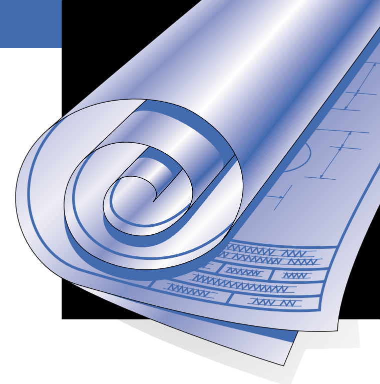

Design Capacities of APA Performance Rated Structural-Use Panels

Number N375B

June 1995

1. SCOPE

Design capacities for specified conditions are presented for APA Rated Sheathing, APA Rated Sturd-I-Floor and APA Structural I Rated Sheathing panel grades. Certain panel capacities and adjustment factors are still under development. Designers are advised to READ ALL INFORMATION prior to using these values. This information applies only to products tested and audited under APA programs. Comparison cannot be made with products manufactured or inspected under other standards or programs.

1.1 Structural-Use Panels

1.1.1 Plywood

Plywood panels are made with an odd number of layers, each layer consisting of one or more plies (thin sheets of wood veneer).

1.1.2 Oriented Strand Board

Mat-formed structural-use panels include primarily oriented strand board (OSB). Strands or wafers are oriented in the face and back layers such that the strength axis of the panel is parallel to the long dimension, unless the direction of the strength axis is otherwise identified. Recommendations for OSB in this Technical Note also apply to waferboard when manufactured and span rated in accordance with standards given in Section 1.2.

1.1.3 COM-PLY®

COM-PLY is a panel made with a combination of veneers and wood-based materials.

1.2 Standards

Panel grade and type shall be identified by one of the following standards:

- Voluntary Product Standard PS 1-83 for Construction and Industrial Plywood
- Voluntary Product Standard PS 2-92, Performance Standard for Wood-Based Structural-Use Panels
- APA PRP-108, Performance Standards and Policies for Structural-Use Panels, where applicable standards are:

  Manufacturing and Performance Standard for APA Rated Sturd-I-Floor Panels

  Manufacturing and Performance Standard for APA Rated Sheathing Panels

1.3 Exposure Durability Classification

1.3.1 Exterior

Exterior panels have bond durability suitable for applications permanently exposed to the weather.

1.3.2 Exposure 1

Exposure 1 panels may be used for applications not permanently exposed to the weather. Over 95% of structural-use panels are rated as Exposure 1.

1.3.3 Exposure 2 or IMG (Intermediate glue)

Exposure 2 or IMG panels may be used for protected applications which are not continuously exposed to high humidity conditions. Exposure 2 or IMG panels are not readily available.

1.3.4 Interior

Interior panels may be used only for permanently protected interior applications. Interior panels are not readily available.

1.4 Panel Grade

1.4.1 APA Rated Sheathing

APA Rated Sheathing panels are assessed for performance as sheathing in roofs, subfloors and walls. Panels are assigned a Span Rating, which is primarily a measure of panel stiffness and strength parallel to the major panel strength axis (usually the long dimension). It consists of two numbers presented in a manner similar to a fraction, e.g. 32/16. The number on the left of the slash (32/16) gives the maximum roof support spacing. The number on the right of the slash (32/16) gives the maximum floor support spacing.

1.4.2 APA Rated Sturd-I-Floor®

The Span Rating for APA Rated Sturd-I-Floor is a single number, e.g. 20 oc, indicating the maximum spacing of supports for combination subfloor-underlayment applications.

APA
The Engineered Wood Association

© 1999 APA - The Engineered Wood Association

©1999 APA – THE ENGINEERED WOOD ASSOCIATION • ALL RIGHTS RESERVED. • ANY COPYING, MODIFICATION, DISTRIBUTION OR OTHER USE OF THIS PUBLICATION OTHER THAN AS EXPRESSLY AUTHORIZED BY APA IS PROHIBITED BY THE U.S. COPYRIGHT LAWS.

1.4.3 APA Structural I Rated Sheathing
The Structural I designation indicates a performance rating that is based not only upon the Span Rating along the major strength axis, but additionally upon performance perpendicular to the major strength axis (usually the cross-panel or short panel dimension) and upon improved shear performance. The intended use is for panelized roof systems, and diaphragm or shear wall applications.

1.5 Panel Thickness

The relationships between nominal panel thickness and Span Rating are shown in Table 3.1. The nominal panel thickness is given in the APA trademark along with the Span Rating.

