# इंटरनेट मानक

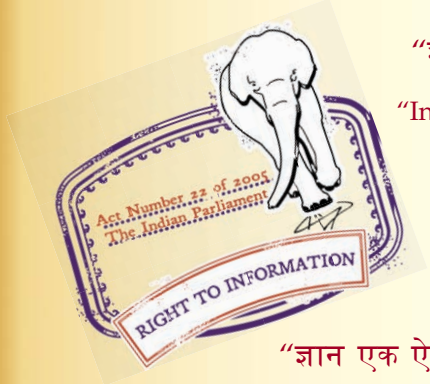
## Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 10505 (1983): Code of practice for construction of floors and roofs using precast concrete waffle units [CED 51: Planning, Housing and pre-fabricated construction]




"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"


"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE


**IS : 10505 - 1983**
Reaffirmed 2008

*Indian Standard*

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

(First Reprint SEPTEMBER 1993)

UDC 69·024/·025 : 691·327 : 006·76



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

Gr 3

*May* 1983

# *Indian Standard*

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

Prefabricated and Composite Construction Sectional Committee, BDC 32

| *Chairman* | *Representing* |
|---|---|
| SHRI A. RAMAKRISHNA | Engineering Construction Corporation Ltd, Madras |
| *Members* | |
| SHRI S. SUBRAMANIAN ( *Alternate* to Shri A. Ramakrishna ) | |
| DR N. S. BHAL | Structural Engineering Research Centre, Roorkee |
| SHRI K. C. NAITHANI ( *Alternate* ) | |
| SHRI AJYA BHARADWAJ | In personal capacity ( *207, Golf Links, New Delhi* ) |
| SHRI DAKSHA BHARADWAJ ( *Alternate* ) | |
| SHRI S. C. CHAKRABARTI | Central Building Research Institute, Roorkee |
| SHRI B. K. CHAKRABORTY | Housing and Urban Development Corporation, New Delhi |
| SHRI A. K. CHATTERJEE | Gammon India Limited, Bombay |
| SHRI A. C. ROY ( *Alternate* ) | |
| CHIEF ARCHITECT | Central Public Works Department, New Delhi |
| SENIOR ARCHITECT ( H&TP ) ( *Alternate* ) | |
| DIRECTOR ( C & MDD ) | Central Water Commission, New Delhi |
| DEPUTY DIRECTOR ( C&MDD ) ( *Alternate* ) | |
| SHRI A. GHOSHAL | In personal capacity ( *C/o M/s Stup Consultants Ltd, 12 Durga Road, Calcutta* ) |
| JOINT DIRECTOR STANDARDS ( B&S ) CB | Research, Designs and Standards Organization, ( Ministry of Railways ), Lucknow |
| DY DIRECTOR STANDARDS ( B&S ) CB ( *Alternate* ) | |
| DR A. G. MADHAVA RAO | Structural Engineering Research Centre ( CSIR ), Madras |
| SHRI G. ANNAMALAI ( *Alternate* ) | |
| SHRI G. K. MAJUMDAR | Hindustan Prefab Limited, New Delhi |
| SHRI M. KUNDU ( *Alternate* ) | |
| SHRI P. V. NAIK | Hindustan Construction Co Ltd, Bombay |
| SHRI A. G. NARWANI ( *Alternate* ) | |
| DR M. NAYAK | The Concrete Association of India, Bombay |
| SHRI P. SRINIVASAN ( *Alternate* ) | |

( *Continued on page* 2 )

( *Continued from page* 1 )

| *Members* | *Representing* |
|---|---|
| DR V. PARAMASIVAM | Indian Institute of Technology, Madras |
| SHRI B. C. PATEL | M/s M. N. Dastur & Co Pvt Ltd, Calcutta |
| SHRI SHIRISH B. PATEL | Shirish Patel & Associates, Bombay |
| SHRI P. H. SRINIVASACHAR ( *Alternate* ) | |
| DR N. RAGHAVENDRA | Cement Research Institute of India, New Delhi |
| SHRI H. K. JULKA ( *Alternate* ) | |
| PROF C. K. RAMESH | Indian Institute of Technology, Bombay |
| SHRI P. RAY CHOWDHRY | Central Road Research Institute, New Delhi |
| SHRI A. K. GARG ( *Alternate* ) | |
| REPRESENTATIVE | Ministry of Defence, Engineer-in-Chief's Branch |
| LT-COL A. C. MOHAN ( *Alternate* ) | |
| SHRI P. V. SHAH | Shah Construction Co Ltd, Bombay |
| SHRI K. S. SRINIVASAN | National Buildings Organization, New Delhi |
| SHRI SUNIL BERY ( *Alternate* ) | |
| DR R. C. SONPAL | The Institution of Engineers ( India ), Calcutta |
| SHRI H. N. SUBBA RAO | Hindustan Steelworks Construction Ltd, Calcutta |
| SHRI S. N. ADHIKARI ( *Alternate* ) | |
| SHRI M. C. TANDON | STUP Consultants Ltd, Bombay |
| SHRI K. VEERARAGHAVACHARY | Bharat Heavy Electricals Ltd, Ranipet |
| SHRI G. VENKATESULU | Ministry of Shipping and Transport, New Delhi |
| SHRI S. SEETHARAM ( *Alternate* ) | |
| SHRI G. RAMAN, Director ( Civ Engg ) | Director General, ISI ( *Ex-officio Member* ) |

