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Specifications for adhesives used for finger joints in non-structural lumber products

Spécifications pour des adhésifs utilisés pour des aboutages dans des produits en bois non structuraux

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Foreword

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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.

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ISO 17087 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

Based with permission of ASTM, on ASTM D 5572, *Standard Specification for Adhesives Used for Finger Joints in Nonstructural Lumber Products*.

Specifications for adhesives used for finger joints in non-structural lumber products

1 Scope

This International Standard specifies performance levels for adhesives to be used in finger joints in nonstructural bonded lumber products. Such products include, but are not limited to, interior and exterior mouldings, window and door components or parts, and bonded lumber panels. Adhesives that meet the requirements of the various performance classes are considered capable of providing an adequate bond for use under the conditions described for the class. This specification is intended to be used to evaluate adhesives as well as the adhesive bonds in the finger joints.

2 Normative references

The following referenced documents are indispensable for the application of this International Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

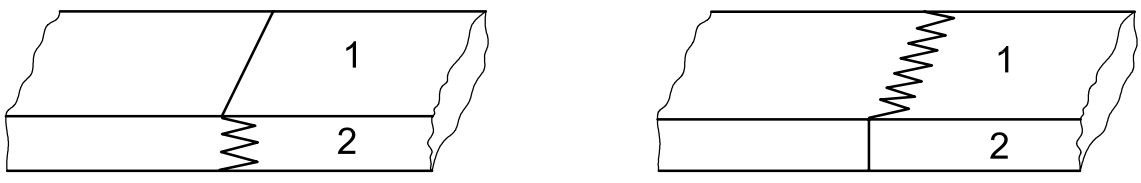
ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

3 Terms and definitions

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

3.1
bond
union between materials produced using adhesives

3.2
finger joint
joint formed by bonding two precut members shaped like fingers (see Figure 1)



a) Horizontal joint **b) Vertical joint**

Key
1 face
2 edge

Figure 1 — Finger joint

3.3
dry-use nonstructural adhesive
adhesive capable of producing sufficient strength and durability to make the bonded lumber product serviceable in nonstructural use, under conditions in which the equilibrium moisture content (EMC) of the wood does not exceed 16 %

3.4
wet-use nonstructural adhesive
adhesive capable of producing sufficient strength and durability to make the bonded lumber product serviceable in nonstructural use, under conditions in which the EMC of the wood may be 16 % or greater

3.5
equilibrium moisture content
EMC
moisture content at which wood neither gains nor loses moisture to the surrounding air

NOTE Adapted from ASTM D 9.

3.6
moisture content
MC
amount of water contained in the wood, usually expressed as a percentage of the mass of the oven-dry wood

NOTE Adapted from ASTM D 9.

4 General principles

4.1 Adhesives are classified as dry-use or wet-use. Each classification includes consideration of short-term in-transit exposure conditions at elevated temperatures up to 104 °C.

NOTE This specification reflects results obtained with laboratory-made specimens compared to those obtained with industrially manufactured specimens. These finger joints were prepared using previously certified adhesives in cooperation with a manufacturer or equipment supplier who had the necessary finger joint cutter and assembly equipment. Such finger joints may vary in geometry and length from manufacturer to manufacturer, and this variation could affect the performance of the bonded finger joint assembly. Figure 2 depicts a typical finger joint configuration.

4.2 When changes are made in the design of industrially manufactured finger joints, the new design should preferably be compared to a control design that has been used successfully.

4.3 An industrially made finger joint assembly should preferably be evaluated using the requirements for compliance with this specification. When this specification is used to evaluate specimens made from laboratory-made assemblies, the results may not compare favourably with those obtained with specimens made from industrially made assemblies.

4.4 Test requirements are provided to determine if the adhesive is suitable for dry use or wet use.

4.5 The dry test and exposure conditions and treatments are to evaluate adhesives used in nonstructural finger joints for typical service conditions.

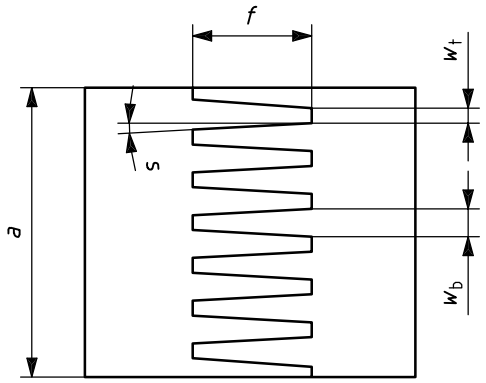
4.6 The 104 °C test is a more severe test designed to evaluate the product after exposure to short-term elevated-temperature conditions. This test is intended to simulate conditions that might be experienced in transit, during further processing or in service conditions.

NOTE Service conditions could typically include stress and time under stress, as well as elevated temperature.

4.7 Procedures are described in sufficient detail to permit duplication in different test laboratories.

To avoid potential problems that would be caused by interrupting the bonding process, the adhesive performance level should preferably be determined by the finger joint manufacturer prior to handling and early shipment.