2. PANEL CAPACITY

2.1 Panel Design Capacity

Panel design capacities listed in Tables 2.1 through 2.4 take into account both the design stress and the cross-sectional property. Use of capacities is not sensitive to specific panel construction, as compared to traditional plywood calculations where layup variations are taken into account. Where allowable stress or section property is required for design purposes, see Section 3.0. Adjustments to panel design capacity are given in Section 2.2.

2.1.1 Panel Flexure (Flat Panel Bending)
Panel design capacities reported in Table 2.1 are based on flat panel bending as measured by testing according to the principles of ASTM D3043 Method C (large panel testing).

2.1.1.1 Stiffness (EI) – Panel bending stiffness is the capacity to resist deflection and is represented in bending equations as EI. The E is the modulus of elasticity of the material and the I is the moment of inertia of the cross section. Units of EI are lb-in.^{2} per foot of panel width.

2.1.1.2 Strength (F_bS) – Allowable bending strength capacity is the design maximum moment, represented in bending equations as F_bS. Terms are the allowable extreme fiber stress of the material (F_b) and the section modulus (S). Units of F_bS are lb-in. per foot of panel width.

2.1.2 Panel Axial Strength
2.1.2.1 Tension (F_tA) – Allowable tension capacities are reported in Table 2.2 based on testing according to the principles of ASTM D3500 Method B. Tension capacity is given as F_tA, where F_t is the allowable tensile stress of the material and A is the area of the cross section. Units of F_tA are lb per foot of panel width.

2.1.2.2 Compression (F_cA) – Allowable compression capacities are reported in Table 2.2 based on testing according to the principles of ASTM D3501 Method B. Compressive properties are generally influenced by buckling; however, this effect was eliminated by restraining edges of specimens during testing. Compression capacity is given as F_cA, where F_c is the allowable compression stress of the material, and A is the area of the cross section. Units of F_cA are lb per foot of panel width.

2.1.3 Panel Axial Stiffness (EA)
Panel axial stiffness is reported in Table 2.3 based on testing according to the principles of ASTM D3501 Method B. Axial stiffness is the capacity to resist axial strain and is represented by EA. The E is the axial modulus of elasticity of the material and A is the area of the cross section. Units of EA are lb per foot of panel width.

2.1.4 Shear in the Plane of the Panel (Rolling Shear) ($F_s[Ib/Q]$)
Allowable shear in the plane of the panel (rolling shear) is reported in Table 2.3 based on testing according to the principles of ASTM D2718. Shear strength in the plane of the panel is the capacity to resist horizontal shear breaking loads when loads are applied or developed on opposite faces of the panel, as in flat panel bending. The term F_s is the allowable material stress, while Ib/Q is the panel cross sectional shear constant. The units of F_s(Ib/Q) are lb per foot of panel width.

2.1.5 Panel Shear Through The Thickness
Panel shear-through-the-thickness capacities are reported based on testing according to the principles of ASTM D2719.

2.1.5.1 Panel Rigidity Through The Thickness (G_vt_v) – Panel rigidity is reported in Table 2.4 and is the capacity to resist deformation when under shear-through-the-thickness stress. Rigidity is represented by G_vt_v, where G_v is the modulus of rigidity and t_v is the effective panel thickness for shear. The units of G_vt_v are lb per inch of panel depth (for vertical applications). Multiplication of G_vt_v by panel depth gives GA, used by designers for some applications.

2.1.5.2 Panel Shear Through The Thickness (F_vt_v) – Allowable shear through the thickness is the capacity to resist horizontal shear breaking loads when loads are applied or developed on opposite edges of the panel, such as in an I-beam, and is reported in Table 2.4. Where additional support is not provided to prevent buckling, design capacities in Table 2.4 are limited to sections 2 ft or less in depth. Deeper sections may require additional reductions. The term F_v is the allowable stress of the material, while t_v is the effective panel thickness for shear. The units of F_vt_v are lb per inch of shear-resisting panel length.

2.2 Adjustment of Capacity

Panel design capacities shall be adjusted as required under the following provisions.

2.2.1 Adjustment for Panel Grade and Construction
Panel design capacities listed in Tables 2.1 through 2.4 are minimum for grade and Span Rating. Tables 2.1.1, 2.2.1, 2.3.1 and 2.4.1 list allowable increases in capacity (C_G) for specific panel constructions and grades. To take

advantage of these, the specifier must insure that the correct APA panel is used in the final construction.

