INTERNATIONAL STANDARD

ISO 20152-2

First edition
2011-07-15

Timber structures — Bond performance of adhesives —

Part 2: Additional requirements

Structures en bois — Performance d'adhérence des adhésifs —

Partie 2: Exigences supplémentaires

Reference number
ISO 20152-2:2011(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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 20152-2 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

ISO 20152 consists of the following parts, under the general title *Timber structures — Bond performance of adhesives*:

— *Part 1: Basic requirements*

— *Part 2: Additional requirements*

Introduction

ISO 20152 was developed by ISO/TC 165 to provide additional performance requirements for adhesive bonds formed in structural wood products. It is required only in some jurisdictions (the high temperature creep and shear strength at elevated temperatures) and under some circumstances (situations where a gap filling requirement exists).

This International Standard focuses on bond line performance and is directed principally at the evaluation of wood adhesives. When used in this manner, the tests and assessments are made against standardized wood species, but it would apply to the bond lines in wood products involving other wood species and possibly preservative and fire-retardant treated wood. It is expected that product standards (e.g. for glulam, laminated veneer timber, etc.) would insist that selected requirements be met in the establishment of a new production line or the introduction of a new product, new adhesive, new species, etc. on an existing production line as part of qualification procedures.

The matter of high temperature performance has been controversial in that various national standards have requirements for:

— strength testing at 220 °C or higher,

— creep testing at 180 °C or higher,

— creep testing at 70 °C or higher,

all purporting to deal adequately with high temperature performance. In the event, ISO/TC 165 determined that the CSA O112.9 and CEN EN 15416-2 tests at 70 °C would be placed in ISO 20152-1, Basic requirements. The tests and requirements for high temperature strength at 220 °C or higher (based on an ASTM requirement), the creep resistance at 180 °C or higher (based on CSA O112.9) together with a gap filling capacity, would be placed in this part of ISO 20152. Manufacturers of adhesive should familiarize themselves with local building regulations to determine if the “additional” requirements are necessary.

Users of this International Standard are reminded that local building regulations are a matter for determination by local and/or national governments or regulatory authorities and cannot be mandated in an International Standard.

Timber structures — Bond performance of adhesives —

Part 2: Additional requirements

1 Scope

This International Standard specifies the performance requirements of wood bond lines in prefabricated structural timber components.

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 3130, *Wood — Determination of moisture content for physical and mechanical tests*

ISO 12579, *Timber structures — Glued laminated timber — Method of test for shear strength of glue lines*

ISO 20152-1, *Timber structures — Bond performance of adhesives — Part 1: Basic requirements*

ASTM D 7247, *Standard Test Method for Evaluating the Shear Strength of Adhesive Bonds in Laminated Wood Products at Elevated Temperatures*

3 Terms and definitions

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

3.1
specific gravity
ratio of the oven dry mass of a specimen to the mass of a volume of water equal to the volume of the specimen at specified moisture content

3.2
oven dry specific gravity
expression of the specific gravity based on oven dry mass of wood and its oven dry volume after drying to constant mass in a ventilated oven at a temperature between 100 °C and 105 °C

3.3
wood failure percentage
percentage of wood fibre ruptured during the separation of an adhesive/adherend interface and used to evaluate the effectiveness of adhesive bonding

4 Application

The evaluation of the adhesive bond detailed in this part of ISO 20152 is based on the performance of the adhesive as measured by the following properties:

a) resistance to creep at high temperature (180 °C or higher) (see 5.2),

b) resistance to shear rupture at high temperature (220 °C or higher) (see 5.3),

c) ability to provide adequate shear strength in thick bond lines (greater than 1,0 mm in thickness) (see 5.4).

The performance requirements are optional in the sense that they are not required in all jurisdictions (high temperature creep and high temperature shear rupture) and for all applications (gap filling is not required normally for finger joints, edge and face joints of glulam, plywood, or LVL). Where local building regulations specify that some of these requirements be met, it shall be necessary to test bond lines as specified herein.

