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Timber structures — Glued laminated timber — Test methods for determination of physical and mechanical properties

Structures en bois — Bois lamellé-collé — Méthodes d'essai pour la détermination de certaines propriétés physiques et mécaniques

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8375 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

This second edition cancels and replaces the first edition (ISO 8375:1985), which has been technically revised.

Timber structures — Glued laminated timber — Test methods for determination of physical and mechanical properties

1 Scope

This International Standard specifies test methods for determining the following characteristic values of glued laminated timber: modulus of elasticity in bending; shear modulus; bending strength; modulus of elasticity in tension parallel to the grain; tension strength parallel to the grain; modulus of elasticity in compression parallel to the grain; compression strength parallel to the grain; modulus of elasticity in tension perpendicular to the grain; tension strength perpendicular to the grain; modulus of elasticity in compression perpendicular to the grain; compression strength perpendicular to the grain and shear strength.

In addition, the determination of dimensions, moisture content, and density are specified.

The methods apply to rectangular shapes of glued laminated timber.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3130, *Wood — Determination of moisture content for physical and mechanical tests*

ISO 3131, *Wood — Determination of density for physical and mechanical tests*

ASTM D198, *Standard test methods of static tests of lumber in structural sizes*

ASTM D2915, *Standard practice for evaluating allowable properties for grades of structural lumber*

ASTM D3737, *Standard practice for establishing allowable properties for structural glued laminated timber*

ASTM D4933, *Standard guide for moisture conditioning of wood and wood-based materials*

JAS 235, *Standard for structural glued laminated timber*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
characteristic density
mean density obtained at a 75 % confidence limit with mass and volume corresponding to equilibrium moisture content at a temperature of 20 °C and a relative humidity of 65 %

3.2
characteristic strength
lower 5-percentile value at a 75 % confidence limit obtained from the results of tests using test specimens at an equilibrium moisture content resulting from a temperature of 20 °C and a relative humidity of 65 % or the strength value at the observed moisture content when full size members are tested

3.3
characteristic stiffness
mean stiffness at a 75 % confidence limit obtained from the results of tests using test specimens at an equilibrium moisture content resulting from a temperature of 20 °C and a relative humidity of 65 %

NOTE Annex A provides a set of guidelines for statistical processing of data to determine characteristic values as defined in 3.1, 3.2 and 3.3.

3.4
minimum number of test specimens
for the determination of all characteristic values a minimum number of 30 test specimens is required unless otherwise noted for the specific test involved

3.5
population
test specimens used to determine characteristic values should be representative of the population that they are intended to represent

NOTE *Specimen* is used throughout this International Standard to mean *test specimen* as used in 3.4 and 3.5.

4 Symbols

A	cross-sectional area (mm^2)
a	distance between a loading position and the nearest support in a bending test (mm)
b	width of cross section in a bending test, or the smaller dimension of the cross section (mm)
$E_{c,0}$	modulus of elasticity in compression parallel to the grain (MPa)
$E_{c,90}$	modulus of elasticity in compression perpendicular to the grain (MPa)
$E_{m,g}$	global modulus of elasticity in bending (MPa)
$E_{m,l}$	local modulus of elasticity in bending (MPa)
$E_{m,app}$	apparent modulus of elasticity in bending (MPa)
$E_{t,0}$	modulus of elasticity in tension parallel to the grain (MPa)
$E_{t,90}$	modulus of elasticity in tension perpendicular to the grain (MPa)
F	load (N)
$F_{c,90}$	compressive load perpendicular to the grain (N)
$F_{c,90,max}$	maximum compressive load perpendicular to the grain (N)
$F_{c,90,max,est}$	estimated maximum compressive load perpendicular to the grain (N)
F_{max}	maximum load (N)

