PRESTRESSED CEMENT CONCRETE POLES

1.0 PSC POLES

PSC poles shall be of solid rectangular type suitable for use in 33kV, 11 KV overhead power lines, LT power lines and double pole/Triple pole/four pole structures associated with the lines and Distribution substations. The poles of different length and working loads shall be as per the **Table-I**

1.1 APPLICABLE STANDARDS

Except when they conflict with specific requirements in this Specification, the PSC poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

a) IS: 1678, Specification for prestressed concrete poles for overhead power, traction and telecommunication lines.
b) IS : 2905, Method of test for concrete poles for overhead power and telecommunication lines.
c) IS: 7321, Code of Practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

1.2 TERMINOLOGY

For the purpose of this specification, following definitions shall apply:-

1.2.1 AVERAGE PERMANENT LOAD

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

1.2.2 LOAD FACTOR

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

1.2.3 TRANSVERSE

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

1.2.4 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.

1.2.5 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 600mm below the top with the butt end of the pole planted to the required depth as intended in the design.

1.2.6 ULTIMATE FAILURE

The condition 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.

1.2.7 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.

1.3 MATERIAL

1.3.1 CEMENT

The cement used in the manufacture of prestressed concrete poles shall be ordinary or rapid hardening Portland cement conforming to IS: 269 - 1976 (Specification for ordinary and low heat Portland cement) or IS : 8041 E-1978 (Specification for rapid hardening Portland cement) and Pozzolana Portland cement (fly ash based) confirming to IS 1489 Part-I .

1.3.2 AGGREGATES

Aggregates used for the manufacture of pre-stressed concrete poles shall confirm to IS : 383 (Specification for coarse and fine aggregates from natural sources for concrete). The nominal maximum size of aggregates shall in no case exceed 12 mm .

1.3.3 WATER

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

1.3.4 ADMIXTURE

Admixture should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel. The admixture shall conform to IS 9103.

1.4 PRE-STRESSING STEEL

The pre-stressing steel wires including those used as untensioned wires should conform to IS: 1785 (Part-I) (Specification for plain hard-drawn steel wire for prestressed concrete, Part-I cold drawn stress relieved wire), IS: 1785 (Part-II) (Specification for plain hard-drawn steel wire) or IS:6003 (Specification for indented wire for prestressed concrete). The type designs given in the annexure are for plain wires of 4 mm diameter with a guaranteed ultimate strength of 175 kg/mm^2 and for plain wires of 5 mm diameter with a guaranteed ultimate strength of 160 kg/mm^2.

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.

1.5 CONCRETE MIX

The concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS : 1343 - 1980 (Code of practice for prestressed concrete) and IS :

456 - 1978 (Code of practice for plain and reinforced concrete), subject to the following special conditions;

a) Minimum works cube strength at 28 days (14 days for rapid hardening cement) should be at least 420 Kg/cm2.

b) The concrete strength at transfer should be at least 210 Kg/cm2.

c) The mix should contain at least 380 Kg. of cement per cubic meter of concrete.

d) The mix should contain as low a water content as is consistent with adequate workability. If it becomes necessary to add water to increase the workability, the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

1.6 DESIGN REQUIREMENTS

The poles shall be designed for the following requirements:

a) The poles shall be planted directly in the ground with a planting depth as per IS : 1678. Wherever, planting depth is required to be increased beyond the specified limits or alternative arrangements are required to be made, on account of ground conditions e.g. water logging etc., the same shall be in the scope of the bidder at no extra cost to owner. The bidder shall furnish necessary design calculations/details of alternative arrangements in this regard.
b) The working load on the poles should correspond to those that are likely to come on the pole during their service life.
c) The factor of safety for all 9.0 Mts. and 8.0 mtr poles shall not be less than 2.5.
d) The average permanent load shall be 40% of the working load.
e) The F.O.S. against first cracking load shall be 1.0.
f) At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm2.

g) At the design value of first crack load, the modulus of rupture shall not exceed 53.0 kg/cm2 for M-40.
h) The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.
i) The maximum compressive stress in concrete at the time of transfer of pre-stress should not exceed 0.8 times the cube strength.
j) The concrete strength at transfer shall not be less than half, the 28 days (14 days for rapid hardening Portland cement) strength ensured in the design, i.e. 400 x 0.5 = 200kg/sq. cm.

