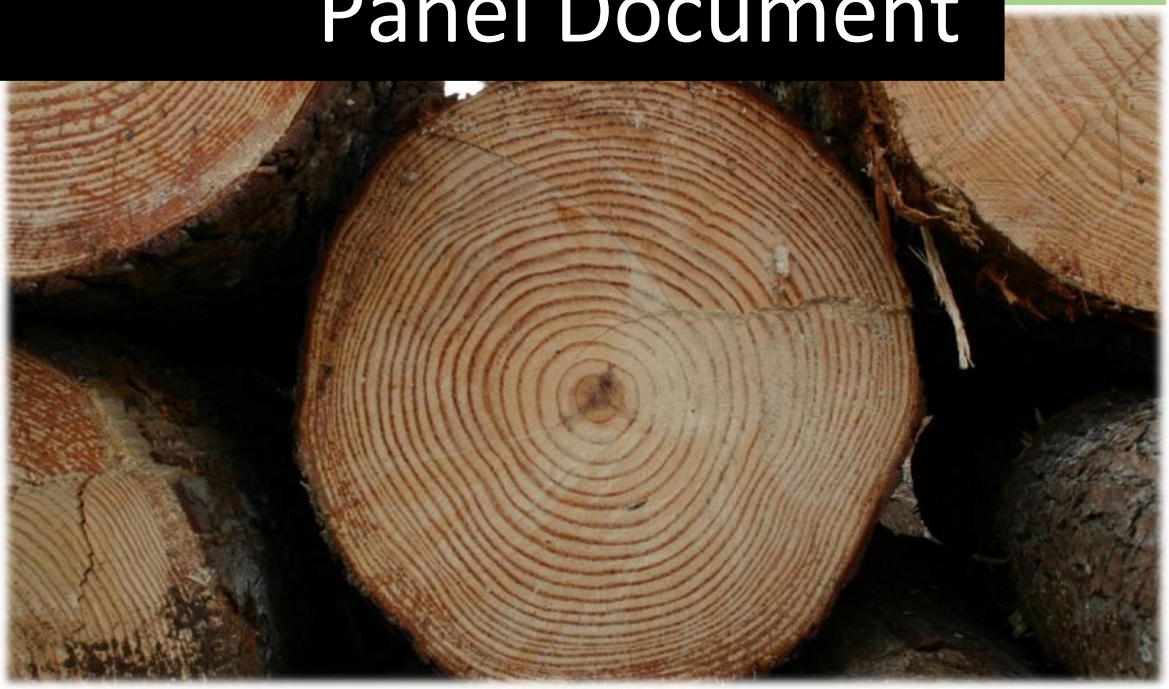
2017

Timber Products Inspection, Inc. Panel Document



Timber Products Inspection, Inc.

10/1/2017

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QUAL-STND-2-Rev2017 - TP Panel Document

October 1, 2017

1.0 Table of Contents

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2.0 Introduction

Timber Products Inspection, Inc. (TP) recognizes that as building codes evolve, the importance of quality monitoring systems grows. Building component manufacturers are continuously facing new regulations from design professionals, government officials, and others. TP programs are recognized by ANSI, IAS, MAFF, and ALSC.

Panels certified by an accredited agency are equivalent and interchangeable with panels of the same grade and thickness and certified to the same standard by other accredited agencies. When specifying panels for use in floor, wall, and roof applications, it is suggested to specify panels by grade or span ratings in accordance with the Voluntary Product Standards PS 1 and PS 2.

Panels audited by the TP® certification mark are interchangeable with panels marked by other certification agencies. Copies of TP accreditation certificates as a recognized Inspection Agency and Testing Laboratory can be downloaded from the TP website (www.tpinspection.com).

3.0 Scope

This document presents the recommended design and application for structural wood panels in accordance with the PS 1, PS 2, IBC, IRC, and NDS. This document may be used as a general guide. Structural analysis should be conducted by a registered design professional.

4.0 References

- *ASD/LRFD National Design Specification 2015 Edition (NDS 2015)*
- *2015 International Building Code (IBC 2015)*
- *Voluntary Product Standard Structural Plywood (PS 1)*
- *Voluntary Product Standard Performance Standard for Wood-Based Structural-Use Panels (PS 2)*

5.0 Wood Structural Panels

Plywood, oriented strand board (OSB), and composite panels are collectively referred to as “wood structural panels”. Because of relatively high load capacities and ease of installation, wood structural panels are widely accepted and top choice for use in roof, floor, wall sheathing, shear wall, and diaphragm applications. Wood structural panels when used structurally shall conform to the requirements for their type in PS 1 or PS 2. Each panel shall be identified for grade, bond classification,

and Performance Category by the trademarks of an approved testing and grading agency—such as TP. Wood structural panels when permanently exposed in outdoor applications shall be of Exterior type, except that wood structural panel for roof sheathing exposed to the outdoors on the underside is permitted to be Exposure 1 type.

5.1 Plywood

Plywood is a wood structural panel built up of sheets of veneer called plies, which are united under pressure by a bonding agent to create a panel with an adhesive bond between plies as strong as or stronger than, the wood. Plywood is constructed of an odd number of layers with grain of adjacent layers perpendicular. Layers consist of a single ply or two or more plies laminated with parallel grain direction. Outer layers and all odd-numbered layers generally have the grain direction oriented parallel to the long dimension of the panel. The layers with alternating grain direction equalize strains, reduce splitting, and minimize dimensional change and warping of the panel.

5.2 Oriented Strand Board (OSB)

Oriented strand board (OSB) refers to a mat-formed wood structural panel comprised of thin rectangular wood strands arranged in cross-aligned layers with the surface layers orthogonally arranged in the long panel direction and bonded with waterproof adhesive. OSB was first produced in the early 1980s and is considered to be interchangeable with plywood in most applications.

6.0 Panel Standards

6.1 Voluntary Product Standard (PS 1)

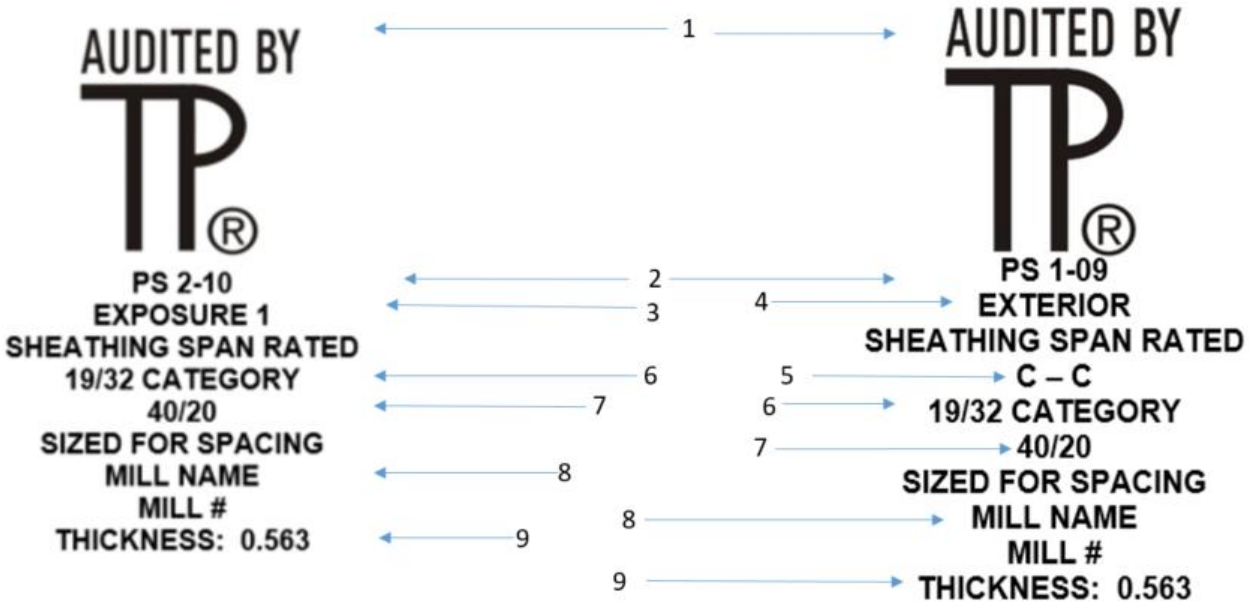
Voluntary Product Standard PS 1 covers the manufacture of plywood for construction and industrial uses from some 70 wood species. The Standard establishes the requirements for the principal types and grades of structural plywood and provides a basis for common understanding among producers, distributors, and end users of the product. PS 1 covers the wood species, veneer grading, adhesive bonds, panel construction and workmanship, dimensions and tolerances, marking, moisture content and packaging of structural plywood intended for construction and industrial uses. PS 1 also covers procedures for qualifying other wood species not listed in the PS 1 through performance rated testing. Quality certification program is provided whereby qualified testing agencies inspect, sample, and test products identified as complying with PS 1.

