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# Standard Specification for Adhesives Used for Laminate Joints in Nonstructural Lumber Products[1]

This standard is issued under the fixed designation D5751; 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 performance levels for adhesives to be used in laminate joints in nonstructural lumber products. Such products include, but are not limited to, interior and exterior mouldings, window and door components or parts, and bonded lumber panels. This specification is to be used to evaluate adhesives as well as the adhesive bonds in nonstructural-glued-lumber products.

NOTE 1—This specification supersedes the laminate-joint portion of Specification D3110.

NOTE 2—See 3.2.1 and 3.2.2 for descriptions of a dry-use-nonstructural adhesive and a wet-use-nonstructural adhesive.

1.2 This specification applies to laminate-joint specimens made under both laboratory and field conditions. See Section 4 for limitations in using this specification to evaluate industrially manufactured laminate joint products.

1.3 The following safety caveat applies only to the apparatus and test methods portions, Sections 6, 7, 8, and 9 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.*

1.4 The values stated in inch-pound units are to be regarded as standard.

1.5 In this specification, *laminate joint* refers to both face and edge joints.

1.6 The following index is provided as a guide to the test methods in this specification:

| | Section |
|---|---|
| Apparatus | 6 |
| Conditioning | 7 |
| Material and Preparation of Assemblies and Specimens | 8 |
| Exposure Conditions and Treatments | 9 |
| Testing, Calculation, and Reporting | 10 |

NOTE 3—The conditioning needed for various stages in the preparation of the specimens and for the exposure tests are given in Sections 7, 8, and 9.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading

D907 Terminology of Adhesives

D2016 Methods of Test for Moisture Content of Wood (Withdrawn 1987)[3]

D2555 Practice for Establishing Clear Wood Strength Values

D3110 Specification for Adhesives Used in Laminate Joints for Nonstructural Glued Lumber Products (Withdrawn 1996)[3]

D5266 Practice for Estimating the Percentage of Wood Failure in Adhesive Bonded Joints

E4 Practices for Force Verification of Testing Machines

E6 Terminology Relating to Methods of Mechanical Testing

E41 Terminology Relating To Conditioning

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

## 3. Terminology

3.1 *Definitions:*Many terms in this specification are defined in Terminologies D907, E6, and E41.

3.1.1 *bond, n*—the union of materials by adhesives.

3.1.2 *laminate joint, n—in wood bonding*, a joint made by bonding layers of adherends face-to-face or edge-to-edge to form thicker or wider stock.

3.1.3 *edge joint, n—in wood bonding*, a type of laminate joint made by bonding adherends edge-to-edge with grain directions parallel to form wider stock.

[1] This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.30 on Wood Adhesives.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.1.4 *face joint, n—in wood bonding*, a type of laminate joint made by bonding adherends face-to-face with grain directions parallel to form thicker stock.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dry-use nonstructural adhesive, n*— an 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 does not exceed 16 %.

3.2.2 *wet-use nonstructural adhesive, n*—an 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.

3.3 *Abbreviations:*

3.3.1 *EMC*—equilibrium moisture content.

3.3.2 *MC*—moisture content.

## 4. Significance and Use

4.1 Adhesives are classified as dry use or wet use. Each classification includes consideration of short-term in-transit exposure conditions at temperatures up to 220°F. These test methods are designed to determine the performance level of a nonstructural wood adhesive when used in a laminate joint. See Fig. 1 for a depiction of a laminate joint.

4.1.1 The dry test and exposure conditions and treatments are to evaluate adhesives and adhesive bonds of laminate joints in nonstructural bonded lumber products for typical service conditions.

4.1.2 The 220°F test, a more severe test, is designed to evaluate the product after exposure to short-term elevated temperature. This test method is intended to simulate conditions that might be experienced in transit, further processing, or in service.

NOTE 4—These typical service conditions may include stress and time under stress, as well as elevated temperature.

4.2 This specification may be used to evaluate the adhesive bonds in a laminate joint that is the industrial-end product of a manufacturing process. The use of the specification for this purpose requires close evaluation of the configuration of the joint, the wood used, and the manufacturing process.

