IS 13158 : 1991
(Reaffirmed 1997)

भारतीय मानक

शिरोपरि पावर कर्षण और दूरसंचार लाइनों के लिए बर्तल स्पन खम्बे — विशिष्टि

Indian Standard

PRESTRESSED CONCRETE CIRCULAR SPUN POLES FOR OVERHEAD POWER, TRACTION AND TELECOMMUNICATION LINES — SPECIFICATION

UDC 621·315·668·3

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

September 1991

Price Group 4

FOREWORD

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

Prestressed concrete circular spun poles are now-a-days being used for overhead power, traction and telecommunication lines. This standard has been prepared with a view to defining design requirements, materials, manufacture and test procedure for prestressed concrete spun poles in order to encourage the manufacture and use of such poles. These poles are lighter and easy to handle than those manufactured according to IS 1678 : 1978 'Specification for prestressed concrete poles for overhead power, traction and telecommunication lines (*first revision*)'.

The composition of the 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

PRESTRESSED CONCRETE CIRCULAR SPUN POLES FOR OVERHEAD POWER, TRACTION AND TELECOMMUNICATION LINES — SPECIFICATION

1 SCOPE

1.1 This standard covers the requirements for prestressed concrete circular spun poles suitable for use in overhead power, traction and telecommunication lines. It also covers prestressed concrete circular spun poles where untensioned longitudinal reinforcement is used along with tensioned steel.

2 REFERENCES

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

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Average Permanent Load

That fraction of the working load which may be considered of long duration over a period of one year.

3.2 Load Factor

The ratio of ultimate transverse load to the transverse load at first crack.

3.3 Transverse

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of straight run, this will be normal to the run of the pole.

3.4 Transverse Load at First Crack

For design, the transverse load at first crack shall be taken as not less than the value of the working load.

3.5 Ultimate Failure

The conditions existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the prestressing tendon or permanent stretching of the steel in any part of the pole.

3.6 Ultimate Transverse Load

The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

3.7 Working Load

The maximum load in the transverse direction that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600 mm below the top with the butt end of the pole planted to the required depth as intended in the design.

4 OVERALL LENGTH OF POLES

4.1 The minimum overall length of poles shall be 6 m and subsequent lengths shall be in steps of 0·5 m.

4.2 Tolerances

The tolerance on overall length of the poles shall be ± 15 mm. The tolerance on outside diameter shall be $^{+\ 4}_{-\ 2}$ mm. Unless otherwise specified, the tolerance on uprightness of the pole shall be 0·5 percent.

4.2.1 For measurement of uprightness or straightness of prestressed concrete pole, the procedure indicated in the note below or any other satisfactory method, mutually agreed between the supplier and the purchaser, may be adopted.

NOTE — For measuring uprightness or straightness of a pole, it should be placed lengthwise on a rigid straight surface, as indicated in Fig. 1. Then, using a measuring steel scale graduated in mm, measure the distance (deviation) of pole surface from the rigid surface at several locations along the length of the pole. At least two measurements in each 1 m length of pole shall be taken. The largest value of the measured distance (deviation) shall be taken for determining uprightness.

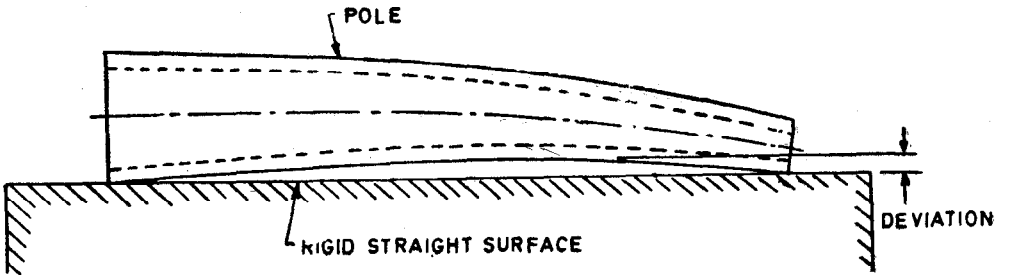

FIG. 1 MEASUREMENT OF UPRIGHTNESS OR STRAIGHTNESS OF POLE

5 MATERIALS

5.1 Cement

The cement used in the manufacture of prestressed concrete circular spun poles shall be 43 grade ordinary Portland cement conforming to IS 8112 : 1989 or 53 grade ordinary Portland cement conforming to IS 12269 : 1987.