6.2 Voluntary Product Standard (PS 2)

Voluntary Product Standard PS 2 covers the performance requirements, adhesive bond performance, panel construction, required dimensional tolerances, moisture content, and quality marking requirements of wood-based structural-use panels. PS 2 covers structural-use panels which include structural plywood, OSB, other mat-formed panels, and composite panels. Quality certification program is provided whereby qualified testing agencies inspect, sample, and test products identified as complying with PS 2.

7.0 TP Gradestamp

Key attributes that determine the proper identification of wood structural panels in accordance with industry standards are identified in the following TP gradestamp. Wood structural panels certified as PS 1 or PS 2 shall always include the certification agency, the standard, glue bond durability, bond classification, panel grade, Performance Category, span rating, and any supplemental application specifications of the manufacturer.



1 Third party certification agency
2 Product standard
3 Glue bond durability; D veneer is used in the construction
4 Glue bond durability; C grade is the minimum veneer in the construction
5 C grade face and C grade back. Inner plies are C grade or better
6 Performance Category
7 Span Rating
8 Mill name and mill number
9 Decimal thickness designation

8.0 Panel Selection and Classification

Wood structural panels are classified by bond classification, grade, span rating, and performance category.

8.1 Bond classification

Wood structural panels are classified as either Exposure 1 or Exterior, which is a function of veneer grade and adhesive performance to the moisture resistance under the intended end-use.

8.2 Exposure 1

Panels classified as Exposure 1 are suitable for uses not permanently exposed to the weather but are intended to resist the effects of moisture on structural performance that may occur due to construction delays or other conditions of similar severity. Panels classified as Exposure 1 should be protected from exposure to weather until application.

Exposure 1 - Plywood

The minimum veneer grade in an Exposure 1 classification is D grade for plywood.

Average percentage (%) of wood failure for plywood: 80% wood failure or greater shall be considered as Exposure 1 adhesive bond requirements. PS 1 requires at least 20 panels to be sampled. In addition, when at least 10 panels are tested, 90% of the individual panels tested must have at least 60% wood failure or better. When at least 20 panels are tested, 95% of the individual panels must have at least 30% wood failure or better. When 10 or less panels are tested, all individual panels tested must have at least 60% wood failure or better.

Some examples of Exposure 1 plywood are the following but not limited to: Un-sanded panels, Sheathing Span Rated (DD), CD Sheathing Span Rated, Touch-Sanded panels—Single Floor Span and C-D Plugged.

Exposure 1 - Composite Panels

Composite panels rated as Exposure 1 shall be evaluated based on the test method and sampling as described in PS 2. Per PS 2, one sample from each of at least 20 panels shall be tested and evaluated for delamination following the fourth and sixth moisture cycles. Bond performance requirements are considered satisfied if at least 95% of the samples shall pass four moisture cycles, and 90% of the samples shall pass six moisture cycles. Additional test set is permitted if more than 85% but fewer than 90% of the samples pass delamination requirements.

Exposure 1 - OSB

OSB panels rated as Exposure 1 shall be evaluated based on the bending capacity requirement criteria in Table 7 of PS 2 when tested in accordance with the small static bending test for OSB (PS 2 Section 7.6) following the moisture cycling (PS 2 Section 7.16). One sample from each of at least 20 panels shall be tested, and if no more than one of the samples is below the minimum requirement per Table 7, the 20-panel test is considered passing. Four or more samples that fall below the minimum requirement is considered failing for the 20-panel test. If two or three of samples are below the minimum requirement, an additional test of 20 more samples from the same lot is permitted. Combined pass rate of the 40-panel test shall be no less than 92.5%.

Exposure 1 - Mat-Formed Panels

Mat-formed panels and other wood-based material for composite panels rated as Exposure 1 shall meet the minimum average strength retention of 50% with no individual panel of retained strength less than 40%. One sample from each of at least 20 panels shall be tested. Bond performance requirements are

considered satisfied if the samples tested meet or exceed the minimum strength retention following six moisture cycles in accordance with PS 2 Section 7.17 and tested in accordance with the small static bending test as described in PS 2 Section 7.7.

8.3 Exterior (Plywood Only)

Panels classified as Exterior are suitable for long-term exposure to weather or other conditions of similar severity. Exterior rated panels are designed for applications subject to permanent exposure to weather or moisture. They are fully waterproof. The minimum permitted veneer in an Exterior classification is C grade.

Average percentage (%) of wood failure: 85% wood failure or greater shall be considered as Exterior adhesive bond requirements. PS 1 requires at least 20 panels to be sampled. In addition, when at least 4 panels are tested, minimum of 75% of the individual panels tested must have at least 80% wood failure or better. When at least 10 panels are tested, 90% of the individual panels must have at least 60% wood failure or better. When at least 20 panels are tested, 95% of the individual panels must have at least 30% wood failure or better. When 4 or less panels are tested, all individual panels tested must have at least 80% wood failure or better.

Some examples of Exterior panels are the following but not limited to: Siding panels, Overlaid panels (HDO and MDO), Un-sanded panels, C-C Sheathing Span Rated, Sanded panels (A-A, A-B, A-C, B-B, and B-C), Touch-sanded panels, C-C Plugged, and Single Floor Span with all C grade or better veneers.

8.4 Group

PS 1 classifies certain wood species into Groups as 1, 2, 3, 4, and 5. Species classified in Group 1 are considered to have the highest strength characteristics. Species classified in Group 5 are considered to have the lowest strength properties. Plywood can be manufactured using different groups in a given panel; however, the species group in the face and back grain plies shall be included in the grade stamp. Typically, the weakest species group make up the inner plies for plywood. PS 1 provides the following table for the classification of species.

PS 1 TABLE 1. CLASSIFICATION OF SPECIES[a][f]

Group 1	Group 2		Group 3	Group 4	Group 5
North American Species – Applicable to trees grown in North America					
Beech, American Birch Sweet Yellow Douglas-fir [b] Larch, Western Maple, Sugar Pine, Southern Loblolly Longleaf Shortleaf Slash Tanoak	Cedar, Port Orford Cypress Douglas-fir [b] Fir Balsam California Red Grand Noble Pacific Silver White Hemlock, Western Maple, Black	Pine Pond Red Virginia Western White Spruce Black Red Sitka Sweetgum Tamarack Yellow Poplar	Alder, Red Birch, Paper Cedar, Alaska Fir, Subalpine Hemlock, Eastern Maple, Bigleaf Pine Jack Lodgepole Ponderosa Spruce Redwood Spruce Engelmann White	Aspen Bigtooth Quaking Cedar Incense Western Red Cottonwood Eastern Black (W. Poplar) Pine Eastern White Sugar	Basswood Poplar, Balsam
Non North American Species					
Apitong[c][d] Kapur[c] Keruing[c][d] Pine Caribbean Ocote	Lauan Almon Bagtikan Mayapis Red Lauan Tangile White Lauan	Mengkulang[c] Meranti, Red[c][e] Mersawa[c]		Cativo	

[a] Table 1 species classified in accordance with ASTM D 2555 as discussed in Appendix A. The species groupings are only valid for species grown in the regions referenced in Appendix A. (See Section 5.2.1.)

[b] Douglas-fir from trees grown in the states of Washington, Oregon, California, Idaho, Montana, Wyoming, and the Canadian Provinces of Alberta and British Columbia shall be classed as Group 1 Douglas-fir. Douglas-fir from trees grown in the states of Nevada, Utah, Colorado, Arizona and New Mexico shall be classed as Group 2 Douglas-fir.

[c] Each of these names represents a trade group of woods consisting of a number of closely related species.

[d] Species from the genus Dipterocarpus marketed collectively: Apitong if originating in the Philippines, Keruing if originating in Malaysia or Indonesia.