Before beginning the full testing process, the test laboratory should preferably take a representative sample and check the dry strength first, in order to ensure that the product basically conforms to the dry-strength performance level certified by the adhesive manufacturer.



Key

a	height of joint	33 mm
f	length of finger	6 mm
w_t	width of finger tip	1 mm
w_b	width of finger base	2 mm
s	slope of finger	5°

NOTE The dimensions given are examples for a typical horizontal finger joint.

Figure 2 — Example of cross-section of finger joint test specimen

5 Apparatus and materials

5.1 Tensile-testing machine, capable of maintaining a pre-determined constant crosshead 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 uncertainty of ± 1 % or better.

The machine shall have a capacity of not less than 9 800 N in compression, shall be equipped for one-third-span, two-point loading for the flexure test as described in 9.1 and shown in Figure 3, shall be equipped with grips of sufficient length to hold the specimen firmly, preferably with a minimum length of 63 mm and minimum width of 19 mm, and shall be located in an atmosphere such that the moisture content of the specimen is not noticeably altered during testing.

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

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

The finger joint specimens to be broken in tension are shorter than those to be broken in flexure. Accommodation shall be made in the equipment for handling the larger flexure specimen.

5.2 Environmental chamber, capable of conditioning specimens at (23 ± 2) °C and (65 ± 5) % relative humidity, having a capacity for at least 20 specimens well spaced and supported on racks to allow free air flow.

5.3 **Oven(s)**, with sufficient air circulation to remove moisture from the oven chamber, capable of meeting all the following temperature requirements: (41 ± 2) °C (see 10.2.3), (65 ± 2) °C (see 10.2.6 and 10.3.3), (104 ± 2) °C (see 10.2.4, 10.2.5 and 10.3.4) and (110 ± 2) °C (see 10.2.4).

5.4 **Specimen-soaking tank**, having a capacity meeting the requirements of 10.2.3, so that all of the specimens are at least 50 mm below the water level for the duration of the soak cycles.

5.5 **Specimen-boiling tank**, having a capacity meeting the requirements of 10.3.3, so that all of the specimens are at least 50 mm below the water level for the duration of the boil cycles.

5.6 **Vacuum/pressure vessel**, having a capacity meeting the requirements of 10.3.5, so that all of the specimens are at least 50 mm below the water level for the duration of the vacuum/pressure cycles.

5.7 **PVDC wrap**: poly(vinylidene chloride) film for wrapping test specimens.

6 Requirements

6.1 To demonstrate compliance with this specification, the test adhesive shall be tested for performance in accordance with Clauses 9 and 10, and it shall meet the requirements in Table 1 for the selected test mode and performance classification.

6.2 Compliance with this specification shall warrant certification of the adhesive for use on the species of wood that is used for the tests, or for use on a designated group of species when tested and found to be in compliance for any one member of said group of species. The designated species groupings for commonly used woods, as accepted in this specification, are given in Table 2. In the event that the user or supplier of the adhesive, or both, cannot accept the designated groupings in Table 2, either party shall have the option of requesting a test on an individual species. Furthermore, the user and supplier may agree to change any of the wood-failure requirements of Table 1 when applied to tests on group 3 and 4 hardwoods in Table 2.

6.3 The wood-failure requirements listed in Table 1 are given for softwoods and hardwoods.

6.4 An industrially manufactured finger joint may be used to evaluate the adhesive, provided its construction meets the requirements set forth in Clauses 7 to 10, and the joint is tested against the requirements in Table 1.

7 Test specimens

7.1 Prepare the finger joint assemblies in cooperation with a wood-products manufacturer, an equipment manufacturer or a laboratory having all of the proper equipment.

7.2 Use lumber that conforms to the following requirements: maximum slope of grain of 7 % (1 in 14) on any face or edge; EMC of 8 % to 12 %, preferably brought to 10 % to 12 % MC prior to cutting and bonding; free of knots and decay; free of machining defects such as chipped grain, feed-roll polish, coarse knife marks and feed-roll compression; free of drying effects such as case hardening, collapse and splits or checks.

Recommended minimum specific gravities are given in Table 3. Finger joints shall be cut on the day the assemblies are to be made. See Clause 6 for species compliance rules relative to testing, and Table 2 for information on the bondability of some species of wood.

7.3 Follow the adhesive manufacturer's instructions for conditions and procedures for preparing and applying the adhesive, as well as for assembling, pressing and curing the assembly.

7.4 For each exposure condition within the unique performance classification, a test group shall consist of 20 specimens representing at least four different assemblies with no more than five specimens for each assembly.