*Secretary*

SHRI A. K. AVASTHY
Assistant Director ( Civ Engg ), ISI

## The Prefabrication System Subcommittee, BDC 32 : 1

| | |
|---|---|
| *Convener* | |
| SHRI G. K. MAJUMDAR | Hindustan Prefab Limited, New Delhi |
| *Members* | |
| SHRI M. KUNDU ( *Alternate* to Shri G. K. Majumdar ) | |
| SHRI P. S. AMBIKE | City and Industrial Development Corporation of Maharashtra Ltd, Bombay |
| SHRI R. M. DESHPANDE ( *Alternate* ) | |
| SHRI AJYA BHARADWAJ | In personal capacity ( *207, Golf Links, New Delhi* ) |
| SHRI S. N. CHANDA | Metallurgical & Engineering Consultants ( India ) Ltd, Ranchi |
| SHRI S. PASUPATHY ( *Alternate* ) | |
| SHRI N. K. GUPTA | Engineers India Limited, New Delhi |
| SHRI P. C. JAIN | Ministry of Defence, Engineer-in-Chief's Branch |
| SHRI DINESH SIKAND ( *Alternate* ) | |

( *Continued on page* 10 )

AMENDMENT NO. 1 MARCH 1986

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 accordan with 23.4 of IS:456-1978* or as flat slab in accordanc with 30 of IS:456-1978*.

*Code of practice for plain and reinforced concre (*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*).

# *Indian Standard*

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

## 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.

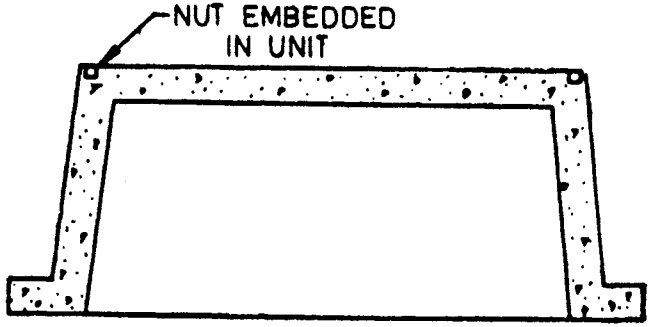



FIG. 1 TYPICAL SQUARE WAFFLE SLAB UNIT

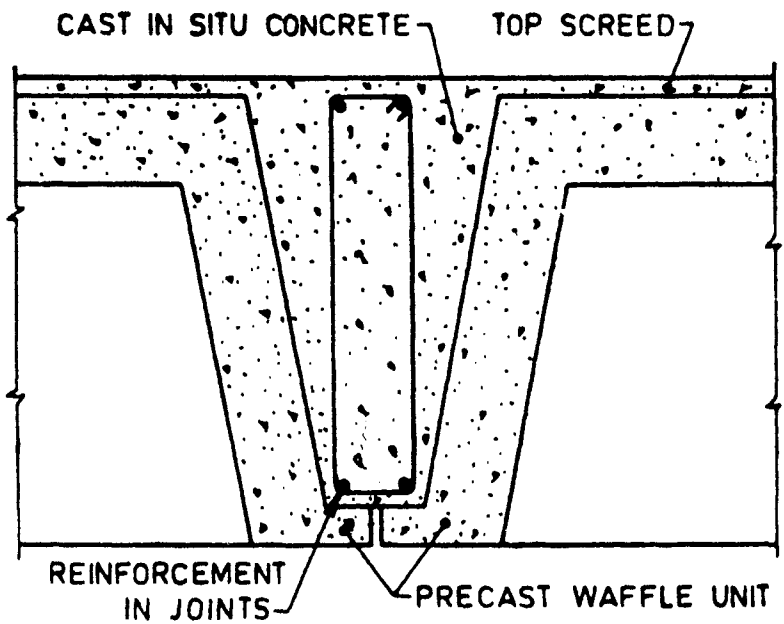



FIG. 2 TYPICAL SECTION OF FLOOR USING WAFFLE UNITS

**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 — $\pm$ 5 mm or $\pm$ 0·1 percent whichever is greater, and

b) Thickness — $\pm$ 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.

