
11.6	Terrazo (Marble Chips) Flooring laid in situ	538
11.7	Terrazo (Marble Chips) Skirting in situ	541
11.8	Wax Polishing	541
11.9	Crazy Marble Flooring	542
11.10	Terrazo Tile Flooring	543
11.11	Terrazo Tiles in Risers of Steps, Skirting & Dado	545
11.12	Chequered Tile Flooring	546
11.13	Chequered Tiles in Stair Treads	547
11.14	Acid or Alkali Resistant Tiles	548
11.15	Pressed Ceramic Tiles Flooring	549
11.15A	Pendulum test for skid resistance	551
11.16	Pressed Ceramic Tile Flooring (Vitrified Tile Flooring)	551
11.17	Fixing of Tile Flooring with Cement based High Polymer Modified Quick Set Adhesive (Water Based)	552

11.18	Pressed Ceramic Tiles in Skirting & Dado. (Clause Shifted to 8.19)	552
11.19	Marble Stone Flooring	552
11.20	Marble Stone in Risers of Steps and Skirting	554
11.21	Kota Stone Flooring	554
11.22	Kota Stone in Risers of Steps, Skirting & Dado	555
11.23	Red or White Fine Dressed Sand Stone Flooring	555
11.24	Red or White Fine Dressed and Rubbed Sand Stone Flooring	556
11.25	Wooden Flooring	557
11.26	Wood Block Flooring	558
11.27	Turf Paver	559
11.28	Border Tiles	560
11.29	Epoxy based Grouting for Tiles	560
11.30	Italian Marble Stone Flooring	561
11.31	Flamed Finish Granite Stone Flooring	561
Appendix A	Abrasion Test for Concrete Hardening Compounds	562
Appendix B	Test Requirements and Procedure for Testing Pre-Cast Cement Concrete/Terrazo Tiles	563
Fig. 11.1	Crazy Marble Flooring	564
Fig. 11.2	Chequred Terrazo Tiles	565

LIST OF MANDATORY TESTS

Material	*Clause*	*Test*	*Field/ Laboratory Test*	*Test Procedure*	*Min. quantity of material for carrying out the test*	*Frequency of testing*
1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*
Terrazzo Tiles	11.10.1 & 11.11.1	1. Transverse strength 2. Water absorption 3. Abrasion test	Laboratory	I S: 1237	5000 Nos. (no testing need be done if total number of tiles of all types of all sizes from all Manufacturers used in a work is less than 5000 Nos)	One test for every 10,000 Nos. or part thereof for each type and size from a single manufacturer. (One test to be done even if the number of terrazo tiles of any type and size from a single manufactur- ers is less than 5000 Nos. provided the total number of terrazo tiles of all types and sizes from all manufacturers used in a work exceed 5000 Nos
Pressed Ceramic tiles (for floor)	11.4,11.5& 11.16	1. Dimensions and surface quality 2. Physical properties 3. Chemical properties	Laboratory	I S: 13630	3000 Nos.	3000 Nos. or part ereof

LIST OF BUREAU OF INDIAN STANDARDS CODES

S.No.	*IS No.*	*Subject*
1.	IS 269	Specification for 33 grade ordinary portland Cement
2.	IS 401	Code of practice for preservation of timber
3.	IS 451	Technical supply conditions for wood screws
4.	IS 455	Specification for portland slag cement
5.	IS 661	Code of practice for thermal insulation of cold storages
6.	IS 702	Specification for industrial bitumen
7.	IS 1124	Method of test for determination of water absortion, apparent specific gravity and porosity of natural building stones
8.	IS 1130	Specification for marble (blocks, slabs and tiles)
9.	IS 1141	Code of practice for Seasoning of timber
10.	IS 1200-(Part XI)	Method of measurement of Building and Civil Engineering work (Part 11) paving, floor finishes, dado and skirting
11.	IS 1237- Edition 2.3	Specification for cement concrete flooring tiles
12.	IS 1322	Specification for bitumen felts for water proofing and damp-proofing
13.	IS 1443	Code of practice for laying and finishing of cement concrete flooring tiles
14.	IS 1489 (Part-I)	Specification for portland pozzolana cement (Part-I) flyash based
15.	IS 1489-(Part II)	Specification for Portland pozzolana cement (Part II) calcined clay based
16.	IS 1580	Specification for bituminous compounds for water proofing and caulking purpose
17.	IS 2114	Code of practice for laying in-situ terrazzo floor finish
18.	IS 2571	Code of practice for laying in-situ cement concrete flooring
19.	IS 3622	Specification for sand stone (Slab & Tiles)
20.	IS 3670	Code of practice for construction of timber floors
21.	IS 4457	Acid and/or alkali Resistant tiles.
22.	IS 5318	Code of practice for laying of hard wood parquet and wood block floors
23.	IS 5766	Code of practice for laying of burnt clay brick floor
24.	IS 8041	Specification for rapid hardening portland cement

25.	IS 8042	Specification for white portland cement
26.	IS 8043	Specification for hydrophobic portland cement
27.	IS 8112	Specification for 43 grade ordinary portland cement
28.	IS 12330	Specification for sulphate resisting portland cement.
29.	IS: 13630 (Part-1 to 15)	Methods of Testing of ceramic tiles
30.	IS 13712	Specification for ceramic tiles; definition, classification characteristic and marking
31.	IS 15622	Specification for pressed ceramic tile

11.0 FLOORING

11.1 BRICK ON EDGE FLOORING

11.1.1 Bricks

Bricks of Specified class designations shall be used. These shall conform to the specifications described in Subhead 6.0. Broken bricks shall not be used in flooring except for closing the line. The bricks shall be laid on edge.

11.1.2 Mortar

The mortar used shall be as specified (in case of dry bricks flooring fine sand shall be filled in the joints).

11.1.3 Base Concrete

11.1.3.1 Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slope required for the flooring. Floors in verandah, courtyard kitchens, baths shall have slope ranging from 1 : 36 to 1 : 48 depending upon locations as decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1 : 30 or as decided by the Engineer-in-Charge to drain off washing water. Plinth masonry off-set shall be depressed so as to allow the base concrete to rest on it.

11.1.3.2 If the base is of lean cement concrete, the flooring shall commence within 48 hours of the laying of base, failing which, the surface of base shall be roughened with steel wire brushes without disturbing the concrete. Before laying the flooring the base shall be wetted and smeared with a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between sub-grade and flooring.

11.1.3.3 Where base concrete is not provided, the earth below shall be properly sloped, watered, rammed and consolidated. Before laying the flooring, it shall be moistened.

11.1.4 Soaking of Bricks

Bricks required for flooring shall be perfectly soaked in stacks before use, by profusely spraying clean water at regular intervals for a period of not less than six hours so as to keep them wet to the satisfaction of the Engineer-in-Charge. (In case the joints are to be filled with sand, the bricks need not be soaked).

11.1.5 Laying

11.1.5.1 The bricks shall be laid on the edge, diagonal herring bone bond, or other pattern as specified or directed by the Engineer-in-Charge.

11.1.5.2 Bricks shall be laid on edge on 12 mm thick mortar of specified ratio bed and each brick shall be properly bedded and set home by gentle tapping with trowel handle or wooden mallet. Its inside face shall be buttered with mortar, before the next brick is laid and pressed against it.

11.1.5.3 On completion of a portion of flooring, the vertical joints shall be fully filled from the top with mortar. During laying, the surface of the flooring shall be frequently checked with a straight edge of length at least 2 m, so as to obtain a true plain surface with the required slope.

11.1.6 Joints

Bricks shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 1.0 cm for brick work with bricks of any class designation. All face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. The face of brick work shall be cleaned on the same day on which brick work is done and all mortar droppings removed promptly.

11.1.7 Curing

Brick work shall be protected from rain by suitable covering when the mortar is green. Brick work in cement mortar, shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

11.1.8 Measurements

Length and breadth of the flooring shall be measured correct to a cm and area shall be calculated in square metres correct to two places of decimal. Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

Brick flooring when laid in diagonal herring bone bond or other pattern as specified or directed by the Engineer-in-Charge shall be measured separately.

11.1.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above, including application of cement slurry on base concrete or RCC slab and cleaning of base. Base concrete shall be paid for separately.

11.1.10 Dry Brick Flooring

All provisions of para's 11.1.1 to 11.1.8 will be applicable except that bricks need not be soaked. Bricks will be laid on a bed of 12 mm thick mud mortar laid to required slope. The joints shall be as thin as possible and not exceeding 5 mm which will be filled with fine sand. No curing is to be done.

11.1.10.1 ***Rate:*** The rate shall include the cost of all materials and labour involved in all the operations described above.

11.2 CEMENT CONCRETE FLOORING

11.2.1 Cement Concrete

Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications described under sub head 4.0 .

11.2.2 Base Concrete

11.2.2.1 Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, Courtyard, kitchens & baths shall have slope ranging from 1 : 48 to 1 : 60 depending upon location and as decided by the Engineer-in- Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer -in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6 mm to 10 mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

11.2.2.2 The flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

11.2.2.3 If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

11.2.3 Thickness

The thickness of floor shall be as specified in the description of the item.

11.2.4 Laying

11.2.4.1 ***Panels :*** Flooring 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 450 mm 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 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

11.2.4.2 ***Laying of Flooring with Strips :*** Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4 mm thick glass strips or 2 mm PVC strips or 2 mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun. Cost of providing and fixing strips shall be paid for separately.

Concreting : 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 be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

11.2.4.3 ***Laying of Flooring without Strips :*** Laying of cement concrete flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.

Shuttering : The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

Concreting : The concreting shall be done in the manner described under 11.2.4.2. The angle iron/ flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1 : 2 (1 cement : 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

11.2.5 Finishing

11.2.5.1 The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

11.2.5.2 Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

11.2.5.3 The edges of sunk floors shall be finished and rounded with cement mortar 1:2 (1 cement : 2 coarse sand) and finished with a floating coat of neat cement.

11.2.5.4 The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

11.2.5.5 The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

11.2.6 Curing

The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remanents of cement dust from the bags.

11.2.7 Precautions

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38° C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

11.2.8 Measurement

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

11.2.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning the surface but excluding the cost of strips which shall be paid separately under relevant item. Nosing of steps where provided shall be paid for separately in running metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

11.3 CEMENT CONCRETE FLOORING WITH METALLIC HARDENER TOPPING

11.3.0 Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardner is justified on the basis of cost. Where metallic hardener topping is used, it shall be 12 mm thick.

11.3.1 Metallic Hardening Compound

The compound shall be of approved quality consisting of uniformally graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. Where so directed by the Engineer-in-Charge it shall be tested as described in Appendix A.

11.3.2 Base Concrete

It shall be as specified in 11.2.2.

11.3.3 Under Layer

Cement concrete flooring of specified thickness and mix (mentioned in item for under layer) shall be laid as under layer (11.2.1 and 11.2.4). The top surface shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping.

11.3.4 Topping

This shall consist of 12 mm thick layer of mix 1:2 (1 cement : 2 stone aggregate 6 mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1 : 4 (1 metallic concrete hardener : 4 cement) by weight. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6 mm nominal size or as otherwise specified in the ratio of 1 : 2 (1 cement : 2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 to 4 hours of its laying. The topping shall be laid 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.

The junction of floor with wall plaster, dado or skirting and finishing operations shall be dealt with as described in 11.2.5.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as to prevent damage to new work.

11.3.5 The specifications for curing, precautions to be taken, 'Measurements' and 'Rates' shall be as specified in 11.2.

11.4 CEMENT PLASTER IN RISERS OF STEPS, SKIRTING, DADO

11.4.0 Plaster at the bottom of wall not exceeding 30 cm in height above the floor shall be classified as skirting. It shall be flush with wall plaster or projecting out uniformly by 6 mm from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor. It's corners and junctions with floor shall be finished neatly as specified.

11.4.1 Thickness

The thickness of the plaster specified shall be measured exclusive of the thickness of key i.e. grooves or open joints in brick work. The average thickness shall not be less than the specified thickness. The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges. Extra thickness required in rounding of corners at junctions of wall shall be ignored.

11.4.2 Preparation of Wall Surface

The joints shall be raked out to a depth of at least 15 mm 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.

11.4.3 Application

Skirting with specified mortar and to specifed thickness 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.

11.4.4 Finishing

The finishing of surface shall be done simultaneously with the borders or the adjacent panels of floor. 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.

Where skirting is flush with plaster, a groove 10 mm wide and upto 5 mm deep shall be provided in plaster at the junction of skirting with plaster.

11.4.5 Curing

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.

11.4.6 Measurement

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimals for a specified the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm.

11.4.7 Rate

Rate shall include the cost of all materials and labour involved in all the operations described above.

11.5 CEMENT CONCRETE PAVEMENT IN COURTYARD AND TERRACE ETC.

11. 5.1 Specifications described in 11.2.1, 11.2.2.1, 11.2.3, 11.2.4, 11.2.6 and 11.2.7 shall hold good as far as applicable except that :

(i) The panels shall be of uniform size and no dimension of a panel shall exceed 1.25 m and the area of panel should not exceed 1.25 sqm for the thickness of panels upto 50 mm.
(ii) Concreting shall be done in alternate panels only and no glass/asbestos strips shall be provided.

11.5.2 Finishing

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some-time, till moisture disappears from it or surplus water can be mopped up.

Use of dry cement or cement and sand mix on the surface to stiffen the concrete or to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided. When the surface becomes fairly stiff, it shall be finished rough with wooden floats or where so specified chequered uniformly by pressing a piece of expanded metal of approved size.

11.5.3 Measurements

Same as 11.2.8 except that the volume will be calculated in cum nearest to two decimal places.

11.5.4 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above except the base concrete below flooring which shall be paid for separately. Chequering to pattern shall be paid for separately unless otherwise specified.

11.6 TERRAZO (MARBLE CHIPS) FLOORING LAID IN SITU

11.6.1 Under Layer

Cement concrete of specified mix shall be used and the specifications given under sub head 4.0 shall apply. The panels shall be of uniform size, not exceeding 2 sqm in area or 2 m in length for inside situations. In exposed situations, the length of any side of the panel shall not be more than 1.25 metre. Cement slurry @ 2.00 kg per sqm shall be applied before laying of under layer over the base cement concrete/RCC base.

11.6.2 Fixing of Strips

4 mm thick glass strips or 2 mm thick PVC strips/aluminium strips/brass strips / stainless steel strips/copper strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or of any other material of specified thickness can also be used if specifically required. Use of glass and metallic strips shall be avoided in areas exposed to sun. The fixing and laying shall be as specified in para 11.2.4.2.

11.6.3 Top Layer

11.6.3.1 ***Mortar :*** The mix for terrazo shall consist of cement with or without pigment, marble powder, marble aggregate (marble chips) and water. The cement and marble powder shall be mixed in the proportion of three parts of cement to one part marble powder by weight. For every part of cement marble powder mix, the proportion of aggregate by volume shall be as shown in Table 1.

The marble chips shall be white or pink Makrana, black Bhainslana, Chittoor black, Jaisalmer Yellow, Baroda green, Dehradun white, Chittoor pink, yellow Patam cherala (Madras), grey Gadu (Surat), Chittoor green and yellow and Alwar black or as specified. It shall be hard, sound, dense and homogenous in texture with crystaline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. The maximum thickness of the top layer for various sizes of marble aggregates (marble chips) shall be as shown in Table 11.1 below:

TABLE 11.1

Grade No	*Size of Aggregates in (mm)*	*Proportion of Aggregates to Binder Mix*	*Minimum Thickness of Top Layer (mm)*
00	1—2	1.75: 1	6
0	2—4	1.75: 1	6
1	4—7	1.75: 1	9
2	7—10	1.5: 1	12

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than one and one third times the maximum size of the chips. Where large size chips such as 20 mm or 25 mm are used, they shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of wearing layer.

Before starting the work, the contractor shall get the sample of marble chips approved from the Engineer -in -Charge. This shall be done in advance by mixing different colour marble chips and panel samples of minimum 1 m x 1 m size shall be prepared and got approved from the Engineer-in -charge before laying of flooring. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the Engineer-in-Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour. This mixture shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogenous and stiff and contain just sufficient water to make it workable.

The terrazo topping shall be laid while the under layer is still plastic, but has hardened sufficiently to prevent cement from rising to the surface. This is normally achieved between 18 to 24 hours after the under layer has been laid. A cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. It shall be laid to a uniform thickness slightly more than that specified in order to get the specified finished thickness after rubbing. The surface of the top layer shall be trowelled over, pressed and brought true to required level by a straight edge and steel floats in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface.

11.6.3.2 ***Curing, Polishing and Finishing :*** The surface shall be left dry for air-curing for a duration of 12 to 18 hours depending on atmospheric temperature conditions. It shall then be cured by allowing water to stand in pools over it for a priod of not less than 4 days.

The grinding and polishing may be commenced not before 2 days from the time of completion of laying for manual grinding and not before 7 days for maching grinding. For polishing by machines, the surface shall be watered and ground evenly with machine fitted with special rapid cutting grit blocks (carborundum stone) of coarse grade (No. 60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter in same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to dry for 24 hours and wet cured for 4 days and then rubbed with machine fitted with fine grit blocks (No. 120). Curing shall be done by ponding of water between panels formed with fine sand. The surface is cleaned and repaired as before and allowed to cure again for 3 to 5 days. Finally the third grinding shall be done with machine fitted with mere fine grade grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of fine grade (No. 120) for final rubbing polishing.

After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface @ 33 gm per square metre sprinkled with water and rubbed hard with a nemdah block (Pad of Woolen rags). The following day, the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

Curing shall be done by suitable means such as laying moist sawdust or ponding water.

11.6.4 Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

11.6.5 Measurements

11.6.5.1 Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. The area as laid shall be calculated in sqm correct to two decimal places.

The thickness of the under layer shall be measured correct to a cm. The thickness of top layer shall not be less than that specified.

No deduction shall be made, nor extra paid for voids not exceeding 0.20 square metre. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard.

11.6.5.2 Terrazo (Marble Chips) flooring laid as floor borders, margins and similar bands upto 30 cm width and on staircase treads shall be measured under the item of terrazo flooring but extra shall be paid

for such work. This extra in the case of staircase treads shall include the cost of forming the nosing also. However, moulded nosing shall be paid for staircase treads etc. extra in running metres except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall also be paid for laying flooring in narrow bands not exceeding 7.5 cm in width and such bands shall be measured in running metres for this purpose.

11.6.5.3 Dividing strips inserted in terrazo to form bays, patterns shall be described stating the materials, its width and thickness and measured in running metres.

11.6.5.4 Special surface finishes to treads, risers and the ends of concrete steps and the like shall be measured separately and given in square metres and shall include form work, if required.

11.6.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including cleaning of surface of RCC slab or base concrete and application of cement slurry but shall not include the cost of base concrete and cost of providing and fixing strips of glass or aluminium or of any other material used for making panels, which shall be paid for separately.

11.7 TERRAZO (MARBLE CHIPS) SKIRTING IN SITU

11.7.1 Under Coat

The under coat of skirting shall be of cement plaster of the thickness and mix described in the item. Specifications given under 11.4.0, 11.4.1 and 11.4.2 shall apply. As regards application, the work shall be carried out in the manner described in para 11.4.3 except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

11.7.2 Top Coat

The specifications as in para 11.6.3 shall hold good as far as applicable and shall include cutting to line and fair finish to top edges of terrazo and polishing.

11.7.3 Thickness

The thickness of the bottom and top coats shall be as specified. The total thickness of skirting specified is of the total thickness of plaster including top coat as measured from the unplastered face of the masonry. Average thickness of the under coat shall not be less than 6 mm and minimum thickness over any portion of the surface shall not be less than 4 mm. The thickness of top coat shall not be less than the thickness specified.

11.7.4 Measurements

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. Length shall be measured as finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm where the height of skirting does not exceed 30 cm and when the height exceeds 30 cm it shall be measured correct to a cm.

11.7.5 Rates

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.8 WAX POLISHING

11.8.1 Application, Polishing and Precautions

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the floor/skirting.

11.8.2 When the layer of the wax is stiffened and surface of floor is saturated with the polish, polishing shall be resorted with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

11.8.3 The fresh polished floor surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed**.**

11.8.4 Measurements

Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal.

11.8.5 Rates

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.9 CRAZY MARBLE FLOORING (Fig. 11.1)

11.9.1 Base Concrete

Crazy marble stone flooring shall be laid on cement concrete base. The base concrete shall be provided with slope required for the flooring in verandahs and courtyards to drain off washing and rain water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating cost of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between base and flooring.

Before laying the flooring on RCC slabs, the laitance shall be removed, the surface of slab hacked and a coat of cement slurry at rate of 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between RCC slab and floor.

11.9.2 Under Layer

The under layer of crazy marble flooring shall be of cement concrete of thickness 25 mm or as specified. The mix shall normally be 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) by volume unless otherwise specified. It shall conform to the specifications given under para 4.2 of sub-head 'Cement Concrete'.

11.9.3 Top Layer

The mix of crazy marble stone flooring shall consist of white cement with or without pigment, marble powder, marble chips of 00 Nos. and marble stone pieces and water. The marble stone pieces shall be hard, sound, dense and homogenous in texture with crystaline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. Before starting the work the contractor shall get the sample of marble stone approved by the Engineer- in-Charge. The marble stone pieces shall be of sizes as approved by the Engineer-in-Charge but the thickness shall be according to the overall thickness specified which could be achieved when laid over the under layer as specified. Thus for 50 mm thick floor, the thickness of marble pieces will be 25 mm while for 40 mm thick floor, the thickness will be 15 mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix. The marble chips shall be as specified. It shall be hard, sound, dense and homogeneous in texture. It shall be uniform in colour and free from stains, cracks decay and weathering.

11.9.4 Laying

A coat of cement slurry at the rate of 2 kg of cement per sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

11.9.5 Polishing

Curing and Finishing shall be as described in 11.6.3.2.

11.9.6 Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned.

11.9.7 Measurements

Length and breadth shall be measured correct to a cm before skirting, dado or wall plaster and it shall be calculated in sqm correct to two decimal places. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying floor at different levels in the same room or courtyards.

