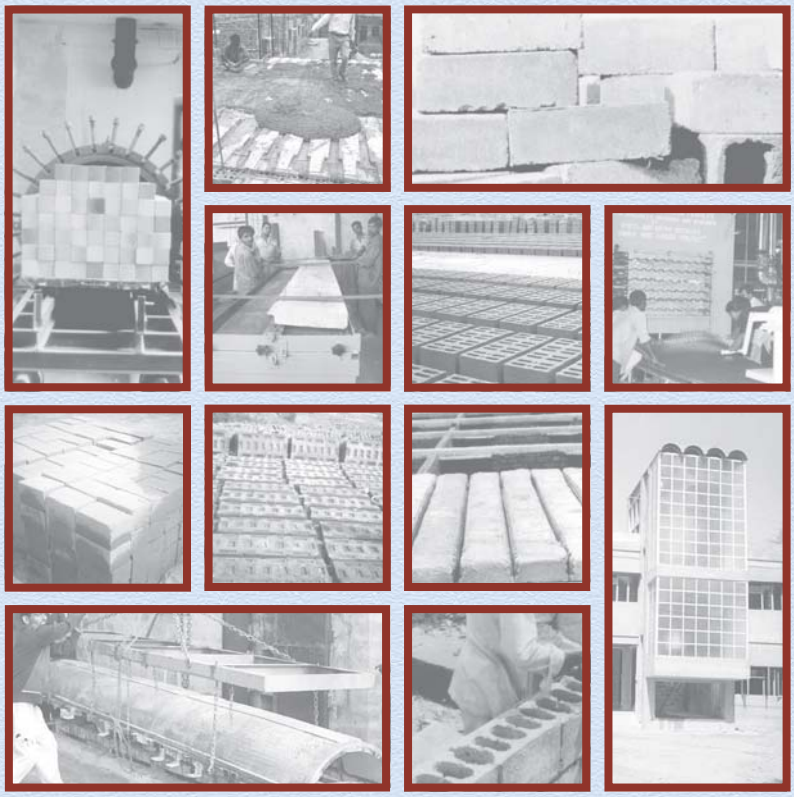
Standards & Specifications

for Cost-Effective Innovative Building Materials and Techniques including Rate Analysis

Second Edition



Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India

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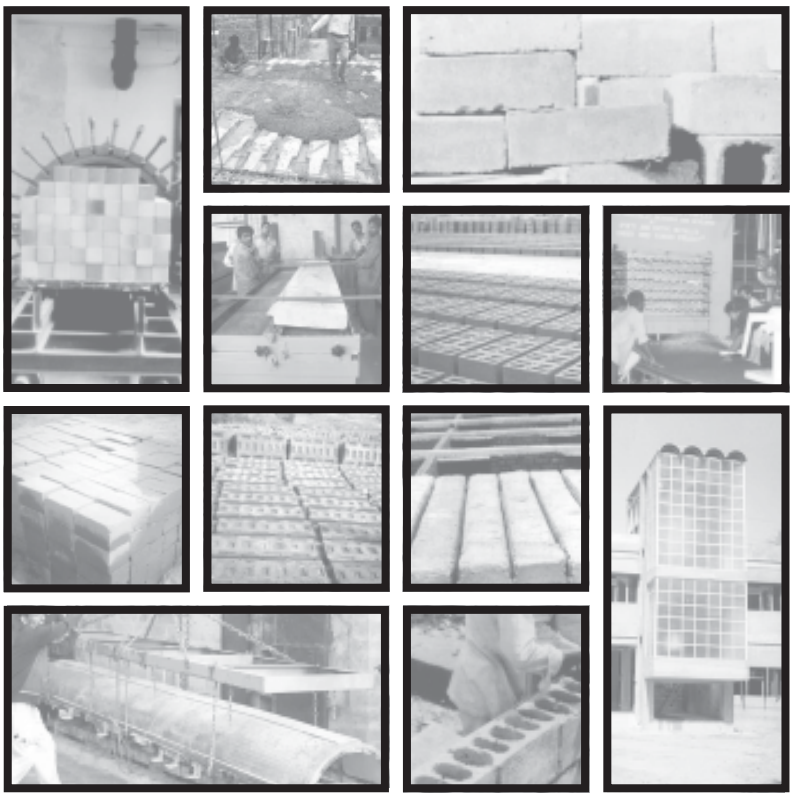

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PREFACE

The scarcity frequent non-availability, constantly rising costs of building materials and the declining quality of housing and building construction are causing concern to Central & State Governments. It is now widely recognized that the cost of housing can be reduced and speed and quality of construction stepped up through the use of emerging innovative building materials and technologies. Despite a number of innovative cost-effective building materials, components and construction techniques developed through research, the housing and building agencies have not adopted them in their construction practices. The extent to which lack of standards and specifications has been instrumental in hampering the adoption of homegrown innovative building material technologies has long been a matter of concern. Since non-listing of these new techniques in Indian Standards and Codes is quoted as one of the foremost reasons by construction agencies for non- adoption in their practice, the Bureau of Indian Standards (BIS) has been constantly striving to cover new technologies within the fold of standardisation. While quite a few of new materials and techniques have attracted attention of the building industry and several housing agencies and have also been gradually identified in Codes of Practices, these have not percolated to the practices of organisations like CPWD, MES, State PWDs and others in public and private sectors.

BMTPC's recent interaction with various architects, engineering departments and building construction organisations resulted in a common observation that many of the new techniques do not find proper place in their construction practices due to the absence of standard specifications -a factor which hinders their induction in departmental schedules of specifications and contract documents. Regarding the use of prefabrication systems many a times, a passive attitude is to be seen probably because of some past adverse experience with large-scale prefabrication systems adopted by couple of organisations. However, the open prefab systems based on appropriate production level and small elements with rationalised production methods have attracted the attention of housing experts as an important option for arresting the rapidly rising escalation in costs of materials and labour. Building Centres in different regions also been propagating several of these technologies.

While formulating specifications on the identified technologies, an attempt has been made to gather technical information from various sources and to compare the same with existing relevant Indian and/or International Standards. Detailed specifications have been so formatted that these can be inducted in the schedules of specifications by public and private construction agencies. It is hoped this compilation will help the construction agencies in promoting and adopting the new technologies in their housing and building projects.

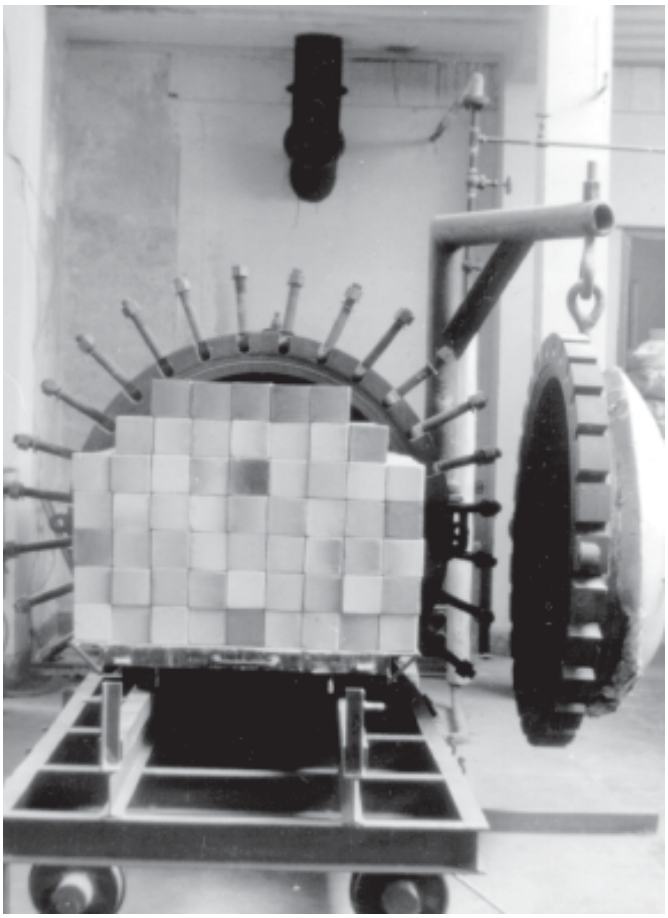
The formulation of standards and specifications need to be complemented by promotional efforts. There is an imperative need, therefore, for incorporating these specifications by all construction departments in their building codes, schedules and tendering and contractual documents. Standards and Specifications are not static but dynamic instruments to facilitate incorporation of new developments and advances. It is important that these are periodically reviewed taking into account actual field experiences of construction agencies and producers of the materials and components recommended here.

With a view to expedite their adoption in different field conditions, the proposed specifications may have to be appropriately complemented, in few cases by preparation of simple manuals, appropriate training programmes for artisans, supervisors and all those associated with different aspects of construction projects. BMTPC in association with BIS and the concerned R&D organisations will be happy to assist in such efforts.

The Council had brought out the earlier edition in 1996. The help received in formulating the specifications from CBRI, BIS, CPWD, HUDCO is gratefully acknowledged. I would like to place on record special thanks to the BMTPC's officials for their valuable contribution in compiling and formulating the various specifications.

(Dr.Shailesh Kr.Agrawal)
Executive Director

Building Materials



BM 01

Specifications for Sand Lime/ Calcium Silicate Bricks

1 General

1.1 Bricks shall be solid, compact and uniform in shape with or without frog. Bricks shall be free from visible cracks, warpage, organic matter, pebbles and nodules of free lime.

1.2 Bricks shall have rectangular faces with sharp and square corners and shall be uniform in colour.

2 Materials

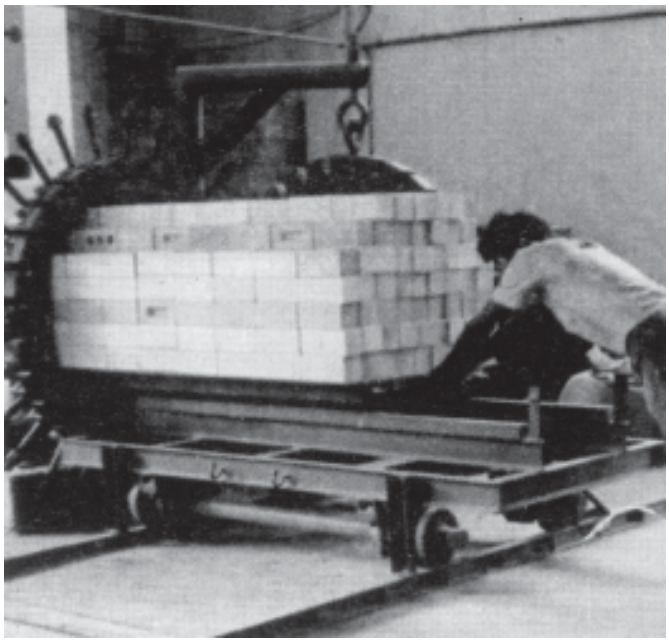
2.1 Bricks shall be made of finely ground sand/siliceous rock with clay and silt content less than 5 percent and lime. Lime shall conform to class C hydrated lime of IS 712.

2.2 Additives - Any suitable additive considered not deterimental to the durability of the bricks may be used to provide early strength and or colour.

3 Dimensions and Tolerances

3.1 The actual size of the sand lime/calcium silicate bricks shall be 190 mm x 90 mm x 90 mm and 190 mm x 90 mm x 40 mm. The size of the frog shall be 100 mm x 40 mm and 10 mm to 20mm deep on one of its flat side.

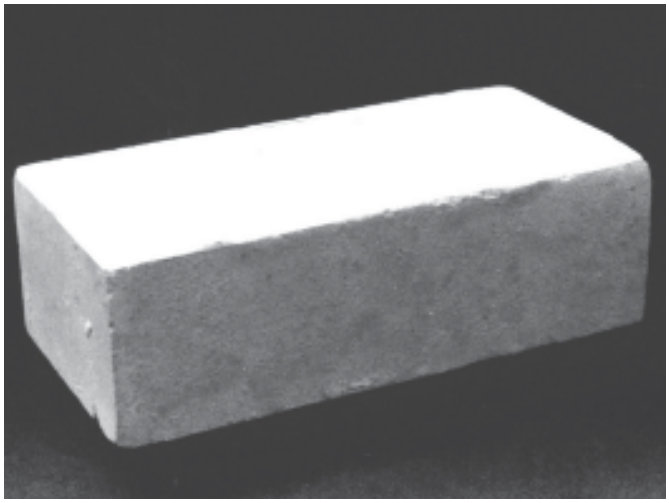
3.2 Brick shall have tolerance on length ± 3 mm, breadth and height ± 2 mm.



4 Classification

4.1 Sand lime/calcium silicate bricks shall be of four classes depending upon their average compressive strength as given below:

Class Designation	Ave. Compressive Strength (kg/cm^2)	
	Minimum	Maximum
75	75	100
100	100	150
150	150	200
200	200	-



5 Physical Characteristics

5.1 ***Compressive Strength*** - The minimum average compressive strength of sand lime/calcium silicate bricks shall not be less than that specified for each class in 4.1 when tested as described in IS 3495 (Part I). The compressive strength of any individual brick shall not fall below the minimum average compressive strength specified for the corresponding class of bricks by more than 20 per cent.

5.2 ***Drying Shrinkage*** - The average shrinkage of sand lime/cal cium silicate bricks when tested as per IS 4139 shall not be greater than that given below:

Class Designation	Drying Shrinkage (% of Wet Length)
75	0.06
100	0.06
150	0.04
200	0.04

6 Sampling and Criteria for Conformity

6.1 The sampling of the bricks and the criteria for conformity shall be as given in IS 5454.

7 Marking

7.1 Each brick shall be marked in a suitable manner with the manufacturer's identification mark or initials and the class of brick.

BM 02

Specifications for Flyash Lime Bricks

1 General

1.1 Bricks shall be solid, compact and uniform in shape with or without frog. Bricks shall be free from visible cracks, warpage and organic matters.

1.2 The bricks shall have rectangular faces with sharp and square corners and shall be uniform in shape and colour.

2 Materials

2.1 ***Flyash*** - Flyash shall conform to Grade I or Grade 2 of IS 3812.

2.2 ***Bottom Ash*** - Bottom ash used as replacement of sand shall not have more than 12 per cent loss on ignition when tested according to IS 1727.

2.3 ***Sand*** - Deleterious materials, such as clay and silt in sand, shall preferably be less than 5 percent

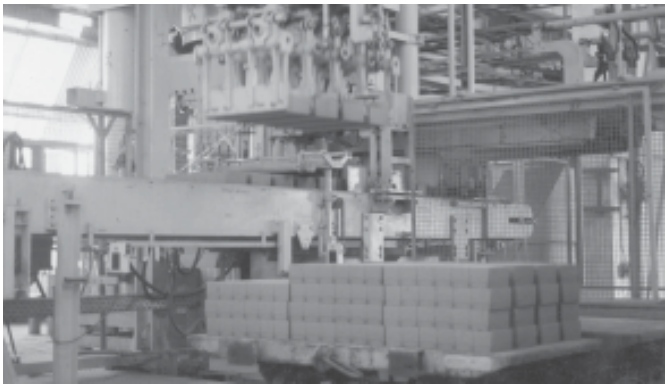
2.4 *Lime* - Lime shall conform to Class C hydrated lime of IS 712.

2.5 ***Additives*** - Any suitable additive considered not detrimental to the durability of the bricks such as gypsum, cement, etc. may be used to provide early strength and/or colour.

3 Dimensions and Tolerances

3.1 The standard modular sizes of the flyash-lime bricks shall be 190 mm x 90 mm x 90 mm and 190 mm x 90 mm x 40 mm. The non-modular sizes of bricks shall be 230 mm x 110 mm x 70 mm and 230 mm x 110 mm x 30 mm. For obtaining proper bond arrangement and modular dimensions for the brick work, with non-modular brick, bricks of sizes 70 mm x 110 mm x 70 mm (1/3 length of brick) and 230 mm x 50 mm x 70 mm (1/2 width of brick) may be used.The size of the frog shall be 100 mm x 40 mm and 10 mm to 20 mm deep on one of its flat side.

3.2 The tolerance on dimensions, when tested as per method prescribed in IS 12894 shall be ± 80 mm in length and ± 40 mm in width and ±40 mm in height per 20 bricks (both for modular size and non-modular size).



4 Classification

4.1 Flyash-lime bricks shall be of the following classes depending upon their average wet compressive strength:

Class Designation	Average Wet Compressive Strength - Not less than	
	N/mm^2	Kgf/cm^2 (Aprox)
30	30.0	(300)
25	25.0	(250)
20	20.0	(200)
17.5	17.5	(175)
15	15.0	(150)
12.5	12.5	(125)
10	10.0	(100)
7.5	7.5	(75)
5	5.0	(50)
3.5	3.5	(35)

5 Physical Characteristics

5.1 ***Compressive Strength*** - The minimum wet average compressive strength of flyash-lime bricks shall not be less than the one specified for each class in 4.1 when tested in accordance with IS 3495 (Part 1). The compressive strength of any individual brick shall not fall below the minimum average wet compressive strength specified for the corresponding class of bricks by more than 20 percent.

Note: In case any of the test results of wet compressive strength exceed the upper limit for the class, the same shall be limited to the upper limit of the class for the purpose of averaging.

5.2 ***Drying Shrinkage*** - The average drying shrinkage of the bricks when tested by the method described in IS 4139, being the average of three units, shall not exceed 0.15 percent.

5.3 ***Efflorescence Test*** - The bricks when tested in accordance with the procedure laid down in IS 3495 (Part 3), shall have the rating of efflorescence not more than 'moderate' up to Class 12.5 and 'slight' for higher classes.

5.4 ***Water Absorption*** - The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part 2), after immersion in cold water for 24 h, shall have average water absorption not more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes.

6 Sampling and Criteria for Conformity

6.1 Sampling and criteria for conformity of flyash-lime bricks shall be done in accordance with the procedure laid down in IS 5454.

7 Marking

7.1 Each brick shall be marked in a suitable manner with the manufacturer's identification mark or initials and the class of brick.

BM 03

Specifications for Burnt Clay-Flyash Bricks

1 General

1.1 Bricks shall be made from admixture of suitable soils and flyash in optimum proportions. The flyash shall conform to grade 1 or grade 2 as per IS 3812.

1.2 Clay-fly ash bricks shall be solid, compact and uniform in shape, size and colour. Bricks shall have rectangular faces with sharp and square corners. The brick shall be free from visible cracks, flaws, warpage, nodules of stone and/or free lime and organic matters. The bricks shall be hand or machine moulded.

2 Dimensions and Tolerances

2.1 The size of clay-flyash bricks shall be as follows:

Modular Sizes:

Length (L)	Width (W)	Height (H)
mm	mm	mm
190	90	90
190	90	40

Non Modular Sizes

230	110	70
230	110	30

For obtaining proper bond arrangement and modular dimensions for the brick work, with non-modular sizes, the following sizes (mm) of brick may also be used:

70	110	70 (1/3 length brick)
230	50	70 (1/2 width brick)

2.2 Brick of 90 mm or 70 mm height shall be with frog of 100 mm in length, 40 mm in width and 10 to 20 mm deep on one of its flat side.

2.3 The tolerances on dimensions, when tested as per the method prescribed in IS 13757 shall be ± 80 mm in length and ± 40 mm in width and ±40 mm in height per 20 bricks (both for modular size and non-modular size).

3 Physical Characteristics

3.1 ***Classification*** - Clay flyash bricks shall be classified on the basis of the average compressive strength as given in Table 1.

Table 1:

Class Designation	Average Compressive Strength - Not less than	
	N/mm^2	Kgf/cm^2 (Aprox)
30	30.0	(300)
25	25.0	(250)
20	20.0	(200)
17.5	17.5	(175)

15	15.0	(150)
12.5	12.5	(125)
10	10.0	(100)
7.5	7.5	(75)
5	5.0	(50)
3.5	3.5	(35)

Notes:

(i) In case of any of the test results of wet compressive strength exceed the upper limit for the class, the same shall be limited to the upper limit of the class for the purpose of averaging.

(ii) The compressive strength of any individual brick tested shall not fall below the minimum compressive strength specified for the corresponding class of brick. The lot shall be then checked for next lower class of bricks.

3.2 ***Compressive Strength*** - The clay flyash bricks, when tested in accordance with the procedure laid down in IS 3495(Part-I), shall have a average compressive strength as given in Table 1.

3.3 ***Water absorption*** - The bricks, when tested in accordance with the procedure laid down in IS 3495(Part 2), after immersion in cold water for 24 h., water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes.

3.4 ***Efflorescence*** - The bricks when tested in accordance with the procedure laid down in IS 3495(Part 3), the rating of efflorescence, shall not be more than 'moderate' upto class 12.5 and 'slight' for higher classes.

4 Sampling and Criteria for Conformity

4.1 Sampling and criteria for conformity of common clay-flyash bricks shall be done in accordance with the procedure laid down in IS 5454.

5 Marking

5.1 Each brick shall be marked in a suitable manner with the manufacturer's identification mark or initials and the class of brick.

BM 04

Specifications for Clay Flooring Tiles

1 General

1.1 Flooring tiles are unglazed tiles made from natural clays or shales and burnt to dense mass which are used for flooring of residential, public and industrial buildings.

1.2 Flooring tiles shall be made from good soils of even texture and shall be uniformly well burnt. Tiles shall be uniform in size and shape and shall be free from irregularities, such as twists, bends, cracks, flaws, laminations and imperfections which affect appearance or serviceability. The faces of tiles shall be plain, grooved, fluted or figured as specified and the edges shall be square. The back of the tiles may have some type of either plain or engraved or embossed design.

1.3 Class I tiles shall be specially hard-burnt as they are meant for use in industrial flooring where heavy wear is anticipated.

2 Dimensions and Tolerances

2.1 ***Dimensions and shape*** - The dimensions of the square tiles shall be as given in Table 1. The tiles & half-tiles, both rectangular and triangular in shape may also be made. Half-tiles for use with the full tiles shall be such as to make two half-tiles, when joined together, match the dimensions of one full tile.

2.1.1 The dimension and shape of flooring tiles other than square shall be as agreed to between the purchaser and the vendor.

2.1.2 The depth of the grooves or frogging on the underside of flooring tiles shall not exceed 3 mm.

2.2 ***Tolerances*** - The permissible tolerances shall be as under:

2.2.1 Length and Breadth-The avenge dimensions of the tile when measured, as described in 2.2.1.1, shall not vary more than ± 5 mm from nominal dimensions and also the dimensions of the individual tile furnished for a given area or space shall not vary more than ± 2 mm from the average.

2.2.1.1 The measurement of the dimensions shall be made to the nearest 0.5 mm and the results averaged, the dimensions shall not include spacers.

2.2.2 ***Thickness*** - The average thickness of the tile when measured, as described in 2.2.2.1, shall not vary more than ± 2 mm from the nominal thickness, also the thickness of individual tile supplied for a given area or a space shall not vary more than ± 1 mm.

2.2.2.1 The thickness of tile shall be measured 10 mm from each of the edges of the tile and rounded off to the nearest 0.25 mm. Four points in measurement shall be selected to give an average thickness representative of the tile. In case tile has keys or ribs, these shall be included in the thickness.

2.2.3 ***Warpage*** - When measured as described in 2.2.3.1, the warpage shall not exceed 2 percent along the edges and 1.5 percent along the diagonals.

2.2.3.1 Place a straight edge flat over the tile resting on a plane surface so as to leave maximum gap between the straight edge and the surface of the tile, as judged by the naked eye. Insert the measuring metallic wedge in the gap and measure the maximum value of the gap.

3 Classification

Flooring tiles shall be of three classes, namely, Class 1, Class 2 and Class 3, with the characteristics as specified in Table 2 and shall satisfy the details of test given in 5.

Table 1:
Dimensions of Square Tiles

S.No.	Size (mm)	Thickness(mm)
1.	150 x 150 mm	15mm
2.	150 x 150 mm	20mm
3.	200 x 200mm	20 mm
4.	200 x 200mm	25 mm
5.	250 x 250 mm	30 mm

4 Sampling

4.1 For conducting the tests at least six tiles shall be selected at random for every 1000 tiles or fraction thereof in a lot. The number of tiles taken from a lot for tests shall be not less than 15 in any one lot.

5 Details of Tests

5.1 ***Water Absorption Test*** - The average water absorption of six tiles, when tested by the method described below, shall conform to the requirements specified in Table-2.

5.1.1 Dry the six tiles in an oven at a temperature of 100 to 110°C till they attain a constant weight and then cool; weigh when cool and immerse the dry specimens completely in clean water at 24°C to 30°C for 24 h. Remove each specimen, wipe off the surface water carefully with a damp cloth, and weigh the specimen correct to a gram, within three minutes after removing the specimen from water.

5.1.2 The percentage water absorption shall be calculated as follows:

Percentage water absorption

$$= \frac{(B - A)}{A} \times 100$$

Where A = weight of the dry specimen in g, and

Where B = weight of the specimen in g after 24 h. immersion in cold water

5.1.3 The average percentage water absorption of the six tiles shall be calculated and reported as the percentage water absorption.

5.2 ***Flexural Strength Test*** - When tested as per IS 1478 the average strength of six tiles, that is, three tiles in the dry condition and three in the wet condition, shall conform to the requirements specified in Table 2.

5.3 ***Impact Test*** - When tested as per IS 1478 the maximum height of release of the steel ball, which does not cause a fracture in the tile obtained by tests on three specimens, shall conform to the requirements specified in Table 2. In case of tiles other than square tiles, the height of release of the steel ball shall be subject to prior agreement between the purchaser and the vendor.

Table 2: Classification of Flooring Tiles

S.No.	Characteristic	Requirement for		
		Class 1	Class 2	Class 3
1.	Water absorption percent, Max	10	19	24
2.	Flexural strength kg/cm width, Min			
	a) Average	6	3.5	2.5
	b) Individual	5	3.0	2.0
3.	Impact, maximum height in mm of drop of steel ball:			
	a) 15 mm thick	25	20	15
	b) 20 mm thick	60	50	40
	c) 25 mm thick	75	65	50
	d) 30 mm thick	80	70	60

6 Non-Compliance with Tests

6.1 If any of the tiles in the sample fails to comply with the requirements of any of the tests, another sample shall be similarly drawn and tested. If any of tiles in the second sample also fails to comply with the requirements of any of the tests, then the whole lot, from where the samples were taken, shall be rejected as not complying with this standard.

7 Marking

7.1 Each tile shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, if any, the marking shall not cover more than 5% of the area of the specimen.

BM 05

Specifications for Burnt Clay Flat Terracing Tiles

1 General

1.1 The terracing tile shall be made from good soil of even texture and shall be uniformly well burnt They shall be uniform in shape, sizes and shall be free form irregularities, such as twists, bends, cracks and particles of stones. The face of the tile shall be either plain or grooved but the back of the tile should be corrugated so as to adhere the mortar.

1.2 Burnt clay flat terracing tiles may be machine pressed or hand made and are used for flat roof finishing over lime concrete or cement concrete base.

A MACHINE MADE TILES

The specifications for machine-made burnt clay flat terracing tiles are as under.

2 Dimensions and Tolerances

2.1 The size of terracing tiles shall be as given below:
Length in mm - 150, 175, 200, 225 and 250
Width in mm -100,125,150,175 and 200
Thickness in mm - 20 and 15

2.2 ***Tolerance*** - The tolerances in length, width and thickness shall be ±2 percent in the case of machine pressed tiles and ±3% in case of machine extruded tiles.

3 Physical Characteristics

3.1 ***Water Absorption***

3.1.1 The average water absorption of the tile when tested by the method described in 3.1.2 to 3.1.4 shall not exceed 15 percent.

3.1.2 Dry the tiles in an oven at a temperature of 100°C to 110° C till they attain a constant weight and then cool; weigh when cool and immerse the dry specimen completely in clean water at 24°C to 30° C for 24 h. Remove each specimen, wipe off the surface water carefully with a damp cloth and weigh the specimen correct to a gram within three min. after removing the specimen from water.

3.1.3 The percentage water absorption shall be calculated as follows:

$$\text{Percentage water absorption} = \frac{(B - A)}{A} \times 100$$

Where
A = weight of the dry specimen in g, and
B = weight of the specimen in g after 24 h. immersion in cold water.

3.1.4 The average percentage water absorption of six tiles shall be calculated and reported as the percentage water

absorption.

3.2 ***Flexural Strength*** - The average modulus of rupture in bending of six tiles shall not be less than 20 kg/cm^2 when tested as per IS 2690 (Part 1).

3.3 ***Warpage*** -The maximum warpage for the tiles measured as described in 3.4 shall not exceed in any direction by one percent.

3.4 Place a straight-edge flat over the tile resting on a plane surface so as to leave maximum gap between the straight-edge and the surface of the tile, as judged by the naked eye, insert the measuring metallic wedge in the gap and measure the maximum value of gap.

4 Sampling and Testing

4.1 For conducting the tests specified in para 3 at least six tiles shall be selected at random for every 1000 tiles or fraction thereof in a lot. The number of tiles taken from a lot for tests shall not be less than 15 in any one lot.

4.2 Tiles shall be tested for water absorption and flexural strength. If any of the tiles in the sample fails to comply with the requirements of any of the tests, another sample shall be similarly drawn and tested. If any of the tiles in the second sample also fails to comply with requirements of any of the tests, then the whole lot, from where the samples were taken shall be rejected as not complying with the standard.

5 Marking

5.1 Each terracing tile shall be legibly and indelibly marked with indication of source of manufacture; the marking shall not cover more than 5% of the area of specimen. The tile be also marked by letter 'M' to indicate machine made.

B HAND MADE TILES

1 General

1.1 The terracing tile shall be made from good soil of even texture and shall be uniformly well burnt. They shall be uniform in shape and sizes and shall be free from irregularities, such as twists, bends, cracks and particles of stones.

1.2 The specifications for hand made burnt clay flat terracing tiles are as given in 2.

2 Dimensions and Tolerances

2.1 The size of terracing tiles shall be as given below:-

Length in mm - 150,175,200,225 and 250

Width in mm - 75, 100, 125, 150, 175 and 200

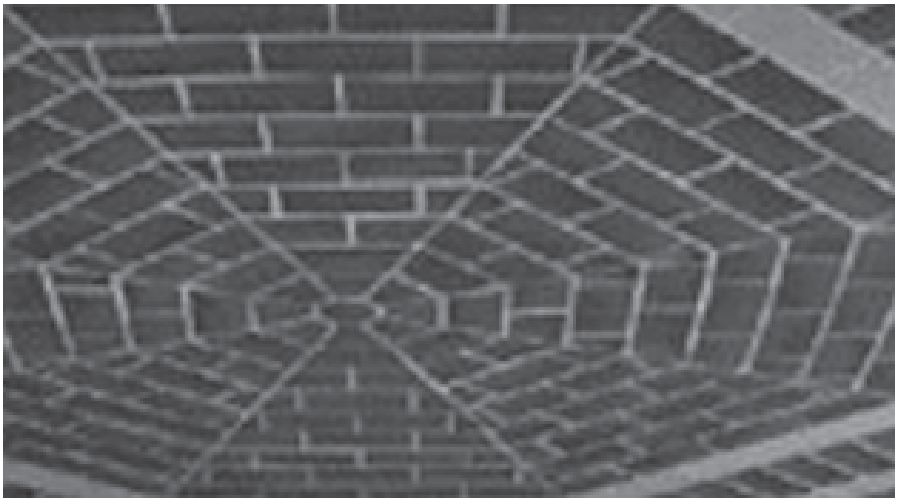
Thickness in mm - 25, 30, 35, 40, 45 and 50

2.2 ***Tolerances*** - The tolerances in length, width and thickness shall be ±3 percent.

3 Physical Characteristics

3.1 ***Water Absorption***

3.1.1 The water absorption by weight when tested according to the method described in IS 3495 (Part 2) shall not exceed 20 percent.



3.2 ***Flexural Strength***

3.2.1 The modulus of rupture in bending when tested by the method as described in IS 2690(Part 2) shall not be less than 15 kg/cm^2.

3.3 ***Warpage***

3.3.1 The maximum warpage for the tiles measured as described in 3.3.2 shall not exceed 2 percent of the dimensions in any direction.

3.3.2 Place a straight-edge flat over the tile resting on a plane surface so as to leave maximum gap between the straight-edge and the surface of the tile. Judging by the naked eye, insert the measuring metallic wedge in the gap and measure the maximum of gap.

4 Sampling and Testing

4.1 Sampling and the criteria for determining the suitability of the hand made tiles shall be as per IS 5454.

5 Marking

5.1 Each terracing tile shall be legibly and indelibly marked with indication of source of manufacture; the marking shall not cover more than 5% of the area of specimen. The tile be also marked by letter 'H' to indicate hand made tiles.

BM 06

Specifications for Reinforced Gypsum Plaster Boards

1 General

1.1 ***Fibrous Gypsum Plaster Board***

A composition of gypsum plaster and sisal, coconut, jute or other fibre forming body of regular dimensions forms the board.

1.2 ***Glass Reinforced Gypsum Board (GRG)***

A composition of gypsum plaster and glass fibre forming body of regular dimensions forms the board.

1.3 Fibrous Gypsum plaster boards and Glass Reinforced Gypsum boards are used as covering material for walls, ceilings and partitions in normally dry environments in buildings. These boards have the specific advantage of being light weight when compared to other boards of similar nature and have high fire resistant properties.

1.4 The specifications of the boards for use as a lining material for ceiling, dry surfacing material for walls are as under:

2 Materials

2.1 The gypsum plaster shall comply with the requirements of IS 8272. For high strength GRG boards, gypsum plaster of properties:

i) Fineness – Not more than 5 percent retained on BIS Sieve (75 Micron),

ii) Normal Consistency – Min 60 percent, and

iii) Compressive Strength – Min 16.0 MPa.

By-product gypsum conforming to the requirements of IS 12679 shall be used for the preparation of plaster.

2.2 Fibre -The reinforcing fibre may be sisal or a mixture of such sisal fibre and coconut containing not more than 20 percent by mass of coconut fibre. It shall be thoroughly teased and free from dust, grease or other similar substances. For GRG Boards, the reinforcing fibre shall be of 'E-type' having good chopping characteristics and dispersibility.

2.3 Potable water shall be used for mixing plaster.

2.4 The oil and greases used in the preparation of benches and moulds for casting shall be such as will leave the plaster surface of the product clean and unstained.

3 Methods of Manufacture

3.1 ***Fibre Gypsum Plaster Board***

The plaster board shall be manufactured by either of the methods described below:

3.1.1 *Method 1*

a) A steel mould 1 mm thinner than the thickness of the board required, shall be laid over a concrete casting

table having smooth trowelled surface or polished stone surface.

b) The table shall be coated with a thin layer of oil to prevent ht plaster board sticking to the surface.

c) Gypsum plaster shall be gauged to an even consistency free from lumps. This shall be spread evenly to cover the entire surface of the casting table within the mould to an even thickness of 4 mm and allowed to set partially.

d) The requisite amount of fibre reinforcement shall be distributed evenly over the surface of the face gauge as to over hang the edges by 50 mm.

e) The requisite amount of body plaster shall then be poured over the fibre, and the fibre shall be pressed and rolled down until it is thoroughly incorporated in the body plaster.

f) The overhanging fibre shall be turned into the board to strengthen the edges and the whole board shall then be ruled to an even thickness.

3.1.2 *Method 2*

a) A steel mould, 1 mm thinner than the thickness of the board required, shall be laid over a concrete casting table having surface trowelled to a high gloss or table surfaced with polyester resin.

b) The table shall be coated with a thin layer of oil to prevent the plaster board sticking to the surface.

c) Gypsum plaster shall be gauged to an even consistency free from lumps at water-plaster ratio of 0.5 to 0.6. This shall be spread evenly to cover the entire surface of the casting table within the mould to an even thickness of 1.5 to 2.0 mm and allowed to set partially.

d) A plaster of thinner consistency at water-plaster ratio of 0.7 to 0.8 shall be prepared and poured on the bench to cover it to about the depth of the bench bars.

e) When the plaster has spread evenly, teased fibre at the rate of not less than 250 g/m^2 of board shall be spread over the table. This shall be incorporated into the plaster by running a fluted roller over the table.

f) The overhanging edge of fibre shall be next turned back to strengthen the edges and the plaster ruled off with a screeding bar to an even thickness.

g) When the sheet has hardened sufficiently, it shall be lifted and placed in racks to dry.

3.2 ***Glass Reinforced Gypsum Boards***

3.2.1 The GRG Board may be manufactured either by spray suction technique or premixing method. The main objectives of these methods is to ensure thorough dispersal of the glass fibre in the plaster slurry.

4 Dimensions and Tolerances

4.1 The boards shall be square or rectangular in shape. The dimensions and tolerances shall be as under:

Fibrous Gypsum Plaster Board

Dimensions: mm	**Tolerances**: mm
Length – 1200, 1500, 1800	+0, -6
Width – 400, 600, 900, 1200	+0, -5
Thickness – 12	+1, -1

Glass Reinforced Gypsum Board (GRG)

Dimensions: mm	**Tolerances**: mm
Length – 2000, 3000	+0, -6
Width – 1000, 1200	+0, -5
Thickness – 4, 6, 8, 10, 12	+1, -1

4.2 The minimum mass of plaster per m^2 of board shall be 10 kg for Fibrous Gypsum Plaster Board and 4-10 kg for 1000mm and 6-15 kg, 8-20 kg, 10-25 kg, 12-30 kg for 1200 mm for GRG Boards.

4.3 The minimum density for Fibrous Gyspum Plaster Board shall be 834 kg/m^3 and 2500 kg/m^3 for GRG Boards.

4.4 The minimum quantity of fibre per square meter of board shall be 250 g.

5 Finish

5.1 The surface of the board shall be true and free from imperfections that would render the board unfit for uses. The edges shall be straight and corners shall be square.

6 Physical Characterstics

The tests as described in 6.1, 6.2, 6.3 and 6.4 shall be performed on the boards:

6.1 ***Visual Inspections***

6.1.1 All boards shall be sound, free from cracks, broken edges and such other imperfections.

6.2 ***Thickness***

The mean thickness of the board shall be determined as described in IS 2542 (Part 2/Set 1 to 8).

6.3 ***Transverse/Flexural Strength***

6.3.1 The test shall be carried out as described in IS 2542 (Part 2/ Sec 1 to 8). When subjected to a load of 340 N, the deflection of the specimen shall not exceed 19 mm. Should the deflection under proof load be less than 6 mm, the load shall be increased until failure occurs. The specimen shall then deflect not less than 6 mm before failure occurs.

GRG boards when tested as per IS 2542 (Part 2/Set 4) shall have flexural and impact strength as per the value specified below:

Average Flexural Strength	18 MPa
Minimum Flexural Strength on either Side	15 MPa
Average Impact Strenth	17 Nmm/mm^2
Minimum Impact Strength on either Side	14 Nmm/mm^2

6.4 ***Jolting Test***

The boards shall be tested in the manner described in IS 2095 (Part 3). None of the sample should show crack or chipping off from the surface before 80 cycles of jolting.

6.5 ***Free Moisture***

Average free moisture of the samples shall not exceed 2 percent when tested as per IS 2542 (Part 2).

6.6 ***Surface Hardness Test***

The test shall be carried out as described in IS 2095 (Part 3). The diameter of any impression shall not exceed 8 mm for both the materials.

6.7 ***Water Absorption***

For GRG Boards as per IS 2380 (Part 16), the value shall not exceed 15 percent in 24 h.

6.8 ***Swelling***

GRG when tested as per IS 2380 (Part 17), the value shall not exceed 0.5 percent in 24 h.

6.9 ***Test for Determining Fibre Contents***

The test as specified in IS 2542 (Part I/Sec 1 to 12) for wood fibre content in wood fibre gypsum plaster shall be used for determining the mass of fibre in the board.

7 Sampling and Testing

7.1 The number of boards to be selected for the sample from a lot shall depend upon the size of the lot and shall be as under:

No.of Boards in the Lot	No.of Boards to be selected	Permissible No.of defectives	Sub-Sample Size
Upto 100	6	0	3
101 to 150	8	0	3
151 to 300	13	1	4
301 to 500	20	2	5
501 to 1000	32	3	7
1001 and above	50	5	10

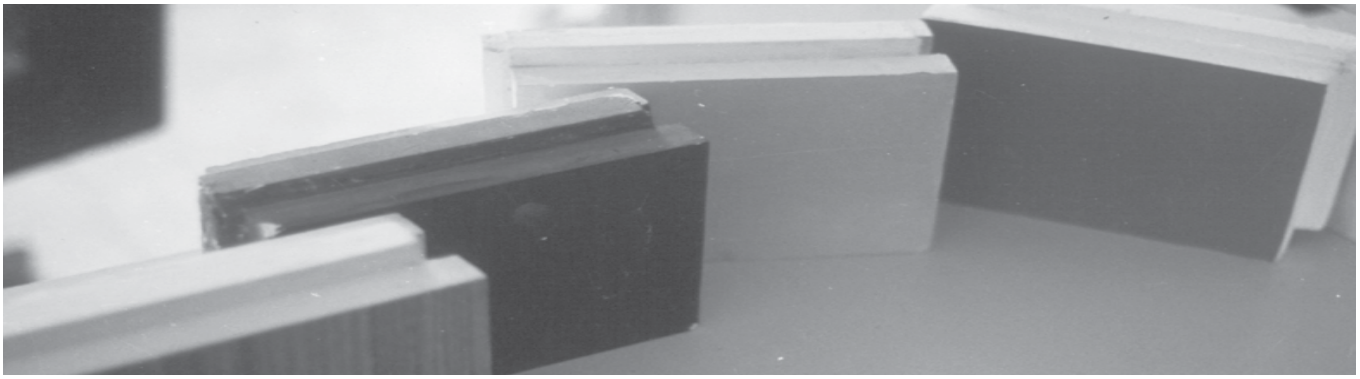
7.2 Sampling and criteria for conformity of these boards shall be done in accordance with the procedure laid in IS 2542 Part I and 2/Section 1 to 12 and IS 2095 (Part 1).

8 Specific Requirements

Building boards generally used as partitioning, panelling, cladding and false ceiling shall be made from industrial wastes such as phospho-gypsum.

9 Marking

Each board shall be legibly and indelibly marked or stamped with indication of source of manufacture, size of board, year of manufacturer and batch number.



BM 07

Specifications for Bamboo Mat Corrugated Roofing Sheets

1 General

Bamboo Mat Corrugated Sheet (BMCS) is a sheet made up of adhesive soaked and coated mats assembled and pressed under specified temperature and pressure to obtain sinusoidal or other suitable corrugations. Bamboo Mat Corrugated Sheets (BMCS) are alternate eco-friendly, energy efficient and cost-effective roofing sheets. These sheets are resistant to water, decay and fire. They are light but strong and possess high resilience and offer thermal comforts.

2 Dimensions and Tolerances

2.1 The sheets shall conform to the dimensions and tolerances given in Table 1 and Fig. 1.

Table - 1: Dimensions and Tolerances

All dimensions in millimeter

Length	Width	Thickness *(T)*	Depth of Corrugation *(D)*	Pitch of Corrugation *(P)*
(1)	(2)	(3)	(4)	(5)
1800	1050	3.8	30	120
2140	1050	3.8	30	120
2440	1050	3.8	30	120
Tolerances				
±10 mm	±10 mm	±10percent	±2mm -0mm	±2mm

Notes:

i. The thickness of the sheets shall be taken as the average of six measurements and shall be measured randomly along the width (except at the valleys) with a suitable screw gauge.

ii. The depth of each of the six corrugations shall be measured randomly and the deviation in any of the cases measured shall not exceed the limits, specified in Table 1. The gauge shall be measured with suitable depth gauge.

iii. Tolerances given for pitch of corrugation relate to measurement over 6 pitches. The total length over 6 pitches shall be mentioned and it shall not vary from six times the specified pitch with tolerance.

iv. Any alternate design of corrugation may be used as per agreement between the manufacturer and the purchaser provided all the requirements of this standard are met. In such cases, the manufacturer shall specify the corrugation details including a section specifying thickness, depth and pitch and tolerance thereon.

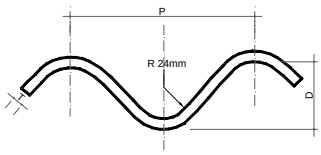


Fig. 1
PITCH AND DEPTH OF CORRUGATED SHEETS

2.1.1 Any other dimension as agreed to between the manufacturer and purchaser may also be used.

3 Materials

3.1 ***Bamboo***

Any species of bamboo suitable for mat making may be used for BMCS.

3.1.1 ***Bamboo Mats***

Bamboo Mats required for the manufacture of BMCS shall be compactly woven in suitable pattern from slivers of uniform thickness and width. Thickness of slivers shall be in the range of 0.6 mm – 0.8 mm and with a minimum width of 5 mm. Care shall be taken to exclude the slivers with epidermal and endodermal layer.

3.1.2 ***Prophylactic Treatment***

If the storage time including the time of transportation is one month or more, the mats shall be given prophylactic treatment as per Group 9 in Table 2 of IS 401, IS 1902.

3.2 ***Adhesive***

Resin for BMCS shall be of phenolic type conforming to BWP grade specified in IS 848. For the outermost layers of mats of BMCS, resin admixed with suitable filler shall be used.

3.3 ***Preservative***

Preservative treatment shall be given by incorporating the suitable preservatives like sodium pentachloro phenate into the resin before soaking the mats to protect against biodegradation.

4 Manufacture

4.1 ***Application of Adhesive***

Adhesive shall be applied by soaking the mats in the adhesive as explained in 3.2. A second coat of adhesive shall be applied on the soaked and dried mats which are used as outer layers, using a mechanical glue spreader.

4.2 ***Conditioning of Adhesive Coated Bamboo Mats***

Adhesive coated mats shall be conditioned to bring down the moisture content to 12, ±2 percent.

4.3 ***Hot Pressing***

Assembled mats shall be hot pressed to obtain the specified properties.

4.4 ***Conditioning of BMCS***

After hot pressing the finished bamboo mat corrugated sheet shall be stored at ambient conditions at least for 24 h.

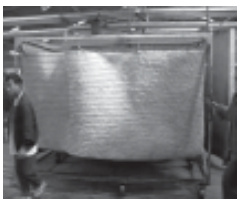
5 Finish

5.1 The face of the bamboo mat corrugated sheet shall be reasonably smooth and uniform in colour.

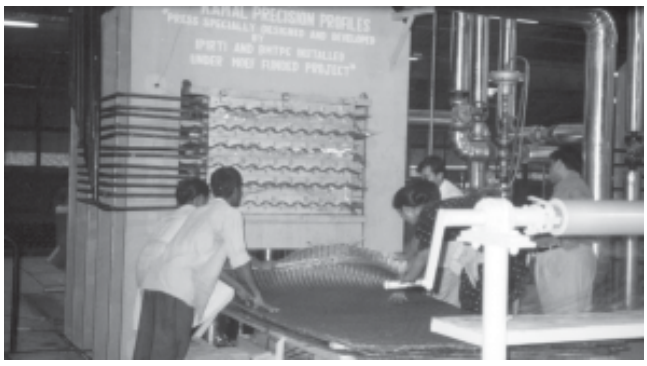
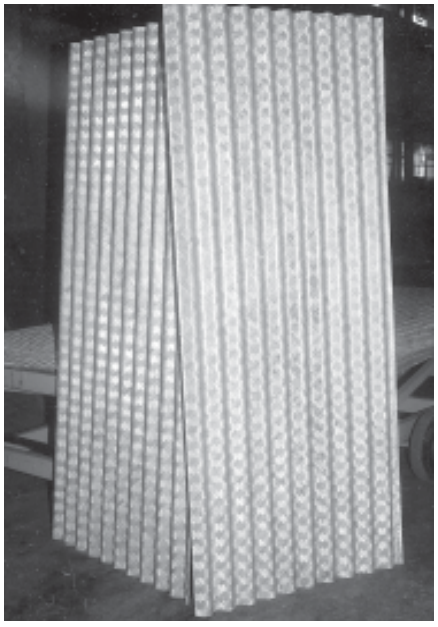
5.2 The finished sheets shall be given brush coating with light organic solvent preservatives to avoid fungis growth and the edges sealed with suitable adhesives sealant.

6 Tests & Requirements

BMCS shall conform to the requirements given in Table-2 when tested in accordance with the provision given in IS 15476.



7 Sampling and Criteria for Conformity

7.1 ***Scale of Sampling***

7.1.1 Lot, in any consignment, all the sheets of the same size and manufactured under similar conditions of production shall be grouped together to constitute a lot.

7.1.2 All the sheets in the lot shall be inspected for finish requirement as given in 5. The defective sheets shall be removed from lot.

7.1.3 The lot shall then be examined for dimensional requirements. For this purpose, the number of sheets to be selected at random from the lot shall be in accordance with IS 15476.

7.1.3.1 These shall be selected from the lot at random. In order to ensure the randomized of selection, the procedure given in IS 4905 may be followed.

7.2 ***Criteria for Conformity***

7.2.1 All the sheets selected in accordance with IS 15476, shall be subjected to dimensional requirement. A sheet failing to satisfy the requirements mentioned below shall be termed as defective. The lot shall be considered as conforming to dimensional requirements, if the number of defectives found in the sample is less than or equal to the corresponding acceptance number given in IS 15476, otherwise the lot shall be rejected without further testing.

7.2.2 The lot which has been found as conforming to the dimensional requirements shall be tested as per Table 2. For this purpose, the same size shall be in accordance with IS 15476.

7.2.3 A lot shall be considered as conforming to the requirements of IS 15476, if 7.2.1 and 7.2.2 are satisfied.

8 Marking

8.1 Each BMCS shall be legibly and indelibly marked or stamped with indication of source of manufacture, nominal dimension, year of manufacture and batch number.

8.2 Each markings shall be done on the face of the sheet near on edge.

Table 2:

Sl.No.	Properties	Requirements	Method of Test Ref to Annexures of IS 15476
(1)	(2)	(3)	(4)
i)	Density, g/cm^3	0.75, *Min*	B
ii)	Load bearing capacity, N/mm: 1. Dry state 2. Wet state	 4.0, *Min* 3.0, *Min*	C
iii)	Impermeability	The lower surface shall not show any formation of drops of water except for traces of moisture	D
iv)	Water absorption, Percent (after 24 h soaking)	15, *Max*	E
v.)	Cyclic test	No delamination	F
vi)	Resistance to falling weight	The test piece shall not break or show any crack or tear	G
vii)	Resistance to fire: 1. Flame penetration 2. Rate of burning 3. Surface spread of flame, maximum area of char in mm^2	 Not less than 10 min Not less than 20 min 4500	H

BM 08

Specifications for Micro Concrete Roofing Tiles

1 General

1.1 Micro Concrete Roofing (MCR) tiles are precast tiles made out of a mix of micro chips (4mm down), coarse sand and cement. These are made on a table vibrator. Tiles thus made are strong, durable and economical.

1.2 MCR tiles are energy efficient, eco-friendly and low cost roofing elements made from a carefully controlled mix of cement, sand fine stone aggregate and water. The MCR tiles can be made in two distinctive profiles namely Pan and Roman. They are designed to meet high quality standards in strength, shape and colour and are therefore, acceptable to both the rural and urban markets. MCR is suitable in all places where a need for reliable, affordable and aesthetic roofing material exists. MCR roofing is similar to roofing materials like clay tiles or sheets.

1.3 The MCR technology provides an inexpensive and reliable roof covering and is specially suited for the needs of developing countries.

2 Shape, Dimensions and Tolerances

2.1 Shape of the Pan and Roman tile shall be as given in Fig.1 and Fig.2. The nominal dimensions of the tile shall be as given in Table 1.

Table 1

	Pan Tile	Roman Tile
Clear length	488 mm	480 mm
Clear width	240 mm	240 mm
Thickness	8 mm or 10 mm	8 mm to 10 mm
Corrugation depth	55 mm	55 mm

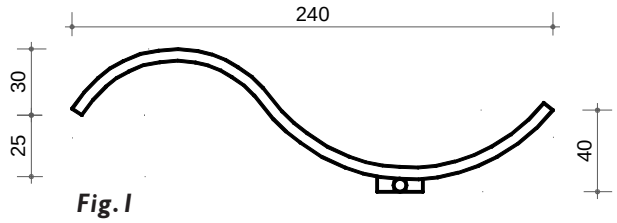


Fig.1
PAN TILE

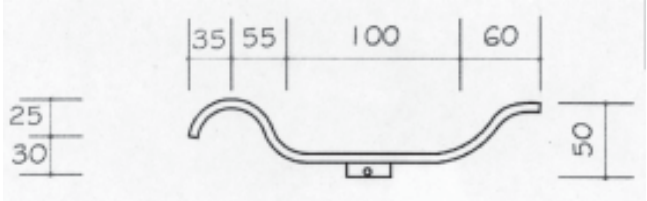


Fig.2
ROMAN TILE

2.2 ***Tolerances*** – The permissible tolerances shall be as under:-

2.2.1 ***Length and Width*** – The average dimensions of the tile when measured to the nearest 0.1 mm, shall not vary more than ±0.5mm.

2.2.2 ***Thickness*** – The average thickness of the tile when measured to the nearest 0.1 mm, shall not vary more than ±0.5 mm from the nominal dimensions.

3 Physical Characteristics

3.1 Physical characteristics of the Tiles shall be as given below:

Standard Size	:	Pan Tile – 240mm X 488mm Roman Tile – 240mm X 480mm
Thickness	:	8mm or 10mm
Weight (Min.)	:	2.25kg (8mm) 2.75kg (10mm)
Loading capacity (Min.)	:	60kg/m^2 (8mm) 80kg/m^2 (10mm)

3.2 ***Strength*** - When stuck by coin the tile shall give a uniform ringing sound.

3.2.1 ***Transverse bending strength*** - When tested in accordance with IS 654, transverse bending strength shall not be less than 60 kg weight for 8 mm thick tile and 80 kg weight for 10 mm thick tile.

3.2.2 Bearing capacity of the nib shall not be less than 20 kg weight.

3.3 ***Water Tightness*** - Not more than 50 percent of the underside of the tile shall have signs of dampness if topside is made to be a water pool for 24 h. Underside shall be free from water droplets.

3.4 ***Water Absorption*** - Average percentage of water absorption after soaking tiles in water at normal temperature and humidity for 24 h., shall not be more than 10 percent.

3.5 ***Pores and Cracks*** - Pores, if any, shall not be deeper than 2mm, wider than 5mm and more than six in number with dia more than 2mm. The cracks shall not be longer than 5 mm.

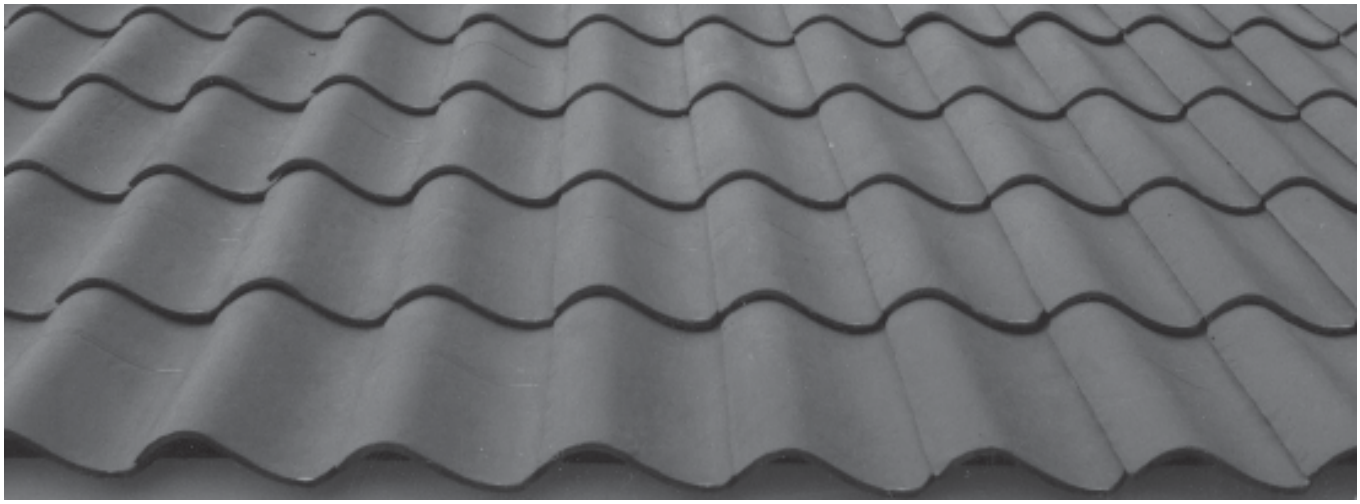
4 Finish

4.1 Tiles shall have smooth finish on the top side, un-coloured and unpigmented tile shall be of uniform grey colour.

5 Manufacturing

5.1 ***Raw Materials specification***

Cement: Shall conform to IS 8112.



Fine Aggregate: Sand or crusher dust passing through 4.75mm sieve shall be free from clay and silt.

Sand: Should conform to the following grading:

Sieve size	*Percent passing through*
10mm	100
4.75mm	90-100
2.36mm	75-100
1.18mm	55-70
600microns	35-59
300microns	8-30
150microns	0-10

Water: Potable, free from organic matter Chlorides & sulphates should not exceed permissible limits specified in IS 456.

Water Cement Ratio : 0.5 - 0.6

5.2 ***Material preparation*** - Generally, proportions of cement, sand and aggregate used shall be 1:2:1 by volume. Proper mix ratio is necessary for optimising the materials use and for achieving high strength tile without fine cracks & air bubbles and with low water absorption. With any change of raw material proportion shall be reviewed to get proper result.

5.3 ***Casting of tiles*** - The tiles shall be casted on a Tile Making Machine after placing plastic sheet in position on vibrating plate. The operation should not take more than 30 - 35 seconds. After casting of tile Nib shall be casted. The casted tile shall be placed carefully on the mould to take the shape.

5.4 ***Mould curing*** - The curing shall start immediately after the product has been cast. The tiles shall be stacked in an airtight manner or covered within 5 minutes after casting. Tiles shall be cured in a horizontal position while still on the mould, by covering their surface with plastic sheets or stacking with moulds that guarantee airtight and damp proof stacking. The mould shall be placed on a flat surface with fresh tile lying flat on it. Second mould shall be placed careful enough on the first mould without damaging the edges of tile in the mould underneath. Make sure moulds fit with each other airtight. All the moulds shall be placed in stacks upto 1m high for the first day curing. Care shall be taken to cover the uppermost tile with cover. The moulds shall be kept in the same position for 24 h.

5.5 ***Demoulding*** - Demoulding of tiles shall be done after 24 h of casting.

5.6 Moulds and polythene sheets shall be thoroughly cleaned after each use.

5.7 ***Water Tank Curing*** - After the tiles have been cured for 24 h in a horizontal position, they shall be carefully moved to the curing tank, where they shall be kept completely under water in a vertical position for atleast 5 days.

5.8 Depending upon the choice of customer/end user, the tile shall be painted by standard procedure.

6 Sampling and Testing

6.1 1 percent or more tiles from the daily production stock shall be tested regularly.

6.2 ***Test***

6.2.1 ***Pores and Cracks*** - Every tile shall be visually checked for pores and cracks as mentioned in 3.5.

6.2.2 ***Ring Test*** - Every tile shall be tested. The test is done by taping the tile with a coin or a stone. A clear ringing sound shall be heard. If there is a dull sound, the tile is probably cracked and shall be rejected.

6.2.3 ***Water Tightness Test*** - 1percent of the tile shall be tested. It shall be as per 3.3.

6.2.4 ***Bending Test*** - The strength of tile shall be as per 3.2.1.

6.2.5 ***Weight Test*** - Take 4 randomly chosen tile from each week's production. Store them and dry for 24 h and weight them. The weight of the tile shall not differ more than 10 percent from the weight as mentioned in 3.1.

6.2.6 ***Nib Tensile Test*** - 1 percent of the tile shall be tested by suspending a 20 kg weight on the loop of the nib. The nib should bear a 20 kg weight without cracking.

6.2.7 If any of the tiles in the sample fails to comply with the requirements of any of the tests, another sample shall be similarly drawn and tested. If any of the tiles in the second sample also fails to comply with requirements of any of the tests, then the whole lot, from where the samples were taken shall be rejected.

7 Marking

7.1 Before putting tile in water tank for curing, each tile shall be legibly or indelibly marked or stamped with identification of source of manufacture, year of manufacture and batch number.

List of Indian Standards referred in this Section

BUILDING MATERIALS

1.	IS 401:2001	Preservation of Timber - Code of Practice
2.	IS 456:2000	Plain and Reinforced Concrete - Code of Practice *(Fourth Revision)*
3.	IS 654:1992	Clay Roofing Tiles, Mangalore Pattern - Specification
4.	IS 712:984	Specification for Building Limes *(Third Revision)*
5.	IS 848:2006	Synthetic Resin Adhesives for Plywood (Phenolic and Aminoplastic) - Specification
6.	IS 1478:1992	Clay Flooring Tiles – Specification
7.	IS 1727:1967	Methods of Test for Pozzolanic Materials (*First Revision*)
8.	IS 1902:1993	Preservation of Bamboo and Cane for Non-structural Purposes - Code of Practice
9.	IS 2095:1996 (Part 1)	Specification for gypsum plaster boards Part 1 Plain gypsum plaster boards
10.	IS 2095:1996 (Part 2)	Gypsum Plaster Boards - Specification Part 2 - Coated/Laminated Gypsum Plaster Boards
11.	IS 2095:1996 (Part 3)	Gypsum Plaster Boards - Specification Part 3 - Reinforced Gypsum Plaster Boards
12.	IS 2380:1977 (Part 1 to 21)	Method of Test for Wood Particle Boards and Boards from other Lignocellulosic Materials
13.	IS 2542:1978 (Part 1/Set 1 to 12)	Methods of Test for Gypsum Plaster, Concrete and Products - Part 1 : Plaster and Concrete (*First Revision*)
14.	IS 2542:1981 (Part 2/Set 1 to 8)	Methods of Test for Gypsum Plaster, Concrete and Products - Part 2 : Gypsum Products
15.	IS 2690:1993 (Part 1)	Burnt Clay Flat Terracing Tiles - Specification Part 1: Machine Made
16.	IS 2690:1993 (Part 2)	Burnt Clay Flat Terracing Tiles - Specification Part 2: Hand Made
17.	IS 3495:1992 (Part 1)	Methods of Tests of Burnt Clay Building Bricks - Part 1: Determination of Compressive Strength (*Third Revision)*
18.	IS 3495:1992 (Part 2)	Methods of Tests of Burnt Clay Building Bricks - Part 2 : Determination of Water Absorption (*Third Revision)*
19.	IS 3495:1992 (Part 3)	Methods of Tests of Burnt Clay Building Bricks - Part 3 : Determination of Efflorescence (*Third Revision)*
20.	IS 3812:1981	Specification for Fly Ash for Use as Pozzolana and Admixture (*First Revision*)
21.	IS 4139:1989	Calcium Silicate Bricks – Specification (Second *Revision*)
22.	IS 4905:1968	Methods of Random Sampling – Specification
23.	IS 5454:1978	Methods of Sampling of Clay Building Bricks (*First Revision*)
24.	IS 8112:1989	43 Grade Ordinary Portland Cement – Specification
25.	IS 8272:1984	Specification for Gypsum Plaster for Use in the Manufacture of Fibrous Plaster Boards (*First Revision*)
26.	IS 12894:2002	Pulverized Fuel Ash-Lime Bricks - Specification *(First Revision)*
27.	IS 13757:1993	Burnt Clay Fly Ash Building Bricks – Specification
28.	IS 15476:2004	Bamboo Mat Corrugated Roofing Sheets - Specifications

Note: Indian Standards are subjected to revision from time to time. The actual version at the time of preparing this document has been listed. Users may, however, check for the latest version of the referred Standards from BIS.

Construction Techniques

CT 01

Specifications for Precast Channel Unit for Floors/ Roofs

1 General

These are full span precast RCC units-trough shaped in section. These can be used for intermediate floors and roof on suitable supporting structures. These do not require any in-situ structural concrete over them, nor any intermediate temporary props or supports. The units are strong enough for the full span for which these are designed.

2 Dimensions and Tolerances

2.1 *Dimensions*

2.1.1 The cross-section of the unit is channel shape (Inverted Trough) with outer sides corrugated and grooved at the ends to provide shear key action and transfer of moments between adjacent units (Fig.1 and 2).

2.1.2 Nominal width of the unit shall be 300mm or 600mm and overall depth 150mm or 200mm. The length of the unit may be adjusted to suit the span to be covered. However, from stiffness consideration, maximum length shall not exceed more than 4.5m. Actual cross sectional dimensions of a 300mm unit shall be 295mm x 145mm with a minimum flange thickness of 30mm, and minimum thickness of web 25mm (Fig 2).

2.1.3 In case of 600 mm unit, the cross sectional dimensions shall be 595mm x145mm or 595mm x195mm with a minimum flange thickness of 35mm and minimum web thickness of 25mm.

2.1.4 When the units are placed side by side, the corrugated sides of the units provide space which shall be filled with in-situ concrete to provide monolithicity between the units and helps in transferring the load in transverse direction.

2.2 *Tolerances*

2.2.1 Tolerances on various dimensions of channel units shall be length ±5mm, width ±3 mm, Bow (deviation from intended line or plane) ±3 mm, Twist (distance of any corner from the plane containing other three corners) ±3 mm.

2.2.2 For squareness of the corner, the longer of the two sides being checked, shall be taken as the base line. The shorter length shall not vary in length from the perpendicular by more than 3 mm.

2.2.3 For flatness, the maximum deviation from a 1500mm straight edge placed in any position on a nominal plane surface shall not exceed 2mm.

3 Structural Design

3.1 The channel units shall have adequate strength and stability in accordance with IS 456 during various stages namely demoulding; handling; stacking; transporting and placing; final stage with all design dead and imposed loads acting on the roof/floor.

3.2 The unit shall be designed either simply supported or continuous depending upon actual end conditions. Main reinforcement shall be either designed or shall be as per IS 14215 for residential loads.

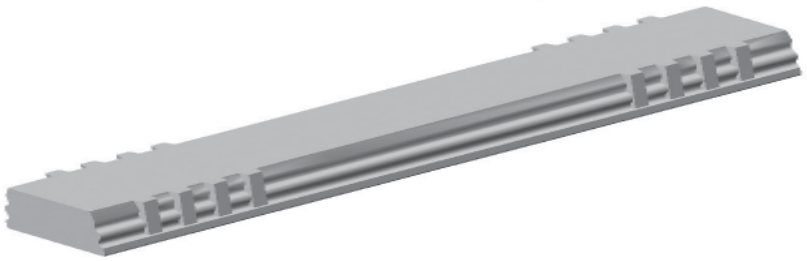
3.3 ***Design Stage 1 (Just after placing of in-situ concrete)***

3.3.1 At the time of laying the units, the load comprises of self weight of the channel unit, weight of in-situ concrete in the joint between two units and also the incidental live load, likely to act on the structure at this stage. Incidental load may be taken as half the imposed load likely to act on the structure at final stage as recommended in IS 875 (Part 2).

3.3.2 Effective Section - At this stage of loading, as the in-situ concrete has not attained any strength to ensure monolithicity, the effective width of channel unit shall be taken as width of flange portion only.

3.4 ***Design Stage 2 : (With Full Design Load)***

3.4.1 ***Loads*** - At this stage, the loads acting on the structure shall comprise dead load and full imposed load as per IS 875 (Part 2). This shall be the maximum load likely to act on the structure during its lifetime. For calculating the limit state of collapse at the critical section, a combined load factor of atleast 1.5 shall be applied for calculating the limit state of collapse load.



Channel Unit View

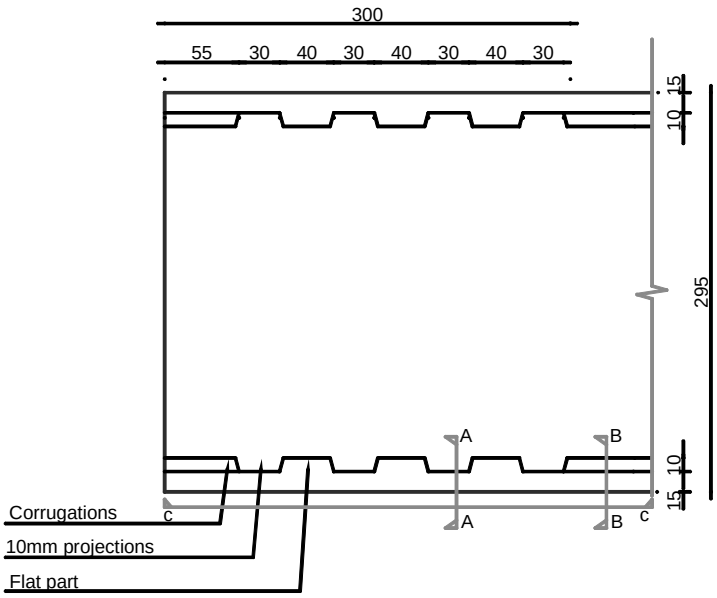


Fig.01
CHANNEL UNIT TOP PLAN

ALL DIMENSIONS ARE IN mm

3.4.2 ***Effective Section*** - As the in-situ concrete has attained strength at this stage, an effective width equal to the nominal width (see Fig 1 and 2) of the unit shall be taken for calculating the strength of the section.

3.5 ***Design Bending Movement and Shear Force*** - When the floors/ roofs consist of three or more continuous and approximately equal spans, the values of Bending Moments and Shear Force coefficient given in IS 456 may be used. These coefficients shall be used for imposed live load as well as dead load of finishing but not for dead weight of units (including that of in-situ concrete). To the bending moment and shear forces so found out, simply supported movement and shear force due to dead weight of units (including that of in-situ concrete) shall be added.

3.6 In-situ concrete, which brings monolithic connection and continuity between precast units, shall be designed in accordance with IS 3935.

