भारतीय मानक

छत बनाने के लिए पूर्व ढली प्रबलित काँक्रीट एल-पैनल — विशिष्टि

Indian Standard

PRECAST REINFORCED CONCRETE L-PENEL FOR ROOFING — SPECIFICATION

UDC 691·328-413 : 692·4

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

April 1995

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. The 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 group.

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 the series of standards on new materials and techniques of roof/floor construction which when implemented is 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) Design and construction of roofs using precast reinforced concrete L-panel — Code of practice
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 concrete channel units — Code of practice
f) Precast reinforced conerete planks and joists for roofing and flooring — Specification
g) Design and construction of floor and roof with precast reinforced concrete planks and joists — Code of practice
h) Construction of walls precast using concrete stone masonry blocks — Code of practice

Prefabricated reinforced concrete L-panel can be used for construction of sloping roofs in place of conventional roofings. It mainly consists of a full span reinforced concrete L-shapes component thereby combining sheeting, purlins and battens of a conventional sloping roof into a monolithically composed component fulfilling the functions of all these separate components. The panel acts as L-beam having wide flange for resisting flexural compressive stress and hence resulting in an efficient use of material thereby leading to considerable saving in material and overall cost. Additional advantages of L-panel are its durability, aesthetic presence and its reusability to suit temporary constructions.

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

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

PRECAST REINFORCED CONCRETE L-PANEL FOR ROOFING — SPECIFICATION

1 SCOPE

This standard lays down requirements for prefabricated reinforced concrete L-panels used for making roofs for buildings. This standard also covers the requirements for prefabricated reinforced concrete channel units which are to be used along with L-panels in the roof construction.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
432 (Part 1) : 1982	Mild steel and medium tensile steel bars hard-drawn steel wire for concrete reinforcement: Part 1 Mild steel bars (*third revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
1786 : 1985	Specification for high strength deformed steel bars and wires for concrete reinforcement (*third revision*)
2645 : 1975	Specification for integral cement water proofing compounds (*first revision*)
4905 : 1968	Methods for random sampling
14242 : 1995	Design and construction of roofs using precast reinforced concrete L-panels — Code of practice

3 MATERIALS

3.1 Concrete

Concrete used for making L-panel shall conform to grade M-15 or for higher rainfall area or corrosive atmosphere, grade M-20 of IS 456 : 1978. Raw materials used for making concrete shall conform to the requirements of IS 456 : 1978. Impermeability of concrete shall be ensured, in addition to strength. While designing the mix or otherwise choosing the proportions, recommendations of Table 1 should be considered.

3.2 Steel

Mild steel conforming to grade I to IS 432 (Part 1) : 1982, high strength deformed bars conforming to IS 1786 : 1985 or other steels as recommended in IS 456 : 1978 shall be used.

4 SHAPE AND DIMENSIONS

4.1 Shape

The precast L-panel units shall have a cross-section of 'L' shape with end bearing of 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 the overall width of L-panel to provide an overlapping of 80-150 mm depending upon climatic conditions (*see* Fig. 1).

4.1.1 *Channel Units*

Units having a cross-section of channel shape shall also be produced in required numbers, to be used at the eaves in a verandah or for achieving aesthetic effect (*see* Fig.1).

4.2 Dimensions

4.2.1 *Length*

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

4.2.2 *Width*

4.2.2.1 Width also varies depending upon the span and is so chosen as to give maximum overall economy. A guidance may be taken for choosing the width from Table 2. Also, keeping in view the need for modular (dimensional) co-ordination, final value of width and the number of L-panels required to cover the room of given dimensions may be calculated by using the approximate formula given below for a moderate size of room.

$$B_r + 2p = N(B - b - 2) + \frac{D}{2} + 2.b \quad \text{..... for double sloping roof}$$

$$B_r + 2p = N(B - b - 2) + \frac{D}{4} + b \quad \text{... for single slope roof over two vertical walls with outer projection on both sides}$$

$$B_r + p = N(B - b - 2) + \frac{D}{4} + b \quad \text{.....for single slope roof adjoining a vertical wall (with outer projection on one side only)}$$

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-panels, in cm;

b = Overlap of L-panel; and

D = Depth of L-panel, in cm.

