
Methods of test for
Determination of certain physical
and mechanical properties of timber
in structural sizes

Méthodes d'essai pour la détermination de certains caractéristiques physiques et mécaniques des bois ayant des dimensions pour la construction

Prüfverfahren für den Nachweis bestimmter physischer und mechanischer Eigenschaften von Holz in Baugrößen

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Foreword

The values obtained in any determination of the properties of timber depend upon the test methods used. It is therefore desirable that these should be standardized so that results from different test centres may be correlated and more widely applied. Also with the adoption of limit state design and with the development of both visual and machine stress grading, attention will be increasingly centred on the determination and monitoring of the strength properties and variability of timber in structural sizes. Again this can be more effectively undertaken if the basic data are defined and obtained under the same conditions. Guidance on timber sizes is given in BS 4471 : Part 1.

Attention is drawn to the advantages that may be gained, often with little extra effort, in extending the scope of application of test results, by recording additional information on the growth characteristics of the specimens that are tested, particularly at the fracture sections. Generally such additional information should include grade determining

features such as knots, slope of grain, wane, etc., on which visual grading rules are based, and strength indicating properties such as localized modulus of elasticity, on which machine stress grading is based.

Sampling techniques, the selection of test specimens and the analysis of data will reflect the objectives of an investigation and have not been dealt with in this standard. In drafting this standard account has been taken of the recommendations made by working group W18, Timber Structures, of the International Council for Building Research, Studies and Documentation and by the International Union of Testing and Research Laboratories for Materials and Structures.

NOTE. The technical committee has reviewed the provisions of ISO 3130 and ISO 3131, to which reference is made in clauses 6 and 7 respectively, and has decided that they are acceptable for use in conjunction with this standard. A related standard is BS 373 : 1957 and a revision of this is now in course of preparation.

British Standard Methods of test for

Determination of certain physical and mechanical properties of timber in structural sizes

Section one. General

1. Scope

This British Standard gives preferred test methods for determining the following.

- (a) Modulus of elasticity in bending.
- (b) Shear modulus.
- (c) Bending strength.
- (d) Modulus of elasticity in tension.
- (e) Tension strength.
- (f) Modulus of elasticity in compression.
- (g) Compression strength.

In addition reference is made to the measurement of dimensions, density, moisture content and grade determining characteristics.

2. Field of application

These test procedures apply to rectangular and square sections of solid timber and for convenience they are presented in three sections as follows.

- Section two: Physical properties.
- Section three: Grade determining properties.
- Section four: Mechanical properties.

3. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

Section two. Physical properties

4. General

Before being subjected to the tests specified in sections three and four, each specimen shall be checked and its physical properties recorded as set out in clauses 5 to 8.

5. Dimensions of test specimens

The width and thickness of the test specimen shall be

measured in millimetres to three significant figures*. The length of the test specimen shall be measured in metres to three significant figures.

All measurements shall be made when the specimen is at the moisture condition required for the tests.

6. Moisture content

The moisture content of the test specimen shall be determined from a full cross-sectional piece cut from the specimen, free from knots and resin pockets and in accordance with the requirements of ISO 3130†.

7. Density

The density of the test specimen shall be determined from a full cross-sectional piece cut from the specimen, free from knots and resin pockets and in accordance with the requirements of ISO 3131†.

8. Conditioning of test specimens

The test specimens shall normally be conditioned, prior to final machining and testing, to constant mass‡ and moisture content in an atmosphere of relative humidity $60 \pm 2\%$ and temperature $23 \pm 3^\circ\text{C}$ §.

Where possible the conditions at testing shall be the same as those in the conditioning chamber, but where this is not possible, tests should be carried out immediately after the specimens have been removed from the conditioning chamber.

Section three. Grade determining properties

9. General

For many investigations it will be sufficient simply to record the grade of each specimen according to established visual or mechanical stress grading rules. However, when ultimate strength is to be determined, the value of the test results will be enhanced if the magnitude of the growth characteristics and defects present in the test specimen, or the magnitude of an indicating property for machine stress grading, are recorded. See appendix A.

*If width or thickness is likely to vary, for example with some sawn timber, they should be recorded as the average of three separate measurements taken at different positions in the length of the specimen.

†See the note at the end of the foreword.

‡Constant mass is considered to be reached when the results of two successive weighings, carried out at an interval of 6 h, do not differ by more than 0.1 % of the mass of the test specimen.

§For particular investigations it may be necessary to condition the specimens to other climate classes or moisture conditions.

