Designation: D5824 – 98 (Reapproved 2017)

Standard Test Method for Determining Resistance to Delamination of Adhesive Bonds in Overlay-Wood Core Laminates Exposed to Heat and Water[1]

This standard is issued under the fixed designation D5824; 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 test method provides a procedure to determine the quality of bond between an overlay and a wood core in an adhesively bonded laminate. The quality of bond is determined by measuring the resistance to delamination of the adhesively bonded laminate when tested under specific conditions of preparation, conditioning, and testing. Such products include, but are not limited to, window and door components, such as stiles and rails, and other overlaid panels. Typical wood-based cores are finger-jointed lumber, particleboard, oriented strand board, and hardboard. Typical overlays would be veneer, high-pressure laminate, high-density polyethylene, and fiberglass-reinforced plastic.

1.2 Adhesive bond performance as measured by resistance to delamination in this test method is suitable for use in adhesive product development, manufacturing quality control, and monitoring bonding processes.

1.3 This test method does not provide guidance for determining bond line performance for plywood products.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *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, health and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D907 Terminology of Adhesives

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

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

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:*

3.1.1 Certain terms in this test method are defined in Terminologies D907, E6, and E41.

3.1.2 *delamination, n*—the separation of layers in a laminate because of failure of the adhesive, either in the adhesive itself or at the interface between the adhesive and the adherend. (See Terminology D907.)

3.1.3 *overlay, n*—a uniform layer of material, usually in the form of a sheet, adhesively bonded to an adherend with the purpose of improving the appearance or physical properties of the laminate.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *edge, n—in an adhesively bonded laminate*, the dimension along its length [and parallel to the grain] where the overlay is bonded to the core.

3.2.2 *end, n—in an adhesively bonded laminate*, the dimension which is perpendicular to the length of the laminate where the overlay is bonded to the core.

[1] This test method 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.

4. Significance and Use

4.1 This test method measures quantitatively the effects of water soaking and drying, and their associated swelling and shrinking stresses on adhesive bonds in overlay-laminated assemblies.

4.2 Adhesive bond performance is based on the ability of the adhesive and adhesive bonds to resist delamination during accelerated exposure to water and heat.

4.3 Resistance to delamination when subjected to environmental factors is critical to the performance of the laminated assembly in service.

4.4 This test method is to be used to determine the quality of adhesive bonds in overlay-wood core laminates after the adhesive has been certified by a specification appropriate for the product, class, and end use.

5. Apparatus

5.1 *Oven(s)*—Forced-air oven capable of maintaining 170 ± 5°F (77 ± 3°C), with sufficient air circulation to ensure that the prescribed drying temperature is uniformly maintained when the oven is fully loaded and the air flow is parallel to the faces of the specimens. A mechanism is to be provided for moisture to be removed from the chamber during drying of the specimens.

5.1.1 Use an oven to accommodate a sufficient number of test specimens and to provide for at least 3-in. (76-mm) separation between the test specimens so that the drying temperature is uniformly maintained.

5.2 *Vacuum-Pressure Vessel*—Autoclave or similar vessel capable of withstanding 80-psi (562-kPa) pressure, equipped with a pump or similar device capable of drawing a vacuum of 25 in. Hg (84.4 kPa). Provide a system so that pressure is maintained at 75 psi (517 kPa).

5.2.1 Use a vessel so that all the specimens are at least 2 in. (51 mm) below the water level during the complete cycle.

6. Test Specimens

6.1 Cut laboratory specimens from prepared test panels (see Fig. 1) as described in Sections 7 and 8 to the form and dimensions shown in Fig. 2 and Table 1.

6.2 Cut field specimens from test panels (see Fig. 3) to the form and dimensions shown in Fig. 2 and Table 1. When the nominal width of the panel is used, the edges are to be prepared as the product would exist in service.

6.3 Test ten specimens, representing at least four different panels.

7. Preparation and Conditioning of Laboratory Test Panels

7.1 Select veneer, either rotary cut or sliced, 0.063 in. (1.6 mm) in thickness, and wood-based core, a minimum of 0.5 in. (13 mm) in thickness, so that they are free from defects such as knots, cracks, rough surfaces, or any unusual amount of discoloration. The species and type of veneer and composition of the wood core are to be agreed upon between the purchaser and the manufacturer of the adhesive. As an alternative to veneer, specific overlays can be used as agreed upon between the purchaser and the adhesive manufacturer. Surface the core to a thickness tolerance of ±0.005 in. (0.13 mm) (see Table 1). If finger-jointed/edge-bonded core stock is used, it must remain intact without delamination during the test cycle. Both the veneer and the wood-based core are to be ±1 % of the moisture content recommended by the manufacture of the adhesive. In the absence of such a recommendation, the moisture content is to be from 10 to 12 %, based on oven-dry weight as determined on representative samples in accordance with Method A of Test Methods D4442. Cut the veneer and wood core to a suitable size and grain orientation in order to build a panel with the grain of the veneer parallel to the grain of the wood core. A size that has been found to be convenient is shown in Fig. 1.