3.7 When precast units are used for the construction of buildings in high

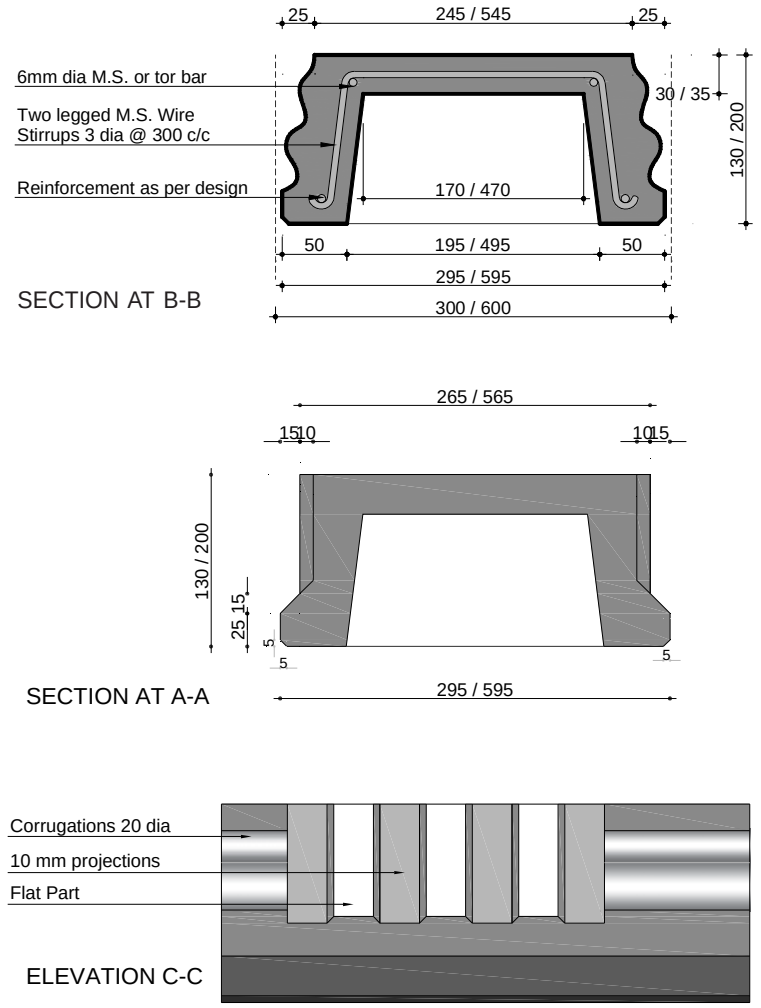


Fig.02

SECTION OF A CHANNEL UNIT

ALL DIMENSIONS ARE IN mm

seismic zones the floors and roof shall be strengthened in accordance with clause 9 of IS 4326.

3.8 ***Reinforcement***

3.8.1 Main reinforcement of the channel units shall comprise two bars of required diameter as per the design placed at the bottom of two legs of channel unit. Two bars of mild steel grade I conforming to IS 432 (Part 1), 6mm ϕ shall be provided at the top corners to support the stirrups (see Fig. 1 and 2). Stirrups of 3 mm ϕ at the rate of 300 mm c/c along the length of the channel unit (see Fig.2) shall be provided.

3.8.2 ***Cover to Reinforcement*** - The minimum cover to reinforcement shall be 15 mm.

4 Materials

4.1 ***Concrete*** - The concrete used for making precast units shall conform to grade M-20 or higher in accordance with IS 456. Coarse aggregate used for making concrete shall be well graded with maximum size of 12 mm.

4.2 ***Steel Reinforcement*** - The reinforcing shall be as recommended in IS 456.

5 Manufacturing of Precast Unit

5.1 ***Moulds***

5.1.1 The mould consist of two parts - the outer frame and the inner frame. Typical sketches showing details of various components of mould are given in Fig.3.

5.1.2 The mould shall be made from well seasoned timber or steel or other rigid, non- corrodible and non-absorant materials such as fibre reinforced plastic. In case timber mould is used for the inner trough frame, the surface shall be lined with GI sheet.

5.1.3 Dimensions of the mould shall be selected depending upon the size of channel units. Tolerances on mould shall be length ±4mm, width and thickness ±2mm and warp/bow ±2mm.

5.2 ***Manufacturing of Channel Units***

5.2.1 The inner side of outer frame of the mould shall be applied with a bond releasing agent and placed on smooth and level concrete platform on which a bond releasing agent has been applied.

5.2.2 The reinforcement cage shall be placed in position. It shall be ensured that the reinforcement is not distorted, in any way, during storage, handling, placement and concreting.

5.2.3 The concrete shall be placed in the flange portion in such a way as to avoid segregation upto such a height that it achieves a thickness equal to the flange of the unit after compaction. The concrete shall then be compacted with plate vibrator.

5.2.4 The trough frame applied with bond releasing agent on the outer survace

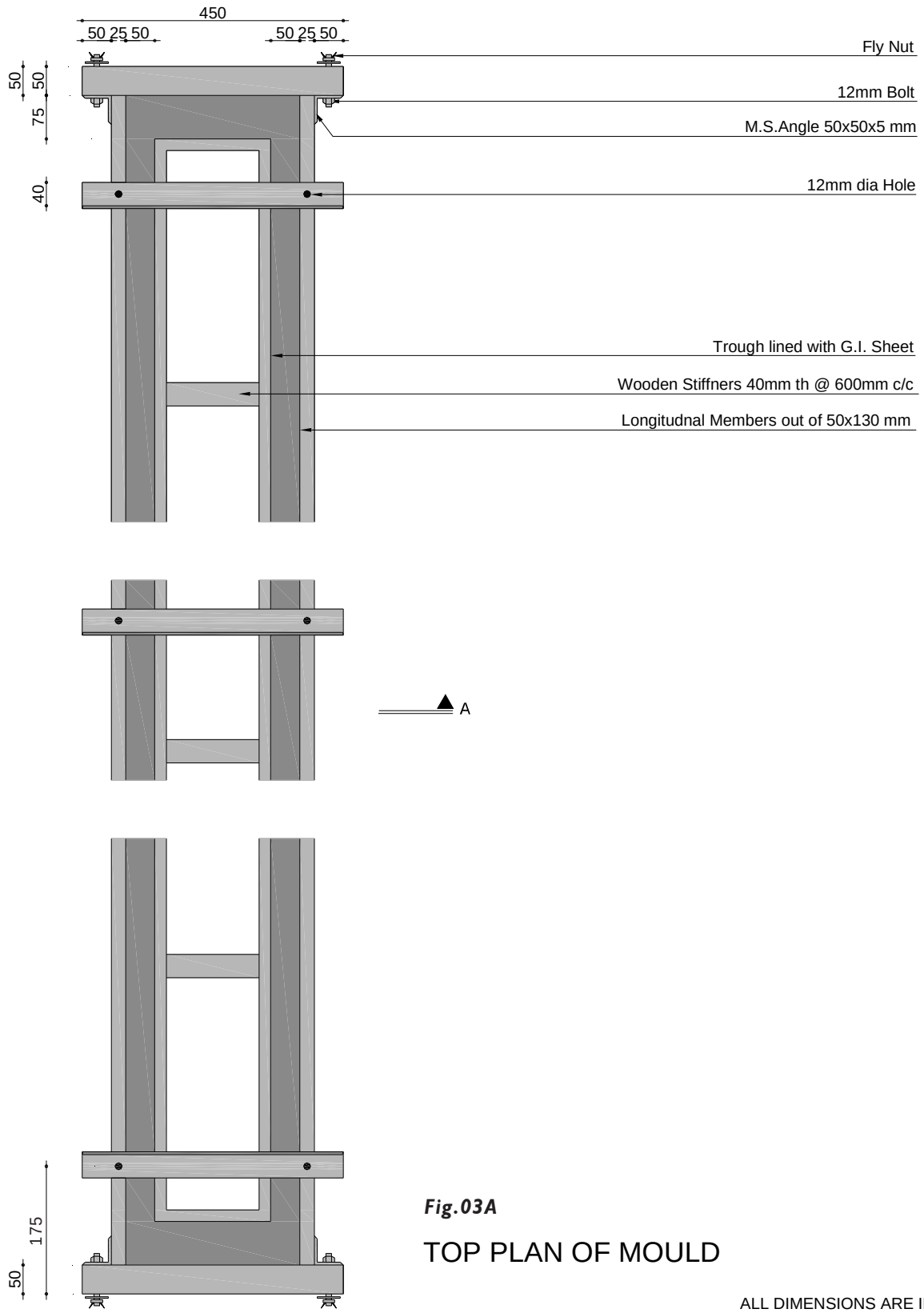


Fig.03A

TOP PLAN OF MOULD

ALL DIMENSIONS ARE IN mm

(i.e. the surface facing concrete) shall be kept inside the outer frame and flange concrete shall be levelled by moving the trough frame to and fro. Afterwards the trough frame shall be fixed in position with the outer frame.

5.2.5 The Web (leg) portion of the channel unit shall now be filled with concrete compacted by vibration with a plate vibrator/needle vibrator and finished level.

5.2.6 The trough frame may be removed gently after about 1 h (depending upon the weather) after casting. The outer frame may also be stripped off after about 3 h (depending upon the weather) after casting. The units shall be left undisturbed for about 48 h and shall be kept wet during this period by occasional sprinkling of water or by covering by wet gunny bags.

5.2.7 ***Curing*** - After about 48 h the units shall be turned upside down so that the flange is brought to the top. The units shall then be transported to curing yard by supporting near the ends and stacked with the trough (flange) facing up. The units shall be cured for atleast 12 days by keeping the tough filled with water and

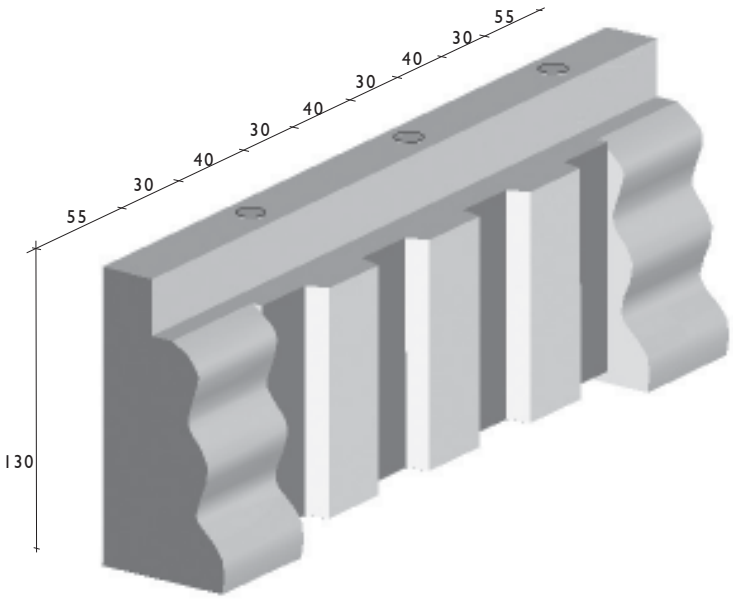
further air-cured for another 14 days before placing it in position in a building.

6 Storage, Transportation and Erection of Precast Elements

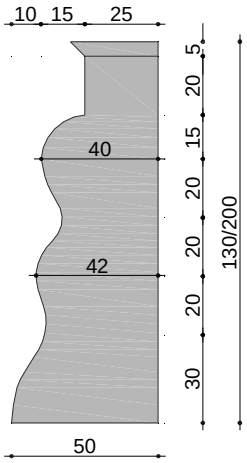
6.1 ***Handling and Transportation of Units***

The precast units shall be handled by placing slings placed at about 1/5 of span from ends. Care shall be taken to see that no support is placed at the centre of span and the main reinforcement is always at the bottom of stacked units, that is trough shall be facing downwards.

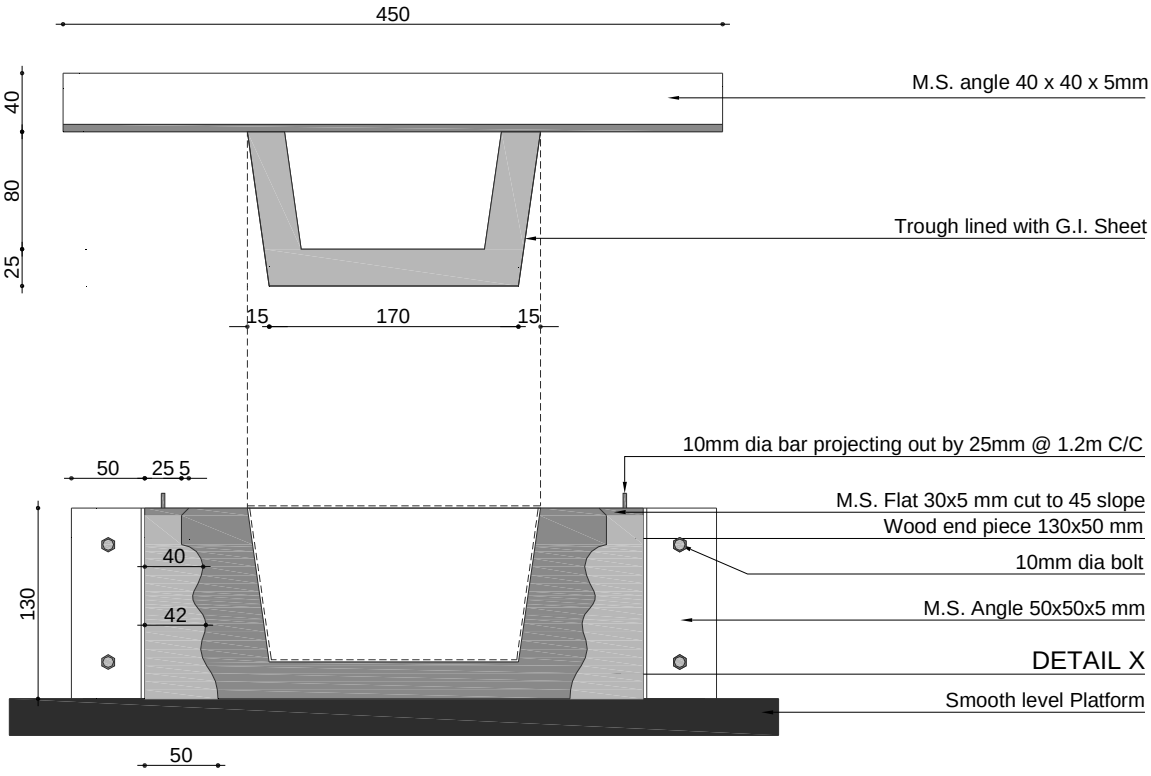
6.2 ***Transportation***



End View of Long Side Mould



DETAIL X



SECTION AT A

Fig.03B

TIMBER MOULD

ALL DIMENSIONS ARE IN mm

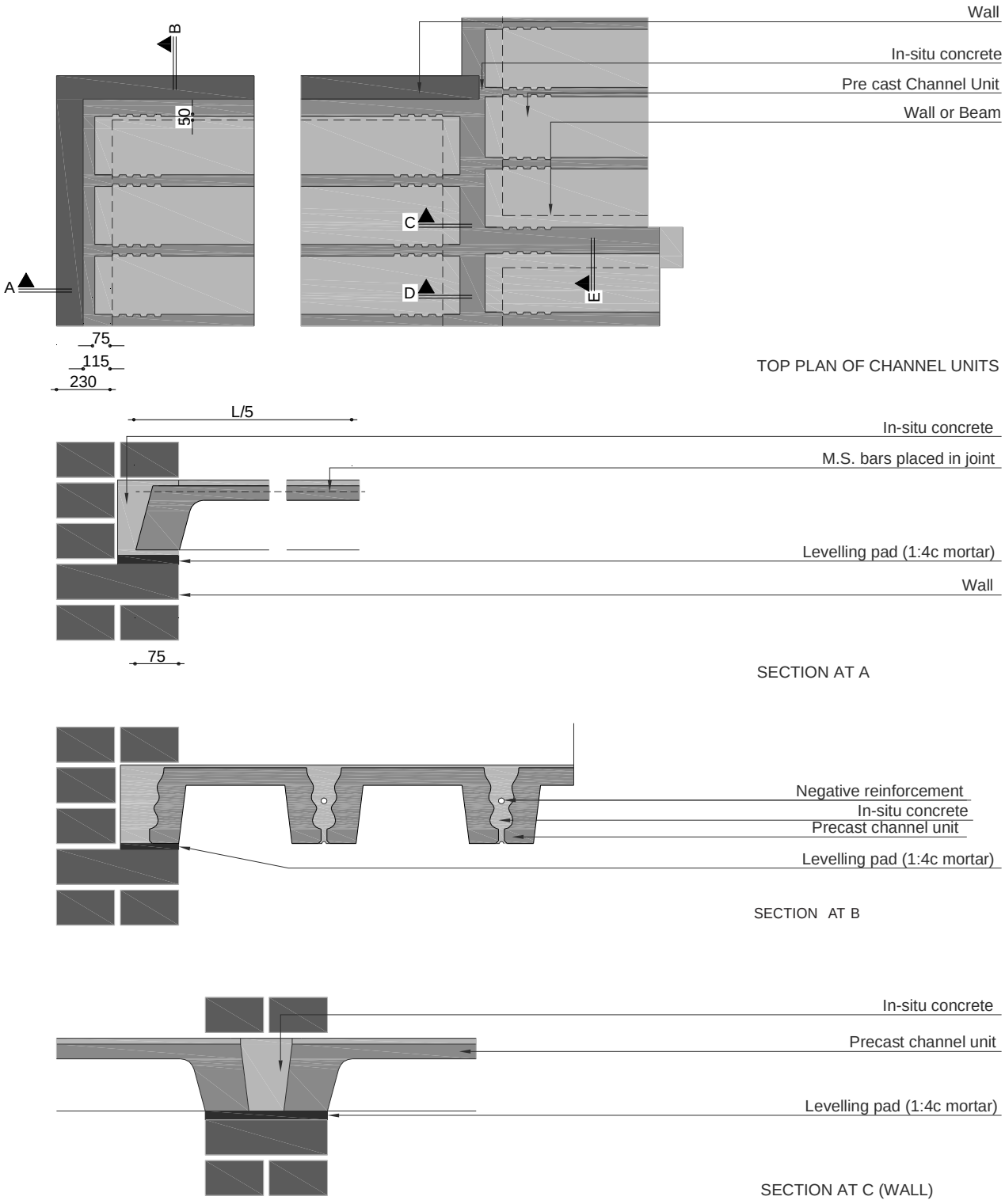


Fig.04

PLACEMENT OF CHANNEL UNITS

ALL DIMENSIONS ARE IN mm

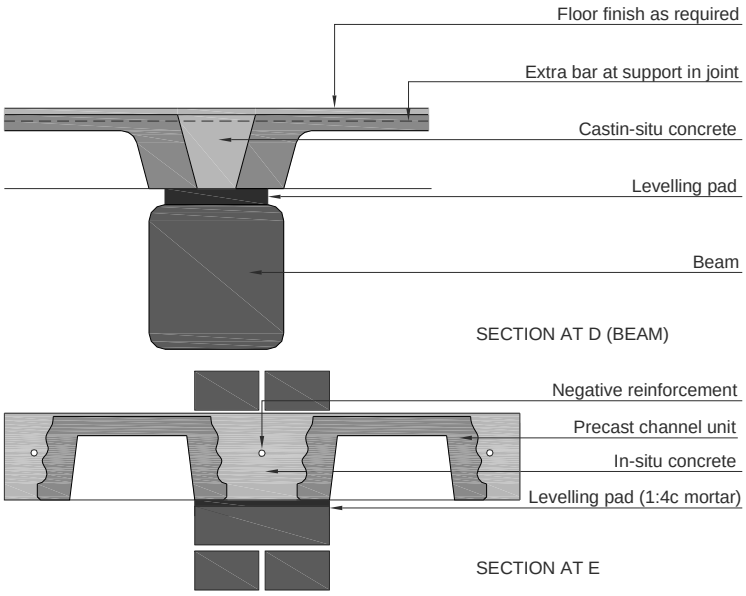


Fig.04
PLACEMENT OF CHANNEL UNITS

ALL DIMENSIONS ARE IN mm

The unit shall be lifted either manually, or preferably with the help of a chain pulley block or mechanically with a hoist and placed side by side across the span to be covered.

6.3 ***Placing and Aligning***

The top surface of the wall or beam support shall be leveled so as to provide uniform bearing to the webs of channel units. While placing the units, care shall be taken to see that they have the specified bearing on supporting wall/beam. While aligning and leveling the units, care shall be taken not to drag the units or apply load eccentrically which may damage the unit. The tops of walls/beams on which units are to be placed should be leveled with 6 mm thick plaster (1 cement : 3 fine sand) finished with a floating coat of neat cement plaster and a thick coat of lime wash or kraft paper. This is necessary to allow free movement of the roof over the walls/beams so as to avoid development of thermal stresses.

6.4 ***Bearing***

The precast units shall have a minimum end bearing of 75 mm, and a minimum side bearing of 50 mm.

6.5 ***Negative Reinforcement***

Negative reinforcement, required in case of continuous floor/roof slabs, shall consist of one bar of required diameter designed in accordance with IS 14215.

6.5.1 The negative reinforcement shall be placed in position, at supports, upto a distance from support as specified in IS 456 near the top, in the joints between the units (see Fig.4).

6.6 Cement wash shall be applied to the sides of the units and the joints shall be filled with concrete. The concrete shall be compacted by either

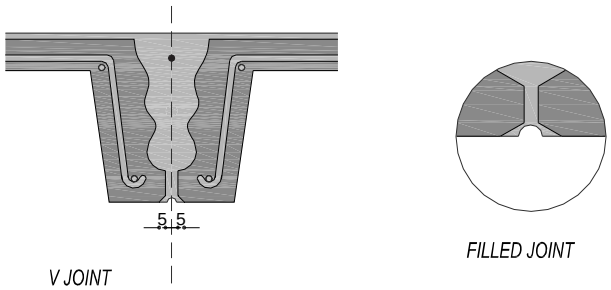
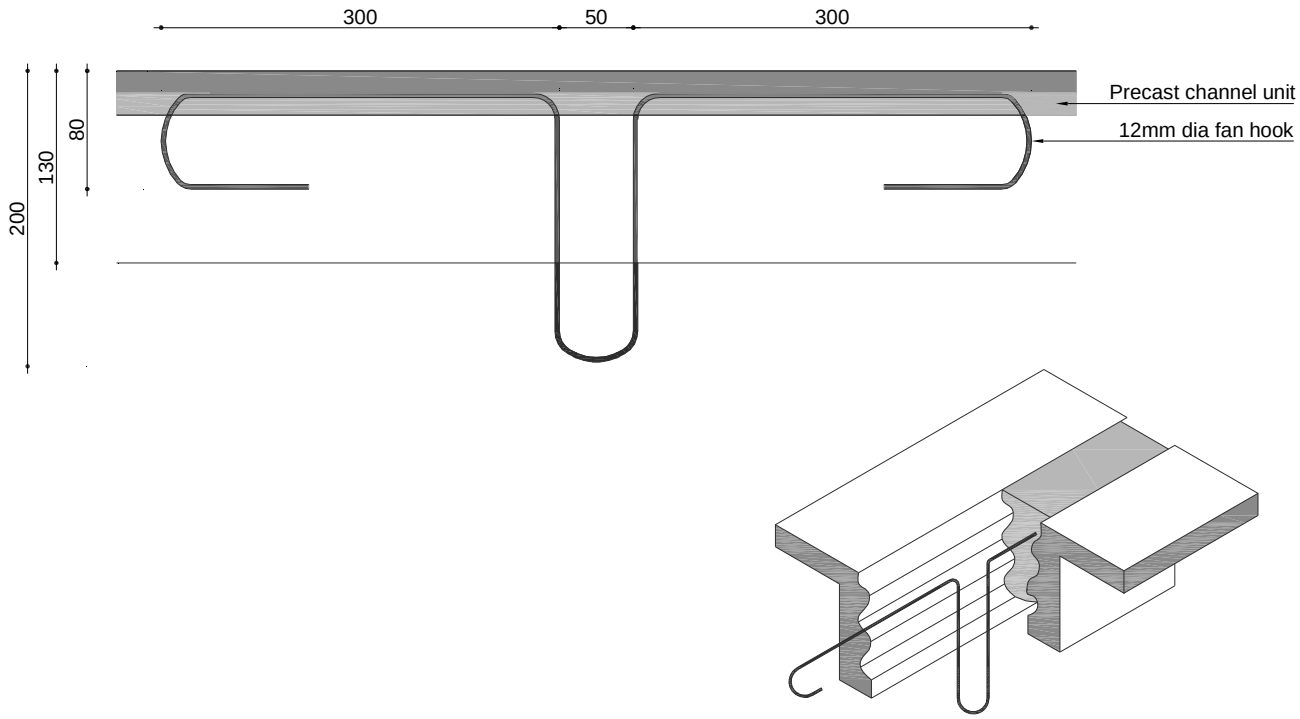


Fig.05
V OR GROOVE JOINT DETAILS

ALL DIMENSIONS ARE IN mm



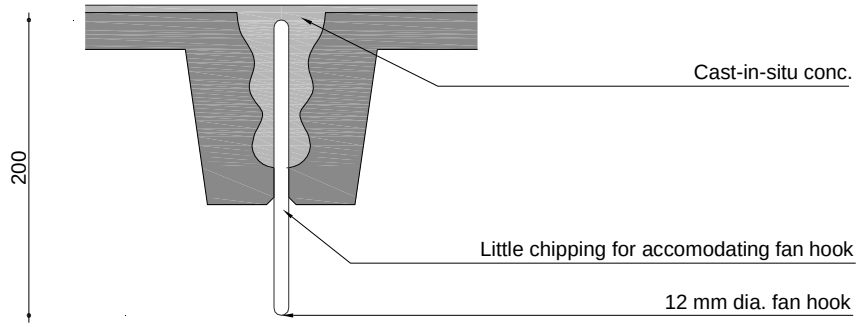


Fig.06

FIXING OF FAN HOOK

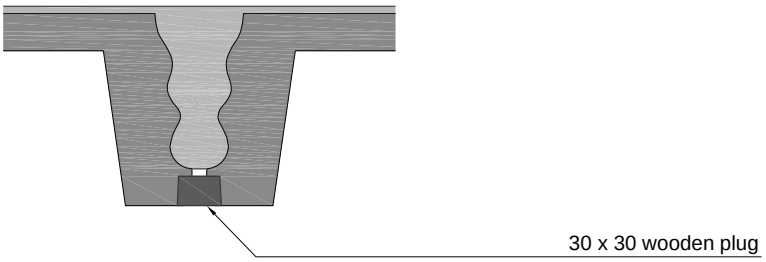


Fig.07

FIXING OF WOODEN PLUG

ALL DIMENSIONS ARE IN mm

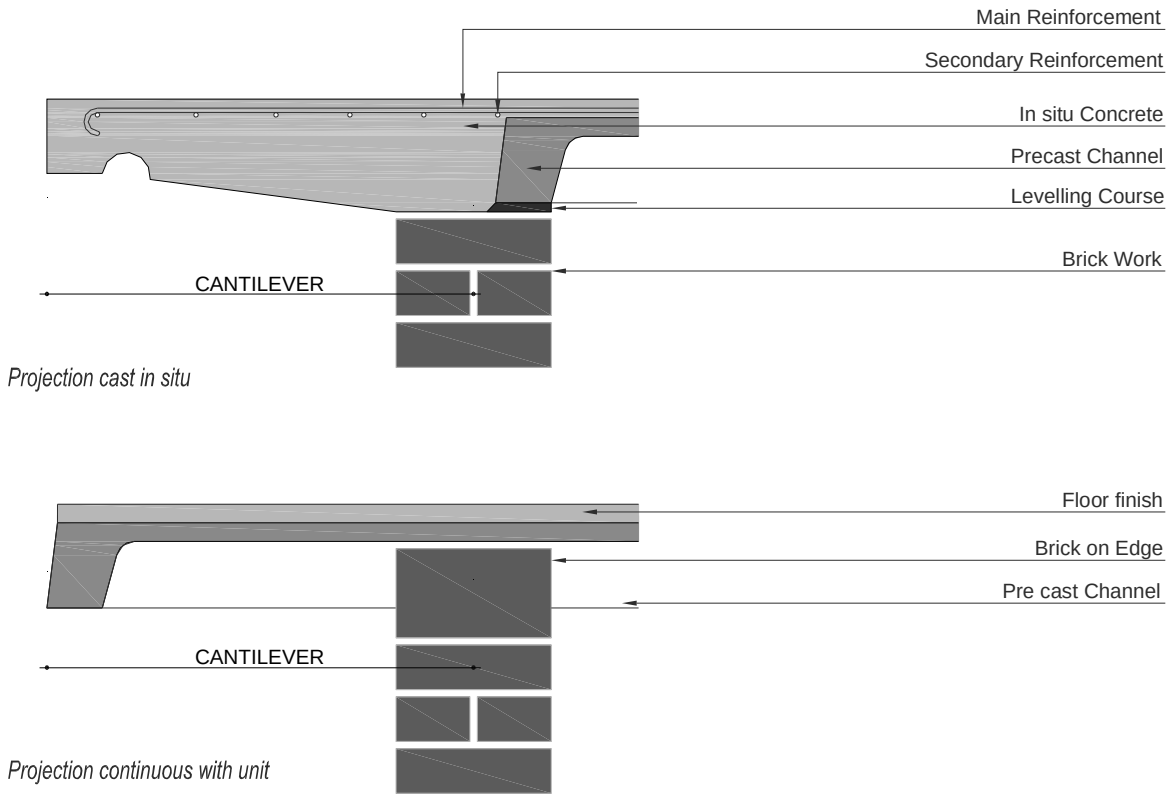


Fig.08
BALCONY OR CHAJJA

ALL DIMENSIONS ARE IN mm

vibration or rodding.

7 Curing of In-situ Concrete

7.1 In-situ concrete shall be cured for atleast one week. A coat of cement slurry may then be applied to the joints to fill the hairline cracks that might have developed.

8 Fixtures

8.1 Designers shall indicate provisions for fixtures like fanhooks/inserts/ electric conduits, etc, to be incorporated within the precast units or in-situ joints. Some typical illustrations are given for guidance in 8.1.1 to 8.1.3.

8.1.1 In case of concealed wiring, conduits may be placed within the joints along the length or within the screed wherever it is provided before concreting. If adequate thickness is available, it can be concealed within the floor/roof finish.

8.1.2 Holes, openings and fixtures required to be provided within the precast units shall be fixed accurately with adequate embedment at the precasting stage. Drilling of holes or cutting of edges shall not be permitted.

8.1.3 For fixing fan hooks, electric junction boxes and wooden plugs shall be as given in 8.1.3.1 to 8.1.3.3.

8.1.3.1 ***Fan Hooks*** - These may be provided in the cast in-situ concrete of the units by slightly chipping off the edges of the units at the location of the fan (see Fig.6).

8.1.3.2 ***Electric Junction Boxes*** - These may be fixed with rawl plugs in the cast in-situ joint between units or embedded during filling of the joint.

8.1.3.3 ***Wooden Plugs*** - Wooden plugs for electrical wiring or any other fixture shall be provided as illustrated in Fig.7.

9 Projection of Balcony

9.1 In case of projection in the same direction as the length of units, the unit itself can be projected out for short cantilever by designing and providing necessary reinforcement

for cantilever moment in accordance with IS 456. However, care shall be taken to see that the projecting part of the precast channel unit is kept supported till in-situ concrete in the joint hardens. Alternatively, the cantilever can be cast in-situ. In such a case, reinforcement shall be kept projecting out from units or from the joints between the units as shown in Fig.8.

9.2 No person should be allowed to walk on the floor or roof for atleast 3 days after the in-situ concrete has been laid in the joints between the units.

10 Floor/Roof Finishing

10.1 Floor/roof finishing as desired may be provided directly over the slab erected by using these units. Guidance in this connection may be taken by referring to the relevant Indian Standards. For water proofing treatment of roofs IS 1346, IS 4365, IS 3036 and IS 9918 may be referred.

10.2 The joints in the ceiling may be finished with deep ruled lines for better appearance (see Fig.5). The ruled joints also have the added advantage as they conceal the cracks at the joint, which are likely to occur due to differential shrinkage of in-situ joint concrete and the concrete in precast units as well as any difference in the thickness of the units.

11 Precautions During and After Construction

11.1 During construction, no heavy loading should be permitted over the units until the cast in-situ concrete filled in the joints attains full strength.

11.2 During all stages of erection, the units should be handled so that the main reinforcement is always on the underside only.

11.3 The units should be stacked on a level ground sprinkled with a thin layer of sand in single tier or multiple tiers up to a maximum of 5.

11.4 In-situ concreting in the joints between adjacent units at their ends along the length should also be properly compacted and its water tightness ensured so as to avoid moisture ingress.

12 Sampling

12.1 All the precast reinforced concrete units of the same size, manufactured from similar materials and under similar conditions of production shall be grouped together to constitute a lot.

12.2 Five units shall be selected at random out of a lot consisting of 300 units or less. For lots bigger than 300 units, 5 units shall be selected for every 300 units or part thereof. In order to ensure randomness of selection, procedure given in IS4905 may be followed.

13 Tests

Tests shall be conducted on samples of the units as given in IS 14215.

14 Criteria for Conformity

14.1 If four out of the five samples satisfy the dimensional requirements, the lot represented by the sample shall be deemed to have passed the dimensional requirements. If more than one unit fails to satisfy the dimensional requirements, the lot represented by the sample shall be rejected.

14.2 In the deflection recovery test, if the deflection 24 h after the removal of the imposed load is atleast 75% of the deflection under the load for 24 h, the unit shall be deemed to have passed the test. If the deflection recovery is less than 75%, the lot represented by the unit shall be rejected.

If the maximum deflection in mm shown during 24 h under load is less than $401^2/D$, where l is the effective span l in mm and D, the overall depth of the section in mm, it is not necessary for the deflection recovery to be measured and the recovery provision mentioned in this clause earlier will not apply.

14.3 In the failure load test, the unit shall carry a load atleast equal to 1.33 times the characteristic load to pass the test. If the load at failure is less than twice the characteristic load, the lot represented by the sample shall be rejected.

15 Marking

15.1 Each channel units manufactured in accordance with this specification shall legibly and indelibly marked with identification of the source of manufacture and month and year of manufacture.

CT 02

Specifications for Precast RC Planks and Joists for Floors & Roofs

1 General

1.1 Precast Reinforced Cement Concrete (RC) planks are partially precast rectangular slab elements. These are supported over partially precast RC joists side by side and then joined together and also to the joint by pouring in-situ concrete over the haunches provided in the planks and the gaps between the planks over the joists. Monolithic action of the slab elements is ensured by leaving hooks projecting out of joists and providing reinforcement across the joists over haunched portion of planks, tying them together and pouring in-situ concrete over them.

2 Dimensions and Tolerances

2.1 The floor/roof shall consist of precast R.C.planks and partially precast R.C.joists with cast in-situ reinforced cement concrete as shown in Fig.1.

2.1.1 ***Precast R.C. Planks*** - The plank (Fig.2) shall be made partly 30 mm and partly 60 mm thick. A 100 mm wide tapered concrete filling shall be provided for strengthening the haunch portion for shear during handling and erection. Length of tapered concrete filling at both ends shall be kept 300 mm for all length of planks and the length of central 60 mm thick portion shall be decreased for length of planks smaller than 1.5 m. The plank shall be made up of nominal MS reinforcement as per structural design and concrete of grade not less than M-20. The width of the plank shall be 300 mm and the maximum length 1500 mm. However, to suit to the room size, the width may be suitably changed to ±50mm. Smaller lengths requires for varying room dimensions may also be casted. However, it is prefarable to use lengths in multiples of 300 mm only, keeping in view the requirement of modular co-ordination.

2.1.2 ***Partially Precast RC Joists*** - The width of precast joist (Fig.3) shall be kept equal to required width of web of T-beam (IS 13994) and the depth shall be kept equal to the required overall depth of T-beam less the thickness of flange i.e. the maximum thickness of RC planks (60 mm).

2.2 Tolerances

2.2.I. Casting tolerances on plank shall be, length ±5mm, width ±3mm, thickness ±2mm, Bow (diviation from intended line or plane) ±2mm, and Twist (distance of any corner from the plane containing other 3 corners) ± 1mm.

2.2.2 For squareness, the long edge of planks shall be taken as the base line. The shorter side shall not vary in its length from perpendicular distance between long edges by more than 3mm.

2.2.3 The maximum deviation for flatness from a 1.5m straight

edge placed in any position on a nominal plane surface shall not exceed 2mm.

2.2.4 Casting tolerance for joist shall be length ±8mm, width ±3mm, thickness ±3mm.

3 Structural Design

3.1 The design shall be as per limit state method in accordance with IS 456. Design load on various components of the flooring/roofing shall comprise of self weight, imposed load in accordance with IS 875 (Part-2) and dead load due to floor finish in case of intermediate floors and dead load due to roof treatment in case of roofs shall be in accordance with IS 875 (Part 1).

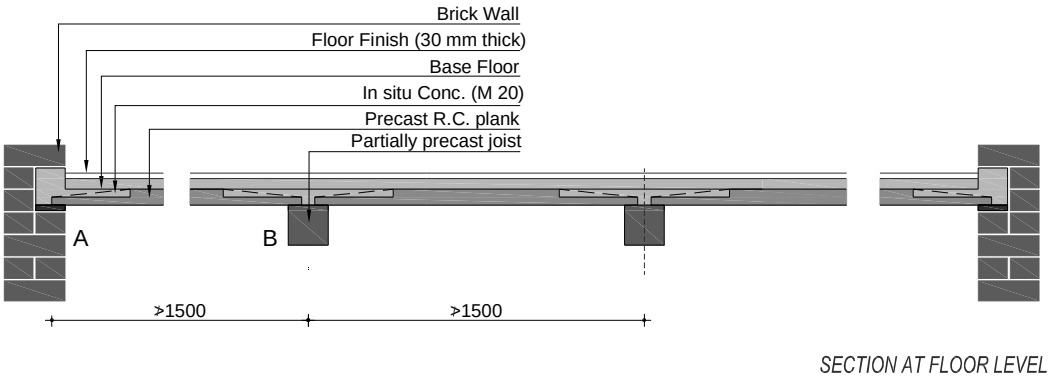
3.1.1 ***Precast R.C.Planks*** - The RC planks shall be designed as simply supported for self weight including in-situ concrete over haunches, and as continuous slab for a load comprising live load, self weight and dead load of floor finish and/or water proofing treatment. The precast plank for floor as well as roof of normal residential buildings has 3 nos. 6 mm dia. MS bars as main reinforcement and the transverse reinforcement comprises of 6 mm dia MS bars spaced at 200 mm on centres. For continuity, in RC planks, at the support, 2 nos.6 mm dia MS bars per plank along the length and 2 nos. 6mm dia MS bars as transverse reinforcement over each support are provided in the haunch portion.

3.1.2 ***Partially Precast RC Joists*** - It shall be designed as simply supported or continuous T-beam with 60 mm flange thickness depending upon whether the joists are having single span or continuous over adjacant span. The reinforcement shall be provided as per design requirements depending upon the spacing and span of the joist determined in accordance with IS 456.

3.2 For large spans requiring high moment of resistance, either the depth of the joist can be increased, or if depth cannot be increased due to head room requirements, the joist shall be designed as doubly reinforced beam at the support. In the latter case, the bottom reinforcement of the joist shall be kept projecting out by about 20 mm and the bottom reinforcement of joists covering adjacent spans shall be welded together for continuity. The top reinforcement to resist negative moment shall be provided in the joists upto a distance from supports as specified in IS 456. This shall be embedded in in-situ concrete (Fig. 8A, 8B and 8C). The moments and shears at various sections shall be determined either theoretically or the co-efficients as given in IS 456 may be used wherever applicable. The movement of resistance of T-beam with different reinforcement based on limit state method are given in IS 13994 for reference.

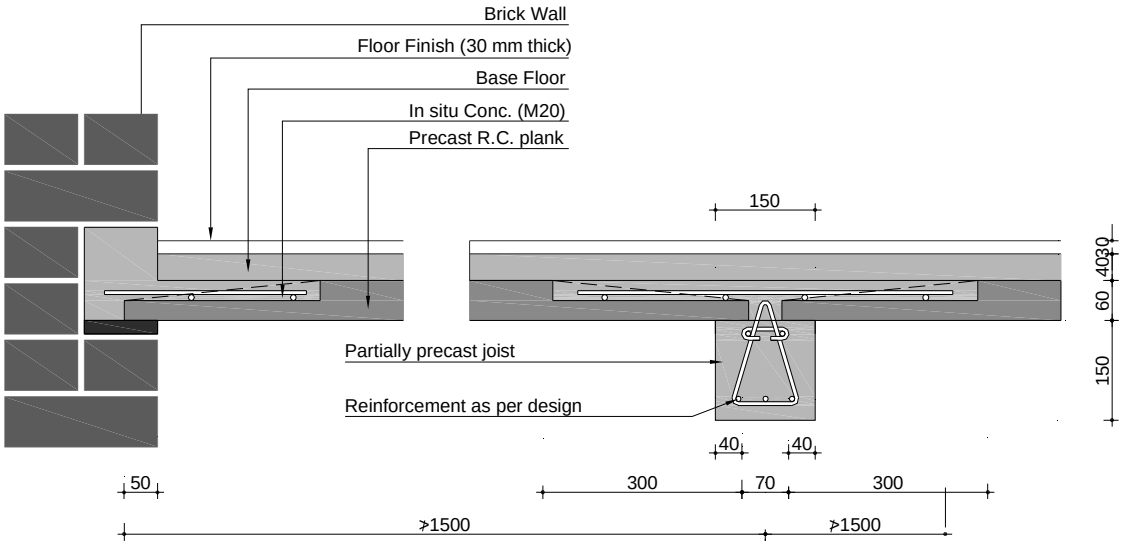
3.3 ***Cover to Reinforcement*** - A minimum clear cover of 15 mm for planks and 25 mm for joists shall be provided.

3.4 When precast unit are used for the construction of building in high



SECTION AT FLOOR LEVEL

PRECAST R.C. PLANK SCHEME



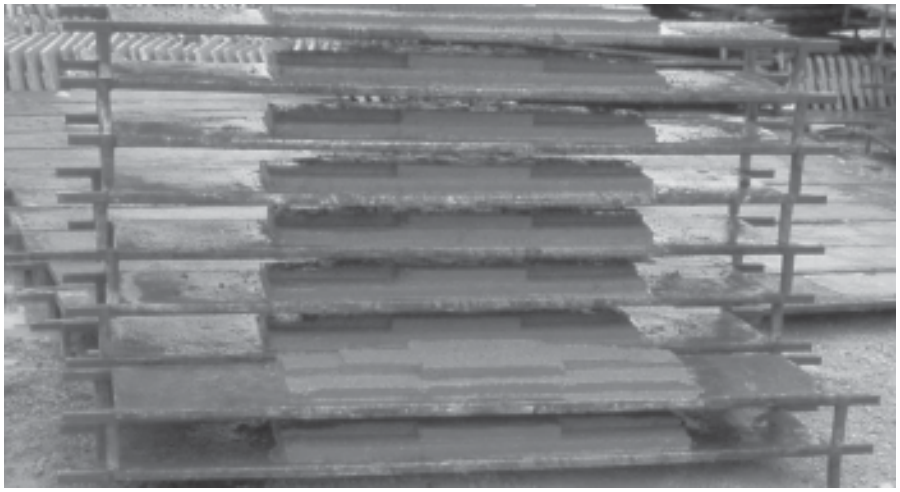
SECTION AT FLOOR LEVEL

Fig.01

PRECAST R.C. PLANK SCHEME

ENLARGED DETAILS A & B

ALL DIMENSIONS ARE IN mm.



seismic zones, the roofs/slabs shall be strengthened in accordance with the provision of IS 4326.

4 Manufacture of Precast RC Planks & Joists

4.1 ***Moulds***

4.1.1 Mould consist of two frames and two tapering members of steel, plastic or FRP for planks Fig. 4.

4.1.2 Mould consist of two longitudinal members, end cross plates and spacer plates steel, plastic or FRP

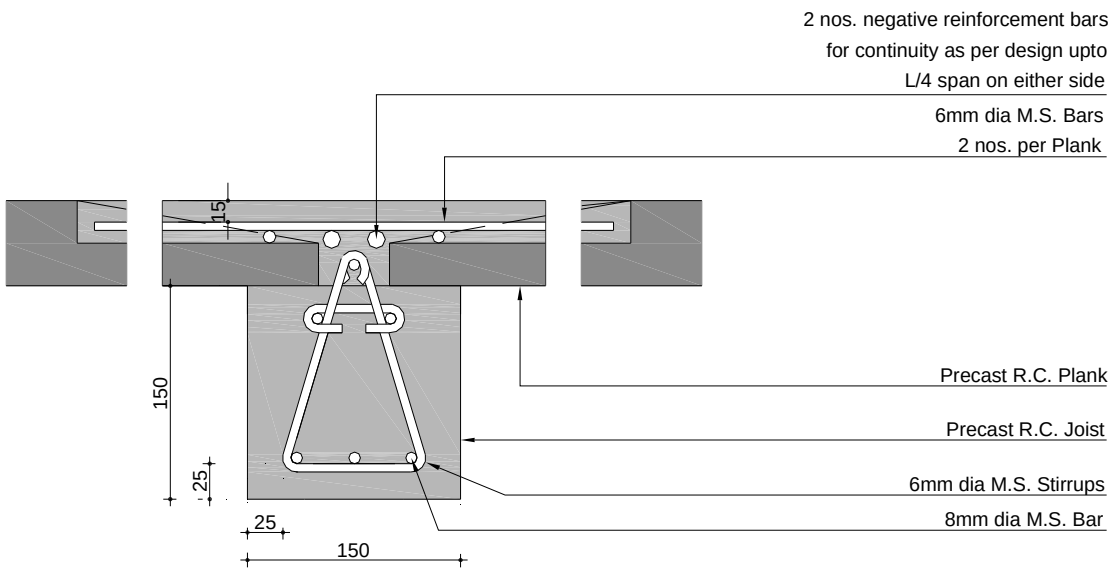


Fig.01

JOIST REINFORCEMENT AND JOINT DETAILS

ALL DIMENSIONS ARE IN mm.

for joists Fig. 5.

4.1.3 The material used for making moulds shall be rigid, non absorbant and non-corrodible. It shall maintain the dimensions within the specified limit.

4.1.4 For mass production, the precast RC planks & joists may also be manufactured in vibrating machines.

4.1.5 Tolerances on mould dimensions shall be, length ±4mm, width ±2mm and depth ±2mm.

4.2 Casting and Curing

4.2.1 *Precast R.C.planks*

4.2.1.1 Inner sides of the mould shall be applied with a suitable bond releasing agent and it shall be kept on a smooth concrete platform coated with bond release agent. Alternatively, wrinkle free old newspapers may be used over the concrete platform. Reinforcement cage shall be placed inside the mould in such a way as to provide a cover of 15 mm. Concrete with well graded aggregate of maximum size 10 mm shall be poured to a depth such that after compaction with a plate vibrator shall become 30 mm. The upper side of the longitudinal members of the mould and the two tapering members shall then be placed over the mould. Concrete shall than be poured in middle and the sides and compacted with a plate vibrator. Concrete shall be finished level with the mould and the top surface shall be made rough by trowel markings.

4.2.1.2 After about half an hour of casting, the two tapering members may be lifted off. The mould may be stripped off in about 2 h. (depending on the weather) after casting. The demoulded cast unit is first slide by push and then tilted through right angles on long edge after 24 to 30 h. of casting depending upon the weather. It shall be transported in vertical position for curing.

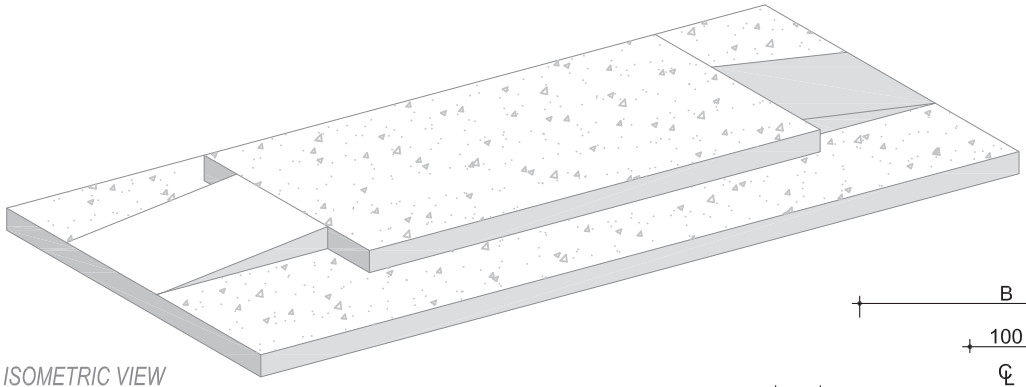
4.2.1.3 The units shall be stacked against a vertical support in nearly vertical position and cured for atleast two weeks by sprinkling water. It shall further be air cured for another two weeks before it can be used for construction.

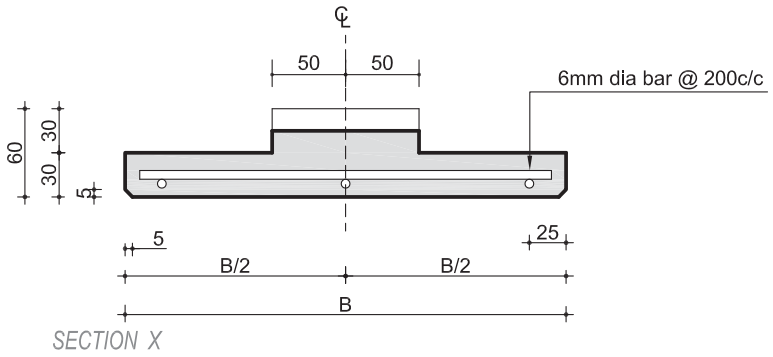
4.2.2 *Partially Precast RC Joists*

4.2.2.1 The mould shall be assembled and bond releasing agent applied on the inner sides. Reinforcement cage with a gap from bottom of 25 mm for cover shall be placed in mould with the stirrups projecting out as shown in Fig.3. The top spacer pieces shall be fixed over the mould. Cement concrete with well graded aggregate of 20 mm maximum size shall be poured in the mould and compacted with a plate vibrator by placing it on the top of the mould or by inserting a needle vibrator.

4.2.2.2 The mould may be stripped off in about 3 to 4h. (depending on weather) after casting. The demoulded cast joist shall be first slided by push and then transported to the curing area by holding them near the ends after 48 to 72h. of casting depending on the weather.

4.2.2.3 The precast joists shall be water





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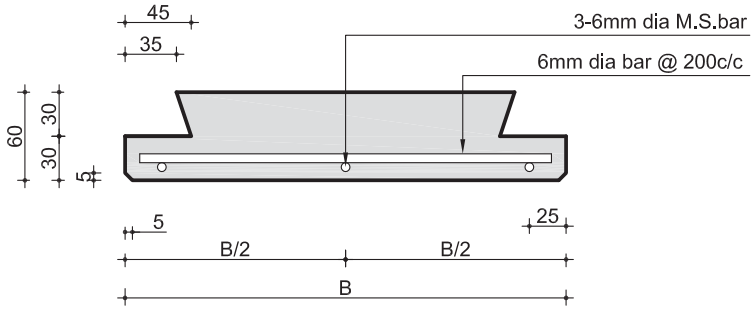

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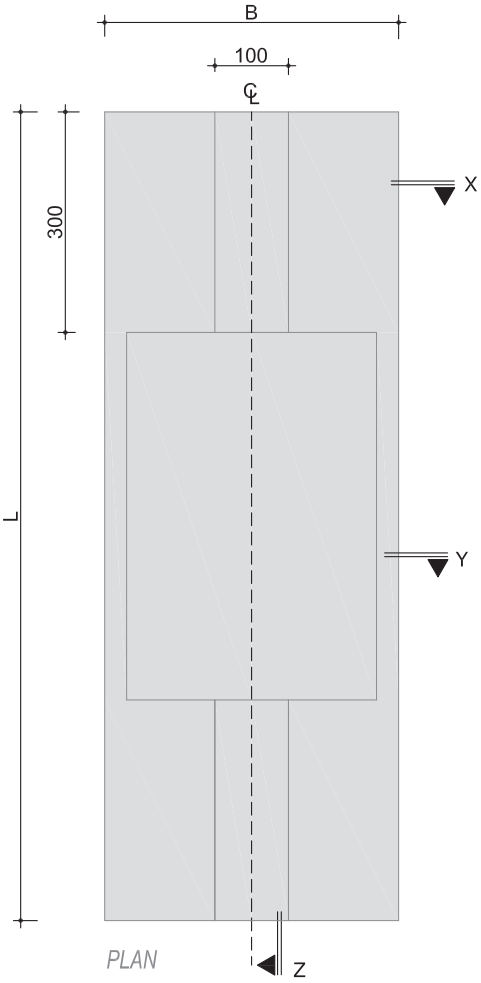


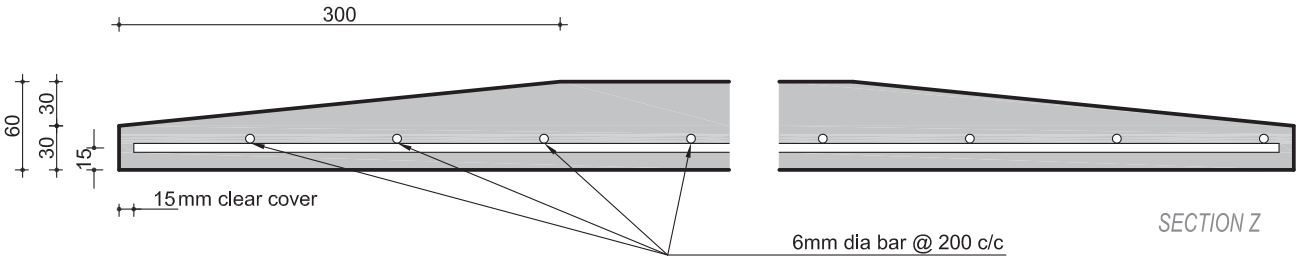


Fig.02

PRECAST R.C.C. PLANK

ALL DIMENSIONS ARE IN mm.

Note: 1. The projection of Stirrups over Precast joist to be 40mm

2. L = Clear span + 200mm

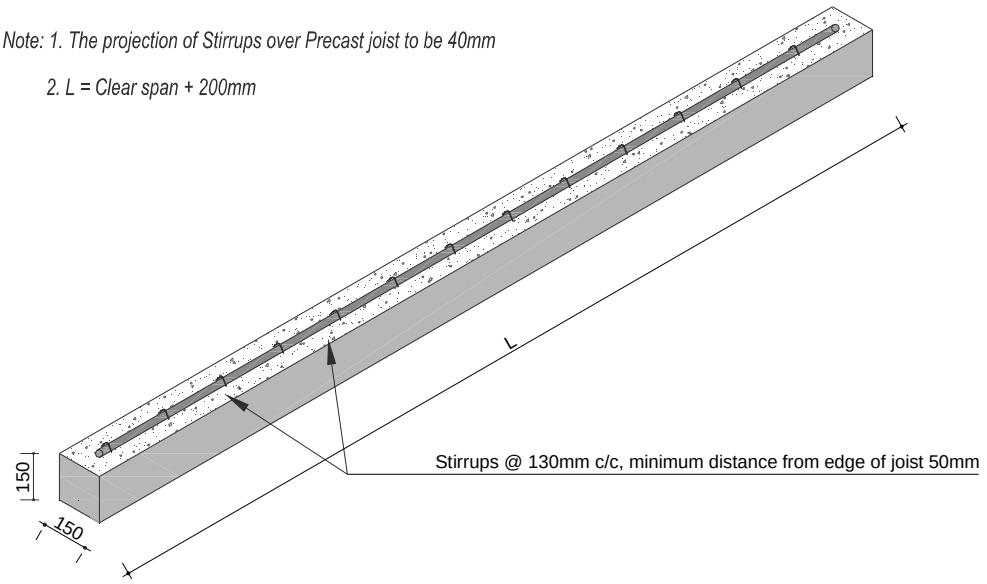


Fig.03

PARTIALLY PRECAST JOIST

ALL DIMENSIONS ARE IN mm.

cured for a minimum period of two weeks and air cured further for atleast two or more weeks before they may used for construction.

5 Erection of Floor/Roof

5.1 Cement concrete bed blocks of 300 mm x 230 mm x 75 mm size for joist with proportions of 1:3:6 (cement : fine aggregate : coarse aggregate) shall be laid on wall in a thickness of 75 mm. The top of the blocks shall be finished smooth.

5.2 Partially precast joists shall then be aligned over these blocks. The joists shall be propped at centre of span, immediately after putting them, with a prop having a timber plank of minimum dimensions of 350 mm x width of joist, of 30 mm thickness at bearing level (Fig.6). The minimum bearing of joists over the walls should be 100 mm.

5.3 Top surface of the walls/beams where planks have to bear, shall then be leveled smooth with 1:6 cement sand mortar. In case of roofs, the entire wall top shall be leveled smooth with the mortar and given a thick coat of white wash or bitumenised paper or polythene film shall be placed for free movement of roof/floor.

5.4 Precast planks shall now be placed over the joists/walls side by side. Fan hooks may be provided if the fan is to be hung in between the planks (Fig.7A and 7B). If, however, the fan is to be hung from the joist, a through and through hole of around 15 mm diameter is to be left in the joist during its casting and the fan can be hung by a clamp (Fig.7C). The minimum bearing of joists shall be 50 mm on load bearing walls and 40 mm on beams.

5.5 Reinforcing bars across the joist (that is, parallel to planks) having an area required to resist negative moment and to provide continuity to planks in successive spans shall then be placed in the haunch portions. This negative reinforcement may be determined in accordance with IS 456. Alternatively, two 6 mm diameter mild steel grade I bars conforming to IS 432 (Part1) may be provided which satisfies the reinforcement requirements for normal residential buildings. Distribution reinforcement consisting of two mild steel grade I bars of 6 mm diameter conforming to IS 432 (Part 1) shall be kept parallel to joists near the ends of the planks as shown in Fig.1. These bars shall then be tied with the cross bars.

5.6 Near the supports of joists where two joists are meeting the negative reinforcement shall be provided, as shown in Fig.1.

5.7 Cement slurry wash at the rate of 4 kg cement per 10 m^2 of the floor/ roof shall be applied over the joists and in the haunch portions of the precast planks where in-situ concrete is to be laid.

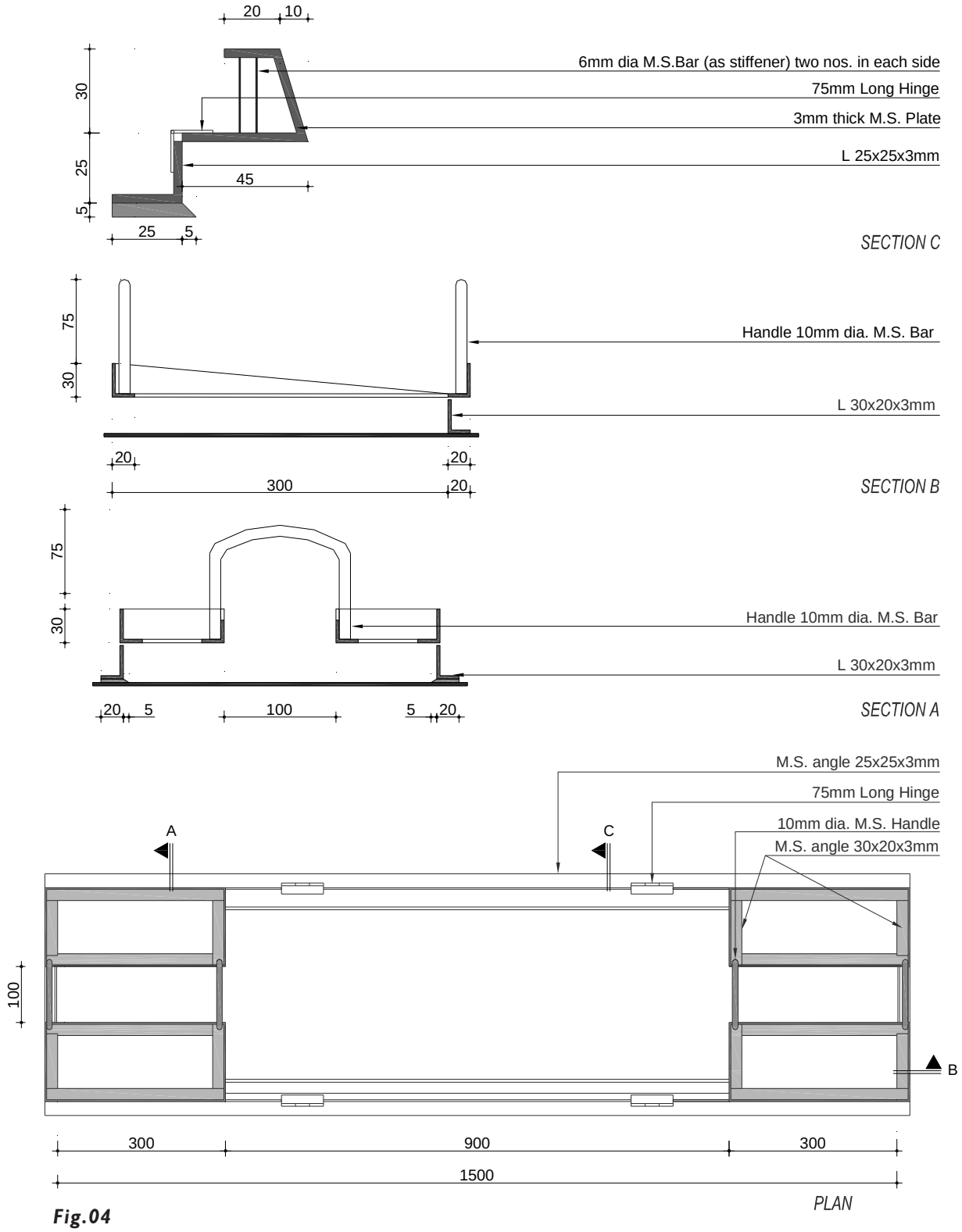
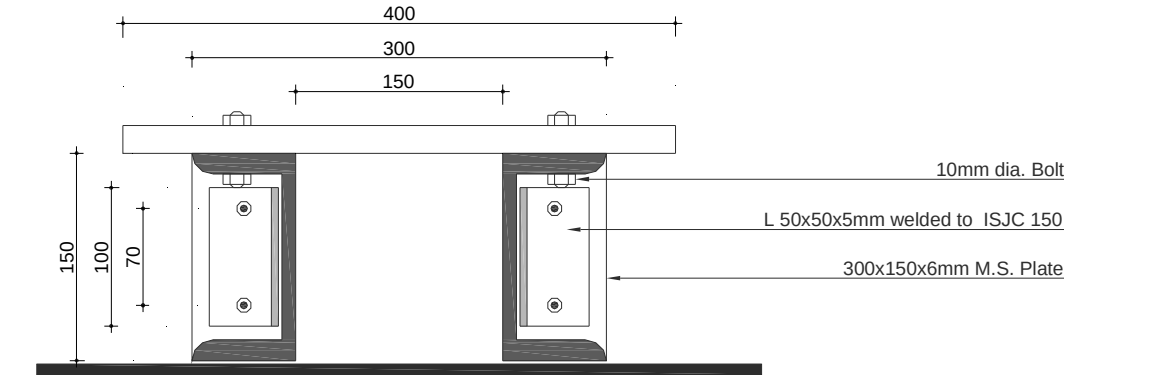
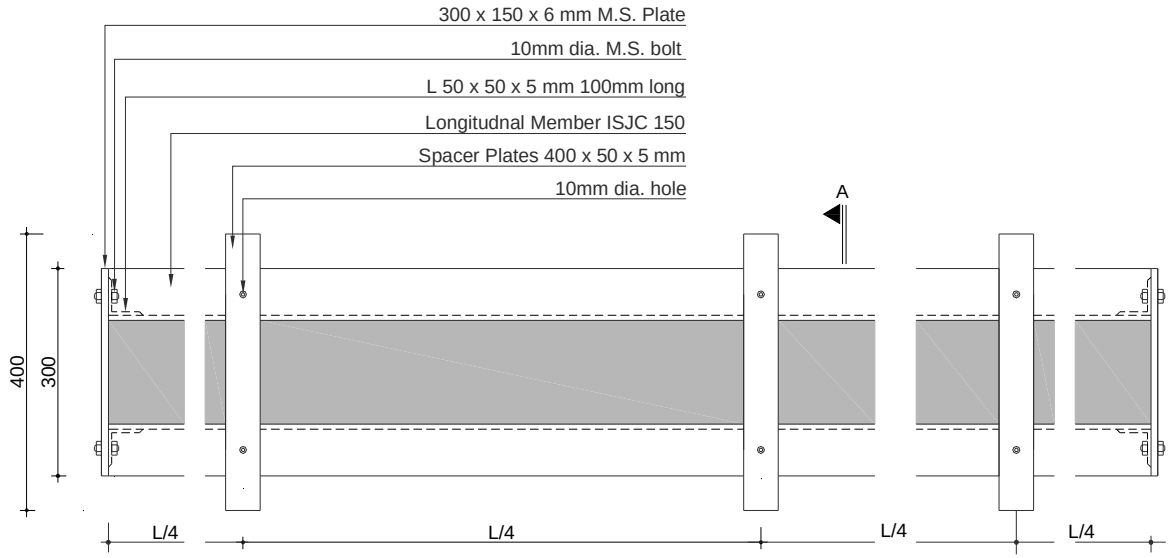


Fig.04
STEEL MOULD FOR R.C. PLANK

ALL DIMENSIONS ARE IN mm.



SECTION A



PLAN

Fig.05
STEEL MOULD FOR R.C. JOIST

ALL DIMENSIONS ARE IN mm.

5.8 A thick paste of cement-sand (1:4) mortar shall be laid in the gaps between the planks along their length, to fill them up completely.

5.9 Cement concrete of M-20 grade with well graded coarse aggregate of maximum size 10 mm shall then be laid over the joists and in haunches between the planks and the top leveled flush with the top of central portion of the planks.

5.10 In case of roofs without parapet, the planks shall be kept projecting out by a maximum of 100 mm in either direction to avoid leakage at the junction of wall and roof (Fig.9). Alternatively, a maximum projection of 500 mm across the joists may be provided by providing shuttering, laying reinforcement and concreting flush with the roof treatment as shown in Fig.9. A projection of 100 mm may be provided along the joists by providing the negative reinforcement in joist at top and projecting the same and concreting as shown in Fig.1.

5.11 In-situ concrete shall be cured for a minimum period of 10 days. The props of the joists shall not be removed before the curing period is over and in-situ concrete has attained strength.

5.12 A minimum clear cover to all the reinforcement bars shall be 15 mm or the diameter of the bar whichever is greater.

6 Floor/Roof Finishing

6.1 For waterproofing using bitumen felts, bitumen mastic, glass fibre tissue reinforced bitumen and lime concrete, IS 1346, IS 9918 and IS 3036 may be referred.

7 Care During and After Erection

7.1 Concentrated load shall not be allowed on the floor/roof till in-situ concrete has attained strength. Workers shall not walk on the floor/roof before the insitu concrete has attained strength. For placing of reinforcement and concreting in the haunches and over joists, cat walks resting on joists/walls shall be provided.

7.2 The planks shall be handled and transported in vertical position as far as possible and these should be supported only near the edges. The joists shall be handled from very near the ends or at a distance of L/5 from the ends.

7.3 Partition walls shall not be constructed over the planks but only over joists or wall in which case their weight has to be considered while designing the joists.

