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Third edition
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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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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 8375:2009), which has been technically revised.

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

1 Scope

This document specifies test methods suitable 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.

This document is applicable to rectangular shapes of glued laminated timber.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
density
characteristic 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 %

Note 1 to entry: ISO 12122-1 and ISO 12122-3 provide guidelines for statistical processing of data to determine characteristic values such as density.

3.2
strength
characteristic 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

Note 1 to entry: ISO 12122-1 and ISO 12122-3 provide guidelines for statistical processing of data to determine characteristic values such as strength.

3.3
elasticity
characteristic 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 1 to entry: ISO 12122-1 and ISO 12122-3 provide guidelines for statistical processing of data to determine characteristic values such as elasticity.

3.4
specimen
item to be tested for the determination of all characteristic values

Note 1 to entry: The minimum number of test specimens required for the determination of all characteristic values is provided in ISO 12122-1 and ISO 12122-3, unless otherwise noted for the specific test involved.

3.5
population
specimens (3.4) used to determine characteristic values

Note 1 to entry: Specimens should be reflective of the population they are intended to represent.

4 Symbols and suffixes

4.1 Symbols

A	cross-sectional area, in square millimetres
a	distance between a loading position and the nearest support in a bending test, in millimetres
b	width of cross section in a bending test, or the smaller dimension of the cross section, in millimetres
$E_{c,0}$	modulus of elasticity in compression parallel to the grain, in megapascals
$E_{c,90}$	modulus of elasticity in compression perpendicular to the grain, in megapascals
$E_{m,g}$	global modulus of elasticity in bending, in megapascals
$E_{m,app}$	apparent modulus of elasticity in bending, in megapascals
$E_{t,0}$	modulus of elasticity in tension parallel to the grain, in megapascals
$E_{t,90}$	modulus of elasticity in tension perpendicular to the grain, in megapascals
F	load, in newtons
$F_{c,90,max}$	maximum compressive load perpendicular to the grain, in Newtons
$F_{c,90,max,est}$	estimated maximum compressive load perpendicular to the grain, in Newtons
F_{max}	maximum load, in Newtons
$F_{max,est}$	estimated maximum load, in Newtons
$F_{t,90,max}$	maximum tensile load perpendicular to the grain, in Newtons
$f_{c,0}$	compressive strength parallel to the grain, in megapascals

$f_{c,90}$	compressive strength perpendicular to the grain, in megapascals
f_m	bending strength, in megapascals
$f_{t,0}$	tensile strength parallel to the grain, in megapascals
$f_{t,90}$	tensile strength perpendicular to the grain, in megapascals
f_v	shear strength parallel to the grain, in megapascals
G	shear modulus, in megapascals
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, in millimetres
h_0	gauge length, in millimetres
I	second moment of area, in millimetres to the fourth power
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, in millimetres
S	section modulus, in millimetres to the third power
w	deformation, in millimetres

4.2 Suffixes

1, 2 loads or deformations at particular points of a test, referred to as necessary in the text

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, shear, 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 or ASTM D4442 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 test from the measurements of mass and volume of the whole test specimen.

As an alternative, the provisions of ISO 3131 or ASTM D2395 are acceptable 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 weightings, carried out at an interval of 6 h, do not differ by more than 0,1 % of the mass of the test specimen.

The provisions of ASTM D4933 are also acceptable 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.

NOTE Test specimens can be stored in the test area for up to 24 h provided they are closely stacked and wrapped in vapour-tight wrapping.

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 document 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.