2.2.2 Duration of Load (DOL)
Design capacities listed are based on 'normal duration of load' as traditionally used for solid wood in accordance with U.S. Forest Products Laboratory Report R1916, and successfully used for plywood for approximately 40 years. Adjustment factors for *strength* capacities are:

Time Under Load	DOL Adjustment Factor (C_D)
Permanent	0.90
Normal	1.00
Two Months	1.15
Seven Days	1.25
Wind or Earthquake	1.60*

*Check local building code.

2.2.2.1 Creep – Wood-based panels under constant load will creep (deflection will increase) over time. For typical construction applications, panels are not normally under constant load and, accordingly, creep need not be considered in design.

When panels will sustain permanent loads which will stress the product to one-half or more of its design strength capacity, allowance should be made for creep. Limited data indicates that under such conditions, creep may be taken into account in deflection calculations by applying the applicable following adjustment factor (C_C) to panel stiffness, EI:

	Creep Adjustment Factor (C_C) for Permanent Loads	
Moisture Condition	Plywood	OSB
Dry	1/2	1/2
16% m.c. or greater	1/2	1/6

See Section 2.2.3 for additional adjustments related to service moisture conditions, which for EI is cumulative with the adjustment for creep.

2.2.3 Service Moisture Conditions
Design capacities apply to panels under moisture conditions which are continuously dry in service; that is, where equilibrium moisture content is less than 16%. Adjustment factors for conditions where the panel moisture content in service is expected to be 16% or greater are as follows:

	Moisture Content Adjustment Factor (C_M)
Strength (F_bS, F_tA, F_cA, $F_s[Ib/Q]$, F_vt_v)	0.75
Stiffness (EI, EA, G_vt_v)	0.85

2.2.4 Pressure Treatment
2.2.4.1 Preservative Treatment – Capacities given in this document apply without adjustment to plywood pressure-impregnated with preservative chemicals and redried in accordance with American Wood Preservers Association (AWPA) Specification C-9.

Due to the absence of applicable treating industry standards, OSB and COM-PLY panels are not currently recommended for applications requiring pressure-preservative treating.

2.2.4.2 Fire-Retardant Treatment –
This document does not apply to fire-retardant-treated structural panels. For fire-retardant-treated panels, all capacities and end-use conditions shall be in accordance with the recommendations of the company providing the treating and redrying service.

2.2.5 Panel Size
Strength capacity in bending and tension are appropriate for panels 24 inches or greater in width (x, dimension perpendicular to the applied stress). For panels less than 24 inches in width used in applications where failure could endanger human life, the following adjustment shall be made:

$C_s = 1.00$

when: x = a minimum of 8 inches to a maximum of 24 inches, then

$C_s = 0.25 + 0.0313x$

when: $x \leq 8$ inches, then

$C_s = 0.50$

Single strips less than 8 inches wide used in stressed applications shall be chosen such that they are relatively free of surface defects.

3. SECTION PROPERTIES

Where required, geometric cross-sectional properties may be calculated by assuming a uniform rectangular cross section in conjunction with nominal panel thickness given in Table 3.1. Computed rectangular (geometric) properties on a per-foot-of-panel-width basis are provided in Table 3.2.

Similarly, where design stress is required, design capacity may be divided by the applicable rectangular section property in Table 3.2.

4. UNIFORM LOADS FOR APA PERFORMANCE-RATED PANELS

Computation of uniform-load capacity of APA Performance Rated structural-use panels shall be as outlined in this section for such applications as roofs, floors and walls. The design capacities are subject to adjustment as specified in Section 2.2.

Three basic span conditions are presented for computing uniform-load capacities of structural-use panels. For normal framing practice and a standard panel size (4x8 ft), the APA has used the following assumptions in computing recommendations for load-span tables. When the panel strength axis is across (perpendicular to) the supports, the three-span condition is assumed for

© 1999 APA - The Engineered Wood Association

support spacing up to and including 32 inches. The two-span condition is assumed for support spacing greater than 32 inches.

When the panel strength axis is placed parallel to the supports, the three-span condition is assumed for support spacing up to and including 16 inches, the two-span condition is assumed when the support spacing is greater than 16 inches up to 24 inches, and a single span is assumed for spans greater than 24 inches.

Two-inch-nominal lumber framing is assumed for support spacings less than 48 inches. Four-inch-nominal lumber framing is assumed for support spacing of 48 inches or greater.