8 Service Area Provisions

8.1 In service area, pipes, floor traps, water closet etc. are provided and hence the supporting slab is sunk. In such cases, to take care of the additional load of the filling and also

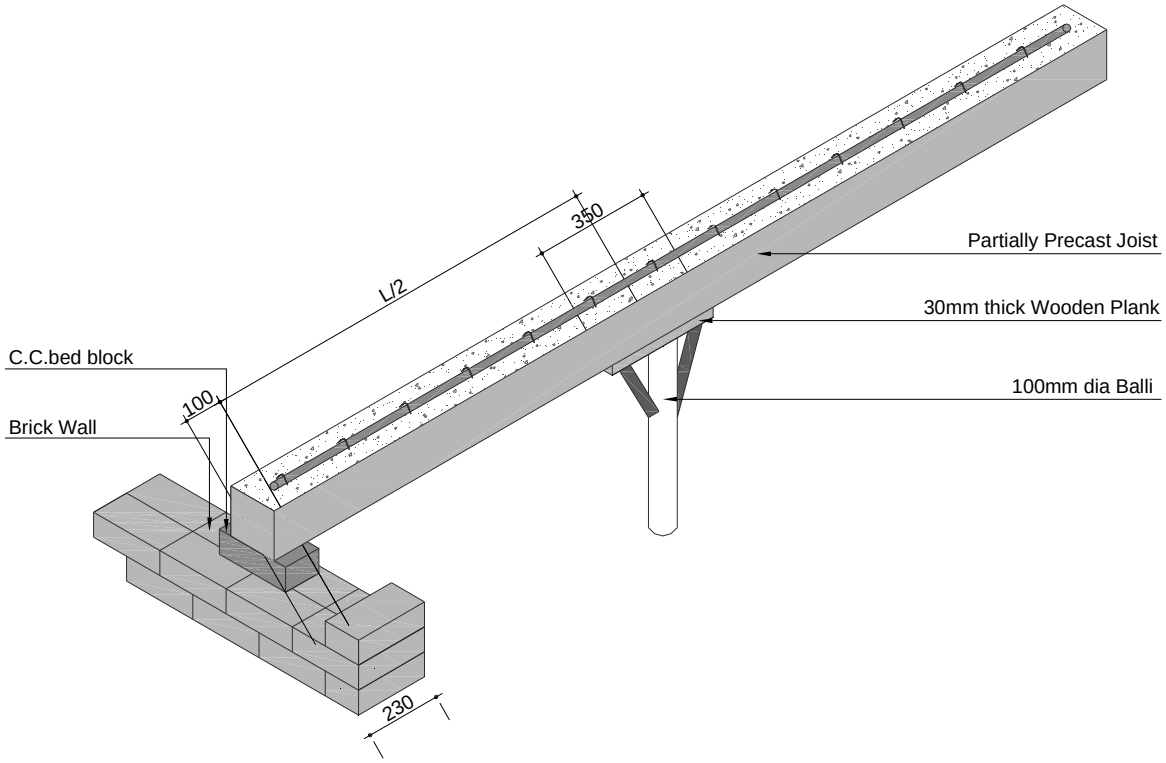
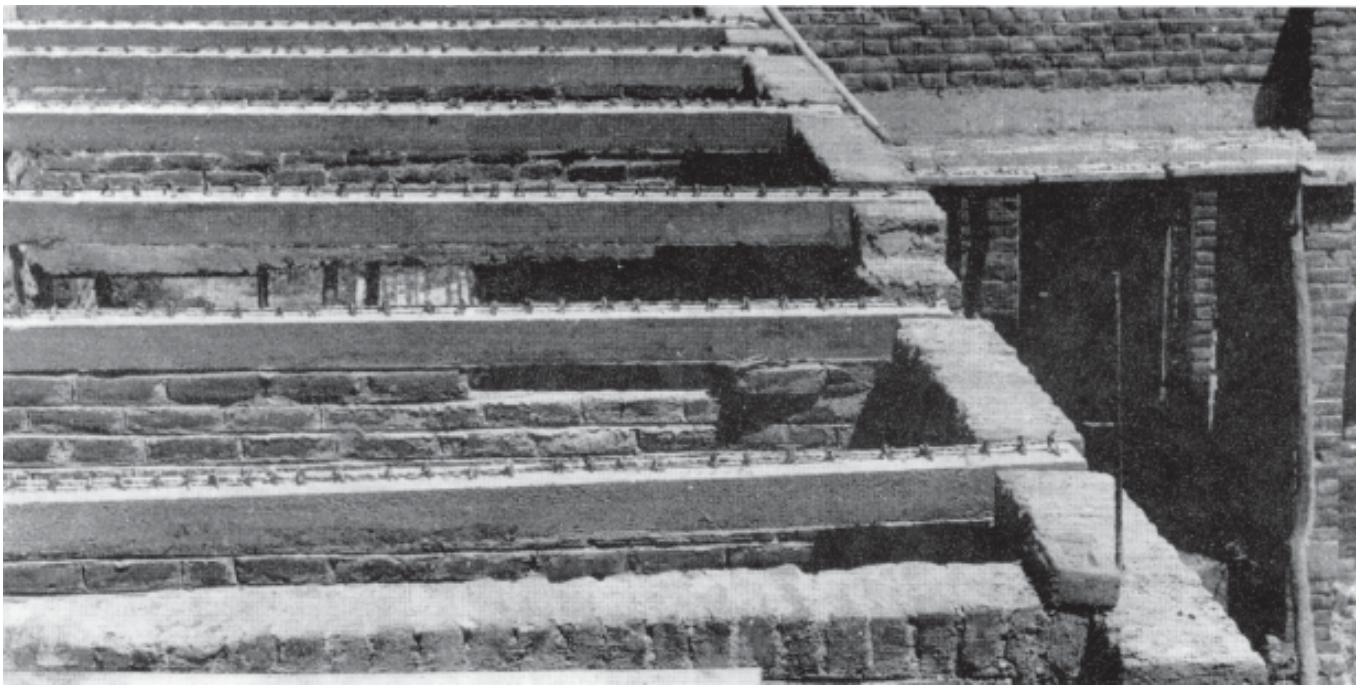


Fig.06

PROPPING OF PARTIALLY PRECAST JOIST

ALL DIMENSIONS ARE IN mm.



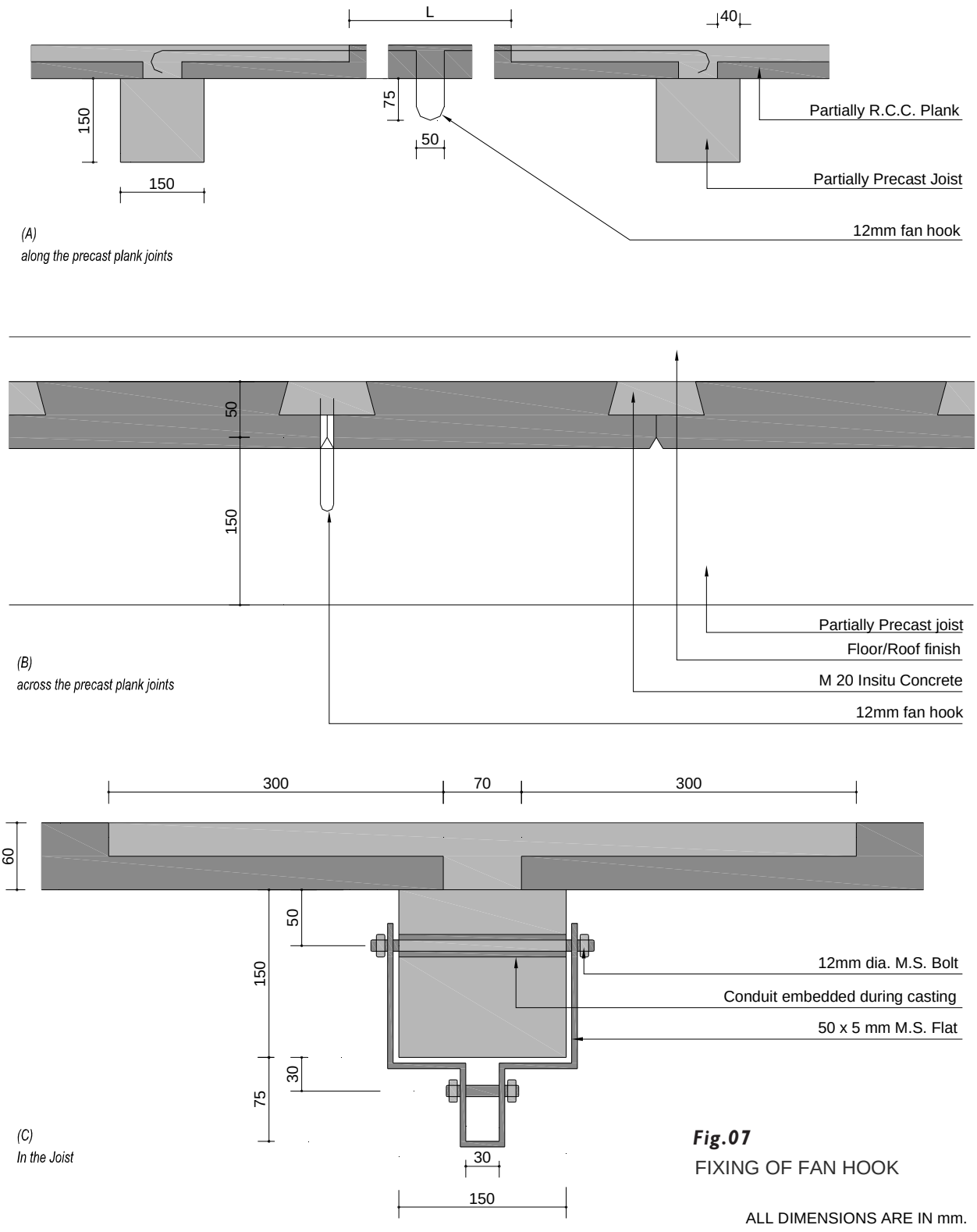


Fig.07

FIXING OF FAN HOOK

ALL DIMENSIONS ARE IN mm.

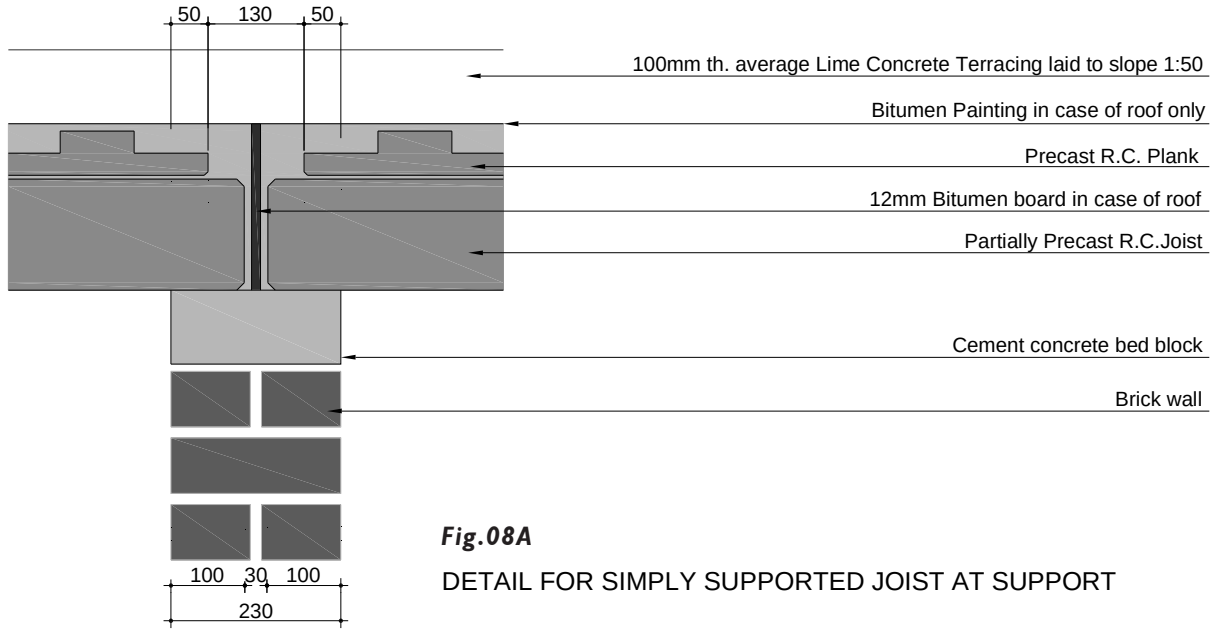


Fig.08A

DETAIL FOR SIMPLY SUPPORTED JOIST AT SUPPORT

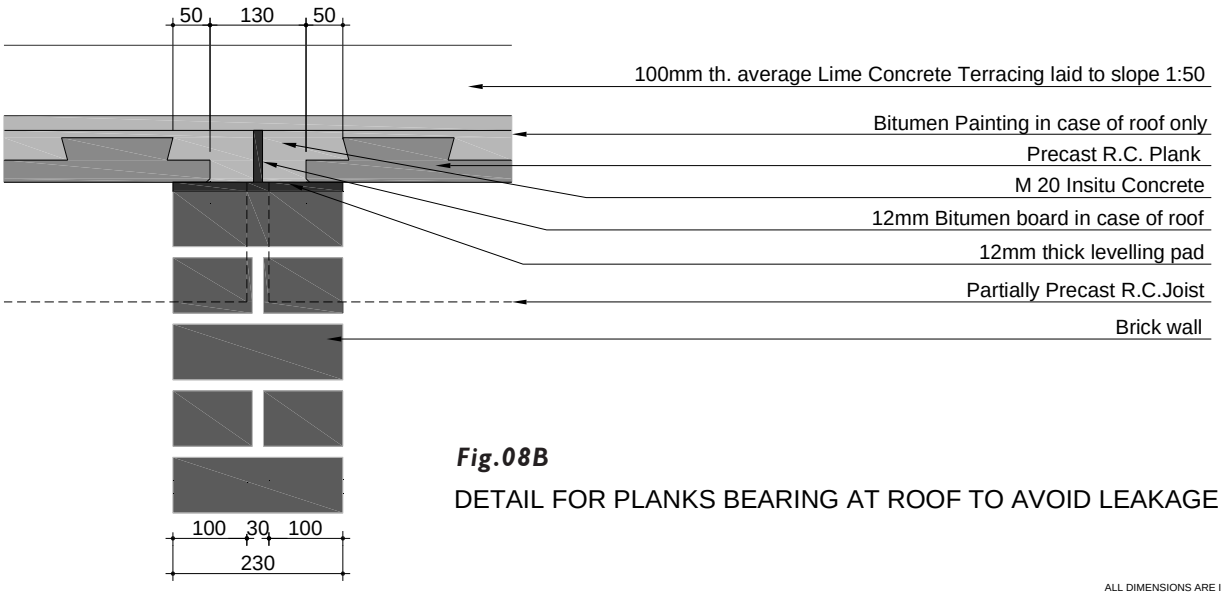


Fig.08B

DETAIL FOR PLANKS BEARING AT ROOF TO AVOID LEAKAGE

ALL DIMENSIONS ARE IN mm.

to make the floor leak-proof, the in-situ concrete thickness is increased by 25 mm over top of the planks in addition to haunch filling.

9 Balcony/Chhajja Projections

9.1 Balcony projections shall be provided along the partially precast joists as given in IS 13994. The joist shall be designed with an overhang, carrying superimposed loads for balcony as specified in IS 875, in addition to the self load and the load due to railing. Main reinforcement shall be provided at the top in in-situ concrete while the precast portion will take the compression. The free end of the joist shall be propped adequately until in-situ concrete attains sufficient strength.

10 Sampling

10.1 All the precast reinforced concrete units of the same size, manufactured from similar condition of productions shall be grouped together to constitute a lot.

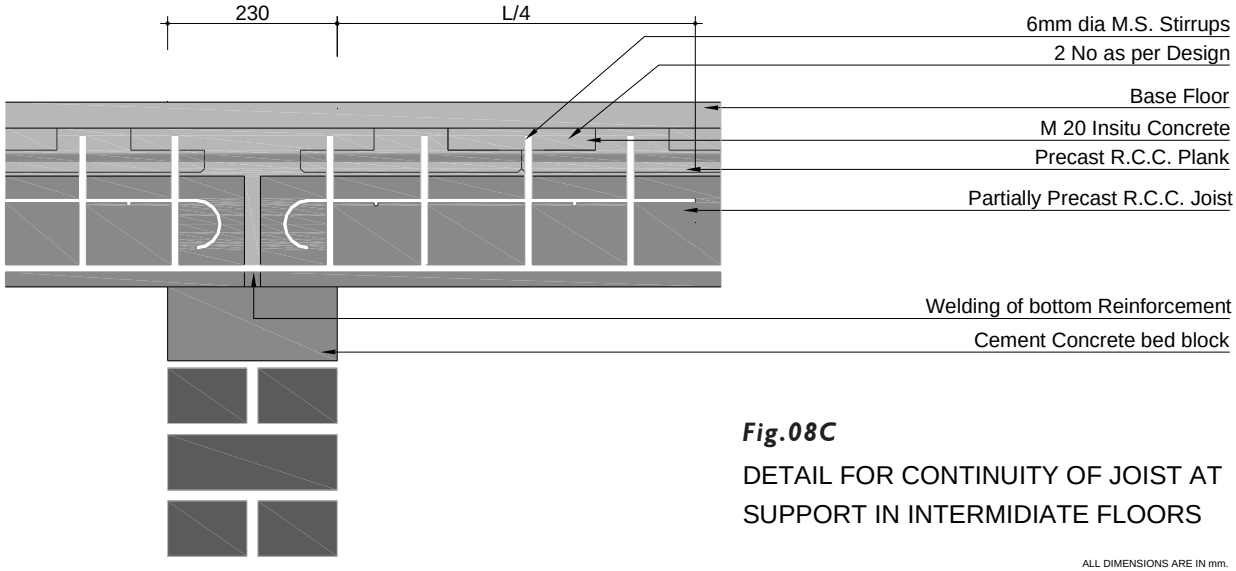


Fig.08C

DETAIL FOR CONTINUITY OF JOIST AT SUPPORT IN INTERMIDIATE FLOORS

ALL DIMENSIONS ARE IN mm.

10.2 Five units shall be selected at random out of a lot consisting of 300 units or less. For lot bigger than 300 units 5 units shall be selected for every additional 300 units or part thereof. In order to ensure randomness of selection, procedure given in IS 4905 may be followed.

10.3 The samples shall be suitably marked for future identification of the lot it represents.

11 Test

11.1 Tests shall be conducted on samples of the units as given in IS 13994.

11.2 Dimensional test and deflection recovery test shall be routine test whereas failure load test shall be a type test. Type test is intended to prove the suitability and performance of a new design and size of a component. Failure load test be applied at the time of design of a component of a particular size or at the time of any change in the design/ size.

12 Criteria of Conformity

12.1 If four out of the five samples satisfy the shape and dimensional requirements, the lot represented by the sample shall be deemed to have passed the dimensional requirements, otherwise it shall be rejected.

12.2 In the deflection recovery test performed in accordance with IS 13994, if the deflection after 24 h of the removal of the imposed load is atleast 75 percent of the deflection under the load for 24 h, the units shall be deemed to have passed the test. If the deflection recovery is less than 75 percent the lot represented by the unit shall be rejected. If the maximum deflection in mm, shown during 24 h under load is less than $40\ l^2/D$, where l is the effective span in mm and D, the overall depth of the section in mm, it is not necessary for the deflection recovery to be measured and the recovery provision mentioned in this clause earlier shall not apply.

In case of the failure load performed in accordance with IS 13994, the unit shall carry a load atleast equal to 1.33 times the characteristics load to pass the test. If the load at failure is less than 1.33 times the characteristic load, the lot represented by the sample shall be rejected.

13 Marking

13.1 Each component shall be legibly and indelibly marked with identification of the source of manufacture, and month and year of manufacture.

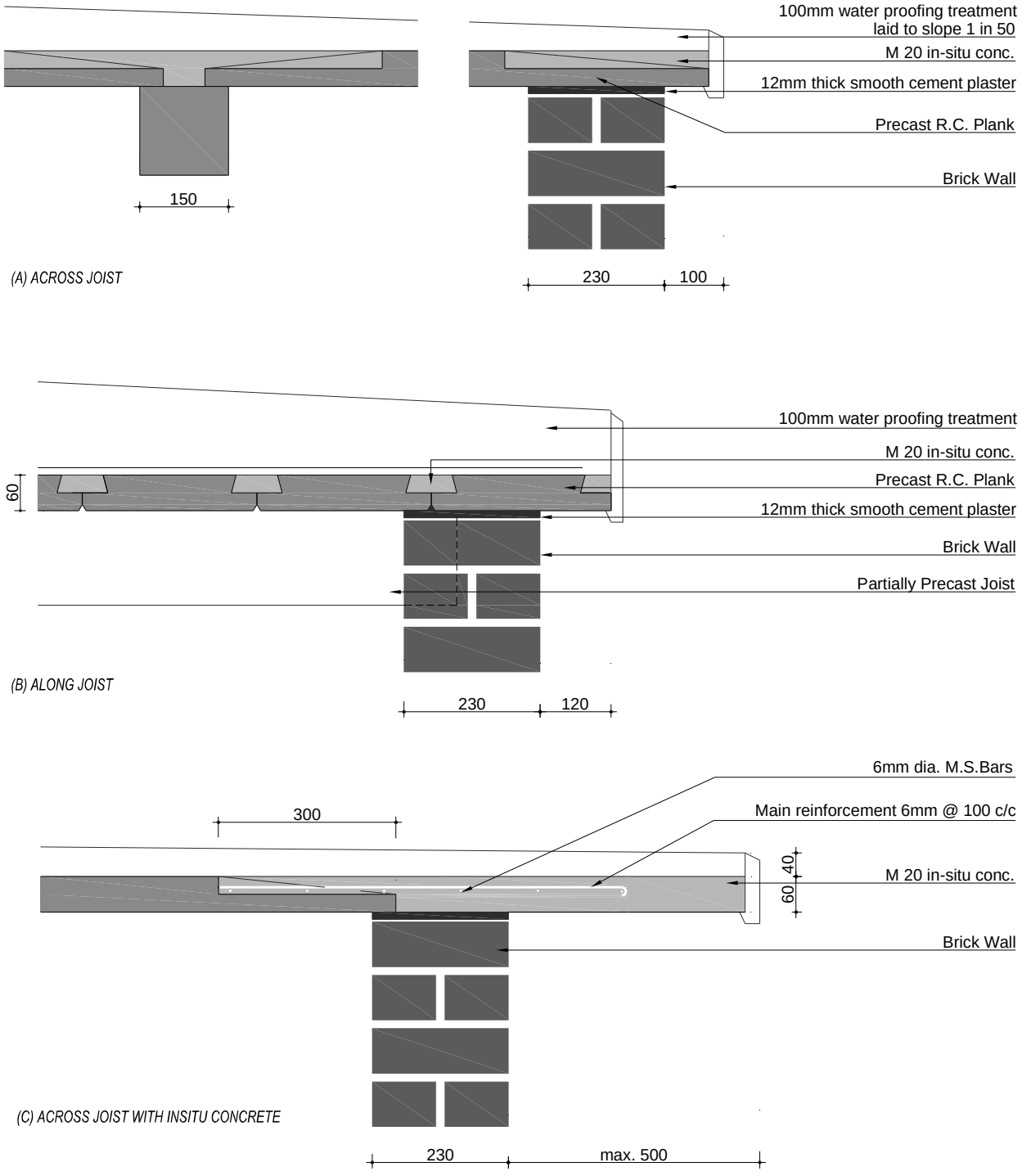


Fig.09

DETAIL OF ROOF WITHOUT PARAPET

ALL DIMENSIONS ARE IN mm.

CT 03

Specifications for Thin R.C.Ribbed Slab for Floors and Roofs

1 General

1.1 Thin R.C. ribbed slab consists of precast R.C. ribs 110 mm x 200 mm spaced equidistance at 1200 mm/centre to centre and 50 mm thick cast-in-situ R.C. flanges (Fig 1). It can be used for floors as well as roofs in buildings. Conventional floor/roof finish can be used above the ribbed slab, as the case may be. Ceiling plaster could be avoided in case of exposed concrete is desired.

2 Dimensions & Tolerances

2.1 Partially precast RC rib: The cross section of R.C. Rib has two portions, precast portion is rectangular shape, 110mm width and 150mm height, with stirrups projecting out 25 mm on top surface of the rib. The total height of rib, including 50mm thick in-situ concrete shall be minimum 200 mm. The maximum length of precast rib shall not be more than 4.0 m. It is designed as composite T-Beam with 50mm thick RCC flange. RC ribs can be placed on load bearing walls or beams.

2.2 RC Flange: The minimum thickness of in-situ concrete for flange shall be 50mm.The flanges are treated as continuous slab spanning over the ribs.

2.3 Tolerances on precast rib shall be length ± 8 mm, width and height ± 3 mm and for in-situ concrete thickness ± 3mm.

3 Structural Design

3.1 Ribs: The structural design shall be as per the limit state method as per IS 456. The precast ribs shall be designed to act as rectangular Tee beam during the construction to support the weight of concrete in the flange, till it has attained strength, the shuttering and the live load of workmen and equipments. The flange shall be designed as a continuous slab spanning over the ribs.

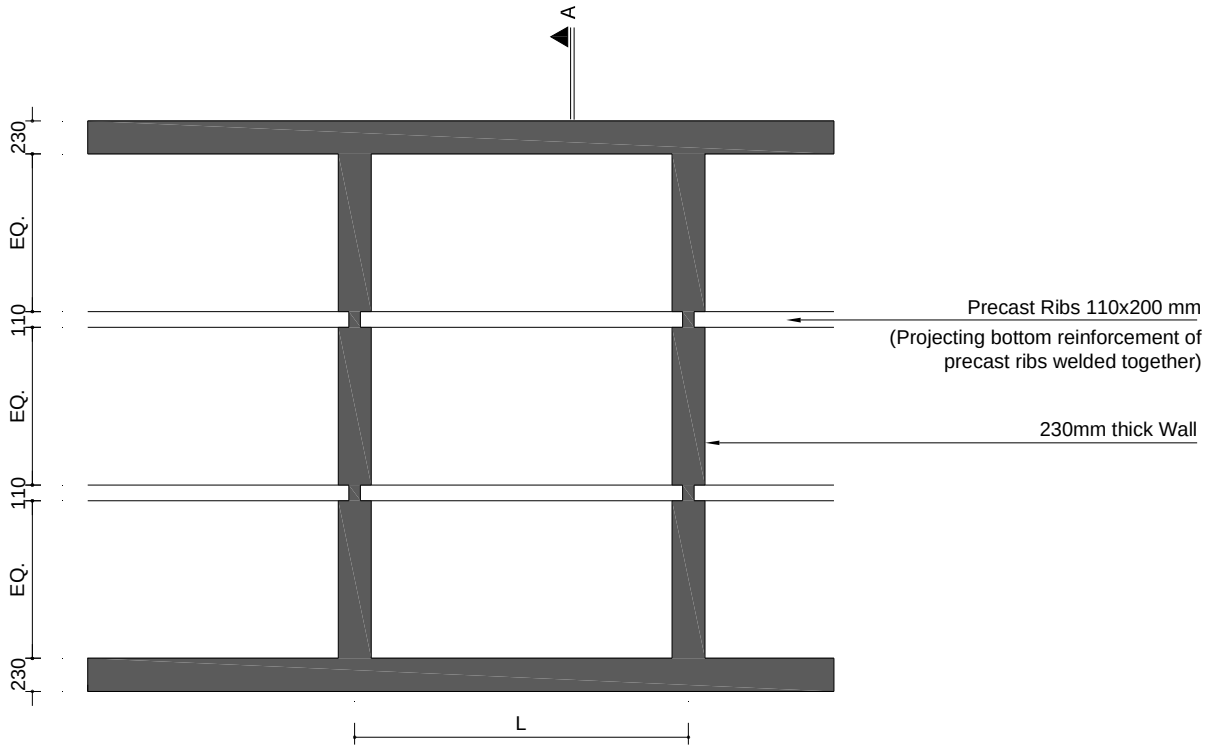
3.2 Flanges: The monolithic action of precast ribs with in-situ concrete flange shall be ensured by keeping rib stirrups projected which shall be embeded along flanges. The thickness of the flange shall be minimum 50mm and this shall be designed as continuous slab.

4 Manufacture of Thin RC Ribbed Slab

4.1 ***Moulds***

4.1.1 The moulds for the ribs shall be made of steel or FRP as per details shown in Fig.2.

4.1.2 The shuttering for the flange shall be made of well seasoned timber or steel plates or FRP as per details shown in Fig.3.



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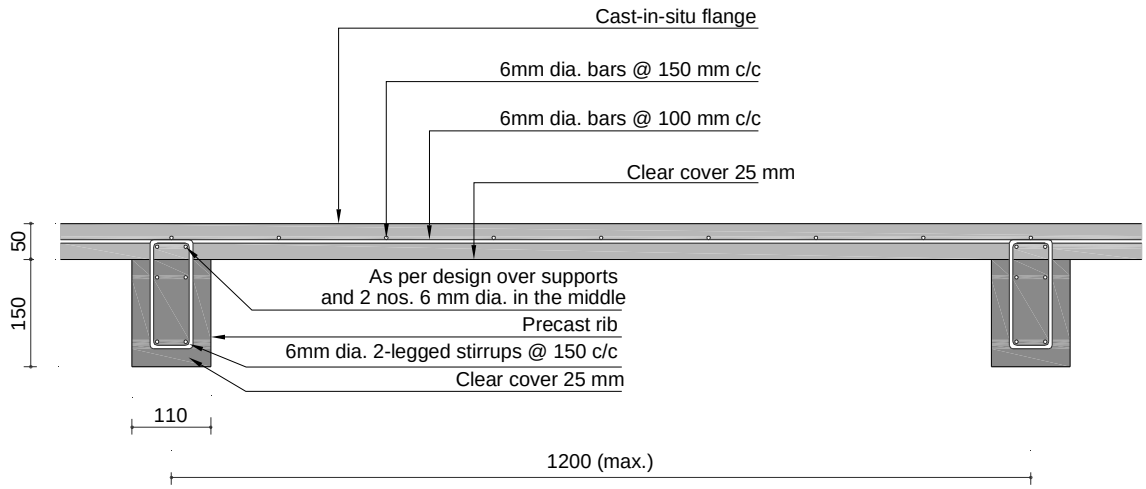


SECTION AT A

Fig.01

THIN R.C. RIBBED SLAB

ALL DIMENSIONS ARE IN mm.

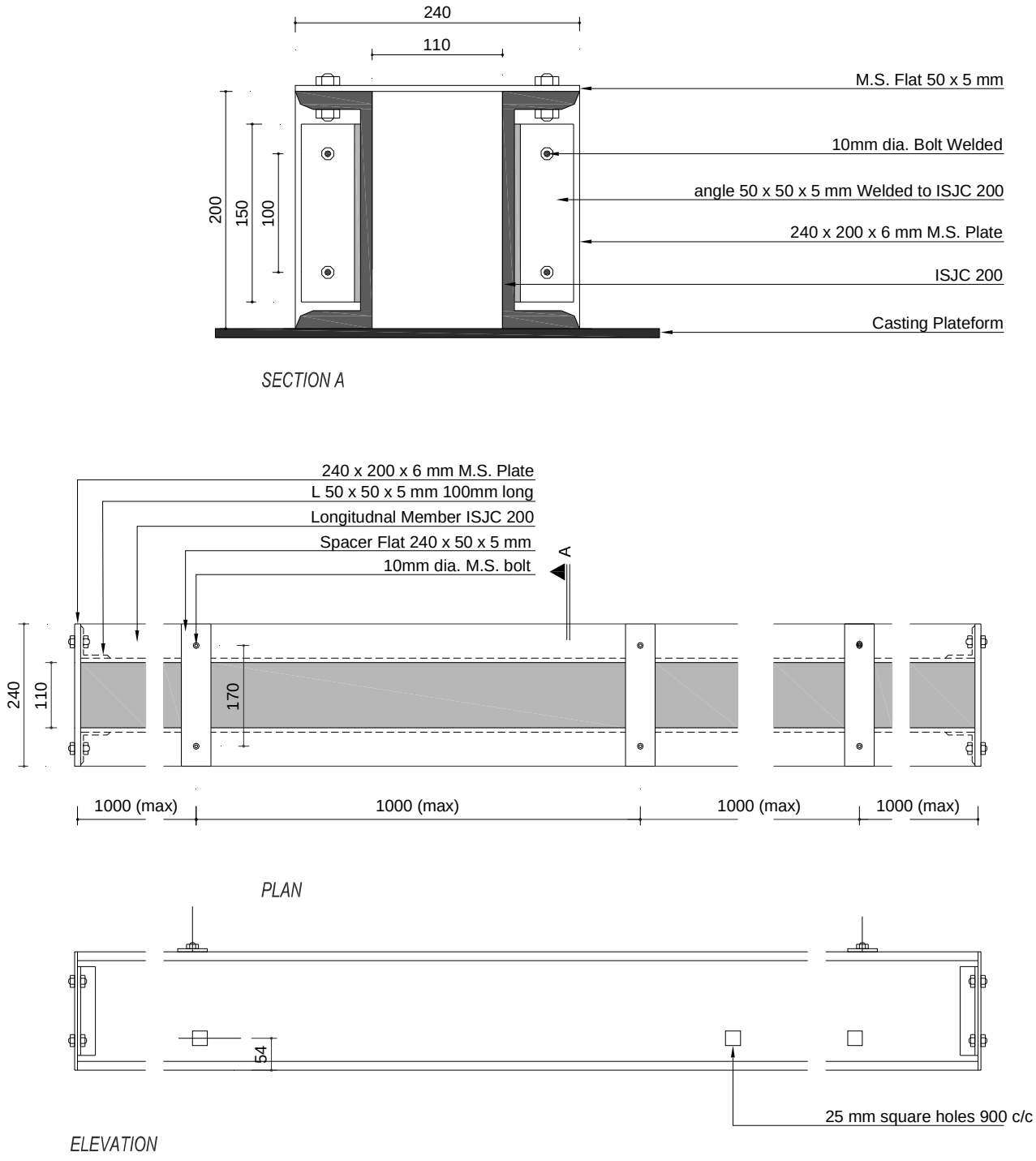
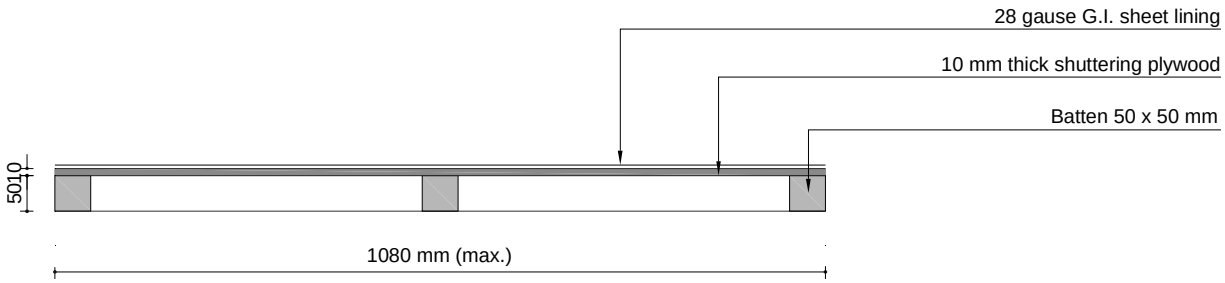


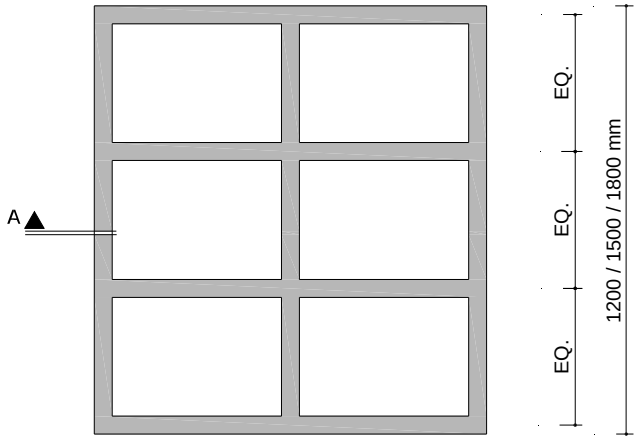
Fig.02

STEEL MOULD FOR PRECAST RIB

* ALL DIMENSIONS ARE IN mm.



SECTION AT A



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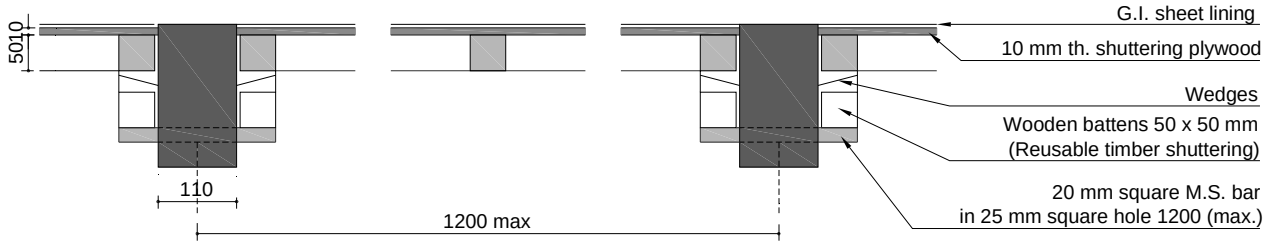


Shuttering in position

Fig.03

TIMBER SHUTTERING FOR THIN R.C. RIBBED SLAB

ALL DIMENSIONS ARE IN mm.

4.2 ***Casting and Curing***

4.2.1 *Precasting of Ribs*

4.2.1.1 The ribs shall be cast in steel moulds (Fig.2) over a casting plat form. The casting platform and inner sides of the mould shall be applied with mould oil and reinforcement cage kept in position with 25 mm cover. To provide holes in the ribs, 25 mm square MS hollow box sections shall be inserted through square holes in the longitudinal members of the mould. The concrete used shall be of grade M-20 with 20 mm and down graded coarse aggregate. The concrete shall be thoroughly compacted by needle vibrator and the top surface shall be finished rough.

4.2.1.2 When Ordinary Portland Cement is used, about 3 to 4 h. after casting, the rib shall be demoulded by sliding the longitudinal pieces of the mould away from the precast rib. The rib shall be kept covered with wet gunny bags for 72 h. Afterwards, they shall be slided horizontally on the casting platform to break the bond with platform and transported to the curing yard or curing tank by de-moulding them from the ends. After two weeks of water curing, the units shall be allowed to air dry for another two weeks, before using them in any construction. The pre cast ribs shall be placed in 115 mm wide recesses left in the wall at the specified spacing either manually or with mechanical means.

4.2.2 *Casting of Flange*

4.2.2.1 The width of the shuttering panel shall be kept as the clear distance between the ribs with the clearance of 5mm on both sides. The length of the panels shall preferably be kept in modules of 300mm i.e. 1200mm, 1500mm, 1800mm. A combination of these could be used to suit the span of the room. Even number of panels shall be used in each bay, so that they could be placed symmetrical with respect to midspan of the rib. The shuttering panels shall be kept supported on 20mm square MS bars projecting out of holes left in the precast ribs as shown in Fig. 3. As the ribs are designed to act as rectangular Tee beams to take load of the in-situ concrete, shuttering, workmen and equipments during concreting, no props are required in this type of construction. The shuttering panels shall then be kept in position and levelled with the help of wedges, with the top surface of the precast ribs in level with the top of the shuttering.

4.2.2.2 Reinforcement in the flanges shall be laid over the shuttering as shown in Fig. 1. The minimum cover of 15 mm to the main reinforcement shall be ensured by tying the reinforcement to the projecting stirrups of the precast ribs at supports and by keeping cement mortar cover blocks below the main reinforcement bars at mid span. For free movement of ribbed slab over sup porting walls/beams, the bearing area shall be plastered with 1:6 cement sand mortar finished smooth and applied with a thick coat of white wash. The top surface of the precast ribs shall be given a coating of cement slurry 4kg per 10m^2 just before concreting. Concrete of grade M-20 with 12mm and down graded coarse aggregate shall then be laid over the shuttering and ribs and compacted to a thickness of 50mm by a plate vibrator and the top surface finished with floats.

4.2.2.3 The concrete shall be water cured for two weeks by ponding water over the flange and then allowed to air cure.

5 Fitting and Fixtures

5.1 Provision for fan hooks shall preferably be provided in the precast ribs at the time of casting. In case the fan is to be located in the flange portion, the fan hook shall extend over the adjacent ribs and rest over them.

5.2 Positions of electrical junction boxes and other fittings shall be preplanned and provided in the pre cast ribs or cast-in-situ flange. If concealed wiring is to be done, conduits of diameter not exceeding 20mm may be provided above the precast ribs along its length. In the other direction, conduits shall be provided along recess cut in the wall.

6 Balcony or Chajja Projections

6.1 Short cantilevers, such as roof projection or chajja projections upto 500mm can be provided in the ribbed slab along or across the direction of the ribs by keeping the flange projected out. The cantilever has to be designed as per the normal practice.

6.2 For larger projections along the direction of the ribs, the ribs have to be designed suitably. They can be precast and kept projecting out and the cantilever portion of the ribs can be cast-in-situ along with the flange. For large cantilever projections across the direction of the ribs, cantilever beams have to be provided in the direction.

CT 04

Specifications for Precast Concrete Waffle Units for Floors & Roofs

1 General

1.1 The scheme consists of nominally reinforced precast open box type concrete units called waffle units laid in a grid pattern and cast in-situ concrete is laid in the joints between the units with the reinforcement provided in the joints. Minimum thickness of top screed is provided depending upon structural and functional requirements. The finished scheme has a pleasant grid pattern in the ceiling. The scheme is suitable for floors/roofs spanning in two directions.

2 Dimensions and Tolerances

2.1 The units are of the shape of inverted trough, square, rectangular, triangular, or any other shape. The ribs of the units may be given an out ward slope to enable the precast components to demoulded easily and also to enable them to act monolithically with cast-in-situ beams in joints between the units.

2.2 Typical details of cross-section of square waffle unit and cross-section of floor/roof using waffle units are shown in Fig. 1 and 2.

2.3 The lateral dimensions of the units shall be modular (IS 6820). The depth of the unit shall be as per structural design and will vary according to loads and spans. The minimum

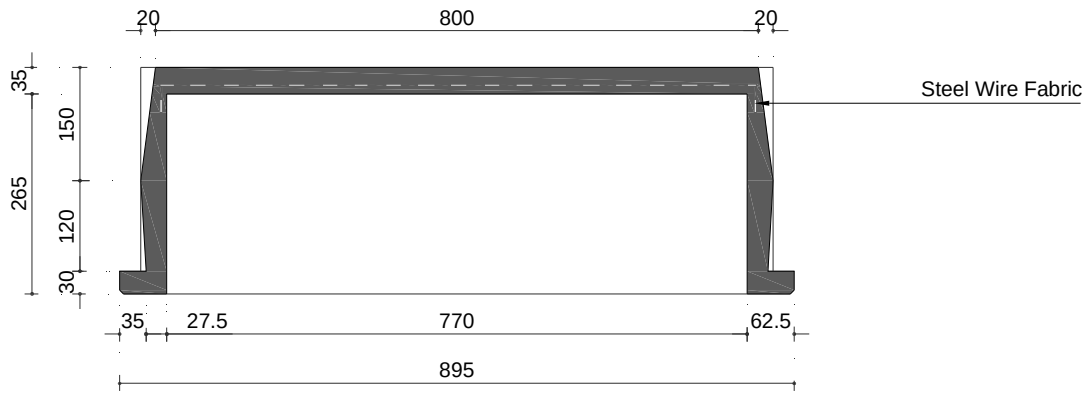


Fig.01

TYPICAL SQUARE WAFFLE SLAB UNIT

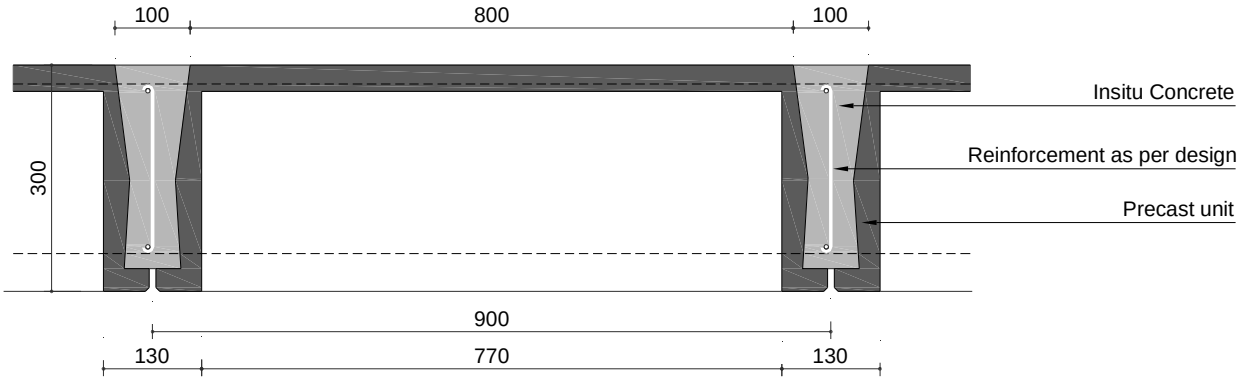


Fig.02

SECTION OF FLOOR USING WAFFLE UNITS

ALL DIMENSIONS ARE IN mm.

thick ness of the flange and web of the units shall be 25 mm.

2.4 Tolerance on precast waffle unit shall be as under:

(a) Length/breadth : ±5mm or ±0.1 percent, whichever is greater

(b) Thickness : ±2mm.

3 Structural Design

The grid floor slab design shall be analysed by any of the accepted methods of analysis.

3.1 ***Loads and Forces*** - Loads and forces shall be taken in accordance with IS 456. In addition, slab shall be checked for incidental concentrated load which is likely to occur during the construction.

3.2 ***Analysis of Floors/Roofs***

3.2.1 The floor/roof with waffle units upto a span of 6 meters having ribs of width not less than 100 mm (excluding thickness of precast waffle rib) spaced at not more than 750 mm may be analysed as solid slab spanning in two directions at right angles in accordance with Clause 23.4 of IS 456 or as a flat slab in accordane with clause 30 of IS 456.

3.2.2 The floor/roof with waffle unit having span of more than 6 m and rib spacing of more than 750 mm shall be designed as slab and grid beam system. The shear at the interface of precast and in-situ concrete shall be calculated and suitable shear keys/shear reinforcement shall be provided to avoid separation.

3.3 ***Reinforcement in Precast Unit*** Reinforcement shall be provided according to the structural requirements. Any mesh type of reinforcement/ welded mesh/ expanded metal/ chicken mesh with a maximum spacing of 100 mm both ways shall be provided.

4 Moulds

4.1 The mould used for manufacture of waffle unit shall consist of two parts (a) bottom mould and (b) side moulds. The bottom mould can be made out of timber, masonry, concrete, steel, FRP, plastic or any other suitable materials. The side moulds similarly can be of timber, steel, FRP or plastic. When using masonry or concrete moulds, the top surface shall be finished to the required accuracy and made smooth. In case of masonry moulds, the use of chicken mesh or fibre reinforcement in the top surface will help in making the mould last longer and higher efficiency. Admixtures for higher strength of concrete can also be used.

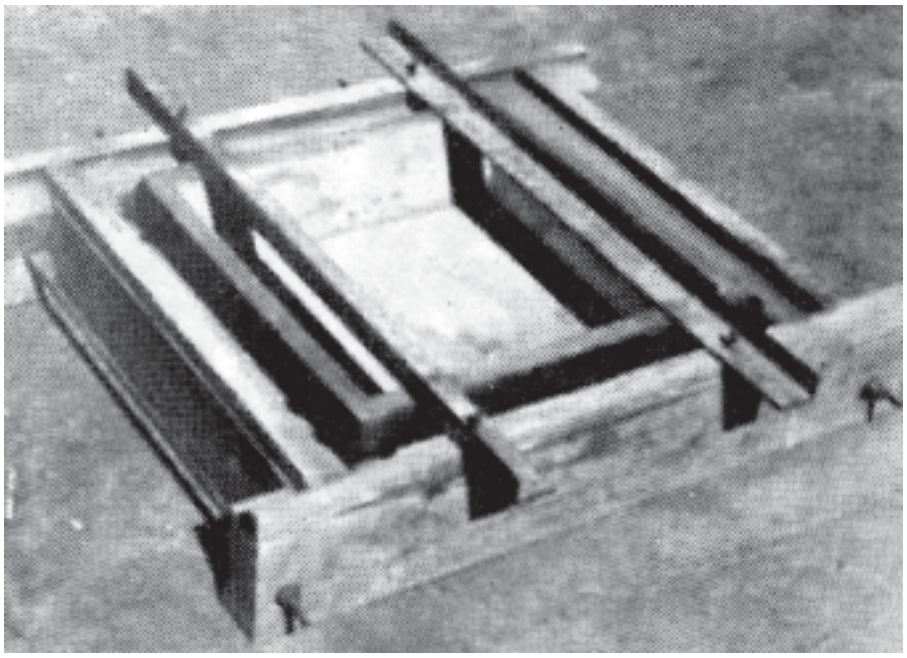
5 Concrete

5.1 ***Mix*** - The concrete mix shall be of minimum of M 20 as per IS 456.

6 Casting and Curing

6.1 Waffle units shall be cast on a smooth and level concrete platform. The outer mould shall be placed and oiled on inner side. Cement concrete M-20 grade as per IS 456 shall be laid and compacted to a minimum depth of 12mm. Reinforcement cage shall then be placed over the laid concrete. Concrete shall be laid to the full thickness and compacted either through mould/table vibrator or screet vibrator. The inner mould shall then be placed and concrete shall be filled in the webs and compacted by a needle vibrator or shutter vibrator. After 2h. of casting, the inner mould shall be demoulded. The outer mould shall be demoulded after 4h. depending upon the weather.

6.2 The cast unit shall be covered with wet gunny bags for 2 to 3 days. After wards, the unit shall be pushed to slide to break bond with the bottom. The cast units shall be transported by placing them on trolly to curing yard where these shall be placed in the same position as cast and filled with water for 10 to 14 days for curing. These shall be air cured for another 2 weeks before use in building.



7 Lifting, Stacking and Transportation

7.1 ***Lifting Hooks*** - Wherever lifting hooks/holes are used these shall be provided at structurally advantageous points to facilitate demoulding and erection of the precast unit. The lifting hooks can be formed out of normal mild steel reinforcing bars with adequate carrying capacity to carry the self weight during demoulding, handling and erection. After erection, the hooks can be either cut or bent down inside the screed or joint concrete that will be laid subsequently.

7.2 ***Stacking of Units*** - After removal from moulds the precast units shall be stacked over support placed at about 1/6 of span from ends. Care shall be exercised that no support is placed at the centre of span.

7.3 ***Transportation*** - For transporting and erecting the units, rope slings shall be tied near the ends at 1/5 of the length from either end of the unit. In case the units are transported in trolleys, the overhang of the units from the trolley shall not be more than 1/5 of length. The units shall be lifted manually or with the help of chain pulley blocks or mechanically with a hoist or a crane.

8 Method of Construction

8.1 The area to be covered with waffle units shall be provided with adequate shuttering.

8.2 The units shall be placed and aligned side by side across the span to be covered. Placing of units shall be started from one end of the building. The top of the bearing walls shall be plastered with a smooth coat of 1:6 cement, sand mortar finished with a thick coat of lime wash. The minimum bearing of the waffle units over the walls shall be 50mm.

8.3 Reinforcement shall be laid in both the directions in the spaces in between the waffle units.

8.4 Before concreting a cement slurry wash of 4kg per 10m^2 shall be carried out on all the faces of the joints.

8.5 M-20 grade cement concrete shall be laid in all the joists which forms the ribs and compacted by needle vibrator.

8.6 In-situ Concrete in Joints shall be cured for at least 7 days and then shall be allowed to dry for at least a week. A coat of cement slurry may be applied to the joints to fill the hairline cracks that might have developed.

9 Fitting and Fixtures

9.1 Provisions for fixtures like fan hooks/ inserts/electric conduits, etc. to be incorporated within the precast units or the in-situ joints/ screed concrete shall be indicated.

9.2 In case of concealed wiring, conduits may be placed within the joints along the length or within the screed before concreting. If adequate thickness is available this may be concealed within the floor/roof finish.

9.3 Holes, openings and fixtures required to be provided within the precast units shall be fixed accurately with adequate embedment at the precasting stage. Drilling of holes/ cutting of edges shall not be made.

10 Floor Finish

10.1 In case of floor slab, the floor finish shall be done in accordance with the relevant IS code.

10.2 To provide adequate resistance against impact/acoustic treatment the floor thickness at any place shall not be less than 75mm.

11 Roof Treatment

11.1 Adequate water proofing and thermal insulation to suit the local the local climatic conditions shall be adopted in accordance with relevant Indian Standard Code of Practice.

12 Sampling

12.1 The sampling procedure for precast concrete waffle unit shall be in accordance with IS 10505.

13 Tests and Criteria for Conformity

13.1 The test and criteria for conformity of precast waffle unit shall be in accordance with IS 10505.

CT 05

Specifications for Precast Reinforced Concrete L-Panels for Roofs

1 General

1.1 Precast RC L-panels are replacement of conventional roofing materials for gable or lean to roof. It consists of full span monolithic rib and flange to act as purlin and sheet. The panel is designed as L beam having wide flange for resisting flexural compressive stress. L panels are durable and reusable for temporary construction. (Fig. 1)

2 Dimensions and Tolerances

2.1 ***L-Panels***

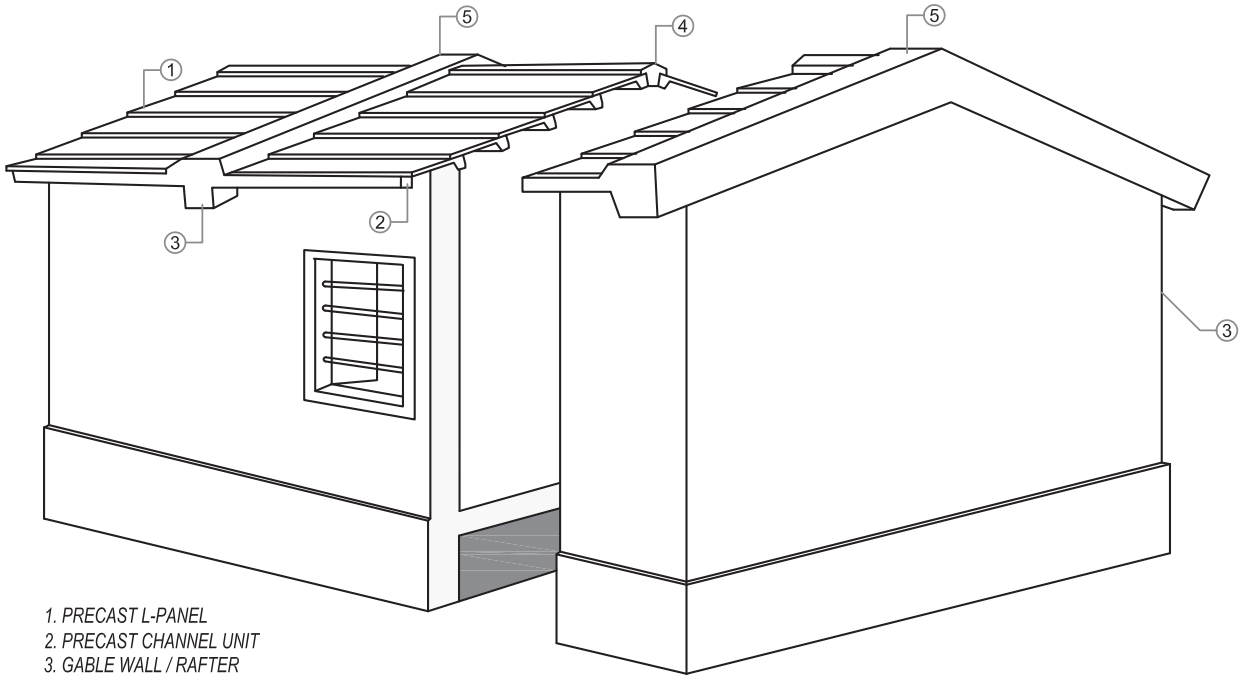
2.1.1 The precast L-panel units shall have a cross section of L-shape with end bearing of the same depth and width as the rib of L-section at the two ends of length. The end bearing length of rib parallel to the width of L-panel shall be kept lesser than overall width of L-panel to provide overlapping of 80-150 mm depending upon climatic conditions (Fig.2A).

2.1.2 ***Length*** - The length of L-panel depends upon the room size but the maximum span of L-panels shall be restricted to 4 m. Lower length may be preferred, whenever possible, for easy handling. A minimum bearing on the gable walls shall be kept 60 mm on either side of the L-panel.

2.1.3 ***Width*** - The width of L-panel also varies depending upon the span and is so chosen as to give maximum overall economy. The guidance may be taken from choosing the width from Table - 2. Also keeping in view the need for modular coordination, final value of width and the number of L-panels required to cover the room of given dimension may be calculated by using following approximate formula for a moderate size of room:

$B_r + 2p = N(B-b-2) + D/2 + 2b$ ….*for double sloping roof*

$B_r + 2p = N(B-b-2) + D/4 + b$ …. *for single slope roof over two vertical walls with outer projections on both sides.*



1. PRECAST L-PANEL
2. PRECAST CHANNEL UNIT
3. GABLE WALL / RAFTER
4. INSITU RIDGE
5. INSITU SIDE CONCRETE

Fig.01

SECTIONAL PERSPECTIVE OF L-PANEL ROOFING

ALL DIMENSIONS ARE IN mm.

$B_r + p = N(B-b-2) + D/4 + b$

…. for single slope roof adjoining a vertical wall (with outer projections on one side only).

Where:

B_r = Outer dimension of room perpendicular to span of L-panel in cm.

p = Outer roof projection (horizontally measured) in cm.

N = Number of L-panels required.

B = Width (overall) of L-panel in cm.

b = Overlap of L-panel.

D = Depth of L-panel in cm.

2.1.3.1 The maximum overall width of L-panels shall be as per Table-2 and minimum overlap between adjacent L-panel shall be as per Table-1. For design of panel based on upon utility and climatic factor, Table-1 may be referred.

2.1.4 A thickness of flange of 30-40 mm depending upon the size of units and climatic condition shall be adopted, keeping it 30 mm for overall width upto and including 700 mm and 40 mm for widths upto 900 mm.

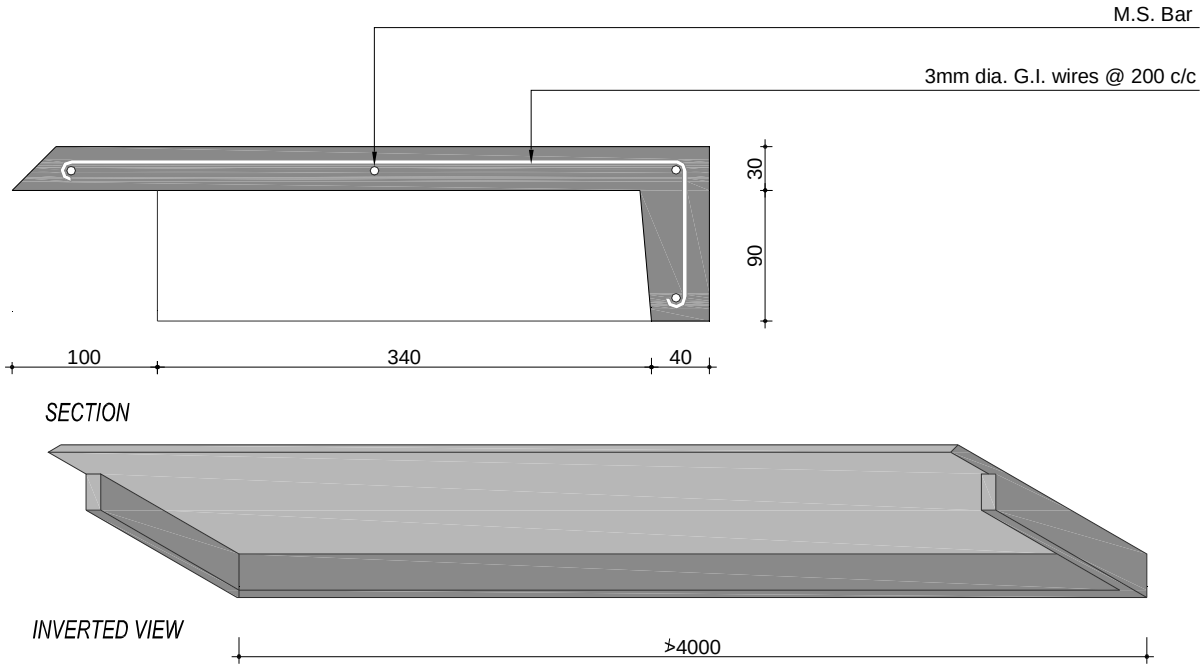
2.1.5 After deciding span, width, thickness of flange, the dimensions of rib shall be determined in accordance with the design procedure laid down in IS 14242. Alternatively, the depth and width of rib may also be taken directly from Table-2. In any case, the width of rib shall not be less than those given in Table-2.

2.1.6 Units having a cross section of channel shape shall also be produced in required numbers, to be used at eaves in a verandah or for achieving aesthetic effect. The dimensions of channel unit shall be as that of L-panels (Flg.2B).

2.1.7 Main reinforcement required shall consist of one bar or required diameter provided at the bottom of the rib of L-panel having an adequate cover. The required diameter may be taken from Table-2 which applies for reinforcement conforming to mild steel grade I of IS 432(Part I) and high strength deformed bar as per IS 1786. The detailing shall be followed in accordance with Fig.2.

2.1.7.1 Reinforcement for temperature and handling shall be provided in the flange as per Table-2.

2.1.7.2 At the eaves over verandah where channel unit are provided, the same



L PANEL

Fig.02A

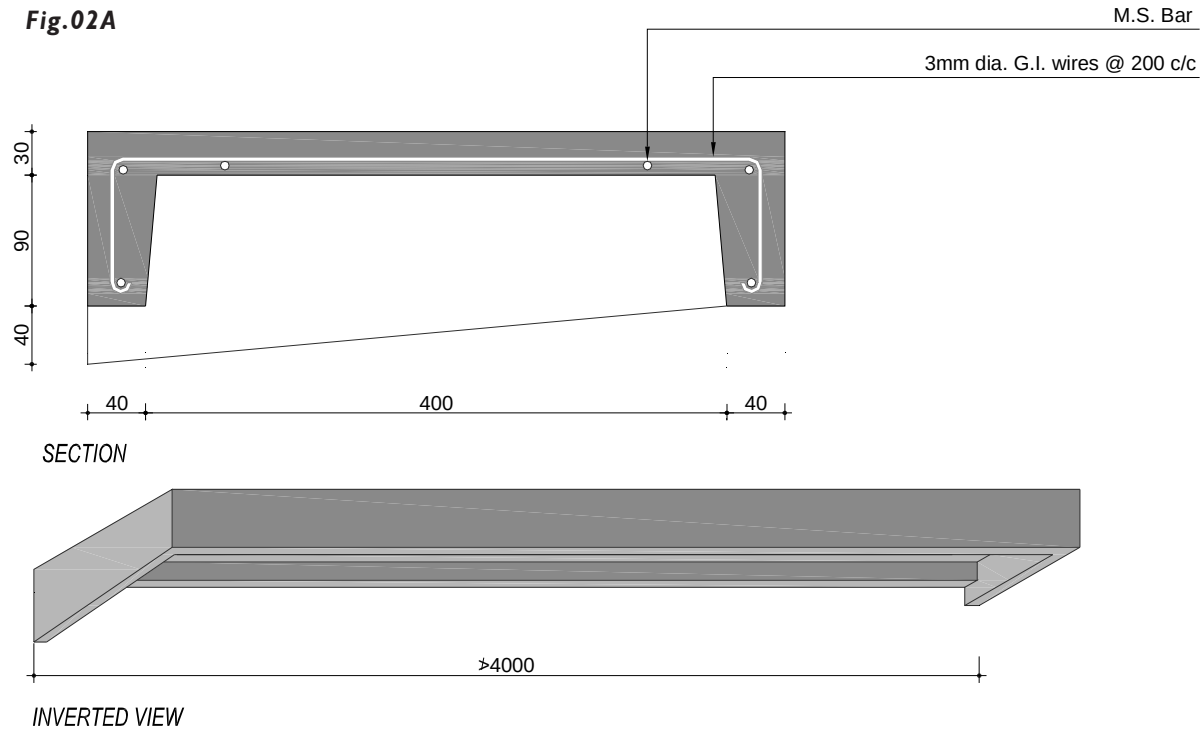


Fig.02B CHANNEL UNIT

DETAILS OF L-PANEL AND CHANNEL UNIT

* ALL DIMENSIONS ARE IN mm.

Table 1: Utility and Climatic Factors for Design

Sl. No.	Deciding Factor: Types of Building Utility	Deciding Factor: Climates	Mimimum Specifications: Slope of Gable Wall (tan 0)	Mimimum Specifications: Overlap Between Panels (cm)	Mimimum Specifications: Thickness of Flange (cm)	Mimimum Specifications: Grade of Concrete (M)	Mimimum Specifications: Admix-tures in Concrete	Mimimum Specifications: Other Treatments Recommended
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	School buildings, sheds, garage, etc.	Very low rainfall area	1:4	8	3	15	Nil	-
2	School buildings, sheds, ordinary storage, community buildings, office buildings, etc.	Low rainfall area	1:4	9	3	15	Nil	-
3	School buildings, residential buildings, ordinary shops, general stores, etc.	Medium rainfall area	1:3.5	10	3	15	Nil	-
4	Important residential buildings, important shops, important storages, record rooms, etc.	High rainfall area	1:3	12	3.5	20	D.P.C.	-
5	Very important shops, record rooms, dry storage, etc.	Very high rainfall area	1:2.5	15	4	25	D.P.C.	-
6	Any building	Cold and snowfall regions	1:2	10	3.5	20	Nil	-
7	Any building at coastal area	Aggressive climates	1:3	12	3.5	20	D.P.C.	Anticorrosive treatments to reinforcement
8	Chemical factories, industrial buildings dealing with reactive materials, etc.	Reactive environment	1:3.5	10	3.5	20	D.P.C.	Anticorrosive treatments to reinforcement and other suitable coatings and admixtures

Note: Any one of col (2) and (3) shall be the deciding factor for the design.

tensile reinforcement as for L-panel shall be provided in both the ribs, while the overall dimension shall be kept the same.

3 Structural Design

3.1 *L-Panels*

3.1.1 L-Panels shall be designed as simply supported L-beams in accordance with IS 456.

3.1.2 Total moment acting on the L panels shall be spilt into two components, one perpendicular to the flange of panels and the other parallel to the flange of panels. Bending movement parallel to the flange is usually very small and s[redacted]care of by steel provided in flange for temperature and handling stress. The L-panel shall be designed for bending movement perpendicular to flange.

3.1.3 Safety against shear force and bond stresses shall also be checked as per IS 456.

3.2 *Loads*

3.2.1 Following loads shall be considered in designing the L panels:

i) Self weight
ii) Live load as per IS 875 (part 2)
iii) Wind load as per IS 875(part 3)
iv) Handling stresses while lifting the unit simply supported and upside dov[redacted]

load, 1-25 times the self weight of the panels may be considered for calculation.

3.2.2 Load factors taken while designing or checking the stability under wind load and handling stresses shall be those recommended in IS 456.

3.3 No anchorage is found necessary for basic wind pressure of 150 kg/m^2 , if the dimensions given in Table-2 are adopted. For basic wind pressure higher than 150 kg/m^2, anchorage shall be designed. However, for dimensions other than those indicated above, anchorage requirement shall always be checked.

3.4 For prevailing wind speed in India,

Table 2 : Schedule of Design of L-Panels and Channel Units

Sl. No.	Length	Reasonable Breadth Ranges	Depth of Rib	Width of Rib	Thick-ness of Flange	Dead Weight	Dia of Tension Bar		Diameter of Bars in Flange			
	L	*B*	*D*	*r*	*T*	*Wd*	R_1	R_2	R_3	R_4	R_5	R_6
					(All dimensions in millimeters)							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1200	500	80	40	30	52	6	6	6	-	6	-
2	1200	600	80	40	30	62	6	6	6	-	6	-
3	1200	700	100	50	40	96	6	6	6	6	6	6
4	1200	800	100	50	40	110	6	6	6	6	6	6
5	1200	900	100	50	40	123	6	6	6	6	6	6
6	1500	500	80	40	30	65	6	6	6	6	6	-
7	1500	600	80	40	30	77	8	6	6	6	6	-
8	1500	700	100	50	40	120	8	6	6	6	6	6
9	1500	800	100	50	40	135	8	6	6	6	6	6
10	1800	500	100	40	30	82	8	6	6	-	6	-
11	1800	600	100	40	30	96	8	6	6	6	6	6
12	1800	700	100	50	40	142	8	6	6	6	6	6
13	2100	500	100	50	30	100	8	6	6	-	6	-
14	2100	550	100	50	30	108	8	6	6	6	6	-
15	2100	600	100	55	35	132	8	6	6	6	6	6
16	2100	650	100	55	35	143	8	6	6	6	6	6
17	2400	500	100	50	30	113	8	6	6	6	6	-
18	2400	550	100	50	30	122	8	6	6	6	8	6
19	2400	600	120	55	35	154	10	6	6	6	8	6
20	2700	450	100	50	30	115	8	8	6	-	6	-
21	2700	500	100	50	30	126	10	6	6	6	6	-
22	2700	550	120	55	30	150	10	8	6	6	8	6
23	3000	450	120	60	30	144	10	8	6	-	6	-
24	3000	500	120	60	30	156	10	8	6	6	8	-
25	3000	550	120	60	30	158	10	8	6	6	8	6
26	3150	500	120	60	30	163	10	8	6	6	8	6
27	3300	400	120	60	30	145	10	8	6	-	8	-
28	3300	450	130	60	30	164	10	8	6	-	8	-
29	3600	350	130	60	30	150	10	8	6	-	8	-
30	3600	400	140	65	30	174	10	10	6	-	8	-
31	3900	300	140	65	30	157	10	10	6	-	8	-
32	3900	350	150	70	30	184	10	10	6	-	8	-

Note: Mild steel should be used up to 6 mm dia and high strength deformed bars shouldbe for 8 mm dia and above.

no exra reinforcement in L-panels shall be needed to resist wind forces.

4 Supporting Beam or Truss

4.1 When the rooms of large lengths are required to be covered by more than one span of L-panels, L-panels shall be supported on either a truss or a simply supported rectangular reinforced concrete, steel or composite beam. Any of these supporting members shall be designed to take all the loads acting on the roof in addition to its self weight.

5 Manufacturing of L-Panels & Channels

5.1 ***Moulds***

5.1.1 The mould shall generally be made of well seasoned good quality timber or an equivalent wood substitute. For mass production, a steel, FRP or plastic mould may be used. The mould consists of mainly two parts - an outer frame and an inner piece. Typical details of a mould are shown in Fig.3. While designing a plastic or FRP mould warping of members should be taken care of. Appropriate clamps should be used during casting of panels.

5.1.2 The L-panels & channels may also be cast on vibrating machine.

5.2 ***Materials***

5.2.1 ***Concrete*** - Concrete used for making L-Panels, shall conform to grade M-20,or for higher rainfall area or corrosive atmosphere as per IS 456. Raw materials used for making concrete shall conform to the requirements of IS 456. Impermeability of concrete shall be ensured, in addition to the strength. While designing the mix or otherwise choosing the properties, recommendations of Table-1 should be considered.

5.2.2 ***Steel*** - Mild steel conforming to grade 1 of IS 432(Part 1), high

strength deformed bar conforming to IS 1786 or other steels recommended in IS 456 shall be used.

5.3 ***Casting and Curing***

5.3.1 *Casting* - Outer piece of the mould, after lubrication of inner faces shall be assembled over a smooth sheet of paper or alkathene sheet spread over a smooth and level platform. A thin layer of cement-sand (1:1) slurry with suitable water proofing compound (see IS 2645) mixed in it shall be spread over the sheet to a thickness of 3 to 5 mm. Well mixed concrete shall then be filled in the mould over the slurry to half the flange thickness. Reinforcement cage shall then be placed over it and the inner piece of the mould shall also be placed in position. Remaining mould shall be filled with concrete and well compacted. The top surface of concrete shall be finished with very thin (2-3 mm) cement, fine sand (1:3) plaster. Inner frame of the mould may be removed after about 20 min. and the outer frame after 30 min. depending on the weather.

