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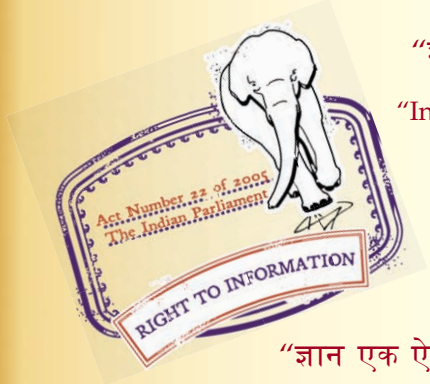

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Indian Standard
METHODS OF TESTS FOR WOOD POLES
(First Revision)

UDC 621·315·668·1 : 674·71 : 620·1

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METHODS OF TESTS FOR WOOD POLES

(First Revision)

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METHODS OF TESTS FOR WOOD POLES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 15 March 1974, after the draft finalized by the Wood Products Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 In order to use the wood poles economically, determination of allowable stresses and other characteristics of full length poles which depends on sizes, species of timber, effect of treatment, and influence of defects (like knots, checks, taper, etc) are necessary. This standard has, therefore, been formulated to cover the various methods of tests conducted on full size of wood poles.

0.2.1 This standard was first published in 1961. In this revision certain additional methods of determining static bending of poles have been added.

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

---

1. SCOPE

1.1 This standard covers the methods of testing of wood poles, required for determining the suitability of full length wood poles meant for overhead power and telecommunication lines.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definition of terms given in IS : 707-1968† shall apply.

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

†Glossary of terms applicable to timber and timber products (*first revision*).

3. CLASSES OF TESTS

3.1 All the tests required for full size of poles are divided in two categories, major tests and minor tests. The former are done on full length wood poles and the latter on small clear specimen cut from the butt portion of the pole after conducting major tests.

3.1.1 Major tests comprise the determination of following:

a) Weight of the full pole,
b) Static bending,
c) Age,
d) Rate of growth,
e) Moisture content, and
f) Sapwood percentage.

3.1.2 Minor tests comprise the determination of the following:

a) Moisture content and specific gravity,
b) Static bending,
c) Compression parallel to grain, and
d) Shear.

4. CONDITION AT TEST

4.1 The pole shall be tested under the following conditions:

a) Green condition,
b) Air dry condition,
c) Air dry and treated condition, and
d) Air-seasoned and butt soaked to the ground line for a period of time sufficient to raise the moisture content of the butt sections to a point at or close to the fibre saturation point.

4.1.1 It is recommended that, as far as possible, the poles may be tested as follows:

	Percent
a) In green condition	50
b) In air dry condition	20
c) In air dry and treated condition	20
d) With alternate wetting and drying condition	10

4.2 Storage — Test specimens and samples of poles shall be stored under cover on raised drainage to prevent deterioration by termites or wood destroying agents.

4.3 Rate of Loading — The rate of loading of the testing machine used shall not vary by more than ±25 percent from the specified calculated speed for different tests.

4.4 Calibration of Apparatus — All apparatus and testing equipment used for obtaining the data shall be calibrated periodically to ensure accuracy within 1 percent error.

5. MAJOR TESTS

5.1 Determination of Weight of the Full Pole — The weight of the pole to the nearest kilogram shall be recorded on a suitable weighing machine. If such machine is not available, then one specimen of 20 cm length from each end shall be taken after the test and weighed nearest to a kilogram and averaged for calculating the weight of the full pole.

5.2 Static Bending

5.2.1 The poles shall be tested by any one of the following methods:

a) Fixed concrete crib method,

b) Portable crib method, and

c) Machine method.

The details of the tests are described in **5.2.3** and, **5.2.4**.

5.2.2 *Initial Measurements* — Before placing the pole in the testing apparatus, a record shall be made of the following items:

a) The weight of the pole to the nearest kilogram (*see* **5.1**);

b) The length to the nearest centimetre;

c) The circumference at every 30 cm distance beginning from the top;

d) The diameter of each knot and its location on the surface of the pole relative to the butt and to the longitudinal line of the face of the pole and any other defect observed other than knots, such as cracks, checks, shakes, spiral grain, insect damage and rot, and a sketch shall be made indicating the various defects on all the faces;

