
**Timber structures — Bond performance
of adhesives —**

**Part 1:
Basic requirements**

Structures en bois — Performance d'adhérence des adhésifs —

Partie 1: Exigences de base

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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 20152-1 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*

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Introduction

ISO 20152 has been developed by ISO/TC 165 to provide performance requirements for adhesive bond lines formed in structural wood products. It is largely based on the Canadian Standards Association's CSA O112.9^[1] and CSA O112.10^[2]. These CSA-based tests for resistance to shear in the dry and wet states, resistance to delamination during exposure to wetting and drying, and resistance to creep static shear loading during exposure to high humidity, heat and combined heat and moisture are designated as Method A. An alternative "pathway" to the provisions has been provided by equivalent provisions of CEN (European Committee for Standardization) standards, designated as Method B. Both the CSA and CEN standards evaluate adhesive bonds against standardized wood species having tightly prescribed specific gravities.

ISO/TC 165 is nevertheless aware that North American and European species are not readily available in many other countries. Future revisions of ISO 20152 are expected to include evaluations of bond line performance made against other species having alternative specific gravities, provided evidence is produced to show that such evaluations produce equivalent results.

ISO 20152 consists of two parts: this part gives minimum requirements for adhesive bonds in all jurisdictions; ISO 20152-2 gives requirements that are specified by building regulatory authorities (high temperature performance at or above 180 °C) in other jurisdictions or for specific applications (gap-filling performance).

In the above-mentioned Canadian standards, normative reference is made to a number of other documents, which means that they (and a standard based on them) could not be used independently of those documents. Such references have been replaced wherever possible in this part of ISO 20152 without unduly lengthening the text. Because International Standards in the wood products area are not extensive, this has not been practicable in all instances, and normative reference to CEN and ASTM (American Society for Testing and Materials) standards has been retained. The ASTM references, for example, apply only to adhesive bond requirements that are less likely to be specified or are rather lengthy.

The Method A provisions for adhesives provide assessments based on using tightly specified hardwood and/or softwood substrates; the Method B provisions, on the other hand, are confined to the use of beech substrates. The tests and provisions herein represent only a first stage of adhesive evaluation when manufacturing an adhesively bonded structural wood product. It is anticipated that product standards will specify qualification procedures that verify the capacity of the adhesive to produce effective wood bonds, given the specific species and manufacturing processes involved. Within an international context, there are many variations in species and manufacturing practices that cannot be taken into account in an adhesive standard and thus case-by-case evaluations are essential.

Creep performance criteria and tests under elevated temperatures (180 °C) contained within CSA O112.9 have been removed. The matter was discussed within ISO/TC 165 and it was agreed that high temperature performance (greater than 180 °C) is not a requirement in all jurisdictions. A number of countries do not require the bond line itself to have a fire rating. Where a wood product (either protected or unprotected) is required to have a fire rating for specific classes of building construction, the view is taken that it is the structural assembly that must be evaluated by a national fire testing standard for assessment against national building code requirements.

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Timber structures — Bond performance of adhesives —

Part 1: Basic requirements

1 Scope

This part of ISO 20152 specifies the basic performance requirements for adhesives used to bond structural timber components. These requirements depend upon the service conditions according to Service Classes 1, 2 and 3, as defined herein.

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*

EN 301, *Adhesives, phenolic and aminoplastic, for load-bearing timber structures — Classification and performance requirements*

EN 302-1, *Adhesives for load-bearing timber structures — Test methods — Part 1: Determination of bond strength in longitudinal tensile shear strength*

EN 302-2, *Adhesives for load-bearing timber structures — Test methods — Part 2: Determination of resistance to delamination*

EN 302-3, *Adhesives for load-bearing timber structures — Test methods — Part 3: Determination of the effect of acid damage to wood fibres by temperature and humidity cycling on the transverse tensile strength*

EN 15416-2, *Adhesives for load bearing timber structures other than phenolic and aminoplastic — Test methods — Part 2: Static load test of multiple bondline specimens in compression shear*

EN 15425, *Adhesives — One component polyurethane, for load bearing timber structures — Classification and performance requirements*

ASTM D1583, *Standard Test Method for Hydrogen Ion Concentration of Dry Adhesive Films*

ASTM D3535, *Standard Test Method for Resistance to Creep Under Static Loading for Structural Wood Laminating Adhesives Used Under Exterior Exposure Conditions*

ASTM D4300, *Standard Test Methods for Ability of Adhesive Films to Support or Resist the Growth of Fungi*

3 Terms and definitions

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

3.1
Service Class 1
service class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and a relative humidity of the surrounding air exceeding 65 % for a few weeks per year

NOTE In Service Class 1, the average equilibrium moisture content of most softwoods does not exceed 12 %.