Table 1 — Minimum test requirements

Performance classification and exposure conditions [a]	Subclause number for exposure description	Test mode: tension [b]					Test mode: flexure
		Strength [c] MPa	Wood failure [d]				Stress at rupture [c] (min. [g]) MPa
			Group average [e] %		Individual minimum [f] %		
			Soft-wood	Hard-wood [h]	Soft-wood	Hard-wood [h]	
Dry use:							
Cured (dry)	10.2.2	13,8	60	30	30	15	13,8
Three-cycle soak	10.2.3	6,9	30	15	15	—	6,9
Elevated-temperature test method 1 (104 °C)	10.2.4	6,9	—	—	—	—	—
Elevated-temperature test method 2 (104 °C)	10.2.5	6,9	—	—	—	—	—
Temperature/humidity (65 °C, 16 % EMC)	10.2.6	5,2	—	—	—	—	—
Wet use:							
Cured (dry)	10.3.2	13,8	60	30	30	15	13,8
Boil	10.3.3	11,0	50	25	25	—	9,7
Elevated temperature (104 °C)	10.3.4	6,9	—	—	—	—	—
Vacuum/pressure	10.3.5	11,0	50	25	25	—	9,7

[a] Twenty specimens required for each classification and exposure.

[b] Parallel to the grain.

[c] Tension and flexure results may vary with the species. To be acceptable, a wood shall produce joints able to meet these requirements.

[d] The wood-failure requirements are given for softwoods and hardwoods. Group 3 and 4 hardwoods are listed at 50 % of the softwood value, with no wood-failure requirement if the calculated value is 15 % or less.

[e] For total group of specimens tested.

[f] 90 % of the specimens tested shall meet or exceed the minimum wood-failure percentages shown. If a zero value is obtained for any of the specimens, the specimen shall meet the strength requirement.

[g] For any individual specimen.

[h] See recommended minimum specific gravity in Table 3.

Table 2 — Bondability groupings of commonly used wood

Group [a]	Hardwoods	Softwoods	Other	
Group 1 [b] Bond easily	Alder Aspen Basswood Chestnut, American Cottonwood Magnolia Willow, Black	Cedar, Incense Fir, Grand Fir, Noble Fir, Pacific Fir, White Pine, Eastern white Pine, Western white Redcedar, Western Redwood Spruce, Sitka	Balsa Cativo Courbaril Determa [c]	Hura Purpleheart Roble
Group 2 [d] Bond well	Butternut Elm, American Elm, Rock Hackberry Maple, Soft Sweetgum Sycamore Tupelo Walnut, Black Yellow-poplar	Fir, Douglas Larch, Western [e] Pine, Ponderosa Pine, Sugar Redcedar, Eastern	Afrormosia Andiroba Angelique Avodire Banak Cedar, Spanish Iroko Jarrah Limba Mahogany, African Mahogany, True	Meranti (Lauan), Light red Meranti (Lauan), White Meranti (Lauan), Yellow Obeche Okoume Opepe Peroba rosa Sapele Sucupira Wallaba
Group 3 [f] Bond satisfactorily	Ash, White Beech, American Birch, Sweet Birch, Yellow Cherry Hickory, Pecan Hickory, True Madrone Maple, Hard Oak, Red [c] Oak, White [c]	Cedar, Alaska Cedar, Port Orford Pine, Southern	Angelin Azobe Benge Bubinga Karri	Meranti (Lauan), Dark red Pau marfim Pine, Caribbean Pine, Parana Pine, Radiata Ramin
Group 4 [g] Bond with difficulty	Orange, Osage Persimmon		Balata Balau Greenheart Kaneelhart Kapur	Keruing Lapacho Lignumvitae Rosewood Teak

[a] It is recognized that more modern adhesives might lead to different species groupings in regard to difficulty of bonding.

[b] Bond very easily with adhesives having a wide range of properties and under a wide range of bonding conditions.

[c] Difficult to bond with phenol-formaldehyde adhesives.

[d] Bond well with a fairly wide range of adhesives under a moderately wide range of bonding conditions.

[e] Wood from butt logs with a high extractive content is difficult to bond.

[f] Bond satisfactorily with good-quality adhesives under well-controlled bonding conditions.

[g] Satisfactory results require careful selection of adhesives and very close control of bonding conditions; may require special surface treatment.

Table 3 — Recommended minimum specific gravities by species

Species	Specific gravity [a] g/cm^3
Cedar, Alaska	0,44
Fir, Douglas (East)	0,48
Fir, Douglas (interior South)	0,46
Fir, White	0,39
Hemlock, Western	0,45
Larch, Western	0,52
Pine, Lodgepole	0,41
Pine, Loblolly	0,51
Pine, Ponderosa	0,40

[a] Values are averages based on oven-dry mass and volume at 10 % to 12 % moisture content.

8 Moisture content and conditioning

8.1 Measuring moisture content

There are several stages in this test method where it is necessary to determine the MC, as follows: on the lumber before bonding, on the assemblies before cutting into specimens, and on the specimens during several tests when they have to be dried to a given MC before testing.

Select lumber within the range from 10 % to 12 % MC before bonding (see 7.2). Determine the MC by use of an electronic moisture meter. After bonding the assemblies in the field, control the MC of the specimens throughout the testing process.

If needed, condition the assemblies to the original MC $\pm$ 1 % by use of an environmental chamber prior to cutting the specimens.

8.2 Specimen conditioning during the testing process

The allowable variation in MC at the completion of a drying cycle or before testing dry is $\pm$ 1 %. For example, if the MC of the specimen before exposure is 9 %, the acceptable range for testing is 8 % to 10 %. Wood failure is estimated on specimens after they have been conditioned to less than 8 %, except for the dry test described in 10.2.2 and 10.3.2, where the specimens have never left the dry state. Wood failure may be read on these test specimens following the strength testing, with no further conditioning to reduce MC.