Table 1 Utility and Climatic Factors for Design

(*Clauses* 3.1 *and* 4.2.2.2)

Sl No.	Deciding Factor		Minimum Specifications					
	Type of Building Utility	Climates	Slope of Gable Wall (tan θ)	Overlap Between Panels (cm)	Thickness of Flange (cm)	Grade of Concrete (M)	Admixtures in Concrete	Other Treatments Recommended
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	School buildings, sheds, garage, etc	Very low rainfall area	1:4	8.0	3.0	15	Nil	—
ii)	School, buildings, sheds, ordinary storage, community buildings, office buildings, etc	Low rainfall area	1:4	9.0	3.0	15	Nil	
iii)	School buildings, residential buildings, ordinary shops, general stores, etc	Medium rainfall area	1:3.5	10	3.0	15	Nil	—
iv)	Important residential buidings, important shops, important storages, record rooms, etc	High rainfall area	1:3.0	12	3.5	20	D.P.C.	—
v)	Very important shops, record rooms, dry storage, etc	Very high rainfall area	1:2.5	15.0	4.0	25	D.P.C.	—
vi)	Any building	Cold and snowfalll regions	1:2	10.0	3.5	20	Nil	—
vii)	Any building at coastal area	Aggressive climates	1:3	12	3.5	20	D.P.C.	Anticorrosive treatments to reinforcement
viii)	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

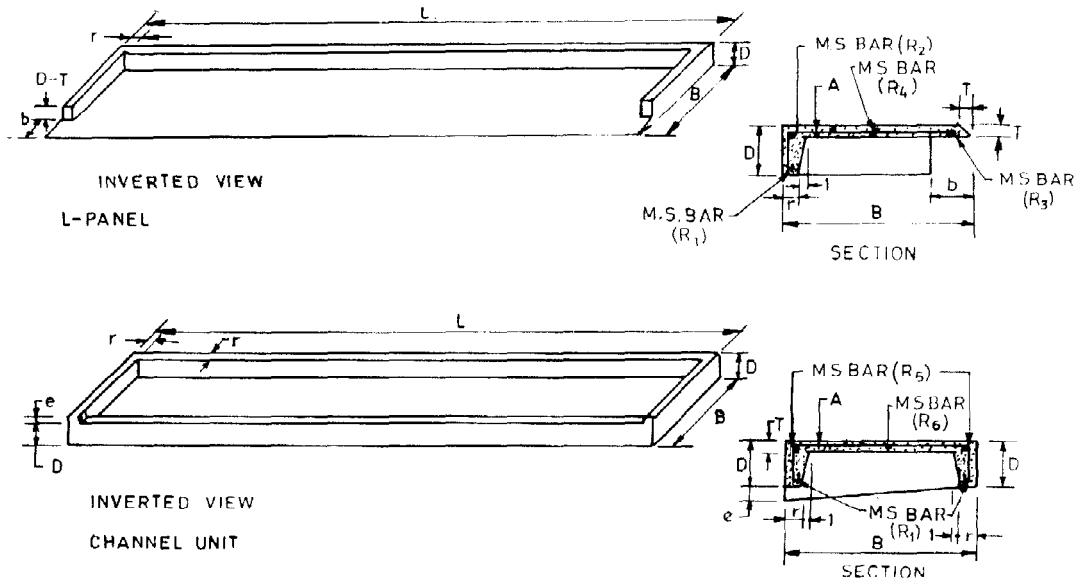
NOTE — Any one of col (2) and (3) shall be the deciding factor for the design.

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

(*Clauses* 4.2.2.1, 4.2.4, 5.1 *and* 5.2)

