

2021 Virginia Construction Code

CHAPTER 23 WOOD

SECTION 2306 ALLOWABLE STRESS DESIGN

2306.1 Allowable stress design.

The design and construction of wood elements in structures using *allowable stress design* shall be in accordance with the following applicable standards listed in [Table 2306.1](#).

TABLE 2306.1

STANDARDS FOR DESIGN AND CONSTRUCTION OF WOOD ELEMENTS IN STRUCTURES USING ALLOWABLE STRESS DESIGN

STANDARDS PROMULGATOR	STANDARD	TITLE
American Wood Council		
	ANSI/AWC NDS	National Design Specification for Wood Construction
	SDPWS	Special Design Provisions for Wind and Seismic
American Society of Agricultural and Biological Engineers		
	ASABE EP 484.3	Diaphragm Design of Metal-clad, Wood-Frame Rectangular Buildings
	ASABE EP 486.3	Shallow Post and Pier Foundation Design
	ASABE EP 559.1	Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies
APA—The Engineered Wood Association		
	ANSI 117	Standard Specifications for Structural Glued Laminated Timber of Softwood Species
	ANSI A190.1	Structural Glued Laminated Timber
		Panel Design Specification
		Plywood Design Specification Supplement 1—Design & Fabrication of Plywood Curved Panel
		Plywood Design Specification Supplement 2—Design & Fabrication of Glued Plywood-lumber Beams
		Plywood Design Specification Supplement 3—Design & Fabrication of Plywood Stressed-skin Panels
		Plywood Design Specification Supplement 4—Design & Fabrication of Plywood Sandwich Panels
		Plywood Design Specification Supplement 5—Design & Fabrication of All-plywood Beams
	APA T300	Glulam Connection Details
	APA S560	Field Notching and Drilling of Glued Laminated Timber Beams
	APA S475	Glued Laminated Beam Design Tables
	APA X450	Glulam in Residential Construction
	APA X440	Product and Application Guide: Glulam
	APA R540	Builders Tips: Proper Storage and Handling of Glulam Beams
Truss Plate Institute, Inc.		
	TPI 1	National Design Standard for Metal Plate Connected Wood Truss Construction
West Coast Lumber Inspection Bureau		
	AITC 104	Typical Construction Details
	AITC 110	Standard Appearance Grades for Structural Glued Laminated Timber
	AITC 113	Standard for Dimensions of Structural Glued Laminated Timber
	AITC 119	Standard Specifications for Structural Glued Laminated Timber of Hardwood Species
	AITC 200	Inspection Manual

2306.1.1 Joists and rafters.

The design of rafter spans is permitted to be in accordance with the [AWC STJR](#).

2306.1.2 Plank and beam flooring.

The design of plank and beam flooring is permitted to be in accordance with the [AWC Wood Construction Data No. 4](#).

2306.1.3 Treated wood stress adjustments.

The allowable unit stresses for *preservative-treated wood* need not be adjusted for treatment, but are subject to other adjustments.

The allowable unit stresses for *fire-retardant-treated wood*, including fastener values, shall be developed from an *approved* method of investigation that considers the effects of anticipated temperature and humidity to which the *fire-retardant-treated wood* will be subjected, the type of treatment and the redrying process. Other adjustments are applicable except that the *impact load* duration shall not apply.

2306.1.4 Lumber decking.

The capacity of lumber decking arranged according to the patterns described in [Section 2304.9.2](#) shall be the lesser of the capacities determined for [moment](#) and deflection according to the formulas in [Table 2306.1.4](#).