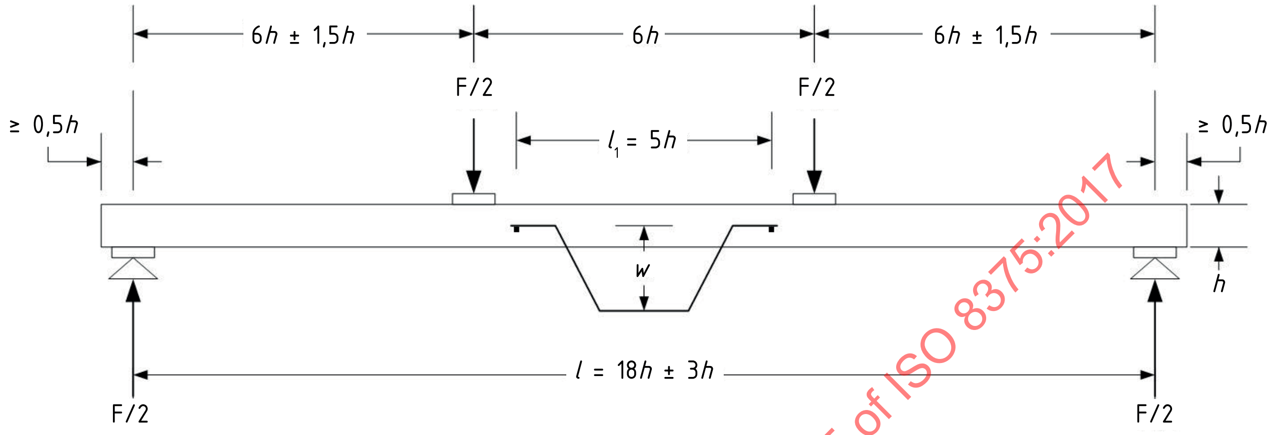


Figure 1 — Test arrangement for measuring local modulus of elasticity in bending

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 is given by Formula (1):

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

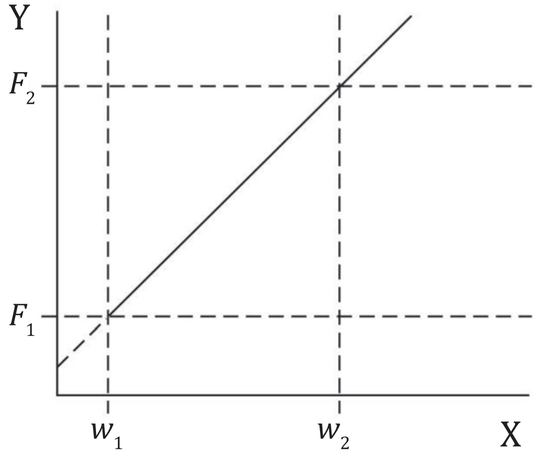
where

$F_2 - F_1$ 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 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 document 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.

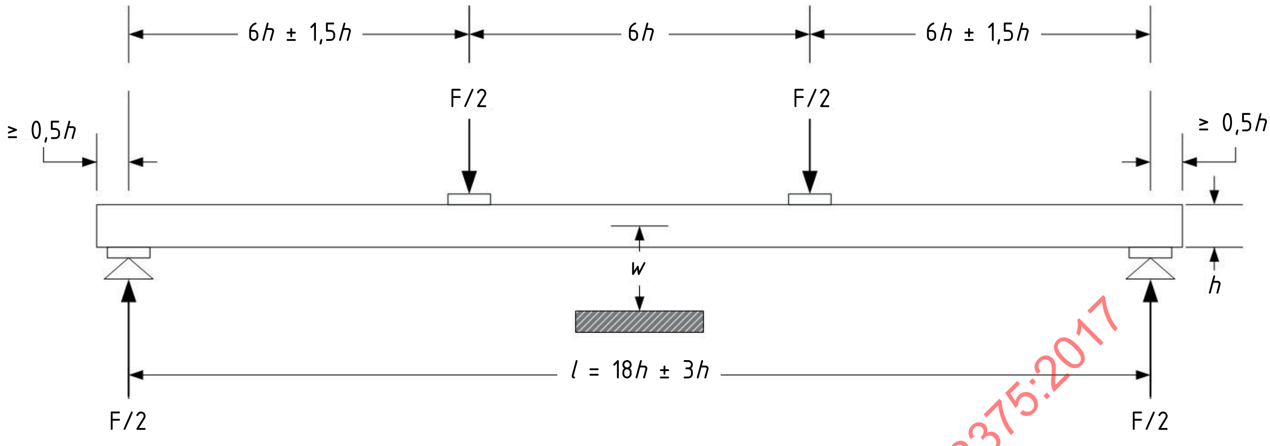


Figure 3 — Test arrangement for measuring global modulus of elasticity in bending

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 is given by Formula (2):

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

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

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

11.1 General

This method involves the determination of the apparent modulus of elasticity $E_{\mathrm{m,app}}$ for each test specimen over a number of spans with the same cross section at the centre.

11.2 Test piece

The test specimen shall have a minimum length of 18 times the depth of the section as shown in Figure 4.

11.3 Procedure

The test specimen shall be loaded in centre point bending over at least four different spans with the same cross section at the centre of each, as shown in Figure 4. The spans shall be chosen so as to have approximately equal increments of $\left(\frac{h}{\ell}\right)^2$ between them, within the range 0,002 5 to 0,035. The test spans shall be reported.

