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

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

Reference number
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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6238 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 6238:1987), which has been technically revised.

Annexes A and B form a normative part of this International Standard.

Adhesives — Wood-to-wood adhesive bonds — Determination of shear strength by compressive 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 compression and under specified conditions of preparation, conditioning and testing. This method is intended for testing only those adhesives used in bonding wood to wood.

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

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*.

ISO 7500-1:1999, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*.

3 Apparatus

3.1 Apparatus for preparation of adhesive

3.1.1 Balance and **other suitable 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 compression.

3.2 Apparatus for the determination

3.2.1 Analytical balance, capable of weighing to 0,000 1 g.

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

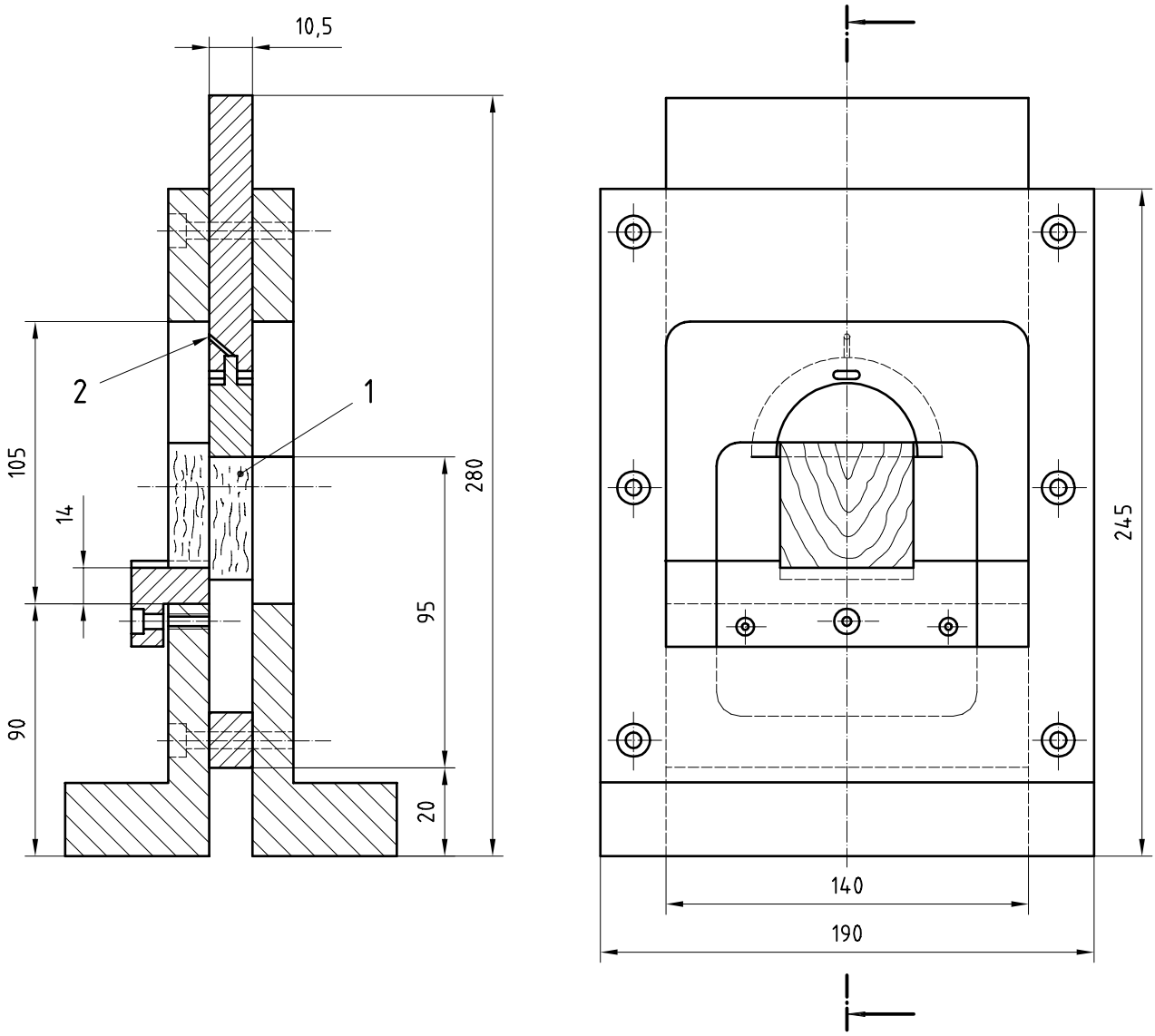
3.2.3 Tensile-testing machine, operating in the compression mode, capable of maintaining a pre-determined constant cross-head rate. The machine shall be capable of determining a maximum load. The measured strength shall be between 15 % and 85 % of the capacity of the machine. The machine shall permit the measurement and recording of the applied force with an accuracy of $\pm$ 1 %. The testing machine shall be fitted with a shearing tool containing a self-alignment seat to ensure uniform lateral distribution of the force.