TABLE 2306.1.4
ALLOWABLE LOADS FOR LUMBER DECKING

PATTERN	ALLOWABLE AREA LOAD ^a	
	Moment	Deflection
Simple span	$w_{\Delta} = \frac{384\Delta E'd^3}{5l^4 \cdot 12}$	$w_b = \frac{8F_b'd^2}{l^2 \cdot 6}$

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Two-span continuous	$w_b = \frac{8F_b' d^2}{l^2 6}$	$w_\Delta = \frac{185 \Delta E' d^3}{l^4 12}$
Combination simple- and two-span continuous	$w_b = \frac{8F_b' d^2}{l^2 6}$	$w_\Delta = \frac{131 \Delta E' d^3}{l^4 12}$
Cantilevered pieces intermixed	$w_b = \frac{20F_b' d^2}{3l^2 6}$	$w_\Delta = \frac{105 \Delta E' d^3}{l^4 12}$
Controlled random layup		
Mechanically laminated decking	$w_b = \frac{20F_b' d^2}{3l^2 6}$	$w_\Delta = \frac{100 \Delta E' d^3}{l^4 12}$
2-inch decking	$w_b = \frac{20F_b' d^2}{3l^2 6}$	$w_\Delta = \frac{100 \Delta E' d^3}{l^4 12}$
3-inch and 4-inch decking	$w_b = \frac{8F_b' d^2}{l^2 6}$	$w_\Delta = \frac{116 \Delta E' d^3}{l^4 12}$

For SI: 1 inch = 25.4 mm.

- a. w_b = Allowable total uniform load limited by **moment**.
 w_Δ = Allowable total uniform load limited by deflection
 d = Actual decking thickness.
 l = Span of decking
 F_b' = Allowable bending stress adjusted by applicable factors.
 E' = Modulus of elasticity adjusted by applicable factors.

2306.2 Wood-frame diaphragms.

Wood-frame *diaphragms* shall be designed and constructed in accordance with **AWC SDPWS**. Where panels are fastened to framing members with staples, requirements and limitations of **AWC SDPWS** shall be met and the allowable shear values set forth in **Table 2306.2(1)** or **2306.2(2)** shall be permitted. The allowable shear values in **Tables 2306.2(1)** and **2306.2(2)** are permitted to be increased 40 percent for wind design.

TABLE 2306.2(1)
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS UTILIZING STAPLES WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^f

PANEL GRADE	STAPLE LENGTH AND GAGE ^d	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES ^e (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6) ^b				Fasteners spaced 6 inches max. at supported edges ^b	
					6	4	2 1/2 ^c	2 ^c	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6) ^g
					6	6	4	3		
Structural I grades	1 1/2 16 gage	1	3/8	2	175	235	350	400	155	115
				3	200	265	395	450	175	130
			15/32	2	175	235	350	400	155	120
				3	200	265	395	450	175	130

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Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	1 1/2 16 gage	1	3/8	2	160	210	315	360	140	105
				3	180	235	355	400	160	120
			7/16	2	165	225	335	380	150	110
				3	190	250	375	425	165	125
			15/32	2	160	210	315	360	140	105
				3	180	235	355	405	160	120
			19/32	2	175	235	350	400	155	115
				3	200	265	395	450	175	130

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of lumber in [ANSI/AWC NDS](#). (2) For staples find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Space fasteners maximum 12 inches on center along intermediate framing members (6 inches on center where supports are spaced 48 inches on center).
- Framing at adjoining panel edges shall be 3 inches nominal or wider.
- Staples shall have a minimum crown width of 7/16 inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- For shear loads of normal or permanent load duration as defined by the [ANSI/AWC NDS](#), the values in the table shall be multiplied by 0.63 or 0.56, respectively.
- For Case 1 through 6 descriptions see [Figure 2306.2\(1\)](#).

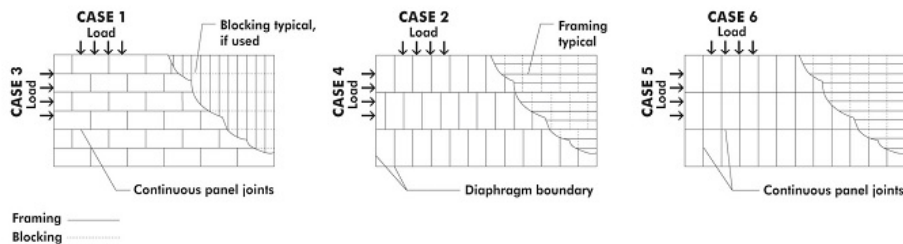


FIGURE 2306.2(1)
CASES 1 THROUGH 6 FOR USE WITH TABLE 2306.2(1)