5 Requirements

5.1 Adhesive details, mixing and application

The adhesive shall be mixed and applied to the wood substrate in accordance with the adhesive manufacturer's specification. The type and amount of fillers and/or extenders used in the adhesive shall comply with the adhesive manufacturer's specification.

5.2 Creep resistance at elevated temperatures

5.2.1 General

High temperature (180 °C or higher) creep resistance tests shall be carried out in accordance with 6.3 and shall meet the requirements in 5.2.2.

5.2.2 Requirements

High temperature creep resistance shall be demonstrated by testing in accordance with 6.3. The average creep displacement (see Figure 6 of ISO 20152-1 and Annex A of this part of ISO 20152) for all bonded cross-sections for each specimen shall not exceed 0,6 mm and the maximum average creep displacement at any single bonded cross-section for each specimen shall not exceed 2,9 mm after the prescribed load period.

NOTE Temperatures in the range of 180 °C to 220 °C in 5.2.2 are generally appropriate for assessing adhesives used in small cross-section members in fire-protected assemblies.

5.3 Shear strength at elevated temperatures

5.3.1 General

High temperature (220 °C or higher) shear strength resistance tests shall be carried out in accordance with 6.4 and shall meet the requirements in 5.3.2.

5.3.2 Requirements

Reference shall be made to the relevant national product standard, manufacturer of the laminated wood product, qualified agency and/or code evaluation agency to specify a combination of test temperature and exposure durations, or shear strength retention. The performance of bonded specimens shall be compared to that of solid control specimens.

5.4 Gap filling strength

5.4.1 General

Gap filling tests shall be undertaken when bond lines in structural wood products of thickness typically in excess of 1,0 mm are required to exhibit adequate strength. The test is conducted on bond lines at a thickness exceeding 1,0 mm and up to 2,0 mm, but tests at other thicknesses shall be permitted upon agreement between the manufacturer and the user.

5.4.2 Requirements

The performance requirements shall be subject to agreement between the adhesive manufacturer and user. Basic adhesive performance for gap-filling adhesives shall conform to the requirements specified in ISO 20152-1.

6 Sample preparation and test methods

6.1 Specimen requirements

6.1.1 Evaluation of hardwoods

Adhesives for hardwoods tested in accordance with 6.3, 6.4 and 6.5 shall be evaluated on hard maple (*acer saccharum* or *acer nigrum*). Additional species shall be permitted to be tested, as specified by the relevant national product standard, manufacturer of the laminated wood product, qualified agency and/or code evaluation agency when meeting the requirements specified in ISO 20152-1.

6.1.2 Evaluation of softwoods

Adhesives for softwoods tested in accordance with 6.3, 6.4 and 6.5 shall be evaluated on one of the following species when meeting the requirements specified in ISO 20152-1:

a) lodgepole pine (*pinus contorta* var. *latifolia*),

b) black spruce (*picea mariana*),

c) Douglas fir (*pseudotsuga menziesii*), or

d) a species specified by the relevant national product standard, manufacturer of the laminated wood product, qualified agency and/or code evaluation agency.

6.1.3 Wood oven dry specific gravity

6.1.3.1 A 25 mm long full cross-section shall be cut at least 150 mm from the end of each board used to provide wood samples for the tests described in 6.3 to 6.5.

6.1.3.2 The wood oven dry specific gravity of each full cross-section shall be as follows:

a) not less than 0,65 for hardwoods;

b) not less than 0,49 for softwoods.

6.2 Wood moisture content

6.2.1 The moisture content shall be determined in accordance with ISO 3130.

6.2.2 The moisture content of the wood samples at the time of assembly shall be as specified by the adhesive manufacturer.

6.2.3 When the adhesive sample is designated as suitable for bonding green timber, the moisture content of all the samples shall be greater than 30 % at the time of bonding.

6.3 Creep resistance test

6.3.1 Preparation of test assemblies

Preparation of assemblies and test specimens for the creep test shall be as described in ISO 20152-1. It is permissible to use the same specimens used in the creep test in Environment B of ISO 20152-1 for this creep resistance test at an elevated temperature.

