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Adhesives — Wood-to-wood adhesive bonds — Determination of shear strength by tensile loading

Adhésifs — Joints collés de bois à bois — Détermination de la résistance au cisaillement par effort de traction

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Foreword

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

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

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

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

ISO 6237 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 6237:1987), of which it constitutes a minor revision which included the correction of an error in Figure 1 a).

Adhesives — Wood-to-wood adhesive bonds — Determination of shear strength by tensile loading

1 Scope

This International Standard specifies a method for determining the shear strength of wood-to-wood adhesive bonds, with a standard specimen loaded in tension and under specified conditions of preparation, conditioning and testing. This method is intended for testing only those adhesives used in bonding wood to wood in either parallel-laminated or cross-laminated construction.

NOTE 1 To carry out this test, basic information regarding certain variables is needed by the test laboratory (see Annex A).

NOTE 2 This method is not intended for use in testing manufactured products.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472, *Plastics — Vocabulary*

3 Apparatus

3.1 Apparatus for preparation of adhesive

3.1.1 Balance and **equipment** capable of measuring the proportions of the adhesive mix to within a tolerance of $\pm$ 1 %.

3.1.2 Mixing equipment to ensure homogeneous mixing of the constituents with minimum aeration of the adhesive (except foamed adhesive).

3.1.3 Spreading equipment such as a **wire-wound bar**, **roller spreader**, **curtain coater** or **suitable hand applicators**, capable of spreading the adhesive uniformly within $\pm$ 5 % of the desired spread.

3.1.4 Equipment, designed to exert the required pressure evenly over the whole bonded area within $\pm$ 5 % of the desired value, for example a **press** or **clamps**. If necessary, **heated platens** capable of maintaining the prescribed temperature within $\pm$ 2 °C during pressing.

3.2 Test apparatus

3.2.1 Analytical balance.

3.2.2 Linear measuring device, to read to 0,05 mm, e.g. vernier calipers or micrometer.

3.2.3 Test machine, capable of exerting a tensile force of at least 5 kN with an accuracy of $\pm$ 2 %. The force shall be applied at a uniformly increasing rate in the range 2,5 kN/min to 6 kN/min or at a uniform crosshead speed between 0,5 mm/min and 1,0 mm/min unless otherwise agreed between the interested parties.

The test machine shall be equipped with suitable grips and jaws so that the specimen is held tightly without slipping during testing and is held in alignment so that the stress is applied as required in Clause 8.

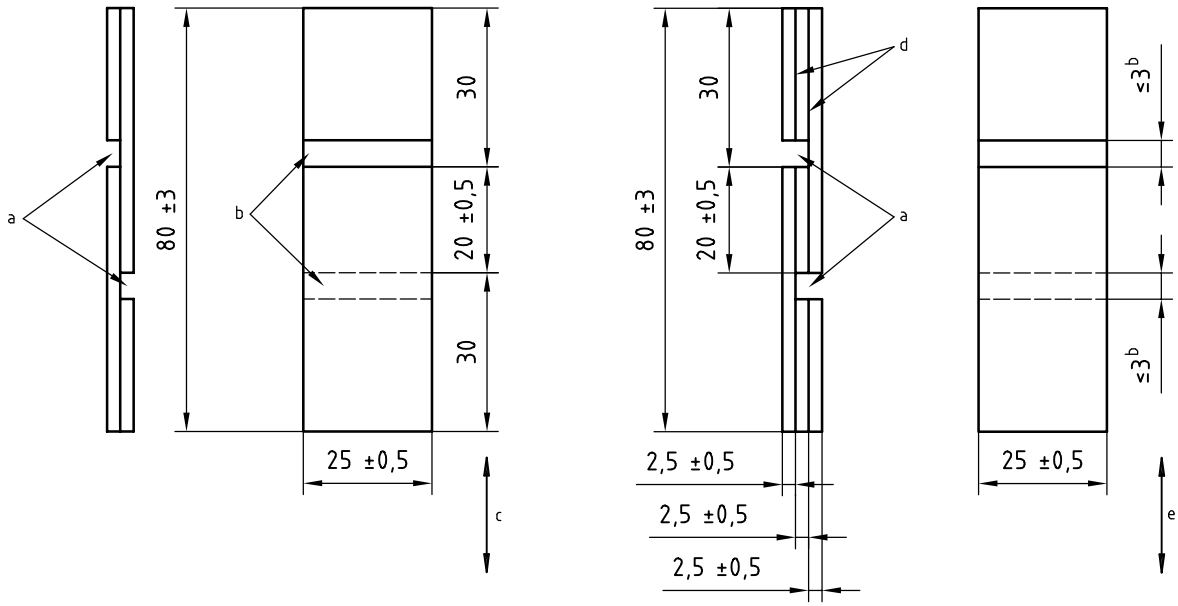
NOTE It is necessary for all equipment, including gauges, thermometers, etc., to be calibrated regularly, as prescribed by the test authority of each country.