e) Curvature of the pole as indicated in **8.3** of IS : 876-1970*; and

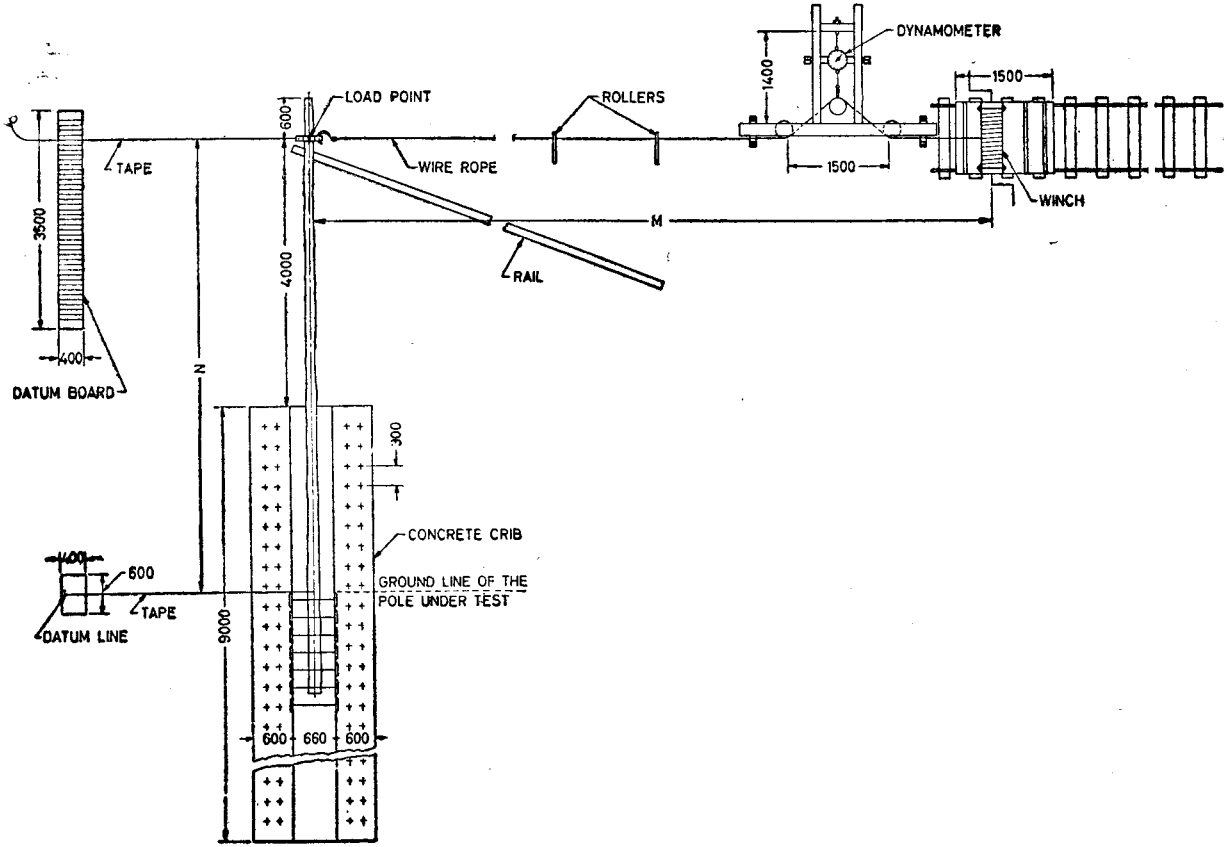
f) Temperature and humidity at the time of test.

5.2.2.1 A data sheet for this purpose is indicated in Appendix A.

5.2.3 *Fixed Concrete Crib and Portable Crib Method*

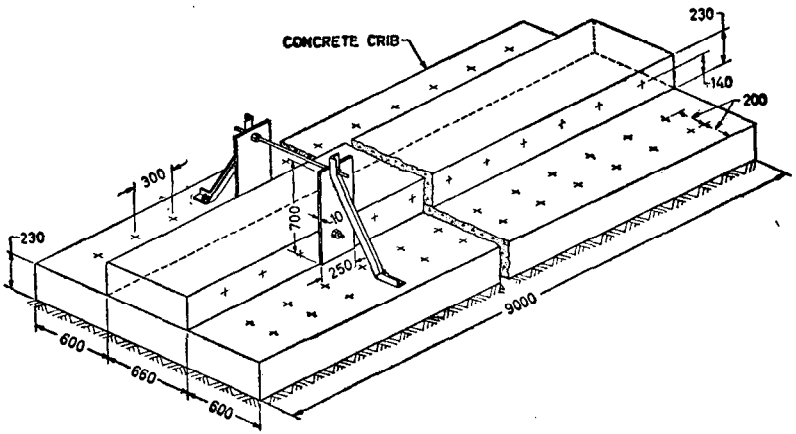
5.2.3.1 *Testing equipment* — A schematic drawing of the testing equipment and the field layout for conducting the major test, is shown in Fig. 1 and 2 when using a fixed concrete crib and in Fig. 3 when using a portable crib.