$F_{max,est}$	estimated maximum load (N)
$F_{t,90}$	tensile load perpendicular to the grain (N)
$F_{t,90,max}$	maximum tensile load perpendicular to the grain (N)
$f_{c,0}$	compressive strength parallel to the grain (MPa)
$f_{c,90}$	compressive strength perpendicular to the grain (MPa)
f_m	bending strength (MPa)
$f_{t,0}$	tensile strength parallel to the grain (MPa)
$f_{t,90}$	tensile strength perpendicular to the grain (MPa)
f_v	shear strength parallel to the grain (MPa)
G	shear modulus (MPa)
G_{est}	estimated shear modulus (MPa)
h	depth of cross section in a bending test, or the larger dimension of the cross section, or the test specimen height in perpendicular to grain tests (mm)
h_0	gauge length (mm)
I	second moment of area (mm^4)
K, k	coefficients (—)
k_G	coefficient for shear modulus (—)
l	span in bending, or length of test specimen between the testing machine grips in compression and tension (mm)
l_1	gauge length for the determination of modulus of elasticity (mm)
l_{pt}	plate thickness (mm)
S	section modulus (mm^3)
w	deformation (mm)

NOTE Suffixes “1” and “2”, refer to loads or deformations at particular points of a test, and are referred to throughout this International Standard.

5 Determination of dimensions of test specimens

The dimensions of the test specimen shall be measured to an accuracy of 1 %. The dimension-measuring devices shall be such as to permit measuring dimensions in millimetres to three significant figures. All measurements shall be made when the test specimens are conditioned as specified in Clause 8. If the width or thickness varies within a test specimen, these dimensions should be recorded as the average of three separate measurements taken at different positions on the length of each specimen.

Where possible, the measurements should not be taken closer than 150 mm to the ends of the specimen.

6 Determination of moisture content of test specimens

The moisture content of the test specimen shall be determined on a section taken from the test specimen.

In strength tests for bending, tension parallel and perpendicular to grain and compression parallel and perpendicular to grain, the moisture content of the test specimen shall be determined as soon as practical after testing, or the specimen shall be sealed to prevent any further moisture change until testing can be initiated. The section shall be cut as close as possible to the fracture.

As an alternative, the provisions of ISO 3130 may be used for determining moisture content.

7 Determination of density of test specimens

If a density value is needed, the density shall be determined on a portion of the cross section or the entire cross section taken from the test specimen near the fracture area.

In strength tests such as bending and parallel to grain, the density of the test specimen shall be determined after the testing and the section shall be cut as close as possible to the fracture.

For perpendicular to grain test specimens, the density of the test specimens shall be determined prior to testing from the measurements of mass and volume of the whole test specimen.

As an alternative, the provisions of ISO 3131 or ASTM D2915 may be used for determining density.

8 Conditioning of test specimens

The tests shall be carried out on specimens that are conditioned at the standard environment of (20 ± 2) °C and (65 ± 5) % relative humidity. A test piece is conditioned when it attains constant mass. Constant mass is considered to be attained 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.

As an alternative, the provisions of ASTM D4933 may be used to establish moisture conditioning.

Where the timber to be tested cannot be readily conditioned to the above standard environment, that fact shall be reported and the moisture content of the test specimen shall be reported with the test results.

For small specimens, unless otherwise protected, test specimens shall not be removed from the conditioning environment more than 1 h before testing.

Test specimens may be stored in the test area for up to 24 h if they are closely piled and vapour-tight wrapped.

9 Determination of local (shear-free) modulus of elasticity of the beam in bending

9.1 Test specimen

The test specimen shall have a minimum length to permit testing with a span of approximately 18 times the depth of the section. The test span shall be reported.

9.2 Procedure

The test specimen shall be symmetrically loaded in bending at two points over a span of (18 ± 3) times the depth as shown in Figure 1. The span between load heads shall be six times the specimen depth. All spans and distances shall be noted and measured to the nearest millimetre.

NOTE 1 The intent of this International Standard is to test with a span equal to 18 times the depth; tolerances are provided to enable testing of a broader range of specimens.

The test specimen shall be simply supported.

