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.

Designation: D7446 – 09 (Reapproved 2017)

Standard Specification for Structural Insulated Panel (SIP) Adhesives for Laminating Oriented Strand Board (OSB) to Rigid Cellular Polystryene Thermal Insulation Core Materials[1]

This standard is issued under the fixed designation D7446; 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 specification is designed to evaluate adhesives suitable for the bonding of oriented strand board (OSB) to rigid cellular polystyrene insulation core materials for general structure use.

1.2 The requirements of the structural insulated panel (SIP) adhesive are based on the performance of the adhesive as measured by:

1.2.1 Resistance to shear by compression loading in ambient conditions and after accelerated aging.

1.2.2 Resistance to tensile loading in ambient conditions and after accelerated aging.

1.2.3 Resistance to creep (deformation) under static load in ambient conditions and after accelerated aging.

1.2.4 Tensile and shear strength to polystyrene core materials.

1.3 The classification of the adhesive formulation is based on, but not limited to the adhesive's industry accepted generic names, for example: phenol-resorcinol, emulsion polymer isocyanate, one and two-part urethane. The type of adhesive application and curing terminology are also usually included for classification purposes such as cold-setting phenol resorcinol, heat-cured phenol resorcinol, and hot melt one component urethane.

1.4 Evaluation of adhesive performance at high temperature conditions, such as during a fire exposure, is beyond the scope of this specification.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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.*

1.7 *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]

C273/C273M Test Method for Shear Properties of Sandwich Core Materials

C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

D572 Test Method for Rubber—Deterioration by Heat and Oxygen

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

D907 Terminology of Adhesives

D1183 Practices for Resistance of Adhesives to Cyclic Laboratory Aging Conditions

D1583 Test Method for Hydrogen Ion Concentration of Dry Adhesive Films

D2294 Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)

D4300 Test Methods for Ability of Adhesive Films to Support or Resist the Growth of Fungi

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

D4444 Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

E4 Practices for Force Verification of Testing Machines

[1] This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

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[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.

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2.2 *Other Standards:*

PS2 Performance Standard for Wood-Based Structural-Use Panels[3]

ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories[4]

3. Terminology

3.1 *Definitions*—Many terms in this specification are defined in Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *core material, n*—located between structural insulated panel facings; for this specification, consists of rigid cellular polystyrene thermal insulation, either expanded polystyrene (EPS) or extruded polystyrene (XPS) that conforms to Specification C578.

3.2.2 *facings, n*—the outer layers of a structural insulated panel typically consisting of oriented strand board.

3.2.3 *oriented strand board (OSB), n*—a mat formed panel product with oriented layers resulting in directional properties.

3.2.3.1 *Discussion*—Oriented strand board is comprised primarily of wood strands bonded with exterior adhesive formulations under heat and pressure. Design capacities are referenced to the primary and secondary structural axis, which typically correspond to the manufacturing machine and cross-machine directions, respectively. The primary direction is often referred to as the strength direction.

3.2.4 *practical equilibrium, n*—physical state in which the material weight does not change more than 0.5 % in 24 h.

3.2.5 *standard conditions, n*—consist of a controlled environment set at 23 ± 2°C (73 ± 3°F) and 65 ± 3 % relative humidity (RH).

3.2.6 *structural insulated panel (SIP), n*—factory manufactured assembly consisting of a rigid polystyrene bonded with a structural adhesive between two rigid facings such as OSB.

4. Significance and Use

4.1 This specification addresses minimum performance criteria for adhesives used to laminate oriented strand board (OSB) structural panel facing material to expanded or extruded polystyrene core materials. Adhesive performance is based on tests that simulate exposure to moisture, temperature, seasonal weathering, and creep. Additionally, the adhesive is to demonstrate resistance to oxidation, mold, chemical reagents, and compatibility to the specific laminating materials.

4.2 The adhesive manufacturers can use this specification for new product development and quality control purposes.

4.3 Structural insulated panel manufacturers rely on an adhesive performance specification that determines its suitability before use.

4.4 Performance of the SIP adhesive when evaluated in accordance with this specification aids in determining the suitability of the adhesive for laminating OSB facings to rigid cellular polystyrene core materials in the manufacture of structural insulated panels.

