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Standard Practice for Establishing Design Capacities for Oriented Strand Board (OSB) Wood-Based Structural-Use Panels[1]

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INTRODUCTION

Oriented strand board (OSB) wood-based structural-use panels have been used in a variety of applications since the 1970s. OSB panels manufactured for use in North America generally comply with U.S. Department of Commerce Standard PS 2. Panels that comply with PS 2 are subjected to various kinds of qualification performance testing and ongoing quality assurance testing. While many panel applications are specified simply on the basis of meeting a given "span rating" as defined in PS 2, some construction and specialty applications may require a complete set of engineering design values. Based on the structural tests required by PS 2 (flexure), along with data for other properties, a set of baseline capacities has been available since 1988. As is customary for structural-use panels, design values will be discussed in this practice in terms of design capacities rather than design properties, where the difference is that a design property is expressed in units of stress (that is, pounds-per-square inch (newtons-per-square millimeter) and a design capacity is expressed in the engineering units of strength (that is, inch-pounds (newton-millimeters) of bending strength capacity, pounds (newtons) of tensile capacity, and so forth). The term "design values" will be used generically and can apply to either properties or capacities.

As uses for OSB wood-based structural-use panels extend into new applications, it becomes increasingly important that manufacturers, qualified agencies, and regulatory bodies reference a set of common, consensus-based procedures for establishment of design values. The purpose of this practice is to provide these common procedures.

1. Scope

1.1 This practice covers the basis for code recognition of design capacities for OSB structural-use panels. Procedures are provided to establish or re-evaluate design capacities for OSB structural-use panels in flatwise and axial applications. Design capacities for OSB structural-use panels in edgewise applications, such as rim board, are outside the scope of this standard. Procedures for sampling and testing are also provided. Design values stated as capacity per unit dimension are to be regarded as standard. Design capacities developed in accordance with this practice are applicable to panels intended for use in dry in-service conditions.

NOTE 1—This practice is based on ICC-ES Acceptance Criteria AC-182. Relative to the scope of AC-182, this practice is limited to OSB panels.

NOTE 2—While this practice makes reference to PS 2, this practice applies similarly to products certified to other standards such as CAN/CSA O325.

NOTE 3—OSB produced under PS 2 is rated with the "Exposure 1" bond classification. Exposure 1 panels covered by PS 2 are intended for dry use applications where the in-service equilibrium moisture content conditions are expected to be less than 16 %. Exposure 1 panels are intended to resist the effects of moisture due to construction delays, or other conditions of similar severity. Guidelines on use of OSB are available from manufacturers and qualified agencies.

NOTE 4—PS 2-10 replaced the use of nominal thicknesses with a classification term known as Performance Category, which is defined in PS 2 as "A panel designation related to the panel thickness range that is linked to the nominal panel thickness designations used in the International Building Code (IBC) and International Residential Code (IRC)." Therefore, the PS 2 Performance Category should be considered equivalent to the term "nominal thickness" used within this standard.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

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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]

D9 Terminology Relating to Wood and Wood-Based Products

D143 Test Methods for Small Clear Specimens of Timber

D1037 Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

D1761 Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials

D2718 Test Methods for Structural Panels in Planar Shear (Rolling Shear)

D2719 Test Methods for Wood Structural Panels in Shear Through-the-Thickness

D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products

D3043 Test Methods for Structural Panels in Flexure

D3500 Test Methods for Wood Structural Panels in Tension

D3501 Test Methods for Wood-Based Structural Panels in Compression

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

D4933 Guide for Moisture Conditioning of Wood and Wood-Based Materials

D5456 Specification for Evaluation of Structural Composite Lumber Products

D5457 Specification for Computing Reference Resistance of Wood-Based Materials and Structural Connections for Load and Resistance Factor Design

D5764 Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products

D6815 Specification for Evaluation of Duration of Load and Creep Effects of Wood and Wood-Based Products

D7672 Specification for Evaluating Structural Capacities of Rim Board Products and Assemblies

2.2 *Other Documents:*

ASD/LRFD Manual for Engineered Wood Construction[3]

CAN/CSA O325 Construction Sheathing[4]

CSA O86 Engineering Design in Wood[4]

ICC Evaluation Service Acceptance Criteria AC-182 Acceptance Criteria for Wood-Based Structural-Use Panels[5]

NDS ANSI/AWC National Design Specification for Wood Construction[3]

PS 2 Performance Standard for Wood Structural Panels, U.S. Department of Commerce Voluntary Product Standard [6]

3. Terminology

3.1 *Definitions*—For definitions of terms related to wood, refer to Terminology D9.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *baseline capacities, n*—capacities developed for OSB panels intended for use in applications that are not governed by building codes. As distinct from PS 2 and proprietary panels, documentation of baseline capacities is on the basis of test reports rather than evaluation reports or code reference. Example applications include, but are not limited to, concrete form and industrial panels.

