



Designation: D 906 – 98

## Standard Test Method for Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading<sup>1</sup>

This standard is issued under the fixed designation D 906; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

### INTRODUCTION

The accuracy of the results of strength tests of adhesive bonds will depend on the conditions under which the bonding process is carried out. Unless otherwise agreed upon between the manufacturer and the purchaser, the bonding conditions shall be prescribed by the manufacturer of the adhesive. In order to ensure that complete information is available to the individual conducting the tests, the manufacturer of the adhesive shall furnish numerical values and other specific information for each of the following variables:

- (1) The moisture content of the wood at the time of bonding.
- (2) Complete mixing directions for the adhesive.
- (3) Conditions for application of the adhesive including the rate of spread or thickness of film, number of coats to be applied, whether more than one coat is required.
- (4) Assembly conditions before application of pressure, including the room temperature, length of time, and whether open or closed assembly is to be used.
- (5) Curing conditions, including the amount of pressure to be applied, the length of time under pressure and the temperature of the assembly when under pressure. It should be stated whether this temperature is that of the bond line, or of the atmosphere at which the assembly is to be maintained.
- (6) Conditioning procedure before testing, unless a standard procedure is specified, including the length of time, temperature, and relative humidity.

A range may be prescribed for any variable by the manufacturer of the adhesive if it can be assumed by the test operator that any arbitrarily chosen value within such a range or any combination of such values for several variables will be acceptable to both the manufacturer and the purchaser of the adhesive.

### 1. Scope

1.1 This test method covers the determination of the comparative shear strengths of adhesives in plywood-type construction, when tested on a standard specimen and under specified conditions of preparation, conditioning, and testing. This test method is intended to be applied only to adhesives used in bonding wood to wood.

1.2 The values stated in SI units are to be regarded as the standard. The values given 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 143 Methods of Testing Small Clear Specimens of Timber<sup>2</sup>
  - D 907 Terminology of Adhesives<sup>3</sup>

### 3. Terminology

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

3.1.1 *plywood, n*—a panel generally flat built up of layers of veneer called plies, united under pressure by an adhesive to

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.10.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.06.

create a panel with the bond between the plies as strong as, or stronger than, the wood, and that has the following characteristics: (1) is constructed of an odd number of layers with grain of adjacent layers perpendicular, (2) with a layer consisting of either a single ply or two or more plies laminated with parallel grain direction, and (3) with outer layers and all odd numbered layers generally having the grain direction oriented parallel to the long dimension of the panel.

3.1.1.1 *Discussion*—Generally, the grain of one or more plies is approximately at right angles to the other plies, and almost always an odd number of plies are used.

3.1.2 *shear, n*—in an adhesively bonded joint, stress, strain or failure resulting from applied forces that tend to cause adjacent planes of a body to slide parallel in opposite directions.

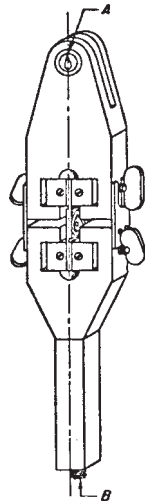
#### 4. Significance and Use

4.1 The way adhesives are used in plywood makes shear strength an important performance criteria.

4.2 Shear strength measured by this test is suitable for use in adhesive development, manufacturing quality control, and in materials performance specifications.

#### 5. Apparatus

5.1 The testing machine shall be adjusted to a loading rate of between 4535 and 7560 g/s (600 and 1000 lb/min). Where the testing machine is adjusted by rate of crosshead movement rather than load application rate, an appropriate head movement rate shall be selected so as to yield an average load application rate in the 4535 to 7560 g/s (600 to 1000 lb/min) range. It shall be provided with suitable grips and jaws so that the specimen can be gripped tightly and held in alignment as the load is applied. The grips and jaws shown in Fig. 1 have been found satisfactory. The testing machine shall be located in an atmosphere such that the moisture content of the specimens developed under the conditions prescribed in Section 8 is not noticeably altered during testing.