5.1.1 As far as possible, the cement shall be obtained from one source to minimise variations in the quality. Each consignment shall be covered by a test certificate, which shall be submitted to the purchaser or inspecting officer for check. Each consignment of cement shall be stocked separately and shall be clearly identified.

5.1.2 If required by the purchaser before using a particular batch of cement, a minimum of 3 trial cubes shall be made with aggregate grading to be used for the approved design mix and the average compressive strength results at 7 days shall be determined to assess the suitability of the cement. Suitable quick testing method may be adopted with the approval of the purchaser.

5.2 Aggregates

Coarse and fine aggregates used in the manufacture of poles shall conform to IS 383 : 1970. A sample of aggregates shall be submitted by the manufacturer to the purchaser for approval, if so desired by the purchaser. The nominal maximum size of coarse aggregate shall in no case exceed 20 mm or one-fourth the minimum thickness of the pole, whichever is less.

5.2.1 The nominal maximum size of coarse aggregate shall be at least 5 mm less than the spacing between the prestressing wires.

5.3 Reinforcement

Reinforcing bars and wires used for the manufacture of prestressed concrete poles shall conform to IS 432 (Part 1) : 1982 or IS 432 (Part 2) : 1982 or IS 1786 : 1985 or IS 1785 (Part 1) : 1983 or IS 1785 (Part 2) : 1983 or IS 2090 : 1983 or IS 6003 : 1983 or IS 6006 : 1983, as the case may be.

5.3.1 The surface of all reinforcement shall be free from loose scale, oil, grease, clay or other material that may have deteriorating affect on the bond between reinforcement and the concrete. Slight rust may, however, be permitted provided there is no surface pitting visible to the naked eye.

5.4 Concrete

The design of concrete mix shall conform to the requirements laid down in IS 1343 : 1980.

5.5 Admixtures

Admixtures may be used with the approval of the purchaser. However, use of any admixture containing chlorides in any form is prohibited. The admixtures shall conform to IS 9103 : 1979.

6 DESIGN

6.1 The poles shall be so designed that they do not fail owing to failure initiated by compression of concrete.

6.2 The maximum wind pressure to be assumed for computing the design transverse load at first crack shall be as specified by the State Governments who are empowered in this behalf under the Indian Electricity Rules, 1956. In this connection, reference may be made to the 'Code of practice as regards Wind Pressures and Temperatures Variations for the Design of Overhead Power Lines', published by Central Electricity Authority. This publication gives the recommended values of wind pressures to be assumed for power lines in all the Indian States. Wind pressure may also be determined as specified in IS 875 (Part 3) : 1987.

6.3 Transverse, longitudinal and vertical loads on poles shall be designed as given in IS 802 (Part 1/ Sec 1) : 1991.

6.3.1 Broken wire condition for different types of poles as given in IS 802 (Part 1/Sec 1) : 1991 shall also be assumed in the design.

6.4 Depth of Planting

The minimum depth of planting of a pole below ground level shall be in accordance with Table 1, the actual depth being determined on the basis of ground conditions.

