भारतीय मानक

पूर्वढली प्रबलित प्लैंक एवं जॉइस्ट से बनी फर्श एवं छत की डिज़ाइन एवं निर्माण — रीति संहिता

Indian Standard

DESIGN AND CONSTRUCTION OF FLOOR AND ROOF WITH PRECAST REINFORCED CONCRETE PLANKS AND JOISTS — CODE OF PRACTICE

UDC 691·328—413 : 692·4/5

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

September 1994

Price Group 4

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 greatest amongst the lower income groups, both rural and urban, the greatest stress is being laid on housing for these target groups.

This calls for development and standardization of new building materials and construction techniques which are simple and economical, commensurate with structural and hygienic safety and durability, in order to ensure speedy and economical construction.

This standard is one of a series of standards being published by BIS on new materials and techniques of roof/floor construction which when implemented will result in substantial savings in materials and cost of construction, in addition to achieving speedy construction. The other standards to be published in the series are:

a) Precast reinforced concrete planks and joists for flooring and roofing — Specification

b) Prefabricated brick panel and partially precast concrete joist for flooring and roofing — Specification

c) Design and construction of roofs and floors with prefabricated brick panel — Code of Practice

d) Precast reinforced concrete channel units for construction of floors and roofs — Specification

e) Design and construction of floor and roof with precast reinforced channel units — Code of practice

f) Precast reinforced concrete L-panels for construction of roofs — Specification

g) Design and construction of roofs using precast reinforced concrete L-panels — Code of practice

h) Construction of walls with precast concrete stone masonry blocks — Code of practice

Precast reinforced concrete planks are partially precast rectangular slab elements which are supported over partially precast RCC joists side by side and then joined together and also to the joist 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 stirrups projecting out of joists and providing reinforcement across the joists over haunched portion of planks, tying them together and pouring *in-situ* concrete over it.

Roofs and floors made with precast RC planks are found economical as compared to conventional RC slabs mainly due to the following reasons:

a) Components used for construction being precast, shuttering is eliminated.

b) Quality can be controlled better in precast elements.

c) Moderate size components are used thereby eliminating need for mechanical handling and erection equipment.

d) Prefabrication leads to substantial reduction in time required for construction.

Considerable assistance has been rendered in the preparation of this standard by the Central Building Research Institute, Roorkee, who have developed these techniques.

The composition of the technical committee responsible for the formulation of this standard is given in 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 FLOOR AND ROOF WITH PRECAST REINFORCED CONCRETE PLANKS AND JOISTS — CODE OF PRACTICE

1 SCOPE

This standard lays down recommendations for design and construction of floors and roofs with precast reinforced concrete planks and joist. Planks up to a length of 1·5 m are covered.

2 REFERENCES

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

3 MATERIALS/ELEMENTS OF ROOF/ FLOOR

3.1 Precast RC Planks and Joist

The precast RC planks and joist used for construction of floor/roof shall conform to IS 13990 : 1994.

3.2 Concrete

In-situ concrete shall conform to grade M 15 of IS 456 : 1978.

4 DESIGN REQUIREMENTS

4.1 Loads

Design load on various components of the flooring/roofing shall comprise self weight, imposed load in accordance with IS 875 (Part 2) : 1987 and dead load due to floor finish in case of intermediate floors and dead load due to roof treatment in case of roofs in accordance with IS 875 (Part 1) : 1987.

4.2 Structural Design of Roof/Floor

4.2.1 *Precast RC Planks*

The plank shall be designed as simply supported for self weight including *in-situ* concrete over haunches, and as a continuous slab for a load comprising live load, self weight and dead load of floor finish and/or water proofing treatment. The design shall be in accordance with the limit state method of IS 456 : 1978.

4.2.2 *Partially Precast Joists*

4.2.2.1 The joists shall be designed as simply supported or continuous T-beam with 60 mm flange thickness (equal to full thickness of flange with *in-situ* concrete) depending upon whether the joists are having single span or continuous over adjacent span. Reinforcement shall be determined in accordance with IS 456 : 1978 for the required spacing and span of the joists.