NOTE 1 A shearing tool as shown in Figure 1 has been found satisfactory.

The equipment shall be calibrated regularly in accordance with ISO 7500-1.

NOTE 2 It is recommended that the machine be autographic, giving a chart that can be read in terms of millimetres of cross-head movement as one coordinate and applied force as the other coordinate. It is also recommended that inertialess equipment be used.

Dimensions in millimetres



Key

1 Test specimen
2 Oil hole

Figure 1 — Example of shearing tool for compressive shear testing of specimen A

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 Individual test joints shall conform to the form and dimensions shown in Figure 2. The individual test joints shall be cut from bonded blocks prepared as described in clauses 5 and 6.

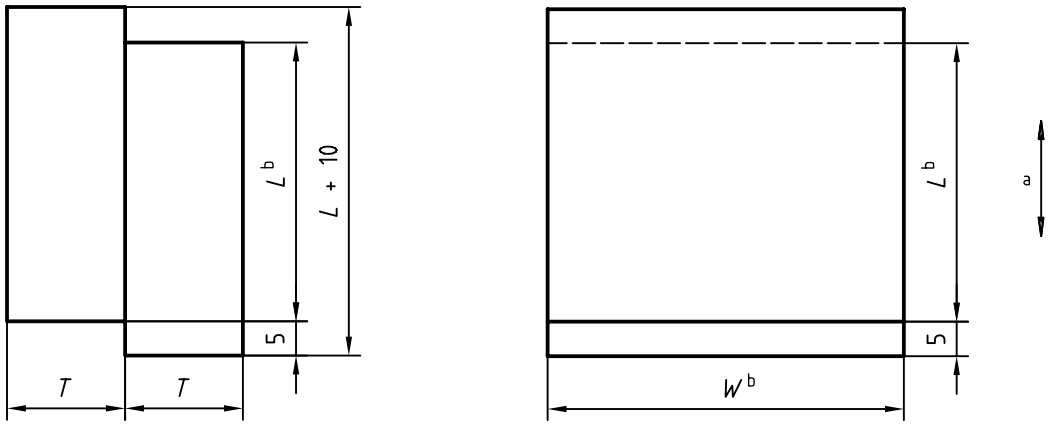
L and W represent the length and the width of the bonded area. The user shall select either the geometry of specimen A (bonded area 40 mm $\times$ 50 mm) or the geometry of specimen B (bonded area 25 mm $\times$ 25 mm). T represents the thickness, which is 20 mm for specimen A and 10 mm for specimen B.

In cases of dispute, only specimen A shall be used.

4.3 For adhesive quality control purposes, test a minimum of three test joints from each of three different bonded blocks, prepared as described in clauses 5 and 6.

4.4 Where greater precision is required, test a minimum of five test joints from each of four different bonded blocks.

Dimensions in millimetres



[a] Direction of grain

[b] L and W = 40 mm $\times$ 50 mm for specimen A or 25 mm $\times$ 25 mm for specimen B

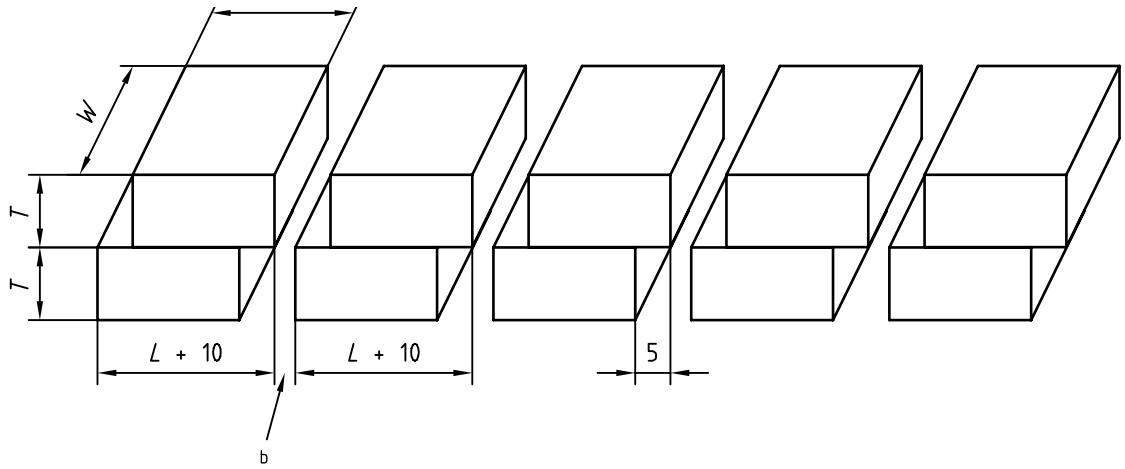
Figure 2 — Shape and dimensions of test specimen

