IS 4091 (1979): Code of practice for design and construction of foundations for transmission line towers and poles [CED 43: Soil and Foundation Engineering]

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Indian Standard

CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF FOUNDATIONS FOR TRANSMISSION LINE TOWERS AND POLES

(First Revision)

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NEW DELHI 110002

Gr 5 July 1980

Indian Standard
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(First Revision)

Foundation Engineering Sectional Committee, BDC 43

(*Continued on page* 2)

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Indian Standard
CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF FOUNDATIONS FOR TRANSMISSION LINE TOWERS AND POLES
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0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 10 August 1979, after the draft finalized by the Foundation Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Transmission line towers and poles are subjected to large horizontal forces at the top, thereby causing overturning and/or uplifting of foundation. The design of foundations for such structures involves special problems and this standard has been prepared with a view to providing guidance to the designer. Often well foundations are used in river beds for which IS : 3955-1967* may be referred. This standard was first published in 1967. The revision has been done to bring in line with latest practice.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in this field in the country.

0.4 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†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard covers the design and construction of concrete foundations including anchor bolts grouted into rock for transmission-line towers and poles.

*Code of practice for design and construction of well foundations.

†Rules for rounding off numerical values (*revised*).

1.2 Grillage, brick and masonry footings and anchor plates are not covered in this code. The design and construction of prestressed concrete foundations are also not covered.

2. TERMINOLOGY

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

2.1 Broken Wire Conditions (BWC) — This is a condition when one or more of the wires on one side or both sides of the tower or pole are broken causing an unbalanced pull or a twisting moment on the tower or pole.

2.2 Footings — Foundations are normally constructed by making open excavations, they may have enlarged base provided either in the open excavation or by under-cutting the soil by suitable devices.

2.3 Foundations — That part of the structure which is in direct contact with soil and transmits the loads to the ground.

2.4 Highest Flood Level (HFL) — Highest flood level of a river or stream is the level of the highest flood ever recorded or the calculated level for the highest possible flood.

2.5 Low Water Level (LWL) — Low water level or a river of stream is the level of the water surface obtained generally in the dry weather.

2.6 Normal Condition (NC) — This is a condition when the wires on either side of the transmission tower are intact.

2.7 Ordinary Flood Level (OFL) — Ordinary flood level of a river or stream is the average level of a high flood which is expected to occur normally every year.

2.8 Pile (Concrete) — A particular type of cast *in-situ* or precast foundation normally provided by driving or boring, and having uniform, bulbed, tapered or corrugated section along its length.

2.9 Rock — Foundation supporting material other than soil which is possible to excavate, in the case of soft rocks with pick axe and shovels, and in case of hard rocks by special methods like blasting.

2.10 Soil, Black Cotton — Clayey soil, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement of ground. In deep deposits of these soil generally there is no appreciable ground movement due to seasonal moisture changes beyond 3·5 m [*see* IS : 2720 (Part XL)-1977*].

*Methods of test for soils: Part XL Determination of free swell index of soils.

3. NECESSARY INFORMATION

3.1 For the design and construction of foundation the following information shall be supplied:

a) Route map showing the proposed lay-out of the towers with the general topography of the country and important towns, villages, etc, in the vicinity;

b) Sections of trial borings or pits showing soil data at the site of work;

c) Details of general layout of the towers;

d) The nature, direction and magnitude of loads at the base of transmission tower both under normal condition and broken wire condition;

e) Special information, for example, prevailing wind direction, depth of frost penetration and earthquake (*see* IS : 1893-1975*);

f) A review of the performance of similar structures, if any, in the locality; and

g) Maximum deformation allowed at the base of the tower or pole.

3.2 In the case of river crossings with towers or poles located in the river bed, the following additional information shall be given:

a) A site plan showing the details of the site selected for the crossing extending at least 90 m upstream and downstream from the central line of the crossing. The plan should normally include the following:

1) The approximate outlines of the bank,

2) The direction of flow of water,

3) The alignment of the crossing and the location of the towers, and

4) The location of trial pits or borings taken in the river bed.

b) A cross section of the river at the site of the proposed crossing indicating the following:

1) The bed line up to the top of the banks and the ground line beyond the edges of the river, with levels at intervals sufficiently close to give a clear outline of marked features of the bed or ground, showing right and left bank and names of villages on each side;

*Criteria for earthquake resistant design of structures (*third revision*).

