IS 2408 (1963): Methods of static tests of timber in structural sizes [CED 9: Timber and Timber Stores]

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Indian Standard

METHODS OF STATIC TESTS OF TIMBERS IN STRUCTURAL SIZES

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METHODS OF STATIC TESTS OF TIMBERS IN STRUCTURAL SIZES

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Indian Standard

METHODS OF STATIC TESTS OF TIMBERS IN STRUCTURAL SIZES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 2 July 1963, after the draft finalized by the Timber Sectional Committee had been approved by the Building Division Council.

0.2 Primary and secondary species of timber are increasingly used in building and other constructional activities, and timber has, thus, become one of the principal structural materials. In order to guide the use of timber as a structural material, IS : 883-1961 Code of Practice for Use of Structural Timber in Building (Material, Grading and Design) (*Revised*) has already been issued. The Indian Standard Methods of Testing Small Clear Specimens of Timber [IS : 1708 (Part I)-1960] had also been issued, and this Indian Standard is now being issued for testing timber in larger sizes known as 'Structural Sizes'.

0.3 The main objects of collecting strength data on structural sizes are:

a) to establish for Indian timbers, corrected ratio between the strength functions based on standard small clear specimens [*see* IS : 1708 (Part I)-1960 and IS : 1708 (Part II)-1963] and the allowable working stresses in structural members (*see* IS : 883-1961);

b) to verify and modify, if necessary, the grading rules for Indian structural timbers;

c) to determine the influence of defects, seasoning and preservative treatments on the strength of timbers in structural sizes; and

d) to study such other factors as may be necessary for specific structural designs.

0.4 The field of timber testing is so broad and involves so many detailed considerations that it is obviously difficult to codify all cases. Hence, in the presentation of the standard, keeping in view the general objectives enunciated above, it is hoped that the principles incorporated would serve as a guide for any other test of special structural designs. The data recorded under these tests should be analyzed for the specific

purpose in view, keeping however in mind, that the methods of tests do form an important consideration, for drawing generalized conclusions with any uniform degree of assurance. With this consideration in view, no provisions have been made in this standard to cover sampling and selection of material, or analysis and presentation of data when collected on different specimens. However, an Indian Standard specification covering such aspects will be issued separately.

0.5 The Sectional Committee responsible for the preparation of this standard has taken into consideration the views of producers, consumers and technologists and has related the standard to the manufacturing and trade practices followed in the country in this field. Due weightage has also been given to the need for international co-ordination among standards prevailing in different countries of the world.

0.6 Wherever a reference to any Indian Standard appears in this standard, it shall be taken as a reference to the latest version of the standard.

0.7 All quantities and dimensions in this standard have been given in the metric system.

0.8 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*).

0.9 This standard is intended chiefly to cover the technical provisions relating to methods of static tests of timbers in structural sizes, and it does not include all the necessary provisions of a contract.

1. SCOPE

1.1 This standard covers methods of testing and collection of data on timber sections of structural sizes, and it does not include sampling of specimens or methods of analysis for making use of the data for different purposes.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 707-1958 Glossary of Terms Applicable to Timber, Plywood and Joinery shall apply.

3. CLASSES OF TESTS

3.1 In general, the tests are divided into two classes as given under **3.1.1** and **3.1.2**.

3.1.1 *Major Test* — Major tests are tests on full sized material for structural bending, compression parallel to grain and compression perpendicular to grain.

3.1.2 *Minor Tests* — Minor tests are tests on 'small-clear-specimens' cut from the matched portions of material intended for major tests or from undamaged portions of material already subjected to major tests. They include static bending, compression parallel and perpendicular to grain, indentation and shear, and shall be carried about the same time as the major tests so as to prevent changes of conditions. Determinations of specific gravity and moisture content form part of the routine, and all tests shall conform to IS : 1708 (Part I)-1960 Methods of Testing Small Clear Specimens of Timber.