9 Test procedures — Flexure and tension

9.1 Testing in flexure

Specimens shall be conditioned in accordance with Clause 8.

From a finger-jointed assembly (see 7.2), cut the flexure-test specimens with sufficient length for the joint to be centered at midspan as in Figure 3, and with a distance between the reaction points of 24 times the depth d. Allow at least 25 mm at both ends of the specimen outside the reaction points (see dimension e in Figure 3).

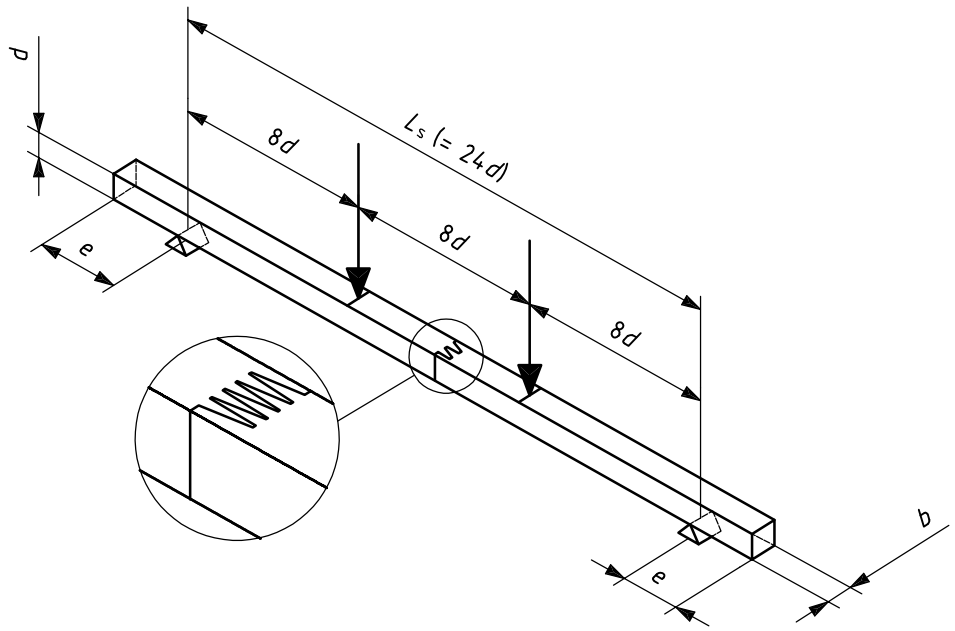
On each edge of the specimen, feather out the finger at the midpoint of the joint, adjusting the width of the specimen accordingly (see Figure 4).

NOTE In this application, “to feather” means to remove any portion extending beyond the normal surface of the outer finger so that the stress riser (butt joint effect) is not present on the surface (see Figure 4).

Subject the specimens to the tests for the selected classification (wet use or dry use), or both, in accordance with the applicable conditions and treatments given in Clause 10. Consult Table 1 for the tests required for each test mode and performance classification.

Attach each specimen in turn to the test machine and apply the load with a continuous motion of the movable head at a rate of (12 ± 1,2) mm/min, testing the specimens by one-third-span, two-point loading with the load applied perpendicular to the face showing the fingers, as shown in Figure 3.

Report the stress at rupture values on the form shown in Table A.1 in Annex A for dry use and wet use. Also, report the wood species used for testing, indicate whether it is classified as softwood or hardwood, and report the slope of the finger in degrees. Report the measurements of width or thickness b and depth of specimen d, to the nearest 0,1 mm, for each specimen. Table A.1 also includes spaces for the recording of several items of bonding information that, although not required for test reporting, have been found useful in product quality control.

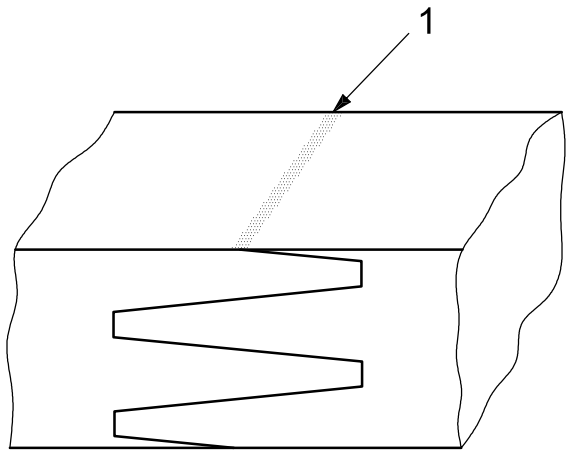


Key

L_s	length of specimen between reaction points	312 mm
b	width of vertical joint or thickness of horizontal joint	19 mm
d	depth of specimen	13 mm
e	length of specimen outside reaction points	at least 25 mm

NOTE These dimensions are given as examples of a finger joint assembly. Use the actual measurements of b and d. Note that dimension b is the width of a vertical joint but the thickness of a horizontal joint.