*Specification for wood poles for overhead power and telecommunication lines (*second revision*).



All dimensions in millimetres

FIG. 1 ARRANGEMENT FOR TESTING WOOD POLES

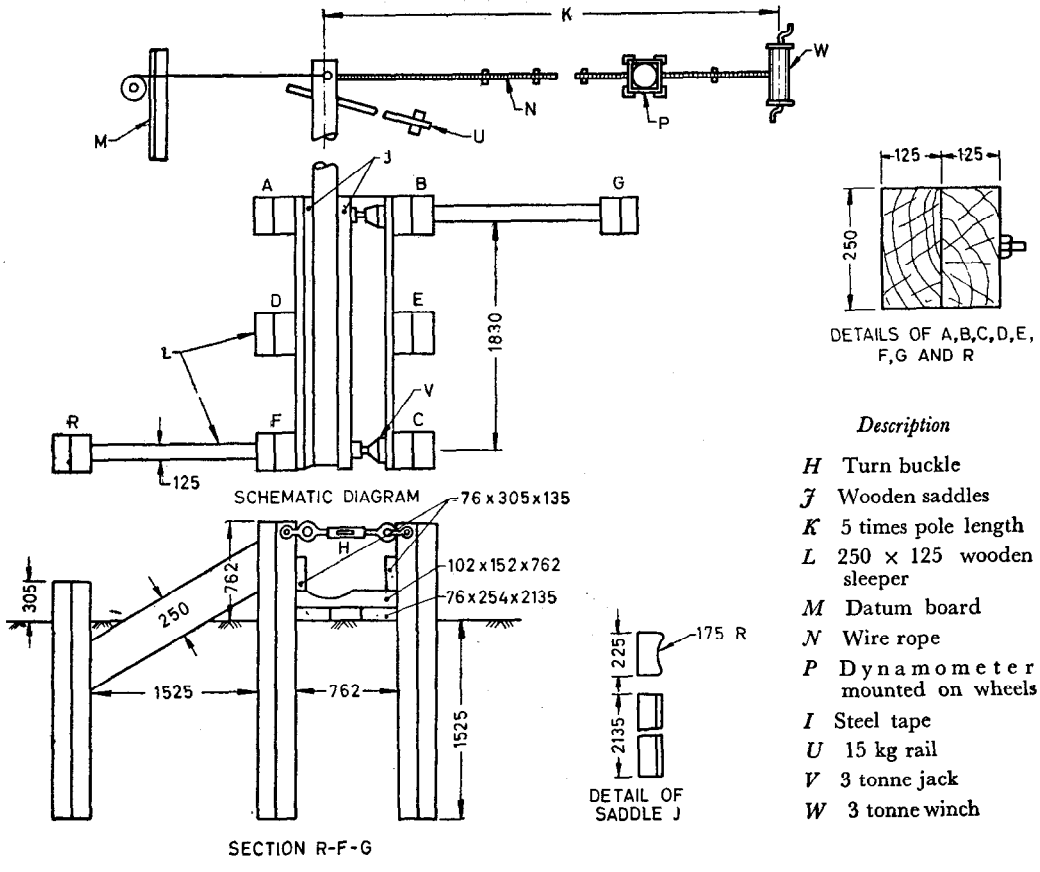


All dimensions in millimetres.

FIG. 2 LAYOUT OF CONCRETE CRIB

5.2.3.2 *Fixing of pole* — The pole to be tested shall be held securely from the butt to the ground line in the crib. The design of the crib and holding device shall be such that all the vertical and rotational motion of the butt portion of the pole during the test shall be prevented. A rail support shall be provided near the point of load application so as to minimize vertical movement at that point and to reduce the stresses due to the dead weight of the pole. This support shall be such that any friction associated with the deflection of the pole under load shall not be a significant portion of the measured load on the pole. The pole when it is placed in the testing crib, shall be rotated until most of the visible defects other than curvature are on the top side or on the bottom side. In the case of poles with curvature, the concave side should be up. The pole shall be fixed in the crib longitudinally from butt to its ground line and then it shall be secured firmly in place. Wooden saddles with concave surfaces and other packings shall be placed around the pole to prevent injury to the butt section. These saddles and packings shall be of wood at least as hard as the pole under test.