5.3.2 *Curing* - The panels may be moved to curing yards after 48 to 60 h. of casting depending upon the weather conditions (temperature and humidity). The panels shall be kept vertical at all stages of handling and transportation. Old papers sticking to the back of panels shall be removed just at the time of lifting them from the platform, otherwise it becomes difficult to remove once it is dried and hardened. The panels shall be cured by sprinkling water for atleast 2 weeks and air cured for further two week before using in construction.

6 Transportation

6.1 The panels keeping the flange in vertical position may be transported by trolley, cart or truck. For loading in layers, intermediate flat cross timber pieces shall be used between two layers.

7 Method of Erection

7.1 The bearing surfaces of gable walls and the L panels shall be properly cleaned to remove dust and loose materials. The panels shall then be placed over the gable walls with suitable overlap and side bearing. The joints shall then be filled with in-situ concrete of the same grade as used for L panels along with required reinforcement (see Fig.4).

7.2 The ridge shall be finished with in-situ M-20 grade concrete with reinforcement as shown in fig 5.

7.3 The intermediate gable wall or rafter shall be finished in the same manner as in 7.2.

7.4 The gaps over the gable walls shall be filled with cement mortar 1:3 and the side and the top finished smooth with plaster.

7.5 In-situ concrete shall be cured by sprinkling water for atleast one week. Roof surfaces shall now be painted with cement slurry mixed with water proofing compounds (see IS 2645).

8 Sampling and Acceptance Criteria

8.1 All the precast reinforced concrete units of the same size, manufactured from similar materials and under similar conditions of production shall be grouped together to constitute a lot.

8.2 Five L-panels and five channel units shall be selected at random out of the lots consisting of 300 units or less of each category. For lots bigger than 300 units, 5 units shall be selected for every 200 units or part thereof. In order to ensure randomness of selection, procedure given in IS 4905 may be followed.

8.3 The sample shall be marked for future identification of the lot it represents.

9 Tests

9.1 Tests shall be conducted on samples of the units as given in IS 14241.

9.2 Dimension test and deflection recovery during test shall be routine test whereas failure load test shall be a type test. Type test is intended to prove the suitability and performance of a new design and size of the component. Failure load test be applied at the time of any change in the design.

10 Criteria for Conformity

10.1 If four out of the five samples of each category satisfy the dimensional requirements, the lot represented by the sample shall be deemed to have passed the dimensional requirements. If more than one unit fail to satisfy the dimensional requirements, the lot represented by the sample shall be rejected.

10.2 In the deflection recovery test of the assembly of components, as per IS 14241, if the deflection of all the units 24 h after the removal of the imposed load is atleast 75 percent of the deflection under the load for 24 h, the units shall be deemed to have passed the test. If the deflection recovery is less than 75 percent, the lot represented by the unit shall be rejected.

If the maximum deflection in mm,

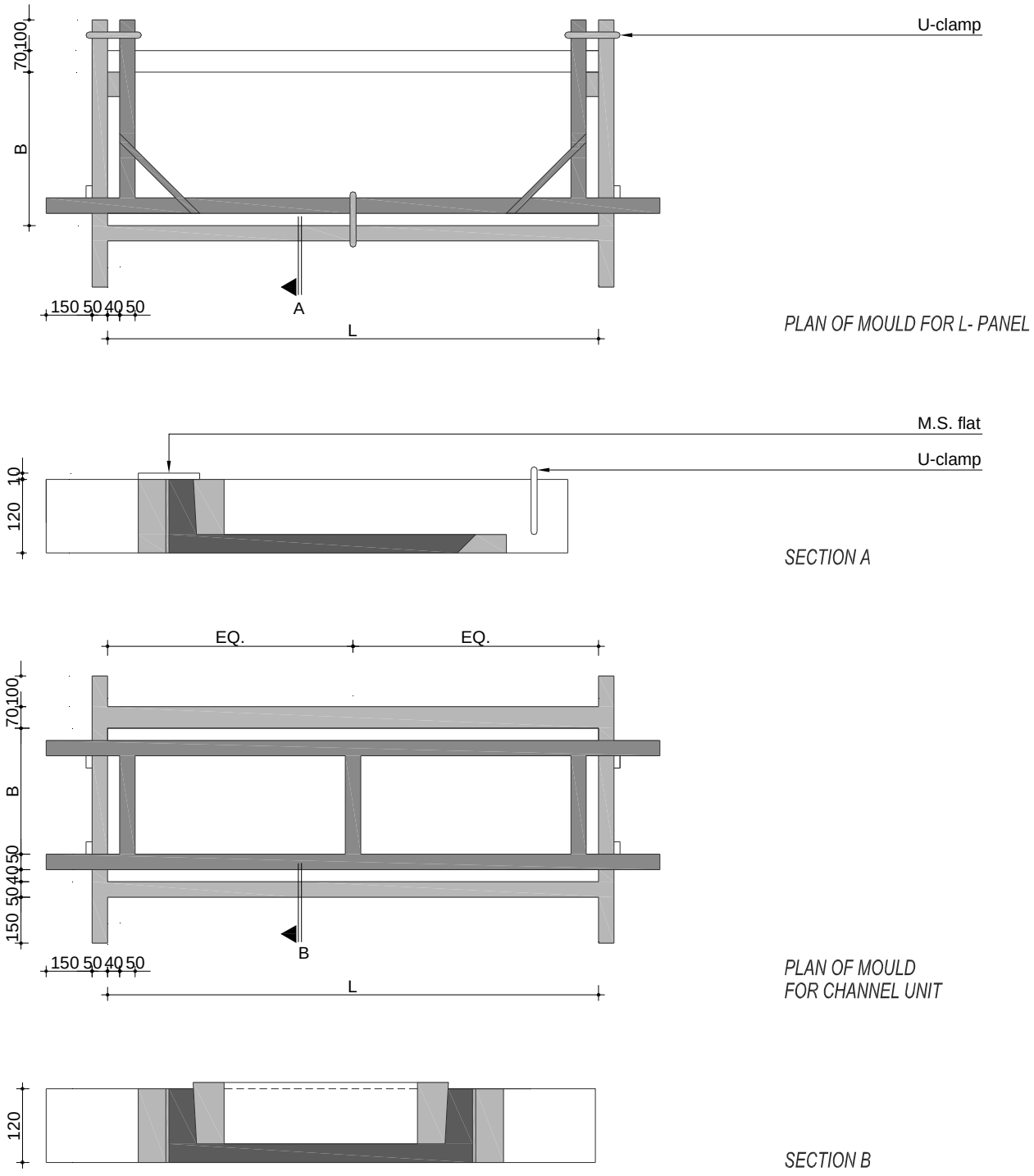


Fig.03

DETAILS OF MOULDS FOR L-PANEL AND CHANNEL UNIT

ALL DIMENSIONS ARE IN mm.

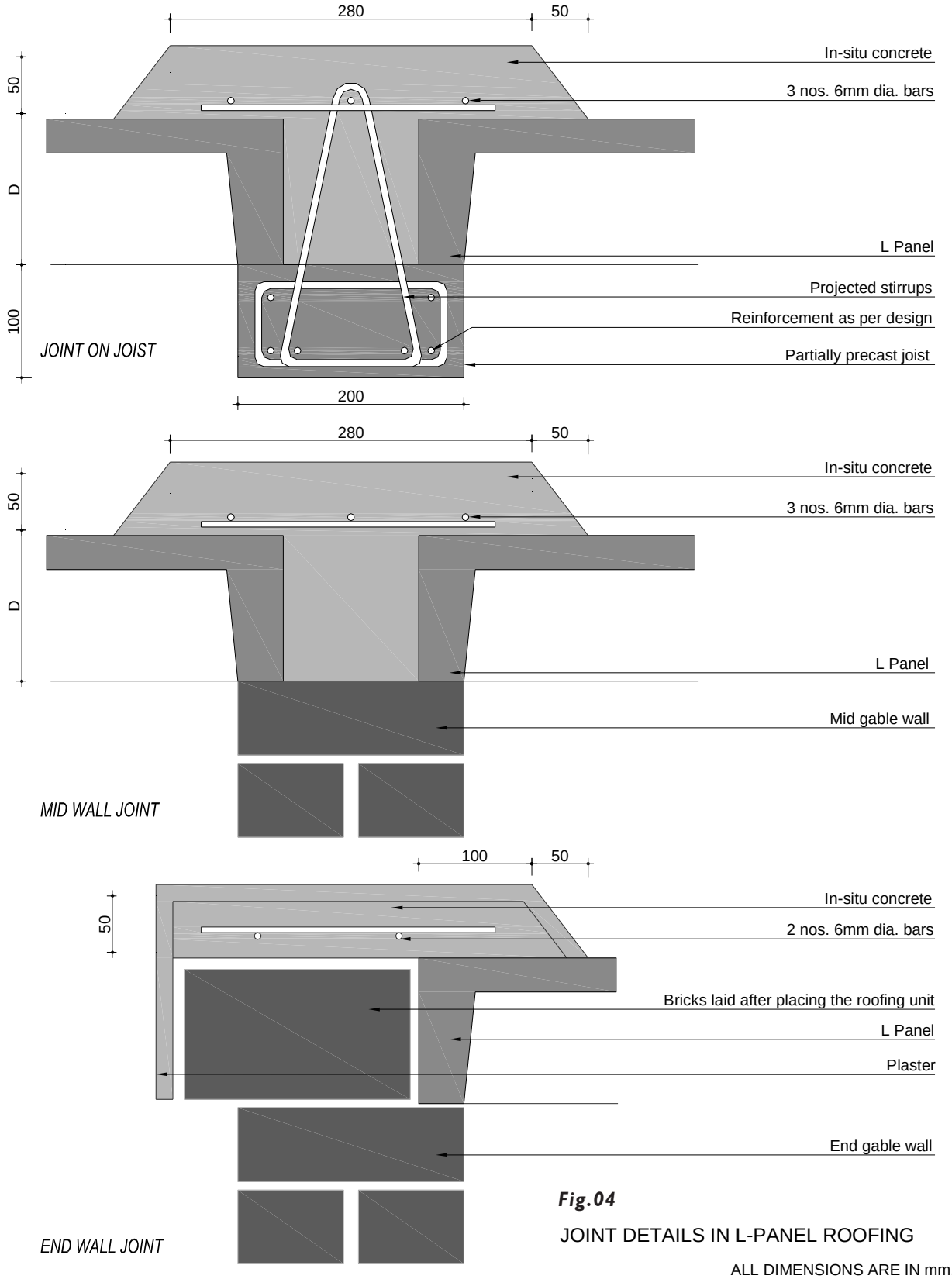


Fig.04

JOINT DETAILS IN L-PANEL ROOFING

ALL DIMENSIONS ARE IN mm.

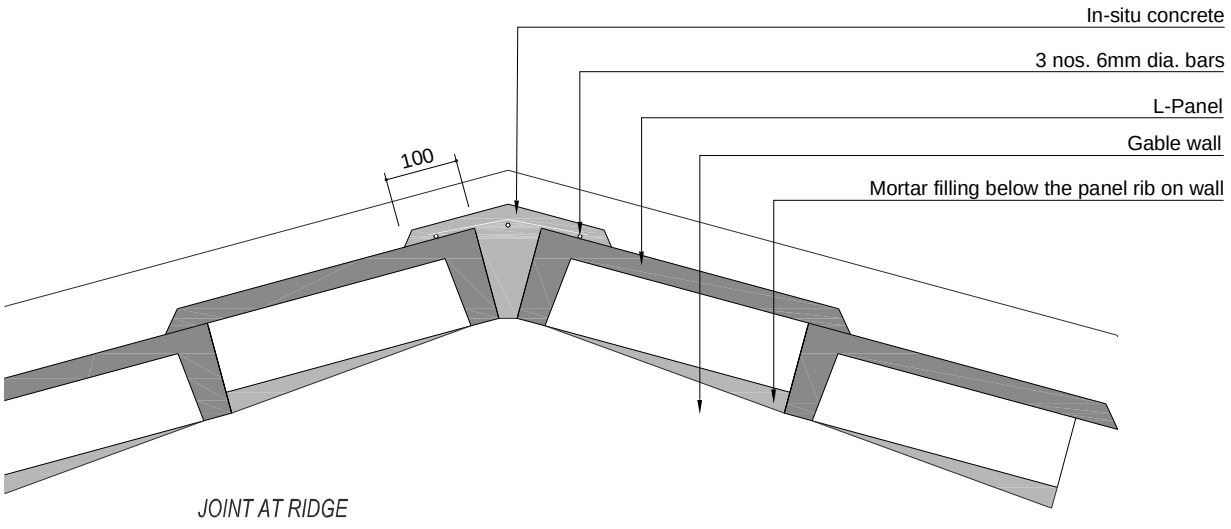


Fig.05

JOINT DETAILS IN L-PANEL ROOFING

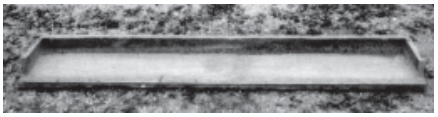
ALL DIMENSIONS ARE IN mm.

shown during 24 h under is less than 40 l^2/D, where l is the effective span in meter and D the overall depth of the section in mm, it is not necessary for the deflection recovery to be measured and the recovery provision mentioned in this clause earlier shall not apply.

10.3 In the failure load test as per IS 14241, every unit in assembly shall carry a load atleast equal to twice the characteristic load to pass the test. If the load at failure is less than twice the characteristic load, the lot represented by the sample shall be rejected.

11 Marking

11.1 Each component shall be legibly and indelibly marked with the indication of the source of manufacture and month and year of manufacture.



CT 06

Specifications for Precast Doubly-Curved Shell Units for Floors/ Roofs

1 General

1.1 Precast doubly-curved or funicular shells in conjunction with precast joists or battens or planks or by providing in-situ ribs in two directions are suitable for floors/roofs in buildings, workshop floors and loading platforms carrying heavy uniform loads.

2 Dimensions and Tolerances

2.1 ***Doubly curved shell***

2.1.1 The cross section of the unit shall be simple shell with double curvature, mid rise of 20mm having square shape, sides dimension of minimum 700mm, maximum 1200 mm and thickness of 25 mm. The shell shall be square, rectangular or triangular in plan to suit the dimensions of the floor or roof. Fig. 1

2.1.2 The unit shall be stiffened all around by an edge beam or flange as per design. The flange, shall be 20 mm wide and 25mm thick. In case of rib/beam, 40mm width and minimum depth shall be 70mm with 6mm dia MS bars as reinforcement. Fig.4

2.2 ***Partially Precast Joist/Beam/Plank***

2.2.1 The length of beam shall be maximum 3600mm. The cross section of precast portion shall be 130mm breadth and 90mm depth. The stirrups shall be kept projected 40mm height from the top of the joist or beam or plank.

2.3 ***Tolerances***

2.3.1 The tolerance on unit shall be length and thickness ±2mm.

2.3.2 For individual partially precast unit the tolerance on length shall be ±8mm and that on width and height ±2mm.

3 Structural Design

3.1 Precast shell units supported on prefabricated joists or battens made in reinforced concrete or prestressed concrete. When concrete beams or battens are used, they shall be designed either to carry the entire load without props or as proposed tensioned flanges with in-situ concrete poured between the haunches to form compression flange later. In this type of construction, the supporting elements and the shell units shall be at different levels in the two directions. The partially precast elements shall be designed for the following loading:

a. Live load - 147 kg/m^2

b. Water proofing - 147 to 225 kg/m^2

c. Weight of shell units and in-situ concrete in haunches and

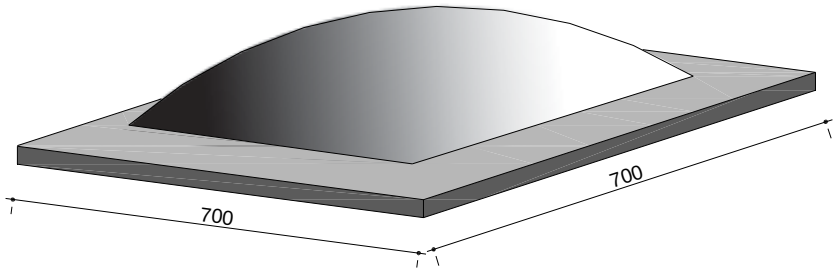


Fig.01

VIEW OF THE SHELL

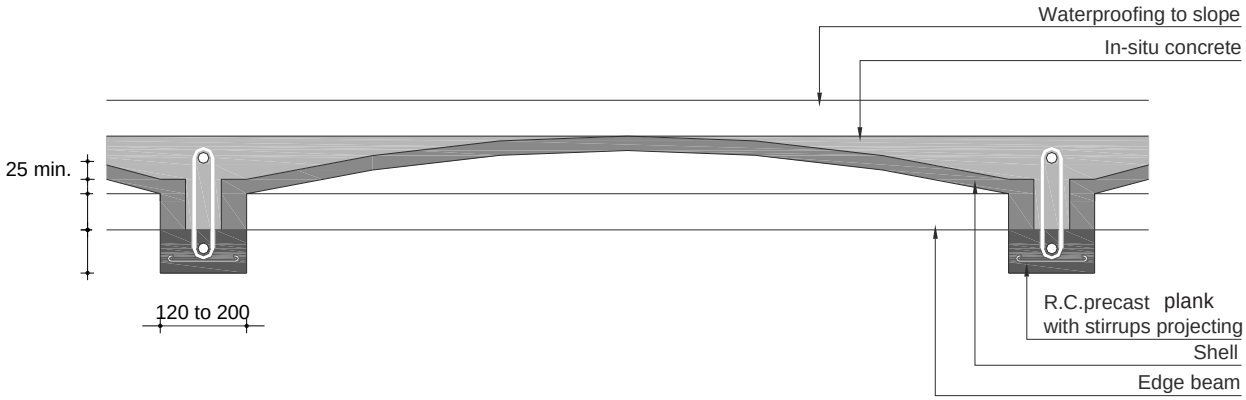


Fig.02

TYPICAL DETAILS OF PRECAST SHELL UNITS AND PRECAST JOISTS/BATTENS

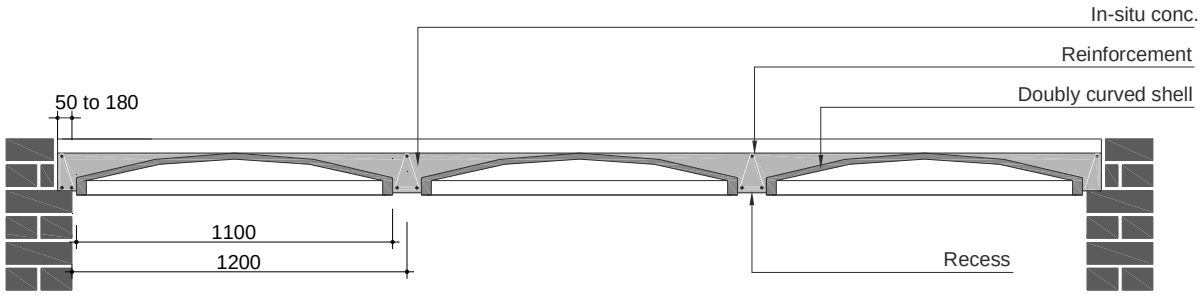


Fig.03

AN INTERGRID SHELL

* ALL DIMENSIONS ARE IN mm.

elements - 225 kg/m^2.

A typical detail of the scheme is shown in Fig.2.

3.2 Precast shell units kept supported on staging to form waffles in two directions. The haunches with reinforcement placed between the shell units shall be concreted up with structural concrete and made to a level of 20 to 50 mm (depending upon span) above the crown of the shell. The scheme finished in this pattern will have ribs in both directions in the room or column grid at same level. Recess in the rib may be given for the purposes of architectural treatment. A typical detail of the scheme is shown in Fig.3.

4 Casting and Curing

4.1 Precasting of the doubly-curved shell units shall be carried out by any one of the following methods:

4.1.1 *Sagging fabric mould*

a) Frame for casting the shell unit shall be fabricated of well seasoned timber which will have headless nails projecting out on all four outer sides to hold hessian cloth or canvas as given in Fig.4.

b) A level platform of the size of shell unit in masonry shall be built on level ground.

c) The frame with hessian, canvas or cloth stretched and tucked to it shall be placed over the masonry platform so that the inside surface of the frame snugly fits into the outside of the plat form. The fabric is thus fully supported from sagging. A frame equal to the shell thickness shall be set up on the plat form. Concrete of the specific mix grade M-20 shall be poured inside the frame and compacted. The mould shall next be lifted off the platform and sup ported at 4 corners. The hessian sags and the shell gets itself cast (see Note). Ensure that shell is finished smooth as for ceiling finish.

d) The mould for the edge beam shall be next set up. The reinforcement cage shall be placed in position and the edge beam concreted all round.

e) The edge beams shall be demoulded 3 h. after casting.

f) The shell unit with frame shall be carried to curing yard after 24 h. of casting and inverted on level ground having sand filled and cured in the normal way.

g) The shell units shall be cured by sprinkling water for 14 days and air cured for another 14 days before use in buildings.

NOTE -The extent of sag and tension in the fabric may be regulated within the prescribed limits by two to three trial castings.

4.1.2 *Masonry Mould*

a) For any desired plan shape and rise of the shell ordinates on various points shall be calculated using formula as per IS 6332.

The ordinates thus obtained shall be set off from a level platform and the surface concreted and finished smooth.

b) The finished surface shall be coated with oil, grease or any other releasing agents.

c) Outer mould of timber or steel or FRP for the edge beams shall be set up.

d) The designed reinforcement for the edge beam shall be placed between the outer edge beam mould and the built up masonry platform.

e) Concrete of the specified mix M20 shall be laid in the edge beam and over the shell mould. The thickness over the shell mould equal to the designed thickness of the shell shall be con trolled by thickness gauge. The shell is thus cast in the erect position. Ensure that finished concrete is rough enough to bond with screed concrete.

f) The edge beam mould shall be released 3 h. after casting.

g) The shell unit shall be lifted off the mould using levers at the four corners 24 to 48 h. after casting depending on weather conditions. Longer time up to 72 h. may be necessary in cold climate (below 25°C) as also when pozzolana cement is used. In using levers ensure that the levers are operated only on one side at a time and never at the end at diagonals.

h) The shell unit shall be kept stacked on level ground with sand filing and cured by sprinkling water for 14 days and air cured for another 14 days before using them in buildings. The stacking of the shells may be done one above the other supported at four corners only, in piles of 8 to 10 shells.

I) Shell units up to 1500 mm in size may be handled manually. Shells heavier than this shall need lifting hooks for hoisting equipment.

4.1.3 *Mechanised Process*

a) The mechanised process shall normally be adopted when the size of the shell exceeds 1500 mm and where reinforcement is provided in the body of the shell.

b) Surface of the shell shall be calculated using the equations given in IS 6332.

c) The ordinates thus obtained shall be laid out to form a steel, timber, or plastic mould. The mould for the shell unit and the inner surface of

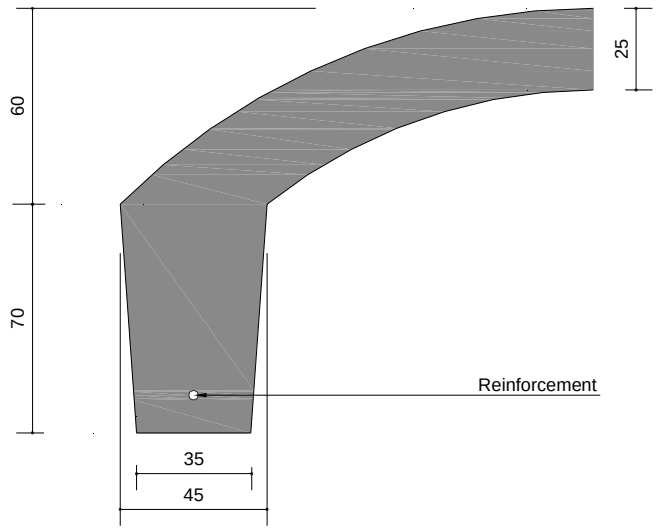


Fig.04
DETAIL OF EDGE BEAM IN CORROSIVE ATMOSPHERE

ALL DIMENSIONS ARE IN mm

the edge beam shall be fabricated as a monolithic block.

d) A level platform 600mm to 1000 mm above the ground level shall be made in RCC with openings equal to the size of internal dimensions of the shell unit. Four to five openings may be provided in platform.

e) The fabricated mould shall be mounted on a trolley with jacking arrangements for lifting and lowering the mould to the level of the casting platform.

f) The trolley shall be positioned below the opening and the mould raised to the appropriate levels. The outer edge beam mould shall then be positioned over the casting platform. The designed reinforcement in the edge beam and in the shells, if any, shall then be placed.

g) Concrete of the specified mix M-20 grade shall be laid in the edge beam and over the shell mould. The thickness over the shell mould shall be controlled by thickness gauges. The shell is thus cast in the erect position.

h) Outer edge beam mould may be released 3h. after casting. Twenty-four to forty-eight hours after casting the shell depending upon weather, the mould shall be lowered and the cast shell left on the platform for a further period of 24 to 48 h.

i) The mould shall then be moved to the next opening in the casting platform and set for the casting of the next shell. The shells thus cast may be lifted off the casting platform after 48 to 96 h.

j) Lifting hooks shall be provided at corners of the shell within the edge beam thickness.

k) The shell units shall then be kept stacked and cured by sprinkling water for 14 days and air cured for another 14 days before use.

4.2 ***Joists/Beams/Planks***

a) Place two wooden planks 130 mm apart and equal to the overall length, on a level and firm base.

b) Place reinforcement bars according to the design requirement and cast the elements up to required depth.

c) Keep stirrups projecting out of the element.

d) Cure these elements by sprinkling water for 10 days, and

e) Then keep them in shaded place for about 15 days before use.

5 Method of Construction

5.1 The construction of the floor or roof using the doubly-curved shell units shall be carried out as given below:

5.1.1 *Precast Battens and Precast Shell Units*

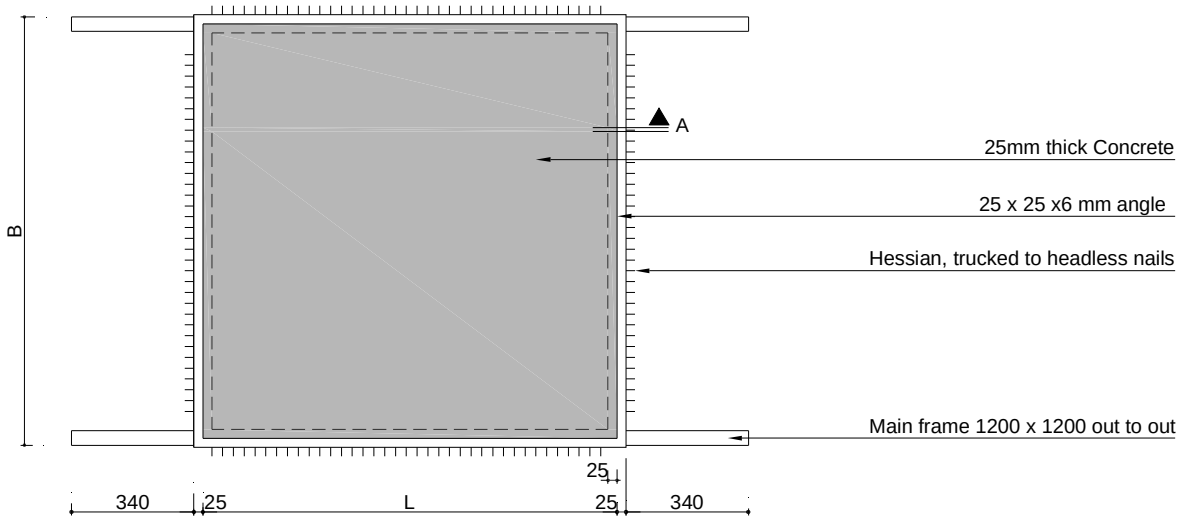
a) The supporting elements either on load bearing walls or beams shall be finished smooth to the bearing level of the precast elements, and coated with a thick coat of whitewash, or bituminous paper placed.

b) The precast, RCC or prestress planks or battens or beams or joists shall be placed at the appropriate levels with proper mortar pad bearing over the walls or beams.

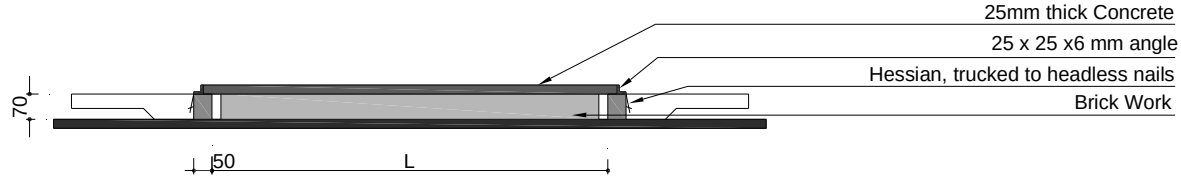
c) The battens or precast joists shall be proped at points mentioned in the design.

d) The shell units shall then be placed on spanning of the battens or joists or beams with proper mortar pad bearing.

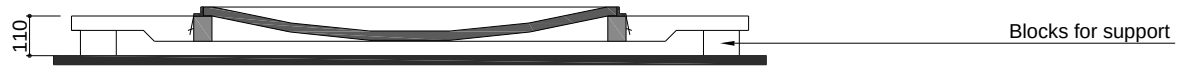
e) The shells thus positioned leave space between edge beam equal to web thicknesses to be concreted along the length of battens or beams. In the other direction, between two shell units, only dry mortar packing



PLAN of shell and Main frame

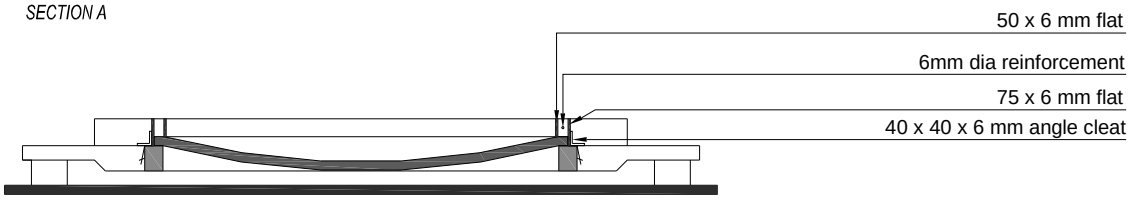


Casting of shell on Hessian cloth supported on brick base



Form of shell is generated by gravity when the formwork is removed from brick base and supported on pegs

SECTION A



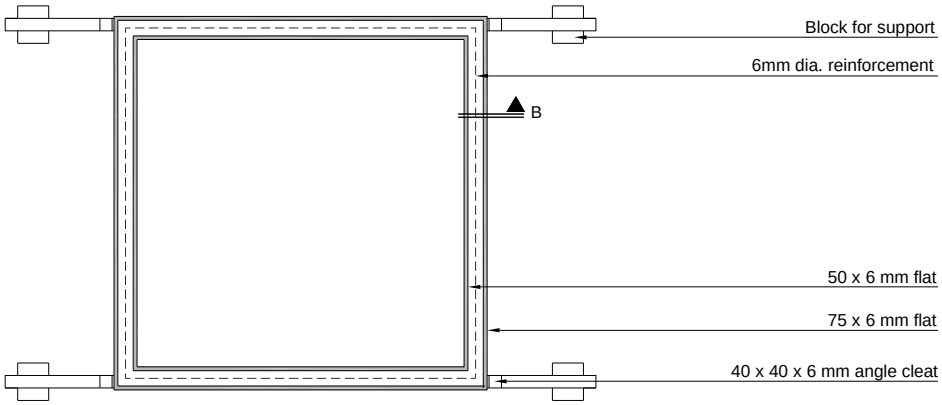
Casting of the edge beams by placing another mould on the formed shell

SECTION B

Fig.04

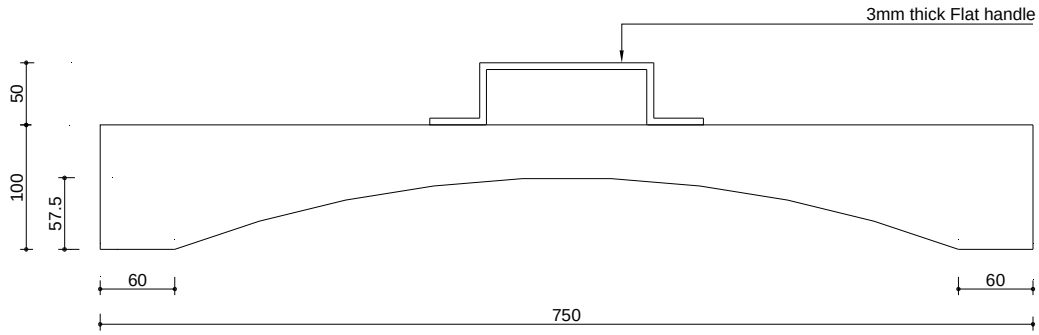
EXAMPLE OF A FRAME FOR CASTING A SHELL UNIT

ALL DIMENSIONS ARE IN mm.



PLAN of edge beam mould superimposed on the shell and frame

Fig.04
A FRAME FOR CASTING A SHELL UNIT



Template to ensure thickness and shape of shell when precast doubly curved tile is used as mould

Fig.05
TEMPLATE FOR SHELL UNIT

ALL DIMENSIONS ARE IN mm.

of cement sand mortar (1:4) shall be provided.

f) The necessary reinforcement in the compression flange of the joist and for continuity over supports shall then be placed.

g) The in-situ cement concrete of designed grade for compression flange of the battens or beams shall then be poured to the designed level and width. The haunches and uneven surface now left shall be filled with dry filling to the level of the crown of the shell. This dry filling may be replaced by lean concrete.

h) On attaining strength by the in-situ compression flange, props shall be removed.

i) The floor or roof shall then be ready to receive finishes and water-proofing as the case may be.

5.1.2 *Precast Shell Units in Intergrid Pattern*

a) Erect staging and place shuttering planks for the bottom of the ribs at the spacing of edge ribs of shells.

b) The staging and the shuttering planks shall be levelled to the designed level.

c) If recess is provided in the ribs, strips of planks or plywood shall be nailed along the ribs in two directions over the shuttering planks for the ribs.

d) The precast shell units shall then be positioned in the grid pattern. The reinforcement designed for the ribs shall be tied and placed with 25 mm cover. The distribution reinforcement and torsion bars shall also be laid over the shells and tied up to the rib reinforcement. The necessary triangular stirrups in webs shall also be tied up.

e) Concrete of the specified mix M-20 shall then be poured in the ribs and over the shells to the designed level.

Compaction of the concrete shall be done with vibrators.

f) The surface of the shell units at the top shall be made as rough as possible, while precasting them, to ensure perfect bonding between the in-situ con crete and the shell units.

g) After the normal curing of 10 to 14 days, staging and shuttering planks shall be removed.

h) The floor or roof shall now be ready to receive the finishes and waterproofing as the case may be.

5.2 ***Openings***: The necessary provision of openings shall be pre planned in advance for the shell units while precasting. Such openings shall be proper stiffened by adding reinforcement around the opening of shell. It shall not be desirable to puncture openings in the precast shell units.

5.3 ***Water proofing*** : Waterproofing treatments shall also be provided for the roofs built with doubly-curved shell units.

5.4 ***Floor Finishes***: In finishing the ceiling of the floor or roof using doubly-curved shells, the joints between precast units shall be neatly finished with 1:6 cement-sand mortar. Small air holes on the surface of the shell units shall be finished by taking lime or cement paste on a piece of gunny bag and wiping the same before painting. No raking of surface shall be done to receive plaster on the inside of the shell or its edge beam.

CT 07

Specifications for Precast Reinforced Prestressed Concrete Ribbed or Cored Slab Units for Floors / Roofs

1 General

1.1 Precast ribbed slab units have a thin flange stiffened by longitudinal and/or transverse ribs. Cored slab units are panels in which voids are created in manufacturing process to reduce the cross-section without appreciably decreasing the stiffness or strength. These ribbed or cored slabs are lighter than the normal cast in-situ solid slabs or slab and beam. These units can be used for floors, roofs as well as for wall panels, in residential, public and industrial buildings. These units can be advantageously used for spans up to 9 meters in case of reinforced concrete units and up to 30 metres in case of prestressed concrete units with mechanical handling equipment.

2 Dimensions and Tolerances

2.1 ***Design Dimensions***

2.1.1 The width of the ribbed units shall be a maximum of 3000 mm with cross ribs and 2100 mm without cross ribs.

2.1.2 The nominal width of the unit may vary from 300, 600, 900 or 1200 mm.

2.1.3 The preferred nominal width may be 1500 mm for channel units and 2100 mm for double Tee units.

2.1.4 The cored slab units the breadth shall be a minimum 1200mm and maximum 2100 mm.

2.2 The overall depth of the longitudinal ribs shall not be less than 1/25 of span for reinforced concrete units and 1/30 of span in the case of prestressed concrete units.

2.3 The minimum breadth of the rib shall not be less than 50 mm for spans up to 5.0 m and 70 mm in the case of larger spans. The cross section of the rib shall have internal slopes in the range of 1/15 to 1/8 of depth of the rib.

2.4 The minimum thickness of flange shall be 35 mm with concrete mix M-20 grade using the maximum size of coarse aggregate as 12mm and compacted by mechanical vibrator. The reinforcement in the flange shall be provided in the form of a mesh with spacing of bars/wires not exceeding those stipulated for slabs in IS 456 subject to the condition that the maximum unreinforced concrete area does not exceed 15 t^2 where t is the thickness of the flange. In the thin units (of 35 mm thickness of flange) the spacing may be a maximum of 150 mm both ways.

2.5 ***Tolerances***

2.5.1 Tolerances of units shall be as follows.

a) Length: ± 5 mm or ±0.1 per cent, whichever is greater.

b) Cross-Sectional Dimensions : ± 3 mm or ± 0.1 percent, whichever is greater.

c) Straightness of Bow : ± 5 mm or 1/750 of the length, whichever is greater.

d) Squareness : When considering the squareness of the corner, the longer of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.

e) Twist : Any corner shall not be more than the tolerance given below from the plane containing the other three corners:
Up to 600 mm in breadth and up to 6000 mm in length, 5 mm Over 600 mm in breadth and for any length, 10 mm.

f) Flatness : The maximum deviation from a 1500 mm straight edge placed in any position on a nominal plane surface shall not exceed 5 mm.

3 Materials

3.1 The materials used for the construction shall conform to IS 456 or IS 1343 depending upon type i.e. reinforced or prestressed.

3.2 Concrete : The concrete mix used shall be minimum of M-20 grade in accordance with IS 456. In the case of prestressed concrete units, it will be in accordance with IS 1343. The maximum size of aggregate used shall be restricted to 12 mm in the case of ribbed slabs and cored slabs with flange thickness less than 50 mm.

4 Structural Design

4.1 The precast units shall have adequate strength and stability in accordance with the relevant code of practice (IS 456 or IS 1343 and IS 3935) during the following stages:

a) Demoulding;
b) Handling, stacking, transporting and placing; and
c) With all design loads together with dead load of in-situ concrete placed for connection purposes.

4.2 Loads shall be in accordance with IS 875 and the continuity of in-situ concrete joints shall be designed according to IS 3935.

4.3 For calculating the critical cross-sections, at stage of demoulding and handling, a load factor of at least 1.5 shall be applied for calculating the design limit state of collapse load.

4.4 ***Effective Flange Width***

4.4.1 Reinforced Concrete Ribbed Slab Units :When the thickness of flange is more than 1/10 of overall depth of the rib, the overall width of the flange is effective in the compressive zone and can be taken into consideration in calculations for moment of resistance of the cross sections.

4.4.2 In case the thickness of flange is less than 1/10 of the overall depth of the rib, the effective flange width can be taken as in Tee section. Typical sketch of the channel unit and double tee unit is shown in Fig.1.

4.4.3 Prestressed Concrete Ribbed Slab Units - In the design of prestressed ribbed slabs, the entire flange shall be taken as effective for all cases and the Tee beam formula shall not be applied as this may lead to under estimation of the prestressing force required, if a lesser cross-section is assumed to be effective.

4.4.4 Reinforced or Prestressed Cored Slab Units - The thickness '*d*' of cored slab units shall be in accordance with 2.2. The depth 'd_1' be at least 1/4 *d* and 'd_2' shall be at least 1/5 *d* (Fig.2) subject to minimum of 20 mm.

a) The smallest cross-section width excluding the hollow space, $b_o = b - \Sigma a$, shall be at least 1b/3 unless a greater width is required for contemplated shear stress.

b) The effective cross section for de sign can be modified by adopting equivalent rectangular/square instead of circular or elliptical openings as given in Fig.3.

5 Mould

5.1 The mould used for casting ribbed slabs shall consist of two parts, (a) bottom mould, and (b) side moulds. The bottom mould shall be made out of masonry, concrete, steel, FRP, or any other material acceptable to engineer-in-charge. The side moulds similarly can be of steel or FRP. If masonry or concrete moulds, the use of chicken wire mesh or fibre reinforcement in the top surface shall help in making the mould last longer for higher efficiency. The top surface shall be smooth finished to the required accuracy.

5.2 In case of cored slabs, the voids shall be created either by an extrusion process, by inflated tubes or mild steel tubes.

5.3 The castellations/depressions/roughening of depth shall be provided in the sides of the precast units. Suit able provisions in the side of the mould may create better key action between in-situ concrete and precast concrete units at the joints.

6 Reinforcement Cover

6.1 Minimum cover for the reinforcement for precast units shall be as follows:

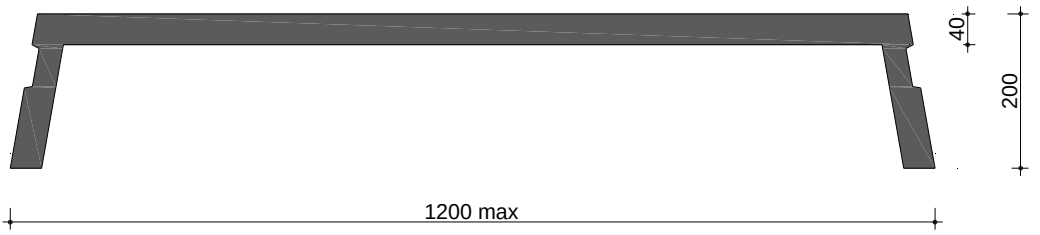


Fig 1a
Channel Slab Unit

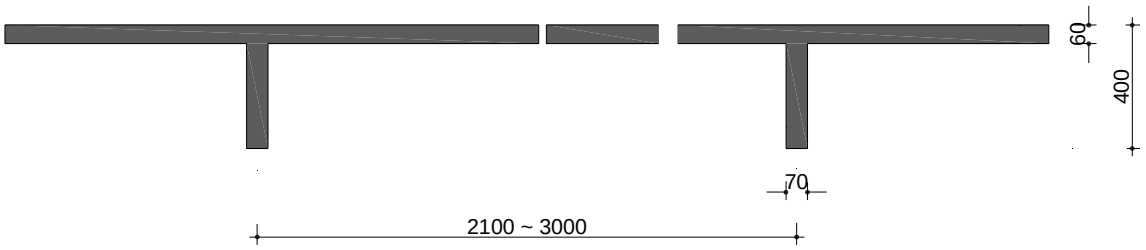


Fig 1b
Double Tee Slab Unit

Fig.01
RIBBED SLAB UNIT

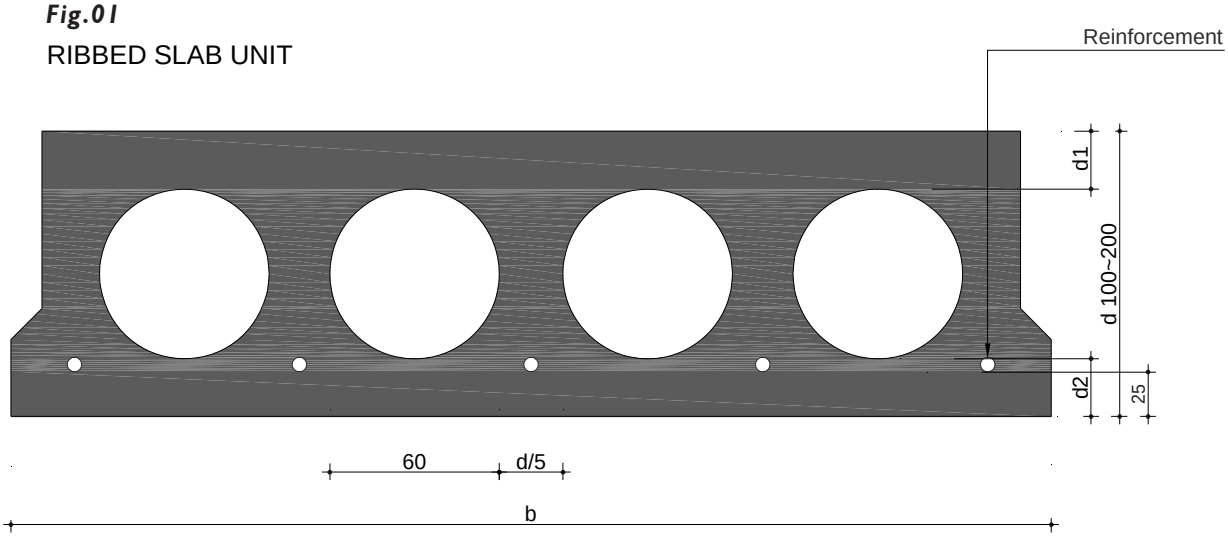


Fig.02
CORED SLAB UNIT

ALL DIMENSIONS ARE IN mm

a) In the flange, 15 mm clear in all directions. This shall be increased to 20 mm when surfaces of precast members are exposed to corrosive atmosphere; and

b) Main reinforcement in the rib, 20 mm or diameter of bar whichever is greater. In case of corrosive atmosphere, this shall be increased to 25 mm, or diameter of bar, whichever is greater.

6.2 It shall be ensured that the reinforcement cages are not in any way distorted during storage, handling, placement and casting. In the case of mass production in large precasting factories, the use of reinforcement ladders and mesh made by using a resistant-welding machine will be advantageous for improving production.

7 Casting and Curing

7.1 Mechanical vibration either through mould/table vibrators or screed vibrators shall be essential to ensure good compaction. Needle vibrators shall be used for compacting concrete in the ribs. Screed vibrators for compacting concrete in the flange. Concrete placing machine which level, vibrate and finish the concrete units shall be used for mass production of units.

7.2 ***Curing*** - Curing shall be done as per IS 456 i.e., by sprinkling water for 14 days and air curing for another 14 days. If necessary, low pressure steam curing may be adopted to obtain early stripping/release strength.

7.3 ***Lifting Hooks*** - The lifting hooks/ holes shall be provided at structurally advantageous points (such as, 1/5 of the length from the end of the element) to facilitate demoulding and erection of the precast unit. The lifting hooks shall be formed out of normal mild steel reinforcing bars with adequate carrying capacity to carry the self weight during demoulding, handling and erection. After erection, the hooks shall either be cut or bent down inside the screed or joint concrete that will be laid subsequently.

7.4 ***Stacking of Units*** -The demoulded precast units shall be stacked over supports placed at about 1/6 of span from ends. Care shall be exercised that no support is placed at the centre of span, and main reinforcement shall always be at the bottom of stacked units which shall be achieved in practice by proper markings.

7.5 ***Transportation*** - The units shall be transported always with the main reinforcement at the bottom. For transporting and erecting the units, rope slings shall be tied near the ends at 1/5 of the length from either end of the unit. If the units are transported in trolleys, the over-hang of the units from the trolley shall not be more than 1/5 of the length. The unit shall be lifted

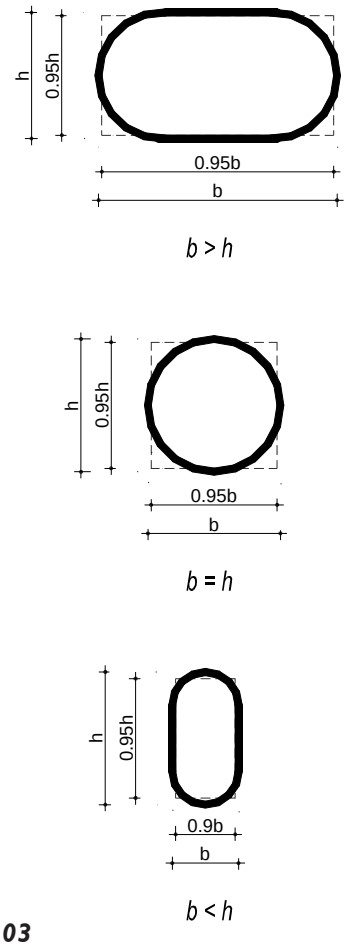
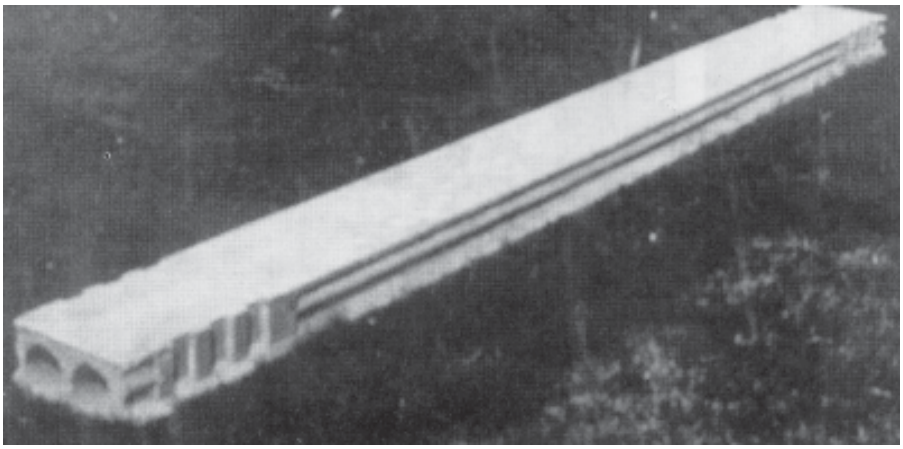
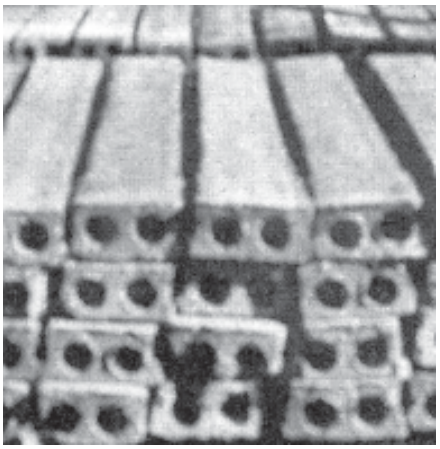


Fig.03

TYPICAL CROSS SECTION OF HOLLOWS OF CORE UNIT

ALL DIMENSIONS ARE IN mm





manually or with the help of chain pulley blocks or mechanically with a hoist or a crane.

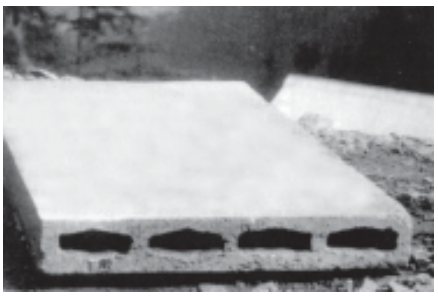
8 Method of Construction

8.1 ***Placing and Aligning*** - The units shall be placed and aligned side by side across the span to be covered. Placing of units shall be started from one end of the building with specified bearing on supporting wall/beam.

8.2 ***Bearing*** - The precast units shall have a minimum bearing of 75 mm on the beams and 100 mm on the conventional masonry wall.

8.3 The ribbed slab units without end diaphragm shall be placed over concrete bed blocks beneath the ribs in conventional masonry walls.

8.4 ***Curing of In-situ Concrete in Joints -*** The in-situ concrete in the joint shall be cured for at least 7 days by sprinkling water or putting wet gunny bags. The concrete shall then be allowed to dry for at least a week. A coat of cement slurry shall be applied to the joints to fill the hairline cracks that might have developed.



8.5 Load tests shall be carried out in accordance with IS 456.

9 Fittings and Fixtures

9.1 Provisions for fixtures like fanhooks/ inserts/electric conduits, etc. shall be incorporated within the precast units or in-situ joints/screed concrete. This shall be predetermined and indicated on the drawings.

9.2 For the concealed wiring, conduits shall be placed within the joint along the length or within the screed before concreting. The conduit shall be permitted to conceal within the floor/roof finish.

9.3 Holes, openings and fixtures required to be provided within the precast units shall be fixed accurately with adequate embedment at the precasting stage. Drilling of holes/cutting of edges shall not be made unless permitted by the engineer-in- charge before hand.

10 Floor Finish

10.1 In case of floor slab, the floor finish shall be done as per the relevant Indian Standard Code of Practice. The Indian Patent Stone or mosaic flooring shall be layed in bays with the bay lines in the direction of the unit coinciding with any of the joints between the units.

10.2 When the floor is made up of series of strips, mechanical connections/ screed concrete/overlapping reinforcement may be provided to account for differential loading.

10.2 To provide adequate resistance against impact/acoustic treatment, the floor thickness at any place shall not be less than 75 mm.

11 Roof Treatment

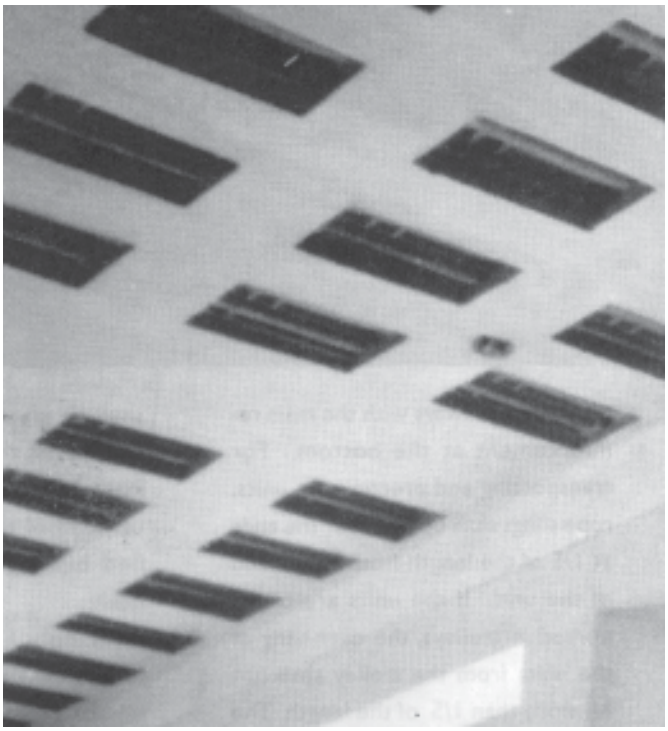
11.1 Adequate waterproofing and thermal insulation to suit local climatic conditions shall be adopted in accordance with relevant Indian Standard Code of Practice.

12 Sampling

12.1 The sampling procedure for precast slab units, number of test and criteria for conformity shall be as per IS 10297.

CT 08

Specifications for Reinforced Brick and Reinforced Brick Concrete Slabs for Floors / Roofs



1 General

1.1 Reinforced brick slab consist of bricks, steel and mortar while reinforced brick concrete slab comprise of bricks, steel and concrete. In case of Reinforced Brick (RB), the compression is taken by brick while in Reinforced Brick Concrete (RBC), the compression is taken by cement concrete, thus in RB, good quality bricks are required. In later case, the slab can be laid even with low strength bricks. In both cases bricks can be placed either flat or on-edge. RB slab can be constructed with two layers of bricks depending upon the load and span.

1.2 Reinforced brick work (Fig.1) is practically the same as reinforced concrete in all its essential features except that brick work in cement mortar is substituted for cement concrete.

2 Dimensions and Tolerances

2.1 ***Reinforced Brick Slab***

2.1.1 Reinforced brick floor/roof shall consist of good quality bricks placed each brick on-edge with keeping 8mm to 10mm dia. MS bars in Joints width of 30 mm in both direction filled up with cement mortar. Normally span shall vary from 2.4 m to 3.6 m. The reinforcement spacing shall form grid of 190mm x 260 mm.

2.1.2 The thickness of floor/roof shall also vary 110mm to 150mm (Fig.1).

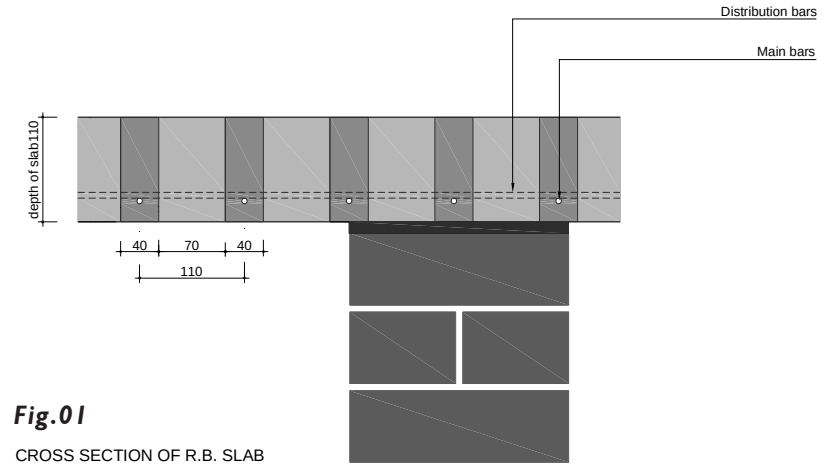


Fig.01

CROSS SECTION OF R.B. SLAB

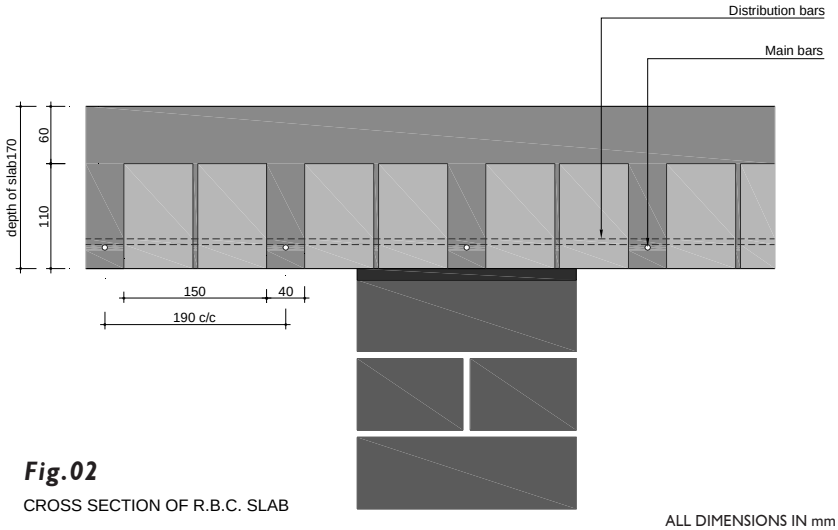


Fig.02

CROSS SECTION OF R.B.C. SLAB

ALL DIMENSIONS IN mm

2.2 **Reinforced Brick Concrete Slab**

2.2.1 In reinforced brick concrete construction cement concrete M-20 shall be used in conjunction with bricks (Fig.2). Normally two bricks-on-edge shall form reinforcement grid of 260 mm. The cement concrete, joints thickness shall be 40 mm. On top of the bricks 30 mm to 50mm cement concrete M-20 shall be laid along the joints. The compression zone shall be made up of concrete alone. Bricks shall be considered as fillers.

2.2.2 Normally, span shall vary from 2.4 m to 3.9 m with reinforcement of 10 mm or 12 mm MS bars.

2.2.3 The thickness shall be 150 mm, having top concrete of minimum 40 mm.

2.3 ***Tolerances*** – On joints and thick ness of slab shall be ±3 mm.

3 Materials

3.1 ***Bricks*** - These shall be of atleast Class 75 for RB and Class 35 for RBC construction and conforming to IS 1077. Overburnt bricks having vitrified surface shall not be used.

3.2 ***Cement Concrete*** - Cement concrete used in filling the interstices in reinforced brick slabs and for providing top decking of reinforced brick concrete slabs shall be of grade not less than M-20 and shall conform to IS 456. It shall contain just enough water to flow freely without segregation of the aggregates. The size of the aggregates may be suitably selected to suit the construction.

3.3 ***Reinforcement*** - It shall conform to IS 432 (Part 1) or IS 1786. Reinforcement shall be free from rust scale or other coating.

3.4 ***Centering and Formwork*** - The formwork shall consist of timber or steel possessing sufficient strength so as to carry the superimposed load. Unless otherwise specified formwork shall consist of platforms composed of planks or sheets supported on runners or beams. The props and bracings supporting the platforms shall have sufficient lateral stability.

4 Structural Design

4.1 ***Reinforced Brick Slab***

4.1.1 The behaviour of reinforced brick slab is similar to that of reinforced concrete. Within the range of practical applications of reinforced brick slabs, failures are generally by yielding of tensile reinforcement. R.B. slabs may be designed by the same methods as followed in R.C.C.

4.2 ***Reinforced Brick Concrete Slab***

4.2.1 RBC slabs may also be designed like R.C.C. slab, both by working load as well as limit state methods given in IS 456.

4.2.2 A continuous RBC slab is to be designed at the support like R.B. slab. The bottom reinforcement is to be continued over the support and advantage of this reinforcement taken in resisting the compression.

Reinforcement for taking negative moment over the support is to be provided in the top concrete.

4.3 ***Reinforcement***

4.3.1 ***Design*** - The reinforcement in RB and RBC slabs shall be designed according to the provision of IS 456 taking the spacing of bricks into consideration. The reinforcement in either direction shall, however, not be less than 0.20 percent of the cross sectional area of the slab where plain steel bars are used and not less than 0.16 percent where high strength deformed bars are used.

4.3.2 ***Spacing*** - The horizontal distance between two parallel main reinforcement shall not be more than three times the effective depth of the slab or 450 mm whichever is smaller. The pitch of the distribution bars shall not be more than five times the effective depth or 450 mm whichever is smaller.

4.3.3 ***Protection Against Corrosion*** - Reinforcements shall be so placed that they do not touch bricks at any point. A minimum cover of 25 mm shall be provided all round the reinforcement. Further measures for preventing corrosion of reinforcements shall be taken as recommended in IS 9077. In general, two bars shall not be used in the same joint.

5 Method of Construction

5.1 Medium absorption bricks (about 15 percent) should be preferred since these develop comparatively high bond strength with mortar.

5.2 Bricks should be thoroughly wetted and preferably soaked in water before use but at the time of laying it should be ensured that they are skin-dry.

5.3 ***Erection of Centering and Formwork*** - Centering shall be erected to support the RB floor or roof from below. The centering shall be smooth, clean and to correct alignment. The top surface of formwork shall be given an upward camber of 1 mm for every 150 mm of span subject to a maximum of 30 mm to allow for initial settlement. Before laying the slab, the formwork and the supports shall be checked to prevent undue sag and to ensure overall safety and stability of the formwork.

5.4 ***Detailing of Reinforcement*** - All main and distribution reinforcement shall be placed in the position shown in Fig. 1 & 2 and shall be completely embedded in concrete. They shall be rigidly secured against any displacement and arrangement shall be made to ensure proper cover to the reinforcements. Splices in adjacent bars, if needed shall be staggered.

5.5 ***Spacing of Bricks*** - The bricks prepared shall be laid as show in Fig. 1 and 2 with cement mortar 1:3. Preferably a minimum spacing of 60 mm in between the bricks should be maintained for preventing corrosion.

5.6 ***Laying of Bricks and Reinforcement*** - The bricks for single brick thickness of floor or roof shall be laid directly on the forms without bedding of any kind. After one row of bricks has been laid the next row is similarly laid providing the gap for concrete joint. Concrete shall be then poured in the gaps to fill the bottom of the joint to a uniform thickness equal to the clear bottom cover to the reinforcing bars. Concrete should be poured into the joints after the placement of reinforcement. Concrete shall be fluid enough to run freely around the reinforcing bars and fill the joints completely. The joints shall be puddled sufficiently with a trowel or a sharp ended 16 mm diameter rod to aid the flow of concrete to every corner and to fill any void space left in the joint due to entrapping of air or otherwise. A typical cross section of RB and RBC floor or roof is show in Fig. 1 & 2. If a slab of two courses of brick is laid, a fresh layer of concrete shall be spaced over the first course to make the middle horizontal joints and screeded properly to the desired thickness of the joint. The top course of brick is then laid in the same manner as in the first course.

5.7 ***Curing*** - The brick work shall be kept wet by means of wet straw or wet sand or merely by sprinkling water gently over the surface for about 24 h after finishing. The slab shall then be watered profusely and allowed to set for a period of atleast 10 days.

5.8 ***Removal of Formwork*** - The formwork for the RB and RBC floor or roof shall not be removed before 14 days after laying.

5.9 ***Finishing*** - The completed floor or roof shall be further finished with a waterproofing course of lime concrete (IS 3036) or Mud Phuska with tiles (IS 2115). The ceiling shall be rendered or plastered after drying with cement mortar (1:3) or lime mortar (1:2) as specified. The plaster may be in a single coat of 12 mm thick, and shall be done in accordance with IS 1661. The finished surface of the floor or roof shall be cured with water for a period of not less than 3 weeks.

CT 09

Specifications for Prefabricated Brick Panels for Floors / Roofs

1 General

1.1 Prefabricated brick panels are made by a combination of concrete, bricks and reinforcement. These prefab brick panels are placed on partially precast RC joists. The precast joists are supported on walls or beams. Concrete is used in the zone of maximum compressive stresses thus bricks of lower compressive strength may also be used. Further the in-situ concrete, provide over the prefabricated brick panels helps in designing the supporting partially precast RC joists as T beam.

1.2 The floor/roof consists of (i) prefab brick panel (ii) partially precast R.C.joists and insitu concrete (reference Fig. 1).

2 Dimensions and Tolerances

2.1 ***Prefab brick panel*** : Brick panel (Fig.2) shall be made of good quality bricks reinforced with two M.S.bars of 6 mm dia. and joists filled with either 1:3 cement, coarse sand mortar or concrete grade M-20. The length of brick panel shall not exceed 1.1 m for brick having strength less than 40 N/mm^2. For bricks having strength more than 40 N/mm^2 conforming to IS 2180, the length of brick panel shall not exceed 1.2 m For economic point of view, the minimum recommended length of panel is 0.9 m. The width of brick panel shall be 530 mm for panels made out of conventional size (230 mm x 110 mm x 75 mm) bricks and 450 mm for panel made out of modular size (190 mm x 90 mm x 90 mm) bricks. The thickness of panel shall be equal to thickness of brick i.e. 75 mm for conventional size brick and 90 mm for modular size bricks. The thickness of longitudinal joints shall be 40 mm to accommodate 6 mm reinforcing bar with adequate cover. However, the thickness of joints may vary to compensate for variation in brick dimensions, so that specified panel dimensions remain the same. The thickness of transverse joints shall vary from a minimum of 15 mm to a maximum of 30 mm. However, in a single panel unit, this shall be kept uniform for all transverse joints. Each panel of 530x900 mm require 16 bricks and 530x1150mm require 18 bricks of conventional type.

2.2 ***Partially precast RC Joist*** : The joist shall be rectangular in shape with steel stirrups projecting out which shall be tied with reinforcement along the joists to achive monolithicity with concrete (see Fig.2). The width of partially precast joists shall be sufficient to support two successive spans of brick panels with sufficient bearing, leaving an adequate gap between them. The minimum recommended width is 130 mm, which may be increased, if required, for

structural strength. The recommended depth for precast joists, for clear span of joist up to 4200 mm shall be 100 mm for both conventional and modular size bricks. Accordingly, overall depth of joist with in-situ concrete of 350 mm shall be 210 mm for conventional bricks and 225 mm for modular bricks.It shall be designed as composite Tee beam with 35mm thick flange concrete.

2.3 ***Tolerances*** **:** The tolerance on various dimensions of the panels shall be length ± 10mm, width ± 5mm and thickness ±4mm.The tolerances for moulds shall be, length ±8mm,width ±3mm and depth ±3mm.

3 Reinforcement

3.1 Reinforcement required for brick panel shall be provided as per design along the length. This shall consist of 2 bars of required diameter embedded in longitudinal joints as shown in Fig.2.

3.1.1 For span and dimension of brick panels mentioned in 2.1, a reinforcement with 2 mild steel Grade I bar of 6 m conforming to IS 432 may be used in residential buildings without any calculation.

3.1.2 Reinforcement of RCC joist shall be provide as per design (see IS 14142).

3.2 A minimum clear cover of 15 mm shall be provided to reinforcement in the panel while for the joist the minimum clear cover shall be 25 mm.

4 Structural Design

4.1 ***Prefabricated Brick Panels***

4.1.1 The prefabricated brick panel shall be designed as simply supported between two joists or a joist and a wall.

4.1.2 The panel shall be designed for three stages as follows:

i) Precasting, lifting, transportation and handling (Stage I)

ii) Placing and accidental loading during construction (Stage II)

iii) Final loading condition (Stage III)

4.1.2.1 The following loads shall be considered for different stages of design:

i) For stage I, self weight of panel without in-situ concrete plus 50 percent of self weight of panel for impact or vibration during handling and transporting.

ii) For stage II, self weight of panel including weight of in-situ concrete and an accidental load, which, in absence of more accurate information, may be taken as half the imposed load given for stage III.

iii) For stage III, self weight of panel including in-situ concrete and imposed load as specified in IS 875 (Part 2) and a load of 200 kg/m^2 or 100 kg/m^2 for roofs or floors respectively. Load of 200 kg/m^2 is taken for weight of waterproofing and insulation treatment while the load of 100 kg/m^2 in case of intermediate floors is taken for weight of floor finish. In case other specification being followed the loads for the floors or roofs may be accordingly considered in the design.