TABLE 2306.2(2)
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS UTILIZING MULTIPLE ROWS OF STAPLES (HIGH-LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^{b, g, h}

PANEL GRADE ^c	STAPLE GAGE ^f	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER AT ADJOINING PANEL EDGES AND BOUNDARIES ^e	LINES OF FASTENERS	BLOCKED DIAPHRAGMS					
						Cases 1 and 2 ^d					
						Fastener Spacing Per Line at Boundaries (inches) ⁱ					
						4	2 1/2	2			
Structural I grades	14 gage staples	2	15/32	3	2	6	4	4	3	3	2
						0	0	0	0	0	0
				4	3	8	9	1	1	1	1
						0	0	0	0	0	0

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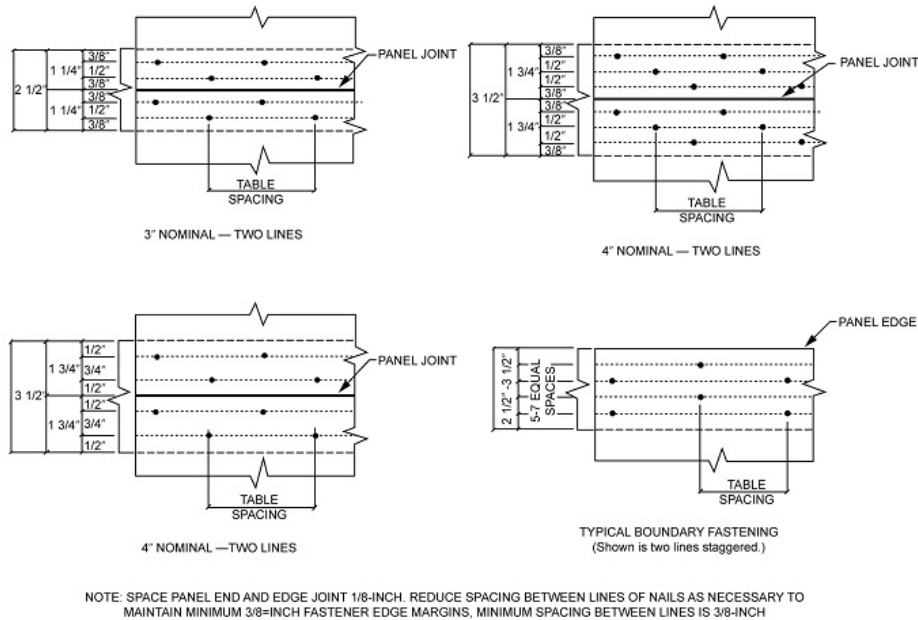
Sheathing single floor and other grades covered in DOC PS 1 and PS 2	14 gage staples	2	$19/32$	3	2	60	60	87	96	1,07	1,200
				4	3	87	90	1,17	1,44	1,47	1,795
			$15/32$	3	2	54	54	73	86	91	1,080
				4	3	73	81	1,00	1,10	1,10	1,195
			$19/32$	3	2	60	60	86	96	1,06	1,200
				4	3	86	90	1,13	1,43	1,37	1,485
			$23/32$	4	3	89	96	1,13	1,49	1,43	1,545

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of framing lumber in [ANSI/AWC NDS](#). (2) For staples, find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Fastening along intermediate framing members: Space fasteners not greater than 12 inches on center, except 6 inches on center for spans greater than 32 inches.
- Panels conforming to [DOC PS 1](#) or [PS 2](#).
- This table gives shear values for Cases 1 and 2 as shown in [Table 2306.2\(1\)](#). The values shown are applicable to Cases 3, 4, 5 and 6 as shown in [Table 2306.2\(1\)](#), providing fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.
- The minimum nominal depth of framing members shall be 3 inches nominal. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- Staples shall have a minimum crown width of $7/16$ inch, and shall be installed with their crowns parallel to the long dimension of the framing members.
- High-load diaphragms shall be subject to special inspection in accordance with [Section 1705.5.1](#).
- For shear loads of normal or permanent load duration as defined by the [ANSI/AWC NDS](#), the values in the table shall be multiplied by 0.63 or 0.56, respectively.
- For fastener spacing diagrams see [Figure 2306.2\(2\)](#).

