IS 1678 (1998): Prestressed concrete poles for overhead power, traction and telecommunication lines - [CED 53: Cement Matrix Products]

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*भारतीय मानक*

# शिरोपरि पावर और दूर संचार लाइनों के लिए पूर्व प्रतिबलित कॉंक्रीट के खम्बे – विशिष्टि

*( दूसरा पुनरीक्षण )*

*Indian Standard*

# PRESTRESSED CONCRETE POLES FOR OVERHEAD POWER TRACTION AND TELECOMMUNICATION LINES — SPECIFICATION

*( Second Revision )*

ICS 91.100.30



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

*March* 1998 **Price Group 5**

FOREWORD

This Indian Standard ( Second Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement Matrix Products Sectional Committee had been approved by the Civil Engineering Division Council.

This specification has been prepared with a view to clarifying and defining design requirements for different types of prestressed concrete poles used in overhead electric power transmission, traction and telecommunication lines. This specification mainly relates to prestressed concrete poles in which initial compression has been induced by one of the pretensioned systems. This specification also covers the requirements of earthing to be provided for prestressed concrete poles.

This standard was first published in 1960 and subsequently revised in 1978. The present revision incorporates the modification found necessary in the light of experience gained with the use of this standard and due to revision of various other standards referred in this standard. The major changes incorporated in this revision are modifications in respect of materials, cover and spacing of prestressed steel, sampling and inspection. In this revision, a method for measuring the uprightness of poles has also been incorporated.

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*

# PRESTRESSED CONCRETE POLES FOR OVERHEAD POWER TRACTION AND TELECOMMUNICATION LINES — SPECIFICATION

*( Second Revision )*

## 1 SCOPE

This standard covers prestressed concrete poles suitable for use in overhead power, traction and telecommunication lines.

## 2 REFERENCES

The Indian Standards listed in Annex A contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

## 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 set 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 POLE

**4.1** The minimum overall length of poles shall be 6 m and subsequent length shall be in steps of 0.5 m.

**4.2 Tolerances**

The tolerances for prestressed concrete poles shall be as under:

| | | |
|---|---|---|
| a) | Overall length of poles | ±15 mm |
| b) | Cross-sectional dimension | ± 5 mm |
| c) | Uprightness or straightness | 0.5 percent |

**4.2.1** For measurement of uprightness of straightness of prestressed concrete pole, the procedure given in **4.2.1.1** or any other satisfactory method, mutually agreed between the supplier and the purchaser may be adopted.

**4.2.1.1** For measuring uprightness or straightness of a pole, it shall be placed lengthwise (with smaller cross-section side parallel to rigid surface) on a rigid straight surface. 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. Atleast two measurements in each one metre length of the pole should be taken. The largest value of the measured distance (deviation) shall be taken for determining uprightness. Similar measurements should be taken on the pole laid with larger cross-section side parallel to the rigid surface.

## 5 MATERIALS

### 5.1 Cement

The cement used in the manufacture of prestressed concrete poles shall be any of the following:

a) Portland slag cement conforming to IS 455 but with not more than 50 percent slag content,

b) Rapid hardening Portland cement conforming to IS 8041,

c) 43 grade ordinary Portland cement conforming to IS 8112, and

d) 53 grade ordinary Portland cement conforming to IS 12269.

### 5.2 Aggregates

Aggregates used for the manufacture of reinforced concrete poles shall conform to IS 383. Where specified, a sample of the aggregate shall be submitted by the manufacturer to the purchaser for approval.

### 5.3 Prestressing Steel

The prestressing steel shall be any one of the following:

a) Plain hard drawn steel wire conforming to either IS 1785 (Part 1) or IS 1785 (Part 2),

b) Cold drawn indented wire conforming to IS 6003,

c) Uncoated stress relieved strand conforming to IS 6006 or IS 14268, and

d) High tensile steel bar conforming to IS 2090.

All prestressing steel shall be free from splits, harmful scratches, surface flaws, rough, aged and imperfect edges and other defects likely to impair its use in prestressed concrete. Slight rust may be permitted provided there is no surface pitting visible to the naked eye.

### 5.4 Reinforcement

Reinforcing bars and wires shall conform to IS 432 (Part 1) or IS 432 (Part 2) or IS 1786, as the case may be.