5.2.3.3 *Loading* — The load shall be applied at a point 60 cm from the top of the pole by means of a suitable device, such that a wire rope and loading equipment, in a direction normal to the direction of the length of the pole and at a distance which is not less than five times the length of the pole. If the loading device is set sufficiently far away from the pole to make the angle small between the initial and final positions of pulling line, the error in assuming that the pulling line is always perpendicular to the original direction of the pole axis will be negligible. The pulling line shall be kept in level between the winch position and the point where load is



Description

H Turn buckle
J Wooden saddles
K 5 times pole length
L 250 × 125 wooden sleeper
M Datum board
N Wire rope
P Dynamometer mounted on wheels
I Steel tape
U 15 kg rail
V 3 tonne jack
W 3 tonne winch

All dimensions in millimetres.

FIG. 3 LAYOUT OF PORTABLE CRIB

applied to the pole. The load shall be applied at a constant rate of speed and continuously until the pole fails so as to cause the deflection at the point of load of N cm/min as determined by the following formula:

$$N = \frac{0{\cdot}001\ 5\ L^2}{C_g}$$

where

N = the rate of deflection in cm/min,

L = the lever arm in cm, and

C_g = the circumference at ground line in cm.

5.2.3.4 *Pulling lines* — The pulling line shall be secured around the pole at the load point. Load measuring device shall be placed in a way so as to accurately measure the tension in the pulling line, the other end of which is attached to the loading equipment (winch).

5.2.3.5 *Load measurements* — The load may be measured by a dynamometer or any other device of a suitable capacity. The dynamometer or any other device shall be calibrated at regular intervals. The load measuring device shall be supported in such a way that the force required to pull it shall not add materially to the measured load on the pole and that no damage is caused to the instrument when the pole suddenly breaks under test.

5.2.3.6 *Deflections* — The deflection of the pole shall be measured at the load point at such intervals of load as to provide a convenient number of simultaneous readings of load and deflection. The measurement of the deflection of the load point shall be made in a direction perpendicular to the unloaded position of the pole axis. A measurement of the movement of the load point towards the butt, called deviation, resulting from the bending of the pole shall also be made simultaneously at each interval of load measurement. The arrangement for measuring both the deviation and deflection in the respective directions is given in Fig. 1. The measurements shall be made correct to the nearest 5 mm by the use of a datum board.

5.2.3.7 *Recording of data* — The corrected readings of the load, the corresponding deflections and deviations, and the position of final failure shall be recorded in the data sheet shown in Appendix A. Where necessary, photographs of typical failures may be taken.

5.2.3.8 *Load deflection curve* — A load deflection curve shall be plotted for each pole tested.

5.2.3.9 *Calculation*

a) The maximum fibre stress at the ground line shall be calculated by the following formula:

$$F = \frac{Pl}{Z}$$

where

F = maximum fibre stress at ground line in kg/cm²,

P = load at failure in kg,

l = corrected lever arm in cm,

$Z = \frac{C_g^3}{32\ \pi^2}$, and

C_g = circumference at ground line in cm.

b) If the maximum fibre stress at break is desired, it shall be calculated by the following formula:

$$F_b = \frac{Pl}{Z_a}$$

where

F_b = maximum fibre stress at break in kg/cm²,

P = load at failure in kg,

l = distance from break to point of load,

$Z_a = \frac{C_a^3}{32\ \pi^2}$, and

C_a = circumference at point of break in cm.

c) The modulus of elasticity may be calculated by the following formula:

$$E = \frac{Pl^3\ D_g}{3\ I_g\ Y D_1}$$

where

E = modulus of elasticity in kg/cm²,

P = applied load at the top-end (from the load deflection curve) in kg,

l = corrected lever arm ($L - X$) in cm,

L = length between ground line to the load point in cm,

X = deviation along the length of the pole in cm,

D_g = diameter of the pole at ground line in cm,

I_g = moment of inertia at ground level in cm⁴,

Y = deflection at load point in cm, and

D_1 = diameter of the pole at load point in cm.

5.2.4 *Machine Method*

5.2.4.1 *Testing equipment* — The pole shall be tested in a hydraulic or mechanical testing machine of suitable capacity. The load shall be applied by the movable head of the testing machine at ground line of the pole.