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For SI: 1 inch = 25.4 mm.

FIGURE 2306.2(2)
FASTENER SPACING DIAGRAMS FOR USE WITH TABLE 2306.2(2)

2306.2.1 Gypsum board diaphragm ceilings.

Gypsum board diaphragm ceilings shall be in accordance with Section 2508.6.

2306.3 Wood-frame shear walls.

Wood-frame shear walls shall be designed and constructed in accordance with AWC SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AWC SDPWS shall be met and the allowable shear values set forth in Table 2306.3(1), 2306.3(2) or 2306.3(3) shall be permitted. The allowable shear values in Tables 2306.3(1) and 2306.3(2) are permitted to be increased 40 percent for wind design. Panels complying with ANSI/APA PRP-210 shall be permitted to use design values for Plywood Siding in the AWC SDPWS.

TABLE 2306.3(1)
ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS UTILIZING STAPLES WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE^a FOR WIND OR SEISMIC LOADING^{b, f, g, i}

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM FASTENER PENETRAT ION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING					PANELS APPLIED OVER 1/2" OR 5/8" GYPSUM SHEATHING				
			Staple length and gage ^h (inches)	Fastener spacing at panel edges (inches)				Staple length and gage ^h (inches)	Fastener spacing at panel edges (inches)			
				6	4	3	2 ^d		6	4	3	2 ^d
Structural I sheathing	3/8	1	1 1/2 16 Gage	155	235	315	400	2 16 Gage	155	235	310	400
	7/16			170	260	345	440		155	235	310	400
	15/32			185	280	375	475		155	235	300	400
Sheathing, plywood siding ^e except Group 5 Species, <i>ANSI/APA PRP 210</i> siding ^e	5/16 ^c or 1/4 ^c	1	1 1/2 16 Gage	145	220	295	375	2 16 Gage	110	165	220	285
	3/8			140	210	280	360		140	210	280	360
	7/16			155	230	310	395		140	210	280	360
	15/32			170	255	335	430		140	210	280	360
	19/32		1 3/4 16 Gage	185	280	375	475	—	—	—	—	—

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of lumber in ANSI/AWC NDS. (2) For staples find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Panel edges backed with 2-inch nominal or wider framing. Install panels either horizontally or vertically. Space fasteners maximum 6 inches on center along intermediate framing members for

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- $\frac{3}{8}$ -inch and $\frac{7}{16}$ -inch panels installed on studs spaced 24 inches on center. For other conditions and panel thickness, space fasteners maximum 12 inches on center on intermediate supports.
- c. $\frac{3}{8}$ -inch panel thickness or siding with a span rating of 16 inches on center is the minimum recommended where applied directly to framing as exterior siding. For grooved panel siding, the nominal panel thickness is the thickness of the panel measured at the point of fastening.
- d. Framing at adjoining panel edges shall be 3 inches nominal or wider.
- e. Values apply to all-veneer plywood. Thickness at point of fastening on panel edges governs shear values.
- f. Where panels are applied on both faces of a wall and fastener spacing is less than 6 inches on center on either side, panel joints shall be offset to fall on different framing members, or framing shall be 3 inches nominal or thicker at adjoining panel edges.
- g. In Seismic Design Category D, E or F, where shear design values exceed 350 pounds per linear foot, all framing members receiving edge fastening from abutting panels shall be not less than a single 3-inch nominal member, or two 2-inch nominal members fastened together in accordance with [Section 2306.1](#) to transfer the design shear value between framing members. Wood structural panel joint and sill plate nailing shall be staggered at all panel edges. See [AWC SDPWS](#) for sill plate size and anchorage requirements.
- h. Staples shall have a minimum crown width of $\frac{7}{16}$ inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- i. For shear loads of normal or permanent load duration as defined by the [ANSI/AWC NDS](#), the values in the table shall be multiplied by 0.63 or 0.56, respectively.