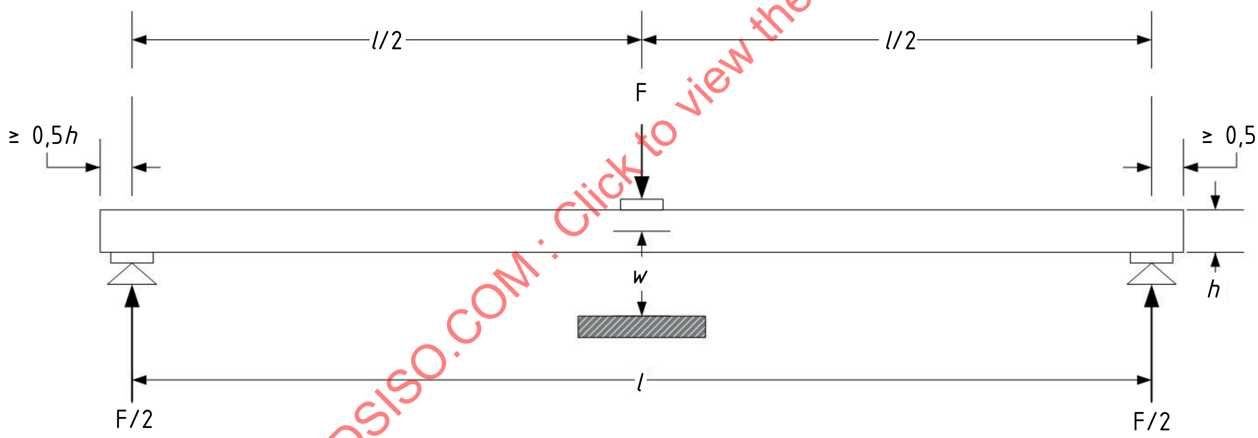
The test specimen shall be simply supported.

NOTE Small steel plates of length not greater than one-half of the depth of the test specimen can be inserted between the piece 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.

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



NOTE See 11.3 for variable spans (l) as a function of beam depth (h).

Figure 4 — Test arrangement for measuring shear modulus of the beam

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

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.

Deformations shall be measured 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.

11.4 Expression of results

11.4.1 Determination of K_1 *and* K_2

The apparent modulus of elasticity for each test specimen is given by Formula (3):

$$E_{\mathrm{m,app}} = \frac{l^3 (F_2 - F_1)}{4bh^3 (w_2 - w_1)} \tag{3}$$

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.

For each specimen, the values of $1/E_{\mathrm{m,app}}$ shall be plotted against $\left(\frac{h}{\ell}\right)^2$ as shown in Figure 4 and the slope K_1 of the best straight line through the points shall be determined.

K_2 is the intercept of the line at zero $\left(\frac{h}{\ell}\right)^2$.

11.4.2 Shear modulus

The shear modulus G is given by Formula (4):

$$G = k_G / K_1 \tag{4}$$

where

k_G is equal to 1,2 for rectangular or square cross sections;

K_1 is the slope of the straight line (see Figure 5).