5. Fillers and Extenders

5.1 If amylaceous or protein fillers and extenders are used, the adhesive shall not only pass requirements of this specification but, in addition, possess antifungal properties to inhibit the growth of selected fungal species when tested in accordance with Test Method D4300. The adhesive manufacturer's literature shall indicate whether such materials are present.

6. Apparatus

6.1 *Testing Machine*—shall conform to the requirements of and have the capabilities of the machines prescribed in Test Methods C297/C297M, C273/C273M, and D905 and have an accuracy of ±1 % when calibrated in accordance with Practices E4 requirements. The grips shall be capable of securely grabbing the specimen throughout the test without allowing the specimen to slip. The grips shall be self-aligning.

6.2 *Temperature and RH-Controlling Equipment*—The equipment shall be capable of maintaining the test temperature to ±3°C (±5°F) and the relative humidity to ±3 %.

7. Chemical Requirements

7.1 The cured adhesive film shall develop a pH value of not less than 2.5 when tested in accordance with Test Method D1583.

8. Physical Requirements

8.1 Adhesive manufacturer recommendations for preparation, application, and handling of the SIP adhesive shall ensure proper usage and maintain product integrity. The adhesive manufacturer shall furnish written instructions stating the general chemical type of adhesive, its storage and mixing procedure, the method of surface preparation with materials to be laminated, and any other data that is pertinent to the use of the adhesive in the manufacture of structural insulated panels.

8.2 The adhesive shall pass the tests required by this specification. See Table 1, Table 2, and Section 10. The adhesive manufacturer's application specification sheet shall provide application instructions which include the limiting conditions.

8.2.1 The adhesive manufacturer is to provide specific application instructions for the test adhesive related to the preparation of test assemblies required by this specification including both Douglas-fir to Douglas-fir and OSB to Core to OSB.

8.3 Limiting conditions are conditions that must be controlled within maximums, minimums, or ranges so that the adhesive can function as designed. These conditions include, but are not limited to the following:

8.3.1 Maximum storage life of adhesive;

8.3.2 Assembly conditions including temperature and humidity;

8.3.3 Allowable moisture content and temperature for facings and core materials;

[3] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

TABLE 1 Douglas-fir to Douglas-fir Qualification Series

Test Type	Shear (Test Method D905)		Tension (Test Method C297/C297M)		Creep (Test Method D2294)
Specimen Type	Solid Douglas-fir	Bonded Douglas-fir	Solid Douglas-fir	Bonded Douglas-fir	Bonded Douglas-fir
Treatment	NA	Dry Shear	NA	Dry Tensile	Uncontrolled
Reference Section	NA	14.5	NA	14.6	14.9.7 and Table 3
Minimum Requirements	NA	7033 kPa (1020 psi)	NA	2110 kPa (306 psi)	344.7 kPa (50 psi) for 30 days
Reference Section	NA	10.1.1.1	NA	10.1.2.1	10.1.3
Treatment	Practices D1183 "C"	Practices D1183 "C"	Practices D1183 "C"	Practices D1183 "C"	Practices D1183 "C"
Reference Section	14.5.4	14.5.3	14.6.3	14.6.3	14.9.9 and Table 3
Minimum Requirements	NA	80 % of Solid Douglas-fir Practices D1183 "C"	NA	80 % of Solid Douglas-fir Practices D1183 "C"	344.7 kPA (50 psi) for 7 days
Reference Section	NA	10.1.1.2	NA	10.1.2.2	10.1.3
Treatment	Soak/Re-dry	Soak/Re-dry	Soak/Re-dry	Soak/Re-dry	Soak/Re-dry
Reference Section	14.5.5 and Table 3	14.5.3 and Table 3	14.6.4 and Table 3	14.6.4 and Table 3	14.9.10 and Table 3
Minimum Requirements	NA	80 % of Solid Douglas-fir Soak/Re-dry	NA	80 % of Solid Douglas-fir Soak/Re-dry	344.7 kPa (50 psi) for 7 days
Reference Section	NA	10.1.1.3	NA	10.1.2.3	10.1.3
Treatment	NA	Oxidation	NA	Mold (as required)	Elevated Temperature
Reference Section	NA	14.5.6 and 14.7	NA	14.6.5 and 14.8	14.9.8 and Table 3
Minimum Requirements	NA	80 % of Bonded Douglas-fir-Conditioned	NA	90 % of Bonded Douglas-fir-Conditioned	344.7 kPa (50 psi) for 7 days
Reference Section	NA	10.1.1.4	NA	10.1.2.4	10.1.3
Treatment	NA	Mold (as required)	NA		
Reference Section	NA	14.5.7 and 14.8	NA		
Minimum Requirements	NA	90 % of Bonded Douglas-fir-Conditioned	NA		
Reference Section	NA	10.1.1.5	NA		