4. GENERAL PROVISIONS FOR MAJOR TESTS

4.1 Measurements and Weights — Prior to each test, the dimensions of the specimens shall be measured to the nearest millimetre and the specimens shall be weighed to an accuracy of 0·1 kg.

4.2 Marking — All specimens shall be so marked as to be able to identify at any time the origin of the specimen.

NOTE 1 — If fresh species from forests are taken for tests, the consignment number shall be a reference to all the field information of the trees but additional markings would be necessary to indicate the position of the specimen in a tree and to know the larger and smaller end of the tree.

NOTE 2 — The number and type of specimens taken should be representative of all variations within and between the trees, and green and dry conditions.

4.3 Moisture — Immediately after each test, moisture discs shall be cut as described under each test and the moisture content shall be determined as given in Appendix A.

4.4 Conditions of Tests — To avoid significant differences, all the specimens shall be tested at a temperature of 27° ± 2°C both in green and dry conditions separately. When testing air-dry material, the same shall be brought to constant weight by storage under conditions of temperature at 27° ± 2°C and relative humidity 65 ± 2 percent. All tests shall be carried in such a manner as to prevent large changes in moisture content.

4.5 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.

4.6 Calibration of Apparatus — All apparatus and testing equipment used for obtaining the data shall be calibrated once every year to ensure accuracy.

4.7 Identification and Grading — All species shall be identified before test and shall be graded according to IS : 883-1961 Code of Practice for Use of Structural Timber in Building (Material, Grading and Design).

4.8 Records — The sample data sheet given in Appendix B is recommended for keeping a record of all observations and calculations.

4.9 Ring Width — Average ring width shall be evaluated along an average radial line in peripheral, intermediate and core zones of the cross-section of the specimens.

5. STRUCTURAL BENDING

5.1 Test Specimens — Structural bending tests shall be made on specimens not less than 350 cm in length, not less than 20 cm in depth and not less than 15 cm in breadth. Actual width and depth at 15 cm intervals over the middle third of its length shall be recorded correct to the nearest millimetre. For non-rectangular beams and beams of non-uniform cross-section, data shall be recorded in such a way as to obtain the exact size and shape at any cross-section.

5.2 Sketch — A sketch shall be made of both ends and all the four faces of the beam giving the location and nature of all the defects (*see* Fig. 1). The poorer of the two narrow faces shall be designated as *'a'* face and the remaining faces marked *'b'*, *'c'* and *'d'* round the beam in a clockwise direction when looking from the butt and (if it can be located).