Sl No.	Length	Reasonable Breadth Ranges	Depth of Rib	Width of Rib	Thickness of Flange	Dead Weight	Dia of Tension Bar (*see* Fig. 1)		Diameter of Bars in Flange (*see* Fig. 1)			
	L	*B*	*D*	*r*	*T*	*Wd*	R_1	R_2	R_3	R_4	R_5	R_6
					(All dimensions in millimetres.)							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1 200	500	80	40	30	52	6	6	6	—	6	—
2	1 200	600	80	40	30	62	6	6	6	—	6	—
3	1 200	700	100	50	40	96	6	6	6	6	6	6
4	1 200	800	100	50	40	110	6	6	6	6	6	6
5	1 200	900	100	50	40	123	6	6	6	6	6	6
6	1 500	500	80	40	30	65	6	6	6	6	6	—
7	1 500	600	80	40	30	77	8	6	6	6	6	—
8	1 500	700	100	50	40	120	8	6	6	6	6	6
9	1 500	800	100	50	40	135	8	6	6	6	6	6
10	1 800	500	100	40	30	82	8	6	6	—	6	—
11	1 800	600	100	40	30	96	8	6	6	6	6	6
12	1 800	700	100	50	40	142	8	6	6	6	6	6
13	2 100	500	100	50	30	100	8	6	6	—	6	—
14	2 100	550	100	50	30	108	8	6	6	6	6	—
15	2 100	600	100	55	35	132	8	6	6	6	6	6
16	2 100	650	100	55	35	143	8	6	6	6	6	6
17	2 400	500	100	50	30	113	8	6	6	6	6	—
18	2 400	550	100	50	30	122	8	6	6	6	8	6
19	2 400	600	120	55	35	154	10	6	6	6	8	6
20	2 700	450	100	50	30	115	8	8	6	—	6	—
21	2 700	500	100	50	30	126	10	6	6	6	6	—
22	2 700	550	120	55	30	150	10	8	6	6	8	6
23	3 000	450	120	60	30	144	10	8	6	—	6	—
24	3 000	500	120	60	30	156	10	8	6	6	8	
25	3 000	550	120	60	30	158	10	8	6	6	8	6
26	3 150	500	120	60	30	163	10	8	6	6	8	6
27	3 300	400	120	60	30	145	10	8	6	—	8	—
28	3 300	450	130	60	30	164	10	8	6		8	
29	3 600	350	130	60	30	150	10	8	6	—	8	
30	3 600	400	140	65	30	174	10	10	6		8	
31	3 900	300	140	65	30	157	10	10	6	—	8	
32	3 900	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 should be for 8 mm dia and above.



L = Length of panel
B = Width of panel
b = Overlap between two panels
D = Depth of rib
T = Thickness of flange
t = Thickness of rib
r = Width of rib

FIG. 1 DETAILS OF L-PANELS AND CHANNEL UNITS

4.2.2.2 The maximum overall width of the 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 upon utility and climatic factors, Table 1 may be referred.

4.2.3 *Thickness of Flange*

A thickness of flange of 30 to 40 mm depending upon the size of units and climatic conditions should be adopted, keeping it 30 mm for overall width up to and including 700 mm and 40 mm for widths up to 900 mm.

4.2.4 *Depth and Width of Rib*

After deciding span, width and thickness of flange in accordance with **4.2.1**, **4.2.2** and **4.2.3**, the dimensions of rib shall be determined in accordance with the design procedure laid down in IS 14242 : 1995. Alternatively, the depth and width of rib may also be taken directly from Table 2. In any case, the width of rib shall be not less than those given in Table 2.

5 REINFORCEMENT

5.1 Main reinforcement required shall consist of one bar of required diameter provided at bottom of the rib of L-panel having an adequate cover. The required diameter shall be designed in accordance with IS 14242 : 1995. Alternatively, the required diameter may be taken from Table 2 which applies for reinforcement conforming to mild steel grade I of IS 432 (Part 1) : 1982 and high strength deformed bars as per IS 1786 : 1978. The detailing shall be followed in accordance with Fig. 1.

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

5.3 At the eaves over verandah where channel units are provided, the same tensile reinforcement as for L-panel shall be provided in both the ribs (the total reinforcement thus being double that of L-panel) while the overall dimensions shall be kept the same.

6 MANUFACTURE (CASTING OF PANELS) AND CHANNEL

6.1 Mould

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. 2. While designing a plastic or FRP mould warping of members should be taken care of. Appropriate clamps should be used during casting of the panel.

6.2 Casting

Outer pieces of the mould, after lubrication 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 : 1975) 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 shall be finished with a very thin (2-3 mm) cement, fine sand (1 : 3) plaster. Inner frame of the mould may be removed after about 20 minutes and the outer frame after about 30 minutes.

6.3 Curing

The panels may be moved to curing yards after 48 to 60 hours 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 at wet condition, otherwise it becomes difficult to remove once it is dried and hardened.

7 SAMPLING AND ACCEPTANCE CRITERIA

7.1 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.

7.2 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 : 1968 may be followed.

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

8 TESTS

8.1 Tests shall be conducted on samples of the units as given in Annex A.

8.2 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.