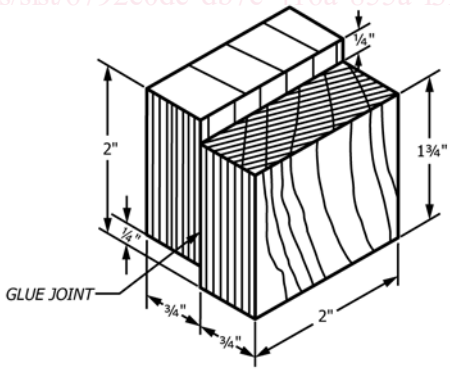
4.2.1 An industrially manufactured laminate joint should be evaluated using the requirements for compliance to the specification set forth in 5.1.1, 5.1.2, and 5.2.

4.2.2 To measure up to the criteria of the controlled conditions of a laboratory-made specimen, hand pick the lumber, prepare extra joints, and select those joints that most closely meet the requirements of 5.1 and 5.2.

4.3 Special circumstances may require modification of some of the details of these procedures. Record these variations in the report sections, as they may have an impact on the results obtained.

4.4 As the industrially manufactured laminate joint product is often handled, machined, and shipped within a few hours of manufacture, it may not have reached the maximum performance level before it is shipped or tested. To avoid potential product damage, the adhesive-performance level should be determined by the laminate-joint manufacturer prior to initial handling and early shipment. Before beginning the full testing process, the testing laboratory should ensure that the product






| Dimension | Dimensions: Face Joint (Example)[A] | |
|---|---|---|
| | Measurement, in. (mm) | Tolerance, in. (mm) |
| Specimen width | 2 (50.8) | + 0.32 (0.79) |
| Single lamina length | 1.75 (44.4) | + 0.32 (0.79) |
| Single lamina thickness (preferred) | 0.75 (19) | + 0.010 (0.25) |
| Single lamina thickness (alternative) | 0.688 (17.5) | + 0.010 (0.25) |
| Overall specimen thickness | 1.5 (38.1) | + 0.32 (0.79) |
| Overlap between adherends | 1.5 (38.1) | + 0.32 (0.79) |

[A] The ratio of width to height should be maintained at 4/3.

**FIG. 1 Block Shear Specimens**

**TABLE 1 Minimum Test Requirements**

| Performance Classification and Exposure Conditions[A] | Paragraph No. for Exposure Description | Laminate Joint in Shear[B] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Strength[C] | | %Wood Failure[D] | | | |
| | | Group Average,%[E] | Individual Minimum,%[F,G] | Group Average,%[E,G] | | Individual Minimum, %[F,G] | |
| | | | | Soft Wood | Hard Wood | Soft Wood | Hard Wood |
| Dry Use: | | | | | | | |
| Cured (Dry) | 9.1.1 | 60 | 30 | 60 | 30 | 30 | 15 |
| Three-Cycle Soak | 9.1.2 | 30 | 15 | 30 | 15 | 15 | [H] |
| Elevated Temperature (220°F) | 9.1.3 | 40 | 20 | 40 | 20 | 20 | [H] |
| Wet Use: | | | | | | | |
| Cured (Dry) | 9.2.1 | 60 | 30 | 60 | 30 | 30 | 15 |
| Boil | 9.2.2 | 50 | 25 | 50 | 25 | 25 | [H] |
| Elevated Temperature (220°F) | 9.2.3 | 40 | 20 | 40 | 20 | 20 | [H] |
| Vacuum Pressure | 9.2.4 | 50 | 25 | 50 | 25 | 25 | [H] |

[A] Twenty specimens are required for each classification and exposure.
[B] Parallel to the grain.
[C] The shear strength of the test specimens expressed as a percentage of the average shear strength of the wood species at 12 % MC. (See Table 2.) Adjustments are required for lower MC values. (See Footnote A in Table 2 (*a*).)
[D] The wood failure values given are for softwoods and hardwoods. Groups 3 and 4 hardwoods (Table 3) are listed at 50 % of the softwood value, with no requirement if the wood failure value calculates to 15 % or less. (See 5.1.2.2 and Table 3.)
[E] For all specimens tested.
[F] For 90 % of the specimens tested, they shall meet or exceed the minimum wood failure values shown. If a zero value is obtained for any of the specimens, the test shall be ruled a failure.
[G] See recommended average specific gravity in Table 4.
[H] No requirement.



conforms with the performance level certified by the adhesive manufacturer and has not been damaged by early handling and shipping.

## 5. Test Requirements

5.1 *Test Adhesive:*

5.1.1 To comply with this specification, the test adhesive shall be tested for performance in accordance with Sections 7 through 10, and it shall meet the requirements in Table 1 for the selected performance classification as measured against the average shearing strength of lumber from common species of wood as shown on Table 2(*a*) and Table 2(*b*).