3.2.2 *characteristic value, n*—a population mean, confidence interval, or tolerance limit estimated from the test data. The characteristic value is an intermediate value in the development of design values.

3.2.3 *design capacity, n*—a value that is a function of material design property and design section property.

3.2.4 *design property, n*—the stress-based design value derived by dividing design capacity by the design section property.

3.2.5 *oriented strand board (OSB), n*—a mat-formed panel product with oriented layers resulting in directional properties. 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 axes, which typically correspond to the manufacturing machine and cross-machine directions, respectively. The primary direction is often referred to as the strength direction.

3.2.6 *primary axis, n*—the primary axis typically corresponds to the manufacturing machine direction and exhibits higher mechanical properties relative to the secondary axis. The primary axis typically corresponds to the eight-foot dimension of four-foot by eight-foot OSB.

3.2.7 *proprietary panels, n*—refers to OSB structural-use panels having proprietary design capacities as provided in an evaluation report issued by a code evaluation service.

3.2.8 *PS 2 panels, n*—refers to panels manufactured in accordance with PS 2.

NOTE 5—Design values for OSB certified to CAN/CSA O325 are published in CSA O86 Engineering Design in Wood. See CSA 086 for specific applications of OSB design values.

3.2.9 *secondary axis, n*—the secondary axis typically corresponds to the manufacturing cross-machine direction and exhibits lower mechanical properties relative to the primary axis. The secondary axis typically corresponds to the four-foot dimension of four-foot by eight-foot OSB.

3.2.10 *test cell, n*—the combined test data for a single span rating/property that is intended to characterize that sampling unit.

[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 American Wood Council (AWC), 222 Catoctin Circle SE, Suite 201, Leesburg, VA 20175, https://www.awc.org.

[4] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON Canada M9W1R3.

[5] Available from ICC Evaluation Service, 3060 Satum St. Suite 100, Brea, CA 92821.

[6] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

3.2.11 *tolerance limit, n*—in this standard, a one-sided tolerance limit is a value about which it may be stated with 75 % confidence that a proportion (that is, 90 %, 50 %, and so forth) of the population has values greater than this tolerance limit.

4. Significance and Use

4.1 The procedures described in this practice are intended to be used to establish design capacity (both strength and stiffness) values based on testing of OSB that, at a minimum, satisfies the relevant performance requirements of PS 2.

4.2 Review and reassessment of values derived from this practice shall be conducted on a periodic basis. If a change is found to be significant, retesting or reevaluation, or both, in accordance with the procedures of this practice shall be considered.

5. Minimum Sampling Matrix and Frequency

5.1 Development of design capacities under this practice may be for either a single span rating or a full matrix of span ratings as defined in PS 2.

5.2 Panels sampled for testing shall be representative of the population for which design capacities are desired. Panel sampling and grouping procedures shall comply with Annex A1.2 of Specification D5457.

5.3 Each product (span rating, grade, nominal thickness) represents a unique product designation. Grouping within product designations shall comply with Annex A1.2 of Specification D5457.

NOTE 6—Data should be reviewed periodically. Inclusion of data beyond the review period should be supplemented by proof that it represents more recent production.

5.4 *Sampling Matrix for Design Capacities*—For the purpose of developing design capacities, the minimum sampling matrix shall include every thickness and span rating for which a design value will be claimed. Alternatively, when supported by a documented model, characteristic values for untested cells are permitted to be established by analytical methods. For each manufacturing facility and product for which design capacities are desired, the minimum number of test replications shall be 30, with the exception of bending stiffness and bending strength capacity, for which the minimum number of test replications shall be 60. A quality assurance program monitored by a qualified agency shall provide verification of continuing compliance with claimed design values.

6. Testing Requirements

6.1 *Bending Stiffness (EI, lbf-in.^{2}/ft)*—Bending stiffness shall be determined in accordance with Test Methods D3043, Method C—Pure Moment Test. Test panel thickness shall be recorded. Flexural stiffness shall be determined in the primary and secondary panel directions and shall be reported on a per foot of width basis. The applicable moment arm shall be the load bar spacing between points of contact with the test panel.