TABLE 2306.3(2)
ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION UTILIZING STAPLES FOR TYPE V CONSTRUCTION ONLY^{a, b, c, d, e}

THICKNESS AND GRADE (inches)	STAPLE GAGE AND DIMENSIONS	ALLOWABLE SHEAR VALUE (pounds per linear foot) STAPLE SPACING AT PANEL EDGES (inches) ^a		
		4	3	2
$\frac{1}{2}$ or $\frac{25}{32}$ Structural	No. 16 gage galvanized staple, $\frac{7}{16}$ " crown $1\frac{3}{4}$ inches long	150	200	225
	No. 16 gage galvanized staple, 1" crown $1\frac{3}{4}$ inches long	220	290	325

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. Fiberboard sheathing shall not be used to brace concrete or masonry walls.
- b. Panel edges shall be backed with 2-inch or wider framing of Douglas Fir-larch or Southern pine. For framing of other species: (1) Find specific gravity for species of framing lumber in [ANSI/AWC NDS](#). (2) For staples, multiply the shear value from the table by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- c. Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.
- d. Fastener shall be spaced 6 inches on center along intermediate framing members.
- e. Values are not permitted in Seismic Design Category D, E or F.

TABLE 2306.3(3)
ALLOWABLE SHEAR VALUES FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD WOOD FRAMED WALL ASSEMBLIES UTILIZING STAPLES

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	STAPLE SPACING ^b MAXIMUM (inches)	SHEAR VALUE ^{a, c} (plf)	MINIMUM STAPLE SIZE ^{f, g}
1. Expanded metal or woven wire lath and Portland cement plaster	$\frac{7}{8}$ "	Unblocked	6	180	No. 16 gage galv. staple, $\frac{7}{8}$ " legs
2. Gypsum lath, plain or perforated	$\frac{3}{8}$ " lath and $\frac{1}{2}$ " plaster	Unblocked	5	100	No. 16 gage galv. staple, $1\frac{1}{8}$ " long
3. Gypsum sheathing	$\frac{1}{2}$ " x 2' x 8'	Unblocked	4	75	No. 16 gage galv. staple, $1\frac{3}{4}$ " long
	$\frac{1}{2}$ " x 4'	Blocked ^d Unblocked	4 7	175 100	

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4. Gypsum board, gypsum veneer base or water-resistant gypsum backing board	1/2"	Unblocked ^d	7	75	No. 16 gage galv. staple, 1 1/2" long
		Unblocked ^d	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked ^e	7	125	
		Blocked ^e	4	150	
	5/8"	Unblocked ^d	7	115	No. 16 gage galv. staple , 1 5/8" long
			4	145	
		Blocked ^e	7	145	
			4	175	
		Blocked ^e Two-ply	Base ply: 9	250	No. 16 gage galv. staple 1 5/8" long No. 15 gage galv. staple, 2 1/4" long
			Face ply: 7		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

- a. These shear walls shall not be used to resist loads imposed by masonry or concrete walls (see [AWC SDPWS](#)). Values shown are for short-term loading due to wind or seismic loading. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of [ASCE 7](#). Values shown shall be reduced 25 percent for normal loading.
- b. Applies to fastening at studs, top and bottom plates and blocking.
- c. Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.
- d. Maximum framing spacing of 24 inches on center.
- e. All edges are blocked, and edge fastening is provided at all supports and all panel edges.
- f. Staples shall have a minimum crown width of $\frac{7}{16}$ inch, measured outside the legs, and shall be installed with their crowns parallel to the long dimension of the framing members.
- g. Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of $\frac{3}{4}$ inch, measured outside the legs.

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