Table 1 Minimum Depths of Planting of Prestressed Concrete Circular Spun Poles in the Ground

(*Clause* 6.4)

Length of Poles (1) m	Minimum Depth in Ground (2) m
6·0 to 7·0	1·20
7·5 to 9·0	1·50
9·5 to 11·0	1·80
11·5 to 13·0	2·00
13·5 to 14·5	2·20
15·0 to 16·5	2·30
17·0 to 18·0	2·40
18·5 to 19·5	2·75
20·0 to 21·0	3·00

6.5 Transverse Strength at Failure

The poles shall be so designed that its strength in transverse direction shall be sufficient to take the load due to wind on wires and pole, multiplied by load factor. Where specifically stated, snow load shall also be taken into consideration.

6.5.1 The load factor on transverse strength for prestressed concrete circular spun poles shall not be less than 2·5. This factor may be reduced to a value not less than 2·0 in the case of power transmission lines by the State Governments, who are empowered in this behalf under the Indian Electricity Rules, 1956.

6.5.2 The prestressed concrete circular spun pole shall be checked for transverse cracking strength under the following condition:

a) The design transverse load at first crack shall be assumed to act at 600 mm from top;

b) The hypothetical flexural tensile stress in concrete shall not exceed the values given in IS 1343 : 1980; and

c) Untensioned steel, if provided for augmenting the ultimate strength, shall not be considered in computing the transverse strength at first crack.

6.5.3 The average permanent load on prestressed concrete circular spun poles shall be taken as 40 percent of the load at first crack.

6.5.4 The permissible design stresses for high tensile steel and for concrete in compression under the average permanent load shall be in accordance with IS 1343 : 1980. The permissible design flexural tensile stress for concrete under average permanent load may be taken as 3·0 N/mm^2.

6.6 At transfer of prestress, direct compressive stress in concrete at top section of prestressed concrete spun pole shall not exceed 0·8 times the characteristic strength of concrete at 28 days.

6.7 Poles intended to be fitted with stays or supported by struts shall be designed accordingly, and if required by the purchaser, shall be appropriately tested.

6.8 Method of selection of prestressed concrete circular spun poles in any given situation shall be as specified in IS 7321 : 1974.

7 MANUFACTURE

7.1 Moulds

7.1.1 Moulds shall be of steel and of rigid construction to prevent distortion and so arranged as to provide smooth surfaces. The moulds shall not allow any leakage of cement grout during spinning. The holes in the end plates for the H.T. wires shall be accurately drilled by jigs to ensure interchangeability. These end plates shall be designed to withstand the forces arising out of the change in direction of prestressing wires during tensioning.

7.2 Stretching of Wires

7.2.1 The prestressing wires shall be stretched by an approved method. The anchoring of the stretched wires shall be such that during manufacture and until the wires are released, no slipping occurs. The force at the time of initial stretching shall in addition to imparting of designed prestress also be sufficient to overcome the friction on account of any change in the inclination of wires and slippage that might occur during the anchoring process which will have to be suitably compensated.

7.2.2 The tensioning of prestressing steel shall be carried out in a manner that will induce a smooth and even rate of increase of stress in the wires.

7.2.3 The force induced in the prestressing wires shall be determined by means of gauges attached to the tensioning apparatus and cross checked by extension of the wires observed. The extension to be achieved shall be determined in advance, based on trials conducted on representative samples of the wires as used in the poles. The accuracy of the devices for measuring of the tensioning force shall be within ± 2 percent.

7·3 Mixing and Consolidation of Concrete

7.3.1 Provision shall be made to measure the quantities of cement and of fine and coarse aggregates by mass only. The accuracy of the measuring equipment shall be ± 3%. All the measuring equipment shall be maintained in clean, serviceable condition and its accuracy checked regularly. Modern high speed mixers, preferably pan or turbine type should be used for mixing the concrete.

7.3.2 Mixing and placing of concrete shall as far as possible be avoided during the extreme temperatures in summer and winter. The concreting shall commence within 2 hours of stressing of the wires, failing which the tensioned wires shall be checked and retensioned, if necessary.

