INTERNATIONAL STANDARD

ISO 10033-1

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2011-04-15

Laminated Veneer Lumber (LVL) — Bonding quality —

Part 1: Test methods

Lamibois — Qualité du collage —

Partie 1: Méthodes d'essai

Reference number
ISO 10033-1:2011(E)

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Foreword

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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 10033-1 was prepared by Technical Committee ISO/TC 89, *Wood-based panels*, Subcommittee SC 3, *Plywood*.

ISO 10033 consists of the following parts, under the general title *Laminated Veneer Lumber (LVL) — Bonding quality*:

— *Part 1: Test methods*

— *Part 2: Requirements*

Laminated Veneer Lumber (LVL) — Bonding quality —

Part 1:
Test methods

1 Scope

This part of ISO 10033 specifies test methods for determining the bonding quality of Laminated Veneer Lumber (LVL) bonded with thermosetting resin.

NOTE If it is possible to demonstrate a correlation between the methods defined in this part of ISO 10033 and other methods, those methods can be used.

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 10033-2, *Laminated Veneer Lumber (LVL) — Bonding quality — Part 2: Requirements*

ISO 12466-1, *Plywood — Bonding quality — Part 1: Test methods*

ISO 12466-2, *Plywood — Bonding quality — Part 2: Requirements*

ISO 16999, *Wood-based panels — Sampling and cutting of test pieces*

3 Test pieces

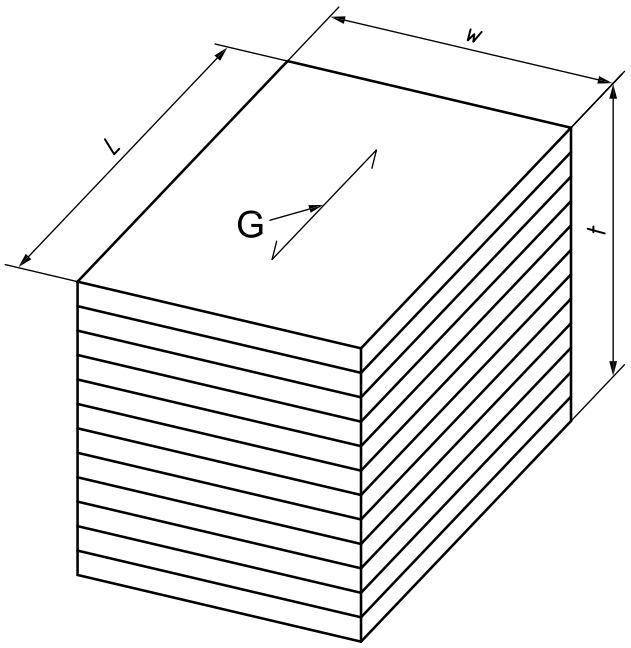
3.1 Sampling

Sampling shall be in accordance with ISO 16999.

The test pieces shall be without any visible defect in the testing area.

3.2 Shape and size

Each test piece shall be a (75 ± 1) mm $\times$ (75 ± 1) mm square and the full thickness of the LVL as shown in Figure 1. If the LVL sample is less than 75 mm across the end section, the test specimen shall have the actual width of the sample and a length of 75 mm. Permitted imperfection may be included in the test pieces.



Key

t thickness
L length
w width
G grain direction

Figure 1 — Test piece — Shape and size

4 Apparatus

4.1 Temperature-controlled water bath, suitable for immersing test pieces and capable of maintaining a minimum temperature of 17 °C, and/or (70 ± 3) °C.

NOTE Temperature capability depends on employed pre-treatment cycle(s).

4.2 Boiling tank, enabling test pieces to be immersed in boiling water.

4.3 Ventilated drying oven, capable of maintaining a temperature of (60 ± 3) °C and/or (70 ± 3) °C at all points.

NOTE Temperature capability depends on bonding class.

4.4 Vacuum pressure chamber, capable of maintaining in water at room temperature a vacuum of 85 kPa for 30 min followed immediately by application of pressure of (465 ± 15) kPa for 30 min.

4.5 Autoclave, capable of maintaining steam pressure at (200 ± 7) kPa for 6 h ± 15 min.

5 Pre-treatment

5.1 Sequence of pre-treatment

The choice of pre-treatment, described in 5.1.1 to 5.1.7 for particular LVL bonding classes, shall be made in accordance with ISO 10033-2.

5.1.1 24 h cold soak: immersion for 24 h in water at a temperature not lower than 17 °C.

NOTE (20 ± 3) °C can be considered as a test reference temperature.

5.1.2 6 h boil: immersion for 6 h in boiling water, followed by cooling in water at less than 30 °C for at least 1 h.

5.1.3 BDB (boil-dry-boil): immersion for 4 h in boiling water, then drying in the ventilated drying oven for 16 h to 20 h at (60 ± 3) °C, then immersion in boiling water for 4 h, followed by cooling in water at less than 30 °C for at least 1 h.