4.2.2.2 For large spans requiring high moment of resistance, either the depth of joist can be increased, or if depth can not be increased due to headroom 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 reinforcements of joists covering adjacent spans shall be welded together for continuity. The top reinforcement to resist negative moment shall also be provided in the joists up to a distance from supports as specified in IS 456 : 1978. This shall be embedded in *in-situ* concrete (*see* Fig. 1). The moments and shears at various sections shall be determined either theoretically or the co-efficients given in IS 456 : 1978 may be used, wherever applicable. Moment of resistance of T-beam with different reinforcement based on limit state methods are given in Table 1 for reference.

4.2.3 *Cover to Reinforcement*

A minimum clear cover of 15 mm for planks and 25 mm for joists shall be provided.

4.3 When precast units are used for the construction of building in high seismic zones, the roofs/floors shall be strengthened in accordance with the provision of IS 4326 : 1993.

5. ERECTION OF FLOOR/ROOF

5.1 Cement concrete bed blocks of 300 mm × 230 mm × 75 m 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.

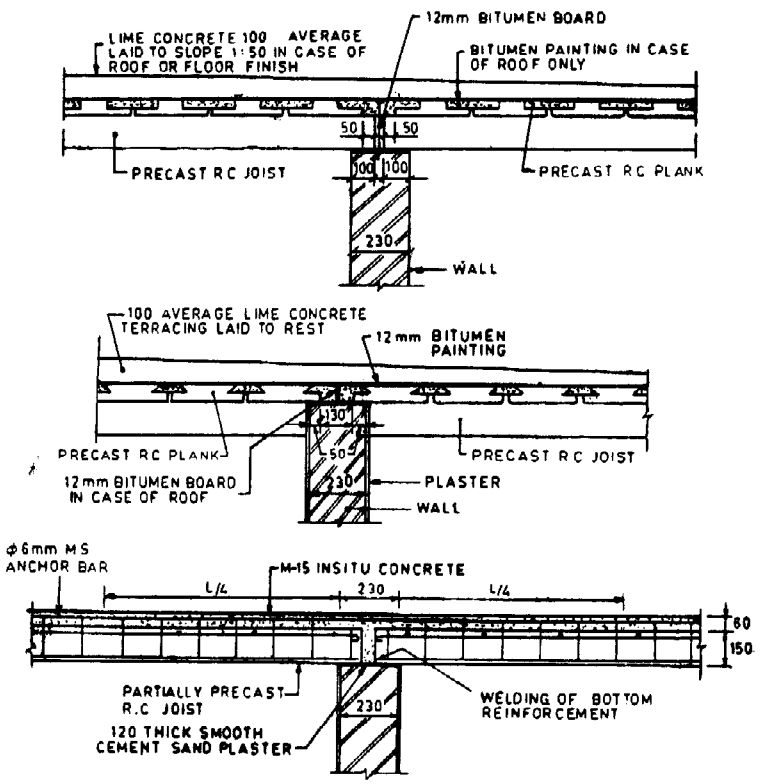
5.2 Partially precast joists shall then be aligned over these blocks. The joists shall be propped at centre of span, immediately after putting them, with a prop having a timber plank of minimum dimensions of 350 mm × width of joist, of 30 mm thickness at bearing level (*see* Fig. 2). The minimum bearing of joists over the walls should be 100 mm.

Table 1 +Ve Moment of Resistance with Different Reinforcement for Partially Precast Joist (Width 150 mm, Depth of Precast Portion 150 mm and Overall Depth with *In-Situ* Concrete 210 mm)

(*Clause* 4.2.2.2)

A. M. S. bars, Moment of resistance (kgm)	898	1 030	1 157	1 286	1 355	1 609	1 774	1 894	2 206
Area of reinforcement (cm^2)	2·356	2·702	3·047	3·393	3·58	4·27	4·806	5·452	6·032
Reinforcement	3-10 mm	2-10 mm +1-12 mm	2-12 mm +1-10 mm	3-12 mm	2-10 mm +1-16 mm	2-12 mm +1-16 mm	2-16 mm + 1-10 mm	2-16 mm + 1-12 mm	3-16 mm
B. Deformed bars, Moment of resistance (kgm)	994	1 304	1 420	1 477	1 686	1 895	2 103	2 433	2 580
Area of reinforcement (cm^2)	1·57	2·073	2·263	2·356	2·702	3·047	3·393	4·02	4·273
Reinforcement	2-10 mm	2-10 mm + 1-8 mm	2-12 mm	3-10 mm	2-10 mm +1-12 mm	2-12 mm +1-10 mm	3-12 mm	2-16 mm	2-12 mm + 1-16 mm

NOTE — Mild steel conforming to IS 432 (Part 1) : 1982 and cold twisted bars conforming to IS 1786 : 1985 shall be used as reinforcement.