5.1.1.1 For certification, a test shall be conducted on a laminate joint using the test adhesive.

5.1.1.2 Lumber with various grain orientations (for example, flat sawn or quarter sawn) shall be allowed to be used interchangeably, provided they do not fall outside the requirements of 8.1.1.

5.1.2 Compliance with this specification shall warrant certification of the adhesive for use on a designated grouping of wood, either softwood or hardwood, when tested and found to be in accordance with any one of the species of that group. See Table 3 for the designated groupings of commonly used domestic and imported woods, as accepted in this specification.[4]

5.1.2.1 The wood failure requirements of Table 1 are given for softwoods, Groups 1 and 2, and for hardwoods, Groups 3 and 4.

5.1.2.2 In the event that the adhesive user or supplier, or both, cannot accept the designated groupings in Table 3, either party shall have the option of requesting a test on an individual species.

5.2 *Industrially Manufactured Laminate Joints*—An industrially manufactured laminate joint may be used to evaluate the adhesive used to produce it, provided its construction meets the requirements in Sections 7 and 8, and the joint is tested in accordance with the requirements in Table 1.

## 6. Apparatus

6.1 *Environmental Chambers*—For moist-heat aging, capable of conditioning specimens at 80 ± 5°F (27 ± 3°C) and 80 ± 5 % relative humidity, and with capacity for up to 20 specimens well-spaced and supported on racks to allow free air flow.

6.2 *Oven(s)*—Capable of meeting all the temperature requirements of 9.1.2, 105 ± 5°F (41 ± 3°C); 9.1.3, 220 and 230± 5°F (104 and 110 ± 3°C); 9.2.2 and 9.2.3, 145 ± 5°F (63 ± 3°C), with sufficient air circulation to remove moisture from the chamber. An oven capable of enclosing the testing machine is also recommended. (See 9.1.3.1.)

6.3 *Tank for Soaking,* meeting the requirements of 9.1.2, so that all of the specimens are completely covered with water for the duration of the soak cycles.

6.4 *Tank for Boiling,* meeting the requirements of 9.2.2, so that all of the specimens are completely covered with water for the duration of the boil cycles.

6.5 *Testing Machine*—Capacity of not less than 15 000 lb (6810 kg) in compression, fitted with a shearing tool containing

[4] For wood property information on imported woods, refer to U.S. Forest Service, Agricultural Handbook No. 72, *Wood Handbook*, 1987 ed., Table 4.4.

**TABLE 2 (*a*) Average Shear Strength of Common Woods at 12 % Moisture Content, psi[A]**

| Species[B] | Green Value | Dry to Green Ratio[C] | 100 % Value | 60 % Value | 50 % Value | 40 % Value | 25 % Value | 20 % Value | 15 % Value |
|---|---|---|---|---|---|---|---|---|---|
| Cedar, Incense Incense | 834 | 1.05 | 878 | 527 | 439 | 351 | 220 | 176 | 132 |
| Douglas-Fir, Coast-Type | 904 | 1.25 | 1130 | 678 | 565 | 452 | 282 | 226 | 170 |
| Fir, White | 756 | 1.46 | 1104 | 662 | 552 | 442 | 276 | 221 | 166 |
| Hemlock, Western | 864 | 1.49 | 1287 | 772 | 644 | 515 | 322 | 257 | 193 |
| Pine, Ponderosa | 704 | 1.61 | 1133 | 680 | 567 | 453 | 283 | 227 | 170 |
| Pine, Sugar | 718 | 1.58 | 1134 | 680 | 567 | 454 | 284 | 227 | 170 |
| Redwood[D] | 894 | 1.25 | 1118 | 671 | 559 | 447 | 280 | 224 | 168 |

[A] For tests conducted in which the wood moisture content is less than or greater than 12 %, the measured strength should be adjusted upward 3 % for each 1 % decrease in moisture content, or downward 3 % for each 1 % increase in moisture content.
[B] For these or other species, values are those for shear parallel to the grain in Test Methods D2555, adjusting to 12 % moisture content using the ratios of dry to green clear wood properties of Test Methods D2555.
[C] Ratio of dry to green strength in Test Methods D2555.
[D] Second growth.

