CSIR-CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE – 247667 (INDIA)
(A Constituent Establishment of CSIR)

BUILDING RESEARCH NOTE

B.R.N.79

PREFAB BRICK PANEL SYSTEM FOR ROOFING/ FLOORING

Introduction

Prefab Brick Panel System developed at the Central Building Research Institute; Roorkee has been used in a number of low cost houses all over the country and is becoming popular due to its simplicity, ease in adoption and economy. Earlier, a Building Research Note (BRN) giving various details regarding design, casting, reaction and its use in floor/ roof was published. The present BRN is an updated version of that note, incorporating the latest code & guidelines etc. Indian standards i.e. IS 14142 : 1994 & IS 14143 : 1994 have also been released for 'Design and Construction of Floors and Roofs with Prefabricated Brick Panel - Code of Practice' & 'Prefabricated Brick Panel and Partially Precast Concrete Joist for Flooring and Roofing – Specification' respectively.

In this system, concrete is used in maximum compressive stress zone and bricks in less compressive stress zone. Reinforcement in Brick Panels is encased in cement concrete grade not leaner than M 20 or cement mortar 1:3 (1 cement: 3 course sand) with proper cover to avoid corrosion. The method of precast fabrication is adopted for making precast concrete joists and brick panels. Partially precast concrete joists (M20) are designed to behave like T-beam along with the in-situ concrete (M20) laid over the panels and joists. The precast portion of the joists is designed to take self load and handling stresses only and therefore, it needs to be propped at two equidistant points before placing panels and laying concrete.

Prefab Brick Panel

Prefab brick panels are made of first class bricks and

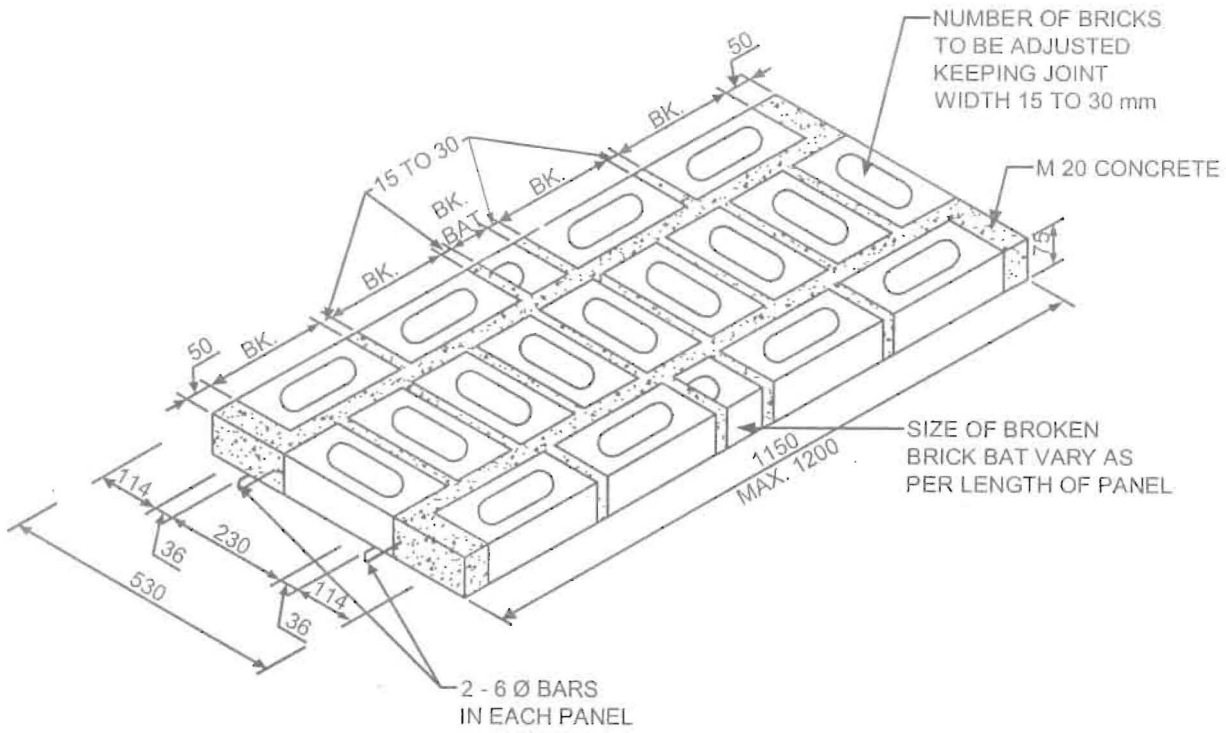


FIG. 1: ISOMETRIC VIEW OF BRICK PANEL

ALL DIMENSIONS IN mm

reinforced with two MS bars of 6 mm dia (Fig. 1). The joints are filled with either M20 concrete or cement mortar 1:3 (1 cement: 3 course sand). The length of the brick panels varies from 900 mm to 1200 mm depending upon the room size, but the width is normally kept at 530 mm to allow 36 to 40 mm wide gap between the bricks for placing reinforcement with proper cover and for laying concrete. If the length of brick panel is to be increased further, the diameter of reinforcing bars should be increased according to structural requirement. The two panels are placed in position with a gap of 2 to 4 cm in width which is then filled with cement concrete. If bricks have crushing strength less than 7 N/mm^2, only cement concrete should be filled in all joints and their width should be suitably adjusted. However, these inferior bricks should not disintegrate when placed in water for 24 hours.

Partially Precast Joist

It is rectangular shaped concrete joist 130 mm wide, and 100 to 125 mm deep (Fig. 2). Their stirrups are kept projecting upward to provide 215 to 235 mm as its overall depth with in-situ concrete (M20). It is designed as composite T-beam with 35 mm thick deck concrete (M20), working as flange.