7.3.3 The manufacture of poles shall be done under suitable cover and not in the open.

7.3.4 The concrete shall be thoroughly mixed and consolidated by means of an approved method of spinning.

7.3.5 The freshly manufactured poles shall be protected during the first stage of hardening from the harmful effects of sunshine, dry winds, cold and rains.

7.4 Detensioning of Wires

7.4.1 The anchoring system shall provide a device for gradual detensioning of the wires. No back pulling of the wires shall be permitted in the gradual detensioning device for the purpose of releases of any wedge or other parts of the detensioning device. Flame cutting of the wires before release of the full tension shall be prohibited.

7.4.2 The transfer of prestress shall not be effected until the concrete in the poles has attained the necessary strength as established by tests on cubes.

7.5 Curing

The concrete shall be covered with a layer of sacking, canvas, hessian or similar absorbent material and kept constantly wet up to the time of transfer of prestress. If desired by the manufacturer, steam curing at atmospheric pressure may be done till transfer of prestress. Prior approval of purchaser shall be obtained for the process and details such as temperature, duration, etc, for the steam curing cycle. After detensioning, the poles shall be cured for a further period of not less than 14 days by submerging in water tanks. Alternatively, the poles may be cured by submerging them in water tanks for a period of 7 days followed by curing for a further period of 7 days with mechanical water spraying arrangements which shall be invariably carried out under cover and shall ensure full humidity conditions.

7.6 During manufacture, daily tests on concrete cubes shall be carried out till the concrete achieves the required strength at transfer. Thereafter the test on concrete shall be carried out as detailed in IS 1343 : 1980. The manufacturer shall supply, when required by the purchaser or his representative, results of compressive test conducted in accordance with IS 456 : 1978 on concrete cubes made from the concrete used for the poles. If the purchaser so desires, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with IS 456 : 1978.

7.7 Earthing

Earthing shall be provided as specified by the purchaser. The details of embedment of wire or strip or cable shall be as agreed to between the manufacturer and the purchaser.

7.8 Finish

7.8.1 Poles shall be free from surface defects including hair cracks. The surfaces of the poles in contact with the steel moulds shall be smooth and regular in shape and shall, as far as possible, be free from pores. Water retaining pockets or honeycombing formation shall not be admissible. 25 mm thick 1 : 2 cement mortar cover shall be provided on the full area of the top of pole.

7.8.2 The ends of the prestressing wires shall be cut as close to the surface of the pole as possible and in any case shall not project more than 3 mm.

7.8.3 The ends of the prestressing wires shall be given two coats of suitable anti-corrosive paints approved by the purchaser.

7.8.4 The clear cover of concrete measured from the outside of longitudinal reinforcement shall be not less than 20 mm.

7.8.5 No touching up or finishing by cement grout, etc, shall be done on the poles after it is removed from the moulds.

8 TESTING

8.1 During manufacture, tests on concrete shall be carried out as detailed in 7.6.

8.2 Transverse Strength Test

The transverse strength test of poles shall be conducted in accordance with IS 2905 : 1989. A prestressed concrete pole shall be deemed not to have passed the test if cracks wider than 0·1 mm appear at a stage prior to the application of the design transverse load at first crack and the observed ultimate transverse load is less than the design ultimate transverse load.

9 SAMPLING AND INSPECTION

9.1 Scale of Sampling

9.1.1 *Lot*

In a consignment, 500 spun poles or part thereof of the same length, same dimensions and belonging to the same batch of manufacture, shall be grouped together to constitute a lot.

9.1.2 For ascertaining the conformity of the material in the lot to the requirements of this specification, samples shall be tested from each lot separately.

9.1.3 The number of spun poles to be selected from the lot shall depend on the size of the lot and shall be according to Table 2.

Table 2 Scale of Sampling and Permissible Number of Defectives

No. of Poles in the Lot	Dimensional Requirements		Transverse Strength at First Crack	Transverse Strength, Ultimate
	Sample Size	Acceptance Number		
(1)	(2)	(3)	(4)	(5)
Up to 100	10	1	2	1
101 to 200	15	1	3	1
201 to 300	20	2	4	1
301 to 500	30	3	5	2

NOTE — The spun poles tested up to first crack may be used, provided the crack is closed after removal of the load.