2) The nature of the surface soil in bed and banks with trial pit or bore hole sections showing the levels and nature of the various strata down to the stratum suitable for founding the towers;
3) The ordinary flood level;
4) Low water level;
5) The highest flood level and years in which it occurred. State if the flood level is effected by back water or tidal effect and, if so, give details; and
6) The estimated depth of scour or of the scour depth has been observed, the depth of scour so observed.

c) The maximum mean velocity of water current.

4. MATERIALS

4.1 Cement — This shall be ordinary or rapid-hardening Portland cement conforming to IS : 269-1976*, blast furnace slag cement conforming to IS : 455-1966†, Portland pozzolana cement conforming to IS : 1489-1976‡, supersulphated cement conforming to IS : 6909-1973§, high strength ordinary Portland cement conforming to IS : 8112-1976¶, or rapid-hardening Portland cement conforming to IS : 8041-1976||.

4.2 Steel — This shall be mild steel and medium tensile steel conforming to IS : 432 (Part I)-1966**, hard-drawn steel conforming to IS : 432 (Part II)-1966**, hot rolled mild steel, medium tensile steel and high yield strength steel conforming to IS : 1139-1966†† and cold twisted steel conforming to IS : 1786-1979‡‡.

4.3 Concrete — Materials, mixing and quality control for concrete shall in general be in accordance with IS : 456-1978§§.

*Specification for ordinary and rapid-hardening Portland cement (*revised*).

†Specification for blast furnace slag cement.

‡Specification for Portland pozzolana cement (*second revision*).

§Specification for supersulphated cement.

¶Specification for high strength ordinary Portland cement.

||Specification for rapid-hardening Portland cement.

**Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement:

Part I Mild steel and medium tensile steel bars (*second revision*).

Part II Hard-drawn steel wire (*second revision*).

††Specification for hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement (*revised*).

‡‡Specification for cold-twisted steel bars for concrete reinforcement (*second revision*).

§§Code of practice for plain and reinforced concrete (*third revision*).

5. GENERAL DESIGN CRITERIA

5.1 General Design Criteria for Footings in Soils

5.1.1 Normally the following load(s) are given at the ground levels:

a) Downward load,

b) Uplift load,

c) Horizontal thrust, and

d) Overturning moments.

5.1.2 Inclined loads shall be split up into vertical and lateral loads at the top of footings (lateral load is also sometimes called a shear).

5.1.3 The uplift loads are assumed to be resisted by the weight if the footing plus the weight of an inverted frustum of a pyramid of earth on the footing pad with sides inclined at an angle of up to 30° with the vertical.

5.1.3.1 A footing with an under-cut generally develops uplift resistance of two to three times that of an identical footing without an under-cut (*see* Fig. 1A, Fig. 1B and Fig. 1C). However, for design purpose, the 20°and 30° cone assumption shall be taken with a factor of safety of 1·00 for under-cut footing, and 1·5 for footings without an under-cut.

5.1.3.2 A 30° cone shall be taken for an average firm cohesive material.

5.1.3.3 A 20° cone shall be taken for non-cohesive materials, such as sand and gravelly soils.

5.1.3.4 For footings below water table, submerged weight of the soil shall be taken.

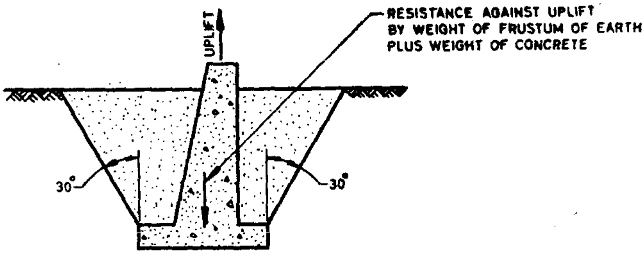
5.1.4 Alternative footing designs with or without under-cut should be provided where field investigations have not been made to determine the feasibility of under-cutting.