5.1.4 VP (vacuum pressure): test specimens are immersed in water at room temperature and a vacuum of 85 kPa is applied for 30 min followed by the immediate application of a pressure of (465 ± 15) kPa for 30 min.

5.1.5 72 h boil: immersion for (72 ± 1) h in boiling water, followed by cooling in water at less than 30 °C for at least 1 h.

5.1.6 Steam: specimens are placed in steam at (200 ± 7) kPa pressure for 6 h ± 15 min followed by cooling for at least 1 h in water at less than 30 °C.

5.1.7 Hot water soak: immersion in water at (70 ± 3) °C for 2 h. This test is not applicable to Annex A or B.

6 Procedure

6.1 Test piece preparation

After the pre-treatment, test pieces shall be processed as follows:

— bonding class 1: after the pre-treatment, test pieces shall be dried at a temperature of (60 ± 3) °C for 24 h, prior to evaluation;

— bonding class 2: after the pre-treatment, test pieces shall be dried at a temperature of (70 ± 3) °C for 24 h, prior to evaluation;

— bonding class 3: the pre-treatment shall be carried out twice. Test pieces shall be dried after each cycle of pre-treatment at (70 ± 3) °C for 24 h, prior to evaluation.

6.2 Measurement of delamination

The length of delamination in each glueline on the four sides of the test piece shall be measured. Delamination of a length less than 3 mm shall be ignored. The ratio of the delamination in each single glueline to the total length of the glueline on four sides shall be determined as a percentage. The ratio of the total length of delamination on the four sides to the total length of all gluelines on four sides shall also be calculated as a percentage.

The ratio of delamination shall be calculated by the following equations:

Ratio of delamination (%)

$$r_{\text{single}} = \frac{l_{\text{d,single}} \times 100}{l_{\text{g,single}}} \quad (1)$$

where

$l_{d,single}$ is the total length of delamination in a single glueline on four sides;

$l_{g,single}$ is the total length of a single glueline on four sides;

$$r_{total} = \frac{l_{d,total} \times 100}{l_{g,total}} \quad (2)$$

where

$l_{d,total}$ is the total length of delamination in all gluelines on four sides;

$l_{g,total}$ is the total length of all gluelines on four sides.

6.3 Alternative procedures

Alternative procedures for bond testing and evaluation, the lap shear test and the knife or chisel test are provided in Annexes A and B. These procedures are deemed suitable for quality control purposes.

7 Expression of results

The results shall be expressed as two ratios in percentages:

1) ratio of delamination (%) in any single glueline,

2) ratio of delamination (%) in total length of all gluelines.

8 Test report

The test report shall be in accordance with ISO 16999 and shall also contain the following information:

a) ratio of delamination (%) in any single glueline;

b) ratio of delamination (%) in total length of all gluelines;

c) details of pre-treatment (see 5.1);

d) reference to this part of ISO 10033.

Annex A
(normative)

Bond testing and evaluation using the shear testing procedures (suitable for internal production control)

A.1 General

For the evaluation of the bonding quality of LVL, apply ISO 12466-1 with the following modifications.

Depending on the lay-up and the position of the layers, the shear load shall be applied to the glueline by tension or compression of test pieces.

A.2 Test pieces

A.2.1 Preparation of test pieces

A.2.1.1 General

The making of the test pieces may require the removal of the material not to be tested and, in some cases, to bond a wood or plywood plate on the face(s) of the remaining material. It depends on:

— the number of plies in a layer: one or two plies in one direction and more than two plies in one direction;

— the position of the layer in the lay-up.

A.2.1.2 Layers with one or two plies in one direction

A.2.1.2.1 General

The test piece design is such that the tension load is applied across the grain of the layer to be tested.

A.2.1.2.2 **Face layer** (Figure A.1)

Cut a sample of a set of test pieces in such a way so that the length of a piece shall be across the grain of the face layer.

Keep the face layers and those underneath up to 15 mm and machine off the rest.

Cut a plate of 15 mm LVL made of the same species.

Bond this plate on the face layer of the LVL sample (the grain of the latter being at right angles to the grain of the face of the plate).

This glueline shall be compatible with the pre-treatment and the shear force applied to control the resistance of the glueline of the LVL to be tested.

On the LVL face, make a saw cut through it so that it reaches into the LVL face layer of the sample.

On the cleared face of the test sample, make a saw cut through the opposite layers so it reaches into the LVL face layer of the sample.

Cut the individual test pieces out of the sample.

The dimensions in the plane of the test pieces are the following:

— distance between the closer edges of the saw cuts: (25 ± 0,5) mm;

— width of the test piece: (25 ± 0,5) mm.

Total length of the test piece shall be consistent with:

— a shear area dimension along the load direction of 25 mm;

— a clearance of 50 mm, at least, between the clamps;

— the necessary length for its gripping.

Prior to pre-treatment, condition the test pieces in the standard climate (20 ± 2) °C and (65 ± 5) % RH so as to achieve the curing of the bond of the plates and the equilibrium of the moisture content.