7.2 Follow the adhesive manufacturer's instructions for conditions and procedures for preparing the adhesive and applying it to the wood core, as well as for assembling, pressing, and curing the panel.

7.3 After assembly, condition the panels for a period of seven days (or until the panels reach equilibrium) at a relative humidity of 50 ± 2 % and a temperature of 73.4 ± 2°F (23 ± 1°C), or condition them in accordance with a specific recommendation by the adhesive manufacturer.

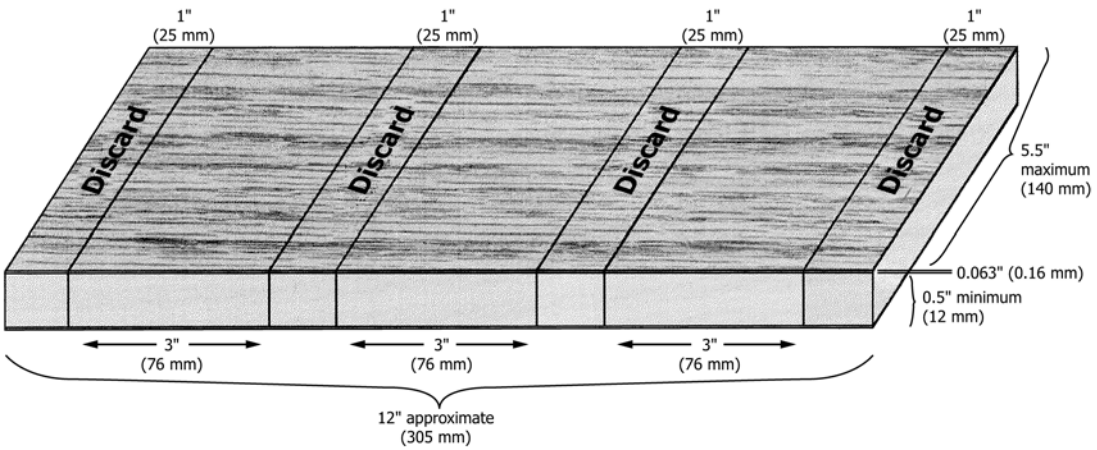

FIG. 1 Laboratory Test Panel

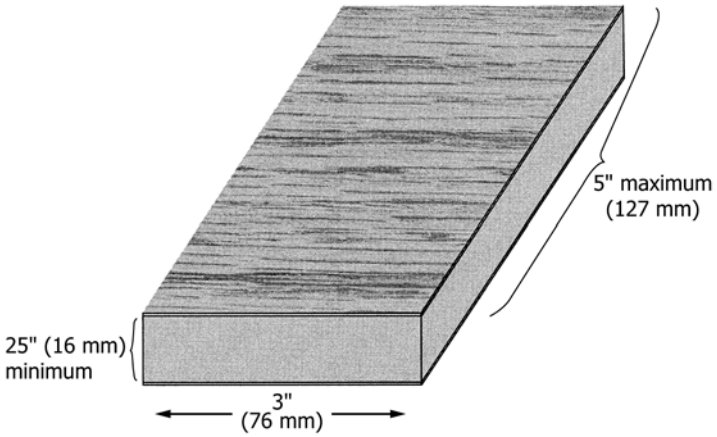

FIG. 2 Form and Dimensions of Test Specimens

TABLE 1 Test Specimen Dimensions, and Tolerances

Dimension	Measurement, in. (mm)	Tolerance, in. (mm)
Specimen width[A]	5 (127)	±0.031 (0.79)
Specimen length	3 (76)	±0.031 (0.79)
Specimen thickness, min[B]	0.625 (15.9)	±0.031 (0.79)
Wood core thickness, min[B]	0.5 (12.7)	±0.031 (0.79)
Overlay thickness, min[B]	0.063 (1.6)	±0.005 (0.13)

[A] The specimen width is nominal or cut to a maximum of 5 in.
[B] For field-prepared specimens, the minimum overlay thickness is 0.050 in. (1.3 mm). Alternative thickness is permitted as agreed upon between the purchaser and the adhesive manufacturer.

