भारतीय मानक

पूर्वढली प्रबलित कांक्रीट चैनल इकाइयों से फर्श एवं छत की डिजाइन एवं निर्माण — रीति संहिता

Indian Standard

DESIGN AND CONSTRUCTION OF FLOORS AND ROOFS WITH PRECAST REINFORCED CONCRETE CHANNEL UNITS — CODE OF PRACTICE

UDC 691·328-413 : 692-4 : 006·76

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 5

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Housing Sectional Committee had been approved by the Civil Engineering Division Council.

Considerable shortage of houses in the country, which is also increasing continuously, has led to increasing stress being laid in the development programmes of Central and State governments on facilitating speedy and economical construction of houses. Problem of housing being gravest amongst the lower income groups, both rural and urban, the greatest stress is being laid on housing for these target groups.

This standard is one of a series of standards being processed on new materials and techniques of roof/floor construction which are likely to result in substantial savings in materials and cost of construction, in addition to achieving speedy construction. The other standards in the series are:

a) Prefabricated brick panel and partially precast concrete joist for flooring and roofing — Specification
b) Design and construction of floors and roofs with prefabricated brick panel — Code of practice
c) Precast reinforced concrete channel unit for flooring and roofing — Specification
d) Precast reinforced concrete planks and joist for flooring and roofing — Specification
e) Design and construction of floor and roof with precast reinforced concrete planks and RC joist — Code of practice
f) Precast reinforced concrete L-panel units for roofing — Specification
g) Design and construction of roof using precast reinforced concrete L-panel units — Code of practice
h) Construction of walls with precast concrete stone masonry blocks — Code of practice

The reinforced concrete channel units are channel (inverted trough) shaped precast beams which can be used for intermediate floors and roofs supported on walls or RCC beams. Their shape ensures more area of concrete in compression zone where it is required and less area on tension side and thus they have an efficient section. Further, being precast, use of these units also saves the cost of shuttering, ensures better quality control on concrete and speeds up construction work. All these lead to substantial savings in materials as well as cost of construction.

The recommended width of the channel units has been selected keeping in view the requirements of modular co-ordination.

Considerable assistance has been rendered in the preparation of this standard by the Central Building Research Institute, Roorkee.

The composition of the Committee responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DESIGN AND CONSTRUCTION OF FLOORS AND ROOFS WITH PRECAST REINFORCED CONCRETE CHANNEL UNITS — CODE OF PRACTICE

1 SCOPE

This standard lays down the recommendations for design and construction of floors and roofs using precast reinforced concrete channel units.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 MATERIALS/ELEMENTS OF ROOFS AND FLOORS

3.1 Precast R. C. Channel Units

The precast units used for construction shall conform to IS 14201 : 1994.

3.2 *In-situ* Concrete

In-situ concrete shall conform to grade M15 of IS 456: 1978 with well graded coarse aggregate of maximum size 12 mm.

3.3 Reinforcement

Steel used for reinforcement shall be as recommended in IS 456 : 1978.

4 STRUCTURAL DESIGN

4.1 The channel units shall have adequate strength and stability in accordance with IS 456 : 1978 during the following stages:

i) Demoulding;
ii) Handling, stacking, transporting and placing; and
iii) Final stage with all design dead and imposed loads acting on the floor/roof.

4.2 The units shall be designed either simply supported or continuous depending upon actual end conditions. Main reinforcement shall be either designed or shall be taken directly from Tables 1 to 8 for residential loads.

4.3 Design Stage 1 (Just After Placing of *In-situ* Concrete)

4.3.1 At the time of laying the units, the load comprises the self weight of the channel unit, weight of the *in-situ* concrete in the joint between two units and also the incidental live load, likely to act on the structure at this stage. In absence of more accurate information, 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) : 1987.

