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Timber structures — Laminated veneer lumber — Structural properties

Structures en bois — Lamibois — Propriétés structurelles

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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.

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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 22390 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

Introduction

Laminated veneer lumber (LVL) is being produced in many countries under different national standards and these products are being exported from one country to another. While the national standards have many similarities, there are also many areas of dissimilarity. Thus, there is a need for the development of this International Standard to establish consistency between these standards in order to ensure the suitability of LVL for structural end-use applications, regardless of country of manufacture or country of end use. It is intended for this to have value to industry, consumers, governments and distributors.

Timber structures — Laminated veneer lumber — Structural properties

1 Scope

This International Standard specifies requirements for establishing the characteristic properties of structural laminated veneer lumber (LVL), including 5th percentile strength values, stiffness characteristics and other performance characteristics, related to its end use as a structural product for dry use (bonding class 1). It is applicable to members used in flatwise or edgewise bending orientations.

It does not cover the assessment of formaldehyde requirements, biological durability, fire performance or manufacturing, such as quality control and marking.

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 10033-1, *Laminated veneer lumber — Bonding quality — Part 1: Test methods*

ISO 10033-2, *Laminated veneer lumber — Bonding quality — Part 2: Requirements*

ISO 13910*, Structural timber — Characteristic values of strength-graded timber — Sampling, full-size testing and evaluation*

ISO 16572, *Timber structures — Wood-based panels — Test methods for structural properties*

ISO 16979, *Wood-based panels — Determination of moisture content*

EN 408-03, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

ASTM D143-09, *Standard Test Methods for Small Clear Specimens of Timber*

ASTM D198-09, *Standard Test Methods of Static Tests of Lumber in Structural Sizes*

ASTM D4761-05*, Standard Test Methods for Mechanical Properties of Lumber and Wood-Base Structural Material*

ASTM D5456-06, *Standard Specification for Evaluation of Structural Composite Lumber Products*

ASTM D6815-09, *Standard Specification for Evaluation of Duration of Load and Creep Effects of Wood and Wood-Based Products*

MAFF Notification No. 701, *Japanese Agricultural Standard for Laminated Veneer Lumber*

3 Terms and definitions

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

3.1
laminated veneer lumber
LVL
composite of wood veneer sheet elements manufactured from one or more species, either separately or mixed, with wood fibres primarily oriented along the length of the member

NOTE This does not exclude laminated veneer lumber with cross-laminated veneers.

3.2
characteristic value for strength
estimate of the 5th percentile values based on a statistical distribution obtained from results of tests on the defined properties in accordance with Clauses 5 and 6 with the test duration between 60 s and 300 s

3.3
characteristic value for stiffness
estimate of the mean property from results of tests on the defined properties in accordance with Clauses 5 and 6 with the test duration between 60 s and 300 s

NOTE The characteristic values used for 3.2 and 3.3 are either an estimate of the 5th percentile value or an estimate of the mean value of the sample as determined from ISO/TC 165 draft document on the evaluation of characteristic values for structural timber products.

3.4
population
assembly of samples that are clearly defined since the characteristic properties apply only to that population

NOTE The sample size is chosen to be representative of the reference population, taking into consideration the occurrence of strength-reducing characteristics which affect the structural property being evaluated.

3.5
test specimen
specimen cut from random locations within the pieces of the LVL samples

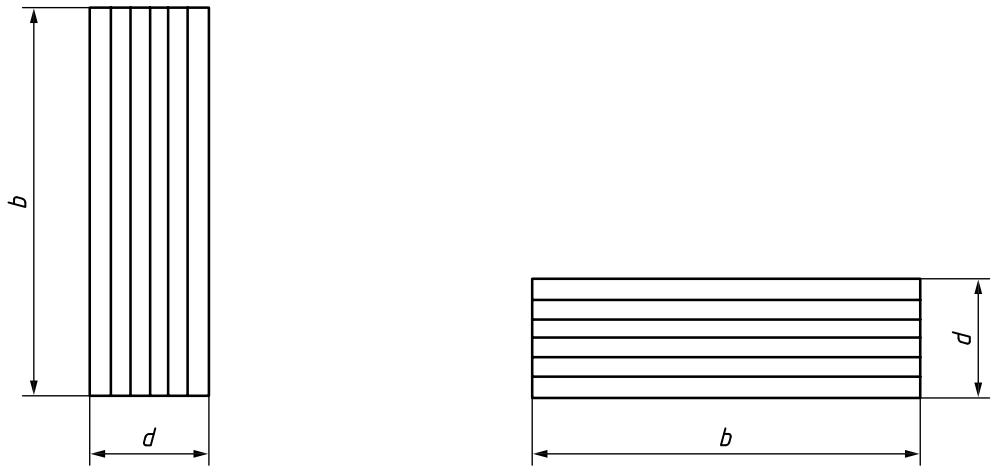
3.6
thickness
d
least dimension of a cross-section, which is perpendicular to the plane of the veneers

See Figure 1.