The equations presented in this section are standard beam formulas altered to accept the mixed units noted. These formulas are provided for computing uniform loads on structural-use panels over conventional lumber framing. Because it is assumed that no blocking is used, the formulas are for one-way “beam” action, rather than two-way “plate” action. The resulting loads are assumed to be applied to full-sized panels in standard sheathing-type applications. Loads are for the panels only, and in no way account for the design of the framing supports. Further consideration should be given to concentrated loads, in compliance with local building codes and with maximum span recommendations of *APA – The Engineered Wood Association.*

4.1 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 (lb-in./ft)

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

4.2 Uniform Loads Based on Shear Strength

The following formulas shall be used for computing loads based on design shear strength capacity (Fs[Ib/Q]). Symbols are the same as shown in Section 4.1 unless otherwise noted.

For a single span:

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

For a two-span condition:

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

For a three-span condition:

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

Where:

w_s = uniform load based on shear strength (psf)

$F_s(Ib/Q)$ = design shear strength capacity (lb/ft)

ℓ_2 = clear span (in., center-to-center of supports minus support width)

4.3 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 (lb-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. For additional information on this factor see *APA Research Report 120.*

4.3.1 Uniform Load

For uniform load based on a deflection requirement, compute bending deflection as in Section 4.3 with a uniform load (w) equal to one psf. The allowable uniform load based on the allowable deflection is then computed as:

$$w_d = \frac{\Delta_{all.}}{\Delta}$$

Where:

w_d = uniform load based on deflection (psf)

$\Delta_{all.}$ = allowable deflection (in.)

© 1999 APA - The Engineered Wood Association

TABLE 2.1

PANEL DRY DESIGN BENDING STRENGTH AND STIFFNESS CAPACITY

	Span Rating	Stress Applied Parallel to Strength Axis[(a)]	Stress Applied Perpendicular to Strength Axis[(a)]
Panel Bending Stiffness, EI (lb-in.^{2}/ft width)			
Rated Sheathing	24/0	60,000	3,600
	24/16	78,000	5,200
	32/16	115,000	8,100
	40/20	225,000	18,000
	48/24	400,000	29,500
Rated Sturd-I-Floor	16 oc	150,000	11,000
	20 oc	210,000	13,000
	24 oc	300,000	26,000
	32 oc	650,000	75,000
	48 oc	1,150,000	160,000
Panel Bending Strength, F_bS (lb-in./ft width)			
Rated Sheathing	24/0	250	54
	24/16	320	64
	32/16	370	92
	40/20	625	150
	48/24	845	225
Rated Sturd-I-Floor	16 oc	415	100
	20 oc	480	140
	24 oc	640	215
	32 oc	870	380
	48 oc	1,600	680

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

TABLE 2.1.1

ADJUSTMENTS TO FLEXURAL DESIGN CAPACITIES BASED ON PANEL GRADE AND CONSTRUCTION, C_G

APA Rated Sheathing and APA Rated Sturd-I-Floor	Stress Applied		
	Parallel to Strength Axis[(a)]	Perpendicular to Strength Axis[(a)]	
		Other	Structural I
Panel Bending Stiffness			
3-ply plywood	1.1	1.0	1.5
4-ply plywood, COM-PLY	1.1	2.2	3.3
5-ply plywood[(b)]	1.1	3.1	5.2
OSB	1.0	3.1	5.2
Panel Bending Strength			
3-ply plywood	1.0	1.0	1.3
4-ply plywood	1.1	1.2	1.7
COM-PLY	1.2	1.2	1.7
5-ply plywood[(b)], OSB	1.2	1.8	2.8

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

(b) Adjustments apply to plywood with 5 or more layers; for 5-ply/3-layer plywood, use adjustments for 4-ply.

© 1999 APA - The Engineered Wood Association

TABLE 2.2

PANEL DRY DESIGN AXIAL TENSION AND COMPRESSION CAPACITY

	Span Rating	Stress Applied Parallel to Strength Axis[a]	Stress Applied Perpendicular to Strength Axis[a]
Panel Tension, F_tA (lb/ft width)			
Rated Sheathing	24/0	2,300	600
	24/16	2,600	990
	32/16	2,800	1,250
	40/20	2,900	1,600
	48/24	4,000	1,950
Rated Sturd-I-Floor	16 oc	2,600	1,450
	20 oc	2,900	1,600
	24 oc	3,350	1,950
	32 oc	4,000	2,500
	48 oc	5,600	5,000
Panel Compression, F_cA (lb/ft width)			
Rated Sheathing	24/0	2,850	2,500
	24/16	3,250	2,500
	32/16	3,550	3,100
	40/20	4,200	4,000
	48/24	5,000	4,800
Rated Sturd-I-Floor	16 oc	4,000	3,600
	20 oc	4,200	4,000
	24 oc	5,000	4,800
	32 oc	6,300	6,200
	48 oc	13,000	12,500

