Designation: D7966/D7966M – 16 (Reapproved 2023)

Standard Test Method for Resistance to Creep of Adhesives in Static Shear by Compression Loading (Wood-to-Wood)[1]

This standard is issued under the fixed designation D7966/D7966M; 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 creep properties of structural adhesives in wood-to-wood bonds when a standardized specimen is subjected to shearing stresses at various levels of static load, constant temperature, and relative humidity. Apparatus and procedures are provided for shear deformation (creep) of adhesive bonds under static load. This test method is used under the indicated conditions to evaluate resistance to creep properties of a structural wood adhesive.

1.2 The test method is used to evaluate creep performance of adhesives suitable for the bonding of wood, including treated wood, into structural wood products for general construction, marine use, or for other uses where a high-strength general construction, creep-resistant, durable adhesive bond is required. Individual block shear specimens are prepared from adhesively bonded laminations, subjected to a constant load under various combinations of temperature and relative humidity, and the amount of creep measured.

1.3 Creep of structural wood adhesives as measured by this test method may not be comparative to other ASTM methods and is limited to the conditions of the test and procedures contained herein.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading

D907 Terminology of Adhesives

D1101 Test Methods for Integrity of Adhesive Joints in Structural Laminated Wood Products for Exterior Use

D2395 Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials

D2559 Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

E4 Practices for Force Calibration and Verification of Testing Machines

2.2 *Other Document:*[3]

CSA O112.9 Evaluation of Adhesives for Structural Wood Products (Exterior Exposure)

2.3 *ASTM Adjuncts:*

Compression-Shear Creep Test Apparatus[4]

3. Terminology

3.1 *Definitions:* Many terms in this test method are defined in Terminology D907.

3.1.1 *laminated wood, n*—the fabricated product resulting from the bonding of two or more laminations, with each lamination made from one or more pieces bonded either

[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.30 on Wood Adhesives.

Current edition approved May 1, 2023. Published May 2023. Originally approved in 2014. Last previous edition approved in 2016 as D7966/D7966M – 16. DOI: 10.1520/D7966_D7966-16R23.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from APA – The Engineered Wood Association, 7011 S.19th St., Tacoma, WA 98466-5333, www.apawood.org.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJ-ADJD4680. Original adjunct produced in 1987.

lengthwise, edgewise, or both, and all with the direction of the grain essentially parallel, to form a larger piece such as a structural member.

3.1.1.1 *Discussion*—Laminated wood as defined in D1101.

3.1.2 *stress, n*—the force exerted per unit area at a point within a plane.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *average creep of specimen, n*—calculated creep displacement in the bondline of a specimen as shown in Fig. 1 $[(D_1+D_2)/2]$.

3.2.2 *maximum average creep, n*—the largest average creep observed with any one test specimen from a test assembly.

3.2.3 *overall average creep, n*—the average creep observed in the test assembly based on the average creep of the tested specimens.

3.2.4 *laminated test assembly, n*—an assembly formed by bonding layers of lumber with an adhesive so that the grain of all laminations is essentially parallel.

4. Summary of Test Method

4.1 An adhesive to be evaluated for suitability in structural wood products in terms of resistance to creep is used to prepare block shear test specimens which will then be loaded to a prescribed level of stress.

4.2 Following the adhesive manufacturers recommendations two 2-ply test assemblies of a designated species are laminated following specific recommendations of wood selection and preparation.

4.3 After a designated curing period, eight 25 mm [1.0 in.] by 25 mm [1.0 in.] block shear specimens are prepared from each assembly and preconditioned.

4.4 Both sides of the geometric center of each specimen are marked with a scribe.

4.5 The block shear specimens from each assembly are loaded to the required stress in a prescribed compression-shear creep test jig and then subjected to a designated test environment in terms of temperature, moisture level and time.

4.6 At the completion of the designated exposure time, the amount of creep for each specimen is measured and reported along with the average creep for the group of specimens.

5. Significance and Use

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

5.2 Test results from the evaluation of adhesive creep resistance, under designated environmental conditions of the test, provide a measure of the adhesive's ability to withstand constant loading over a relatively long period of time.