Cohesive wood fibre failure (or wood fibre adhesion) shall be evaluated only on the glueline between the face layer and across the layer below.

NOTE The evaluation of the wood fibre adhesion of the glueline bonding the 15 mm LVL plate is not relevant.

A.2.1.2.3 **Core layers** (Figure A.1)

Considering the pair of gluelines to be tested, keep one or more layers on both sides of the layer in-between and machine off excess material on both sides; the test piece shall be nominally symmetrical.

Make a saw cut so as to reach into the layer between the two gluelines to be tested.

A.2.1.3 Layers with more than two plies

A.2.1.3.1 General

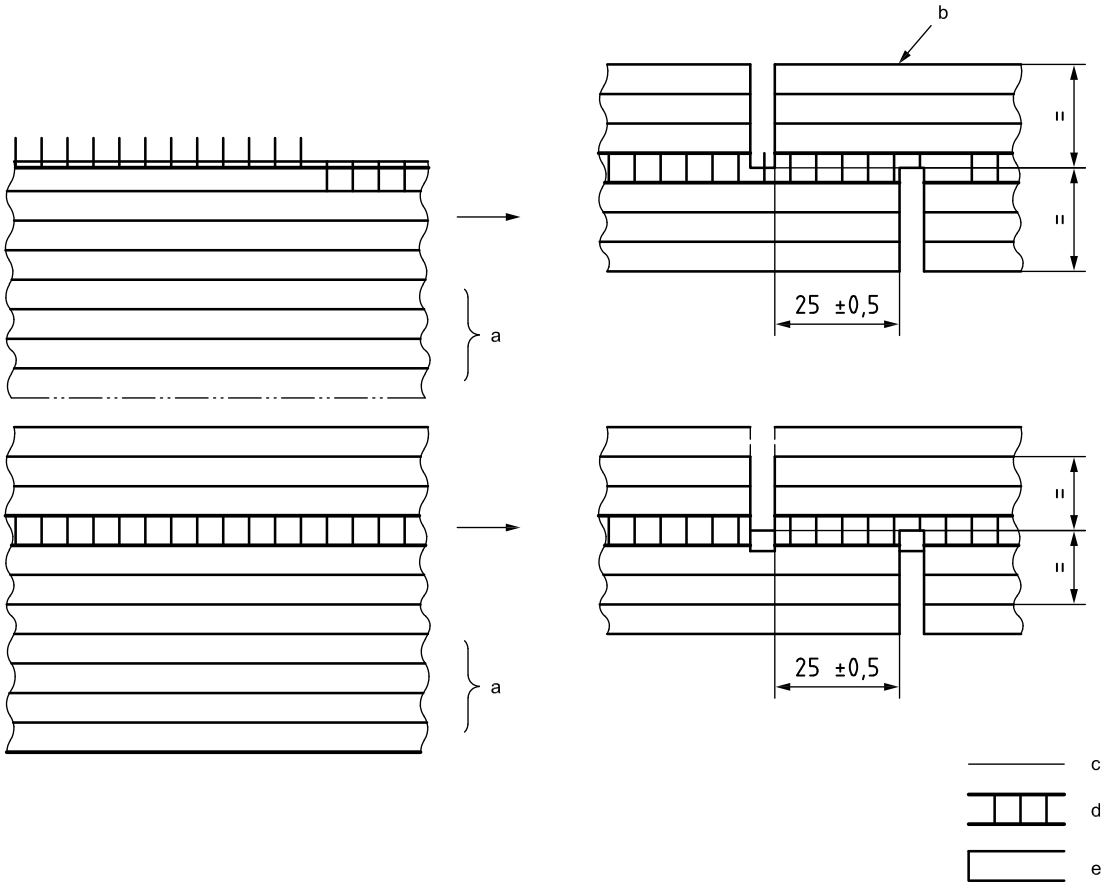
The shear strength is evaluated by applying a load along the direction of the grain of the layers to be tested.

Two options are available:

— testing gluelines per pair;

— testing gluelines per sets of more than two.

Dimensions in millimetres



Key

a Remove these layers.

b Add these layers.

c Glueline to be tested.

d Layer (one or two plies) with grain across the length of test piece.

e Notch.