11.9.8 Rate

The rates shall include the cost of all materials and labour involved in all the operations described above including the cost of cleaning of RCC slab surface and applying the cement slurry, but it shall not include the cost of base concrete.

11.10 TERRAZO TILE FLOORING

11.10.1 Terrazo Tiles

Terrazo tiles shall generally conform to IS 1237-Edition 2.3. Requirements and methods of testing of tiles are described in Appendix B. Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of wearing layer.

The size of tiles shall be as given in Table 11.2 or as shown in the drawings or as required by the Engineer-in-Charge. Half tiles for use with the full tiles shall be such as to make two half tiles when joined together, match with the dimensions of one full tile.

TABLE 11.2

Length Nominal	*Breadth Nominal*	*Thickness not less than*
200 mm	200 mm	20 mm
250 mm	250 mm	22 mm
300 mm	300 mm	25 mm

11.10.1.1 ***Tolerance :*** Tolerances on length and breadth shall be plus or minus one millimetre, and tolerance on thickness shall be plus 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness.

11.10.1.2 The tiles shall be manufactured in a factory under pressure process subjected to hydraulic pressure of not less than 140 kg per square centimetre and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded.

11.10.1.3 The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight. Where colouring material is used in the wearing layer, it shall not exceed 10 per cent by weight of cement used in the mix.

11.10.1.4 The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest upto 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for size of marble chips varying from the smallest upto 20 mm.

11.10.2 Laying

11.10.2.1 Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion and in conformity with provisions in relevant para of chapter on 'Mortar'.

Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

11.10.2.2 Cement mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set. If cement mortar is laid in bedding the terrazo tiles, these shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with cement grout of matching colour.

11.10.2.3 The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.

11.10.2.4 Where full tiles or half tiles can not be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.

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

11.10.2.6 After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

11.10.3 Curing, Polishing and Finishing

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

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

11. 10.3.3 The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

11.10.3.4 For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No. 80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

11.10.3.5 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 the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

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

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

11.10.4 Measurements

11.10.4.1 Terrazo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazo tile flooring shall be measured separately according to para 11.6.5 Terrazo tile flooring shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm before laying skirting, dado or wall plaster shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room or courtyard.

11.10.4.2 Terrazo tile flooring laid in floor borders and similar band shall be measured under the item of terrazo tile flooring. Nothing extra shall be paid in respect of these and similar bands formed of half size or multiplies of half size standard tiles or other uncut tiles.

11.10.4.3 Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running metre except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

11.10.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Where cement mortar bedding is used in place of lime mortar the rate will be adjusted accordingly.

11.11 TERRAZO TILES IN RISERS OF STEPS, SKIRTING AND DADO

11.11.1 The terrazo tiles shall be as specified in 11.10.1, as far as applicable. The minimum finished thickness of tiles shall, however, be 12 mm. The finished thickness of the upper layer shall be not less than 5 mm for size of marble chips from the smallest upto 12 mm and not less than 6 mm for size of chips varying from the smallest upto 20 mm. Where the bigger sized chips are used the tiles shall be not less than 20 mm thick. The requirements of transverse strength tests specified in Appendix B, shall not apply when the tiles used are less than 20 mm thick.

11.11.2 Preparation of Surface

The specification for this shall be same as specified in 11.4.2.

11.11.3 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) or mix as specified, shall then be applied and allowed to harden. The plaster shall then be roughened with wire brushes or by scratching diagonal lines 2 mm deep at approximately 7.5 cm centres both ways. The back of tiles shall be buttered with a coat of grey cement slurry and edges with grey or white cement slurry with or without pigments to match the shade of tiles, and set in the bedding mortar. These shall be tamped and corrected to proper planes and lines. The tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal with projection from finish wall surface not more than tile thickness and joints truly vertical except where otherwise indicated.

The risers of steps, skirting or dado shall rest on the top of the tread or flooring. Where full size tiles cannot be fixed, the tiles shall be cut (sawn) to the required size and their edges rubbed smooth.

11.11.4 Curing, Polishing and Finishing

The specifications as in 11.10.3 shall hold good as far as applicable. Polishing shall be done only with hand.

11.11.5 Measurements

The thickness of the skirting shall be as stated. Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread or floor to the top (the underside of tread in the case of steps). This shall be measured correct to 5 mm in case of risers and skirting (not exceeding 30 cm in height). In case of heights more than 30 cm, as in the case of dado and on walls, the height shall be measured correct to a cm and such work shall be paid for separately. The area shall be calculated in square metre, correct to two places of decimal.

Where the height of risers, skirting or dado does not admit of full size or other finished size tiles and the tiles are to be cut (sawn), nothing extra shall be paid for the same.

11.11.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

Nothing extra shall be payable for use of cut (sawn) tiles to suit the size of risers, skirting, portions of dado etc.

11.12 CHEQUERED TILE FLOORING

11.12.1 Chequered Tiles

The tiles shall be of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in- Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.

The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or terrazo tiles as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm.

The terrazo tiles shall be given the first grinding with machine before delivery to site.

The tiles shall conform to the specifications for plain cement concrete or terrazo tiles in respect of method of manufacture and the mix of the backing and wearing layers.

11.12.2 Laying, curing, Polishing and Finishing shall be as specified in 11.10.2 and 11.10.3 except that the polishing of the tiles and the chequer grooves, after laying, may be done by hand. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as described above.

11.12.3 Measurement and Rate: Shall be as specified in 11.10.4 and 11.10.5.

11.13 CHEQUERED TILES IN STAIR TREADS (FIG. 11.2)

11.13.1 Chequered Tiles

The specifications for tiles shall be as specified in 11.12.1 except in the following respects :

(1) The length of the tiles including nosing shall be as specified.

(2) The nosing edge of the tile shall be rounded.

(3) The minimum thickness of the tile shall be 30 mm.

(4) The front portion of the tile for a minimum length of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centres not exceeding 25 mm. Beyond that the tiles shall have the normal chequer pattern.

(5) The nosing shall also have the same wearing layer as the top.

11.13.2 Preparation of Surface and Laying

11.13.2.1 RCC or brick work in treads on which the tiles are to be laid shall be cleaned wetted and mopped. The bedding for tiles shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or of specified mix. The minimum thickness of bedding mortar at any place shall be 10 mm. Bedding mortar shall be spread, tamped and corrected to proper levels. After laying bedding mortar, neat grey cement slurry of honey like consistency shall be spread over the mortar at the rate of 4.4 kg of cement per square metre over each tread. Tiles shall be washed cleaned and shall be fixed in this grout butting one at another. Each tile being gently tapped with a wooden mallet till it is properly bedded, and is in level and line with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines. The surface shall be checked with a straight edge during laying to obtain a true surface.

11.13.2.2 The square end of the tile shall, as far as possible butt against the riser face of the concrete or brick tread and in any case shall be embedded under the side wall plaster, skirting or dado and under the riser tile or other finish to a depth of not less than 10 mm.

11.13.2.3 Where full size tiles cannot be fixed, these shall be cut (sawn) to the required size (along the groove of the chequers where the cut edge is exposed) and used. The cut in the case of embedded edges will be neat and true while the cut in the case of exposed edges shall in addition be rubbed smooth to ensure a straight and true joints.

11.13.2.4 After the tiles have been laid surplus cement grout shall be cleaned off.

11.13.3 Curing, Polishing and Finishing

The specifications shall be as described in 11.10.3 except that polishing of the treads nosing and chequered grooves, after laying, may be done by hand in the same manner as specified under terrazo tile flooring. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform, section for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

11.13.4 Measurements

Chequred tiles on stair treads shall be measured in square metre correct to two places of decimal. Length shall be measured correct to a cm before laying skirting, dado or wall plaster. Width shall be measured correct to a cm from the outer edge of the nosing, as laid, before providing the riser. In the case of the edge tiles of the landing and wide steps, width shall be measured upto the near edge of the chequered stair tread tiles. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.13.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

Nothing extra shall be payable for cutting the tiles to suit the size of treads and also for nosing.

11.14 ACID OR ALKALI RESISTANT TILES

11.14.0 Manufacture and Finish

The 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 ^{0}C and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to shope, flat and free from flows and manufacturing defects affecting their utility.

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

11.14.1 Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 X 98.5 mm, 148.5 X 148.5 mm and 198.5 X 198.5 mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be $\pm$ 2 percent.

11.14.2 Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for squareness and warp as per IS 4457.

11.14.3 Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

11.14.4 Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

11.14.5 Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture.

Each tile may also be marked with the ISI certification mark.

11.14.6 Preparation of Surface and Laying

Preparation of surface and laying to be according to para 11.15.4, except the cement used to be acid and or alkali resistant cement and cement mortar to be used to be acid and or Alkali resistant mortar. Thickness of bedding of mortar for flooring to be 10 mm or specified on the item and for dado/skirting to be 12 mm or specified on item.

11.14.7 Pointing and Finishing

As per para 11.15.5, except that cement used for pointing to be acid and or alkali resistant cement.

11.14.8 Measurements

As per para 11.15.6.

11.14.9 Rate

The rate for flooring shall include the cost of all materials and labor in volved in all the operations described above. For tiles of sizes upto 0.16 Sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Sawn) tiles in the work.

11.15 PRESSED CERAMIC TILE FLOORING

11.15.1 Pressed Ceramic Tiles

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.

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

The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for unrectified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).

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.

11.15.2 Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

11.15.3 Decorative Tiles

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

(i) **Decorated white back ground tiles**
The size of these tiles shall be as per IS 15622.

(ii) **Decorated and having coloured back-ground**
The sizes of the tiles shall be as per IS 15622.

11.15.4 Preparation of Surface and Laying

11.15.4.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

11.15.4.2 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.

11.15.4.3 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. 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.

11.15.4.4 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.

11.15.4.5 Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

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

11.15.4.6 After tiles have been laid surplus cement slurry shall be cleaned off.

11.15.5 Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.15.6 Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

11.15.7 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above, For tiles of sizes upto 0.16 sqm. unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

11.15A Pendulum Test for skid resistance

In case of skid resistance test, Pendulum should be done for dry and wet condition. The criteria of Pendulum reading for various types of flooring material for dry wet conditions is given in Table No. 11.3.

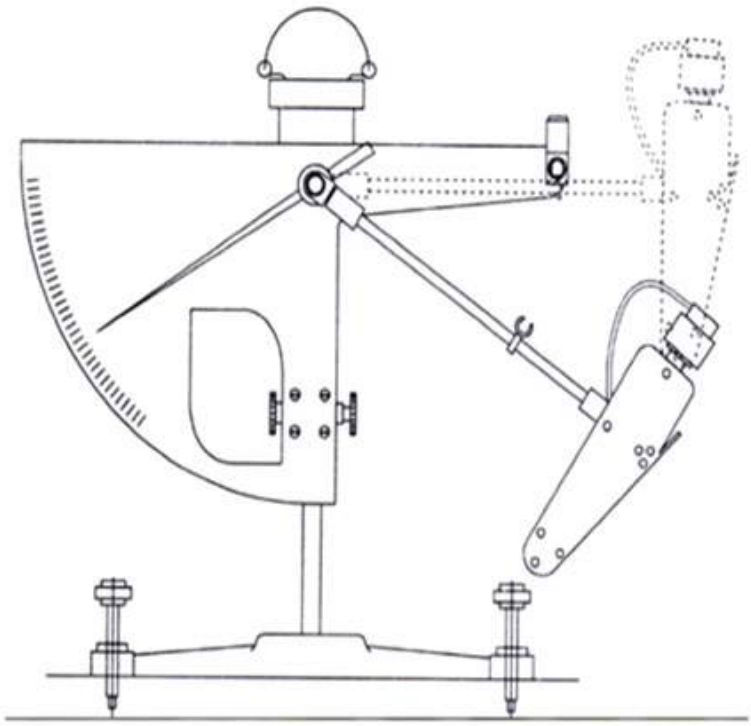
This test consists of Pendulum shaped apparatus that is allowed to fall from certain angle so that it rubs against the surface that is being tested. A four S rubber cap is fitted on its end & it is allowed to fall in a per pendulum arc depending upon the height reached after rubbing against the tested surface, a value is obtained that will be use to classify its slip resistance, is interpreted follows:-

Table No. 11.3

S. No	*Classification of flooring*	*Pendulum Reading (Range)*	*Remarks*
A.	Dry Areas	25 to 35	For all type of flooring material tested in dry condition
B.	Wet Areas	35 to 64	-do-

Note:

1. Dry areas – All spaces in residential building except toilet and kitchen.
2. Wet areas – Toilet and Kitchen in residential building, swimming pool, public places, etc.



Pendulum Test Method

11.16 PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)

11.16.1 Operations as described in 11.15.1 to 11.15.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption E d" 0.08 per cent Group BIa) and the joint thickness in flooring shall not be more than 1mm.

11.16.2 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

11.17 FIXING OF TILE FLOORING WITH CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)

11.17.1 When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand). Old cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.

11.17.2 High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used with in 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 3 mm 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.

11.17.3 The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

11.17.4 Where spacer lugs tiles are provided these shall be filled with grout with lugs remaining exposed.

11.17.5 Where full size tile can not be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

11.17.6 Finishing: para 11.15.5 shall apply.

11.17.7 Measurements: para 11.15.6 shall apply.

11.17.8 Rate

Provisions of para 11.15.7 and 11.16.2 shall apply.

11.18 Clause shifted to Sub Head 8 (Cladding work) as clause no 8.19

11.19 MARBLE STONE FLOORING

11.19.1 Marble Stone

It shall be as specified in sub head 8.0.

11.19.2 Dressing of Slabs

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. In case machine cut slabs are used, fine chiesel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machine rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 18, 30 or 40 mm as specified in the description of the item. Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of $\pm$ 2% shall be allowed.

11.19.3 Laying

11.19.3.1 Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as given in the description of the item.

11.19.3.2 The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

11.19.3.3 The slabs shall be laid in the following manner:

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 is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine 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. The flooring shall be cured for a minimum period of seven days. 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 1 mm.

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.

11.19.3.4 The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

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

11.19.3.6 Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

11.19.4 Polishing and Finishing

Slight unevenness at the meeting edges of slabs shall then be removed by fine chiselling and finished in the same manner as specified in 11.10.3 except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

11.19.5 Measurements

Marble stone flooring with different kind of marble shall be measured separately and in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. **In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimeter.** No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room. Steps and treads of stairs paved with marble stone slabs shall also be measured under the item of Marble Stone flooring. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm. Nosing for treads shall be measured in running metre and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

11.19.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. However, extra shall be paid for making special type of pattern/design/flowers as per drawings. No deductions shall be made in rate even if flooring is done without any pattern/design.

11.20 MARBLE STONE IN RISERS OF STEPS AND SKIRTING

11.20.1 Marble Stone Slabs and Dressing of Slabs shall be as specified in 11.19.1 and 11.19.2 except that the thickness of slabs shall be 18 mm. A tolerance of ± 3% mm shall be allowed, unless otherwise specified in the description of the item.

11.20.2 Preparation of Surface

It shall be as specified in 11.18.2 where necessary, 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.

11.20.3 Laying

The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12 mm and at no place the width shall be less than 10 mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed into the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement : 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

11.20.4 Curing, Polishing and Finishing

It shall be as specified in 11.11.4 as far as applicable, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

11.20.5 Measurements

Length shall be measured along the finished face of riser or skirting, correct to a cm. Height shall be measured from the finished level of tread or floor, to the top (the underside of tread, in the case of steps) correct to 0.5 cm. The areas shall be calculated in square metre correct to two places of decimal.

Dado and lining of pillars etc. shall be measured as 'Marble work in wall lining. If the thickness is upto 25 mm or as "Marble Work" in Jambs, walls, columns and other plain work' if the thickness is more.

11.20.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.21 KOTA STONE FLOORING

11.21.1 Kota Stone Slabs

The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

11.21.2 Dressing

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

The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the description of the item. Tolerance of ±2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

11.21.3 Preparation of Surface and Laying

The specification shall be as described in 11.19.3 except that 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 1 mm.

11.21.4 Polishing and Finishing

The specifications shall be as described in 11.19.3 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

11.21.5 Measurements and Rates

These shall be as described in paras 11.19.5 and 11.19.6.

11.22 KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO

11.22.1 Kota Stone Slabs and Dressing shall be as specified in 11.21.1 and 11.21.2 except that the thickness of the slabs shall be 25 mm or as specified in the description of the item. The slabs may be of uniform size if required.

11.22.2 Preparation of surface shall be as specified in 11.20.2.

11.22.3 Laying shall be as specified in 11.20.3 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

11.22.4 Curing, Polishing and Finishing shall be as specified in 11.20.4 except that first polishing with coarse grade carborundum stone shall not be done.

11.22.5 Measurements

Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). This shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

11.22.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.23 RED OR WHITE FINE DRESSED SAND STONE FLOORING

11.23.1 Stone Slabs

The slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone,

white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of slabs approved by the Engineer-in-Charge.

The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

11.23.2 Dressing of Slabs

Every slab shall be cut to the required size and shape and chisel dressed on all sides to a minimum depth of 20 mm. The top and the joints shall be fine tooled so that straight edge laid along the face is fully in contact with it. In case machine cut stones are used, chisel dressing and fine tooling of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surface is in contact with every point on it.

The thickness of the slabs after dressing shall be 40 mm or as specified in the description of item with a permissible tolerance of ± 2 mm.

11.23.3 Laying

11.23.3.1 Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:5 (1 cement : 5 coarse sand) or as given in the description of the item.

11.23.3.2 The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

11.23.3.3 The slab shall be laid in the following manner:

Mortar of specified mix shall be spreaded under each slab. The slab shall be washed clean before laying. It shall then be laid on top, pressed and larried, so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs, with thickness of joint not exceeding 5 mm. Subsequent slabs shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

11.23.3.4 In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge.

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

11.23.3.6 The finished floor shall not sound hollow when tapped with wooden mallet.

11.23.4 Finishing

In case of chisel dressed stone flooring slight unevenness, if any existing between the edges of slabs at joints shall then be removed by chiselling in a slant.

11.23.5 Measurements

These shall be as specified in para 11.19.5.

11.23.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

11.24 RED OR WHITE FINE DRESSED AND RUBBED SAND STONE FLOORING

11.24.1 Stone Slabs shall be as specified in 11.23.1.

11.24.2 Dressing

The specifications for dressing the top surface and the sides shall be as described in 11.23.2. In addition the dressed top and sides shall be table rubbed with coarse grade carborundum stone before paving, to obtain a perfectly true and smooth surface free from chisel marks.

The thickness of the slabs after dressing shall be as specified with a permissible tolerance of ± 2 mm.

11.24.3 Laying

The slabs shall be laid with 3 mm thick or 5 mm thick joints as specified in the description of the item.

Where the joints are to be limited to 3 mm thickness, the slabs shall be laid as specified in 11.19.3 except that the bedding mortar shall be as specified in 11.23.3 and sides of the slabs to be jointed shall be buttered with cement mortar 1:2 (1 cement : 2 stone dust) admixed with pigment to match the shade of the slab.

Where the slabs are to be laid with 5 mm thick joints, the specifications for laying shall be as described in 11.23.3.

11.24.4 Finishing shall be as specified in 11.23.4 except that chisel marks and unevenness shall be removed by rubbing with coarse grade carborundum stone.

11.24.5 Measurement and Rate shall be as specified in 11.23.5 and 11.23.6.

11.25 WOODEN FLOORING

11.25.0 Seasoning and Preservation

All timber used for timber floors shall be thoroughly seasoned in accordance with IS 1141. After seasoning the timber shall be treated with preservative in accordance with IS 401. Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

11.25.1 Supporting Joists

Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-Charge shall be fixed in position to dead levels. The width of the joints shall not be less than 50 mm. The arrangement and spacing of beams joists etc. shall be as per design furnished.

11.25.2 Boards

It shall be of the class of timber and thickness specified in the description of the item. The timber shall be as specified in para 9.1. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall not be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra.

Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the square butt type and shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

11.25.3 Iron Screws

Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm, subject to a minimum of 40 mm, and of designation No. 9 conforming to IS 451.

11.25.4 Fixing

The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.

The floor shall be planed in both directions and made perfectly even, true and smooth.

Note : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilation in the space below the floor in case of ground floor and between floor and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

11.25.5 Finishing

The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-in-Charge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid for separately unless specifically included in description of the flooring item.

11.25.6 Measurements

Length and breadth of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.25.7 Rate

The rate shall include the cost of the labour and materials involved in all the operations described above, with the exceptions noted in the relevant sub-paras.

11.26 WOOD BLOCK FLOORING

11.26.1 Wood Blocks

The wood blocks shall be of the class of timber specified in the description of the item and shall be in accordance with the .general specifications for 'Wood Work' given under para 9.1. The size of blocks shall be as shown in the drawings. The longitudinal edges of the blocks shall be dovetailed grooved near the bottom. The blocks shall be truly rectangular in shape with clean sharp edges and true faces. The top and sides shall be planed true. The thickness of the blocks shall be 38 mm unless otherwise specified. The timber used for making the blocks shall be thoroughly seasoned in accordance with IS 1141. After seasoning, the timber shall be treated with preservatives in accordance with IS 401.

11.26.2 Base Concrete

The specifications shall be same as in 11.2.2.

11.26.3 Levelling Concrete

The levelling layer of concrete shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm nominal size) by volume unless otherwise described in the item. Its thickness shall be 25 mm. Cement concrete shall be placed in position and levelled up with the help of a straight

edge and trowel. It shall then be beaten with wooden 'Thappy' or a mason's trowel till the cream comes up. The surface shall be finished with a wooden float to give a sand paper finish, plane and true to level. The finished level of the concrete shall be lower than the proposed finished level of the flooring by the specified thickness of the wooden blocks plus a minimum of 1.5 mm. The levelling layer shall be cured for a weak and then allowed to dry thoroughly, before paving with wood blocks.

11.26.4 Laying

The wood blocks shall be first laid 'dry' to the margin and pattern shown in the drawings or as directed by the Engineer-in -Charge. The blocks shall fit closely and sides and end shall be corrected by further planing if necessary to get closed and even joints. After the blocks have been fitted and matched they shall be removed and stacked in such a way as to facilitate their repaving in the same order.