# APPENDIX 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 fo 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 )

| *Members* | *Representing* |
|---|---|
| SHRI MAHENDRA RAJ | Engineering Consultants ( India ), New Delhi |
| SHRI M. P. JAI SINGH | Central Building Research Institute, Roorkee |
| SHRI N. N. BHISE ( *Alternate* ) | |
| SHRI G. M. MANDALIA | Indian Institute of Architects, Bombay |
| SHRI S. NAHAROY | Engineering Construction Corporation Limited, Madras |
| SHRI G. B. SINGH ( *Alternate* I ) | |
| SHRI S. SUBRAMANIAN ( *Alternate* II ) | |
| SHRI A. NANDY | Civengers Enterprise Pvt Ltd, New Delhi |
| SHRI B. V. B. PAI | The Concrete Association of India, Bombay |
| SHRI P. SRINIVASAN ( *Alternate* ) | |
| DR N. RAGHAVENDRA | Cement Research Institute of India, New Delhi |
| SHRI H. K. JULKA ( *Alternate* ) | |
| SHRI S. RAY | Bridge and Roof Co ( India ) Ltd, Calcutta |
| SHRI ARUP KUMAR DUTTA ( *Alternate* ) | |
| SHRI L. R. SASTRI | Tamil Nadu Police Housing Corporation Ltd, Madras |
| SHRI P. CHELLAM ( *Alternate* ) | |
| SHRI P. V. SHAH | Shah Construction Company, Bombay |
| SHRI B. G. SHIRKE | M/s B. G. Shirke and Co, Pune |
| SHRI D. V. KULKARNI ( *Alternate* I ) | |
| SHRI R. T. PAWAR ( *Alternate* II ) | |
| SHRI K. S. SRINIVASAN | National Buildings Organization, New Delhi |
| SHRI SUNIL BERY ( *Alternate* ) | |
| SURVEYOR OF WORKS V | Central Public Works Department, New Delhi |
| SHRI R. K. SUNDARAM ( *Alternate* ) | |
| SHRI K. VEERARAGHAVACHARY | Bharat Heavy Electricals Ltd, Ranipet |
| SHRI V. MALVIYA ( *Alternate* ) | |
| SHRI ZACHARIA GEORGE | Structural Engineering Research Centre, Madras |
| DR A. G. MADHAVA RAO ( *Alternate* ) | |

# 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 :* | | *Telephone* |
|---|---|---|
| Central | : Manak Bhavan, 9, Bahadur Shah Zafar Marg, NEW DELHI 110002 | { 331 01 31<br>{ 331 13 75 |
| * Eastern | : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054 | 37 86 62 |
| Northern | : SCO 445-446, Sector 35-C, CHANDIGARH 160036 | 53 16 40 |
| Southern | : C.I.T. Campus, IV Cross Road, MADRAS 600113 | 235 23 15 |
| † Western | : Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093 | 632 92 95 |

*Branch Offices :*

| | |
|---|---|
| 'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001 | 2 63 48 |
| ‡ Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road, BANGALORE 560058 | 39 49 55 |
| *Gangotri Complex*, 5th Floor, Bhadbhada Road, T.T. Nagar, BHOPAL 462003 | 55 40 21 |
| Plot No. 21, Satyanagar, BHUBANESHWAR 751007 | 40 36 27 |
| Kalai Kathir Building, 6/48-A Avanasi Road, COIMBATORE 641037 | 21 01 41 |
| Plot No 43, Sector 16A, Mathura Road, FARIDABAD 121001 | 8-28 88 01 |
| Savitri Complex, 116 G. T. Road, GHAZIABAD 201001 | 8-71 19 96 |
| 53/5 Ward No. 29, R.G. Barua Road, 5th By-lane, GUWAHATI 781003 | 4 11 37 |
| 5-8-56C L. N. Gupta Marg, ( Nampally Station Road ) HYDERABAD 500001 | 20 10 83 |
| R14 Yudhister Marg, C Scheme, JAIPUR 302005 | 52 13 74 |
| 117/418 B Sarvodaya Nagar, KANPUR 208005 | 21 68 76 |
| Plot No. A-9, House No. 561/63, Sindhu Nagar, Kanpur Road, LUCKNOW 226005 | 5 55 07 |
| Patliputra Industrial Estate, PATNA 800013 | 26 23 05 |
| C/o Smt. Sunita Mirakhar, 66 D/C Annexe, Gandhi Nagar, JAMMU (TAWI) 180004 | — |
| T. C. No. 14/1421, University P. O., Palayam THIRUVANANTHAPURAM 695034 | 6 21 04 |

*Inspection Offices* (With Sale Point) :

| | |
|---|---|
| Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010 | 52 51 71 |
| Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005 | 5 24 35 |

| | |
|---|---|
| *Sales Office Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, CALCUTTA | 27 99 65 |
| † Sales Office is at Novelty Chambers, Grant Road, BOMBAY | 309 65 28 |
| ‡ Sales Office is at Unity Building, Narasimharaja Square, BANGALORE | 22 39 71 |



Printed at Dee Kay Printers, New Delhi, India