NOTE 2 Small steel plates of length not greater than one-half of the depth of the test specimen can be inserted between the specimen and the loading heads or supports to minimize local indentation.

Lateral restraint shall be provided as necessary to prevent buckling. This restraint shall permit the specimen to deflect without significant frictional resistance.

Load shall be applied at a constant rate and the test should be completed within approximately 300 s but not less than 180 s.

NOTE 3 Ideally, the load application rate is determined from the results of preliminary tests. The objective is that the average time to reach F_{max} is 300 s.

The maximum load applied shall not exceed the proportional limit load or cause damage to the piece.

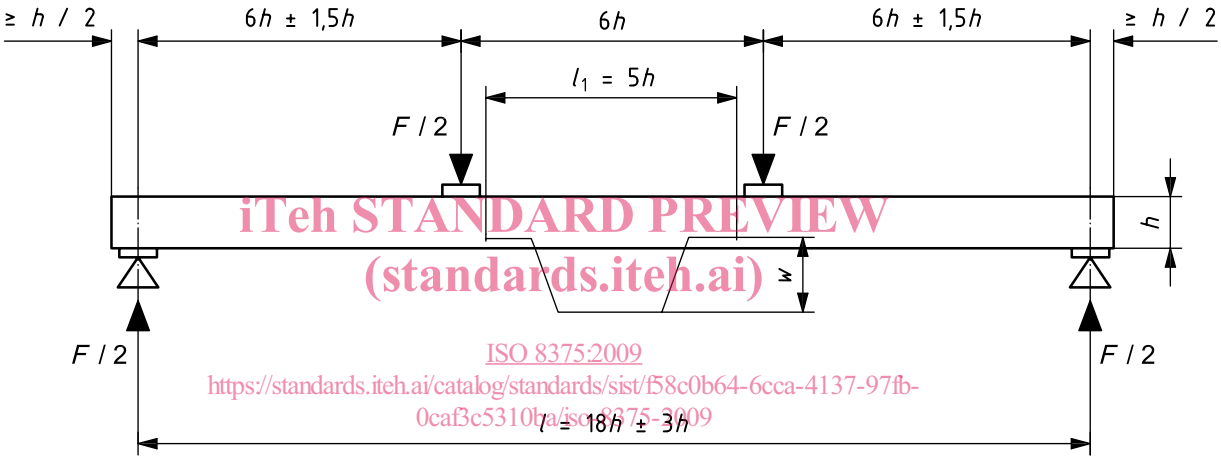


Figure 1 — Test arrangement for measuring local modulus of elasticity in bending

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test specimen or, for loads less than 10 % of the applied maximum load, with an accuracy of 0,1 % of the maximum applied load.

The deformation, w, shall be measured at the neutral axis, at the centre of a central gauge length of five times the depth of the section as shown in Figure 1.

The deformation measuring devices and recording system shall be such as to permit measuring deflections to the nearest millimetre.

NOTE 4 ASTM D198 provides a description of an acceptable deflection measuring device and the yoke.

9.3 Expression of results

The local modulus of elasticity in bending, $E_{m,l}$, is given by the equation

$$E_{m,l} = \frac{a l_1^2 (F_2 - F_1)}{16 l (w_2 - w_1)} \quad (1)$$

where

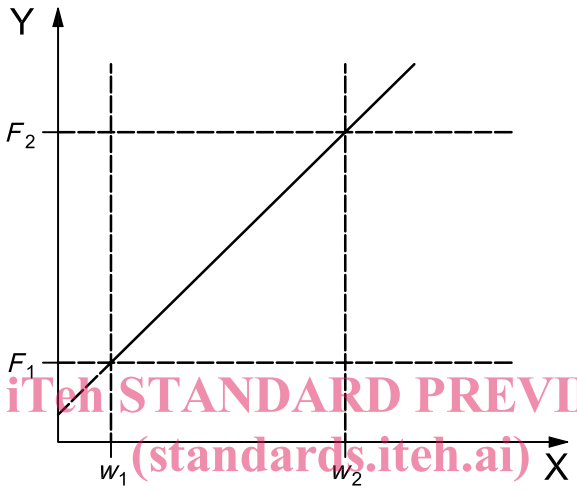
$F_2 - F_1$ is an increment of load on the straight-line portion of the load deformation curve, in newtons