5 Preparation of test blocks

5.1 Blocks shall be cut from the timber, preferably of a size such that five test joints may be cut from one bonded block as shown in Figure 3. The grain direction shall be parallel to the longest dimension of the block. The blocks shall have surfaces substantially free from saw marks. The blocks shall be weighed and assembled in pairs so that blocks of approximately the same relative density are bonded together. The test blocks shall be knife-planed to ensure the bonding faces are flat, smooth and parallel to the surface where pressure will be applied; they shall be free from dirt, dust or other contamination. Unless otherwise agreed between the interested parties, the thickness of each of the blocks shall not vary by more than 0,1 mm to ensure even pressure during cure.

5.2 Prepare and apply the adhesive to the blocks in accordance with the procedure recommended by the manufacturer of the adhesive. Assemble and compress the coated blocks, also in accordance with the recommendations of the manufacturer of the adhesive. Number each bonded block. The net mass of the adhesive applied may be verified by weighing the blocks before and after spreading the adhesive.

Dimensions in millimetres



[a] Direction of grain

[b] Saw kerf

Figure 3 — Method of cutting test specimens from bonded blocks

6 Conditioning of test blocks

Upon release of pressure, condition the bonded blocks at a relative humidity of (50 ± 5) % and a temperature of (23 ± 2) °C, either for a period of 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 bonded block.)

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

NOTE Other conditions of humidity and temperature may be used by agreement between the interested parties.

7 Preparation of test joints

7.1 Reduce the width of the test blocks to $(L \pm 0{,}5)$ mm by planing or sawing an approximately equal amount from each side. Before cutting off the test joints, cut approximately 10 mm from each end, then cut off the individual test joints as shown in Figure 3. When preparing the test specimens, make sure that the loaded surfaces are smooth and parallel to each other and perpendicular to the height. While reducing the lengths of the overlap to $(W \pm 0{,}5)$ mm, ensure that the saw cuts extend to, but not beyond, the bondline. Also ensure that the saw cuts are perpendicular to the major axis.

Number each test joint consecutively from one end of the bonded block to the other.

7.2 Store the test joints in the conditioning atmosphere described in clause 6, until tested. The bonded blocks may be briefly removed for the cutting operations.

8 Procedure

8.1 Place the test joint in the shearing tool so that the force may be applied as described in 3.2.3. The position of the test joint in one type of shearing tool is shown in Figure 1. Apply a continuously increasing force or a continuous motion of the movable head so that the test joint fails within (60 ± 20) s.

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 100 N.

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

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 test specimens from each bonded block and for all the specimens tested, by the following equations:

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

and

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

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) a reference to this International Standard;

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

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

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

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

f) the temperature and relative humidity of the test room;

g) the force application rate or cross-head speed;

h) the number of bonded blocks represented and their dimensions;

i) the number of test joints tested;

1) 1 kPa = 1 kN/m^2

j) the individual test results, identified with regard to the bonded block of origin and the identification number of the test joint;

k) the mean breaking force or stress and the mean percentage of wood failure for each bonded block and for all the test joints;

l) the standard deviation of the breaking force or stress for each bonded block and for all the test joints;

m) all modifications of the test procedure that may have affected the results;

n) the date of the test.

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 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 bonding;

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

e) the assembly conditions before application of pressure, including open and closed assembly time and assembly temperature;

f) the compression conditions, including time, bondline temperature and pressure;

g) the 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, 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.

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:

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

where

m is the mass of the block, expressed in kilograms (kg);

V is the volume of the block, expressed in cubic metres (m^3);

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:

$$\rho_{12} = \rho_H \left[1 - \frac{(1 - v)\,(H - 12)}{100}\right]$$

where

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

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 of the specimen at moisture content H, expressed in kilograms (kg);

V_H is the volume of the specimen at moisture content H, expressed in cubic metres (m^3);

v is the coefficient of shrinkage;

H is the moisture content;

V_0 is the volume of the dry specimen, expressed in cubic metres (m^3).

B.2 Timber quality and surface

The blocks for the test specimens may be smoothly sawn or planed prior to abrading. They shall be of straight grain and free from all defects that may interfere with the bond strength determination, such as knots, holes, cracks, bark or gum pockets, short grain, distorted grain or decay.

B.3 Timber moisture content

The moisture content of the wood immediately before adhesive application shall be within the range of the moisture content recommended by the adhesive supplier. In the absence of such recommendations, the moisture content shall be (10 ± 2) % for room temperature setting adhesives and (7 ± 2) % for trot setting adhesives. Except where otherwise agreed upon between the interested parties, the moisture content shall be determined on at least two representative specimens by the oven-dry method [constant mass at (103 $\pm$ 2 °C)].

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

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

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

[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

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