The surface of the levelling course shall be thoroughly cleaned and a small area of the surface shall be coated with a thin layer of a hot bitumen such as blown type petroleum bitumen grade 85/25 of IS 702 or other equivalents, applied at a temperature of not less than 180° C and at the rate of 2.45 kg per square metre. The wood blocks shall then be taken in turn serially and be dipped in the same hot bitumen for about half their depth so as to coat thoroughly the bottom and part of the sides and quickly set and pressed into place to required patterns, on the previously coated concrete surface so that the dovetailed grooves at the edges of the blocks get filled up with bitumen. The joints of the work shall be very thin and fine.

When all the blocks shall have been set in position, the surface shall be cleaned of any bitumen droppings and planed or machined level and smooth.

The floor shall then be given a final smooth finish by rubbing down with sand paper.

Note: No wood of any kind shall be placed within 60 cm of any fire place or flue.

11.26.5 Finishing

The floor shall be Bees waxed or polished with ready made wax polish or given any other finish as required.

11.26.6 Measurements

Length and breadth of superficial areas of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.26.7 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above but shall not include the cost of base concrete bees waxing or other finishing unless otherwise specifically described in the item.

11.27 TURF PAVER

11.27.1 Turf Paver is used primarily for the creation of grass or gravel access pathways for heavy emergency vehicles and stabilization of areas such as overflow parking, home driveways, golf buggy and equestrian dressage arenas and paths, helicopter landing pads and boat parking rams. It also serves as a stabilizer for mild slopes and functions as an erosion control measure.

It is a high strength plastic module designed to contain and stabilize grass or decorative gravel with the ability to withstand heavy loads imposed by emergency vehicles such as fire trucks. It replaces asphalt and concrete to create permeable surfaces that may be turfed or planted with ground cover and enable these areas to blend into the aesthetics of their surroundings.

It consists of a network of sturdy porous cells which prevents soil compaction. It has top and bottom notches with a large open base that allow root and plant runners to spread freely for vigorous root development and promote healthy plant growth.

Advantages

(i) Supports heavy vehicular load
(ii) Does not hinder root and runner growth

(iii) Reduces erosion and soil migration
(iv) Easily installed and removed
(v) Conforms to uneven surfaces
(vi) Supports Green Building Certification

11.27.2 Applications

Fire engine access lanes, Pedestrian pathways, Residential driveways, Overflow & street shoulder parking areas, Golf buggy paths & Racetrack infields and pit areas 150 mm thick compacted bid of 20 mm nominal size stone aggregate shall be prepared by ramming and consolidation. 150 mm thick jamuna sand shall be spreaded, rammed and consolidated including watering and finishing smooth etc. as per direction of Engineer-in-Charge. The turf paver shall then be laid on finished smooth surface.

11.27.3 Technical Specifications

Description	**Specification**
Material	Polypropylene
Dimensions	500 mm x 500 mm
Height	40 mm
Cell Size (diagonal)	70 mm
Weight	4.3 kg/m^2 (Tolerance= (-) 1%)
Compressive Strength (unfilled)	150 t/m^2 (Tolerance= (-) 1%)
Compressive Strength (sand filled)	3000 t/m^2 (Tolerance= (-) 1%)
Service Temperature	-30 °C to 80 °C
Biological Resistance	Unaffected by moulds and algae
Chemical Resistance	Resistant to rot, oils, acids, alkalis, bitumen and naturally occurring soil chemicals

11.27.5 Measurements

Length and breadth correct to a cm of Turf paver surface shall be measured and area shall be calculated in sqm correct to two places of decimal.

11.27.6 Rates

The rate for Turf paver shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

11.28 BORDER TILES

11.28.1 Border tiles may be use to frame, highlight, and add a decorative edge finish to an area for perfection. Border tiles are often used in kitchens and bathrooms.

The preparation of surfaces, laying, curing and finishing shall be as described under clause 8.19.

11.28.2 Measurement

The length of border tile shall be measured in running metre correct upto a cm.

11.29 EPOXY BASED GROUTING FOR TILES

11.29.1 Epoxy Grout

Grout is the material that is used to fill the space between adjacent tiles and support the joints.

The Epoxy grout consists of mix of 0.70 kg of organic coated filler of desired shade and mixing of 0.10 kg of hardener and 0.20 kg of resin per kg.. They have very low water absorption, higher compressive strength and are resistant to staining and easy to maintain. Epoxy grout is a waterless mix formed by mixing a base material (part A) and a hardener (part B). These components are mixed at site just prior to grouting.

Generally, epoxy grouts require no additional sealer to protect the surface.

11.29.2 Application process

Surface preparation

It shall be ensured that tiles are firmly set and adhesive or mortar is completely dry for 24 hours. All spacers, pegs, ropes and string shall be removed and joints be cleaned by removing free loose dirt particles.

11.29.3 Preparing mix and application

The complete unit Part A (Base) and Part B (Hardener) shall be properly mixed in given ratio. The desired colour of grout shall be obtained by mixing required quantity of colour with base to ensure homogeneity.

The grout shall be pressed firmly by using a hard rubber squeeze into joints ensuring that joints are completely filled. Excess grout material shall be removed from joints and surface by moving squeeze on grout line after 22 to 25 minutes. The damp sponge shall be used in circular motion on tile surface to achieve the flush joint. After completion of work the grout haze shall be cleaned with clean water or soap solution. The suitable rubber gloves shall be used to avoid skin contact during application.

11.29.4 Measurement

Length and breadth of grouted tile area shall be measured correct to a cm and the area shall be calculated in sqm correct to two places of decimal.

11.29.5 Rates

The rate shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

11.30 ITALIAN MARBLE STONE FLOORING

Italian marbles Quarried and processed in Italy and these marble raw stones are imported from Italy to India. Italian marble is famous for rendering a high sheen and visual appeal to the ambiance in which it is installed. It is available all over world.

Italian Marble gives the rich appearance to the house floor, walls, Kitchen, rooms and bathroom with its beautiful colour and special lusters. Because of its elegant visual it is commonly used for the decorative purpose in buildings.

11.30.1 Italian Marble Stone

The Italian marble details shall be as specified in sub head 8.0. Other details such as dressing of slabs, laying ,polishing , finishing, measurements and rates shall be as specified in clause 11.19 with Italian marble stone in place of Indian marble stone.

11.31 FLAMED FINISH GRANITE STONE FLOORING

The process is often referred to as a “flamed” or “thermal” finish and can be best described as creating a textured look. To achieve the style, an intense flame is held at the stone’s wet surface. While firing it, the surface becomes so hot it bursts and a layer flakes away to reveal a rough, even texture.

It is especially used at a location of high importance to have a great finish for designs requiring a modern aesthetic.

11.31.1 Flamed Finish Granite Stone

Other granite details shall be as specified in sub head 8.0 . The flamed finish granite stone details shall be as specified in sub head 8.0. Other details such as dressing of slabs, laying ,polishing , finishing, measurements and rates shall be as specified in clause 11.19 with flamed finish granite stone in place of Indian marble stone.

APPENDIX A

ABRASION TEST FOR CONCRETE HARDENING COMPOUNDS

(Clause 11.3.1)

A-1 Preparation of Sample

25 mm cylinder shall be prepared in ratio 1:2 mix (1 cement: 2 grades stone aggregate 6 mm nominal size by weight) one each with and without the admixture of concrete hardening compound. The concrete hardening compound shall be used in the proportion by weight of cement as recommended by the firm. The cylinder shall be placed inside a damp box for 24 hours and then cured in water for 27 days. After that, they shall be subject to abrasion test on 'Dorry Type Avery Abrasion Testing Machine, using Emery powder No 80 as the abrasing medium under the condition given in para A-2 below:

A-2 Conditions of Test

(a) Area of rubbing surface shall be same in both the cylinders.

(b) Age of cylinder	28 days
(c) Duration of Test	60 minutes
(d) Total distance traverse During rubbing	About 2.4 km
(e) Pressure on rubbing surface	0.04 kg/cm^2

A-3 Results of Tests

The following observations shall be made in both the cases.

(a) Composition of the Test specimen

(b) Mean thickness rubbed away

(c) Percentage loss in weight

A-4 Remarks

Percentage loss in weight in the case of cylinders with concrete hardening compound, should not be more than 40% of the percentage loss in the case of cylinder without concrete hardening compound.

APPENDIX B

TEST REQUIREMENTS AND PROCEDURE FOR TESTING "PRE-CAST CEMENT CONCRETE/ TERRAZO TILES"

(Clause 11.10.1 & 11.11.1)

B-1 Sampling

The tiles required of carrying out test described below shall be taken by 'random sampling'. Each tile sample shall be marked to identify the consignement from which it was selected.

Minimum quantity of tiles for carrying out the test and frequency of test shall be as specified in the list of Mandatory Test. The number of tiles selected for each mandatory test shall be as follows"

(a) For conformity to requirements on shape and dimensions, wearing layer, and general quality - 12 tiles
(b) For wet transverse strength test - 6 tiles
(c) For resistance to wear test - 6 tiles
(d) For water absorption test - 6 tiles

Note: (1) The tests on the tiles shall not be carried out earlier than 28 days from the date of manufacture.

(2) The tiles selected for (a) may as well after verification of requirements, be used for (b).

B-2 Flatness of the Tiles Surface

The tiles when tested according to procedure laid down in IS 1237 edition 2.3, the amount of concavity and convexity shall not exceed 1 mm.

B-3 Perpendicularity

When tested in accordance with the procedure laid down in IS 1237 edition 2.3, the longest gap between the arm of the square and edge of the tile shall not exceed 2 per cent of the length of edge.

B-4 Straightness

When tested as per IS 1237 edition 2.3, the gap between the thread and the plane of tile shall not exceed 1 percent of the length of edge.

B-5 Water Absoption

When tested the average water absoption shall not exceed 10 per cent.

B-6 Wet Transverse Strength Test

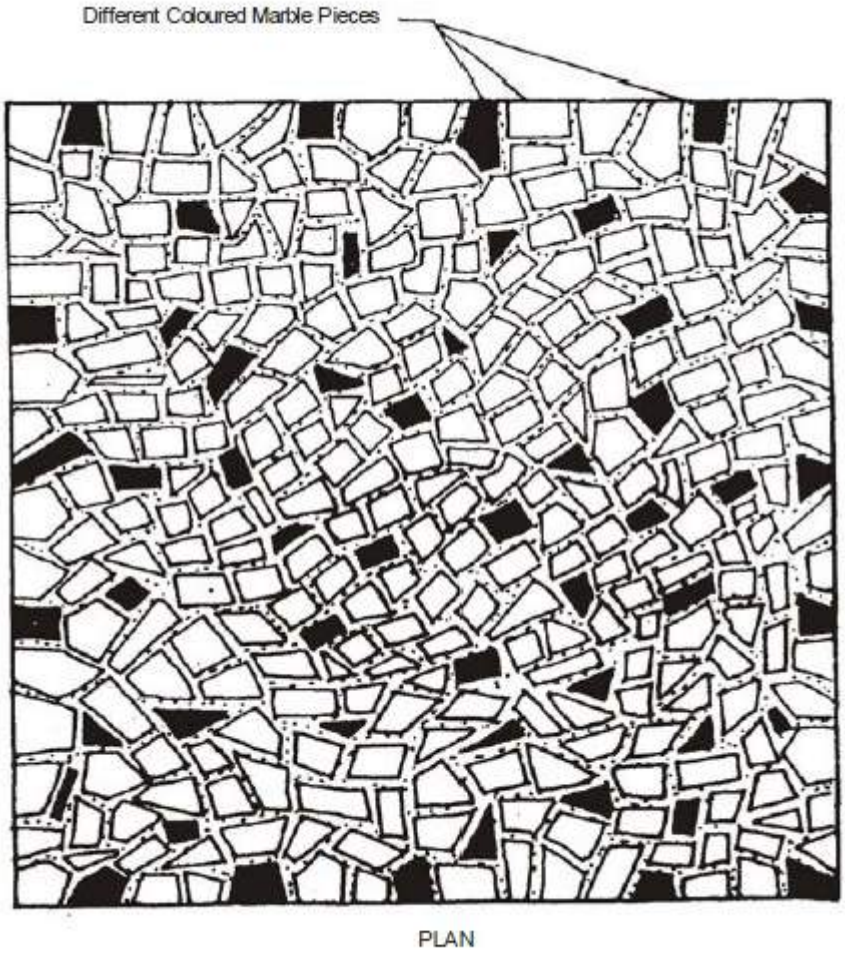
Six full size tiles shall be tested for the determination of wet transverse strength. When tested according to the procedure laid down in IS 1237 edition 2.3, the average wet transverse strength shall not be less than 3 N/mm^2 (30 kgf/cm^2)

B-7 Resistance to Wear Test

When tested according to IS 1237 edition 2.3, average wear shall not exceed 3.5 mm and the wear on any individual specimen shall not exceed 4 mm, for general purpose tiles. And 2 mm and 2.5 mm of average wear on any individual specimen, respectively for heavy duty floor tiles.

CRAZY MARBLE FLOORING

Sub Head : Flooring
Clause : 11.9

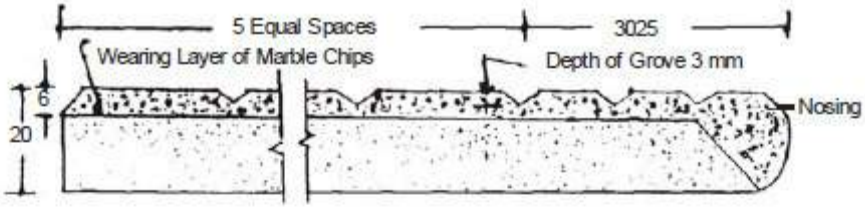


Drawing not to scale

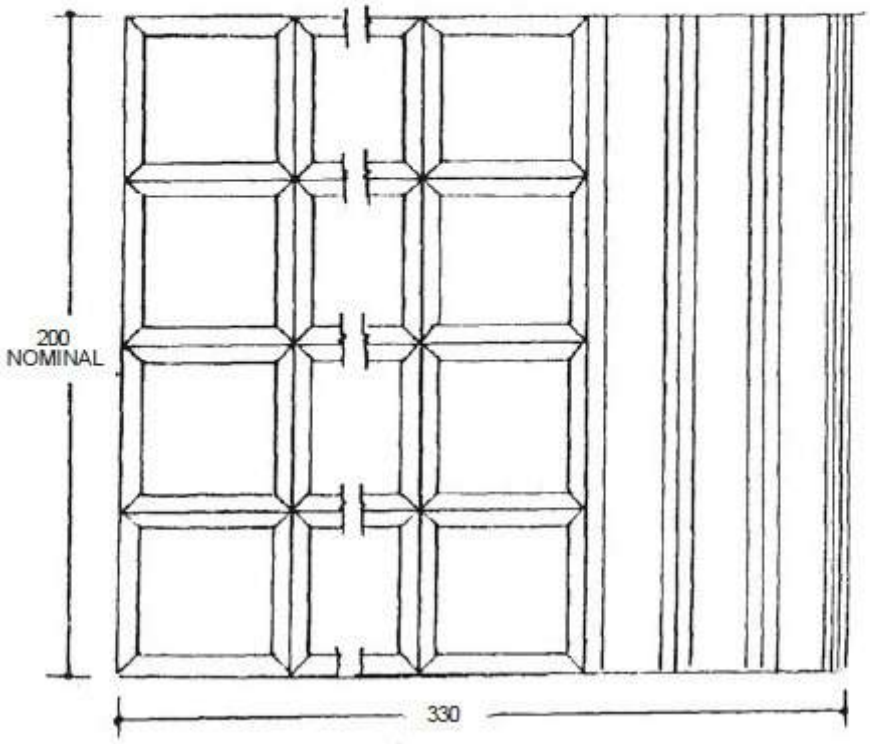
Fig. 11.1 : Crazy Marble Flooring

CHEQURED TERRAZO TILES

Sub Head : Flooring
Clause : 11.13



SIDE ELEVATION



PLAN
TILE FOR STAIR TREADS

Drawing not to Scale
All Dimensions are in mm

Fig. 11.2 : Chequered Terrazo Tiles

SUB HEAD : 12.0

ROOFING

CONTENTS

Clause No.	*Brief Description*	*Page No.*
	List of Bureau of Indian Standards Codes	571
12.0	Terminology	573
12.1	Corrugated Galvanised Steel Sheet Roofing	573
12.2	Ridges and Hips of Plain Galvanised Steel Sheets	576
12.3	Valley and Flashing of Plain Galvanised Steel Sheets	576
12.4	Gutters Made of Plain Galvanised Steel Sheets	577
12.5	Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Corrugated Sheet Roofing	578
12.6	Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Semi-Corrugated Sheet Roofing	581
12.7	Ridges and Hips of Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement	582
12.8	Other Roofing Accessories of Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement	583
12.9	Eaves and Valley Gutters of Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement	584
12.10	Painting of Roof Slab with Hot Bitumen	587
12.11	Mud Phuska Terracing with Brick Tile Paving	588
12.12	Paving over Mumty Roofs with Bricks Tile	589
12.13	Cement Concrete Gola	590
12.14	Khurras	591
12.15	Red or White Sand Stone Roofing	591
12.16	Wooden Ceiling	592
12.17	Ceiling with Fibre Insulating Building Boards	594
12.18	Particle Board/Multipurpose Cement Board Ceiling	595
12.19	Plain/Semi Perforated Particle Board Tiles Ceiling	596

12.19A	G.I Metal Tiles Ceiling	597
12.20	Transluscent White Acrylic Plastic (PMMA) Sheet Ceiling	597
12.21	Plaster of Paris (Gypsum Anhydrous) Ceiling over Wooden Strips	597
12.22	Rain Water Spouts	598
12.23	Cast Iron Rain Water Pipes	599
12.24	Cast Iron Accessories for Rain Water Pipes	601
12.25	Thermal Insulation for Roofing	602
12.25A	Heat Resistance Terrace Tiles	608
12.26	Unplasticised Polyvinyl Chloride Pipes and Fittings	610
12.27	Thermal Insulation over existing Wall with Fiber Glass Wool	611
12.28	Calcium Silicate Tiles False Ceiling	611
12.29	Calcium Silicate Board False Ceiling	612
12.30	Thermal Insulation of Ceiling	613
12.31	Thermal Insulation over existing False Ceiling	614
12.32	Thermal Insulation over existing Wall	614
Appendix A	Galvanised Steel Sheets	615
Fig. 12.1	C.G.S. Sheets	617
Fig. 12.2	Galvanised Steel Sheet Gutter	618
Fig. 12.3	Wind Tie and Flashing	619
Fig. 12.4	Non-Asbestos Corrugated Sheet	620
Fig. 12.5	Non-Asbestos Cement Accessories	620
Fig. 12.6	Non-Asbestos Cement Gutters	622
Fig. 12.7	Cement Concrete Khurra-Gola	623
Fig. 12.8	Holder Bat Clamp	624

LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	*BIS. No.*	*Subject*
1.	IS 73	Specification for paving Bitumen
2.	IS 277	Galvanised steel sheets (plain and corrugated)
3	IS 651	Glazed stoneware pipes and fittings
4.	IS 702	Specification for industrial bitumen
5.	IS 1199	Methods of sampling and analysis of concrete
6.	IS 1200 (PT.IX)	Method of measurements of building and civil engineering works Part - 9 Roof covering (including cladding)
7.	IS 1200 (PTX)	Method of measurements of building and civil engineering works: Part -10 ceiling and lining
8	IS 1230	Cast iron rain water pipes and fitting
9.	IS 1367 (PT -13)	Technical supply conditions for threaded steel fasteners pt.13 hot dip galvanized coating on threaded fasteners
10	IS 2095 (PT-1)	Gypsum plaster boards (Pt.1) plain Gypsum plaster boards
11.	IS 2115	Code of practice for flat roof finish: mud phuska
12.	IS 2633	Method of testing uniformity of coating on zinc coated articles
13.	IS 2645	Specification for integral water proofing compounds for cement mortar
		and concrete
14.	IS 3007 (PT.1)	Code of practice for laying of asbestos cement sheets: part- 1 corrugated sheets
15.	IS 3007 (PT.2)	Code of practice for laying of asbestos cement sheets part- 2 semi-corrugated sheets
16.	IS 3087	Particle boards of wood and other lignocellulogic materials (medium density) for general purposes - specifications
17.	IS 3144	Methods of test for mineral wool thermal insulation materials
18.	IS 3346	Method of the determination of thermal conductivity of thermal insulation materials
19.	IS 3348	Specification for fibre insulation boards
20.	IS 3384	Specification for bitumen primer for water proofing and damp proofing
21.	IS 4671	Expanded polystyrene for thermal insulation purposes
22	IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
23.	IS 5688	Methods of test of performed block type and pipe covering type thermal insulations
24.	IS 6598	Cellular concrete for thermal insulation

25.	IS 7193	Specification for glass fibre base coal tarpitch & bitumen felts (Amendment I)
26.	IS 8183	Bonded mineral wool
27.	IS 10192	Specifications for synthetic resin bonded glass fibre (SRBGF) for electrical purposes.
28.	IS 13592	Unplasticised polyvinyl chloride (UPVC) pipes for soil and Waste discharge system for inside and outside building.
29.	IS 14753	Specifications for polymethyl Methacrylate (PMMA) (Arylic) sheets
30	IS 14862	Fibre cement flat sheets - specifications
31	IS 14871	Specifications for products in fibre reinforced cement - Long corrugated or Asymmetrical section sheets and fittings for roofing and cladding.

12.0 ROOFING

12.0 TERMINOLOGY

12.0.1 Accessories

Purpose made fittings, such as apron flashing pieces, barge boards, bottom glazing flashing, corner piece (corner flashing), eaves filler pieces, expansion joints, hip capping, hip tile or cap, ridge capping, ridge finials, roof lights, ventilators, with which the roof is furnished.

12.0.2 Eaves

The lower edge of the inclined roof.

12.0.3 Finial

A decorative fitting used at the Junction of ridges and hips to form a water proof covering and at the top of conical, pyramidal, or dome roofs.

12.0.4 Flashing

A strip of impervious material, usually metal used to exclude water from the junction between a roof covering and another part of the structure.

12.0.5 Gable

Part of wall above the general eaves level at tie end of ridged or partially hipped roof.

12.0.6 Gutter

Any form of roof water channel.

