



Designation: D 3498 – 01

Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems¹

This standard is issued under the fixed designation D 3498; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers minimum performance standards and test requirements for gap-filling construction adhesives for bonding plywood to lumber framing, particularly floor joists, at the construction site.

1.2 This specification provides a basis for ensuring the quality of the adhesives and is not intended as an application specification.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 The following precautionary caveat pertains only to the test method portion, Section 11, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 572 Test Method for Rubber—Deterioration by Heat and Oxygen²
- D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading³
- D 907 Terminology of Adhesives³
- D 1174 Test Method for Effect of Bacterial Contamination on Permanence of Adhesive Preparations and Adhesive Bonds⁴
- D 1286 Test Method for Effect of Mold Contamination on Permanence of Adhesive Preparations and Adhesive Bonds⁴

¹ This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

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² *Annual Book of ASTM Standards*, Vol 09.01.

³ *Annual Book of ASTM Standards*, Vol 15.06.

⁴ Discontinued; see 1983 *Annual Book of ASTM Standards*, Vol 15.06.

D 2016 Test Methods for Moisture Content of Wood⁵

E 4 Practices for Force Verification of Testing Machines⁶

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods⁷

3. Terminology

3.1 *Definitions*—Many terms in this specification are defined in Terminology D 907.

3.1.1 *gap-filling adhesive, n*—an adhesive capable of forming and maintaining a bond between surfaces that are not close-fitting.

3.1.1.1 *Discussion*—Close-fitting is relative to a given material and industry; for example, standards in construction differ from standards in electronics. Some adhesives will bond by bridging without completely filling the gap; others by filling the gap completely.

3.1.2 *open assembly time, n*—the time interval between applying adhesive on the substrates and closing them together before bonding.

4. Significance and Use

4.1 This specification establishes test methods and performance requirements for adhesives bonding plywood to wood framing members.

4.2 This specification provides a basis for ensuring the quality of the adhesives.

4.3 The tests provide shear strength performance data when the substrates are conditioned to simulate various conditions that may occur during sub-floor adhesive application and curing.

4.4 The tests are suitable for product performance certification and quality control programs, and can be useful to the general public, adhesive manufacturers, distributors, specifiers, architects, contractors, testing laboratories and other businesses and professionals.

4.5 The results do not include all possible conditions, which

⁵ Discontinued; see 1989 *Annual Book of ASTM Standards*, Vol 04.09.

⁶ *Annual Book of ASTM Standards*, Vol 03.01

⁷ *Annual Book of ASTM Standards*, Vol 14.02.



may occur during final assembly, but indicate a set of performance characteristics for laboratory controlled bonding variables.

5. Ordering Information

5.1 The adhesive may be furnished by the manufacturer in any suitable form agreeable to the purchaser.

6. Materials

6.1 The adhesive shall be a gap-filling construction adhesive that sets at temperatures as low as 40°F (4.4°C).

6.2 The adhesive shall not support mold or bacterial growth. If the adhesive contains any materials that will support mold or bacterial growth, such as amylaceous or protein fillers, the adhesive must not only pass requirements of this specification, but in addition, show no significant loss in strength at the 0.05 level of probability when tested for mold and bacterial contamination in accordance with Test Methods D 1174 and D 1286, and procedures contained in this specification. The adhesive manufacturer shall notify in writing the agency responsible for testing, certifying, and compliance labeling of the adhesive whether any such materials are present in the adhesive.

6.3 The adhesive, when completely set, shall form a resilient bond that shall be durable when protected from direct exposure to the weather, as defined by the requirements of this specification.

6.4 The adhesive shall be a uniform mixture suitable for extrusion by a caulking gun or other pressurized application equipment.

6.5 The adhesive shall permit an open assembly time of not less than 10 min when applied to the lumber framing in accordance with the manufacturer’s instructions. It shall be functional, as defined in this specification, when applied to surfaces having a temperature range from 0 to 100°F (–17.8 to 37.8°C).