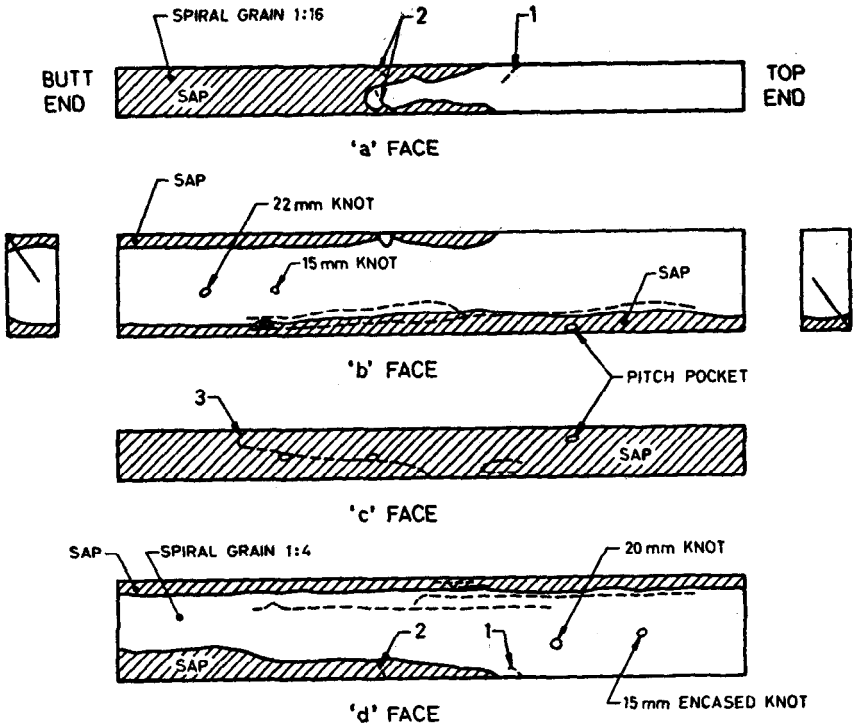
5.3 Equipment and Placing of Specimen

5.3.1 The loads shall be applied at two points at a distance of one-third of the span from each support on the poorer of the two narrow faces of the beam and denoted as *'a'* face in the sketch. In the case of beams of non-rectangular cross-section, the load shall be applied to the poorest of the loading faces.

5.3.2 The tests shall be conducted on a span 14 times the depth of the beam and on a suitable testing machine. When members are tested for any special use, the loading and span shall be changed to approximate as closely as possible to the actual condition of use.

5.3.3 The supports on which the specimens are placed should generally be of the rocker types (*see* Fig. 2A *and* 2B) placed to rock outwards and protected by one centimetre thick iron plate. Due precautions shall be taken for providing safety devices to prevent accidents by any sudden failures of the specimen.

5.3.4 The bearing blocks, through which loads are applied, shall extend entirely across the face of the beam and shall have a radius of



NOTE — Broken lines indicate test failures and the accompanying numbers 1, 2, etc, their order of occurrence.

FIG. 1 SKETCH OF STRUCTURAL SIZE TIMBER SHOWING LOCATION AND TYPE OF DEFECTS AND OTHER PERTINENT DATA

curvature three times the depth of the beam for a chord length at least equal to the depth of the beam. Additional bearing, if required, may be obtained by continuing the curvature in both directions at a radius equal to twice the depth of the beam.

5.4 Rate of Loading — The load shall be applied continuously and with a uniform motion of the movable head throughout the test so as to produce a rate of strain of 0·001 5 cm per cm of outer fibre length per minute at the point of maximum bending moment. The required head speed shall be calculated from the following formula in the case of simple beams:

$$N = \frac{Za}{3d} \times (3L - 4a)$$

and for third point loading, this becomes:

$$N = \frac{ZL^2}{5{\cdot}4\,d}$$

where

N = head speed in cm per minute,

Z = unit rate of strain of outer fibre in cm per cm per minute,

a = distance from support to nearest load in cm,

L = span in cm, and

d = depth of the specimen in cm.

5.5 Measurement of Load and Deflection — Deflection shall be recorded by the telescope and scale method or by any other suitable method at the mid-span and mid-height of the beam. A fine wire may be stretched between nails driven at the mid-height of the beam over the supporting knife edges, and a scale graduated in cm and mm may be fastened to the beam at mid-span, so as to read from the scale by a telescope at a convenient distance. Deflections corresponding to load increments shall be recorded until the time interval between readings is found to increase materially. A load interval of 2 000 kg is recommended in load deflection readings.

5.6 Recording of Failure — Failure shall be recorded on the sketch showing type, position, manner and the order of occurrence and shall be classified as indicated in Fig. 3.