[e] Red Meranti shall be limited to species having a specific gravity of 0.41 or more based on green volume and oven dry weight.

[f] Reference: PS 1 09 Table 1. Classification of Species

8.5 Grade

Wood structural panel grade depends on the intended end-use. Each bond classification contains numerous panel grades (N, A, B, C, C-plugged, and D) based on the grade of the veneers and panel construction. Common wood structural panel grades are sheathing, sheathing structural I, and single floor span. Wood structural panels with any wood veneer as a component of the panel construction shall be in accordance with the applicable veneer grade and workmanship requirements of PS 1. PS 1 provides the following tables for Exposure 1 Plywood Grades and Exterior Plywood Grades.

PS 1 TABLE 2. EXPOSURE 1 PLYWOOD GRADES (PERMITS D GRADE VENEER)[d]

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
N-N	N	N	C	Sanded 2 sides
N-A	N	A	C	Sanded 2 sides
N-B	N	B	C	Sanded 2 sides
N-D	N	D	D	Sanded 2 sides
A-A	A	A	D	Sanded 2 sides
A-B	A	B	D	Sanded 2 sides
A-D	A	D	D	Sanded 2 sides
B-B	B	B	D	Sanded 2 sides
B-D	B	D	D	Sanded 2 sides
Underlayment[a]	C Plugged	D	C & D	Touch-sanded
C-D Plugged	C Plugged	D	D	Touch-sanded
Structural I C-D		See 5.6.5		Unsanded[b]
Structural I C-D Plugged, Underlayment		See 5.6.5		Touch-sanded
C-D	C	D	D	Unsanded[b]
D-D[c]	D	D	D	Unsanded[b]

[a] See Section 5.6.3 and Table 5 for special limitations.

[b] See Section 5.8.4 for requirements.

[c] Applicable only to panels qualified through performance testing per Section 5.8.6 (plus Section 6.2.2.3 of PS 2-04) or PS 2-04.

[d] Reference: PS 1-09 Table 2. Exposure 1 Plywood Grades (Permits D Grade Veneer)

PS 1 TABLE 3. EXTERIOR PLYWOOD GRADES[a] (DOES NOT PERMIT D GRADE VENEER)[f]

Panel Grade Designations	Minimum Veneer Quality			Surface
	Face	Back	Inner Plies	
Marine (A-A, A-B, B-B, HDO, MDO)		See 5.6.1		See regular grades
Special Exterior (A-A, A-B, B-B, HDO, MDO)		See 5.6.6		See regular grades
A-A	A	A	C	Sanded 2 sides
A-B	A	B	C	Sanded 2 sides
A-C	A	C	C	Sanded 2 sides
B-B (concrete form)	B	B	C	See 5.6.4
B-C (concrete form)	B	C	C	See 5.6.4
B-B	B	B	C	Sanded 2 sides
B-C	B	C	C	Sanded 2 sides
C-C Plugged[b]	C Plugged	C	C	Touch-sanded
C-C	C	C	C	Unsanded[c]
HDO-Industrial A-A, B-B, B-C			C [d]	
HDO-Concrete Form[e] A-A, B-B, B-C			C	
MDO-General B-B, B-C			C	
MDO-Concrete Form[e] B-B, B-C			C	
Special Overlays	C	C	C	—

[a] Available also in Structural I classification as provided in Section 5.6.5.
[b] See Section 5.6.3 and Table 5 for special limitations.
[c] See Section 5.8.4 for requirements.
[d] C Plugged for HDO-Industrial when intended for sign applications
[e] For more clarification on concrete form grades, see Section 5.6.4.
[f] Reference: PS 1-09 Table 3. Exterior Plywood Grades (Does Not Permit D Grade Veneer)

8.6 Span Rating

Panels for sheathing or single floor applications shall be designed to a span rating. Span ratings may be presented as a fraction for sheathing applications and as a single number for single floor applications. For sheathing applications, the left-hand number represents the recommended maximum center-to-center spacing of supports for roof framing, and the right-hand number represents the recommended maximum center-to-center spacing of supports for floor framing. The following figures provide example sheathing span rating and single floor span rating.

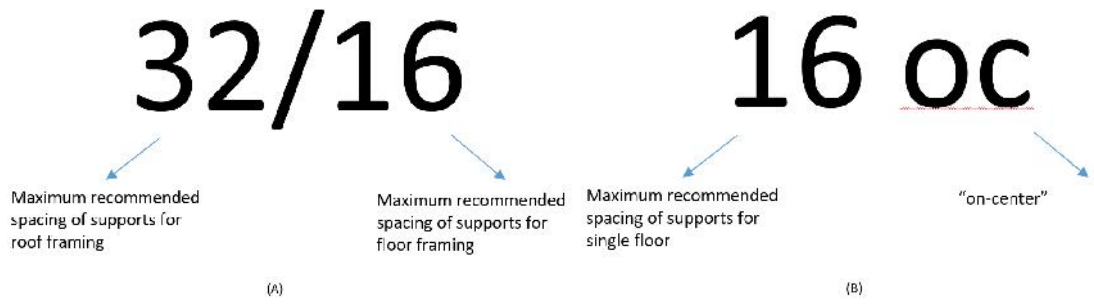


Figure. Example Sheathing Span Rating (A); Example Single Floor Rating (B)

Span rating number is related to the species, thickness of face and back veneers, and Performance Category. PS 1 provides prescriptive specifications for span ratings for sheathing and single floor panels

and is shown in the table below. Performance testing to meet the strength, stiffness, and bond criteria requirements shall be performed by a qualified testing agency.

Actual maximum spans shall be established by local building codes.

The relationship between span rating and nominal thickness is provided in the table below. Reference material for table is 2015 NDS Table C9.2.3 Relationship Between Span Rating and Nominal Thickness.

RELATIONSHIP BETWEEN SPAN RATING AND NOMINAL THICKNESS											
Span Rating	Nominal Thickness (in.)										
	3/8	7/16	15/32	1/2	19/32	5/8	23/32	3/4	7/8	1	1-1/8
Sheathing											
24/0	**P**	A	A	A							
24/16		**P**	A	A							
32/16			**P**	A	A	A					
40/20					**P**	A	A	A			
48/24							**P**	A	A		
Single Floor											
16 oc					**P**	A					
20 oc					**P**	A					
24 oc							**P**	A			
32 oc									**P**	A	
48 oc											**P**

P = Predominant nominal thickness for each span rating.

A = Alternative nominal thickness that may be available for each span rating. Check with suppliers regarding availability.

Source: 2015 NDS Table C9.2.3

8.7 Performance Category

Minimum and maximum thickness requirements for wood structural panels certified in accordance with PS 1 and PS 2 are the same for both standards and provided in the table below.

Panel Thickness Requirements Per PS 1 and PS 2

Performance Category	Thickness Requirement[1]	
	Minimum Thickness, mm (in.)	Maximum Thickness, mm (in.)
1/4	5.56 (0.219)	7.14 (0.281)
5/16	7.14 (0.281)	8.73 (0.344)
11/32	7.94 (0.313)	9.53 (0.375)
3/8	8.73 (0.344)	10.32 (0.406)
7/16	10.32 (0.406)	11.91 (0.469)
15/32	11.11 (0.438)	12.70 (0.500)
1/2	11.91 (0.469)	13.49 (0.531)
9/16	13.49 (0.531)	15.08 (0.594)
19/32	14.29 (0.563)	15.88 (0.625)
5/8	15.08 (0.594)	16.67 (0.656)
23/32	17.46 (0.688)	19.05 (0.750)
3/4	18.26 (0.719)	19.84 (0.781)
13/16	19.84 (0.781)	21.43 (0.844)
7/8	21.11 (0.831)	23.34 (0.919)
1	24.13 (0.950)	26.67 (1.050)
1-1/8	27.15 (1.069)	30.00 (1.181)
1-1/4	30.16 (1.188)	33.34 (1.313)

1. Thickness requirements are based on a tolerance of +/- 0.8mm (1/32 in.) for panels with Performance Categories of 13/16 and less than +/- 5% for panels with Performance Categories greater than 13/16 unless a closer tolerance is determined through qualification testing.

9.0 Panel Construction

Construction of all panels to be certified in accordance with PS 1 or PS 2 shall meet or exceed all applicable requirements set forth in PS 1 and PS 2, respectively.

