Designation: D 6435 – 99

Standard Test Method for Shear Properties of Plastic Lumber and Plastic Lumber Shapes[1]

This standard is issued under the fixed designation D 6435; 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 the determination of the mechanical properties of plastic lumber and plastic lumber shapes when loaded in shear at relatively low uniform rates of straining or loading.

1.2 Plastic lumber and plastic lumber shapes are currently made predominately with recycled plastics where the product is nonhomogenous in the cross section. However, this test method would also be applicable to similarly manufactured plastic products made from virgin resins or where the product is nonhomogenous in the cross section.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.4 *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.*

NOTE 1—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 883 Terminology Relating to Plastics[2]

D 2915 Practice for Evaluating Allowable Properties for Grades of Structural Lumber[3]

D 4000 Classification System for Specifying Plastic Materials[4]

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[5]

E 4 Practices for Force Verification of Testing Machines[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *plastic lumber*, *n*—a manufactured product composed of more than 50 weight percent resin, and in which the product generally is rectangular in cross section and typically supplied in sizes that correspond to traditional lumber board and dimension lumber sizes, that may be filled or unfilled, and that may be composed of single or multiple resin blends.

3.1.2 *plastic lumber shape*, *n*—a plastic lumber, which generally is not rectangular in cross section.

3.1.3 *resin*, *n*—a solid or pseudosolid organic material often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally (see Terminology D 883).

3.1.3.1 *Discussion*—In a broad sense, the term is used to designate any polymer that is a basic material for plastics.

3.1.4 *shear stress (nominal)*—the shear force per unit area of the shear surface of the test specimen. It is expressed in force per unit area.

3.2 Additional definitions of terms applying to this test method appear in Terminology D 883 and Guide D 5033.

4. Significance and Use

4.1 Shear tests provide information about the shear properties of plastic lumber when employed under conditions approximating those under which the tests are made. For many materials, there may be a specification that requires the use of this test method, but with some procedural-modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 in Classification D 4000 lists the ASTM materials standards that currently exist.

4.2 Shear properties are limited to shear strength only. In the case of a material that fails in shear by a fracture, the shear strength has a very definite value. In the case of a material that

[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.20 on Plastic Products.

Current edition approved June 10, 1999. Published September 1999.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

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

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] *Annual Book of ASTM Standards*, Vol 08.03.

[6] *Annual Book of ASTM Standards*, Vol 03.01.

does not fail in shear by a fracture, the shear strength is based on the maximum load carried by the test specimen. Many plastic lumber materials may not fail in the classic shear mode; that is, separation of the test specimen into two pieces by failure along the critical shear surface.

4.3 Shear tests provide a standard method of obtaining data for research and development, design, quality control, acceptance, or rejection under specifications. The tests cannot be considered appropriate for engineering design in applications differing widely from the load-time scale of the standard test. Such applications may require additional tests, such as impact, creep, and fatigue.

5. Apparatus

5.1 *Testing Machine*—Any suitable testing machine capable of satisfactory control of constant-rate-of-crosshead movement and comprising of essentially the following components:

5.1.1 *Drive Mechanism*—A drive mechanism for imparting to the crosshead movable member, a uniform, controlled rate of movement with respect to the base (fixed member), with this crosshead rate to be regulated as specified in Section 9.

5.1.2 *Load Indicator*—A load-indicating mechanism capable of showing the total-load carried by the test specimen. The mechanism shall be essentially free from inertia lag at the specified rate of testing and shall indicate the load with an accuracy of ±1 % of the indicated value of the load. The accuracy of the testing machine shall be verified at least once a year in accordance with Practices E 4.

5.2 *Shear Test Setup*—Use a test setup similar to that illustrated in Figs. 1 and 2. Apply the load to, and support the specimen, as shown in Figs. 1 and 2. The shear test box shown in Figs. 1 and 2 should be manufactured of steel to accommodate the test specimen, the lower bearing plate, and the loading plate, as shown in Figs. 1 and 2. The shear test box may be anchored to the base of the test frame to prevent movement and to ensure stability of the test setup for large member testing.

5.3 *Micrometers*—Suitable micrometers, reading to 0.0004 in. (0.01 mm) for measuring the width, thickness, and length of the specimens shall be used.

