Designation: D5266 – 13 (Reapproved 2020)

Standard Practice for Estimating the Percentage of Wood Failure in Adhesive Bonded Joints[1]

This standard is issued under the fixed designation D5266; 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 practice provides procedures for estimating the percentage of wood failure that occurs in plywood-shear, block-shear, finger joint test specimens, or any other bondline involving wood.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are provided for information only.

1.3 *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.*

1.4 *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]

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

D906 Test Method for Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading

D2559 Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions

D4688 Test Method for Evaluating Structural Adhesives for Finger Jointing Lumber

D5572 Specification for Adhesives Used for Finger Joints in Nonstructural Lumber Products

D5751 Specification for Adhesives Used for Laminate Joints in Nonstructural Lumber Products

2.2 *American National Standards:*

ANSI/HPVA HP-1-2009 American National Standard for Hardwood and Decorative Plywood[3]

ANSI A190.1-2012 American National Standard for Wood Products—Structural Glued, Laminated Timber[3]

2.3 *Other Documents:*

American Plywood Association Proposed Standard Method for Estimating Percentage Wood Failure on Plywood Shear Specimens[4]

PS 1 U.S. Product Standard for Construction and Industrial Plywood[4]

CSA O112.9 Evaluation of Adhesives for Structural Wood Products (Exterior Exposure)[4]

General Technical Report FPL-GTR-190 [5]

Inspection Bureau Memorandum No. 1 Interpretation of Wood Failure[4]

2.4 *ASTM Adjunct:*

Photographs for Visually Estimating the Percentage of Wood Failure in Standard Adhesively Bonded Specimens[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *deep wood failure, n*—failure that is invariably several to many cells away from the adhesive layer, in which the fracture path is strongly influenced by the grain angle and growth–ring structure.

3.1.2 *shallow wood failure, n*—failure that is invariably within the first one or two layers of cells beyond the adhesive layer in which the fracture path is not influenced by the wood–grain angle or growth-ring structure (see 7.7 and 8.1).

3.1.3 *wood failure, n*—the rupturing of wood fibers in strength tests on bonded specimens, usually expressed as the percentage of the total area involved which shows such failure.

[1] This practice 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] Available from Hardwood Plywood & Veneer Association, 1825 Michael Faraday Drive, P.O. Box 2789, Reston, VA 20190, www.hpva.org.

[4] Available from APA – The Engineered Wood Association, 7011 South 19th St., Tacoma, WA 98466, www.apawood.org.

[5] *Wood Handbook: Wood as an Engineering Material*, Madison, WI: U. S. Department of Agriculture, Forest Service, Forest Products Laboratory, 508 p. 2010.

[6] Available from ASTM International Headquarters. Request Adjunct No. ADJD5266. Original adjunct produced in 1991.

4. Significance and Use

4.1 An estimate of wood failure is one of the principal means for determining the quality of an adhesively bonded wood joint.

4.2 When evaluated after a water soaking, water soaking and drying, or boiling and drying, the percentage of estimated wood failure is an important criterion for qualifying adhesives for use in plywood, laminated structural timber, adhesively bonded wood products and for daily quality control of the processes for manufacturing various adhesively bonded wood products including but not limited to plywood and laminated timbers. Standards that use the percentage of wood failure are included in Section 2.

4.3 In plywood manufactured from North American softwood species, the percentage of wood failure of Test Method D906 specimens, tested wet after either a vacuum-pressure soak-dry or boil-dry treatment, correlates with the percentage of panels that delaminate in outdoor exposure without protection.[7]

4.4 Similar correlations for other products have not been published.

5. Apparatus

5.1 Various light sources have been found useful in estimating wood failure. In determining compliance to standard specifications, the source must be agreed upon by the user of this practice and the individual or agency requiring these tests.

5.1.1 *Dual-Element Fluorescent Desk Lamp* equipped with one 15 W daylight and one 15 W cool white tube.

NOTE 1—This source is used by the APA – The Engineered Wood Association for compliance to the commercial standard PS 1.