12.0.7 Hip

The outer angle (more than 180 degree) formed by the inclined ridge between two intersecting roof slopes.

12.0.8 Pitch

12.0.8.1 The angle of inclination with the horizontal of the rafters or substructure surface on which the roof coverings are laid.

12.0.8.2 In patent glazing, the angle at which the plane of a stretch of glazing is inclined to the horizontal.

12.0.9 Pitched Roof

A roof the pitch of which is greater than 10 degree to the horizontal.

12.0.10 Ridge

The horizontal inter-section at the apex of the two rising roof surfaces inclined in opposite directions.

12.0.11 Valley

The re-entrant angle formed by the inter-section of two inclined roof surfaces.

12.0.12 Verge

Free edge of a roof surface ending at a gable.

12.1 CORRUGATED GALVANISED STEEL SHEET ROOFING

12.1.1 C.G.S. Sheets

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

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

12.1.2 Purlins

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

TABLE 12.1

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

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

12.1.3 Slope

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

12.1.4 Laying and Fixing

12. 1.4.1 The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

12.1.4.2 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.

12.1.4.3 The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

12.1.4.4 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.

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

12.1.4.6 The laying operation shall include all scaffolding work involved.

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

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

12.1.4.8 The galvanised coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanised coating should conform to IS 1367 (Pt. XIII) The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of Coating

Minimum Mass (g/m^2)	*Average Thickness (µm)*	*Minimum Mass (g/m^2)*	*Individual Thickness (µm)*
375	54	300	43

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

12.1.5 Wind Tie

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

12.1.6 Finish

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

12.1.7 Measurements

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

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

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

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

12.1.8 Rate

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

12.2 RIDGES AND HIPS OF PLAIN GALVANISED STEEL SHEETS

12.2.1 Ridges and Hips

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

12.2.2 Fixing

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

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

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

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

12.2.3 Finish

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

12.2.4 Measurement

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

12.2.5 Rate

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

12.3 VALLEY AND FLASHING OF PLAIN GALVANISED STEEL SHEETS

12.3.1 Valley and Flashing

Valley shall be 90 cm wide overall plain G.S. sheet 1.6 mm thick or other size as specified in the item bent to shape and fixed. They shall lap with the C.G.S. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain G.S. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not be less than 25 cm.

12.3.2 Laying and Fixing

Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonary with the mortar of mix 1: 3 (1 cement: 3 coarse sand). Refer Fig. 12.3.

12.3.3 Surface of G.S. sheets under overlaps shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. sheets.

12.3.4 Finish

The edges of valley and flashing should be straight from end to end. The surfaces should be true and without bulges and depressions.

12.3.5 Measurements

The length of the valleys and flashing shall be measured for the finished work correct to a cm. The laps along the length of the valley or flashing pieces, including the portion embedded in masonary, shall not be measured.

12.3.6 Rates

The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of seam bolts and the cost of requisite G.I. hook bolts, nuts and washers required over and above those needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost of boarding underneath which shall be paid for separately. The rate for flashing shall be for all the labour and materials specified above, and shall include the cost of painting and mortar for fixing in wall.

12.4 GUTTERS MADE OF PLAIN GALVANISED STEEL SHEETS (FIG. 12.2)

12.4.1 Gutters

Gutter shall be fabricated from plain G.S. Sheets of thickness as specified in the item.

Eaves gutters shall be of the shape and section specified in the description of the item. The overall width of the sheet referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

12.4.2 Slope

Gutter shall be laid with a minimum slope of 1 in 120.

12.4.3 Laying and Fixing

12.4.3.1 Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

12.4.3.2 Where these brackets are to be fixed to the sides of rafters, they shall be of 40 × 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centres.

12. 4.3.3 Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 × 3 mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10 mm dia bolts nuts and washers. The bracket will be stiffened by provision of 50 × 3 mm. M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10 mm dia, bolt, nut and washer. The over hang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

12.4.3.4 The gutter shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

12.4.3.5 For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riverted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles etc., should be provided.

12.4.4 Finish

The gutters when fixed shall be true to line and slope and shall be leakproof.

12.4.5 Measurements

Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured.

12.4.6 Rate

The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members. Brackets of 50 × 3 mm flats fixed to purlins with stiffener flats will be paid extra.

12.5 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT CORRUGATED SHEET ROOFING (FIG. 12.4)

12.5.1 Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Corrugated Sheets

The sheets shall be of the approved quality and shall conform to IS 14871. The sheets shall be free from cracks, chipped edges or corners and other damages.

12.5.1 (a) General Composition of Sheets

The product shall be composed essentially of an inorganic hydraulic binder (see Note) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a siliceous (includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced by organic fibres 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 pozzolana (fly ash based) cement conforming to IS 1489. (Part 1) or Portland pozzolana cement

(calcined clay based) 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 be conforming to IS 3812.

Note : In case of Portland pozzolana cement and Portland slag cement, addition of pozzolanic materials and slag shall not be permitted.

12.5.1 (b) Classification – Sheets may be classified according to thickness as under :

Type A - The thickness of the sheets shall be approximately constant throughout the width of profile.

Type B - The thickness of the sheets shall vary regularly between the valley and the crown for corrugated sheets or between the lower part and the upper part of ribs for asymmetrical section sheets, in the same cross-section.

The sheets shall be categorized based on height of corrugations, 'h' and minimum thickness 'e' as under:

Category and Class (Minimum Breaking Load N/m)

Category	*Minimum Thickness e (mm)*	*Class*									
		1	2	3	4	5	6	7	8	9	10
A (15 mm < h < 55 mm)	3	600	800	1000	1400	-	-	-	-	-	-
B (25 mm < h < 55 mm)	4	-	-	1000	1400	2000	2500	3300	-	-	-
C (40 mm < h < 80 mm)	4.5	-	-	-	1400	2000	2500	3300	4250	-	-
D (60mm < h < 150 mm)	5.5	-		-	-	-	-	3300	4250	5600	7400

12.5.2 Slope

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

12.5.3 Laying

12.5.3.1 The sheets shall be laid on the purlins and other roof members as indicated in the working drawings or as instructed by the Engineer-in-Charge.

12.5.3.2 The maximum spacing of purlins under the sheets shall be 1.40 metres in the case of 5.5 mm thick sheets and these shall in no case be exceeded. Ridge purlins shall be fixed at 75 mm to 115 mm from the apex of the roof.

12. 5.3.3 The top bearing surfaces of all purlins and of other roof members shall be in one plane so that the sheets when being fixed shall not require to be forced down to rest on the purlins. The finished roof shall present a uniform slope and the line of corrugations shall be straight and true. The sheets shall be laid with the smooth side upwards

12.5.3.4 The sheets shall be laid with a side lap of half a corrugation and an end lap of 15 cm minimum in the case of roofs with a pitch flatter than 1 vertical to 2.5 horizontal (approx. 22 degree) or in the case of very exposed situations, the minimum permissible end lap shall be 20 cms. Side laps should be laid on the side facing away from the prevailing monsoon winds.

12.5.3.5 The free overhang of the sheets at the eaves shall not exceed 30 cm. Corrugated sheets shall be laid from left to right starting at the eaves. The first sheet shall be laid uncut but the remaining sheets in the bottom row shall have the top left hand corners cut or mitred. The sheets in the second and other intermediate rows except the first and the last sheets, shall have both the top left hand corner and bottom right hand corner cut. The last or top row sheets shall all have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If for any reason such as on considerations of the direction of prevailing winds, laying is to be started from the bottom right hand corner, then the whole procedure should be reversed.

12.5.3.6 The 'Mitred' described above is necessary to provide a snug fit where four sheets meet at a lap. It is cut from a point 15 cm (or whatever the length of the end lap may be) up the vertical side of the sheet to a point 5 cm along the horizontal edge. This cutting may be done with an ordinary wood saw at site.

12.5.4 Fixing

12.5.4.1 Sheets shall be secured to the purlins and other roof members by means of 8 mm diameter polymer coated iron J or L hook bolts and nuts. While, J hooks are used for fixing to angle iron purlins, L hooks are used for fixing to R.S. joists, timber or precast concrete purlins.

The grip of the J or L hook bolt on the side of the purlin shall not be less than 25 mm. Each iron J or L hook bolt shall have a bitumen washer and a galvanised iron washer placed over the sheet before the nut is screwed down from above. On each purlin there shall be one hook bolt on the crown adjacent to the side lap on either side. Bitumen washer shall be of approved manufacture. Galvanising of washers shall be as provided in para 12.1.4.8. Polymer coating of hooks, bolts and nuts shall be as per IS code 14871.

12.5.4.2 The G.I. flat washer shall be 25 mm in diameter, 1.6 mm thick and the bitumen washer shall be 35 mm in diameter and 1.5 mm thick. The length of J bolt or crank bolt shall be as specified in Table 12.2 below.

TABLE 12.2

S.No.	*Situation*	*No. of Bolts & Washers*	*Length of Bolts*
1.	At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.	Twice the No. of sheets in one horizontal course.	Depth of purlin plus 90 mm.
2.	At eaves when filler pieces are not used. At ridge when corrugated sheets and ridge pieces are not secured by the same bolt.	Twice the No. of sheets in the horizontal course.	Depth of purlin plus 75 mm.
3.	At intermediate purlins where horizontal laps do not occur.	Twice the No. of sheets in the horizontal course.	Depth of purlin plus 75 mm.

12.5.4.3 Each nut shall be screwed lightly at first. After a dozen or more sheets are laid, the nuts shall be tightened to ensure a leak proof joint.

12.5.4.4. Holes for hook bolts etc. shall be drilled and not punched, always through the crown of the corrugation and not in valleys, in locations to suit the purlins while the sheets are on the roof in their correct position. The diameter of holes shall be 2 mm more than the diameter of the fixing bolts. No hole shall be nearer than 40 mm to any edge of a sheet or any accessory.

12.5.4.5 Roof ladders or planks shall always be used when laying and fixing the sheets, to avoid damage to the sheets, and to provide security to the workmen.

12.5.5 Wind Ties

Wind ties may be provided where the situation justify their provision. These shall be of 40 × 6 mm flat iron section or of other size as specified. These shall be fixed at the eave ends of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be paid for separately unless described as included in the items of the roof work.

12.5.6 Finish

The completed roof shall present a neat and uniform appearance and be leakproof.

12.5.7 Measurements

12.5.7.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.

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

12.5.7.3 Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed. The breadth of the roof shall be measured along the rest of the curved sheets.

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

12.5.8 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated or L hook, bolts and nuts, bituminous and galvanised iron washers.

12.6 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT SEMI-CORRU-GATED SHEET ROOFING

12.6.1 Non Asbestos reinforced by organic fibres and/or inorganic synthetic Cement Semi Corrugated Sheets

These shall be of the specified thickness and of approved quality and shall conform to IS 14871 they shall be free from cracks, chipped edge corners or other damages.

12.6.2 Laying

The specifications for laying shall be the same as described in 12.5.3 except that (a) the sheets shall be laid with the end stamped 'Top' on the smooth side pointing towards the ridge, (b) the sheets shall invariably be laid from right to left starting at the eaves with the procedure for mitring etc. described under 12.5.3.5 and 12.5.3.6 reversed, (c) the side laps provided will be of one corrugation, the left hand small corrugation of each sheet being covered by the right hand large corrugation of the next sheet and
(d) asbestos cement expansion joints shall be inserted every 45 metres or so in the length of the roof. Specially manufactured expansion joint pieces shall be used for the purpose. The end lap of expansion joints shall not be less than 150 mm. If the expansion joints may be between the purlins, these should be stitched with seam bolts.

12.6.3 Fixing

The specifications shall be same as described in 12.5.4 except that along each line of purlin there shall be a hook bolt in every vertical side lap corrugation and at the two verges and there shall be an

additional hook -bolt through one of the two intermediate corrugations on each sheet. When sheets are supported over intermediate purlins as in the case of length over1.40 metres for 5.5 mm thick sheets, fixing accessories are required on the intermediate purlins, through each side lap and the verges only.

The number and length of bolts and number of bitumenous felt and galvanised iron washers are given in Table 12.3.

TABLE 12.3

S.No.	*Situation*	*No. of Bolts & Washers*	*Length of Bolts*
1.	At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.	Short bolts: The number of sheets in one horizontal course plus two Long bolts: The number of sheets in one course less one.	Depth of purlin 75 mm Depth of purlin plus 90 mm.
2.	At eaves when filler pieces are not used. At ridge when sheets and ridge pieces are not secured by the same bolt.	Twice the No. of sheets in one horizontal course plus one.	Depth of purlin plus 75 mm.
3.	At intermediate purlin when horizontal laps do not occur.	The No. of sheets in one horizontal course plus one.	Depth of purlin plus 75 mm.

12.6.4 Wind Ties & Finish

The specifications shall be as described in 12.5.5 and 12.5.6.

12.6.5 Measurements

It shall be as described in 12.5.7 in addition, the end lap of the sheets under asbestos cement expansion joints where provided shall also be included in measurements. Gap between the sheets under expansion joint shall not be measured. The expansion joint sheets shall be measured for the finished work correct to one cm.

12.6.6 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated J or L hook bolts and nuts, bituminous and galvanised iron washers.

12.7 RIDGES AND HIPS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.4)

12.7.0 Ridges and hips shall be of the same manufacture as the corrugated or semi-corrugated sheets used for roof, unless specifically permitted in writing by the Engineer-in-Charge. The sections shall be free from cracks, chipped edges or corners or other damages.

Ridges shall be of the type specified in the item, such as:

1. One piece plain angular.
2. Serrated or plain wing adjustable.
3. Close fitting adjustable.
4. Northlight adjustable and appropriate for the corrugated or semi-corrugated roof which is to be covered ‘Plain Wing Angular’ type ridges can be used only if the slope of the roof is exactly 30 degree. Hips shall be of ‘under-rated adjustable for hips’ sections.
5. Un-serrated adjustable.

12.7.1 Laying

The ridge sections shall be laid as per manufacturers instructions with the rolls of the two wings in the case of adjustable ridges fitting closely and with the serrations of serrated ridges registering correctly with the sheets underneath. The stagger lapping or two wings of an adjustable ridge section and the laps between adjacent pieces on the same wing of the ridges shall be as per manufacturers instructions. The end portions of the wings of the adjustable ridges which project beyond the verges of the roof shall be cut and trimmed off neatly. Asbestos cement expansion joint ridge pieces shall be provided every 45 metres (approx.) of ridge where the latter is of the semi-corrugated serrated adjustable type.

In laying hip pieces, serrations to suit the corrugations in the sheets below should be cut in them so that they will be a snug fit over the sheets.

12.7.2 Fixing

12.7.2.1 The wings of ridges shall be fixed to the sheets below with the seam bolts and nuts 8 mm diameter polymer coated J or L hook bolts and nuts and bitumen and G.I. washers which fix the sheets to the purlins. In additions, in northlight adjustable ridges the curves of the two wings shall be joined together at their crown with 8 mm dia polymer coated seam bolts and nuts, at the rate of 2 numbers per pair of wings. Each seam bolt shall be provided with one bitumen and a pair of G.I. washers.

12.7.2.2 Where 'Plain wing angular' or 'Plain wing adjustable' ridges are used, the gaps formed by the roofing corrugations and the wings shall be filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) upto the full length of the overlap. The exposed face shall be finished perpendicular to the sheeting.

12.7.2.3 Wing of hips shall be fixed to the roof members below with the same 8 mm dia polymer coated or L hook bolts and nuts which fix the sheet to those members. In addition, they shall be secured to the sheets below with 8 mm dia polymer coated seam bolts, nuts and washers, so that taken together with hook bolts there shall be bolt on each wing atleast every fifth corrugation of the sheet below in the case of 'Corrugation' and at least every second corrugation of the sheet below in the case of 'semi-corrugated' sheets. The seam bolts shall each be provided with one bitumen and a pair of G.I. washers.

12.7.3 Measurements

The measurements for ridges and hips shall be taken for the finished work along the centre line of the ridge and hip lines in length, correct to a cm. The laps in adjacent ridges or hip pieces shall not be measured. The underlay of ridges under expansion joint pieces where the latter are provided shall however be measured.

12.7.4 Rate

The rate shall include the cost of all materials and labour specified above, but does not include (a) the cost of required polymer coated hook bolts and nuts and their washers, (b) the cost of supplying and fixing expansion joint pieces, (c) the cost of closing the gaps between plain ridge and the sheet corrugations with concrete. Item (a) above will be covered by the rate for the non-asbestos cement sheet roofing while items (b) and (c) will be paid for separately unless specifically included in the description of item of the ridge or hip item.

12.8 OTHER ROOFING ACCESSORIES OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.5)

12.8.1 Accessories

The other accessories that may be required to be used on a roof are (a) finishing pieces, eaves filler pieces, northlight and ventilator curves, barge boards and expansion joint sheets (b) ridge finials, cowl type ventilators, curved boards for northlight, curves, roof light expansion joints for ridge and expansion

joints for northlight curves and (c) 'S' type louver. The accessories shall be of the type appropriate for use with corrugated or semi corrugated sheets which form the roofing.

The accessories shall be of the same manufacture as the corrugated or semi -corrugated sheets used for the roof. The pieces shall be free from cracks, chipped edges or corners and other damages.

12.8.2 Laying & Fixing

These shall be laid and secured with the same polymer coated hook bolts which secure sheets to the roof members below where possible or with separate polymer coated hook bolts to the roof members below and/or with 8 mm dia polymer coated seam bolts, nuts and washers to the sheeting, generally as per manufacturers printed instructions and as ordered by the Engineer-in-Charge. 'S' type louvers shall be fixed to ventilators to timber, M.S. angle or flat iron verticals spaced not more than 1.65 metre centres. The laps of adjacent pieces over the verticals shall not be less than 10 cm. The upper flat of the top most row of louvers shall be fixed to the vertical by 10 mm dia polymer coated bolts and nuts and bitumen and polymer coated washers.

The lower flats of the top and intermediate rows of louvers and the flat of the louvers pieces below shall be secured together to the verticals behind by 10 mm dia G.I. separating bolts threaded at both ends and of suitable length. Each of these bolts shall be equipped with 2 pair of nuts, G.I. and bitumen washers. The louver flats of the lowest line of louvers shall also be fixed to the verticals at the proper distance from the same by the use of similar separating bolts and nuts.

12.8.3 Measurements

The accessories listed under group (a) in 12.8.1 shall be measured for finished work in length correct to a cm. Laps between adjacent pieces shall not be measured.

The accessories listed under group (b) in 12.8.1 shall be measured and paid for in number. This applies in the case of finial too where the unit shall consist of a pair of inter locking pieces.

The 'S' type louvers listed under group (c) in 12.8.1 shall be measured for the finished work in length of each row of louvers correct to a cm. The laps, between adjacent pieces of louvers will not be taken into account in the measurements.

12.8.4 Rate

12.8.4.1 The rates for supplying and fixing, non-asbestos cement accessories listed in groups (a) & (b) of 12.8.1 shall include the cost of all materials and labour involved in all the operations described above bolts, nuts, washers and other fixing accessories but does not include the members.

12.8.4.2 The rate for supplying and fixing roof lights shall not unless otherwise described in the item, include the glazing which shall be paid for separately.

12.8.4.3 The rate for supplying and fixing 'S' type louvers shall include all fixing accessories such as ordinary and separating polymer coated bolts, nuts, and bitumen washers including drilling the holes for the same in the vertical supporting member behind but shall not unless otherwise described in the item the cost of supplying and fixing the supporting members which shall be paid for separately.

12.9 EAVES AND VALLEY GUTTERS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.6)

12.9.1 Gutters and Accessories

Eaves gutters shall be of the type specified in the item such as (1) plain ended eaves, (2) boundary wall, (3) socketed eaves ogee and (4) socketed half round. These shall be of standard size as stipulated in the item. Valley gutters shall be of the 'Plain' ended valley types and of size as stipulated in the item.

These shall be of approved manufacture, approved by the Engineer-in-Charge. The gutter sections and their accessories such as drop ends, stop ends, nozzles, angles and union clips shall be free from cracks, chipped edges or corners and other damages.

12.9.2 Laying and Fixing

12.9.2.1 Gutters shall be laid with a minimum slope of 1 in 120, which should be increased where possible. Gutters shall be true to line and slope and shall be laid with the requisite accessories such as drop ends, stop ends, nozzles, angles and union clips as shown in the working drawing or as ordered by the Engineer-in-Charge.

12.9.2.2 The size of outlet of drop ends and nozzles shall be of the same size as the size of the rain water pipes into which they shall be discharging the water.

12.9.2.3 Gutters and their accessories shall be supported by M.S. flat iron bracket. Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bent to shape and fixed rigidly to the sides of the rafter with 3 Nos. 10 mm diameter bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be 11.5 cm centres.

12.9.2.4 Where the brackets are to be fixed to the purlins they shall consist of 50 × 3 mm M.S. flat iron bent to shape with one end turned at a right angle, and fixed to the purlin face with a 10 mm dia bolt, nut and washer. The perpendicular over hang portion of 50 × 3 mm bracket shall be stiffened by another 50 × 3 mm flat, bent to right angle shape with its lower leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with one number 10 mm dia bolt, nuts and washers. The overhang of the vertical portion of the flat iron bracket from the face of the purlin shall not exceed by 22.5 cm with this arrangement.

12.9.2.5 The requisite slope in the gutters shall be given in the line of the bracket. The brackets shall be placed at not more than 90 cm centres.

12.9.2.6 The gutters shall be fixed to the brackets with 2 Nos. 8 mm dia polymer coated seam bolts and nuts, each bolt and nut being equipped with a pair of bitumen and polymer coated washers. These connecting bolts shall be above the water line of the gutters.

12.9.2.7 Spigot and socket ends of gutters of ‘socketed eaves ornamental’ or ‘socketed half round’ type and their accessories shall be connected together at their laps with one row of 8 mm dia polymer coated bolts and nuts, each bolt and nut being provided with a pair of bitumen and a pair of polymer coated washers. The gap between the socket and spigot shall be packed with approved plastic roofing compound, flanked on both sides with 6 mm dia non-asbestos rope. The connecting polymer coated bolts are then tightened so that the lapped joints become leak proof. The outer faces of the packed non-asbestos rope shall not be farther than 6 mm from the edges of the spigot and socketed ends.