9 CRITERIA FOR CONFORMITY

9.1 If four out of the five samples of each category satisfy the dimensional requirements given in **4.2**, the lot represented by the sample shall be deemed to have passed the dimensional requirements. If more than one

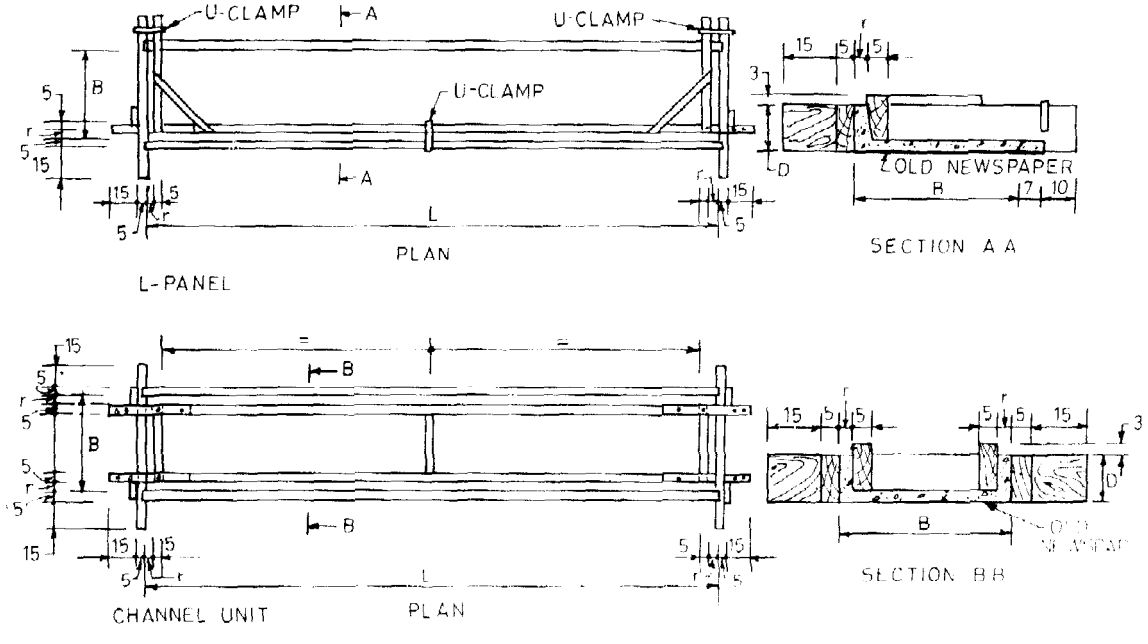


FIG. 2 DETAILS OF MOULDS FOR L-PANEL AND CHANNEL UNIT (TYPICAL SKETCH)

unit fail to satisfy the dimensional requirements given in **4.2**, the lot represented by the sample shall be rejected.

9.2 In the deflection recovery test of the assembly of components, as per Annex A, if the deflection of all the units 24 hours after the removal of the imposed load is atleast 75 percent of the deflection under the load for 24 hours, 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 hours 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.

9.3 In the failure load test as per Annex A, 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.

10 MARKING

10.1 Each component shall be legibly and indelibly marked with the following:

a) Indication of the source of the manufacture, and

b) Month and year of manufacture.

10.2 The components may also be marked with the Standard Mark.

10.2.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of the conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clauses* 8.1, 9.2 *and* 9.3)

TEST FOR PRECAST REINFORCED CONCRETE UNITS

A-1 AGE AT TESTING

The units shall be tested in assembly at an age of 28 to 33 days after casting.

A-2 DIMENSIONAL CONFORMITY

Every five sample out of 300 units or part thereof of each category shall be checked for conformity with dimensional requirements as given in **4.2**. Length of unit shall be measured with a steel tape atleast 5 m long graduated in mm division. Other dimensions shall be measured with 1 m long steel scale graduated in mm dimensions.

A-3 DEFLECTION RECOVERY TEST

A-3.1 At least three L-panels and one channel unit selected at random out of the units which have satisfied dimensional requirements as per **4.2** and **9.1** shall be subjected to deflection recovery test in assembly as a roof (*see* Fig. 3). The precast units shall be simply supported with a bearing of 75 minutes on either end of the units over masonry walls with a 6 mm thick mild steel plate fixed in slope at top of the wall. For convenience of placement of loading blocks over the flange of units, the gable wall slope shall be kept quite flat and not more than 1 : 10. After placement of L-panels and channel unit in assembly over the mild steel plates over sloped gable walls, the gap at bearing shall be filled up with 1 : 2 : 4 concrete or with suitable cement, sand and mortar. Design dead load other than due to concrete weight for the unit shall be applied uniformly over the units through loading blocks or by other means. A dial gauge having a least count of 0.02 mm or less and a range of 50 mm or more shall be fixed at midspan of each unit. The dial gauge shall be adjusted to indicate zero reading under self weight of the unit and applied dead load.