4.1.2.2 While designing the panel for stage II, the in-situ concrete shall not be considered as sharing the compression because it does not attain strength at this stage. While designing for stage III, the in-situ concrete of 3.5 cm depth shall be considered as acting together with brick panels in the compression zone.

4.2 ***Partially Precast Joists***

4.2.1 The partially precast joist shall be designed for three stages as follow:

i) Precast, lifting, transportation and handling (Stage I).

ii) Placing and accidental loading during construction (Stage II)

iii) Final loading condition (Stage III)

4.2.1.1 The following loads shall be considered for different stages of design:

i) Stage I, self weight of joists plus 50 percent of self weight of joist for impact or vibration during handling and transportation.

ii) Stage II, joist shall be propped at two points at 1⅓rd span before laying

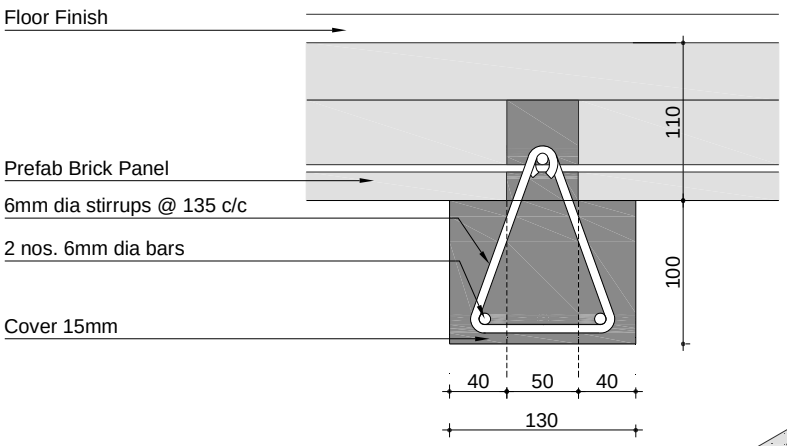


Fig.01
PARTIALLY PRECAST JOIST

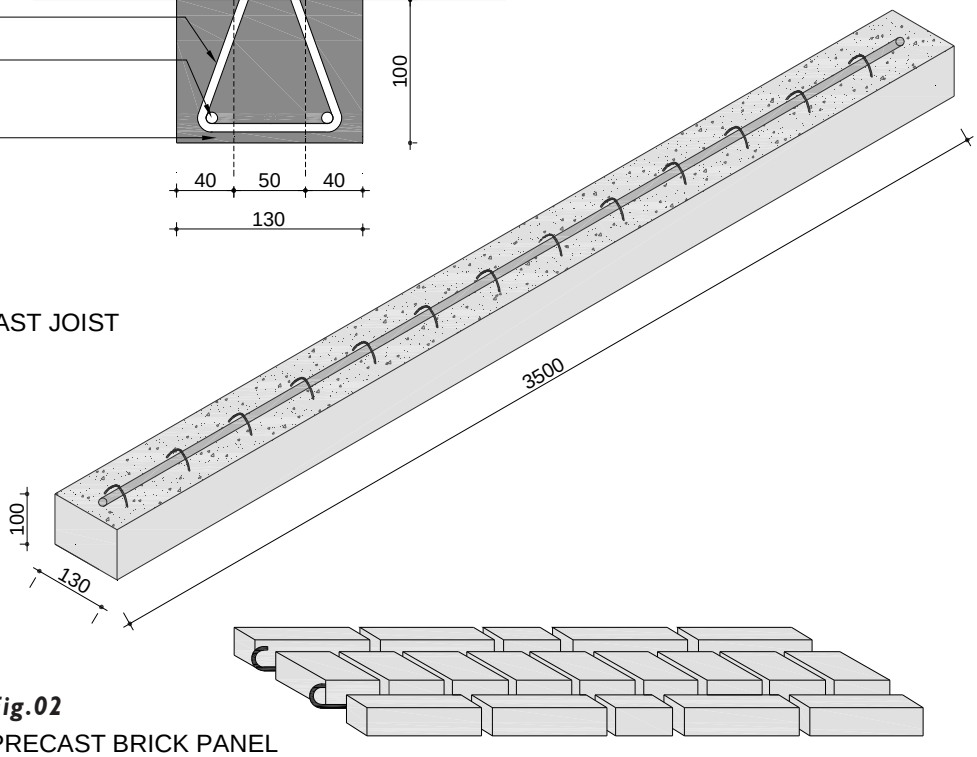
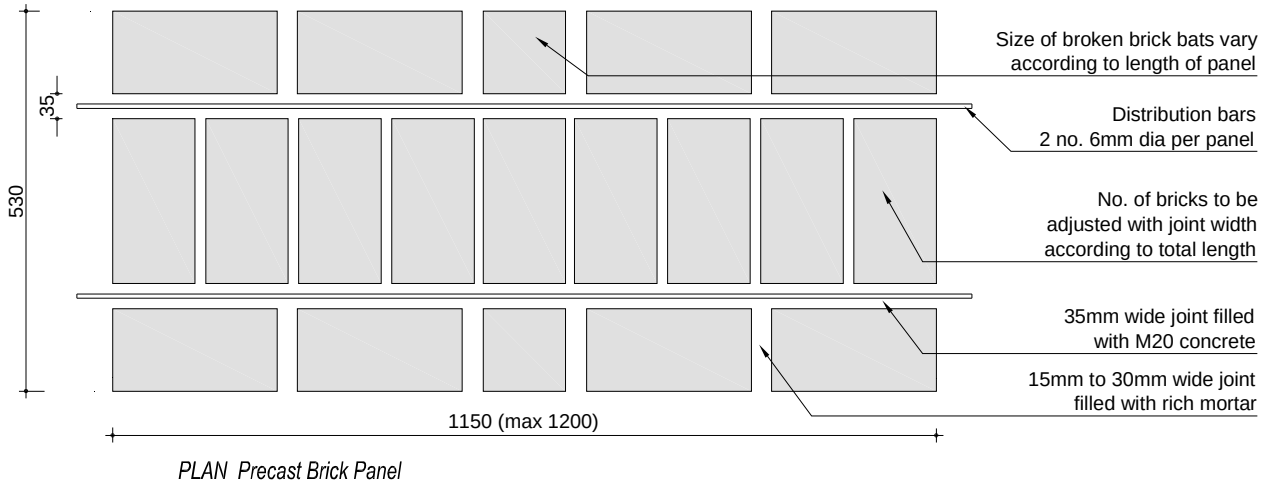


Fig.02
PRECAST BRICK PANEL



PLAN Precast Brick Panel

ALL DIMENSIONS ARE IN mm.

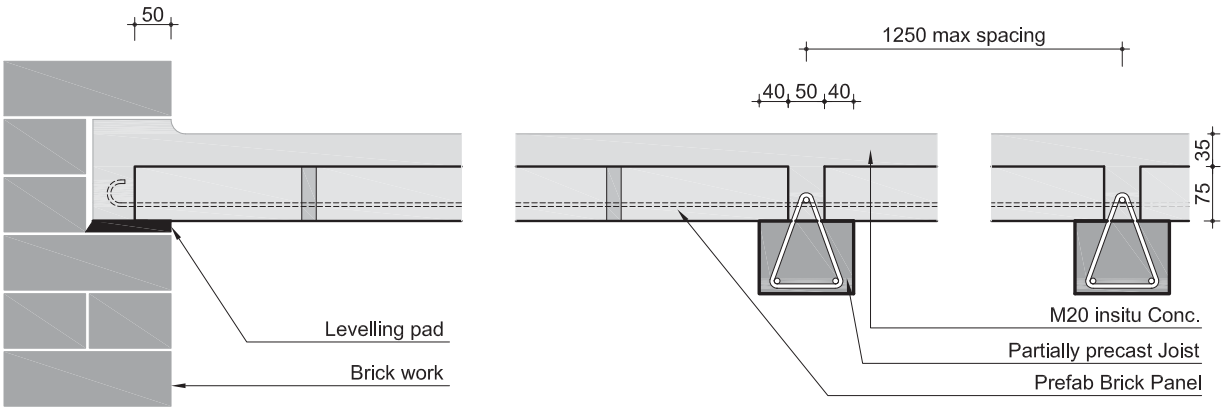


Fig. 3A
LONGITUDINAL CROSS SECTION

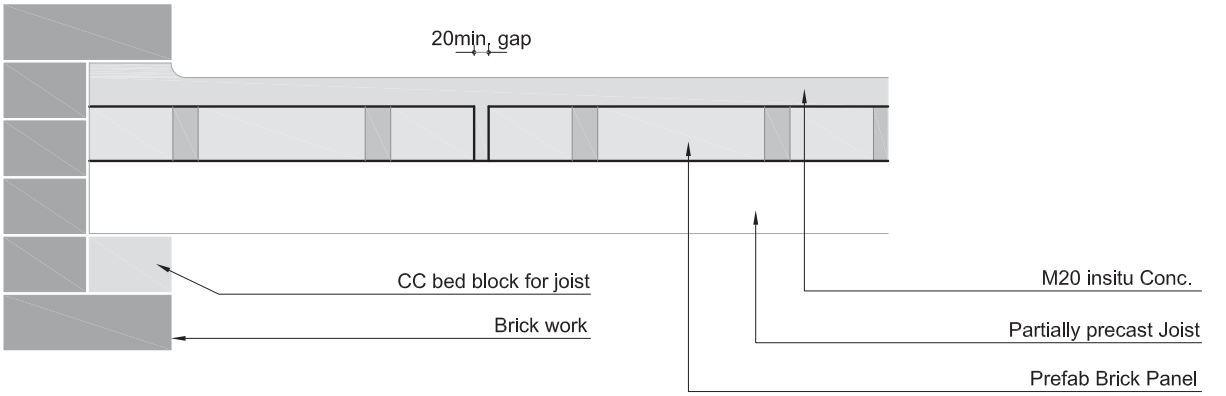


Fig. 3B
TRANSVERSE CROSS SECTION

Fig.03
PRECAST BRICK PANEL SCHEME

ALL DIMENSIONS ARE IN mm.

bricks panel and l/3 span shall be taken for design purpose and self weight of joist and panel including in-situ concrete and accident load, which in the absence of more accurate information, may be taken as half the imposed load given for stage II.

iii) Stage III, self weight of joist, dead weight of brick panels including in-situ concrete, imposed load in accordance with IS 875 (Part 2) and load of roof or floor.

4.2.2 The partially precast concrete joist shall be designed as T-beam with 35 mm flange thickness for stage III of loading and as a partially precast beam for stage I and II of loading. Reinforcement required with normal loading for various span of joist for a spacing of 1200 mm c/c may be taken from Table 1.

4.2.3 The joist shall be designed as continuous beam, it may be designed either as simply supported or continuous T-beam in accordance with IS 456.

4.2.3.1 When the joist is designed as continuous beam, it may be designed as doubly reinforced beam. When it is possible to weld the bottom reinforcement at supports the same shall be kept projecting. If the welding is not possible, the joist shall be designed as singly reinforced for hogging bending moment at support. In such a case, redistribution of moment in accordance with IS 456 may be

Table 1: For Steel Reinforcement Requirement for Various Spans for Joists for a Spacing to 1200 mm c/c

Reinforcement at	Clear Span of Joists in mm								
	1800	**2100**	**2400**	**2700**	**3000**	**3300**	**3600**	**3900**	**4200**
Bottom	2-8ϕ or 2-8‡	2-10ϕ or 2-8‡	2-10ϕ or 3-8‡	2-12ϕ or 1-10‡+ 2-8‡	3-10ϕ or 1-12‡+ 2-8‡	3-12ϕ or 2-12‡+ 1-10‡	2-16ϕ or 3-12‡	2-16ϕ 1-10ϕ or 2-16‡	3-16ϕ or 1-16‡+ 2-12‡
Middle	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.8ϕ+	1 No.8ϕ+	1 No.8ϕ+	1 No.10ϕ+	1 No.10ϕ+
Top	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ	1 No.6ϕ
Stirrups	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	6ϕ 130 mm c/c	4 No.6ϕ 100 mm c/c at ends and 130 mm c/c in middle portion

+= Can be reduced to 6ϕ if proper handling is ensured. ϕ = Mild steel bars ‡= Deformed bars

resorted.

4.2.4 A clear cover of 25 mm shall be provided for longitudinal reinforcement.

4.3 When precast units are used for construction of building in high seismic zones, the roofs/floors shall be strengthened as per the provision of IS 4326.

5 Manufacturing of Precast Elements

5.1 Prefabricated Brick Panels

5.1.1 ***Mould:*** The mould for brick panels shall be made from well seasoned good quality timber or an equivalent wood substitute. For mass production, moulds may be made of mild steel or other rigid, non absorbent and non-corrodible material such as FRP.

5.1.2 ***Casting:*** The moulds which are open at bottom shall be kept on a levelled ground having thin layer of sand or pucca floor or platform. Bricks properly wetted shall be arranged in the mould with outer most bricks touching the sides of mould and keeping specified gaps in between bricks for joints. Broken brick bat shall be used for staggering transverse joints as shown in Fig.2. The frogs of bricks shall face upwards to provide shear key to deck concrete laid in-situ. 15mm thick layer of concrete or 1:3 cement coarse sand mortar shall be placed in the longitudinal gaps between the bricks and two reinforcing bars shall be provided over it. All the gaps between the bricks shall then be filled with mortar or concrete. The mould may be removed just after casting.

5.1.3 The panels shall be cured for 14 days by sprinkling water and dried for 14 days thereafter before they are used in construction.

5.2 ***Partially Precase Joists***

5.2.1 Same as 5.1.1.

5.2.2 ***Casting:*** Moulds shall be placed on a smooth and levelled surface and 25mm thick layer of M-20 grade concrete shall be laid in the mould. Over this concrete layer, reinforcement shall be placed. M-20 grade concrete shall be poured in the mould and well compacted by vibration. The mould may be stripped after 2 to 3 h. of casting depending upon weather.

5.2.3 The joist shall be water cured for 2 weeks followed by air-curing for another 2 weeks, before using them in construction.

6 Method of Construction

The floor/roof shall be assembled in the following sequence.

6.1 The joists and panels shall be cleaned properly by using wire brush to remove dust and loose particles before lifting and placing in position for assembly of floor/roof.

6.2 The surface of wall on which the joists are placed shall be overlaid by 10-15 mm thick layer of 1:4 cement and coarse sand mortar. Top of the mortar shall have smooth finish. The joist shall be placed above this and properly aligned.

6.3 The joists shall be propped immediately after placing, at two places dividing the length of joist in three equal spans. The props shall not be removed before the insitu concrete has hardned. The minimum bearing of joists over walls shall be 75 mm. The wall in between the joists shall be raised to the level of joists using cement sand (1:6) mortar.

6.4 The brick panels shall be placed over

the joists/walls, side by side after laying a 6 mm thick layer of 1:4 cement coarse sand mortar to ensure propoer setting of panels. Frogs of bricks should be kept upwards while casting and placing of brick panel on joists. The minimum bearing of at least 40 mm shall be provided for panels. A gap of 20-40 mm is left in between adjacent panels.

6.5 All the joints between panels shall be filled up with M-20 concrete with the help of wooden strips placed below the joists and held in position during filling of concrete. The strip can be removed immediately by sliding horizontally.

6.6 Distribution/temperature reinforcement shall than be laid over the panels in both directions i.e. parallel and perpendicular to the joists. This may consist of atleast one 6 mm mild steel grade I bar conforming to IS 432 in each direction.

6.7 Concrete shall then be laid over the panels and joists to a depth of 135 mm above the top of panels.

6.8 The roof shall then be finished with a floating coat of 1:3 cement, fine sand mortar of not more than 6mm thickness just after laying the insitu concrete.

6.9 The in-situ concrete shall be cured for atleast 2 weeks by ponding.

6.10 The spouts for rain water shall be made while laying the deck concrete to avoid any seepage through the joints.

6.11 To have proper drainage of rain water, a slope of 1:40 shall be given to roof either by raising the joists on one side or if needed, otherwise by completing and finishing the walls with the required slope.

7 Floor/Roof Finish

7.1 Floor/roof finish shall be provided after the in-situ concrete has hardened. Guidance for providing different types of floor/roof finishes may be taken from relevant Indian Standards. Waterproofing treatment to the roofs shall be provided as desired. Guidance for this may be taken from relevant Indian Standards. For waterproofing using bitumen felts, bitumen mastic, glass fibre tissue reinforced bitumen and lime concrete, IS 1346, IS 4365, IS 9918 and IS 3036 may be referred.

8 Sampling

8.1 All prefabricated brick panels and joists of the same size manufactured from similar materials and under similar conditions of production shall be grouped together to constitute the lot.

8.2 Five units of prefabricated brick panel and joist shall be selected at random out of a lot consisting of 300 units or less. For a lot bigger than 300 units, 5 units shall be selected for every 300 units or part thereof. In order to ensure randomness of selection, procedure given in IS 4905 may be followed.

8.3 The samples shall be suitably marked for future identification of the lot it represents.

9 Tests

Tests shall be conducted on samples of the units as given in IS 14143.

9.1 Dimensional test and deflection recovery test shall be routine tests whereas failure load test shall be a type test. Type test is intended to prove the suitability and performance of a new design and size of a component. Failure load test is applied at the time of any change in the design/size.

10 Criteria for Conformity

10.1 If four out of five samples satisfy the shape and dimensional requirements, the lot represented by the sample shall be deemed to have passed the dimensional requirements. If more than one panel fails to satisfy the dimensional requirements, the lot represented by sample shall be rejected.

10.2 In the deflection recovery test as per IS 14143, if the deflection 24 h after the removal of imposed load is at least 75 percent of the deflection under the load for 24 h, the units shall be deemed to have passed the test. If the deflection recovery is less than 75 percent, the lot represented by the unit shall be rejected. If the maximum deflection in mm, shown during 24 h under load is 40 l^2/D, where l is the effective span in mm and D, the overall depth of the section in mm, it is not necessary for deflection recovery to be measured and the recovery provision mentioned in this clause earlier shall not apply.

10.3 In the case of the failure load performed in accordance with IS 14143, the unit shall carry a load at least equal to 1.33 times the characteristic load to pass the test. If the load at failure is less than 1.33 times the characteristic load, the load represented by the sample shall be rejected.

11 Marking

11.1 Each component shall be legibly and indelibly marked with identification of the source of manufacture, month and year of manufacture.

CT 10

Specifications for Ferocement Roofing Channels

1 General

Ferrocement is a thin walled concrete, reinforced with closely spaced layers of galvanized wire mesh. Ferrocement roofing channels are prefabricated lightweight, slender element shell structures. The standardization on these roofing channels is based on Optimized concrete mix, Controlled vibration and Dimensional regularity in shape and size.

2 Dimensions and Tolerances

2.1 There are two portions in a channel: Shell, Curved portion and Nibs, the square edges at the bottom. The clear bay length shall be 750 mm and the outer to outer dimension including the nibs 840 mm. The rise of Arch shall be 290 mm and shell thickness 25mm. The bottom nib dimension shall be 40 x 45 mm. Length of the full channel can be upto 6100 mm. (Fig.1)

2.2 Tolerance limit for thickness, bay length & nibs shall be within ± 1.00 which ensure consistency of channels in terms of strength, performance and durability.

2.3 Porosity measured as dampness (%) of ponding area shall not exceed 5% of contact area with water in pond test.

2.4 Bottom surface finish measured as pore >5 mm in nos. shall not be more than 0 and pores <2 mm in nos. shall not be more than 2.

3 Materials

3.1 The Cement to be used shall be Ordinary Portland Cement 43 grade conforming to IS 8112. The Fine Aggregate of sand or crusher dust passing 4.75mm sieve, free from clay, loam shall be used. Sand shall confirm to the following grading:

Sieve size	% passing through
10mm	100
4.75mm	90-100
2.36mm	75-100
1.18mm	55-70
600microns	35-59
300microns	8-30
150microns	0-10

The ratio of cement and fine aggregate shall be 1:2 to 1:3 by weight. Water used shall be potable and free from organic matter. Chlorides & sulphates shall not exceed permissible limits. Water- Cement Ratio shall be 0.45 to 0.55 (by weight) for getting the required strength and durability.

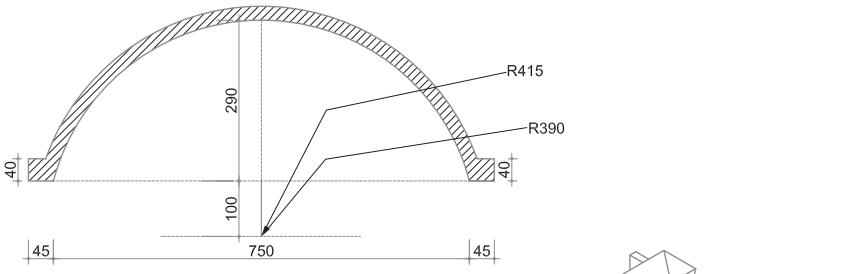


Fig.01A
CHANNEL SECTION

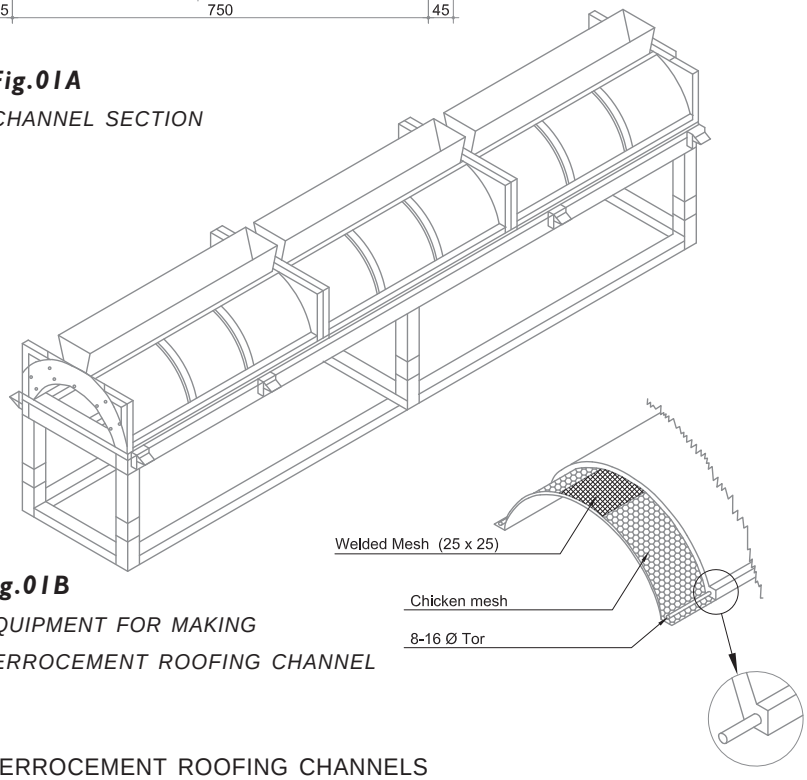


Fig.01B
EQUIPMENT FOR MAKING FERROCEMENT ROOFING CHANNEL

FERROCEMENT ROOFING CHANNELS

ALL DIMENSIONS ARE IN mm

3.2 Reinforcement: 8-16mm High Strength Deformed Bars depending upon application.

Bottom Steel Reinforcement

Span Range	Roof Application	Floor Application
Upto 3.00 m	2 Nos. 6mm ϕ	2 Nos. 8mm ϕ
3.00 - 3.30 m	2 Nos. 8mm ϕ	2 Nos. 8mm ϕ
3.30 - 3.60 m	2 Nos. 10mm ϕ	2 Nos. 10mm ϕ
3.60 - 3.90 m	2 Nos. 10mm ϕ	2 Nos. 10mm ϕ
3.90 – 4.20 m	2 Nos. 10mm ϕ	2 Nos. 12mm ϕ
4.20 – 4.50 m	2 Nos. 10mm ϕ	2 Nos. 12mm ϕ
4.50 – 4.80 m	2 Nos. 12mm ϕ	2 Nos. 12mm ϕ
4.80 – 5.10 m	2 Nos. 12mm ϕ	2 Nos. 16mm ϕ
5.10 – 5.40 m	2 Nos. 12mm ϕ	2 Nos. 16mm ϕ
5.40 – 5.70 m	2 Nos. 12mm ϕ	2 Nos. 16mm ϕ
5.70 – 6.10 m	2 Nos. 12mm ϕ	2 Nos. 16mm ϕ

Mesh Reinforcements: 200mm strip of MS square welded mesh of 25 mm opening along crown of channel GI wire mesh of hexagonal pattern of 22 gauge, 12mm opening throughout the shell.

4 Structural Design

4.1 The channels shall be designed to ensure 250kg/cm^2 of 28 days compressive strength and in such a way that the roof of floor, as the case may be, shall be able to carry loads as per IS-875. Channels are to design as idealized T-beam when they are laid in succession one after the another on roof. The valley portion formed between the adjacent channels constitutes the web of the idealized T-beams and the filling concrete is to act as the flange of the beam. Once the channel dimension and geometric are optimized and standardized, all the parameter except the reinforcement becomes constant.

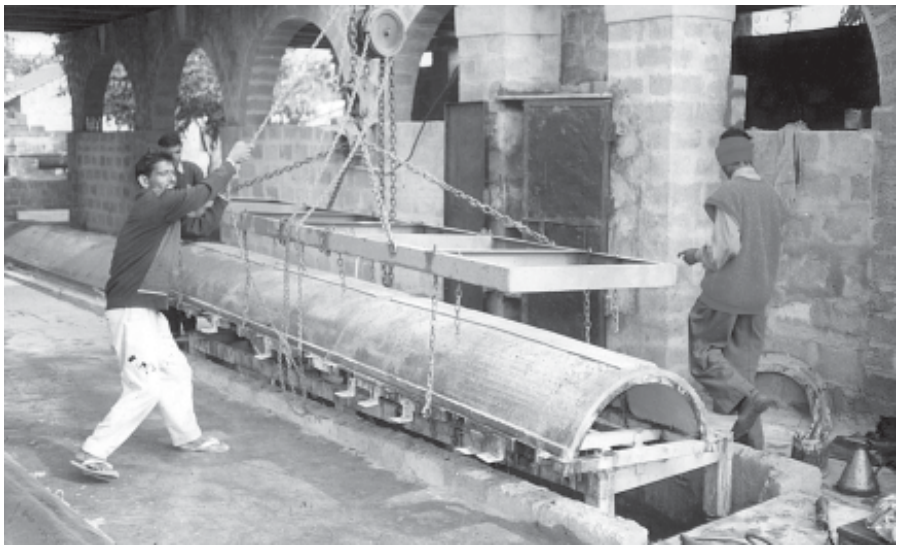
4.2 The reinforcement in the channel is the tensile reinforcement that resists bending moment caused by loads and the span. For a standardized channel profile, moment carrying capacity of channels in roofs or floors can be increased or decreased using various steel rods reinforcement as given in 3.2.

4.3 Other than tensile reinforcement, the channel shall satisfy other design requirement such as bending compression and shear. Bending compression is governed by the grade of concrete and shear is resisted primarily by reinforcement (mesh reinforcement) provided in the shear zone. The thickness of concrete filling and mesh

reinforcement provided in the channel can be suitably designed for the shear stresses. This will also take care of handling stresses that are developed while using channels during lifting, transportation and hoisting.

4.4 Serviceability requirement such as deflection of channels should also be considered in the design of the channel.

4.5 Such standards are set not only for product but for the building system. They include strength, performance and durability specifications. Ferrocement roofing channel can be used in two different applications viz. simple roofs (Flat terrace) and immediate floors (for upper storey living). Accordingly, the standards are given in Table-1.



5 Casting and Curing

5.1 *Mesh Preparation*

5.1.1 *Chicken Wire mesh* - galvanised, 22 gauge, mesh opening 12mm & hexagonal, wire netting - uniform
Welded mesh - galvanised or MS, of 14 gauge & 25mm square opening
Reinforcement - Deformed bars
Binding Wire - 20 gauge.
All steel shall be cleaned of dust & rust Chicken mesh (Lx1.5)x width laid flat on ground. Welded mesh (300 mm wide for apex) is tied over it. Reinforcement, as required, are tied on two sides. Chairs (using welded mesh) are placed as required.

5.2 *Casting*

5.2.1 Wash Sand or fine aggregate Mix: 1:2 to 1:2.5. Dry mix Cement & Fine Aggregates / Sand. W/C ratio 0.45 to 0.55 (by weight) is used. Add water later. Use of mixer recommended.

5.2.2 Mesh is placed on mould. Chairs shall be used for spacing. Mesh shall be aligned correctly and stoppers placed correctly. Top part of the mould is closed and all the nuts & bolts fixed. After fixing the hopper, all nuts & bolts are checked and tightened.

5.2.3 Measurable quantities of mortar are poured at the same time. The vibrator is switched on. 'Karni' is used to ensure uniform spread of mortar. Process is repeated till no more mortar is going inside the mould.

5.2.4 Casting mix shall be used within 30 min. of preparation. Uniform vibration required. No air gaps shall come inside and mortar shall not leak. The process shall take about 15 min.

5.3 *Demoulding*

5.3.1 After 24 h. of setting, all the nuts & bolts are carefully unscrewed. The tongs are carefully placed on the base of the top cover. They are then lifted carefully and place on floor for cleaning. After the top cover has been removed, tongs are carefully

Table 1: Performance Standards

Mode of Use	Simple Roof	Intermediate Floor
Accessibility	Inaccessible	Accessible
Structural Standards		
Load carrying capacity (kg/sqm.)	450	800
Dead loads	75	75
Superimposed loads	150	250
Live loads	75	200
Total loads	300	525
Factor of safety	1.50	1.50
Design loads	450	800
Deflection to span ratio	not to exceed 1/240	not to exceed 1/240
Performance		
Water tightness	Should not leak	Should not leak
Dampness	<20% area in contact with water in 24 h.	<20% area in contact with water in 24 h.

placed on the base of the channel. Lifting shall be done very gently. If the channel does not come out on its own, applying hammering (gently) on the mould is required.

5.3.2 The channel is carefully lifted and taken to the stacking yard and placed on the dwarf walls. Dwarf wall on which the fresh channels are kept shall be absolutely level so that no eccentric load falls on the channels. Channels shall not be cantilevered during stacking.

5.4 ***Curing***

5.4.1 Hessian cloth or unstitched gunny bags are used to cover the channels totally. (If necessary wrap them around the channels). Water is sprinkled twice daily- mornings & forenoon, for curing. This process shall continue for 14 days and air cured for next 14 days. Channels shall not run dry at any stage.

5.4.2 The transportation frame is place & re-assembled on the truck. The channel is lifted and placed on the gantry. With the gantry, the channel is lifted onto the transportation frame. Soft padding or air gap between two channels shall be used. Channels shall be lifted in upright position only.

6 Erection and Alignment

6.1 ***Manual Lifting of Channels - "Straight On Method"***

The simple approach shown in Fig.2 uses a minimum of scaffolding and works well for shorter, lighter, channels. For heavier channels, one should build up a proper ramp, and the workers simply walk up the ramp with the channel.

6.2 ***Manual Lilting of Channels "Back and Forth Method"***

This approach is slower (Fig.3); but requires less people and space. It is also harder on the channels as they are drag back and forth on the supports several times and are often twisted.

6.3 ***Manual Lifting of Channels "Through the Window Method"***

This approach requires less space (Fig.4). It is otherwise similar to the "Straight on Method".

6.4 ***Erection using Lifting Equipment***

Uses a minimum of space and people, and is also gentle with the channels (Fig.5). The channels should only be lifted from two points near where the channel will be supported by the walls or beams.

7 Openings and Fan Hooks

7.1 Openings through a floor or roof are often necessary to provide water or electrical piping, air conditioning, chimneys, staircases, etc. Being modular in nature and one-way reinforced, channels offer more restrictions than are there with a normal RCC slab; however, these restrictions are not difficult to work with. There are basically three kinds of openings possible:

1) Through the channel itself
2) In-between two channels side-by-side
3) In-between two channels end-to-end

7.2 ***Openings through Channel Itself***

In the 75 cm wide channel case, openings of 10 to 20 cm width are possible. Because of waterproofIng considerations, it is better to make the openings at the upper end of the roof slope, and as high up on the channel itself as possible. When the opening is coming through the bottom of the channel, a flexible, waterproof joint needs to be made. Rubber, bitumen and plastic or GI sheet can be used in the standard manner. Openings should be atleast 5 cm away from the main steel, and preferably 10 cm, to ensure that the covering mortar remains intact.

7.3 ***Water Pipes and Medium Sized Openings***

These can be chipped through the channel, or a hole left during precasting, as shown in Fig.6. The main concern is to avoid cutting through the main steel bars. A secondary concern is to use a very small chisel when chipping, to avoid massive shocks to the channel, and thereby minimize the risk of cracking the channel.

7.4 ***Openings between Two Channels - Side-By-Side***

This technique is only possible for the added element style of channel as the overlapping style does not have a gap in-between the channels. Basically, the gap between the channels is increased to allow the piping to fit through. Under no circumstances should the channels be chipped if the main steel is coming at the edge.

7.5 ***Electrical Piping and Small Sized Openings***

These can be chipped through as with the medium sized openings; or

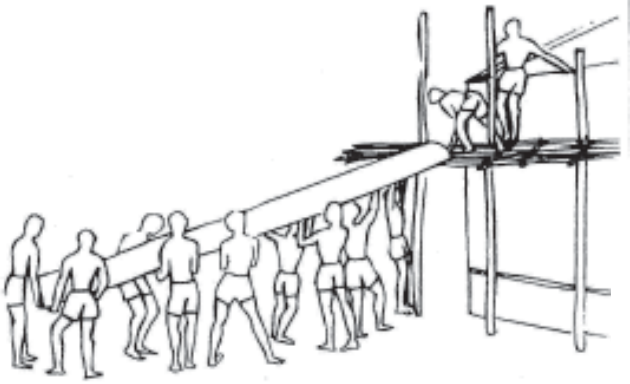


Fig.2: Manual Lifting "Straight on Method"

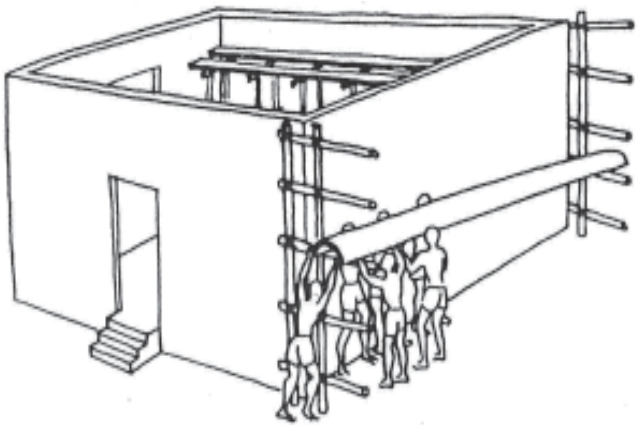


Fig.3: Manual Lifting "Back and Forth Method"

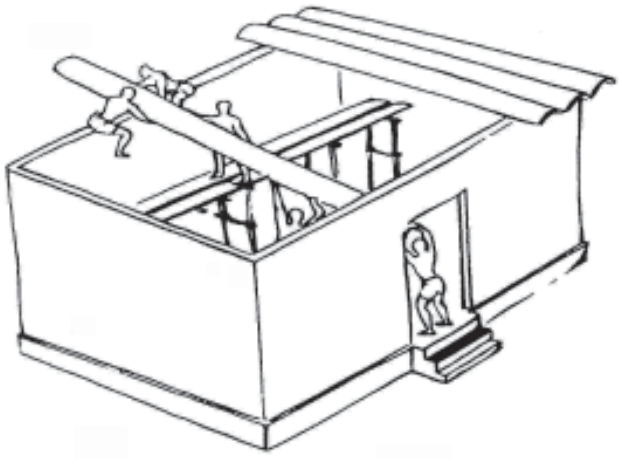


Fig.4: Manual Lifting "Through the Window Method"

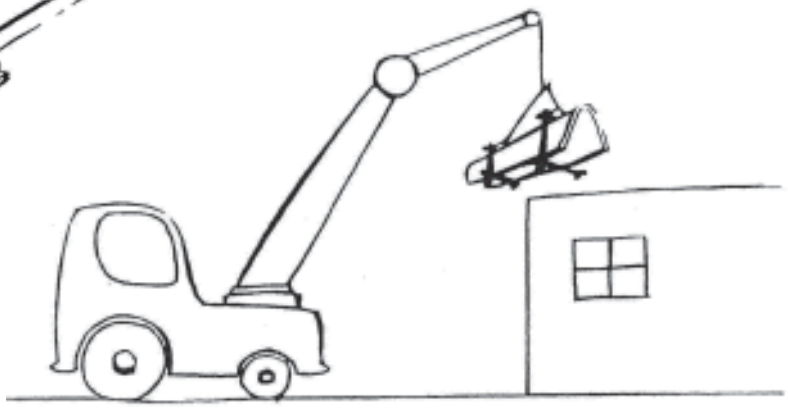


Fig.5: Erection using Lifting Equipment

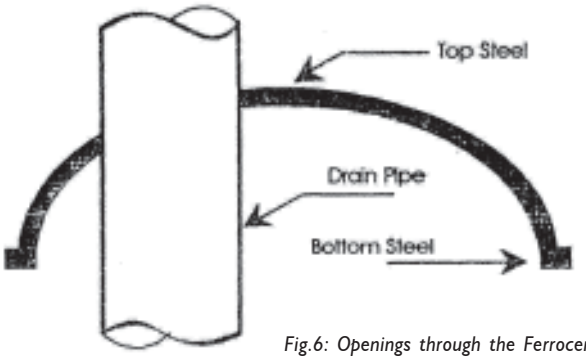


Fig.6: Openings through the Ferrocement Channel

in many cases, can be put through the gaps in between the channels as shown in Fig.7.

7.6 ***Openings between Two Channels - End-To-End***

For larger openings such as staircases, it is often necessary to stop one or two of the channels short of the wall support. One can then support these channels in one of three ways:

1)With one or two pillars

2)With one or two beams

3)By hanging these channels on the adjacent channels.

As the first two methods are common and self-explanatory, regarding (3), it has the advantages of giving a clean look from below, and using a minimum of materials. Essentially, hanging a beam from the adjacent channels and then resting the short channels inside this beam, This is illustrated in Fig.8.

7.7 ***Fan Hooks and Other Anchorage's***

While, in principle, these can be put anywhere, in practice, the two best places are at the top of the channel or at the joint in-between two channels. The best place will depend on which kind of channel is being used; especially in the bare case. In the filled case, one may provide the additional reinforcement required externally (to be later covered with the filling), (Fig.9). In the bare case, where the waterproofing is provided by over-lapping the edges of the channels, the best would be to put the anchorage in the lower channel edge (because of waterproofing). In order to facilitate this, additional reinforcement needs to be built into the channel at that spot during its fabrication (Fig.10).

8 Joining and Grouting

8.1 In placing the channels on the roof, there are essentially three possibilities for joining them together to form the surface of the roof. In the majority of the simple cases, this will be side-to-side; however, sometimes it is also interesting to place them end-to-end, to cover longer spans or to create a sloping roof or overhang; or end-to-side to accommodate L-shaped buildings, or for architectural effect,

The main problem in joining channels is to ensure waterproofing. Specifically, the problems are:

- Side-to-Side (Fig.11): This is the most common case. The main difficulty is that as the structure moves, or there is shrinkage in the grouting, a crack in-between the channels appears. If overlapping or added element 'U'-shaped channels are used, there is little problem as the overlap or added-element (If done with some room for movement) act as an expansion joint. Otherwise, in the filled case, where the 'U' shape is less practical, minimum 'distribution' steel can be placed in the slab (6 mm every 50 cm) or a separate, elastic, waterproofing layer may be provided.
- End-to-End (Fig.12): The tension moment comes from the bottom of the channel, in-between the supports, to the top of the channel, at the support. The top steel of the two channels should be connected, or additional steel should be placed, or a crack will often appear as the top of the channels pull apart due to creep (additional deflection over time) or thermal cycling.
- End-to-Side (Fig.13): This is the same as the End-to-End situation, except that only the channels with the ends on the support need to extend their top steel, in one fashion or another, over the top of one or two of the 'Side' channels.

8.2 ***Joining Channels - Filled Case***

The techniques for the filled case are similar to the bare case. The major addition is that because we are creating a slab, we have both the opportunity and the necessity (because of the higher dead and live loads) to put additional steel to fake up tensile stresses over the fop of the supports. The main mistake made in joining the channels end-to-end or end-to-side is to leave out this top steel. The main mistakes made in joining the channels side-by-side are:

1) not cleaning and wire brushing the edges before joining
2) not using the mortar mix within one hour of mixing
3) not using the proper water/ cement ratio.
4) not immediately beginning the curing by covering the joint with damp sand, plastic sheet, or other suitable material to prevent the mortar from drying out.
5) additionally, for roofs, 6 mm distribution steel every 30 to 50 cm in the slab will help to take up thermal stresses. But this is optional depending on other factors such as waterproofing and weathering course,

9 Filling

9.1 Normally the channels, by themselves, provide a thin, irregular surface. Often it is desirable to have

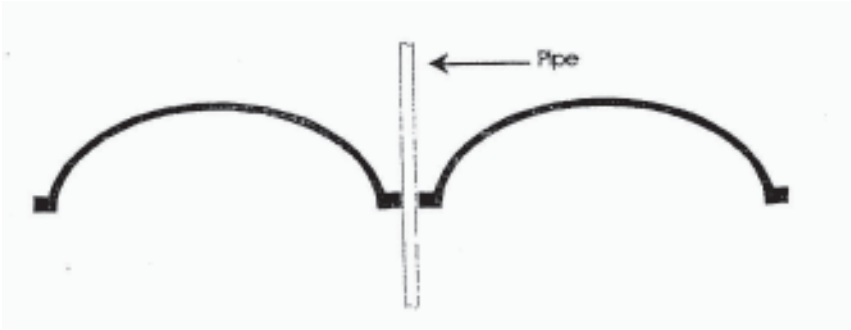


Fig.7: Piping through gap in-between Channels

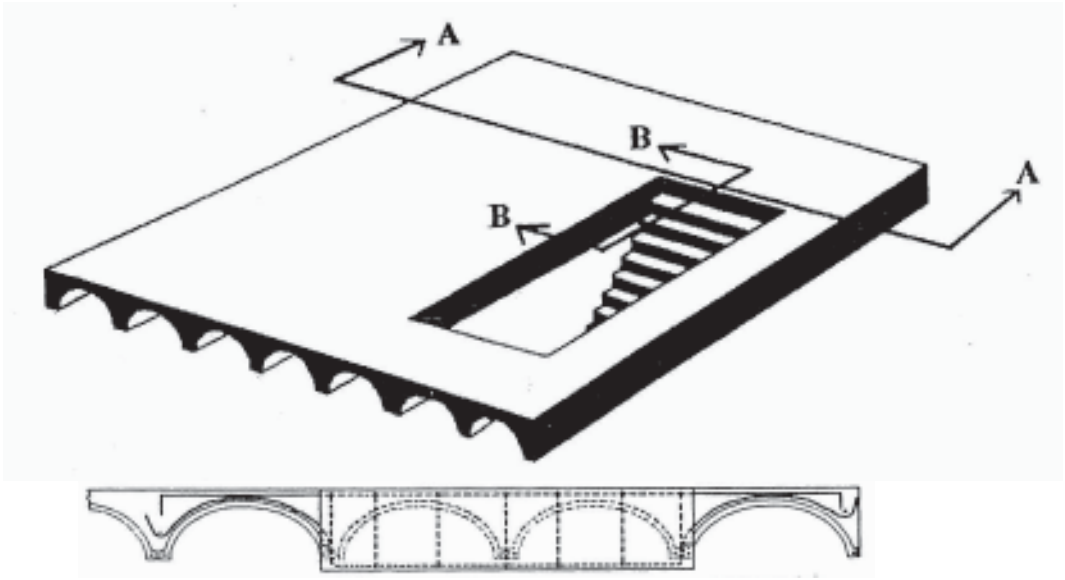


Fig.8: Staircase Opening, Overview & Section A

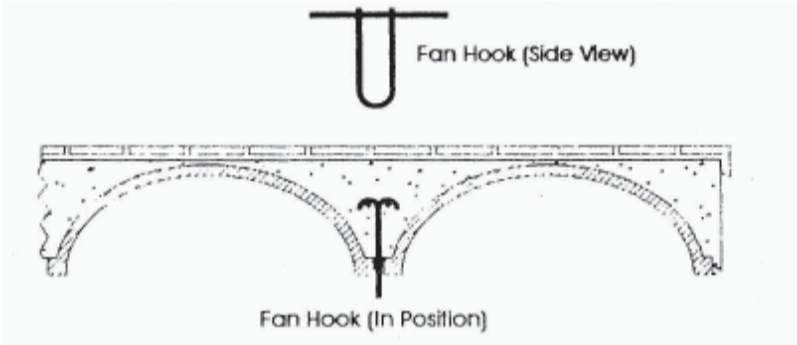


Fig.9: Fan Hook Anchorage Detail

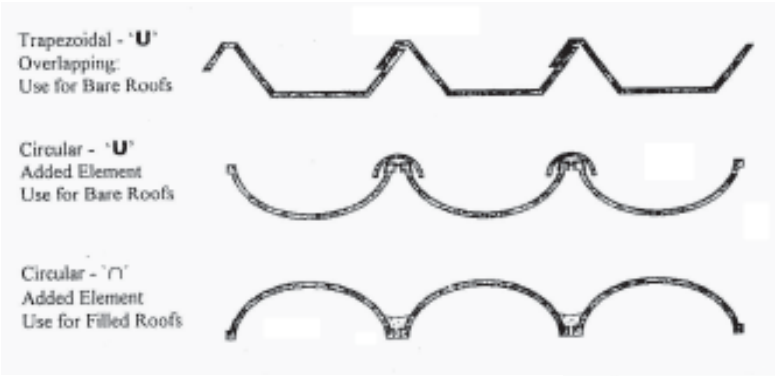


Fig.10: Channels Joined Side-to-Side

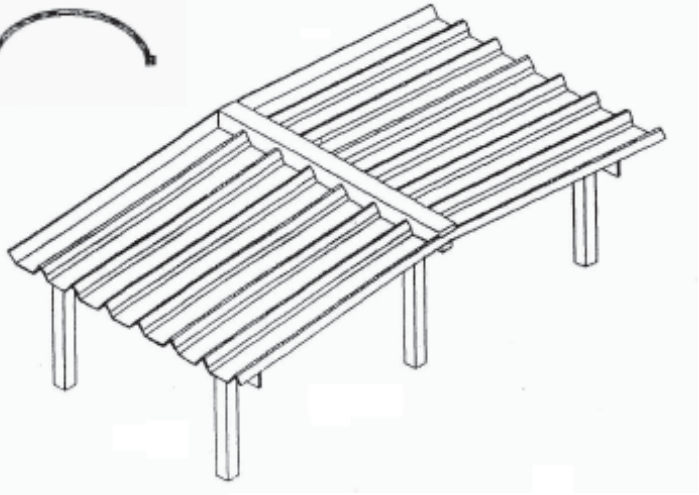


Fig.11: Channels Joined End-to-End

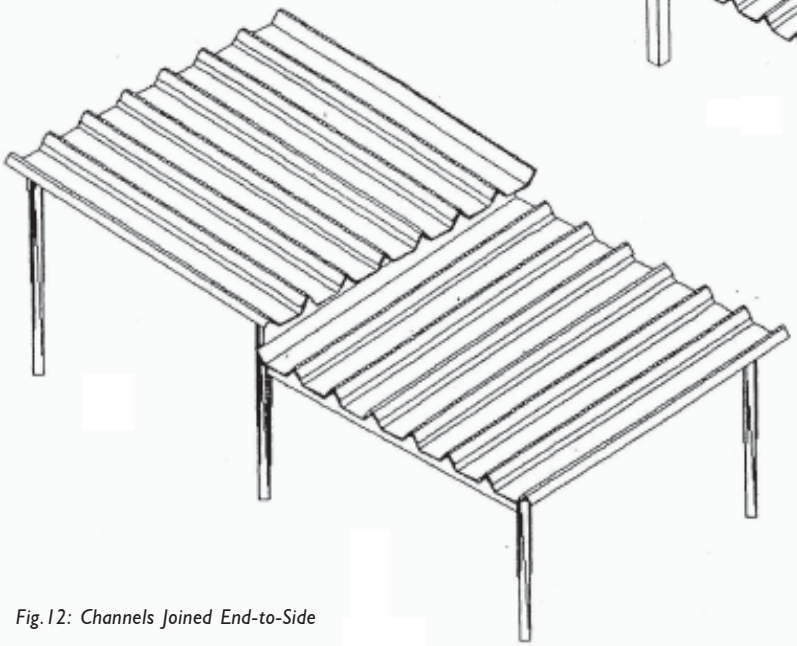


Fig.12: Channels Joined End-to-Side

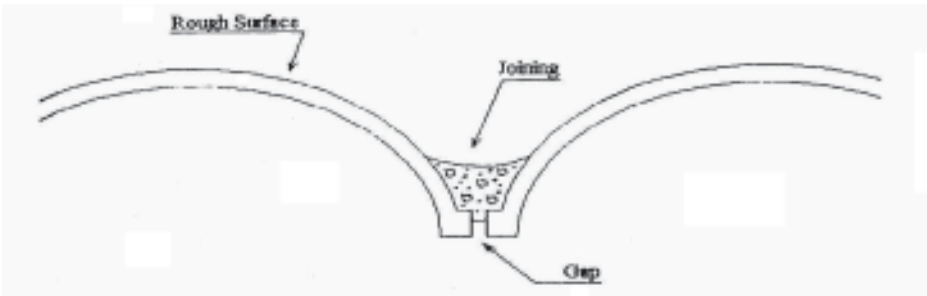


Fig.13: Filled Channels Joined Side-by-Side

either a smooth surface, to use as a floor or terrace; or a thicker, more insulating section to protect from the heat. The valleys in-between the channels in the 'ᑎ' orientation can be readily filled in to provide such a surface and protection.

9.2 ***Broken Brick - Lime (BBL)***
Also called brick jelly lime, the mixture of 1 part hydrated lime with 2 parts by volume broken fired brick (nominally 1.5 cm dia. pieces along with the brick powder (surkhi) from the breaking process) creates a low density, lower cost concrete. In the general case, broken brick lime concrete is recommended for the filling because of its thermal characteristics and lower cost.

9.3 ***Concrete (M10)***
Normally filled channels are under-reinforced. In other words, the strength of the resulting slab is not limited by the compressive stress of the concrete, but by the size and type of steel used. Except when using 16 or 20 mm tension steel, the maximum compressive stress is 25 kg/cm^2 or less. The implication is that either where a waterproof filling is not required or where waterproofing is supplied by some other means (such as an impermeable membrane), a lower grade concrete can be used.

9.4 ***Concrete (M20)***
As channels are only one-way reinforced, it is advisable for high quality floors or roofs to lay distribution steel in the slab. In order to protect this steel, M20 or better grade concrete is recommended.

10 Equipment Specifications

Table: 4.6 m or 6.1m in length, 0.9 m wide and freestanding

Moulds: 5m x 4.6m or 4m x 6.1m length fabricated in steel

Vibrators: 2 vibrators each powered with 1 HP motor, 440V, 3000 r.p.m.

Lifting Frame: 4.6m or 6.1m in length for lifting of green channels

Gantry: chain pulley block or lifting crane of capacity 2 tonnes with X-Y-Z motion provided through electric motors or manually

Accessories: consisting of lifting tongs, strength testing cubes, tools and spanners.

List of Indian Standards referred in this Section

CONSTRUCTION TECHNIQUES

1	IS 432:1982 (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 *(Third Revision)*
2	IS 456:2000	Plain and Reinforced Concrete - Code of Practice *(Fourth Revision)*
3	IS 875:1987(Part 1)	Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures - Part 1 : Dead Loads – Unit Weights of Building Materials and Stored Materials *(Second Revision)*
4	IS 875:1987 (Part 2)	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Part 2 : Imposed Loads *(Second Revision)*
5	IS 875:1987 (Part 3)	Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures - Part 3 : Wind Loads *(Second Revision)*
6	IS 1343:1980	Code of Practice for Prestressed Concrete *(First Revision)*
7	IS 1346:1991	Code of Practice for Waterproofing of Roof with Bitumen Felt.
8	IS 1489:1991 (Part 1)	Portland-Pozzolana Cement – Specification - Part 1 : Fly Ash Based *(Third Revision)*
9	IS 1489:1991 (Part 2)	Portland-Pozzolana Cement – Specification - Part 2 : Calcined Clay Based *(Third Revision)*
10	IS 1786:2008	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement - Specification
11	IS 2011:1980	Code of Practice for Flat Roof Finish – Mud Phuska
12	IS 2645:2003	Integral Waterproofing Compounds for Cement Mortar and Concrete - Specification *(Second Revision)*
13	IS 3036:1992	Laying Lime Concrete for Waterproofed Roof Finish – Code of Practice
14	IS 3935:1966	Code of Practice for Composite Construction *(Fifth Reprint May 1993)*
15	IS 4326:1993	Earthquake Resistance Design Construction of Buildings – Code of Practice
16	IS 4365:1967	Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs
17	IS 4905:1968	Method of Random Sampling
18	IS 6332:1984	Code of Practice for Construction of Floors and Roofs Using Precast Doubly-curved Shell Units *(First Revision)*
19	IS 6820:1987	Recommendation for Modular Coordination in Building Industry - Application
20	IS 8112:1989	43 Grade Ordinary Portland Cement – Specification *(First Revision)*
21	IS 9918:1981	Code of Practice for Insitu Waterproofing and Damp proofing Treatment with Glass Fibre Tissue Reinforced Bitumen
22	IS 10297:1982	Code of Practice for Design and Construction of Floors using Precast Reinforced/Prestressed Concrete Ribbed or Core Slab Units
23	IS 10440:1983	Code of Practice for Construction of RB & RBC Floors & Roofs
24	IS 10505:1983	Code of Practice for Construction of Floors & Roofs using Precast Concrete Waffle Units
25	IS 13990:1994	Precast Reinforced Concrete Planks & Joists for Roofing & Flooring - Specification
26	IS 13994:1994	Design and Construction of Floor & Roof with Precast Reinforced Concrete Planks & Joists – Code of Practice
27	IS 14142:1994	Design and Construction of Floors & Roofs with Prefabricated Brick Panels – Code of Practice
28	IS 14143:1994	Prefabricated Brick Panel and Partially Precast Concrete Joist for Flooring & Roofing - Specification
29	IS 14201:1994	Precast Reinforced Concrete Channel Units for Construction of Floors & Roofs - Specification
30	IS 14215:1994	Design and Construction of Floors & Roofs with Precast Reinforced Concrete Channel Units – Code of Practice
31	IS 14241:1995	Precast Reinforced Concrete L-Panels for Roofing – Specification
32	IS 14242:1995	Design and Construction of Roofs using Precast Reinforced Concrete L-Panels – Code of Practice.

Building Components

BC 01

Specifications for Precast Solid /Hollow Cement Concrete Blocks

1 General

1.1 Precast Solid/Hollow Cement Concrete Blocks shall be used as masonry units for walls. The blocks shall be made to required shape and sizes to fit the different construction need. They include strecher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units. Well-graded concrete mix shall be adopted for casting of blocks.

1.2 Following types of blocks are used in the construction of load bearing and partition walls:

a) Hollow (open and closed cavity) load bearing concrete blocks,

b) Hollow (open and closed cavity) non-load bearing concrete blocks, and

c) Solid load-bearing concrete blocks and non-load bearing concrete blocks.

1.3 ***Hollow (Open and Closed Cavity) Concrete Block***

The hollow (open and closed cavity) concrete blocks shall conform to the following grades:

a) Grade A – These are used as load bearing units and Shall have a minimum block density of 1500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5, 7.0, 8.5, 10.0, 12.5 and 15.0 N/mm^2 respectively at 28 days,

b) Grade B – These are also used as load bearing units and shall have a block density between 1100 kg/m^3 and 1500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5 and 5.0 N/mm^2 respectively at 28 days.

1.4 ***Solid Concrete Block – Grade C***

The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/m^3. These shall be manufactured for minimum average compressive strength of 4.0 and 5.0 N/mm^2 respectively.

2 Dimensions and Tolerances

2.1 The actual dimensions of the blocks shall be 10 mm short of the nominal dimensions. The nominal dimensions of concrete block shall be as follows:

Length : 400, 500 or 600 mm

Height : 200 or 100 mm

Width : 50,75, 100, 150,200, 250 or 300 mm.

2.2 In addition, block shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full lengths. Full length and half length U-blocks may also be manufactured for the purposes of band and lintels.

Table-1: Minimum Face Shell and Web Thickness

All dimensions in millimetres.

Sl No.	Nominal Block Width	Face Shell	Thickness of Web	Total Web Thickness per Course in Anv 200 mm Length of Wall
		Min	*Min*	*Min*
i)	100 or less	25	25	25
ii)	100-150	25	25	30
iii)	150-200	30	25	30
iv)	Over 200	35	30	38

2.3 The nominal dimensions of the units are so designed that taking account of the thickness or mortar joints, they will produce wall lengths and heights which will conform to the principles of modular co-ordination.

2.4 Blocks of sizes other than those specified in 2.1 may also be used by mutual agreement between the purchaser and the supplier. In the case of special concrete masonry units such as jallie wall blocks and ornamental blocks, the specified sizes may not necessarily apply.

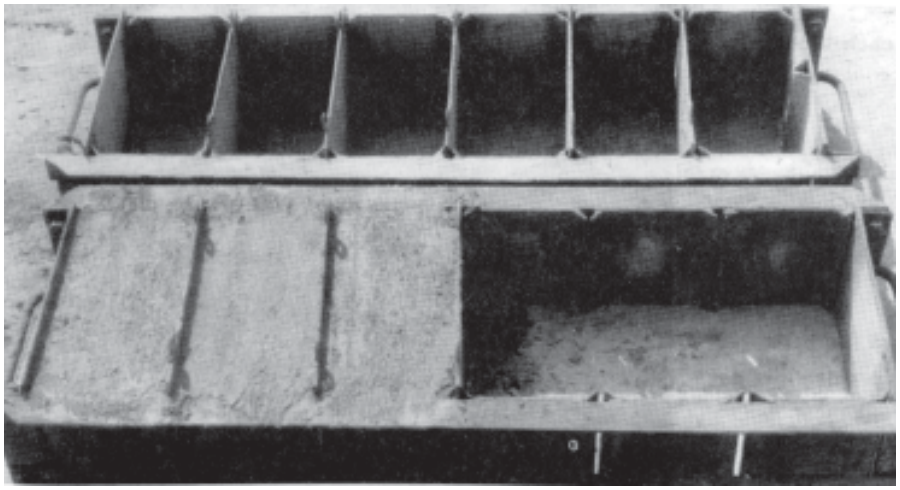
2.5 Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shall be not less than the values given in Table-1.

2.6 A block with special faces shall be manufacatured and supplied. These shall be semi-circular recess for accommodating vertical reinforcement or conduits etc. Fig.1.

2.7 ***Tolerances:***

Following maximum deviation in the each block shall be permitted

Length	±5mm
Breadth/width	±3mm
Height	±3mm



3 Materials

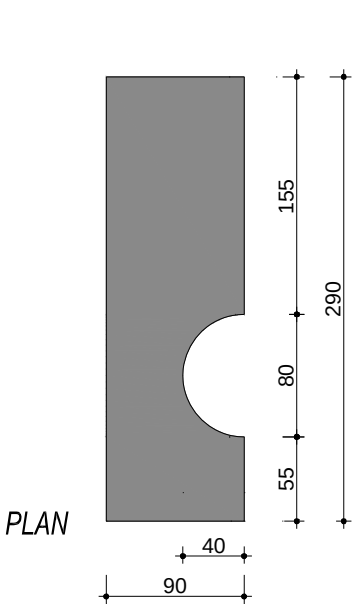
3.1 ***Cement***

33 grade ordinary Portland cement, conforming to IS 269 or 43 grade ordinary Portland cement, conforming to IS 8112, or Portland slag cement conforming to IS 455, or Portland pozzalana cement, fly ash based conforming to IS 1489 (Part 1), or Supersulphated cement conforming to IS 6909, or Rapid hardening Portland cement conforming to IS 8041, or White Portland cement conforming to IS 8042, or Hydrophobic Portland cement conforming to IS 8043, or 53 grade ordinary Portland cement conforming to IS 12269, may be used.

3.1.1 When cement conforming to IS 269 or IS 8112 or IS 12269 is used, replacement of cement by fly ash conforming to IS 3812 (Part 1) may be permitted up to a limit of 25 percent. However, it shall be ensured that blending of fly ash with cement is as intimate as possible, to achieve maximum uniformity.

3.2 ***Aggregates***

3.2.1 The aggregates used in the manufacture of blocks at the mixer



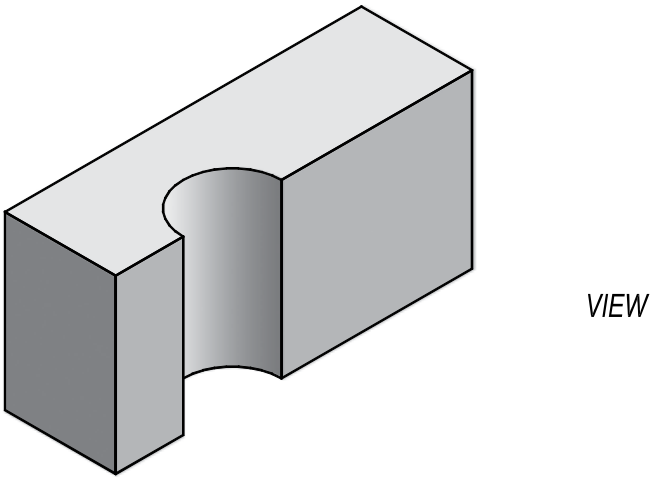


FIG 1
SPECIAL BLOCK FOR EMBEDDING VERTICAL STEEL

ALL DIMENSIONS ARE IN mm

or the mixing platform shall be clean and free from deleterious matter and shall conform to the requirements of IS 383.

3.2.2 Fly ash conforming to IS 3812 (Part 2) may be used for part replacement of fine aggregate upto a limit of 20 percent .

3.3 ***Water***

The water shall conform to the requirements of IS 456.

3.4 ***Additives or Admixtures***

Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be:

a) accelerating, water reducing, air-entraining and super plasticizer conforming to IS 9103,
b) Waterproofing agents conforming to IS 2645, and
c) Colouring pigments.

3.5 Well-graded concrete mix shall be used for casting of the blocks. It is advisable to adopt the precise mix design with the available ingredients. The concret mix used for the blocks shall not be richer than one part by volume of cement to six parts by volume of combined aggregate before mixing.

4 Manufacture

4.1 ***Manual Method :***

The mould shall be of mild steel plate of required size with handles for obtaining clean, sharp-edged blocks with pre-finished faces. 8 to 20 moulds can be arranged in a row with no gap in between to form a battery. Platform and moulds shall be cleaned properly. Lubricating oil shall be applied inside the moulds and on the area of platform under the moulds. The moulds shall be filled up thoroughly and compacted with a plate vibrator. Pressure is applied on the handles of the high frequency vibrator to impart the vibrations more effectively. Vibration shall be stopped as soon as slurry appears under the moulds side. The mould shall be released within a few minutes of casting.

4.2 ***Mechanised Method:***

The blocks can be manufactured by vibro compaction type of machines.

4.3 ***Mixing***

4.3.1 Batching of the ingredients should be done accurately and concrete mixing shall be done in a mixer to achieve homogeneous mix.

4.3.2 Mixing shall be continued until there is a uniform distributicm of the materials, and the mass is uniform in colour and consistency.

4.4 ***Placing and Compaction***

4.4.1 The block should be compacted by vibro-compaction and finished to proper size -without broken edges.

4.4.2 After ejection demoulding, the blocks shall be handled carefully to avoid damage. The blocks shall be protected until they are sufficiently

hardened before starting curing.

4.5 ***Curing***

4.5.1 The blocks hardened shall then be cured as per IS 456 or by mist curing so as to deliver the specified strength of block.

4.5.2 The blocks hardened may alternatively be cured by steam.

4.6 ***Drying***

After curing the blocks, they shall be dried for a period of 4 weeks before being used on the work. In case of curing by steam, once low pressure steam curing has been done, the blocks shall be dried at ambient temperature for a period of seven days. The blocks shall then be stacked with voids horizontal to facilitate through passage of air. It shall be ensured that the blocks have been thoroughly dried and allowed to complete their initial drying shrinkage before supply to the work-site.

5 Physical Properties of the Block

5.1 All units shall be sound and free of cracks or other defects which interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor chiping resulting from the customery methods of handling during delivery, shall not be deemed grounds for rejection.

5.1.1 Where 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 percent of a consignment contains slight cracks or small chippings not larger than 25 mm, this shall not be deemed grounds for rejection.

5.2 The overall dimensions of the units shall be as per point 2 subject to tolerances mentioned therein.

5.3 Block Density, Compressive Strength at 28 days for various types of blocks will be as per Table-2.

5.4 The water absorption, being the average of three units, when determined in the manner prescribed in IS 2185 (Part 1) shall not be more than 10 percent by mass.

5.5 The drying shrinkage of the units when unrestrained being the average of three units, shall be determined in the manner described in IS 2185 (Part 1) and shall not exceed 0.06 percent.

5.6 The moisture movement of the dried blocks on immersion in water, being the average of three units, when determined in the manner described in IS 2185 (Part 1), shall not exceed 0.09 percent.

6 Method of Construction

6.1 The wall made of solid/hollow concrete masonry blocks shall be designed like any other masonry wall. The values of basic permissible stresses given in IS 1905 'Structural safety of building masonry wall' shall also be adopted for these blocks.

6.2 Provision of vertical reinforcement at corners and openings to impart desired protection to the structure in seismic regions shall be made by

Table 2 : Physical Properties of Blocks

Type	Grade	Density of Block kg/m^2	Minimum Average Compressive Strength of Units N/mm^2	Minimum Compressive Strength of Individual Units, N/mm^2
Hollow (open and closed cavaty) load bearing unit	A(3.5)	Not less than 1500	3.5	2.8
	A(4.5)		4.5	3.6
	A(5.5)		5.5	4.4
	A(7.0)		7.0	5.6
	A(8.5)		8.5	7.0
	A(10.0)		10.0	8.0
	A(12.5)		12.5	10.0
	A(15.0)		15.0	12.0
	B(3.5)	Less than 1500 but not less than 1100	3.5	2.8
	B(5.0)		5.0	4.0
Solid load bearing unit	C(5.0)	Not less than 1800	5.0	4.0
	C(4.0)		4.0	3.2

using special blocks with recess.

6.3 Average joint thickness shall be 10 mm.

6.4 Control of shrinkage cracks and in joints - It shall be controlled by using the mortar weaker than that of blocks and metal reinforcements shall be embedded in block masonry at openings or other points where the section of a wall changes.

6.5 Wetting of blocks - Wetting may generally not be necessary. The blocks shall be dry at the time of being laid in the wall. In dry hot climate, the blocks shall be wetted on the surface only by sprinkling water.

6.6 Laying of blocks - Recommendations for laying of blocks are similar to those for laying of brick work.

6.6.1 Vertical joints in alternate courses shall be broken by 1/3 overlap or by using smaller length blocks.

6.6.2 At T junction of two 200mm walls, a vertical joint at the centre line of cross wall shall be broken in alternate courses by providing 2/3 size blocks.

6.6.3 At T junction of 200mm wall with 100 mm wall and 100 mm wall with 100 mm wall, the joints shall be staggered by using 1/3 size and 2/3 size blocks respectively.

6.7 Service pipes and electrical fittings - The nitches for fixing electrical switch boards can be created by using thinner 100 mm thick precast blocks. In case the opening is required after construction, full blocks shall be taken out. The cement concrete shall be filled in remaining gap, if any.

7. The testing, sampling and marking of blocks shall be as per the IS 2185 (Part 1).

BC 02

Specifications for Precast Concrete Stone Masonry Blocks

1 General

1.1 Concrete Stone masonry blocks are made of large size stone spalls bonded together with lean cement concrete mix. Precast concrete stone masonry block are true in size and shape.

1.2 ***Concrete Stone Masonry Blocks*** are a precast cement concrete solid blocks having stone spalls 25-30 percent of block volume and cement concrete with dense stone aggregate and sand. It is 100 percent solid.

1.3 ***Stone Spalls*** are broken stone pieces of varying sizes obtained by breaking the natural river boulders or quarry stones.

1.4 ***In case of Stone Face Exposed Blocks*** the stone spalls are exposed at one of its face. This face, when forms the exposed wall face, the wall gets the texture of stones.

2 Dimensions and Tolerances

The nominal dimensions of concrete stone masonry blocks shall be as given in Table-1.

2.1 The term 'nominal' means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10 mm short of the nominal dimensions.

2.2 A special block with semi-circular recess can be cast for accommodating vertical reinforcement or conduits or pipes for earthquake resistant construction.

2.3 ***Tolerances***

2.3.1 The maximum variation in the units shall not be more than specified.

Length	:	±5mm
Breadth	:	±3mm
Height	:	±3mm

3 Materials

3.1 ***Stone Spalls***

The stone spalls shall be of size ranging from 50mm to 250mm in dimension. The stone spalls shall be hard, solid, round in shape, durable, free from decay and weathering. These shall not be flaky. The spalls shall have rough surface for better bond with cement concrete. Good quality stones, such as granite, sand stone and basalt shall be used. Slate shale or any other soft and flaky stone shall not be used.

3.2 ***Cement***

3.2.1 Ordinary and low heat Portland cement conforming to IS 269, or Portland slag cement conforming to IS 455, or Portland pozzolana cement conforming to IS 1489 (Part 1), or Supersulphated cement conforming to IS 6909, or

Table 1: Dimensions of Blocks

Nominal Size (mm)			Actual Size (mm)						
Length	Breadth		Height		Length	Breadth		Height	
100	100	150	200	150	90	90	140	190	140
150	100	150	200	150	140	90	140	190	140
200	100	150	200	150	190	90	140	190	140
225	100	150	200	150	215	90	140	190	140
300	100	150	200	150	290	90	140	190	140

Rapid hardening Portland cement conforming to IS 8041, or White Portland cement conforming to IS 8042, or Hydrophobic Portland cement conforming to IS 8043 shall be used.