6.3.2 Conditioning of test specimens

The specimens shall be conditioned before testing at (20 ± 2) °C and (65 ± 5) % relative humidity until a constant weight is attained. When the specimen tested in Environment B of ISO 20152-1 is used, the specimen shall be unloaded from the test jig and allowed to cool to the ambient temperature prior to reloading.

6.3.3 Test procedure

The specimen shall be loaded in accordance with ISO 20152-1 and maintained at a stress level of (2,1 ± 0,1) MPa for a period of 2 h. The applied stress level shall be increased to compensate for the decrease in the spring constant when the creep jig is heated to 180 °C or higher. The amount of required increase can be determined by comparing the spring constant of the spring at room temperature to that when the spring is heated to the specified temperature.

NOTE The spring constant changes with the temperature. The required creep load at an elevated temperature can be calibrated with a load cell.

6.3.4 Interpretation of results

Interpretation of results shall follow Clause 7.8.1.5 of ISO 20152-1.

6.4 Shear strength test at elevated temperatures

NOTE This method follows the general principle of ASTM D 7247.

6.4.1 Preparation of test assemblies

6.4.1.1 The wood species used for the tests shall be the wood species specified in 6.1.1 and 6.1.2. The timber shall have the annual growth rings oriented 45° to 90°, as measured from the wide face (vertical grain), and be free of defects. The moisture content of the specimens shall be between 10 % and 12 %, except for tropical species that shall be between 12 % and 15 %, prior to bonding or as recommended by the adhesive manufacturer. Timber having a minimum thickness of 35 mm is required to manufacture the test specimens.

6.4.1.2 Specimens shall be prepared in accordance with the general principles of ISO 12579. An example of the shear specimen cutting pattern is shown in Figure 1. Care shall be exercised to ensure the same annual ring orientation when bonding the timber together into a bonded assembly.

6.4.1.3 The adhesive preparation, spread rate, clamping pressure, and clamping time shall follow the adhesive manufacturer's recommendations and the production conditions, such as wood moisture content, adhesive spread rate, press pressure and curing temperature.

6.4.1.4 A minimum of 20 bonded specimens shall be prepared in accordance with Figure 2. An equal number of solid wood (without the bond line) control specimens side-matched with the bonded specimens shall be prepared, as shown in Figure 1. The side-matched solid wood specimens shall be surfaced to the same thickness as the bonded specimens. The bonded and matched solid wood control specimens shall be prepared as 20 pairs.

6.4.1.5 A total of 10 pairs of bonded and matched solid wood control specimens shall be tested at ambient temperature and the remaining 10 pairs of bonded and matched solid wood control specimens shall be tested at the targeted elevated temperature.

6.4.1.6 For specimens tested at the elevated temperature, a hole shall be drilled through one lamination at a 90° angle to the bond line and reaching to within 1,6 mm of the bond line. The drilled hole shall allow the thermocouple wire casing to fit snugly inside the hole with the exposed portion of the thermocouple wire touching the bond line of the bonded specimen or the geometric centre (shear plane) of the matched solid wood control specimen.

6.4.1.7 All specimens shall be oven dried for 48 h at (60 ± 2) °C and placed in an atmosphere, such as a desiccator, to allow for cooling in dry conditions.

NOTE The low temperature drying is intended for minimizing the thermal degradation of wood.

6.4.1.8 After cooling, the specimen weight shall be determined. The width and length of the test specimen shall be measured and recorded, at the bond line, to the nearest 0,25 mm to determine the shear area. Test specimens are to be kept in the desiccator until just prior to testing in accordance with 6.4.2.

6.4.2 Test procedure

6.4.2.1 Specimens tested at ambient condition

A sample set consisting of 10 solid wood control specimens and 10 bonded specimens shall be tested at ambient laboratory conditions in accordance with the procedures outlined in ISO 12579. Loads shall be applied with a continuous motion of the movable head at a rate of 5 mm/min until failure. The ultimate load shall be recorded in accordance with ISO 12579.