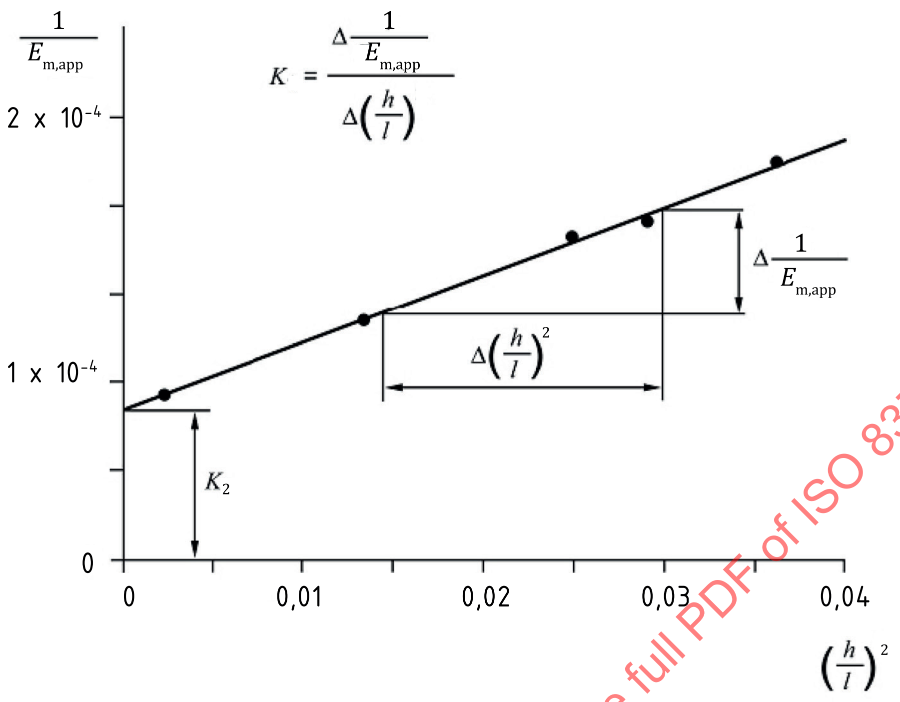


Figure 5 — Determination of shear modulus — Variable span method

12 Determination of bending strength of the beam

12.1 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.

12.2 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 document 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.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test specimen.

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

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

The time to failure for each test piece shall be recorded and reported.

12.3 Expression of results

The bending strength f_m is given by Formula (5):

$$f_m = a\,F_{max}/(2S) \qquad (5)$$

The mode of fracture and the growth characteristics at the fracture section of each test piece shall be recorded.

13 Determination of the modulus of elasticity in tension parallel to the grain of the glued laminated timber

13.1 General

The measurement of modulus of elasticity in tension parallel to grain of glued laminated timber presents considerable difficulty but values suitable for use in design can be obtained using the method of this section. The axial modulus of elasticity may also be estimated as the average weighted average of the modulus of elasticity of the individual laminations.

13.2 Test specimen

The test specimen shall be of sufficient length to provide a test length clear of the testing machine grips of at least nine times the larger cross-sectional dimension.

13.3 Procedure

The test specimen shall be loaded using gripping devices that will permit the application of a tensile load without inducing bending. The gripping devices and loading conditions actually used shall be reported.

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

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

The maximum load applied shall not exceed the proportional limit load or cause damage to the test specimen. If significant movement occurs, for example with wedge type grips, preliminary tests may be needed to establish a rate of movement of the machine cross-head.

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.

Deformation shall be measured over a length of five times the width of the specimen, located not closer to the ends of the grips than twice this width. Two extensometers shall be used and shall be positioned to minimize the effects of distortion.

The deformation measuring devices and recording system shall be such as to permit measuring deformations in millimetres to three significant figures.

13.4 Expression of results

The modulus of elasticity in tension $E_{t,0}$ is given by Formula (6):

$$E_{t,0} = \frac{l_1 (F_2 - F_1)}{A(w_2 - w_1)} \quad (6)$$

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 modulus of elasticity in tension should be reported to no more than three significant figures.

14 Determination of the parallel to the grain tension strength of the glued laminated timber

14.1 Test specimen

The test specimen shall be of sufficient length to provide a test length clear of the testing machine grips of at least nine times the larger cross-sectional dimension.

14.2 Procedure

The test specimen shall be loaded using gripping devices that will permit the application of a tensile load without inducing bending. The gripping devices and loading conditions actually used shall be reported.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test specimen.

Load shall be applied at a constant loading-head movement so adjusted that maximum load is reached within approximately 300 s but not less than 180 s.

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

The time to failure for each test specimen shall be recorded and reported.

14.3 Expression of results

The tensile strength $f_{t,0}$ is given by Formula (7):

$$f_{t,0} = F_{max} / A \quad (7)$$

The mode of fracture and growth characteristics at the fracture section of each test specimen shall be recorded. If failure is associated with the grips, this shall be reported.

When failure is associated with the grips, it should be permitted to disregard that result in the evaluation of the results.

15 Determination of the modulus of elasticity in compression parallel to the grain of the glued laminated timber

15.1 General

The measurement of modulus of elasticity in compression parallel to grain of glued laminated timber presents considerable difficulty but values suitable for use in design can be obtained using the method of this section. The axial modulus of elasticity may also be estimated as the average weighted average of the modulus of elasticity of the individual laminations.

15.2 Test specimen

The test specimen shall have a length of six times the smaller cross-sectional dimension. The end surfaces shall be accurately prepared to ensure that they are plane and parallel to one another and perpendicular to the axis of the piece.

15.3 Procedure

The test specimen shall be loaded concentrically using spherically seated loading-heads or other devices that permit the application of a compressive load without inducing bending. After an initial load has been applied, the loading-heads shall be locked to prevent angular movement. The gripping devices and loading conditions actually used shall be reported.

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

Ideally, the load application rate should be 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.

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

Deformation shall be measured over a central gauge length of four times the smaller cross-sectional dimension of the piece. Two extensometers shall be used and shall be positioned to minimize the effects of distortion.