NOTE 1—Open assembly times that are less than 10 min as agreed upon between the manufacturer and user, are acceptable provided the adhesive

meets the requirements of Table 1.

6.6 The adhesive shall be functional when applied to lumber framing free of standing water, ice, or snow.

7. Requirements

7.1 The adhesive shall conform to the strength and durability properties shown in Table 1.

8. Sampling

8.1 A representative sample totaling not less than 1 qt (946 cm³) of the adhesive shall be taken from each lot to be tested.

8.2 For the purpose of sampling, a lot shall consist of material from the same batch or blending operation subject to the same processing operations and conditions.

9. Number of Tests

9.1 The number of test specimens shall be as specified in each test method designated in Section 11 and Table 1. The average result for the specimens tested shall conform to the requirements prescribed in this specification.

10. Specimen Preparation

10.1 *Materials*—Use the following materials for the tests outlined:

10.1.1 *Plywood*—5/8-in. or (1 9/32-in. (15.1-m) thick, U.S. Product Standard PS-1–95 grade marked stamped, commercial plywood, Group 1 Species, exterior glue, or sanded exterior-grade plywood, underlayment type with A grade face ply for the adhesion surface. The plywood must be flat within 1/16 in. (2 mm); that is, the maximum permissible bow for a 16-in. (406-mm) length of plywood shall be 1/16 in. (2 mm). Make the measurement across the top surface of the plywood. Use bowed plywood only if it meets the limitation above and if the convexity occurs on the bottom surface that will contact the lumber. The plywood must be free of patches, core voids, and knot holes in the glue line area.

10.1.2 *Lumber*—2-in. (51-mm) (nominal) Douglas-fir and southern pine; (Note 2) clear dry lumber (moisture content of

TABLE 1 Adhesive Strength and Durability Requirements

Test	Property	Number of Specimens	Requirement	Section Reference
Test A (wet lumber)				
Douglas-fir	shear strength	24	150 psi (1.035 MPa), min avg	11.2
Southern pine	shear strength	24	150 psi (1.035 MPa), min avg	11.2
Test B (frozen lumber)				
Douglas-fir	shear strength	24	100 psi (0.689 MPa), min avg	11.2
Southern pine	shear strength	24	100 psi (0.689 MPa), min avg	11.2
Test C (dry lumber)				
Douglas-fir	shear strength	24	150 psi (1.035 MPa), min avg	11.2
GAP-filling				
Douglas-fir	shear strength	24	100 psi (0.689 MPa), min avg	11.3
Durability (moisture resistance)				
Douglas-fir	delamination	24	a minimum of 22 of 24 specimens shall show no delamination.	11.4
	shear strength	24	150 psi (1.035 MPa), min avg	11.4
Durability (oxidation resistance)	flexibility	3	no fracture of free film on mandrel bend or visible signs of melting after exposure	11.5
Mold resistance				
Douglas-fir	shear strength	48	no significant loss in average strength at the 0.05 level of probability.	11.6
Bacterial resistance				
Douglas-fir	shear strength	48	no significant loss in average strength at the 0.05 level of probability.	11.7

12 to 19 %) (Note 3). The surface shall be free of bark, knots, splits, and pitch.

NOTE 2—Only the sapwood of loblolly, slash, longleaf, and shortleaf pine may be used.

NOTE 3—Test Methods D 2016 can be used to determine moisture content.

10.1.3 *Adhesive*—applied with a caulking gun.

10.2 *Number of Test Assemblies*—Prepare three wood-adhesive composite test assemblies as shown in Fig. 1 for each condition specified.

10.3 *Conditioning of Materials:*

10.3.1 Cut lumber and plywood to the required size as shown in Fig. 1. If the lumber must be reduced in height, retain at least one mill-finished surface as the surface to be bonded. If the lumber must be reduced in width to achieve a maximum 1½-in. (38-mm) dimension, plane both sides in equal amounts.

