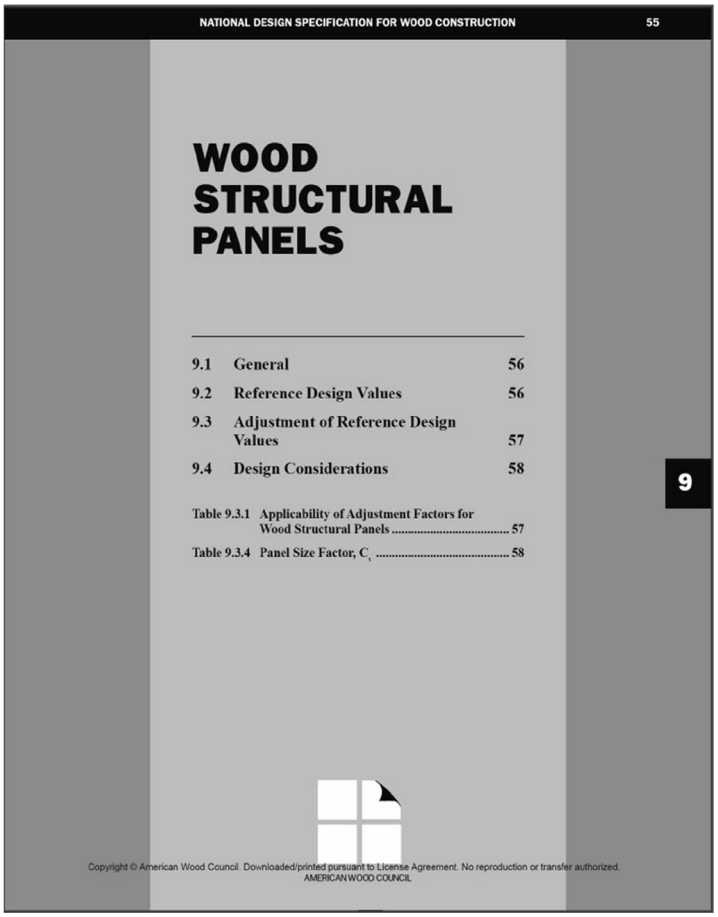
Wood Structural Panels

NDS - Chapter 9


NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 55

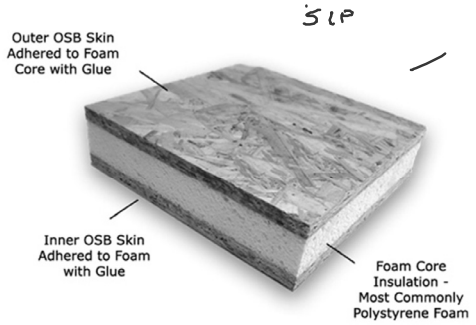
WOOD STRUCTURAL PANELS

9

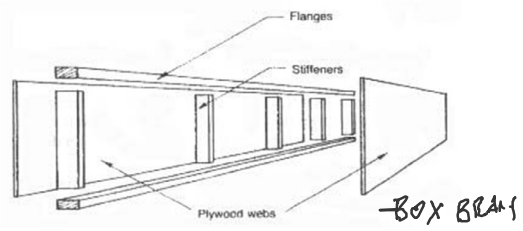
Wood Structural Panels

Applications:

- Roof, Floor and Wall Sheathing
- Horizontal and Vertical Shearwalls / Diaphragms
- Structural Components
  - Lumber and Plywood Beams
  - Stressed Skin Panels
  - Curved Panels
  - Folded Plates
  - Sandwich Panels
- Gusset Plates
  - Trusses
  - Frame Connections
- Concrete Formwork



C. Robeller, TU Kaiserslautern



NDS - 9.1 General

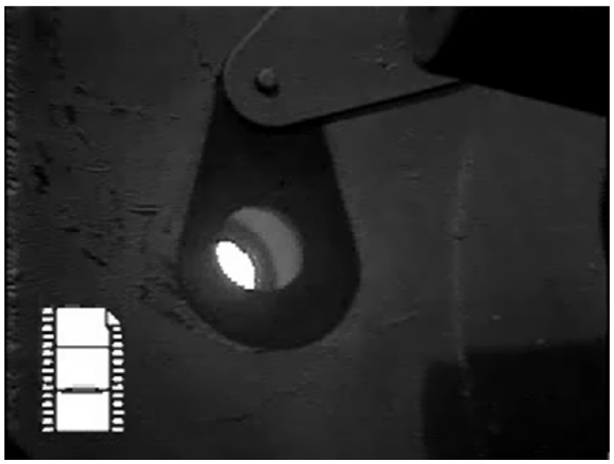
9.1.1 Scope – Wood Structural Panels

- **Plywood**
- Oriented Strand Board (OSB)
- Composite Panels

NDS - 9.1 General

9.1.1 Scope – Wood Structural Panels

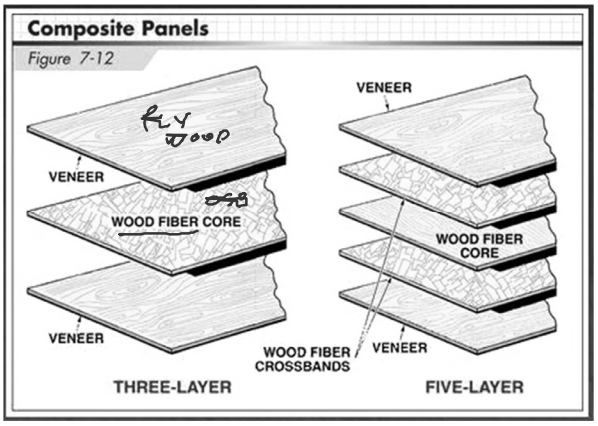
- Plywood
- **Oriented Strand Board (OSB)**
- Composite Panels



NDS - 9.1 General

9.1.1 Scope – Wood Structural Panels

- Plywood
- Oriented Strand Board (OSB)
- **Composite Panels**

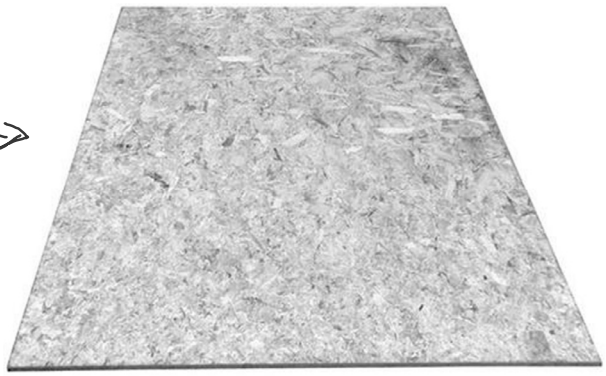


Carpentry, American Technical Publishers, 2013

Other Panels

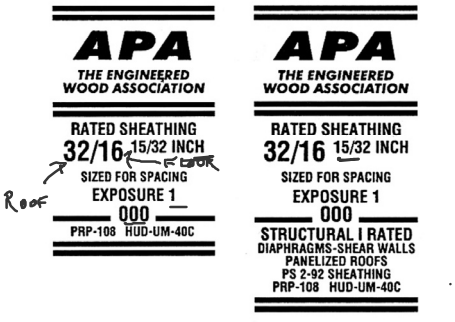
not NDS but can be APA rated

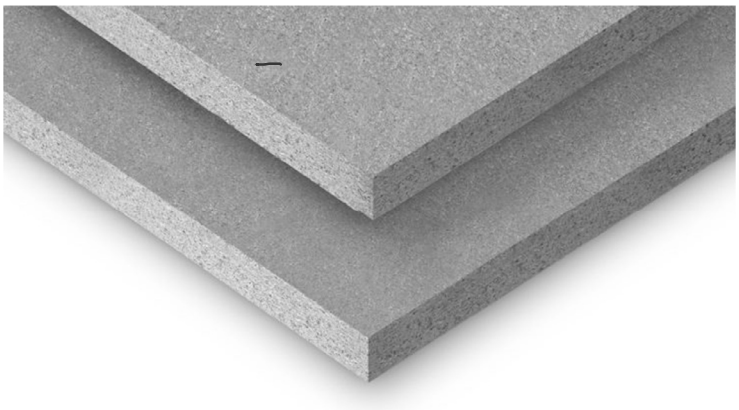
Waferboard – nonveneer, larger flakes.
Can be oriented or random.
Precursor to OSB but generally inferior.
Replaced by OSB.



Particleboard – nonveneer, small, non-oriented particles – not wafers or strands. Susceptible to water damage.

EXAMPLE 8.9 Nonveneer Sheathing Grade





Plywood vs. OSB

Plywood	OSB
higher impact resistance	stronger in shear
better moisture resistance	more cost effective (cheaper)
more grades and types	meets most code requirements

NDS Adjustment Factors

9.3.2 Load Duration Factor, C_D (ASD Only)

All reference strength design values (F_bS, F_tA, F_vt_v, $F_s(Ib/Q)$, F_cA) shall be multiplied by load duration factors, C_D, as specified in 2.3.2.