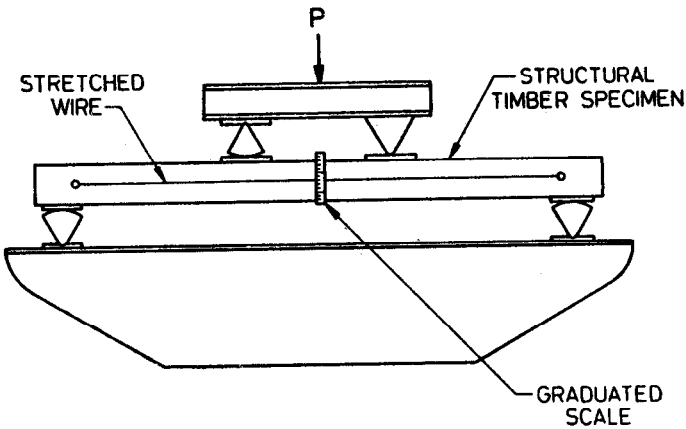
5.7 Moisture Determination — Immediately after test, one disc, 2·5 cm in length and of full section as the test piece, shall be taken normally near the place of the biggest failure. Moisture distribution and average moisture content shall be determined as given in Appendix A.

5.8 Recording of Data and Computation — The data shall be recorded on the sample data sheet given in Appendix B and the properties shall be calculated in accordance with formulæ given in Appendix C.

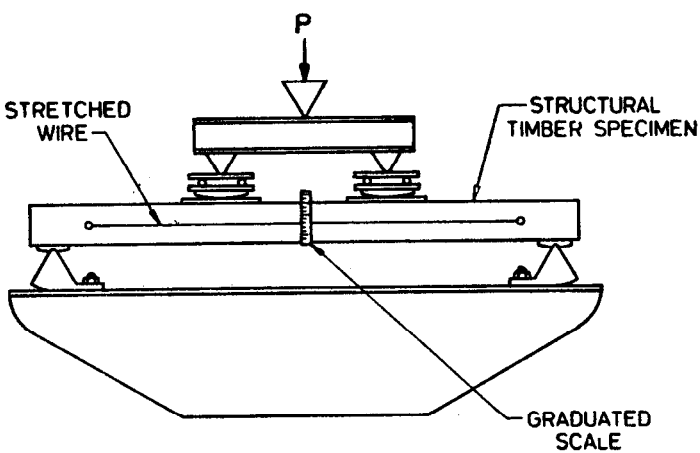
6. COMPRESSION PERPENDICULAR TO GRAIN

6.1 Test Specimen — The specimen shall be 70 cm in length and of the same cross-sectional dimensions as of the beam under major bending test but shall be not less than 20 cm in depth and 15 cm in breadth.

6.2 Sketch — A sketch shall be made indicating all the defects on all the sides and ends and marked '*a*', '*b*', '*c*' and '*d*' as given under **5.2** and Fig. 1.



2A Diagrammatic Sketch Showing the Method of Conducting Static Bending Test of Timber in Structural Sizes



2B Diagrammatic Sketch Showing Alternative Method of Loading Static Bending Test of Timber in Structural Sizes

FIG. 2 STATIC BENDING TESTS OF TIMBERS IN STRUCTURAL SIZES

FIG. 3 FAILURE OF SPECIMEN UNDER STATIC BENDING TEST

6.3 Equipment and Placing of Specimen — The specimen shall rest directly on the machine in such a way that the load is applied on face '*a*'. The load shall be applied through a metal plate of 15 cm in width and one centimetre in thickness placed across the entire width of the specimen at its centre at right angles to it.

6.4 Rate of Loading — The rate of loading shall be constant throughout the test and shall be determined by the following formula:

$$N = 0{\cdot}029\ 1\ d^{\frac{1}{6}}$$

where

N = machine head speed in cm per minute, and

d = depth of specimen in cm.

6.5 Measurement of Load and Compression — Compression readings shall be taken by suitable compressometers until the elastic limit has well

passed, and final load reading shall be taken at one-fifteenth of the depth of the specimen or maximum load, whichever is reached earlier. The compression readings shall be taken correct to 0·002 cm.

NOTE — It is recommended that two compressometers be placed on either side of the specimen and the average of their readings be taken.

6.6 Recording of Failure — If any mechanical deterioration or failure is observed on the specimen during test, the same shall be recorded on the sketch in their order of occurrence.