Figure 3 — Flexure test specimen dimensions and set-up



Key

1 feathered joint

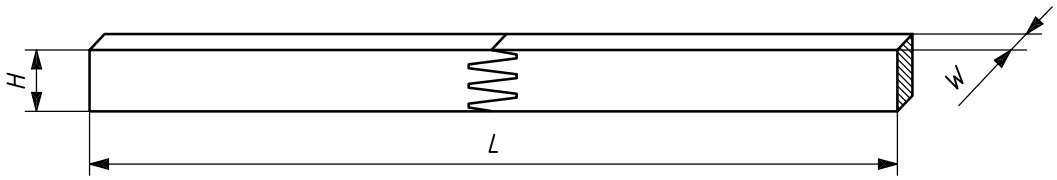
Figure 4 — Feathered finger joint

9.2 Testing in tension

Specimens shall be conditioned in accordance with Clause 8.

From a finger-jointed assembly, cut the tension test specimens, each measuring 6 mm × (19 ± 0,25) mm and with a recommended length of 254 mm (see Figure 5). Trim the outer fingers of the specimen as described in the Note to Subclause 9.1 and as shown in Figure 4, a process known in this specification as “feathering”.

NOTE Figure 5 illustrates the finger joint configuration. 254 mm is the preferred length, but shorter lengths may be necessary to accommodate certain test machines.



Key

L	length of specimen	254 mm
H	height of specimen	19 mm
W	width of specimen	6 mm

NOTE 1 These dimensions are given as examples only.

NOTE 2 The recommended length is 254 mm. Some test machines cannot accommodate this length.

Figure 5 — Tension test multifinger specimen

Subject the specimens to the tests for the selected classification (wet use or dry use), or both, in accordance with the applicable conditions and treatments given in Clause 10. Consult Table 1 for the tests required for each test mode and performance classification.

Attach each specimen in turn to the test machine and apply the load with a continuous motion of the movable head at a rate of 13 mm/min.

Report the tensile stress values, together with the estimated percentages of wood failure, on the form shown in Table A.2 and Table A.3 for dry use or Table A.4 and Table A.5 for wet use. Indicate whether the assemblies were industrially manufactured or laboratory made (see Table A.6). Also, report the wood species and indicate whether it is classified as softwood or hardwood. Report the slope of the finger in degrees and the dimensions of each specimen to the nearest 0,1 mm: length of the finger f, width of the finger at the tip w_t and width of the finger at the base w_b (see Figure 2).

Estimate the wood failure at the finger joints by eye to the nearest 5 % (see Annex B for guidelines on reading wood failure). In addition, the mode and location of failure may be noted, i.e. as wood failure away from the joint, through the tips or following the fingers.

10 Exposure conditions

10.1 Time schedule for the tests

Due to the number of specimens to be tested and the types of test to be run, there may not be sufficient time to run all the specimens at one time in the time allotted. So that the time schedule can be followed, before running the tests in 10.2.3, 10.2.4, 10.2.5, 10.3.3, 10.3.4, and 10.3.5, determine whether 1 h is enough time to test 20 specimens. If not, divide the specimens into smaller groups before running the exposure tests.

10.2 Dry use

10.2.1 General

The exposure conditions and treatments used with each test mode to meet the dry-use classification requirements are listed in Table 1. Details of the test methods are given as follows.

10.2.2 Dry test

Following the prescribed curing period for the adhesive being tested, condition or dry one group of the specimens to within the allowable range of ± 1 % of the original moisture content (MC), and test in accordance with the instructions in 9.1 or 9.2.

10.2.3 Soak test (three-cycle)

Place one group of the specimens in water at (23 ± 2) °C in the soak tank, separated by stickers, wire screens or other suitable means in such a manner that all surfaces are freely exposed to the water. Weight down the specimens so that all specimens are at least 50 mm below the surface of the water. Keep the specimens immersed for a period of 4 h, followed by drying at a temperature of (41 ± 2) °C for a period of 19 h, with sufficient air circulation to reduce the moisture content of the specimens to within ± 1 % of the original MC. Repeat this procedure twice more for a total of three cycles. Following the third cycle, conduct the tests in the dry condition at (23 ± 2) °C. If needed, before testing and again before reading wood failure, condition or dry to less than 8 % MC in an environmental chamber.

10.2.4 Elevated-temperature test method 1

Either this elevated-temperature test method or that described in 10.2.5 may be used for the elevated-temperature test.

Place one group of specimens in an oven at (104 ± 2) °C and hold for 6 h. Remove the specimens individually and immediately wrap each in two layers of poly(vinylidene chloride) (PVDC) wrap. Place the wrapped specimens in a single layer in an oven at (110 ± 2) °C and hold for a minimum of 12 min and maximum of 20 min. Remove them from the oven one specimen at a time, and test within 30 s without removing the PVDC wrap. Conduct the test in a room with an ambient temperature of (23 ± 2) °C.

NOTE 1 The exposure of the unwrapped specimens for 6 h at (104 ± 2) °C is for the purpose of simulating an elevated-temperature environment that could be encountered during transportation. PVDC wrap slows the cooling rate while testing.