= same dimension

Figure A.1 — Layers with one or two plies in one direction intended for a shear

A.2.1.3.2 Testing with a single pair of gluelines

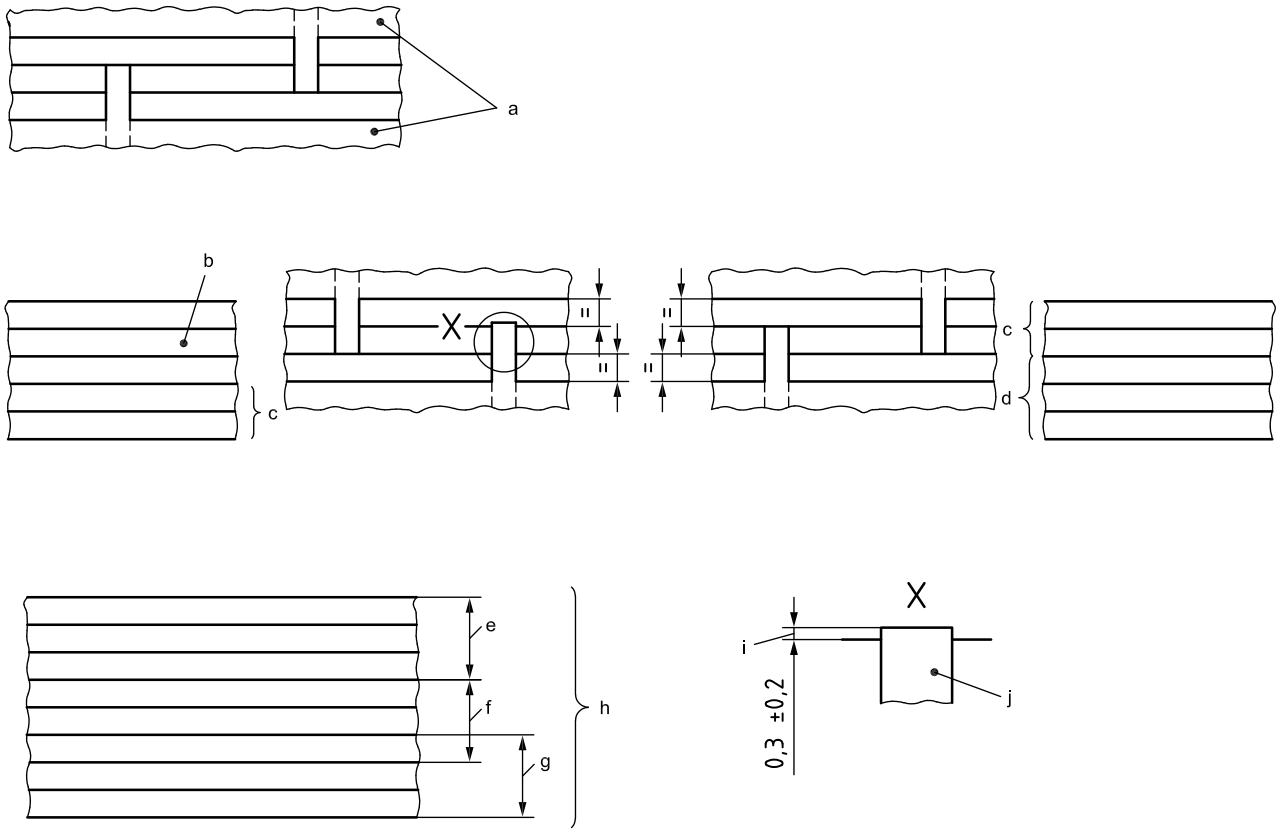
The shear strength is evaluated by application of a tension force along the grain of the test piece; the length of a piece shall be along the grain.

Pick a pair of gluelines and cut the samples. Cut off the excess material to make the test piece symmetrical (at least one ply shall remain on both sides of the pair of gluelines to be tested and more may be needed if the plies are thin).

On each face of each sample test piece, make the saw cuts so as to reach the opposite glueline and indent into the ply beyond, to a depth of $(0,3 \pm 0,2)$ mm. The pair of gluelines between the bottoms of the two saw cuts shall thus be controlled (see detail in Figure A.2).

Cut the individual test pieces (the dimensions in the plane of the test pieces are those already defined in A.2.1.2.2).

Dimensions in millimetres



Key

= same dimension

a Possible extra ply.

b 1st pair.

c To be removed.

d 2nd pair.

e 1st.

f 2nd.

g 3rd.

h Test piece.

i Glueline to be tested.

j Notch.

Figure A.2 — Layers with more than two plies — Test piece with a single pair of gluelines intended for a shear test by tension

A.2.1.3.3 Testing with more than one pair of gluelines (Figures A.3 and A.4)

The shear strength is evaluated by application of a compression force along the grain of the test piece.

It is defined in Figure A.3; it is intended for a shear test by compression and its design is close to the design of the standard lap-shear test. Its main features are:

— width: (50 ± 1) mm;

— distance between nearer sides of saw cuts: (25 ± 0,5) mm;