9.1 Plywood (PS 1 only)

Plywood panels shall conform to the minimum number of plies and layers as set forth in the table below.

PS 1 TABLE 4. PANEL CONSTRUCTIONS (MINIMUM NUMBER OF PLIES AND LAYERS)[a]

Panel Grades	Finished Panel Performance Category Range	Minimum Number of Plies	Minimum Number of Layers
Exterior			
Marine	Through 3/8 Over 3/8 , through 3/4	3	3
Special Exterior (See 5.6.6)	Over 3/4	5	5
B-B Concrete form		7	7
B-C Concrete form			
HDO Industrial A-A, B-B, B-C			
HDO Concrete Form A-A, B-B, B-C			
MDO Concrete Form B-B, B-C			
Exposure 1			
N-N, N-A, N-B, N-D, A-A, A-B, A-D, B-B, B-D			
Structural I (C-D, C-D Plugged and Underlayment)	Through 3/8	3	3
	Over 3/8 , through 1/2	4	3
	Over 1/2 , through 7/8	5	5
	Over 7/8	6	5
Exterior			
A-A, A-B, A-C, B-B, B-C			
Structural I (C-C and C-C Plugged) (See 5.6.5)			
MDO General B-B, B-C			
Special Overlays			
Exposure 1			
Underlayment	Through 1/2	3	3
	Over 1/2 , through 3/4 Over 3/4	4	3
Exterior		5	5
C-C Plugged			
Exposure 1			
C-D	Through 5/8	3	3
C-D Plugged	Over 5/8 , through 3/4	4	3
D-D	Over 3/4	5	5
Exterior			
C-C			

[a] Reference: PS 1-09 Table 4. Panel Constructions (Minimum Number of Plies and Layers)

9.2 OSB

OSB panels shall conform to the minimum and maximum thickness requirements as shown in Section 8.7 of this document. Detailed information is provided in PS 2.

9.3 Veneer Requirements (PS 1 only)

Veneers used in each ply of panel shall conform with the applicable veneer grade as shown in the table from PS 1 below. Requirements of selected end uses, the type and frequency of specific characteristics are also shown in the table.

TABLE 5. CHARACTERISTICS PROHIBITED OR RESTRICTED IN CERTAIN PANEL GRADES

Panel Grade Designation	Description and Number of Characteristics Per Panel
N-N, N-A	No crossband laps adjacent to faces and backs
N-B	No crossband laps adjacent to N faces No more than 2 crossband laps adjacent to B grade side (Section 5.8.3) Laps are limited to 4.8 mm (3/16 in)
N-D	No crossband laps adjacent to faces No more than a total of 2 of any combination of the following: — Knothole in D veneer over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Split in D veneer over 12.7 mm (1/2 in) but not over 25.4 mm (1 in) — Crossband lap adjacent to backs
Underlayment and C-C Plugged	No knotholes in veneer adjacent to face over 25.4 mm (1 in) across the grain where C grade is required per Tables 2 and 3 No knotholes in veneer adjacent to face over 63.5 mm (2-1/2 in) where D grade is permitted or over 38.1 mm (1-1/2 in) where C grade is permitted per 5.6.3 No laps adjacent to face
Structural I C-D	No splits in faces over 6.4 mm (1/4 in) No splits in backs over 12.7 mm (1/2 in) No more than a total of 2 of any combination of the following: — Knothole in C veneer over 25.4 mm (1 in) but not over 38.1 mm (1-1/2 in) — Knot in D backs over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Knothole in D veneer over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Crossband lap adjacent to faces (See Section 5.8.4) — Crossband lap adjacent to backs (See Section 5.8.4)
Structural I C-D Plugged	No splits in backs over 12.7 mm (1/2 in) No more than a total of 2 of any combination of the following: — Knot in D backs over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Knothole in D veneer over 63.5 mm (2-1/2 in.) but not over 76.2 mm (3 in) — Crossband lap adjacent to faces (See Section 5.8.4) — Crossband lap adjacent to backs (See Section 5.8.4)
Structural I Underlayment	No knotholes in core veneer next to face over 25.4 mm (1 in) No crossband laps adjacent to faces No splits in backs over 12.7 mm (1/2 in) No more than a total of 2 of any combination of the following: — Knot in D backs over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Knothole in D veneer over 63.5 mm (2-1/2 in) but not over 76.2 mm (3 in) — Crossband lap adjacent to backs (See Sections 5.8.3, 5.8.4)

10.0 Guide to Panel Use

NDS 2015 ASD/LRFD Manual for Engineered Wood Construction provides a Guide to Panel Use table which presents the general information regarding grades, thicknesses, and typical uses for various panel types. Refer to the table below.

Guide to Panel Use (Reference Source: Table M9.1-1 2015 NDS)				
Panel Grade and Bond Classification	**Description & Use**	**Common Performance Category (in)**	**Panel Construction**	
			OSB	**Plywood Minimum Veneer Grade**
Structural I EXP 1	Unsanded sheathing grade for wall, roof, subflooring, and industrial applications such as pallets and for engineering design with proper capacities.	5/16, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	Yes	Yes
Structural I Sheathing EXP 1	Panel grades to use where shear and cross-panel strength properties are of maximum importance. Plywood Structural I is made from all Group 1 woods.	3/8, 7/16, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	Yes	Yes
Single Floor EXP 1	Combination subfloor-underlayment. Provides smooth surface for application of carpet and pad. Possesses high concentrated impact load resistance during construction and occupancy. Touch-sanded. Available with tongue-and-groove edges.	19/32, 5/8, 23/32, 3/4, 7/8, 1, 1-3/32, 1-1/8	Yes	Yes
Underlayment EXP 1 or EXT	For underlayment under carpet and pad. Available with exterior glue. Touch-sanded or sanded. Panels with performance category of 19/32 or greater may be available with tongue-and-groove edges.	1/4, 11/32, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	No	Yes, face C-Plugged, back D, inner D
C-D-Plugged EXP 1	For built-ins, wall and ceiling tile backing. Not for underlayment. Touch-sanded.	1/2, 19/32, 5/8, 23/32, 3/4	No	Yes, face C-Plugged, back D, inner D
Sanded Grades EXP 1 or EXT	Generally applied where a high-quality surface is required. Includes A-A, A-C, A-D, B-B, B-C, and B-D grades.	1/4, 11/32, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	No	Yes, face B or better, back D or better, inner C & D
Marine EXT	Superior Exterior-type plywood made only with Douglas-fir or western larch. Special solid-core construction. Available with medium density overlay (MDO) or high density overlay (HDO) face. Ideal for boat hull construction.	1/4, 11/23, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	No	Yes, face A or face B, back A or inner B

11.0 General Code Provisions

This document is consistent with the provisions provided in the PS 1, PS 2, and the International Building Code (IBC). Design capacities referenced in this document are tested values provided by the NDS 2015. Maximum spans are established by the minimum strength requirements provided in the PS 1 and PS 2 and are often controlled by concentrated load considerations. Deviations from the prescriptive capacity tables, change in allowable loads due to concentrated loads, or any other changes to the structural capacities of panels shall always be verified by a qualified professional.

PS 1 TABLE 6. SPAN RATINGS FOR SHEATHING AND SINGLE-FLOOR PANELS BASED ON PRESCRIPTIVE SPECIFICATIONS (FOR SPECIAL PLY-LAYER AND SPECIES REQUIREMENTS APPLICABLE TO STRUCTURAL I PANELS, SEE SECTION 5.6.5 AND TABLE 4. FOR CROSSBAND AND TOTAL INNER PLY THICKNESS PROPORTION REQUIREMENTS, SEE SECTION 5.8.)