Table 1 Design Table for 300 mm Wide Channel Units Simply Supported

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Limit State Shear
		Limit State Moment	Reinforcement		
			Number	Dia	
(1)	(2)	(3)	(4)	(5)	(6)
m	mm	Nm		mm	N
2.1	150	1 348	2	8	2 406
2.4	150	1 760	2	8	2 774
2.7	150	2 228	2	8	3 140
3.0	150	2 751	2	8	3 507
3.3	150	3 328	2	8	3 873
3.6	150	3 961	2	8	4 240
3.6	200	4 374	2	8	4 617
3.9	200	5 133	2	8	5 022
4.2	200	5 954	2	8	5 427
4.5	200	6 834	2	10	5 832

Table 2 Design Table for 300 mm Wide Channel Units Continuous Over Two Equal Spans

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Support			Limit State Shear
		Limit State Moment	Reinforcement		Limit State Moment	Reinforcement		
			Number	Dia		Number	Dia	
(1) m	(2) mm	(3) Nm	(4)	(5) mm	(6) Nm	(7)	(8) mm	(9) N
2.1	150	914	2	8	868	1	8	2 406
2.4	150	1 194	2	8	1 134	1	8	2 774
2.7	150	1 510	2	8	1 435	1	8	3 140
3.0	150	1 865	2	8	1 772	1	8	3 507
3.3	150	2 256	2	8	2 144	1	10	3 873
3.6	150	2 685	2	8	2 552	1	10	4 240
3.9	150	3 151	2	8	2 995	1	10	4 607
4.2	150	3 654	2	8	3 473	1	12	4 975
4.5	150	4 195	2	8*	3 987	1	12	5 341
3.6	200	3 098	2	8	2 552	1	8	4 617
3.9	200	3 636	2	8	2 995	1	8	5 022
4.2	200	4 217	2	8	3 473	1	10	5 427
4.5	200	4 841	2	8	3 987	1	10	5 832

*Bottom bars of units of adjacent spans to be projected out and to be welded together.

Table 3 Design Table for 300 mm Wide Channel Units Continuous Over Three Equal Spans, Residential Building

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Support			Limit State Shear
		Limit State Moment	Reinforcement		Limit State Moment	Reinforcement		
			Number	Dia		Number	Dia	
(1) m	(2) mm	(3) Nm	(4)	(5) mm	(6) Nm	(7)	(8) mm	(9) N
2.1	150	1 108	2	8	727	1	8	2 406
2.4	150	1 447	2	8	950	1	8	2 774
2.7	150	1 832	2	8	1 203	1	8	3 140
3.0	150	2 261	2	8	1 485	1	8	3 507
3.3	150	2 736	2	8	1 797	1	8	3 873
3.6	150	3 256	2	8	2 139	1	10	4 290
3.9	150	3 821	2	8	2 510	1	10	4 607
4.2	150	4 432	2	10	2 911	1	10	4 975
4.5	150	5 088	2	10	3 341	1	12	5 341
3.6	200	3 669	2	8	2 139	1	8	4 617
3.9	200	4 306	2	8	2 510	1	8	5 022
4.2	200	4 994	2	8	2 911	1	8	5 427
4.5	200	5 733	2	8	3 341	1	10	5 832

Table 4 Design Table for 600 mm Wide Channel Units Simply Supported, Residential Building

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Limit State Shear
		Limit State Moment	Reinforcement		
			Number	Dia	
(1) m	(2) mm	(3) Nm	(4)	(5) mm	(6) N
2.1	150	2 447	2	8	4 371
2.4	150	3 197	2	8	5 037
2.7	150	4 046	2	8	5 703
3.0	150	4 995	2	10	6 369
3.3	150	6 044	2	10	7 035
3.6	150	7 193	2	12	7 701
3.9	150	8 441	2	12	8 367
3.6	200	7 533	2	10	7 951
3.9	200	8 841	2	10	8 649
4.2	200	10 253	2	12	9 346
4.5	200	11 770	2	12	10 044

Table 5 Design Tables for 600 mm Wide Channel Units Continuous Over Two Equal Spans, Residential Building

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Support			Limit State Shear
		Limit State Moment	Refinforcement		Limit State Moment	Reinforcement		
			Number	Dia		Number	Dia	
(1) m	(2) mm	(3) Nm	(4)	(5) Nm	(6) Nm	(7)	(8) mm	(9) N
2.1	150	1 579	2	8	1 736	1	8	4 371
2.4	150	2 063	2	8	2 268	1	10	5 037
2.7	150	2 611	2	8	2 870	1	10	5 703
3.0	150	3 223	2	8*	3 544	1	12	6 369
3.3	150	3 900	2	8*	4 288	1	12	7 035
3.6	150	4 640	2	8*	5 103	1	16	7 701
3.9	150	5 447	2	10*	5 989	1	16	8 367
4.2	150	6 317	2	10*	6 946	1	16	9 033
3.6	200	4 981	2	8	5 103	1	12	7 951
3.9	200	5 846	2	8	5 989	1	12	8 649
4.2	200	6 780	2	10	6 945	1	16	9 346
4.5	200	7 784	2	10	7 973	1	16	10 044

*Bottom bars of units of adjacent spans to be projected out and to be welded together.