TABLE 2 OSB to Core to OSB Qualification Series

Test Type	Shear (Test Method C273/C273M)	Tension (Test Method C297/C297M)
Specimen Type	SIP	SIP
Treatment	Conditioned	Conditioned
Reference Section	15.1	15.2
Minimum Requirement	62 kPa (9 psi)	103.4 kPa (15 psi)
Reference Section	10.2.1	10.2.2

8.3.4 Mixing ratios, if applicable;

8.3.5 Pot life, if applicable;

8.3.6 Application method: applied to one surface or both contracting surfaces:

8.3.7 Spread rate expressed as weight per unit area and tolerance;

8.3.8 Open and closed assembly times;

8.3.9 Laminating pressure and press time;

8.3.10 Curing conditions such as time, temperature, and humidity.

9. Qualification Tests

9.1 Douglas-fir to Douglas-fir Qualification Series (Table 1) and OSB to Core to OSB Qualification Series (Table 2).

10. Test Requirements

10.1 *Douglas-fir to Douglas-fir:*

10.1.1 *Test Method D905 Block Shear Strength:*

10.1.1.1 *Dry Shear Test*—The average shear strength of bonded Douglas-fir specimens shall be a minimum of 7033 kPa (1020 psi) at 12 % moisture content.

NOTE 1—The 7033 kPa (1020 psi) requirement is based on 90 % of the shear strength parallel to grain at 12 % moisture content from Table 4-3 of the 1999 Wood Handbook for Douglas-fir.[5]

10.1.1.2 *Practices D1183 Test Condition "C"*—After cycling bonded Douglas-fir specimens in accordance with Practices D1183 "C" procedure (see Table 3), the average shear strength shall be equal to or greater than 80 % of the average shear strength of solid Douglas-fir specimens exposed to the same accelerated aging procedure. Preparation details for solid Douglas-fir specimens are located in 14.1, 14.5, and Fig. 1.

10.1.1.3 *Soak/Re-dry*—After cycling bonded Douglas-fir specimens in accordance with the soak/re-dry procedure (see Table 3), the average shear strength shall be equal to or greater than 80 % of the average shear strength of solid Douglas-fir specimens exposed to the same accelerated aging procedure. Specimen preparation details for solid Douglas-fir specimens are located in 14.1, 14.5, and Fig. 1.

10.1.1.4 *Oxidation Resistance Test*—After cycling bonded Douglas-fir specimens in accordance with procedures indicated in 14.7 the average shear strength shall be equal to or greater than 80 % of the average dry shear strength of bonded Douglas-fir specimens tested in 10.1.1.1.

10.1.1.5 *Mold Resistance Test (when required)*—After conditioning and aging bonded Douglas-fir specimens in accordance with 14.8 procedure, the average shear strength shall be equal to or greater than 90 % of the dry shear strength of the bonded Douglas-fir specimens tested in 10.1.1.1.

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

TABLE 3 Douglas-fir Procedures

Practices D1183 Procedure C	Soak/Re-dry	Creep Resistance
48 h at 71 ± 2°C (170 ± 3°F) <10 % RH	48 h submerged in 18 to 23°C (65 to 75°F) tap water	Set 1: Control Test for 30 days in uncontrolled temperature and relative humidity
48 h submerged in at 23± 2°C (73 ± 3°F) tap water	8 h oven dry at 63 ± 3°C (175 ± 5°F)	Set 2: Elevated Temperature Test at 70°C (158°F) for 7 days in uncontrolled (ambient) humidity
8 h at -40 ± 2°C (-40 ± 3°F) ~ 100 % RH	followed by three cycles comprised of the following:	Set 3: Test after Practices D1183 Procedure C
64 h at 39 ± 2°C (100 ± 3°F) ~ 100 % RH	17 h submerged soak in 18 to 23°C (65 to 75°F) tap water	Set 4: Test after soak/re-dry in uncontrolled temperature and relative humidity
all steps repeated twice more for a total of three cycles	8 h oven dry at 63 ± -3°C (175 ± 5°F)	
after cycling, then 7 days at standard conditions	after cycling, then 7 days at standard conditions	