**5.4.1** All reinforcement shall be free from loose scale, rust and coats of paint, oil, grease, clay or other material that may have deteriorating effect on the bond between the reinforcement and the concrete. Slight rust may be permitted provided there is no surface pitting visible to the naked eye.

### 5.5 Concrete

The grade of concrete shall be not less than M 40.

### 5.6 Admixture

Admixture may be used with the approval of the purchaser. However, any admixture containing chlorides in any form shall not be used. The admixture shall conform to IS 9103.

## 6 DESIGN

**6.1** The poles shall be so designed that they do not fail owing to failure initiated by compression in 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. Wind pressure may also be determined as specified in IS 875 (Part 3).

### 6.3 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 Depth of Planting of Reinforced Concrete Poles in the Ground**

| Length of Pole<br>m<br>(1) | Minimum Depth of Planting in Ground<br>m<br>(2) |
|---|---|
| 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 | 2.40 |

### 6.4 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 poles, multiplied by load factor. Where specifically stated, snow load shall also be taken into consideration.

NOTE — In this connection, reference may be made to the 'Code of practice as regards wind pressure and temperature 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.

**6.4.1** The strength of the pole in the direction of the line shall not be less than one-quarter of the strength required in the transverse direction.

**6.4.2** The load factor on transverse strength for prestressed concrete 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.

**6.4.3** The prestressed concrete pole shall be checked for transverse cracking strength under the following conditions:

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

b) The hypothetical flexural tensile strength in concrete shall not exceed the value given in IS 1343; and

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

**6.4.4** The average permanent loads on prestressed concrete poles shall be taken as 40 percent of the load at first crack.

**6.4.5** The permissible design stress for high tensile steel and for concrete in compression under the average permanent load shall be in accordance with IS 1343. The permissible design flexural tensile stress for concrete under average permanent load may be taken as 3.0 N/mm$^2$.

At transfer of prestress, direct compressive stress in concrete at top section of pretensioned concrete poles shall not exceed 0.8 times the cube strength of concrete.

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

**6.6** Method of selection of prestressed concrete pole in any given situation shall be as specified in IS 7321.

## 7 MANUFACTURE

**7.1** All reinforcement and ducts shall be accurately placed and maintained in position during manufacture. Grouping of high tensile wires may be permitted as long as the diameter of the wire is between 3 mm and 5 mm.

**7.2** For prestressed pretensioned system, all wires shall be accurately stretched with uniform prestress in each wire. Each wire or group of wires shall be anchored positively during casting. Care shall be taken to see that the anchorages do not yield before the concrete attains the necessary strengths.

**7.3** For post-tensioned poles, the relative position of wires in a cable, whether curved or straight, shall be accurately maintained by suitable means to ensure the free flow of grout.

### 7.4 Grouting

All post tensioned ducts shall be grouted using any suitable grouting technique ( *see* IS 1343 ).

### 7.5 Cover

In pre-tensioned work, the cover of concrete measured from the outside of the prestressing tendon shall be atleast 30 mm or the size of the cable or bar whichever is bigger.

### 7.6 Spacing

**7.6.1** In the case of single wire used in pretensioned system, the minimum clear spacing shall not be less than greater of the following:

a) Three times the diameter of the wire, and

b) One and one-third ($1\frac{1}{3}$) times the maximum size of aggregate used.

**7.6.2** In the case of cables or large bars, the minimum clear spacing (measured between sheath/ducts, wherever used) shall not be less than greater of the following:

a) 40 mm,

b) Maximum size of cable or bar, and

c) 5 mm plus maximum size of aggregate.

### 7.7 Welding and Lapping of Reinforcement

The high tensile steel wire or bar shall be continuous over the entire length of the tendon. Welding shall not be allowed in any cases. Jointing or coupling in the case of bars and indented or crimpted wires may be permitted provided the strength of the joint or coupling is not less than the strength of each individual bar or wire.

**7.8 Compacting**

Concrete shall be compacted by vibrating, shocking or other suitable mechanical means. Hand compaction shall not be permitted.

**7.9 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 when the strength of concrete is at least equal to the minimum strength of concrete at transfer of prestress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit; the interval should depend on the atmospheric humidity and temperature. Steam curing may also be permitted.

