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Standard Test Method for Resistance to Deformation Under Static Loading for Structural Wood Laminating Adhesives Used Under Exterior (Wet Use) Exposure Conditions[1]

This standard is issued under the fixed designation D 3535; 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] This test method 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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1. Scope

1.1 This test method covers adhesives suitable for the bonding of wood, including treated wood, into structural laminated wood products for general construction, for marine use, or for other uses where a high-strength general construction, deformation-resistant, waterproof adhesive bond is required.

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 907 Terminology of Adhesives[2]

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

3. Terminology

3.1 *Definitions:*

3.1.1 *glulam*, *n*—synonym for structural-glued-laminated timber.

3.1.2 *structural-glued-laminated timber*, *n*— an engineered, stress-rated product of a timber laminating plant comprising assemblies of specially selected and prepared wood laminations securely bonded together with adhesives, with the following characteristics: (*1*) the grain of all laminations is approximately parallel longitudinally; and (*2*) the laminations may be comprised of pieces end-joined to form any length, of pieces placed or glued edge-to-edge to make wider ones or of pieces bent to curved form during gluing. (Synonym *glulam*) ANSI/AITC A190.1 – 1992, American National Standard for Wood Products—Structural Glued Laminated Timber (Edited to conform with ASTM format).

3.1.3 For other terms used in this test method, refer to Terminology D 907.

4. Summary of Test Method

4.1 Glued laminations are subjected to a constant load under various combinations of temperature and relative humidity. The amount of deformation is measured.

5. Significance and Use

5.1 This test method rates the performance of the adhesive in laminated wood as measured by resistance to deformation under static load.

5.2 This test method will normally be used in conjunction with Specification D 2559.

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

6. Apparatus

6.1 *Compression-Type Deformation Tester*, as shown in Fig. 1,[3] required for testing the specimens under the static load. This tester consists of:

6.1.1 *Base Plate*,

6.1.2 *Four Tension Rods*,

6.1.3 *Spacer Plate*,

6.1.4 *Center Rod*,

6.1.5 *Spring*,

6.1.6 *Top Plate*, and

6.1.7 *Nuts*.

6.2 *Square Metal Spacers*, coated with an effective mold-release agent. Seven are needed for each laminate. Dimensions are 69.8 mm (2¾ in.) long by 15.9 mm (⅝ in.) wide by 6.4 mm (¼ in.) thick.

6.3 *Oven*, capable of maintaining 71 ± 2°C (160 ± 3.6°F) and humidity chamber capable of maintaining 26.7 ± 2°C (80 ± 3.6°F) and 90± 5 % relative humidity.

NOTE 1—Some ovens may not be able to accommodate a full length deformation tester. Since the test specimen is 276 mm in length, it is permissible to reduce the "filler pieces" and angles to a length of 267 mm each allowing pressure to be exerted directly on the test specimen without the use of filler blocks. Fig. 2 shows an optional deformation tester. The changes are to the lengths of the 4-tension rods, center rod, angles and filler pieces. Use of this tester requires special care when choosing a spring (see footnote 3 in Fig. 1 and 10.1) that will fit the reduced space. All other measurements will be the same as Fig. 1.

7. Selection and Preparation of Wood

7.1 Use any softwood or hardwood planned for gluing. Only one species is required, even if several will be glued. Flat-grained wood is most desirable, however experience has shown that flat-grained specimens may break in the wood when loaded. (This test measures only deformation. Use Specification D 2559 to measure bondability to all species considered.)

7.2 The wood shall have a slope of grain not steeper than 1 in 15 on any face or any edge. The wood shall contain no knots larger than 3.18 mm (⅛ in.) in diameter and shall be free of decay, machining defects (such as chipped grain, dubbed ends, feed roll polish, coarse knife marks, and feed roll compression), and any drying defects such as case hardening, collapse, splits, or checks.

7.3 Condition the wood at 23 ± 2°C (73.4± 3.6°F) and a relative humidity of 50 to 70 % (preferably 65 %) until a moisture content of 8 to 14 % or, preferably, 9 to 12 % has been obtained.