10.3.2 Predrill the plywood and lumber with a No. 37 (diameter 0.104 in. (2.64 mm)) to receive nails as shown in Fig. 1. Predrill the lumber to a depth of 1 in. (25 mm).

10.3.3 Condition the adhesive at 70 ± 5°F (21.1 ± 2.8°C) for a period of 48 h prior to use.

10.3.4 Condition the lumber and plywood in accordance with the schedules shown in Table 2, and the following procedures:

10.3.4.1 Run Test A (wet lumber) and Test B (frozen lumber) with both Douglas-fir and southern pine lumber.

10.3.4.2 Before fabricating samples with wet lumber surfaces (Test A), seal both ends of the lumber sections with paraffin. Completely submerge the lumber in water at 70 ± 5°F (21.1 ± 2.8°C) for 48 h for Douglas-fir, and for 2 h for southern pine. After submersion, wipe off visible surface water and expose the lumber for 48 h at 100 ± 5°F (37.8 ± 2.8°C), and 90 ± 5 % relative humidity. At the completion of the humidity cycle, submerge the lumber in water at 70 ± 5°F (21.1 ± 2.8°C) for 15 min. Wipe off visible surface water with a clean, dry cloth and immediately begin the fabrication procedure as outlined in 10.4.1.

10.3.4.3 Seal lumber for test assemblies with frozen lumber surfaces (Test B) at both ends with paraffin and submerge in water as described in Table 2. After submersion, wipe off visible surface water with a clean, dry cloth and store immediately at 0 ± 5°F (−17.8 ± 2.8°C) for 48 h.

NOTE 4—For safety, conditioning chambers should have no ignition sources within the vapor space.

10.4 *Preparation of Shear Strength Specimens:*

10.4.1 Apply an adhesive bead along the center line of a mill-finished surface of the lumber, such that the bead extends from one predrilled hole to the other, but not beyond. Apply sufficient adhesive to give 100 % coverage of the lumber surface, as evidenced by a “squeeze-out.” If it is necessary to apply the adhesive outside of the lumber conditioning chamber, remove only one piece of lumber at a time, apply the adhesive bead, then condition the lumber with adhesive applied for a minimum of 10 min and a maximum of 12 min in accordance with Table 3.

10.4.2 Before placing the plywood on the adhesive-covered surface, insert spacers, ¼ in. wide by 0.006 in. thick by 4 in. long (6 by 0.15 by 102 mm), at the midpoint of the lumber and at the outboard side of each nail, as shown in Fig. 2. Before the spacer is inserted at the midpoint, scrape away a 1-in. (25-mm) segment of the adhesive bead at the midpoint. Do not permit adhesive between the spacer and substrate.

NOTE 5—Aluminum embossing tape is suggested for use as spacers.

10.4.3 Position the plywood on the adhesive-covered surface with the aid of a positioning jig as shown in Fig. 3. Nail in place with 6-penny (2 in. (51 mm) in length) scaffold nails. Make the top of the lower head of a scaffold nail flush with the surface of the plywood.

10.4.4 Apply a uniform pressure of 4 ± 0.25 psi (28 ± 2 kPa) across the entire bonded area of the assembly for a period of 1 min at 70 ± 5°F (21.1 ± 2.8°C). Apply this pressure by any appropriate means, including a press with a suitable insert between the nails or a combination of uniformly distributed weights between the nails.

10.4.5 Set the adhesive in the assemblies in accordance with the schedules shown in Table 4.

10.4.6 After the specified setting time, remove the nails, but leave the spacers in place. Using a sharp saw, cut off the plywood flush with the side surfaces of the lumber, at the same time removing any excess adhesive. Cut eight block-shear specimens from each assembly as shown in Figs. 4 and 5.