9.3.3 Wet Service Factor, C_M, and Temperature Factor, C_t

Reference design values for wood structural panels are applicable to dry service conditions as specified in 9.1.4 where $C_M = 1.0$ and $C_t = 1.0$. When the service conditions differ from the specified conditions, adjustments for high moisture and/or high temperature shall be based on information from an approved source.

dry condition is M.C. < 16%

Table 9.3.1 Applicability of Adjustment Factors for Wood Structural Panels

		ASD only	ASD and LRFD			LRFD only		
		Load Duration Factor	Wet Service Factor ✓	Temperature Factor ✓	Panel Size Factor ✓	Format Conversion Factor K_F	Resistance Factor ϕ	Time Effect Factor
$F_bS' = F_bS$	x	C_D	C_M	C_t	C_s	2.54	0.85	λ
$F_tA' = F_tA$	x	C_D	C_M	C_t	C_s	2.70	0.80	λ
$F_vt_v' = F_vt_v$	x	C_D	C_M	C_t	-	2.88	0.75	λ
$F_s(Ib/Q)' = F_s(Ib/Q)$	x	C_D	C_M	C_t	-	2.88	0.75	λ
$F_cA' = F_cA$	x	C_D	C_M	C_t	-	2.40	0.90	λ
$F_{c\perp}' = F_{c\perp}$	x	-	C_M	C_t	-	1.67	0.90	-
$EI' = EI$	x	-	C_M	C_t	-	-	-	-
$EA' = EA$	x	-	C_M	C_t	-	-	-	-
$G_vt_v' = G_vt_v$	x	-	C_M	C_t	-	-	-	-

Adjustment Factors

9.3.3 Wet Service Factor, C_M, and Temperature Factor, C_t

Reference design values for wood structural panels are applicable to dry service conditions as specified in 9.1.4 where $C_M = 1.0$ and $C_t = 1.0$. When the service conditions differ from the specified conditions, adjustments for high moisture and/or high temperature shall be based on information from an approved source.

dry condition is M.C. < 16%

TABLE 7

MOISTURE CONTENT ADJUSTMENT FACTORS FOR WOOD STRUCTURAL PANELS

Capacity	Moisture Content Adjustment Factor (C_M)
Strength (F_bS, F_tA, F_cA, F_s[lb/Q], F_vt_v)	0.75
Stiffness (EI, EA, G_vt_v)	0.85
Bearing ($F_{c\perp}A$)	
Plywood	0.50
OSB	0.20
Nail withdrawal strength	0.75
Wood screw withdrawal strength and lateral strength for dowel-type fasteners (nails, screws and bolts) of 1/4 inch or less in diameter	NDS Table 10.3.3

APA D510C 2012

Panel Size Factor

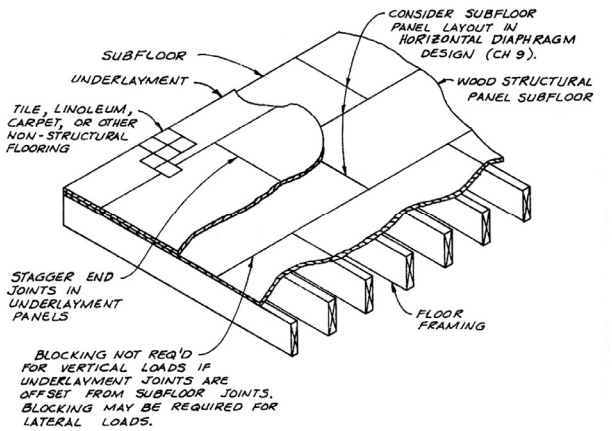
9.3.4 Panel Size Factor, C_s

Reference bending and tension design values (F_bS and F_tA) for wood structural panels are applicable to panels that are 24" or greater in width (i.e., dimension perpendicular to the applied stress). For panels less than 24" in width, reference bending and tension design values shall be multiplied by the panel size factor, C_s, specified in Table 9.3.4.

Table 9.3.4 Panel Size Factor, C_s

Panel Strip Width, w	C_s
$w \leq 8"$	0.5
$8" < w < 24"$	$(8 + w) / 32$
$w \geq 24"$	1.0

NDS



Other Considerations

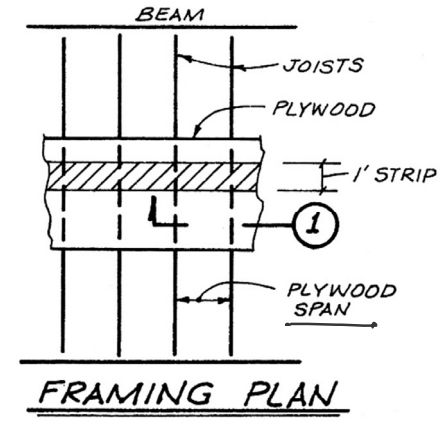
9.4.1 Flatwise Bending

Wood structural panels shall be designed for flexure by checking bending moment, shear, and deflection. Adjusted planar shear shall be used as the shear resistance in checking the shear for panels in flatwise bending. Appropriate beam equations shall be used with the design spans as defined below.

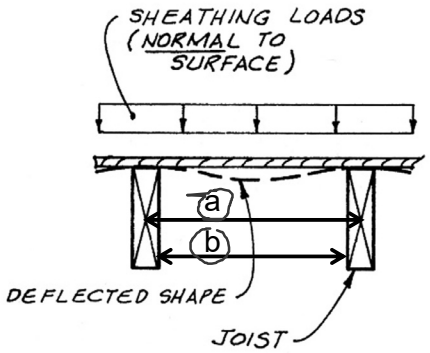
(a) Bending moment-distance between center-line of supports.
(b) Shear-clear span.
(c) Deflection-clear span plus the support width factor. For 2" nominal and 4" nominal framing, the support width factor is equal to 0.25" and 0.625", respectively.

d + .25" OR .625"
2" 4"

NDS



FRAMING PLAN



SECTION 1

Shear

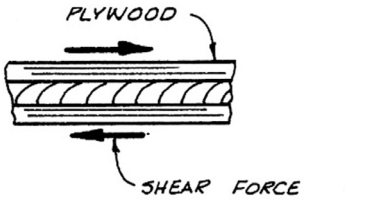
NDS

9.4.4 Planar (Rolling) Shear

The adjusted planar (rolling) shear shall be used in design when the shear force is applied in the plane of wood structural panels.

9.4.5 Through-the-Thickness Shear

The adjusted through-the-thickness shear shall be used in design when the shear force is applied through-the-thickness of wood structural panels.



Rolling Shear

FLEXURE

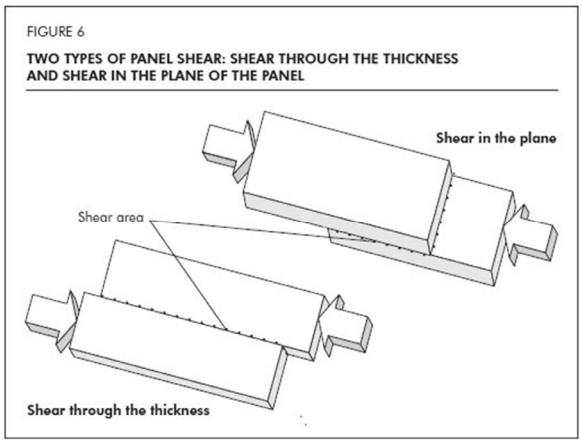
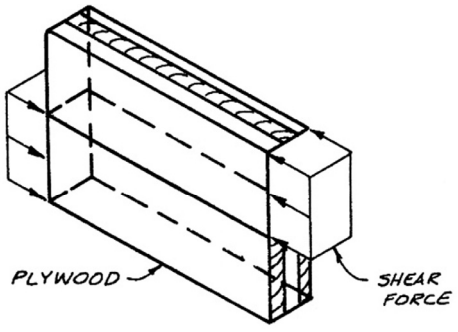


FIGURE 6
TWO TYPES OF PANEL SHEAR: SHEAR THROUGH THE THICKNESS AND SHEAR IN THE PLANE OF THE PANEL

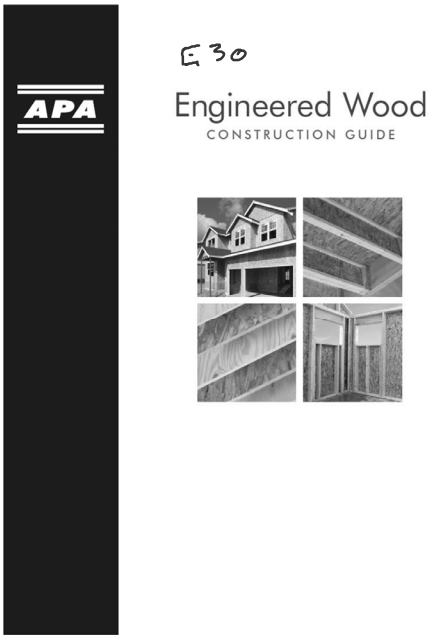


Shear through the Thickness

Specification

APA E30 Engineered Wood Construction Guide

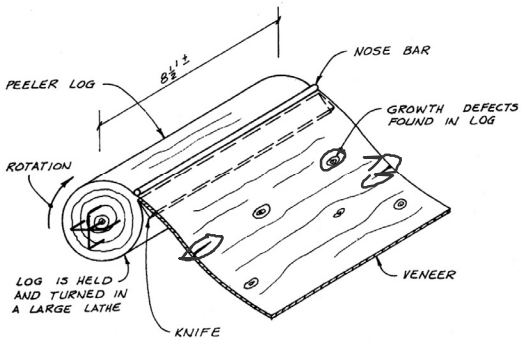
APA D510 Panel Design Guide

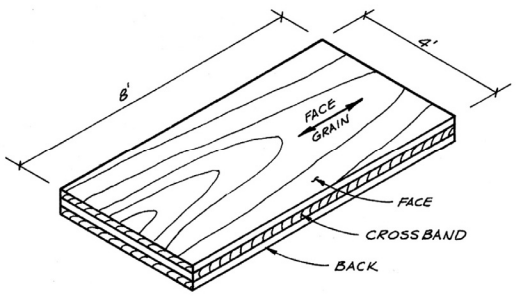


Plywood

Composition

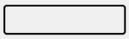
- peeled as continuous sheets of veneer
- cut to size
- defects cut out and patched by grade
- layup with odd layers and cross grain
  - each veneer is a ply
  - a layer may have 1 or more plys
  - each layer is cross laminated
  - Face – top/outside ply
  - Back – bottom/inside ply
  - Crossband – inner layer(s) 90° to face/back
  - Center – inner layer(s) parallel with face/back
- glued and pressed
- finished (sanding levels)
- nominal dimension: 4’ x 8’
  - special sizes 4’ x 10’ or 4’ x 12’
- tolerance 0” to 1/8” undersized
- thickness generally 1/32 undersize