Mould

Moulds are made from seasoned timber of good quality. Alternatively, the MS channels can be used as moulds when large numbers of joist are cast. Clamps of angle iron are used to hold the two long sides of a mould i.e. mild steel channels or wooden planks to avoid their bulging during laying of concrete (Fig. 3). The sides of the mould for brick panels (Fig. 4) is provided with a groove to enable placing of the reinforcing bars with their hooks projecting outside the panels.

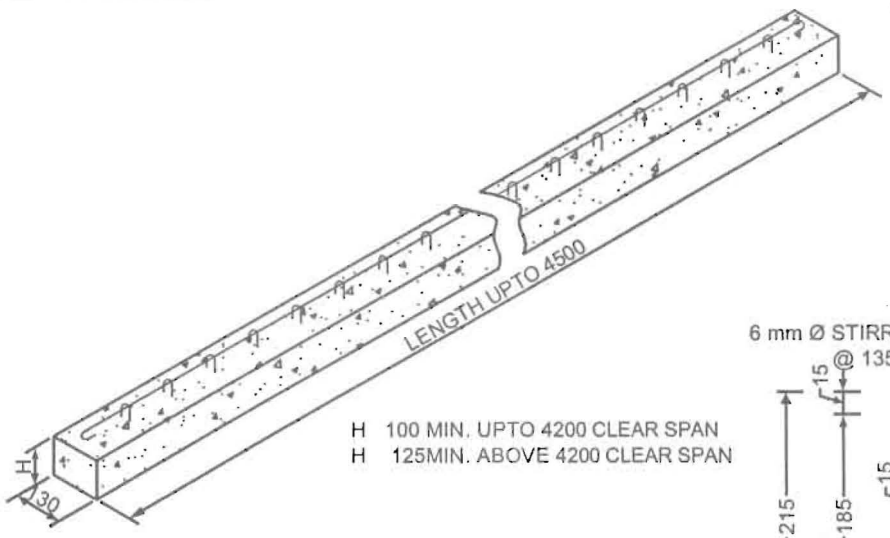
Casting and Curing

Brick Panels

These panels are cast on a levelled ground. A puc platform can also be made when a large number of pan are to be cast at a central place. Burnt engine oil can used as a separating media over the pucca platfor When the numbers of panels are small, the ground can levelled properly and a layer of fine sand can be sprinkle the mould before placing bricks to work as separat media between the ground and brick panels. The bri are placed in the mould keeping their frogs upward identify the top position of the brick panel and to g advantage of their use as shear key in the deck concre The gaps between bricks are kept 15 to 30 mm wide transverse direction and 36 to 40 mm in longitudi direction to provide space for filling cement concrete (M or cement mortar 1:3 (1 cement : 3 course sand). There no reinforcement in transverse direction. A thin layer o 20 or cement mortar 1:3 (1 cement : 3 course sa concrete is laid in longitudinal joints before placing reinforcing bars to ensure proper cover. All the joints then filled with concrete or mortar. The mould is remo after casting the panels and the joints are properly finish The panels can be transported to the curing yard or t after 48 hrs of casting in summer and 72 hrs in winter. panels are cured for 14 days and dried for as many d before placing on the roof.

Partially Precast RCC Joists

RCC joists are cast on a pucca platform. In case of sma numbers, they may also be cast on levelled ground, wh is checked after placing the mould. Sand is sprinkled in mould to get proper level. Newspapers may be used a separating media between sand and the joists. A 25