Table 6 Design Tables for 600 mm Wide Channel Units Continuous Over Three Equal Spans, Residential Building

(*Clause* 4.2)

Effective Span	Depth	Mid Span			Support			Limit State Shear
		Limit State Moment	Reinforcement		Limit State Moment	Reinforcement		
			Number	Dia		Number	Dia	
(1) m	(2) mm	(3) Nm	(4)	(5) mm	(6) Nm	(7)	(8) mm	(9) N
2.1	150	1 968	2	8	1 455	1	8	4 371
2.4	150	2 570	2	8	1 900	1	8	5 037
2.7	150	3 253	2	8	2 406	1	10	5 703
3.0	150	4 016	2	8	2 970	1	10	6 369
3.3	150	4 859	2	10	3 594	1	12	7 035
3.6	150	5 783	2	10*	4 277	1	12	7 701
3.9	150	6 787	2	10*	5 019	1	16	8 367
4.2	150	7 872	2	12*	5 821	1	16	9 033
4.5	150	9 036	2	12*	6 883	1	16	9 699
3.6	200	6 124	2	8	4 277	1	10	7 951
3.9	200	7 187	2	10	5 019	1	12	8 649
4.2	200	8 335	2	10	5 821	1	12	9 346
4.5	200	9 568	2	10	6 682	1	16	10 044

*Bottom bars of units of adjacent spans to be projected out and to be welded together.

Table 7 Limit State Moment of Resistance and Shear Capacity of 300 mm Wide Channel Unit

(*Clause* 4.2)

Depth	Mid Span			Support			Shear Capacity
	Reinforcement		Moment of Resistance	Reinforcement		Moment of Resistance	
	Number	Dia		Number	Dia		
(1) mm	(2)	(3) mm	(4) Nm	(5)	(6) mm	(7) Nm	(8) N
150	2	8	4 397	1	8	2 116	5 344
150	2	10	6 585	1	10	3 081	6 426
150	–	–	–	1	12	3 443	7 356
200	2	8	6 202	1	8	3 019	6 544
200	2	10	9 437	1	10	4 506	7 776

Table 8 Limit State Moment of Resistance and Shear Capacity of 600 mm Wide Channel Unit

(*Clause* 4.2)

Depth	Mid Span			Support			Shear Capacity
	Reinforcement		Moment of Resistance	Reinforcement		Moment of Resistance	
	Number	Dia		Number	Dia		
(1) mm	(2)	(3) mm	(4) Nm	(5)	(6) mm	(7) Nm	(8) N
150	2	8	4 564	1	8	2 116	5 344
150	2	10	6 990	1	10	3 081	6 426
150	2	12	9 676	1	12	3 443	7 356
150	–	–	–	1	16	3 443	8 796
200	2	8	6 369	1	10	4 506	7 776
200	2	10	9 840	1	12	6 092	9 116
200	2	12	13 758	1	16	6496	10 988

4.3.2 *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 (*see* Fig. 1).

4.4 Design Stage 2 (With Full Design Load)

4.4.1 *Loads*

At this stage, the loads acting on the structure shall comprise dead load and full imposed load as per IS 875 (Part 2) : 1987. 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 at least 1.5 shall be applied for calculating the limit state of collapse load.

4.4.2 *Effective Section*

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

4.5 Design Bending Moment and Shear Force

When the floors/roofs consist of three or more continuous and approximately equal spans, the values of bending moment and shear force coefficients given in IS 456 : 1978 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 moment and shear force due to dead weight of units (including that of *in-situ* concrete) shall be added.

4.6 *In-situ* concrete, which brings monolithic connection and continuity between precast units, shall be designed in accordance with IS 3935 : 1966.