5.1.5 In enlarged footings without an under-cut where individual footing is not provided under each leg and where a combination of uplift loads with lateral loads occurs, the suitability should be checked by the following criteria:

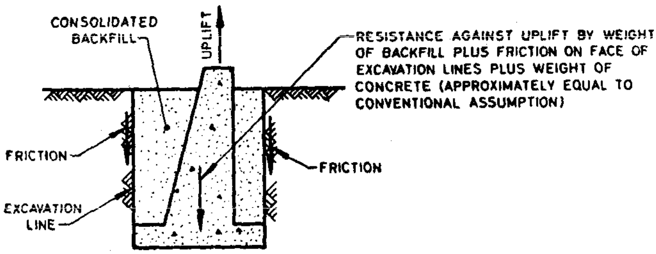
a) The resultant of forces acting vertically and laterally should act at a point in its base at a distance of one-sixth of its width from the toes;

b) The weight of the footing acting at the centre of the base; and

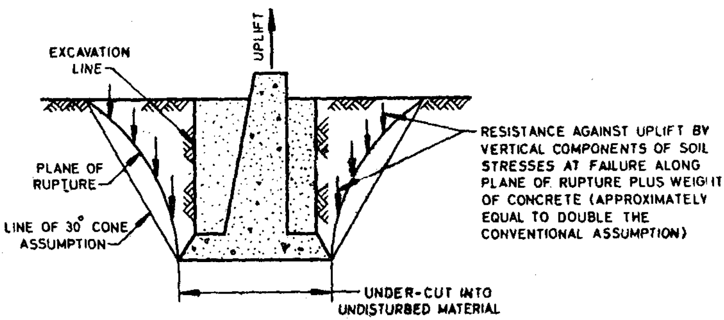
c) Mainly that part of the cone which stands over the heel causes a stabilizing moment. However, for design purposes, this may be taken equal to half the total weight of the cone of earth acting over the base. It shall be assumed to act through the tip of the heel.



1A Conventional Assumption



1B Actual Action Without Under-Cut



1C Actual Action with Under-Cut

FIG. 1 SOIL RESISTANCE TO UPLIFT

5.1.6 Depending upon the relative magnitude of upward or downward vertical loads, lateral load and overturning moment, footings in soil shall be as classified in Table 1 according to their suitability.

5.1.7 Bored piles with enlarged bases usually provide an economical type of footing in many soils where under-reaming is possible. In expansive type of soils such as black cotton soils, they have to be carried down to a depth of 3·5 m in deep layers of these soils to counteract the effect of upthrust due to swelling pressure introduced in the soil. Normal type of independent spread footing carried down to shallow depths will not be suitable in such soils.

5.1.8 Different types of piles can be used depending upon the location and in case of heavy uplift forces and moments multiple under-reamed piles or anchors may be used. In case of loose to medium sandy soils bored compaction under-reamed piles may be used.

5.1.9 The piles in uplift should be designed by the usual considerations of the friction on stem and bearings on the annular projections. A factor of safety of 3 may be applied for safe uplift.

5.1.10 The load carrying capacity of an under-reamed pile may be determined from a load test as given in IS : 2911 (Part IV) - 1979*. In the absence of actual tests, the safe loads allowed on piles under-reamed to 2·5 times the shaft diameter may be taken as given in Table 2.

5.1.10.1 The safe loads given in Table 2 apply to both medium compact sandy soils and clayey soils of medium consistency. For dense sandy ($N \geqslant 30$) and stiff clayey ($N \geqslant 8$) soils the loads may be increased by 25 percent. However, the values of lateral thrust should not be increased unless stability of top soil (strata to a depth of about three times the stem diameter) is ascertained. On the other hand a 25 percent reduction should be made in case of loose sandy ($N \leqslant 10$) and soft clayey ($N \leqslant 4$) soils.

NOTE — For determining the average 'N' values (the standard penetration test values) a weighted average shall be taken and correction for fineness under water table shall be applied where applicable.

5.1.10.2 *Load carrying capacity from soil properties*

a) In case of clayey soils the ultimate load bearing capacity of an under-reamed pile may be worked out from the following expression:

$$Q_u = A_p . N_c . C_p + A_a \, N_c \, C'_a + C'_a \, A'_s + \alpha \, C_a \, A_s$$

where

Q_u = ultimate bearing capacity of the pile, in kg;

A_p = cross-sectional area of the pile stem at toe, level in cm^2;

*Code of practice for design and construction of pile foundations: Part IV Load test on piles.

N_c = bearing capacity factor usually taken as 9;

C_p = cohesion of the soil around the toe, in kgf/cm²;

A_a = $\pi/4\ (D_u^2 - D^2)$ where D_u and D are the under-reamed bulb and the stem diameter respectively, in cm;

C'_a = average cohesion of soil around the under-reamed bulbs, in kgf/cm²;

A'_s = surface area of the cylinder circumscribing the under-reams, in cm²;

α = reduction factor (usually 0·5 for clays);

C_a = average cohesion of the soil along the pile stem, in kgf/cm²; and

A_s = surface area of the stem, in cm².