3.7
width
b
largest dimension of a cross-section, which is perpendicular to the thickness (or parallel to the plane of the veneers)

See Figure 1.

3.8
depth
dimension of the specimen related to the direction of the applied load, b for edgewise (joist) and d for flatwise (plank)



a) Cross-section related to edgewise bending **b) Cross-section related to flatwise bending**

Figure 1 — Thickness, d, and width, b, of cross-section of laminated veneer lumber

4 Requirements

4.1 Veneers

The minimum number of veneers in the cross-section shall be five. The maximum thickness of each veneer shall be 6 mm.

4.2 Bonding quality

The LVL shall utilize a structural adhesive suitable for dry service (bonding class 1) and the bonding quality and adhesive qualification shall be determined in accordance with ISO 10033-1 and ISO 10033-2.

NOTE 1 Attention is drawn to national standards which can be applicable.

NOTE 2 Examples of applicable national standards include EN 314-1, ASTM D5456 and JAS Notification No. 701.

NOTE 3 Additional testing to cover more severe bonding service conditions (bonding classes 2 and 3) can be considered as a manufacturer's option and can be required by some national standards.

4.3 Dimensions and tolerances

The dimensions of the test specimens shall be measured to the following accuracy:

a) for dimensions $\leqslant$ 150 mm: $\pm$ 0,1 mm;

b) for dimensions > 150 mm and $\leqslant$ 400 mm: $\pm$ 0,5 mm;

c) for dimensions > 400 mm: $\pm$ 1 mm.

All measurements shall be made after the test pieces have been conditioned in accordance with Clause 5. Width and thickness measurements (see Figure 1) shall be the average of three measurements taken at three different positions within the middle third of the specimen. Where possible, the measurements should not be taken within 150 mm of the ends of the test piece.

Local thickness deviations related to discontinuities of the veneers, e.g. knotholes and veneer joints, are allowed, but should be avoided in the measurement of section properties.

The angle of the cross-section, α, shall not deviate by more than 1:50 (about 1,1°) from a right angle. See Figure 2, where α is the angle between the vertical axis and the sloped end.

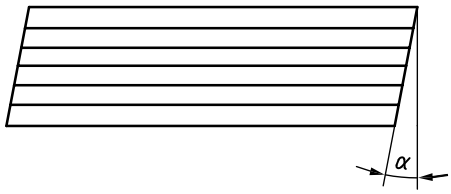


Figure 2 — Example of an angle, α, of a cross-section of laminated veneer lumber

5 Test methods

5.1 General

Characteristic strength values for edgewise and flatwise bending, tension parallel to the grain, compression parallel to the grain, edgewise and flatwise longitudinal shear and the mean compression perpendicular to grain strength shall be determined for laminated veneer lumber, as required by the product end-use application in accordance with 3.2 and the following requirements using the test methods in this clause.

All test specimens shall be conditioned to an equilibrium moisture content resulting from a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %. A test piece is considered to be conditioned when it attains constant mass. Constant mass is deemed to have been attained when the results of two successive weighings, carried out at intervals of not less than 6 hours, do not differ by more than 1 %.

If test pieces cannot be conditioned due to their size, the moisture content at time of test shall be reported and shall be within ±2% of the moisture content of a subsample of the same product and grade conditioned in accordance with 7.2, or the provisions of ASTM D5456 may be used for developing a moisture content correlation for applications to large specimens.

If other conditions, such as tropical conditions, are used, they shall be permitted and reported. The data should be developed at the specific moisture content relative to those conditions.

5.2 Edgewise bending strength

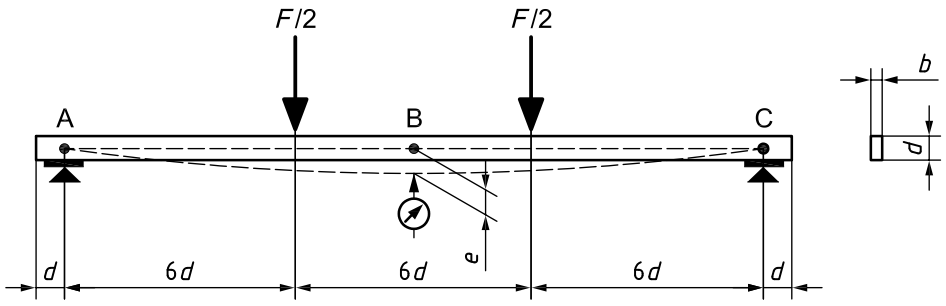
The edgewise bending strength test shall be carried out using a symmetric third-point load set-up as given in ISO 13910 (see Figure 3). In edgewise bending, the specimen dimension [d in Figure 1 a) and b in Figure 3] shall be at least 38 mm and the test span shall be at least 18 times dimension b in Figure 1 a). In addition, the minimum size of the specimen shall not be less than the minimum structural size manufactured.