Span Rating (a)	Panel Performance Category	Minimum Number of Plies-Layers	Minimum Face & Back Veneer Thickness Before Pressing, for Species Group[b]				Inner Ply Species Group
			1	2	3	4	
Sheathing Panels (C-D, C-C)							
12/0	5/16	3-3	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.1 mm (1/12 in)	1, 2, 3 or 4
16/0	5/16	3-3	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.1 mm (1/12 in)	(c)	1, 2, 3 or 4
	11/32	3-3	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.1 mm (1/12 in)	1, 2, 3 or 4
20/0[e]	5/16 11/32	3-3	2.1 mm (1/12 in)	(c)	(c)	(c)	1, 2, 3 or 4
	3/8	3-3	2.1 mm (1/12 in)	2.1 mm (1/12 in)	2.5 mm (1/10 in)	(c)	1, 2, 3 or 4
		3-3	2.5 mm(1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	1, 2, 3 or 4
24/0	3/8	3-3	2.5 mm (1/10 in)	(c)	(c)	(c)	1, 2, 3 or 4
	13/32	3-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	(c)	(c)	1, 2, 3 or 4
	1/2	3-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	1, 2, 3 or 4
32/16	1/2	3-3	2.5 mm (1/10 in)	4.2 mm (1/6 in)	(c)	(c)	1, 2, 3 or 4
	17/32	3-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	4.2 mm (1/6 in)	(c)	1, 2, 3 or 4
	5/8	3-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
40/20.[e]	5/8	3-3	(d)	4.2 mm (1/6 in)	(c)	(c)	1, 2, 3 or 4
	21/32 3/4	3-3	2.5 mm (1/10 in)	3.2 mm (1/8 in)	4.2 mm (1/6 in)	(c)	1, 2, 3 or 4
	25/32	4-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	3.2 mm (1/8 in)	1, 2, 3 or 4
		4-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	1, 2, 3 or 4
48/24	3/4	4-3	2.5 mm (1/10 in)	4.2 mm (1/6 in)	(c)	(c)	1, 2, 3 or 4
	25/32	4-3	2.5 mm (1/10 in)	3.2 mm (1/8 in)	4.2 mm (1/6 in)	(c)	1, 2, 3 or 4
	7/8	5-5	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	(c)	1, 2, 3 or 4
	29/32	5-5	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	3.2 mm (1/8 in)	1, 2, 3 or 4
Single-Floor Panels (UNDERLAYMENT, C-C Plugged)							
16 o.c.	1/2	3-3	2.5 mm (1/10 in)	(c)	(c)	(c)	1, 2, 3 or 4
	1519/32	4-3	(d)	(d)	(d)	4.2 mm (1/6 in)	1, 2, 3 or 4
	5/8	4-3	(d)	(d)	(d)	(d)	1, 2, 3 or 4
20 o.c.[e]	19/32	4-3	(d)	4.2 mm (1/6 in)	(c)	(c)	1, 2, 3 or 4
	5/8	4-3	(d)	3.2 mm (1/8 in)	4.2 mm (1/6 in)	(c)	1, 2, 3 or 4
	23/32 3/4	4-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	3.2 mm (1/8 in)	1, 2, 3 or 4
		4-3	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	1, 2, 3 or 4
24 o.c.	23/32	4-3	2.5 mm (1/10 in)	4.2 mm (1/6 in)	4.8 mm (3/16 in)	(c)	1, 2, 3 or 4
	3/4	4-3	2.5 mm (1/10 in)	3.2 mm (1/8 in)	4.2 mm (1/6 in)	(c)	1, 2, 3 or 4
	7/8	5-5	2.5 mm (1/10 in)	2.5 mm (1/10 in)	2.5 mm (1/10 in)	3.2 mm (1/8 in)	1, 2, 3 or 4
48 o.c.	1-1/8 1-1/8	7-5	3.2 mm (1/8 in)	4.2 mm (1/6 in)	(c)	(c)	1 or 2
	1-1/8	7-5	3.6 mm (1/7 in)	4.2 mm (1/6 in)	(c)	(c)	1, 2 or 3
	1-1/8	7-7	2.5 mm (1/10 in)	4.2 mm (1/6 in)	4.8 mm (3/16 in)	(c)	1
		7-7	3.2 mm (1/8 in)	4.2 mm (1/6 in)	4.8 mm (3/16 in)	(c)	1, 2 or 3

[a] See Section 5.8.5 for description.

[b] Intermixing between species groups and/or thicknesses in the faces and backs of panels is permitted. Use the lowest applicable span rating to identify the panel. Also see Section 5.5.1.

[c] Not permitted.

[d] A minimum of 3.2 mm (1/8 in) for 3, 4 and 5-ply 3-layer panels per 5.5.1. A minimum of 2.5 mm (1/10 in) for 5-ply 5-layer panels.

[e] The “20”span designation is intended for spans of 19.2 inch.

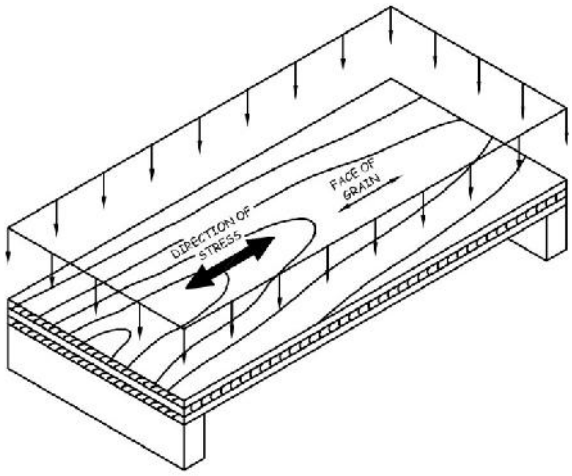
12.0 Mechanical Properties

12.1 Plywood

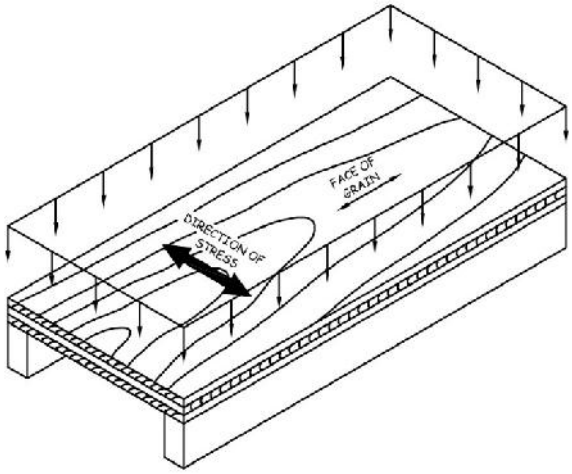
For plywood, the cross-lamination gives the panel its unique strength and dimensional stability. Cross-lamination reduces cracking and splitting, and fasteners can be placed closer to the edge without a reduction in load capacity. The direction of grain in the finished product must be clearly understood, because the strength capacity is directly correlated to the strong or weak axis orientation. Odd number of layers (plies) in plywood ensures that the face and back grain will always be the same, and plies with the grain parallel to the stress will always be the strong orientation. It is common to refer to the strong orientation as the "strength axis". Tabulated design values will have two sets of properties—one for each strength orientation.

12.2 OSB

Similar to the cross-lamination of plywood, OSB panels also have strength orientation associated with its strength capacity. Directional layers of the oriented strands provide similar strength and dimension stability like that of the orthogonal plies of plywood. Per PS 2, the axis parallel to the face and back orientation of the strands is the strength axis, unless otherwise marked.



a) Stress parallel to strength axis



b) Stress perpendicular to strength axis

Reference design values have been tabulated with the lowest possible strength value. The variables that affect the reference design values are the direction of the stress to the strength axis and the makeup of the material species. In addition, the presence of cross-lamination in wood structural panels results in two different reference shear design values—depending of the type and direction of the loading involved. The tabulated capacities and adjustment factors provided are referenced from the 2015 NDS Engineered Wood Construction Manual and based on the testing of panels manufactured in accordance with industry standards. Reference design values shall be multiplied by the appropriate adjustment factors to determine the adjusted design values as shown in the table below.

Applicability of Adjustment Factors for Wood Structural Panels

NDS 2015 Table 9.3.1

		ASD Only	ASD and LRFD		
		Load Duration Factor	Wet Service Factor	Temperature Factor	Panel Size Factor
$F_bS'=F_bS$	x	C_D	C_M	C_t	C_S
$F_tA'=F_tA$	x	C_D	C_M	C_t	C_S
$F_vt_v'=F_vt_v$	x	C_D	C_M	C_t	C_S
$F_S(Ib/Q)'=F_S(Ib/Q)$	x	C_D	C_M	C_t	--
$F_cA'=F_cA$	x	C_D	C_M	C_t	--
$F_c'=F_c$	x	--	C_M	C_t	--
$EI'=EI$	x	--	C_M	C_t	--
$EA'=EA$	x	--	C_M	C_t	--
$G_vt_v'=G_vt_v$	x	--	C_M	C_t	--

Reference design values include the following mechanical properties for wood structural panels:

12.3 Panel bending stiffness, EI

Panel bending stiffness is the ability of the material to resist deflection. E is the reference modulus of elasticity of the material, and I is the moment of inertia of the cross section.