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

TABLE 2.2.1

ADJUSTMENTS TO AXIAL STRENGTH DESIGN CAPACITIES BASED ON PANEL GRADE AND CONSTRUCTION, C_G

APA Rated Sheathing and APA Rated Sturd-I-Floor	Stress Applied		
	Parallel to Strength Axis[a]	Perpendicular to Strength Axis[a]	
		Other	Structural I
Panel Tension			
3-ply plywood, COM-PLY	1.0	1.0	1.0
4-ply plywood	1.0	1.0	1.0
5-ply plywood[b]	1.3	1.3	1.3
OSB	1.0	1.3	1.3
Panel Compression			
3-ply plywood, COM-PLY	1.0	1.0	1.0
4-ply plywood	1.5	1.5	1.5
5-ply plywood[b]	1.5	1.5	1.5
OSB	1.0	1.0	1.0

(a) The strength axis is the long panel dimension unless otherwise identified.
(b) Adjustments apply to plywood with 5 or more layers; for 5-ply/3-layer plywood, use adjustments for 4-ply.

© 1999 APA - The Engineered Wood Association

TABLE 2.3

PANEL DRY AXIAL STIFFNESS AND SHEAR-IN-THE-PLANE CAPACITY

	Span Rating	Stress Applied Parallel to Strength Axis[(a)]	Stress Applied Perpendicular to Strength Axis[(a)]
Panel Axial Stiffness, EA (lb/ft width)			
Rated Sheathing	24/0	3,350,000	2,900,000
	24/16	3,800,000	2,900,000
	32/16	4,150,000	3,600,000
	40/20	5,000,000	4,600,000
	48/24	5,850,000	5,000,000
Rated Sturd-I-Floor	16 oc	4,500,000	4,200,000
	20 oc	5,000,000	4,600,000
	24 oc	5,850,000	5,000,000
	32 oc	7,500,000	7,300,000
	48 oc	15,000,000	14,600,000
Panel Shear In The Plane, F_s(Ib/Q) (lb/ft width)			
Rated Sheathing	24/0	165	105
	24/16	190	105
	32/16	210	130
	40/20	265	165
	48/24	340	190
Rated Sturd-I-Floor	16 oc	225	145
	20 oc	265	170
	24 oc	340	195
	32 oc	400	280
	48 oc	600	450

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

TABLE 2.3.1

ADJUSTMENTS TO DESIGN CAPACITIES BASED ON PANEL GRADE AND CONSTRUCTION, C_G

APA Rated Sheathing and APA Rated Sturd-I-Floor	Stress Applied			
	Parallel to Strength Axis[(a)]		Perpendicular to Strength Axis[(a)]	
	Other	Structural I	Other	Structural I
Panel Bending Stiffness				
3-ply plywood, COM-PLY	1.0	1.0	1.0	1.0
4-ply plywood	1.0	1.0	1.0	1.0
5-ply plywood(b), OSB	1.0	1.0	1.0	1.0
Panel Shear in the Plane				
3-ply plywood	1.0	1.4	2.8	5.2
4-ply plywood	1.0	1.4	3.9	7.9
5-ply plywood(b)	1.1	1.6	1.0	1.4
OSB, COM-PLY	1.0	1.0	1.0	1.0

(a) The strength axis is the long panel dimension unless otherwise identified.
(b) Adjustments apply to plywood with 5 or more layers; for 5-ply/3-layer plywood, use adjustments for 4-ply.

© 1999 APA - The Engineered Wood Association

TABLE 2.4

PANEL DRY DESIGN RIGIDITY AND SHEAR CAPACITY THROUGH THE THICKNESS

	Span Rating	Stress Applied Parallel or Perpendicular to Strength Axis[(a)]
Panel Rigidity Through The Thickness, $G_v t_v$ (lb/in. of panel depth)		
Rated Sheathing	24/0	25,000
	24/16	27,000
	32/16	27,000
	40/20	28,500
	48/24	31,000
Rated Sturd-I-Floor	16 oc	27,000
	20 oc	28,000
	24 oc	30,000
	32 oc	36,000
	48 oc	50,500
Panel Shear Through The Thickness, $F_v t_v$ (lb/in. of shear-resisting panel length)[(c)]		
Rated Sheathing	24/0	53
	24/16	57
	32/16	62
	40/20	68
	48/24	75
Rated Sturd-I-Floor	16 oc	58
	20 oc	67
	24 oc	74
	32 oc	80
	48 oc	105

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

(c) See Section 2.1.5.2 for limitations.