12.9.2.8 Where both ends of gutters and or their accessories to be connected together are of spigot ends they shall be laid as butt joints with 1.5 mm gap in between over union clips (loose socket pieces). The union clip shall be connected to the two butt ends of the gutter or other section on both ends with two rows (one row per ends) of 8 mm dia polymer coated bolts and nuts, each bolt and nut being provided with a pair of bitumen and a pair of G.I. washers. The gap between the union clips and the butt ends of the gutter sections or accessories shall be packed with approved plastic roofing compound flanked at both edges by 6 mm dia non-asbestos rope as before. The whole joint shall be made leak proof by tightening the bolts.

12.9.2.9 The ends of ‘Plain’ ended eaves or boundary wall type and ‘Plain’ ended valley type gutters and their accessories shall be laid with butt joints over union clips and connected together in the same manner as for connecting spigot and socket ends described in the preceding sub-para.

12.9.2.10 The number of connecting bolts, nuts and washers and the quantities of 6 mm diameter non-asbestos rope and plastic roofing compound required per spigot socket of 'ornamental' and 'half round' gutters of different sizes and butt joint of plain ended 'Boundary wall or eave' and 'valley' type gutters of different sizes shall be shown in Table 12.4.

TABLE 12.4
Jointing Materials per Joint of Gutter

Type of Gutter	*Nominal Sizes*	*6 mm dia Asbestos Rope*	*Required per joint*			
			Plastic Roofing Compound	*8 mm dia nuts and bolt*	*G.I. Washer 25mm dia*	*Bitumen Washer 25mm dia*
Socketed ornamental	125 mm	0.57 m	170 g	1 No. 45 mm long	2 Nos	2 Nos
Socketed ornamental	200 mm	0.98 m	255 g	3 Nos. 45 mm long	6 Nos	6 Nos
Socketed half round	150 mm	0.57 m	170 g	1 No. 45 mm long	2 Nos	2 Nos
Socketed half round	250 mm	0.92 m	567 g	3 Nos. 45 mm long	6 Nos	6 Nos
Socketed half round	300 mm	1.07 m	709 g	3 Nos. 45 mm long	6 Nos	6 Nos
Plain ended boundary wall or eaves	275 × 125 × 175 mm	0.97 m	737 g	8 Nos. 40 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	300 × 150× 225 mm	1.15 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	450 × 150 × 300 mm	1.38 m	1020 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended boundary wall or eaves	500 × 150× 250 mm	1.43 m	1049 g	10 Nos. 50 mm long	20 Nos	20 Nos
Plain ended valley	400 × 125× 250 mm	1.12 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	50 × 125	1.12 m	850 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	600 × 150× 225 mm	1.48 m	1105 g	8 Nos. 50 mm long	16 Nos	16 Nos
Plain ended valley	900 × 200× 225 mm	2.08 m	1531 g	12 Nos. 50 mm long	24 Nos	24 Nos

12.9.3 Finish

The gutters and accessories when fixed shall be true to line and slope and shall be ridged. All the joints shall be leak proof.

12.9.4 Measurements

The measurement of gutters shall be taken for the finished work in length correct to a cm along the centre line of the gutters. The measured length of the finished gutters will include the length over accessories such as drop ends, stop ends, nozzles and angles, though the rate for the same shall not include the cost of the accessories unless specially described in the item. Laps between the adjacent pieces of gutter and gutter section or between gutter section and accessories shall not be measured.

Accessories such as drop ends, stop ends, nozzles and angles shall be measured and paid for separately.

Union clips (loose sockets) shall not be measured separately as they are included in the rate for gutters.

12.9.5 Rate

The rate for the gutters shall not, unless otherwise specified in the description of item, include the cost of providing and fixing accessories such as drop ends, stop ends, nozzles and angles. The rate shall include the cost of providing and fixing all union clips (loose sockets), all connecting G.I. bolts, nuts and bitumen and G.I. washers, M.S. flat iron brackets and their fixture to the gutter sections and to the roof members, non-asbestos rope and plastic roofing compound.

Extra over the rate for the gutter shall be paid for providing and fixing accessories, stop ends, drop ends, angles and nozzles. Where brackets of 50 × 3 mm size are provided in place of brackets of 40 × 3 mm size as indicated in para 12.9.2.4 extra rate will be paid for separately.

12.10 PAINTING OF ROOF SLAB WITH HOT BITUMEN

12.10.1 Preparing the Surface

The surface shall be painted only when it is thoroughly dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

12.10.2 Painting with Bitumen

12. 10.2.1 The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorised representative. The containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used and has given his permission to remove the empty containers.

12.10.2.2 The surface prepared and treated shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof. In case of parapet walls it shall be continued upto the drip courses.

12.10.2.3 Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180 degree C and not more than 190 degree C and shall be applied on the roof surface at not less than 180 degree C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than 165 degree C and not more than 170 degree C and shall be applied on the surface at not less than 165 degree C.

12.10.2.4 Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied per 10 square metres of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg. per 10 square metres.

12.10.3 Spreading Sand

Immediately after painting, dry, clean sharp coarse sand at the rate of 60 cubic decimeter per 10 sqm. shall be evenly spread and levelled over the surface when the bitumen is still hot.

12.10.4 Measurements

The superficial area of the surface painted shall be measured in square metres. No deduction in measurements shall be made for unpainted areas of roof slab occupied by chimney stacks, roof lights etc. of areas, each upto 40 sq. decimetre. The measurements of length and breadth shall be taken correct to a cm.

12.10.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.11 MUD PHUSKA TERRACING WITH BRICK TILE PAVING

12.11.1 Mud Phuska

For mud phuska, selected soil which should be a good quality earth suitable for making bricks not containing excessive clay or sand, free from stones, kankar, vegetable matter and other foreign matter, shall be collected and stacked at site. The soil shall not be collected from a locality infested with white ants. Before laying on the roof, the soil shall be made damp by adding water about 12 hours earlier. It shall be turned over with phawaras so as to break clods and to pulverise the same. Quantity of water to be added to the soil shall be carefully regulated so that the soil shall have optimum moisture content at the time of laying and compaction on the roof. The soil shall be laid on the roof to requisite thickness and slope, well compacted with wooden rammers and thappies, to obtain an even surface to correct slope. Average thickness of soil after compaction shall be as specified for the item.

Note: A practical way of determining the moisture content of soil suitable for giving good compaction is that the soil should contain that much quantity of moisture, which when a handful of soil is moulded with hand to the shape of a ball, it shall just retain its form. If the soil on moulding cannot retain its shape of a ball, moisture content is inadequate. On the other hand, if the ball can be plastically deformed on pressing with hand, the moisture content is on the high side.

12.11.2 Mud Plaster

After laying the mud phuska, the surface shall be given a coat of mud plaster 25 mm thick and the plaster shall be allowed to dry and crack.

The mud plaster shall be prepared from the same soil as for mud phuska. The dry soil shall be reduced to fine powder and mixed with water in a pit, adding fibrous reinforcing materials such as chopped straw (Bhusa) in proportion of 35 kg per cum of soil. The mixture shall be allowed to mature for a period of not less than 7 days. During this period it shall be worked over with feet and spades (Phawaras) at intervals so as to get pugged into a homogeneous mass free from lumps and clods. The mud mortar shall be puddled again very thoroughly just before use.

The consistency of mud mortar shall be checked by taking it on a trowel and observing how it slides off the face of trowel. The mortar shall readily slide off the trowel and should not be so wet as to part on to large drops before falling. Alternatively slump test may be performed in accordance with IS 1199. The slump should be about 70 mm.

12.11.3 Gobri Leaping

After the mud plaster has dried, the surface should be given a coat of gobri leaping so as to completely fill any crack that may have formed in the mud plaster. Mortar for gobri leaping shall be prepared by mixing equal quantities of fresh gobar and finely sieved clay and adding sufficient water to form a thin paste. The quantity of gobar used in gobri leaping shall not be less than 0.03 cum per 100 sqm of plaster area. Five percent of cut back bitumen by mass of dry clay may be added to improve upon the water proofing qualities.

12.11.4 Laying of Bricks Tile

After the gobri leaping has dried, brick tiles shall be laid using the minimum amount of plain mud mortar (without bhusa) as bedding so as to obtain correct slope and even surface of tile floors. Care shall be exercised to see that mud mortar does not rise into the vertical joints of the tiles more than 12 mm. The brick tiles shall be either flat tile bricks of class designation 100 or machine moulded tile bricks of class designation 125 conforming to IS 2690 (Prt I) as per the nomenclature of the item. The tiles shall be laid such that the thickness of joints shall not be less than 6 mm and more than 12 mm in width. After the tiles are well set and bedding mortar has dried, joints of the tiles shall be grouted with cement mortar of mix 1:3 (1 cement : 3 fine sand) such that all the joints of tiles are completely filled with mortar and the

joints should be finished neat. Cement used for the mortar shall be mixed with 2% of integral water proofing compound which should conform to IS 2645.

12.11.5 Curing

As soon as cement grouting obtains initial set, the surface of the brick tile floor shall be covered with wet gunny bags, hessian cloth or wet sand to prevent quick drying. After 8- 12 hours, the brick tile floor shall be cured by frequent sprinkling of water on the surface for a period of 7 days. After curing has been done, the surface shall be swept clean.

The tile surface as completed shall be even and true to slopes of 1 in 48 or as specified and should be leak proof.

Note: When surplus earth of a suitable quality exists at the site of work, the contractor shall be allowed to use the same free of cost for laying the mud terracing, mud plaster and gobri leaping on the top. The Engineer-in-Charge shall be the final authority to decide whether the earth obtained from excavation is surplus to the requirements at site and is suitable for mud phuska work.

12.11.6 Measurements

Length and breadth shall be measured correct to a cm. The measurements shall be taken for the finished work, (mud phuska terracing of stipulated thickness with mud plaster, gobri leaping and tile paving and grouting) over the tiled surface, in superficial area.

No deductions in measurements shall be made for either openings or recesses for chimney stacks, roof lights or khurras, of area upto 0.40 sqm. No extra shall be paid either for any extra materials or labour involved in forming such openings, recesses etc. For areas exceeding 0.40 sqm deductions will be made in the measurements for the full opening but extra shall be paid for any extra labour, materials etc. in forming such openings.

For plus or minus deviation from the average thickness stipulated for the mud phuska in the item, payments will be adjusted in the rate admissible to the contractor for the relevant schedule item provided that such deviations were authorised by the Engineer-in-Charge in writing.

12.11.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.12 PAVING OVER MUMTY ROOFS WITH BRICKS TILE

12.12.0 The roofs shall be paved with bricks tile laid flat and grouted with cement mortar.

12.12.1 Bricks Tile

These shall conform to the specifications detailed in subhead 6.0 of masonry work

12.12.2 Cement Mortar

The cement mortar shall be of 1:3 mix (1 cement : 3 fine sand) unless otherwise specified in the description of the item and shall conform to the specifications described in subhead 3.0 of Mortars.

12.12.3 Preparing the Surfaces

The surface shall be hacked, roughened and cleaned of all dust and other foreign matter. It shall then be wetted before applying the mortar.

12.12.4 Paving and Grouting

Cement mortar shall be spread in 12 mm layer over the surface evenly to required slope. Brick tiles which had been soaked as in brick work in water for at least an hour before hand shall then be laid open

jointed and flat on the mortar and lightly pressed, and set to plane surface true to slopes etc. using a trowel and wooden straight edge. The brick tiles shall be laid with their joints not more than 10 mm wide. They shall be laid with their longitudinal lines of joints truly parallel and horizontal and at right angles to the sloping edges of the roof.

Transverse joints in alternate rows should come directly in line with one another. Transverse joints in adjacent courses shall not have distance by less than 5 cm. As soon as the paving is done, the open joints shall be grouted with cement mortar 1:3 (1cement : 3 fine sand) . Cement used for grouting mortar shall be mixed with 2% (by unit of cement) water proofing compound conforming to IS 2645. Care shall be taken to see that no joints are left unfilled or inadequately filled. The joints shall be finished flush with the brick surface.

12.12.5 Curing

The tile paving shall be cured for at least 7 days during which period it shall be suitably protected from damage.

12.12.6 Measurements

Length and breadth shall be measured correct to a cm. Measurements shall be taken for the finished work in superficial area covered.

No deduction in measurement shall be made for either openings or recesses for chimney stacks, roof lights, or for khurras, for areas upto 0.40 sqm nor extra shall be paid for forming such openings.

For similar areas exceeding 0.40 sqm deduction shall be made in measurements for all openings but nothing extra shall be paid for forming such openings.

12.12.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.13 CEMENT CONCRETE GOLA (FIG. 12.7)

12.13.1 Cement Concrete

The specifications for concrete shall be the same as described in subhead 4.0 of concrete work.

12.13.2 Gola

A chase of 75 mm wide and 75 mm deep shall be cut in the parapet wall just above the junction of mud phuska or lime concrete with parapet wall and it shall be filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm and down gauge) the external face finish with a slope of 1 : 0.75 and the exposed surface of the gola shall be plastered with cement mortar 1 : 3 (1 cement : 3 fine sand).

Expansion joint at every 3.5 to 4.5 metres shall be provided and filled with bitumen filler. The bitumen filler shall be prepared by mixing bitumen, cement and coarse sand in the ratio of 80 : 1 : 0.25 (80 kg of hot bitumen : 1 kg of cement and 0.25 cum of coarse sand).

12.13.3 Curing

The finished surface shall be cured for at least 7 days.

12.13.4 Measurements

The length of the finished gola shall be measured at its junction with the wall face correct to a cm. No deduction shall be made in measurements for gaps for water outlets.

12.13.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of bitumen filler in expansion joint. The rate includes for all turnings and roundings at all the corners and risers.

12.14 KHURRAS (FIG. 12.7)

12.14.0 The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

12.14.1 Laying

12.14.1.1 A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

12.14.1.2 The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

12.14.1.3 The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement : 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

12.14.1.4 In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer- in- Charge. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the Engineer in Charge.

12.14.2 Measurements

Khurras shall be counted in numbers.

12.14.3 Rate

The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.

12.15 RED OR WHITE SAND STONE ROOFING

12.15.1 Sand Stone Slabs

The stone slabs shall be hard, even, sound and durable and shall conform to standards as detailed in subhead 7.0 of stone work. Slabs shall have been sawn or chiselled in a plane parallel to the natural bed of the stone. The slabs shall be rough chisel dressed on the top so that the dressed surface shall not be more than 6 mm from a straight edge placed on it. The edges of the depressions or projections shall be chisel dressed in a slant, so that surface does not have sharp unevenness. The sides shall also be chisel dressed to a minimum depth of 20 mm so that the dressed edges shall at no place be more than 3 mm from a straight edge butted against it. The thickness of the slab shall be uniform and as

specified in the item with a permissible tolerance of 2 mm. The slabs shall be uniform in length, the length being 5 to 8 mm less than the centre to centre spacing of the supporting wooden Joists (Karries) or RCC battens. Unless the design require some other shape the slabs shall be rectangular.

The width of the slabs may vary unless otherwise stipulated. It shall not be less than 40 cm.

12.15.2 Rafter Spacing

The maximum spacing of rafters (karries) or RCC battens supporting the slabs shall not exceed figures given in Table 12.5.

TABLE 12.5

Thickness of Slab	*Maximum Spacing of Rafters*
40 mm	52.5 cm.
45 mm	60 cm.
50 mm	68 cm.

The bearing of slabs over the supporting rafts karries shall not be less than 30 mm. Where a raft karry supports a slab from one side only, the bearing of such slab shall be for full width of the rafts. For bearing over the wall, the stone slabs shall be bedded over a layer of cement mortar 1 : 4 (1 cement : 4 fine sand) of thickness not less than 12 mm.

12.15.3 Laying

The slabs shall be washed clean and wetted before being laid. The stone slabs shall be jointed in cement mortar 1:4 (1 cement : 4 coarse sand). The width of joints shall not be more than 8 mm not less than 5 mm. The top joints shall be finished flush and ceiling joints pointed with the cement mortar 1:3 (1 cement : 3 fine sand).

12.15.4 Finish

The finished surface shall be truly levelled or slopped as shown in the plan or as directed by the Engineer-in-Charge. It shall be cleaned off all mortar droppings and cement markings both on top and on the under side.

12.15.5 Curing

The slabs and their joints shall be kept wet during progress of work and for 7 days after completion.

12.15.6 Measurements

Length and width of finished stone slab work including bearing shall be measured correct to a cm. The area shall be calculated in sqm correct up to two places of decimal.

No deduction in area shall be made for openings in roof slab for chimney, stacks, roof lights etc. of area upto 40 square decimetre nor any extra shall be paid for extra labour, materials etc. involved in cutting and wastage, in forming such openings. For openings exceeding 40 sq. decimeter in area, deduction shall be made in measurements for the full opening but extra shall be paid for extra labour, material etc. required in forming such openings.

12.15.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.16 WOODEN CEILING

12.16.1 Boards

12.16.1.1 Boards shall be of the class of timber and of finished thickness as specified in the description of the item and shall be in accordance with the general specifications for wood work. Only selected boards of

uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of boards selected for use shall not be less than 100 mm nor more than 150 mm.

12.16.1.2 The specific width of boards once selected within these two limits shall be maintained through-out and shall not be varied except in the first and last lines of boards adjustment to the two walls, where remaining odd width shall be adjacent equally on both sides. The maximum length of the board in the finished work shall be 180 cm. The minimum length of board in the finished work shall be such that it will span at least two spacings of the supporting frame work except where shorter lengths are unavoidable, depending on the arrangements of the lines of heading joints which shall be carried out to the pattern ordered by the Engineer-in-Charge.

The boards shall be plained true on the exposed side.

12.16.1.3 Unless stipulated otherwise in the description of the item, the longitudinal joints of the boards shall be tongued and grooved, while the heading joints shall be of the square butt type and shall occur under the centre line of the supporting joint. Heading joints in adjacent boards shall not be placed over the same joists, those in alternate boards being arranged in the same line, except where the joints are to be concealed by headings.

12.16.2 Frame

Timber frame of the class of timber and section specified in the description of the item or as ordered by the Engineer-in-Charge shall be provided. The width of the frame scantling shall not be less than 50 mm. The arrangements and spacing of the frame scantling shall be as per design furnished. The frame shall be given two coats of approved preservative paint before the boarding is screwed. The frame and paints thereof shall be paid for separately unless specifically included in the description of the item. M.S. angles or other sections shall be used for suspending the frame and paid for separately.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

12.16.3 Mild Steel Screws

Screws shall be got approved from the Engineer-in-Charge before fixing. They shall be of the slotted counter sunk head type of length not less than the thickness of the board plus 20 mm. The designation number shall not be less than 9 for screws of length 40 to 50 mm and shall not be less than 6 for screws of length 25 to 35 mm.

12.16.4 Fixing

The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frame and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

The unexposed faces of planks shall be painted with wood preservative before fixing.

12.16.5 Finishing

The exposed side of the boards shall be truely level and plane. The joints shall be truely parallel and/or perpendicular to the walls.

Beadings shall then be fixed to the ceiling, to the size and pattern required. These shall be measured and paid for separately unless specifically included in the description of the ceiling item.

12.16.6 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01 sqm. The superficial area of the finished work ceiling shall be measured in square metres.

No deduction in measurements shall be made for openings of areas upto 40 square decimetre. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.40 sqm in area, deductions in measurements for the full opening will be made and in such case any labour involved in making these openings shall be paid for separately in running metres.

Wooden ceiling of boardings fixed to curve surfaces in narrow widths shall be measured and paid for separately and shall include making the joints to proper splay.

Circular cutting and waste shall be measured and paid for separately in running metres.

12.16.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.17 CEILING WITH FIBRE INSULATING BUILDING BOARDS

12.17.1 Insulating Building Boards

The insulating building boards shall be of approved quality as per IS code 3348 and, unless otherwise specified, shall have square edges. The dimension shall be subjected to the tolerances given in the Table 12.6 below:

TABLE 12.6
Dimensions and Tolerances

S.No.	*Type of Board*	*Nominal Thickness mm*	*Tolerance on Thickness mm*	*Length cm*	*Width cm*	*Tolerance on length and width*
(i)	Fibre insulation board, ordinary or flame retardant type	9 12 18 25	± 0.75 ± 0.75 ± 1.00 ± 1.25	365, 300 270, 240 210,180 150,120 100, 90 60, 45 and 30	180,150 120,100 90, 60 45 and 30	120 cm and below ± 3 mm Above120 cm ± 6 mm

12.17.2 Frame

Frame of the class of timber and section specified in the description of the relevant item or as ordered by the Engineer-in-Charge shall be provided. The width of the scantlings provided shall be sufficient to provide a minimum nailing surface of 50 mm. The longitudinal and header scantlings shall be so arranged that (a) the boards can be fixed to form the panel arrangements required as per drawings or as ordered by the Engineer -in-Charge (b) the longitudinal scantling to which the boards are mainly fixed are spaced at 30 to 45 cm centres, the actual spacing selected depending on the width of the cut board in the panel arrangement, (c) all edges of the cut board units are supported either on the longitudinal scantlings or on the header scantlings or on both.

The frame shall be given two coats of approved preservative paint (to be paid for separately) before the board is nailed on. M.S. angles or other sections shall be used for suspending the frame and will be paid for separately.

Where the joints in the board are to be covered with beadings the frames should allow 3 to 6 mm for space between boards.

The frame and painting thereof shall be paid for separately unless specifically included in the description of the ceiling item.

The bottom surface of the frame shall be checked and corrected to true planes and slopes.

12.17.3 Nails

The sheets shall be fixed to the frame scantling with G.I. headless nails 2.24 mm dia when the joints are to be left exposed. Where the joints will be covered with beadings, the sheets are to be fixed to the frames scantlings with G.I. felt headed (clout) nails 2.5 mm dia. The length of the nails shall generally be equal to thickness of sheet plus 25 mm so that their grip on the framing members will not be less than 25 mm.