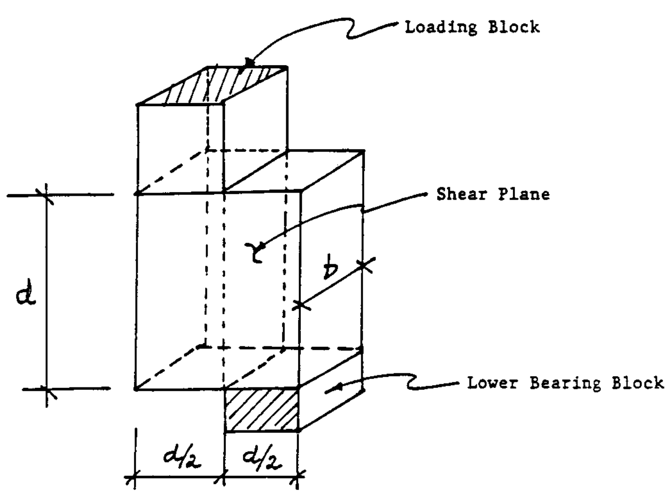

FIG. 1 Shear Test Specimen

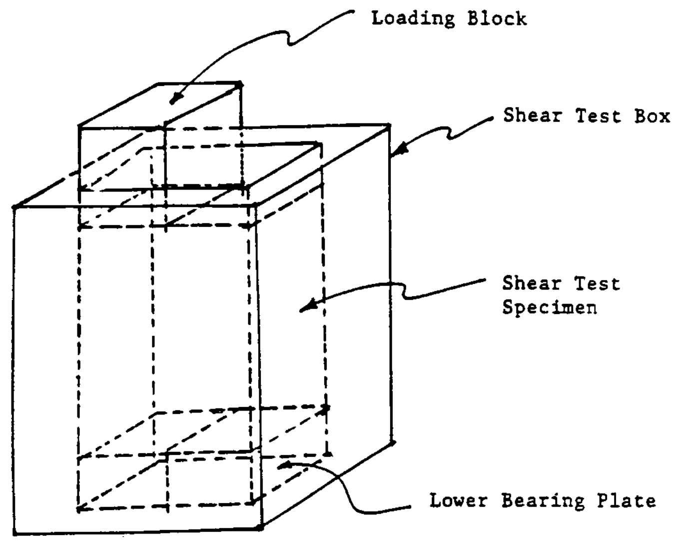

FIG. 2 Shear Test Specimen in Shear Test Box

6. Test Specimens

6.1 The specimens shall be full-size as manufactured, then cut so that they may be oriented in the shear test setup to produce failure on the desired face of the specimen. The original outside surface of the specimen shall be unaltered.

6.2 The length of the specimen should be larger than either the width or depth of the cross section perpendicular to the shearing plane.

6.3 The test specimens shall be representative of the population for which the property estimates are being made. It may be necessary to sample specimens from several production runs to characterize population variability.

7. Conditioning

7.1 *Conditioning*—Condition the test specimens at 73 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h prior to testing in accordance with Procedure A of Practice D 618 for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ±1.8°F (±1°C) and ±2 % relative humidity.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 73 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods. In cases of disagreement, the tolerances shall be ±1.8°F (±1°C) and ±2 % relative humidity.

7.3 *Testing at Different Temperatures*—Test procedure can be used at other temperatures provided test specimens and test box are at equilibrium with the desired temperature. Paragraphs 7.1 and 7.2 can be adopted by substituting 73°F with the desired temperature.

8. Number of Test Specimens

8.1 A minimum of five specimens shall be tested for each sample.

9. Speed of Testing

9.1 Rate of motion of the driven platen may be used if it can be shown that the resulting speed of testing is within the limits of variation allowed.

9.2 The load shall be applied continuously throughout the test at a rate of motion of the movable crosshead of 0.024 ± 0.0024 in.(0.6 ± 0.06 mm)/min.

10. Procedure

10.1 Measure the width and length of the shearing surface to the nearest 0.01 mm after conditioning and before testing. Calculate and record the value of the cross-sectional area.

10.2 Place the test specimen between the surfaces of the compression platens, taking care to align the centerline of the loading plate with the centerline of the platens to ensure that the load is applied on the desired half of the test specimen. Adjust the crosshead of the testing machine until it just contacts the top of the compression platen.

10.3 *Proceed As Follows*:

10.3.1 Set the speed control so that it results in a crosshead movement of 0.024 ± 0.0024 in. (0.6 ± 0.06 mm)/min test and start the test.

10.3.2 Take care to ensure that the edges of the specimen are vertical and the end rests evenly on the support over the contact area.

10.3.3 Record the maximum load carried by the specimen during the test, and describe the nature of failure.

11. Calculation

11.1 *Shear Strength*—Calculate the shear strength for each specimen as the maximum shear stress obtained in the test.

$$F_v = V_{max}/A_v \quad (1)$$

where:

F_v = shear strength, MPa,
V_{max} = maximum shear force, N, carried by specimen as recorded per 10.3.3, and
A_v = area of shear plane = $b \times d$ (see Fig. 1).

12. Report

12.1 Report the following information:

12.1.1 Complete identification of the material tested, including type, source, manufacturer's code number, form, principal dimensions, and previous history.

12.1.2 Laboratory name,

12.1.3 Date of test,

12.1.4 Method of preparing test specimens,

12.1.5 Type of test specimen and dimensions,

12.1.6 Orientation of the shear plane with respect to the longitudinal axis of the member,

12.1.7 Conditioning procedure used, if nonstandard conditioning has been employed,

12.1.8 Atmospheric conditions in test room, if nonstandard conditioning has been employed.

12.1.9 Number of specimens tested,

12.1.10 Speed of testing,

12.1.11 Shear strength values, namely the mean and lower limit of the 75 % confidence interval on the nonparametric fifth percentile estimate. This value is computed by subtracting K times the standard deviation from the mean value, where K is tabulated in statistics books (and in Table 2 of Practice D 2915).

NOTE 2—The K-factor for the minimum sample size (five specimens) is 2.464. This factor decreases asymptotically to 1.645 for very large sample sizes. Many standards require a minimum sample size of approximately 30 (K = 1.869) to balance testing costs against the large reductions in values required for very small sample sizes.

13. Precision and Bias

13.1 This is a new test method for which precision and bias have not been determined by full round robin testing.

13.1.1 Based on tests conducted at Louisiana State University, LA, the coefficient of variation was determined to be at least 0.37.

13.2 It is the intent of Subcommittee D20.20 to publish this test method and then begin an investigation of its precision and bias. Anyone wishing to participate in this work may contact the Chairman, Subcommittee D20.20, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

14. Keywords

14.1 plastic lumber; plastic shapes; recycled; shear properties; shear strength