NOTE 2 Using this procedure, the temperature of a specimen 15 s after removal from the oven will be approximately 104 °C. This cool-down rate is based on actual tests on specimens.

10.2.5 Elevated-temperature test method 2

Either this elevated-temperature test method or that described in 10.2.4 may be used for the elevated-temperature test.

Test the specimens for the effect of elevated temperature by using a heated chamber that is capable of heating the specimens at (104 ± 2) °C for 6 h, and also enclosing the test machine for testing immediately following the exposure period.

10.2.6 Temperature/humidity test

Condition one group of specimens to equilibrium at (27 ± 2) °C and (80 ± 5) % relative humidity (equivalent to 16 % EMC). Wrap each specimen in two layers of PVDC wrap and place in a single layer in an oven at (65 ± 2) °C for 12 min to 20 min. In a room with ambient temperature of (23 ± 2) °C, remove the specimens one at a time and test within 30 s without removing the PVDC wrap.

NOTE Using this procedure, the temperature of a specimen 15 s after removal from the oven will be approximately 60 °C. This cool-down rate is based on actual tests on specimens.

10.3 Wet use

10.3.1 General

The exposure conditions and treatments used with each test mode to meet the wet-use classification requirements are listed in Table 1. Details of the test methods are given as follows.

10.3.2 Dry test

Follow the instructions in 10.2.2.

10.3.3 Boil test

Place one group of specimens in a tank of boiling water, separated by stickers, wire screens or other suitable means in such a manner that all surfaces are freely exposed to the water. Weight down the specimens so they remain immersed by at least 50 mm during the boil cycle. Boil for 4 h. Dry for 20 h at (65 ± 2) °C with sufficient air circulation to lower the MC of the specimens to the original MC, within an allowable variation of ± 1 %. Determine the MC by removing a specimen at 18 h, 19 h, and 20 h and testing with a moisture meter until the MC reading is in the desired range, or predetermine the time required to reach the desired MC by running trials. Repeat the 4 h boil cycle. Then remove the specimens and cool in running water at 18 °C to 27 °C for 1 h. Remove the specimens from the water and place them in a plastic bag to keep them wet. Test while wet within 1 h.

For the specimens broken in tension, dry to less than 8 % MC before estimating the percentage of wood failure.

10.3.4 Elevated-temperature test

Either the elevated-temperature test method described in 10.2.4 or that described in 10.2.5 may be used for the elevated-temperature test. Follow the instructions in the relevant subclause.

10.3.5 Vacuum/pressure test

Place one group of specimens in a pressure vessel, separated by stickers, wire screens or other suitable means in such a manner that all surfaces will be freely exposed to the water. Weight down the specimens and fill the vessel with water at 18 °C to 27 °C so that all specimens are immersed by at least 50 mm. Produce and maintain a vacuum of at least 84,4 kPa for 30 min. Release the vacuum, and follow immediately with pressure of (517 ± 14) kPa for 30 min. Remove the specimens from the vessel and place in a plastic bag to keep them wet. Test while wet within 1 h. Dry to less than 8 % MC before reading the wood failure.

11 Expression of results

For the flexure test, calculate the stress at rupture R, in MPa, as follows:

$$R = PL_s/bd^2$$

where

P is the maximum load, expressed in newtons (N);

L_s is the length of the specimen between the reaction points ($24d$), expressed in millimetres (mm);

b is the width of the specimen, expressed in millimetres (mm);

d is the depth of the specimen, expressed in millimetres (mm).

Wood failure shall be also indicated as a test result.

For the tensile test, calculate the ultimate tensile stress UTS, in MPa, as follows:

$$\text{UTS} = P/bd$$

where

P is the maximum tensile load, expressed in newtons (N);

b is the width of the specimen, expressed in millimetres (mm);

d is the depth of the specimen, expressed in millimetres (mm).

Wood failure shall be also indicated as a test result.

NOTE In the tensile test, the load is applied along the length of the test specimen, whereas in the flexure test the load is applied by the loading edges acting on the upper surface of the test specimen.

12 Precision

The precision of this test method is not known because interlaboratory data are not available. When interlaboratory data are obtained, a precision statement will be added at the following revision.

Annex A
(informative)

Report forms

A.1 This annex provides report forms that are intended to be used to record test results and to provide an easy reference to determine whether the specimens prepared with the adhesive under test satisfy the requirements of this specification.

a) A report form for the flexure test is given in Table A.1.

b) Report forms for the tension test are given in Tables A.2, A.3, A.4 and A.5.

A supplementary page for recording information needed for the interpretation of the results is given in Table A.6.

Table A.1 — Report form — Flexure test for dry-use and wet-use classifications

Report No.: _____
Adhesive manufacturer: _____
Test facility: _____
Laboratory No.: _____

Specimen No.	Stress at rupture, dry use MPa		Stress at rupture, wet use MPa		
	Dry (10.2.2)	**3-Cycle soak (10.2.3)**	**Dry (10.3.2)**	**Boil (10.3.3)**	**Vacuum/pressure (10.3.5)**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Avg for group					
Required avg [a]	13,8	6,9	13,8	9,7	9,7
WF % [b]	XXX	XXX	XXX	XXX	XXX
Passed?	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Meets dry-use requirements? Yes ___ No ____			Meets wet-use requirements? Yes ___ No ____		

[a] Required minimum average strength for total group of specimens, in MPa.