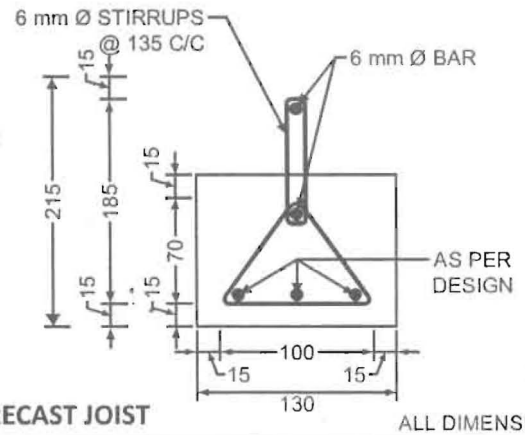


FIG. 2: PARTIALLY PRECAST JOIST

ALL DIMENSIONS IN mm

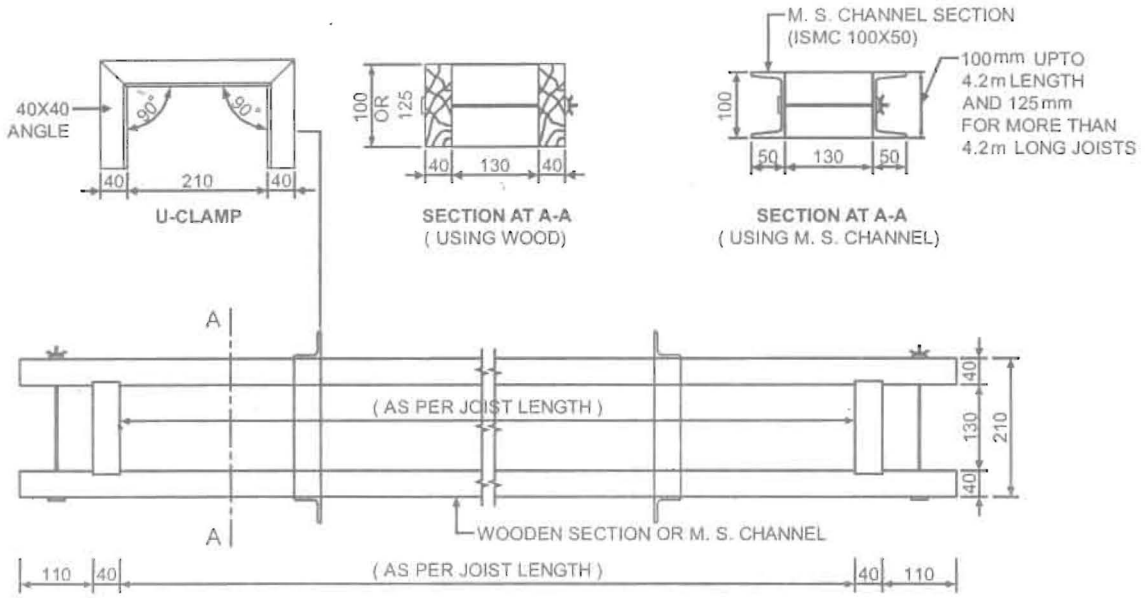


FIG. 3: MOULD FOR PARTIALLY PRECAST JOISTS

ALL DIMENSIONS IN mm

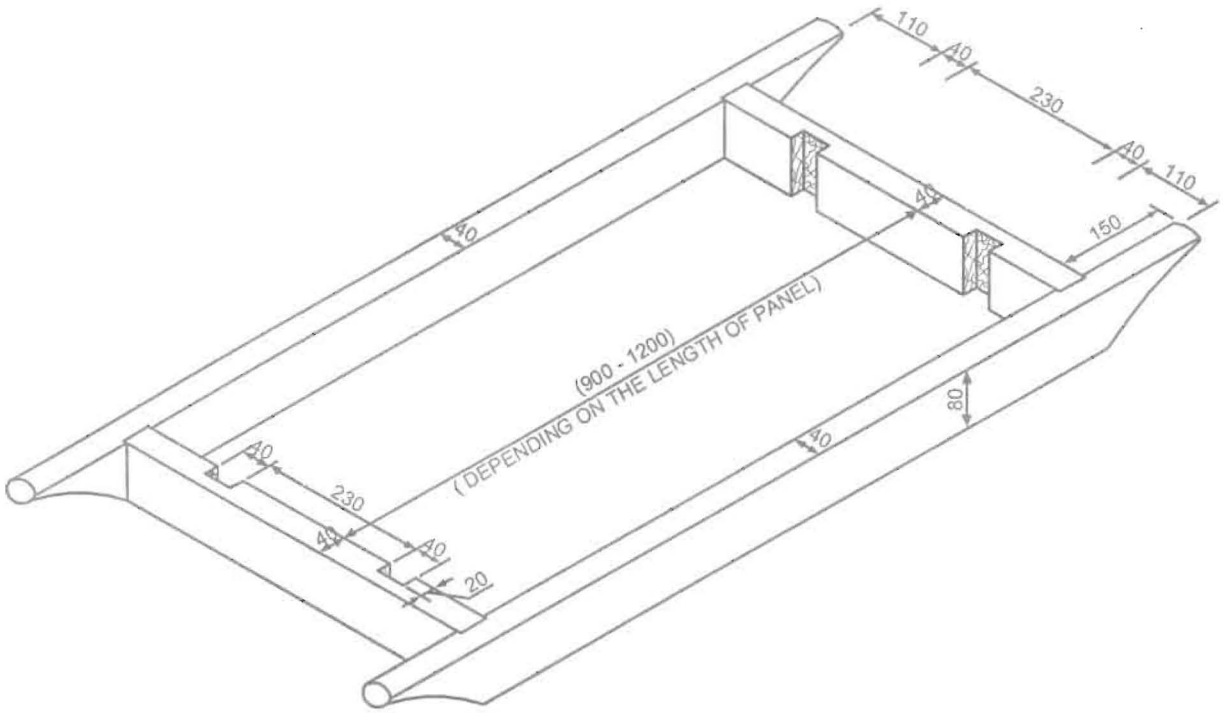


FIG. 4: MOULD FOR PREFAB BRICK PANELS

ALL DIMENSIONS IN mm

thick layer of cement concrete of M 20 grade is put in the mould before placing reinforcement to maintain the required cover. The cement concrete is then filled in the mould upto the top with proper compaction by rodding or vibrating. The mould can be stripped off after about 2 hrs depending on w/c ratio and climatic conditions. Joist should be cured for a period of 14 days and then dried for another 14 days before using in buildings.

Erection and Assembly of Roof/Floor

The roof/floor is assembled in the following sequence as shown in Fig. 5.

(i) Joists and panels are cleaned with wire brush to remove dust, loose sand and soil particles before lifting and placing them in position for roof/floor.

(ii) Joists are placed in position over concrete bed blocks. They are properly levelled with 1:4 cement sand mortar.

(iii) Joists are propped at two points with wooden supports dividing the span into three equal

parts. The panels should be laid only after the props are properly fixed in position.

(iv) Brick walls in between joists are raised upto the top level of partially precast joist.

(v) Brick panels are placed over joists and walls with a bearing of about 40 mm (min.) and 50 mm (min) respectively. A thin layer of cement coarse sand mortar (1:4) is laid over the joists and walls to avoid any gap and to allow proper placing of panels. A gap 20 to 40 mm is left in-between the panels.

(vi) All gaps between panels are filled with M20 concrete by holding a wooden strip under them which is removed by sliding sideways just after the completion of concreting work.

(vii) Distribution reinforcement (6 mm dia. bars, one on each panel both ways) is laid over the centre of the panels in both the directions viz., parallel and perpendicular to the joists.

(viii) Cement concrete of 35 mm thickness is laid over the panels and joists with 10 mm stone aggregate. The roof may be finished with a floating coat of 1:3 cement sand mortar (not more than 6 mm thick) just after laying the deck concrete.

(ix) The in-situ concrete is cured for not less than 14 days by ponding with water before the wooden supports (props) are removed.

(x) A slope of 1:40 is provided to roof by raising the joists one side, for draining rain water. Water-proofing treatment is given as in the case of normal RC/RBC roofs i.e. by applying two coats of hot bitumen, mud phuska and brick tiling or using lime concrete.