5.3 Creep measured with this test method is normally used in conjunction with specifications such as, but not limited to Specification D2559 and CSA O112.9 to confirm suitability of an adhesive to resist creep under designed loads when subjected to specific levels of stress, load duration and environmental conditions.

6. Apparatus

6.1 *Testing Machine*—A testing machine, or other suitable loading machine, capable of applying compression loads from 0 kN to 22 kN (5000 lbf) having an accuracy of ±1 % when calibrated in accordance with Practice E4, and cross-head speeds from 0.3 mm/min to 10 mm/min [0.01 in./min to 0.40 in./min] is sufficient for this test method. A minimum vertical space of 510 mm [20 in.] is required to compress the loading spring in the creep-test apparatus.

6.2 *Creep-Test Apparatus*—Static loads shall be applied and maintained on block-shear specimens by means of the compression-loaded creep-test cylinder shown in Fig. 2. The specific spring used in the apparatus shown in Fig. 2 has a design load of 2300 lbf (10 kN) and is made of corrosion-resistant components so that is can be used in high-temperature and humid environments for prolonged periods without concern for damaging the apparatus or interfering with the effectiveness. The apparatus is spring-loaded and shall contain

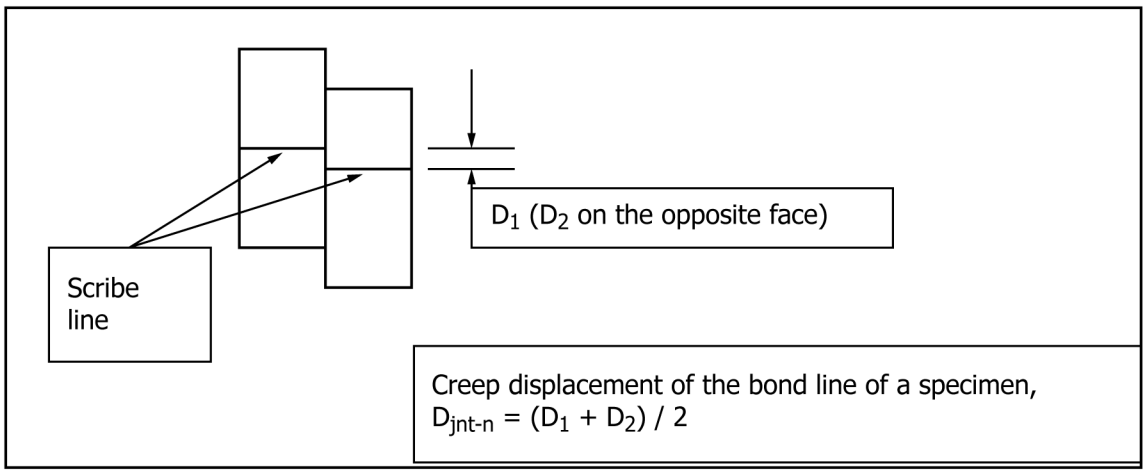

FIG. 1 Creep Measurement of Test Specimen

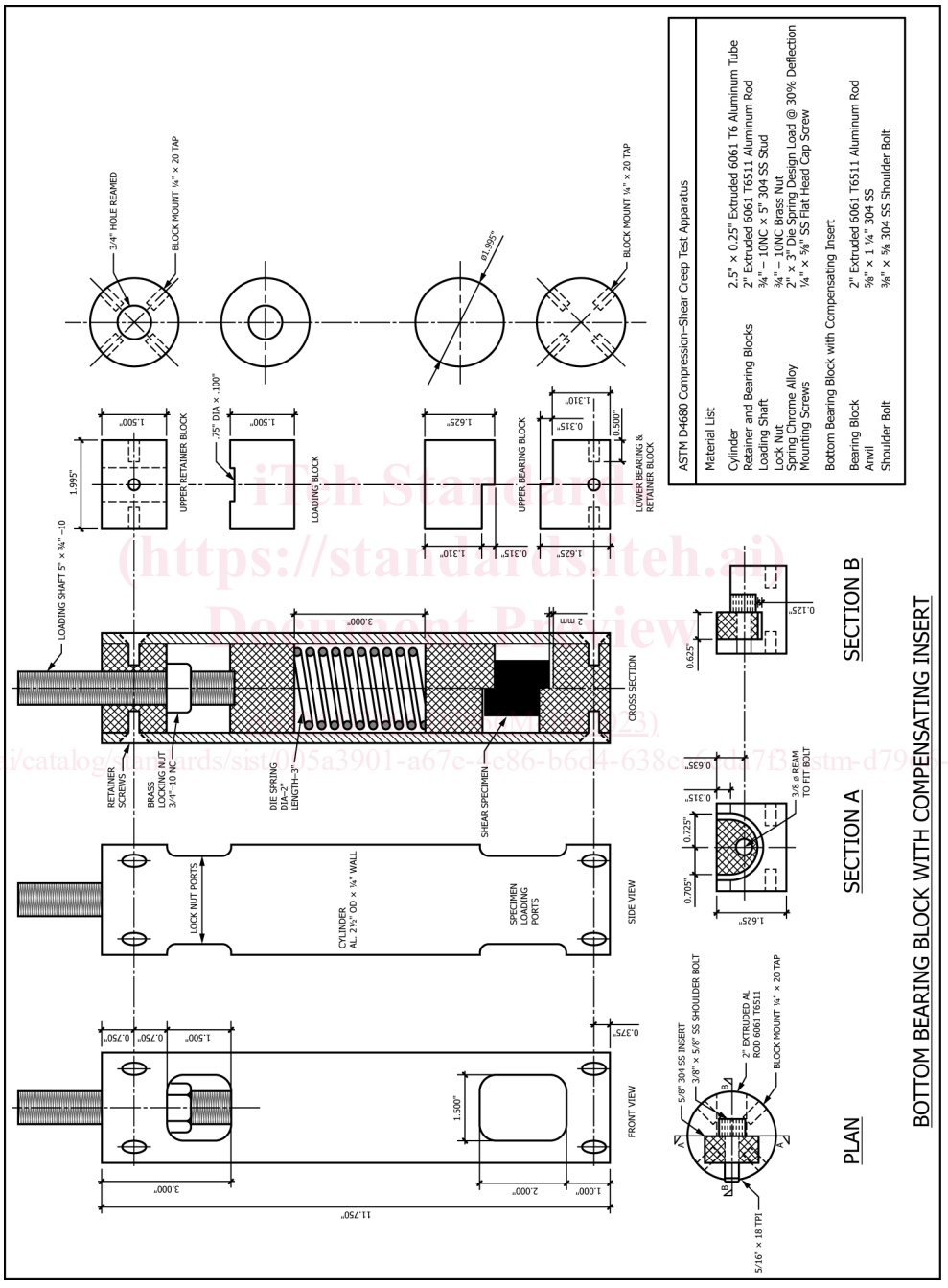

FIG. 2 Creep Test Apparatus

TABLE 1 Standard Environmental Conditions

Test Condition	Temperature	Relative Humidity (%)	Time (days)	Stress Level
A[A]	20 ± 2.0 °C [68 ± 3.6 °F]	95	7	2.5 MPa (360 psi)
B[A]	70 ± 2.0 °C [158 ± 3.6 °F]	ambient humidity	7	2.5 MPa (360 psi)
C[A]	50 ± 2.0 °C [122 ± 3.6 °F]	100	28	2.1 MPa (300 psi)

[A] Conditions for A, B, and C are the same as those found in CSA O112.9–10.

a mechanism to provide a self aligning surface to account for specimens where the two bearing surfaces are not perfectly parallel.

NOTE 1—Although this particular spring has a design load of 10 kN (2300 lbf) others of greater or less capacity may be substituted. Varying spring capacities with outside diameters no greater than the cylinder inside diameter are available. Additional details, including options for providing self aligning surface can be found in Adjunct ADJD4680.