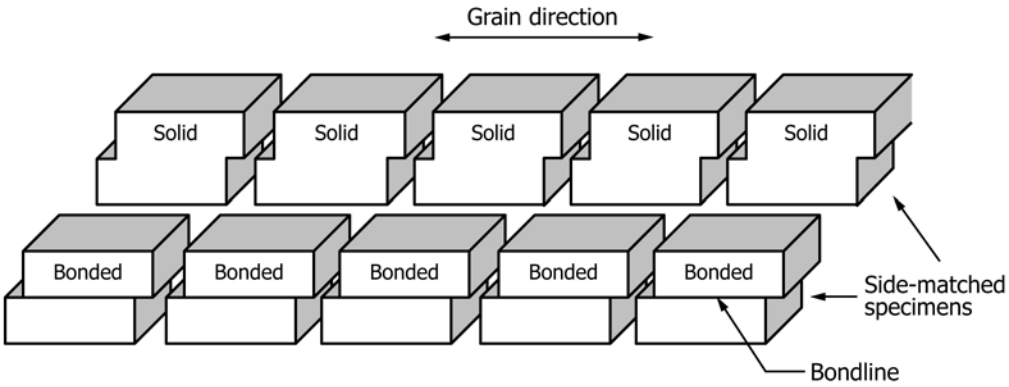

FIG. 1 ASTM Test Method D905 Shear Block — Matched Pair Diagram

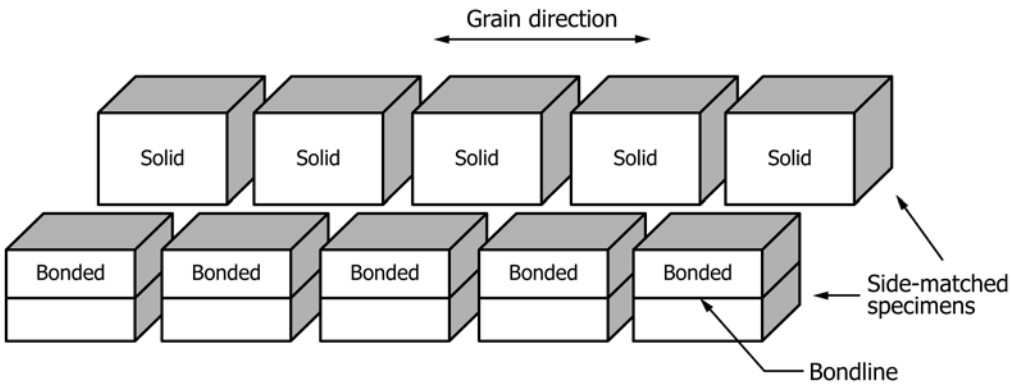

FIG. 2 ASTM Test Method C297/C297M Tensile Specimen — Matched Pair Diagram

10.1.2 *Douglas-fir to Douglas-fir Tensile Strength:*

10.1.2.1 *Dry Tensile Bond Strength*—The minimum average dry tensile strength of bonded Douglas-fir specimens shall be 2110 kPa (306 psi) at 12 % moisture content.

NOTE 2—The 306 psi value is based on 90 % of the Wood Handbook Table 4-2,[5] Tension, perpendicular to grain-maximum tensile strength for Douglas-fir, Coast, Dry (12 % M.C.).

10.1.2.2 *Practices D1183 Test Condition "C"*—After cycling the bonded Douglas-fir specimens in accordance with Practices D1183 Test Condition "C," or the soak/re-dry accelerated aging procedures (see Table 3), the minimum average tensile strength shall be equal to or greater than 80 % of the average tensile strength of solid Douglas-fir specimens exposed to the same accelerated aging procedure. Specimen preparation of solid Douglas-fir specimens is detailed in 14.1, 14.6, and Fig. 2.