12.4 Bending design value, F_bS

Bending strength capacity is the design maximum moment. F_b is the reference extreme fiber bending stress of the material, and S is the section modulus of the cross section.

Wood Structural Panel Bending Stiffness and Strength Capacities - Table M9.2-1 2015 NDS

	Stress Parallel to Strength Axis[1]				Stress Perpendicular to Strength Axis[1]			
	Plywood				Plywood			
Span Rating	3-ply	4-ply	5-ply	OSB	3-ply	4-ply	5-ply	OSB
PANEL BENDING STIFFNESS, EI (lbf-in.^{2}/ft of panel width)								
24/0	66,000	66,000	66,000	60,000	3,600	7,900	11,000	11,000
24/16	86,000	86,000	86,000	78,000	5,200	11,500	16,000	16,000
32/16	125,000	125,000	125,000	115,000	8,100	18,000	25,000	25,000
40/20	250,000	250,000	250,000	225,000	18,000	39,500	56,000	56,000
48/24	NA	440,000	440,000	400,000	NA	65,000	91,500	91,500
16oc	165,000	165,000	165,000	150,000	11,000	24,000	34,000	34,000
20oc	230,000	230,000	230,000	210,000	13,000	28,500	40,500	40,500
24oc	NA	330,000	330,000	300,000	NA	57,000	80,500	80,500
32oc	NA	NA	715,000	650,000	NA	NA	235,000	235,000
48oc	NA	NA	1,265,000	1,150,000	NA	NA	495,000	495,000
Multiplier for Structural I Panels	1.0	1.0	1.0	1.0	1.5	1.5	1.6	1.6
PANEL BENDING STRENGTH, F_bS (lbf-in./ft of panel width)								
24/0	250	275	300	300	54	65	97	97
24/16	320	350	385	385	64	77	115	115
32/16	370	405	445	445	92	110	165	165
40/20	625	690	750	750	150	180	270	270
48/24	NA	930	1,000	1,000	NA	270	405	405
16oc	415	455	500	500	100	120	180	180
20oc	480	530	575	575	140	170	250	250
24oc	NA	705	770	770	NA	260	385	385
32oc	NA	NA	1,050	1,050	NA	NA	685	685
48oc	NA	NA	1,900	1,900	NA	NA	1,200	1,200
Multiplier for Structural I Panels	1.0	1.0	1.0	1.0	1.3	1.4	1.5	1.5

1. Strength axis is defined as the axis parallel to the face and back orientation of the flakes or the grain (veneer), which is generally the long panel direction, unless otherwise marked.
NA = Not applicable. Atypical panel construction.

12.5 Panel axial stiffness, EA

Panel axial stiffness is the ability of the material to resist axial strain. E is the reference modulus of elasticity of the material, and A is the cross-sectional area.

12.6 Tensile strength parallel to grain, F_tA

Tensile capacity of the material is expressed as F_tA for strength parallel to grain. F_t is the reference axial tensile stress of the material, and A is the cross-sectional area.

12.7 Compressive strength parallel to grain, F_cA

Compressive strength of the material is expressed as F_CA for strength parallel to grain. F_C is the reference compression stress of the material, and A is the cross-sectional area.

12.8 Compressive strength perpendicular to grain, $F_{c\perp}A$

Compressive strength perpendicular to grain is the bearing capacity of the material. $F_{c\perp}$ is the reference compression stress of the material, and A is the contact area.

Wood Structural Panel Axial Stiffness, Tension, and Compression Capacities - Table M9.2-2 2015 NDS

	Stress Parallel to Strength Axis[1]				Stress Perpendicular to Strength Axis[1]			
	Plywood				Plywood			
Span Rating	3-ply	4-ply	5-ply	OSB	3-ply	4-ply	5-ply	OSB
PANEL TENSION, F_tA (lbf/ft of panel width)								
24/0	2,300	2,300	3,000	2,300	600	600	780	780
24/16	2,600	2,600	3,400	2,600	990	990	1,300	1,300
32/16	2,800	2,800	3,650	2,800	1,250	1,250	1,650	1,650
40/20	2,900	2,900	3,750	2,900	1,600	1,600	2,100	2,100
48/24	NA	4,000	5,200	4,000	NA	1,950	2,550	2,550
16oc	2,600	2,600	3,400	2,600	1,450	1,450	1,900	1,900
20oc	2,900	2,900	3,750	2,900	1,600	1,600	2,100	2,100
24oc	NA	3,350	4,350	3,350	NA	1,950	2,550	2,550
32oc	NA	NA	5,200	4,000	NA	NA	3,250	3,250
48oc	NA	NA	7,300	5,600	NA	NA	4,750	4,750
Multiplier for Structural I Panels	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PANEL COMPRESSION, F_CA (lbf/ft of panel width)								
24/0	2,850	4,300	4,300	2,850	2,500	3,750	3,750	2,500
24/16	3,250	4,900	4,900	3,250	2,500	3,750	3,750	2,500
32/16	3,550	5,350	5,350	3,550	3,100	4,650	4,650	3,100
40/20	4,200	6,300	6,300	4,200	4,000	6,000	6,000	4,000
48/24	NA	7,500	7,500	5,000	NA	7,200	7,200	4,300
16oc	4,000	6,000	6,000	4,000	3,600	5,400	5,400	3,600
20oc	4,200	6,300	6,300	4,200	4,000	6,000	6,000	4,000
24oc	NA	7,500	7,500	5,000	NA	7,200	7,200	4,300
32oc	NA	NA	9,450	6,300	NA	NA	9,300	6,200
48oc	NA	NA	12,150	8,100	NA	NA	10,800	6,750
Multiplier for Structural I Panels	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PANEL AXIAL STIFFNESS, EA (lbf/ft of panel width)								
24/0	3,350,000	3,350,000	3,350,000	3,350,000	2,900,000	2,900,000	2,900,000	2,500,000[2]
24/16	3,800,000	3,800,000	3,800,000	3,800,000	2,900,000	2,900,000	2,900,000	2,700,000[2]
32/16	4,150,000	4,150,000	4,150,000	4,150,000	3,600,000	3,600,000	3,600,000	2,700,000
40/20	5,000,000	5,000,000	5,000,000	5,000,000	4,500,000	4,500,000	4,500,000	2,900,000[3]
48/24	NA	5,850,000	5,850,000	5,850,000	NA	5,000,000	5,000,000	3,300,000[3]
16oc	4,500,000	4,500,000	4,500,000	4,500,000	4,200,000	4,200,000	4,200,000	2,700,000
20oc	5,000,000	5,000,000	5,000,000	5,000,000	4,500,000	4,500,000	4,500,000	2,900,000[3]
24oc	NA	5,850,000	5,850,000	5,850,000	NA	5,000,000	5,000,000	3,300,000[3]
32oc	NA	NA	7,500,000	7,500,000	NA	NA	7,300,000	4,200,000
48oc	NA	NA	8,200,000	8,200,000	NA	NA	7,300,000	4,600,000
Multiplier for Structural I Panels	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

1. Strength axis is defined as the axis parallel to the face and back orientation of the flakes or the grain (veneer), which is generally the long panel direction, unless otherwise marked.
2. The values shall be permitted to be increased to 2,900,000 lbf/ft for the calculation of the bending stiffness (EI_{joist}) of prefabricated wood I-joists.
3. The values shall be permitted to be increased to 4,500,000 lbf/ft for the calculation of the composite floor bending stiffness ($EI_{composite}$) of prefabricated wood I-joists.

NA = Not applicable. Atypical panel construction.

12.9 Shear in the plane of the panel, F_s(Ib/Q)

Shear in the plane of the panel is also referred to as interlaminar shear or rolling shear. It is the material's ability to resist horizontal shear loads when loads are applied on opposite faces of the panel. Shear area is in between the cross-laminated layers. F_s is the reference material innerlaminar shear stress, and Ib/Q is the panel cross-sectional shear constant. An example of this type of shear occurs when the wood structural panel is applied as a sheathing material and the loads are normal to the surface of the panel.