6.2.1 For creep testing up to 50 °C [122 °F], it is not necessary to adjust the spring or load to compensate for the effects of changing temperature. It is only necessary that the apparatus, with included specimen, be preconditioned to the test temperature before the test load is applied to the spring. The preheated apparatus must be wrapped with a piece of flexible thermal insulation material while the test load is applied to the specimen. After loading and measurements, return the loaded apparatus to the test environment.

NOTE 2—Since there are no significant changes in temperature before or after loading, no adjustments are needed in the spring.

6.2.1.1 When conducting creep testing a temperatures of 50 °C [122 °F] or higher the applied stress level shall be increased to compensate for the decrease in the spring constant. This can be determined by comparing the spring constant for the spring at room temperature to that when the spring is heated to the specified temperature. Laboratories shall establish that the spring constant, when repeatedly heated to the specified temperature, is consistent between each use. Compensation for spring stiffness at temperature shall be determined by the testing laboratory.

6.3 *Microscope*—A microscope with an objective lens of at least 7× magnification or a magnifying glass, such as a 10× loupe is required to measure displacement of scribe marks across the two adherends of a specimen to measure and record any creep that has occurred. A linear traveling binocular microscope is ideally suited to creep measurements; however, a microscope fitted with an appropriately graduated scale is satisfactory.

6.4 *Environmental Chambers*—An environmental chamber is required to precondition test specimens to their intended test environment and subject the conditioned specimens, after loading to a specified shear stress, to the required conditions of temperature and relative humidity. In the absence of specific required test conditions of temperature, relative humidity, applied shear stress and time under test, Table 1 provides examples of standard conditions that are considered appropriate.

6.4.1 Conditioning equipment, such as but not limited to ovens and humidity cabinets, should be capable of maintaining a constant temperature within ±2.0 °C [±3.6 °F] of the set-point and constant relative humidity within ±5 % of the set-point at a given temperature for each of the test conditions selected for evaluation.

NOTE 3—The standard conditions listed in Table 1 are considered appropriate to evaluate the suitability of a structural wood adhesive for creep resistance when exposed to a variety of environmental exposure conditions up to and including continuous exposure to the weather. Other conditions of temperature, humidity, load duration and stress level may be used or specified provided that the conditions and their precision has been determined and reported. Specific and appropriate product standards, qualified evaluation and code approval agencies, or combinations thereof, may specify the targeted stress level for a particular species or species group, including exposure duration, when adopting this test method.

NOTE 4—Section 8.6 provides requirements for preconditioning specimens prior to testing.

7. Materials

7.1 *Wood Selection, Preparation and Conditioning*—Use any softwood or hardwood single species planned for bonding and intended for use and considered suitable for bonded structural wood products. The selected species shall be compatible with the test structural wood adhesive and determined suitable to evaluate resistance to creep using this test method as required, specified or desired. Bond only to vertical grain wood surfaces (Note 6).

NOTE 5—This test only measures resistance to creep; for characterizing additional adhesive properties related to the selected species, such as bondability, an alternative test method or specification, including but not limited to Specification D2559 should be considered.

NOTE 6—The bond face is considered vertical grain when the growth rings make an angle of between 45° and 90° to the face.

7.1.1 For the species under evaluation, each piece of wood selected for use in resistance to creep testing and in accordance with this test method shall have a minimum specific gravity as indicated in Table 1, Required Shear Strength for Structural Laminated Wood Products, in Specification D2559. For species not included in Table 1 of Specification D2559 consult the USDA Wood Handbook[5] for the reported specific gravity at 12 % moisture content (Note 7).

NOTE 7—For the species selected for evaluation, the wood quality selected is such that it is able to sustain the applied stress under the selected environmental conditions. For species not found in Table 1 of Specification D2559, trial tests should be conducted to confirm the wood has adequate strength for the specific test. Wood with higher specific gravity and slower growth rate (relatively large number of growth rings per inch) have been found to be effective metrics for selecting suitable wood substrate for resistance to creep testing.

7.1.2 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

[5] Available from USDA, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726, http://www.fpl.fs.fed.us.