4.7 When precast units are used for the construction of buildings in high seismic zones the floor and roof shall be strengthened in accordance with 9 of IS 4326 : 1993.

5 STORAGE, TRANSPORTATION AND ERECTION OF PRECAST ELEMENTS

5.1 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.

5.2 Transportation

The unit shall be lifted either manually, or preferably with

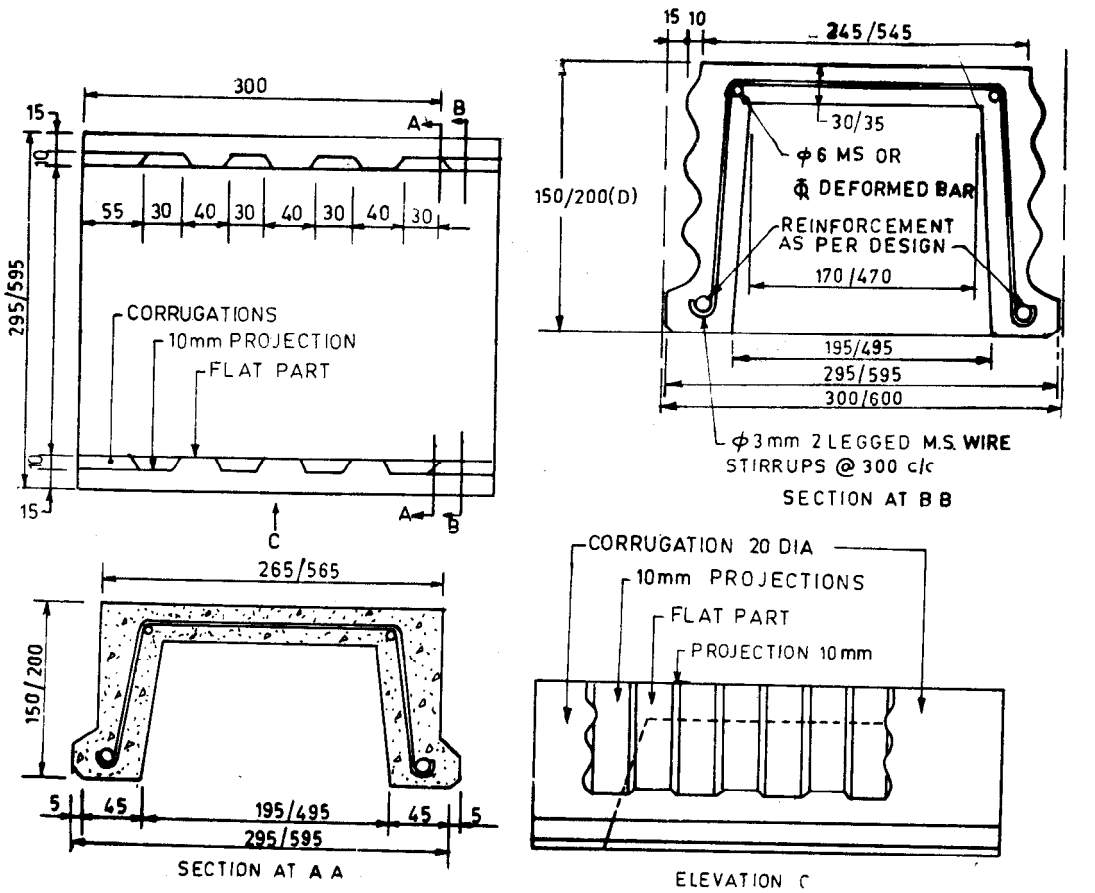


FIG. 1 A CHANNEL UNIT

the help of a chain pulley block or mechanically with a hoist and placed side by side across the span to be covered.

5.3 Placing and Aligning

The top surface of the wall or beam support shall be levelled 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 levelling 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 levelled 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.