12.17.4 Fixing

The boards shall be laid with lengths parallel to all joints centered over the framing members. Where joints are to be covered, the boards may be spaced 3 to 6 mm apart as described in the respective manufacturers' specifications. Where joints are to be left exposed the sheets shall be butt laid with their edges abutting in moderate contact, but without having to force them into place. The boards shall be supported and held tight to the frame with timber pieces the later being moved outwards as the nailing proceeds. The boards are first nailed to the intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

Where the joints are to be left exposed, the outer rows of nails are placed at 10 cm centres and about 12 mm from the edge of the sheet. In the rows in the middle of the sheets, the nails are placed 20 cm apart. The nails should be counter sunk in the under side of board with a suitable punch. Care shall be taken in driving the nails so that the sheets are not marked by hammer blows.

Where the joints are to be covered with beadings, felt headed (clout) nails shall be used instead of nails without head. The spacing of the nails in the interior rows in boards shall be the same as in the preceding para. In the outer rows at edges to be covered by beadings, the nails will be spaced at 20 cm centres in each row with the nails staggered. The beadings will then be fixed over the sheets with screws at 20 cm centres in each row with the screws in the two rows staggered and passing through beading, sheet and framing so that ultimately the spacing of the fixing (nails and screws taken together) in each row will be at 10 cm centres so far as the sheets and frames are concerned.

12.17.5 Finishing

The exposed side of the board shall be truely level and plane without any local bulges or sags. The joints shall be truely parallel and/or perpendicular to the walls. The width of joints shall be uniform. Care shall be taken to see that the uniformity of colour of the sheets is not spoilt during the fixing operations.

Where the joints are required to be covered, beadings of size, pattern and material as approved by Engineer-in-charge be fixed with screws. These shall, however, be measured and paid for separately, unless specifically included in the description of the ceiling item.

The ceiling shall be treated with distemper or painting if so required but such surface treatment will be paid for separately, unless specifically included in the description of the ceiling item.

12.17.6 Measurements and Rate

These shall be the same as described in 12.16.6 and 12.16.7.

12.18 PARTICLE BOARD /MULTIPURPOSE CEMENT BOARD CEILING

12.18.1 Boards

12.18.1.1 ***Particle Board :*** Particle board flat pressed 3 layers medium density shall be graded particle board grade-1 conforming to IS 3087 of specified thickness. The specifications for particle board shall be same as in sub head 9.0 of wood work and PVC work.

12.18.1.2 ***Multipurpose Cement Board :*** (High Pressure Steam cured). This shall be conforming to IS 14862 and of thickness specified in the item.

12.18.2 Frame

The specifications as described in 12.17.2 shall apply except that the maximum spacing of the longitudinal scantlings shall be 40 cm centres. The specifications for cutting and chamfering etc. will be same as in 12.17.2.

12.18.3 Nails

The specifications shall be the same as in 12.17.3.

12.18.4 Fixing

The specifications as in 12.17.4 shall apply.

12.18.5 Finishing

The specifications as in 12.17.5 shall apply except that normally no surface treatment like painting, varnishing, etc. is necessary.

12.18.6 Measurements and Rate

These shall be the same as under 12.17.6.

12.19 PLAIN/SEMI PERFORATED PARTICLE BOARD TILES CEILING

12.19.1 Frame

The frame work shall consist of anodized aluminium T sections for main runners /cross runners of size specified in the item with anodic coating of 15 micron and perimeter wall angle of anodized aluminium section of size specified by the Engineer-in- charge with anodic coating of 15 micron fixed to the wall with M.S. screws 50 mm long and PVC raw plugs. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The frame work shall be suspended from ceiling by level adjusting hangers made of 6 mm dia. M.S. rods fixed to slab by means of MS ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners 6 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

12.19.2 Ceiling Tiles

Ceiling tiles shall be of 12 mm plain/semi perforated or with design BWP type phenol formaldehyde synthetic resin bonded particle board conforming to IS 3087 of required size. Tiles shall be finished with a coat of aluminium primer on both side and edges and two coats of synthetic enamel paint of approved quality and shade on exposed faces of the tiles.

12.19.3 Fixing of Ceiling Tiles

The ceiling tiles shall be placed over the aluminium frame and fixed to the frame with help of 25 mm long CP brass screws with minimum 2 screws on each side of the grid. The CP brass screws shall be counter sunk star head screws.

12.19.4 Measurements

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square metre correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

12.19.5 Rate

The rate shall include the cost of all the materials and labour involved in all the operation described above including scaffolding etc. Aluminium frame work mentioned in para 12.19.1 will be paid for separately unless otherwise stipulated in the description of the items.

12.19A G.I. METAL TILES CEILING

12.19A.1 Frame

The frame work shall consists of G.I spring tee of specified size fixed to main C carrier with the help of suspension Brackets. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The pre-painted steel 'C' wall angle of size 20x30x20 mm and 0.5mm thick shall be fixed along the periphery of the room with nylon sleeves and wooden screws at 300 mm center to center. The main 'C' carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick shall be fixed with cleats of size 37x27x25x1.6 mm and rawl plugs of size 38x12 mm.

12.19A.2 Ceiling tiles

Ceiling tiles shall be of G.I metal plain beveled of specified white color of size 600x600 mm and 0.5 mm thick with 25 mm height made of G.I. sheet having galvanizing of 100 gms/sqm and electro statically polyester powder coated of minimum 60 microns thickness including factory painted after bending with or without perforation.

12.19A.3 Fixing of ceiling tiles

The ceiling tiles shall be placed over the G.I frame and clip-in with frame.

12.19A.4 Measurements

These shall be the same as under 12.19.4.

12.19A.5 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above including scaffolding etc.

12.20 TRANSLUSCENT WHITE ACRYLIC PLASTIC (PMMA) SHEET CEILING

12.20.1 Frame

It shall be as para 12.19.1

12.20.2 Ceiling Tiles

These shall be made of tanslucent white acrylic plastic sheet conforming to IS 14753 of thickness specified in the item.

12.20.3, 12.20.4, 12.20.5 Fixing, Measurements & Rate

Same as per paras 12.19.3, 12.19.4, 12.19.5 respectively.

12.21 PLASTER OF PARIS (GYPSUM ANHYDROUS) CEILING OVER WOODEN STRIPS

12.21.1 Frame

The frame work shall be of the specified wood. In case of sloping roofs, wooden battens of suitable section (depending upon the span and load to be carried) shall be firmly fixed as main supports, to the under side of the tie beams of the trusses at required spacing by means of bolts and nuts of proper size. In case of flat roofs, the battens shall be securely fixed to the walls and pillars by holding down bolts and shall be fastened to the slabs above with iron straps of suitable sections and encroached therein. Cross battens of 50 x 40 mm sections at 40 cm centres or so, shall then be fixed at right angles to the main battens. The frame work shall be treated with approved wooden preservative before fixing. The underside of the frame work shall be true to planes and slopes.

The frame work for ceiling shall be paid for separately unless specifically included in the description of the ceiling item.

12.21.2 Wooden Strips

Wooden strips of size 25 x 6 mm of first class kailwood, (unless otherwise stipulates specifically in the description of the item) shall be fixed to the cross battens, in the parallel rows with gaps of 10 mm in between adjacent rows, by means of felt headed (clout) nails. The strips shall be fixed butt jointed and not overlapped. The joints shall be staggered. The minimum length of strips to be used shall be 1.5 m depending upon the length of strips required.

12.21.3 Rabbit Wire Mesh

Rabbit Wire mesh shall then be fixed to the underside of wooden strips and their junctions with the battens with nails at pitch of 15 to 20 cm as ordered by the Engineer-in-Charge. The rabbit wire mesh shall be straight, tight and perfectly true to planes and slopes and without any sagging and shall be slightly below the underside of the laths to allow the plaster to encase the metal round.

12.21.4 Plaster of Paris

The plaster of Paris shall be of the calcium-sulphate semi-hydrate variety.

Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35 mm for 5 minutes the residue left on it after drying shall be not more than 1% by weight. It shall not be too quick setting. Initial setting time shall not be less than 13 minutes. The average compressive strength of material determined by testing 5 cm cubes after removal from moulds, after 24 hours and drying in an oven at 40 degree C till weight of the cubes is constant, shall not be less than 84 kg per square metre.

12.21.5 Applications

The material will be mixed with water to a workable consistency. Plaster of Paris shall be applied to the underside of the laths over the rabbit wire mesh in suitable sized panels and finished to a smooth surface by steel trowels. The plaster shall be applied in such a manner that it fully fills the gaps between the laths and the thickness over the laths is as specified in the description of the item. The joints shall be finished flush to make the ceiling in one piece. The finished surface shall be smooth and true to plane, slopes or curves as required.

12.21.6 Measurements

12.21.6.1 Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square metre correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimetre nor shall extra payment be made either for any extra material or labour involved in forming such openings.

12.21.6.2 For openings exceeding 40 square decimetre in area, deduction in measurements shall be made but extra payment will be made for any extra material or labour involved in making such openings.

12.21.6.3 Curved surfaces shall be measured and paid for separately from flat surfaces. The work shall be deemed to comprise of flat surfaces only unless specifically stated otherwise in the description of the item.

12.21.6.4 Any sunk or raised mouldings in the plaster shall be measured and paid for separately, deductions being made from plastering on ceiling only if the width exceeds 15 cm. Ceiling at a height greater than 5 metres shall be so described and measured separately stating the height.

12.21.7 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc. The frame work mentioned in para 12.21.1 supporting the ceiling will be paid for separately unless otherwise stipulated in the description of the item.

The rate does not include for any raised or sunk mouldings or for any patterned finishing of the surface which will be measured and paid for extra over the plaster work.

12.22 RAIN WATER SPOUTS

12.22.0 The sectional area of rain water spouts provided shall be generally at the rate of 1 square cm per 70 to 80 square decimetre of roof area drained. However in locations subject to excessive and high intensities of rainfalls, the area of spouts provided may be suitably increased to suit local conditions. No spout shall be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.

12.22.1 Stone Ware Spouts

The spouts shall be 100 mm in diameters and 60 cm long.

12.22.1.1 The stone ware pipe shall be perfectly sound, free from fine cracks, imperfections of glazing etc. They must be straight cylindrical and of standard nominal diameter and length and depth of socket as given in IS 651. Full length of pipes shall be used on the work. They must be thoroughly salt glazed inside and outside shall generally conform to IS 651.

12.22.1.2 ***Fixing :*** These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1:3 (1 cement : 3 coarse sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry alround the pipe and socket shall be thoroughly wetted and the holes shall be given a coat of cement mortar alround. The S.W. pipe shall then be inserted and fixed with a surround of mortar. In case the hole has become much larger than the size of the pipe, cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at the rate of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance into the pipe shall be smoothly rounded to meet the internal bore of the pipe to facilitate easy flow. Care shall be taken to ensure that the vertical plane through the centre line of the spouts is at right angles to the plane of the wall. Spouts in a row shall be true to line.

12.22.1.3 ***Measurements :*** Spouts shall be measured in numbers.

12.22.1.4 ***Rate :*** The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding.

12.23 CAST IRON RAIN WATER PIPES (FIG. 12.8)

12.23.1 Cast Iron Pipes

Pipes shall conform to IS 1230 and shall be perfectly, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and of uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes.

12.23.2 Dimensions

C.I. rain water pipes shall be of the dia specified in the description of the item and shall be in full length of 1.8 metre including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and tenacious.

Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in Table 12.7.

TABLE 12.7
Dimensions and Weight of C.I. Rain Water Pipes

Nominal size of pipes (Internal diameter in mm)	*50*	*75*	*100*	*125*	*150*
1. PIPE					
(a) External diameter in mm	53	79	104	130	156
Tolerance in mm	± 3	± 3	± 3.50	± 3.50	± 4.00
(b) Thickness in mm	3.00	3.00	3.00	3.00	4.00
Tolerance in mm	± 1	± 1	± 1	± 1	± 1
(c) Nominal weight of 1800 mm long pipe without ears in kg	7.50	11.00	14.00	20.00	26.00
Tolerance in weight	(–) 10%	(–) 10%	(–) 10%	(–) 10%	(–) 10%
Tolerance in length in mm	± 13.00	± 13.00	± 13.00	± 13.00	± 13.00

Nominal size of pipes (Internal diameter in mm)	*50*	*75*	*100*	*125*	*150*
2. SOCKET					
(a) Internal diameter in mm	63	89	114	139	167
Tolerance in mm	± 3.00	± 3.00	± 3.00	± 3.00	± 3.00
(b) Thickness in mm	4.00	4.00	4.00	4.00	4.00
Tolerance in mm	± 1.00	± 1.00	± 1.00	± 1.00	± 1.00
(c) Internal depth in mm	60	65	65	75	75
Tolerance in mm	± 10	± 10	± 10	± 10	± 10

Note: 1. All dimensions are in mm.

2. Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of this standard.
3. The above table applies only to rain water pipes fixed on wall face.
4. For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes. For their weights, specifications under chapter 19.0 shall be referred to.

12.23.3 Fixing and Jointing

12.23.3.1 Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

12.23.3.2 Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be made from 1.6 mm thick galvanised M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semi -circular pieces, hinged with 6 mm dia M.S. bolt on one side and provided with flanged ends on the other side with hole to fit by the screw bolt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long 10 mm diameter M.S. bar, rivetted to the ring at the centre of one semi circular piece. The details of the clamps are shown in Fig 12.8. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note : Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.

12.23.3.3 The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45 degree sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

12.23.3.4 Where pipes are to be embedded in masonry, these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position.

The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe.

The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm dia. 75 mm and 50 mm pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively for purpose of reckoning theoretical Consumption.

In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead per joint approved by the Engineer-in-Charge.

The actual consumption of lead should be within ± 5% of the approved sample job subject to the provision that a variation of ± 20% shall be allowed over the theoretical quantity of lead due to dimensional tolerances allowed as per Indian Standards. This variation includes allowances of wastage also.

12.23.3.5 The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be lead caulked as described in detail under jointing of S.C.I soil, waste and vent pipes.

12.24 CAST IRON ACCESSORIES FOR RAIN WATER PIPES (FIG. 12.8)

12.24.1 C.I. Fittings

C.I. accessories such as bends of various degrees, heads, offsets of different projections, branches and shoes shall conform to IS 1230.

Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375 mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

12.24.2 Dimensions

The fittings shall be of the diameter specified in the description of the item.

The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fittings shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the Table 12.8.

TABLE 12.8
Weight of C.I. Rain Water Pipe Fittings

S.No	*Description*	*75 mm dia (weight in kg)*	*100 mm dia (weight in kg)*	*150 mm dia (weight in kg)*	*Unit*
1	*2*	*3*	*4*		*6*
1.	Bends (Plain)	3.20	4.50	9.10	Each
2.	Offsets (Plain)				
	(a) 55 mm projection	2.70	5.00	8.20	Each
	(b) 75 mm projection	3.20	5.50	9.10	Each

1	2	3	4	5	6
	(c) 115 mm projection	4.10	5.90	9.50	Each
	(d) 150 mm projection	4.50	6.40	10.40	Each
	(e) 225 mm projection	5.00	7.30	11.80	Each
	(f) 300 mm projection	6.00	8.60	12.70	Each
3.	Branches (Plain)				
	Single	5.00	7.30	14.50	Each
	Double	6.80	10.00	19.10	Each
4.	Standard shoes (Plain)	3.20	4.10	8.60	Each
5.	Longer shoes (Plain)				
	(a) 300 mm	3.20	5.00	-	Each
	(b) 375 mm	4.10	5.50	-	Each
	(c) 450 mm	5.50	6.40	-	Each
	(d) 600 mm	7.30	8.60	-	Each
6.	Heads	6.40	6.80	11.30	Each
7.	Extras:				
	(a) For ears cast on any fitting and short pipes	0.90	0.90	1.35	Each
	(b) For inspection doors fitted on any fitting	1.80	1.80	2.25	Each

Note: 1. The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible tolerance in weight of fittings shall be 5%.

2. For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond with those of pipe fittings for soil, waste and vent pipes. For their weights, specifications under S.C.I. soil, waste and vent pipes may be referred to.

12.24.3 Fixing and jointing shall be as specified in 12.23.3.

12.24.4 Measurements

The fittings shall be measured by numbers. Where longer shoes are used in lieu of standard shoes specified in the description of the item, they shall be measured as standard shoes of 180 mm, 205 mm and 275 mm for 75 mm dia, 100 mm dia and 150 mm dia respectively in number and the extra lengths of the shoes shall be measured and paid for under the corresponding size of pipes.

12.24.5 Rate

The rate shall include in the case of fittings fixed on the face of wall, the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing the M.S. holder bat clamps in walls and the anchoring concrete. Unless otherwise specified in the description of the item, the rate shall apply for fittings without access doors. In the case of fittings forming part of a rain water pipe line embedded in masonry, the rate shall be for supplying and embedding the fittings in masonry but shall not include for the jointing and lead caulking which shall be paid for separately.

12.25 THERMAL INSULATION FOR ROOFING

12.25.1 With Cellular Concrete

12.25.1.1 ***Types and Grades:*** Cellular concrete is a light weight concrete formed by producing gas or air bubbles in cement slurry or a cement sand slurry. Cellular concrete shall conform to IS 6598 and shall be of following two types depending on the manner of manufacture.

(i) Type I: High pressure steam cured (auto-claved) materials in the form of precast blocks.
(ii) Type II: Materials cured under natural conditions (that is under ambient pressure and temperature) by water. The material may be either cast in situ or may be in the form of precast blocks.

Grades - Each of these two types of the material shall have three grades, namely:
Grade A - Light weight cellular concrete;
Grade B - Medium weight cellular concrete and;
Grade C - Heavy weight cellular concrete.

12.25.1.2 ***Materials***

(a) Aggregate: A variety of sillicious fines, such as ground quarts sand shale, flyash and granulated slag may be used in the manufacture of cellular concrete.
(b) Water and binder shall conform to para 3.1.1 and 3.1.2 of CPWD Specifications 2019.
(c) Gassing Agents: Organic foaming agents based on resin soap, glue, surface active agents, or fine aluminium powder, zinc, dust, calcium carbide, calcium by pocheride etc. may be used for gassing the concrete.

12.25.1.3 ***Dimensions :*** The dimensions of the type I and type II precast cellular concrete block shall be either 50 or 60 cm in length, 20, 25 or 30 cm in width and 7.5, 10, 15, 25 or 40 cm in thickness.

12.25.1.3.1 *Tolerance :* A tolerance of ±3 percent shall be allowed on width and height and ±1 percent on thickness.

12.25.1.4 ***Requirement for Cellular Concrete***

TABLE 12.9

S. No.	*Characteristics*	*Grade A*	*Grade B*	*Grade C*	*Test reference*
1.	Density in kg/cum	Upto 320	321 to 400	400 to 500	IS 5688
2.	Crushing Strength in kg/sq. cm. (type I) (type II)	 7.0 2.5	 12.0 4.5	 20.0 8.0	 -do-
3.	Thermal conductivity in kw/cm deg c at 50 deg. c mean temperature	0.7	0.85	1.0	IS 3346
4.	Capillary absorption not to exceed 20% in case of type I cellular concrete when tested as per Appendix A of IS 6598.				

12.25.1.5 ***Sampling:*** In a consignment, cellular concrete of the same type and grade and manufactured approximately in the same period shall be grouped to form a lot. If it is in the form of blocks, a lot shall be made up of not more than 1000 blocks. If the material is in situ, not more than 10 tons of materials shall constitute a lot.

If the material is transported in lorries and received as such, the material in lorry (or vehicle load) & may conveniently be termed as lot.

Each lot shall be tested for all the requirements separately.

If the lot is made up of precast blocks, the number of sample blocks to be tested shall be selected at random as per the following Table 12.10.

TABLE 12.10

Lot Size	*Sample size (block to be sampled) (n)*	*Permissible No. of defectives (visual and dimensional requirements) (a)*
Up to 100	5	0
101 to 300	8	0
301 to 500	13	0
501 to 1000	20	1

12.25.1.6 ***General :*** Cellular concrete if done with precast blocks shall be laid on terrace slab after thoroughly cleaning the surface. The blocks shall be laid over a layer of 12 mm average thick cement mortar 1:4 (1 cement : 4 coarse sand) and the joints shall also be filled properly with neat cement slurry. The joints shall be staggered. Thickness of joints shall be as minimum as possible and not more than 5 mm.

12. 25.1.7 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

12.25.1.8 ***Rate :*** The rate shall include the cost of all materials and labour required in providing cellular concrete.

12.25.2 With Resin Bonded Fibre Glass Wool (Bonded Mineral Wool)

12.25.2.1 ***Material:*** The material shall be mineral wool made from rock slag or glass processed from a molten state into fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall conform to specifications of group I of IS 8183.

12.25.2.2 ***Dimensions:*** The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded mineral wool shall be 25, 40, 50, 65 or 75 mm.

12.25.2.3 ***Tolerances:*** For width and length, the dimensional tolerances of the bonded mineral wool slabs shall be -½%. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

12.25.2.4 ***Requirements for Fibre Glass Wool***

TABLE 12.11

S. No.	*Characteristics*	*Group I*	*Test Reference*
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	not less than 90% of original thickness	Annex. A of IS 8183

S. No.	*Characteristics*	*Group I*	*Test Reference*
3.	Shot content max	500 micron - 5% 250 micron - 15%	IS 3144
4.	Moisture content and absorption	not more than 2%	IS 3144
5.	Incombustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg.C	0.49 mw/ $cm^{o}C$	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

12.25.2.5 ***General :*** Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

In the second case when space above false ceiling is to be used for carrying return air 1.5" x 1.5" slotted angle (3" length) shall be fixed to the ceiling by means of rawl plugs at 2'0" spacing. Draw 14 gauge tie wires from the slots. Make a mat of mineral wool insulation backed with scrim cloth with a light coating of Plaster of Paris or polythene faced hessian and 24g x 1" wire mesh netting. The joints of wire netting should be butted and tightly laced down with G.I. wire. Stretch the mat tightly across the angles holding it in place by means of tie wires.

12. 25.2.6 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

12.25.2.7 ***Rate :*** The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

12.25.3 With Expanded Polystyrene

12.25.3.1 ***Material :*** Expanded polystyrene shall conform to IS 4671. It is of two types as given below:

(a) Type N - Normal
(b) Type SE - It shall be of self extinguishing type when tested in accordance with Appendix E of IS 4671.

12.25.3.2 ***Dimensions*** **:** The size of the finished boards shall be 1.0 × 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100 mm.