6.4.2.2 Specimens tested at elevated temperature

6.4.2.2.1 The oven shall be preheated to the targeted temperature using a thermocouple to monitor the interior oven temperature. The oven air temperature shall be held at the desired level for sufficient time to heat all of the components of the oven to the targeted temperature.

6.4.2.2.2 Only one specimen, either one solid wood control specimen or one side-matched bonded specimen, shall be placed in the oven at a time. A thermocouple wire shall be placed into the specimen, as described in 6.4.1.6. The drilled hole shall be backfilled, if necessary, with glass insulation, high temperature silicon, or a similar protective barrier. The backfill materials shall be allowed to cure according to the manufacturer's recommendations prior to testing. The tip of the thermocouple wire shall have a maximum of 1 mm of insulation removed.

When a manually controlled oven is used, previous studies have shown that for a targeted temperature of 220 °C, the heat should be turned down when the interior temperatures of the specimens reach approximately 200 °C. The bond line temperature will continue to rise, but the rate of increase will decrease. As the rate of temperature rise decreases, heat can be reintroduced, if necessary, to attain the targeted bond line temperature. Practice runs with "dummy" specimens are recommended before the collection of actual data. The use of a proportional-integral-derivative (PID) device may help the temperature control.

6.4.2.2.3 The bond line temperature of the bonded specimen or the temperature at the shear plane of the matched solid wood control specimen shall be monitored. The amount of time for the specimen to reach the targeted temperature shall not be less than 30 min nor more than 90 min.

6.4.2.2.4 The time when the bond line temperature of the bonded specimen or the temperature at the shear plane of the matched solid wood control specimen reaches the targeted temperature shall be recorded. The bond line temperature of the bonded specimen or the shear plane of the solid wood control specimen shall be maintained at the targeted temperature of no less than 220 °C for a duration determined from 6.4.2.2.5.

NOTE Caution! The specimen is hot. Handle the specimen with insulated gloves to avoid burns.

6.4.2.2.5 The exposure duration of the elevated temperature shall be determined using all solid wood control specimens. After reaching the targeted temperature at the shear plane, the exposure duration of the solid control specimens shall be sufficient to arrive at the mean residual shear strength, as defined in 6.4.3.4, of

(30 ± 10) % or 10 min, whichever is longer. This may require the experiment to be repeated several times before the adequate exposure duration can be determined. However, once the exposure duration is determined based on the solid wood control specimens, the same exact targeted temperature and exposure duration shall be applied to the bonded specimens.

6.4.2.2.6 After the temperature at the shear plane of the matched solid wood control specimen or the bond line temperature of the bonded specimen has been exposed to the targeted temperature for the exposure duration, the block shear testing in accordance with 6.4.2.1 shall be conducted immediately after the specimen is removed from the oven such that the specimen bond line or shear plane temperature does not drop more than 5 °C prior to failure after leaving the oven. This provision is deemed to be satisfied when the time interval from the removal of the specimen from the oven to the failure of the block shear specimen does not exceed 60 s for each specimen tested and the room temperature of the test laboratory at the time of testing is not less than 15 °C. The ultimate load shall be recorded in accordance with ISO 12579. The specimen weight after testing shall be recorded.

6.4.3 Calculation of results

6.4.3.1 The shear strength in MPa shall be calculated based on the shear area of the specimen, computed to the nearest 5 mm^2, in accordance with Equation (1).

$$f_v = P/A \tag{1}$$

where

f_v is the shear strength, in MPa;

P is the load at failure, in N;

A is the shear area of the specimen, in mm^2.

6.4.3.2 The shear strength of each specimen shall be reported.

6.4.3.3 The specimen weight loss ratio, which is the specimen weight after testing divided by the specimen oven dry weight prior to 6.4.2 test procedures, shall be calculated and reported.