TABLE 2.4.1

ADJUSTMENTS TO DESIGN CAPACITIES BASED ON PANEL GRADE AND CONSTRUCTION, C_G

APA Rated Sheathing and APA Rated Sturd-I-Floor	Stress Applied	
	Parallel or Perpendicular to Strength Axis[(a)]	
	Other	Structural I
Panel Rigidity Through The Thickness		
3-ply plywood	1.0	1.3
4-ply plywood, COM-PLY	1.3	1.7
5-ply plywood[(b)]	1.5	1.7
OSB	3.1	3.1
Panel Shear Through The Thickness		
3-ply plywood	1.0	1.3
4-ply plywood, COM-PLY	1.3	1.7
5-ply plywood[(b)]	1.5	2.0
OSB	2.9	2.9

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

(b) Adjustments apply to plywood with 5 or more layers; for 5-ply/3-layer plywood, use adjustments for 4-ply.

(c) See Section 2.1.5.2 for limitations.

© 1999 APA - The Engineered Wood Association

TABLE 3.1

NOMINAL THICKNESS BY SPAN RATING.
*(The nominal thickness is given. The predominant thickness for each Span Rating is highlighted in **bold** type.)*

	Nominal Thickness (in.)										
Span Rating	**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**

TABLE 3.2

PANEL SECTION PROPERTIES[a]

Nominal Panel Thickness	Approximate Weight[b] (psf)	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	.375	4.500	.053	.281	.211	3.000
7/16"	1.3	.437	5.250	.084	.383	.287	3.500
15/32"	1.4	.469	5.625	.103	.440	.330	3.750
1/2"	1.5	.500	6.000	.125	.500	.375	4.000
19/32"	1.8	.594	7.125	.209	.705	.529	4.750
5/8"	1.9	.625	7.500	.244	.781	.586	5.000
23/32"	2.2	.719	8.625	.371	1.033	.775	5.750
3/4"	2.3	.750	9.000	.422	1.125	.844	6.000
7/8"	2.6	.875	10.500	.670	1.531	1.148	7.000
1"	3.0	1.000	12.000	1.000	2.000	1.500	8.000
1-1/8"	3.3	1.125	13.500	1.424	2.531	1.898	9.000

(a) Properties based on rectangular cross section of 1-ft width.
(b) Approximate plywood weight for calculating actual dead loads. For OSB and COM-PLY panels, increase tabulated weights by 10%.

© 1999 APA - The Engineered Wood Association

Design Examples

Note: In these examples, panel type is selected for illustrative purposes. Normally specification is by grade and Span Rating without regard to panel type, and calculations should assume the lowest adjustments (C_G) applicable to available constructions as given in Table A1 for the specified Span Rating.

Example 1 – Conventional Roof

A 4-ply plywood panel trademarked APA Rated Sturd-I-Floor 24 oc with tongue-and-groove edges was inadvertently installed over 4-in.-nominal roof supports 48 in. on center. The long dimension (strength axis) of the panel was placed perpendicular to supports. The local building code requires that the panel support a 25-psf snow load.

Bending Strength
From Table 2.1, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis (long panel dimension perpendicular to supports) has a bending strength capacity (F_bS) of 640 lb-in./ft. This capacity is adjusted by a C_G factor of 1.1 as shown in Table 2.1.1 for 4-ply plywood, and by a duration-of-load factor (C_D) of 1.15 (see Section 2.2.2). From Section 4.0, a two-span condition is assumed.

$$W_b = \frac{96\ F_bS}{\ell_1^2}$$

$$= \frac{96 \text{ x } (640 \text{ x } 1.1 \text{ x } 1.15)}{48^2}$$

$$= 34 \text{ psf}$$

Shear Strength in the Plane
From Table 2.3, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis has shear strength in the plane (F_s[Ib/Q]) of 340 lb/ft. This capacity is adjusted by a C_G factor of 1.0 for 4-ply plywood, and by a duration-of-load factor (C_D) of 1.15 (see Section 2.2.2).

