

Indian Standard

CODE OF PRACTICE FOR
CONSTRUCTION OF FLOORS AND ROOFS
USING PRECAST CONCRETE WAFFLE UNITS

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION OF FLOORS AND ROOFS USING PRECAST CONCRETE WAFFLE UNITS

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(*Continued on page 2*)

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(Continued on page 10)

Indian Standard

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 February 1983, after the draft finalized by the Prefabricated and Composite Construction Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 The scheme consists of a nominally reinforced precast open box type concrete units called waffle units laid in a grid pattern and cast-in-situ concrete 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 slab has a pleasant grid pattern in the ceiling. The scheme is suitable for roofs/floors spanning in two directions.

1. SCOPE

1.1 This standard covers the details of construction of floors and roofs using precast concrete waffle units.

2. DETAILS OF THE SCHEME

2.1 Precast Unit

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

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

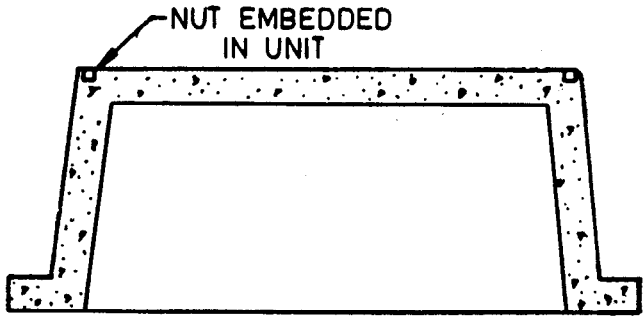


FIG. 1 TYPICAL SQUARE WAFFLE SLAB UNIT

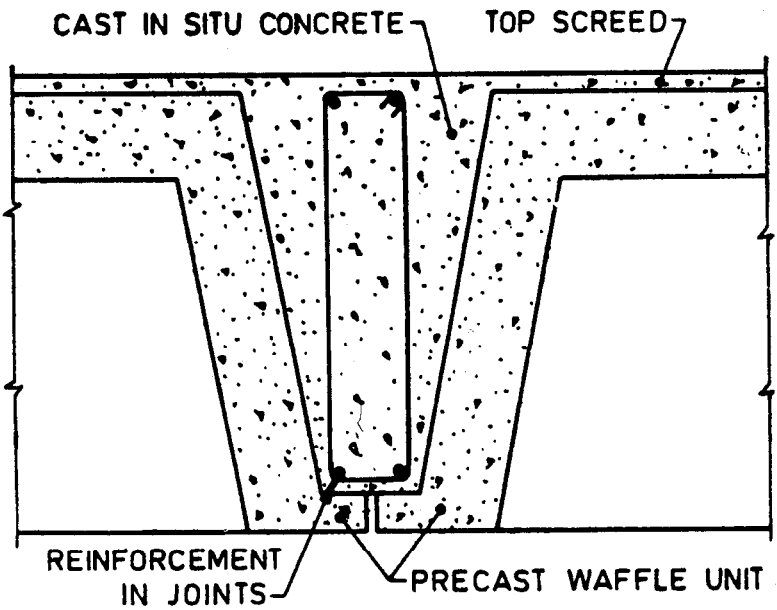


FIG. 2 TYPICAL SECTION OF FLOOR USING WAFFLE UNITS

2.1.2 Size — The lateral dimensions of the units should be modular (see IS : 6820-1972*). The depth of the unit shall be as per structural design and will vary according to loads and spans. The minimum thickness of the flange and web of the units shall be 25 mm.

3. MATERIALS

3.1 General — The material used for the construction shall conform to IS : 456-1978†.

4. STRUCTURAL DESIGN

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

4.2 The precast units shall have adequate strength and stability in accordance with relevant code of practice (IS : 456-1978†) 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 in joints.

NOTE — Where portland pozzolana cement is used delayed strength development at the early ages shall be considered.

4.3 Loads shall be in accordance with IS : 875-1964‡.

4.4 For calculating the limit state of collapse at 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.

5. MOULD

5.1 The mould used for manufacturing waffle slabs normally consists 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 material acceptable to engineer-in-charge. The side moulds similarly can be 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 for higher efficiency. Admixtures for higher strength of concrete can also be used.

*Recommendations for modular co-ordination rules for modular planning.

†Code of practice for plain and reinforced concrete (*third revision*).

‡Code of practice for structural safety of buildings : Loading standards (*first revision*).

6. REINFORCEMENT IN PRECAST UNIT

6.1 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.

7. CONCRETE

7.1 Mix — The concrete mix shall be of minimum grade M 20 as per IS : 456-1978*.

8. CASTING AND CURING

8.1 Mechanical vibration either through mould/table vibrators or screed vibrator is essential to ensure good compaction. Needle vibrators can be used for compacting concrete in the ribs and screed vibrators can be used for compacting concrete in the flange. For larger factories, concrete placing machine which level, vibrate and finish the concrete units can be advantageously utilized.

8.2 Curing shall be done according to IS : 456-1978*. If necessary, low pressure steam curing may be provided to get early stripping/release strength.

9. TOLERANCES

9.1 Tolerances on the dimensions shall be as follows:

- a) Length/breadth — ± 5 mm or ± 0.1 percent whichever is greater, and
- b) Thickness — ± 2 mm.