The deformation measuring devices and recording system shall be such as to permit measuring deformations in millimetre to three significant figures.

15.4 Expression of results

The modulus of elasticity in compression $E_{c,0}$ is given by Formula (8):

$$E_{c,0} = \frac{\ell_1 (F_2 - F_1)}{A(w_2 - w_1)} \quad (8)$$

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 modulus of elasticity in compression should be reported to no more than three significant figures.

16 Determination of the parallel to grain compression strength of the glued laminated timber

16.1 Test specimen

The test specimen shall have a length of six times the smaller cross-sectional dimension. The end surfaces shall be accurately prepared to ensure that they are parallel to one another and perpendicular to the axis of the piece.

16.2 Procedure

The test specimen shall be loaded concentrically using spherically seated loading-heads or other devices, which permit the application of a compressive load without inducing bending. After an initial load has been applied the loading-heads shall be locked to prevent angular movement. The gripping devices and loading conditions actually used shall be reported.

The loading equipment used shall be capable of measuring the load to an accuracy of 1 % of the load applied to the test piece.

Load shall be applied at a constant loading-head movement so adjusted that maximum load is reached within approximately 300 s but not less than 180 s.

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

The time to failure of each test specimen shall be recorded and reported.

16.3 Expression of results

The compressive strength $f_{c,0}$ is given by Formula (9):

$$f_{c,0} = F_{max} / A \tag{9}$$

The mode of fracture and growth characteristics at the fracture section of each test piece shall be reported.

17 Determination of the modulus of elasticity in compression and tension perpendicular to the grain of the glued laminated timber

17.1 Requirements for test specimens

Specimens for perpendicular to grain tests shall be planed to obtain a smooth surface to allow for uniform application of the loads to the test pieces.

For tension tests, the test specimen shall be glued to steel plates. The gluing process shall be capable of ensuring the specified position of the test specimen during testing.

A suitable adhesive for fixing the steel plates to the timber test specimen is a two-part epoxy. Immediately prior to gluing, the surfaces to be joined should be prepared by planing the timber test specimen surfaces and cleaning the steel plates.

The loaded surfaces shall be accurately prepared to ensure that they are parallel to each other and perpendicular to the test specimen axis. This preparation shall be carried out after conditioning.

The test specimens shall have the dimensions given in Table 1, with the object of achieving a volume of 0,01 m^3 for tension test specimens and be as shown in Figure 7.

17.2 Procedure

The test specimen shall be mounted vertically between the test machine plates and the appropriate compression or tension loads applied. The gauge length, h_0 (approximately 0,6 h), shall be located centrally in the test piece height and not closer than $b/3$ to the loaded ends of the test piece; see Figure 8. For the compression perpendicular tests, the gauge length, h, is the distance between the test machine plates.

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 maximum load, with an accuracy of 0,1 % of the maximum load.

The test specimen shall be loaded concentrically such as by applying the load through a pin located at the geometric centre of the specimen cross-section.

NOTE 1 This can also be achieved using spherically seated loading-heads

In the case of the compression test, after an initial load has been applied, the loading-heads shall be locked to prevent rotation or angular movement during the test.

In the case of either a tension test or a compression test, the longitudinal axis of the test specimen shall be aligned with the axis of the machine and fixed in such a way that no initial stresses in the test piece are introduced, except those due to the weight of the test specimen and the equipment.

In the case of tension tests on glued laminated timber, the test specimen shall have pinned ends, with the axis of the pin parallel to the grain direction of the test specimen.

The load F shall be applied at a constant rate of cross head movement throughout the test so adjusted that the maximum load $F_{c,90,max,est}$ or $F_{t,90,max}$ is reached within approximately 300 s but not less than 180 s.

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

NOTE 2 The relationship between $F_{c,90,max,est}$ and $F_{c,90,max}$ is discussed in 17.3.1.

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

Two extensometers shall be used and shall be positioned to minimize the effects of distortion. The extensometers shall permit the measurement of the deformations to three significant figures and shall be determined to an accuracy of 1 %. The deformation in the load direction refers to the centre of the loaded section and is calculated on the basis of measurements on two opposite sides of the test piece.

The data from each extensometer shall be recorded separately.