The expression given in **5.1.10.2** holds and for the usual vertical spacing between under-reamed bulbs not greater than 1·5 times the diameter of the under-reamed bulb.

b) In case of sandy soils the ultimate load carrying capacity of an under-reamed pile may also be worked out by the following expression:

$$Q_u = \frac{\pi}{4}(D_u^2 - D^2)\left[\tfrac{1}{2} D_u n \gamma N_\gamma + \gamma N_q \sum_{r=1}^{r=n} d_r\right] + \frac{\pi}{4} D^2 \left(\tfrac{1}{2} D \gamma N_\gamma + \gamma d_t N_q\right) + \tfrac{1}{2}\pi D \gamma K \tan\delta \left(d_1^2 + d_f^2 - d_n^2\right)$$

where

D_u = diameter of under-reamed bulb, in cm;

D = diameter of stem in cm;

n = number of under-reamed bulbs;

γ = average field density of soil in kg/cm³;

N_γ and N_q = bearing capacity factors depending on the angle of internal friction [for values N_γ *see* IS : 6403-1971* and N_q, *see* IS : 2911 (Part III)-1980†];

d_r = depth of the centre of different under-ream bulbs in cm;

d_t = total depth of pile in cm;

K = earth pressure constant (usually 1·75 for sandy soils);

δ = angle of wall friction;

d_1 = depth of the centre of the first under-ream bulb in cm; and

d_n = depth of the centre of last under-ream bulb in cm.

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*Code of practice for determination of allowable bearing pressure on shallow foundation.

†Code of practice for design and construction of pile foundations: Part III Under-reamed piles (*first revision*).

TABLE 1 LOADING AND FOOTING CLASSIFICATION

(*Clause* 5.1.6)

Class of Footings	Type of Loads	Type of Structure	Type of Footing Recommended	Type of Soil Reaction
(1)	(2)	(3)	(4)	(5)
A	Heavy uplift with light shear	Wide base towers or individual footing under each leg	With enlarged (under-cut) type base, or under-reamed	Weight of earth on enlarged base or pull-out resistance
B	Heavy over-turning moments with light shear and vertical loads	Poles or columns with narrow footings	a) With or without an enlarged base b) Piles	Lateral resistance or weight of cone of earth on half of the enlarged base and soil pressure on bottom of the base
C	Heavy downward load	Heavy electrical equipment mounted directly on footings	a) With enlarged base b) Under-reamed or group of piles	Allowable soil pressure on bottom of footing shaft resistance and point bearing

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TABLE 2 SAFE LOAD FOR VERTICAL UNDER-REAMED PILES IN SANDY AND CLAYEY SOILS INCLUDING BLACK COTTON SOILS

(*Clause* 5.1.10)

Diameter of Pile	Under-reamed Diameter	Reinforcement			Safe Loads									
		Longitudinal Reinforcement		Ring Spacing of 6 mm Diameter Rings	Bearing Resistance				Uplift Resistance				Lateral Thrust	
		No. of bars	Dia		Single under-reamed	Double under-reamed	Increased per 30 cm length	Decrease per 30 cm length	Single under-reamed	Double under-reamed	Increase per 30 cm length	Decrease per 30 cm length	Single under-reamed	Double under-reamed
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
cm	cm		mm	cm	t	t	t	t	t	t	t	t	t	t
20	50	3	10	18	8	12	0·9	0·7	4	6	0·65	0·55	1·0	1·2
25	62·5	4	10	22	12	18	1·15	0·9	6	9	0·85	0·70	1·5	1·8
30	75	4	12	25	16	24	1·4	1·1	8	12	1·05	0·85	2·0	2·4
37·5	94	5	12	30	24	36	1·8	1·4	12	18	1·35	1·10	3·0	3·6
40	100	6	12	30	28	42	1·9	1·5	14	21	1·45	1·15	3·4	4·0
45	112·5	7	12	30	35	52·5	2·15	1·7	17·5	25·75	1·60	1·30	4·0	4·8
50	125	9	12	30	42	63	2·4	1·9	21	31·5	1·80	1·45	4·5	5·4

NOTE 1 — The values of bearing resistance, uplift resistance and lateral thrust given in the table are for a minimum pile length of 3·5 m except in double under-reamed piles, in double under-reamed piles the minimum recommended lengths for 37·5, 40, 45 and 50 cm piles will normally be 3·75, 4·0, 4·5 and 5·0 m respectively so as to suitably accommodate the bulbs at specified distance.