10.1.2.3 *Soak/Re-dry Test*—After cycling the bonded Douglas-fir specimens in accordance with the soak/re-dry accelerated aging procedures (see Table 3), the minimum average tensile strength shall be equal to or greater than 80 %

of the average tensile strength of solid Douglas-fir specimens exposed to the same accelerated aging procedure. Specimen preparation of solid Douglas-fir specimens is detailed in 14.1, 14.6, and Fig. 2.

10.1.2.4 *Mold Resistance Test (when required)*—After conditioning and aging bonded Douglas-fir specimens inoculated with mold, the average tensile strength shall be equal to or greater than 90 % of the average dry tensile strength of bonded Douglas-fir specimens in 10.1.2.1.

10.1.3 *Douglas-fir to Douglas-fir Creep*—The allowable creep (see Table 3) of bonded Douglas-fir specimens is limited to an average of 0.051 mm (0.002 in.) in the first hour, with an average of 0.127 mm (0.005 in.), for the full duration of each test.

10.2 *Oriented Strand Board to Rigid Cellular Polystryene Core to Oriented Strand Board (OSB to Core to OSB):*

10.2.1 *Shear Strength*—Test results of OSB to Core to OSB shear specimens tested in accordance with Test Method C273/C273M following procedures in 15.1 shall demonstrate an average shear strength that is not less than 62 kPa (9 psi). The failure character of each specimen shall show no more than 10 % bond line failure and be reported in Section 16.

10.2.2 *Tensile Strength*—Test results of OSB to Core to OSB tensile specimens tested in accordance with Test Method C297/C297M following procedures in 15.2 shall demonstrate an average tensile strength that is not less than 103.4 kPa (15 psi). The failure character of each specimen shall show no more than 10 % bond line failure and be reported in Section 16.

11. Sampling, Selection, and Preparation of Douglas-Fir, OSB, Core Materials, and Test Adhesive

11.1 *Adhesive:*

11.1.1 The adhesive sample must be the same as the final product for which recognition is sought.

NOTE 3—Regulatory authorities require qualification testing to be performed by ISO 17025 accredited laboratories.

11.1.2 The sample container shall indicate the manufacturer's name, adhesive name, batch number, lot number, and date of manufacture.

11.2 *Douglas-fir*—Use flat-grained (Note 1) Douglas-fir wood having an average specific gravity between 0.45 and 0.55, for each board, based on oven-dry weight and volume and possessing a minimum of 8 rings per inch. Each wood piece shall be surfaced by knife planing, un-sanded, free of dust, and free from defects including knots, short grain, decay, and any unusual discoloration within the laminating area.

NOTE 4—Flat-grained wood growth rings make angles of less than 45°. See Fig. 3.

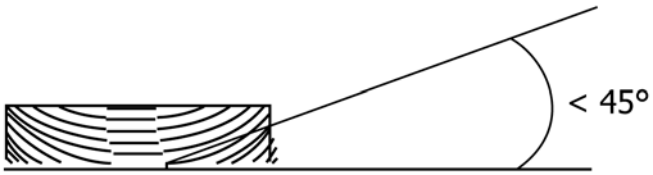

FIG. 3 Flat-grained Lumber Profile

11.2.1 Protect the bonding surfaces from contamination before and during bonding. Douglas-fir bonding surfaces shall be freshly planed within 24 h of bonding.

11.2.2 Use Douglas-fir with the wood grain parallel to the test load application for shear testing and Douglas-fir wood grain perpendicular to the test load for tensile testing.

11.2.3 After pressing, excess adhesive shall be removed from all edges of test assemblies prior to the adhesive setting.

11.3 *Oriented Strand Board (OSB)*—The OSB shall be grade mark stamped 11.11 mm (7⁄16 in.) thick, PS2, Exposure 1 rated, and include Mill No.

11.3.1 OSB to Core to OSB shear testing shall be in accordance with Test Method C273/C273M following procedures in 15.1 and performed with the OSB strong axis direction parallel with the test load application.

11.3.2 OSB to Core to OSB tensile testing shall be in accordance with Test Method C297/C297M following procedures in 15.2 and performed with the OSB planar surface perpendicular to the test load application.

11.3.3 The OSB laminating surface can be either the rough (screen) or smooth side surface in accordance with the adhesive manufacturer's recommendations and shall be consistent with the actual use of the product. The actual surface used for bonding shall be identified in the test report.