1.7 DIMENSIONS AND REINFORCEMENTS

The cross-sectional dimensions and the details of pre-stressing wires should conform to the particulars given in the annexure, however number of pre stressed wire shall be calculated as per IS1678 :1998 latest and IS 1343-1980 latest reaffirmed 1999.

The provisions of holes for fixing cross-arms and other fixtures should conform to the REC specification No. 15/1979.

1.8 MANUFACTURE

1.8.1 All pre-stressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The untensioned reinforcement, as indicated in the drawings, should be held in position by the use of stirrups which should go round all the wires.

1.8.2 All wires shall be accurately stretched with uniform prestress in each wire. Each wire or a group of wires shall be anchored positively during casing. Care should be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

1.9 COVER

The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

1.10 WELDING AND LAPPING OF STEEL

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

1.11 COMPACTING

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

1.12 CURING

The concrete shall be covered with a layer of sacking, canvass, 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.

The prestressing wires shall be de-tensioned only after the concrete has attained the specified strength at transfer. The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS : 1343 (Code of practice for prestressed concrete). The manufacturer shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS : 456 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the owner so desired, the manufacturer shall supply cubes for test purposes and such cubes

shall be tested in accordance with IS : 456 (Code of practice for plain and reinforced concrete).

The detensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of detensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic.

The poles shall not be detensioned or released by cutting the prestressing wires using flames or bar croppers while the wires are still under tension.

1.13 LIFTING EYE-HOOKS OR HOLES

Separate eye-hooks or holes shall be provided for handling the transport, one each at a distance of 1/4th i.e. 0.25 times the overall length of the pole from top and 1/5th i.e. 0.20 times the overall length of the pole from bottom of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section.

1.14 HOLES FOR CROSS ARMS ETC

Sufficient number of holes shall be provided in the poles for attachment of cross arms and other equipments.

1.15 STACKING & TRANSPORTATION

Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleeper located as 0.25 times the overall length from top and 0.20 times the overall length from bottom of the pole. The timber supported in the stack should be aligned in a vertical line.

Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. Supports should be so arranged that they are located approximately at a distance equal to 0.25 times the overall length from top and 0.20 times the overall length from bottom of the pole. The erection of the pole should be carried out in such a way that the erection loads are applied so as to

cause moment with respect to the major axis, i.e. the rope used for hoisting the pole should be parallel to the broader face of the pole.

1.16 Earthing

1.16.1 Earthing shall be provided by having length of 8 SWG GI wire embedded in concrete during manufacture. This earth wire shall be terminated on M 16 bolt of 120 mm. The 50 % length of the bolt shall be embedded in concrete with head inside the pole. The shall be projected at 250 mm from top and 150 mm below ground level.

1.16.2 Earth wire shall not be allowed to come in contract with the prestressing wires.

1.17 TESTS

1.17.1 TRANSVERSE STRENGTH TEST

1.17.1.1 Poles made from ordinary Portland cement shall be tested only on the completion of 28 days and poles made from rapid hardening cement only on the completion of 14 days, after the day of manufacture.

1.17.1.2 The poles may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole, for this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

1.17.1.3 The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting

1.17.1.4 Load shall be applied at a point 600 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at first crack. The deflection at this load shall be measured.

1.17.1.5 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.

1.17.1.6 The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and held up for 2 minutes. This procedure shall be repeated until the load reaches the value of 80 per cent of the minimum ultimate transverse load and thereafter increased by 5 per

cent of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to prestressed concrete pole at the point of failure shall be measured to the nearest five Kilograms.

1.17.1.7 The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

1.18 MEASUREMENT OF COVER

1.18.1 After completion of the transverse strength test, the sample pole shall be taken and checked for cover. The cover of the pole shall be measured at 3 points, one within 1.8 meter from the butt end of the pole, the second within 0.6 meters from the top and the third at an intermediate point and the mean value compared with the specified value.