**FIG. 1** Grips and Jaws

#### 6. Test Specimens

6.1 The test specimens shall conform to the form and dimensions shown in Fig. 2. The specimens shall be cut from test panels prepared as described in Sections 7 and 8.

6.2 At least 40 specimens, representing at least five different panels, shall be prepared, selected and tested as prescribed in Sections 9 and 10.

#### 7. Preparation and Test Panels

7.1 The standard substrate for this test method is 1.6-mm (1/16-in.) thick rotary-cut or sliced veneer of sweet birch (*Betula lenta*) or yellow birch (*Betula alleghaniensis*). Any other thickness or species of veneer may be substituted upon written agreement between the party requesting this test and the manufacturer of the adhesive. Select veneer that is free of defects such as knots or distorted grain around knots, cracks, short grain (fibers out of plane), rough surfaces, or unusual discoloration that would indicate decay. Do not sand the veneer.

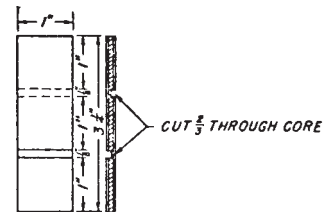
7.2 Cut the selected veneer into a size suitable for pressing and for cutting specimens with minimal waste. Allow at least 1/2-in. (13 mm) for trim around the edges.

**NOTE 1**—When cutting the veneer to size, ensure that the fiber direction is parallel and perpendicular to the edges. Appearances may be deceptive. If there is any question, the fiber direction should be checked with a scratch awl.

7.3 Condition the veneer to within  $\pm 1\%$  of the moisture content recommended by the adhesive manufacturer or the party requesting this test. In the absence of any guideline, condition the veneer to 10 to 12 % moisture content based on the oven dry weight. Check moisture content of recommended samples in accordance with Sections 124 to 127 of Methods D 143.

7.4 Prepare the adhesive in accordance with the adhesive manufacturer's instructions.

7.5 Apply the adhesive to each veneer in accordance with the adhesive manufacturer's instructions. Allow the prescribed open assembly time, if any, before reassembling the veneer. Reassemble the veneer with the fiber direction of the center veneer perpendicular to the two face veneer. Allow the prescribed closed assembly time, if any, before pressing. Press the assembly under the conditions prescribed by the adhesive manufacturer.



Metric Equivalents			
in.	1/8	1	3/4
mm	3.2	25.4	82.6

**FIG. 2** Form and Dimensions of Test Specimen

## 8. Conditioning of Test Panels

8.1 Upon removal from pressure, condition the panels at a relative humidity of  $50 \pm 2\%$  and at a temperature of  $23 \pm 1^\circ\text{C}$  ( $73.4 \pm 2^\circ\text{F}$ ) either for a period of 7 days, or until the specimens reach equilibrium as indicated by no progressive changes in weight, whichever is the longer period. The length of this period of conditioning may be extended beyond this limit by written agreement between the purchaser and the manufacturer of the adhesive.