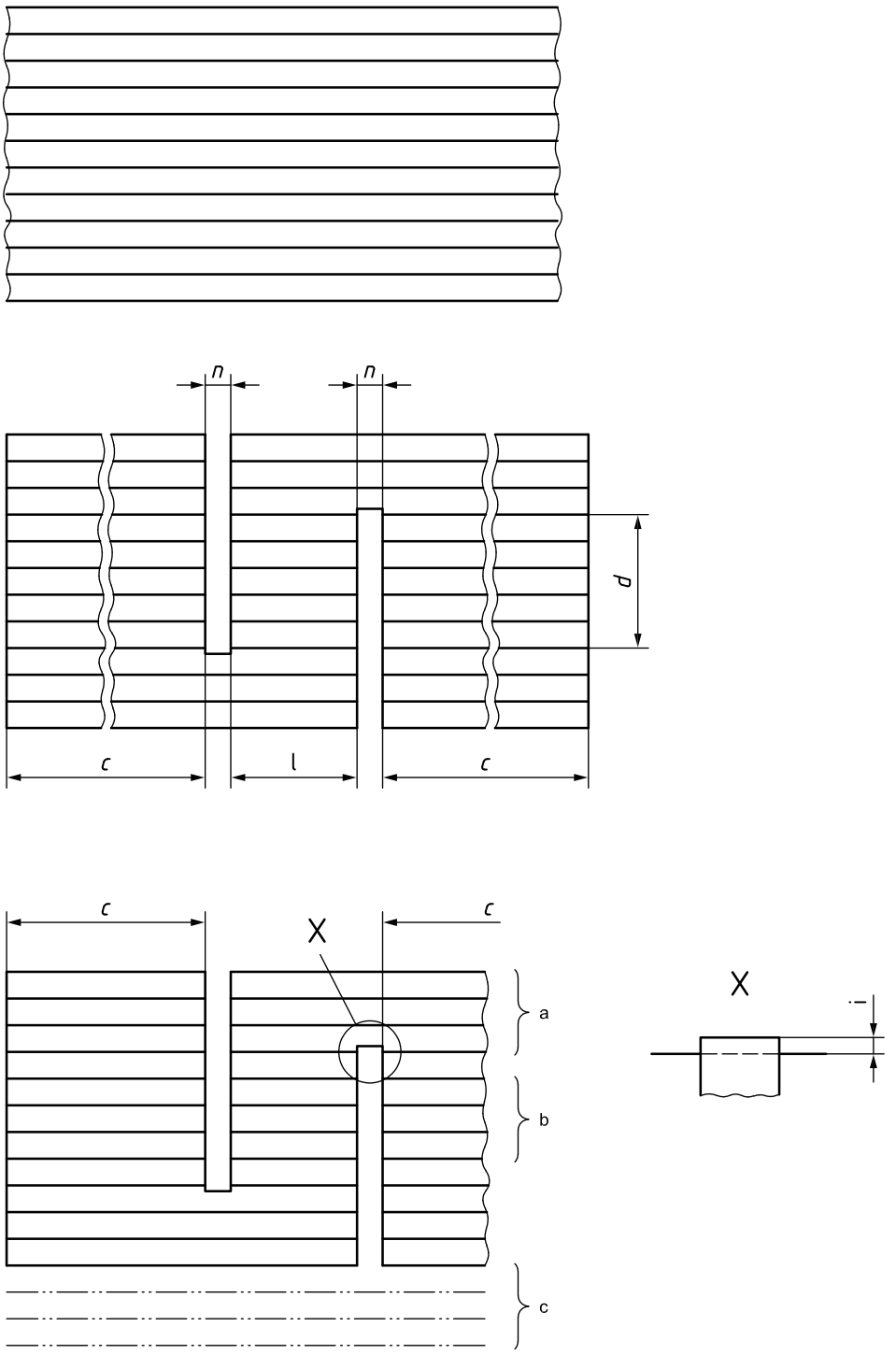
— width of saw cut: 3 mm minimum;

— distance d between the furthest pair of gluelines to be tested: $d \leqslant 20$ mm;

— distance between saw cut and nearer end of the test piece: $\geqslant 50$ mm.

To ensure proper loading, the cutting of the ends of the test pieces shall be such that the corresponding sections shall be square (tolerance not exceeding 1 mm per 50 mm).

NOTE Although testing several pairs of gluelines at the same time appears an attractive method of improving productivity, torsional effects can produce unreliable results. For this reason, the value of d is limited to $\leqslant 20$ mm.