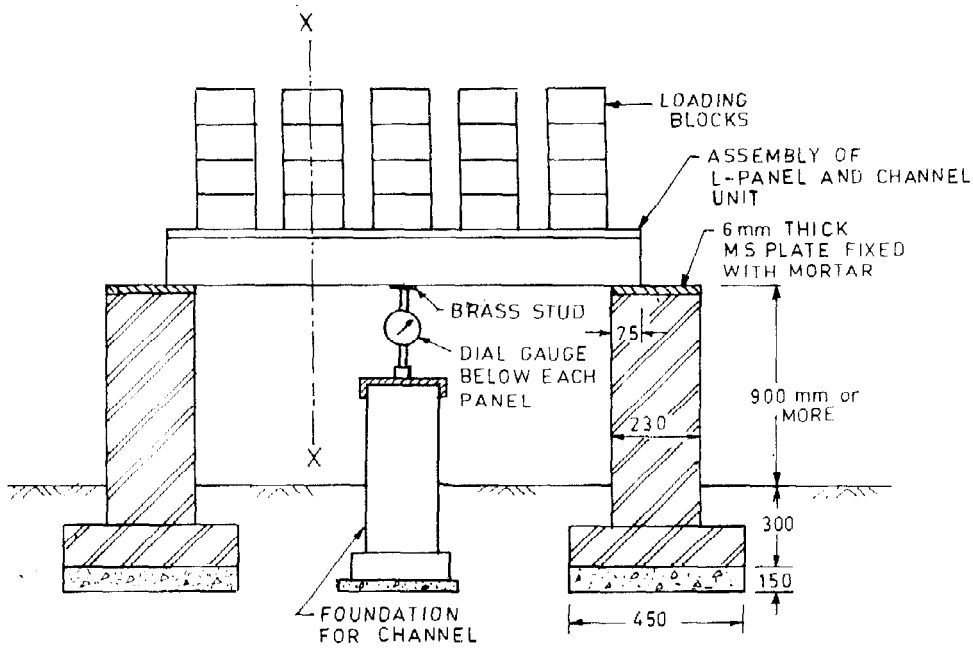
A-3.2 The units shall be subjected to a uniformly distributed load equal to 1.25 times the imposed load, that is 1.25 times the design live load applied through loading, blocks of concrete or steel. Alternatively, uniform load could be applied by hydraulic joint through a self reacting frame and a set of beams to distribute the loads. The load shall be retained for 24 hours. After recording deflection at the end of time period, the load shall be removed.

A-3.3 Twenty four hours after removal of the load, the deflection of each unit shall be recorded again.

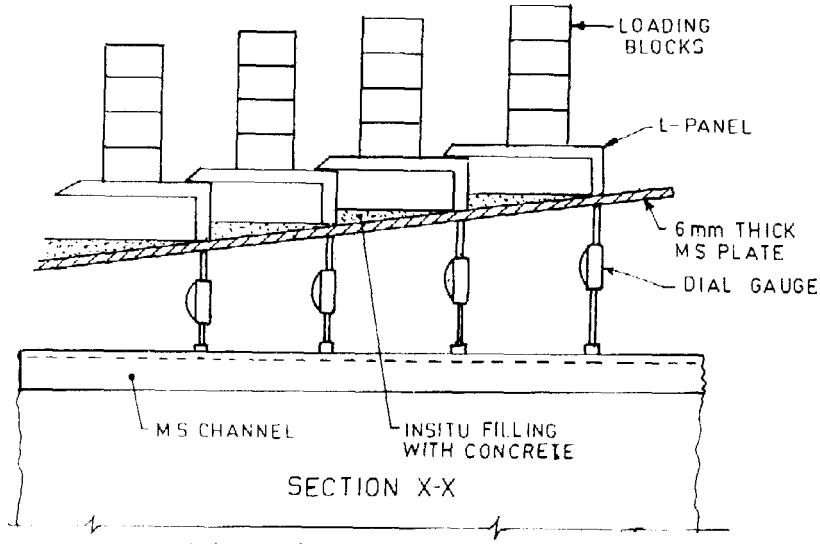
A-4 FAILURE LOAD TEST

A-4.1 The unit which have passed the deflection recovery test shall be subjected further to failure load test. Loading shall be done uniformly through loading blocks or through hydraulic jacks and a set of beams to distribute the load. If loading is done through blocks, sufficient gap shall be ensured that they do not touch each other even at the final stages of loading, to prevent transfer of load through arch action. Placement of loading blocks shall be done from an independent scaffold as a safety precaution.