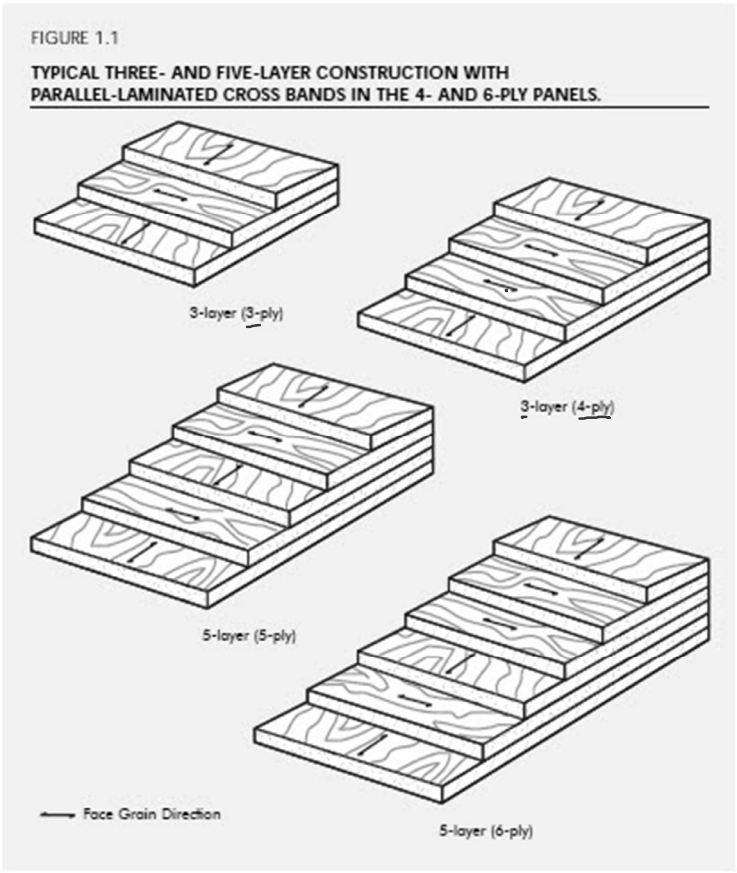




Layers and Plys

Actual Thickness of Plywood

	nominal	actual
	1/4"	7/32"
	3/8"	11/32"
	**1/2"**	15/32"
	**3/4"**	23/32"



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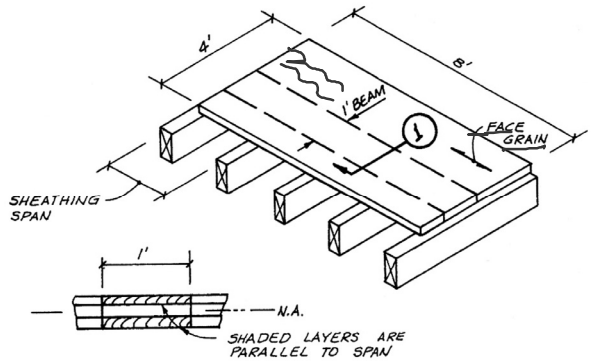
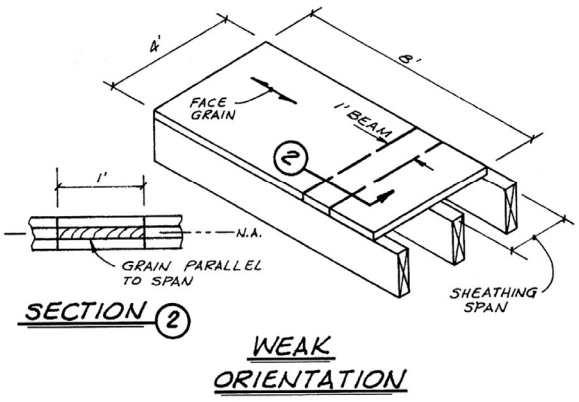
Span Direction

strong direction
vs.
weak direction





Species Classification

Groups by strength
- 1 – 4 are structural
- group 1 is strongest
- Structural 1 has group 1 all plys
- group 4 is weakest
- group 5 is not rated

TABLE 1

NON-STRUCTU

CLASSIFICATION OF SPECIES[a]

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

(a) Table 1 species classified in accordance with ASTM D2555 as discussed in Appendix A of *Voluntary Product Standard PS 1-09, Structural Plywood*, APA Form L870. The species groupings are only valid for species grown in the regions referenced in Appendix A of PS 1-09. (See Section 5.2.1. of PS 1-09 for additional information.)

(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.

APA D510

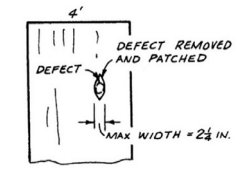
Veneer Grades

APA D510

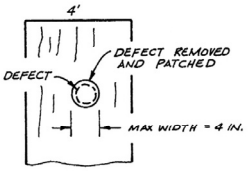
TABLE 2

VENEER GRADES

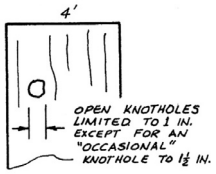
A	Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. Wood or synthetic repairs permitted. May be used for natural finish in less demanding applications.
B	Solid surface. Shims, sled or router repairs, and tight knots to 1 inch across grain permitted. Wood or synthetic repairs permitted. Some minor splits permitted.
C Plugged	Improved C veneer with splits limited to 1/8-inch width and knotholes or other open defects limited to 1/4 x 1/2 inch. Wood or synthetic repairs permitted. Admits some broken grain.
C	Tight knots to 1-1/2 inches. Knotholes to 1 inch across grain and some to 1-1/2 inches if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.
D	Knots and knotholes to 2-1/2-inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to Exposure 1 panels.



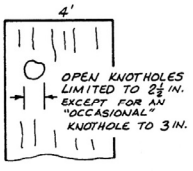
TYP. PATCH IN AN "A" VENEER



TYP. PATCH IN A "B" VENEER



TYP. KNOTHOLE IN A "C" VENEER



TYP. KNOTHOLE IN A "D" VENEER

A and C are structurally similar (C can upgrade to A)
B and D are structurally similar (D can upgrade to B)
A and B are usually face veneers, C and D are inner

Exposure Classification

- Exterior
  - Waterproof Glue
  - Permanently exposed to weather
  - C-grade or better
- Exposure 1
  - Waterproof glue
  - Temporarily in weather
  - D or C grade
- Exposure 2 – IMG
  - Intermediate glue
  - Intermediate resistance to moisture
  - High humidity
- Interior
  - Permanently protected
  - Short periods of 90% humidity

TABLE 3

GUIDE TO PANEL USE

Panel Grade	Description & Use	Common Performance Categories	Panel Construction: OSB	Panel Construction: Plywood
APA RATED SHEATHING 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, 7/16*, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	Yes	Yes
APA STRUCTURAL I RATED SHEATHING EXP 1	Panel grades to use where shear and cross-panel strength properties are of maximum importance.	3/8, 7/16*, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	Yes	Yes
APA RATED STURD-I-FLOOR EXP 1	Combination subfloor-underlayment. Provides smooth surface for application of carpet and pad. Possesses high concentrated and 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
APA UNDERLAYMENT EXP 1	For underlayment under carpet and pad. Touch-sanded. Available with tongue-and-groove edges for panels with Performance Categories of 19/32 or greater.	1/4, 11/32, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	No	Yes
APA C-C Plugged EXT	For underlayment, refrigerated or controlled atmosphere storage rooms, open soffits and other similar applications where continuous or severe moisture may be present. Touch-sanded. Available with tongue-and-groove edges for panels with Performance Categories of 19/32 or greater.	1/2, 19/32, 5/8, 23/32, 3/4	No	Yes
APA Sanded Grades EXP 1 or EXT	Generally applied where a high quality surface is required. Includes APA A-A, A-B, 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
APA MARINE EXT	Superior Exterior plywood made only with Douglas-fir or Western Larch. Special solid-core construction. Available with MDO or HDO face. Ideal for boat hull construction.	1/4, 11/32, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	No	Yes

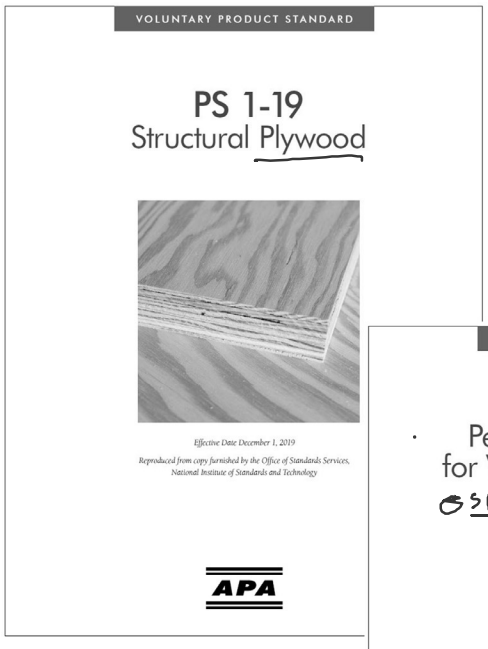
*7/16 available in OSB only.