$$W_s = \frac{19.2\ F_s(\text{Ib/Q})}{\ell_2}$$

$$= \frac{19.2 \text{ (}340 \text{ x } 1.0 \text{ x } 1.15)}{(48 - 3.5)}$$

$$= 169 \text{ psf}$$

Bending Stiffness
From Table 2.1, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis has a dry stiffness capacity (EI) of 300,000 lb-in.^{2}/ft. This capacity is adjusted by a C_G factor of 1.1 for 4-ply plywood as shown in Table 2.1.1. The deflection limit for live load is ℓ/240.

$$\Delta = \frac{w\ell_3^4}{2{,}220 \text{ EI}}$$

$$= \frac{1.0\ (48 - 3.5 + .625)^4}{2{,}220 \text{ x } (300{,}000 \text{ x } 1.1)}$$

$$= 5.66 \text{ x } 10^{-3} \text{ in.}$$

$$W_d = \frac{\Delta_{all}}{\Delta} = \frac{48/240}{6.226 \text{ x } 10^{-3}} = 35 \text{ psf}$$

Bending strength controls (provides the lowest capacity) for this application. The bending strength capacity of 34 psf represents total load, from which dead load is subtracted to arrive at live load capacity. The bending stiffness capacity of 35 psf represents live load only. Here, if dead load (panel weight plus roofing) is no more than 9 psf, the 25-psf snow load capacity is achieved. The tongue-and-groove edges provide required edge supports.

TABLE A1

TYPICAL APA PANEL CONSTRUCTIONS[(a)]

Span Rating	Plywood 3-ply	Plywood 4-ply	Plywood 5-ply[(b)]	COM-PLY	OSB
APA Rated Sheathing					
24/0	X				X
24/16					X
32/16	X	X	X		X
40/20	X	X	X		X
48/24		X	X		X
APA Rated Sturd-I-Floor					
16 oc					
20 oc		X	X	X	X
24 oc		X	X	X	X
32 oc			X	X	X
48 oc			X	X	X

(a) Constructions listed may not be available in every area. Check with suppliers concerning availability.
(b) Applies to plywood with 5 or more layers.

Example 2 – Panelized Roof

An oriented strand board (OSB) panel trademarked APA Structural I Rated Sheathing 32/16 is to be used in a panelized roof system over 2-in.-nominal framing members 24 in. on center. The long panel dimension (strength axis) of the panel will be placed parallel to supports.

© 1999 APA - The Engineered Wood Association

Bending Strength

From Table 2.1, a Rated Sheathing 32/16 panel with stress applied perpendicular to strength axis (long panel dimension parallel to supports) has a bending strength capacity (F_bS) equal to 92 lb-in./ft. This capacity is adjusted by a C_G factor of 2.8 for OSB Structural I (Table 2.1.1), and by a duration-of-load factor (C_D) of 1.15 (see Section 2.2.2). This duration-of-load factor is normally associated with snow loads for roof structures. From Section 4.0, a two-span condition is assumed.

$$W_b = \frac{96\ F_bS}{\ell_1^2}$$

$$= \frac{96\ (92 \times 2.8 \times 1.15)}{24^2} = 49 \text{ psf}$$

Shear Strength in the Plane

From Table 2.3, a Rated Sheathing 32/16 panel with stress applied perpendicular to strength axis has shear strength in the plane (F_s[Ib/Q]) of 130 lb/ft. This capacity is adjusted by a C_G factor of 1.0 for OSB Structural I (Table 2.3.1) and by a duration-of-load factor (C_D) of 1.15 (see Section 2.2.2).

$$W_s = \frac{19.2\ F_s(Ib/Q)}{\ell_2}$$

$$= \frac{19.2\ (130 \times 1.0 \times 1.15)}{(24 - 1.5)}$$

$$= 128 \text{ psf}$$

Bending Stiffness

From Table 2.1, a Rated Sheathing 32/16 panel with stress applied perpendicular to strength axis has a dry stiffness capacity (EI) of 8,100 lb-in.^{2}/ft. This capacity is adjusted by a C_G factor of 5.2 for OSB Structural I as shown in Table 2.1.1. The deflection limit for live load is ℓ/240.

$$\Delta = \frac{w\ell_3^4}{2{,}220\ EI}$$

$$= \frac{1.0\ (24 - 1.5 + .25)^4}{2{,}220 \times (8{,}100 \times 5.2)}$$

$$= 2.865 \times 10^3 \text{ in.}$$

$$W_d = \frac{\Delta_{all}}{\Delta} = \frac{24/240}{2.865 \times 10^3} = 35 \text{ psf}$$

Example 3 – Floor

A COM-PLY panel marked APA Rated Sturd-I-Floor 24 oc is to be used in a floor system over supports 24 in. on center. The panels will be placed with the long panel dimension (strength axis) perpendicular to supports. Supports are 2-in.-nominal framing members. The capacity of the panel will be computed based on bending strength, shear strength in the plane and bending stiffness.

