Designation: D 5266 – 99

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

This standard is issued under the fixed designation D 5266; 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 purposes 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading[2]

D 906 Test Method for Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading[2]

D 2559 Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions[2]

D 4688 Test Methods for Evaluating Structural Adhesives for Finger Jointing Lumber[2]

D 5572 Specification for Adhesives Used for Finger Joints in Nonstructural Lumber Products[2]

D 5751 Specification for Adhesives Used for Laminate Joints in Nonstructural Lumber Products[2]

2.2 *American National Standards:*

ANSI/HPMA HP American National Standard for Hardwood and Decorative Plywood[3]

ANSI/AITC A190.1 American National Standard for Wood Products—Structural Glued, Laminated Timber[4]

2.3 *Other Standards:*

American Plywood Association Proposed Standard Method for Estimating Percentage Wood Failure on Plywood Shear Specimens[5]

PS 1 U.S. Product Standard for Construction and Industrial Plywood[5]

Wood Handbook: Wood as an Engineering Material, Agricultural Handbook No. 72, Forest Service, Forest Products Laboratory (1987)[6]

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[7]

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.

4. Significance and Use

4.1 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 wood failure is an important criterion for qualifying adhesives for use in plywood and glued laminated structural timber for exterior use, and for daily quality control of the processes for manufacturing plywood and glued, laminated timbers. Standards that use the percentage of wood failure are included in Section 2.

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[1] This practice is under the jurisdiction of ASTM Committee D-14 on Adhesives, and is the direct responsibility of Subcommittee D14.30 on Wood Adhesives.

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[2] *Annual Book of ASTM Standards*, Vol 15.06.

[3] Available from Hardwood Plywood Manufacturers' Association, 1825 Michael Faraday Drive, P.O. Box 2789, Reston, VA 22090-2789.

[4] Available from American Institute for Timber Construction, 11818 S. E. Mill Plain Blvd., Suite 415, Vancouver, WA 98684-5092.

[5] Available from American Plywood Association, P.O. Box 11700, Tacoma, WA 98411-0700.

[6] Available from Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

[7] Available from ASTM Headquarters. Order ADJD5266.

4.3 In plywood manufactured from North American softwood species, the percentage of wood failure of Test Method D 906 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.[8]

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 American Plywood 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.

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.

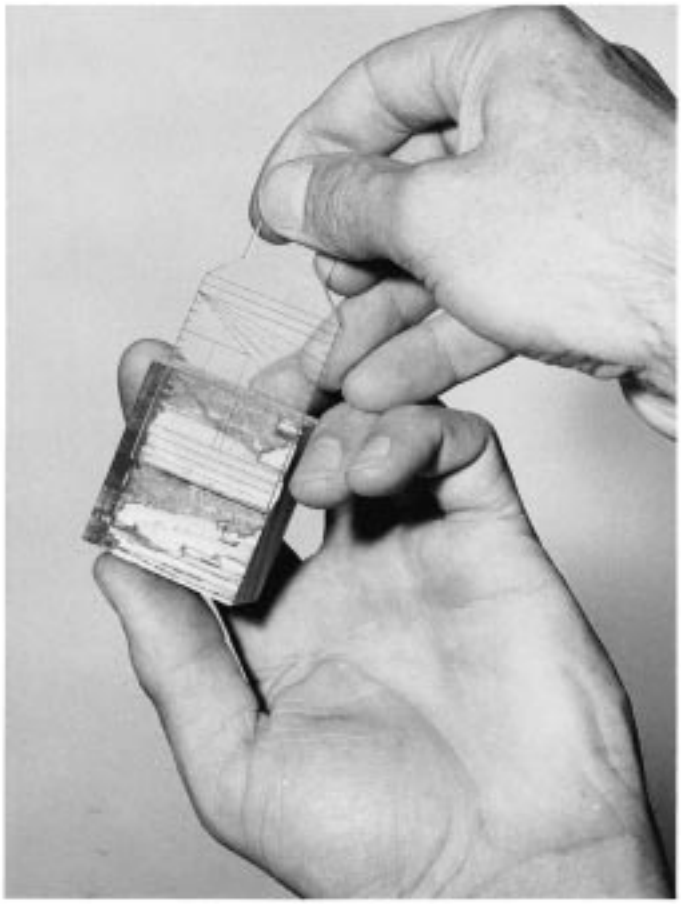
6.3 Specimens with manufacturing defects, such as wiped bondline, chips, core gaps, and laps, may also be discarded by agreement between the interested parties.

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.

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



NOTE 1—In this case, a standard D 905 shear block is shown.

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

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.

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

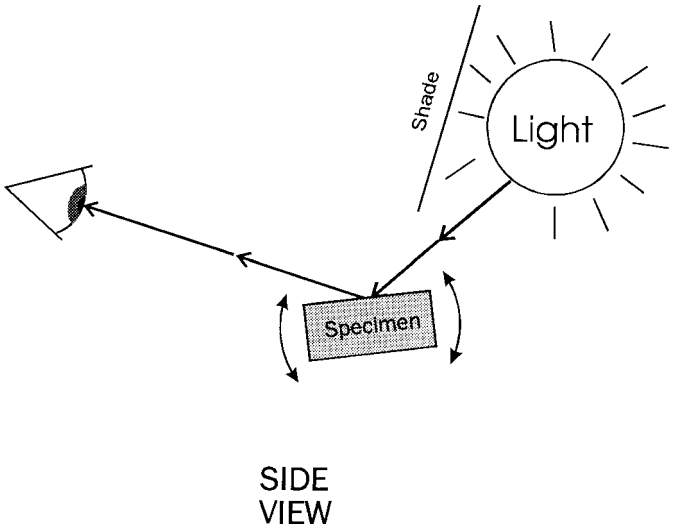


FIG. 2 Positioning of Test Specimen in Relation to Light Source and Eye

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.

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.

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.

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 adhesive as a background. When the adhesive is light colored, shallow wood failure can be easily mistaken for adhesive or adhesion failure.

8.3 If the percentage of wood failure is high and the failure is mostly on one side of the adhesive layer, the grain orientation may be a factor. In this case, the grain orientation should be determined and recorded.

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

9. Report

9.1 Report for each specimen as follows:

9.1.1 The exposure or treatment of the specimen before testing.

9.1.2 The percentage of total wood failure.

9.1.3 If there is shallow wood failure, report separate percentages for shallow and deep wood failure.

NOTE 3—See Note 2 regarding practice in the plywood industry.

9.1.4 Grain deviations, if affecting the percentage of wood failure.

9.1.5 Indications of improper bonding conditions affecting the percentage of wood failure.

9.2 For all specimens, report the following:

9.2.1 The average of each wood failure category; total, shallow, deep.

9.2.2 The standard deviation of each category of wood failure percentage.

10. Keywords

10.1 adhesive; finger joints; parallel laminates; plywood; wood failure