$w_2 - w_1$ is the increment of deformation corresponding to $F_2 - F_1$, in millimetres

(see Figure 2 for $F_2 - F_1$ and $w_2 - w_1$ plot).

The other symbols are as given in Clause 4.

The local modulus of elasticity should be reported to no more than three significant figures.



Key

X deformation (mm)
Y load (N)

Figure 2 — Load-deformation graph within the range of elastic deformation

10 Determination of global modulus of elasticity of the beam in bending

10.1 Test specimen

The test specimen shall have a minimum length to permit testing with a span of approximately 18 times the depth of the section as shown in Figure 3. The test span shall be reported.

10.2 Procedure

The test specimen shall be symmetrically loaded in bending at two points over a span of (18 ± 3) times the depth. The span between the load heads shall be six times the specimen depth. All spans and distances shall be noted and measured to the nearest millimetre.

NOTE 1 The intent of this International Standard is to test with a span equal to 18 times the depth; tolerances are provided to enable testing of a broader range of specimens.

The test specimen shall be simply supported.

NOTE 2 Small steel plates of length not greater than one-half of the depth of the test specimen can be inserted between the specimen and the loading heads or supports to minimize local indentation.

Lateral restraint shall be provided as necessary to prevent buckling. This restraint shall permit the specimen to deflect without significant frictional resistance.

Load shall be applied at a constant rate and the test should be completed within approximately 300 s but not less than 180 s.

NOTE 3 Ideally, the load application rate is determined from the results of preliminary tests. The objective is that the average time to reach F_{max} is 300 s.

The maximum load applied shall not exceed the proportional limit load or cause damage to the specimen.

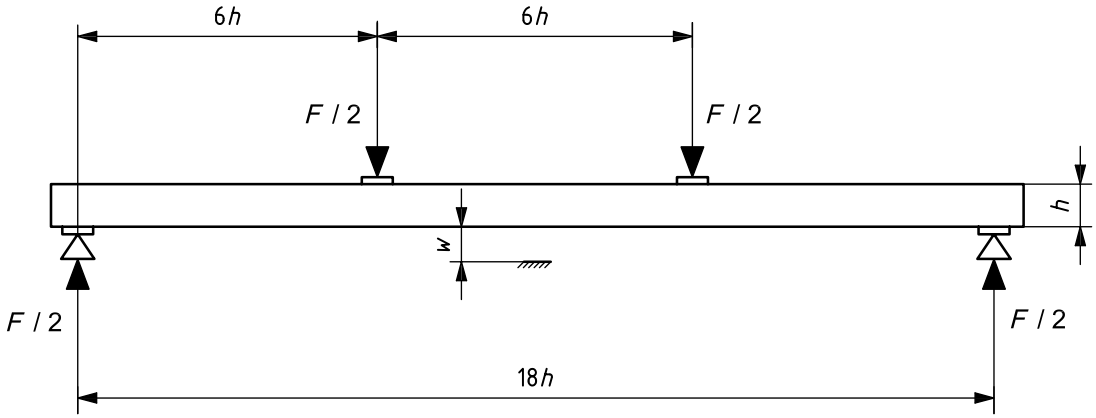


Figure 3 — Test arrangement for measuring global modulus of elasticity in bending

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test specimen or, for loads less than 10 % of the applied maximum load, with an accuracy of 0,1 % of the maximum applied load.

The deformation, w, shall be measured at the neutral axis at the centre of the span.

The deformation measuring devices and recording system shall be such as to permit measuring deflections to the nearest millimetre.