**TABLE (*b*) Average Shear Strength of Common Woods at 12 % Moisture Content, MPa[A]**

| Species[B] | Green Value | Dry to Green Ratio[C] | 100 % Value | 60 % Value | 50 % Value | 40 % Value | 25 % Value | 20 % Value | 15 % Value |
|---|---|---|---|---|---|---|---|---|---|
| Cedar, Incense Incense | 5.75 | 1.05 | 6.05 | 3.63 | 3.03 | 2.42 | 1.52 | 1.21 | 0.91 |
| Douglas-Fir, Coast-Type | 6.23 | 1.25 | 7.79 | 4.67 | 3.90 | 3.12 | 1.94 | 1.56 | 1.17 |
| Fir, White | 5.21 | 1.46 | 7.61 | 4.56 | 3.80 | 3.05 | 1.90 | 1.52 | 1.14 |
| Hemlock, Western | 5.96 | 1.49 | 8.87 | 5.32 | 4.44 | 3.55 | 2.22 | 1.77 | 1.33 |
| Pine, Ponderosa | 4.85 | 1.61 | 7.81 | 4.69 | 3.91 | 3.12 | 1.95 | 1.56 | 1.17 |
| Pine, Sugar | 4.95 | 1.58 | 7.82 | 4.68 | 3.91 | 3.13 | 1.96 | 1.56 | 1.17 |
| Redwood[D] | 6.16 | 1.25 | 7.71 | 4.63 | 3.85 | 3.08 | 1.93 | 1.54 | 1.16 |

[A] For tests conducted in which the wood moisture content is less than or greater than 12 %, the measured strength should be adjusted upward 3 % for each 1 % decrease in moisture content, or downward 3 % for each 1 % increase in moisture content.
[B] For these or other species, values are those for shear parallel to the grain in Test Methods D2555, adjusting to 12 % moisture content using the ratios of dry to green clear wood properties of Test Methods D2555.
[C] Ratio of dry to green strength in Test Methods D2555.
[D] Second growth.



a self-aligning seat to ensure uniform lateral distribution of the load, capable of maintaining a uniform rate of loading in accordance with 10.1, and located in an atmosphere such that the moisture content of the specimens to be tested dry, as developed under the conditions in Section 9, is not significantly altered during testing.

NOTE 5—This testing machine is described in Test Method D905. The shearing tool in Fig. 2 has been found to be satisfactory.

6.6 *Vacuum-Pressure Vessel,* meeting the requirements of 9.2.4 and large enough so that all the specimens are below the water level during the complete cycle.

NOTE 6—The size of the vessel is critical in order to prevent the uppermost specimens from becoming exposed to the air, as water is absorbed by the specimens during treatment.

## TEST METHODS

## 7. Conditioning

7.1 *Measuring Moisture Content*—To measure specimen MC, use Method A (oven dry method) in Methods D2016; or Method B (electronic moisture meter method), when agreement within ±1 % MC with Method A has been determined.

7.2 *Conditioning Prior to Testing:*

7.2.1 Before bonding of lumber or cutting the specimens, measure the MC of the laminate joint assemblies at the lumber end with a moisture meter. If the MC is not within the range from 10 to 12 %, use an environmental chamber to bring the assemblies into that range.

7.3 *Specimen Conditioning During the Testing Process*—The allowable variation in MC at the completion of a drying cycle or before testing dry is ±1 % MC. 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 in 9.1.1 and 9.2.1, where the specimens have never been taken from the dry state. Wood failure may be read on these test specimens following the strength testing, with no further conditioning to reduce MC.

## 8. Material and Preparation of Specimens

8.1 *Material:*

8.1.1 *Lumber*—Use lumber that conforms to the following requirements: maximum slope of grain of 1 in 14 on any face or edge; EMC of 8 to 14 %, preferably 10 to 12 %, unless otherwise recommended by the adhesive manufacturer; free of knots and decay; free of machining defects such as chipped grain, dubbed ends, feed-roll polish, coarse knife marks, and feed-roll compression; free of drying effects, such as case hardening, collapse, splits or checks; flat-grain cut; and surfaced on the day the assemblies are to be bonded. See 5.1.2 for species compliance rules relative to testing and Table 3 for information on the bondability of some species of wood.

NOTE 7—Recommended average specific gravities for the various species are given in Table 4. This material is for information only.

8.1.1.1 *Lumber for Laboratory Specimens*—The lumber species to be used for laboratory specimens is Ponderosa Pine.