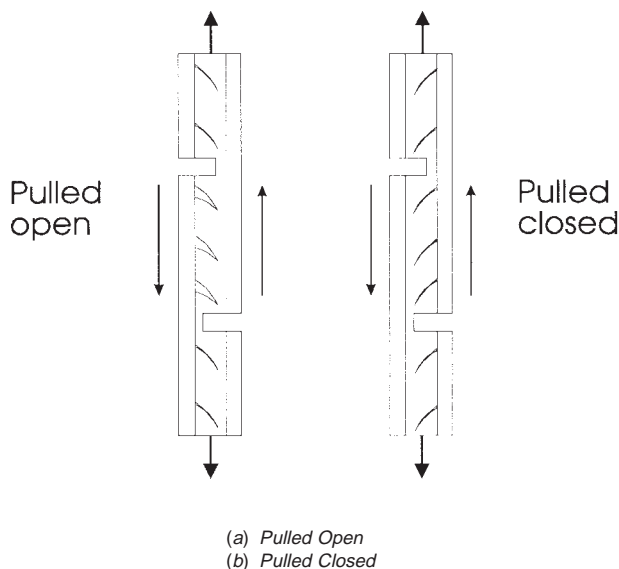
## 9. Preparation of Specimens

9.1 Cut the test specimens as shown in Fig. 2. This is best accomplished by cutting the notches to the proper width, depth, and location in the test panel, using a hollow-ground grooving saw or any other method that will give equally satisfactory results. Cut the notches in the panel in such a manner as to ensure that when the specimens are subjected to loading, the lathe checks in the center ply of half the specimens will be pulled open (tension) (see Fig. 3(a)), while in the other half the lathe checks will be pulled closed (compression) (see Fig. 3(b)). One method of accomplishing this is by notching the panel as illustrated in Fig. 4. When the panel has been notched, the individual specimens may be cut from the panel. Number them consecutively from one end of the panel to the other and identify with regard to panel of origin. Select the specimens to be tested so that an even and equal number of specimens are taken from each end of each panel. Measure the width of each specimen and the distance between notches to the nearest 0.025 cm (0.01 in.) to determine the shear area.

9.2 Retain the specimens in the conditioning atmosphere described in Section 8, until tested, except during the cutting operations.

## 10. Procedure

10.1 Place the test specimen in the jaws of the grips in the testing machine so that the specimen is perfectly aligned and



**FIG. 3** Lathe and Notch Orientations for Testing

parallel to the centerline of the jaws. If jaws such as those in Fig. 1 are used, then the specimen should be perfectly aligned with the pairs of jaws directly above each other and in such a position that an imaginary straight vertical line would pass through the center of the core ply and through the points of suspension *A* and *B* as shown in Fig. 1. Test specimens from each panel in numbered sequence and place in the jaws alternately so that in one case the upper notch is to the left and in the other case to the right. Apply the load at a rate of 4535 to 7560 g/s (600 to 1000 lb/min), or select a crosshead speed that will yield this.

## 11. Calculation

11.1 Record the load at failure to the nearest 35 kPa (5 psi) and the estimated wood failure to the nearest 5%. Express all failing loads in grams per square centimetre (or pounds per square in.) of shear area, calculated to the nearest 0.06 cm<sup>2</sup> (0.01 in<sup>2</sup>).

11.2 Calculate the average failing load for the group of specimens cut from each end of each test panel. Combine the groups having the higher average failing load from each of the various test panels into one major group representing half of the total number of test specimens. Combine the remaining half of the test specimens, made up of the groups having the lower average failing load from each of the various test panels into a second major group. Calculate the average failing load and average percentage wood failure for each of the two major groups.

## 12. Report

12.1 The report shall include the following:

12.1.1 Complete identification of the adhesive tested including type, source, manufacturer's code numbers, form, etc., and the wood species used as well as its moisture content when used,

12.1.2 Application and bonding conditions used in preparing the specimens,

12.1.3 Conditioning procedure used for the specimens,

12.1.4 Temperature and relative humidity in the test room,

12.1.5 Number of specimens tested,

12.1.6 Number of panels represented,

12.1.7 Individual test results identified with regard to panel of origin and specimen number, and

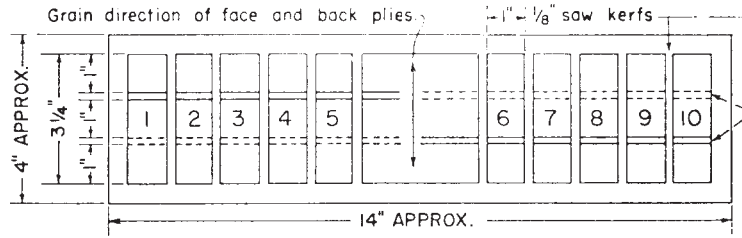
12.1.8 Average failing load and average percentage wood failure for each of the two major groups of specimens.

## 13. Precision and Bias

13.1 A precision and bias statement does not exist for this test method because resources necessary for round-robin testing have not been forthcoming.

## 14. Keywords

14.1 plywood; shear



Metric Equivalents

in.	1/8	1	3/4	4	14
mm	3.2	25.4	82.6	101.6	354.8

FIG. 4 Size of Test Panel and Method of Cutting and Numbering of Test Specimens

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