Designation: D 3044 – 94 (Reapproved 2000)

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

This standard is issued under the fixed designation D 3044; 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 covers determination of the shear modulus of wood-based structural panels associated with shear distortion in the plane of the panels. The method is applicable to all types of wood-based structural panels. The grain direction or orientation of the individual plies, laminations, or layers shall be parallel or perpendicular to the edge of the test specimen. If the plies, laminations, or layers are of different material or elastic properties, the method gives the effective shearing modulus. Wood-based structural panels in use include plywood, waferboard, oriented strand board, and composites of veneer and of wood-based layers.

NOTE 1—This test method is primarily designed for material in which the grain or orientation of the individual plies, laminations, or layers is parallel or perpendicular to the edge of the specimen. It may be used, however, for plywood specimens in which the grain is at 45° to the specimen edges if a four-ply panel with all plies of the same thickness is used. The controlling condition is that the EI (modulus of elasticity × moment of inertia) values along both diagonals shall be equal.

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 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. Summary of Test Method

3.1 The test consists of twisting a square plate of material by applying loads at the ends of one diagonal and supporting the plate at the ends of the other diagonal. From theory on the flexure of flat plates the deflections of the plate under this loading is related to the shear modulus of the plate. Deflections of the plate at points on the diagonal are measured relative to its center. The shear modulus of the specimen is determined from load-deflection data. The shear modulus obtained is that associated with shearing distortion in the plane of the plate. A photograph of testing apparatus and a deflection measuring device is given in Fig. 1.

4. Significance and Use

4.1 This test method is most useful for determining the moduli of rigidity of orthotropic materials for which moduli of rigidity cannot be computed from elastic moduli and Poisson's ratios. The shear modulus determined by this method appears in the equation governing the bending of a plate. This is the modulus that is needed in discussing the deflection and buckling of plates.

5. Control of Moisture Content

5.1 The structural panel samples to be tested at specific moisture contents or equilibrium relative humidities shall be conditioned to approximately constant mass 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. Specimens shall be tested without undue delay after conditioning. Testing in similarly controlled atmosphere is recommended whenever possible.

6. Test Specimen

6.1 The test specimen shall be square, with the thickness equal to the thickness of the material, and the length and width not less than 25 nor more than 40 times the thickness. The thickness, length, and width of each specimen shall be measured to an accuracy of not less than± 0.3 %. Care shall be taken to avoid obtaining test specimens with initial curvature.

7. Loading Procedure

7.1 Support the test specimen on supports having a radius of curvature not greater than ¼ in. (6 mm) on the opposite ends of a plate diagonal, and loaded in a similar manner on the opposite ends of the other diagonal. In order that the loads are applied at the corners, first attach metal plates as shown in Fig. 1. Fig. 1 also shows suggested apparatus for applying load and measuring deflection. Apply the load with a continuous and

[1] This test method is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.03 on Panel Products.