**TABLE 3 Bondability Groupings of Commonly Used Domestic and Imported Wood[A]**

| U.S. Hardwoods | U.S. Softwoods | Imported Woods | |
|---|---|---|---|
| | Group 1—Bond Easily[B] : | | |
| Alder | Cedar, incense | Balsa | Hura |
| Aspen | Fir: | Cativo | Purpleheart |
| Basswood | White | Courbaril | Roble |
| Cottonwood | Grand | Determa[C] | |
| Chestnut, American | Noble | | |
| Magnolia | Pacific | | |
| Willow, black | Pine: | | |
| | Eastern white | | |
| | Western white | | |
| | Redcedar, western | | |
| | Redwood | | |
| | Spruce, Sitka | | |
| | Group 2—Bond Well[D] : | | |
| Butternut | Douglas-fir | Afrormosia | Meranti (lauan): |
| Elm: | Larch, western[E] | Andiroba | White |
| American | Pine: | Angelique | Light red |
| Rock | Sugar | Avodire | Yellow |
| Hackberry | Ponderosa | Banak | Obeche |
| Maple, soft | Redcedar, eastern | Iroko | Okoume |
| Sweetgum | | Jarrah | Opepe |
| Sycamore | | Limba | Peroba rosa |
| Tupelo | | Mahogany: | Sapele |
| Walnut, black | | African | Spanish-cedar |
| Yellow-poplar | | True | Sucupira |
| | | | Wallaba |
| | Group 3—Bond Satisfactorily[F] : | | |
| Ash, white | Alaska-cedar | Angelin | Meranti (lauan), dark red |
| Beech, American | Port-Orford-cedar | Azobe | Pau marfim |
| Birch: | Pine, southern | Benge | Parana-pine |
| Sweet | | Bubinga | Pine: |
| Yellow | | Karri | Carribbean |
| Cherry | | | Radiata |
| Hickory: | | | Ramin |
| Pecan | | | |
| True | | | |
| Madrone | | | |
| Maple, hard | | | |
| Oak: | | | |
| Red[C] | | | |
| White[C] | | | |
| | Group 4—Bond with Difficulty[G] : | | |
| Osage-orange | | Balata | Keruing |
| Persimmon | | Balau | Lapacho |
| | | Greenheart | Lignumvitae |
| | | Kaneelhart | Rosewood |
| | | Kapur | Teak |

[A] From *Wood Handbook*, 1987 Edition, Table 9-1 (with the species incense cedar added to Group 1) U.S. Forest Service, USDA, Washington, DC. Although this table is of historical significance, it is recognized that more modern adhesives might lead to different species groupings in regard to difficulty of bonding. The user is referred to 5.2.
[B] Bond very easily with adhesives of a wide range of properties and under a wide range of bonding conditions.
[C] Difficult to bond with phenol-formaldehyde adhesive.
[D] Bond well with a fairly wide range of adhesives under a moderately wide range of bonding conditions.
[E] Wood from butt logs with high extractive content are 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.



8.1.2 *Adhesive*—Follow the adhesive manufacturer's instructions for conditions and procedures when preparing the adhesive and applying it to the stock, and also for assembling, pressing, and curing the assembly.

8.2 *Assemblies*—Prepare the laminate joint assemblies in accordance with Test Method D905, except for lumber properties (see 8.1.1).

8.3 *Specimens:*

8.3.1 *Group of Specimens*—See Table 5 for the number of test specimens required for each performance class.

8.3.2 *Form and Dimension*—Following the prescribed adhesive curing period, cut the laminate joint assemblies into specimens. For the form and dimensions of the laminate joint specimen, see Fig. 1 and Fig. 3 with the accompanying table of dimensions.

## 9. Exposure Conditions and Treatments

NOTE 8—Due to the number of specimens to be tested and the type of tests that must be run, there may not be sufficient time to run all the specimens in the time allotted. So that the schedule may be followed, before running the tests in 9.2.2 and 9.2.4, determine whether 1 h is