11.3.4 After pressing and prior to the adhesive setting, excess adhesive shall be removed from all edges of test assemblies.

11.4 *Rigid Cellular Polystryene Core:*

11.4.1 The core material (expanded or extruded polystyrene) shall be certified to meet Specification C578. The type tested shall be reported in Section 16. The core material thickness used for test specimen construction shall be 25.4 ± 0.8 mm (1 ± 1⁄32 in.) thick. The gloss surface of extruded polystyrene shall be removed by sanding or knife planing prior to preparing the test assemblies. A detailed description of how the surface preparation was performed and final core material thickness shall be included in the test report.

11.4.2 The rigid polystyrene core material type shall be the same as intended for the final manufactured insulated panel.

11.5 *Chemical Treatments*—Chemical treatments to bonding surfaces of the OSB or core materials, or both, shall be tested for compliance with this specification.

11.6 *Conditioning*—Condition the Douglas-fir at at 23 ± 2°C (73 ± 4°F) and a relative humidity of 65 to 70 %. After conditioning the wood moisture content shall be 12 ± 1 %. Wood moisture content shall be determined with either Test Methods D4442 (oven dried method) or D4444 (electronic moisture meter method). Condition the OSB and core materials in accordance with the adhesive manufacturer's recommendations. OSB moisture content shall be determined with Test Method D4442 (oven dried method). All materials shall be conditioned until practical equilibrium (3.2.4) is attained.

12. Number of Tests and Retests

12.1 Shear, tensile, and creep tests are conducted in sets with a minimum of five specimens.

12.2 Any test that fails to meet this specification's performance can be retested. The analysis of failing results and processes may indicate incorrect adhesive preparation, or an assembly practice was deficient, or an equipment set-up or equipment operation was not in compliance, or the condition of the substract was found noncompliant. These type departures will allow to discard the original data and replace with retest results. However, if analysis of failing results indicate a valid evaluation of the adhesive performance then further retest results with equal or greater size data set are averaged with the original results. Any adhesive formulation change disqualifies the retesting.

12.3 All materials that are used for retesting shall be from the same lot or batch as the materials used for the original testing.

13. Materials Conditioning

13.1 Before bonding, all adherends (OSB and core materials) shall be conditioned in accordance with 11.6.

14. Douglas-fir to Douglas-fir Tests

14.1 Test specimens shall be prepared in accordance with the general principles of Test Method D905 (shear) or Test Method C297/C297M (tensile), or both. The solid Douglas-fir block dimensions (including thickness) must be the same as the bonded Douglas-fir blocks.

14.2 To ensure pieces with similar specific gravity and wood properties are bonded together, a single piece of 2 by 6 Douglas-fir is recommended.

14.3 The 2 by 6 can provide the two pieces necessary for each bonded specimen and also is sufficient size to provide enough material for the side-matched solid wood (control) specimen. An example of the shear and tensile specimen-cutting pattern is shown in Fig. 1 and Fig. 2 respectively.

14.4 The mating surfaces of the bonded specimens shall be surfaced, no more than 24 h, prior to bonding. The bonded Douglas-fir to Douglas-fir specimen shall be a 1-in. minimum thickness. The adhesive preparation, spread rate, clamping pressure, and clamping time shall follow the adhesive manufacturer's recommendations.

NOTE 5—Specimens in Fig. 1 and Fig. 2 are prepared from the same board. For example, the block shear specimens are prepared from a sing 2 by 6 Douglas-fir board. It is cut down the center, longitudinally. One half is used to prepare the solid wood specimens. The other is re-sawn through the thickness, planed, and the sections bonded with the test adhesive. Specimens are then prepared from the bonded assembly.

14.5 *Test Method D905 Block Shear Strength:*

14.5.1 Before test adhesive application, orient the direction of the annular growth rings, when viewed on the end of the laminations in the bonded assembly, so that they are alternated.

14.5.2 All tests shall be performed in accordance with Test Method D905, except that a load application rate of 0.381 mm (0.015 in.) per minute is used.

14.5.3 Prepare and test bonded Douglas-fir specimens for dry shear strength.

14.5.4 Prepare and test solid Douglas-fir shear and matching pair of bonded Douglas-fir shear test specimen sets after exposure to Practices D1183 Test Condition "C." Practices D1183 Test Condition "C" accelerated aging procedure is shown in Table 3.