4 Test specimens

4.1 The timber species, timber quality and timber moisture content for the specimens shall be as described in Annex B.

4.2 The test specimen shall be of a two-ply or three-ply construction and shall conform to the form and dimensions shown in Figures 1 and 2. The test specimens shall be cut from test panels prepared as described in this clause and Clause 5.

Dimensions in millimetres



a) Two-ply tensile shear specimen **b) Three-ply tensile shear specimen**

[a] Cut up to but not beyond glue line

[b] Width of sawcut

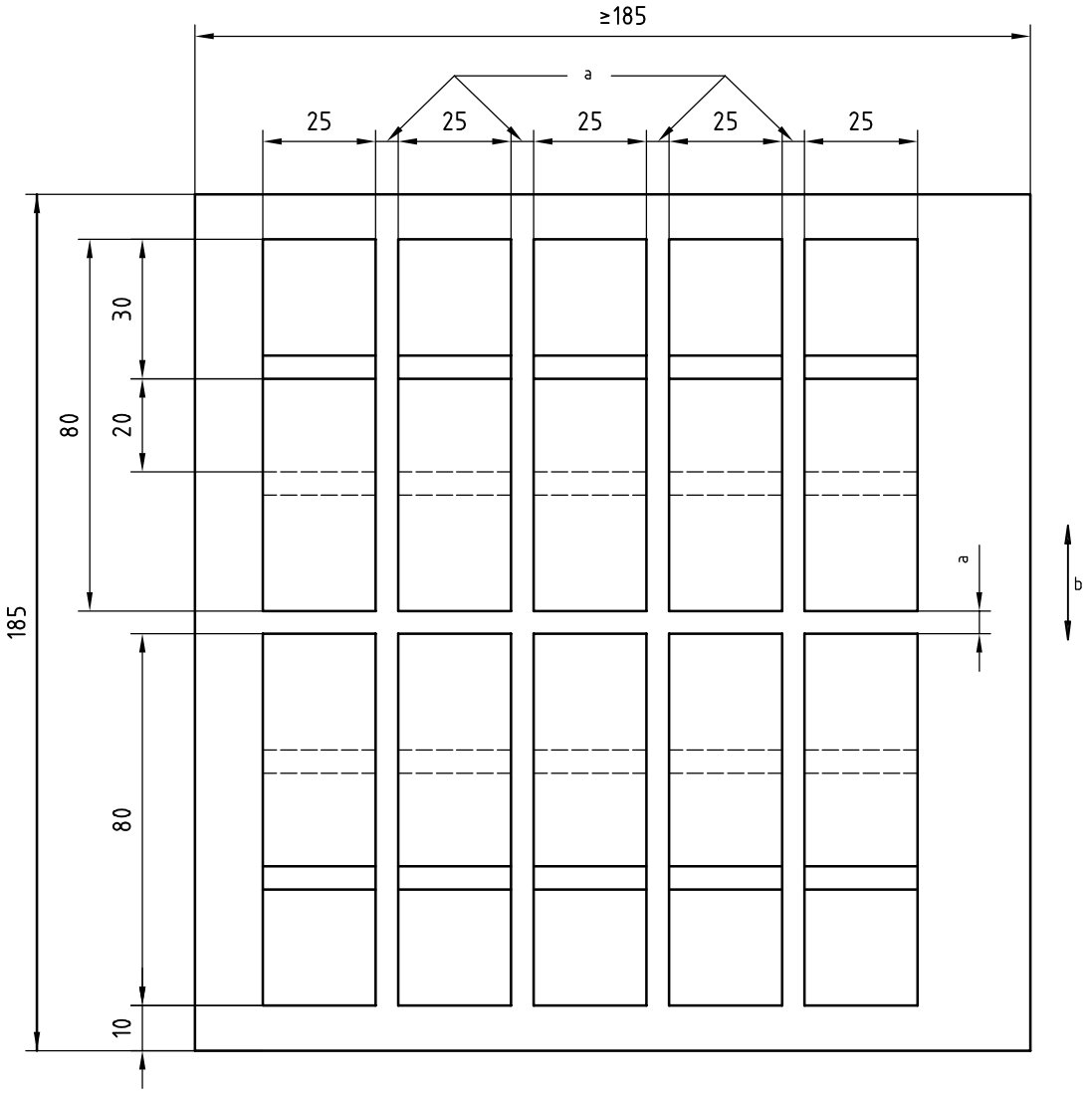
[c] Direction of grain of both veneers

[d] Glue lines

[e] Direction of grain of face veneers (direction of grain of central veneer shall be at right angles to grain of two face veneers)

Figure 1 — Test specimens

Dimensions in millimetres



[a] Width of sawcut

[b] Direction of grain

Figure 2 — Suggested arrangement of specimens

4.2.1 For the specimen of two-ply construction, the grain of both plies shall be parallel to the long dimension of the specimen.

4.2.2 For the specimen of three-ply or cross-laminated construction, the grain of the face plies shall be parallel to the long dimension of the specimen and the grain of the centre ply shall be parallel to the short dimension of the specimen and at right angles to the grain of the two outer plies.

NOTE Both types are suitable for general testing of close contact adhesives but values obtained with the two different specimens are not comparable. Two-ply specimens are often used for applications where the grain of the adherends is parallel while the three-ply specimens may be preferred for adhesives predominantly used in the production of wooden panels such as plywood or particle board.

4.2.3 For adhesive quality control purposes, test a minimum of four specimens from each of three panels of similar construction.

4.2.4 Where greater precision is required, test at least 40 specimens, eight from each of five different panels of similar construction.

5 Preparation of test panels

5.1 Cut the veneer into suitable sizes and assemble in groups of two or three sheets (see 4.2).