3.2.2 When cement conforming to IS 269 is used, replacement of cement by flyash conforming to IS 3812 (Part 1) may be permitted up to a limit of 25 percent. However, it shall be ensured that blending of flyash with cement is as intimate as possible, to achieve maximum uni- formity.

3.3 Coarse aggregate shall be 10mm and down grade conforming to IS 383.

3.4 Sand shall be well-graded, clean and free from deleterious matter, and shall conform to IS 383. Besides, it shall have fine particles 15 to 20 percent passing 300 micron IS Sieve and 5 to 15 percent passing 150 micron IS Sieve.

3.5 The grading of the combined aggregates shall conform as near as possible to the requirements indicated in IS 383. It is recommended that the fineness modulus of the combined aggregates shall be between 3.6 and 4.

3.6 Flyash conforming to IS 3812 (Part 2) may be used for part replacement of fine aggregate up to a limit of 20 percent.

3.7 The water used in the manufacture of precast concrete stone masonry blocks shall conform to the rcquirements of IS 456.

4 Casting and Curing

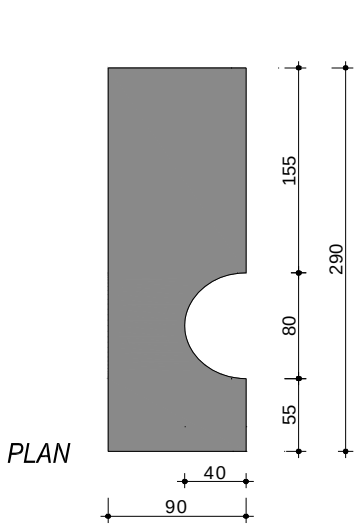
4.1 Blocks may be manufactured either at construction site or in factory. It shall be cast on platform using steel moulds with surface vibrator for compaction of cement concrete.

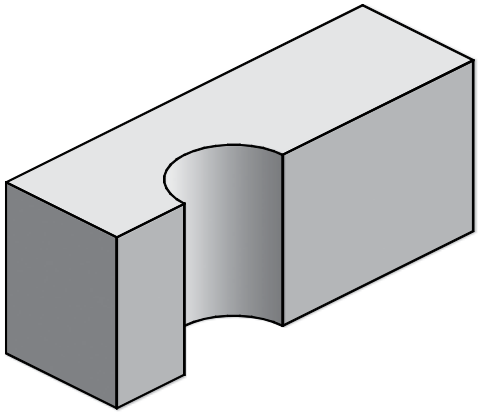
4.2 ***Mix***

4.2.1 The cement concrete mix for blocks shall not be richer than 1:3:6 and shall not be leaner than 1:5:8.

4.3 ***Placing and compaction***

4.3.1 Depending upon the size of the stone spalls, these shall be used either in one layer or in two layers. When used in two layers, large size spalls of 100mm and above shall be placed in the bottom and concrete poured all around and at top, and shall be tamped manually. Second layer of stone spalls of size 50 mm and above shall be placed over the first layer, and again concrete is poured all around and up to 20 to 30 mm above the top level of mould. Afterwards compaction of concrete shall be achieved by placing plate vibrator on the top of concrete filled.





VIEW

FIG 1
SPECIAL BLOCK FOR EMBEDDING VERTICAL STEEL

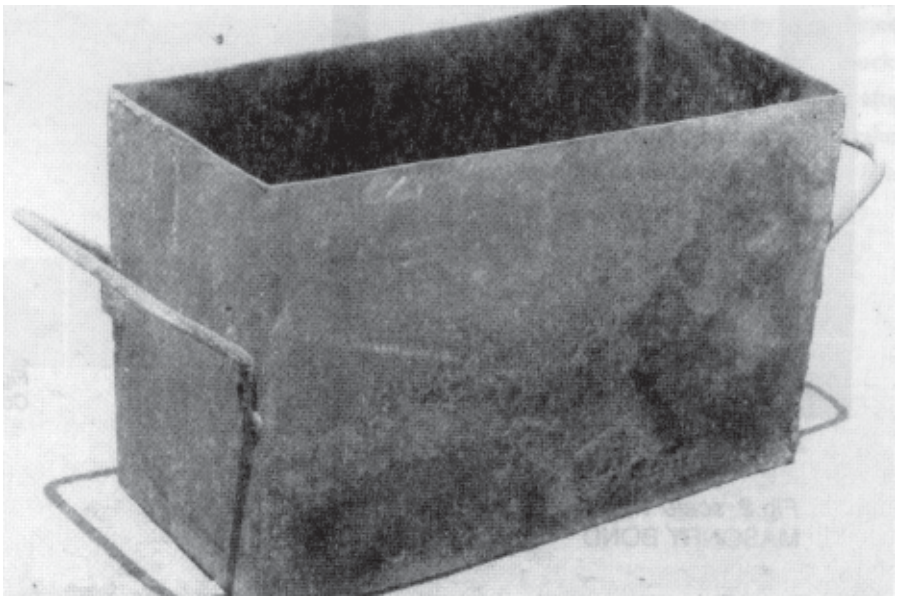
ALL DIMENSIONS ARE IN mm

4.3.2 Each stone spall shall have minimum space of about 15 to 20 mm around it and between mould and spall to enable cement concrete to flow in for binding together the stone spalls and also to provide cover and give shape to the block. For blocks with exposed stone texture, the stone spalls shall touch the surface of the mould or the casting platform.

4.3.3 Blocks may be compacted manually as well as mechanically. In case of manual compaction, the concrete laid after the first layer of stone spalls shall be tamped with mason's tool and again it shall be tamped with suitable tampers and compacted from top and finally struck off level with trowel.

4.3.4 In case of mechanical compaction, the mould shall be filled up to overflow, vibrated and mechanically tamped using external vibrator and struck off level.

4.3.5 Demoulding shall be done 5 to 10 minutes after compaction. In case of fixed type mould it shall be pulled up with side handles while



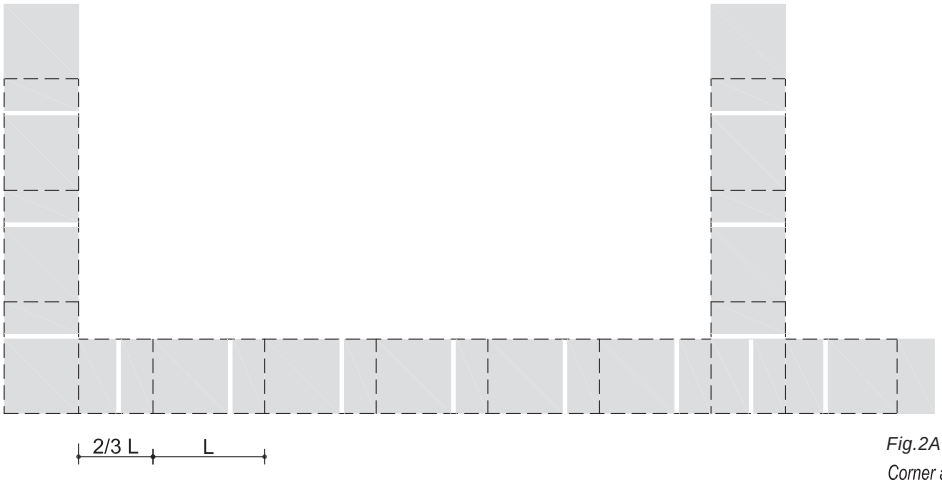


Fig.2A
Corner and T- Junction of 200 mm Wall

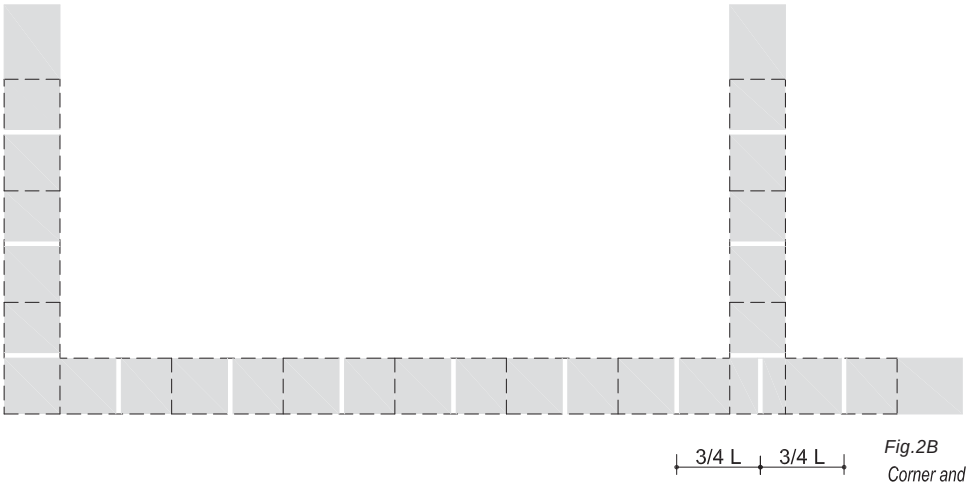


Fig.2B
Corner and T- Junction of 150 mm Wall

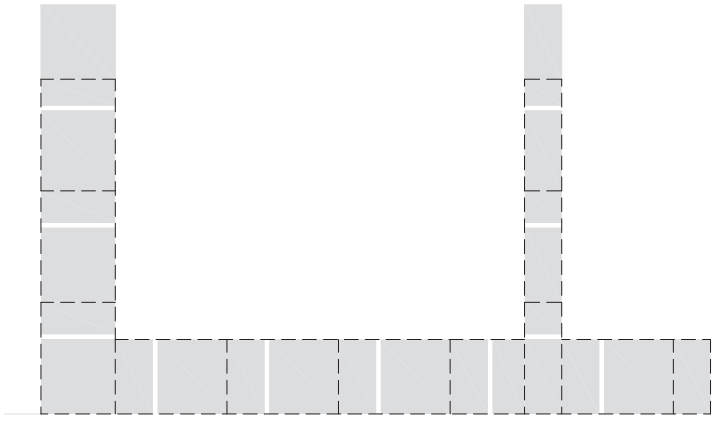


Fig.2C
Corner and T- Junction of 200 and 100 mm Wall

Fig.02
MASONRY BOND

ALL DIMENSIONS ARE IN mm

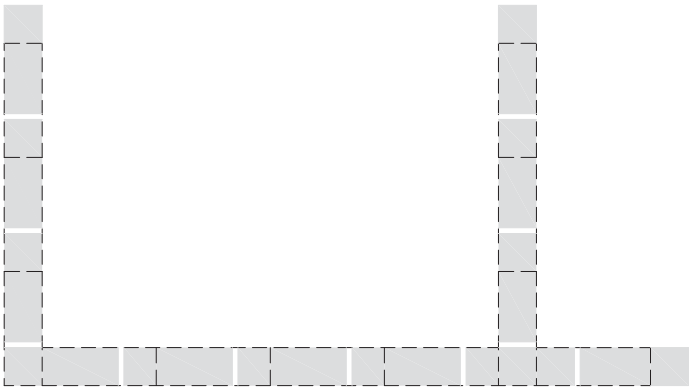


Fig.2D
Corner and T- Junction of 100 mm Wall

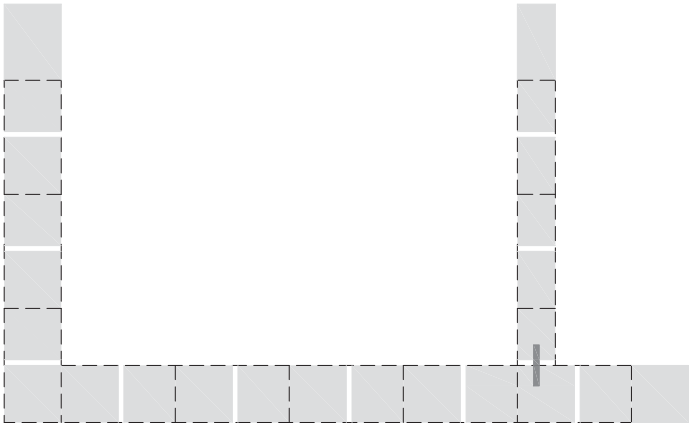


Fig.2E
Corner and T- Junction of 150 and 100 mm Wall

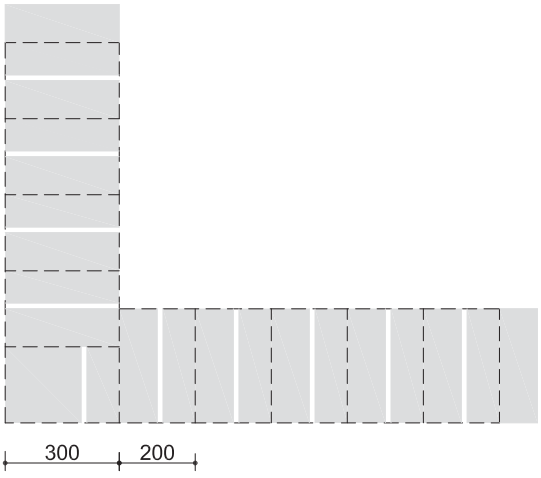


Fig.2F
Corner and T- Junction of 300 mm Wall

Fig.02
MASONRY BOND

ALL DIMENSIONS ARE IN mm

pressing down the block with the plate at top with thumb. In case of split type mould, the sides shall be removed first and the partition plates (gang mould) shall be pulled up subsequently.

4.3.6 After demoulding, the blocks shall be protected until they are sufficiently hardened to permit handling without damage.

4.4 **Curing** - The blocks shall he cured by sprinkling water for at least 14 days. There after the blocks shall be dried for a period of 2 weeks before use in construction.

5 Physical Requirements

5.1 ***General*** - All blocks shall be solid and free of cracks or other defects which interfer with the proper placing of the unit or impair the strength or performance of the construction.

5.2. ***Classification*** - The blocks shall be classified according to the average compressive strength as given in Table 2.

5.3 ***Compressive Strength*** - The minimum compressive strength at 28 days, being the average of eight blocks, and the minimum compressive strength at 28 days of individual blocks, when tested as described in IS 12440 shall be as prescribed in Table.2.

5.4 ***Water Absorption*** - The water absorption, being the average of three blocks, when determined in the manner prescribed in IS 12440 shall not be more than 6 per cent by mass.

5.5 The testing, sampling and marking shall be as per IS 12440.

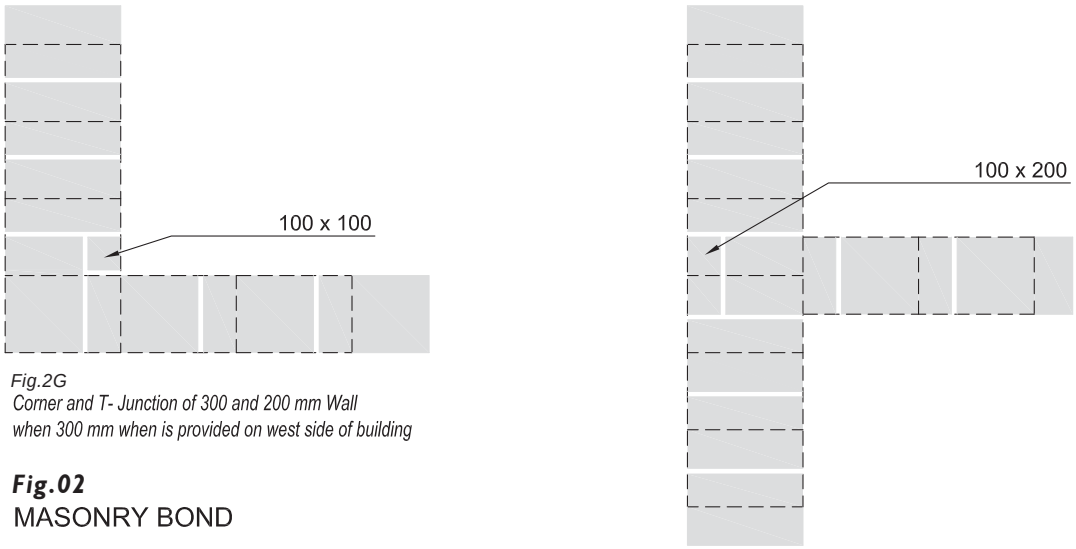


Fig.2G
Corner and T- Junction of 300 and 200 mm Wall when 300 mm when is provided on west side of building

Fig.02
MASONRY BOND

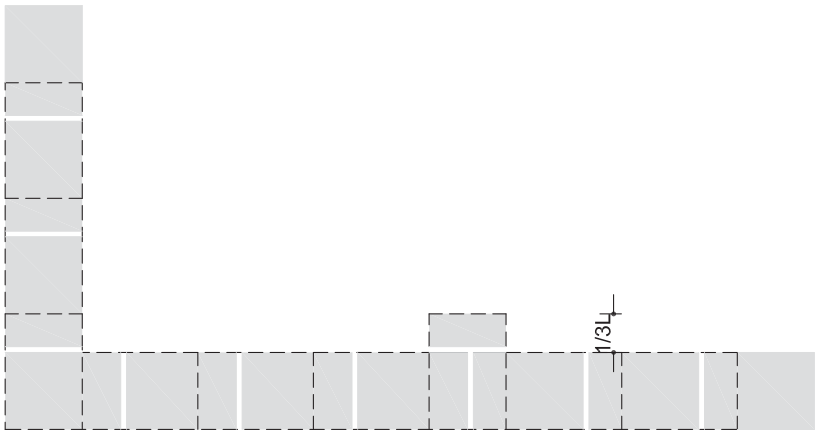


Fig.3A
200 mm Wall with 300 mm Pilaster

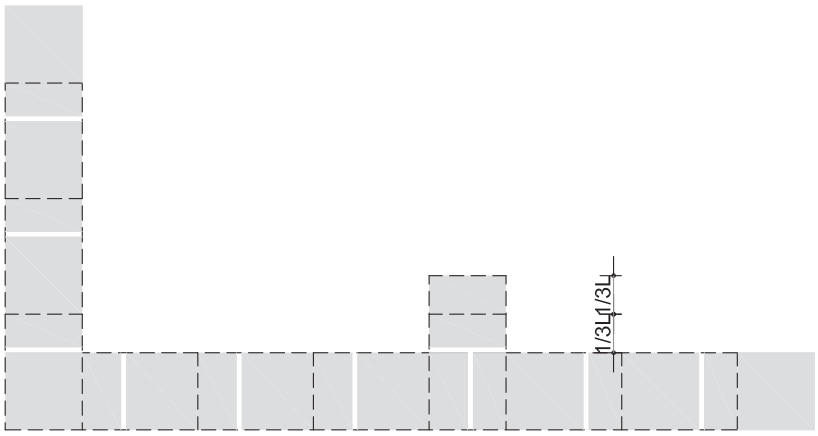


Fig.3B
200 mm Wall with 400 mm Pilaster

Fig.03
MASONRY BOND AND PILASTER

ALL DIMENSIONS ARE IN mm

Table 2 : Compressive Strength of Blocks

Class Designation	Minimum Average* Compressive Strength of Blocks kg/cm²	Minimum Strength of Individual Blocks kg/cm²
50	50	35
60	60	42
70	70	50
90	90	63
100	100	75

* For 100mm wide blocks (for 100mm thick walls) the minimum strength may be 35 kg/cm²

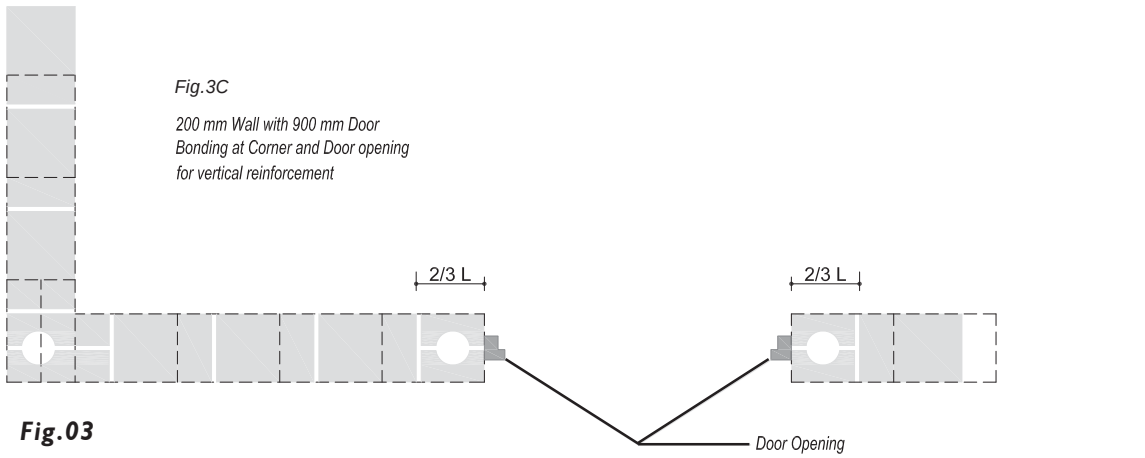


Fig.3C

200 mm Wall with 900 mm Door Bonding at Corner and Door opening for vertical reinforcement

Fig.03

MASONRY BOND AND PILASTER

ALL DIMENSIONS ARE IN mm

6 Method of Construction

6.1 The wall made of solid concrete masonry blocks shall be designed like any other masonry wall. The values of basic permissible stresses given in IS 1905 'Structural safety of building masonry wall' shall also be adopted for precast concrete stone masonry blocks.

6.2 Provision of vertical reinforcement at corners and openings to impart desired protection to the structure in seismic regions shall be made by using special blocks with recess (Fig.1).

6.3 The cutting of these blocks is not possible, building dimensions shall be planned to suit block dimensions. Alternatively special size blocks can be made.

6.4 Average joint thickness shall be 10mm.

6.5 Shrinkage cracks and in joints shall be controlled by using the mortar weaker than that of blocks, and metal reinforcements shall be embedded in masonry at opening or other points where the section of a wall changes (Fig. 2E).

6.6 Wetting of blocks shall generally not be necessary. The blocks shall be dry at the time of being laid in the wall. In dry hot climate, the blocks shall be wetted on the surface only by sprinkling water.

6.7 Laying of blocks – Recommendations for laying of blocks are similar to those for laying of brick work. This is shown in Fig.2 and 3.

6.8 Curing - The masonry shall be kept constantly wet for at least 7 days.

6.9 Service pipes and electrical fittings - The nitches for fixing electrical switch boards can be created by using thinner 100 mm thick precast stone blocks. In case the opening is required after construction, full blocks shall be taken out. The cement concrete shall be filled in remaining gap, if any.

6.10 Method of construction shall conform to the IS 14213.

BC 03

Specifications for Hollow or Solid Lightweight Concrete Masonry Units

1 General

1.1 Hollow or solid light weight concrete masonry units can be produced from wastes such as sintered flyash, light-weight aggregate or bloated clay light-weight aggregate. Their use will be specially economical in high rise buildings to reduce the dead weight. The following type of light-weight concrete masonry units are used in the construction of load-bearing and non-load bearing walls:

A Hollow (open and closed cavity) load bearing concrete blocks,

B Hollow (open and closed cavity) non-load bearing concrete blocks,

C Solid load-bearing concrete blocks, and

D Solid non-load bearing concrete blocks.

2 Dimensions and Tolerances

2.1 The nominal sizes of concrete block shall be as follows:

Length	400, 500 or 600 mm
Height	100 or 200 mm
Breadth	50, 75, 100,150,200,250 or 300 mm

2.2 In addition, block shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full length.

2.3 Hollow concrete blocks shall be made either with two cores or three cores. Stretchers in the 200, 250 and 300 mm breadth shall generally have concave ends, each end flange being grooved or plain. All 100 and 150 mm wide units shall generally be made with plain ends.

2.3.1 Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered the former providing a wider surface for mortar. The minimum thickness of the face shell and web shall not be less than 20mm. However, for the top face shell of the closed cavity units, the minimum thickness may be less than 20 mm, but not less than 15 mm.

2.4 Tolerances on each unit shall be: length ± 5mm, height and breadth ± 3.

3 Materials

3.1 ***Cement***: Ordinary portland cement, portland slag cement, portland pozzolana cement, super sulphated cement, white portland cement, rapid harderning portland cement, hydrophobic portland cement conforming to relevant standards can be used for manufacture of these blocks. When ordinary and low heat portland cement is used, replacement of cement by fly ash conforming to IS 3812 (Part 1) may

Table 1:

Fine aggregate	-	1120 kg/m³ maximum
Coarse aggregate	-	880 kg/m³ maximum
Combined aggregate	-	1100 kg/m³ maximum

be permitted up to a limit of 25 percent. However, it shall be ensured that blending of fly ash with cement is as intimate as possible, to achieve maximum uniformity.

3.2 ***Light-weight aggregate***: The light-weight aggregate used for making blocks shall conform to IS 9142. The dry loose bulk density of the light-weight aggregates shall be as shown in above Table 1.

3.3 ***Water***: The water shall conform to IS 456.

3.4 ***Additives and Admixtures***: Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be:

a) accelerating, water-reducing and air entraining admixtures conforming to IS 9103,
b) colouring pigments,
c) flyash conforming to IS 3812 (Part 2), and
d) waterproofing agents conforming to IS 2645.

3.5 The additives or admixtures shall be shown by test or experience to be not deterimental to the durability of the concrete.

4 Casting and Curing

4.1 ***Concrete Mix***: The concrete mix used for blocks shall not be richer than one part by volume of cement to six parts of combined fine and coarse aggregates. Allowance shall be made for bulking of materials, if necessary. Concrete shall be normally mixed in a mechanical mixer for good results,

4.2 ***Casting of blocks***: The blocks shall be made by hand or mechanically operated machine. Immediately the block is made it should be released from the mould and removed with the pallet to a covered shed, to protect it against sun and strong winds. The blocks shall normally be stored in the shed until they are sufficiently hardened to permit handling.

4.3 ***Curing***: After 12 h. the blocks shall be removed from the pallets and placed in a curing tank or taken to curing yard where these shall be kept moist for at least 21 days. Steam curing of the blocks may also be adopted provided the requirements of pressure or non-pressure steam curing are fulfilled. For non-pressure steam curing the blocks shall be subjected to the action of thoroughly saturated steam at a temperature of 38°C to 54° C for a period not less than 24 h., or when necessary, for such additional time as may be necessary.

4.4 ***Drying***: After curing the blocks shall be dried for a period of 4 weeks before being used for the works. The blocks shall be allowed to complete their initial shrinkage before they are use in construction.

5 Physical Requirements

5.1 ***Classification***: Load-bearing light weight masonry units hollow (open and closed cavity) or solid shall conform to the following two grades:

5.1.1 Grade A - These are used below and above ground level in damp-proof course, in exterior walls that may or may not be treated with a suitable weather-protective coating and for interior walls.

5.1.2 Grade B - These are used above ground level in damp-proof course, in exterior walls that are treated with a suitable weather-protective coating and for internal walls.

5.2 Non-load-bearing light-weight concrete masonry units, hollow (open and closed cavity) or solid shall be used in interior walls, partitions, panels and for exterior panel walls in steel or reinforced concrete frame construction when protected from weather by rendering or by some other efficient treatment.

5.3 Blocks/units shall be solid and free of cracks or other defects which interfere with the proper placing or impair the strength and performance of the construction. The block density shall not exceed 1600 kg/m³. The physical requirements shall be as prescribed in Table 2.

5.4 ***Drying Shrinkage:*** The drying shrinkage of the units when unrestrained shall be determined in the manner described in IS 2185 (Part II) Appendix-E and shall be as follows:

5.4.1 Load-bearing light-weight concrete masonry units, hollow (open or closed cavity) or solid,
Grade A - 0.08 percent, maximum,

Table 2: Physical Requirements

Types and Grade	Minimum Compressive Strength		Maximum Average Water Absorption, with Oven-dry Mass of Concrete	
	Average of 8 units, min N/mm²	Individual unit, Min. N/mm²	Less than 1360 kg/m³	Less than 1600 kg/m³
Hollow, load bearing				
Grade A	7.0	5.5	-	290
Grade B	5.0	4.0	320	-
Hollow, non-load bearing	4.0	3.5	-	-
Solid, load-bearing				
Grade A	12.5	10.8	-	290
Grade B	8.5	7.0	320	-

and Grade B - 0.09 percent. maximum.

5.4.2 Non-Load-bearing light-weight - 0.09 percent, maximum concrete masonry units.

5.5 Moisture movement of the dried blocks on immersion in water shall be less than the drying shrinkages as specified above by at least 0.01.

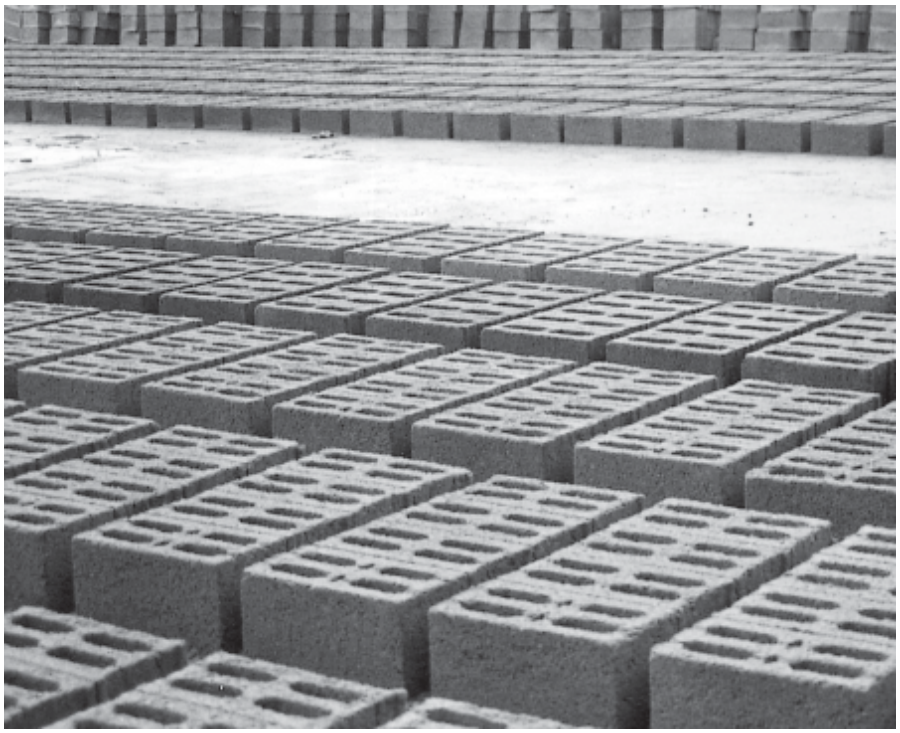
6 Surface Texture and Finish

6.1 Concrete masonry building units shall be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by proper selection, grading and proportioning of the aggregates at the time of manufacture.

6.2 Textures may also be developed by treating the face of the units while still green by wire brushing or combing, by slightly eroding the surface, by a fine spray of water upon it, and by splitting (split block).

6.3 Colour may be introduced by incorporating non-fading mineral pigments in the facing concrete or by applying a coloured Portland cement grout or paint to the face of the units soon after they are removed from the moulds. Selected coloured aggregates may also be used in the facing and exposed by washing with water or dilute hydrochloric acid.

7 The testing, sampling and marking shall be as per IS 12440.



BC 04

Specifications for Cellular Light-weight Concrete Blocks

1 General

1.1 The cellular concrete is concrete which contains stable air or gas cells uniformly distributed in the mix. It is a product consisting of Portland cement, silica, pozzolana or pastes containing blends of these ingredients and having homogeneous void or cell structure, attained with preformed srable foam. The air cells are usually added at the mixer as stable preformed foam metered from a calibrated nozzle and thoroughly blended into the mix. In preformed foam cellular concrete the density control is achieved by substituting macroscopic air cells for all or part of the fine aggregate. Normal weight coarse aggregate is usually not used. The blocks for masonry units of various dimensions can be produced which are relatively large and true in size and shape from Cellular Light-weight Concrete (CLC).

2 Dimensions and Tolerances

2.1 The CLC blocks shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose and partition block and floor units.

2.2 The term 'nominal' means that the dimension includes the thickness of the mortar joint. Actual dimensions (length and height) shall be 10 mm short of the nominal dimension (or 6 mm short in special cases where finer jointing is specified).

2.3 The nominal sizes of concrete block shall be as follows:

Length	400, 500 or 600 mm
Height	250 or 300 mm
Breadth	100,150,200 or 250 mm

2.4 In addition, block shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full length.

2.5 Tolerances on each unit shall be: length ± 5mm, height and breadth ± 3.

3 Materials

3.1 ***Cement***: 43 or 53 Grade ordinary portland cement, rapid harderning portland cement, sulphate resisting portland cement, portland pozzolana cement, portland slag cement conforming to relevant standards may be used for manufacture of these blocks.

3.2 ***Sand***: Sand conforming to IS 383 and to suit the final product density shall be used.

3.3 ***Fly Ash***: Fly ash conforming to IS 3812 (Part 1) maybe used, if cements enumerated in 3.1 except portland pozzalana

cement and portland slag cement, are used and provided uniform blending with cement is ensured.

3.4 ***Water***: The water shall conform to IS 456.

3.5 ***Foaming Agent***: The foam concentrate shall be of such chemical composition that is capable of producing stable foam cells in concrete, which can resist the physical and chemical forces imposed during mixing, transporting, pumping, placing and setting of concrete. The foaming agent should meet the requirements of IS 9103 and the foam produced shall be stable for duration beyond the final setting time of Portland cements. Such foaming agents shall be completely harmless to concrete and embedded steel reinforcement and be non- toxic, non-flammable and biodegradable.

3.6 ***Additives and Admixtures***: Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be:

a) accelerating, water-reducing and air entraining admixtures conforming to IS 9103,
b) colouring pigments,
c) waterproofing agents conforming to IS 2645.

3.7 The additives or admixtures shall be shown by test or experience to be not deterimental to the durability of the concrete.

4 Casting and Curing

4.1 ***Mix***

The concrete mix design indicating the proportions of various ingredients should be worked out carefully keeping in view the desired physical properties of the finished blocks.

4.2 ***Batching***

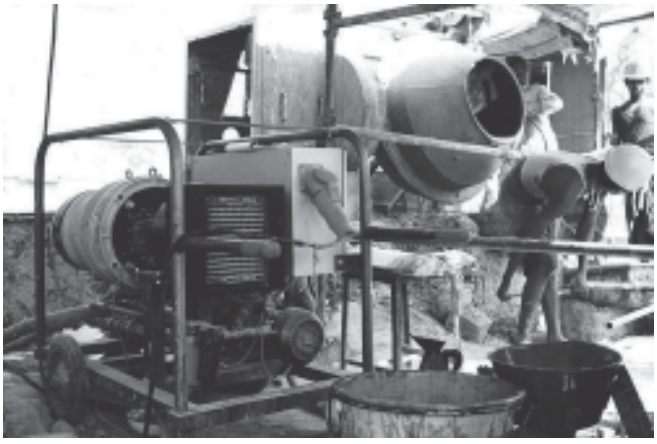
The quantities of various ingredients should be proportioned on the basis of weight, with due correction being made to the quantity of solid ingredients on account of their inherent moisture content.

4.3 ***Mixing***

The ingredients shall be mixed in a mechanical mixer having rotating drum. These may also be mixed in a mobile truck mixer. The dry ingredients like sand, fly ash and cement shall be fed into the mixer first and thoroughly mixed to ensure even distribution of cement. The appropriate amount of water shall be added thereafter continuing the mixing. The preformed foam, which is made by blending the foam concentrate, water and compressed air in predetermined proportions in a foam generator, calibrated for a specific discharge rate, shall be added in measured amount to the slurry of cement, sand, fly ash and water in the batch mixer. After an additional mixing to get uniform consistency, the slurry form of foamed cellular concreteof desired wet unit weight shall be ready to be poured out into forms/moulds, etc. When truck mixing equipment is used for foamed cellular concrete, the preformed foam should be added at the job site just prior to pumping or otherwise conveying the concrete into forms, unless it is demonstrated that a mix of the desired density and other properties can be delivered to the job site after adding the foam at the batching plant.

4.4 ***Moulds***

Gang moulds of required sizes of blocks may be constructed either of wood, steel, rigid plastics, aluminium, concrete or other acceptable materials. The mould surfaces should be pre-coated with an approved 'mould releasing agent' to ensure proper surface finish.



4.5 ***Conveying and Placing***

All equipments for conveying and placing, whether manual like wheel barrows or big buckets, or mechanical like mortar pumps, should be of such size and design and used in such a manner as to ensure uniform unsegregated concrete at the point of placement. Cellular concrete is a fluid mass and due to the absence of coarse aggregate and the ball bearing effect of minute foam bubbles, the fluid mass of cellular concrete fills up and levels into moulds by itself without the need of external vibration or compaction.

4.6 ***De-moulding of Cast Elements***

Depending on the ambient temperature and quality of cement used, the building blocks may be de-moulded after 24 h. from pouring of foam concrete unless accelerated curing processes are used, and shifted to the curinglstacking yard.

4.7 ***Curing***

Curing shall be done as per IS 456. After curing, the blocks shall be allowed to dry under shade for a period of 2 to 3 weeks, so as to complete their initial shrinkage before being used in the work.

5 Physical Requirements

5.1 ***Classification:*** CLC blocks shall be classified into two categories:

5.1.1 Non-load bearing units – These are blocks in density rmges 800 kg/m^3 and 1000 kg/m^3 and having grade designations of G-2.5 and G-3.5 as per Table 1.

5.1.2 Load bearing units – These are the blocks in density range 1200 kg/m^3 to 1800 kg/m^3, having grade designations G-6.5, G-12.0, G-17.5 and G-25.

5.2 Blocks/units shall be sound and free of cracks or other defects which interfere with the proper placing or impair the strength and performance of the construction.

5.3 When units are to be used in exposed wall construction, the face or the faces that are to be exposed shall be free of chips, cracks or other imperfections, except that in a consignment not more than 5 percent of the units with small chippings not larger than 25 mm may be accepted.

5.4 ***Block Density***: Average block density shall not vary by more than ±5 percent of the density given in Table-1.

5.5 ***Drying Shrinkage:*** The drying shrinkage of the units when unrestrained shall be determined in the manner described in IS 2185 (Part 4). The drying shrinkage shall be a maximum of 0.05 percent for the load bearing blocks and a maximum of 0.08 percent for the non-load bearing blocks.

5.6 Moisture movement of the dried blocks on immersion in water shall be less than the drying shrinkages as specified above by at least 0.01 percent as specified in IS 2185 (Part 4).

6 Surface Texture and Finish

6.1 Concrete masonry units may be given a variety of surface finishes on the exposed face by casting against textured surface plate. Colour may be introduced by incorporating non-fading mineral pigments in the facing concrete or by applying a coloured Portland cement grout or paint to the face of the units soon after they are removed from the moulds.

6.2 Concrete masonry units used in constructing exposed walls shall be free from visible stains and discoloration, blemishes or defects which distract the desired appearance of the finished wall.

7 The testing, sampling and marking shall be as per IS 2185 (Part 4).

Table 1: Physical Requirements

Sl. No.	Block Density in Oven Dry Condition	Grade	Compressive Strength N/mm^2		Thermal Conductivity in Air Dry Condition	Water Absorption (Oven Dry Density)
			Average Min	*Individual Min*	kcal/m/h/°C	Percentage
i)	800	G-2.5	2.5	2.0	0.32	12.5
ii)	1000	G-3.5	3.5	2.8	0.36	12.5
iii)	1200	G-6.5	6.5	5.2	0.38	10.0
iv)	1400	G-12	12.0	9.0	0.45	10.0
v)	1600	G-17.5	17.5	14.5	0.50	7.5
vi)	1800	G-25	25.0	22.0	0.54	7.5

BC 05

Specifications for Precast Reinforced Concrete Door and Window Frames

1 General

1.1 Precast RC door and window frames are alternate to traditional timber frames. They are more suitable in wet areas and are resistant to termite, fungus and fire as compared to wooden frames. Door and window frames are precast reinforced concrete of similar cross section of wooden frames. The maximum opening width of precast reinforced concrete door and window frames are restricted to 2250 mm.

2 Dimensions and Tolerances

2.1 Precast reinforced concrete door and window frames shall be 60 x100 mm or 70 x 75 mm in cross-section for single rebate door and 60x 120 mm for two rebates.

2.2 The tolerance in dimensions shall be of ± 2 mm

3 Materials

3.1 Cement shall be ordinary portland cement or portland slag cement or portland pozzolana cement or rapid harderning portland cement or high strength ordinary portland cement conforming to relevant Indian Standards. The aggregates shall consist of well graded mixture of clean coarse and fine aggregate. The size of coarse aggregates shall be 10mm and below. The aggregates shall conform to IS 383 and IS 456. (Fig.1).

3.2 Steel reinforcement shall conform to IS 432 (Part 1) and IS 1786. Reinforcement shall be a minimum 3 bars of 6 mm dia or equivalent of about 1.5 percent of the sectional area of the concrete member whichever is more. It 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).

3.3 The mix proportion of the concrete shall be such as to produce a dense concrete not weaker than grade M-25.

4 Casting and Curing

4.1 ***Mould*** : The mould shall be of steel. Provision shall be made in the mould to accommodate fixing devices for hinges and hold fast.

4.2 ***Construction and finish***: Each member of the frame shall have a dense surface finish free from voids, honeycombing and showing no coarse aggregate. Compaction by vibration may be done using a vibrating table or a shutter vibrator Any small defects may be removed by rubbing with carborundum stone before erection of the frame. Plastering or touching shall not be permitted.

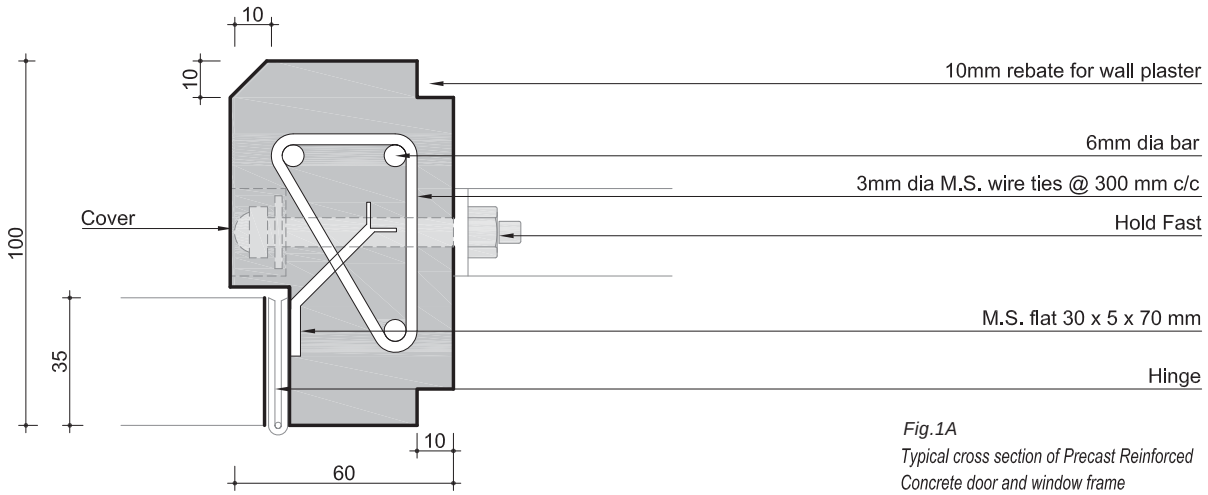


Fig.1A
Typical cross section of Precast Reinforced Concrete door and window frame

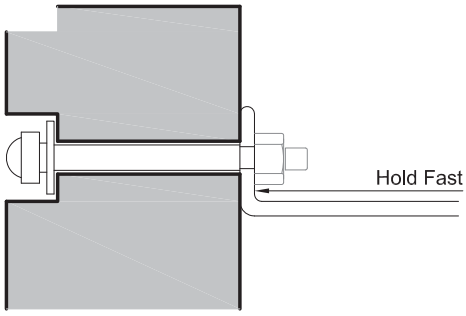


Fig.1B
Section showing fixing the holdfast to frame with a bolt and a water

Fig.01
R.C. FRAME FOR DOORS AND WINDOWS

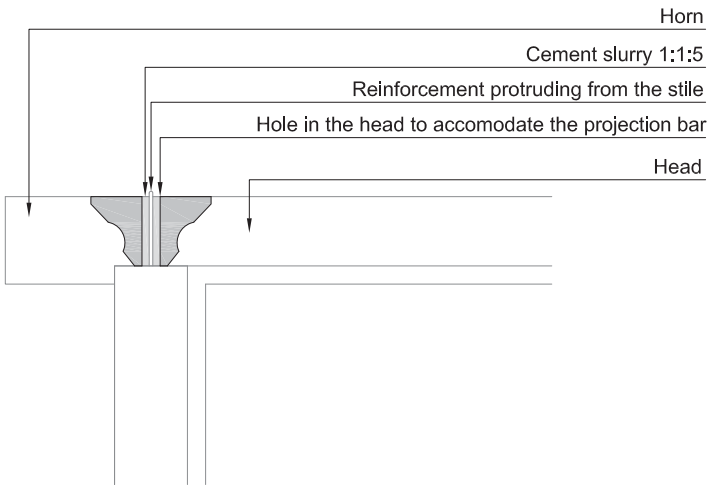


Fig.02
R.C. JOINERY OF HEAD TO STILE IN R.C. FRAME
DETAIL X

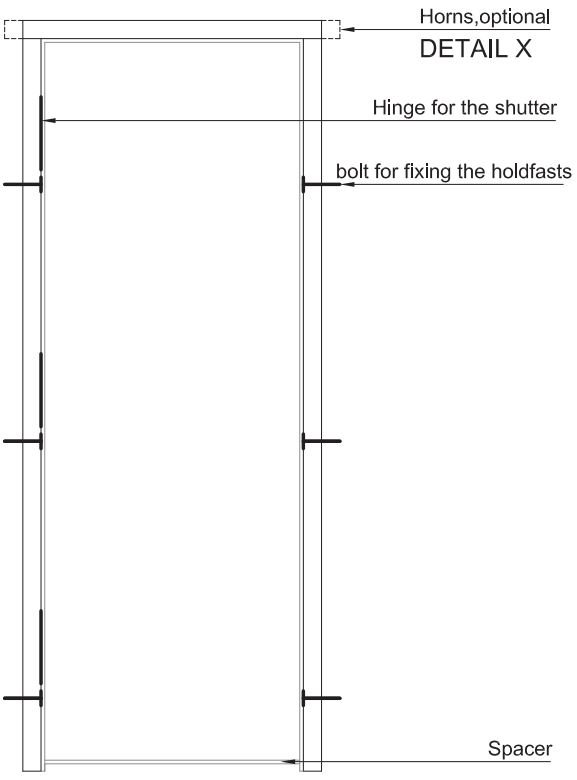
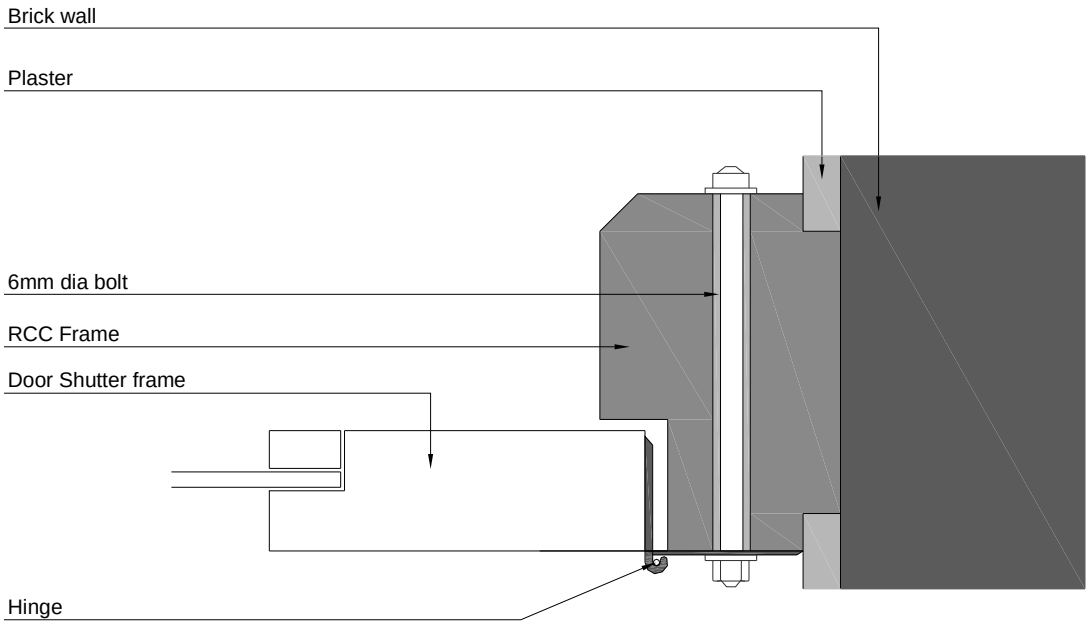
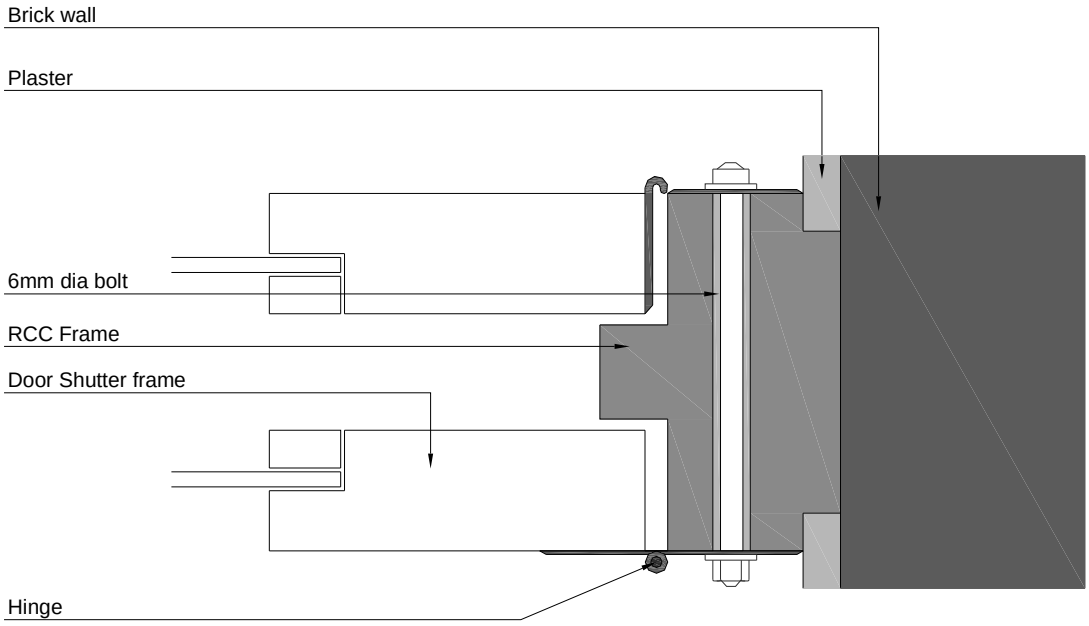


Fig.02
ELEVATION OF THE FRAME

ALL DIMENSIONS ARE IN mm.





HINGE FIXED DIRECTLY ON RCC FRAME (DOUBLE SHUTTER)

Fig.03

ARRANGEMENTS FOR FIXING HINGES ON THE FRAMES

ALL DIMENSIONS ARE IN mm.

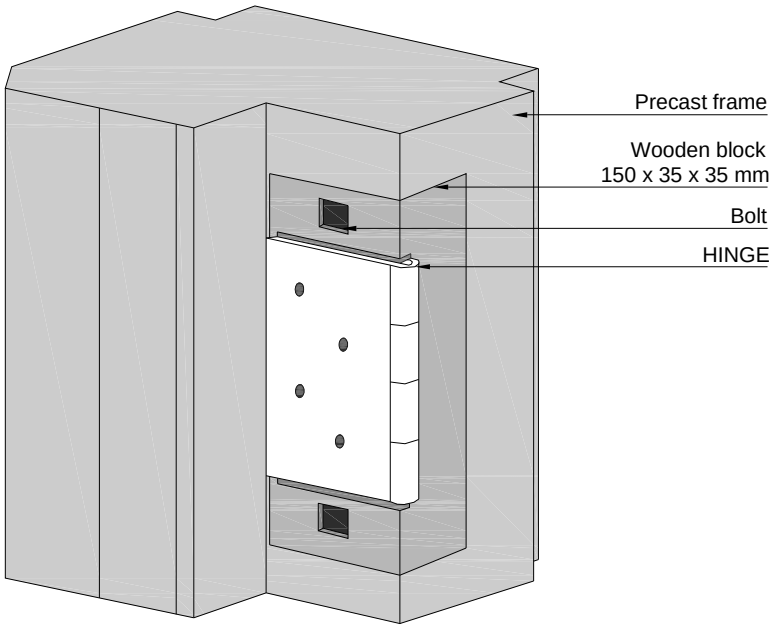
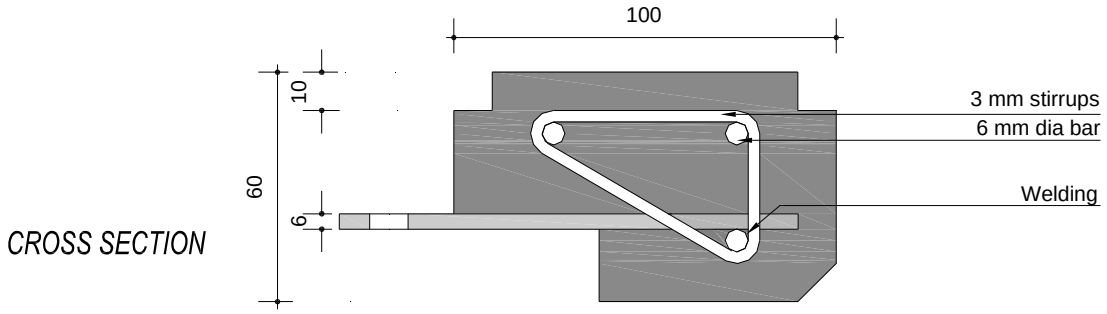
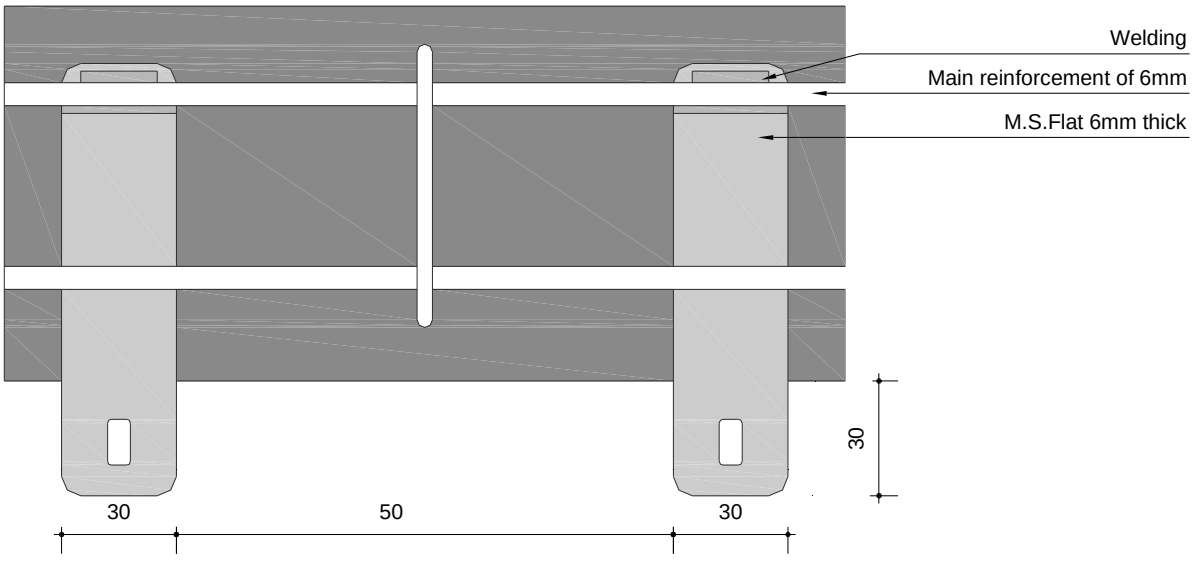


Fig.04

FIXING HINGE TO RCC FRAMES
WITH WOOD BLOCK INSERT



CROSS SECTION



PLAN

Fig.05

METHOD OF FIXING TOWERBOLTS TO RCC FRAMES

* ALL DIMENSIONS ARE IN mm.

4.3 ***Positioning of reinforcement*** : The longitudinal reinforcement for each of the vertical or horizontal member shall be in one piece. The longitudinal bar shall be firmally held by means of at least 3 mm dia steel stirrups spaced at not more than 300 mm c/c.

4.4 ***Casting***: The entire frame may be cast complete in one piece or separately. The vertical and horizontal members of the frame may be cast in separate parts. The entire frame shall be assembled at site. If the frame is cast in separate parts (see Fig.2), one of the reinforcing bars of the vertical posts shall be kept projected to fit into the corresponding holes horizontal member for rigid bonding. The hole in the head member shall be slightly larger than the bar diameter to facilitate easy insertion of the projected bar. After assembly at site the holes shall be grouted with cement slurry 1:1.5 (cement:sand).

4.5 ***Arrangements for Fixtures and Fittings***: Suitable arrangements for fixing of hinges shall be provided in the frame by any one of the following methods (Fig.3):

4.5.1 Hinge directly attached to frame: L type flap hinge may be attached directly to the reinforced cement concrete frame with the help of 6 mm dia mild steel bolt (see Fig.3).

4.5.2 Hinge welded to frame:The hinge may be welded to two numbers mild steel flat 30 x 5 mm size and 70mm long, embedded in the reinforced concrete frame. Gas welding is recommended.

4.6 Tower bolts: Suitable arrangements shall be provided in the frame for the receiving tower bolts, sliding bolts and other door and window fixtures as shown in Fig.4 & 5.

4.7 Hold fasts : 3 nos. hold fast of 40x 3mm flat shall be fixed with the machine screws to M.S. anchors or rubber plug/bushes already provided on the back of each of the vertical member of the door frame. In case of windows 2 nos. hold fast shall be provided in the each vertical members (see figures IA and IB).

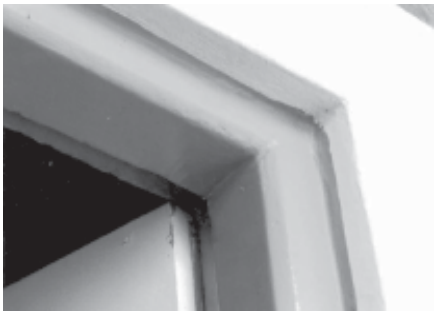
5 Method of Construction:

5.1 The vertical members shall be held in position and the top member placed over them. The frame shall be plumbed, aligned, and supported temporarily till the concrete around the hole fast has properly set and hardened.

5.2 The window door frames having sills, the bottom member shall be first placed in the position and the other members erected on this base.

5.3 Cement slurry 1:1.5 (cement:sand) shall be used in grouting the joints between the vertical and horizontal members of the door frames (Fig.2).

6 The testing, sampling and marking shall be as per IS 6523.



BC 06

Specifications for Ferrocement Door Shutters

1 General

1.1 The Ferrocement is an alternative material for making door and window shutters. It could be described as a layer of steel meshes embedded in a mortar mix. Ferrocement is a composite material consisting of rich cement sand mortar normally in 1:3 or 1:2 proportions and can be made to get any shape with mild steel sections/bars and more than one layer of chicken/wire mesh/expanded mesh etc.

2 Dimensions and Tolerances

2.1 The ferrocement shutters shall be in following dimensions. However, the shutters can be manufactured in whatever size is specified by users.

Panelled or flush shutters size

Height = upto 2500 mm

Width = upto 1500mm

Thickness of Flush Shutters shall be minimum 8mm and maximum 12mm.

Thickness of Panelled Shutters

Stiles & rails minimum	=	20mm
Stiles & rails maximum	=	25mm
Panels minimum	=	12mm
Panels maximum	=	14mm

Weight:

Between 20 to 50 kg/m^2

For flush shutters, 30 kg/m^2

2.2 Tolerances : Height ±8mm, width ±5mm, thickness ±2mm.

3 Materials

3.1 The door shutters with ferrocement of single leaf, double leaf, and jali shutter, panelled, one side panelled and other side flush, both sides flush, shutter with glass peeping window can all be cast with this technology using steel moulds. The fixing of the shutters shall be achieved either with hinges or on pivots.

3.2 Ferrocement shall consist of following materials: steel, cement, sand and water.

3.3 The type and number of layers of mesh used in ferrocement door and window shutters shall depend on the proposed utilisation which influences the required strength. The most commonly used steel reinforcements in ferrocement are:

- Galvanized or non-galvanized wire mesh in various gauges
- Chicken mesh.
- Woven mesh.
- Expanded mesh.
- Welded mesh.
- Small diameter mild steel wires.
- Binding wire.
- Steel bars (mild or tor).
- M.S.Angles (Additional supports)

3.4 The ferrocement shutters shall be of different designs and thicknesses depending upon the application and use identified by engineer-in-charge. These shall be normally procured from the manufacturers unless at in-house production unit is proposed to be set up.

3.5 Ratio of the mix shall be given by Water:Cement:Sand (W:C:S) by weight. This ratio for ferrocement doors is 0.40:1:1.5 by weight. Sand and cement shall first be evenly mixed, the required quantity of water shall be added afterwards.

4 Casting and Curing

4.1 *Mesh Preparation*

4.1.1 Hexagonal 12 mm x 0.71 mm (22 gauge) galvanized iron (GI) "chicken mesh". Rolls of either 900 or 1200 mm width shall be used as reinforcement.

4.1.2 Four separate pieces of mesh shall be cut off with a wiremesh cutter Each piece shall be door size plus 100 mm all around. They shall be flattened separately on the floor.

4.1.3 These 4 separate layers of wiremesh shall be laid on top of each other in alternate layers at right angles to one another Two layers of mesh projecting beyond the door marking shall be folded in so that the final mesh size is 10mm less all around than the actual door size for cement cover For folding the mesh an aluminium or timber straight edge may be used. The 4 layers shall be correctly bound together with binding wire and the whole steelmat shall once more be lightly flattened.

4.1.4 A standard door size of 900mm wide and 2000 mm height needs 3 kg of hexagonal 12mm x 0.71 mm wire mesh of 4 layers and 200 g of binding wire.

4.2 *Casting*

4.2.1 The portion of the casting platform shall be oiled with a paint brush to ensure easy demoulding.

4.2.2 The required amount of sand, cement and water is mixed on clean surface nearby or in a mixing vat.

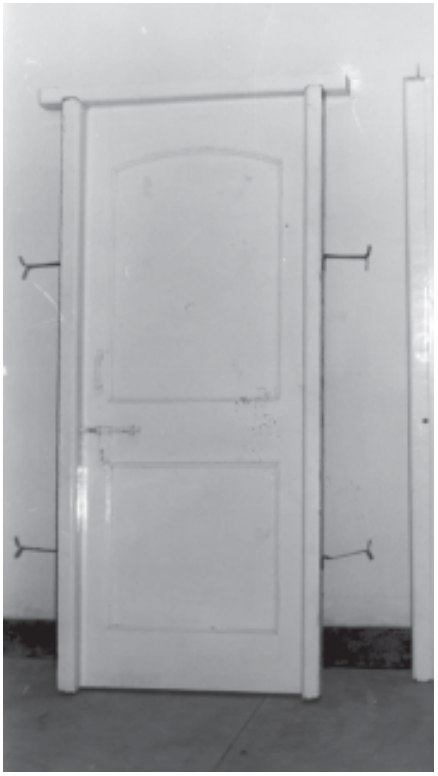
4.2.3 The following quantity of materials and water shall be required for door shutter size of 900x2000x12 mm thick.

water = 8.1 litre
cement = 20.0 kg
sand = 30.0 kg(dry)

4.2.4 A fine layer of mortar thickness not more than 5 mm shall be spread out over the oiled surface.

4.2.5 The steel mat shall be softly pressed onto the spread out mortar layer taking care to position it correctly. Two wooden or aluminium rulers shall be placed along the two longest sides of the door to facilitate the filling up of the second layer of 5mm thick mortar over the steelmat.

4.2.6 A smooth finish shall be obtained by sprinkling a handful of cement and rubbing it in with a masons trowel by moving it in a circular manner and special care shall be taken to finish the top, sides and edges of the shutter neatly.



4.2.7 The cast door shutter shall be kept in postion at least for 12 h. for proper setting.

4.3 *Demoulding*

4.3.1 The ferrocement door shutter shall be demoulded by carefully inserting a large mason's trowel under one of the long sides of the door shutter and moved slowly under the whole length of the door shutter to separate the ferrocement plate softly from the casting platform. The oil ensures that no bond has taken place with the mortar during the casting and curing period.

4.3.2 The door shall now be ready for the fitting of the hinges and locks.

4.4 *Curing*

4.4.1 A pond shall be used to submerge the whole product in order to have an absolutely reliable curing process.

4.4.2 Alternatively the freshly cast door shutter shall be left in place on the casting platform. Sand or coirdust

layer shall be spread out evenly over the shutter. Water shall be sprinkled several times a day so that it does not get dry and remains moist for about 15 to 21 days depending on weather.

5 Method of Construction

5.1 In the simplest form the door shutter is now ready to be fitted with hinges, handles and locking arrangement. For this purpose 300mm to 460mm steel Tee-hinges, tower bolts, aldrops and rim locks may be used.

5.1.1 The holes are premarked for hinges and locks.

5.1.2 An electric power drill with a small diameter masonry drill bit is used to drill the required holes. Afterwards a bigger size masonry drill is used to enlarge the holes to the required size.

5.1.3 The hinges are attached with bolts, nuts and washers.

5.1.4 Tower bolts, aldrops and rim locks are fitted in the same way.

6 Painting

6.1 A mastic paste made from chalk powder and white cement primer paint is prepared and applied on the two surfaces.

6.2 After the mastic has dried, the door shutter is properly sand-papered down and is ready for the final paint coats.

BC 07

Specifications for Precast Ferocement Water Tanks

1 General

1.1 Ferrocement is a versatile material possessing unique properties of strength and serviceability. It is made with closely- knit wire mesh and mild steel reinforcing bars or welded mesh filled with rich cement mortar (Fig. 1). The materials required for making it, namely, cement, sand, wire mesh, and welded mesh or mild steel reinforcing bars. Ferrocement combines the lightness of steel and mouldability of mortar and can be cast to any shape. These water storage tanks are suited for residential and community buildings.

1.2 Capacity

1.2.1 The net capacity of the tank shall be taken as the volume of the actual usable water confined between the levels of the centres of the overflow and out-let sockets.

1.2.2 Gross capacity of a tank shall be taken as the total storage capacity including the dead storage and free board.

1.2.3 The following net capacities are recommended for different uses:

Uses	Net Capacity (Litres)
Domestic use	270, 540, 750 & 1250
Industrial & Community use	1250, 2500, 5000, 7500, 10,000

2 Dimensions and Tolerances

2.1 Ferrocement water tanks shall generally be made in square, rectangular and circular shapes. The tanks shall have flat bottom. The circular tanks having diameter more than 2.0 meter, a shallow spherical dome, shall be provided for the bottom or alternatively suitable fillets may be provided at the junction of bottom slab and vertical wall.

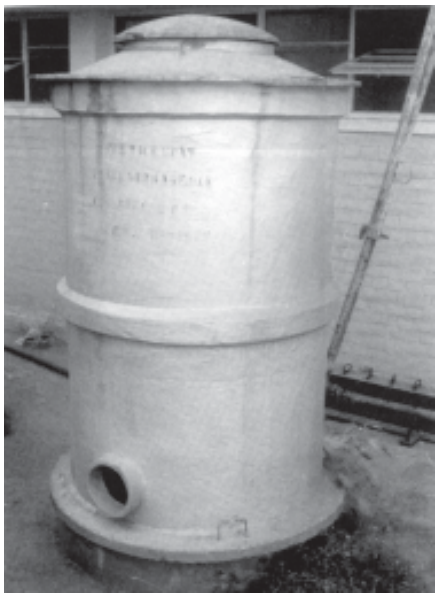
2.2 Circular tanks, height to diameter ratio shall be 1.

2.3 Rectangular tanks, length to breadth ratio shall be 1.5 where as height to length or breadth ratio shall be 0.5 to 1.5. If the length of any side exceeds 1.5m it is desirable to provide stiffness in the side walls at spacing not exceeding 1.5m.

2.4 A free board of 75 mm shall be provided.

2.5 Sizes of water tanks based on capacity is given in Table 1.

2.6 Tolerances shall be ± 5mm for height, length and breadth and diameter upto 1 m, and above 1 m the tolerance will be ±10 mm. For wall thickness it shall be ± 2 mm



3 Materials

3.1 The cement used shall conform to IS 269 or IS 1489(Part 1 and 2) or IS 455.

3.2 The sand shall be clean, inert and free from organic matter silt and clay content shall be less than 3%. Sand shall conform to grading zone II of IS 383. The maximum particle size shall be less than 1.18 mm.

3.3 Mild steel wire conforming to IS 280 shall be used in the manufacture of wire mesh. The mesh shall have hexagonal, rectangular or square openings. It shall be woven or welded. The wires shall be galvanized before weaving. Aperture size of 6 mm to 20 mm and wire diameter shall be 0.56 to 1.25 mm. In case of welded wire mesh the diameter of wire shall be not less than 1 mm.

3.4 Mild steel skeletal bars diameter shall be from 3 mm to 10 mm conforming to IS 432 (Part 1) or hard-drawn steel wire IS 432 (Part 2) or hard drawn steel wire mesh fabric IS 1566. Normally the diameter of skelatal steel should be from 3 mm to 10 mm.

3.5 In case galvanized wire mesh is used with mild steel bars/wires, chromium trioxide at the rate of 200 to 300 ppm of water should be added to the water used for mortar preparation.