Structural Design

The flooring/roofing scheme is designed on limit state method as per IS: 456-2000. Live load is taken as per IS 875-1987 Code of Practice for Design loads for Buildings and Structures. Structural design of precast components and complete roof/floor is done for the following three stages of loading which are related to the construction sequence.

a) For pre-casting, lifting transporting and handling.

- Self load of brick panels and concrete joists.
- Impact or vibrations during handling and transporting porting (50% of the self load).

b) For placing in position and accidental loading during construction.

- Self load of brick panels and concrete joist.
- Point load of one person standing on the brick panel/concrete joist.

c) For final loading condition.

- Self Weight of panel - 2000 N/m^2
- Self Weight of Concrete Joists - 2500 N/m^2
- Dead Load of Deck Concrete - 2500 N/m^2
- Dead Load of Roof Treatment - 2000 N/m^2
- Live Load (Roof) - 1500 N/m^2
- Live Load (Floor) - 2000 N/m^2

The prefab brick panel for roof and floor of residential buildings is provided with 2 nos. 6 mm dia MS reinforcement bars upto a span of 1200 mm. The contribution of

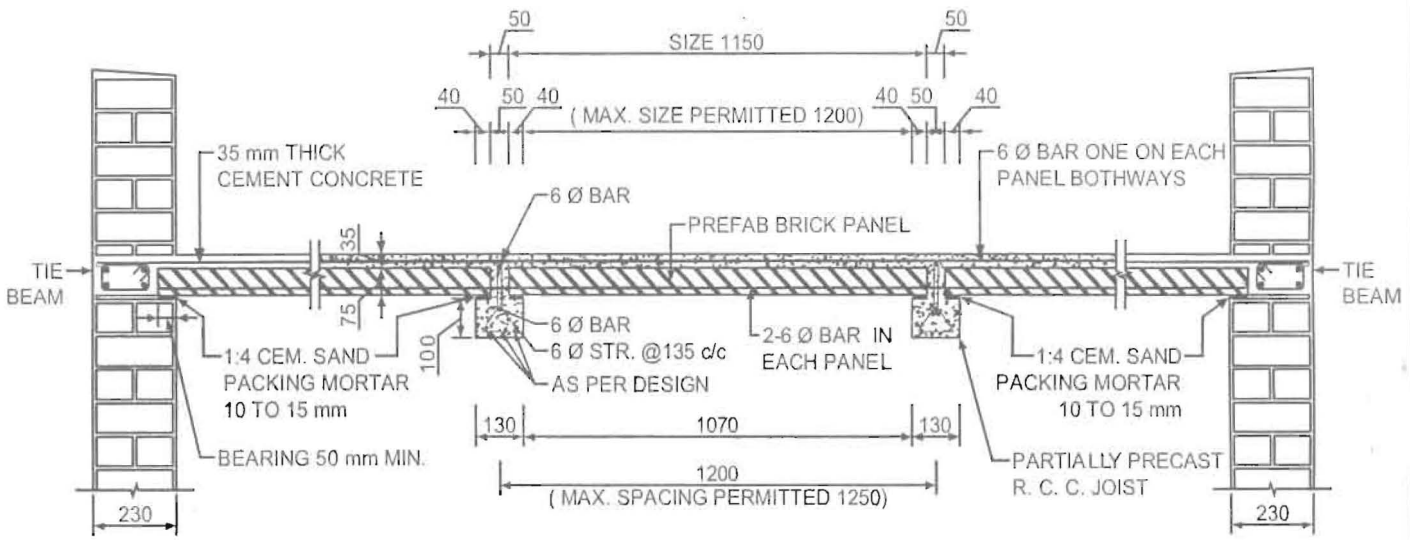


FIG. 5: ROOF SECTION

ALL DIMENSIONS IN mm

brick in compression zone is taken for structural calculations when their crushing strength is more than 7 N/mm^2. In other cases, their contribution is neglected and only concrete in two joints with reinforcement is taken as two simple beams for transferring loads.

Partially precast R.C. joist is to be designed as T-beam with 35 mm thick deck concrete as flange. Reinforcement is provided as per design requirements depending upon the loads, spacing and span of the joist.

An illustrative design is given in Appendix I and the design reinforcements for joists are given in Table 1.

APPENDIX - I

PREFAB BRICK PANEL

Illustrative Example of Design

Spacing of joist = 1.2 m
Size of joist = 130 x 100 mm
Eff. span of joist = 3.6 m

Depending upon the compressive strength of bricks, the brick panels shall be designed. Bricks compressive stress is more than 7 N/mm^2.

Design of panel for lifting, pre-casting and transportation

Self load (0.53 x 0.075 x 20000) = 795 N/m

Handling load (50% of self load) = 397.5 N/m

L.S. Design load {1.5 (795 + 397.5)} = 1788.75 N/m

Eff. Depth = 70 - 15 - 3 = 52 mm

Let X_u be the depth of neutral axis

$$X_u = \frac{0.87 \times f_y \times A_{st}}{0.36 f_{ck} b} = \frac{0.87 \times 250 \times 56}{0.36 \times 7 \times 530} = 9.1 \text{ mm}$$

Max. depth of X_u = 0.53 d = 27.6 mm.

Lever arm (d_1) = 52 - 0.42 x 9.1 = 48.18 mm

M.R. = 0.87 f_y A_{st} d_1
= (0.87 x 250 x 56 x 48.18)/1000
= 586.8 Nm

$$\text{Max. span} = \sqrt{\frac{586.8 \times 8}{1788.75}} = 1.62 \text{ m}$$

Design for placing in position and accidental loading during construction

Self load (0.53 x 0.075 x 20000) = 795 N/m
3.5 cm thick Deck concrete
(0.035 x 0.53 x 25000) = 463.7 N/m
Handling load of 1500 N/m^2
(0.53 x 1500) = 795 N/m
Total = 2053.7 N/m

L.S. Design load (1.5 x 2053.7) = 3080 N/m

Moment of Resistance = 586.8 Nm

$$\text{Max span} = \sqrt{\frac{586.8 \times 8}{3080}} = 1.23 \text{ m}$$

Design for final loading

When the concrete laid over the roof panel has attained full strength, this along with brick panel forms the flange of the T-beam. Now the top portion of brick panel is concrete of depth 3.5 cm, characteristic strength of concrete shall govern the design of panel.