Bending Strength

From Table 2.1, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis (long panel dimension perpendicular to supports) has a bending strength capacity (F_bS) of 640 lb-in./ft. This capacity is adjusted by a C_G factor of 1.2 as shown in Table 2.1.1 for COM-PLY. From Section 4.0, a three-span condition is assumed.

$$W_b = \frac{120\ F_bS}{\ell_1^2} = \frac{120 \times (640 \times 1.2)}{24^2}$$

$$= 160 \text{ psf}$$

Shear Strength in the Plane

From Table 2.3, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis has shear strength in the plane (F_s[Ib/Q]) equal to 340 lb/ft. This capacity is adjusted by a C_G factor of 1.0 as shown in Table 2.3.1 for COM-PLY.

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

$$= \frac{20\ (340 \times 1.0)}{(24 - 1.5)} = 302 \text{ psf}$$

Bending Stiffness

From Table 2.1, a Rated Sturd-I-Floor 24 oc panel with stress applied parallel to the strength axis has a dry stiffness capacity (EI) of 300,000 lb-in.^{2}/ft. This capacity is adjusted by a C_G factor of 1.1 as shown in Table 2.1.1 for COM-PLY. The deflection limit for live load is ℓ/360.

$$\Delta = \frac{w\ell_3^4}{1{,}743\ EI}$$

$$= \frac{1.0\ (24 - 1.5 + .25)^4}{1{,}743 \times (300{,}000 \times 1.1)}$$

$$= 4.657 \times 10^4 \text{ in.}$$

$$W_d = \frac{\Delta_{all}}{\Delta} = \frac{24/360}{4.657 \times 10^{-4}} = 143 \text{ psf}$$

While the above calculations would indicate that this Sturd-I-Floor construction has a live load capacity of 143 psf (limited by bending stiffness), it is important to note that some structural panel applications are not controlled by uniform load. Residential floors, commonly designed for 40 psf live load, are a good example. The calculated allowable load is greatly in excess of the typical design load. This excess does not mean that floor spans for Sturd-I-Floor can be increased, but only that there is considerable reserve strength and stiffness for *uniform* loads. Recommended maximum spans for structural panel floors are based on deflection under concentrated loads, how the floor "feels" to passing foot traffic, and other subjective factors which relate to user acceptance. Always check the maximum floor and roof spans for structural panels before making a final selection for these applications.

© 1999 APA - The Engineered Wood Association

We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying APA engineered wood products, get in touch with your nearest APA regional office. Call or write:

WESTERN REGION
7011 So. 19th St. ▪ P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 ▪ Fax: (253) 565-7265

EASTERN REGION
2130 Barrett Park Drive, Suite 102
Kennesaw, Georgia 30144-3681
(770) 427-9371 ▪ Fax: (770) 423-1703

U.S. HEADQUARTERS AND INTERNATIONAL MARKETING DIVISION
7011 So. 19th St. ▪ P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 ▪ Fax: (253) 565-7265

Web Address:
@
www.apawood.org

PRODUCT SUPPORT HELP DESK
(253) 620-7400
E-mail Address: help@apawood.org

(Offices: Antwerp, Belgium; Bournemouth, United Kingdom; Hamburg, Germany; Mexico City, Mexico; Tokyo, Japan.) For Caribbean/Latin America, contact headquarters in Tacoma.

The product use recommendations in this publication are based on APA – The Engineered Wood Association's continuing programs of laboratory testing, product research, and comprehensive field experience. However, because the Association has no control over quality of workmanship or the conditions under which engineered wood products are used, it cannot accept responsibility for product performance or designs as actually constructed. Because engineered wood product performance requirements vary geographically, consult your local architect, engineer or design professional to assure compliance with code, construction, and performance requirements.

Form No. N375B
Revised August 1999/0100

A P A

The Engineered Wood Association

© 1999 APA - The Engineered Wood Association