Wood Structural Panel Shear-in-the-Plane Capacities - Table M9.2-3 2015 NDS

	Stress Parallel to Strength Axis				Stress Perpendicular to Strength Axis			
	Plywood				Plywood			
Span Rating	3-ply	4-ply	5-ply	OSB	3-ply	4-ply	5-ply	OSB
PANEL SHEAR-IN-THE-PLANE, F_S(lbf/Q) (lbf/ft of panel width)								
24/0	155	155	170	130	275	375	130	130
24/16	180	180	195	150	315	435	150	150
32/16	200	200	215	165	345	480	165	165
40/20	245	245	265	205	430	595	205	205
48/24	NA	300	325	250	NA	725	250	250
16oc	245	245	265	205	430	595	205	205
20oc	245	245	265	205	430	595	205	205
24oc	NA	300	325	250	NA	725	250	250
32oc	NA	NA	390	300	NA	NA	300	300
48oc	NA	NA	500	385	NA	NA	385	385
Multiplier for Structural I Panels	1.4	1.4	1.4	1.0	1.4	1.4	1.0	1.0

NA = Not applicable. Atypical panel construction.

12.10 Panel rigidity through the thickness, G_vt_v

Panel rigidity through the thickness is the ability of the material to resist deformation under shear through the thickness stress. G_v is the reference modulus of rigidity, and t_v is the effective panel thickness.

12.11 Panel shear through the thickness, F_vt_v

Shear through the thickness is the material's ability to resist horizontal shear loads when loads are applied or developed on opposite edges of the panel. F_V is the reference shear through the thickness stress of the material, and t_v is the effective panel thickness for shear. An example of this type of shear occurs when the wood structural panel is applied as a diaphragm.

Wood Structural Panel Rigidity and Shear Through-the-Thickness Capacities - Table M9.2-4 2015 NDS

	Stress Parallel to Strength Axis				Stress Perpendicular to Strength Axis			
	Plywood				Plywood			
Span Rating	3-ply	4-ply	5-ply[1]	OSB	3-ply	4-ply	5-ply[1]	OSB
PANEL RIGIDITY-THROUGH-THE-THICKNESS, $G_V t_V$ (lbf/in. of panel depth)								
24/0	25,000	32,500	37,500	77,500	25,000	32,500	37,500	77,500
24/16	27,000	35,000	40,500	83,500	27,000	35,000	40,500	83,500
32/16	27,000	35,000	40,500	83,500	27,000	35,000	40,500	83,500
40/20	28,500	37,000	43,000	88,500	28,500	37,000	43,000	88,500
48/24	NA	40,500	46,500	96,000	NA	40,500	46,500	96,000
16oc	27,000	35,000	40,500	83,500	27,000	35,000	40,500	83,500
20oc	28,000	36,500	42,000	87,000	28,000	36,500	42,000	87,000
24oc	NA	39,000	45,000	93,000	NA	39,000	45,000	93,000
32oc	NA	NA	54,000	110,000	NA	NA	54,000	110,000
48oc	NA	NA	76,000	155,000	NA	NA	76,000	155,000
Multiplier for Structural I Panels	1.3	1.3	1.1	1.0	1.3	1.3	1.1	1.0
PANEL SHEAR-THROUGH-THE-THICKNESS, $F_V t_V$ (lbf/in. of shear-resisting panel length)								
24/0	53	69	80	155	53	69	80	155
24/16	57	74	86	165	57	74	86	165
32/16	62	81	93	180	62	81	93	180
40/20	68	88	100	195	68	88	100	195
48/24	NA	98	115	220	NA	98	115	220
16oc	58	75	87	170	58	75	87	170
20oc	67	87	100	195	67	87	100	195
24oc	NA	96	110	215	NA	96	110	215
32oc	NA	NA	120	230	NA	NA	120	230
48oc	NA	NA	160	305	NA	NA	160	305
Multiplier for Structural I Panels	1.3	1.3	1.1	1.0	1.3	1.3	1.1	1.0

1. 5-ply applies to plywood with five or more layers. For 5-ply plywood with three layers, use $G_v t_v$ values for 4-ply panels.
NA = Not applicable. Atypical panel construction.

13.0 General Wood Structural Panel Application

Wood structural panels are common for roof, wall, and floor constructions. The required thickness of the panel is often determined by sheathing type loads (loads normal to the surface of the panel). Maximum spans determined by the span rating is under the assumption that the edges parallel to the span are supported. Common edge supports are panel clips or lumber blocking. Panels without edge support will experience a reduction in maximum spans. Providing panel edge support will limit the differential movement between adjacent panels. Tongue-and-groove (T&G) panel edge supporting is an acceptable alternative edge support for sheathing loads only. It is important to note that lumber blocking required by diaphragm applications shall not be substituted with any other form of alternative edge support—unless 1 1/8-in thick Performance Category panel is used. On the other hand, the nailing requirement for the panel are determined by the unit shears in the horizontal or vertical diaphragm. In addition, it is common for panel sheathing applications for roof, floors, and walls to recommend an edge and end spacing of 1/8-in to allow panel swelling or shrinkage due to changes in moisture content, unless otherwise specified. General minimum recommendations are provided in this section to help facilitate engineering applications and calculations.

13.1 Roof Sheathing/Wall Sheathing (Sheathing Span Rated)

Roof or wall sheathing intended for exterior use shall be of exterior exposure durability classification in accordance with PS 1 or PS 2; otherwise, sheathing intended for interior or otherwise not exposed finish shall be of either Exposure 1 or Exterior durability classification.

TP Gradestamps include the term “sized for spacing”, when applicable.

Wood structural panel appropriate for roof sheathing are Exposure 1 sheathing and Exposure 1 Structural I sheathing. Structural I sheathing implies that the panel was manufactured with only glue intended for exterior applications and comprised of materials identified as Group 1 species. It is recommended to use Structural I when added shear capacity and cross-panel strength is desired.

13.2 Floors

Wood structural panels are commonly used in floor applications in two ways—a system of two layers or a single layer. Common industry terminology for the bottom layer in a two-layer system is referred to as a subfloor. The top layer in a two-layer system is referred to as underlayment, and the underlayment layer lies under the finish floor covering. In the USA, ¼-in to ½-in thick underlayment layers are common, and its purpose is to provide a smooth, solid surface for the nonstructural floor finishes (i.e. hardwood flooring). In addition, panels intended to be used for underlayment layers are touched-sanded to achieve a smooth surface. A single layer system is commonly known as combined subfloor-underlayment, because one layer achieves both functions as the name implies. Single Floor Span rated panels are sanded or touch-sanded on the face to achieve a smooth, solid surface for the nonstructural floor finishes. Refer to the next section of this document for nailing requirements.

Subfloor – Sheathing Span Rated

For subfloor construction, panels should be installed in the strong direction and must be continuous over two or more spans. Differential movement between adjustment panels shall be limited by utilizing one of the following edge supporting techniques:

- T&G
- Lumber blocking
- ¼-in underlayment with offset panel edges
- 1 ½-in of lightweight concrete over the subfloor
- Finish floor of ¾-in wood strips

Underlayment – Sheathing Span Rated

For underlayment construction, the most common panel thicknesses are between ¼-in and ½-in thick, and its purpose is to achieve a smooth, solid surface for the direct application of nonstructural floor finishes. Refer to Guide in Panel Use.

Single layer – Single Floor Span

It is common to assume that the wood structural panel application for floor sheathing are controlled by deflection under concentrated loads rather than uniform load criteria. This presence of subjectivity

should be taken into consideration for floor sheathing selection and application. The span rating for Single Floor Span (TP) is in the format of a single number (in inches) followed by “o.c.” (i.e. on center).

14.0 Nailing Requirements

For panel applications, installation recommendations are aimed at avoiding nail popping. This behavior is most common in floor applications, and it occurs when the sheathing is nailed into the supporting member (i.e. joist) with a higher moisture content. As the supporting member shrinks, the nails fastening the sheathing and the lumber can project upward towards the sheathing. Proper nailing procedures can help minimize such phenomenon. Nails should be driven flush with the sheathing surface if the supporting lumber is dry. If the supporting lumber is green, nails should be driven below the sheathing surface.