[b] No wood-failure requirement.

XXX No information needed.

Table A.2 — Tension test for dry-use classification (dry test and soak test)

Report No.: _____
Adhesive manufacturer: _____
Test facility: _____
Laboratory No.: _____

Specimen No.	Dry (10.2.2)			3-Cycle soak (10.2.3)		
	Strength	Wood failure [a]		Strength	Wood failure [a]	
		Softwood	Hardwood		Softwood	Hardwood
	MPa	%	%	MPa	%	%
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Avg for group						
Required avg [b]	13,8	XXX	XXX	6,9	XXX	XXX
WF % (total) [c]	XXX	60	30	XXX	30	15
WF % (min.) [d]	XXX	30	15	XXX	15	— [e]
Passed?	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Meets dry-use requirements? Yes ___ No ___						

[a] Place a check alongside the minimum wood-failure percentage.
[b] Required minimum average strength for total group of specimens, in MPa.
[c] Required minimum average wood-failure percentage for total group of specimens, in %.
[d] Required minimum wood-failure percentage for individual specimens, in % (see Table 1, Footnote f).
[e] No wood-failure requirement.

XXX No information needed.

Table A.3 — Report form — Tension test for dry-use classification: elevated-temperature test and humidity test

Report No.: _____
Adhesive manufacturer: _____
Test facility: _____
Laboratory No.: _____

Specimen No.	104 °C (10.2.4, 10.2.5)			65 °C (10.2.6)		
	Strength	Wood failure [a]		Strength	Wood failure [a]	
		Softwood	Hardwood		Softwood	Hardwood
	MPa	%	%	MPa	%	%
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Avg for group						
Required avg [b]	6,9	XXX	XXX	5,2	XXX	XXX
WF % (total) [c]	XXX	— [e]	— [e]	XXX	— [e]	— [e]
WF % (min.) [d]	XXX	— [e]	— [e]	XXX	— [e]	— [e]
Passed?	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Meets dry-use requirements? Yes ___ No ___						

[a] Place a check alongside the minimum wood-failure percentage.
[b] Required minimum average strength for total group of specimens, in MPa.
[c] Required minimum average wood-failure percentage for total group of specimens, in %.
[d] Required minimum wood-failure percentage for individual specimens, in % (see Table 1, Footnote f).
[e] No wood-failure requirement.
XXX No information needed.

Table A.4 — Report form — Tension test for wet-use classification: dry test and boil test

Report No.: _____
Adhesive manufacturer: _____
Test facility: _____
Laboratory No.: _____

Specimen No.	Dry (10.3.2)			Boil (10.3.3)		
	Strength	Wood failure [a]		Strength	Wood failure [a]	
		Softwood	Hardwood		Softwood	Hardwood
	MPa	%	%	MPa	%	%
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Avg for group						
Required avg [b]	13,8	XXX	XXX	11,0	XXX	XXX
WF % (total) [c]	XXX	60	30	XXX	30	25
WF % (min.) [d]	XXX	30	15	XXX	25	— [e]
Passed?	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Meets wet-use requirements? Yes ___ No ____						

[a] Place a check alongside the minimum wood-failure percentage.
[b] Required minimum average strength for total group of specimens, in MPa.
[c] Required minimum average wood-failure percentage for total group of specimens, in %.
[d] Required minimum wood-failure percentage for individual specimens, in % (see Table 1, Footnote f).
[e] No wood-failure requirement.

XXX No information needed.

Table A.5 — Report form — Tension test for wet-use classification: elevated-temperature and vacuum/pressure test

Report No.: _____
Adhesive manufacturer: _____
Test facility: _____
Laboratory No.: _____

Specimen No.	104 °C (10.3.4)			Vacuum/pressure (10.3.5)		
	Strength	Wood failure [a]		Strength	Wood failure [a]	
		Softwood	Hardwood		Softwood	Hardwood
	MPa	%	%	MPa	%	%
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Avg for group						
Required avg [b]	6,9	XXX	XXX	11,0	XXX	XXX
WF % (total) [c]	XXX	— [e]	— [e]	XXX	50	25
WF % (min.) [d]	XXX	— [e]	— [e]	XXX	25	— [e]
Passed?	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Meets wet-use requirements? Yes ___ No ____						

[a] Place a check alongside the minimum wood-failure percentage.
[b] Required minimum average strength for total group of specimens, in MPa.
[c] Required minimum average wood-failure percentage for total group of specimens, in %.
[d] Required minimum wood-failure percentage for individual specimens, in % (see Table 1, Footnote f).
[e] No wood-failure requirement.

XXX No information needed.