NOTE 1 If b [see Figure 1 a)] is different than the reference width of 38 mm, the test results can be adjusted to a common size or value based on national codes.

NOTE 2 The provisions of ASTM D5456 provide an example of a methodology to adjust for size effects.

5.3 Flatwise bending strength

The flatwise bending strength tests shall be carried out using a symmetric third-point load set-up as given in ISO 13910 (see Figure 3). The test span of the specimen shall be at least 18 times the depth of the cross-section [dimension d in Figure 1 b)]. The minimum size of the specimen shall not be less than the minimum structural size manufactured.



Key

A and C centreline of bearing

B mid-span

b width of the test specimen

d thickness or depth of the specimen

e centrepoint deflection of the centreline of the specimen relative to the position of the centreline at the ends of the specimen

F load

NOTE For illustrative purposes, Figure 3 is shown for edgewise bending only.

Figure 3 — Configuration for one-third-point loading for determination of bending strength and stiffness

5.4 Tension strength parallel to the grain

The tension strength tests parallel to the grain shall be carried out using gripping devices which permit as far as possible the application of a tensile load without inducing bending. The gripping devices and loading conditions actually used shall be reported. The length of the specimen between the testing machine grips shall be at least 900 mm or at least 8 times the larger cross-sectional dimension and the minimum size of the specimen shall not be less than the minimum structural size manufactured.

If the length of the specimen between the testing machine grips is different than the reference length of 900 mm, the test results may need to be adjusted to a common size or value based on national codes. A failure in the grips of the test machine invalidates the results and a new test shall be required.

NOTE The provisions of ASTM D5456 provide an example of a methodology that can be used to adjust for length effects.

5.5 Compression strength parallel to the grain

The compression strength tests parallel to the grain shall be carried out such that the test piece is loaded concentrically using spherically seated loading-heads or other devices, which permit the application of a compressive load without inducing bending as given in ASTM D198. The bearing blocks and loading conditions actually used shall be reported. The length of the specimen shall be such that:

$$15 \leqslant \frac{L}{r} \leqslant 17$$

where

L is the unsupported length;

r is the least radius of gyration.

The end surfaces shall be accurately prepared to ensure that they are plane and parallel to one another and the load shall be applied in a direction generally parallel to the longitudinal axis of the test piece. The minimum

size of the specimen shall not be less than the minimum structural size manufactured. The mode of failure and growth characteristics at the failure section of each test piece shall be recorded.

5.6 Shear strength (edge) related to edgewise bending

Tests used to determine edgewise shear include a centre point single span test or the double span (five-point load test) as specified in ISO 13910. When evaluating the effects of systematic manufacturing characteristics that can affect horizontal shear strength, the structural size horizontal shear test method given in ASTM D5456-06, A3, may be used or ASTM D198-09, Clauses 36 to 43, may also be used.

5.7 Shear strength (flat) related to flatwise bending

The shear strength tests related to flatwise bending shall be carried out in accordance with the planar shear test method given in ISO 16572 or the block shear test given in ASTM D5456 or ASTM D143 or the short span bending test given in MAF notification No. 701. The thickness of the specimen [dimension d in Figure 1 b)] shall be at least 25 mm.

NOTE Specific test results can be different and can be adjusted according to applicable national standards.

5.8 Compression strength perpendicular to the grain

The compression strength tests perpendicular to the grain shall be carried out in accordance with the principle of ASTM D143 except that references to placement of growth rings are not applicable and the minimum specimen size is as indicated below for flatwise and edgewise orientations.

The loaded surfaces shall be accurately prepared to ensure that they are plane and parallel to each other and perpendicular to the test piece axis. The test piece shall be loaded concentrically using spherically seated loading heads and the load shall be applied at a constant rate of cross head movement throughout the test.

Depending on the product end use, compression perpendicular to grain values can be required for both the edgewise and flatwise orientations of the veneers. For flatwise bending, the minimum cross-section of the specimen shall be 38 mm $\times$ 38 mm. For edgewise bending, the minimum cross-section of the specimen shall be the thickness [dimension d in Figure 1a)] $\times$ 45 mm.

6 Stiffness

6.1 General

Local or apparent modulus of elasticity values for both flatwise and edgewise bending shall be determined. Modulus of elasticity values in tension and compression parallel to the grain shall also be determined and reported as required depending on the end-use application of the product. A correlation between axial stiffness values and bending stiffness values may be established to satisfy the determination of axial stiffness values.