1.18.2 The mean value of the measured cover should not differ by more than (±) 1 mm from the specified cover. The individual values should not differ by more than (±) 3 mm from the specified value.

1.18.3 If these requirements are not met, the workmanship with reference to aligning of the end plates and prestressing wires and assembly of moulds should be improved and inspection at pre-production stage tightened suitably.

1.19 SAMPLING AND INSPECTION

1.19.1 SCALE OF SAMPLING

1.19.1.1 Lot: In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

1.19.1.2 Sub-lot: If the number of poles in a lot exceed 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub-lot shall not exceed 500. The acceptance or otherwise of a sub-lot shall be determined on the basis of the performance of samples selected from it.

1.19.1.3 The number of poles to be selected from a lot or a sub-lot shall depend upon its size and shall be in accordance with Col.1 and 2 of the following table:

SAMPLE SIZE AND CRITERION FOR CONFORMITY

Size of lot or sub-lot	Dimensional Requirement		No. of poles for transverse strength test
	Sample Size	Permissible No. of defective samples	
Upto 100	10	1	*
101 to 200	15	1	3
201 to 300	20	2	4
301 to 500	30	3	5

*The number of poles to be tested shall be subject to the agreement between the owner and supplier.

1.19.1.4 These poles shall be selected at random. In order to ensure randomness, all the poles in the lot or the sub-lot may be arranged in a serial order and starting from any random pole, every r^{th} pole may be included in the sample, r being the integral part of N/n where N is the size of the lot or the sub-lot and n is the sample size.

1.20 NUMBER OF TESTS

1.20.1 All the poles as selected in 9.1.3 shall be tested for overall length, cross-section and uprightness. The tolerance shall be (±) 15 mm on overall length (±), 3 mm on cross sectional dimensions and 0.5 per cent on uprightness.

1.20.2 The number of poles to be tested for transverse strength test shall be accordance with Col. 4 of the above table. These poles may be selected from those already tested in 9.2.1

1.21 CRITERIA FOR CONFORMITY

1.21.1 A lot or sub-lot shall be considered as conforming to this specification if the conditions under 9.3.2 and 9.3.2 are satisfied.

1.21.2 The number of poles which does not satisfy the requirements of overall length, cross-section and uprightness shall not exceed the corresponding number given in Col.3 of Table in 9.1.2. If the

number of such poles exceeds the corresponding number, all poles in the lot or sub-lot shall be tested for these requirements and those not satisfying the requirements shall be rejected.

1.21.3 All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected to the test. If there is no failure among these poles, the lot or the sub-lot shall be considered to have satisfied the requirements of this test.

1.22 MARKING

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

a) Month and year of manufacture
b) Transverse strength of pole in Kg.
c) Maker's serial No. and mark.
d) Planting Depth by black ink of 50mm width all around the pole

1.23 DRAWINGS

1.23.1 The drawings submitted by the Contractor shall be approved/commented by the Owner as the case may be within thirty (30) days of receipt of drawings in Owner's design office. If the designs/drawings are commented by the Owner, the Contractor shall submit revised design/drawings duly incorporating all comments within fifteen (15) days of date of issue of comments.

1.23.2 Pole accessories drawings like name plate, danger plate, anti-climbing device etc. shall be prepared by the Contractor and submitted to the Owner in three copies alongwith one re-producable, for record. These drawings shall be prepared in A4 size only.

1.23.3 While submitting the drawings, the Contractor shall clearly indicate on each drawing Specification No., Name of the line, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.

1.23.4 The Contractor shall furnish the drawings in fifteen (15) copies to the Owner for necessary distribution within fifteen (15) days after the receipt of the approval from the Owner.

Table-I

Details of PSC pole

Height of pole (mtr)	Working load of pole (kg)	Factor of safety	Planting depth of pole (m)*
7.0	200	2.5	1.2
7.5	140		1.5
8.0	200		1.5
8.5	200		1.5
8.5	500		1.5
9.0	200		1.5
9.0	300		1.5
9.0	400		1.5
9.75	270		1.8
11	365		1.8

11	400		1.8

* Planting depth shall be clearly marked all-round the pole indelibly