3.6 Admixtures may be used in ferrocement for reducing water-cement ratio without affecting the workability and for gaining in strength and durability. Such a.dmixture shall conform to IS 9103. Integral cement waterproofing compound, when used, shall conform to IS 2645.

4 Design

4.1 The minimum compressive strength of cement mortar cubes having area of face equal to 50 cm^2 shall be 25 N/mm^2.

4.2 The tensile stress in reinforcement under service condition shall not exceed 200 N/mm^2.

4.3 Ferrocement shall be treated as a composite material for calculation of strength of sections. The principles of reinforced concrete may also be used for calculation of flexural strength. Effective area of steel in the direction of principal tension shall be calculated for hexagonal wire mesh.

4.4 Laps in wire mesh, where provided, shall be not less than 100 mm.

4.5 The skeletal steel shall be spaced at not more than 300 mm centre to centre in both directions. Laps in bars where, provided, shall be not less than 150 mm. The skeletal steel may not be necessary in case of mechanized or semi-mechanized casting processes.

4.6 The minimum wall thickness shall be 12 mm for tanks up to 2000 litres capacity in case of mechanized or semi-mechanized casting and 15 mm for tanks up to 1000 litres capacity when hand cast. For larger capacity tanks the wall thickness may be 20 mm to 40 mm depending on capacity.

4.7 The minimum thickness of the lid/ cover slab shall in no case be less than 15 mm.

4.8 In case the bottom slab thickness exceeds 30 mm, the slab may be cast in ferrocement only. However, an intermediate plain concrete layer using graded coarse aggregate of nominal maximum size 6.3 mm may be introduced between the wire mesh layers to achieve the design thickness without excessive use of cement. In case of composite slab, the minimum thickness of top as well as bottom layer of ferrocement shall not be less than 8 mm.

4.9 The minimum clear cover to reinforcement shall be 4 mm.

5 Method of Construction

5.1 The tanks shall be constructed as per IS 13356. The general fabrication of ferrocement water tanks are given in the figures 2 & 3.

5.2 Reinforcement : A cage made of welded mesh or mild steel rods, as per the details given separately for different types of tanks form the skeletal reinforcement for the ferrocement tanks. This main reinforcement cage, once tied in position, automatically takes the required shape of the tank. Galvanized (GI) thicken mesh or GI square woven mesh as per the requirement forms the distributive reinforcement. This is tied or stitched together on either side of

Table I: Sizes of Ferrocement Water Tanks based on Capacity

Sl. No.	Capacity (litres)	Circular			Square/Rectangular			
		Internal diameter (mm)	Height** (mm)	Plan area (m^2)	Inside* length (mm)	Inside breadth* (mm)	Height** (mm)	Plan area (m^2)
1	300	740	700	0.430	720	720	580	0.518
2	400	800	800	0.503	800	800	640	0.640
3	600	930	890	0.680	910	910	730	0.828
4	800	1040	950	0.850	1000	1000	800	1.000
5	1000	1100	1060	0.950	1080	1080	860	1.166
6	1500	1260	1210	1.247	1240	1240	980	1.538
7	2000	1400	1300	1.540	1350	1350	1100	1.822

* Suitable rectangular base also can be adopted instead of square.

** Excluding free board.

the cage using 20 gauge binding wire.

5.3 The necessary pipe fittings required for the inlet, outlet, overflow, scour pipe connecting pieces and lifting hooks are arranged and tied in position. While forming the cage, care should be taken to see that the wall reinforcement is vertical and sufficient lap length is provided. Similarly, the reinforcement for top cover slab can also be made ready including the necessary lifting hooks.

5.4 The recommended mix proportion of mortar is one part of cement to 1.5 to 2.5 parts of sand by weight and water cement ratio is 0.35 to 0.45.

5.5 The minimum cross-sectional area of main reinforcement in any one of the two directions shall not be less than 1 percent of the gross cross-sectional area of the element.

5.6 The cover shall be provided with a manhole opening of 500 or 600 mm depending on the capacity of the tank and a suitable matching lid shall be provided to cover the manhole opening.

5.7 The cover slab and lid shall be such that when positioned on the tanks no external dirt or water shall enter the tank and contaminate the water inside.

6 Casting and Curing

6.1 ***Casting Platform:*** The cage is made to the required shape and size, a separate shuttering is not necessary for casting the tank. However, a plain, perfectly horizontal casting platform of the appropriate base area of the tank is essential. This platform can be of masonry, steel, or wood. The casting platform is to be lubricated using mould oil in advance of the casting of the tank base.

6.2 ***Casting:***

6.2.1 First, cement mortar paste shall be made by mixing Portland cement and river sand in 1:2 ratio by weight The river sand shall be sieved through a sieve with an aperture size 2.36mm and mixed with cement thoroughly in dry condition for even distribution of cement If manual mixing is resorted to, water shall be added only after dry mixing the mortar. The quantity of water to be added shall depend on the water/cement ratio of 0.45 to 0.5. It is recommended to prepare a consistent and workable cement mortar for casting ferrocement water tanks.

6.2.2 The reinforcement cage shall be placed on the lubricated level platform over 10mm thick cement mortar cover blocks at the base. The bottom slab of the required thickness shall be cast by placing the already prepared cement mortar paste over the bottom slab part of the cage.

6.2.3 In the second stage, the vertical walls shall be plastered with the cement mortar from outside the tank, with the help of another one standing inside over the already cast base slab. A piece of plywood may be used as a back-up on the inside while forcing the mortar from outside. The mortar may be forced into the cage with uniform pressure and finished to the required approximate thickness. This plastering application shall be done in layers of 150mm

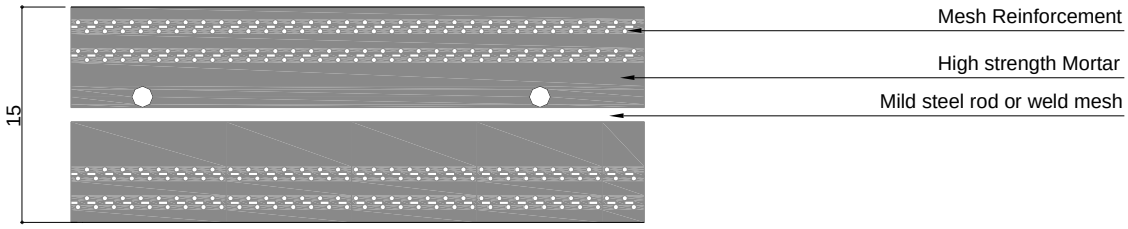
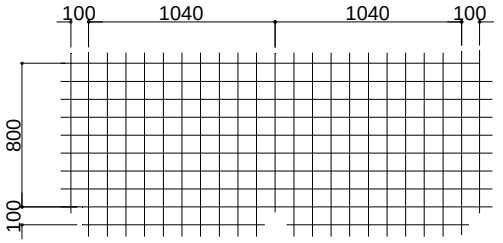


Fig.01

TYPICAL CROSS SECTION OF FERROCEMENT ELEMENT



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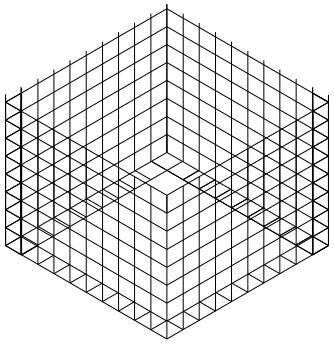
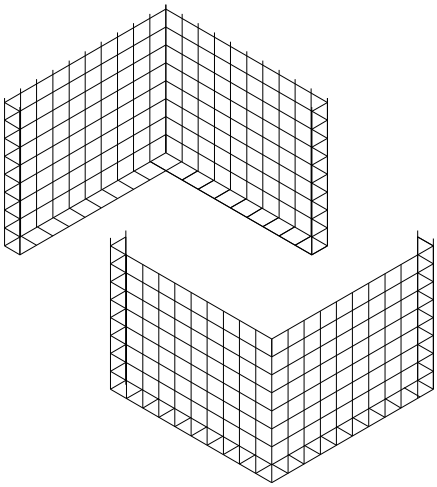
Welded Mesh piece before Bending (2 nos.)



Welded Mesh piece after assembly (for side walls)



Welded Mesh piece after Bending (2 nos.)

Fig.02

DETAILS OF WELDED MESH FOR SQUARE OR RECTANGULAR TANKS

ALL DIMENSIONS ARE IN mm.

height all-round continuously. Otherwise, there is the chance of the mesh reinforcement tilting due to the extra weight of mortar on one side of the wall, resulting in the non-verticality of the tank wall. Since the tank is unstable at this stage, maximum care should be taken so that the plastered tank wall is not subjected to unforeseen impacts.

6.2.4 After completing the plastering of the walls, the tank shall be left undisturbed for 24 h. The mortar would attain about half of its required strength and the tank would attain stability by the next day. The surfaces on either side of the walls are then finished to the exact required thickness using mortar of the same proportions. Cement slurry is applied over the finished surface of the tank by using a brush. The surface shall be finished smooth using a trowel. Extra are shall be taken in finishing the area around the pipe fixtures.

6.2.5 The cover slab shall be cast separately on a level platform by following the procedure adopted for base slab.

6.3 ***Curing***

6.3.1 The tank shall be cured after 24 h. of finishing the surface of the tank. Continuous water spray for seven days will be sufficient to attain the required strength.

6.4 ***Painting***

6.4.1 Tanks which are properly cured shall be put to use in about 10 days after

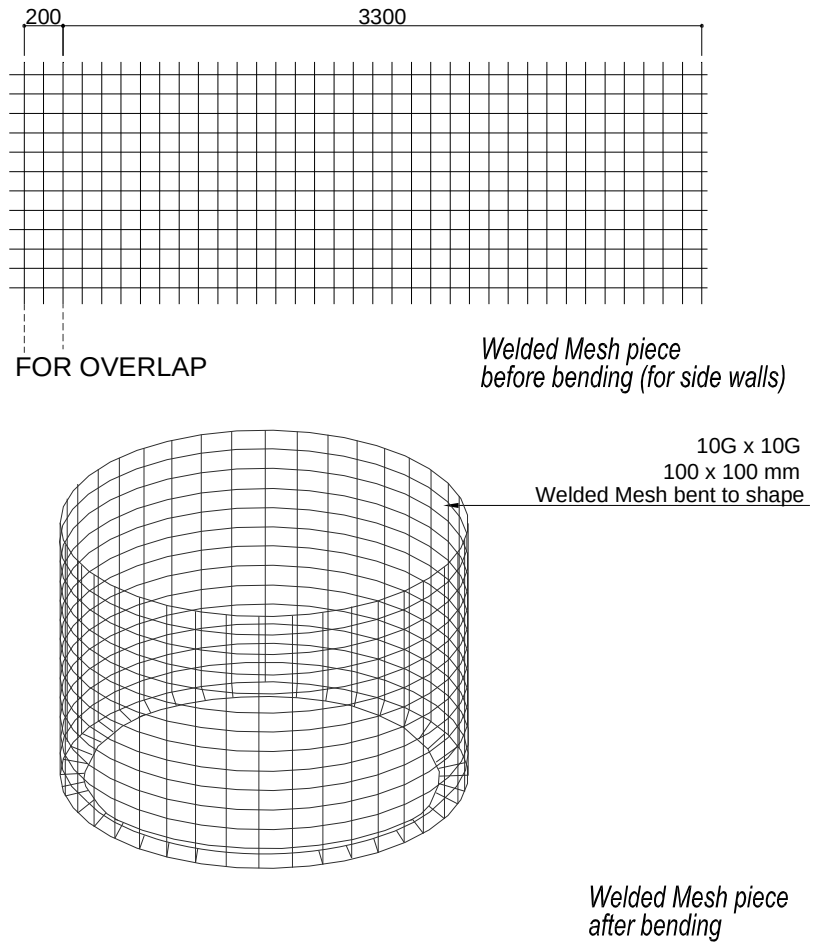


Fig.03

DETAILS OF WELDED MESH FOR CIRCULAR TANKS

ALL DIMENSIONS ARE IN mm.

casting. Though the ferrocement tanks made by the above process are safe against leakage and consequent corrosion, it is preferable to paint the interior of the tanks using a Tankmastic paint or its equivalent commonly known as drinking water black paint. On application by brush, this type of paint dries immediately. However, a day shall be allowed for its proper drying, before water is filled in the tank.

6.5 ***Cover Slab***

6.5.1 The cover slab should be handled carefully. If they are heavier and consequently difficult for handling, separate man-holes may be provided at the time of casting. Additional mild steel rod reinforcement shall be provided around the manhole.

7 Water Tightness Test

7.1 When filled with water, the external faces of the tanks shall show no sign of leakage and sweating and remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption of water after filling. This test shall be done before painting the interior of the tanks.

7.2 In case any leakage is observed during the test, necessary rectifications by exposing the wire mesh at the desired locations and using the same mortar as used in the manufacture of tank shall be carried out and the tank shall be retested.

7.3 All the units shall be tested for water-tightness before put in use.

8 The testing, sampling and marking shall be as per IS 13356.

BC 08

Specifications for Precast Concrete Manhole Covers and Frames

1 General

1.1 Precast concrete manhole covers and frames are alternate to cast iron manhole covers used in sewerage and water works. These are manufactured as per IS 12592.

1.2 The specifications for precast reinforced cement concrete manhole covers intended for use in sewerage and water works shall be as under:

2 Dimensions and Tolerances

2.1 ***Shapes*** - The shapes of precast concrete manhole covers shall be square, rectangular, circular & lamphole.

2.2 ***Dimensions & Tolerances*** – The dimensions and tolerances on dimensions of frames shall be as shown in Table 1 but outside dimensions of cover at top shall match with the corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and cover is in level within a tolerance of ±5 mm.

For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover (see Fig.1).

3 Materials

3.1 ***Cement*** - Cement used for the manufacture of precast concrete manhole covers shall conform to IS 269 or IS 455 or IS 1489 (Part 1) or IS 1489 (Part 2) or IS 6909 or IS 8041 or IS 8043 or IS 8112 or IS 12269.

3.2 ***Aggregates*** - The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS 383. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20mm.

3.3 ***Concrete*** - The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. The minimum cement content in the concrete shall be 360 kg/m^3 with a maximum water cement ratio of 0.45. Concrete weaker than grade M-30 shall not be used. Compaction of concrete shall be done by machine vibration.

3.4 ***Reinforcement*** - The reinforcement steel shall conform to Grade A of IS 2062 or IS 432 (Part 1) or IS 432 (Part 2) or IS 1786 as appropriate.

Reinforcement shall be clean and free from loose mill scale, loose rust, mud, oil, grease or any other coating

which may reduce or destroy the bond between the concrete and steel. A slight film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.

3.5 ***Fibres*** – The diameter/equivalent diameter of steel fibres where used, shall not be greater than 0.75 mm. The aspect ratio of the fibres (ratio of the length of the fibre to its diameter/equivalent diameter) shall be in the range of 50 to 80. The minimum volume of fibres shall be 0.5 percent of the volume of concrete.

In case of propriety fibres, manufacturer's recommendations shall be taken into account.

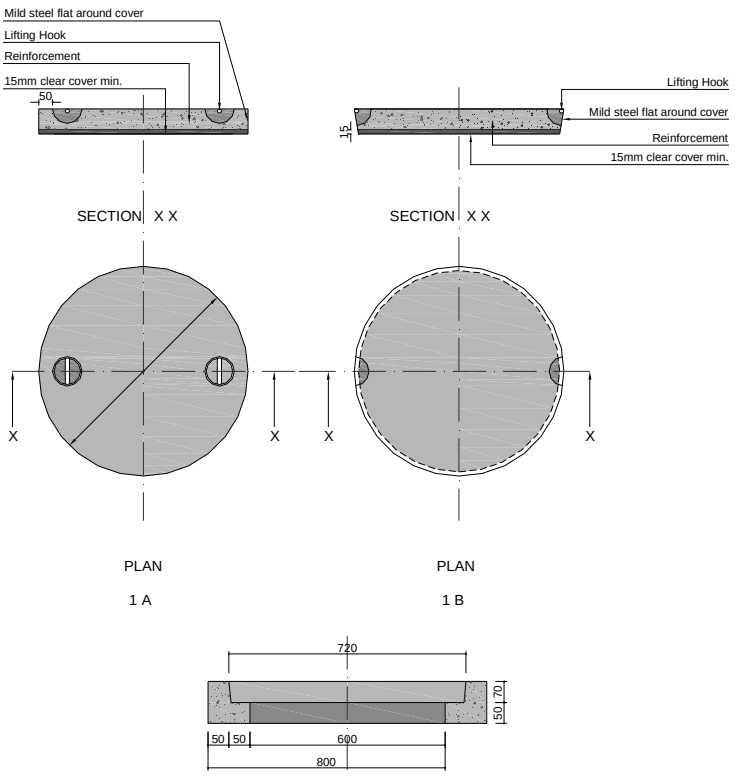


Fig.01

TYPICAL ILLUSTRATION OF CIRCULAR PRECAST CONCRETE MANHOLE COVER

ALL DIMENSIONS ARE IN mm.

4 Classification

4.1 Manhole covers and frames shall be of the following four grades and types:

Grades	Grade Designation	Type/Shape of Cover
Light Duty	LD-2.5	Rectangular, Square, Circular
Medium Duty	MD-10	Rectangular, Circular
Heavy Duty	HD-20	Circular, Square, Rectangular, (Scrapper manhole) & Lamphole
Extra Heavy Duty	EHD-35	Circular, Square Rectangular, (Scrapper manhole)

4.2 The different grades and types of man hole covers shall be used as follows:

a) LD-2.5 Rectangular, square or circular types -These are suitable for use within residential and institutional complexes/ areas with pedestrian but occasional LMV traffic. These covers are also used for "Inspection chambers".

b) MD- 10 - These are suitable for use in service lanes/roads, car parking areas, etc.

c) HD-20 - Suitable for use in institutional/ commercial areas/ carriage ways with heavy duty vehicular traffic like buses, trucks, etc.

d) EHD-35 Circular, square or rectangular (scrapper manhole) types - These are suitable for use on carriageway in commercial/ industrial/ port areas/near warehouses/ godowns where frequent loading and unloading of trucks/trailers are common, with slow to fast moving vehicular traffic of the types having wheel loads upto 115 KN irrespective of the location of the man hole chambers.

5 Manufacture

5.1 ***Mixing***

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. If steel fibres are used in addition to reinforcement it shall conform to the requirements given in 3.5.

5.2 ***Placing and Compaction***

The reinforcement shall be placed in proper position in an appropriate mould coated with a thin layer of

Table 1: Dimensions of Frame

(All dimensions are in mm)

Grade Designation	Description	Clear Opening in Frame	*B*	*C*	*D*	*E* Min.	*F* Min.
LD-2.5	Light Duty Rectangular	450 x 450	50	50	50	50	566
LD-2.5	Light Duty Square	450 x 450	50	50	50	50	566 x 566
		450 x 400	50	50	50	50	516 x 516
LD-2.5	Light Duty Circular	370	50	50	50	50	486
		560	50	50	50	50	676
		500	50	50	50	50	616
		450	50	50	50	50	566
MD-10	Medium Duty Rectangular	450 x 600	70	50	50	50	570 x 720
MD-10	Medium Duty Circular	450	70	50	50	50	570
		500	70	50	50	50	620
		560	70	50	50	50	680
		600	70	50	50	50	720
HD-20	Heavy Duty Rectangular (Scrapper)	900 x 450	90	75	75	75	1080 x 630
HD-20	Heavy Duty Square	560 x 560	90	75	75	75	740 x 740
HD-20	Heavy Duty Circular	450	90	75	75	75	630
		500	90	75	75	75	680
		560	90	75	75	75	740
		600	90	75	75	75	780
HD-20	Heavy Duty Lamphole	350	90	75	75	75	530
EHD-35	Extra Heavy Duty Rectangular	900 x 560	100	75	75	75	1078 x 738
EHD-35	Extra Heavy Duty Square	560 x 560	100	75	75	75	738 x 738
EHD-35	Extra Heavy Duty Circular	450	100	75	75	75	628
		500	100	75	75	75	678
		560	100	75	75	75	738
		600	100	75	75	75	778

Notes:

1. Tolerance on C shall be ±5mm, tolerance on A, B, D and E shall be +5, -0 mm.
2. For facility of removing the manhole cover suitable upward taper not more than 5° may be provided to the inner periphery of the frame.
3. If required for the removal of the moulds suitable taper not more than 5° can be given at the lower inner periphery of the frame (see Fig.1).

mould oil in case of frames and withinthe protectivesheet in case of covers.Concrete shall be tilled toslightly overalland compacted by vibration and struckoff level with a trowel.

5.2.1 Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommended since the holes left by the vibrator in the wet mix may not close after its removal owing to the interlocking of the fibres with the mix. Compaction by means of shutter or form or table vibrators is recommended. In case of extra heavy duty and heavy duty cover and frame, compaction by means of pressure-cum-vibration technique may also be employed so as to achieve dense and strong concrete.

5.2.2 Clear cover to reinforcement shall not be less than 15 mm.

5.2.3 After demoulding, cover and frame shall be protected until they are sufficiently hardened to permit handling without damage.

5.3 ***Curing***

5.3.1 The hardened concrete manhole cover and frame shall be placed in a curing water tank. The period of curing shall be as given in IS 456.

5.3.2 Steam curing of manhole cover and frames may be adopted, followed by normal curing for 7 days provided the requirements of pressure or non-pressure steam curing are fulfilled and the manhole cover and frames meet the requirements specified in IS 12592.

5.4 ***Edge Protection and Finishing***

5.4.1 *Frame* - The top and inside surface of frames shall be smooth. To prevent the top outer edge from possible damages, it shall be protected by 25 mmx3 mm mild steel flat as part of the frame. Sufficient number of steel connectors shall be welded to the inner surface of the mild steel flat so as to connect it with the frame reinforcement and these shall be embedded in the concrete during casting. Exposed surface of mild steel flat shall be given suitable treatment with anticorrosive paint or coating.

5.4.2 *Cover* - To prevent any possible damage from corrosion of reinforcing steel, the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish. In order to protect the edges of the covers from possible damage at the time of lifting and handling, it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anti-corrosive paint or coating.

5.4.3 Suitable arrangements may be made for fixing the manhole cover and frame in position on the manholes.

5.4.4 The manufacture of manhole cover and frame shall be such as to ensure the compatibility of their seatings. For classes HD 20 and HD 35, these seatings shall be manufactured in such a way as to ensure stability and quiteness in use. This may be achieved by grinding the contact surface, if needed.

6 Lifting Device

The minimum diameter of mild steel rod used as lifting device shall be 10mm for light and 12 mm for medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot dip galvanizing or epoxy coating or any other suitable material.

7 Physical Requirements

7.1 General - All units shall be solid and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edges/ surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

7.2 Load Test - The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in Table 2.

8 The testing, sampling and marking shall be as per IS 12592.

Table 2: Test Load and Diameter of Block

Grade of cover	Type	Load (kN)	Diamter of Block (mm)
LD-2.5	Rectangular, Square or circular	25	300
MD-10	Rectuangular or circular	100	300
HD-20	Rectangular, square or circular	200	300
EHD-35	Rectangular, square or circular	350	300

List of Indian Standards referred in this Section

BUILDING COMPONENTS

1	IS 269:1989	Ordinary Portland Cement, 33grade – Specification *(Fourth Revision)*
2	IS 280:1978	Specification for Mild Steel Wire for General Engineering Purposes
3	IS 383:1970	Specification for Coarse and Fine Aggregates from Natural Sources for Concrete *(Second Revision)*
4	IS 401:2001	Preservation of Timber – Code of Practice *(Fourth Revision)*
5	IS 432:1982 (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 *(Third Revision)*
6	IS 432:1982 (Part 2)	Specification for Mild Steel and Medium Tensile Steel Bars and Ward-Drawn Steel Wire for Concrete Reinforcement - Part 2 : Hard-Drawn Steel Wire *(Third Revision)*
7	IS 455:1989	Portland Slag Cement-Specification *(Fourth Revision)*
8	IS 456:2000	Plain and Reinforced Concrete - Code of Practice *(Fourth Revision)*
9	IS 848:1974	Specification for Synthetic Resin Adhesives for Plywood (Phenolic and Aminoplastic) *(First Revision)*
10	IS 875:1987 (Part 1)	Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures - Part 1: Dead Loads - Unit Weights of Building Materials and Stored Materials *(Second Revision)*
11	IS 1489:1991 (Part 1)	Portland-Pozzolana Cement – Specification - Part 1: Fly Ash Based *(Third Revision)*
12	IS 1489:1991 (Part 2)	Portland-Pozzolana Cement – Specification - Part 2 : Calcined Clay Based *(Third Revision)*
13	IS 1566:1982	Specification for Hard-Drawn Steel Wire Fabric for Concrete Reinforcement *(Second Revision)*
14	IS 1786:1985 Superseding IS 1139:1966	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement *(Third Revision)*
15	IS 1902:1993	Preservation of Bamboo and Cane for Non-Structural Purposes - Code of Practice *(First Revision)*
16	IS 1905:1987	Code of Practice for Structural Use of Unreinforced Masonry *(Third Revision)*
17	IS 2062:1999	Steel for General Structural Purposes –Specification
18	IS 2185:2005 (Part 1)	Concrete Masonry Units - Specification Part 1 : Hollow and Solid Concrete Blocks
19	IS 2185:1983 (Part 2)	Specification for Concrete Masonry Units - Part 2 : Hollow and Solid LightweightConcrete Blocks *(First Revision)*

20	IS 2185:2008 (Part 4)	Specification for Concrete Masonry Units - Part 4 : Preformed Cellular Concrete Blocks
21	IS 2645:2003	Integral Waterproofing Compounds for Cement Mortar and Concrete – Specification *(Second Revision)*
22	IS 3812:1981	Specification for Fly Ash for Use as Pozzolana and Admixture *(First Revision)*
23	IS 3812:2003 (Part 1)	Pulverised Fuel Ash - Specification - Part 1 : For Use as Pozzolana in Cement, Cement Mortar and Concrete
24	IS 3812:2003 (Part 2)	Pulverised Fuel Ash - Specification - Part 2 : For Use as Admixture in Cement Mortar and Concrete
25	IS 3951:1975 (Part I)	Specification for Hollow Clay Tiles for Floors and Roofs - Part I : Filler Type *(First Revision)*
26	IS 6523:1983	Specification for Precast Reinforced Concrete Door & Window Frames
27	IS 6909:1990	Supersulphated Cement – Specification *(First Revision)*
28	IS 8041:1990	Rapid Hardening Portland Cement – Specification *(Second Revision)*
29	IS 8042:1989	White Portland Cement - Specification
30	IS 8043:1991	Hydrophobic Portland Cement – Specification *(Second Revision)*
31	IS 8112:1989	43 Grade Ordinary Portland Cement – Specification *(First Revision)*
32	IS 9103:1999	Concrete Admixtures – Specification *(First Revision)*
33	IS 9142:1979	Specification for Artificial Lightweight Aggregates for Concrete Masonry Units
34	IS 12269:1987	Specification for 53 grade Ordinary Portland Cement
35	IS 12440:1988	Specification for Precast Concrete Stone Masonry Blocks
36	IS 12592:2002	Precast Concrete Manhole Cover and Frame – Specification *(First Revision)*
37	IS 13356:1992	Precast Ferrocement Water Tanks upto 10000 litres Capacity specification
38	IS 14213:1994	Construction of Walls using Precast Concrete Masonry Blocks - Code of Practice

Rates Analysis

for items of 'Standards and Specifications' for cost-effective Innovative Building Materials and Techniques

Section 2

CONTENTS

BASIS FOR RATE ANALYSIS

The rate analysis of cost-effective and innovative items contained in 'Standards and Specifications' has been worked out. The rate analysis has been done in two parts. Part – I has been done keeping in view all operations for production of building components/ elements completed manually based on the practice followed earlier. With the development of machines by BMTPC and other entrepreneurs, it has become possible to produce these building components/elements with partial mechanization by adopting the use of these machines resulting in limited automation which gives enhanced production and better quality control. Second part of rate analysis is focused on manufacture of building materials/components by mechanised process.

For analyzing the rates for various items of work, the coefficients have been derived from CBRI-Building Digest Notes, All India Standard Schedule of Rates and Analysis as prepared by NBO which contains many of cost effective/innovative techniques and CPWD-DSR 2007. Some of the coefficients have been derived based on the BMTPC experience on utilization of the innovative techniques in the field.

In order to achieve some uniformity and rationale, the basic rates for various materials and labour have been drawn from CPWD DSR – 2007. The basic rates of these materials and labour are in Indian Rupees & can vary from place to place and can be replaced in the rate analysis as and when required.

This rate analysis will act as tool for adoption of innovative techniques in the field.

BM 04 : Clay Flooring Tiles

Providing and fixing burnt clay flooring tiles on floors and jointing in cement mortar 1:3 over 20mm thick bed of a cement mortar 1:3

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
(a)	Tiles 15mm thick and size 150mmx150mm. Detail cost of 10 sqm.					
	Materials					
	Burnt clay tiles					
	15mm thick and 150mmx150mm.	400				
	5% wastage	20				
		420 no.	1000 nos.	905.13		380.15
	Mortar for jointing and bed					
	Cement mortar 1:3	0.24 cum	cum	3245.80		778.99
	Labour					
	Skilled	2.16 no.	each	151.50		327.24
	Unskilled	2.16 no.	each	135.25		292.14
	Sundries	30 units	unit	2.60		78.00
						1856.52
	Add water charges @ 1%					18.57
		For 10 sqm.				1875.09
		For 1 sqm				187.51
	Rate per Sqm 187.51					
(b)	20mm thick and size of 150mmx150mm. Detail cost of 10 sqm.					
	Materials					
	Burnt clay tiles					
	20mm thick and 150mmx150mm.	400				
	5% wastage	20				
		420 no	1000 nos.	1045.13		438.95
	Mortar for jointing and bed					
	Cement mortar 1:3	0.26 cum	cum	3245.80		843.91
	Labour					
	Skilled	2.16 no.	each	151.50		327.24
	Unskilled	2.16 no.	each	135.25		292.14
	Sundries	30 units	unit	2.60		78.00
						1980.24
	Add water charges @ 1%					19.80
		For 10 sqm.				2000.04
		For 1 sqm				200.00
	Rate per Sqm 200.00					
(c)	20mm thick and size of 200mmx200mm. Detail cost of 10 sqm.					
	Materials					
	Burnt clay tiles					
	20mm thick and 200mmx200mm.	235				
	5% wastage	12				
		247 nos.	1000 nos.	2005.13		495.27
	Mortar for jointing and bed					
	Cement mortar 1:3	0.26 cum	cum	3245.80		843.91
	Labour					
	Skilled	2.16 no.	each	151.50		327.24
	Unskilled	2.16 no.	each	135.25		292.14

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Sundries	30 units	unit	2.60		78.00
						2036.56
	Add water charges @ 1%					20.36
		For 10 sqm.				2056.92
		For 1 sqm				205.69
	Rate per Sqm 205.69					
(d)	25mm thick and size of 200mmx200mm.					
	Detail cost of 10 sqm.					
	Materials					
	Burnt clay tiles					
	25mm thick and 200mmx200mm.	235				
	5% wastage	12				
		247 nos.	1000 nos.	2485.13		613.83
	Mortar for jointing and bed					
	Cement mortar 1:3	0.28 cum	cum	3245.80		908.82
	Labour					
	Skilled	2.16 no.	each	151.50		327.24
	Unskilled	2.16 no.	each	135.25		292.14
	Sundries	30 units	unit	2.60		78.00
						2220.03
	Add water charges @ 1%					22.20
		For 10 sqm.				2242.23
		For 1 sqm				224.22
	Rate per Sqm 224.22					
(e)	30mm thick and size of 250mmx250mm.					
	Detail cost of 10 sqm.					
	Materials					
	Burnt clay tiles					
	30mm thick and 250mmx250mm.	151				
	5% wastage	8				
		159 nos.	1000 nos.	4585.13		729.04
	Mortar for jointing and bed					
	Cement mortar 1:3	0.24 cum	cum	3245.80		778.99
	Labour					
	Skilled	2.16 no.	each	151.50		327.24
	Unskilled	2.16 no.	each	135.25		292.14
	Sundries	30 units	unit	2.60		78.00
						2205.41
	Add water charges @ 1%					22.05
		For 10 sqm.				2227.46
		For 1 sqm				222.75
	Rate per Sqm 222.75					
	Rate Analysis for Cement Mortar 1:3 (1cement :3 Sand)					
	Details of cost for 1 Cum.					
	Materials:					
	Cement	10.20 bag	bag	227.36		2319.07
	Sand	1.07cum	cum	653.21		698.93
	Labour					
	Unskilled	0.60 no.	each	135.25		81.15
	Semi-skilled	0.30 no.	each	138.45		41.53
	Mixer Charges (running and hire charges)	26.91	unit	2.60		69.97
	Sundries	13.52	unit	2.60		35.15
		For 1 Cum				3245.80

BM 05 : Burnt Clay Flat Terracing Tiles

Providing and fixing burnt clay tiles on roof terrace grouted with cement mortar 1:3 (1cement:3 Sand) and finished neat.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
(a)	20mm thick 150mmx100mm					
	Detail of cost for 10 sqm					
	Materials					
	Burnt clay tiles					
	20mm thick and 150mmx100mm.	590				
	5% wastage	30				
		620 nos.	1000 nos.	805.13		499.18
	Mortar for grouting and jointing					
	Cement mortar 1:3	0.061cum	cum	3245.80		197.99
	Labour					
	Skilled	1.5 no.	each	151.50		227.25
	Unskilled	1.5 no.	each	135.25		202.88
	Sundries	30 units	unit	2.60		78.00
						1205.30
	Add water charges @ 1%					12.05
		For 10 sqm.				1217.35
		For 1 sqm				121.73
	Rate per Sqm 121.73					
(b)	20mm thick 175mmx125mm					
	Detail of cost for 10sqm					
	Materials					
	Burnt clay tiles					
	20mm thick and 175mmx125mm.	413				
	5% wastage	21				
		434 nos.	1000 nos.	1135.13		492.65
	Mortar for grouting and jointing					
	Cement mortar 1:3	0.061cum	cum	3245.80		197.99
	Labour					
	Skilled	1.5 no.	each	151.50		227.25
	Unskilled	1.5 no.	each	135.25		202.88
	Sundries	30 units	unit	2.60		78.00
						1198.77
	Add water charges @ 1%					11.99
		For 10 sqm.				1210.76
		For 1 sqm				121.08
	Rate per Sqm 121.08					
(c)	20mm thick 200mmx150mm					
	Detail of cost for 10 sqm					
	Materials					
	Burnt clay tiles					
	20mm thick 200mmx150mm	306				
	5% wastage	16				
		322 nos.	1000 nos.	1525.13		491.09
	Mortar for grouting and jointing					
	Cement mortar 1:3	0.061cum	cum	3245.80		197.99
	Labour					
	Skilled	1.5 no.	each	151.50		227.25
	Unskilled	1.5 no.	each	135.25		202.88
	Sundries	30 units	unit	2.60		78.00
						1197.21

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Add water charges @ 1%					11.97
		For 10 sqm.				1209.18
		For 1 sqm				120.92
	Rate per Sqm 120.92					
(d)	20mm thick 225mmx175mm					
	Detail of cost for 10 sqm					
	Materials					
	Burnt clay tiles					
	20mm thick 225mmx175mm	236				
	5% wastage	12				
		248 nos.	1000 nos.	1975.13		489.83
	Mortar for grouting and jointing					
	Cement mortar 1:3	0.061cum	cum	3245.80		197.99
	Labour					
	Skilled	1.5 no.	each	151.50		227.25
	Unskilled	1.5 no.	each	135.25		202.88
	Sundries	30 units	unit	2.60		78.00
						1195.95
	Add water charges @ 1%					11.96
		For 10 sqm.				1207.91
		For 1 sqm				120.79
	Rate per Sqm 120.79					
(e)	20mm thick 250mmx200mm					
	Detail of cost for 10 sqm					
	Materials					
	Burnt clay tiles					
	20mm thick 250mmx200mm	187				
	5% wastage	10				
		197 nos.	1000 nos.	2485.13		489.57
	Mortar for grouting and jointing					
	Cement mortar 1:3	0.061cum	cum	3245.80		197.99
	Labour					
	Skilled	1.5 no.	each	151.50		227.25
	Unskilled	1.5 no.	each	135.25		202.88
	Sundries	30 units	unit	2.60		78.00
						1195.69
	Add water charges @ 1%					11.96
		For 10 sqm.				1207.65
		For 1 sqm				120.76
	Rate per Sqm 120.76					

BM 06 : Reinforced Gypsum Plaster Boards

BM 0601 : Providing and fixing partition upto 2.40 meter height having composite thickness of 67 mm. Consisting of frame and double skin 8.5mm Thick gypsum board including providing and fixing of frame work made of special section power pressed from M.S. Sheet and galvanized with Zinc coating of grade 175 and consisting of floor and ceiling channel 50 mm Wide having equal flages of 32 mm width 0.50 mm thick fixed to floor/ceiling at the spacing of 610 mm center to center with dash fastner of 12.5 mm diameter 40 mm length and the studs 48mm wide having one flange of 34mm and other flange 36mm and 0.50mm thick fixed vertically within flange of floor and ceiling channel and placed at a spacing of 610mm centre to centre by 6mm dia bolts and nuts at both ends of partition fixed flush to wall with rawl plugs at the spacing of 450mm centre to center and fixing of gypsum board to either side of frame work by 20mm long drive all screws on studs, floors and ceilings channels at the spacing of 300 mm centre to center, including jointing and finishing to a flush finish with recommended joint filler, joint paper tape and joint finisher and two coats of primer suitable for gypsum board.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Consider a panel for gypsum board partition of size 4.165 m long and 2.40 m height.					
	For 4.165 x 2.40 = 9.996 or 10 sqm					
	Details of cost of gypsum board partition for 10 sqm					
	Materials					
	Gypsum board 8.50 mm thick 2 x 10	20.00 sqm				
	Add 5% for wastage	1.00 sqm				
		21.00 sqm	sqm	145.00		3045.00
	Floor and ceiling channels					
	50 mm x 32 mm x 0.50 mm 2 x 4.17	8.34 m				
	Add:- for wastage	0.66 m				
		9.00 m	m	37.00		333.00
	Studs					
	(48 mmx34mmx36mmx0.50mm)					
	No. of studs 4.17 / 0.61 6.83607 or 7+1	8				
	8 x 2.4	19.20 m				
	Add:- for wastage	0.80 m				
		20.00 m	m	24.00		480.00
	20 mm long screws					
	9 x 8 x 2	144.00				
	15 x 2 x 2	60.00				
		204.00				
	Add:- for wastage	6.00				
		210.00 nos.	cent	40.10		84.21
	Dash fastners 8 x 2	16.00 nos.	each	8.10		129.60
	Rawl plugs 7 x 2	14.00 nos.	each	1.00		14.00
	Plaster of Paris (Gypsum Anhydrous)					
	88% of 10 sqm	8.80				
	Add:- for wastage	0.20				
		9.00 kg	kg	2.50		22.50

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Glue					
	22% of 10 sqm	2.20				
	Add:- for wastage	0.30				
		2.50 kg	kg	20.00		50.00
	Paper tape (Roll 120m)	0.25 roll	roll	122.00		30.50
	Galvanised steel bolts and nuts					
	6 mm dia. 25 m m long	32.00 no.	each	0.51		16.32
	G I. washers for screw bolts	32.00 nos.	cent	21.00		6.72
	Primer					
	36% of 10sqm	3.60 litre				
	Add:- for wastage	0.15 litre				
		3.75 litre	litre	73.00		273.75
	Labour					
	Skilled	9.5 no.	each	151.50		1439.25
	Unskilled	0.15 no.	each	131.25		19.69
	Sundries	180 units	unit	2.60		468.00
	Scaffolding	60 units	unit	2.60		156.00
						6568.54
	Add 1% for water charges					65.68
		For 10 sqm				6634.22
	Rate per sqm.	***663.42***				

BM 0602 : Providing and fixing at all height false ceiling of 12.5 mm thick tapered edge gypsum board confirming to IS 2095 including providing and fixing of frame work made of special sections power pressed from MS. Sheet and galvanized in accordance with Zinc coating 600 as per IS 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 22 mm and 37 mm at 1200 mm center to center one flange fixed to the ceiling with dash fastner 12.5 mm dia x 40 mm long with 6 mm dia bolts to the angle hangers of 25 mm x 25 mm x 5mm of required length, and other end of angle hanger being fixed with nut and bolts to G.I, channels 45x15x 0.90mm running at the rate of 1200 mm center to center which the ceiling section 0.50 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having clips of 10.5 mm at 450 mm center to center shall be fixed in a direction perpendicular to G.I channel with connecting clips made out of 2.64 mm dia x 230mm long G.I. wire at every junction including fixing the gypsum board with ceiling section and perimeter channels 0.5m m thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450m m center to center with 25mm long drive all screws @ 230mm interval including jointing and fixing to a flush finish of tapered and square edges of the gypsum board with recommended filler, paper tapes, finisher and two coats of primer suitable for gypsum board and also including the coat of making opening for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed all complete.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Consider an area of 10.7m x 9.70 m – 103.79 sqm					
	Details of cost of 12.50 m m thick gypsum board ceiling for 103.79 sqm					
	Materials					
	12.5 m m thick gypsum board 1 x 10.7 x 9.7	103.79 sqm				
	wastage	5.21 sqm				
		109.00 sqm	sqm	145.00		15805.00
	Ceiling section	240 m	m	37.00		8880.00

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Perimeter channel	42m	m	24.00		1008.00
	Intermediate channel	91.5 m	m	39.00		3568.50
	Strap hangers	11 nos.	each	11.00		121.00
	Connecting clips	190 nos.	each	5.10		969.00
	6 m m dia bolts & nuts	22 nos.	each	0.51		11.22
	Soffit cleats	75 nos.	each	3.10		232.50
	25 m m long drive all screws	1000 nos.	cent	40.10		401.00
	Joint filler	24 kg.	kg	20.00		480.00
	Joint finisher	35 kg.	kg	23.00		805.00
	Joint tape	1.5 roll	roll	122.00		183.00
	12 m m dia 40 m m long with 6 m m dia bolts dash fastner	75 nos.	each	8.10		607.50
	Labour					
	For assembling the structure and fixing					
	Skilled	40 no.	each	151.50		6060.00
	Unskilled	70 no.	each	131.25		9187.50
	Scaffolding	600 units	unit	2.60		1560.00
	Sundries (Rawl plugs, cutting openings)	1500 units	unit	2.60		3900.00
	Cutting channels, angle iron drilling holes etc. (welding, riveting etc. 5%)	1200 units	unit	2.60		3120.00
						56899.22
	Add 1% for water charges					568.99
		For 103.79 sqm				57468.21
	Rate per sqm.	***553.70***				

BM 07 : Bamboo Mat Corrugated Roofing Sheets

Providing and fixing Bamboo Mat Corrugated Roofing Sheet fixed with G.I. Jor L hooks, bolts, nuts, bitumen washers complete on G.I. Pipe Sub-Structure.

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for a shed of size 20mx10m in plan				
	Area of roof 20.2 x 10.7	216.14 sqm	Slope 1:3 (both side)		
A	Sub-Structure				
	Rafters				
	32mm diameter G.I. Pipe (light grade)				
	3x10 = 30 m				
	3x2x5.27 = 31.62 m				
	= 61.62 m @ 2.61 kg/m	160.83 kg			
	Purlins(25mm dia) @2.01kg/m.				
	2x5x20 = 200 m @ 2.03 kg/m	406.00 kg			
		566.83 kg			
	Add:- 15% for fitting and wastage	85.02 kg			
		651.85 kg			
	G.I.pipe(i/c labour charges)	651.85 kg	kg	68.00	44325.80
	Bamboo sheets	90 nos.	each	758.50	68265.00
	8mm dia G.I. J or L hooks	476 nos.	ten	60.00	2856.00
	G.I.Washers	476 nos.	cent	21.00	99.96
	Bitumen Washers	476 nos.	cent	19.00	90.44
	Labour				
	Skilled	19.5 nos.	each	151.50	2954.25
	Unskilled	17.28 nos.	each	131.25	2268.00
					120859.45
	Add 1% for water charges				1208.60
		For 216.14 sqm			122068.05
	Rate per sqm.	***564.76***			
	G.I. Pipe				
	Details of cost for 10m (20.3kg)				
	25mm dia (@2.03kg/m) 10 m x 2.03 kg/m	20.3 kg			
	32mm dia (@2.61kg/m) 10 m x 2.61 kg/m	26.1 kg			
		46.4 kg			
	Materials				
	25mm dia G.I.pipe	10.15 m	m	109.06	1106.96
	32mm dia G.I.pipe	10.15 m	m	140.08	1421.81
	Labour				
	Skilled	1.66 nos.	each	151.50	251.49
	Unskilled	1.67 nos.	each	131.25	219.19
	Sundries	60 units	unit	2.60	156.00
		For 46.40 kg			3155.45
	Rate per kg.	***68.00***			

By Mechanical Process

Production of Bamboo Mat Corrugated Roofing Sheets

Size of sheet 1 No.	8' x 3'-6" 28.00 sqft or	2.60 sqm			
Annual Production		36000.00 sheets			
OR		1008000.00 sqft			
OR		93600.00 sqm			
Production per month		3000.00 sheets			
Details of cost for 3000 sheets		7800.00 sqm			
Materials					
Bamboo Mats 4 mats per sheet	4 x 3000	12000.00 nos.	mat	54.00	648000.00
Glue (350gm/sqm)	4 x 5577 x 0.35=	7808.00 kg	kg	96.00	749568.00
Preservation @ Rs.25,000 pm.					25000.00
Brush Bond Coating		8922.00 sqm	sqm	42.00	374724.00
Labour					
Supervisor		1 no.	month	6000.00	6000.00
Foreman		1 no.	month	8400.00	8400.00
Skilled		10 nos.	month	4545.00	45450.00
Semi-skilled		10 nos.	month	4155.00	41550.00
Unskilled		20 nos.	month	4000.00	80000.00
					1978692.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					296804.00
		For 3000 Sheets			2275496.00
Rate per Sheet.		**758.50 each**			
Rate per sqm.		**291.73 sqm**			

BM 08 : Micro Concrete Roofing Tiles

Providing and fixing MCR Tile roofing on steel Sub-Structure.

No.	Description		Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Area of roof in plan	6 x 3	18.00 sqm				
	Area of roof in slope	6.46 x 4.28	27.65 sqm				
	Details of cost for 27.65 sqm						
	Materials						
	No. of MCR Tiles		395.00 nos.	each	8.66	3420.70	
	(area of tile with overlap 0.07sqm)						
	Sub-Structure steel						
	Angle Iron Rafters						
	40x40x5mm						
	equal angle (3kg/m)						
	2 x 6.46 12.92 m						
	4 x 4.28 17.12 m						
	30.04 m	3.00 kg/m	90.12 kg				
	Flat Iron Purlin						
	40x6mm (1.9kg/m)						
	9 x 6.46 = 58.14 m	1.9 kg/m	110.47 kg				
	(structural steel work)		200.59 kg	kg	37.03	7427.85	
	Nails		2.00 kg	kg	41.00	82.00	
	G.I.Wire		3.00 kg	kg	40.10	120.30	
	Labour						
	Skilled		3.5 nos.	each	151.50	530.25	
	Unskilled		3.5 nos.	each	135.25	473.38	
						12054.48	
	Add 1% for water charges					120.54	
			For 27.65 sqm			12175.02	
	Rate per sqm.		***440.33***				

By Mechanical Process

Production of MCR Tiles using 2 machines each day

Production per day		200 tiles				
Production for a month	2 x 200 x 25	10000 tiles				
Material for 1 tile						
Cement		0.7 kg	kg	4.55	3.18	
Coarse sand		0.0007cum	cum	653.21	0.46	
6 mm & down						
stone aggregate		0.0003 cum	cum	803.21	0.24	
					3.88	
Production of 10000 tiles						
Material		10000 nos.	each	3.88		38800.00
Labour						
Machine operator		2 nos.	month	6000.00		12000.00
Skilled		1 no.	month	4545.00		4545.00
Unskilled		5 nos.	month	4000.00		20000.00
						75345.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%						11301.75
		For 10000 tiles				86646.75
Rate per Tile		***8.66 each***				

CT 01 : Precast Channel Unit for Floors / Roofs

Providing and laying pre-cast reinforced cement concrete channel units (as per standard design) in suspended floors and roofs in M-20 (1:1 1/2:3) concrete including pointing of joints, form work in pre-casting, handling, hoisting, erection and placing in position complete.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
Detail cost for a unit 3.60mx0.30		1.08sqm				
1.						
(i)	Concrete in channel unit					
	$[\{0.245x0.025+2x(0.05x0.105)\}] \times (3.60 - 2 \times 0.05) + (2 \times 1 \times \frac{0.295+0.245}{2} \times 0.05x0.105)$					
	[0.0061 + 0.0105] x 3.5 + 0.00283					
	0.0581 + 0.00283	0.06093 cum				
(ii)	Haunch Concrete					
	1 x 0.05x0.13x3.6 + 1 x 0.05x0.13x.295					
	2 2					
	0.0117 + 0.00096	0.01266 cum				
	M-20 concrete	0.07359 cum	cum	3177.33		233.82
2.	Wooden Mould					
(i)	Outer Frame					
	[(2x3.60x0.05x0.13)sides + (2x0.45x0.05x0.13)ends					
	+ (2x3.60 - 2x0.05)inner frame x 0.025x0.08 + 1x					
	(3.60-2x0.05)x0.17x0.025 + 5x0.08x0.04x0.195]	0.084 cum				
	Add :- 5% wastage	0.004 cum				
	Deodar wood	0.088 cum	cum	33560.81		2953.35
(ii)	M.S. Angle 40mmx40mmx5mm					
	(for fixing the trough to mould 0.45x10) 4.5 m					
	4.5m @3kg/m	13.50 kg				
	M.S. Angle 75mmx50mmx5mm for U-clamps at ends					
	4 x 0.13 0.52 m					
	0.52m @4.71kg/m	2.45 kg				
		15.95 kg				
	M.S. flat 30mmx5mm					
	2 x 3.6 7.2 m					
	7.20m @1.2kg/m	8.64 kg				
		24.59 kg	kg	31.05	763.52	
(iii)	G.I. Sheet 28 gauge outside the inner frame					
	$1x(3.60 - 2 \times 0.05) \times (0.17+ 0.105 + 0.105) + 2 \times \frac{0.17+0.195}{2} \times 0.105$ 1.7 sqm					
	1.70sqm @3.15kg/sqm	5.355kg	kg	34.55	185.01	
(iv)	10mm dia bolts 90mm long with fly nuts and washers. 8 nos.		each	9.00	72.00	
	Sundries (for mould nails, kerosine, grease mixture) 30 units		unit	2.60	78.00	
(v)	*Labour for making mould*					
	Skilled (3 no.+1.50 no.)	4.5 no.	each	151.50	681.75	
	Unskilled	3 no.	each	135.25	405.75	

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Cost of mould (Assuming 100 uses.)				5139.38	
	Cost of 1 use					51.39
3.	Transporting Units (within construction site)					
	For 40 Units					
	Unskilled 1 no. each 135.25	135.25				
	Trolley charges [(5000.00)/(40x12x23)] Rs.0.45each					
	(Assuming cost of trolley as Rs. 5,000/-					
	and its life as 12 month, working days					
	23 per month and number of units transported					
	per day per trolley 40. Trolley charges per unit)					
	40 x 0.45	18.00				
	For 40 Units	153.25				
	For 1 Units	153.25 / 40				3.83
4.	Handling, hoisting and erection					
	For 40 units					
	Skilled 1 no each 151.50	151.50				
	Unskilled 10 nos. each 135.25	1352.50				
	Scaffolding L.S.	80.00				
		1584.00				
	For 1 Units	1584.00 / 40				39.60
5.	Joint finishing and 'V' grooving in (cement mortar 1:2) (3.60m)					
	For 1.08 sqm	1.08 sqm	sqm	61.44		66.35
	For 1 m = 17.07					
6.	Steel reinforcement					
	6mm dia tor steel 2 x 3.6 7.2 m					
	7.20m @0.222kg/m	1.60 kg				
	12mm dia tor steel 2 x 3.6 7.2 m					
	7.20m @0.89kg/m	6.41kg				
	3mm dia M.S. wire 13 x 0.46 6 m					
	6.00m @0.07kg/m	0.42 kg				
	Negative reinforcement					
	6mm dia tor steel 1 x 3.6 3.6 m					
	3.60m @0.222kg/m	0.80 kg				
		9.23 kg	kg	37.24		343.72
						738.71
	Add :- for water charges @ 1%					7.39
	For 1.08 sqm					746.10
	Rate per Sqm 690.83					
	Pointing in cement mortar 1:2					
	Detail cost for 10 sqm					
	Material					
	Cement mortar 1:2	0.03 cum	cum	3940.46		118.21
	Labour					
	Skilled	0.80 no.	each	151.50		121.20
	Un-skilled	0.80 no.	each	135.25		108.20
	Semi-skilled	0.80 no.	each	138.45		110.76

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Sundries	30 units	unit	2.60		78.00
	Scaffolding etc.	30 units	unit	2.60		78.00
						614.37
	Add :- for water charge @1%					6.14
	For 10 sqm.					620.51
	Rate per Sqm	***62.05***				
	Rate per Sqm (without water charges)	***61.44***				
	Cement Mortar 1:2 (1 cement : 2 sand)					
	Details of cost for 1 Cum.					
	Materials					
	Cement	13.60 bag	bag	227.36		3092.10
	Coarse Sand	0.95 cum	cum	653.21		620.55
	Labour					
	Unskilled	0.60 no.	each	135.25		81.15
	Semi-skilled	0.30 no.	each	138.45		41.54
	Mixer Charges (running and hire charges)	26.91	unit	2.60		69.97
	Sundries	13.52	uni	2.60		35.15
		For 1 Cum				3940.46
	Providing M.S./Tor steel reinforcement for R.C.C. work including cutting, bending, binding and placing in position.					
	Detail cost for 1 quintal					
	Materials					
	Steel	1.00 quintal				
	5% wastage	0.05 quintal				
		1.05 quintal	quintal	3142.23		3299.34
	Labour for bending, binding and placing in position					
	Skilled	1.00 no.	each	151.50		151.50
	Unskilled	1.00 no.	each	135.25		135.25
	Sundries (binding wire etc.)	52.91	unit	2.60		137.56
						3723.65
	Add :- for water charge @1%					37.24
		For 1 quintal				3760.89
		For 1 kg				37.61
	Rate per kg	***37.61***				
	Rate per kg (without water charges)	***37.24***				

Average of M.S. & Tor $= \frac{3104.73 + 3179.73}{2}$ = 3142.23 per quintal

CT 02 : Precast RCC Planks and Joists

Providing and laying floor/roof slab consisting of pre-cast R.C.C. plank of cement concrete 1:11/2:3 (1 cement:11/2 sand :3 granded stone aggtregate 10mm and down), partially pre-cast R.C. Joist cement concrete of 1:11/2:3 (1 cement:11/2 sand :3 granded stone aggregate 20mm nominal size)and in-situ cement concrete 1:11/2:3 (1 cement:11/2 sand :3 graded stone aggregate 10mm nominal size) filling in haunches and between planks and joists after a coat of cement slurry at the rate of 4kg per 10 sqm including `casting, stacking, curing, erection, and placing in position with bedding cement mortar 1:4(1 cement: 4 sand), cost of mould oil, casting plateform, props, scaffolding, lifting equipments and finishing the joints between plank in 'V' groove pointing in C.M.1:4 (1 cement: 4 sand) in ceiling etc. and including cost of reinforcement complete all respects.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
(a)	Considering a size of roof 7.13x3.60 = 25.67sqm. (including bearing)					
	Size of R.C. Plank = 113 x 30 x 6 cm					
	Size of R.C. Joist = 15 x 15 x 360 cm					
	No. of Planks	72 nos.				
	No. of Joists	5 nos.				
	Total quantity of concrete in roof (7.13 x 3.6 x 0.06)	1.54 cum				
	Quantity of concrete in 1 Plank	0.01457 cum				
	(Quantity of concrete in one plank	0.01457 cum.				
	As given in Building Research note 4 of CBRI)					
	Concrete in 72 planks. (72 x 0.01457)	1.05 cum				
	Quantity in-situ concrete (haunches etc.) (1.54-1.05)	0.49 cum				
	R.C.Planks (113x30x6cm)	72 nos.				
	Mould (timber) - Deodar wood	0.015 cum	cum	33560.81	503.41	
	M.S. Tie rod 10mm dia 50cm long with nuts & Washers	2 nos.	each	60.00	120.00	
	M.S. hinges 7.5cm	4 nos.	each	10.00	40.00	
	Sundries	6 units	each	2.60	15.60	
	Labour (for making mould)					
	Skilled	1no.	each	151.50	151.50	
	Un-skilled	1no.	each	135.25	135.25	
					965.76	
	Assuming 60 uses of mould					
	Cost for 1 use	16.10				
	Mould cost for 72 Planks	72 nos.	each	16.10		1159.20
(b)	R.C. Planks					
	Materails					
	Concrete M-20 (for 72 nos.)	1.05 cum				
	Cement	8.40 bag	bag	227.36		1909.82
	Coarse Sand	0.45 cum	cum	653.21		293.94
	Stone aggregate 10mm	0.89 cum	cum	753.21		670.36
	Labour					
	Skilled	4.00 nos.	each	151.50		606.00
	Un-skilled	8.50 nos.	each	135.25		1149.62
	Miscellaneous Expenditure	72 nos.	each	7.20		518.40
	Casting platform 2.40 per plank					
	Mould oil & paper 2.40 per plank					
	Vibratar, mixture etc 2.40 per plank					
	7.20 per plank					

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Partially pre-cast R.C. Joists					
	size 15 x 15 x 360 cm	5no.				
	Mould for Joist - Timber (Deodar wood)	0.055cum	cum	33560.81	1845.84	
	(As per Building Research note 4 of CBRI)					
	M.S. Angle Iron clamps 25x25x3mm					
	Type 'A' 1 no. each 50.00	50.00				
	Type 'B' 2 nos. each 75.00	150.00				
		200.00			200.00	
	Labour					
	Skilled 0.5 no. each 151.50	75.75				
	Un-skilled 0.5 no. each 135.25	67.63				
	Sundries 12 units 2.60	31.20				
		174.58			174.58	
					2220.42	
	Assuming 100 uses of mould					
	Cost for 1 use	22.20				
	Mould cost for 5 Joists	5 nos.	each	22.20		111.00
	R.C. Joists					
	Materials					
	Concrete M-20 (for 5 nos.) 5 x 3.6 x 0.15 x 0.15	0.405 cum				
	Cement	3.24 bag	per bag	227.36		736.65
	Coarse Sand	0.172 cum	cum	653.21		112.35
	Stone aggregate 20mm nominal size	0.35 cum	cum	753.21		263.62
	Labour					
	Skilled	0.30 no.	each	151.50		45.45
	Un-skilled	0.90 no.	each	135.25		121.72
	Miscellaneous Expenditure	5 nos.	each	12.00		60.00
	Casting platform	3.60 per joist				
	Mould oil & paper	4.80 per joist				
	Vibrator, mixer etc	3.60 per joist				
		12.00 per joist				
	Erection and Assembly					
	Transportation with in construction site					
	from casting yard.	5 nos.	each	30.00		150.00
(a)	Partially pre-cast Joist proping material (Ballies, wedges etc)					
	per Joist L.S. Rs 30/- per Joist					
	Labour					
	Skilled (0.25 + 0.25)	0.50 no.	each	151.50		75.75
	Un-skilled	1.00 no.	each	135.25		135.25
(b)	Pre-cast R.C. plank	72 nos.				
	Materials (for jointing etc.)					
	Cement	1.40 bag	per bag	227.36		318.30
	Coarse Sand	0.2 cum	cum	653.21		130.64
	Labour					
	Skilled	1.80 nos.	each	151.50		272.70
	Un-skilled	7.20 nos.	each	135.25		973.80
	In situ concrete	0.49 cum				
	Cement (including cement for slurry)	4.02 bag	per bag	227.36		913.99
	Coarse Sand	0.22 cum	cum	653.21		143.71
	Stone aggregate 10mm	0.44 cum	cum	753.21		331.41
	Labour					
	Skilled	0.65 no.	each	151.50		98.47
	Un-skilled	2.60 no.	each	135.25		351.65
	Scaffolding, etc (cats walk etc.)	60 units	unit	2.60		156.00

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Finishing					
	V'-groove pointing in cement mortar 1:4					
	Materials					
	Cement	0.06 bag	per bag	227.36		13.64
	Course Sand	0.008 cum	cum	653.21		5.23
	Labour					
	Skilled	1.30 no.	each	151.50		196.95
	Un-skilled	1.30 no.	each	135.25		175.83
	Scaffolding, etc	30 units	unit	2.60		78.00
	Add :- T&P and Sundries	60 units	unit	2.60		156.00
	Steel reinforcement					
	6mm dia M.S. bar for planks					
	and -ve reinforcement					
	72 x 3 x 1.13 244.08 m					
	72 x 7 x 0.3 151.20 m					
	7 x 2 x 3.6 50.40 m					
	2 x 72 x 0.3 43.20 m					
	488.88 m					
	488.88 @0.22kg/m	107.55 kg				
	Joists					
	Steel reinforcement					
	8mm dia 5 x 4 x 3.6 72.00 m					
	72.00m @0.395kg/m	28.44 kg				
	6mm dia 5 x 2 x 3.6 36.00 m					
	5 x 28 x 0.5 70.00 m					
	5 x 28 x 0.15 21.00 m					
	127.00 m					
	127.00m @0.22kg/m	27.94 kg				
		164.00 kg	kg	37.24		6107.36
						18542.81
	Add for water charges @ 1%					185.43
		For 25.67 sqm				18728.24
		For 1 sqm				729.57
	Rate per Sqm	***729.57***				

By Mechanical Process

CT 0201 : Pre-cast R.C planks of size 113 x 30 cm using M20 concrete

	Quantity of M 20 concrete	0.01457 cum				
	Material for 1 Plank					
	Cement	5.83 kg	kg	4.55	26.53	
	Coarse sand	0.00625 cum	cum	653.21	4.08	
	10 mm stone aggregate	0.01236 cum	cum	803.21	9.93	
	Steel	1.4 kg	kg	37.24	52.13	
	Binding Wire	3 units	units	2.66	7.98	
					100.65	
	Production 80 planks per day with 1 machine					
	Production in one month 1 x 25 x 80	2000.00 Plank				
	Material	2000 nos.	each	100.65		201300.00
	Labour					
	Machine operator	1 no.	month	6000.00		6000.00
	Skilled	1 no.	month	4545.00		4545.00
	Unskilled	5 nos.	month	4000.00		20000.00
						231845.00

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					34777.00
		For 2000 planks				266622.00
	Rate per plank.	***133.31 each***				

CT 0202 : Pre-cast R.C. Joists of size 360 x15 x15cm cast inM20 concrete

Cement Concrete M20 (1 :1½ : 3)	0.081 cum				
Production 80 Joists per day with 1 machine					
Production in one month 1 x 25 x 80	2000 Joist				
Material for 1 Joists					
Cement	32.4 kg	kg	4.55	147.42	
Coarse sand	0.0344 cum	cum	653.21	22.47	
Stone aggregate	0.07 cum	cum	753.21	52.72	
Steel	7.29 kg	kg	37.24	271.48	
Binding Wire	4 units	unit	2.60	10.40	
				504.49	
Material (for 2000 joists)	2000 nos.	each	504.49		1008980.00
Labour					
Machine operator	1 no.	month	6000.00		6000.00
Skilled	1 no.	month	4545.00		4545.00
Unskilled	5 nos.	month	4000.00		20000.00
					1039525.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					155929.00
	For 2000 joists				1195454.00
Rate per joist	***597.73 each***				

Rate Analysis for M20 (1 :1½ : 3) in RCC

Details for 1 cum.	Quantity	Unit	Rate	Amount
Material				
10mm stone aggregate	0.85	cum.	753.21	640.23
Sand (coarse)	0.425	cum.	653.21	277.61
Cement	8	bag	227.36	1818.88
Labour				
Skilled	0.26	each	151.50	39.39
Semi-skilled	0.47	each	138.45	65.07
Unskilled	1.90	each	135.25	256.97
Mixer hire charges	0.07	day	400.00	28.00
Vibrator hire charges	0.07	day	200.00	14.00
Sundries	14.30	unit	2.60	37.18
				3177.33
Add 1% for water charges				31.77
				3209.10
Rate for M20 (1 :1½ : 3) in RCC including water charges per cum.	***3209.10***			

CT 03 : Thin R.C. Ribbed Slab for Floors and Roofs

Providing and laying thin R.C. ribbed slab in M-20 concrete using pre-cast R.C. ribs 110mmx200mm placed at 1200mm c/c and 50mm thick cast-in-situ R.C. flange.