6.2 *Bending Strength Capacity (F_bS, lbf-in./ft)*—Bending strength capacity shall be determined in accordance with Test Methods D3043, Method C—Pure Moment Test. Bending strength capacity shall be determined for the same panel specimens evaluated under 6.1. Bending strength capacity shall be determined in the primary and secondary panel directions and shall be reported on a per foot of panel width basis. Test panel thickness shall be recorded. The applicable moment arm shall be the load bar spacing between points of contact with the test panel.

6.3 *Strength Capacity in Planar Shear ($F_s(Ib/Q)$, lbf/ft)*—Planar shear strength capacity shall be determined in accordance with Test Methods D2718. Test specimen thickness shall be recorded. Planar shear strength capacities along the primary and secondary axes shall be determined and shall be reported on a per foot of panel width basis.

NOTE 7—Test Methods D2718 includes the use of a five-point bending test as an approved method.

6.4 *Strength Capacity in Shear Through-the-Thickness (F_vt_v, lbf/in.)*—Shear through-the-thickness shall be determined in accordance with Test Methods D2719, Method B or Method C. Test panel thickness shall be recorded. Shear through-the-thickness shall be determined along the primary and secondary axes and shall be reported on the basis of pound-force per inch of shear-resisting panel length.

6.5 *Shear Rigidity Through-the-Thickness (G_vt_v, lbf/in.)*—Shear rigidity through-the-thickness shall be determined in accordance with Test Methods D2719, Method B or Method C. Test panel thickness shall be recorded. Shear rigidity through-the-thickness shall be determined along the primary and secondary axes and shall be reported in units of pound-force per inch of panel depth.

6.6 *Axial Stiffness (in tension and compression, EA, lbf/ft)*—Axial tension and compression stiffness shall be determined in accordance with Test Methods D3500, Method B—Tensile Strength of Large Specimens, and Test Methods D3501, Method B—Compression Test for Large Specimens, respectively. Test panel thickness shall be recorded. Axial stiffness shall be determined along the primary and secondary axes and shall be reported on a per foot of panel width basis. Specimen dimensions shall be recorded.

6.7 *Axial Strength (in tension and compression, F_cA, F_tA, lbf/ft)*—Axial tension and compression strength shall be determined in accordance with Test Methods D3500, Method B—Tensile Strength of Large Specimens, and Test Methods D3501, Method B—Compression Test for Large Specimens, respectively. Test panel thickness shall be recorded. Axial strength shall be determined along the primary and secondary axes and shall be reported on a per foot of panel width basis. Specimen dimensions shall be recorded.

6.8 *Fastener Withdrawal Resistance*—Fastener withdrawal resistance tests shall be conducted in accordance with Test Methods D1761, except that 8d common wire (bright, plain-shank medium diamond-point steel nail with a nominal shank diameter of 0.131 in. (3.33 mm), a nominal length of 2.5 in. (63.5 mm), and a head diameter of 0.281 in. (7.14 mm)) nails shall be used. Specimen thickness and density shall be recorded. Results shall be reported as tested and as normalized to a per inch of thickness basis for determination or equivalent specific gravity in accordance with A1.5 of Annex A1. Fastener specifications shall be recorded and shall include actual diameter.

6.9 *Lateral Fastener Resistance*—The equivalent specific gravity of the OSB shall be determined on the basis of dowel-bearing performance in accordance with Annex A2 of Annex A1 except that the test fasteners shall include 8d and 10d common wire nails as defined in Specification D5456, Annex A2. Lateral fastener capacity shall be determined along the primary and secondary axes. Specimen thickness and density shall be recorded.

6.10 *Nail-Head Pull-Through Resistance*—To measure the resistance of a panel to having the head of a nail or other fastener pulled through the board, nail-head pull-through tests shall be conducted in accordance with Test Methods D1037, except that 8d common wire nails with a nominal head diameter of 0.281 in. (7.14 mm) shall be used. Specimen thickness and density shall be recorded. Fastener specifications shall be recorded and shall include actual shank diameter and actual nail head diameter. Results shall be reported as-tested.

6.11 *Compression Perpendicular to Grain (Bearing) (F_{cp}, psi)*—Compression perpendicular tests shall be conducted in accordance with principles of Test Methods D143, except that references to placement of growth rings are not applicable. Specimen dimensions shall be 1.5 in. (38.1 mm) (minimum) by 6 in. (152 mm) by panel thickness with the primary panel direction parallel to the specimen length direction. The compressive load shall be applied perpendicular to the surface of the specimen through a 2 in. (50.8 mm) wide bearing plate aligned across the width of the specimen. Stress at 0.04 in. (1.02 mm) deformation shall be determined. Specimen dimensions and density shall be recorded.