A-4.2 The loading shall continue till the units fail. If no failure occurs by crushing or breaking of the unit, the load causing a deflection equal to 1 in 60 of clear span of the unit shall be considered as the failure load. To check that the limiting deflection is not exceeded, a steel marker shall be fixed below the unit at midspan, bearing a gap of 1 in 60 of clear span before the start of the test.



(A) LONGITUDINAL VIEW



(B) SECTIONAL VIEW

All dimensions in millimetres.

FIG. 3 DEFLECTION RECOVERY TEST

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Housing Sectional Committee, CED 51

Chairman	*Representing*
DR P. S. A. SUNDARAM	Ministry of Urban Development, New Delhi
Members	
SHRI G. R. AMBWANI	Municipal Corporation of Delhi, Delhi
SHRI AROMAR RAVI	The Action Research Unit, New Delhi
PROF H.P. BAHARI PROF SUBIR SAHA (*Alternate*)	School of Planning and Architect, New Delhi
SHRI K. K. BHATNAGAR SHRI M. N. JOGLEKAR (*Alternate*)	Housing and Urban Development Corporation, New Delhi
SHRI H. U. BIJLANI	In personal capacity (*1, Sadhna Enclave, Panchsheel Park, New Delhi 110017*)
SHRI S. N. CHATTERJEE	Calcutta Municipal Corporation, Calcutta
CHIEF ARCHITECT SENIOR ARCHITECT (H & TP - 1) (*Alternate*)	Central Public Works Department, New Delhi
CHIEF ENGINEER, AUTHORITY ARCHITECT, AUTHORITY (*Alternate*)	Maharashtra Housing and Area Development Authority, Bombay
CHIEF ENGINEER (D) SUPERINTENDING ENGINEER (D) (*Alternate*)	Central Public Works Department, New Delhi
ENGINEER MEMBER, DDA	Delhi Development Authority, New Delhi
SHRI Y. K. GARG SHRI CHETAN VAIDYA (*Alternate*)	National Housing Bank, New Delhi
SHRI O. P. GARYALI DR N. K. JAIN (*Alternate*)	National Council for Cement and Building Materials, New Delhi
SHRI T. N. GUPTA	Building Material and Technology Promotion Council, New Delhi
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KUMARI NINA KAPOOR	The Mud Village Society, New Delhi
SHRI A. K. M. KARIM	Housing Department, Government of Meghalaya, Shillong
SHRI K. R. S. KRISHNAN	Department of Science and Technology (DST), New Delhi
COL D. V. PADSALGIKAR	B. G. Shirke and Co, Pune
SHRI RAJA SINGH SHRI S. SELVANTHAN (*Alternate*)	IRCON, New Delhi
DR A. G. MADHAVA RAO SHRI I. K. MANI (*Alternate*)	Structural Engineering Research Centre (CSIR), Madras
SHRI T. K. SAHA SHRI R. K. MITTAL (*Alternate*)	Engineer-in-Chief's Branch, New Delhi
SHRI J. S. SHARMA SHRI B. B. GARG (*Alternate*)	Central Building Research Institute (CSIR), Roorkee
SHRI J. VENKATARAMAN, Director (Civ Engg)	Director General, BIS (*Ex-officio Member*)

Member-Secretary
SHRI J. K. PRASAD
Joint Director (Civ Engg), BIS

(*Continued on page 9*)

(*Continued from page* 8)

Panel for Modular Coordination and Prefabrication for Mass Scale Housing, CED 51 : P2

Convener	*Representing*
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Members	
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SHRI M. N. JOGLEKAR	Housing and Urban Development Corporation, New Delhi
PROF V. P. RAORI PROF P. K. CHOUDHARY (*Alternate*)	School of Planning and Architect, New Delhi
SHRI G. S. RAO	National Building Construction Corporation, New Delhi
REPRESENTATIVE	B. G. Shirke and Co, Pune
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SHRI J. S. SHARMA SHRI M. P. JAI SINGH (*Alternate*)	Central Building Research Institute, Roorkee
SUPERINTENDING ENGINEER (D) EXECUTIVE ENGINEER (HQ) (*Alternate*)	Central Public Works Department, New Delhi