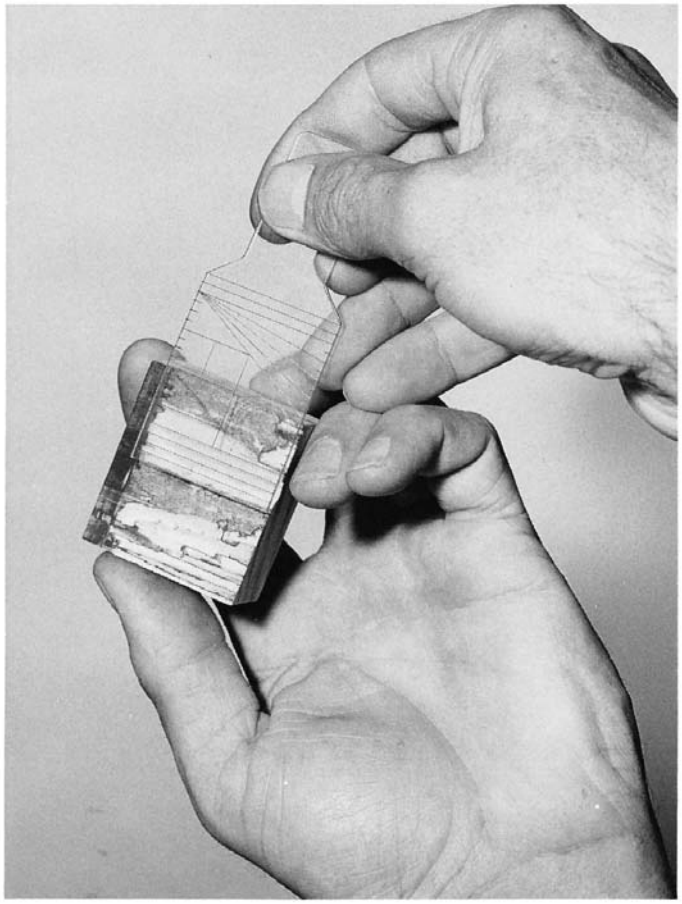
5.1.2 *Circular Fluorescent Desk Lamp* with 5× viewing magnifier in the center of the lamp.

5.1.3 *Diffuse Natural Light* from a window facing away from the sun.

5.2 *Ruler,* with 2.54 mm (0.1-in.) divisions is recommended as an aid to estimating the area of torn wood fibers. A transparent template, the size of the specimen bond area and scribed with various shapes and areas with known percentages of the total area, is also useful for subdividing the area. An example of such a template is shown in Fig. 1.

5.3 *Low-Power Magnifying Glass,* of 3 to 5×, with a field of view able to encompass most of the failed surface, may be useful for inspecting areas where shallow wood failure is suspected.

5.4 *ASTM Adjunct,* which includes photographs for Visually Estimating the Percentage of Wood Failure in Adhesively Bonded Specimens. The adjunct which is found in the Appendix of the digital edition of this practice, and provided as a separate document for the print edition, is a useful tool to aid in the training of reading and estimating percent wood failure. Both plywood specimens and block shear specimens are depicted with wood failure estimates provided by trained technical personnel familiar with the process of reading wood failure. (See Figs. X1.1-X1.4.)



NOTE 1—In this case, a standard D905 shear block is shown.

FIG. 1 Example of Plastic Template Scribed with Lines and Shapes Representing Known Percentages of Given Area

6. Preparation of Test Specimens

6.1 Prepare and test the specimens as outlined in the appropriate test method.

6.2 Do not estimate wood failure percentage of specimens with localized defects such as knots, knotholes, burl, and voids in the bond area, even if they are permitted within the grade of lumber or veneer being tested. Specimens with defects in the grip area may or may not be tested at the discretion of the user or in accordance with the policy of the testing organization.

6.3 Specimens with manufacturing defects, such as wiped bondline, chips, core gaps, and laps, may also be discarded by agreement between the interested parties.

6.4 If the specimens were tested wet, dry the failed surfaces in an air-circulating oven at 71°C (160°F), or under equivalent conditions, before estimating the percentage of wood failure.

7. Procedure

7.1 Work in a location where direct outside light does not fall on the specimen.

[7] Perkins, N. S., *Predicting Exterior Plywood Performance, Proceedings Forest Products Research Society*, 1950, pp. 1–12.

7.2 Select a light source described in 5.1, and use it consistently.

7.3 Open specimen halves as you would open a book.

7.4 Position the specimen below the light source as follows:

7.4.1 *Plywood*—Hold plywood specimens with the long dimension perpendicular to the line between the light source and the eye.

7.4.2 *Parallel Laminates*—Hold specimens with the grain direction perpendicular to the line between the light source and the eye. Tilt the specimen to reflect light from the light source to the eye.

7.4.3 *Finger joints*—Hold the specimen with the length of the fingers perpendicular to the line between the light source and the eye.

7.4.4 Refer to Fig. 2 for general positioning of the light source and the specimen grain direction in relation to the eye. In general, with the exception of plywood specimens, the grain direction is perpendicular to the line of sight between the light source and the eye.