6.12 *Alternative Compression Perpendicular to Grain (Bearing) (F_{cp}, psi)*—Alternative to 6.11, F_{cp} shall be permitted to be determined from compression perpendicular tests conducted in accordance with 6.11 with the exception that the specimens shall be brought to moisture equilibrium in a conditioned environment of 68 °F ± 11 °F (20 °C ± 6 °C) and 65 % ± 5 % relative humidity before testing. Methods for determination of completion of conditioning are given in Guide D4933. In addition, stress at 0.04 in. (1.02 mm) deformation and proportional limit, as specified in 6.12.1, shall be determined. Specimen dimensions and density shall be recorded.

6.12.1 *Proportional Limit Stress*—The proportional limit stress shall be calculated from the proportional limit load defined as the load at which the load-deformation curve deviates from a linear regression fitted to the approximately linear portion of the load-deformation curve.

$$\sigma_{PL} = \frac{P_{PL}}{l_p\, b} \tag{1}$$

where:

σ_{PL} = proportional limit stress,
P_{PL} = proportional limit load,
l_p = measured length of bearing plate parallel to specimen length, and
b = measured width of specimen.

NOTE 8—The proportional limit stress can also be determined from a stress-strain curve derived from the load-deformation curve. This methodology is consistent with Specification D5456.

7. Determination of Design Capacities

7.1 *Allowable Stress Design (ASD)*—Design capacities for allowable stress design shall be determined in accordance with ASD/LRFD procedures established in this practice or through soft conversion from reliability-based design capacities developed in accordance with Specification D5457 (7.2 of this practice and 4.2 of Specification D5457) except that the lower-tail fit per A1.2.2.2 of Specification D5457 shall not be permitted.

7.1.1 *Characteristic Values*—Characteristic values shall be determined by parametric or non-parametric procedures, or both, as specified in Practice D2915. Characteristic values for strength capacities shall be the parametric and non-parametric values, except that the characteristic value for fastener withdrawal, lateral fastener resistance, and head pull-through shall be the average of the test results determined by 6.8, 6.9, and 6.10, respectively.

7.1.2 *Parametric Characteristic Values*—The procedures of Sections 4 and 5 of Practice D2915 shall be followed except that provisions of this practice govern where differences occur.

7.1.2.1 The lower 5 % tolerance limit with 75 % confidence shall be the characteristic value for strength capacities. When grouping results from multiple producing units, the characteristic value shall be determined for the grouped data as well as for each unit represented in the grouped dataset. The characteristic value of the group shall be the lesser of the characteristic value of the grouped data and 1.05 times the characteristic value of the lowest unit in the group.

7.1.2.2 The characteristic value for stiffness properties (such as EI, EA, G_vT_v), bearing (F_{cp}) from 6.11, and fastener properties shall be the average of the test results determined in accordance with this practice. The characteristic value for bearing (F_{cp}), as determined from 6.12, shall be the lower value of the average stress at 0.04 in. (1.02 mm) deformation and the average stress at proportional limit. When grouping results from multiple producing units, the characteristic value shall be the lesser of the grouped mean and 1.1 times the mean of the lowest unit in the group.

7.1.3 *Non-Parametric Characteristic Values*—The nonparametric characteristic value for strength capacities shall be the fifth percentile tolerance limit with 75 % confidence.

7.2 *Load and Resistance Factor Design (LRFD)*—Design capacities for LRFD shall be determined in accordance with reliability-based provisions of Specification D5457. Reliability indices established for each strength limit state shall be presented with corresponding design capacities. Design capacities for ASD can be developed through soft conversion of reliability-based LRFD design strength capacities. See 7.1.

7.3 *Design Capacities*—Design capacities shall be determined by dividing the characteristic values from 7.1 or 7.2 by the corresponding adjustment factors provided in Table 1. The applicable moisture content from which the design values are derived shall be reported. If ASD design capacities are derived through soft conversion from LRFD design capacities in

TABLE 1 Design Capacity Adjustment Factors

Capacity	Adjustment Factor
Bending stiffness	1.00
Bending strength	2.10
Planar shear strength	2.10
Shear strength through-the-thickness	2.10
Shear rigidity through-the-thickness	1.00
Axial stiffness (compression and tension)	1.00
Axial strength (compression and tension)	2.10
Fastener withdrawal resistance	5.00
Lateral fastener resistance	1.00
Nail-head pull-through resistance	5.00
Compression perpendicular to grain (bearing) from 6.11	1.67
Compression perpendicular to grain (bearing) from 6.12	1.00

accordance with 7.2, the adjustment factors provided in Table 1 shall be used in the soft conversion process. Appendix X1 provides examples of design capacity derivation.