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. The manufacturer shall supply when required by the purchaser or his representative, results of compressive test conducted in accordance with IS 456 on concrete cubes made from the concrete used for the poles. If the purchaser so desires, the manufacturer shall supply cubes shall be tested in accordance with IS 456.

**7.10 Earthing**

Earthing shall be provided by one of the following means:

a) By having a length of 25 × 3 mm copper strip or equivalent bare copper cable or 4 mm dia galvanized iron wire embedded in concrete during manufacture and the ends of the strip or cable left projecting from the pole to a length of 50 mm at 215 mm from top and 150 mm below ground level ( *see* Fig. 1 ).

b) By providing two holes of suitable dimensions 215 mm from top and 150 mm below ground level ( *see* Fig. 1 ) to enable 25 mm × 3 mm copper strip or equivalent bare copper cable to be taken from the top hole to the bottom through the central hole.

**7.11** During manufacture, sufficient number of holes shall be provided in the poles for the attachment of cross arms and other equipment. A typical arrangement of holes shown in Fig. 1 permits the use of prestressed concrete poles in conjunction with wood, steel or reinforced or prestressed concrete cross arms.

**7.12** If desired by the purchaser, to facilitate handling of poles during transport and erection, an eyehook may be provided in every pole at 100 mm below ground level on the face of the pole so as to utilize the maximum flexural strength of the section during handling.

**8 TESTS**

**8.1** During manufacture, tests on concrete shall be carried out as detailed in **7.9**.

**8.2 Transverse Strength Test**

The transverse strength test on poles shall be conducted in accordance with IS 2905. 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 poles or a part thereof of the same overall length, same dimensions and belonging to the same batch of manufacturer shall be grouped together to consitute a lot.

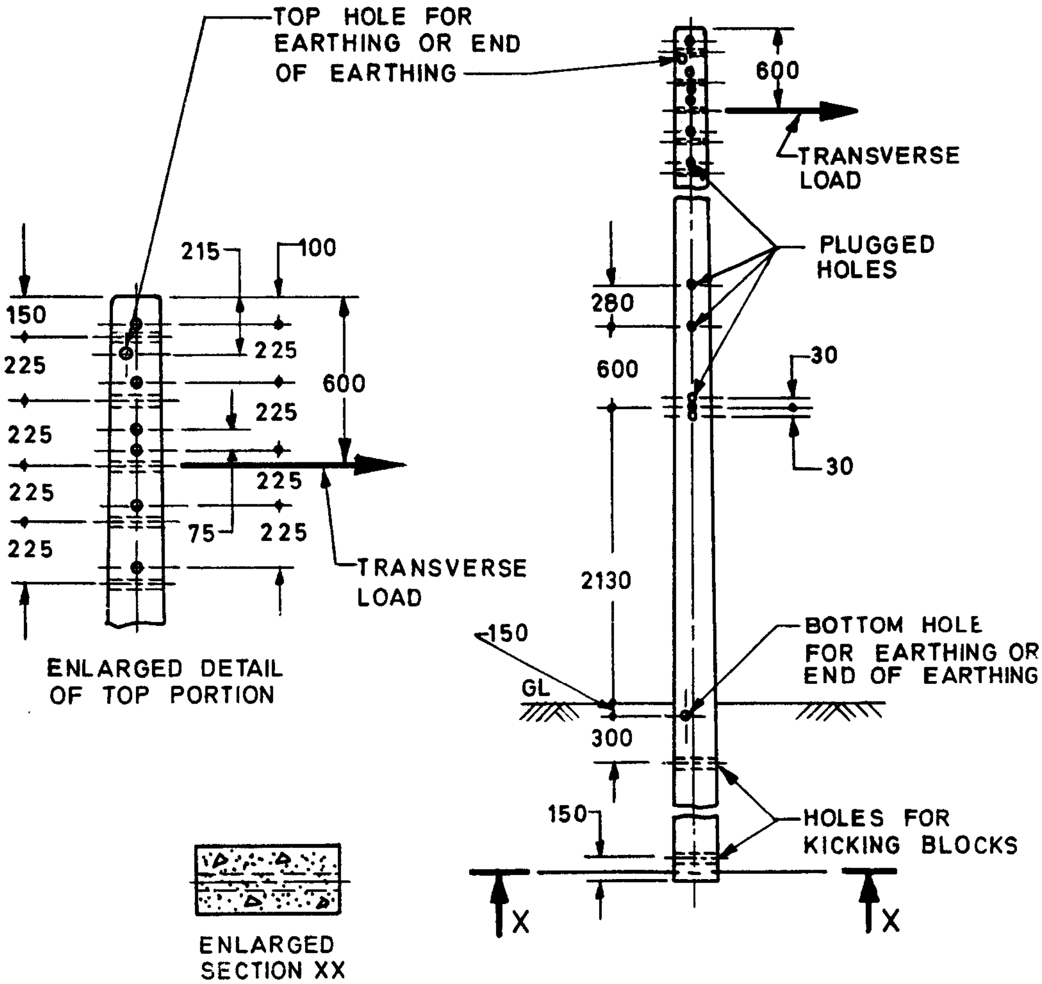
**9.1.2** For ascertaining the conformity of the materials in the lot to the requirements of this specification, samples shall be tested from each lot separately.