5.2.4.2 *Initial measurements* — It shall be done as in **5.2.2.**

5.2.4.3 *Placing the specimen* — The pole shall rest at each end in cradles supported in rocker bearings which are free to rotate about the horizontal axis as the pole deflects. The cradle and rocker bearings at each end shall rest on rollers to accommodate longitudinal movement of the pole during the test.

The axis of rotation of the rocker bearings shall be 30 cm from the butt end and 60 cm from the top end of the pole respectively. When it is supported cradles shall be rotated until most of the visible defects other than curvature are on the top or bottom side. In case of curvature, the concave surface should be kept up.

NOTE — When the poles are short enough to permit supporting the tip end on the extension of the weighing platform, the load may be observed by means of the weighing system of the platform, the extension wing of the testing machine shall be secured in such a manner that it will be capable of carrying the loads applied to it. An arrangement of such a testing apparatus is shown in Fig. 4 A. For longer poles arrangement is shown in Fig. 4 B.

5.2.4.4 *Rate of loading* — The load shall be applied by the movable head of the testing machine at ground line continuously until the pole fails and at such a speed as to cause a deflection at the point of load of N cm/min as determined by the following formula:

$$N = \frac{2\pi abZ}{3C_L}$$

where

N = rate of deflection in cm/min,

a = distance from tip bearing to the point of load in cm,

b = distance from butt bearing to the point of load in cm,

Z = rate of fibre strain in cm/cm/min, and

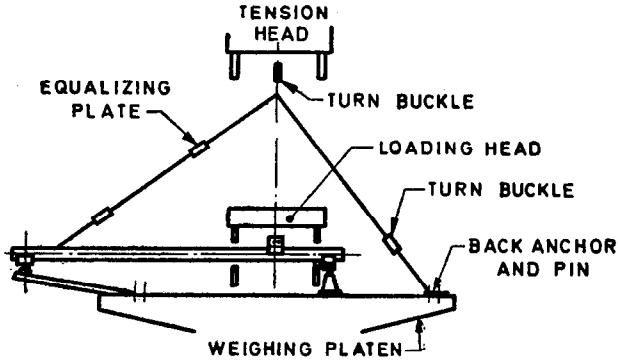
C_L = circumference at point of load in cm.

5.2.4.5 *Measurement of load and deflection* — Deflection of neutral plane at ground line shall be taken by stringing a fine wire taut between nails driven into the neutral axis of the pole directly over the end supports and crossing a scale secured to the pole at the ground line. Deflection reading shall be taken at such increments of load as to provide not less than 20 simultaneous readings of load and deflection.

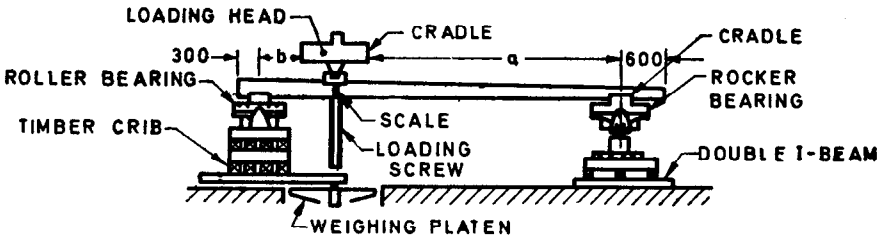
The load and deflection at first failure, the maximum load and point of sudden changes in deflection and load shall be recorded even if they may not occur at any of the regular load or deflection increments.

5.2.4.6 *Recording of data* — *See* **5.2.3.7.**

5.2.4.7 *Load deflection curve* — *See* **5.2.3.8.**



4A WITH EXTENSION WING OF TESTING MACHINE



4B WITH POLE SUPPORT INDEPENDENT TESTING MACHINE

NOTE — Hydraulic weighing cell may be located at either reaction or at the load point.

All dimensions in millimetres.