8. Preparation of Specimens

8.1 *Laboratory Specimens:*

8.1.1 Prepare the test panels as described in Section 7.

8.1.2 Prepare the test panels on the sides to a uniform width of 5 in. (127 mm). Using a sharp saw, trim 1 in. (25 mm) off both ends of each panel by cutting perpendicular to the grain of the veneer. Discard the trim. Prepare each test specimen by cutting 3 in. (76 mm) in length along the grain as shown in Fig. 1 and Fig. 2. Cut the panel across the grain into 3-in. (76-mm) sections to obtain a total of ten specimens from a minimum of four test panels.

8.2 *Field Specimens:*

8.2.1 Select the test panels so that they are representative of production.

8.2.2 Cut the specimens to the nominal width or a maximum of 5 in. (127 mm). Using a sharp saw, trim 1 in. (25 mm) off both ends of each panel. Discard the trim. Cut the panel across the grain into 3-in. (76-mm) sections, as shown in Fig. 3, to obtain a total of ten specimens from a minimum of four panels.

8.3 The number of specimens taken from each panel and the number of panels selected may be varied, depending on the number of panels selected for the test and the purpose of the testing.

8.4 Retain the specimens in the conditioning environment described in 7.3 until tested.

9. Procedure

9.1 Place the specimens in the pressure vessel described in 5.2.1, weight down, and admit water at a temperature of 65 to 80°F (18 to 27°C) so that all specimens are immersed at least 2 in. below the water surface. Separate the test specimens with stickers, wire screens, or other means to ensure that all end-grain surfaces are freely exposed to the water. Draw and maintain a vacuum of 25 in. Hg (84.4 kPa) for 30 min and follow immediately with pressure application of 75 ± 5 psi (517 ± 35 kPa) for 30 min. Remove the specimens from the pressure vessel and place them in the oven described in 5.1.1 at a temperature of 170 ± 5°F (77 ± 3°C) for 4 h. Place the specimens in the oven vertically with the faces parallel, end-grain surfaces perpendicular to the air flow, and spaced at least 3 in. (76 mm) apart. If necessary, place the specimens on stickers to minimize contact with the oven shelves and to ensure that all edges are freely exposed to the air flow.

9.2 At the end of the drying period specified in 9.1, remove the specimens from the drying oven. Immediately measure and record the length of the overlay-wood core laminate bondlines on the ends as well as on the edges of the specimen. Measure to the nearest 0.05 in. (1.27 mm), the total length of visable delamination on the end-grain surfaces as well as on the edges of the specimen. The use of a probe, such as a machine feeler gage, has been found to be a useful aid. Do not regard failure in the wood due to checking or other causes as delamination. When the separation occurs in the wood, even though very close to the bond line, the separation is termed wood failure. Magnification is often necessary to determine whether the failure is in the bond or in the wood. Ignore isolated delamination less than 0.1 in. (2.5 mm) long and more than 0.2 in. (5.1 mm) away from the nearest delamination. Determine the total length of delamination on the end-grain dimension of the specimens, and separately determine the total length of delamination on the edge-grain dimension. Use these numbers to calculate the percent delamination as described in 10.1 – 10.4.