7.3.1 The allowable compression perpendicular to grain (bearing) determined from 6.11 or 6.12 shall be limited to 360 psi for bearing along an edge of a panel, such as where a panel edge is supported on a rim board.

NOTE 9—The 360 psi limitation specified in 7.3.1 is consistent with the allowable compression perpendicular to grain (bearing) value for OSB floor sheathing used in the determination of rim board uniform vertical load capacities in accordance with Specification D7672.

7.4 *Design Section Properties*—Design capacities determined in 7.3 shall be normalized as necessary to compensate for adjustment of section properties of test material to published design section properties. Normalization of design capacities shall be conservative and normalization shall be applied within specific product designations. If the average thickness of the sample (average thickness of all test specimens in the sample) is 98 % of the design thickness or greater, design capacities shall be normalized on the basis of the design thickness. If the average thickness of the sample is less than 98 % of the design thickness, design capacities shall be used as tested without normalization. When grouping results from multiple producing units (see 7.1.2.1 and 7.1.2.2), normalization of design capacities is not required when the lower 90 % confidence bound on the mean thickness is less than or equal to the design thickness. Appendix X2 provides examples of normalization of design capacities.

7.5 *Test Conditions:*

7.5.1 OSB specimens shall be tested at the mill or in an outside laboratory. For specimens tested at the mill, a minimum cure time of 24 h is required prior to qualification testing. If quality assurance testing conducted with a shorter cure time is to be correlated to qualification testing, correlation factors shall be generated and reported.

NOTE 10—If a standardization moisture condition is desired, the test specimens may be equilibrated to constant mass at 65 % ± 5 % relative humidity and 68 °F ± 11 °F (20 °C ± 6 °C).

7.5.2 Report ambient temperature at time of test. Report moisture content of specimens at time of test.

NOTE 11—The reference range of moisture contents for OSB structural-use panels at time of test is typically 2 % to 7 %. For quality assurance testing at the mill, approximate moisture content may be estimated based on prior experience. For specimens tested at an outside laboratory, approximate moisture content shall be estimated based on testing representative specimens in accordance with Test Methods D4442.

7.5.3 Test data from panels tested at the mill prior to exposure to the weather need no adjustment.

7.6 The design capacities determined in accordance with this practice are applicable to dry service conditions as traditionally used for wood structural products.

NOTE 12—Test programs to develop adjustments to design capacities for moisture conditions in which the equilibrium moisture content is 16 % or higher are available in publications cited in the References. (1-5)

NOTE 13—Adjustments to strength and stiffness capacities for higher in-service moisture conditions do not account for any potential biological degradation at high moisture conditions. The user is advised to follow code requirements and industry recommendations or to use only preservatively treated or naturally durable wood products in applications potentially subject to biological degradation.

7.7 The design capacities determined in accordance with this practice are applicable to "normal duration of load" as traditionally used for wood structural products. Adjustments to other durations are permitted in accordance with the duration of load factors in the National Design Specification for Wood Construction (NDS).

NOTE 14—Duration of load factors traditionally used for wood structural products have been evaluated for use with wood-based structural-use panel products as reported in Laufenberg, et al.(6) Specification D6815 provides methodology to be used to evaluate duration of load performance of OSB.

8. Quality Assurance

8.1 *Quality Control*—The wood-based structural-use panel products shall be produced under a quality assurance program administered by a qualified agency. An approved quality assurance manual shall be developed in collaboration with the qualified agency and complying with applicable criteria of model building code evaluation services. The quality assurance manual shall specify quality assurance testing and process control requirements in accordance with 8.2 and 8.3 of this practice.

8.2 *Quality Assurance Testing:*

8.2.1 Test equipment shall be properly maintained, calibrated, and evaluated for accuracy and adequacy at a frequency satisfactory to the qualified agency.

8.2.2 Test frequency shall be chosen to yield quality assurance performance that is consistent with design capacities and design section properties assigned to the product and its intended use.

8.3 *Process Control:*

8.3.1 Data from tests outlined in 8.2 shall be evaluated prior to shipment of the material represented by the sample. Analytical procedures shall determine if product capacities are in statistical control. The control levels selected shall be consistent with current design capacities and design section properties.

8.3.2 When the analysis described in 8.3.1 indicates that the product is below the control level, the associated portion of production shall be subject to re-examination in accordance