9.2 Number of Tests and Criteria for Conformity

9.2.1 All the poles selected according to **9.1.3** shall be tested for overall length, cross-section and uprightness (*see* **4.2**). A pole failing to satisfy one or more of these requirements shall be considered as defective. All the poles in the lot shall be considered as conforming to these requirements if the number of defective poles found in the sample is less than or equal to the corresponding acceptance number given in col 3 of Table 2.

9.2.2 The lot having been found satisfactory according to **9.2.1** shall be further tested for transverse strength (*see* **8.2**) of the poles. For this purpose, the number of poles given in col 4 and 5 of Table 2 shall be tested. These poles may be selected from those already tested according to **9.2.1** and found satisfactory. All these poles tested for transverse strength shall satisfy the corresponding specification requirements. If one or more poles fail, twice the number of poles originally tested shall be selected from these already selected and subjected to this test. If there is no failure among these poles, the lot shall be considered to have satisfied the requirements of this test.

10 MARKING

10.1 The poles shall be clearly and indelibly marked with the following particulars either during or after the manufacture, but before testing, at a position so as to be clearly read after erection in position:

a) Month and year of manufacture;

b) Name of manufacturer or his registered trade-mark or both;

c) Serial number of the poles; and

d) Position of centre of gravity of the poles with the word 'C.G.'

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
383 : 1970	Coarse and fine aggregates from natural sources for concrete (*second revision*)
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*)
432 (Part 2) : 1982	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement : Part 2 Hard-drawn steel wire (*third revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
802 (Part 1/ Sec 1) : 1991	Code of practice for use of structural steel in overhead transmission line towers : Part 1 Materials, loads and permissible stresses, Section 1 Materials and loads (*third revision*)
875 (Part 3) : 1987	Code of practice for design loads (other than earthquake) for buildings and structures : Part 3 Wind loads (*second revision*)
1343 : 1980	Code of practices for prestressed concrete (*first revision*)
1785 (Part 1) : 1983	Plain hard-drawn steel wire for prestressed concrete : Part 1 Cold drawn stress relieved wire (*second revision*)
1785 (Part 2) : 1983	Plain hard-drawn steel wire for prestressed concrete : Part 2 As drawn wire (*first revision*)
1786 : 1985	High strength deformed steel bars and wires for concrete reinforcement (*third revision*)

IS No.	*Title*
2090 : 1983	High tensile steel bars used in prestressed concrete (*first revision*)
2905 : 1989	Methods of test for concrete poles for overhead power and telecommunication lines
6003 : 1983	Indented wire for prestressed concrete (*first revision*)
6006 : 1983	Uncoated stress relieved strand for prestressed concrete (*first revision*)
7321 : 1974	Code of practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines
8112 : 1989	43 grade ordinary Portland cement (*first revision*)
12269 : 1987	53 grade ordinary Portland cement