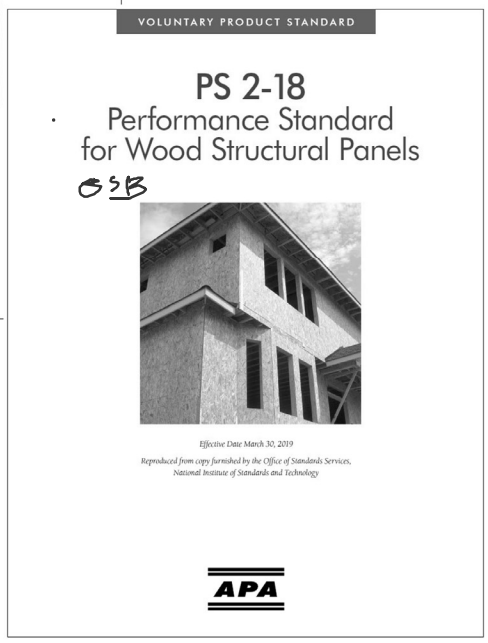
APA D510

Types of Standards

Product Standard (PS 1)
- original standard
- originally prescriptive, but now also performance
- plywood only

Performance Standard (PS 2)
- newer type
- performance based
- all panel types – OSB, plywood, composite, etc.

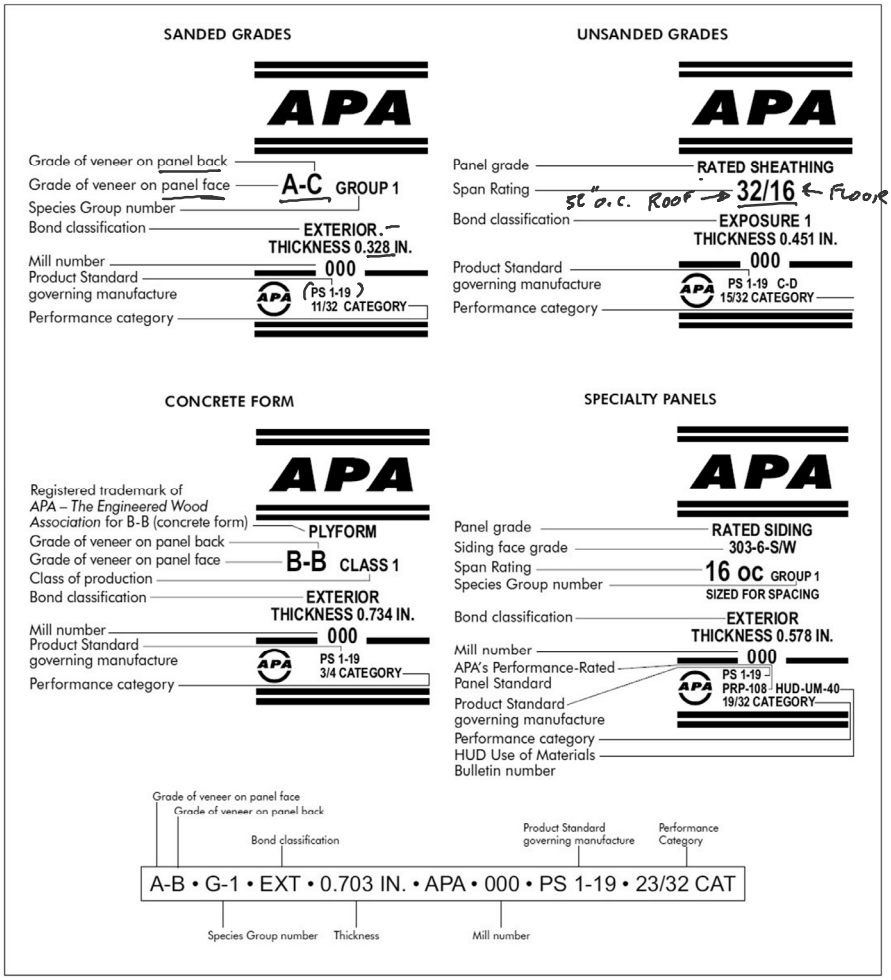




Typical Trademarks

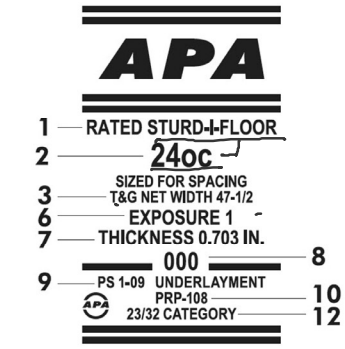
Typical APA marks showing:

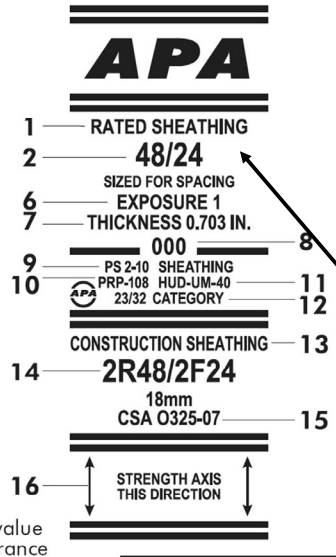
- exposure
- grade and group
- class or span rating
- bond classification
- thickness
- performance catagory

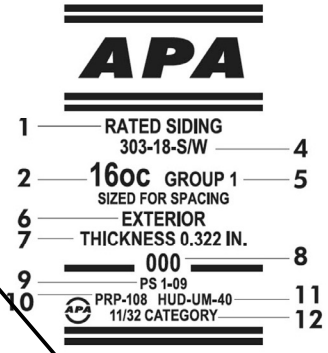


APA L870
PS 1-19

Typical Trademarks







1 Panel grade
2 Span Rating
3 Tongue-and-groove
4 Siding face grade
5 Species group number
6 Bond classification
7 Decimal thickness designation (this value is generally at or near the lower tolerance specified in PS 1 or PS 2)
8 Mill number
9 Product Standard
10 APA's performance rated panel standard
11 HUD recognition
12 Performance Category
13 Panel grade, Canadian standard
14 Panel mark – Rating and end-use designation per the Canadian standard
15 Canadian performance rated panel standard
16 Panel face grain orientation indicator

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2 - Span Rating: roof span / floor span

APA RATED SHEATHING	
Panel Span Rating	Typical Panel Thickness (in.)
12/0	5/16
16/0	5/16
20/0	5/16
24/0	3/8
24/16	7/16
32/16	15/32, 1/2
40/20	19/32, 5/8
48/24	23/32, 3/4
60/32	7/8

APA RATED STURD-I-FLOOR	
Panel Span Rating	Typical Panel Thickness (in.)
16 oc	19/32, 5/8
20 oc	19/32, 5/8
24 oc	23/32, 3/4
32 oc	7/8
48 oc	1-3/32, 1-1/8

Typical Trademarks

TABLE 1

CLASSIFICATION OF SPECIES[a]

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

(a) Table 1 species classified in accordance with ASTM D2555 as discussed in Appendix A of *Voluntary Product Standard PS 1-09, Structural Plywood*, APA Form L870. The species groupings are only valid for species grown in the regions referenced in Appendix A of PS 1-09. (See Section 5.2.1. of PS 1-09 for additional information.)

(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.

KEY TO SPAN RATING AND SPECIES GROUP

For panels with "Span Rating" as across top, and thickness as at left, use stress for species group given in table.

Thickness (in.)	Span Rating (APA RATED SHEATHING grade) 12/0	16/0	20/0	24/0	32/16	40/20	48/24
						Span Rating (STURD-I-FLOOR grade) 16 oc	20 oc	24 oc	48 oc
5/16	4	3	1						
3/8			4	1					
15/32 & 1/2				4	1[1]				
19/32 & 5/8					4	1			
23/32 & 3/4						4	1		
7/8							3[2]		
1-1/8									1

(1) Thicknesses not applicable to APA RATED STURD-I-FLOOR.

(2) For APA RATED STURD-I-FLOOR 24 oc, use Group 4 stresses.

GUIDE TO USE OF ALLOWABLE STRESS AND SECTION PROPERTIES TABLES

INTERIOR OR PROTECTED APPLICATIONS

Plywood Grade	Description and Use	Typical Trademarks	Veneer Grade Face	Back	Inner	Common Thicknesses	Grade Stress Level (Table 3)	Species Group	Section Property Table
APA RATED SHEATHING EXP 1 or 2[3]	Unsanded sheathing grade for wall, roof, subflooring, and industrial applications such as pallets and for engineering design, with proper stresses. Manufactured with intermediate and exterior glue.(1) For permanent exposure to weather or moisture only. Exterior type plywood is suitable.	APA RATED SHEATHING 32/16 EXPOSURE 1 PS 1-09	C	D	D	5/16, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	S-3[1]	See "Key to Span Rating"	Table 1 (unsanded)
APA STRUCTURAL I RATED SHEATHING EXP 1[3]	Plywood grades to use where shear and cross-panel strength properties are of maximum importance. Made with exterior glue only. Structural I is made from all Group 1 woods.	APA STRUCTURAL I RATED SHEATHING 24/0 EXPOSURE 1 PS 1-09	C	D	D	5/16, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	S-2	Group 1	Table 2 (unsanded)
APA RATED STURD-I-FLOOR EXP 1 or 2[3]	For combination subfloor-underlayment. Provides smooth surface for application of carpet and pad. Possesses high concentrated and impact load resitance during construction and occupancy. Manufactured with intermediate and exterior glue. Touch-sanded.(4) Available with tongue-and-groove edges.(5)	APA RATED STURD-I-FLOOR 20 oc EXPOSURE 1 PS 1-09	C plugged	D	C & D	19/32, 5/8, 23/32, 3/4, 1-1/8 (2-4-1)	S-3[1]	See "Key to Span Rating"	Table 1 (touch-sanded)
APA UNDERLAYMENT EXP 1, 2 or INT	For underlayment under carpet and pad. Available with exterior glue. Touch-sanded. Available with tongue-and-groove edges.(5)	APA UNDERLAYMENT GROUP 1 EXPOSURE 1 PS 1-09	C plugged	D	C & D	1/2, 19/32, 5/8, 23/32, 3/4	S-3[1]	As specified	Table 1 (touch-sanded)
APA C-D PLUGGED EXP 1, 2 or INT	For built-ins, wall and ceiling tile backing, Not for underlayment. Available with exterior glue. Touch-sanded.(5)	APA C-D PLUGGED GROUP 2 EXPOSURE 1 PS 1-09	C plugged	D	D	1/2, 19/32, 5/8, 23/32, 3/4	S-3[1]	As Specified	Table 1 (touch-sanded)
APA APPEARANCE GRADES EXP 1, 2 or INT	Generally applied where a high quality surface is required. Includes APA N-N, N-A, N-B, N-D, A-A, A-B, A-D, B-B, and B-D INT grades.(5)	APA A-D GROUP 1 EXPOSURE 1 PS 1-09	B or better	D or better	C & D	1/4, 11/32, 3/8, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4	S-3[1]	As Specified	Table 1 (sanded)