14.5.5 Prepare and test solid Douglas-fir shear and matching pair of bonded Douglas-fir shear test specimen sets after exposure to the soak/re-dry accelerated aging procedure. The soak/re-dry accelerated aging procedure is shown in Table 3.

14.5.6 Prepare and test bonded Douglas-fir specimens for shear strength after exposure to the Oxidation Resistance test.

14.5.7 When required, prepare and test bonded Douglas-fir specimens for shear strength after exposure to the mold resistance test.

14.5.8 Dry shear test performance requirements are described in 10.1.1.

14.6 *Test Method C297/C297M Tensile Strength:*

14.6.1 All tests shall be performed in accordance with Test Method C297/C297M with specimens having a 51 by 51 mm (2 by 2 in.) cross section.

14.6.2 Prepare and test bonded Douglas-fir specimens for dry tensile strength.

14.6.3 Prepare and test solid Douglas-fir tensile and matching pair bonded Douglas-fir tensile test specimen sets after exposure to Practices D1183 Test Condition "C" accelerated aging procedure.

14.6.4 Prepare and test solid Douglas-fir tensile and matching pair bonded Douglas-fir tensile test specimen sets after exposure to the soak/re-dry accelerated aging procedure.

14.6.5 When required, prepare and test bonded Douglas-fir specimens for tensile strength after exposure to the mold resistance test.

14.6.6 Tensile strength performance requirements are described in 10.1.2.

14.7 *Oxidation Resistance*—Required only for shear strength. Adhesives such as elastomers, synthetic elastomers, rubber cement, or others suspected of being affected by long-term aging, shall be evaluated in accordance with Test Method D572. The adhesives shall first be evaluated for possible ingredients known to react violently with oxygen at the test pressures or temperatures.

14.7.1 After preparation and conditioning at standard conditions, subject five test specimens to suspension in an oxygen atmosphere at 70 ± 3°C (158 ± 5°F) and 2068 ± 103 kPa (300 ± 15 psi) pressure for a period of 500 h.

14.7.2 After exposure, the specimens shall be again conditioned at standard conditions and tested immediately in accordance with Test Method D905, except a load application rate of 0.381 mm (0.015 in.) per minute is used. Test requirements are described in 10.1.1.3.

14.8 *Mold Resistance, Test Method D905 Shear Strength and Test Method C297/C297M Tensile Strength:*

14.8.1 *Exception*—Mold testing is not required when the manufacturer submits an affidavit that states the test adhesive's formulation cannot support mold growth and does not use amylaceous or protein fillers and extenders.

14.8.2 Prepare a thin mixture of water and food-grade, acid-precipitated, 80- to 90-mesh casein, with a minimum protein content of 82 %. It is mixed at a case-into-water ratio

of 1:5 by weight. Allow to stand for 1 h at 22 to 27°C (72 to 81°F). Prepare a mold inoculum by soaking three sheets or more of sapwood veneers, approximately 929 cm^2 (1 ft^2) each, for 1 h in the casein suspension. Before moving the veneers, stir the casein suspension to ensure trapping a thin layer of the casein on the surface of the veneers as they are removed.

14.8.3 Store the wet sheets, properly spaced for free circulation of air, in a loosely covered chamber for seven days or until their surfaces are covered with a thick growth of mold, whichever is the shorter period. The chamber shall be a suitable size glass, metal, or fiber drum with a polyethylene liner equipped with a loosely fitting cover or a metal chamber with a suitable door. The chamber shall be capable of maintaining an inside temperature of 22 to 27°C (72 to 81°F) and of providing essentially a saturated vapor condition at these temperatures. The chamber shall be equipped with racks or wire trays to support the specimens and allow good air circulation over the specimens.

14.8.4 Scrape the mold spores from the three sheets of veneer into 1500 mL of tap water at 22.2 to 26.7°C (72 to 80°F) and stir to ensure uniform distribution in the water. Immerse the test specimens in this suspension of mold spores for 30 to 60 s. Remove and space loosely on racks or wire trays and place the racks or trays in the chamber with the cover or the door closed. Maintain the chamber at 22 to 27°C (72 to 81°F) for eight weeks. Check the specimens at intervals during exposure to be certain that they are always covered with an active mold growth. After mold exposure, the specimens are tested in accordance with Test Methods D905 and C297/C297M. Test requirements for shear and tensile strength after mold exposure are found in 10.1.1.4 and 10.1.2.4 respectively.