Loads - Roof

Self load (0.55 x 0.075 x 20000) = 825 N/m
(Assuming 2 cm gap between two panels)

10 cm thick Roof Treatment
(0.55 x 0.10 x 20000) = 1100 N/m

Live load 1500 N/m^2 (0.55 x 1500) = 825 N/m

3.5 cm thick deck concrete
(0.035 x 0.55 x 25000) = 481.2 N/m
Total = 3230 N/m

L.S. Design load (1.5 x 3230) = 4845 N/m

Loads - Floor

Self load (0.55 x 0.075 x 20000) = 825 N/m

4 cm thick floor finish
(0.04 x 0.55 x 24000) = 528 N/m

3.5 cm deck concrete
(0.035 x 0.55 x 25000) = 481.2 N/m

Live load 2000 N/m^2 (0.55 x 2000) = 1100 N/m
Total = 2934.2 N/m

L.S. Design load (1.5 x 2934.2) = 4400 N/m

Since design load is more in case of roof, brick panel shall be designed for this load.

Effective depth = 70 + 35 - 15 - 3 = 87 mm

0.36 f_{ck} b X_u = 0.87 f_y A_{st}

0.36 x 20 x 550 x X_u = 0.87 x 250 x 56

X_u = 3.1 mm < 35 mm

Max. Allowable depth of NA
= 0.53 x 87 = 46.1 mm

As it is an under reinforced section, MR is governed by steel

Liver arm (d_1) = 87 - 0.42 x 3.1 = 85.7 mm

MR = 0.87 x A_{st} x f_{ck} x d_1

= (0.87x250x56x85.7)/1000
= 1043.8 Nm

$$\text{Max. Span} = \sqrt{\frac{1043.8 \times 8}{4845}} = 1.31\ \text{m}$$

Hence brick panel can be spanned upto 1.23 m length. But due to practical consideration length of panel is limited to 1.2 m and spacing of joist is limited to 1.25 m.

RC JOIST

Design for pre-casting, lifting, transportation and handling

Self weight of joist
(0.13 X 0.10 X 25000) = 325 N/m

Handling impact 50 % of self load = 162.5 N/m

Total = 487.5 N/m

L.S. design load (1.5 x 487.5) = 731.3 N/m

$$\text{Design BM} = \frac{731.3 \times (3.6)^2}{8} = 1184.6\ \text{Nm}$$

$M_u = 0.138\ f_{ck}\ b\ d^2$

$1184.6 \times 1000 = 0.138 \times 20 \times 130 \times d^2$

$$d = \sqrt{\frac{1184.6 \times 1000}{0.138 \times 20 \times 130}}$$

$= 57.46$ mm

$d_{provided} = 100 - (25 + 6)$

$= 69\ \text{mm} > 57.46\ \text{mm}$

Hence safe

$$1184.6 \times 1000 = 0.87 \times 415 \times A_{st}\left(57.46 - \frac{415 \times A_{st}}{20 \times 130}\right)$$

Ast $= 71.2\ \text{mm}^2 <$ area provided

Design for placing in position and loads due to construction

Self weight of joist
(0.13 x 0.10 x 25000) = 325 N/m

Weight of 35 mm thick deck concrete
(0.035 x 1.2 x 25000) = 1050 N/m

Self weight of panel
(0.075 x 1.2 x 20000) = 1800 N/m

Partial live load
(750 x 1.2) = 900 N/m

Total = 4075 N/m

Design load = 4075 x 1.5 = 6112.5 N/m

The joist is to be propped at 1/3rd points
Hence

$$\text{B.M} = \frac{6112.5 \times 1.2^2}{8} = 1100.25\ \text{Nm}$$

M.R. of joist $= 0.138 \times f_{ck}\ bd^2$

$$= \frac{0.138 \times 20 \times 130 \times (69)^2}{1000}$$

$= 1708.2\ \text{Nm} > 1100.25\ \text{Nm}$

Design for final loading

The joist shall be designed as a simply supported T-beam with 35 mm thick deck concrete and the neutral axis lying within deck concrete itself.

Depth of joist = 100 + 70 + 35 = 205 mm

Eff. depth = 205 - 31 = 174 mm

Note

There are possibilities that the joints between brick panels are not fully compacted and the concrete in joints may not fully transfer the stresses. Therefore the effect of brick in calculating the effective width of flange is neglected.

Width of flange B_f = 3600/6 + 50 + 6 x 35
= 860 mm

Self load of panel = 1500 N/m²

Weight of deck concrete = 875 N/m²

Lime concrete terracing
(0.1 x 20000) = 2000 N/m²

Live load = 1500 N/m²

Total = 5875 N/m²

L.S. Design load (5875 x 1.5) = 8812.5 N/m²

Load on joist = 1.2 x 8812.5

= 10575 N/m

L.S. self wt. of joist (325 x 1.5) = 487.5 N/m

Total load (LS) = 11062.5 N/m

~ 11100 N/m

$$\text{L.S. B.M.} = \frac{11100 \times 3.6^2}{8} = 17982\ \text{Nm}$$

Provide (2 #12) + (1 #10) bar

$$\frac{X_u}{d} = \frac{0.87 \times 415 \times 304.9}{0.36 \times 20 \times 860 \times 174} = 0.102 < 0.48$$

$X_u = 0.102 \times 174 = 17.7 < 35$ (inside the flange)

$$M_u = \frac{0.87 \times 415 \times 304.9 \times 174}{1000}\left(1 - \frac{304.9 \times 415}{860 \times 174 \times 20}\right)$$

$= 18335 > 17982$ Nm Hence, O.K.