6.7 Moisture Determination — Immediately after test, one disc 2·5 cm in length and of full section as the test piece, shall be taken in the central portion of the specimen or at failure, if it occurs. Moisture distribution and average moisture content shall be determined as given in Appendix A.

6.8 Recording of Data and Computation — The data shall be recorded in the sample data sheet given in Appendix B and properties calculated as per formulæ given in Appendix C.

7. COMPRESSION PARALLEL TO GRAIN

7.1 Test Specimen — The specimens for compression-parallel-to-grain tests shall not be less than 15 × 15 cm in cross-section and 4 times the side in length.

7.2 Sketch — A sketch shall be made of the specimen, indicating all the four sides and ends of the specimen. All defects shall be carefully described and marked on the sketch.

7.3 Equipment and Placing of Specimen — The ends of the specimens shall be planed accurately so as to have the end sections truly perpendicular to the longitudinal ends. Eccentric loading shall be avoided by the use of a hemispherical loading block. The specimen shall be so placed that the centre of the cross-section of the specimen is vertically in line with the centres of the moving heads of the machine. A small load of not more than 500 kg should be initially applied to set the machine.

7.4 Rate of Loading — The rate of loading shall be constant throughout the test, and shall be calculated from the following formula:

$$N = 0{\cdot}001\ 5\ L$$

where

N = machine head speed in cm per minute, and

L = length of specimen in cm.

7.5 Measurement of Loads and Deformation — Deformation under compression shall be measured correct to 0·002 mm by means of suitable compressometers over a central gauge length of three-fourth of the specimen length. The readings shall be continued well beyond the proportional limit after which the compressometers may be detached. The maximum load reached shall also be recorded.

7.6 Recording of Failures — All failures shall be indicated on the sketch and shall be described in the order of their occurrence. Compression failures may be classified as indicated in Fig. 4.

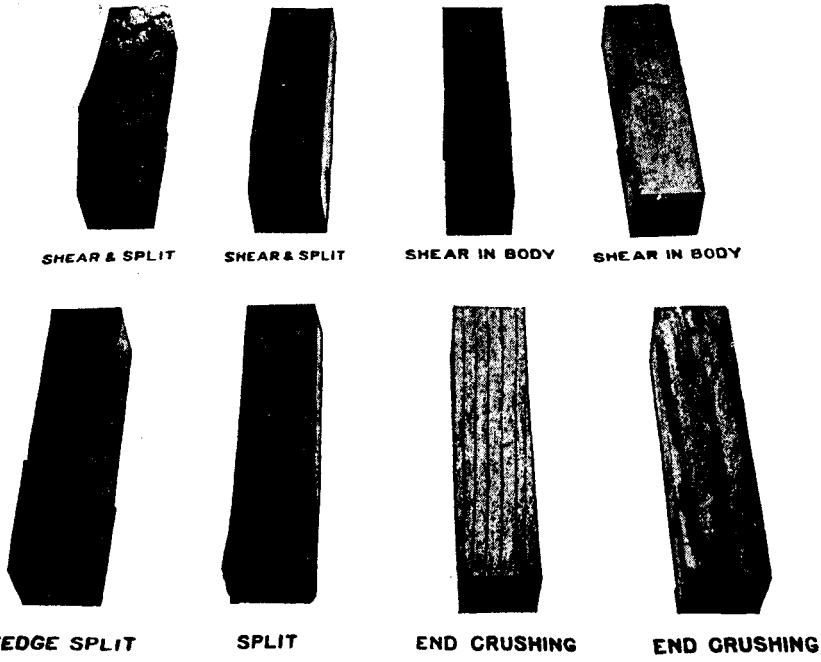


FIG. 4 FAILURE OF SPECIMEN UNDER COMPRESSION PARALLEL TO GRAIN

7.7 Moisture Determination — Moisture discs of 2·5 cm length shall be cut across the specimen near the point of failure and the moisture content shall be determined as given in Appendix A.