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

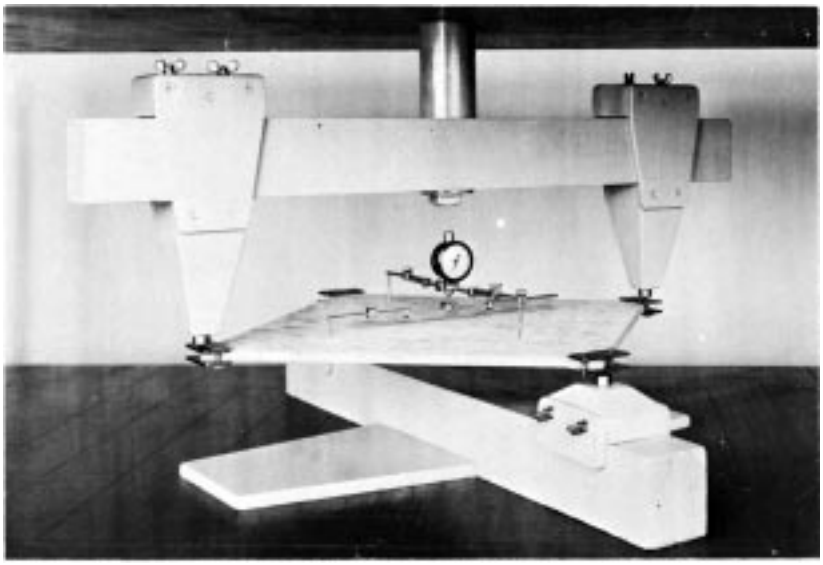

FIG. 1 Shear Modulus Test of Structural Panel Showing Method of Loading and Observing the Deflections Along the Diagonals

uniform motion of the movable head at a rate of 0.012 times the length of the plate in inches or millimetres, expressed in inches or millimetres per minute, within a permissible variation of ±25 %.

7.2 The load applied shall be accurate to within 1 %.

8. Deflection Measurements

8.1 Measure the deflections to the nearest 0.001 in. (0.02 mm) of points on each diagonal relative to the center of the plate. These measurements preferably shall be made near the quarter-points of the diagonals, and if other points than these are chosen, take care to avoid locations near the concentrated loads at the plate corners. Apparatus used to measure the plate deflection should be supported on the plate to ensure accurate measurements. Do not stress the plate beyond its elastic range, and choose increments of load so that not less than 12 and preferably 15 load-deflection readings are taken. To eliminate the effects of slight initial curvature obtain two sets of data, the second set with the panel rotated 90° about an axis through the center of the plate and perpendicular to the plane of the panel. Average the two results to obtain the shear modulus for the plate. A satisfactory arrangement for measuring relative deflections is indicated in Fig. 1; the dial readings in this case give twice the average deflections relative to the panel center of the four points at which the dial and dial stem supports touch the panel.

9. Calculation

9.1 Calculate the shearing modulus of elasticity as follows:

$$G = 3u^2 P/2h^3 \Delta$$

where:

G = shearing modulus, psi (or MPa),
P = load applied to each corner, lbf (or N),
h = thickness of the plate, in. (or mm),
Δ = deflection relative to the center, in. (or mm), and
u = distance from the center of the panel to the point where the deflections are measured, in. (or mm).

NOTE 2—The value of P/Δ is generally taken as the slope of the load-deflection curve.

10. Variables Influencing Shear Modulus

10.1 *Moisture Content*—Cut a moisture content sample having minimum area of 4 in.^{2} (26 cm^2) from the clear areas of the specimens and weigh immediately after each test. Where additional tests are to be made on the plate, a satisfactory moisture content specimen may be provided at the time the specimens are originally cut, in which case subject these specimens to the same conditioning as the plate. If inspection of the edges reveals the presence of a knot in any ply of a plywood panel, select a second specimen. Moisture content specimens also serving as specific gravity specimens shall be free of voids. Moisture content determinations shall be made in accordance with Test Methods D 4442.

10.2 *Specific Gravity*—Specific gravity determination shall be made in accordance with Test Methods D 2395. The specimen may be the same as that for moisture content determination but must be at least 2 in.^{3} (33 cm^3) in volume, and be free of visible knots or voids.

NOTE 3—The moisture content and specific gravity as determined above are the average values. In plywood made up of thin veneers, the glue may constitute a significant part of the total mass, and as a result the calculated specific gravities and moisture contents may vary substantially from the true values for the veneers. In some instances it may be desirable to take this into account.

11. Report

11.1 The structural panel specimen shall be described as to species, construction, and adhesive type used in its manufacture. Data for individual specimens and specimen averages shall include:

11.1.1 Panel thickness,
11.1.2 Moisture content,
11.1.3 Specific gravity,
11.1.4 Modulus of rigidity, and
11.1.5 Load-deflection diagrams.

11.2 When specified, additional data shall include, but are not limited to the maximum applied load, grade, and manufacturing characteristics, which may influence results.

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 shear modulus; structural panel; wood