Shear Resistance

Design shear force $= \frac{11100 \times 3.37}{2} = 18703.5\ N$

$\frac{100 A_s}{b_w d} = \frac{100 \times 304.9}{50 \times 174} = 3.5$

Shear stress $= \frac{18703.5}{50 \times 174} = 2.15\ N/mm^2$

From Table 19, IS 456:2000

$\tau_c bd = 0.82 \times 50 \times 174 = 7134\ N/mm^2$

Max. spacing of stirrups $= 0.75 \times 174$
$= 130.5\ mm < 450\ mm$
$\sim 130\ mm$

Provide 6 mm dia stirrups @ 130 mm c/c

$V_{us} = \frac{0.87 \times 250 \times 56 \times 174}{130} = 16300\ N$

Shear resistance of section $= 7134 + 16300 = 23434$
$= 23434 > 18703.5\ N$

Hence, O.K.

SEISMIC RESISTANCE MEASURES (AS PER IS 4326: 1993- SECOND REVISION)

All floors and roofs to be constructed with small precast components shall be strengthened as specified for various categories of buildings in following Table. The strengthening measures are detailed in from i) to ii).

i) Tie beam (termed a in above Table) is a beam provided all round the floor or roof to bind together all the precast components to make it a diaphragm. The beams shall be to the full width of the supporting wall or beam less the bearing of the precast components. The depth of the beam shall be equal to the depth of the precast components plus the thickness of structural deck concrete, where used over the components. The beam shall be made of cement concrete grade not leaner than M 20 and shall be reinforced as indicated in Table (below). If depth of tie is more than 75 mm equivalent reinforcement shall be provided with one bar of minimum diameter 8 mm at each corner. Tie beams shall be provided on all longitudinal and cross walls. Typical details of the beams are shown in Fig. 6.

ii) The deck concrete normally used over the brick panel with joist floor shall be reinforced with 6 mm dia bars spaced 150 mm apart both ways (termed b in above Table).

Strengthening Measures for Floors/ Roofs with Brick Panels and Joists

Building Categories for Earthquake Resistant Features (Clause 7.1.1)	No. of Storeys	Strengthening to be provided in Floor/ Roof with Brick Panels & Joists
B	1 to 3	a
	4	a, b
C	1 & 2	a
	3 & 4	a, b
D	1 to 4	a, b
E	1 to 3	a, b

Where, a = Tie beam as per i).
b = Reinforced deck concrete as per ii)

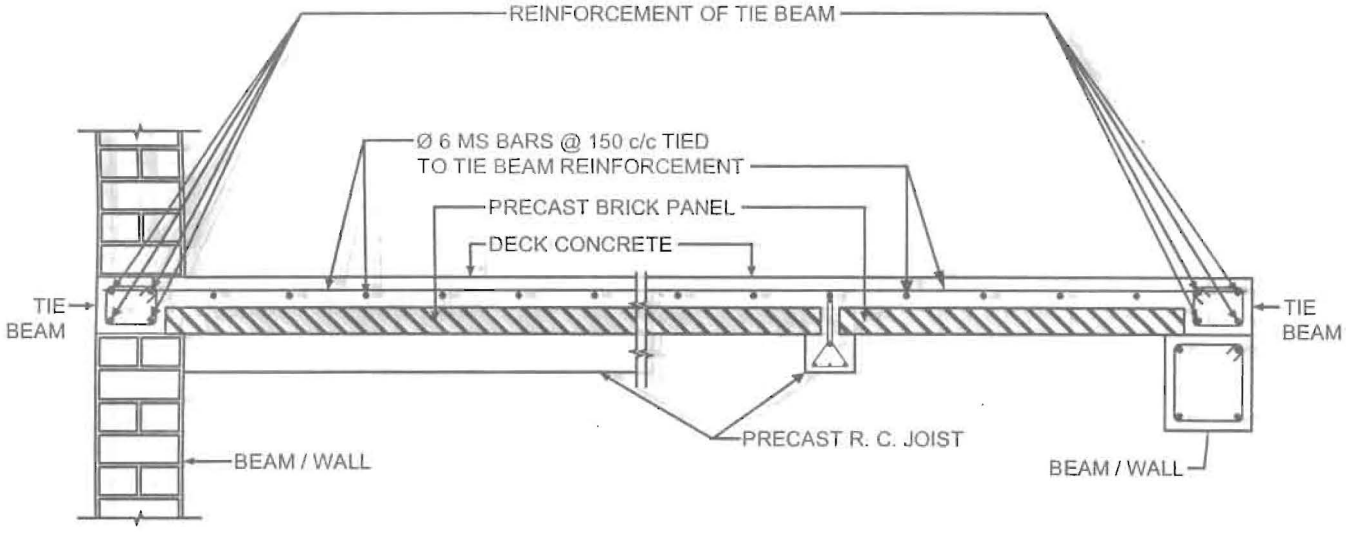


FIG. 6 CONNECTION OF PRECAST BRICK PANEL FLOOR/ ROOF (WITH DECK CONCRETE) WITH TIE BEAM

Recommended Longitudinal Steel in Reinforced Concrete Bands

Span	Building Category B		Building Category C		Building Category D		Building Category E	
in m	Nos.	Dia mm	Nos.	Dia mm	Nos.	Dia mm	Nos.	Dia mm
5 or less	2	8	2	8	2	8	2	10

NOTES

1. Span of wall will be distance between centre lines of its cross walls or buttresses.
2. The number and diameter of bars given above pertain to high strength deformed bars.
3. Width of RC band is assumed same as the thickness of the wall. Wall thickness shall be 200 mm minimum. A clear cover of 20 mm from face of wall will be maintained.
4. The vertical thickness of RC band be kept 75 mm minimum, where two longitudinal bars are specified, one on each face.
5. Concrete mix shall be of grade M20 of IS 456:2000 or 1:1.5:3 by volume. (in accordance with IS 456:2000)
6. The longitudinal steel bars shall be held in position by steel links or stirrups 6 mm dia spaced at 150 mm apart.