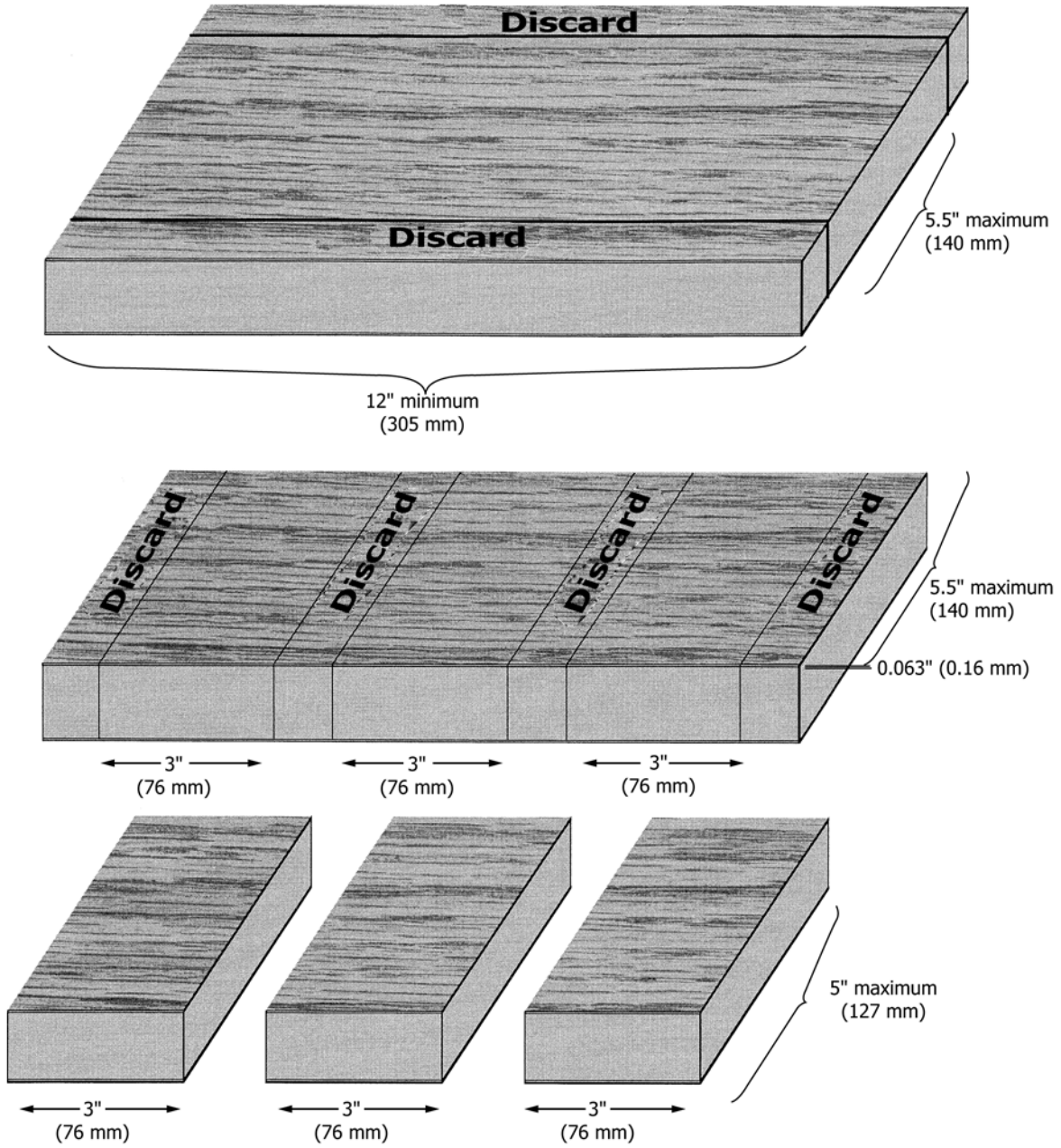

FIG. 3 Field Test Panel Showing Cutting Test Specimens

10. Calculation

10.1 Calculate the percent of end delamination of the specimen by dividing the length of delamination on the end-grain surface by the total length of exposed bond line, and multiplying by 100.

10.2 Calculate the percent of edge delamination of the specimen by dividing the length of delamination on the edge-grain surface by the total length of exposed bond line, and multiplying by 100.

10.3 Calculate the percent of total delamination of the specimen by dividing the sum of the length of delamination on the end- and edge-grain surfaces by the total length on exposed end- and edge-bond lines, and multiplying by 100.

10.4 Calculate the average end delamination, average edge delamination, and average total delamination.

11. Report

11.1 Report the following for each testing condition:

11.1.1 Identification of the adhesive tested, including type, manufacturer, and code numbers,

11.1.2 Type and thickness of overlay, type of wood core used, and their respective moisture contents,

11.1.3 Application and bonding conditions used in preparing the specimens, including temperature and relative humidity,

11.1.4 Conditioning procedure for the specimens,

11.1.5 Number of panels represented,

11.1.6 Number of specimens tested,

11.1.7 Individual test results identified in terms of specimen number,

11.1.8 Maximum and minimum delamination for end and edge surfaces. The standard deviations of all test means for end, edge, and total delamination may be included in the report at the option of either the purchaser or the manufacturer of the adhesive.

11.1.9 The mean end, edge, and total delamination.

12. Precision and Bias[3]

12.1 Round-robin studies were conducted to determine the precision of this test method and the data analyzed using Practice E691. Factors controlled were species of veneer and wood core, adhesive, bonding conditions, and preparation of test specimens.

12.1.1 The round-robin studies were conducted on field-produced panels to determine repeatability and reproducibility. The repeatability and reproducibility standard deviations were large for all the tests, thus indicating a low level of precision. The within-laboratory, single-operator, standard deviation (repeatability) for determining the percent delamination was ≤11.20 %. This was determined for different drying rates where the mean percent delamination was less than or equal to 6.59 %. The between-laboratory standard deviation (reproducibility) was ≤12.24 %. Since the reproducibility standard deviation (between-laboratories) was not much larger than the repeatability standard deviation (within a laboratory), it may indicate that the largest variability was due to a factor which would affect all laboratories.

12.2 The procedure in this test method has no measure of bias, since percent delamination is defined in terms of the test method.

13. Keywords

13.1 bonded; delamination; overlay; veneer

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D14-1006. Contact ASTM Customer Service at service@astm.org.