10. Visual grading

The lowest values for slope of grain, rate of growth, fissures, wane and knots within the length of each specimen, and in ultimate strength tests at the fracture section, shall be determined according to the methods given in ECE Recommended Standard for stress grading coniferous sawn timber, Geneva July 1976. In addition, if a specimen or fracture section contains the pith, this shall also be recorded.

A numerical system shall be used to record knots so that their size, shape, area ratios and location within the section, can be determined.

11. Machine grading

With machine stress grading, grades are established by deciding on the required boundary values for the indicating property to achieve a selection of timber having some specified characteristic strength value. Thus the indicating property has the same significance in machine stress grading as do the visual growth characteristics in visual grading. The scope of application of machine stress grading depends upon the information available on the relations between strength properties and the indicating property. An important indicating property is modulus of elasticity measured over a relatively short span, and for the determination of this property one or both of the following test procedures shall be used. If the associated strength test is to determine bending strength, the tests shall be made with the same edge in compression.

11.1 Edgewise modulus of elasticity

11.1.1 Test specimen. The specimen intended for an ultimate strength test, or the piece from which it will be cut if the specimen itself is not of sufficient length, shall be used. A test length shall be chosen so that the section at which fracture can be expected in the ultimate strength test is at the centre. The total test length shall be not less than six times the nominal depth* plus 1 m, and shall satisfy the requirements of 11.1.2.

11.1.2 Test procedure. The test length shall be loaded on edge as shown in figure 1. The distance between the inner load points shall be 1 m, and between an inner load point and the nearest support it shall be not less than three times the nominal depth of the section.

The test specimen shall be supported on rollers and a knife edge reaction, or by other devices which achieve an acceptable free support condition. Small plates of a length not greater than one-half of the nominal depth may be inserted between the specimen and the loading heads and supports to minimize indentation.

If the depth to width ratio of the test specimen exceeds four, lateral restraint shall be provided to prevent buckling. This restraint shall permit the specimen to deflect without causing significant frictional resistance.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % or better.

Deflection shall be measured at the centre of a central gauge length of 900 mm with the deflectometer attached at the centre of the depth.

Load shall be applied at a continuous rate, and a record of load/deflection shall be made so that the deflection under an increment of load can be determined to an accuracy of 1 % or better. Care shall be taken to ensure that the

maximum applied load does not exceed the proportional limit load, or cause damage to the specimen.

The rate of movement of the machine cross-head shall not be greater than

$$R = 5a (2a + 3000)/(3h \times 10^5)$$

where

R is the rate of cross-head movement, in mm/s

a is the distance between an inner load point and the nearest support point, in mm

h is the nominal depth of the section, in mm

and the equation is based on a rate of straining in the extreme fibres of 0.003 per min.

11.1.3 Results. The edgewise modulus of elasticity shall be calculated from the formula

$$E_m = \Delta F a l_1^2 / 16 I \Delta w$$

where

E_m is the modulus of elasticity in bending, free from shear deflection, in N/mm²

ΔF is an increment of load, in N

a is the distance between an inner load point and the nearest support point, in mm

l_1 is the gauge length of 900 mm

I is the second moment of area of the section determined from its actual dimensions, in mm⁴

Δw is the deflection under the increment of load ΔF , in mm

Modulus of elasticity shall be calculated and recorded to three significant figures.

11.2 Flatwise modulus of elasticity

11.2.1 Test specimen. The specimen for an ultimate strength test, or the piece from which it will be cut if the specimen itself is not of sufficient length, shall be used. A test length of 900 mm shall be chosen so that the section at which fracture can be expected in the ultimate strength test is at the centre. The total test length shall satisfy the requirements of 10.2.2.

11.2.2 Test procedure. The test length shall be loaded on the flat in centre point bending over a span of 900 mm as shown in figure 2.

The test specimen shall be supported on rollers and a knife edge reaction, or by other devices which achieve an acceptable free support condition. Small plates of a length not greater than one-half of the nominal depth may be inserted between the specimen and the loading heads and supports to minimize indentation.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % or better.

Deflection shall be measured at the centre of the span with the deflectometer attached at the centre of the depth.

Load shall be applied at a continuous rate, and a record of load/deflection shall be made so that the deflection under an increment of load can be determined with an accuracy of 1 % or better. Care shall be taken to ensure that the maximum applied load does not exceed the proportional limit load.

*Where the term 'nominal depth' or 'dimension' is used this means the intended actual average depth or dimension of the section.