NOTE 2 — Longitudinal bars should normally be provided with a clear cover of 4 cm and may be curtailed or eliminated towards the toe depending upon the stresses in pile section.

NOTE 3 — For under-reamed piles subjected to a pull and/or lateral thrust the requisite amount of steel should be provided.

NOTE 4 — Values given in col 14 and 15 for lateral thrusts may not be reduced for changes in pile lengths and are fairly conservative. Higher values may be adopted after conducting lateral load tests on single or group of piles.

NOTE 5 — In 25 and 30 cm diameter normal under-reamed piles when concreting is done by a tremie, equivalent reinforcement type of single angle iron piece placed centrally may be used.

NOTE 6 — When a pile designed for a certain safe load is found to be just short of the load required to be carried by it, an overload of 10 percent should be allowed on it.

NOTE 7 — For working out the safe load for a group of piles the safe load of individual piles is multiplied with the number of piles in the group. This would be applicable for piles taking lateral thrusts also.

NOTE 8 — Only 75 percent of the above safe loads should be taken for piles in which the bore holes are full of subsoil water during concreting. When water is confined to the bucket portion only, no such reduction need be made.

NOTE 9 — In sandy soils when boring and under-reaming for forming the piles is done under-water minimum size of pile recommended is 25 cm.

NOTE 10 — In multi-under-reamed piles the depth of the centre of upper bulb below ground level shall be kept a minimum of two times the diameter of the under-ream bulb.

NOTE 11 — The values given should be increased by 50 percent for broken wire condition in the design of transmission line tower footings.

NOTE 12 — Safe loads for multi-under-reamed piles may be worked out from the table by allowing 50 percent of the loads as per col 6 for each additional bulb. Increase in capacity due to increase in length will be as per col 8.

NOTE 13 — For taking very high loads, the pile shaft above the top most under-ream should be either increased in diameter and/or additional reinforcement provided as in short column.

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5.1.10.3 In case of piles resting on rock the bearing component will be obtained by multiplying the safe capacity of rock with the bearing area of pile stem plus the bearing provided by the under-ream portion.

5.2 Allowable Bearing Pressure — The allowable bearing pressure of the soil where the towers or poles are founded shall be based on adequate subsoil exploration and testing carried out in accordance with IS : 1888-1971*, IS : 1892-1979† and IS : 1904-1978‡.

The permissible bearing pressure so arrived may be exceeded at the edges of footings by 25 percent when variation in the intensity of the reaction caused by the transmission of moments to the footing is taken into account.

5.3 Permissible Stresses in Concrete and Reinforcement — Where stresses due to wind, temperature and shrinkage effects are combined with those due to dead, live and impact loads, stresses specified in IS : 456-1978§ for these conditions should be used in the design.

5.4 Structural Safety

5.4.1 For the structural safety against sliding, overturning and for the footings at different levels provisions laid down in IS : 1904-1978‡ shall apply.

5.4.2 The depth of footings shall conform to the provisions laid down in the relevant Indian Standards depending on the type of foundation [*see* IS : 1080-1980||, IS : 1904-1978‡, IS : 2911 (Part I/Sec 1)-1979¶, IS : 2911 (Part I/Sec 2)-1979¶ and IS : 2911 (Part I/Sec 3)-1979¶].

5.5 Footing on Rock

5.5.1 A rock footing, for uplift and horizontal loads, may be considered to develop strength by the dead load of the concrete and the strength of bar anchorage (the pull-out value of anchor bars grouted in drill holes or the failure strength of rock engaged by bars).

5.5.2 The depth of embedment of the bars below the bottom of the footing should not be less than the following:

$$D = 45\,d$$

*Method of load tests on soils (*first revision*).

†Code of practice for subsurface investigations for foundations (*first revision*).

‡Code of practice for structural safety of buildings : Shallow foundations (*second revision*).

§Code of practice for plain and reinforced concrete (*third revision*).

||Code of practice for design and construction of simple spread foundations (*first revision*).

¶Code of practice for design and construction of pile foundations, Part I Concrete piles:
Section 1 Driven cast *in-situ* piles.
Section 2 Bored cast *in-situ* piles.
Section 3 Driven precast piles.

where

D = the minimum depth of embedment in mm, and
d = diameter of anchor bar in mm.