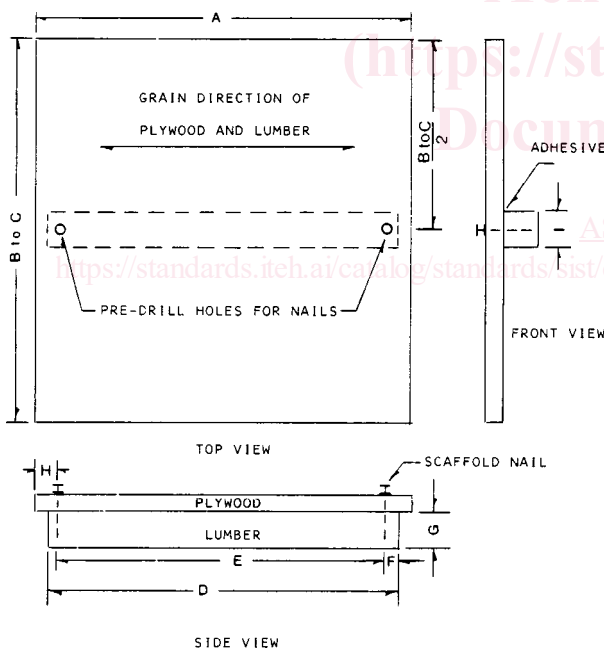


Table of Dimensions

	in.		mm	
	Dimension	Tolerance	Dimension	Tolerance
A	15¾	⅛	400	3
B	5½	...	140	...
C	16	...	406	...
D	15	⅛	381	3
E	13	⅛	330	3
F	1	⅛	25	3
G	1½min	⅛	38 min	2
H	1⅛	⅛	33	2
I	1½max	⅛	38 max	2

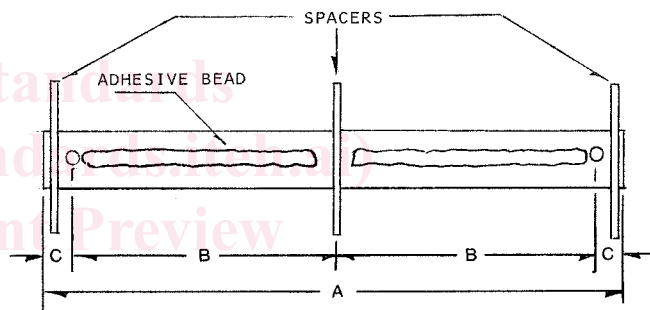
FIG. 1 Test Assembly

TABLE 2 Conditioning of Materials before Fabrication of Test Assemblies

Test	Lumber		Plywood
	Douglas-fir	Southern Pine	
Test A (wet lumber)	48 h soak in water at 70 ± 5°F (21.1 ± 2.8°C), then 48 h at 100 ± 5°F (37.8 ± 2.8°C) and 90 ± 5 % RH, then 15-min soak in water at 70 ± 5°F (21.1 ± 2.8°C)	2 h soak in water at 70 ± 5°F (21.1 ± 2.8°C), then 48 h at 100 ± 5°F (37.8 ± 2.8°C) and 90 ± 5 % RH, then 15 min soak in water at 70 ± 5°F (21.1 ± 2.8°C)	48 h at 100 ± 5°F (37.8 ± 2.8°C) and 90 ± 5 % RH
Test B (frozen lumber)	48 h soak in water at 70 ± 5°F (21.1 ± 2.8°C), then 48 h at 0 ± 5°F (-17.8 ± 2.8°C), with RH uncontrolled	2 h soak in water at 70 ± 5°F (21.1 ± 2.8°C), then 48 h at 0 ± 5°F (-17.8 ± 2.8°C), with RH uncontrolled	48 h at 0 ± 5°F (-17.8 ± 2.8°C), with RH uncontrolled
Test C (dry lumber)	48 h at 100 ± 5°F (37.8 ± 2.8°C) and RH max of 40 %	...	same as lumber
Gap-filling	48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % RH	...	same as lumber
Durability (moisture resistance)	48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % RH	...	same as lumber
Mold resistance	48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % RH	...	same as lumber
Bacterial resistance	48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % RH	...	same as lumber