1 A Typical Sketch of Details for Simply Supported Joist at Support

1 B Typical Sketch of Details for Plank Bearing at Roof to Avoid Leakage

1 C Typical Sketch of Detail for Continuity of Joist at Support in Intermediate Floors

All dimensions in millimetres.

FIG. 1 DETAILS OF IN-SITU CONCRETE

5.3 Top surface of the walls/beams where planks have to bear, shall then be levelled smooth with 1 : 6 cement sand mortar. In case of roofs, the entire wall top shall be levelled 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 (*see* Fig. 3A and Fig. 3B). 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 (*see* Fig. 3C). 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 : 1978. Alternatively, two 6 mm diameter mild steel grade 1 bars conforming to IS 432 (Part 1) : 1982 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) : 1982 shall be kept parallel to joists near the ends of the planks as shown in Fig. 4. 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 (*see* **4.2.2.2**), as shown in Fig. 1 and Fig. 4.

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.

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 15 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 levelled 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 (*see* Fig. 5). 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. 5. A projection of 100 cm 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. 6.

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 : 1978, IS 4365 : 1967, IS 9918 : 1991 and IS 3036 : 1992 may be referred.

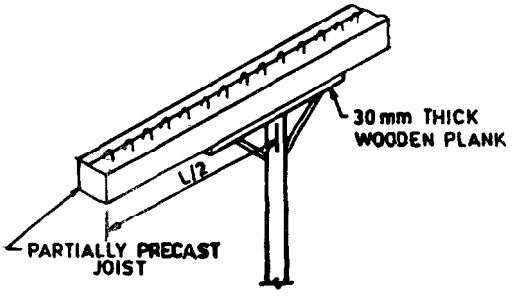
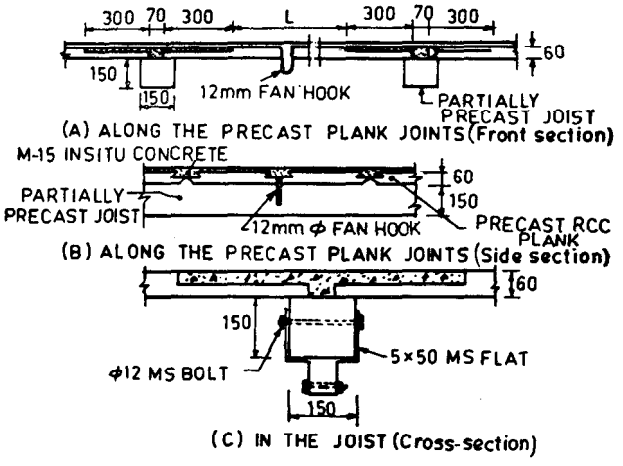
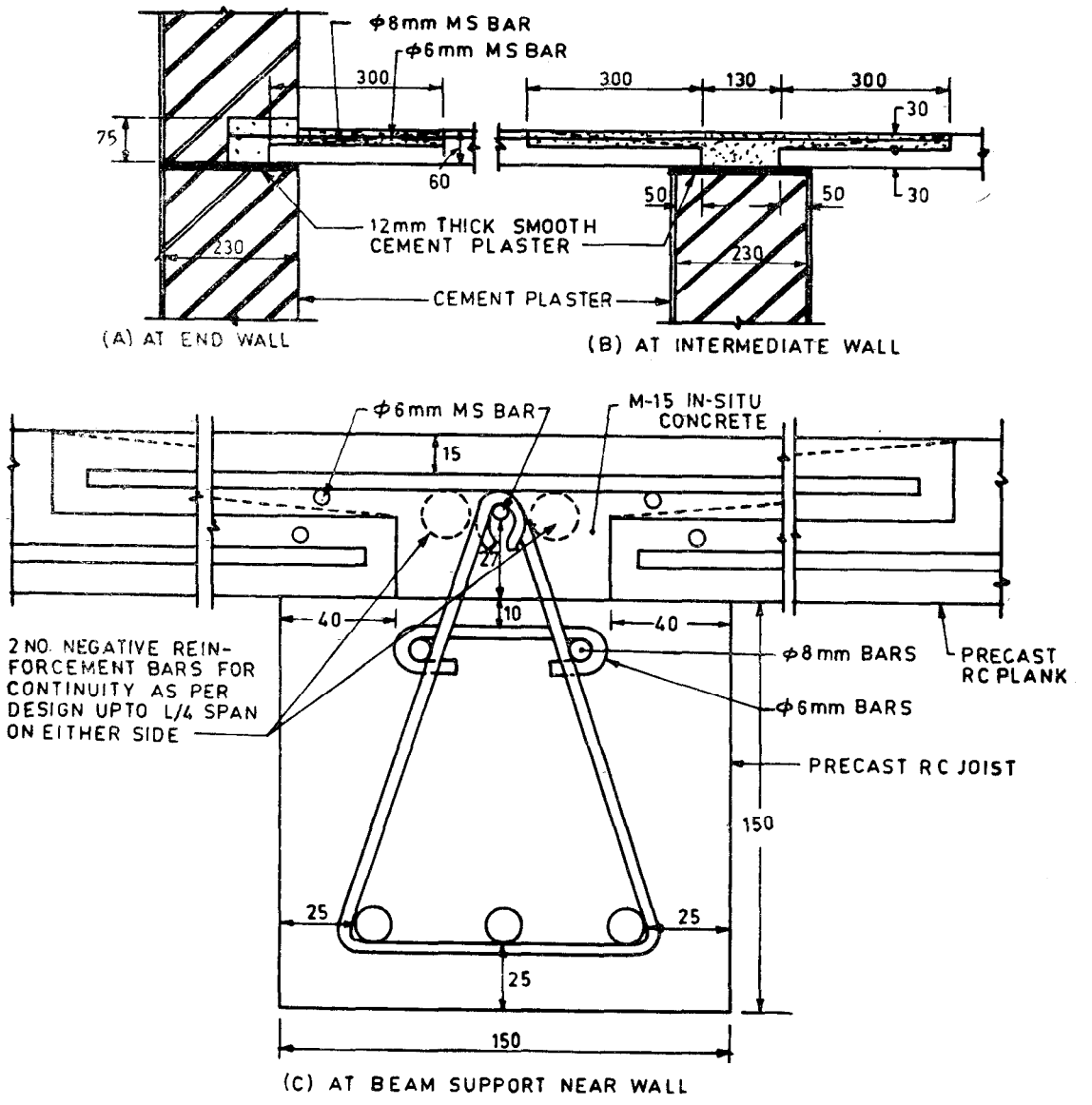