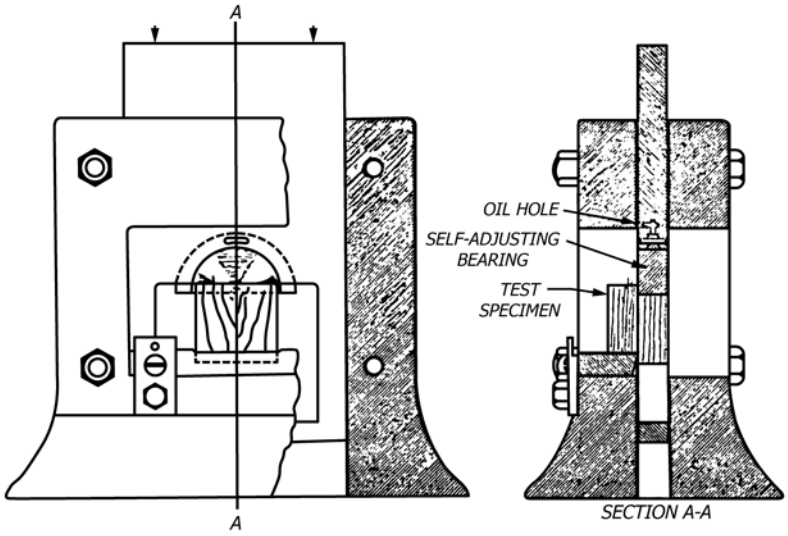



**FIG. 2 Shearing Tool**

**TABLE 4 Recommended Average Specific Gravities by Species**

| Species | Specific Gravity[A,B,C] |
|---|---|
| Douglas Fir, East | 0.48 |
| Douglas Fir, Interior South | 0.46 |
| Cedar, Alaska | 0.44 |
| 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 have been taken from Table 4-2 in the *Wood Handbook*.[7]
[B] Values are averages based on oven-dry weight and volume at 10 to 12 % moisture content.
[C] The specific gravity for the species used for the test should be the average specific gravity ±0.03.

**TABLE 5 Block Shear Tests, Number of Test Specimens**

| | Dry Use | Wet Use |
|---|---|---|
| Total Number of Assemblies | 12 | 16 |
| Total Number of Test Specimens | 60 | 80 |
| Number of Test Specimens per Performance Group[A] | 20 | 20 |

[A] Required for each unique combination of performance and exposure conditions. (See Table 1.)

enough time to test 20 specimens. If not, divide them into smaller groups before running the exposures. These specimens may be held in a plastic bag to keep them wet during the testing period.

9.1 *Dry Use*—The exposure conditions and treatments to meet the dry-use classification requirements are listed in Table 1. See 7.3 for information on allowable MC when testing the specimens. Details of the test methods are as follows:

9.1.1 *Dry Test*—Test in accordance with instructions in 10.1. See Practice D5266 for guidelines on reading wood failure.

9.1.2 *Soak Test (Three Cycle)*—Place one group of specimens (Table 5), separated by stickers, wire screens, or other means, in such a manner that all surfaces are freely exposed to

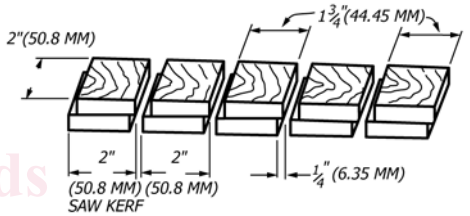



**FIG. 3 Test Joint Showing Method of Cutting Five Test Specimens**

the water. Weight down the specimens in water at 65 to 80°F (19 to 27°C) so that all specimens are at least 2 in. (50.8 mm) below the surface of the water. Keep the specimens immersed for a period of 4 h, followed by drying at a temperature of 105 ± 5°F (41 ± 3°C) for a period of 19 h, with sufficient air circulation to reduce the moisture content of specimens to within ±1 % MC of the original MC as in 7.3. Repeat this procedure twice more for a total of three cycles. Following the third cycle, conduct the tests within 1 h in the dry condition at 75 ± 5°F (24 ± 3°C). If needed, before testing and reading wood failure, condition or dry to less than 8 % MC, in an environmental chamber. (See 7.3.) Use of an electronic moisture meter, as in 7.1, is acceptable to determine MC.

9.1.3 *Elevated Temperature Test:*

9.1.3.1 Test the specimens for the effect of elevated temperature by using an oven that is capable of heating the specimens to 220 ± 5°F (104 ± 3°C) for 6 h and also capable of enclosing the machine for testing immediately following the exposure period. (See 6.2.)

9.1.3.2 If an oven to enclose the testing machine is not available, set up the machine close to the oven, remove specimens from the oven one at a time, and test immediately.

9.2 *Wet-Use*—The exposure conditions and treatments to meet the wet-use performance requirements are listed in Table 1, and details are as follows:

9.2.1 *Dry Test*—Follow the instructions in 9.1.1.

9.2.2 *Boil Test*—Place one group of 20 specimens (see Table 5) in a tank of boiling water, separated by stickers, wire