5.2 Prepare the adhesive in accordance with the procedure specified by the manufacturer of the adhesive.

5.3 The surface to be bonded may or may not be abraded, as agreed between the interested parties. Apply the adhesive to the veneers as specified by the manufacturer of the adhesive. After the specified time has elapsed, assemble the veneers into two- or three-ply panels as described in 4.2.1 or 4.2.2, respectively. Then press the panel under the specified conditions (see Annex A).

6 Conditioning of test panels

Upon release of pressure, condition the panels at a relative humidity of (50 ± 5) % or (65 ± 5) % and a temperature of (23 ± 2) °C, either for 7 days, or until they attain a constant mass, whichever is the longer period. (Constant mass is considered to be reached when the results of two successive weighing operations, carried out at an interval of 6 h, do not differ by more than 0,1 % of the mass of the test panels.)

Conditioning may be extended beyond this limit by agreement between the interested parties.

7 Preparation of specimens

7.1 Cut the test specimens as shown in Figure 1, taking care that a margin to exclude edge effects is removed first. This is best accomplished by first cutting the notches to the proper width, depth and location in the test panel, using a hollow-ground grooving saw or any other method that will give equally satisfactory results. Notch the specimens as shown in Figures 1 and 2. The notch of the two-ply specimen shall go as far as the glue line and care shall be taken that the ply is cut completely. The notch for the three-ply specimen shall go up the second glue line. When the panel has been notched, cut the individual specimens from the panel. Number them consecutively from one end of the panel to the other and identify them with regard to panel of origin. Select the specimens to be tested so that an even and equal number of specimens is taken from each panel. The dimensions of the bond shear area as machined shall be reported.

7.2 Store the specimens in the conditioning atmosphere described in Clause 6, until tested. They may be briefly removed for the cutting operation.