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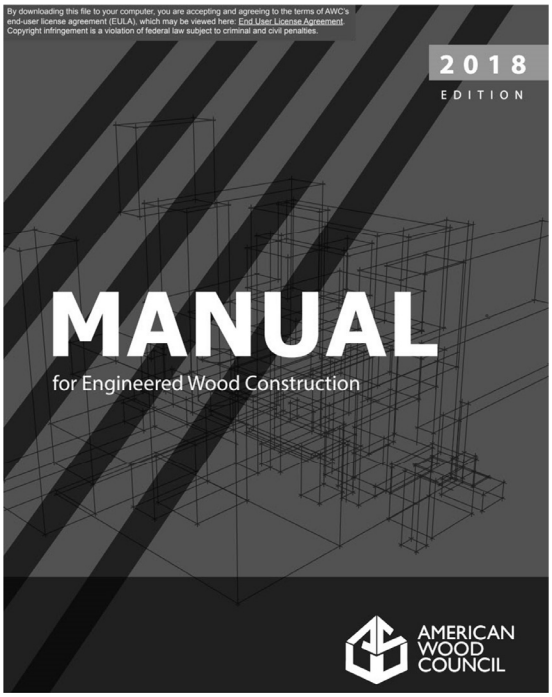
Plywood Design Specification

Design Aids



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TECHNICAL NOTE

Load-Span Tables for APA Structural-Use Panels

Number Q225G
February 2011

Load-span tables for specific structural-use panel applications are included in several APA publications. Recommended loads for sheathing and flooring applications in these publications directly reflect minimum performance criteria given in *APA PRP-108, Performance Standards and Qualification Policy for Structural-Use Panels*, Form E445 and *Voluntary Product Standard PS 2-04, Performance Standard for Wood-Based Structural-Use Panels*, Form S350. To qualify for a given Span Rating under the standards, a panel must meet all of the criteria for that rating. As a result, mechanical properties that are characteristic of APA structural-use panels are actually greater than the minimum necessary to pass one criterion.

Because it is sometimes necessary to have engineering design information for structural panel products for conditions not specifically covered in the other APA literature, APA publishes separate design capacities for various Span Ratings. These values are listed in APA's *Panel Design Specification*, Form D510. The uniform loads in the following tables were calculated using these design capacities. These loads are recommended when engineering principles are used for design. It is important to remember that structural engineering principles alone do not necessarily take into account other factors, such as moisture and thermal conditions, that may impact design.

The following load-span tables apply to APA trademarked structural-use panels qualified and manufactured in accordance with *APA PRP-108, Performance Standards and Qualification Policy for Structural-Use Panels*, Form E445, *Voluntary Product Standard PS 2-04, Performance Standard for Wood-Based Structural-Use Panels*, Form S350 and *Voluntary Product Standard PS 1-09, Structural Plywood*, Form L870. These panels include unsanded, touch-sanded and sanded plywood and oriented strand board (OSB). Loads are provided for applications where the panel strength axis is applied across supports and applied parallel to supports. For each combination of span and Span Rating, loads are given for deflections of L/360, L/240 and L/180 and maximum loads controlled by bending and shear capacity. Table 3 capacities may be adjusted for panel type using Table 4. For special application conditions for Tables 1, 2 and 3, use the factors listed in Table 5, Application Adjustment Factors. Table 6, Typical APA Panel Constructions, is provided to assist in selecting panel constructions for specific Span Ratings.

Table 1a applies to APA Rated Plywood Sheathing. Table 1b applies to APA Rated Plywood Structural I Sheathing. Table 1c applies to APA Rated Plywood Sturd-I-Floor. Table 1d applies to APA Rated Plywood Structural I Sturd-I-Floor. Tables 2a through 2c apply to APA Rated OSB Sheathing, APA Rated OSB Structural I Sheathing, and APA Rated OSB Sturd-I-Floor respectively. For sanded plywood panels, see Table 3.

The values given in Tables 1 and 2 represent the maximum allowable loads for plywood or OSB. In some cases, load capacities of Rated Sheathing and Rated Sturd-I-Floor may be increased by application of the formulas found in *Panel Design Specification*, Form D510. Loads should be further adjusted for application conditions using Table 5. The values in Tables 1 and 2 are generated assuming dry conditions, normal duration of load and untreated, Exposure 1, structural panels. For other conditions, the loads should be appropriately adjusted using the factors given. See the examples for proper use of panel application adjustment factors.

APA

(continued on page 12)

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TABLE 1a

UNIFORM LOADS (PSF) ON APA RATED PLYWOOD SHEATHING.
MULTI-SPAN, NORMAL DURATION OF LOAD, DRY CONDITIONS, PANELS 24 INCHES OR WIDER

Span Rating[b]	Load Governed By[c]	Strength Axis[a]: Perpendicular to Supports, Span Center-to-Center of Supports (inches) 12	16	19.2	24	30	32	36	40	48	60	Parallel to Supports, Span Center-to-Center of Supports (inches) 12	16	24
	L/360	287	108	59	29	14	11	10				16		
	L/240	431	162	89	43	21	17	15				23		
24/0	L/180	574	216	118	57	28	23	20				31		
	Bending	208	117	81	52	33	29	19				45		
	Shear	295	214	175	138	109	102	86				524		
	L/360	544	205	112	54	27	22	19	14			35	13	
	L/240	816	307	168	81	40	32	29	21			53	20	
32/16	L/180	1,088	409	224	108	53	43	38	27			70	27	
	Bending	308	173	120	77	49	43	27	22			77	43	
	Shear	381	276	226	178	140	131	111	100			657	476	
	L/360	1,088	409	224	108	53	43	38	27	18		78	29	10
	L/240	1,631	614	336	163	80	65	57	41	27		117	44	15
40/20	L/180	2,175	818	448	217	106	87	76	55	36		157	59	20
	Bending	521	293	203	130	83	73	46	38	26		125	70	25
	Shear	467	338	277	218	172	161	136	122	106		819	593	367
	L/360	1,914	720	394	191	94	76	67	48	31	15	283	106	36
	L/240	2,871	1,080	591	286	140	114	100	72	47	23	424	160	54
48/24	L/180	3,828	1,440	788	382	187	152	134	96	63	31	566	213	72
	Bending	775	436	303	194	124	109	69	56	39	25	225	127	45
	Shear	571	414	339	267	211	197	167	150	129	102	1,381	1,000	619

(a) The strength axis is the long panel dimension unless otherwise identified.

(b) Nominal thickness may vary within Span Rating. For range of thicknesses, see Table 5 of APA's *Panel Design Specification*, Form D510.

(c) Tabulated values are based on the most conservative plywood construction, as shown in Table 6. Some capacities may be increased by application of formulas in *Panel Design Specification*, Form D510.

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Design Aids

Table M9.1-1 Guide to Panel Use

Panel Grade and Bond Classification	Description & Use	Common Performance Category (in.)	Panel Construction: OSB	Panel Construction: Plywood Minimum Veneer Grade
Sheathing 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 and 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 APA 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, 11/32, 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

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Section Properties

TABLE 12

PANEL SECTION PROPERTIES[a]

Performance Category	Approximate Weight[b] (psf) Plywood	OSB	Nominal Thickness t (in.)	Area A (in.²/ft)	Moment of Inertia I (in.⁴/ft)	Section Modulus S (in.³/ft)	Statical Moment Q (in.³/ft)	Shear Constant Ib/Q (in.²/ft)
3/8	1.1	1.2	.375	4.500	.053	.281	.211	3.000
7/16	1.3	1.4	.437	5.250	.084	.383	.287	3.500
15/32	1.4	1.5	.469	5.625	.103	.440	.330	3.750
1/2	1.5	1.7	.500	6.000	.125	.500	.375	4.000
19/32	1.8	2.0	.594	7.125	.209	.705	.529	4.750
5/8	1.9	2.1	.625	7.500	.244	.781	.586	5.000
23/32	2.2	2.4	.719	8.625	.371	1.033	.775	5.750
3/4	2.3	2.5	.750	9.000	.422	1.125	.844	6.000
7/8	2.6	2.9	.875	10.500	.670	1.531	1.148	7.000
1	3.0	3.3	1.000	12.000	1.000	2.000	1.500	8.000
1-1/8	3.3	3.6	1.125	13.500	1.424	2.531	1.898	9.000

See Section 6 for conversion factors.

(a) Properties based on rectangular cross section of 1-ft width.

(b) Approximate weight for calculating actual dead loads of the panel.