12.25.3.2.1 *Tolerances* **:** The tolerances on length, width and thickness of the finished board shall be ±2 mm.

12.25.3.3 ***Requirements for Expanded Polystyrene for General Use:***

TABLE 12.12

S. No.	*Characteristics*	*Requirements at various nominal apparent densities in kg/cum*					*Test Reference*
		15	20	25	30	35	
1.	Thermal conductivity (K. value) (a) at 0ºC (b) at 10ºC	 0.34 0.37	 0.32 0.35	 0.30 0.33	 0.29 0.32	 0.28 0.30	IS 3346
2.	Compressive strength at 10% deformation in Kg/sq.cm Min.	0.7	0.9	1.1	1.4	1.7	IS 4671 Appendix A
3.	Cross breaking strength in kg/sq. cm Min.	1.4	1.6	1.8	2.2		IS 4671 Appendix B
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671 Appendix C
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671 Appendix D
6.	Water absorption	less than 0.5% by volume (after 24 hrs. immersion)					IS 4671 Appendix E

12.25.3.4 ***Sampling :*** In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judging conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table No. 12.13 given below. The sample shall be taken at random from the lot.

TABLE 12.13

No. of items in the lot	*No. of sample items*	*Permissible number of defective sample items*
1	*2*	*3*
Upto 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

12.25.3.5 ***General*** **:** Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

12. 25.3.6 ***Measurements*** **:** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

12.25.3.7 ***Rate :*** The rate shall include the cost of material and labour in providing and fixing the polystyrene boards.

12.25.4 With Exfoliated Vermiculite

12.25.4.1 ***Material :*** Exfoliated vermiculite consists of vermiculite mineral which has been expanded many times of its original volume after being subjected to high temperature (700 degree C to 1000 degree C).

It is utilised as a thermal insulation material after mixing it with a cementitious material.

12.25.4.2 ***Requirements of Exfoliated Vermiculite for General Use***

12.25.4.2.1 Exfoliated vermiculite in loose fill condition should conform to following :

TABLE 12.14

S.No	*Characteristics*		*Type-I*	*Type-II*	*Type-III*	*Type-IV*
1.	Density in kg/m	Min.	56	64	80	96
			12	128	144	160
		Max				
2.	Thermal conductivity at mean temp. 25 deg. C in mw/cm deg.C		0.72	0.72	0.72	0.72
3.	Guarding: As per following table. Accumulated % age retained on sieves having square holes, by wt					

TABLE 12.15

Size	*9.51 mm*		*4.76 mm*		*2.38 mm*		*1.19 mm*		*595 mcn*		*297 mcn*		*149 mcn*	
designation	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Type-I	0	40	30	90	65	98	85	100	-		-		-	
Type-II	-		0	95	20	80	75	100	90	100	97	100	-	
Type-III	-		-		0	10	20	70	65	95	75	98	90	100
Type-IV	-		-		-		0	5	15	65	60	98	90	100

12.25.4.2.2 Exfoliated vermiculite after being mixed with a cementitious material should conform to following:

TABLE 12.16

S.No.	*Characteristics*	*Requirements*
1.	Consistency	35 to 45% or 178 to 229 mm
2.	Dry covering capacity in sqm of 100 kg of material 1 cm thick	34 sqm
3.	Compressive strength at 5% deformation min.	103.5 KN/sqm
4.	Liner shrinkage after 24 hrs. at 1800 Deg. F max.	3%
5.	Thermal conductivity max. at mean temperature 95 deg.C.	1.37 mw/cm deg.C.

12.25.4.3 ***Sampling & Testing :*** If any of the test date obtained on the samples tested fail to conform to the requirements given above, the material shall be rejected.

12.25.4.4 ***General :*** Exfoliated vermiculite along with cementitious material is mixed with water in the required proportion (as specified by manufacturers). This mix is to be immediately spread over the terrace slab in prescribed thickness. No curing need be done. After laying the insulation, the entire surface shall be cement plastered with cement mortar 1:4 of 20 mm thickness.

12. 25.4.5 ***Measurements :*** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

12.25.4.6 ***Rate :*** The rate shall include the cost of all materials and labour in providing exfoliated vermiculite.

12.25A HEAT RESISTANCE TERRACE TILES

12.25A.1 Terrace tiles

Heat resistance terrace tiles are basically ceramic floor tiles which reflects solar radiation. These tiles are used on the floor of the terrace to prevent building from getting heated. These are used on the roof of any building or balcony. These can be used on wall of a building which are directly exposed to sunlight.

12.25A1.1 Solar Refractive Index (SRI)

It is a measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. SRI is calculated according to ASTM E1980.

12.25A.1.2 Benefits of Heat Resistance Tiles:-

1. Reduce inside building temperature.
2. Save electricity.
3. Lower power demand.
4. Save burning fossil fuel by power plants.
5. Lower emission of green house.
6. Reduction of global warming.
7. Reduce conduction of heat into building.

12.25A.1.3 Requirement for Heat Resistance Terrace Tiles

Table 12.17

S. No.	Characteristics	Requirement
1	Size	300mm x 300mm x 20mm
2	Solar refractive index	Not less than 78
3	Solar reflection	Not less than 0.70
4	Initial emittance	Not less than 0.75

12.25A.1.3.1 Tolerance

Tolerances on length and breadth shall be plus or minus one millimeter, and tolerance on thickness shall be plus 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and in thickness not less than plus 3 mm.

12.25A.2 Laying

12.25A.2.1 Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

12.25A.2.2 Cement mortar bedding shall be spread, tamped and corrected to proper levels. If cement mortar is laid in bedding the tiles, then tiles shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed

in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with grout of mix of white cement and marble powder in the ratio of 1:1.

12.25A.2.3 The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.

12.25A.2.4 Where full tiles or half tiles can not be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.

12.25A.2.5 Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the skirting which shall be fixed upto 150mm height along the parapet walls in the same manner.

12.25A.2.6 After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

12.25A.3 Curing, Polishing and Finishing

12.25A.3.1 The day after the tiles are laid all joints shall be cleaned of the grey cement with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with white cement mixed marble powder in the ratio of 1:1. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

12.25A.3.2 The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60). Water shall be used profusely during grinding. After grinding, the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

12.25A.3.3 The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

12.25A.3.4 For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No. 80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

12.25A.3.5 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 the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

12.25A.3.6 If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

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

12.25A.4 Measurements

12.25A.4.1 Heat resistance terrace tiles shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm including skirting shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same terrace.

12.25A.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.26 UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS

12.26.1 UPVC Pipes

Pipes shall conform to Type A pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

12.26.2 Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified .

12.26.3 Marking

Each pipe shall be clearly and indelibly marked with the following informations at intervals not more than 3 meter.

(a) Manufacturer's name or trade mark.

(b) Nominal outside dia of pipe.

(c) Type 'A'

(d) Batch number.

12.26.4 Dimensions

12.26.4.1 ***Diameter and Wall Thickness:*** Mean outside diameter, outside diameter at any point and wall thickness for type –A manufactured plain or with socket shall be as given in Table- 1 of IS 13592.

UPVC rain water pipes shall be of the dia, specified in the description of the item and shall be in nominal lengths of 2,3,4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be + 10 mm and – 0 mm.

12.26.5 Fixing and Jointing

Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item.

Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

12.26.6 Installation in Wall/Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement

followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

12.26.7 Fittings

Fittings used shall be of the same make as that of the PVC pipes Injeciton moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

12.26.8 Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

12.26.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing of wall plugs and PVC clips which shall be paid for separately.

Note : These pipes shall be used only in shaft or unexposed location to avoid damage to these pipes due to willful act.

12.27 THERMAL INSULATION OVER EXISTING WALL WITH FIBER GLASS WOOL

12.27.1 Material & Fixing:

Resin Bonded fiber glass wool conforming to IS: 8183 having density 24 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded fiber glass wool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire .

12.27.2 Precaution:

All wet trades such as plastering, conducting and painting etc. be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulation work. The area shall be made dry prior to ceiling installation work.

Care should be taken while placing resin bounded glass wool over existing wall so that there will be no displacement to grid.

12.27.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.27.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.28 CALCIUM SILICATE TILES FALSE CEILING

12.28.1 Materials & Fixing:

8 mm thick fully perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm , of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.85, with 50 mm thick rock wool of 48 kg /cum backing shall be used.

Frame is made up of interlocking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main “T” runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to

center and cross “T” of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main “T” at 600 mm center to center to form a grid of 1200x600 mm and secondary cross “T” of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm etc. complete.

Main “T” runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by Engineer-in-charge. false ceiling tiles of approved texture shall be laid in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

12.28.2 Precaution:

All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (Worker should preferably wear clean soft cotton gloves while placing tile).

12.28.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

12.28.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.29 CALCIUM SILICATE BOARD FALSE CEILING

12.29.1 Material &Fixing :

8 mm thick Calcium Silicate Board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process shall be used.

Frame work is made of special section, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/ sqm (both side inclusive) as per IS : 277 and consisting of angle cleat of size 25mm wide x 1.6mm thick with flanges of 27mm and 37mm, at 1200mm c/c, one flange fixed to the ceiling with dash fastener 12.5mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25 x10 x0.50mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I chanels 45 x15 x 0.90mm running at the spacing of 1200 mm c/c, to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26 mm each having lips of 10.5mm, at 450mm c/c, shall be fixed in a direction perpendicular to G.I intermediate channel with connecting clip made out of 2.64mm dia x 230mm long G.I wire at every junction, including fixing perimeter channels 0.50mm thick 27mm high having flanges of 20mm and 30mm long.

The perimeter of ceiling fixed to wall/ partitions with the help of rawl plugs at 450mm centre, with 25mm long dry wall screws @ 230mm interval, including fixing of Calcium Silicate Board to ceiling section and perimeter channels with the help of dry wall screws of size 3.5 x25mm at 230mm c/c, including jointing & finishing to a flush finish of tapered and square edges of the board with recommended jointing compounds, jointing tapes, finishing with jointing compounds in three layers covering up to 150mm on both sides of joints

and two coats of primer suitable for boards, all as per manufacture's specification and also including the cost of making opening for light fittings, grills, diffusers, cut outs made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in charge but excluding the cost of painting.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

12.29.2 Precaution:

All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work.

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

12.29.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

12.29.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.30 THERMAL INSULATION OF CEILING

12.30.1 Material &Fixing:

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. The Wire mesh of 12.5 mm x24 gauge shall be used. Fixing shall be done to ceiling with metallic cleats (50x50x3 mm) @ 60 cm and wire mesh of 12.5mm x 24 gauge wire mesh, for top most ceiling of building.

12.30.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool into the wire mesh so that there will be no displacement to grid.

12.30.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.30.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.31 THERMAL INSULATION OVER EXISTING FALSE CEILING

12.31.1 Material & Fixing:

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be placed over existing false ceiling and to be held in position by criss crossing G.I. wire .

12.31.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing false ceiling so that there will be no displacement to grid.

12.31.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.31.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

12.32 THERMAL INSULATION OVER EXISTING WALL

12.32.1 Material & Fixing :

Resin Bonded Rockwool conforming to IS: 8183,density 48 kg/ m3, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire .

12.32.2 Precaution:

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulating work. The area shall be dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing wall so that there will be no displacement to grid.

12.32.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

12.32.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

APPENDIX A

GALVANISED STEEL SHEETS

(Clause 12.1.1)

A-1 Dimensions

A-1.0 Sizes of plain Sheet: The plain sheets shall be supplied in any combination of the following lengths, widths and thickness.

(a) Length : 2500 and 3000 mm
(b) Width : 900 and 1000 mm
(c) Thickness : 0.50, 0.63, 0.80, 1.00 mm

A-1.1 In case of sheets supplied in coil, the internal diameter of coil shall be 450, 510 and 610 mm and the mass of each coil shall not exceed 12 tonne.

A-1.1.1 Coils weighing more than 12 tonnes may be supplied subject to mutual agreement between the contracting parites.

A-1.2 Corrugated sheets.

A1.2.1 Length- The length of the corrugated sheets shall be as follows: 2500, 3000 mm

A-2 Zinc Coating

The weight of coating referred to in this specification shall represent the total weight of zinc both side inclusive.

On any sample selected at random from the delivery, one set of three samples each 50 x 50 mm or 50 mm diameter shall be selected at random from one sheet for every 500 G.S. sheets, the coating for the different classes shall be within the limit specified in table below:

TABLE I
Mass of Coating (Total Both Sides)

Grade of coating	*Minimum average coating Triple spot test g/sqm*	*Minimum coating single spot test g/sqm**
600	600	510
450	450	380
350	350	300
275	275	235

* minimum individual value obtained in triple spot test.

A-3 Mass

The mass of sheets and coils shall be calculated as given in Table II on the basis of nominal dimensions and mass of zinc coating.

TABLE II
Calculation of Mass of Sheets or Coils

Type of materials	*Order of calculation*	*Method of calculation*	*Number of Numerals in resultant value*
Sheet	Mass of single sheet	Nominal mass of single sheet plus mass of zinc coating	Rounded off to 4 effective figures
	Total mass	Mass of single sheet (kg) x number of sheets	Rounded off to integral value of kg
Coil	Unit mass of coil	Unit mass of sheet (kg/m^2)x width (mm) x10 -3	Rounded off to 3 effective figures
	Mass of single coil	Unit mass of coil (kg/m)x length (m)	
	Total mass (kg)	Total mass of each coil	Integral number of kg

Note:

(i) Nominal mass of single sheet shall be calculated by calculating the volume of the sheet and multiplying the same with density of sheet (density 7.85 g/ cubic cm) and rounding the same to 4 effectve figures.

(ii) Mass of the coating shall be calculated by multiplying the surface area of single sheet with indicated inominal coating mass (g/square metre) as shown for triple spot test (Table I).

(iii) For calculation of corrugated sheet mass, the width before corrugation shall be considered while calculating the area.

A-4 Corrugations

The depth and pitch of corrugation shall be as follows:

Grade	*Depth of Corrugation (mm)*	*Pitch of Corrugation (mm)*
A	17.5	75
B	12.5	75

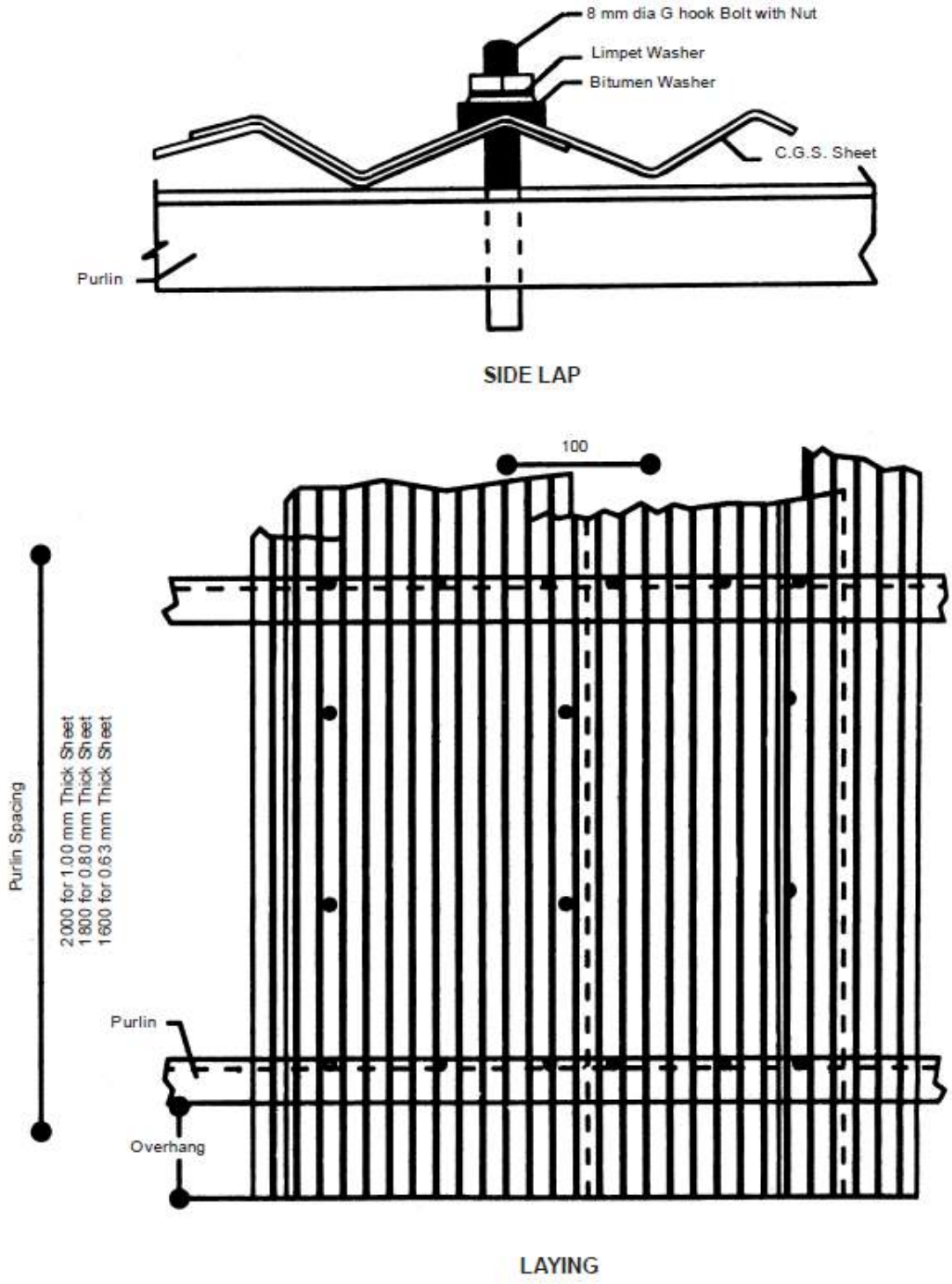
The number of corrugations shall be 8,10, 11 or 13 per sheet. The overall width of the sheets before and after corrugation shall be as given in Table below.

TABLE III
Details of Corrugations

Number of corrugations	*Grade*	*Nominal overall width of sheet measured between crowns of outside corrugations*	
		Before corrugation mm	*After corrugation mm*
(1)	*(2)*	*(3)*	*(4)*
8	A	750	660
10	A	900	810
11	A	1000	910
13	A	1200	1110
8	B	750	680
10	B	900	830
11	B	1000	930
13	B	1200	1130

C.G.S. SHEETS

Sub Head : Roofing
Clause : 12.1

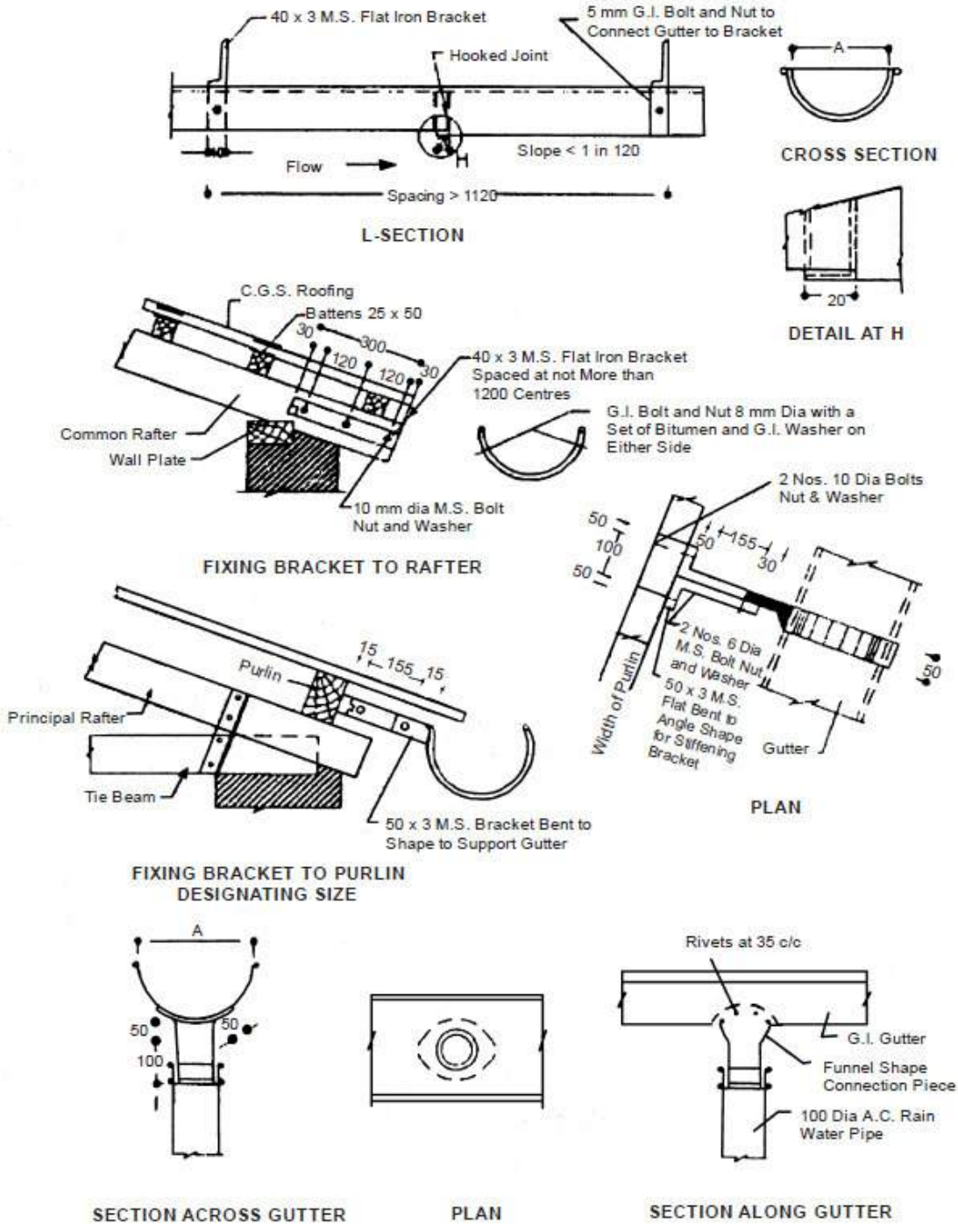


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.1 : C.G.S. Sheets

GALVANISED STEEL SHEET GUTTER

Sub Head : Roofing
Clause : 12.1

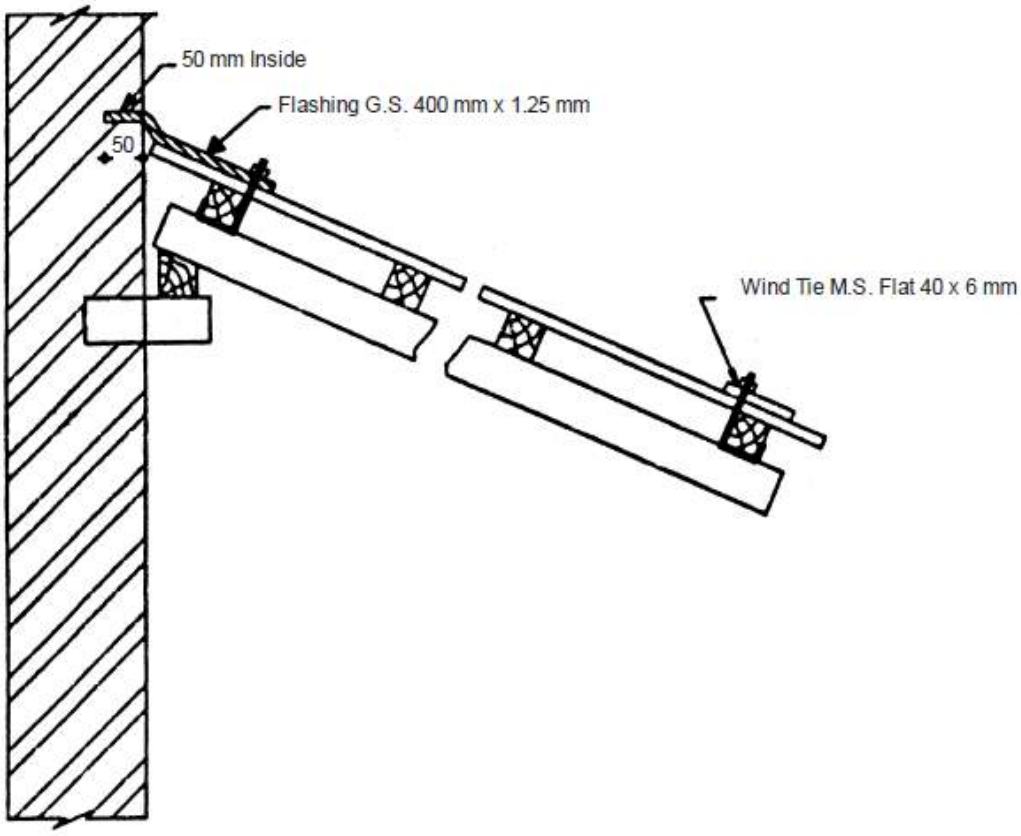


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.2 : Galvanised Steel Sheet Gutter