8 Procedure

8.1 Place the test specimen in the jaws of the grips in the test machine (3.2.3) so that the notches are approximately 5 mm from the end of the jaws. The specimen shall be perfectly aligned and the pairs of jaws shall be directly above each other and in such a position that an imaginary straight vertical line would pass through the centre of the core ply and through the points of suspension of the grips. Test the specimens from each panel in numbered sequence and place them in the jaws alternately so that in one case the upper notch is to the left and in the other case to the right. The rate of separation of the jaws shall be such that the failure occurs within (60 ± 20) s, unless other speeds are agreed upon (see 3.2.3). The rate of separation shall be reported in the test report.

8.2 Record the force at break and the percentage wood failure for each test joint, estimated as described in 8.3. Express all forces in kilonewtons to the nearest 10 N.

8.3 In order to determine the wood failure after testing, illuminate the specimen with oblique light, incident at an angle of 10° to 15°. The light source shall have a black, non-reflecting shade. A clear incandescent 150 W bulb or a 15 W fluorescent tube shall be used. The distance between the incandescent bulb and the specimen shall be between 150 mm and 250 mm and the distance between the fluorescent tube and the specimen shall be between 25 mm and 75 mm. Determine the proportion of area covered by wood, irrespective of depth of

failure. If the shear fracture does not extend over the whole test area, then wood failure shall be calculated as a proportion of the fractured area.

In assessing wood failure, both sides of the fracture shall be evaluated in conjunction. The wood failure shall be evaluated to the nearest 10 %.

8.4 Eliminate all specimens that failed in tension in the wood outside the bond area.

9 Expression of results

9.1 Calculate for each specimen the force in kilonewtons or the stress in kilopascals[1)] at break.

9.2 Calculate the mean $\overline{x}$ and the standard deviation s of the force or stress at break and of the percentage wood failure for the specimens from each test panel and for all specimens, by the following equations:

$$\overline{x} = \frac{\Sigma x}{n}$$

and

$$s = \sqrt{\frac{n\sum x^2 - (\sum x)^2}{n(n-1)}}$$

where

x is each individual result;

n is the number of specimens tested.

10 Test report

The test report shall include the following particulars:

a) reference to this International Standard;

b) complete identification of the adhesive tested, including type, source, manufacturer's code number, physical form, etc.;

c) timber species used, its moisture content at the time of gluing, and description of bonding surfaces, including, if known, the age of the surface;

d) application and bonding methods and conditions used in preparing the test joints;

e) type of specimen used, i.e. two-ply or three-ply, direction of centre ply (see 4.2.2) and dimensions of bond shear area as machined;

f) thickness of adherend used (each ply used is considered as an adherend);

g) conditioning atmosphere and temperature, and conditioning procedure used for the specimens before testing;

h) temperature and relative humidity of the test room;

i) rate of applying force or crosshead speed and description of grips;

j) number of test joints tested;

k) number of panels and press loads represented;

l) individual test results identified with regard to panel of origin and specimen numbers;

1) 1 kPa = 1 kN/m^2

m) mean force or stress at break and mean wood failure for each panel and for all specimens;

n) standard deviation of force or stress at break for each panel and for all specimens;

o) all modifications to the test procedure that may have affected the results.

Annex A
(normative)

Information required prior to testing

The results of strength tests of adhesive bonds are dependent on the conditions under which the bonding process is carried out. Unless otherwise agreed, the bonding conditions shall be as specified by the manufacturer of the adhesive.

In order to ensure that complete information is available to the individual conducting the tests, the manufacturer of the adhesive should furnish numerical values and other specific information for each of the following variables:

a) the recommended moisture content of the wood at the time of gluing;

b) whether or not the surface of the wood to be bonded may be abraded prior to bonding;

c) complete mixing directions for the adhesive;

d) conditions for application of the adhesive, including the rate of spread, number of coats to be applied, whether it is to be applied to one or both surfaces, and the conditions of drying;

e) assembly conditions before application of pressure, including open and closed assembly time and temperature (see ISO 472);

f) pressing conditions, including time, temperature of glue line and pressure;

g) conditioning procedure before testing, including time, temperature and relative humidity.

If a range is prescribed for any variable by the manufacturer of the adhesive, it shall be assured that any arbitrarily chosen value within such a range or any combination of such values for several variables will be acceptable.