10. SAMPLING AND TESTING OF UNITS

10.1 Sampling — Sampling shall be done in accordance with Appendix A.

10.2 Load test on floor/roof shall be carried out in accordance with the provisions of IS : 456-1978*.

11. TRANSPORTATION AND ERECTION OF PRECAST ELEMENTS

11.1 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

*Code of practice for plain and reinforced concrete (*third revision*).

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.

11.2 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 taken to see that no support is placed at the centre of span.

11.3 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.

11.4 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.

12. CURING OF IN-SITU CONCRETE IN JOINTS

12.1 The in-situ concrete in the joint shall be cured for at least 7 days in accordance with IS : 456-1978*. The concrete shall be then 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.

13. FIXTURES

13.1 Designers shall indicate provisions for fixtures like fanhooks/inserts/ electric conduits, etc, to be incorporated within the precast units or the in-situ joints/screed concrete.

13.1.1 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/roofs finish.

13.1.2 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/cutting of edges shall not be made otherwise permitted by the Engineer-in-Charge.

14. FLOOR FINISH

14.1 In case of floor slab, the floor finish shall be done in accordance with relevant Indian Standard Code of practice.

*Code of practice for plain and reinforced concrete (*third revision*).

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

15. ROOF TREATMENT

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

A P P E N D I X A

(Clause 10.1)

SAMPLING PROCEDURE FOR PRECAST SLAB UNITS

A-1. LOT

A-1.1 All the precast slab units of the same size, manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

A-1.2 The number of units to be selected from each lot for dimensional requirements shall depend upon the size of the lot and shall be in accordance with col 1 and 2 of Table 1.

TABLE 1 SAMPLE SIZE AND REJECTION NUMBER

(Clauses A-1.2 and A-2.1)

LOT SIZE	FIRST SAMPLE SIZE	SECOND SAMPLE SIZE	FIRST REJECTION NUMBER	SECOND REJECTION NUMBER
(1)	(2)	(3)	(4)	(5)
Up to 100	5	5	2	2
101 to 300	8	8	2	2
301 to 500	13	13	2	2
501 and above	20	20	3	4

A-1.2.1 The units shall be selected from the lot at random. In order to ensure the randomness of selection, procedure given in IS : 4905-1968* may be followed.

*Methods for random sampling.

A-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

A-2.1 All the slab units selected at random in accordance with col 1 and 2 of Table 1 shall be subjected to the dimensional requirements. A unit failing to satisfy any of the dimensional requirements shall be termed as defective. The lot shall be considered as conforming to the dimensional requirements if no defective is found in the sample, and shall be rejected if the number of defectives is greater than or equal to the first rejection number. If the number of defectives is less than the first rejection number, the second sample of the same size as taken in the first stage shall be selected from the lot at random and subjected to the dimensional requirements. The number of defectives in the first sample and the second sample shall be combined and if the combined number of defectives is less than the second rejection number, the lot shall be considered as conforming to the dimensional requirements; otherwise not.

(Continued from page 2)

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TO

IS:10505-1983 CODE OF PRACTICE FOR CONSTRUCTION OF FLOORS AND ROOFS USING PRECAST CONCRETE WAFFLE UNITS

(Page 5, clause 4.4) - Add the following sentence at the end of the clause:

'Guidelines for design of floors/roofs using waffle units is given at Appendix B.'

(Page 9, Appendix A) - Add the following new Appendix B after A-2.1:

APPENDIX B
(Clause 4.4)

GUIDELINES FOR DESIGN OF FLOORS/ROOFS
USING WAFFLE UNITS

B-1. LOADS AND FORCES

B-1.1 Loads and forces shall be taken in accordance with clause 17 of IS:456-1978*. In addition, slab should be checked for incidental concentrated load which is likely to occur during the construction.

B-2. ANALYSIS OF FLOORS/ROOFS

B-2.1 The floor/roof with waffle units up to a span of 6 metres having ribs of width not less than 100 mm (excluding thickness of precast waffle ribs) spaced at not more than 750 mm may be analysed as solid slab spanning in two directions at right angles in accordance with 23.4 of IS:456-1978* or as flat slab in accordance with 30 of IS:456-1978*.

*Code of practice for plain and reinforced concrete (third revision).

B-2.2 The floor/roof with waffle units having span of more than 6 m and a 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.

NOTE - When the span of waffle unit is more than 750 mm, the structural design of the unit should be made .

B-3. CONTROL OF DEFLECTION

B-3.1 If the system is analysed as per B-2.1, the deflection shall be restricted in accordance with 23 of IS:456-1978* and the depth of rib of the unit shall be considered as depth of slab.

B-3.2 If the system is analysed as per B-2.2, the deflection should be restricted in accordance with 22.1, 22.2 and 23 of IS:456-1978*.

B-4. DETAILING OF REINFORCEMENT

B-4.1 Shear stress in the ribs shall be calculated as per IS:456-1978*.

B-4.2 Detailing of the reinforcement shall be done in accordance with clause 25 of IS:456-1978*.

*Code of practice for plain and reinforced concrete
(third revision).

(BDC 32)