Key

$c \geqslant 50$ mm

$d \leqslant 20$ mm

i $(0{,}3 \pm 0{,}2)$ mm

l $(25 \pm 0{,}5)$ mm

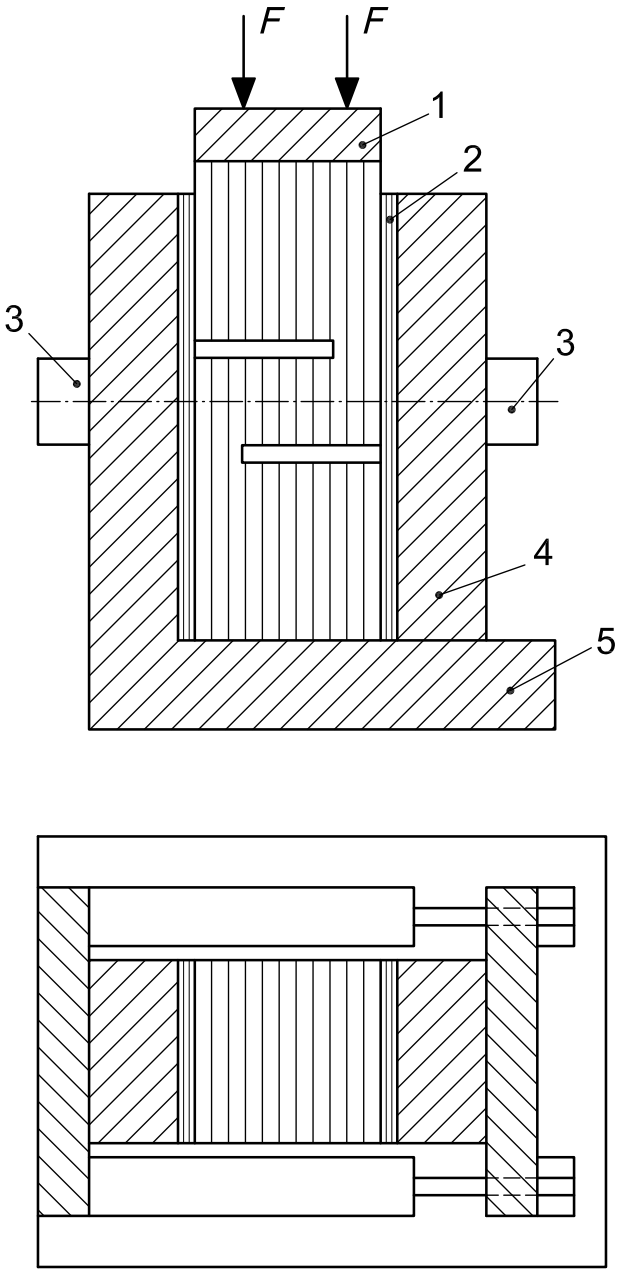
$n \geqslant 3$ mm

a Remaining LVL.

b Remaining gluelines to be tested.

c Excess layers removed to keep the test piece symmetrical.

Figure A.3 — Layers with more than two plies — Test piece with more than one pair of gluelines intended for a shear test by compression



Key

1 loading plate
2 PTFE (polytetrafluoroethylene) plates or equivalent anti-friction system
3 clamping bar
4 adjustable plate
5 support
F force

Figure A.4 — Principle of a compression shear jig for LVL

A.2.2 Sampling

A.2.2.1 General

All the gluelines of the product unit shall be tested. For practical reasons, blocks of five test pieces plus one spare piece are cut per pre-treatment. Then, each block is cut into (5 + 1) test pieces per pre-treatment.

NOTE The width of the blocks takes into account the width of the saw kerfs between the test pieces.

The blocks are sampled at random along the product unit.

The number of test pieces depends on their position in the lay-up of LVL product unit and on the number of pre-treatments.

A.2.2.2 Lay-ups with layers of one or two plies in one direction (Figure A.1)

These one or two plies are either on the face or within the core of the LVL product unit (Figure A.1).

These test pieces are tested by tensile shear.

In accordance with ISO 16999, for each specified pre-treatment:

— a block of $(5 + 1)$ test pieces per LVL product unit and per pre-treatment is cut from one edge and;

— another block of $(5 + 1)$ test pieces per LVL product unit and per pre-treatment is cut a block away, at least $+100$ mm from the edge area.

This shall be repeated for each glueline (face layer) or pair of gluelines (core layer) in the lay-up.

NOTE Per product unit, the number m of test pieces, including the spares, is:

$$m = \left[5 + (1) + 5 + (1)\right] \times p \times N \tag{A.1}$$

where

N is the number of single layers (possibly made of two plies), in one direction in the lay-up to be tested;

p is the number of pre-treatments.

A.2.2.3 Lay-ups with more than two plies in one direction (Figures A.2 and A.3)

These test pieces are tested by compression shear or tensile shear.

A.2.2.3.1 Tensile shear (Figure A.2)

To be consistent with ISO 16999, for each specified pre-treatment

— a block of $(5 + 1)$ test pieces per LVL product unit is cut from one edge, and

— another block of $(5 + 1)$ test pieces per LVL product unit is cut a block away, at least $+100$ mm from the edge area.

This shall be repeated for each pair of gluelines in the lay-up.

NOTE The number, m, of test pieces, in relation to the number of layers, is approximately:

$$m = \left[5 + (1) + 5 + (1)\right] \times p \times (N - 1)/2 \tag{A.2}$$

where

p is the number of pre-treatments;

N is the number of plies in one direction.

A.2.2.3.2 Compression shear (Figure A.3)

To be consistent with ISO 16999, for each specified pre-treatment

— a block of (5 + 1) test pieces is cut from one edge parallel to the grain of the LVL product unit, and

— a block of five test pieces (plus one spare) is cut at least 100 mm away from the edge area (if consistent with the width of the sampled product unit), parallel to the grain of the LVL product unit.

This shall be repeated so as to include all the gluelines along the grain in the lay-up.