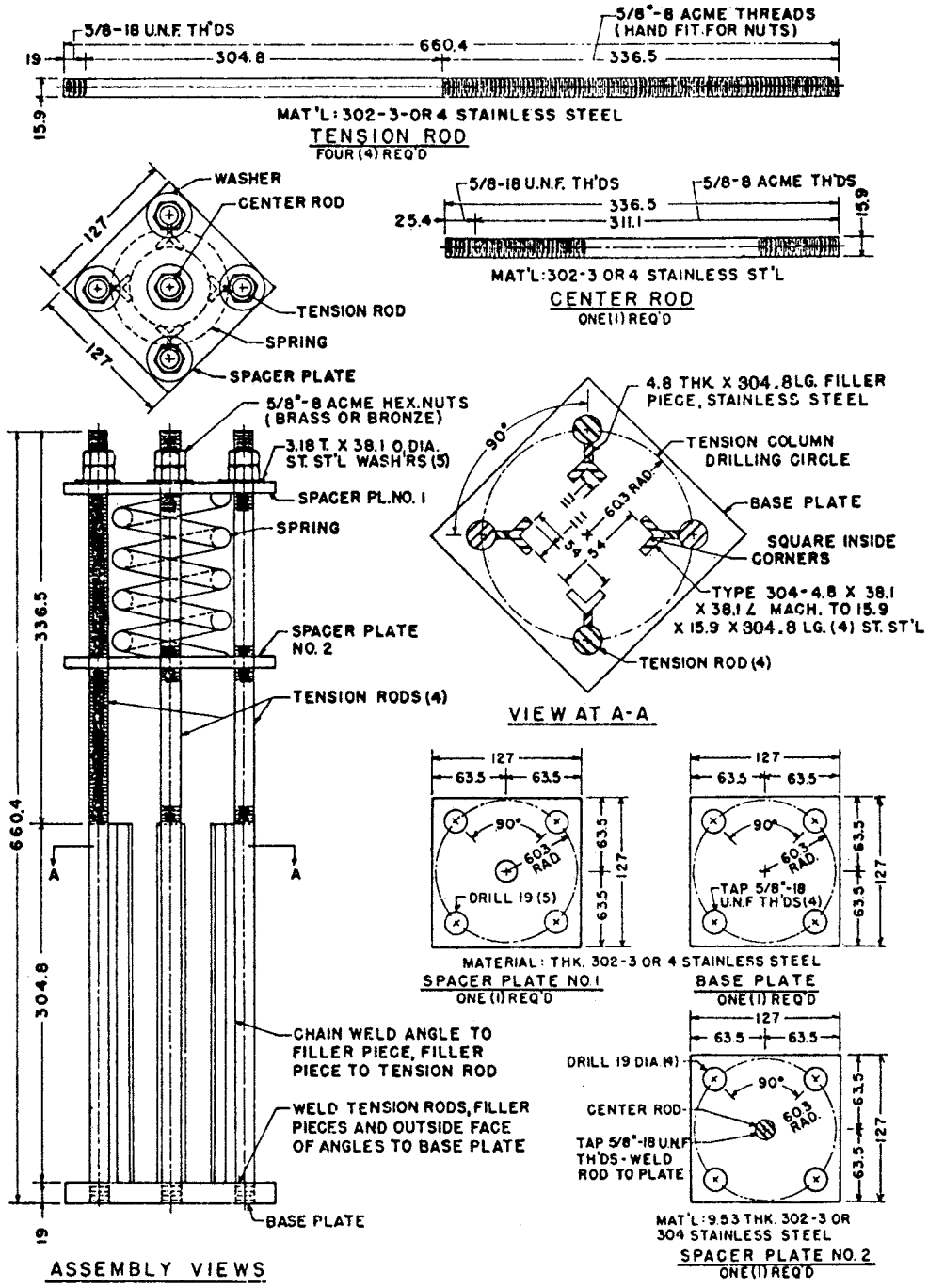
7.4 Freshly knife plane each lamination before applying the test adhesive. The machining tolerances for each lamination used in preparing the test specimen shall be no greater than ±0.25 mm (0.01 in.) between laminations and ±0.20 mm (0.008 in.) within laminations. Observe the most severe of the above tolerances.