7.5 Vary the tilt of the specimen, as shown in the side view in Fig. 2, so that areas of wood and adhesive failure can be distinguished. Exercise care not to create shadows, especially in the case of deep wood failure.

7.6 When there is little color contrast between the wood and the adhesive, and the wood failure is shallow, special measures may be required.

7.6.1 Dyes are sometimes helpful in distinguishing wood failure from light-colored adhesive. For example, aqueous iodine solution turns polyvinyl acetate adhesive black. An aqueous solution of fast green stain colors unpenetrated wood fibers green, but does not color urea-formaldehyde adhesive or adhesive-penetrated wood.

7.6.2 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 colored or transparent. Magnification may or may not be used to make the actual estimate of wood failure; however, the practice should be consistent. If the specimen is rotated to detect shallow wood failure, always reposition the specimen in the standard position when making the estimate of wood failure.

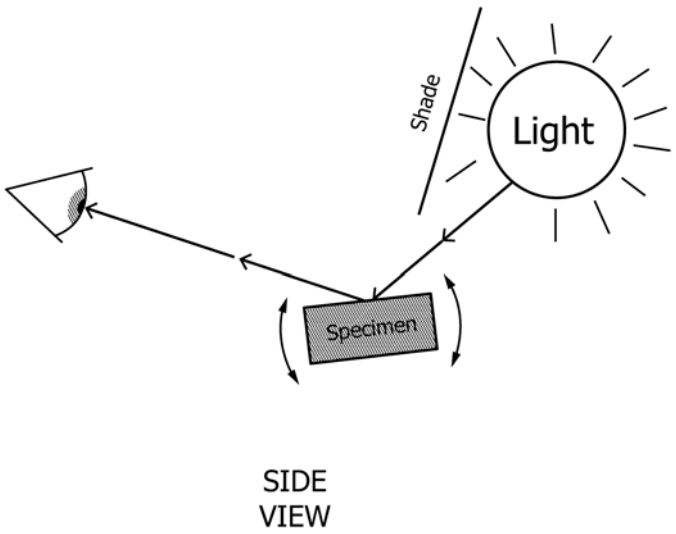


FIG. 2 Positioning of Test Specimen in Relation to Light Source and Eye

7.7 If there are scattered areas of shallow wood failure, blow or brush loose fibers from the surface. Count as wood failure only areas with wood cells that actually adhere to the adhesive. Mentally group those areas into an area that can be estimated.

7.8 Do not count as wood failure isolated wood particles such as sawdust and slivers that were on the surface during the bonding process, unless these particles were actually torn apart during testing.

7.9 It is often helpful to use a ruler or a scribed transparent template as described in 5.2 as an aid to estimate the total percentage of wood failure, or the percentages of shallow and deep wood failure.

7.10 Mentally divide the surface into quadrants for estimating the areas of various forms of failure. Estimate the wood failure on both halves of the specimen, but do not count the wood failure from matching areas more than once. Alternatively, read the wood failure percentage on both halves of the specimen and divide the sum by 2.

7.11 Estimate shallow and deep or total wood fiber failure of each specimen to the nearest 5 %, with a maximum of 100 % of the total bonded test area.

NOTE 2—The North American plywood industry recognizes shallow wood failure, but does not give it any less or any more significance than deep wood failure. Therefore in the case of conformance to PS 1, shallow and deep wood failure are not distinguished and should be estimated together.

7.12 In the absence of any directives within a referenced standard, shallow and deep wood failure are not to be distinguished and are to be estimated together.

8. Evaluation of Wood Failure

8.1 Accurate and consistent estimates are important. Generally, wood failure estimators do not have difficulty with very high or low percentages of wood failure. Difficulty occurs in the middle pass-fail range (30 to 85 %, depending on the standard) where accuracy is most important. Special care must be taken in this range.

NOTE 3—Round robin studies of estimated wood failure indicate the amount of variation between individual readers on the same standard test specimen can vary significantly depending upon the wood species and color of adhesive. Reader differences in the range of 15 to 40 % on an individual specimen within the same middle pass-fail range were not found to be uncommon. If this range of estimates between readers is applied to a group of 20 specimens, the maximum expected difference between readers on the same group of specimens would be 4 to 8 % respectively.[8]

8.2 The color of the adhesive and recognition of shallow wood failure, if present, affect the estimate. Shallow wood failure is more easily recognized and distinguished with a dark

[8] CSA A370/SubCommittee 05, Standard O112.9–4–10, *Evaluation of Adhesives for Structural Wood Products (exterior exposure)*: C4.7.2 Precision Statement of Estimating Percent Wood Failure.