ANNEX B
(*Foreword*)
COMPOSITION OF THE TECHNICAL COMMITTEE

Cement and Concrete Sectional Committee, CED 2

Chairman	*Representing*
DR H. C. VISVESVARAYA	In personal capacity (*University of Roorkee, Roorkee 247667*)
Members	
SHRI B. R. BHARTIKAR SHRI U. N. RATH (*Alternate*)	B. G. Shirke & Co, Pune
SHRI H. BHATTACHARYA	Orissa Cement Limited, New Delhi
DR A. K. CHATTERJEE SHRI S. H. SUBRAMANIAN (*Alternate*)	The Associated Cement Companies Ltd, Bombay
CHIEF ENGINEER (DESIGNS) SUPERINTENDING ENGINEER (S & S) (*Alternate*)	Central Public Works Department, New Delhi
CHIEF ENGINEER, NAVAGAM DAM SUPERINTENDING ENGINEER, QCC (*Alternate*)	Sardar Sarovar Narmada Nigam Ltd, Gandhinagar
CHIEF ENGINEER (RESEARCH-CUM-DIRECTOR) RESEARCH OFFICER (CONCRETE TECHNOLOGY) (*Alternate*)	Irrigation and Power Research Institute, Amritsar
DIRECTOR JOINT DIRECTOR (*Alternate*)	A. P. Engineering Research Laboratories, Hyderabad
DIRECTOR (CMDD) (N & W) DEPUTY DIRECTOR (CMDD) (NW & S) (*Alternate*)	Central Water Commission, New Delhi
SHRI K. H. GANGWAL SHRI V. RATTABHI (*Alternate*)	Hyderabad Industries Limited, Hyderabad
SHRI V. K. GHANEKAR	Structural Engineering Research Centre (CSIR), Ghaziabad
SHRI S. GOPINATH SHRI R. TAMILAKARAN (*Alternate*)	The India Cements Limited, Madras
SHRI S. K. GUHA THAKURTA SHRI S. P. SHANKARANARAYANAN (*Alternate*)	Gannon Dunkerley & Company Limited, Bombay
DR IRSHAD MASOOD DR MD KHALID (*Alternate*)	Central Building Research Institute (CSIR), Roorkee
JOINT DIRECTOR, STANDARDS (B & S) (CB-I) JOINT DIRECTOR STANDARDS (B & S)/ (CB-II) (*Alternate*)	Research, Designs and Standards Organization (Ministry of Railways), Lucknow
SHRI N. G. JOSHI SHRI P. D. KELKAR (*Alternate*)	Indian Hume Pipes Co Limited, Bombay
SHRI D. K. KANUNGO SHRI B. R. MEENA (*Alternate*)	National Test House, Calcutta
SHRI P. KRISHNAMURTHY SHRI S. CHAKRAVARTHY (*Alternate*)	Larsen and Toubro Limited, Bombay
SHRI G. K. MAJUMDAR SHRI S. O. RANGARI (*Alternate*)	Hospital Services Consultancy Corporation (India) Ltd, New Delhi
SHRI P. N. MEHTA SHRI J. S. SANGANERIA (*Alternate*)	Geological Survey of India, Calcutta
MEMBER SECRETARY DIRECTOR (CIVIL) (*Alternate*)	Central Board of Irrigation and Power, New Delhi
SHRI M. K. MUKHERJEE SHRI M. K. GHOSH (*Alternate*)	Roads Wing Department of Surface Transport (Ministry of Transport), New Delhi
SHRI NIRMAL SINGH SHRI S. S. MIGLANI (*Alternate*)	Development Commissioner for Cement Industry (Ministry of Industry)
SHRI R. C. PARATE LT-COL R. K. SINGH (*Alternate*)	Engineer-in-Chief's Branch, Army Headquarters

Members	*Representing*
SHRI H. S. PASRICHA	Hindustan Prefab Ltd, New Delhi
SHRI Y. R. PHULL SHRI S. S. SEEHRA (*Alternate*)	Central Road Research Institute (CSIR), New Delhi
SHRI Y. R. PHULL SHRI K. B. THANDEVAN (*Alternate*)	Indian Roads Congress, New Delhi
DR C. RAJKUMAR DR S. C. AHLUWALIA (*Alternate*)	National Council for Cement and Building Materials, New Delhi
DR M. RAMAIAH DR A. G. MADHAVA RAO (*Alternate*)	Structural Engineering Research Centre (CSIR), Madras
SHRI G. RAMDAS	Directorate General of Supplies and Disposals, New Delhi
REPRESENTATIVE	Builders Association of India, Bombay
SHRI A. U. RIJHSINGHANI SHRI C. S. SHARMA (*Alternate*)	Cement Corporation of India, New Delhi
SHRI J. SEN GUPTA SHRI A. K. LAL (*Alternate*)	National Buildings Organization, New Delhi
SHRI T. N. SUBBA RAO SHRI S. A. REDDI (*Alternate*)	Gammon India Limited, Bombay
SUPT. ENGINEER (DESIGNS) EXECUTIVE ENGINEER (S.M.R. DIVISION) (*Alternate*)	Public Works Department, Government of Tamil Nadu
SHRI S. B. SURI SHRI N. CHANDRASEKARAN (*Alternate*)	Central Soil and Materials Research Station, New Delhi
DR H. C. VISVESVARAYA SHRI D. C. CHATURVEDI (*Alternate*)	The Institution of Engineers (India), Calcutta
SHRI G. RAMAN, Director (Civil Engg)	Director General, BIS (*Ex-officio Member*)