Common nail sizes are in the following table:

Standard Nail Sizes - Common, Box, and Sinker Steel Wire Nails

Common			
Pennyweight	**Length**	**Diameter**	**Head Diameter**
6d	2"	0.113"	0.266"
7d	2-1/4"	0.113"	0.266"
8d	2-1/2"	0.131"	0.281"
10d	3"	0.148"	0.312"
12d	3-1/4"	0.148"	0.312"
16d	3-1/2"	0.162"	0.344"
20d	4"	0.192"	0.406"
30d	4-1/2"	0.207"	0.438"
40d	5"	0.225"	0.469"
50d	5-1/2"	0.224"	0.5"
60d	6"	0.263"	0.531"

Reference: 2015 NDS Table L4

Box			
Pennyweight	**Length**	**Diameter**	**Head Diameter**
6d	2"	0.099"	0.266"
7d	2-1/4"	0.099"	0.266"
8d	2-1/2"	0.113"	0.297"
10d	3"	0.128"	0.312"
12d	3-1/4"	0.128"	0.312"
16d	3-1/2"	0.135"	0.344"
20d	4"	0.148"	0.375"
30d	4-1/2"	0.148"	0.375"
40d	5"	0.162"	0.406"

Reference: 2015 NDS Table L4

Sinker			
Pennyweight	**Length**	**Diameter**	**Head Diameter**
6d	1-7/8"	0.092"	0.234"
7d	2-1/8"	0.099"	0.250"
8d	2-3/8"	0.113"	0.266"
10d	2-7/8"	0.12"	0.281"
12d	3-1/8"	0.135"	0.312"
16d	3-1/4"	0.148"	0.344"
20d	3-3/4"	0.177"	0.375"
30d	4-1/4"	0.192"	0.406"
40d	4-3/4"	0.207"	0.438"
60d	5-3/4"	0.244"	0.5"

Reference: 2015 NDS Table L4

Post-Frame Ring Shank Nails[1] Sizes

Diameter	Length	Minimum Length of Threaded Shank	Head Diameter	Root Diameter[2], D_r
0.135"	3", 3.5"	2.25"	5/16"	0.128"
0.148"	3", 3.5", 4"	2.25"	5/16"	0.140"
	4.5"	3"		
0.177"	3", 3.5", 4"	2.25"	3/8"	0.169"
	4.5", 5", 6", 8"	3"		
0.200"	3.5", 4"	2.25"	15/32"	0.193"
	4.5", 5", 6", 8"	3"		
0.207"	4"	2.25"	15/32"	0.199"
	4.5", 5", 6", 8"	3"		

1. Tolerances are specified in ASTM F1667.
2. Root diameter is a calculated value and is not specified as a dimension to be measured.

Reference: 2015 NDS Table L5

Per NDS 2015, wood structural panels shall conform to the minimum nailing requirements as shown in the table below.

Minimum Nailing for Wood Structural Panel Applications - 2015 NDS Table M9.4-2			
Application	**Recommended Nail Size & Type**	**Nail Spacing (in)**	
		Panel Edges	**Intermediate Supports**
Singe Floor - Glue-nailed installation[5]	**Ring- or screw-shank**		
16, 20, 24 oc, 3/4 performance category or less	6d[1]	6	12
24 oc, 7/8 or 1 performance tageory	8d[1]	6	12
32, 48 oc, (32-in. span (c-c) application)	8d[1]	6	12
48 oc, (48-in. span (c-c) application)	8d[2]	6	6
Single Floor - Nailed-only application	**Ring- or screw-shank**		
16, 20, 24 oc, 3/4 performance category or less	6d	6	12
24 oc, 7/8 or 1 performance tageory	8d	6	12
32, 48 oc, (32-in. span application)	8d	6	12
48 oc, (48-in. span application)	8d[2]	6	6
Sheathing-Subflooring[3]	**Common smooth, ring- or screw-shank**		
7/16 to 1/2 thick performance category	6d	6	12
7/8 perfrmance category or less	8d	6	12
Thicker panels	10d	6	6
Sheathing-Wall sheathing	**Common smooth, ring- or screw-shank or galvanized box**		
7/16 performance category or less	6d	6	12
Over 7/16 performance category	8d	6	12
Sheathing-Roof sheathing	**Common smooth, ring- or screw-shank**		
5/16 to 1 performance category	8d	6	12[4]
Thicker panels	8d ring- or screw-shank	6	12[4]
	or 10d common smooth		

1. 8d common nails may be substituted if ring- or screw-shank nails are not available.
2. 10d ring-shank, screw-shank, or common nails may be substituted if supports are dry in accordance with NDS.
3. Other code-approved fasteners may be used.
4. For spans 48 in. or greater, space nails 6 in. at all supports.
5. Use only adhesives conforming to ASTM D3498.

15.0 Installation Guide for Fastening

Wood structural panels shall be installed in accordance to manufacturer guidelines and general industry standards. For convenience, the following allowable spans and loads tables for structural roof and structural floor sheathing are provided below. Reference material for the tables are from the applicable sections of the 2015 IBC.

Allowable Spans and Loads for Wood Structural Panel Sheathing and Single-Floor Grades

Continuous Over Two or More Spans with Strength Axis Perpendicular to Supports[a,b]

2015 IBC Table 2304.8(3)

Sheathing Grades		Roof[c]				Floor[d]
Panel span rating roof/floor span	Panel thickness (inches)	Maximum Span (inches)		Load[e] (psf)		Maximum span (inches)
		With edge support[f]	Without edge support	Total load	Live Load	
16/0	3/8	16	16	40	30	0
20/0	3/8	20	20	40	30	0
24/0	3/8, 7/16, 1/2	24	20[g]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16[h]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[h,i]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/32	7/8, 1 1/8	60	48	45	35	32
Single Floor Grades		**Roof[c]**				**Floor[d]**
Panel span rating	Panel thickness (inches)	Maximum Span (inches)		Load[e] (psf)		Maximum span (inches)
		With edge support[f]	Without edge support	Total load	Live Load	
16 o.c.	1/2, 19/32, 5/8	24	24	50	40	16[h]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[h,i]
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2

a. Applies to panels 24 inches or wider.

b. Floor and roof sheathing complying with this table shall be deemed to meet the design criteria of Section 2304.8 of IBC.

c. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only.

d. Panel edges shall have approved T&G joints or shall be supported with blocking unless 1/4-inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot except the span rating of 48 inches on center is based on total load of 65 pounds per square foot.

e. Allowable load at maximum span.

f. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.

g. For 1/2-inch panel, maximum span shall be 24 inches.

h. Span is permitted to be 24 inches on center where 3/4-inch wood strip flooring is installed at right angles to joist.

i. Span is permitted to be 24 inches on center for floors where 1 1/2 inches of cellular or lightweight concrete is applied over the panels.

Allowable Span for Wood Structural Panel Combination Subfloor-Underlayment (Single Floor)[a,b] (Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)

2015 IBC Table 2304.8(4)

Identification	Maximum Spacing of Joists (inches)				
	16	20	24	32	48
Species group[c]	Thickness (inches)				
1	1/2	5/8	3/4	--	--
2,3	5/8	3/4	7/8	--	--
4	3/4	7/8	1	--	--
Single floor span rating[d]	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2

a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of 1/360 of span is 100 pounds per square foot except allowable total uniform load for 1 1/8-inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved T&G joints or shall be supported with blocking, unless 1/4-inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4-inch wood strip.

b. Floor panels complying with this table shall be deemed to meet the design criteria of IBC Section 2304.8.

c. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood species groups.

d. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

Allowable Load (psf) for Wood Structural Panel Roof Sheathing Continuous Over Two or More Spans and Strength Axis Parallel to Supports (Plywood Structural Panels Are Five-Ply, Five-Layer Unless Otherwise Noted)[a,b]

2015 IBC Table 2304.8(5)

Panel Grade	Thickness (inch)	Maximum Span (inches)	Load at Maximum Span (psf)	
			Live	Total
Structural I Sheathing	7/16	24	20	30
	15/32	24	35[c]	45[c]
	1/2	24	40[c]	50[c]
	19/32, 5/8	24	70	80
	23/32, 3/4	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	7/16	16	40	50
	15/32	24	20	25
	1/2	24	25	30
	19/32	24	40[c]	50[c]
	5/8	24	45[c]	55[c]
	23/32, 3/4	24	60[c]	65[c]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2

a. Roof sheathing complying with this table shall be deemed to meet the design criteria of IBC Section 2304.8.

b. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

c. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.