3.2
Service Class 2
service class characterized by a moisture content in the materials corresponding to a temperature of 20 °C and a relative humidity of the surrounding air exceeding 85 % for a few weeks per year

NOTE In Service Class 2, the average equilibrium moisture content of most softwoods does not exceed 20 %. Such conditions include resistance to the effects of moisture on structural performance due to construction delays or other conditions of similar severity.

3.3
Service Class 3
service class characterized by climatic conditions leading to higher moisture content than Service Class 2 such as occurs when a member is fully exposed to the weather

3.4
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 the specified moisture content

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3.5
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

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3.6
flat-sawn timber
back-sawn timber
timber whose growth rings make an angle of less than 45° with its wider face

3.7
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 adhesive bond requirements given in this part of ISO 20152 are based on the performance of the adhesive as measured by the following properties:

- a) resistance to biological degradation (see 5.2);
- b) acid damage to wood fibre (see 5.3);
- c) resistance to shear in the dry and wet states (see 5.4);
- d) resistance to delamination during exposure to wetting and drying (see 5.5);
- e) resistance to creep under static shear loading during exposure to high humidity, heat and combined heat and moisture (see 5.6).

In the cases of c), d) and e), two alternative test methods are presented. Method A is based on CSA O112.9^[1] and Method B on equivalent European test methods. Adhesive suppliers shall choose to test according to either Method A or Method B for resistance to shear, resistance to delamination and resistance to creep. There shall be no mixing of Methods A and B (for example, Method A for shear resistance and Method B for delamination) nor shall retesting of the same adhesive be permitted once the choice of the test method family (A or B) is made.

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 adhesive mix evaluated shall contain all ingredients, including fillers, catalysts, hardeners, accelerators, modifiers, inhibitors and other additives necessary for the

- setting or curing of the mix,
- provision of specific properties to the liquid (appropriate viscosity, open and closed assembly times, etc.), and
- development of relevant properties in the final cured state such as minimum strength levels and creep resistance.

The type and amount of fillers and/or extenders used in the adhesive shall comply with the adhesive manufacturer's specification. Where the adhesive supplier specifies that adhesive and hardener are spread separately, all test specimens shall be prepared in that manner and not as a glue mix.

5.2 Anti-fungal properties

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If the adhesive contains amylaceous and/or protein-based components, the adhesive, when tested in accordance with 6.1, shall possess sufficient anti-fungal properties to inhibit the growth of selected fungal species to a grading of OC, OM or NG as defined in ASTM D4300.

5.3 Acid damage to wood fibre

If, when tested in accordance with 6.2, the pH of the adhesive mix or, in the case of separately spread adhesive and hardener, one of its components, is less than 3, then the adhesive shall be tested in accordance with EN 302-3 and shall meet the requirements of EN 301.

5.4 Shear strength and wood failure

5.4.1 General

Depending on whether Method A or B is used, shear strength and wood failure results (if any) shall meet or exceed either the requirements of 5.4.2 or 5.4.3 respectively.

5.4.2 Method A (block shear)

5.4.2.1 General

When tested in accordance with 6.5, the block shear results shall meet or exceed the shear strength requirements given in 5.4.2.2 and the percentage wood failure requirements given in 5.4.2.3.

5.4.2.2 Shear strength requirements

The median shear strength requirements of samples following the treatments specified in 6.5.1.3.2 to 6.5.1.3.6 inclusive shall meet or exceed the requirements given in Table 1.

Table 1 — Median shear strength requirements (MPa)

Treatment and condition at test	Service Class 3		Service Classes 1 and 2
	Hardwood ^a	Softwood ^b	Softwood only
6.5.1.3.2 — Dry	19	10	10
6.5.1.3.3 — Wet (Vacuum-pressure test)	11	5,6	6,5
6.5.1.3.5 — Wet (Boil-dry-freeze test)	6,9	3,5	3,7

^a Oven-dry specific gravity shall not be less than 0,65.
^b Oven-dry specific gravity shall not be less than 0,49.

5.4.2.3 Wood failure

Only block shear specimens that are used in the strength analysis in connection with the requirements of 5.4.2.2 shall determine whether the percentage wood failure requirements of this section are met. The percentage wood failure in the block shear specimens for each of the treatments shall meet or exceed the values specified in Table 2.

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Table 2 — Wood failure (%) requirements

Test condition	Service Class 3				Service Classes 1 and 2	
	Hardwood ^a		Softwood ^b		Softwood only	
	Lower quartile	Median	Lower quartile	Median	Lower quartile	Median
Dry	15	60	75	85	75	85
Wet	35	80	75	85	75	85

^a Oven-dry specific gravity shall not be less than 0,65.
^b Oven-dry specific gravity shall not be less than 0,49.