Annex B
(normative)

Timber species, thickness, surfaces, quality and moisture content

B.1 Timber species

The standard timber species for testing the adhesive shall have a mean density between 670 kg/m^3 and 770 kg/m^3 at 12 % moisture content and a mean shear strength parallel to the grain between 13,0 MPa and 18,0 MPa at the same moisture content. Some suitable species are listed in Table B.1. The timber shall not be treated or coated. Any other species of timber may be used by agreement between the interested parties.

Table B.1 — Examples of timber species suitable for shear tests of adhesives

Common name	Botanical name	Density[a] kg/m^3	Shear strength[b] MPa[c]	Origin
Afzelia	*Afzelia africana* SM	730 to 900	14,6	Africa
Ash, European	*Fraxinus excelsior* L.	530 to 830	14,1	Europe
Ash, white	*Fraxinus americana*	680	15,0	North America
Beech, European	*Fagus sylvatica* L.	690	15,6	Europe
Birch, white	*Betula pubescens* EHRH	650	13,1	Europe
Birch, yellow	*Betula alleghaniensis Conaricum* (DHUP)	700	13,4	North America
Danta	*Nesogordonia papavifera*	760	15,3	Africa
Hickory, pecan	*Carya illinoensis*	740	16,0	North America
Kamahi	*Weinmannia racemosa*	680	14,8	Australasia
Makanba	*Betula maximowicziana*	680	15,5	Japan
Maple, sugar	*Acer saccharum* MARSH	730	18,0	North America
Messmate stringybark	*Eucalyptus obliqua* L.HERIT	710	13,8	Australasia
Nargusta	*Terminalia amazonia* (J.F.GMEL.) EXELL	720 to 930	17,6	Central and South America
Needlewood	*Schima wallichii*	690	16,1	Asia
Peroba, white	*Paratecoma peroba* KUHLM	690 to 830	16,5	South America

NOTE The values shown may vary with the source of the species and the growing conditions of the tree from which the timber is derived.

[a] Typical average value at 12 % moisture content.

[b] Typical average value at 12 % moisture content when determined parallel to grain direction.

[c] 1 MPa = 1 N/mm^2.

NOTE For a block of timber at a moisture content other than 12 %, the approximate value of the density ϱ_{12} at 12 % moisture content may be determined by the following equation:

$$\varrho_{12} = \frac{112m}{V(100 + H)}$$

where

m is the mass of the block, in kilograms;

V is the volume of the block, in cubic metres;

H is the moisture content of the block, expressed as a percentage by mass.

The above equation does not take into account the change in volume due to change in moisture content. For a more exact calculation, use the following equation:

$$\varrho_{12} = \varrho_H \left[1 - \frac{(1 - v)(H - 12)}{100} \right]$$

where

$$\varrho_H = \frac{m_H}{V_H}$$

and

$$v = \frac{V_0 - V_H}{V_H \times H} \times 100$$

in which

ϱ_H is the density at moisture content H;

m_H is the mass, in grams, of the specimen at moisture content H;

V_H is the volume, in cubic centimetres, of the specimen at moisture content H;

v is the coefficient of shrinkage;

H is the moisture content;

V_0 is the volume, in cubic centimetres, of the dry specimen.

B.2 Timber thickness

The veneers for the specimens shall be $(2{,}5 \pm 0{,}5)$ mm thick unless otherwise agreed between the interested parties.

B.3 Timber quality and surface

The veneers for the specimens may be peeled, sliced, planed or sawn. If sawn, they shall be substantially free from saw marks. They shall be of even thickness, of straight grain and free from all defects which may interfere with the bond strength, such as knots, holes, cracks, bark or gum pockets, short grain, distorted grain, or decay. Veneers shall be tight and smooth, and the average depth of peeler checks shall not exceed 70 % of the veneer thickness.

B.4 Timber moisture content

The moisture content of the samples immediately before spreading the adhesive shall be within the range of moisture content recommended by the adhesive supplier. In the absence of such a recommendation, the moisture content shall be (10 ± 2) % for room temperature setting adhesives and (7 ± 2) % for hot setting adhesives. Except where otherwise agreed, the moisture content shall be determined on at least two representative specimens by the oven-dry method [constant mass at (103 ± 2) °C].

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