6.2 Modulus of elasticity in edgewise bending

The modulus of elasticity tests parallel to the grain shall be carried out in accordance with the local modulus of elasticity in the bending test method given in EN 408, using a symmetric third-point loading configuration or the apparent modulus of elasticity determined in accordance with ASTM D198 or D4761. The specimen shall be loaded in edgewise bending. The test width of the specimen [dimension d in Figure 1 a)] shall be at least 60 mm and the test span shall be at least 18 times the depth of the cross-section [dimension b in Figure 1 a)]. The minimum size of the specimen shall not be less than the minimum structural size manufactured.

This value may be determined in combination with the test in 5.2.

Dynamic vibration methods to determine edgewise modulus of elasticity may be used, provided they have been calibrated to static methods.

6.3 Modulus of elasticity in flatwise bending

The modulus of elasticity tests parallel to the grain shall be carried out in accordance with the local modulus of elasticity in the bending test method given in EN 408 using a symmetric third-point loading configuration or the apparent modulus of elasticity determined in accordance with ASTM D198 or D4761. The specimen shall be loaded in flatwise bending. In flatwise bending, the thickness of the specimen [dimension d in Figure 1 b)] shall be the full thickness of the slab from which it was manufactured and the test span shall be at least 18 times the thickness of the cross-section. The minimum size of the specimen shall not be less than the minimum structural size manufactured.

This value may be determined in combination with the test in 5.3.

Dynamic vibration methods to determine flatwise modulus of elasticity may be used, provided they have been calibrated to static methods.

6.4 Modulus of elasticity in tension parallel to the grain

The test pieces shall be of full cross-section with a minimum length to provide a test length between the testing machine grips of at least 8 times the larger cross-section using self-aligning grips (see 5.4). The tension load shall be applied without inducing bending in the specimen. The maximum load applied shall not exceed the proportional limit load or cause damage to the test piece. Deformation shall be measured over a gauge length greater than five times the larger cross-sectional dimension of the piece and located no closer to the grips than twice the larger cross-sectional dimension.

6.5 Modulus of elasticity in compression parallel to the grain

The test pieces shall be of full cross-section with a minimum length of six times the smaller cross-sectional dimension in accordance with EN 408. The maximum length shall be such that:

$$\frac{L}{r} \leqslant 17$$

where

L is the unsupported length;

r is the least radius of gyration.

The test pieces shall be loaded concentrically using spherically seated loading heads, such that the compressive load is applied without inducing bending. Deformation shall be measured over a gauge length of four times the smaller cross-sectional dimension of the piece. Extensometers should be positioned on opposing faces or corners to compensate for end rotation during loading.

7 Other physical characteristics

7.1 Density

Fifth percentile as well as mean characteristic density values shall be determined.

The density shall be determined in accordance with the method given in ISO 13910.

7.2 Moisture content

The moisture content shall be determined in accordance with ISO 16979.

An oven dry method, such as that given in EN 322, may also be used. The provisions of ASTM D4442 may be used as well.

7.3 Species equivalency for connection properties

Species equivalency shall be determined between the laminated veneer lumber and a species or species combination of sawn timber for purposes of establishing withdrawal capacities of nails and bearing capacities of dowel-type fasteners. Species equivalency shall be established by determining an equivalent specific gravity for the laminated veneer lumber using the procedures of ASTM D5456-06, A2.

7.4 Creep and duration of load effects

Creep and duration of load (DOL) performance of the LVL shall be evaluated in accordance with ASTM D6815 for dry conditions of use. LVL products that meet the requirements of ASTM D6815 shall be permitted to use the creep and DOL factors applicable to sawn lumber. At a minimum, one representative grade (containing veneer joints at the expected frequency and spacing anticipated in production) per adhesive being used shall be evaluated. For products manufactured with one or more species, either separately or mixed, the greatest anticipated percentages of the highest density species should be evaluated. Hardwood and softwood species shall be evaluated separately. This test should only be performed in the orientation intended for the end use of the product, that is, edgewise, flatwise or both.

NOTE This test is only applicable to bending stresses and is not intended to be used for determining performance in axial tension or axial compression.

Bibliography

[1] ISO 8375, *Timber structures — Glued laminated timber — Test methods for determination of physical and mechanical properties*

[2] ISO 18776, *Laminated veneer lumber (LVL) — Specifications*

[3] EN 314-1, *Plywood — Bonding quality — Part 1: Test methods*

[4] EN 322, *Wood-based panels — Determination of moisture content*

[5] ASTM D4442-07, *Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials*

[6] AS/NZS 4357.2, *Structural laminated veneer lumber (LVL) — Part 2: Determination of structural properties — Part 2: Test methods*

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