6.4.3.4 The residual shear strength ratio for the bonded and solid wood control specimens shall be calculated separately in accordance with Equation (2).

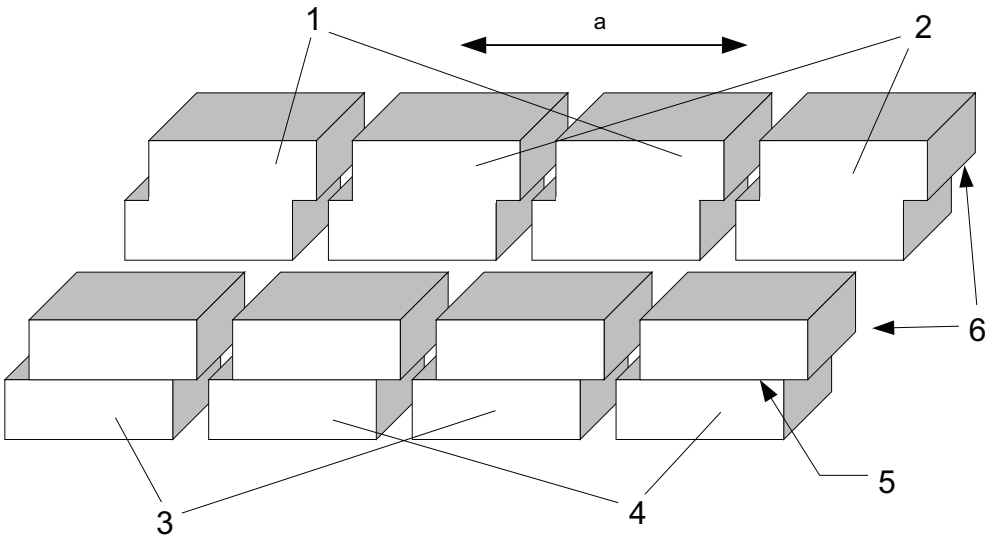
$$R = \frac{f_{v,e}}{f_{v,a}} \tag{2}$$

where

R is the residual shear strength ratio;

$f_{v,e}$ is the mean shear strength at the elevated temperature, in MPa;

$f_{v,a}$ is the mean shear strength at the ambient temperature, in MPa.



Key

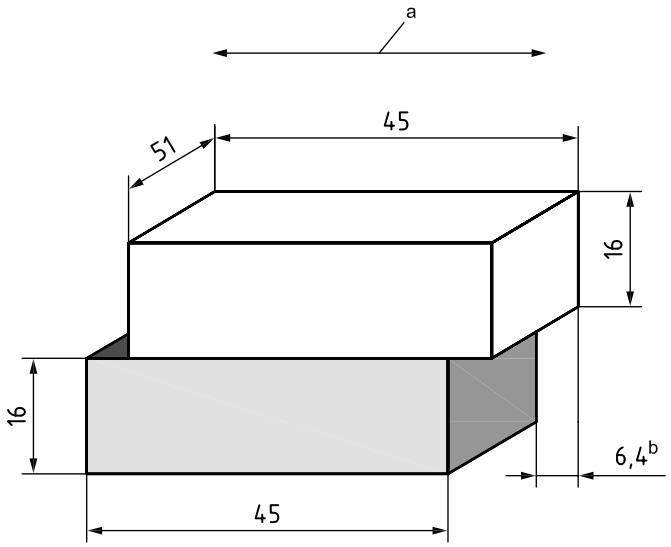
1 solid ambient
2 solid elevated temperature
3 glued ambient
4 glued elevated temperature
5 glue line
6 side-matched specimens

a Grain direction.

NOTE See Figure 2 for specimen dimensions.

Figure 1 — Example of side-matched specimen fabrication using 140 mm × 38 mm **timber with bonded specimens and side-matched solid wood control specimens**

Dimensions in millimetres



a Grain direction.

b The step dimension may be adjusted provided that the shear tool can be set up to function properly.

Figure 2 — Form and dimensions of a bonded specimen