8. Test Specimens

8.1 The laminated wood members shall be prepared from boards 15.9 mm (⅝ in.) thick by 63.5 mm (2½ in.) wide by 304.9 mm (12 in.) along the grain for each test condition. Each test lamination shall be made from two outer laminations as above and alternate metal spacers and wood sections for the inner lamination (Fig. ~~2~~ 3). The wood sections shall be sliced from a third board identical to that above. The wood sections shall be 28.5 mm (1⅛ in.) along the grain by 15.9 mm (⅝ in.) thick by 63.5 mm wide. The laminated wood members shall be prepared by alternately laying seven metal spacers on edge tightly adjacent to eight wood center sections. The wood sections should be slightly thicker than the metal spacers to obtain adequate pressure on the gluelines. It has been found that running a 13-mm (½-in.) piece of tape completely around the 16 loose pieces holds them together as a unit while gluing. Glue should be applied to the outer laminations and not the center ply. The outer laminations shall then be applied overlapping about 13 mm on each end and the entire assembly carefully clamped and the adhesive cured as recommended. After curing and clamp removal, the metal spacers shall be pushed gently (not impact driven) out. Then each three-ply laminated wood member shall be trimmed along the sides to leave a width of 50.8 ± 0.8 mm (2 ± 1/32 in.) and the outer overlapping boards at one end trimmed to 3.2 mm (⅛ in.) longer than the inner section. A center line perpendicular to the grain shall be marked across all of the 28.6-mm center sections and running to the specimen edge. The specimen shall then be notched as in Fig. ~~2,~~ 3, the 3.2-mm notches being visually centered on the above lines. Notching should be to, but not beyond, the adhesive line. The specimen shall then be trimmed at the untrimmed end to 276.2 mm (10⅞ in.). This dressed member, 47.6 by 50.8 by 276.2 mm (1⅞ by 2 by 10⅞ in.) appears in Fig. ~~2.~~ 3. When the specimen is loaded axially, shear loads shall be applied to the 15 overlap areas which are 50.8 by 12.7 mm (2 by 0.5 in.), giving double leg joints with glueline area of 1290 mm^2 (2 $in.^2$).

8.2 Two specimens for each variable combination to be investigated are prepared.

[3] Springs selected must fit within the space provided [approximately 110-mm (4.3-in.) maximum outside diameter and 300-mm (11.8-in.) maximum overall height] and should be of corrosion-resistant material (for example, stainless steel, cadmium, or zinc-plated steel), should have a spring constant of 35 000± 7000 N/m (200 ± 40 lbf/in.) and a load when fully compressed (that is at solid height) of about 4500 N (approximately 1000 lbf). For additional information, refer to Specification A 125 for Steel Springs, Helical, Heat Treated, *Annual Book of ASTM Standards*, Vol 01.05.



Metric Equivalents

mm	in.	mm	in.
~~3.18~~	~~⅛~~	~~60.3~~	~~2⅜~~
3.18	⅛	127	2⅜
~~4.77~~	~~3/16~~	~~63.5~~	~~2½~~
4.77	3/16	139.7	2½
~~9.53~~	~~⅜~~	~~127~~	~~5 ¾~~
9.53	⅜	148	5¾
~~11.1~~	~~7/16~~	~~304.8~~	~~12~~
11.1	7/16	165.1	6½
~~15.9~~	~~⅝~~	~~311.1~~	~~12¼~~
15.9	⅝	267	10½
~~19.1~~	~~¾~~	~~336.5~~	~~13¼~~
19.1	¾	304.8	12
~~25.4~~	~~1~~	~~425.4~~	~~16¾~~
25.4	1	311.1	12¼
~~38.1~~	~~1½~~	~~660.4~~	~~26~~
38.1	1½	336.5	13¼
~~54.0~~	~~2⅛~~		~~16⅜~~
54.0	2⅛	415	16⅜
60.3	2⅜	660.4	26
63.5	2½		