NOTE The number, m, of test pieces is approximately equal to

$$m = \left[5 + (1) + 5 + (1)\right] \times p \times (N \times d_{\mathrm{v}})$$

where

N is the number of layers along the grain;

p is the number of pre-treatments;

d_{v} is the thickness of a layer (all are assumed equal), in mm.

A.3 Apparatus

A.3.1 Equipment for pre-treatment

It is defined in ISO 12466-1.

A.3.2 Apparatus for tensile shear

It is defined in ISO 12466-1.

A.3.3 Apparatus for compression shear

The main features of a suitable jig are:

— a steel corner support;

— a steel adjustable plate;

— a clamping system;

— an anti-friction device to be inserted between test piece and steel plate and support.

NOTE Two PTFE plates make a suitable device.

A.3.4 Apparatus for evaluation of the wood fibre failure

To evaluate the texture of the failure surface correctly, the following equipment is necessary:

— light source fitted with a minimum clear incandescent 150 W lamp or a 15 W fluorescent tube.

— If a fluorescent tube is used, a dual, cool white, and daylight tube is recommended.

— a lens with a magnification of 10.

A.4 Procedure

A.4.1 General

The selection of the pre-treatments shall be carried out in accordance with ISO 12466-2, taking the intended service class into account.

Testing procedure shall follow the guidelines defined in ISO 12466-1.

Results shall be evaluated in accordance with ISO 12466-1, both for shear test and wood fibre failure rate.

NOTE In compression shear, the strength of a test piece is that of the weaker of the gluelines involved in this test piece.

The average values shall be calculated on 10 test pieces, both for shear strength and wood fibre failure rates, whatever the number of gluelines in each test piece of the batch of 10.

A.4.2 Evaluation of the wood fibre failure

The glueline to be evaluated shall be well-lit with oblique light to show the full wood failure.

The angle of the incidence of the illumination should be 10° to 15°. A light source as specified in A.3.4 should be placed so that the incandescent lamp is between 125 mm and 275 mm from the test pieces or the fluorescent tube is between 25 mm and 75 mm from the test piece.

Annex B
(normative)

Bond testing and evaluation using the chisel/knife testing procedures (suitable for internal production control)

B.1 General

This alternative procedure for bond testing and evaluation (chisel/knife test) is deemed suitable for quality control purposes only. It is a stand-alone procedure and shall be used in full. The procedure cannot be combined with that specified in 6.1 and 6.2.

B.2 Principle

In a well-made glueline, the separation of plies occurs, predominantly, through breaking of the wood itself and not by separation of the plies along the glueline. A satisfactory glueline shall therefore include a substantial amount of adhering wood fibre when the plies are forcibly separated. Consequently, the proportion of fractured wood adhering to both plies shall provide a measure of the quality of the bond.

B.3 Test pieces

Each test piece shall be the full thickness of the sheet and a minimum of 150 mm long and 65 mm wide. Each test piece shall be marked to identify it with the sample sheet from which it was cut.

B.4 Apparatus

The following apparatus is required for all tests.

B.4.1 Chisel (knife), examples of which are shown in Figure B.1 and Figure B.2. The shape of the chisel or knife is not specified, but shall be such as to allow the implement to penetrate through the veneer into the glueline in a manner that shall place the glueline under stress and cause a fracture in the vicinity of the glueline in the adhesive or the wood fibre.

NOTE The percussion chisel shown in Figure B.1 could require a percussion mechanism to assist in forcing the chisel along the glueline.

B.4.2 Bench with a timber backstop.

B.4.3 Light source fitted with a minimum clear incandescent 150 W lamp or a 15 W fluorescent tube.

If a fluorescent tube is used, a dual, cool white, and daylight tube is recommended.

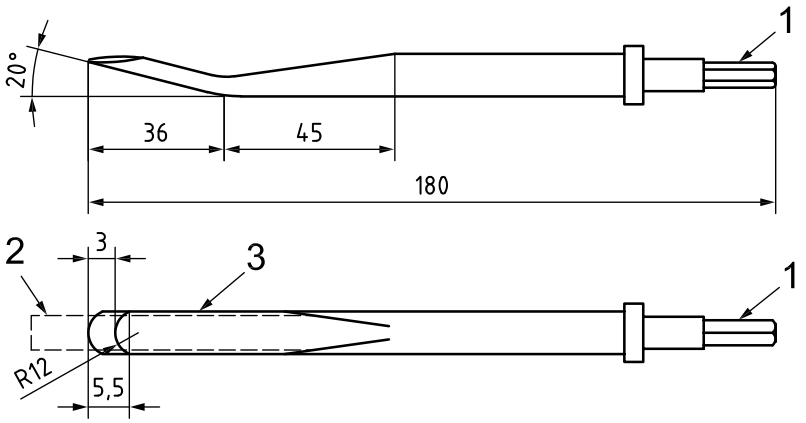
B.4.4 Oven

The oven type in either B.4.4.1 or B.4.4.2 shall be used.