7.8 Recording of Data and Computation — The data shall be recorded in the sample data sheet as in Appendix B and properties shall be calculated in accordance with formulæ given in Appendix C.

8. MINOR TESTS

8.1 The procedure for conducting these tests shall conform to those prescribed in IS : 1708 (Part I)-1960 Methods of Testing Small Clear Specimens of Timber.

APPENDIX A

(*Clauses* 4.3, 5.7, 6.7 *and* 7.7)

DETERMINATION OF MOISTURE CONTENT

A-1. PROCEDURE

A-1.1 The moisture disc cut from each tested specimen shall be cut into moisture distribution sections to represent the peripheral intermediate and core zones of cross-section as shown in Fig. 5. The moisture distribution sections shall be so cut that each zone is approximately equal to one another and represents one-third of the total cross-sectional area.

A-1.2 Moisture content of each section shall be determined as given in Appendix A of IS : 1708 (Part I)-1960 Methods of Testing Small Clear Specimens of Timber.

A-2. CALCULATION

A-2.1 The average value of moisture content of all sections in each zone calculated as given below shall be recorded as the moisture content of the respective zone:

a) Moisture content of peripheral zone $M_p = \frac{M_1 + M_2 + M_3 + M_4}{4}$;

b) Moisture content of intermediate zone $M_i = \frac{M_5 + M_6 + M_7 + M_8}{4}$; and

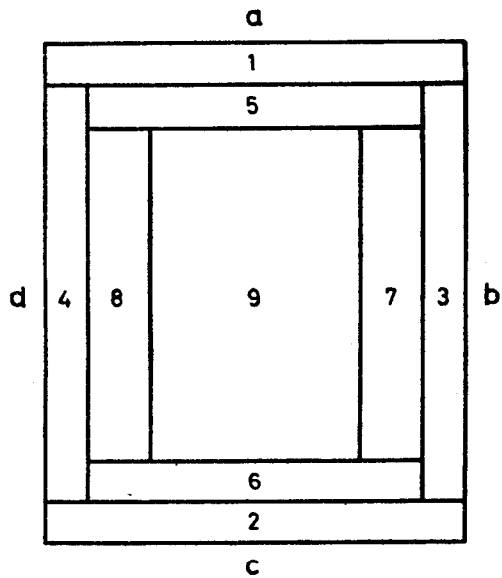
c) Moisture content of core zone $M_c = M_9$

where

M followed by any suffix, 1, 2 and 3 indicates the moisture content of the corresponding section indicated in Fig. 5.

A-2.2 Average moisture content of the zones shall be taken as moisture content of the piece (M_s) at test.

$$M_s = \frac{M_p + M_i + M_c}{3}$$



NOTE — Area (1 + 2 + 3 + 4) = Area (5 + 6 + 7 + 8) = Area 9 = 1/3 of the whole area.

FIG. 5 TYPICAL CROSS-SECTION OF TIMBER SHOWING METHOD OF CUTTING UP MOISTURE DISTRIBUTION SECTIONS

APPENDIX B

(*Clauses* 4.8, 5.8, 6.8 *and* 7.8)

SAMPLE DATA SHEET

1. Name of the testing laboratory .....
2. Tested by .....
3. Marking on specimens .....
4. Laboratory reference .....
5. Species identified as .....
   by .....
6. Kind of test .....
7. Rated grade of the specimen .....

8. Sizes of the specimens .....
9. Weight of the specimen .....
10. Span in structural bending .....
11. Gauge length in compression-parallel-to-grain test .....
12. Width of the plate in compression-perpendicular-to-grain test .....
13. Machine on which tested .....
14. Speed of testing .....
15. Average ring width in mm:
    - Peripheral zone .....
    - Intermediate zone .....
    - Core zone .....
16. Percentage of sapwood .....
17. Seasoning .....
18. Temperature at test .....
19. Moisture distribution:
    - Peripheral zone .....
    - Intermediate zone .....
    - Core zone .....
    - Average .....
20. Kind of failure .....
    .....
    .....
    .....
21. Defects present .....
    .....
    .....
    .....
22. Other remarks on the specimen .....
    .....
    .....
23. Sketch indicating defects and failures .....

