Designation: D 3499 – 94

Standard Test Method for Toughness of Wood-Based Structural Panels[1]

This standard is issued under the fixed designation D 3499; 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 for toughness of wood-based structural panels covers the determination of energy necessary to cause failure by impact loading of a beam specimen which is simply supported and loaded at midspan. Wood-based structural panels in use include plywood, waferboard, oriented strand board, and composites of veneer and of wood-based layers.

1.2 *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 Method of Testing Small Clear Specimens of Timber[2]

D 2395 Test Methods for Specific Gravity of Wood and Wood-Base Materials[2]

D 4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials[2]

3. Significance and Use

3.1 The failure of wood-based materials with impact loads is sometimes an important criteria in design considerations. In addition, some effects on the mechanical properties of wood, such as decay, are best evaluated by measuring its toughness. This test method serves to evaluate the toughness of structural panel products while Methods D 143 can be used to measure the toughness of solid clear wood specimens.

4. Apparatus

4.1 The toughness testing machine (Note 1) shall consist of a frame supporting a pendulum, being so arranged that a measured amount of the energy from the fall of the pendulum may be applied to a test specimen. The pendulum shall consist of a bar to which is fastened a weight adjustable to different positions and shall carry at its upper end a drum or pulley whose center provides the axis of rotation. The force shall be applied to the specimen by means of a flexible steel cable passing over the drum. A stationary graduated scale or dial and a vernier operated by the moving drum shall be provided for reading the angles through which the pendulum swings. The machine shall be adjusted before test so that the pendulum hangs truly vertical and adjusted to correct for friction. The cable shall be adjusted so that the load is applied to the specimen when the pendulum swings to within approximately 15° of the vertical so as to produce complete failure by the time the downward swing is completed.

NOTE 1—The set-up shown in Fig. 1 has been found to give satisfactory results.

5. Test Specimen

5.1 The toughness test specimen to be used in conjunction with the Forest Products Laboratory toughness testing machine shall be 5/8 in. (16 mm) in width for material less than 5/8 in. (16 mm) in thickness, and the thickness of the specimen shall be equal to that of the material. For material more than 5/8 in. (16 mm) in thickness, the width shall be equal to the thickness of the material, thus making the specimen square in cross section. The length shall be determined from the thickness of the material in accordance with Table 1. The actual cross-sectional dimensions, and the specimen and span length shall be measured to an accuracy of not less than ±0.3 % or 0.001 in. (0.02 mm) whichever is larger.

6. Control of Moisture

6.1 Panel specimens to be tested at specific moisture contents or after reaching equilibrium moisture content at specific temperature and relative humidity conditions shall be conditioned to approximate constant weight in controlled atmospheric conditions. For approximating moisture conditions of panels used under dry conditions, a relative humidity of 65 ± 2 % at a temperature of 68 ± 6°F (20 ± 3°C) is recommended.

7. Span and Supports

7.1 The test specimen shall be supported as a beam on two vertical pins, which exert reactions that are perpendicular to the plane of the panels or laminations. These pins shall be adjusted to the span length taken from Table 1 which provides for a specimen overhang of 1 in. (25 mm) at each end.

8. Loading Procedure

8.1 Apply the load at the center of the span perpendicular to the plane of the plies. Apply the load through a tup, attached to

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[2] *Annual Book of ASTM Standards*, Vol 04.10.