NOTE 4 ASTM D198 provides a description of an acceptable defection measuring device and the yoke.

10.3 Expression of results

The global modulus of elasticity in bending, $E_{m,g}$, is given by the equation

$$E_{m,g} = \frac{l^3(F_2 - F_1)}{bh^3(w_2 - w_1)}\left[\left(\frac{3a}{4l}\right) - \left(\frac{a}{l}\right)^3\right] \quad (2)$$

where

$F_2 - F_1$ is an increment of load on the straight-line portion of the load deformation curve, in newtons

$w_2 - w_1$ is the increment of deformation corresponding to $F_2 - F_1$, in millimetres

(see Figure 2 for $F_2 - F_1$ and $w_2 - w_1$ plot).

The other symbols are as given in Clause 4.

The global modulus of elasticity should be reported to no more than three significant figures.

11 Determination of shear modulus of the beam — single span method

11.1 General

This method involves the determination of the local modulus of elasticity in bending, $E_{m,l}$, and the apparent modulus of elasticity, $E_{m,app}$, for the same length of test specimen.

NOTE Measurement of the shear modulus of glued laminated timber presents considerable difficulty but values suitable for use in design can be obtained by either one of the methods described in Clauses 11 and 12. The fixed span method as described in this clause is commonly preferred due to its relative simplicity and reliability. The shear modulus can also be estimated as $G_{est} = E/16$.

11.2 Determination of modulus of elasticity in bending

The local modulus of elasticity in bending shall be determined in accordance with Clause 9.

11.3 Determination of apparent modulus of elasticity

11.3.1 Test specimen

The test specimen shall be that used for the determination of the local modulus of elasticity in bending, see 9.1.

11.3.2 Procedure

The test specimen shall be loaded in centre point bending over a span equal to the gauge length used in 9.2 and including the same test length, as shown in Figure 4 (see also Figure 1). In this case, $l = l_1$.

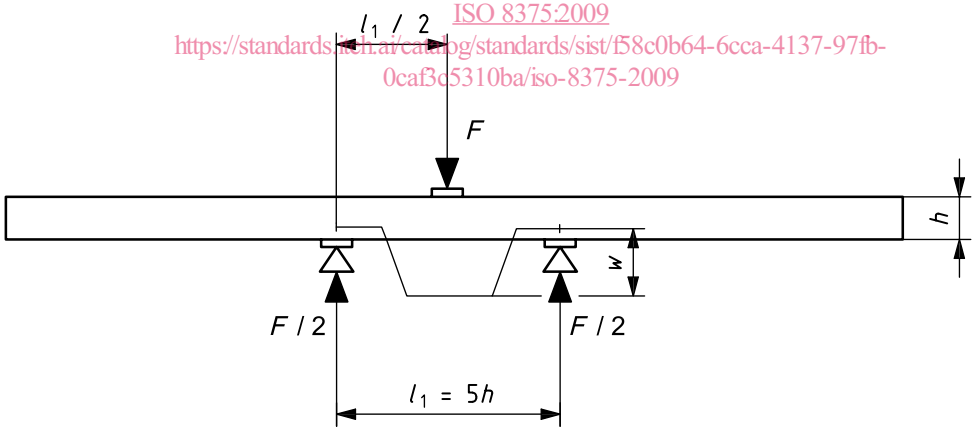


Figure 4 — Test arrangement for measuring apparent modulus of elasticity

The test specimen shall be simply supported.

NOTE 1 Small steel plates of length not greater than one-half of the depth of the test specimen can be inserted between the specimen and the loading heads or supports to minimize local indentation.

Lateral restraint shall be provided as necessary to prevent buckling. This restraint shall permit the specimen to deflect without significant frictional resistance.

Load shall be applied at a constant rate and the test should be completed within approximately 300 s but not less than 180 s.

NOTE 2 Ideally, the load application rate is determined from the results of preliminary tests. The objective is that the average time to reach F_{max} is 300 s.