17.3 Expression of results

17.3.1 Compression perpendicular to the grain

The modulus of elasticity $E_{c,90}$ shall be calculated from Formula (10):

$$E_{c,90} = \frac{(F_{40} - F_{10})h_0}{(w_{40} - w_{10})bl} \tag{10}$$

where

$F_{40} - F_{10}$ is an increment of load on the straight line portion of the load-deformation curve, in Newtons (F_{10} shall be 10 % and F_{40} shall be 40 % of $F_{c,90,max}$);

$w_{40} - w_{10}$ is the increment of deformation corresponding to $F_{40} - F_{10}$, in millimetres.

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

The physical characteristics of the test specimen (presence of knots, other growth characteristics or seasoning characteristics) shall be reported.

The determination of $F_{c,90,max}$ shall be carried out using the iterative process as follows:

a) Using the test results, plot the load-deformation diagram in the form shown in Figure 6.

b) A value of $F_{c,90,max}$ shall be estimated and values of 0,1 $F_{c,90,max}$ and 0,4 $F_{c,90,max}$ are calculated and located on the load-deformation curve.

c) The slope of a line through these two points shall be determined, and a parallel line drawn through the point corresponding to a load of F=0 and a deformation of w=0,01 h_0.

d) The intersection of the line and the load-deformation curve shall be taken as the next estimate of $F_{c,90,max}$.

e) Steps b) to d) shall be repeated until the value of $F_{c,90,max}$ determined in step d) is within 5 % of the previously estimated value.

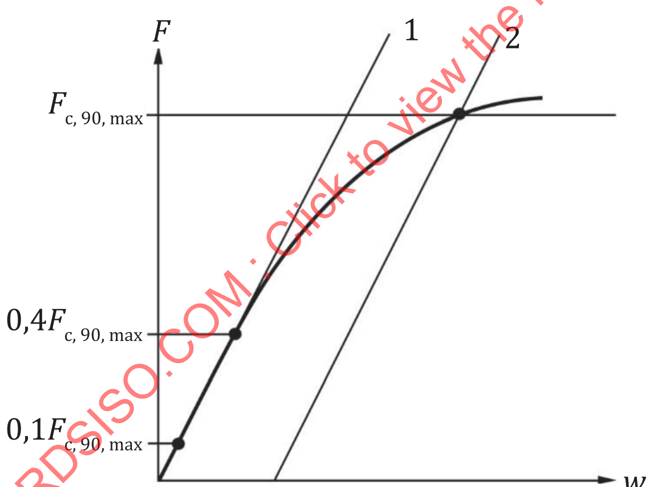


Figure 6 — Load-deformation diagram (compression)

17.3.2 Tension perpendicular to the grain

The modulus of elasticity $E_{t,90}$ shall be calculated from Formula (11):

$$E_{t,90} = \frac{(F_{40} - F_{10})h_0}{(w_{40} - w_{10})bl} \qquad (11)$$

where

$F_{40} - F_{10}$ is an increment of load on the straight line portion of the load-deformation curve, in Newtons (F_{10} shall be 10 % and F_{40} shall be 40 % of $F_{t,90,max}$);

$w_{40} - w_{10}$ is the increment of deformation corresponding to $F_{40} - F_{10}$, in millimetres.

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

The physical characteristics of the test specimen (presence of knots, other growth characteristics or seasoning characteristics) shall be reported.

18 Determination of tension and compression strengths perpendicular to the grain of the glued laminated timber

18.1 Requirements for test specimens

18.1.1 Fabrication

Specimens for perpendicular to grain tests shall be planed to obtain a smooth surface to allow for uniform application of the loads to the test pieces.

For tension tests, the test specimen shall be glued to steel plates. The gluing process shall be capable of ensuring the specified position of the test specimen during testing.

A suitable adhesive for fixing the steel plates to the timber test specimen is a two-part epoxy. Immediately prior to gluing, the surfaces to be joined should be prepared by planing the timber test specimen surfaces and cleaning the steel plates.

18.1.2 Surface preparation

The loaded surfaces shall be accurately prepared to ensure that they are plane and parallel to each other and perpendicular to the test specimen axis. This preparation shall be carried out after conditioning. The test specimens shall have the dimensions given in Table 1, with the object of achieving a volume of 0,01 m^3 for tension test specimens, and be as shown in Figure 7.

Table 1 — Dimensions of glued laminated timber test specimen for perpendicular to grain tests

Test method	Glued laminated timber dimensions			
	Volume (m^3)	A (mm^2)	Minimum b (mm)	h (mm)
Tension perpendicular to grain	0,01	25 000	100	400
Compression perpendicular to grain	—	25 000	100	200

18.2 Procedure

The test specimen shall be mounted vertically between the test machine plates and the appropriate compression or tension loads applied.