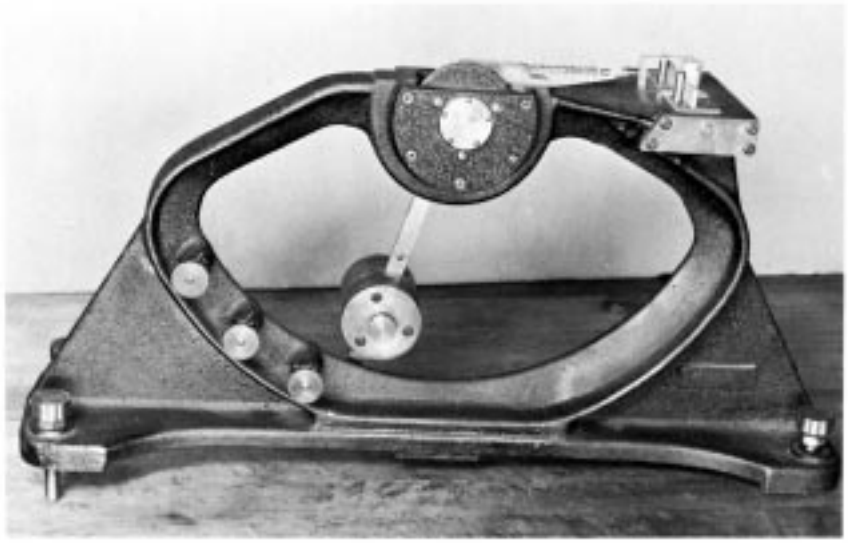

FIG. 1 Toughness Test of Structural Panel Showing Load Applied to Specimen When Pendulum is Approximately 15° from the Vertical

TABLE 1 Length of Toughness Test Specimens

Panel Thickness, in. (mm)	Span Length		Specimen Length	
	in.	mm	in.	mm
up to ⅛ (3), incl	2	50	4	100
Over ⅛ (3) to ¼ (6), incl	3	75	5	125
Over ¼ (6) to ⅜ (9), incl	5	125	7	175
Over ⅜ (9) to ½ (12), incl	6	150	8	200
Over ½ (12) to ⅝ (16), incl	8	200	10	250
Over ⅝ (16) to ¾ (18), incl	9	230	11	275
Over ¾ (18) to 1 (25), incl	12	300	14	350

a flexible cable, having a radius of curvature approximately equal to one and one-half times the depth of the test specimen. Choose the weight position and initial angle of the pendulum so that complete failure of the specimen is obtained on one drop. Most satisfactory results are obtained when the difference between the initial and final angle is at least 10°.

NOTE 2—In order to satisfy these conditions properly, it will be necessary to use a toughness testing machine of proper capacity for the specimens being tested. The larger size specimens can be tested in the large size Forest Products Laboratory toughness machine which has a maximum capacity of 673 in·lbf (76 J), while tests of smaller specimens can be made in the 20 in·lbf (2.3 J), capacity intermediate size machine.

9. Calculation

9.1 Read the initial and final angle to the nearest 0.2° by means of the attached vernier. Calculate the toughness as follows:

$$T = wL\,(\cos A_2 - \cos A_1) \quad (1)$$

where:

T = toughness (work per specimen), in·lbf (or J),
w = weight of the pendulum, lbf (or kgf),
L = distance from the center of the supporting axis to the center of gravity of the pendulum, in. (or mm),
A_1 = initial angle (Note 3), deg, and
A_2 = final angle the pendulum makes with the vertical after failure of the test specimen, deg.

NOTE 3—Since friction is compensated for in the machine adjustment, the initial angle may be regarded as exactly 30, 45, or 60°, as the case may be.

10. Moisture Content and Specific Gravity

10.1 *Moisture Content*—Cut a moisture content sample which is full width and at least 1 in. (25 mm) in length from the specimen and weigh immediately after each test. If inspection of the edges of a plywood specimen reveals the presence of a knot in any of the inner plies, select a second sample. Moisture content samples also serving as specific gravity samples shall be free of voids. Moisture content determinations shall be made in accordance with Test Method D 4442.

10.2 *Specific Gravity*—Determine the specific gravity in accordance with Test Methods D 2395. The specimen may be the same as that for moisture content determination but must have volume of at least 0.2 in.^{3} (3 cm^3), and be free of visible knots or voids.

11. Report

11.1 The specimen shall be described as to species, construction, and adhesive type used in its manufacture.

11.2 Data for individual specimens and specimen averages shall include:

11.2.1 Specimen thickness,
11.2.2 Length,
11.2.3 Span length,
11.2.4 Moisture content,
11.2.5 Specific gravity, and
11.2.6 Toughness (work per specimen), in·lbf (or J).

12. Precision and Bias

12.1 The precision and bias of this test method have not yet been determined, but when data are available, a precision and bias statement will be included.

13. Keywords

13.1 plywood; structural panels; wood