24. Data observed and calculated	Structural Bending	Compression Perpendicular to grain	Compression Parallel to grain
i) Specific gravity at test at oven-dry			
ii) Load at limit of proportionality fibre stress (or crushing strength) at limit of proportionality (FS or CS at LP)			
iii) Maximum load Modulus of rupture			
iv) Deflection (or compression) at limit of proportionality			
v) Deflection at maximum load			
vi) Shear			
vii) Work to EL (elastic resilience)			

APPENDIX C

(*Clauses* 5.8, 6.8 *and* 7.8)

FORMULA FOR CALCULATING STRENGTH PROPERTIES

C-1. Strength functions of all minor tests shall be computed by the formulæ given under corresponding tests in IS : 1708 (Part I)-1960 Method of Testing Small Clear Specimens of Timber.

C-2. Strength functions of all major tests shall be computed by the following formula:

a) **Structural Bending**

1) Maximum horizontal shear at maximum load (HS at ML) $= \frac{3P}{4bh}$ Unit kg/cm²

2) Modulus of rupture (M of R) $= \frac{(P + 0{\cdot}75W)l}{bh^2}$,,

3) Fibre stress at limit of proportionality (FS at LP)	$= \frac{(P' + 0{\cdot}75W)l}{bh^2}$	Unit	kg/cm²
4) Modulus of elasticity (M of E)	$= \frac{P' l^3}{4{\cdot}7 \triangle bh^3}$		,,
5) Work to limit of proportionality (WK to EL)	$= \frac{\triangle P'}{2\ lbh}$ or $\frac{CA_1}{lbh}$		kg·cm/cm³

b) Compression Perpendicular to Grain

1) Crushing strength at maximum load, if any (CS at ML)	$= \frac{P'}{A}$		kg/cm²
2) Compressive stress at limit of proportionality (CS at LP)	$= \frac{P}{A}$		,,

c) Compression Parallel to Grain

1) Compressive stress at maximum load (CS at ML)	$= \frac{P}{A}$		,,
2) Compressive stress at limit of proportionality (CS at LP)	$= \frac{P'}{A}$		,,
3) Modulus of elasticity in compression parallel to grain (M of E in compression parallel to grain)	$= \frac{P'd}{A \triangle}$		,,

where

P = maximum load in kg,
P' = load at limit of proportionality,
b = width of specimen in cm,
h = height of specimen in cm,
l = length of span in cm,
W = weight of the specimen in kg,
$\triangle$ = deformation at limit of proportionality,
A = area of cross-section of the specimen (cm²),

C = area constant in kg·cm (that is, the energy represented by one square cm which is equal to load in kg, represented by one centimetre ordinate multiplied by deflection in centimetres, represented by one centimetre abscissa),

A_1 = area in cm^2 of load-deflection curve to limit of proportionality, and

d = distance between gauge points in cm.

C-3. If S_j is the value of any property in the major test and S_m is the value of the corresponding property in minor tests, then

$$S = \frac{S_m - S_j}{S_m} \times 100$$

is known as structural degree factor, and is the figure employed for introducing the effect of size and grade of the material for evaluation of working stress.

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TO

IS:2408-1963 METHODS OF STATIC TESTS OF TIMBERS IN STRUCTURAL SIZES

Alteration

(*Page 4, clause 0.4, last sentence*) - Substitute the following for the existing sentence:

'Reference may be made to IS:2455-1974* and IS:8745-1978† for these aspects.'

Addendum

(*Page 4, clause 3.1*) - Add the following new foot-notes after 3.1:

'*Methods of sampling of model trees and logs for timber testing and their conversion(*first revision*).

†Methods of representation of data of physical and mechanical properties of timber.'

(EDC 9)

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