14.9 *Creep Resistance*—Prepare bonded Douglas-fir creep specimens and test in accordance with Test Method D2294.

14.9.1 Five (5) creep test specimens are tested for each of four test sets consisting of: Controls, Elevated Temperature, Practices D1183 Test Condition "C," and soak/re-dry.

14.9.2 Prepare the Douglas-fir to Douglas-fir creep specimens by bonding together with the test adhesive. The assembly is made with a pair of 25 mm wide by 152 mm long by 3.2 mm (1 in. wide by 6 in. long by ⅛ in.) thick strips of Douglas-fir.

NOTE 6—Thicker Douglas-fir strips and modified connection details may be used to reduce eccentric loading and to improve the alignment between bonded plane and creep test fixture.

14.9.3 After construction, cure specimens in standard conditions for seven days before testing. The creep load is applied for 7 days, except for the controls which are tested for 30 days.

14.9.4 Before loading, use a box cutter blade to scribe continuous marks across the bond line and into both Douglas-fir sections. Make two scribes at one-third points along the bond-line length on each longitudinal side.

14.9.5 Prepare all test specimens using the application rate recommended by the adhesive manufacturer.

14.9.6 The minimum creep load is 344 kPa (50 psi).

14.9.7 Test a control set of 5 specimens in uncontrolled temperature and humidity of a total of 30 days.

14.9.8 Test a set of 5 specimens while subjected to seven days in an oven operating at an elevated temperature of 70 ± 3°C (158 ± 5°F) and uncontrolled humidity. See Table 3.

NOTE 7—Conduct pre-test verification that the creep load apparatus spring stiffness will remain constant while in high temperature oven.

14.9.9 Test a set of 5 specimens after subjected to Practices D1183 Procedure "C" at uncontrolled temperature and relative humidity. See Table 3.

14.9.10 Test a set of 5 specimens after subjected to soak/re-dry accelerated aging procedure at uncontrolled temperature and relative humidity. See Table 3.

14.9.11 With the test load applied, measure the creep movement by comparing the relative positions of scribe lines across the bonded area using a graduated field view microscope capable of measuring an accuracy of 0.0025 cm (0.001 in.).

15. OSB-to-Core-to-OSB Assemblies

15.1 *Shear Strength*—Test in accordance Test Method C273/C273M using the tensile loading mode.

15.1.1 The test specimen dimensions shall be approximately 48 mm thick by 51 mm wide by 61 mm long (1⅞ in. thick by 2 in. wide by 24 in. long).

15.1.2 Condition the test specimens at standard conditions for seven days before testing.

15.1.3 The test loading is to be applied at a test machine head displacement rate of 0.50 mm/min. (0..20 in./min.).

15.2 *Tensile (Flat wise) Bond Strength*—Test in accordance with a Test Method C297/C297M procedure.

15.2.1 The test specimen dimensions shall be 48 mm high by 51 mm wide by 51 mm deep (1⅞ in. high by 2 in. wide by 2 in. deep).

15.2.2 Condition the test specimens at standard conditions for seven days before testing.

15.2.3 The test loading is to be applied at a test machine head displacement rate of 0.50 mm/min. (0.020 in./min).

16. Report

16.1 The report shall include:

16.1.1 Identification of the adhesive, see 8.1;

16.1.2 Adhesive limiting conditions, see 8.3;

16.1.3 Application and bonding conditions used for the specimens;

16.1.4 OSB manufacturer and mill number;

16.1.5 EPS manufacturer and type;

16.1.6 Douglas-fir preparation and conditioning including specific gravity and moisture content at time of bonding;

16.1.7 Temperature and RH at time of bonding;

16.1.8 Number of specimens tested;

16.1.9 Maximum and minimum values obtained and include the standard deviation or all individual test values, or both, in the report at the option of either the purchaser or the manufacturer of the adhesive; and

16.1.10 Average value for each test and average percentage wood failure for shear and tensile strength.

17. Keywords

17.1 building component; construction materials; engineered wood; lamination; structural insulated panel

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