Table A.6 — Supplementary page for use with Tables A.2, A.3, A.4 and A.5

Report No.: _____

Date: _____

Adhesive manufacturer: _____

Test facility: _____

Laboratory No.: _____

Species used: _____

Softwood: _____ } Check one

Hardwood: _____

Adhesive used: _____

Industrially manufactured: _____ } Check one

Laboratory made: _____

Date bonded: _____

Date received: _____

Tested by: _____

Adhesive mix, application, pressing conditions and comments: _____

_____

_____

Dimensions of flexure test specimen (see Figure 3):

Length of specimen between reaction points, L_s _____ mm

Width (vertical joint) or thickness (horizontal joint), b _____ mm

Depth of specimen, d _____ mm

Dimensions of tension test specimen (see Figure 5):

Length of specimen, L _____ mm

Height of specimen, H _____ mm

Width of specimen, W _____ mm

Dimensions of joint (see Figure 2):

Height of joint, a _____ mm

Length of finger, f _____ mm

Width of finger tip, w_t _____ mm

Width of finger base, w_b _____ mm

Slope of finger, s _____ degrees

Annex B
(informative)

Reading wood failure in finger joints

B.1 General

The types of failure that occur in finger-jointed specimens due to tension loading can be roughly classified into six modes. The failure mode of each specimen should be based on the written and graphical description given in Table B.1.

Failure modes 1 and 2 require the evaluator to make a distinction between less than 70 % wood failure and more than 70 % wood failure. This is often a difficult quantity to judge from an oblique angle. In difficult cases, it is suggested that the fingers be cut off at their roots so that the failed surfaces of the finger can be viewed directly.

NOTE See ASTM D 5266.

B.2 Procedure to determine wood failure of finger joints

The following procedure has been shown to be helpful in determining the wood-failure percentage of finger joints.

a) Do not estimate the wood-failure percentage of specimens with localized defects such as knots, knotholes, burls and voids in the bonded area.

b) Work in a location where direct outside light does not fall on the specimens.

c) Select a light source and use it consistently. A dual-element desk lamp equipped with one 15 W daylight and one 15 W cool white tube is recommended.

d) When reading wood failure on finger joints, hold the specimen with the length of the fingers perpendicular to the line between the light source and the eye.

e) Dyes are sometimes helpful in distinguishing wood failure from light-coloured adhesive.

f) Magnification, rotation of the specimen and variation of the incident angle of the light on the surface are often necessary to distinguish shallow wood failure from adhesive failure, especially when the adhesive is light-coloured or transparent. Magnification may or may not be used to make the actual estimate of wood failure; however, the practice should be consistent. After rotation, always reposition the specimen to the standard position before making the estimate of wood failure.

g) Mentally divide the surface into quadrants for estimating the areas of various forms of failure.

h) Estimate total wood-fibre failure of each specimen to the nearest 5 %, with a maximum of 100 % of the total bonded test area.

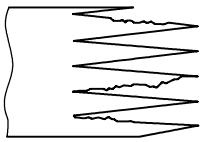
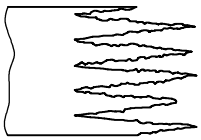
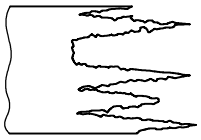
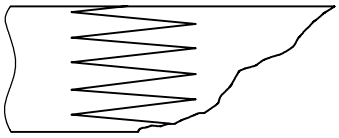
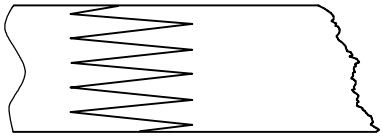
i) For accuracy and consistency, special care should be taken in the middle range from 30 % to 85 %, where most of the difficulty occurs.

j) The colour of the adhesive and recognition of shallow wood failure affect the estimate.

k) If the percentage of wood failure is high and the failure is mostly on the side of the adhesive layer, the grain orientation can be a factor.

l) Record any indications of poor spread, lack of adhesive transfer or other bonding problems.

Table B.1 — Failure-mode criteria

Mode	Description	Example
1	Failure mostly along the bondline surface of the joint profile with poor wood failure of any kind. (Wood failure $<$ 70 %)	
2	Failure mostly along the bondline surface of the joint profile with good wood shear failure. (Wood failure $>$ 70 %)	
3	Failure mostly along the joint profile but with some failure at the finger roots or scarf tips. Good overall wood shear failure along the joint profile surfaces.	
4	Mostly tensile wood failure at the finger-joint roots or scarf tips and with high overall wood failure. Little failure of any kind along the joint profile.	
5	Failure beginning at the joint (possibly due to a stress riser) and progressing away from the joint. Essentially 100 % wood failure.	
6	Failure away from the joint (not influenced by the joint). All-wood failure.	

Bibliography

[1] ASTM D 9, *Standard Termninology Relating to Wood and Wood-Based Products*

[2] ASTM D 5266, *Standard Practice for Estimating the Percentage of Wood Failure in Adhesive Bonded Joints*

[3] ASTM D 5572, *Standard Specification for Adhesives Used for Finger Joints in Nonstructural Lumber Products*

[4] EN 13183-2, *Moisture content of a piece of sawn timber — Part 2: Estimation by electrical resistance method*

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