B.4.4.1 Oven, well-ventilated, with heat-emitting elements, wire mesh shelves or other open material that allows free internal circulation of air, and capable of maintaining a temperature above 100 °C without degrading the specimen.

B.4.4.2 Microwave oven, equipped with a cooling fan and cavity air exhaust.

Dimensions in millimetres



Key

1 orientation of hexagon
2 original outline (see Note to B.4.1)
3 blade (to be hot forged and hardened)

Figure B.1 — Example of percussion chisel for bond testing of LVL

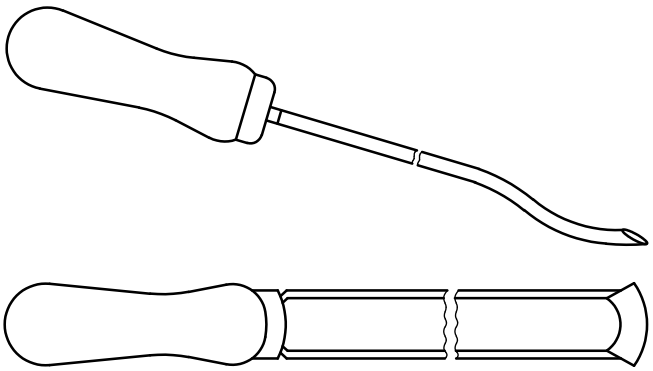


Figure B.2 — Example of hand chisel for bond testing of LVL

B.5 Procedure

The procedure shall take place while the LVL is in the wet state after the pre-treatment. Pre-treatments shall be as defined in Clause 5 of this part of ISO 10033 and 4.2 of ISO 10033-2.

B.5.1 Remove the uppermost veneer of the test piece (see paragraph below) by forcing the chisel along the glueline in a direction perpendicular to the grain of the veneer by guiding the chisel forward 25 mm to 50 mm as nearly as practicable along the glueline (see paragraphs below).

Instead of separating all the veneers of the one test piece, individual test pieces may be used for each glueline; thus for an eight-ply LVL, seven test pieces should be cut from the sample.

NOTE The chisel can be applied to the surface of the test piece or to its edge at the glueline.

A slight wriggle in the motion of the chisel should assist penetration.

B.5.2 Break the veneer with a lever action of the chisel.

NOTE When using a percussion chisel, the percussion action to penetrate the glueline may be used. Use the chisel in the “dead” condition for the lever action for lifting and breaking the veneer.

B.5.3 Separate all the veneers of the test piece by repeating the procedures specified in B.5.1 and B.5.2, taking care not to remove any wood fibre adhering to previously exposed gluelines.

B.5.4 For wet test pieces, after exposing all of the gluelines as specified in B.5.1, B.5.2 and B.5.3, reassemble the separated plies in their original order and dry in an oven until all their surfaces appear dry, then evaluate the percentage of wood failure as described.

Rapid drying is necessary to avoid microbiological attack.

B.5.5 For dry test pieces, after exposing all of the gluelines as specified in B.5.1, B.5.2 and B.5.3, evaluate the percentage of wood failure as described.

B.5.6 Clearly record (if practicable, on the test piece) the assessment of the percentage wood failure in each glueline by the appropriate numeral.

B.6 Determination of apparent cohesive wood failure (bonding quality)

B.6.1 Lighting

The glueline to be evaluated shall be well-lit with oblique light to show the full wood failure.

The angle of the incidence of the illumination shall be 10° to 15°. A light source as specified in B.4.3 shall be placed so that the incandescent lamp is between 125 mm and 275 mm from the test pieces or the fluorescent tube is between 25 mm and 75 mm from the test piece.

B.6.2 Examination

The percentage area of the glueline covered by wood, irrespective of the depth of wood failure, shall be evaluated. Areas where the chisel goes through the glueline and makes a clean cut in the ply, areas where the chisel obviously failed to find the glueline, and areas where faulty bond is due to permitted imperfections, for example knots and holes, shall be disregarded.

Any test piece containing more than 40 % of excluded area shall not be considered in the evaluation of bond quality, and such test piece shall be replaced.

In assessing wood failure, both sides of the glueline shall be evaluated.

B.6.3 Bonding quality scale

After evaluation of wood failure in accordance with B.6.2, a bonding quality value shall be allocated to each glueline as specified in Table B.1.

Table B.1 — Bonding quality scale

Estimated wood failure %	Bonding quality value
< 10	0
10	1
20	2
30	3
40	4
50	5
60	6
70	7
80	8
90	9
> 90	10

B.6.4 Calculation

The average bonding quality of each glueline in all test pieces from the same test sample shall be calculated.

B.7 Test report

The test report shall contain at least the following information:

a) average bonding quality of each glueline of the test sample and the overall average bonding quality of the test sample;

b) details of the pre-treatment (see 5.1);

c) a reference to this part of ISO 10033;

d) product source and description of test material;

e) number of pieces tested per test sample;

f) number of gluelines tests per test sample;

g) any other information deemed relevant to bonding quality.

ICS 79.060.99

Price based on 17 pages