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

**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 of Table 2 shall be tested, these




NOTES

1 All holes except where otherwise specified shall be of 20 mm diameter.

2 For details of earthing, *see* **7.10**.

3 Plugged holes are provided for fixing danger plate and number plate. These may be plugged with hard wood or other suitable material.

All dimensions in millimetres.

FIG. 1 PROVISION OF HOLES

## Table 2 Scale of Sampling and Permissible Number of Defectives

( *Clauses* 9.1.3, 9.2.1 *and* 9.2.2 )

| No. of Poles in the Lot | Sample Size | Dimensional Requirements Acceptance Number | Transverse Strength Test | Transverse Strength Ultimate |
|---|---|---|---|---|
| (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 |

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 orginally tested shall be selected from those 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 or after the manufacture, but before testing, at a position so as to be clearly read after erection in position:

a) Indication of the source of manufacture,

b) Month and year of manufacture,

c) Serial number of the poles, and

d) Position of centre.

### 10.2 BIS Certification Marking

The product may also be marked with the Standard Mark.

**10.2.1** The use of 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 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

( *Clause* 2 )

### LIST OF REFERRED INDIAN STANDARDS

| *IS No.* | *Title* |
|---|---|
| 383 : 1970 | Specification for coarse and fine aggregates from natural sources for concrete ( *second revision*) |
| 432 | Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement |
| (Part 1) : 1982 | Mild steel and medium tensile steel bars ( *third revision* ) |
| (Part 2) : 1982 | Hard drawn steel wire ( *third revision* ) |
| 455 : 1989 | Specification for Portland slag cement ( *fourth revision* ) |
| 456 : 1978 | Code of practice for plain and reinforced concrete ( *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 practice for prestressed concrete ( *first revision* ) |
| 1785 | Specification for plain hard-drawn steel wire for prestressed concrete |
| (Part 1) : 1983 | Cold drawn stress relieved wire ( *second revision* ) |
| (Part 2) : 1983 | As drawn wire ( *first revision* ) |
| 1786 : 1985 | Specification for high strength deformed steel bars wires for concrete reinforcement ( *third revision* ) |
| 2090 : 1983 | High tensile steel bars used in prestressed concrete ( *first revision* ) |
| 2905 : 1989 | Method of test for concrete poles for overhead power and telecommunication lines ( *first revision* ) |
| 6003 : 1983 | Specification for indented wire for prestressed concrete ( *first revision* ) |
| 6006 : 1983 | Specification for 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 |
| 8041 : 1990 | Specification for rapid hardening Portland cement ( *first revision* ) |
| 8112 :1989 | Specification for 43 grade ordinary Portland cement ( *first revision* ) |
| 9103 :1979 | Specification for admixtures for concrete |
| 12269 : 1987 | Specification for 53 grade ordinary Portland cement |
| 14268 : 1995 | Uncoated stress relieved low relaxation seven-ply strand for prestressed concrete |

# ANNEX B

## ( *Foreword* )

## COMMITTEE COMPOSITION

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SHRI J. K. PRASAD
Additional Director ( Civ Engg ), BIS

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## Concrete Poles Subcommittee, CED 53 : 4

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