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Span Rating Chart

TABLE 8

RATED PANELS DESIGN CAPACITIES

Span Rating	Stress Parallel to Strength Axis: Plywood 3-ply	Plywood 4-ply	Plywood 5-ply	OSB	Stress Perpendicular to Strength Axis: Plywood 3-ply	Plywood 4-ply	Plywood 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
16 oc	165,000	165,000	165,000	150,000	11,000	24,000	34,000	34,000
20 oc	230,000	230,000	230,000	210,000	13,000	28,500	40,500	40,500
24 oc	NA	330,000	330,000	300,000	NA	57,000	80,500	80,500
32 oc	NA	NA	715,000	650,000	NA	NA	235,000	235,000
48 oc	NA	NA	1,265,000	1,150,000	NA	NA	495,000	495,000
Structural I Multiplier	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
16 oc	415	455	500	500	100	120	180	180
20 oc	480	530	575	575	140	170	250	250
24 oc	NA	705	770	770	NA	260	385	385
32 oc	NA	NA	1,050	1,050	NA	NA	685	685
48 oc	NA	NA	1,900	1,900	NA	NA	1,200	1,200
Structural I Multiplier	1.0	1.0	1.0	1.0	1.3	1.4	1.5	1.5
PANEL AXIAL TENSION, F_A (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
16 oc	2,600	2,600	3,400	2,600	1,450	1,450	1,900	1,900
20 oc	2,900	2,900	3,750	2,900	1,600	1,600	2,100	2,100
24 oc	NA	3,350	4,350	3,350	NA	1,950	2,550	2,550
32 oc	NA	NA	5,200	4,000	NA	NA	3,250	3,250
48 oc	NA	NA	7,300	5,600	NA	NA	4,750	4,750
Structural I Multiplier	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PANEL AXIAL COMPRESSION, F_A (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
16 oc	4,000	6,000	6,000	4,000	3,600	5,400	5,400	3,600
20 oc	4,200	6,300	6,300	4,200	4,000	6,000	6,000	4,000
24 oc	NA	7,500	7,500	5,000	NA	7,200	7,200	4,300
32 oc	NA	NA	9,450	6,300	NA	NA	9,300	6,200
48 oc	NA	NA	12,150	8,100	NA	NA	10,800	6,750
Structural I Multiplier	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Shaded cells are atypical APA panel constructions, as shown in Table 13.

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Span Rating Chart

(continued)

TABLE 8 (Continued)

RATED PANELS DESIGN CAPACITIES

Span Rating	Stress Parallel to Strength Axis: Plywood 3-ply	4-ply	5-ply	OSB	Stress Perpendicular to Strength Axis: Plywood 3-ply	4-ply	5-ply	OSB
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[a]
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[a]
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[a]
48/24	NA	5,850,000	5,850,000	5,850,000	NA	5,000,000	5,000,000	3,300,000[a]
16 oc	4,500,000	4,500,000	4,500,000	4,500,000	4,200,000	4,200,000	4,200,000	2,700,000
20 oc	5,000,000	5,000,000	5,000,000	5,000,000	4,500,000	4,500,000	4,500,000	2,900,000[a]
24 oc	NA	5,850,000	5,850,000	5,850,000	NA	5,000,000	5,000,000	3,300,000[a]
32 oc	NA	NA	7,500,000	7,500,000	NA	NA	7,300,000	4,200,000
48 oc	NA	NA	8,200,000	8,200,000	NA	NA	7,300,000	4,600,000
Structural I Multiplier	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PANEL SHEAR IN THE PLANE, F_s(lb/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
16 oc	245	245	265	205	430	595	205	205
20 oc	245	245	265	205	430	595	205	205
24 oc	NA	300	325	250	NA	725	250	250
32 oc	NA	NA	390	300	NA	NA	300	300
48 oc	NA	NA	500	385	NA	NA	385	385
Structural I Multiplier	1.4	1.4	1.4	1.0	1.4	1.4	1.0	1.0
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
16 oc	27,000	35,000	40,500	83,500	27,000	35,000	40,500	83,500
20 oc	28,000	36,500	42,000	87,000	28,000	36,500	42,000	87,000
24 oc	NA	39,000	45,000	93,000	NA	39,000	45,000	93,000
32 oc	NA	NA	54,000	110,000	NA	NA	54,000	110,000
48 oc	NA	NA	76,000	155,000	NA	NA	76,000	155,000
Structural I Multiplier	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
16 oc	58	75	87	170	58	75	87	170
20 oc	67	87	100	195	67	87	100	195
24 oc	NA	96	110	215	NA	96	110	215
32 oc	NA	NA	120	230	NA	NA	120	230
48 oc	NA	NA	160	305	NA	NA	160	305
Structural I Multiplier	1.3	1.3	1.1	1.0	1.3	1.3	1.1	1.0

Shaded cells are atypical APA panel constructions as shown in Table 13.

(a) The value shall be permitted to be increased to 2,900,000 lbf/ft for the calculation of the bending stiffness (EI_{panel}) of prefabricated wood I-joists.

(b) The value 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.

APA D510

Capacity Equations

Bending

4.7.1. Uniform loads based on bending strength

The following formulas shall be used for computing loads based on design bending strength capacity (F_bS).

For a single span:

$$w_b = \frac{96\,F_bS}{\ell_1^2}$$

For a two-span condition:

$$w_b = \frac{96\,F_bS}{\ell_1^2}$$

For a three-span condition:

$$w_b = \frac{120\,F_bS}{\ell_1^2}$$

Where:

w_b = uniform load based on bending strength (psf)

F_bS = design bending strength capacity (lbf-in./ft)

ℓ_1 = span (in., center-to-center of supports)

Note the dimensions as given

APA D510

Capacity Equations

Shear

4.7.2. Uniform loads based on shear strength

The following formulas shall be used for computing loads based on design shear strength capacity (F_s[lb/Q]).

For a single span:

$$w_s = \frac{24\ F_s(lb/Q)}{\ell_2}$$

For a two-span condition:

$$w_s = \frac{19.2\ F_s(lb/Q)}{\ell_2}$$

For a three-span condition:

$$w_s = \frac{20\ F_s(lb/Q)}{\ell_2}$$

Where:

w_s = uniform load based on shear strength (psf)
F_s(lb/Q) = design shear strength capacity (lbf/ft)
ℓ_2 = clear span (in., center-to-center of supports minus support width)

Note the dimensions as given

APA D510

Capacity Equations

Deflection

4.7.3. Uniform loads based on deflection requirements

The following formulas shall be used for computing deflection under uniform load, or allowable loads based on deflection requirements.

For a single span:

$$\Delta = \frac{w\ell_3^4}{921.6\ EI}$$

For a two-span condition:

$$\Delta = \frac{w\ell_3^4}{2220\ EI}$$

For a three-span condition:

$$\Delta = \frac{w\ell_3^4}{1743\ EI}$$

Where:

Δ = deflection (in.)
w = uniform load (psf)
EI = design bending stiffness capacity (lbf-in.^{2}/ft)
ℓ_3 = clear span + SW (in.)
SW = support-width factor, equal to 0.25 inch for two-inch-nominal lumber framing and 0.625 inch for four-inch-nominal lumber framing.

Note the dimensions as given

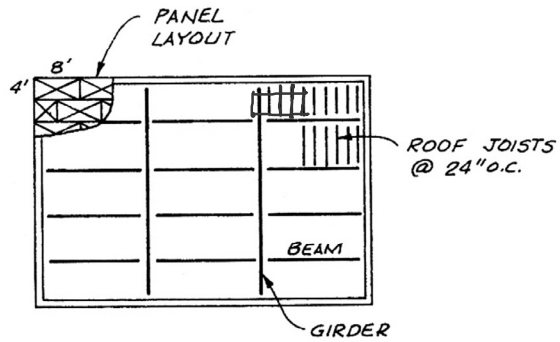
APA D510

Roof Sheathing Design Example

Given:
flat roof framed as shown
roof joists at 24" o.c.
D = 8 psf Lr = 20 psf
deflection limits: Lr = L/240 total = L/180

Find:
panel specifications

D = 8 psf
L_r = 20 psf (no snow load)
TL = 28 psf



ROOF FRAMING PLAN

Roof Sheathing Example

Classification:
exterior (protected)
sheathing

could use either

also either OSB or plywood

Table M9.1-1 Guide to Panel Use

Panel Grade and Bond Classification	Description & Use	Common Performance Category (in.)	Panel Construction	
			OSB	Plywood Minimum Veneer Grade
Sheathing 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 and 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 APA 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, 11/32, 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

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Roof Sheathing Example

Check capacities:

span rating for roof at 24" o.c. = 24/0

deflection limits:

Lr = 20 psf L/240

L/240 = 43 psf **OK**

Total = 28 psf L/180

L/180 = 57 psf **OK**

bending:

psf (C_D)

52 (1.25) = 65 psf **OK**

shear:

psf (C_D)

138 (1.25) = 172psf **OK**

TABLE 1a

UNIFORM LOADS (PSF) ON APA RATED PLYWOOD SHEATHING.
MULTI-SPAN, NORMAL DURATION OF LOAD, DRY CONDITIONS, PANELS 24 INCHES OR WIDER

Span Rating[b]	Load Governed By[c]	Strength Axis[a]: Perpendicular to Supports, Span Center-to-Center of Supports (inches) 12	16	19.2	24	30	32	36	40	48	60	Parallel to Supports, Span Center-to-Center of Supports (inches) 12	16	24
24/0	L/360	287	108	59	29	14	11	10				16		
	L/240	431	162	89	43	21	17	15				23		
	L/180	574	216	118	57	28	23	20				31		
	Bending	208	117	81	52	33	29	19				45		
	Shear	295	214	175	138	109	102	86				524		
32/16	L/360	544	205	112	54	27	22	19	14			35	13	
	L/240	816	307	168	81	40	32	29	21			53	20	
	L/180	1,088	409	224	108	53	43	38	27			70	27	
	Bending	308	173	120	77	49	43	27	22			77	43	
	Shear	381	276	226	178	140	131	111	100			657	476	
40/20	L/360	1,088	409	224	108	53	43	38	27	18		78	29	10
	L/240	1,631	614	336	163	80	65	57	41	27		117	44	15
	L/180	2,175	818	448	217	106	87	76	55	36		157	59	20
	Bending	521	293	203	130	83	73	46	38	26		125	70	25
	Shear	467	338	277	218	172	161	136	122	106		819	593	367
48/24	L/360	1,914	720	394	191	94	76	67	48	31	15	283	106	36
	L/240	2,871	1,080	591	286	140	114	100	72	47	23	424	160	54
	L/180	3,828	1,440	788	382	187	152	134	96	63	31	566	213	72
	Bending	775	436	303	194	124	109	69	56	39	25	225	127	45
	Shear	571	414	339	267	211	197	167	150	129	102	1,381	1,000	619

(a) The strength axis is the long panel dimension unless otherwise identified.
(b) Nominal thickness may vary within Span Rating. For range of thicknesses, see Table 5 of APA's *Panel Design Specification*, Form D510.
(c) Tabulated values are based on the most conservative plywood construction, as shown in Table 6. Some capacities may be increased by application of formulas in *Panel Design Specification*, Form D510.