No.	Description				Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Details of cost for 3m x 3.60m	=10.80 sqm							
	Partially pre-cast ribs	=2 no.							
	Lentgh of rib	=3.23 m							
	Section	=110mm x 200mm							
	Mould for ribs.								
	C-Channel								
	ISJC 200 (200 x 70)	=2 no.							
	(@13.90kg/m) 2 x 3.23	=6.46 m	13.9		89.79 kg				
	M.S. plate 240x200x6mm	=0.05 sqm							
	2 x 0.05	=0.1 x 50			5.00 kg				
	M.S. flat 50x5mm								
	(@2.50kg/m) 4 x 0.24	=0.96 x 2.5			2.40 kg				
	M.S.Angle 50x50x5mm								
	welded to ISJC200								
	(@3.80kg/m) 8 x 0.1	=0.8 x 3.8			3.04 kg				
	20mm square M.S.bars								
	(@2.84kg/m) 5 x 0.3	=1.5 x 2.84			4.26 kg				
					104.49 kg				
	Add:- 5% wastage				5.22 kg				
					109.71 kg	kg	31.05	3406.49	
	10mm dia bolts and nuts				8 nos.	each	25.00	200.00	
	Casting plateform etc.				120 units	unit	2.60	312.00	
								3918.49	
	Labour for making mould								
	Skilled	0.50 no.	each	151.50	75.75				
	Unskilled	1.00 no.	each	135.25	135.25				
					211.00			211.00	
								4129.49	
	Assuming 100 uses for a mould							4129.49	
	Cost for 1 use							41.29	
	Cost of 2 ribs								
	mould costs for 2 uses				2 nos		41.29		82.58
	Concrete for ribs M-20	2 x 3.23 x 0.11 x 0.15			0.11 cum		3177.33		349.51
	Steel reinforcement								
	6mm dia bars	2 x 6 x 3.25 x 0.23			8.97				
	@ 0.23kg/m	2 x 23 x 0.45 x 0.23			4.761				
					13.73 kg		37.24		511.30
	Sundries				30 units	unit	2.60		78.00
	Labour for Transportation, erection and assembly of ribs								
	Skilled	0.10 no.	each	151.50	15.15				
	Unskilled	0.40 no.	each	135.25	54.10				
					69.25				69.25
	Flange concrete M-20	3.46 x 4.06 x 0.05			0.70 cum	cum	3177.33		2224.13
	Steel for flange								
	6mm dia bars	28 x 3.46	96.88						
	@ 0.23kg/m	36 x 4.06	146.16						
			243.04 x 0.23		55.90 kg	kg	37.24		2081.72

No.	Description		Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Form work for flange.						
	G.I sheet (@ 3.15kg/sqm)	3x3.6x10.8x3.15	34.02 kg	kg	34.55	1175.39	
	Shuttering						
	Ply 10mm thick		10.8 sqm	sqm	482.00	5205.60	
	Battens of deodar wood						
	50mmx50mm	6 x 3 x 0.05 x 0.05	0.045 cum				
		3 x 3.6 x 0.05 x 0.05	0.027 cum				
			0.072 cum				
	Add:- 5% wastage		0.004 cum				
			0.076 cum	cum	33560.81	2550.62	
	Wedges		6 nos.		25.00	150.00	
	(50x50x150mm)						
	M.S.square bars 20mm dia	6 x 0.22 x 3.84	5.07 kg	kg	31.05	157.42	
	(@3.84kg/m)					9239.03	
	Assuming 20 uses for a mould		9239.03				
	Cost for 1 use						461.95
	Labour						
	For erection and assembly of form work for flange						
	Skilled		1.50 no.		151.50		227.25
	Unskilled		1.50 no.		135.25		202.88
	Bearing area of ribs plastered and						
	cement slurry on ribs		60 units	unit	2.60		156.00
	Sundries		60 units	unit	2.60		156.00
							6600.57
	Add :- 1% for water charges						66.00
			For 10.8 sqm				6666.57
	Rate per sqm.		***617.27***				
	Structural Steel Work						
	Details of cost for 1 quintal						
	Steel section		1.05 qtl	qtl	3104.73		3259.97
	Labour						
	Skilled		1.00 no.	each	151.50		151.50
	Unskilled		1.00 no.	each	135.25		135.25
	Bolts etc.		30 units	unit	2.60		78.00
	Sundries		30 units	unit	2.60		78.00
			For 1 quital				3702.72
	Rate per qtl.		***3702.72***				
	Rate per kg.		***37.03***				

CT 04 : Precast RCC Waffle Units

Providing and laying precast reinforced cement concrete waffle units square or rectangular as per the standard design for intermediate floors androofs in M-20 (1:1/1/2:3) concrete (1 cement:1 1/2 sand :3 granded stone aggregate 10mm nominal size) including flush or ruled pointing on joints in cement mortar 1:2 (1cement:2sand) form work in pre-casting, handling, hoisting, centering and erection complete including reinforcement in the flange in the form of steel wire fabric having 3.15mm dia wire at 100mm centre to centre both ways.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Using Units 300mm deep					
	Details of cost for a unit					
	900mmx900mmx300mm or 0.81sqm					
	cement concrete in one unit 0.8 x 0.8 x 0.035	0.0224				
	4 x 0.768 (0.0625 x 0.03 +					
	$\frac{0.055 + 0.0375}{2}$ x 0.12 + $\frac{0.055 + 0.035}{2}$ x 0.115)	0.0386				
		0.0610 cum				
	Haunches					
	4x0.895(1x0.0075x0.027+2x1/2x0.02x0.115+					
	2x1/2x0.12x0.0075)	0.012 cum				
	M-20 (1:11/2:3) concrete	0.0730 cum	cum	3177.33		231.95
	Mould					
(i)	Deodar Wood					
	2 x 1.2 x 0.07 x 0.3	0.0504				
	2 x 0.94 x 0.07 x 0.3	0.0395				
	4 x 0.77 x 0.02 x 0.26	0.0160				
	1 x 0.735 x 0.735 x 0.02	0.0108				
		0.1167 cum				
	Add 5% wastage	0.0058 cum				
		0.1225 cum	cum	33560.81	4111.20	
(ii)	M.S. angles 50x50x5mm for lifting handle					
	2 x 1.2 2.40 m					
	4 x 0.01 0.04 m					
	2.44 m					
	2.44m @3.00kg/m	7.32 kg	kg	31.05	227.29	
(iii)	10mm dia bolts 1.20m long with nuts					
	and washers	4.00 nos	each	61.00	244.00	
(iv)	10mm dia bolts 60mm long with nuts					
	and washers	4.00 nos.	each	7.00	28.00	
	Sundries (kerosine,grease etc.)	30 units	unit	2.60	78.00	
	Labour (for making mould)					
	Skilled	2.00 no.	each	151.50	303.00	
	Un-skilled	1.50 no.	each	135.25	202.88	
					5194.37	
	Assuming 100 uses for 1 mould					
	Cost for 100 uses				5194.37	
	Cost for 1uses					51.94
3	Centering for slab					
	1 x 0.9 x 0.9	0.81sqm	sqm	187.35		151.75

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
4	Transportation and erection					
	Labour for 20 units					
	Skilled	1.00 no.	each	151.50	151.50	
	Un-skilled	5.00 nos.	each	135.25	676.25	
	For 20 units				827.75	
	Total Cost for 1 units	827.75 / 20				41.39
						477.03
5	Pointing in Cement mortar 1:2	0.9 m	m	17.07		15.36
6	Reinforcement					
	3mm dia welded mesh					
	2 x 9 x 1.00	18.00 m				
	2 x 4 x 0.30	2.40 m				
	2 x 9 x 1.00	18.00 m				
	38.4m @0.07kg/m	38.40 m	0.07	2.69 kg		
	6mm dia					
	2 x 1.00	2.00 m				
	2 x 6 x 0.30	3.60 m				
	5.60m @0.222kg/m	5.60 m	0.222	1.24 kg		
				3.93 kg		
			say	4.00 kg	37.24	148.96
						641.35
	Add for water charges @ 1%					6.41
		For 0.81 sqm				647.76
		For 1 sqm				799.70
	Rate per Sqm	***799.70***				

CT 05 : Prefabricated Reinforced Concrete L-Panels for Roofs

Providing and laying precast reinforced cement concrete L- Panels as per standared designs for roofs in M20 (1:11/2:3) concrete (1 cement : 11/2 sand: 3 graded stone agg. 10 mm and down) including jointing ,placing in position, formwork in precasting, handling, hoisting centring, erection complete including reinforcement. Size 315 cm x 50cm x 12 cm

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
1	Mould					
	Material per mould					
	Deodar wood	0.062	cum	33560.81	2080.77	
	Sundries (screws, nails, fixtures)	30 units	unit	2.60	78.00	
	Labour for making mould					
	Skilled	1no.		151.50	151.50	
	Unskilled	1no.		135.25	135.25	
	For 100 uses				2445.52	
	Cost for 1 use					24.46
	(Assuming 100 uses for a mould)					
2	RCC 1:11/2:3 L- Panel					
	Concrete	0.067 cum				
	Cement	0.60 bag	bag	227.36	136.42	
	Coarse sand	0.031cum	cum	653.21	20.25	
	Stone Agg. 10 mm and down	0.06 cum	cum	753.21	45.19	
					201.86	201.86
	Mild Steel	5.52 kg				
	G.I. Wire(3mm dia)	0.69 kg				
		6.21 kg	kg	40.10		249.02
	Labour					
	(casting, curing, stacking etc.)					
	Skilled	0.14 no.	each	151.50	21.21	
	Unskilled	0.57 no.	each	135.25	77.09	
					98.30	98.30
3	Miscellaneous items					
	Casting platform	12.00				
	Oil paper etc.	10.00				
	Vibrator etc.	2.50				
	T & P	2.50				
		27.00				
		1.00 no.	each	27.00		27.00
4	Transportation					
	(with in construction site)					
	Trolley etc	3.00 no.	each	0.45	1.35	
	Labour					
	Unskilled	0.19 no.	each	135.25	25.70	
					27.05	27.05
5	Erection & Assembly					
	Mannual Hoisting Scaffolding	6 units	unit	2.60		15.60
	Labour					
	Skilled	0.04 no.	each	151.50	6.06	
	Unskilled	0.33 no.	each	135.25	44.63	
					50.69	50.69

No.	Description	Qty.	Unit	Rate Rs.	Amount	
6	Jointing and Plastering					
	Material					
	Cement	0.10 bag	bag	227.36	22.74	
	Coarse sand	0.01 cum	cum	653.21	6.53	
	Stone agg.	0.01 cum	cum	753.21	7.53	
					36.80	36.80
	Steel	0.4 kg	kg	37.24		14.90
	Labour					
	Skilled	0.10 no.	each	151.50	15.15	
	Unskilled	0.10 no.	each	135.25	13.52	
					28.67	28.67
7	Surface finish outer surface					
	2 coats of cement slurry or lime coat	9 units	unit	2.60	23.40	
	Inner surface	9 units	unit	2.60	23.40	
					46.80	46.80
	Labour					
	Skilled	0.06 no.	each	151.50	9.09	
	Unskilled	0.06 no.	each	135.25	8.11	
					17.20	17.20
	Insitu Ridge for 1 m of ridge					
	M-20 concrete	0.014 cum	cum	3177.33		44.48
	Reinforcement (assuming 1 m cost of ridge for 1 L-Panel)	1.4 kg	kg	37.24		52.13
						934.96
	Add for water charges @ 1%					9.35
		For 1.575 sqm. (3.15 x 0.50)				944.31
	Rate per sqm.	For 1 sqm				599.56
	Rate per Sqm	***599.56***				

CT 06 : Precast Doubly Curved Shell Units for Floors/Roofs

Providing and Laying pre-cast Cement Concrete doubly curved shells as per standard design for roof in 1:11/2:3 mix (1 cement:11/2 sand :3 graded stone aggregate 10mm and down) of 25mm thick including form work in pre-casting, handling, hoisting and erection including filling haunches in cement concrete 1:11/2:3 mix (1 cement:11/2 sand :3 graded stone aggtregate 10mm and down) upto top level of crown of shell unit over partially pre-cast R.C.C Joists.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Detail of cost for 0.49 Sqm. considering an area of 3.5mx3.5m of roof or 12.25 Sqm (size of shell unit 700mmx700mmx25mm deep).					
	No. of Shell units $\frac{12.25}{0.7x0.7}$	25				
	Concrete 1:11/2:3					
	25 x 0.7 x 0.7 x 0.025	0.30625 cum				
	Concrete in haunches over supporting joists.					
	5 x 3.5 x 0.08 x 0.05	0.07 cum				
	Over haunches					
	25 x (0.7x0.7x0.075 - 0.65x0.65x0.04)					
	25 x (0.037 - 0.0169)					
	25 x 0.02	0.50 cum				
1	C.C. 1:11/2:3					
	0.50 + 0.306 + 0.07	0.876 cum	cum	3177.33		2783.34
2	Mould					
(i)	Deodar Wood					
	1st set of frame					
	2 x 1.32 x 0.06 x 0.05	0.00792				
	2 x 0.86 x 0.06 x 0.05	0.00516				
	4 x 0.74 x 0.02 x 0.02	0.001184				
		0.014 cum				
	IInd set of Frame					
	2 x 1 x 0.06 x 0.04	0.0048				
	2 x 0.86 x 0.06 x 0.04	0.004128				
		0.009 cum				
	Template					
	1 x 0.75 x 0.10 x 0.10	0.0075				
	1 x 0.1 x 0.05 x 0.03	0.00015				
		0.008 cum				
	Total	0.031 cum				
	Add wastage 5%	0.002 cum				
		0.033 cum	cum	33560.81	1107.51	
(ii)	Headless nails 2mm and 5cm long	36 no.	each	0.50	18.00	
(iii)	Sundries (Kerosene,Grease mixture)	30 units	unit	2.60	78.00	
	Labour for mould					
	Skilled	0.36 no.	each	151.50	54.54	
	Unskilled	0.36 no.	each	135.25	48.69	
	Assuming 100 uses of mould				4090.08	

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Cost for 1 use					40.90
	Cost for hessian cloth					
	1 0.86 0.86	0.74 sqm	sqm	10.20		7.55
	Cost of polythene sheet.					
	1 0.8 0.8	0.64 sqm	sqm	24.20		15.49
						63.94
3	Brick Work in cement mortar.					
	1:6 (1cement:6 fine Sand) in foundation and plinth.					
	1 x 0.64 x 0.64 x 0.075	0.0307				
	2 x 0.64 x 0.13 x 0.1	0.0166				
		0.047 cum	cum	1851.77	87.03	
4	Cement Plaster in Cemet Mortar					
	1:4 (1cement : 4 fine Sand)					
	1 x 0.64 x 0.64	0.41				
	2 x 0.64 x 0.13	0.17				
		0.58 sqm	sqm	86.55	50.20	
	3 + 4.				137.23	
	Assuming 50 uses of (3 + 4) above.					
	Cost for 1 use	2.74				
	Cost of mould	63.94+ 2.74		66.68		
	for 25 units. Rs. 66.68/each	66.68x25				1667.00
5	Cost of transporting, hoisting and erection of tiles					
	(for 25 units of shells)					
	Skilled	1no.		151.50	151.50	
	Unskilled	2 nos.		135.25	270.50	
	For 25 units				422.00	422.00
	For 1 unit				16.88	
	Cost of partially pre-cast joist					
	Using M-20 concrete. (for 12.25 sqm.)					
	C.C. 1:11/2:3					
	5 3.5 0.12 0.08	0.17 cum		3177.33		540.15
	Mould for Partially pre-cast joist.					
	Deodar wood.					
	3.75 0.12 0.02	0.009				
	2 3.75 0.08 0.02	0.012				
	2 0.12 0.08 0.02	0.0004				
		0.022 cum	33560.81	738.34		
	M.S. Angle Iron clamps 25x25x3mm					
	Type 'A' 1 No. @ Rs.60.00 each	60.00				
	Type 'B' 2 No. @ Rs.80.00 each	160.00				
		220.00		220.00		
	Labour					
	Skilled 0.50 no. @Rs 151.50 each	75.75				
	Unskilled 0.50 no. @Rs 135.25 each	67.63				
	Sundries L.S.	25.00				
		168.38		168.38		
	Total 660.96 + 200.00 + 131.50			1126.72		
	Assuming 100 uses for a mould	1126.72				
	Cost for 1 use	11.27				
	Cost of mould for 5 joists @ Rs.11.27/- each					56.35
	Erection and Assembly					
	Transportation within construction					
	site from casting yard	5 no.	each	30.00		150.00
	Propping material	90 units	unit	2.60		234.00

No.	Description		Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Labour						
	Skilled (0.25 + 0.25)		0.5 no.	each	151.50		75.75
	Unskilled		1no.	each	135.25		135.25
	Steel						
	6mm dia 5 x 2 x 3.5	35 m					
	5 x 15 x 0.12	9 m					
		44 m					
	5 x 15 x 0.35	26.25 m					
		70.25 m					
	(@ 0.22kg/m)		15.455 kg				
	12mm dia 5 x 2 x 3.5		35 m				
	(@ 0.89kg/m)		31.15 kg				
			46.605 kg	kg	37.24		1735.57
							7791.41
	Add for water chareses @ 1% on						77.91
	For 12.25 sqm.						7869.37
	For 1 sqm.						642.39
	Rate per sqm.		***642.39***				
	Brick work in cement mortar 1:6 (1 cement : 6 fine sand)						
	Detail of cost for 1cum.						
	Materials						
	Bricks		475 no	per thousand	2041.88	969.89	
	Cement mortar (1:6)		0.24 cum	cum	1814.82	435.56	
	Sundries		30 units	unit	2.60	78.00	
	Labour						
	Skilled		0.82 no.	each	151.50	124.23	
	Semi Skilled		0.2 no.	each	138.45	27.69	
	Unskilled		1.6 no.	each	135.25	216.40	
			for 1 cum			1851.77	
	Cement Mortar 1:6						
	Detail of cost for 1cum.						
	Materials						
	Cement		5 bag	bag	227.36	1136.80	
	Fine sand		1.07 cum	cum	373.21	399.33	
	Labour						
	Semi Skilled		0.3 no.	each	138.45	41.54	
	Unskilled		0.6 no.	each	135.25	81.15	
	Hire chargesand running charges of mixer		30 units	unit	2.60	78.00	
	Sundries		30 units	unit.	2.60	78.00	
			for 1 cum			1814.82	
	12mm thick Cement Plaster in cement mortar 1:4 (1 cement : 4 fine sand)						
	Detail of cost for 10 sqm.						
	Materials						
	Cement mortar (1:4)		0.172 cum	cum	2405.96	413.82	
	Labour						
	Skilled		0.83 no.	each	151.50	125.75	
	Semi Skilled		0.98 no.	each	138.45	135.68	
	Unskilled		0.83no.	each	135.25	112.26	
	Scaffolding Sundries		30 units	unit	2.60	78.00	
			For 10sqm.			865.51	
	Rate per sqm.		***86.55***				

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Cement Mortar 1:4					
	Detail of cost for 1 cum.					
	Materials					
	Cement	7.6 bag	each	227.36	1727.94	
	Fine sand	1.07cum	cum	373.21	399.33	
	Labour					
	Semi Skilled	0.3 no.	each	138.45	41.54	
	Unskilled	0.6 no.	each	135.25	81.15	
	Hire chargesand running charges of mixer	30 units	unit	2.60	78.00	
	Sundries	30 units	unit	2.60	78.00	
		For 1 cum			2405.96	

CT 07 : Precast Reinforced / Prestressed Concrete Ribbed or Cored Slab Units for Floors / Roofs

Providing and laying pre-cast reinforced cement concrete cored units as per standard design for intermediate floors or roof using M-20 1:1 1/2:3 mix (1 cement:1 1/2 sand :3 granded stone aggregate)with 130mm thick (a.v.) units - 300mm wide at bottom and 243mm wide at top with two circular cores (hollow) of 90mm diameter including pointing of joints in cement mortar 1:2 including formwork in pre-casting, handling, hoisting and placing in position etc. complete and reinforcement.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Detail of cost for 1.08 sqm.					
	Considering a unit 300mm wide and 3600mm long					
	Concrete M-20					
	Cored unit					
	$3.6 \times \frac{0.3 + 0.243}{2} \times 0.13 - 2 \times 3.14 \times \frac{1}{4} \times (0.09 \times 0.09)$					
	0.106 - 0.013	0.0933 cum				
	Concrete in haunches					
	End Plugs $2 \times 2 \times 3.14 \times \frac{1}{4} \times 0.09 \times 0.09 \times 0.32$	0.008 cum				
	$1 \times 0.04 \times 0.13 \times 3.6$	0.019 cum				
1	Total M-20 concrete in cored unit and haunches	0.1203 cum	cum	3177.33		382.23
2	Mould for cored units.					
(i)	Deodar Wood					
	2 x 3.6 x 0.13 x 0.05	0.0468				
	2 x 0.45 x 0.13 x 0.05	0.0059				
	8 x 0.05 x 0.05 x 0.05	0.0010				
		0.054				
	Add :- 5%wastage	0.0030				
		0.057	cum	33560.81	1912.97	
(ii)	M.S. angles					
	40mmx40mmx5mm					
	4 x 0.356	1.424				
	4 x 2 x 0.075	0.6				
	4 x 0.356	1.424				
	(3.45m@3kg/m)	3.45	10.35 kg			
	75mmx50mmx5mm					
	(0.52m@4.7kg/m) 4 x 0.13	0.52	2.44 kg			
			12.79 kg			
	Add 5%wastage		0.64 kg			
			13.43 kg kg	31.05	417.00	
(iii)	10mm diameter bolts 90mm long with fly nuts and washers	12 no.	each	7.00	84.00	
(iv)	Kerosene grease mixture (sundries)	30 units	unit	2.60	78.00	
(v)	*Labour*					
	Skilled	4 nos.	each	151.50	606.00	
	Unskilled	4 nos.	each	135.25	541.00	
	Skilled	0.25 no.	each	151.50	37.87	
	Assuming 100 uses cost				3676.84	
	Cost for 1 use 'A'				36.77	

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
(vi)	90mm dia (external) G.I. Pipe					
	2 x 4 8 m x 363.36	2906.88				
	Assuming 500 uses pipe as mould					
	Cost for 1 use 'B'	2906.88 / 500		5.81		
	Mould cost for one use (A+B)			42.58		42.58
3	Transporting of units with in construction site and erection and placing in position.(for 12 units)					
	Labour					
	Skilled 1 no. each 151.50	151.50				
	Unskilled 7 no. each 135.25	946.75				
		1098.25				
	Cost for 1 unit	91.52				91.52
	For 1.08sqm					516.33
4	Pointing of joints	3.6 m	m	12.61		45.40
5	Reinforcement					
	6mm diameter 3 x 3.6 10.8 m					
	1 x 3.6 3.6 m					
	14.4m@0.23kg/m 14.4 m 0.23	3.312 kg	kg	37.24		123.34
						685.07
Add for water chareses @ 1% on						6.85
		For 1.08 sqm.				691.92
		For 1 sqm.				644.67
	Rate per sqm.	***644.67***				
	Pointing in cement mortar 1:2 (1cement:2 fine sand) to underside of joints					
	Detail of cost for 10m.					
	Materials					
	Cement mortar (1:2) 10 x 0.025 x 0.009	0.0023 cum				
	10%wastage	0.0002 cum				
		0.0025 cum	cum	3940.46	9.85	
	Labour					
	Skilled	0.2 no.	each	151.50	30.30	
	Semi Skilled	0.2 no.	each	138.45	27.69	
	Unskilled	0.2 no.	each	135.25	27.05	
	Sundries & scaffolding	12 no.	each	2.60	31.20	
		For 10 m.			126.09	
	Rate per m.	***12.61***				
	Cement Concrete 1:1:2 (1 cement:1 sand :2 granded stone aggregate 10mm and down)					
	Detail for 1cum					
	Materials					
	Cement	11.20 bag	bag	227.36	2546.43	
	Coarse Sand	0.39 cum	cum	653.21	254.75	
	Stone aggregate 10mm	0.78 cum		753.21	587.50	
	Labour					
	Skilled (0.40+0.08)	0.48 no.	each	151.50	72.72	
	Semi Skilled	0.47 no.	each	138.45	65.07	
	Un-skilled	1.90 no.	each	135.25	256.97	
	Hire and running charges of mixer	30 units	unit	2.60	78.00	
		Cost for 1cum			3861.44	

CT 08 : Reinforced Brick and Reinforced Brick Concrete Slabs for Floors / Roofs

CT 0801 : Providing and laying Cement Concrete (M-20) 1:11/2:3 in R.B.C slab (1cement:11/2coarce sand:3 graded stone aggregate 20mm nominal size)and curing complete excluding cost of reinforcement and form work in suspended floors, roofs.

No.	Description		Qty.	Unit	Rate Rs.	Amount
	Details of cost for 3.30m x					
	3.30m.(thickness of slab170mm)	3.3 x 3.3	10.89 sqm			
	C.C 1:11/2:3	10.89 x 0.17	1.85 cum			
	Deduct volume of bricks					
	11 20 x 0.23 x 0.15 x 0.11		0.83 cum			
			1.02 cum	cum	3177.33	3240.88
	Add cost of bricks		220 nos.	1000 nos	2041.88	449.21
	Extra labour for laying R.C.C					
	Skilled		0.13 nos.	each	151.50	19.69
	Semi-skilled		0.2 nos.	each	138.45	27.69
	Unskilled		0.28 nos.	each	135.25	37.87
						3775.34
	Add 1% for water charges					37.75
			For 10 sqm			3813.39
	Rate per sqm.		***381.31***			

CT 0802 : Providing and laying reinforced brick slab in suspended floors/roof consisting of bricks,steel reinforcement and mortar using 1:2 cement mortar and curing complete using good quality bricks having minimum crushing strength of 70kg/sqcm excluding the cost of reinforcement and form work.

	Details of cost for 3.30mx					
	3.30m.(thickness of slab110mm)	3.3 x 3.3	10.89 sqm			
		10.89 x 0.11	1.20 cum			
Deduct volume of bricks						
	30 11 x 0.23 x 0.11 x 0.07		0.58 cum			
			0.62 cum	cum	3940.46	2443.08
	Add cost of bricks		330 nos.	1000 nos	2041.88	673.82
	Labour					
	Skilled		0.16 nos.	each	151.50	24.24
	Semi-skilled		0.17 nos.	each	138.45	23.54
	Unskilled		1.18 nos.	each	135.25	159.59
						3324.27
	Add 1% for water charges					33.24
			For 10.89 sqm			3357.51
	Rate per sqm.		***308.31***			

CT 09 : Prefabricated Brick Panel for Floors / Roofs

Providing and laying in position floor/roof slab consisting of pre-fabricated brick panels of concrete, bricks and reinforcement placed on partially pre-cast R.C. joists and in situ concrete laid over the pre-fabricated brick panels complete including casting, staking, curing, erection and placing in position, cost of mould, joists, casting plateform, reinforcement.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Details of cost for a room of size 3.55mx3.36					
	3.55 m x 3.36 m	11.93 sqm				
	Size of pre-fabricated panels	1150 mm x 530.00 mm				
	No of pre-fabricated brick panels	21 No.				
	Size of partially pre-cast R.C. Joists	3590 x 130 x 100 mm				
	Pre-fabricated brick panels					
(a)	Mould (timber)					
	Deodar wood					
	2 x 1.18 x 0.075 x 0.015	0.0026 cum				
	2 x 0.53 x 0.075 x 0.015	0.0012 cum				
		0.0038 cum				
	Add 5% wastage	0.0002 cum				
		0.0040 cum	cum	33560.81	134.24	
	M.S. Strap etc	4.00 nos.	each	25.00	100.00	
	Sundries	6 nos.	each	2.60	15.60	
	Labour					
	Skilled	0.50 no.	each	151.50	75.75	
	Unskilled	0.50 no.	each	135.25	67.63	
					393.22	
	Assuming 60 uses for a mould	393.22				
	Cost for 1 use	6.55				
(b)	Brick panel					
	Material					
	Bricks	18.00 nos.	1000 nos	2041.88	36.75	
	M-20 concrete for joints	0.01 cum	cum	3177.33	31.77	
	Steel reinforcement					
	6mm dia bars @ 0.23kg/m 2 x 1.25 x 0.23	0.58 kg	kg	37.24	21.60	
	Labour for laying of bricks and jointing					
	Skilled	0.05 no.	each	151.50	7.57	
	Unskilled	0.12 no.	each	135.25	16.23	
	Miscellaneous like oil, sand etc,	3 units	unit	2.60	7.80	
	Cost for mould				6.55	
					128.27	
(c)	Partially pre-cast joists					
	3.59 x 0.13 x 0.10					
	Cost same as in Planks & Joists system (mould)				22.20	
	C.C 1:11/2:3 3.59 x 0.13 x 0.1	0.05 cum	cum	3177.33	158.87	
	Reinforcement steel					
	6mm dia bars 3 x 3.6 = 10.8 m					
	@ 0.23kg/m 28 x 0.5 = 14 m					
	24.8 x 0.23	5.70 kg	kg	37.24	212.27	
	Sundries	6 units	unit	2.60	15.60	
					408.94	

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Erection and Assembly for 11.93 sqm					
	Cost of 2 joists	2 each	each	408.94		817.88
	Transportation with in construction site from casting yard.	2 each	each	30.00		60.00
(a)	Partially pre-cast joists					
	Proping material - (Ballies, wedges etc.)	30 units	unit	2.60		78.00
	Labour					
	Skilled	0.20 no.	each	151.50		30.30
	Unskilled	0.40 no.	each	135.25		54.10
(b)	Pre-fabricated brick panels 21nos.	21.00 nos.	each	128.27		2693.67
	Labour					
	Skilled	0.53 no.	each	151.50		80.30
	Unskilled	2.10 no.	each	135.25		284.02
(c)	In situ concrete 1:11/2:3 11.92 x 0.035	0.42				
	11.92 x 0.075	0.89				
		1.31				
	Less:- volume of brick panel					
	21x1.15x0.53x0.07 (-)	0.89				
		0.42 cum	cum	3177.33		1334.48
(d)	Steel					
	6mm dia bars @0.23kg/m 8 x 3.8 x 0.23	7 kg	kg	37.24		260.68
	Scaffolding, catwalk, T&P etc.	120	unit	2.60		312.00
						6005.43
	Add 1% for water charges					60.05
		For 11.93 sqm				6065.48
	Rate per sqm.	***508.42***				

CT 10 : Ferrocement Roofing Channel

Providing and Laying in position Fero-cement roofing Channel.

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 2.55 x 4.6 11.73 sqm				
	Length of Freo-cement Channel 4.6 m				
	No. of Fero-cement Channel 2.55 3.00 Nos.				
	0.84				
	Materials				
	Channels 4.60m long	3 nos.	each	1541.10	4623.30
	Jointing in cement concrete M-20				
	3 x 4.6 x 0.1 x 0.1	0.138			
	2 x 4.6 x 0.335 x 0.1	0.308			
		0.446 cum	cum	3177.33	1417.09
	Negative reinforcement				
	8mm dia (@.39kg/m) 9.2 m x 0.39 kg/m	3.59 kg	kg	37.24	133.69
	Labour				
	Skilled	0.56 nos.	each	151.50	84.84
	Unskilled	2.8 nos.	each	135.25	378.70
	Sundries	30 units	unit	2.60	78.00
					6715.62
	Add 1% for water charges				67.16
		For 11.73 sqm			6782.78
	Rate per sqm.	***578.24***			

By Mechanical Process

Ferrocement Channel - size -Bay length 750mm, Rise of arch 290mm, Shell thickness 25mm, Length upto 6.10m

	1 machine + 4 moulds, 5 channel per day.				
	Production in 1 month. 5 x 25	125 Channels			
	Material for 1 channel 4.60m long.				
	Cement	68.15 kg	kg	4.55	310.08
	Coarse sand (Density of				
	sand 1520kg/cum)	0.1605 cum	cum	653.21	104.84
	Steel	8.52 kg	kg	31.05	264.54
	Chicken mesh	9.2 sqm	sqm	31.00	285.20
	Welded mesh	1.23 sqm	sqm	62.00	76.26
	Binding wire	0.46 kg	kg	40.10	18.45
					1059.37
	Production of 125 Channels units in a month.				
	Material	125 nos.	each	1059.37	132421.25
	Labour				
	Supervisor	1 no.	month	6000.00	6000.00
	Skilled	2 nos.	month	4545.00	9090.00
	Unskilled	5 nos.	month	4000.00	20000.00
					167511.25
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%				25126.69
		For 125 Channel units			192637.94
	Rate per Channel.	**1541.10each**			

BC 01 : Precast Solid Cement Concrete Blocks

BC 0101 : Providing and laying pre-cast Concrete block masonry with Solid concrete blocks of approved size made of 1:9 concrete mix (1cement : 9 Aggregates) in foundations and plinth laid in cement mortar 1:6 (1 cement : 6 Sand) using blocks of size 400x200x200 mm

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 1 cum of masonry				
	Wall thickness 200mm				
	Materials				
	Pre-cast solid concrete blocks of C.C(1:9) -				
	(1cement : 4sand : 5stone aggregate 40mm down)				
	Block size 40 x 20 x 20 cm (nominal)				
	No. of blocks	60.00 no.	each	39.38	2362.80
	Cement mortar 1:6	0.10 cum	cum	1814.82	181.48
	Labour				
	Skilled	1.33 no.	each	151.50	201.50
	Unskilled	1.85 no.	each	135.25	250.21
	Sundries	12 no.	each	2.60	31.20
					3027.19
	Add 1% for water charges				30.27
		For 1 cum			3057.46
	Rate per cum	***3057.46***			

BC 0102 : Providing and laying pre-cast Concrete block masonry 100mm thick using Solid concrete blocks of nominal size 40x10x20cm in partitions of 1:9 concrete mix (1cement : 9 Aggregates) in cement mortar 1:4 (1 cement : 4 Sand)

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 10sqm.				
	Materials				
	Pre-cast cement concrete blocks mix 1:9				
	(1cement : 9 aggregates) - (1cement : 4sand :				
	5stone aggregate 40mmdown)				
	Block size 40 x 10 x 20 cm (nominal)				
	No. of blocks	122.00 no.	each	20.98	2559.56
	Cement mortar 1:4	0.11 cum	cum	2405.96	264.65
	Labour				
	Skilled	2.15 no.	each	151.50	325.73
	Unskilled	3.25 no.	each	135.25	439.56
	Scaffolding	12 units	unit	2.60	31.20
	Sundries	12 units	unit	2.60	31.20
					3651.90
	Add 1% for water charges				36.52
		For 10 sqm			3688.42
	Rate per sqm.	***368.84***			

BC 0103 : Providing and laying pre-cast Concrete block masonry with hollow cement concrete block of approved size confirming to IS 2185 using concrete mix (1cement : 9 Aggregates) having solid materials not less than 50% of total volume of block in foundation and plinth laid in cement mortar 1:6 (1 cement : 6 sand). Size of block 40cmx20cmx20cm.(nominal).

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 1 cum.				
	Materials				
	Pre-cast hollow cement concrete blocks				
	Block size 40 x 20 x 20 cm (nominal)				
	No. of blocks	60.00 no.	each	24.61	1476.60
	Cement mortar 1:6	0.10 cum	cum	1814.82	181.48
	Labour				
	Skilled	1.33 no.	each	151.50	201.49
	Unskilled	1.85 no.	each	135.25	250.21
	Sundries	12 units	unit	2.60	31.20
					2140.98
	Add 1% for water charges				21.41
		For 1 cum			2162.39
	Rate per cum.	***2162.39***			

BC 0104 : Providing and laying pre-cast Concrete block masonry 100mm thick in partitions using hollow concrete blocks of approved size made of concrete mix 1:9 (1cement : 9 Aggregates) having solid materail not less than 50% of the total volume of block confirming to IS 2185 and of size 40x10x20cm laid in cement mortar 1:4 (1 cement : 4 sand)

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 10sqm.				
	Materials				
	Pre-cast concrete hollow blocks mix 1:9 (1cement : 9 aggregates)				
	Block size 40 x 10 x 20 cm (nominal)				
	No. of blocks	122.00 no.	each	15.25	1860.50
	Cement mortar 1:4	0.11cum	cum	2405.96	264.65
	Labour				
	Skilled	2.15 no.	each	151.50	325.72
	Unskilled	3.25 no.	each	135.25	439.56
	Scaffolding	12 units	unit	2.60	31.20
	Sundries	12 units	unit	2.60	31.20
					2952.83
	Add 1% for water charges				29.53
		For 10 sqm			2982.36
Rate per sqm.		***298.24***			

BC 0105 : Extra for masonry work with pre-cast concrete block (solid or hollow) using block of nominal size 40cmx20cmx20cm in Super structure

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Detail of cost for 1cum.				
	Scaffolding	18 no	each	2.60	46.80
	Labour				
	Skilled	0.16 no.	each	151.50	24.24
	Unskilled	0.33 no.	each	135.25	44.63
					115.67
	Add 1% for water charges				1.16
		For 1 cum			116.83
Rate per cum.		***116.83***			

By Mechanical Process

BC 0101 : Centre concrete solid blocks mix 1:9(1:4:5). Size 400x200x200 mm
(Production in one month)
1000 x 1 x 25 25000

Mix 1:9-C.C 1:4:5					
Size of block	400 x 200 x 200 mm (nominal size)				
Actual size	390 x 200 x 190 mm				
Material for 1 block					
Cement	3.75 kg	kg	4.55	17.06	
Coarse sand	0.01 cum	cum	653.21	6.53	
40 mm stone aggregate	0.008 cum	cum	707.83	5.66	
20 mm stone aggregate	0.003 cum	cum	753.21	2.26	
10 mm stone aggregate	0.002 cum	cum	753.21	1.51	
				33.02	
For 25,000 blocks in a months					
Material	25000 nos.	each	33.02		825500.00
Labour					
Machine operator	1 nos.	month	6000.00		6000.00
Skilled	1 nos.	month	4545.00		4545.00
Unskilled	5 nos.	month	4000.00		20000.00
					856045.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					128407.00
	For 25000 blocks				984452.00
Rate per block	***39.38 each***				

BC 0102 : Cement Concrete Solid block using CC 1 : 3 : 6 and of nominal size 30 x 20 x 15cm.
(Production in one month)
1000 x 1 x 25 25000

Mix 1:9-C.C 1:3:6					
Size of block	300 x 200 x 150 mm (nominal size)				
Actual size	290 x 200 x 140 mm				
Material for 1 block					
Volume of concrete in 1 block	0.0081 cum				
Cement	1.78 kg	kg	4.55	8.10	
Coarse sand	0.004 cum	cum	653.21	2.61	
40 mm stone aggregate	0.005 cum	cum	707.83	3.54	
20 mm stone aggregate	0.002 cum	cum	753.21	1.51	
10 mm stone aggregate	0.001 cum	cum	753.21	0.75	
				16.51	
For 25,000 blocks in a months					
Material	25000 nos.	each	16.51		412750.00
Labour					
Machine operator	1 nos.	month	6000.00		6000.00
Skilled	1 nos	month	4545.00		4545.00
Unskilled	5 nos.	month	4000.00		20000.00
					443295.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					66494.25
	For 25000 blocks				509789.25
Rate per block	***20.39 each***				

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	BC 0103 : Road Paver blocks of size 23 cm x7.5 cm x 5 cm.					
	Mix 1:3:6	0.0009 cum				
	(Production in a month with 2 machines)					
	2 x 25 x 2500	125000				
	Material					
	For 1 paver block					
	Cement	0.2 kg	kg	4.55	0.91	
	Coarse sand	0.00044 cum	cum	653.21	0.29	
	10 mm stone aggregate	0.0009 cum	cum	753.21	0.68	
					1.88	
	For one month production of 1,25,000 paver blocks					
	Material	125000 nos.	each	1.88		235000.00
	Labour					
	Machine operator	2 nos.	month	6000.00		12000.00
	Skilled	2 nos.	month	4545.00		9090.00
	Unskilled	10 nos.	month	4000.00		40000.00
						296090.00
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					44413.50
		For 125000 blocks				340503.50
	Rate per block	***2.72 each***				
	BC 0104 : Cement Concrete Solid blocks size 40x10x20 cm(nominal) using cement concrete (1:4:5)1 cement :4 coarse sand : 5 stone aggregate 40mm and down					
	(Production in one month)					
	1000 x 1 x 25	25000				
	Mix 1:9-C.C 1:4:5					
	Size of block	400 x 100 x 200 mm (nominal size)				
	Actual size	390 x 100 x 190 mm				
	Material for 1 block					
	Cement	1.88 kg	kg	4.55	8.55	
	Coarse sand	0.0053cum	cum	653.21	3.46	
	40 mm stone aggregate	0.0041cum	cum	707.83	2.90	
	20 mm stone aggregate	0.002 cum	cum	753.21	1.51	
	10 mm stone aggregate	0.0008 cum	cum	753.21	0.60	
					17.02	
	For 25,000 blocks in a months					
	Material	25000 nos.	each	17.02		425500.00
	Labour					
	Machine operator	1 no.	month	6000.00		6000.00
	Skilled	1 no.	month	4545.00		4545.00
	Unskilled	5 nos.	month	4000.00		20000.00
						456045.00
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					68406.75
		For 25000 blocks				524451.75
	Rate per block	***20.98 each***				

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	BC 0105 : Cement Concrete Hollow blocks mix. 1:9:(1:4:5)-1 cement 4 coarse sand : 5 stone aggregate Size 400x200x200 mm (Production in one month) 1000 x 1 x 25	25000				
	Mix 1:9-C.C 1:4:5					
	Size of block 400 x 200 x 200 mm (nominal size)					
	Actual size 390 x 200 x 190 mm					
	Material for 1 block					
	Cement	2.25 kg	kg	4.55	10.24	
	Coarse sand	0.006 cum	cum	653.21	3.92	
	20 mm stone aggregate	0.004 cum	cum	753.21	3.01	
	10 mm stone aggregate	0.004 cum	cum	753.21	3.01	
					20.18	
	For 25,000 blocks in a months					
	Material	25000 nos.	each	20.18		504500.00
	Labour					
	Machine operator	1 no.	month	6000.00		6000.00
	Skilled	1 no.	month	4545.00		4545.00
	Unskilled	5 nos.	month	4000.00		20000.00
						535045.00
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					80256.75
		For 25000 blocks				615301.75
	Rate per block.	***24.61 each***				
	BC 0106 : Cement Concrete Hollow block mix 1:9 (1:4:5) - 1 cement:4coarse sand:5 stone agg. 20 mm and down. Size 400x100x200 mm (Production in one month) 1000 x 1 x 25	25000				
	Mix 1:9-C.C 1:4:5					
	Size of block 400 x 100 x 200 mm (nominal size)					
	Actual size 390 x 100 x 190					
	Material for 1 block					
	Cement	1.313 kg	kg	4.55	5.97	
	Coarse sand	0.004 cum	cum	653.21	2.61	
	20 mm stone aggregate	0.0023 cum	cum	753.21	1.73	
	10 mm stone aggregate	0.0023 cum	cum	753.21	1.73	
					12.04	
	For 25,000 blocks in a months					
	Material	25000 nos.	each	12.04		301000.00
	Labour					
	Machine operator	1no/pm	month	6000.00		6000.00
	Skilled	1 no/pm	month	4545.00		4545.00
	Unskilled	5 no/pm	month	4000.00		20000.00
						331545.00
	Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%					4973175
		For 25000 blocks				381276.75
	Rate per block.	***15.25 each***				

BC 02 : Precast Concrete Stone Masonry Blocks

BC 0201 : Providing and laying stone block masonry pre-cast solid stone blocks of approved size made of stones of size 15 to 20cms and cement concrete 1:5:8 (1 cement : 5 fine sand : 8 stone aggregate 20mm and down gauge) in foundation and plinth laid in cement mortar 1:6 (1cement :6 sand). Size of stone blocks nominal - 30cmx20cmx15cm.

No.	Description	Qty.	Unit	Rate (Rs.)	Amount
	Details of cost for 2 cum.				
	Materials				
	Pre-cast stone masonry blocks				
	Block size 30 x 20 x 15 cm (nominal)				
	No. of blocks	222.00 no.	each	16.92	3756.24
	Cement mortar 1:6	0.19 cum	cum	1814.82	344.82
	Labour				
	Skilled	1.2 no.	each	151.50	181.80
	Unskilled	3 no.	each	135.25	405.75
	Sundries	24 units	each	2.60	62.40
					4751.01
	Add 1% for water charges				47.51
		For 2 cum			4798.52
	Rate per cum.	***2399.26***			

BC 0202 : Providing and laying 100mm thick stone block masonry using pre-cast stone masonry blocks of approved size 30cmx10cmx15cm size made of medium size stone of 10 to 15 cm size and cement concrete 1:5:8 (1 cement : 5 fine sand : 8 stone aggregate 20mm and down gauge) laid in cement mortar 1:6 (1 cement : 6 Sand) for partitions.

No.	Description	Qty.	Unit	Rate (Rs.)	Amount
	Details of cost for 10sqm.				
	Materials				
	Pre-cast stone masonry blocks of nominal size				
	Block size 30 x 10 x 15 cm (nominal)				
	No. of blocks	222.00 no.	each	9.04	2006.88
	Cement mortar 1:6	0.10 cum	cum	1814.82	181.48
	Labour				
	Skilled	0.8 no.	each	151.50	121.20
	Unskilled	1.6 no.	each	135.25	216.40
	Scaffolding	12 units	unit	2.60	31.20
	Sundries	12 units	unit	2.60	31.20
					2588.36
	Add 1% for water charges				25.88
		For 10 sqm			2614.24
	Rate per sqm.	***261.42***			

BC 0203 : Solid Stone Blocks 30 x 20 x 15 cm nominal size in Cement Concrete1:5:8 with stones of 8 cms to 15 cms

Actual size of block = 290 x 200 x 140 mm
Volume of block = 0.00812 cum.
Volume of 1000 blocks = 8.12 cum.
25% of stone spalls by volume
Volume of stone spalls = 2.03 cum.
Volume of concrete = 8.12 - 2.03 = 6.09 cum.
Details of cost for 1000 blocks
Concrete 1:5:8 = 6.09 cum.

Materials	**Qty.**	**Unit**	**Rate (Rs.)**	**Amount**
Cement = 1.03 tonne	20.60	bag	227.36	4683.62
Coarse sand	3.59	cum	653.21	2345.02
40 mm stone aggregate	2.86	cum	707.83	2024.39
20 mm stone aggregate	2.86	cum	753.21	2154.18
Stone	2.03	cum	394.60	801.04
Labour				
Skilled	0.81 no.	each	151.50	122.71
Semi-skilled	2.19 no.	each	138.45	303.20
Skilled	0.31 no.	each	151.50	46.96
Unskilled	13.22 no.	each	135.25	1788.00
Sundries	120 units	each	2.60	312.00
Hire and running charges of mixer/vibrator	120 units	each	2.60	312.00
Form work	150 sqm.	sqm.	13.50	2025.00
For 100 blocks				16918.12
Rate per block	***16.92***			

BC 0204 : Solid Stone Blocks 30 x 10 x 15 cm nominal size in Cement Concrete 1:5:8 with stones of 8 cms to 15 cms

Actual size of block = 290 x 100 x 140 mm
Volume of block = 0.00406 cum.
Volume of 1000 blocks = 4.06 cum.
25% of stone spalls by volume
Volume of stone spalls = 1.01 cum.
Volume of concrete = 4.06 - 1.01 = 3.05 cum.
Details of cost for 1000 blocks
Concrete 1:5:8 = 3.05 cum.

Materials	**Qty.**	**Unit**	**Rate (Rs.)**	**Amount**
Cement	10.30	bag	227.36	2341.81
Coarse sand	1.80	cum	653.21	1175.78
40 mm stone aggregate	1.43	cum	707.83	1012.20
20 mm stone aggregate	1.43	cum	753.83	1077.09
Stone	1.01	cum	394.60	398.54
Labour				
Skilled	0.40 no.	each	151.50	60.60
Semi-skilled	1.10 no.	each	138.45	152.29
Unskilled	6.61 no.	each	135.25	894.00
Sundries	60 units	each	2.60	156.00
Hire and running charges of mixer/vibrator	60 units	each	2.60	156.00
Form work	120 sqm.	sqm.	13.50	1620.00
For 100 blocks				9044.31
Rate per block	***9.04***			

BC 03 : Hollow or Solid Lightweight Concrete Masonry Units

BC 0301 : Providing and laying pre-cast solid light weight concrete block masonry of approved size400mmx200mmx200mm (CLC blocks) having a density of 1200kg/cum for load bearing structures in foundation and plinth laid in cement mortar 1:6 (1cement :6 coarse sand).

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 1 cum.				
	Materials				
	Pre-cast solid CLC blocks of nominal size.				
	Block size 400 x 200 x 200 mm (nominal)				
	No. of blocks	60.00 no.	each	32.94	1976.40
	Cement mortar 1:6	0.10 cum	cum	1814.82	181.48
	Labour				
	Skilled	1.33 no.	each	151.50	201.49
	Unskilled	1.85 no.	each	135.25	250.21
	Sundries	12 units	each	2.60	31.20
					2640.78
	Add 1% for water charges				26.41
		For 1 cum			2667.19
	Rate per cum.	***2667.19***			

BC 04 : Cellular Light-weight Concrete Blocks

BC 0401 : Providing and laying pre-cast solid light weight concrete block (CLC blocks) of approved size400mmx100mmx200mm in partition walls 100mm thick laid in cement mortar 1:4 (1cement :4 coarse sand).

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 10sqm.				
	Materials				
	Pre-cast solid CLC blocks.				
	Block size 400 x 100 x 200 mm (nominal)				
	No. of blocks	122.00 no.	each	17.44	2127.68
	Cement mortar 1:4	0.11cum	cum	2405.96	264.65
	Labour				
	Skilled	2.15 no.	each	151.50	325.72
	Unskilled	3.25 no.	each	135.25	439.56
	Scaffolding	12 units	each	2.60	31.20
	Sundries	12 units	each	2.60	31.20
					3220.01
	Add 1% for water charges				32.20
		For 10 sqm			3252.21
	Rate per sqm.	***325.22***			

BC 0402 : CLC Solid Blocks size 40 x 20 x 20 cms nominal size

Details of cost for 1000 blocks
Volume of concrete (1000 x 0.39 x 0.20 x 0.19) = 14.82 cum. – Say 15 cum.

Description	Qty.	Unit	Rate Rs.	Amount
Materials				
Cement (205x15=2075 kg)	61.50 bags	bag	227.36	13982.64
Flyash (389x15)	5835 kg	kg	0.15	875.25
Sand (610x15=9150 kg)	6.10 cum.	cum.	653.21	3984.58
Foaming agent (0.69x15)	10.35 kg	kg	450.00	4657.50
Water mix and foam (255x15)	3825 kg	kg	0.03	114.75
Labour	15 cum.	cum	159.15	2387.25

Labour for 1250 cum.

Supervisor	1 no. @ 12000/- pm	=	12000.00
Project Manager	1 no. @ 25000/- pm	=	25000.00
Skilled	3 nos @ 4545/- pm	=	13635.00
Semi skilled	2 nos @ 4150/- pm	=	8300.00
Unskilled	35 nos. @ 4000/- pm	=	140000.00
For 1250 cum.			198935.00
For 1 cum.			159.15

Add for interest, depreciation, maintenance of P&M, electricity, water and utilities	15%			3900.30
				29902.27
Mould	225 sqm.	sqm	13.50	3037.50
For 1000 blocks				32939.77
Rate per block	***32.94***			

BC 0403 : CLC Solid Blocks size 40 x 10 x 20 cms nominal size

Details of cost for 1000 blocks
Volume of concrete (1000 x 0.39 x 0.10 x 0.19) = 7.41 cum. – Say 7.50 cum.

Description	Qty.	Unit	Rate Rs.	Amount
Materials				
CLC (as per details at BC0303)	7.50 cum	cum.	1993.48	14951.10
Mould	184 sqm.	sqm	13.50	2484.00
For 1000 blocks				17435.10
Rate per block	***17.44***			

BC 05 : Precast RCC Door & Window Frames

Providing and fixing pre-cast reinforced cement concrete door, window frames in 1:1:2 mix cement concrete (1 cement:1 sand :2 graded stone aggregate 10mm and down) including formwork reinforcement, handling and erection etc. complete.

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
	Details of cost for 1 frame size 2100mmx900mm					
A.	5.1m size 60mmx100mm (single shutter frame)					
	Materials					
1	Cement concrete 1:1:2 5.1 x 0.1 x 0.06	0.0306 cum	cum	3861.44		118.16
2	Mould for frame					
(i)	Deodar Wood					
	2 x 1 x 2.1 x 0.04 x 0.25	0.042				
	1 x 1 x 0.9 x 0.04 x 0.25	0.009				
	2 x 2 x 2.1 x 0.10 x 0.025	0.021				
	2 x 1 x 0.9 x 0.10 x 0.025	0.005				
	2 x 2.1 x 0.04 x 0.015	0.003				
	ends					
	4 x 0.1 x 0.06 x 0.02	0.001				
		0.081				
	Add:- 5% wastage	0.004				
		0.085 0.085 cum	cum	33560.81	2852.75	
(ii)	Angle iron 30mmx30mmx5mm					
	10 x 0.08	0.8 m				
	0.8m@2.2kg/m 0.8 x 2.2	1.76 kg				
	Add:- 5% wastage	0.088 kg				
		1.85 kg	kg	31.05	57.44	
(iii)	Screw 37.5mm long	20 no.	each	0.35	7.00	
(iv)	Labour for mould					
	Skilled	2 no.	each	151.50	303.00	
	Un Skilled	2 no.	each	135.25	270.50	
	(assuming 40 uses of a mould)				3490.69	
	Cost for 1 use					87.27
3	Steel reinforcement					
	6mm dia M.S. bar					
	3 x 2.1	6.3 m				
	3 x 2.1	6.3 m				
	3 x 0.9	2.7 m				
		15.3 m	0.222 kg/m	3.40		
	3mm dia M.S. Wire @ 300mm c/c					
	2.10+2.1+0.9 / 0.30	18 no.				
	18x(0.07+0.03+0.08)	3.24 m	0.063 kg/m	0.204		
	3.24@0.063kg/m			3.604		
	Add:- 5% wastage			0.180		
				3.784	kg 37.24	140.92
4	Aluminium tube sleeves 5mm dia					
	45mm long 20 x 0.045	0.9 m	m	36.00		32.40
	Sundries	12 units	each	2.60		31.20

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
5	Labour for handling and erection for 20 nos of frames					
	Skilled 1 no. each	151.51	151.50			
	Un Skilled 2 no. each	135.25	270.50			
	(for 20 nos)		422.00			
	Cost for 1 farme		21.10			21.10
						431.05
Add 1% water charges						4.31
	For 1 frame or 5.10m					435.36
	Rate / each	435.36				
	Rate per meter	85.36				
B	For double shutter frame size 2100 x 900mm 5.10m long 60mm x 120mm					
	Materials					
1	Cement concrete 1:1:2 5.1 x 0.12 x 0.06	0.037 cum	cum	3861.44		142.87
2	Mould for frame					
(i)	Deodar Wood					
	2 x 1 x 2.1 x 0.04 x 0.25	0.042				
	1 x 1 x 0.9 x 0.04 x 0.25	0.009				
	2 x 2 x 2.1 x 0.12 x 0.025	0.025				
	2 x 1 x 0.9 x 0.12 x 0.025	0.005				
	2 x 2.1 x 0.04 x 0.015	0.003				
	4 x 0.12 x 0.06 x 0.02	0.001				
		0.085				
	Add:- 5% wastage	0.004				
		0.089 0.089 cum	cum	33560.81	2986.91	
(ii)	Angle iron 30mmx30mmx5mm					
	10 x 8 cm	0.8 m				
	14.4m@0.23kg/m 0.8 x 2.2	1.76 kg				
	Add:- 5% wastage	0.088 kg				
		1.85 kg	kg	31.05	57.44	
(iii)	Screw 37.5mm long	20 no	each	0.35	7.00	
(iv)	Labour for mould					
	Skilled	2 no	each	151.50	303.00	
	Un Skilled	2 no.	each	135.25	270.50	
	(assuming 40 uses of a mould)				3624.85	
	Cost for 1 use					90.62
3	Steel reinforcement					
	6mm dia M.S. bar					
	3 x 2.1 = 6.3 m					
	3 x 2.1 = 6.3 m					
	3 x 0.9 = 2.7 m					
	15.3 m		0.222 kg/m	3.40		
	3mm dia M.S. Wire @ 300mm c/c					
	2.10+2.1+0.09 / 0.30	18 no.				
	18x(0.07+0.03+0.08)	3.24 m	0.063 kg/m	0.204		
	(@0.063kg/m)			3.604		
	Add:- 5% wastage			0.180		
				3.784	kg 37.24	140.92

No.	Description	Qty.	Unit	Rate Rs.	Sub-Amount	Amount
4	Aluminium tube sleeves 5mm dia					
	45mm long 20 x 0.045	0.9m	m	36.00		32.40
	Sundries	12	each	2.60		31.20
5	Labour for handling and erection for 20 nos of frames					
	Skilled	1 no.	each	151.50	151.50	
	Unskilled	2 no.	each	135.25	270.50	
	(for 20 nos)				422.00	
	Cost for 1 frame				21.10	21.10
						459.11
	Add 1% water charges					4.59
		For 1 frame or 5.10m				463.70
	Rate / each			***463.70***		
	Rate per meter			***90.92***		

By Mechanical Process

BC 0501 : Door/window frame using cement concrete 1:1:2

Opening Size 2100 mm x 900 mm 5.10 m long 60 mm x 100 mm		0.0306 cum				
4 frames in a day from 1 machine Production from 5 machines in a month	5 x 4 x 25	500.00 units				
Material for 1 Frame						
Cement		17.14 kg	kg	4.55	77.99	
Coarse sand		0.012 cum	cum	653.21	7.84	
Stone aggregate 10 mm and down		0.024 cum	cum	753.21	18.08	
Steel		3.78 kg	kg	31.05	117.37	
Binding Wire, Inserts, gullies, botls polyproplyne fibre		15 units	unit	2.60	39.00	
					260.28	
Details of cost for 500 units of Frames in a month using 5 machines						
Material		500 nos.	each	260.28		130140.00
Labour						
Skilled		6 nos.	month	4545.00		27270.00
Unskilled		10 nos.	month	4000.00		40000.00
						197410.00
Add for interest, depreciation, maintenance of P&M, electricity,water and other consumables @ 15%						29611.50
		For 500 frames				227021.50
Rate per Frame.		***454.04 each***				

BC 06 : Ferrocement Door Shutter

Providing and fixing ferrocement Flush door shutter of size 2000mmx900mm having thickness of 12mm.

No.	Description	Qty.	Unit	Rate Rs.	Amount
	Details of cost for 1 door of size 2000mmx900mm 12mm thick.				
	Materials				
	Cement	20 kg	kg	4.55	91.00
	Coarse sand 30 kg or 0.02 cum	0.02 cum	cum	653.21	13.06
	Steel				
	Steel mat of 4layer of Chicken mesh 4 x 1.8	7.2 sqm			
	Add for cutting wastage @ 10%.	0.72 sqm			
		7.92 sqm	sqm	31.00	245.52
	Binding wire	0.2 kg	kg	40.10	8.02
	Hinges	6 nos.	each	9.20	55.20
	Labour (for casting curing)				
	Skilled	0.5 no.	each	151.50	75.75
	Unskilled	0.8 no.	each	135.25	108.20
					596.75
	Add:- 10% for mould etc				59.68
	For fixing in position				
	Skilled	0.6 no.	each	151.50	90.90
	Semi-skilled	0.06 no.	each	138.45	8.31
	Unskilled	0.8 no.	each	135.25	108.20
					863.84
	Add :- 1% for water charges				8.64
		For 1.80 sqm			872.48
	Rate per sqm.	***484.71***			

BC 07 : Precast Ferrocement Water Tanks

Ferro-cement Water Tank - 1000 litres

No.	Description	Qty.	Unit	Rate Rs.	Amount
(i)	Circular, internal diameter 1100mm and height 1060mm				
	Details of cost for 1 Ferro-cement water tank of 1000 litres capacity.				
	Size of tank Internal dia 1100mm, height 1060mm				
	Actual height of tank				
	1060 + 250mm (free board)	1310 mm			
	Materials				
	Chicken mesh				
	Bottom 2 x 0.95	1.9 sqm			
	Periphery $\frac{22}{7}$ x 1.1=3.46 m				
	Wall area 3.46 x 1.31=4.53 sqm				
	Two layers 2 x 4.53	9.06 sqm			
	Cover				
	$(0.95 - \frac{1}{4} \times 3.14 \times 0.50 \times 0.50)$				
	0.95 - 0.19 0.76				
	Two layers 2 x 0.76	1.52 sqm			
		12.48 sqm			

No.	Description		Qty.	Unit	Rate Rs.	Amount
	Add:- 10% wastage		1.25 sqm			
			13.73 sqm	sqm	31.00	452.63
	Welded mesh	6.24 + 0.62	6.86 sqm	sqm	62.00	425.32
	Binding wire		0.69 kg	kg	40.10	27.67
	Cement mortar 1:2	6.24 x 0.015	0.0936 cum	cum	3940.46	368.83
						1247.45
	Sundries mould etc (10%)					124.75
						1372.20
	Labour					
	Skilled		0.21 no.	each	151.50	31.81
	Unskilled		0.42 no.	each	135.25	56.81
						1460.82
	Cost of lid					60.00
						1520.82
	Add 1% for water charges					15.21
			For 1 tank			1536.03
	Rate per tank.		***1536.03***			
(ii)	Square Tank - 1000 litre capacity					
	Details of cost for 1 Ferro-cement water tank of 1000 litres capacity.					
	Tank size 1080mmx1080mmx860mm					
	Actual height of tank					
	860+250mm (free board)		1110 mm			
	Materials					
	Chicken mesh					
	Bottom	2 x 1.166	2.332 sqm			
	Side	2 x 1.095 x 1.11	2.43 sqm			
		2 x 1.08 x 1.11	2.40 sqm			
	Cover	2 x (1.166 - 0.19)	1.952 sqm			
			9.114 sqm			
	Add:- 10% wastage, overlap		0.911 sqm			
			10.025 sqm	sqm	31.00	310.77
	Welded mesh		4.56 sqm			
	Add:- 10% wastage, overlap		0.45 sqm			
			5.010 sqm	sqm	62.00	310.62
	Binding wire		0.5 kg	kg	40.10	20.05
	Cement mortar 1:2	4.56 x 0.015	0.068 cum	cum	3940.46	267.95
						909.39
	Sundries mould etc (10%)					90.94
						1000.33
	Labour					
	Skilled		0.21 no.	each	151.50	31.82
	Unskilled		0.42 no.	each	135.25	56.81
						1088.96
	Cost of lid					60.00
						1148.96
	Add 1% for water charges					11.49
			For 1 tank			1160.45
	Rate per tank.		***1160.45***			

BC 08 : Precast Concrete Manhole Covers & Frames

Making of Pre-cast Concrete Manhole Covers and Frames. (Typical Manhole Cover)

No.	Description	Qty.	Unit	Rate Rs.	Amount	
	Detail of cost for 1 Manhole Cover with Frame - size 600 mm dia					
	Circular					
	M-30 Concrete					
	Volume of Concrete Frame					
	(a) $\frac{\pi}{4} d^2 x t$					
	$\frac{3.142}{4} \times (0.80)^2 \times 0.05 - \frac{3.142}{4} \times 0.60^2 \times 0.05$					
	$\frac{3.142}{4} \times 0.05 \times (0.80^2 - 0.60^2)$					
	$0.7855 \times 0.05 \times (0.64 - 0.36)$					
	0.039×0.28					
	0.011 cum					
	(b) $0.7855 \times 0.07 \times (0.80^2 - 0.72^2)$					
	$0.055 \times (0.64 - 0.52)$					
	0.055×0.12					
	0.007 cum					
	Total quantity in frame (a+b)	0.018 cum				
	Concrete quantity in cover	$\frac{\pi}{4} d^2 x t$				
		$\frac{3.142}{4} \times (0.72)^2 \times 0.07$				
		0.028 cum				
	Total quantity of concrete in cover and frame	0.028 + 0.018				
		0.047 cum				
	Cement Concrete 0.047 cum					
	(1:1:2)	0.047 x 3861.44			181.49	
	Form work (basis as per item 3)	L.S.			50.00	
	Transporting of unit within casting yard and stacking yard (basis as per item 3)					
	Steel (125kg/cum-including for lifting)	12.62 kg		37.24 /kg	469.97	
	Polypropylene fibre(0.5% by weight of cement)	0.282 kg		230 /kg	64.86	
	Paint-anticorrosive (underside)	$\frac{3.142}{4} \times (0.75)^2$				
		0.44 sqm		24.80 /sqm	10.91	
	Top side					
	Chaquered finish plaster	0.44 sqm		75 /sqm	33.00	
	Steel rim					
	Periphery (πd)	3.142 x 0.75				
		2.36 m				
	Steel sheet (for making rim)					
	2.5mm thick	2.36 x 0.20				
		0.47 sqm				
	(@19.60kg/sqm)	9.24 kg		37.03 /kg	342.16	
						1152.39
	Add :- 1% for water charges					11.52
		For 1no.				1163.91
	Rate for 1 manhole cover	***1163.91***				

BASIC RATES OF LABOUR

S.No.	Description	Unit	Rate (in Rs.)
1.	Bandhani	Per day	138.45
2.	Bhishti	Per day	138.45
3.	Black smith 1st class	Per day	151.50
4.	Carpenter 1st class	Per day	151.50
5.	Unskilled	Per day	135.25
6.	Fitter (grade-I)	Per day	151.50
7.	Mason	Per day	151.50
8.	Mate	Per day	138.45
9.	Mistry	Per day	151.50
10.	Painter	Per day	141.60
11.	White washer	Per day	138.45
12.	Foreman	Per day	151.50

S.No.	Description	Unit	Rate (in Rs.)
1.	Skilled	Per day	151.50
2.	Semi skilled	Per day	138.45
3.	Un skilled	Per day	135.25

Source : CPWD DSR 2007

BASIC RATES OF IMPORTANT MATERIAL AND CARRIAGE OF MATERIALS

S. No.	Description	Unit	Rate (in Rs.)	Carriage	Total
1	40 mm brick aggregate.	Cum.	360.00	57.83	417.83
2	25 mm brick aggregate.	Cum.	365.00	57.83	422.83
3	20 mm brick aggregate.	Cum.	370.00	57.83	427.83
4	40 mm nominal size stone aggregate	Cum.	650.00	57.83	707.83
5	25 mm nominal size stone aggregate	Cum.	675.00	53.21	728.21
6	20 mm nominal size stone aggregate	Cum.	700.00	53.21	753.21
7	12.5 mm nominal size stone aggregate	Cum.	700.00	53.21	753.21
8	10 mm nominal size stone aggregate	Cum.	700.00	53.21	753.21
9	6 mm nominal size stone aggregate	Cum.	750.00	53.21	803.21
10	Pea size gravel	Cum.	717.00	53.21	770.21
11	Geo textile 120gsm non-woven	Sqm.	25.00		
12	Fibre glass cloth	Sqm.	33.00		
13	25 mm thick particle board	Sqm.	390.00		
14	Bricks	Per/ Thousand	1900.00	141.88	2041.88
15	Brick tiles(230x115x38mm)	Per/ Thousand	1950.00	85.13	2035.13
16	Fly ash lime (Fal-G) bricks	Per/ Thousand	1792.00	141.88	1933.88
17	Calcium silicate bricks	Per/ Thousand	3083.00	141.88	3224.88
18	Machine moulded brick tiles	Per/ Thousand	2600.00	85.13	2685.13
19	Portland cement	Tonne	4500.00	47.29	4547.29
20	Hessain cloth	Sqm	10.00	0.20	10.20
21	Screws (C. P) 50mm	Cent	150.00		
	Screws (C. P) 40mm	Cent	123.00		
	Screws (C. P) 30mm	Cent	90.00		
	Screws (C. P) 25mm	Cent	83.00		
	Screws (C. P) 20mm	Cent	63.00		
	Screws (Iron) 50mm	Cent	40.00		
	Screws (Iron) 40mm	Cent	35.00		
	Screws (Iron) 30mm	Cent	24.00		
	Screws (Iron) 25mm	Cent	16.00		
	Screws (Iron) 20mm	Cent	15.00		
	Hinges of MS	Each	9.20		
22	Barbed wire	Quintal	4400.00	4.73	4404.73
23	6mm dia bolts and nuts 25mm long	Ten	18.00		
24	10mm dia bolts and nuts 125mm long	Each	7.00		
25	10mm dia 7cm long bolts with nuts	Each	9.00		
26	8mm dia bolts and nuts	Each	3.50		
27	8mm dia J-hooks	Ten	58.00	2.00	60.00
28	C.G. I sheets	Quintal	3450.00	4.73	3454.73
29	7 to 10 cm size hooks (brass)	Each	28.00		
30	Cement concrete jalli 50 mm thick	Sqm	145.00		
	Cement concrete jalli 40 mm thick	Sqm	115.00		
	Cement concrete jalli 25 mm thick	Sqm	92.00		
31	White lime	Quintal	295.00	53.21/ cum	
32	Mobil oil	Litre	95.00		
33	PVC sheet	Sqm	24.00	0.20	24.20
34	Coarse sand	Cum	600.00	53.21	653.21
35	Fine sand	Cum	320.00	53.21	373.21

S. No.	Description	Unit	Rate (in Rs.)	Carriage	Total
36	Fly ash (800kg/cum)	Cum	6.00	53.21	59.21
	Primer	Litre	72.00	1.00	73.00
37	Stone dust	Cum	700.00	53.21	753.21
38	Surkhi	Cum	390.00	53.21	443.21
39	STEEL				
	Steel plates	Quintal	3400.00	4.73	3404.73
	Steel sheets	Quintal	3475.00	4.73	3479.73
	Steel barbed wire	Quintal	4400.00	4.73	4404.73
	Wire mesh	Sqm	38.00		
	Steel wire	Quintal	3100.00	4.73	3104.73
	Bolts and nuts upto 300mm length	Quintal	4300.00	4.73	4304.73
	20mm dia holding down bolts	Quintal	3800.00	4.73	3804.73
	Flats iron upto 10 mm thickness	Quintal	2900.00	4.73	2904.73
	Flats exceeding 10 mm thickness	Quintal	2875.00	4.73	2879.73
	Steel hooks	Each	22.00		
	Hoop Iron 30mmx25mmx1.6mm	Quintal	2900.00	4.73	2904.73
	Rivets – M. S	Quintal	3500.00	4.73	3504.73
	M. S bars 12mm dia and below	Quintal	3100.00	4.73	3104.73
	Twisted or deformed bars	Quintal	3175.00	4.73	3179.73
	Structural steel	Quintal	3100.00	4.73	3104.73
	"U"- shaped MS clamps	Each	35.00		
	Wire nails	Kg	40.00	1.00	41.00
	Steel beading	M	15.00		
	Tie bolts 12mm dia 100mm long	Each	29.00		
	12mm dia 150mm long	Each	31.00		
	20mm dia 150 mm long	Each	57.00		
	20mm dia 225 mm long	Each	72.00		
	Binding wire	Kg	40.00	0.10	40.10
40	Timber				
	Deodar wood	Cum	33500.00	60.81	33560.81
	Teak wood	Cum	41000.00	60.81	41060.81
41	Washers				
	Limpet washers –G.I	Cent	20.00	1.00	21.00
	Bitumen washers	Cent	18.00	1.00	19.00
42	GYPSUM BOARD CEILING				
	Gypsum board	Sqm	140.00	5.00	145.00
	Ceiling sections	Meter	36.00	1.00	37.00
	Perimeter channel	Meter	23.00	1.00	24.00
	Intermediate channel	Meter	38.00	1.00	39.00
	Ceiling angle	Meter	16.00	1.00	17.00
	Connecting clips	each	5.00	0.10	5.10
	Soffit cleat	each	3.00	0.10	3.10
	Joint filler	kg	19.00	1.00	20.00
	Joint finisher	kg	22.00	1.00	23.00
	Joint tape	roll	120.00	2.00	122.00
	Dash fastner	each	8.00	0.10	8.10
	Drive all screws	100nos.	40.00	0.10	40.10
	Plaster of paris	kg	2.50		
43	Stone –size 15cm to 20cm	cum	332.00	62.60	394.60
44	Alumimium beading	meter	28.00		
45	Alumimium grip strip 50x12x2mm	each	7.00		

S. No.	Description	Unit	Rate (in Rs.)	Carriage	Total
46	Foaming agent	kg	450.00		
47	Chicken mesh	sqm	30.00	1.00	31.00
48	Welded mesh	sqm	60.00	2.00	62.00
49	32mm dia G. I. Pipe	meter	140.00	0.08	140.08
50	25 mm dia G. I. Pipe	meter	109.00	0.06	109.06
51	Plain G.I. Pipe	Quintal	3800.00	4.73	3804.73
52	10mm thick shuttering ply	sqm	480.00	2.00	482.00
Assumed Rates :-					
53	Burnt clay Tiles				
	Flooring Tiles				
(a)	150mmx150mmx15mm	Per/ Thousand	820.00	85.13	905.13
(b)	150mmx150mmx20mm	Per/ Thousand	960.00	85.13	1045.13
(c)	200mmx200mmx20mm	Per/ Thousand	1920.00	85.13	2005.13
(d)	200mmx200mmx25mm	Per/ Thousand	2400.00	85.13	2485.13
(e)	250mmx250mmx30mm	Per/ Thousand	4500.00	85.13	4585.13
54	Burnt clay Tiles				
	Roofing				
(a)	150mmx100mmx20mm	Per/ Thousand	720.00	85.13	805.13
(b)	175mmx125mmx20mm	Per/ Thousand	1050.00	85.13	1135.13
(c)	200mmx150mmx20mm	Per/ Thousand	1440.00	85.13	1525.13
(d)	225mmx175mmx20mm	Per/ Thousand	1890.00	85.13	1975.13
(e)	250mmx200mmx20mm	Per/ Thousand	2400.00	85.13	2485.13
55	10mm dia bolts 1.20m long with	each	60.00	1.00	61.00
	nuts and washers.				
56	90mm dia (external) G.I pipe	meter	355.00	8.36	363.36
57	5mm dia Aluminium Sleeve	meter	36.00		36.00

Source : CPWD DSR 2007

The Building Materials & Technology Promotion Council (BMTPC) was setup in 1990 as an inter-ministerial organisation under the Ministry of Housing & Urban Poverty Alleviation to bridge the gap between laboratory research and field level application. The Council provides technical support for strengthening of SMEs in the building materials sector through development and promotion of eco-friendly and energy-efficient projects, manufacturing technologies and appropriate services to entrepreneurs.

Vision

BMTPC to be world class knowledge and demonstration hub for providing solutions to all with special focus on common man in the area of sustainable building materials, appropriate construction technologies & systems including disaster resistant construction.

Mission

To work towards a comprehensive and integrated approach for promotion and transfer of potential, cost-effective, environment-friendly, disaster resistant building materials and technologies including locally available materials from lab to land for sustainable development of housing.