5.4 Bearing

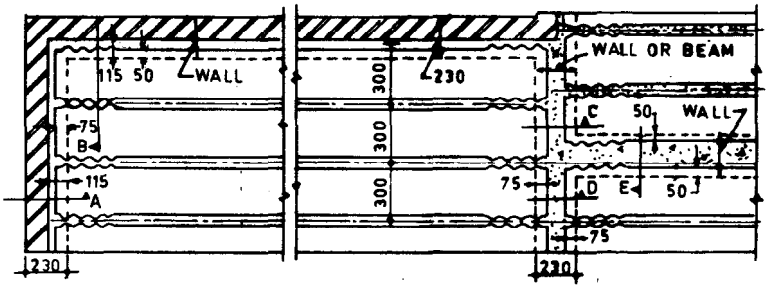
The precast units shall have a minimum end bearing of 75 mm, and a minimum side bearing of 50 mm.

5.5 Negative Reinforcement

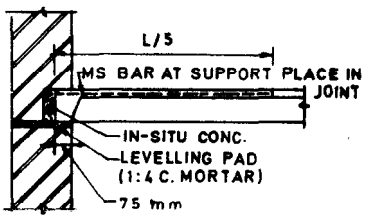
Negative reinforcement, required in case of continuous floor/roof slabs, shall consist of one bar of required diameter designed in accordance with **4.**

5.5.1 The negative reinforcement shall be placed in position, at supports, upto a distance from support as specified in IS 456 : 1978, near the top, in the joints between the units (*see* Fig. 2).

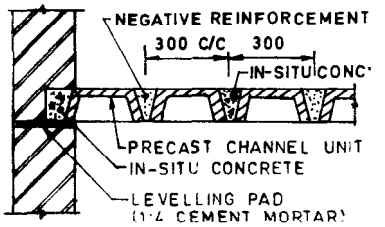
5.6 Cement wash shall be applied to the sides of the units and the joints shall be filled with concrete. The



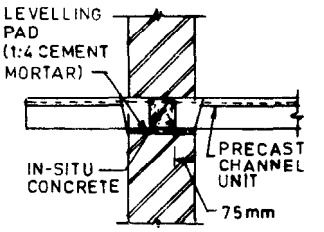
2A Top Plan of Channel Units



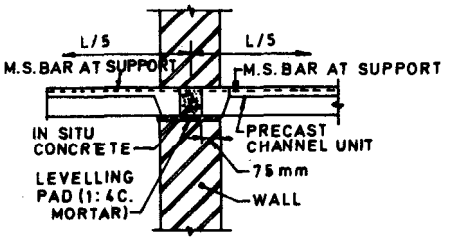
2B Section 'A'



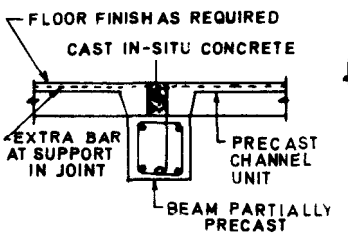
2C Section 'B'



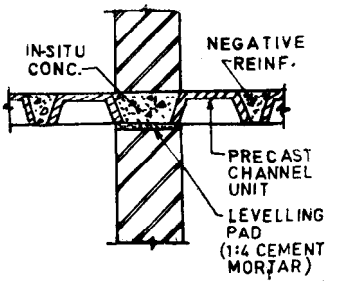
2D Section 'C'



2E Section 'E' (Wall)



2F Section 'D' (Beam)



2G Section 'E'

FIG. 2 DETAILS OF JOINTS IN A FLOOR WITH CHANNEL UNITS

concrete shall be compacted by either vibration or rodding.

6 CURING OF *IN-SITU* CONCRETE

6.1 *In-situ* concrete shall be cured for at least one week by sprinkling water. It shall further be aircured for a week. A coat of cement slurry may then be applied to the joints to fill the hairline cracks that might have developed.

7 FIXTURES

7.1 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 **7.1.1** to **7.1.3**.

7.1.1 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.

7.1.2 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.

7.1.3 For fixing fan hooks, electric junction boxes and wooden plugs shall be as given in **7.1.3.1** to **7.1.3.3**.

7.1.3.1 *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. 3).

