

Wood Diaphragm Assemblies with PWT I-Joist Framing for Seismic or Wind Loading

The International Building Code (IBC) Section 2306.2. permits wood-framed diaphragms to resist lateral forces such as wind or seismic loadings. The code stipulates that wood-framed diaphragms be designed and constructed in accordance with American Wood Council (AWC) Special Design Provision for Wind and Seismic (SDPWS).

SDPWS Table 4.2A "Nominal Unit Shear Capacity for Wood-Frame Diaphragms, Blocked Wood Structural Panel Diaphragms" defines the nominal unit shear capacity based on: Sheathing Grade, Common Nail size, Min. Fastener Penetration, Min. Nom. Panel Thickness, and Min. Nom. Width of Nailed Face, and Nail Spacing and Load Case.

Footnote 2 identifies the values in the table as being based on the Specific Gravity (SG) of the framing lumber or I-Joist "flange" of SG=0.50. The footnote also defines the Specific Gravity Adjustment Factor.

When comparing products it is critical that the Specific Gravity Adjustment Factor be applied to the correct Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.). Example: Framing with a Nominal Width of 3" with a SG Adjustment Factor based on SG = 0.42 (Factor of 0.92 applied to, 4" Boundary Nail Spacing, 8d nails, 15/32 Panel is 0.92 * 1120) is 1030 plf. For the same assembly with a 2" Nominal Width and a SG=0.5 the value is 1010.

The 3" nominal framing member with a SG of 0.42 has a higher capacity than the 2" nominal framing member with a SG of 0.50.

Table 4.2A Nominal Unit Shear Capacities for Sheathed Wood-Frame Diaphragms

Blocked Wood Structural Panel Diaphragms ^{1,2,3,4,6}																
Sheathing Grade	Common Nail Size ⁵ Length (in.) x Shank diameter (in.) x Head diameter (in.)	Minimum Nail Bearing Length in Framing Member or Blocking, ℓ _n (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.)	Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6)											
					6			4			2-1/2			2		
					Nail Spacing (in.) at other panel edges (Cases 1,2,3, & 4)											
					6		6		4		3					
v _n (plf)		G _s (kips/in.)		v _n (plf)		G _s (kips/in.)		v _n (plf)		G _s (kips/in.)		v _n (plf)		G _s (kips/in.)		
OSB		PLY		OSB		PLY		OSB		PLY		OSB		PLY		
Structural I	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	520	15	12	700	8.5	7.5	1050	12	10	1175	20	15
				3	590	12	9.5	785	7.0	6.0	1175	9.5	8.5	1330	17	13
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	3/8	2	755	14	11	1010	9.0	7.5	1485	13	10	1680	21	15
				3	840	12	10	1120	7.5	6.5	1680	10	9.0	1890	18	13
	10d (3 x 0.148 x 0.312)	1-1/2	15/32	2	895	24	17	1190	15	12	1790	20	15	2045	31	21
				3	1010	20	15	1345	12	9.5	2015	16	13	2295	26	18
Sheathing and Single-Floor	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	475	15	10	630	9.0	7.0	940	13	9.5	1065	21	13
				3	530	12	9.0	700	7.0	6.0	1065	10	8.0	1205	17	12
			3/8	2	520	13	9.5	700	7.0	6.0	1050	10	8.0	1175	18	12
				3	590	10	8.0	785	5.5	5.0	1175	8.5	7.0	1330	14	10
			3/8	2	670	15	11	895	9.5	7.5	1345	13	9.5	1525	21	13
				3	755	12	9.5	1010	7.5	6.0	1510	11	8.5	1710	18	12
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	7/16	2	715	14	10	950	8.5	7.0	1415	12	9.5	1610	20	13
				3	800	11	9.0	1065	7.0	6.0	1595	10	8.0	1805	17	12
			15/32	2	755	13	9.5	1010	7.5	6.5	1485	11	8.5	1680	19	13
				3	840	10	8.5	1120	6.0	5.5	1680	9.0	7.5	1890	15	11
			15/32	2	810	25	15	1080	15	11	1610	21	14	1835	33	18
				3	910	21	14	1205	12	9.5	1820	17	12	2060	28	16
10d (3 x 0.148 x 0.312)	1-1/2	19/32	2	895	21	14	1190	13	9.5	1790	18	12	2045	28	17	
			3	1010	17	12	1345	10	8.0	2015	14	11	2295	24	15	