Precautions in Construction

Following precautions re to be taken in this scheme:

(1) Joists should be propped at two equidistant points before placing the panels, and laying concrete. They should be retained in position for 14 days.

(2) Frogs of bricks should be kept upward while casting and placing prefab brick panels on joists.

(3) Reinforcement in brick panels should be 15 mm above the bottom of bricks. This is done by applying mortar or concrete before placing reinforcement.

(4) Brick panels are to be lifted and transported without jerks and vibrations. They should always be lifted with hooks, a pair of which could be tied to a small rope for this purpose.

(5) Longitudinal joints between adjacent panels should be filled with M 20 concrete.

(6) Any loose materials like dried cement mortar, sand, stone pebbles, should be removed before laying cement concrete. It is advisable to sprinkle cement solution in water over brick panels before laying concrete.

(7) Rain water spouts should be fixed or made while laying deck concrete.

TABLE 1

Precast RC Joists for Pre Fabricated Brick Panel System with 35mm Deck Concrete above Simply Supported Residential Buildings

Eff. Span (m)	Size		Spacing of Joist (m)	LS Bending Moment (Nm)	LS Shear Force (N)	f_{ck}	f_y	Reinforcement		
	b (mm)	d (mm)				N/mm²		Bottom (mm)	Middle (mm)	Top (mm)
2.1	130	100	1.2	6119	10379	20	415	2 – 8 (dia)	6 (dia)	6 (dia)
						20	500	2 – 8 (dia)	6 (dia)	6 (dia)
2.4	130	100	1.2	7992	12044	20	415	3 – 8 (dia)	6 (dia)	6 (dia)
						20	500	2 – 6 (dia) + 1 – 8 (dia)	6 (dia)	6 (dia)
2.7	130	100	1.2	10115	13709	20	415	2 – 8 (dia) + 1 – 10 (dia)	6 (dia)	6 (dia)
						20	500	2 – 6 (dia) + 1 – 10 (dia)	6 (dia)	6 (dia)
3.0	130	100	1.2	12488	15374	20	415	2 – 8 (dia) + 1 – 12 (dia)	6 (dia)	6 (dia)
						20	500	2 – 6 (dia) + 1 – 12 (dia)	6 (dia)	6 (dia)
3.3	130	100	1.2	15110	17039	20	415	2 – 12 (dia) + 1 – 8 (dia)	6 (dia)	6 (dia)
						20	500	2 – 10 (dia) + 1 – 8 (dia)	6 (dia)	6 (dia)
3.6	130	100	1.2	17982	18704	20	415	2 - 12 (dia)+ 1 – 10 (dia)	8 (dia)	6 (dia)
						20	500	2 - 12 (dia)+ 1 – 6 (dia)	8 (dia)	6 (dia)
3.9	130	100	1.2	21104	20369	20	415	2 - 16 (dia)	8 (dia)	6 (dia)
						20	500	2 - 12 (dia)+ 1 – 10 (dia)	8 (dia)	6 (dia)
4.2	130	100	1.2	24476	22034	20	415	2 - 12 (dia)+ 1 – 16 (dia)	8 (dia)	6 (dia)
						20	500	2 - 10 (dia)+ 1 – 16 (dia)	8 (dia)	6 (dia)

Stirrups for joist is 6 mm dia bars @130mm c/c; for eff. Span 4.2 m, 4 stirrups at each end should be placed @ 100 mm c/c.

ANALYSIS OF RATES FOR CALCULATION OF COST

Description of Item of Work

Providing and laying floor/ roof slab consisting of prefab brick panels of cement concrete 1: 1.5: 3 (1 cement : 1.5 coarse sand: 3 graded stone aggregate 12 mm nominal size), partially precast RC Joists of cement concrete 1: 1.5: 3 (1 cement : 1.5 coarse sand: 3 graded stone aggregate 20 mm nominal size) and 35 mm thick layer of deck concrete with a nominal reinforcement of 6 mm dia bars 150 mm c/c at both ways is provided above the panels as per design and shape with cement concrete 1: 1.5: 3 (1 cement : 1.5 coarse sand: 3 graded stone aggregate 12 mm nominal size) including casting, staking, curing, erecting and placing the panels in position, cost of mould, mould oil, casting platform, props, scaffolding, centring and shuttering for deck concrete etc. all necessary equipment as needed and including filling and finishing the joints underneath with cement mortar 1:3 (1 cement : 3 fine sand) but excluding the cost of reinforcement complete as per design & drawing in all respect.

Sl. No.	Description	Unit	Quantity	Rate (in Rs.)	Amount (in Rs.)
1.	2.	3.	4.	5.	6.

Total area covered = 3.6 m x 3.6 m = 12.96 sq.m
Size of Brick Panel = 530 x 1200 x 750 mm
Size of Joist = 130 x 100 x 3600 mm
Number of Panels = 21 Nos.
Number of Joists = 2 Nos.