FIG. 2 PROPPING OF PARTIALLY PRECAST JOIST



All dimensions in millimetres.

FIG. 3 FIXING OF FAN HOOK



All dimensions in millimetres.

FIG. 4 TYPICAL SKETCH SHOWING DETAILS OF DIFFERENT BEARING POSITION

7 CARE DURING AND AFTER ERECTION

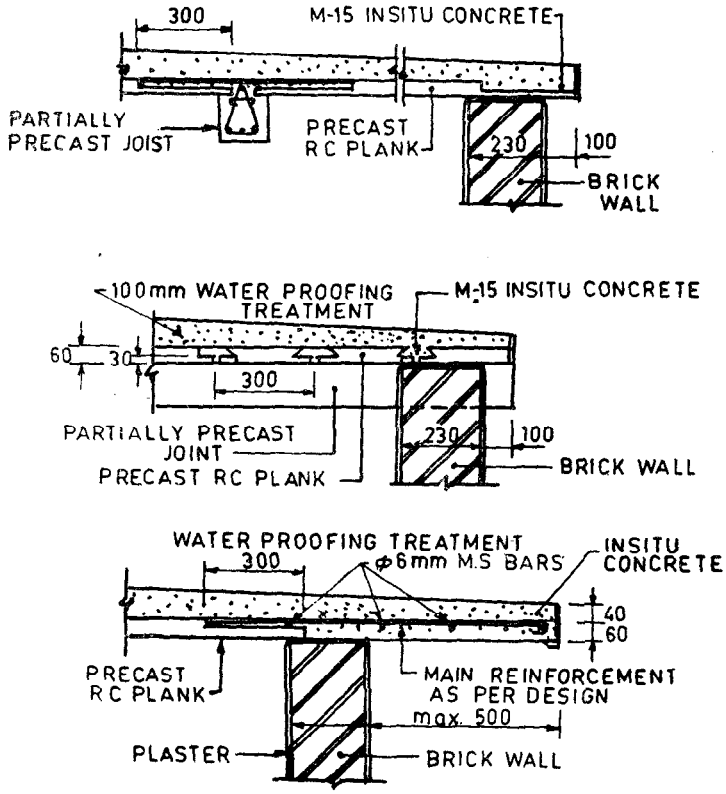
7.1 Concentrated load shall not be allowed on the roof/floor till *in-situ* concrete has attained strength. Workers shall not walk on the roof/floor before the *in-situ* concrete has attained strength. For placing of reinforcement and concreting in the haunches and over joists, cat walks resting on joists/walls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