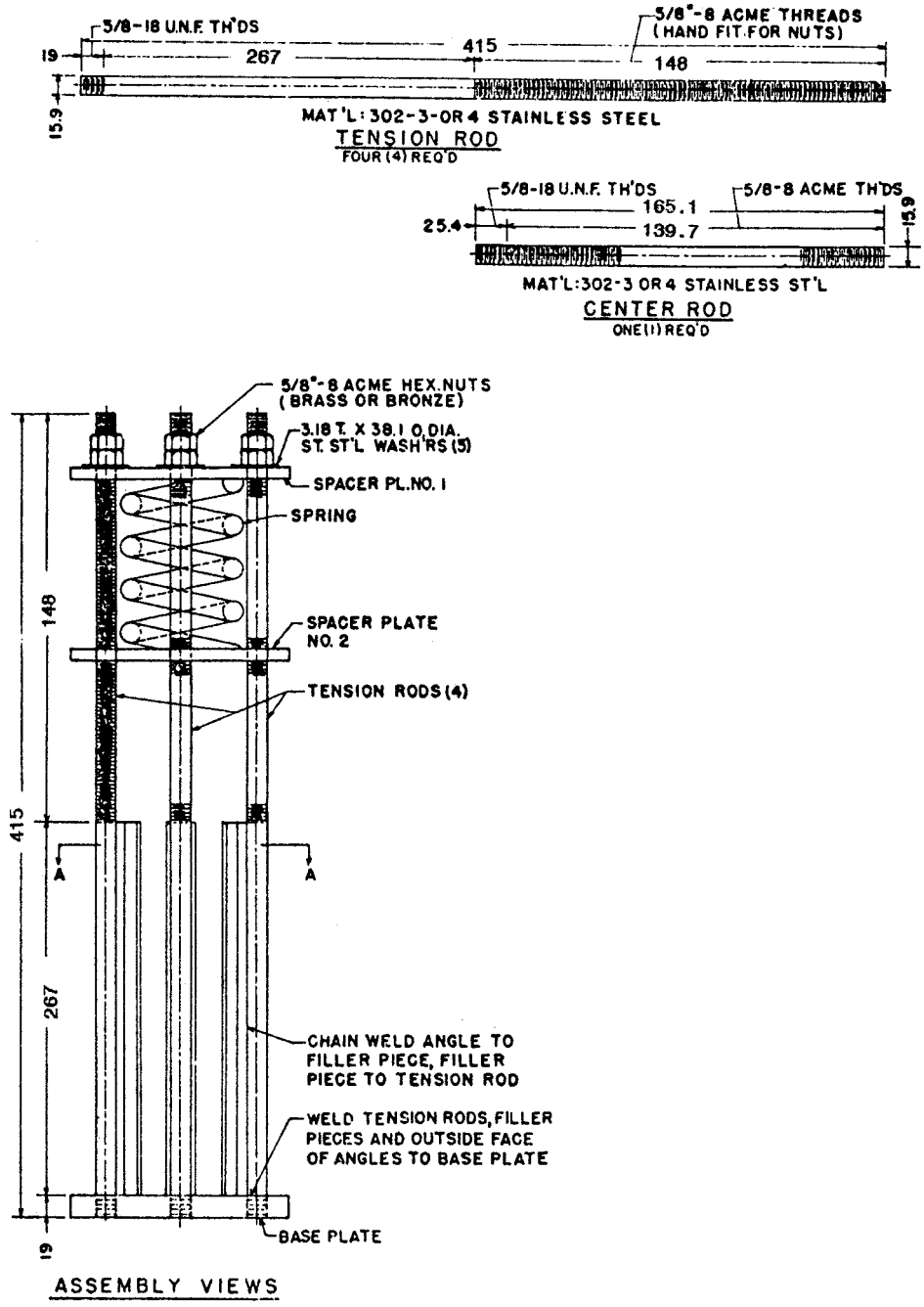


FIG. 2 Optional Compression-Type Deformation Tester

9. Assembly Time

9.1 Only one combination of open and closed assembly time is required. The open and closed assembly times are to be the optimum recommended with the adhesive manufacturer's instructions.