Secretary
SHRI N. C. BANDYOPADHYAY
Joint Director (Civil Engg), BIS

Concrete Poles Subcommittee, CED 2 : 12

Convener	
DR N. RAGHAVENDRA	National Council for Cement and Building Materials, New Delhi
Members	
SHRI J. L. BANDYOPADHYAY SHRI V. V. SURYA RAO (*Alternate*)	Indian Posts and Telegraphs Department, Jabalpur
SHRI S. N. BASU SHRI S. M. MUNJAL (*Alternate*)	Directorate General of Supplies and Disposals
SHRI R. S. BHATIA SHRI S. K. SHARMA (*Alternate*)	Punjab State Electricity Board, Patiala
SHRI P. C. CHATTERJEE SHRI U. N. RATH (*Alternate*)	Orissa Cement Limited, Rajgangpur
DIRECTOR (RE) DEPUTY DIRECTOR (RE) (*Alternate*)	Central Electricity Authority, Rural Electrification Directorate
SHRI G. L. DUA SHRI P. D. GAIKWAD (*Alternate*)	Rural Electrification Corporation Ltd, New Delhi
JOINT DIRECTOR STANDARDS (B & S) CB-II DEPUTY DIRECTOR (CIVIL II) (*Alternate*)	Research, Designs and Standards Organization, Lucknow
SHRI N. G. JOSHI	The Indian Hume Pipe Co Ltd, Bombay
SHRI S. K. NAITHANI SHRI SUBASH GARG (*Alternate*)	Engineer-in-Chief's Branch, Army Headquarters, New Delhi
SHRI M. S. PASRICHA SHRI A. K. CHADHA (*Alternate*)	Hindustan Prefab Ltd, New Delhi
DR C. RAJKUMAR	National Council for Cement and Building Materials, New Delhi
SHRI C. B. RUNWAL SHRI R. B. JOSHI (*Alternate*)	Maharashtra State Electricity Board, Bombay
SHRI R. SAMPATKUMARAM SHRI RAMESH CHANDER (*Alternate*)	Delhi Electric Supply Undertaking, New Delhi
SHRI A. V. TALATI SHRI H. C. SHAH (*Alternate*)	The Steelpipe & Fabrication Works, Vadodara
SHRI S. THEAGARAJAN SHRI LAKSHMINARASIMHAN (*Alternate*)	Tamilnadu Electricity Board, Madras
PROF P. C. VARGHESE SHRI K. GEORGE (*Alternate*)	Concrete Products & Construction Co, Poomamallee (TN)
DR B. VENKATESWARLU	Structural Engineering Research Centre, Madras

Standard Mark

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 Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No. CED 2 (4111)

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 :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	{311 01 31 {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 38 43
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	6 32 92 95

Branches : AHMADABAD, BANGALORE, BHOPAL, BHUBANESHWAR, COIMBATORE, FARIDABAD, GHAZIABAD, GUWAHATI, HYDERABAD, JAIPUR, KANPUR, PATNA, THIRUVANANTHAPURAM.

Printed at Printwell Printers, Aligarh, India