7.1.3.2 *Electric junction boxes*

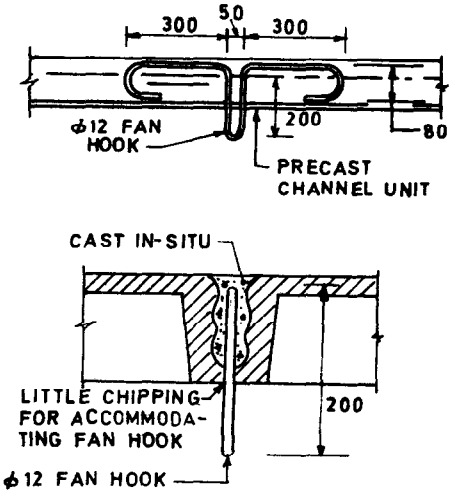


FIG. 3 FIXING OF FAN HOOKS

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

7.1.3.3 *Wooden plugs*

Wooden plugs for electrical wiring or any other fixture shall be provided as illustrated in Fig. 4.

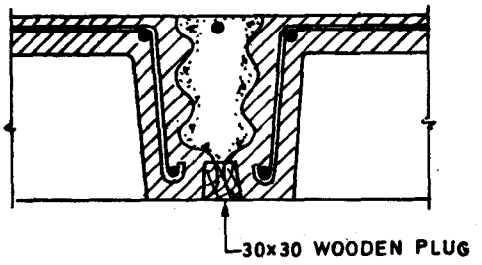


FIG. 4 FIXING OF WOODEN PLUG

8 PROJECTION OF BALCONY

8.1 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 : 1978. However, care shali 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. 5.

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

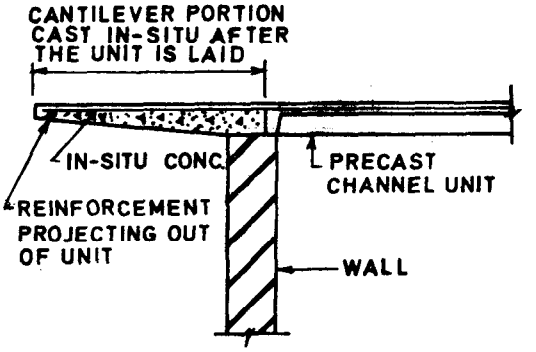


FIG. 5 BALCONY *CHAJJA PROJECTION* CONTINUOUS WITH UNIT

9 FLOOR/ROOF FINISHING

9.1 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 : 1976, IS : 4365 : 1967, IS 3036 : 1992 and IS 9918 : 1981 may be referred.

9.2 The joints in the ceiling may be finished with deep ruled lines for better appearance (*see* Fig. 6). The ruled

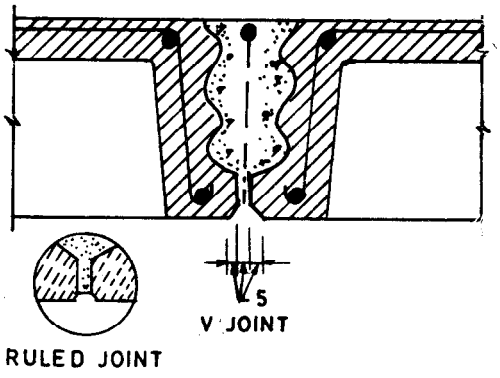


FIG. 6 DETAILS OF 'V' JOINT AND RULED JOINT

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.

10 PRECAUTIONS DURING AND AFTER CONSTRUCTION

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

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

10.3 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.

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

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
432 (Part 1) : 1982	Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement: Part 1 Mild steel and medium tensile steel bars (*third revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
875 (Part 2) : 1987	Code of practice for design loads (other than earthquake) for buildings and structures: Part 2 Imposed loads (*second revision*)
1346 : 1991	Code of practice for waterproofing of roofs with bitumen felts (*third revision*)
3036 : 1992	Code of practice for laying lime concrete for a waterproofed roof finish (*second revision*)
3935 : 1966	Code of practice for composite construction
4326 : 1993	Code of practice for earthquake resistant design and construction of buildings
4365 : 1967	Code of practice for application of bitumen mastic for waterproofing of roofs
9918 : 1981	Code of practice for *in-situ* waterproofing and damp-proofing treatments with glass fibre tissue reinforced bitumen (*first revision*)
14201 : 1994	Specification for precast reinforced concrete channel units for construction of floors and roofs

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Housing Sectional Committee, CED 51

Chairman	*Representing*
DR P. S. A. SUNDARAM	Ministry of Urban Development, New Delhi
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(*Continued on page* 10)

(*Continued from page* 9)

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