5.4.2.4 Interpretation of results

5.4.2.4.1 If a specimen fails with shear strength less than the median value specified in Table 1, but the wood failure exceeds that specified in Table 3, it is permissible to disregard that specimen when determining the median and lower quartile shear strength. If more than one-third of the specimens for any test condition are discarded for this reason, the test shall be repeated for that condition.

5.4.2.4.2 If the shear strengths for all test conditions meet the requirements of Table 1, but the wood failure of each sample fails to meet the requirements of Table 2, the percentage wood failure of the shear specimens may be re-evaluated, provided that the percent wood failure of the 30 specimens evaluated under each test condition meets the requirements of Table 4. The re-evaluation procedure shall be as follows.

Not more than three additional independent laboratories or agencies shall be identified for re-evaluating the wood failure values. These laboratories or agencies shall be noted in the test report. All block shear specimens from the tests shall be sent to the alternative laboratories or agencies to determine the median and lower-quartile wood failure in accordance with this part of ISO 20152. The findings of the additional laboratories or agencies and the procedures used shall be documented and appended to the test report.

If the requirements of Table 2 are met, the adhesive is considered to have passed the wood failure requirements of this part of ISO 20152.

Table 3 — Threshold wood failure (%) rates for discarding block shear test specimens

Test condition	Hardwood	Softwood
Dry	60	85
Wet	80	85

Table 4 — Minimum percent wood failure requirements for re-evaluation

Test condition	Hardwood		Softwood	
	Lower quartile	Median	Lower quartile	Median
Dry	10	50	65	75
Wet	50	70	65	75

5.4.3 Method B (tension shear)

When Method B is used, the tension shear test specified in EN 302-1, together with the requirements given in EN 301, shall be applied.

5.5 Delamination resistance

5.5.1 General

Delamination tests shall be carried out using either Method A or Method B and shall be in accordance with 5.5.2 or 5.5.3 respectively.

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5.5.2 Method A

5.5.2.1 Requirements for hardwoods

5.5.2.1.1 Service Class 3

For adhesives intended for use in Service Class 3, the total delamination within any one bond line shall not exceed 1,6 % of the total length of the bond line in the assembly when tested in accordance with 6.6.1. In order for the adhesive to be approved, three of the four assemblies tested according to 6.6.1 shall meet these requirements.

5.5.2.1.2 Service Classes 1 and 2

There are no requirements for Service Classes 1 and 2 for hardwoods.

5.5.2.2 Requirements for softwoods — Service Classes 1, 2 and 3

For adhesives intended for use in Service Class 1, 2 or 3, the total delamination within any one bond line shall not exceed 1 % of the total length of the bond line in the assembly when tested in accordance with 6.6.1. In order for the adhesive to be approved, three of the four assemblies tested according to 6.6.1 shall meet these requirements.

5.5.3 Method B

When Method B is used, the delamination test specified in EN 302-2, together with the requirements given in EN 301, shall be applied.

5.6 Creep resistance

5.6.1 General

Creep resistance tests for all three service classes shall be carried out using either Method A or Method B and shall meet the requirements given in 5.6.2 or 5.6.3 respectively.

5.6.2 Method A

When tested in accordance with 6.7.1 and under environmental test conditions A, B and C (see Tables 5 and 6), the overall average creep displacement (see Figure 6 and Annex B) across all bonded cross-sections and within any of the six specimens (full length or full length cut into partial lengths) shall not exceed 0,05 mm; the maximum average creep displacement at any single bonded cross-section shall not exceed 0,25 mm after the prescribed load period. In order for the adhesive to be approved, a minimum of two of the three full-length specimens, or seven partial-length specimens taken from two full-length specimens, tested under each set of environmental test conditions in accordance with 6.7.1, shall meet these requirements. If any bonded section of the specimen breaks during the test or if the creep displacement requirement is not met, a retest is permitted, provided the percentage wood failure of the bonded section for that specimen is 95 % or more.

Table 5 — Environmental test conditions applicable to adhesives for use in Service Classes 1, 2 and 3

Service Class	Environmental test conditions for adhesives
3	A, B, C
1 and 2	A, B

5.6.3 Method B

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When Method B is used, the compression shear tests specified in EN 15416-2, together with the requirements given in EN 15425, shall be applied.

6 Sample preparation and test methods

6.1 Anti-fungal properties

This test shall be performed in accordance with ASTM D4300.

6.2 Acid damage to wood fibre

The pH of the adhesive mix shall be determined in accordance with ASTM D1583. If required in accordance with 5.3, the test for acid damage to wood fibre shall be undertaken according to EN 302-3.

6.3 Specimen requirements

6.3.1 Evaluation on hardwoods

When adhesives for hardwoods are tested in accordance with 6.5 to 6.7, the tests shall be performed on hard maple (*acer saccharum* or *acer nigrum*) or the species specified in the relevant CEN standard.