10. Procedure

10.1 Preparatory to testing, use a square and razor blade to scribe a line perpendicular to the exposed gluelines across each of the lapped areas. Then insert the stack of test specimens within the guides of the compression-type deformation tester described in 6.1 and shown in Fig. 1 and position spacer plate No. 2 on top. (In case the stack of specimens does not come to or slightly above the guides, use filler blocks on top of the stack.) Insert the spring and position spacer plate No. 1 on top of the spring. Exert a gentle compression and position the corner nuts. Load the entire unit in any type of compression testing machine such as that described in 6.1 to 218.2 kg (480 lb) total load 1655 kPa (240 psi) and tighten the corner nuts by hand to maintain spring compression. Position the keeper nut on center rod and tighten to within 9.5 mm (⅜ in.) on the top plate, thus retaining the spring in case one or two specimens fail.

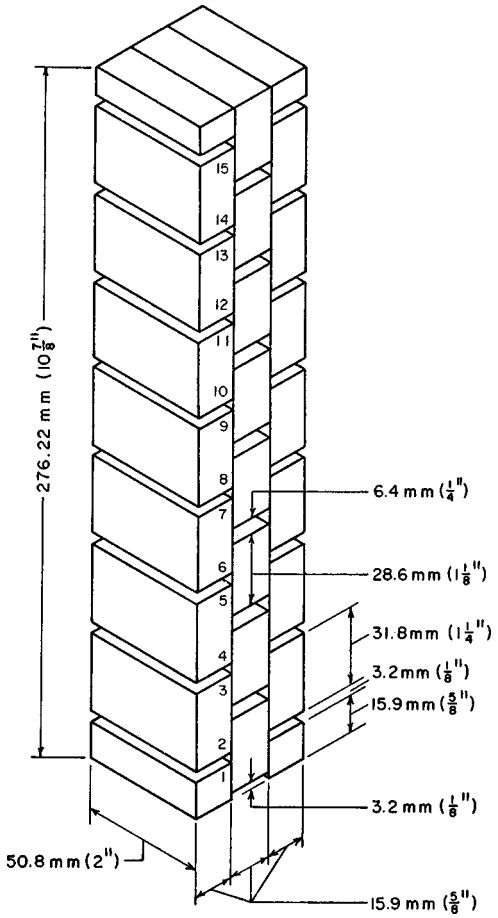


FIG. 2 3 View of Assembled Test Blocks

10.2 Place the entire unit in the test apparatus described in 6.3 and condition at one of the following conditions. Prepare two units for each test condition and adhesive-wood combination.

Temperature			
°F	°C	Relative Humidity, %	Time, days
160	71	ambient	7
80	26.7	90	7

10.3 *Measurements*— At the end of the 7 days remove the four test jigs from the oven and humidity chamber. Measure the total length slippage (deformation) in all gluelines to the nearest 0.127 mm (0.005 in.). Add the total length of deformation for both test specimens and each variable combination report in millimetres (inches).

11. Report

11.1 The report shall include the following:

11.1.1 Identification of the adhesive used by class, number, or manufacturer's mark,

11.1.2 Application and bonding conditions used for the specimen,

11.1.3 Wood preparation and conditioning including specific gravity and moisture content at time of bonding,

11.1.4 Temperature and relative humidity at time of bonding,

11.1.5 Number of specimens tested, and

11.1.6 The deformation values obtained.

12. Precision and Bias

12.1 At the present time, there is no basis for a statement of precision or bias concerning the reproducibility of results among laboratories. Such information may be available in the future following round-robin testing among laboratories.

12.2 The precision and bias of this test method is a function of the properties of the cured bondline; if wood failure occurs, it is a function of the wood's varability. Precision shall be reported in terms of the standard deviation of the data and the standard error of the mean.