TABLE 3 Open Assembly Time Conditions

Test	Temperature	Humidity
Test A (wet lumber)	70 ± 5°F (21.1 ± 2.8°C)	50 ± 10 % RH
Test B (frozen lumber)	0 ± 5°F (-17.8 ± 2.8°C)	RH uncontrolled
Test C (dry lumber)	100 ± 5°F (37.8 ± 2.8°C)	40 % RH max
Gap-filling	70 ± 5°F (21.1 ± 2.8°C)	50 ± 10 % RH
Durability (moisture resistance)	70 ± 5°F (21.1 ± 2.8°C)	50 ± 10 % RH
Mold resistance	70 ± 5°F (21.1 ± 2.8°C)	50 ± 10 % RH
Bacterial resistance	70 ± 5°F (21.1 ± 2.8°C)	50 ± 10 % RH



PLACEMENT OF ¼ IN. WIDE BY 0.062 IN. THICK BY 4 IN. LONG (6.00 X 0.15 X 102.00 MM) SPACERS FOR TESTS A, B, C AND DURABILITY (MOISTURE RESISTANCE) AND ¼ IN. WIDE BY 0.062 IN. THICK BY 4 IN. LONG (6.00 X 1.57 X 102.00 MM) SPACERS FOR GAP-FILLING TEST

10.5 *Preparation of Specimens for Test of Gap-Filling Effect on Strength*—Prepare assemblies as described in 10.4.1-10.4.4, except for thickness of spacers. Before placing the plywood on the adhesive-covered lumber surface, insert spacers, ¼ in. wide by 0.062 in. thick by 4 in. long (6 by 1.57 by 102 mm), as shown in Fig. 2. Avoid disturbing the location of the spacers. Do not permit adhesive between the spacer and substrate.

NOTE 6—TFE-fluorocarbon sheet is suggested for use as spacers.

10.5.1 After the specified setting time (Table 4), remove the nails and spacers before cutting eight block-shear specimens from each assembly, as shown in Figs. 4 and 5.

10.6 *Preparation of Specimens for Test of Durability (Moisture Resistance)*—Prepare assemblies as described in 10.4.1-10.4.4. After the specified setting time (Table 4), remove the nails, but leave the spacers in place. Cut eight specimens from each assembly as shown in Fig. 4 and Fig. 6.

10.7 *Preparation of Specimens for Test of Durability (Oxidation Resistance)*.

10.7.1 Prepare specimens by casting wet films of adhesive lengthwise on silicone release paper or polyethylene sheet, as shown in Fig. 7. Control thickness and width of the castings with the spreader shown in Fig. 7. Cast the first film of adhesive using the 0.050-in. (1.27-mm) gap of the spreader. Condition this film for 3 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity. Then cast a second wet film of

Table of Dimensions

Dimension	in.		mm	
	Dimension	Tolerance	Dimension	Tolerance
A	15	1/8	381	3
B	6½	1/8	165	3
C	1	1/8	25	3
D	13	1/8	330	3

FIG. 2 Placement of Spacers in Test Assemblies

adhesive on top of the first film using the 0.100-in. (2.54-mm) gap of the spreader.

NOTE 7—For adhesives having solids contents in the range from 95 to 100 weight %, the wet film of adhesive may be cast in one step using the 0.100-in. (2.54-mm) gap of the spreader.

10.7.2 Set the completed casting of adhesive at the conditions shown in Table 4. After setting, cut three, 1 by 3-in. (25 by 76-mm) specimens from the free adhesive films.

10.8 *Preparation of Specimens for Test of Mold Resistance*—Prepare six test assemblies as described in 10.4.1-10.4.4. After the specified setting time (Table 4), remove the