Brick Panels:

1) Mould

Materials:

Timber	cu.m	0.0136
Carriage of timber	cu.m	0.0136
Nails	gm	50

Labour:

Carpenter	each	0.50
Unskilled	each	0.50

Sundries etc. L.S. (as per actual requirement)

TOTAL Rs. X1

Considering number of reuse of the mould as 100 times

Cost of mould for one Panel = Rs. X1/100

Cost of mould for 21 Panels = each 21 Rs. X1/100 X2

2) Cement Concrete 1: 1.5: 3 (1 cement: 1.5 coarse sand: 3 graded stone aggregate 12 mm nominal size) for one Panel:

Volume of Panel = (+) 0.0477 cu.m
Volume of Bricks = (-) 0.0347 cu.m
Volume of Concrete = 0.0130 cu.m

Materials:

Cement	tonne	0.0052
Carriage of cement	tonne	0.0052
Coarse sand	cu.m	0.006
Carriage of sand	cu.m	0.006
Graded stone aggregate	cu.m	0.011
Carriage of stone aggregate	cu.m	0.011
Mild Steel 6mm dia (i.e. 2 x 1.34 x 0.22 = 0.59 kg)	kg	0.59
Carriage of Steel	kg	0.59
Bricks	each	17.5
Carriage of Bricks	each	17.5

Labour:

Mason	each	0.04
Bar bender	each	0.01

1.	2.	3.	4.	5.	6.
	Unskilled	each	0.10		
	Sundries etc.		L.S.	(as per actual requirement)	
	Cost of one Panel	=		Rs.	X3
	Cost of 21 Panels (Rs. X3 x21)	=		Rs.	X4

3) Miscellaneous Expenditure

i)	Casting platform			
ii)	Mould oil, kerosene oil, paper etc.			
iii)	Vibrator, mixer etc. (including the cost of fuel & electricity)		L.S.	(as per actual requirement)

4) Carriage of Panel

i)	Within a radius of about 200 m from casting platform			
	Unskilled	each	0.10	
ii)	Cost of trolley		L.S.	(as per actual requirement)

5) Hoisting and placing Panel in position up to floor 2 level

Mason	each	0.02	
Unskilled	each	0.10	
Scaffolding charges		L.S.	(as per actual requirement)
Add 5% of scaffolding charges for every extra floor level to the value given for floor 2 level.			

Partially Precast Joists:

6) Mould

Materials:

Timber	cu.m	0.0329
Carriage of timber	cu.m	0.0329
M.S. Tie Bolts 10 mm dia	each	2
M.S. Angle iron clamp 40x40x5 mm	each	2

Labour:

Carpenter	each	0.50
Unskilled	each	0.50

Sundries etc. L.S. (as per actual requirement)

TOTAL Rs. X5

Considering number of reuse of the mould as 100 times

Cost of mould for one Joist = Rs. X5/100

Cost of mould for 2 Joists = each 2 Rs. X5/100 X6

7) Cement Concrete 1: 1.5: 3 (1 cement: 1.5 coarse sand: 3 graded stone aggregate 20 mm nominal size) for one Joist:

Volume of Concrete i.e. 3.6 x 0.13 x 0.1 = 0.0468 cu.m

Pre-casting and Placing in position

Materials:

Cement	tonne	0.019
Carriage of cement	tonne	0.019
Coarse sand	cu.m	0.04
Carriage of sand	cu.m	0.04
Graded stone aggregate	cu.m	0.08
Carriage of stone aggregate	cu.m	0.08
Wooden Balli for propping P.P.Joists	each	2

1.	2.		3.	4.	5.	6.
	Labour:					
	Mason		each	0.09		
	Unskilled		each	0.24		
	Sundries etc.			L.S.	(as per actual requirement)	
		Cost of one Joist	=		Rs. X7	
		Cost of two Joists	= each	2	Rs. X7/100	X8

8) Miscellaneous Expenditure

i)	Casting platform			
ii)	Mould oil, kerosene oil, paper etc.			
iii)	Vibrator, mixer etc. (including the cost of fuel & electricity)		L.S.	(as per actual requirement)

9) Carriage of Joist

i)	Within a radius of about 200 m from casting platform			
	Unskilled	each	0.10	
ii)	Cost of trolley		L.S.	(as per actual requirement)

10) Hoisting and placing Joist in position up to floor 2 level

Mason	each	0.02	
Unskilled	each	0.10	
Scaffolding charges		L.S.	(as per actual requirement)

Add 5% of scaffolding charges for every extra floor level to the value given for floor 2 level.

11) Laying of Cement Concrete 1: 1.5: 3 (1 cement: 1.5 coarse sand: 3 graded stone aggregate 10 mm nominal size) over Brick Panels (Area = 3.6 m x 3.6 m = 12.96 sq.m)

35 mm thick concrete is laid over Prefab Brick Panel Roof

Materials:		
Cement	tonne	0.181
Carriage of cement	tonne	0.181
Coarse sand	cu.m	0.19
Carriage of sand	cu.m	0.19
Graded stone aggregate	cu.m	0.39
Carriage of stone aggregate	cu.m	0.39
Labour: (upto 6.0 m lift)		
Mason	each	1.3
Unskilled	each	2.27
Hire and running charges of mechanical Mixer & vibrator		L.S. (as per actual requirement)

12) Finishing of roof with floating coat of cement mortar 1:3 (1 cement : 3 fine sand)

Materials:		
Cement mortar 1:3 (1 cement: 3 fine sand)	cu.m	0.08
Labour:		
Mason	each	0.8
Unskilled	each	1.8

1.	2.	3.	4.	5.	6.
	Sundries including T & P		L.S.	(as per actual requirement)	
				TOTAL Rs.	
	Add for water charges @ 1%			Rs.	
				TOTAL Rs.	
	Add for contractor's profit and overhead @ 15%			Rs.	
				TOTAL Rs.	X9
	Total cost of 12.96 sq.m [i.e. from 1) to 12)]			G. TOTAL Rs.	X10
	Total cost of 1.0 sq.m				Rs. X10/12.96

Prepared by : S/Shri. Narendra Verma, V.K.Gupta, N. Singh & Balbir Singh
First Revised by : Shri. Y. K. Batra (Printed on April, 2004)

Second Revised by : **Shri. I. A. Siddiqui**

Published by : **CSIR - Central Building Research Institute, ROORKEE - 247 667, India**
Email : director@cbrimail.com Website : www.cbri.org.in & www.cbri.res.in

Edited by : **Dr. Atul Kumar Agarwal**, Scientist
Printed on : January, 2011