APA – Q225

Roof Sheathing Example

Performance Category (thickness)

for 24/0 four sizes are available with 3/8 being predominant.

So, try 3/8

TABLE 11

PERFORMANCE CATEGORY AND NOMINAL THICKNESS (in.) BY SPAN RATING
The predominant Performance Category for each span rating is highlighted in **bold** type.)

Span Rating	Performance Category 3/8	7/16	15/32	1/2	19/32	5/8	23/32	3/4	7/8	1	1-1/8
APA Rated Sheathing											
24/0	.375	.437	.469	.500							
24/16		**.437**	.469	.500							
32/16			**.469**	.500	.594	.625					
40/20					**.594**	.625	.719	.750			
48/24							**.719**	.750	.875		
APA Rated Sturd-I-Floor											
16 oc					**.594**	.625					
20 oc					**.594**	.625					
24 oc							**.719**	.750			
32 oc									**.875**	1.000	
48 oc											**1.125**

APA – D510

Roof Sheathing Example

Edge support criteria:

0/24 without edge support can only span 20” (19.2).

So either use:
0/24 x 3/8 with edge support
or
0/24 x 15/32 (or 1/2) without edge support
or
24/16 x 7/16 without edge support

Panel Edge Support

For certain span ratings, the maximum recommended roof span for sheathing panels is dependent upon panel edge support. Edge support may be provided by lumber blocking, tongue and groove, or panel clips when edge support is required. Table M9.4-1 summarizes the relationship between panel edge support and maximum recommended spans.

Table M9.4-1 Panel Edge Support[2]

Sheathing Span Rating	Maximum Recommended Span (in.) With Edge Support	Maximum Recommended Span (in.) Without Edge Support
24/0	24	19.2
24/16	24	24
32/16	32	28
40/20	40	32
48/24	48	36

1. 20 in. for 3/8 and 7/16 performance category panels; 24 in. for 15/32 and 1/2 performance category panels.
2. Additional edge support is recommended when panel widths are less than 24 inches. Edge support requirements should be obtained from the manufacturer.

NDS - Manual

Roof Sheathing Example

Nailing criteria:
8d nails
at 6” and 12” o.c.

panel edge gap:
1/8”

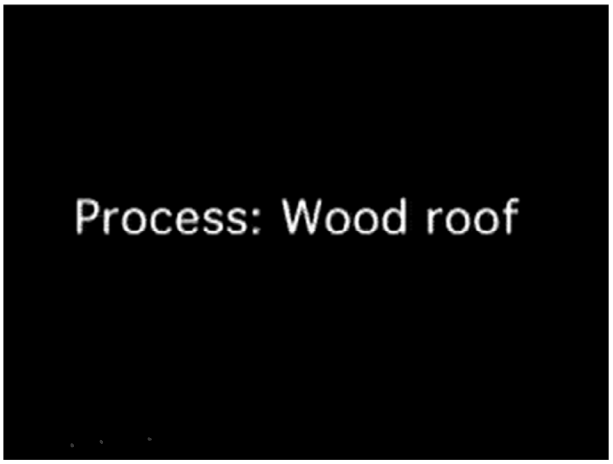
Table M9.4-2 Minimum Nailing for Wood Structural Panel Applications

Application	Recommended Nail Size & Type	Nail Spacing (in.) Panel Edges	Nail Spacing (in.) Intermediate Supports
Single 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 category	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 installation	**Ring- or screw-shank**		
16, 20, 24 oc, 3/4 performance category or less	6d	6	12
24 oc, 7/8 or 1 performance category	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 performance category or less	8d	6	12
Thicker panels	10d	6	6
Sheathing–Wall sheathing	**Common smooth, ring- or screw-shank or galvanized box[3]**		
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[3]**		
5/16 to 1 performance category	8d	6	12[4]
Thicker panels	8d ring- or screw-shank or 10d common smooth	6	12[4]

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.

NDS - Manual

Roof Sheathing



Floor Sheathing

layers:

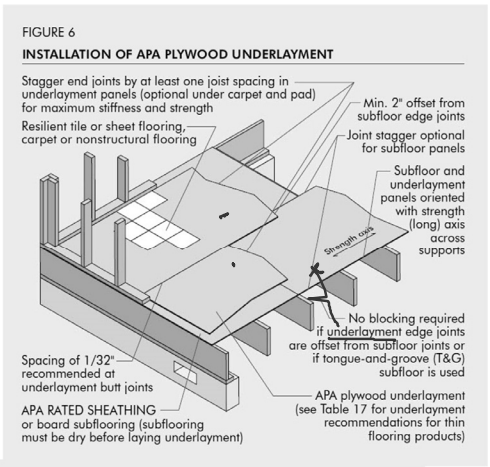
- subfloor
- underlayment
- combined subfloor-underlayment

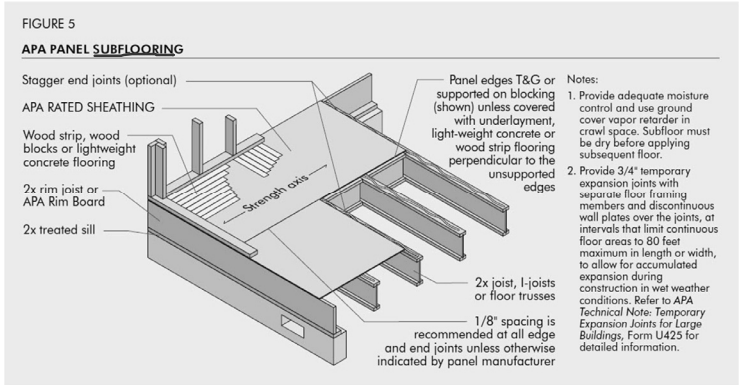
floor types:

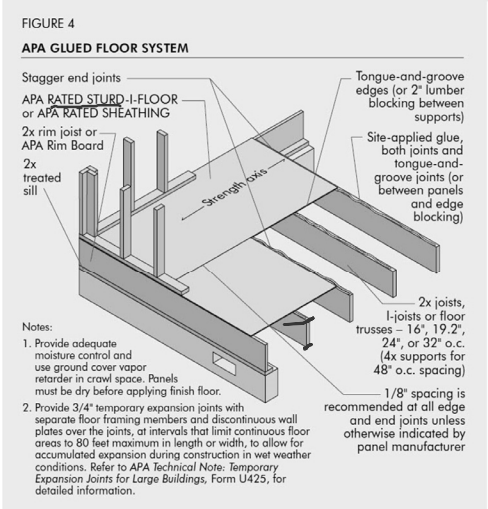
subfloor + underlayment

subfloor + APA rated sheathing (e.g. wood flooring)

combined subfloor-underlayment + carpet







Floor Sheathing

load tables and nailing schedules in APA – E30

limits usually set by point load deflection (person)

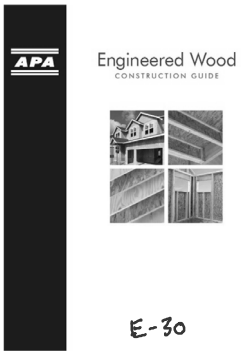


TABLE 15

RECOMMENDED UNIFORM FLOOR LIVE LOADS FOR APA RATED STURD-I-FLOOR AND APA RATED SHEATHING WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS[a]

Sturd-I-Floor Span Rating	Sheathing Span Rating	Minimum Panel Performance Category	Maximum Span (in.)	Allowable Live Loads (psf)[b] Joist Spacing (in.) 12	16	19.2	24	32	40	48[c]
16 oc	24/16, 32/16	7/16[d]	16	185	100					
20 oc[e]	40/20	19/32	19.2	270	150	100				
24 oc	48/24	23/32	24	430	240	160	100			
32 oc	NA	7/8	32		405	295	185	100		
48 oc	NA	1-3/32	48			425	290	160	100	55

a. Panels 24" or wider applied over two spans or more, dry; normal load duration assumed.
b. 10 psf dead load assumed. Live load deflection limit is l/360.
c. 4x nominal or double 2x framing.
d. 19/32 is minimum Performance Category of Rated Sturd-I-Floor.
e. While span rating is shown as 20 oc, the actual joist spacing is 19.2 inches.