5.5.3 The spacing of embedded bars should normally be one-half of the normal depth of embedment as given in **5.5.2**.

5.5.4 The size of the bar shall be governed by the criterion that combined stresses do not exceed the permissible limits.

5.6 Concrete Piles — In case concrete piles (other than under-reamed) the provisions of IS : 2911 (Part I/Sec 1)-1979*, IS : 2911 (Part I/Sec 2)-1979* and IS : 2911 (Part I/Sec 3)-1979* shall apply.

5.7 Special Considerations

5.7.1 *Footings in Seismic Zones* — In designing footings in seismic zones, the provisions of IS : 1893-1979† shall apply.

5.7.2 *Footings in Sulphate Bearing Clays* — Suitable precautions as laid down in IS : 1080-1962‡ shall be taken in the case of footings in sulphate bearing clays.

5.7.3 In the case of river crossing, the horizontal pressure due to forces of water current shall be considered in the design.

NOTE — Towers located in river are likely to be subjected to shock loads due to floating debris. The towers should be suitably protected against such shocks.

5.7.4 *Excavations, Drilling and Blasting* — These operations shall conform to IS : 3764-1966§, and IS : 4081-1967||.

5.7.5 In case the footings under the same tower structure happen to rest such that some of them are in soil and the rest on rock then the consideration shall be given for differential settlement and the structural safety.

5.7.6 In case of deviations in the alignment of the line, modifications should be made in the design of foundations for towers. No special provisions may be necessary for deviations up to 2°.

5.8 Concreting — Concreting shall be done in accordance with the relevant requirements given in IS : 456-1978¶.

*Code of practice for design and construction of pile foundations: Part I Concrete piles :
Section 1 Driven cast *in-situ* piles.
Section 2 Bored cast *in-situ* piles.
Section 3 Driven precast piles.

†Criteria for earthquake resistant design of structures (*third revision*).

‡Code of practice for design and construction of simple spread foundations.

§Specification for safety code for excavation work.

||Specification for safety code for blasting and related drilling operations.

¶Code of practice for plain and reinforced concrete (*third revision*).

6. STAY SETS

6.1 The stay set may be provided by burying a 30 × 30 cm and 5 mm thick mildsteel plate having a 18 × 18 mm hole in the centre through which a 16 mm diameter bolt passes.

6.2 As an alternative to the steel plate in **6.1**, cleats formed by two 30 cm long pieces of angle iron of size 50 × 50 × 15 mm buried in a concrete pad of 15 cm can also be provided.

7. POLES

7.1 The foundation for poles is provided by a certain length of the pole buried into the ground. The bearing capacity in compression is mainly derived by the skin friction on the surface of the poles and to a smaller extent by the base area. Under the action of wind the lateral loading introduces moments and lateral thrust on the foundation.

7.2 Depth of embedment of the pole for the purpose of foundation should not be less than one-sixth of the total length of the pole above ground level.

7.3 A protective collar providing a concrete cover of not less than 10 cm around the pole shall be provided. The depth of the concrete collar below the ground level should not be less then 45 cm and it should be atleast 15 cm above the ground level.

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*Eastern	: 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	36 24 99
Northern	: SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43 3 16 41
Southern	: C. I. T. Campus, MADRAS 600113	41 24 42 41 25 19 41 29 16
†Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	6 32 92 95

Branch Offices:	
'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	2 63 48 2 63 49
‡Peenya Industrial Area 1st Stage, Bangalore Tumkur Road BANGALORE 560058	38 49 55 38 49 56
Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, BHOPAL 462003	6 67 16
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
53/5, Ward No. 29, R.G. Barua Road, 5th Byelane, GUWAHATI 781003	3 31 77
5-8-56C L. N. Gupta Marg (Nampally Station Road), HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	6 34 71 6 98 32
117/418 B Sarvodaya Nagar, KANPUR 208005	21 68 76 21 82 92
Patliputra Industrial Estate, PATNA 800013	6 23 05
T.C. No. 14/1421, University P.O., Palayam TRIVANDRUM 695035	6 21 04 6 21 17

Inspection Offices (With Sale Point):	
Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	2 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

*Sales Office in Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, Calcutta 700072 — 27 68 00

†Sales Office in Bombay is at Novelty Chambers, Grant Road, Bombay 400007 — 89 65 28

‡Sales Office in Bangalore is at Unity Building, Narasimharaja Square, Bangalore 560002 — 22 36 71

Reprography Unit, BIS, New Delhi, India