7.2 The planks shall be handled and transported in nearly 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 walls in which case their weight has to be considered while designing the joists.

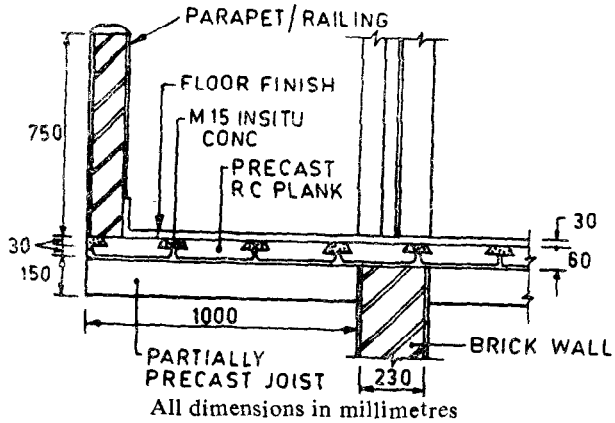
8 SERVICE AREA PROVISIONS

8.1 In service area, pipes, floor trap, 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 to make the floor leak-proof, the *in-situ* concrete thickness shall be increased by 25 mm over top of the planks in addition to haunch filling.



All dimensions in millimetres.

FIG. 5 TYPICAL SKETCH OF DETAILS OF ROOF WITHOUT DARAPET



All dimensions in millimetres

FIG. 6 TYPICAL SKETCH OF CANTILEVER ALONG THE JOIST FLOOR LEVEL

9 BALCONY/CHHAJJA PROJECTIONS

9.1 Balcony projections shall be provided along the partially precast joists as shown in Fig. 6. The joist shall be designed with an overhang, carrying superimposed loads for balcony as specified in IS 875 (Part 2) : 1987, 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.

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
432 (Part 1) : 1982	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*)	1786 : 1985	Specification for high strength deformed steel bars and wires for concrete reinforcement (*third revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)	3036 : 1992	Code of practice for laying lime concrete for a waterproofed roof finish (*second revision*)
875 (Part 1) : 1987	Code or practice for design loads (other than earthquake) for buildings structures: Part 1 Dead loads — Unit weights of building material and stored materials (*second revision*)	4326 : 1993	Code of practice for earthquake resistant design and construction of buildings (*first revision*)
875 (Part 2) : 1987	Code of practice for design loads (other than earthquake) for buildings structures: Part 2 Imposed loads (*second revision*)	4365 : 1967	Code of practice for application of bitumen mastic for waterproofing of roofs
1346 : 1991	Code of practice for waterproofing of roofs with bitumen felts (*third revision*)	9918 : 1981	Code of practice for *in-situ* water-proofing and damp-proofing treatment with glass fibre tissue reinforced bitumen (*first revision*)
		13990 : 1994	Specification for precast reinforced concrete planks and joist for flooring and roofing

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

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SHRI H. U. BIJLANI	In Personal Capacity (*1, Sadhna Enclave, Panchsheel Park, New Delhi 110017*)
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SR ARCHITECT (H and TP) I (*Alternate*)	
CHIEF ENGINEER, AUTHORITY	Maharashtra Housing and Area Development Authority, Bombay
ARCHITECT, AUTHORITY (*Alternate*)	
CHIEF ENGINEER (D)	Central Public Works Department, New Delhi
[SUPERINTENDING ENGINEER (D)] (*Alternate*)	
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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such a review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices:	Telephones
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	37 84 99, 37 85 61 37 86 26, 37 86 62
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