FIG. 4 SCHEMATIC DIAGRAM OF SET-UP FOR TESTING WOODEN POLES IN TRANSVERSE BENDING

5.2.4.8 *Calculation*

a) The maximum fibre stress F at ground line may be calculated by the following formula:

$$F = \frac{\left(T + t - \frac{W}{2}\right)a}{0{\cdot}098\ 2\ d^3}$$

$$T = \frac{Pb}{L}$$

where

F = maximum fibre stress at ground line in kg/cm²,
T = tip reaction at maximum load due to superimposed load in kg,
t = tip reaction due to dead weight of the pole in kg,
W = weight of section of the pole from the load point to the tip end in kg,
a = distance from load point to tip support in cm,
d = diameter of pole at load point in cm,
P = maximum superimposed load on pole in kg,
b = distance from load point to butt support in cm, and
L = distance between the tip and butt support in cm.

b) The modulus of elasticity may be calculated by the following formula:

$$E = \left\{\frac{4a^3 b}{3}\right\} \left\{\frac{T}{\triangle A^2 B (AL - Bb)}\right\}$$

where

E = modulus of elasticity in kg/cm²,
a = length from ground line to tip support in cm,
b = length from ground line to butt support in cm,
T = tip reaction from superimposed load in kg,
$\triangle$ = observed deflection from wire at ground line in cm,
A = radius of pole at ground line in cm,
B = radius of pole at tip support in cm, and
L = length between points of support $L = (a + b)$ in cm.

Where a superimposed load P is measured at ground line, the tip reaction T can be calculated from the formula:

$$T = \frac{Pb}{L}$$

After the pole breaks by any of the above method, the tests as indicated in **5.3** and **6** shall be carried out.

5.3 Determination of Age, Rate of Growth, Moisture Content and Sapwood Percentage — Immediately after the test conducted as given in **5.2**, two discs, each 5 cm in thickness and of full cross section of the pole under the test shall be taken from each side of the failure. The age, sapwood percentage, number of rings per cm and moisture content shall then be determined from each disc and the average of the two values be taken as that of the pole.

The sapwood percentage shall be obtained by the following formula:

$$\frac{R^2 - r^2}{R^2} \times 100$$

where

R = radius of the disc in cm, and

r = inner radius of the disc (containing heart wood only) in cm.

6. MINOR TESTS

6.1 The minor tests (*see* **3.1.2**) shall conform to the corresponding tests as prescribed in IS : 1708-1969*. For performing these minor tests from the butt portions (unstressed) of the pole a disc shall be taken out so as to give at least a clear specimen of 5 × 5 cm in size. The results shall be tabulated as shown in Appendix B.

APPENDIX A

(*Clauses* 5.2.2.1 *and* 5.2.3.7)

DATA SHEET FOR TESTING OF POLES

1) Species..... Class ..... Date .....
2) Seasoning .....
3) Temperature and humidity at the time of testing .....
4) Sap percent .....
5) Treatment .....
6) Weight .....
7) Moisture at fracture .....
8) Lengths:
   a) Total length .....
   b) Butt to ground line .....
   c) Ground line to top .....
   d) Ground line to load point .....
   e) Load point to break point .....
   f) Winch to pole .....

*Methods of testing small clear specimens of timber (*first revision*).

9) Cross section .....

10) Dimension of cross section at:

a) ground line .....

b) load point .....

c) top end .....

d) butt end .....

e) break point .....

11) Average taper .....

12) Maximum load .....

13) Maximum deflection in the direction of the initial position of the rope (Y) .....

14) Maximum deviation of the load point in the direction of the initial position of the pole (X) .....

15) Defects .....

16) Failure .....

17) Maximum fibre stress at break point .....

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APPENDIX B

(*Clause* 6.1)

MINOR TESTS ON SMALL CLEAR SPECIMENS TAKEN FROM BUTT PORTION OF TESTED POLES

Species ..... Seasoning ..... Pole No. ..... Class .....

STATIC BENDING

Lab No.	Stick No.	Mark No.	Length cm	Width cm	Height cm	Weight g	Sap percent	MC percent	Sp gr at Test	Sp gr Oven Dry	FS at EL	M of R	M of E	Work to EL	Date of Test	Room of Test	Room Temp °C	Remarks
Total																		
Average																		

COMPRESSION PARALLEL TO GRAIN

Lab No.	Stick No.	Mark No.	Length cm	Cross Section cm^2	Weight g	Sap percent	MC percent	Sp gr at Test	Sp gr Oven Dry	CS at EL	Crush Strength *Max*	M of E	Date of Test	Room Temp °C	Rings per cm	Remarks
Total																
Average																

KIND OF TEST (SHEARING)

Lab No.	Stick No.	Mark No.	Sap percent	MC percent	Load *Max*	Length cm	Width cm	Shear Strength Radial	Shear Strength Tan	Average	Date of Test	Room Temp °C	Kind of Test	Remarks
Total														
Average														

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117/418 B Sarvodaya Nagar, KANPUR 208005	82 72
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Printed at Delhi Printers, Delhi 6, India