WIND TIE AND FLASHING

Sub Head : Roofing
Clause : 12.1.5 & 12.3

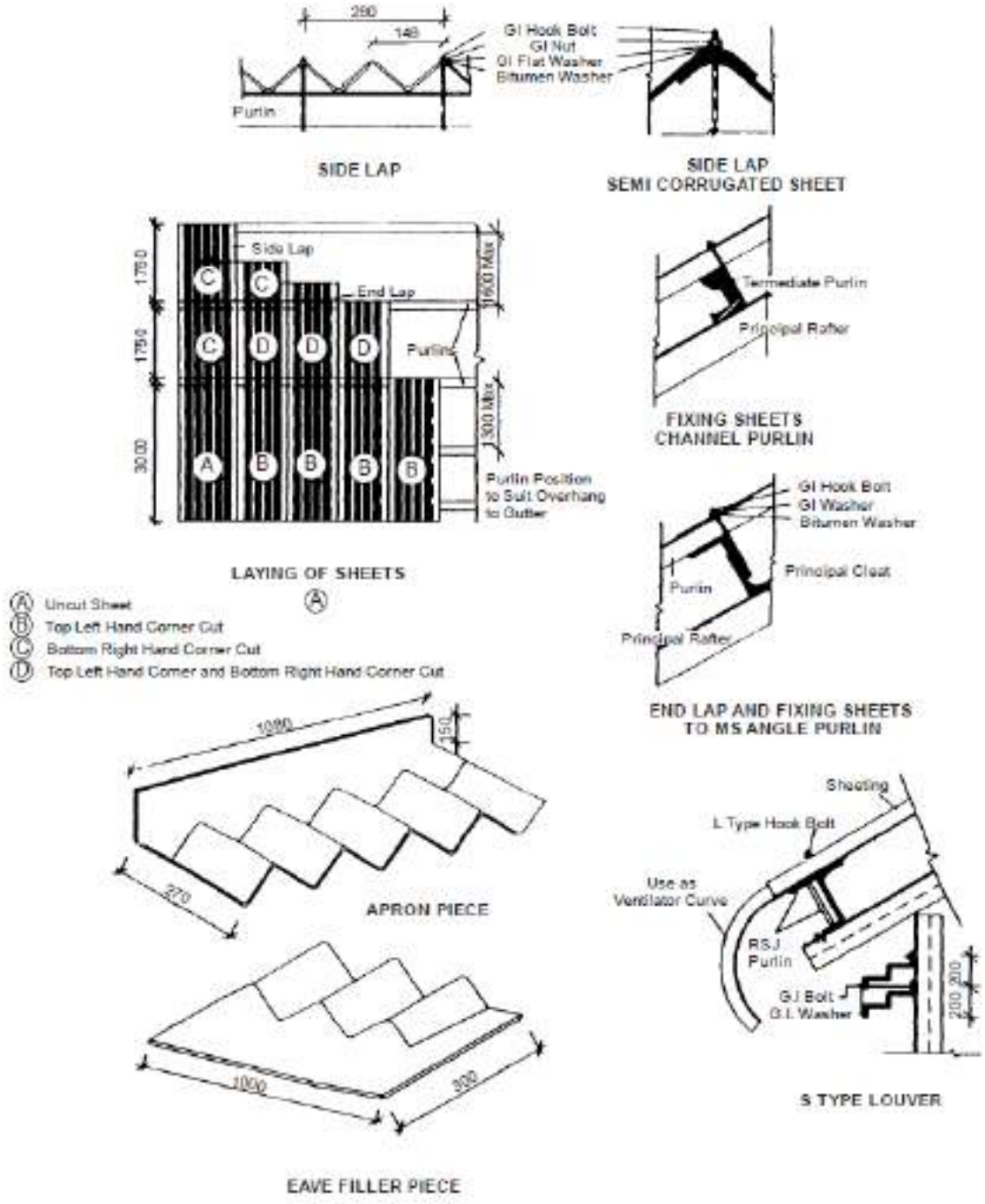


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.3 : Wind Tie and Flashing

NON-ASBESTOS CORRUGATED SHEET

Sub Head : Roofing
Clause : 12.5, 12.8

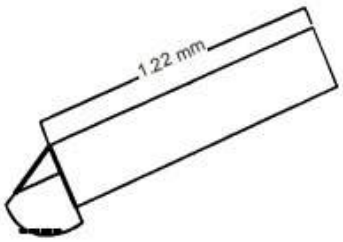


Drawing Not to Scale
All Dimensions are in mm

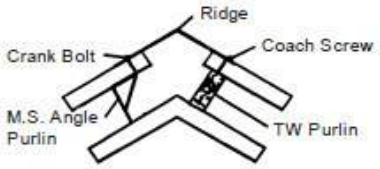
Fig. 12.4 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres cement Corrugated Sheet roofing

NON-ASBESTOS CEMENT ACCESSORIES

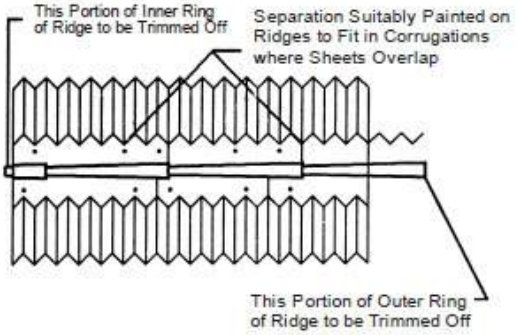
Sub Head : Roofing
Clause : 12.8

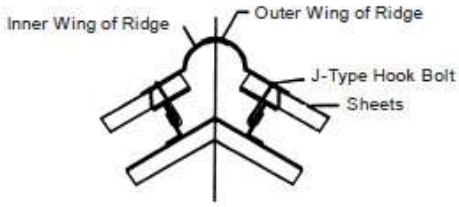


ONE PIECE PLAIN ANGULAR RIDGE

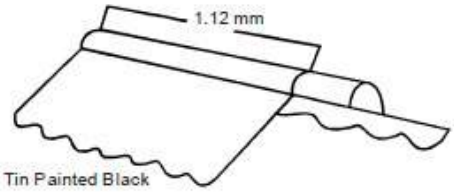


SECTION SHOWING ALTERNATIVE FIXING ACCESSORIES

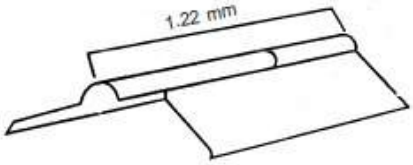




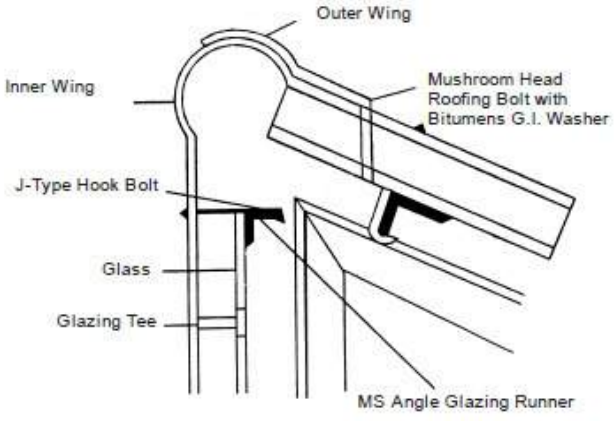
FIXING OF SERRATED ADJUSTABLE RIDGE



SERRATED ADJUSTABLE RIDGE



UNSRPRATED ADJUSTABLE RIDGE

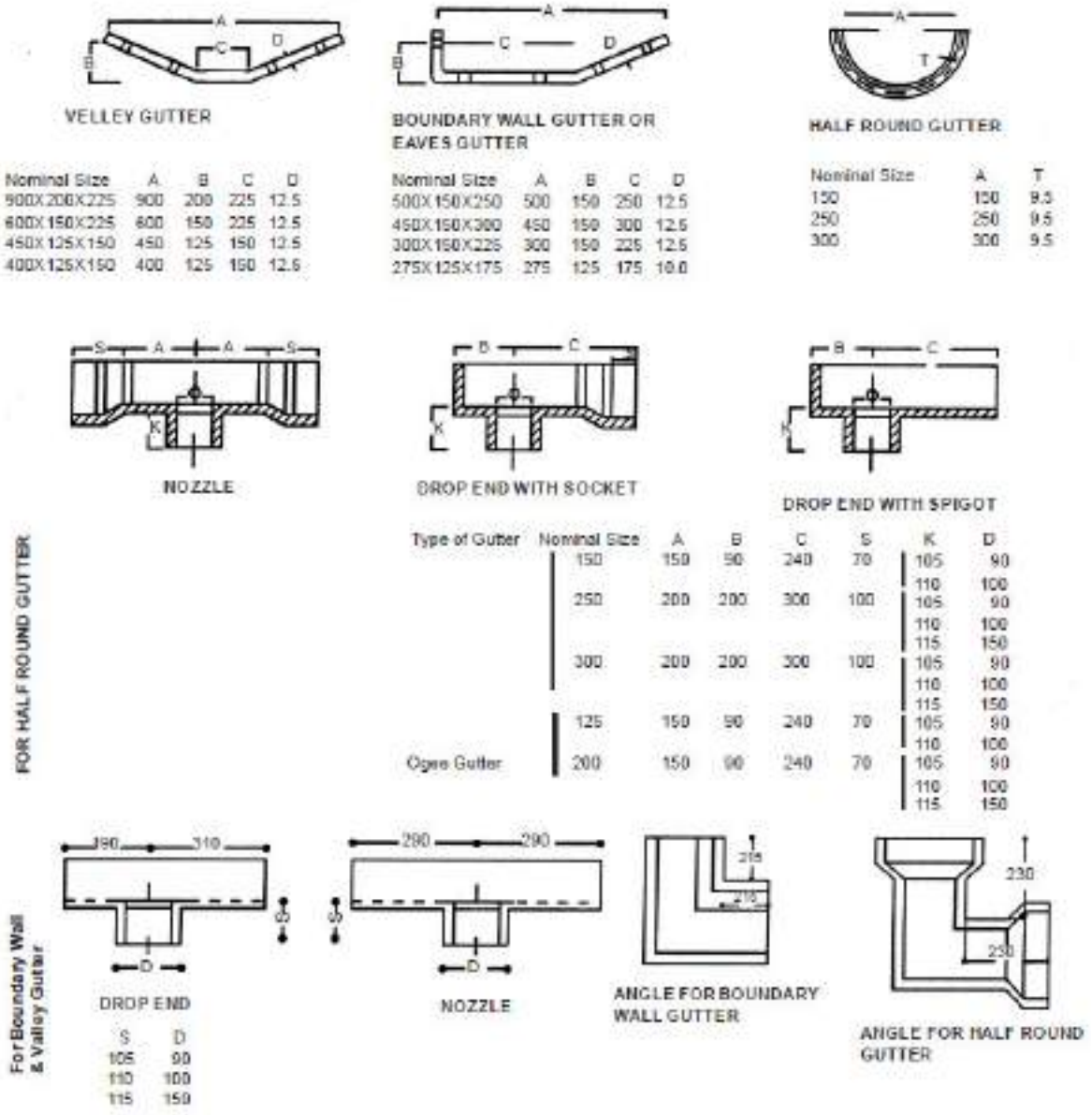


Drawing Not to Scale
All Dimensions are in mm

Fig. 12.5 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Accessories

NON-ASBESTOS CEMENT GUTTERS

Sub Head : Roofing
Clause : 12.9

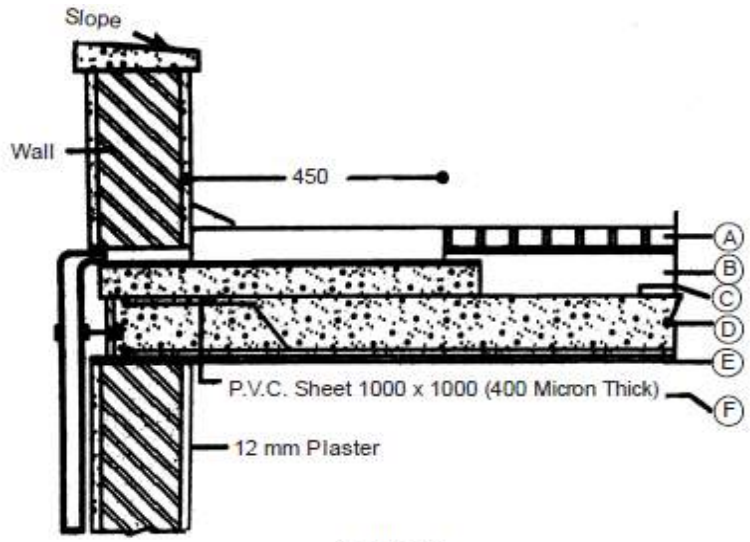


Drawing Not to Scale
All Dimensions are in mm

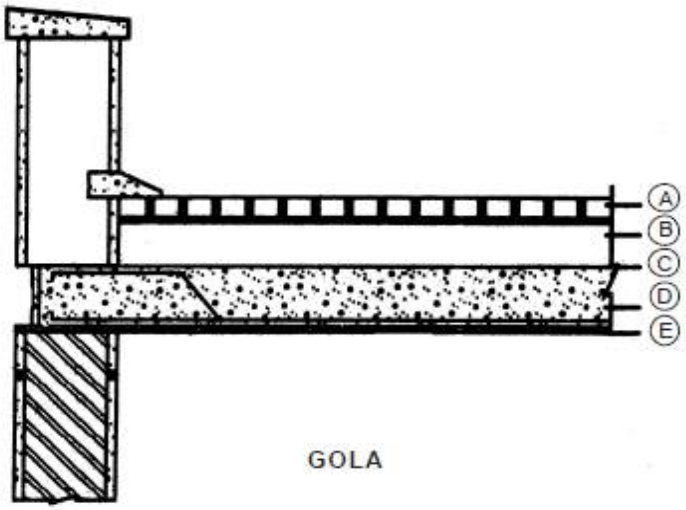
Fig. 12.6 : Non-Asbestos reinforced by organic fibres and/or inorganic synthetic fibres Cement Gutters

CEMENT CONCRETE KHURRA - GOLA

Sub Head : Roofing
Clause : 12.13 and 12.14



KHURRA



GOLA

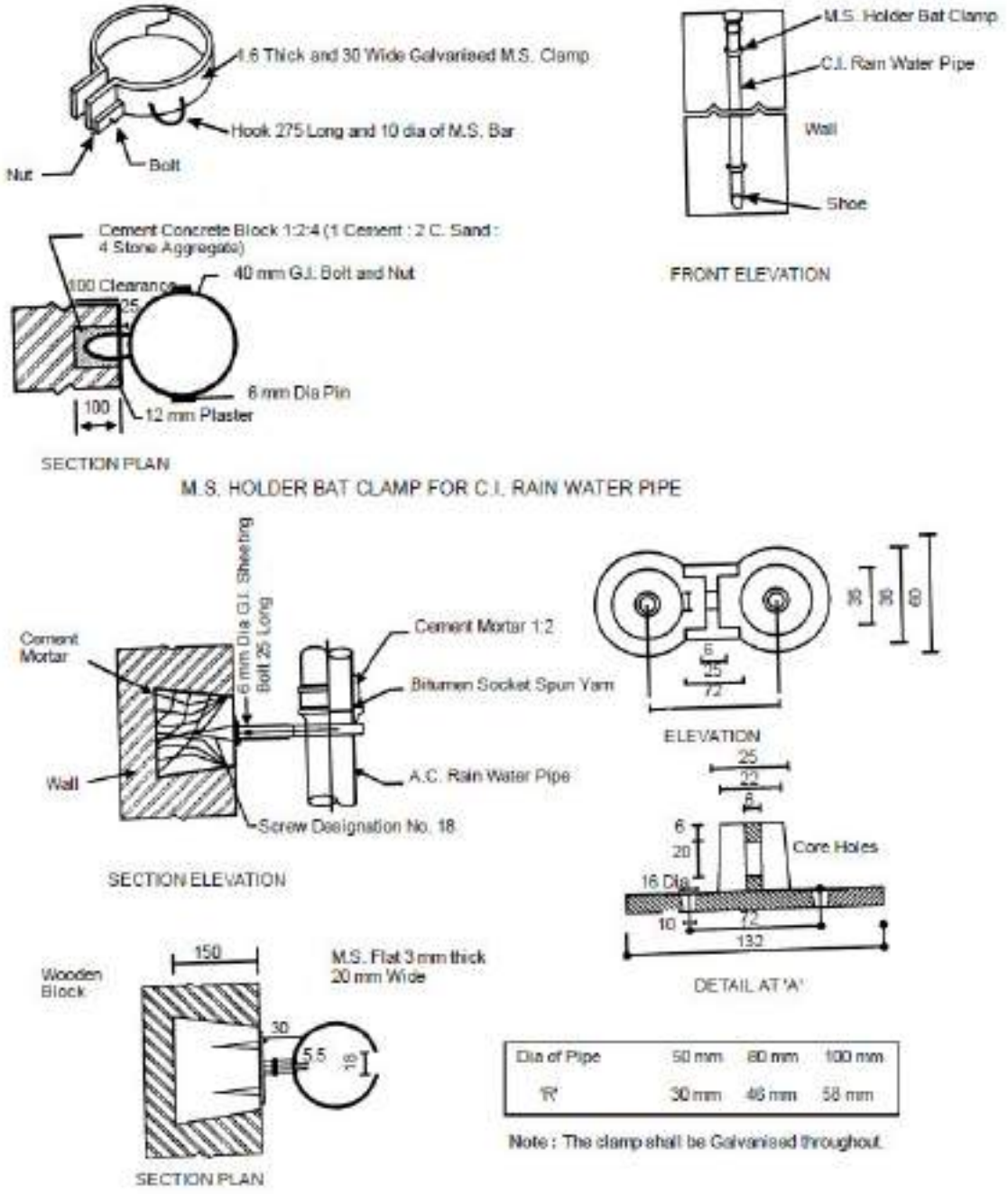
Ⓐ Brick Tiles
Ⓑ Mud Phuska/Lime Concrete
Ⓒ Painting with Hot Bitumen 80/100 at 1.7 kg/sq.cm.
Ⓓ R.C.C. Slab
Ⓔ 6 mm Thick Ceiling Plaster Finished neat and Thick Coat of White Washing or Kraft Paper
Ⓕ P.V.C. Sheet 1000 x 1000 (400 Micron Thick)

Drawing Not to Scale
All Dimensions are in mm

Fig. 12.7 : Cement Concrete Khurra – Gola

HOLDER BAT CLAMP

Sub Head : Roofing
Clause : 12.23, 12.24



Dia of Pipe	50 mm	80 mm	100 mm
'R'	30 mm	46 mm	58 mm

Note : The clamp shall be Galvanised throughout.

Drawing Not to Scale
All Dimensions are in mm

Fig. 12.8 : Holder Bat Clamp

Government of India
Ministry of Housing and Urban Affairs
CENTRAL PUBLIC WORKS DEPARTMENT

Available at : JAIN BOOK AGENCY (CENTRAL)
4574/15, 2nd Floor, Padamchand Marg, Near Happy School, Daryaganj, New Delhi-110002
Phone : 011-43513689, 43513570 Mob: 9667274446, 9810666810
E-mail : thakur@jainbookagency.com