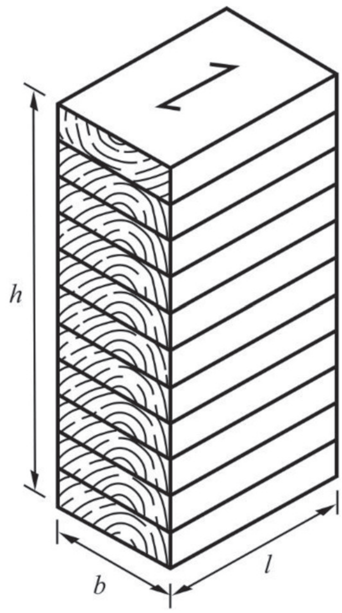


Figure 7 — Glued laminated timber test specimen

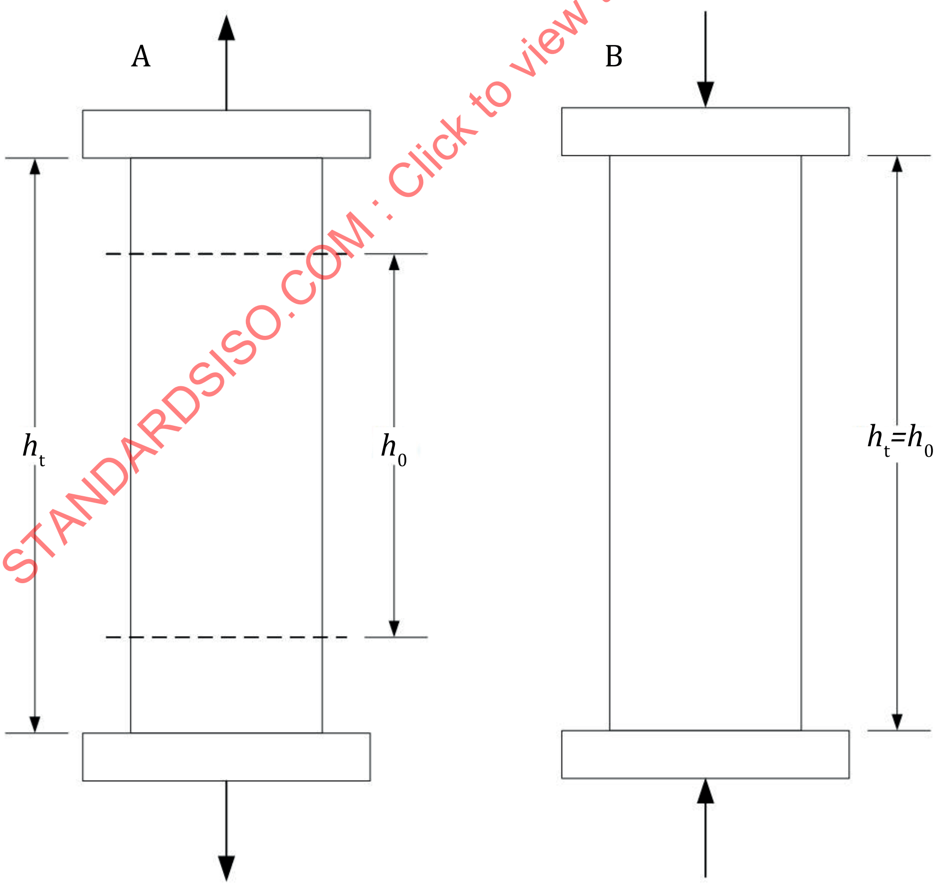


Figure 8 — Test principle

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 maximum load, with an accuracy of 0,1 % of the maximum load.

The test specimen shall be loaded concentrically such as by applying the load through a pin located at the geometric centre of the specimen cross-section.

NOTE 1 This can also be achieved using spherically seated loading-heads.

In the case of the compression test, after an initial load has been applied, the loading-heads shall be locked to prevent rotation or angular movement during the test.

In the case of either a tension test or a compression test, the longitudinal axis of the test specimen shall be aligned with the axis of the machine and fixed in such a way that no initial stresses in the test piece are introduced, except those due to the weight of the test specimen and the equipment.

In the case of tension tests on glued laminated timber, the test specimen shall have pinned ends, with the axis of the pin parallel to the grain direction of the test specimen.

The load F shall be applied at a constant rate of cross head movement throughout the test so adjusted that the maximum load $F_{c,90,max,est}$ or $F_{t,90,max}$ is reached within approximately 300 s but not less than 180 s.