TABLE 16

APA PANEL SUBFLOORING (APA RATED SHEATHING)[a,b]

Panel Span Rating	Panel Performance Category	Maximum Span (in.)	Nail Size & Type[c,d]	Maximum Nail Spacing (in.) Supported Panel Edges[e]	Intermediate Supports
24/16	7/16	16	6d common	6	12
32/16	15/32, 1/2	16	6d common[f]	6	12
40/20	19/32, 5/8	19.2[f]	8d common	6	12
48/24	23/32, 3/4	24	8d common	6	12

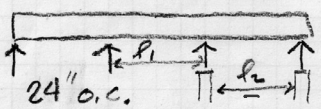
a. For subfloor recommendations under ceramic tile, refer to Table 18. For subfloor recommendations under gypsum concrete, contact manufacturer of floor topping.
b. APA RATED STURD-I-FLOOR may be substituted when the span rating is equal to or greater than tabulated maximum span.
c. Other code-approved fasteners may be used.
d. See Table 6, page 17, for nail dimensions.
e. Supported panel joints shall occur approximately along the centerline of framing with a minimum bearing of 1/2 inch. Fasteners shall be located 3/8 inch from panel edges.
f. Span may be 24 inches if a minimum 1-1/2 inches of lightweight concrete is applied over panels.

Floor Capacity example

Find the floor capacity of the given sheathing

use L/360 deflection limit

GIVEN –
APA RATED SHEATHING
48/24 $\frac{23}{32}$" EXP 1
5 PLY
FROM PLYWOOD DESIGN SPEC.
SUPPLEMENT 1–12
APA D510C



$l_1 = 24"$
$l_2 = 22.5"$
$l_3 = 22.5 + 0.25 = 22.75"$

9.4.1 Flatwise Bending

Wood structural panels shall be designed for flexure by checking bending moment, shear, and deflection. Adjusted planar shear shall be used as the shear resistance in checking the shear for panels in flatwise bending. Appropriate beam equations shall be used with the design spans as defined below.

(a) Bending moment-distance between center-line of supports.
(b) Shear-clear span.
(c) Deflection-clear span plus the support width factor. For 2" nominal and 4" nominal framing, the support width factor is equal to 0.25" and 0.625", respectively.

NDS

Floor Capacity example

TABLE 8

RATED PANELS DESIGN CAPACITIES

Span Rating	Stress Parallel to Strength Axis: Plywood 3-ply	Plywood 4-ply	Plywood 5-ply	OSB
PANEL BENDING STIFFNESS, EI (lbf-in.²/ft of panel width)				
24/0	66,000	66,000	66,000	60,000
24/16	86,000	86,000	86,000	78,000
32/16	125,000	125,000	125,000	115,000
40/20	250,000	250,000	250,000	225,000
48/24	NA	440,000	440,000	400,000
16 oc	165,000	165,000	165,000	150,000
20 oc	230,000	230,000	230,000	210,000
24 oc	NA	330,000	330,000	300,000
32 oc	NA	NA	715,000	650,000
48 oc	NA	NA	1,265,000	1,150,000
Structural I Multiplier				
	1.0	1.0	1.0	1.0
PANEL BENDING STRENGTH, F_bS (lbf-in./ft of panel width)				
24/0	250	275	300	300
24/16	320	350	385	385
32/16	370	405	445	445
40/20	625	690	750	750
48/24	NA	930	1,000	1,000
16 oc	415	455	500	500
20 oc	480	530	575	575
24 oc	NA	705	770	770
32 oc	NA	NA	1,050	1,050
48 oc	NA	NA	1,900	1,900
Structural I Multiplier				
	1.0	1.0	1.0	1.0

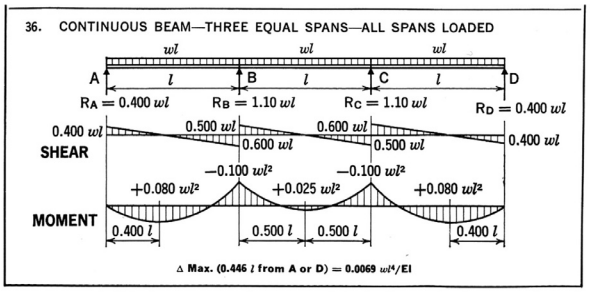
TABLE 8 :
(STRESS PARALLEL TO STRENGTH)
EI = 440,000 PSI/FT
F_bS = 1000 "-#/FT
F_s (Ib/Q) = 325 #/FT
PER 1 FT PANEL WIDTH

5-ply

PANEL SHEAR IN THE PLANE, F_s(Ib/Q) (lbf/ft of panel width)				
24/0	155	155	170	130
24/16	180	180	195	150
32/16	200	200	215	165
40/20	245	245	265	205
48/24	NA	300	325	250
16 oc	245	245	265	205
20 oc	245	245	265	205
24 oc	NA	300	325	250
32 oc	NA	NA	390	300
48 oc	NA	NA	500	385
Structural I Multiplier				
	1.4	1.4	1.4	1.0

APA D510 or NDS Manual M9.2-1 to 4

Floor Capacity example



For a three-span condition:

$$w_b = \frac{120\ F_bS}{\ell_1^{\,2}}$$

For a three-span condition:

$$w_s = \frac{20\ F_s(Ib/Q)}{\ell_2}$$

For a three-span condition:

$$\Delta = \frac{w\ell_3^{\,4}}{1743\ EI}$$

APA D510

FLEXURE

$$w_b = \frac{120\,(F_bS)}{\ell_1^{\,2}\ in} = \frac{120\,(1000)}{24^2} = 208\ PSF$$

SHEAR

$$w_s = \frac{20\,(F_s(Ib/Q))}{\ell_2} = \frac{20\,(325)}{22.5} = 288\ PSF$$

DEFLECTION

$$\Delta_1 = \frac{w\ell_3^{\,4}}{1743\ EI} = \frac{1\,(22.75)^4}{1743\,(440000)} = 0.000349"$$

$$\Delta_{ALL} = \frac{\ell}{360} = \frac{24"}{360} = 0.0667"$$

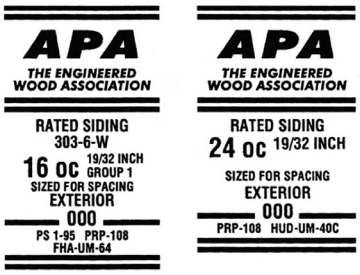
$$w_d = \frac{\Delta_{ALL}}{\Delta_1} = \frac{0.0667}{0.000349} = 190\ PSF$$

Wall Sheathing and Siding

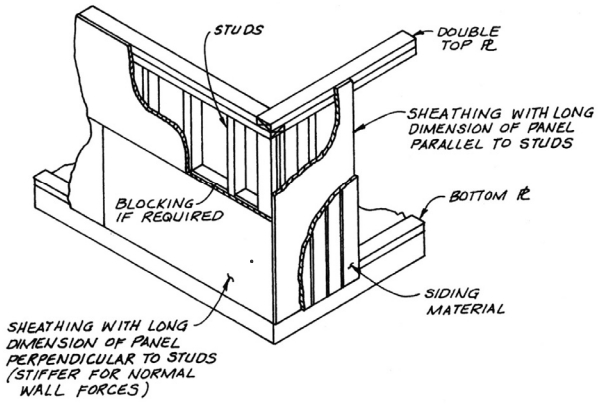
Types:

1. Separate Sheathing + Siding
   - spanning strong or weak direction
   - blocking required for shear wall
   - nailing by APA chart
   - typ. 6d at 6”o.c. edges and 12”o.c. blocking

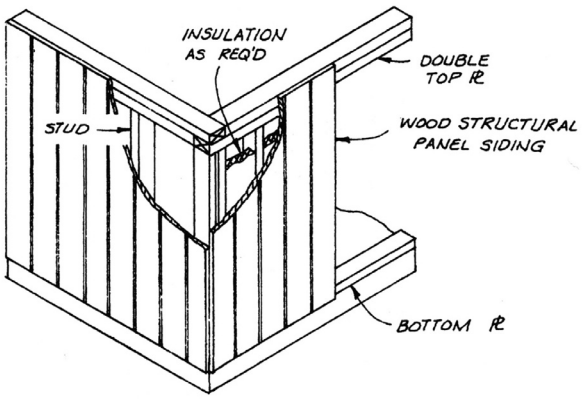
2. Combined as one panel
   - usually with texture or grooved
   - installed vertically (8 ft vertical)
   - APA Rated Siding – 303
   - usually shiplap edges



Wood Structural Panel Sheathing with Separate Siding

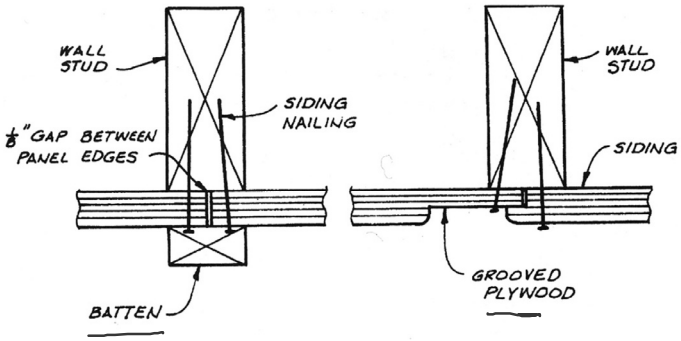


Plywood Combined Sheathing-Siding

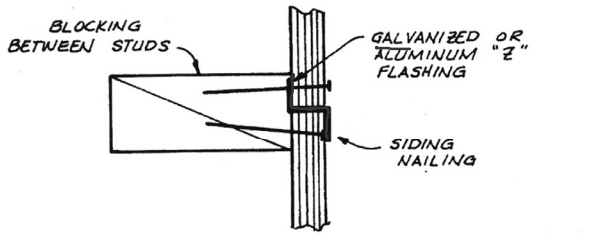


Wall Sheathing and Siding

Joint details for combined type (single layer)



TYP DETAILS FOR VERTICAL PLYWOOD JOINT



TYP DETAIL FOR HORIZONTAL PLYWOOD JOINT