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

NOTE 2 The relationship between $F_{c,90,max,est}$ and $F_{c,90,max}$ is discussed in 18.3.1.

18.3 Expression of results

18.3.1 Compression perpendicular to the grain

The compressive strength $f_{c,90}$ shall be determined from Formula (12):

$$f_{c,90} = \frac{F_{c,90,max}}{bl} \tag{12}$$

The determination of $F_{c,90,max}$ shall be carried out using the iterative process as follows:

a) Using the test results, plot the load-deformation diagram in the form shown in Figure 6.

b) A value of $F_{c,90,max}$ shall be estimated and values of 0,1 $F_{c,90,max}$ and 0,4 $F_{c,90,max}$ are calculated and located on the load-deformation curve.

c) The slope of a line through these two points shall be determined, and a parallel line drawn through the point corresponding to a load of F=0 and a deformation of w=0,01 h_0.

d) The intersection of the line and the load-deformation curve shall be taken as the next estimate of $F_{c,90,max}$.

e) Steps b) to d) shall be repeated until the value of $F_{c,90,max}$ determined in step d is within 5 % of the previously estimated value.

NOTE ISO 12122-3 provides more information, concerning the compressive strength perpendicular to grain, $f_{c,90}$, for glued laminated timber.

The physical characteristics of the test specimen (presence of knots, other growth characteristics or seasoning characteristics) shall be reported.

18.3.2 Tension perpendicular to the grain

The tensile strength $f_{t,90}$ shall be determined from Formula (13):

$$f_{t,90} = \frac{F_{t,90,max}}{bl} \tag{13}$$

The result of a test shall be disregarded where failure occurs on the system used to connect the test specimen to the testing machine (e.g. in the glue line between the steel plates and the timber of the test specimen). If the failure occurs partly in the glued area of the test specimen/steel plate interface, the result is valid only if this area is less than 20 % of the area of failure.

The physical characteristics of the test specimen (presence of knots, other growth characteristics or seasoning characteristics) shall be reported.

19 Determination of shear strength parallel to the grain — Small specimen test

19.1 Requirements for test specimens

19.1.1 Fabrication

The test specimen shall be representative of the lamina used in the core of the glued laminated timber (approximately the centre 50 % of the depth of the member) and not include glue lines. It shall be glued to steel plates as shown in Figure 9. The steel plates shall be tapered as shown in Figure 9.

A suitable adhesive for fixing the steel plates to the timber test specimen is a two-part epoxy. Immediately prior to gluing, the surfaces to be joined should be prepared by planing the timber test specimen surfaces and cleaning the steel plates.

19.1.2 Surface preparation

All surfaces shall be accurately prepared to ensure that adjacent surfaces are perpendicular and opposite surfaces are parallel to each other. This preparation shall be carried out after conditioning.

The test specimen shall satisfy the requirements shown in Figure 9 and the values of the dimensions shown shall be as follows:

l = (300 ± 2) mm;

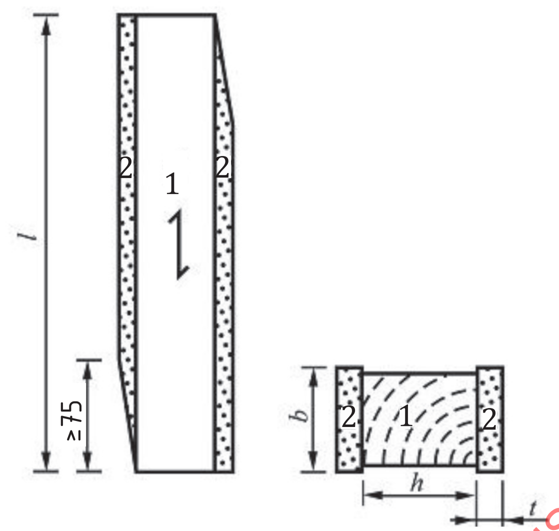
b = (32 ± 1) mm;

h = (55 ± 1) mm.

The steel plate thickness shall be (10 ± 1) mm.

NOTE Variations in these dimensions are permissible within the stated tolerances, to achieve the object of an angle of 14° in the test.

Dimensions in millimetres



Key

1 lamina test specimen

2 steel plates

NOTE ⇀ indicates parallel to grain orientation

Figure 9 — Test specimen shown glued to steel plates

19.2 Procedure

The test specimen shall be mounted in a test machine as shown in Figure 10. The test piece shall be aligned such that continuous contact is maintained where the line loads F are applied. The angle between the load direction and the longitudinal axis of the test piece shall be 14°.