- Nominal unit shear capacities shall be adjusted in accordance with 4.1.4 to determine ASD allowable unit shear capacity and LRFD factored unit resistance. For general construction requirements see 4.2.7. For specific requirements, see 4.2.8.1 for wood structural panel diaphragms. See Appendix A for common nail dimensions.
- For species and grades of framing other than Douglas-Fir-Larch or Southern Pine, reduced nominal unit shear capacities shall be determined by multiplying the tabulated nominal unit shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G = Specific Gravity of the framing lumber from the NDS (Table 12.3.3A). The Specific Gravity Adjustment Factor shall not be greater than 1.
- Apparent shear stiffness values, G_s, are based on nail slip in framing with moisture content less than or equal to 19% at time of fabrication and panel stiffness values for diaphragms constructed with either OSB or 3-ply plywood panels. When 4-ply, or 5-ply plywood panels or composite panels are used, G_s values shall be permitted to be increased by 1.2.
- Where moisture content of the framing is greater than 19% at time of fabrication, G_s values shall be multiplied by 0.5.
- Tabulated nominal unit shear capacities are applicable for carbon steel smooth shank nails of the specified type and size.
- Diaphragm resistance depends on the direction of continuous adjoining panel edges with respect to the loading direction and direction of framing members, and is independent of the panel orientation.

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Wood Diaphragm Assemblies with PWT I-Joist Framing for Seismic or Wind Loading

PWT I-Joists are available in seven different series with different specific gravities (SG) and nominal widths or sizes of nailed face (flange width). Details are shown in Table 5 in ESR-1305 which is available at www.pwtewp.com.

TABLE 5 – EQUIVALENT SPECIFIC GRAVITY FOR DESIGN OF NAIL CONNECTIONS

JOIST SERIES	WITHDRAWAL		DOWEL BEARING	
	Installed in Edge	Installed in Face	Installed in Edge	Installed in Face
SAWN LUMBER FLANGE¹				
PWI 18S / LPI 18 PWI 20S / LPI 20Plus	0.42 (SPF lumber)			
PWI 32S / LPI 32Plus PWI 42S / LPI 42Plus	0.46 (SPF MSR lumber with E = 1.8 to 1.9)			
LVL FLANGES²				
PWI 36L / LPI 36 PWI 56L / LPI 56 PWI 53L / LPI 530	0.46	0.50	0.50	0.50

¹Equivalent specific gravity for sawn lumber flanges in accordance with the NDS for the lumber grade indicated in the parentheses.

²Equivalent specific gravity for LVL flanges in accordance with Table 4 of ICC-ES report ESR-2909 for PWT LVL with a grade of 1.5E-2250Fb and above.

ESR-1305, Table 7 - "Allowable Shear ..." is a comparable to the table on page 1 from SDPWS but for PWT I-Joists.

The adjustment factor is the same, so the conclusion is the same:
For: "Regular" Sheathing, 8d Common Nails, 15/32 Panel Thickness:

2" Nominal, Unblocked, Case 1, with Nails at 4" oc is 240 plf

3" Nominal, Unblocked, Case 1, with Nails at 4" oc is 265 plf.

Applying the adjustment factor for SG=0.42 of 0.92 the value is 244.

The 3" nominal framing member with a SG of 0.42 has a higher capacity than the 2" nominal framing member with a SG of 0.50.

TABLE 7—ALLOWABLE SHEAR (Pounds Per Foot) FOR HORIZONTAL WOOD STRUCTURAL PANEL DIAPHRAGMS FRAMED WITH PWT I-JOISTS (FORMERLY SOLIDSTART®) FOR WIND¹ OR SEISMIC LOADING^{2,3}

Panel Grade	Common Nail Size	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Framing Members at Adjoining Panel Edges and Boundaries ^{4,5} (in.)	BLOCKED DIAPHRAGMS		UNBLOCKED DIAPHRAGMS	
				Nail spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6) ^{6,7}		Nails Spaced 6 in. max. at supported edges ⁶	
				6	4	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 & 6)
Structural 1 Grades	6d ⁶	5/16	2	185	250	165	125
			3	210	280	185	140
	8d	3/8	2	270	360	240	180
			3	300	400	265	200
	10d	15/32	2	320	425	285	215
			3	360	480	320	240
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	6d ⁶	5/16	2	170	225	150	110
			3	190	250	170	125
		3/8	2	185	250	165	125
			3	210	280	185	140
	8d	3/8	2	240	320	215	160
			3	270	360	240	180
		7/16	2	255	340	230	170
			3	285	380	255	190
	10d	15/32	2	270	360	240	180
			3	300	400	265	200
		19/32	2	290	385	255	190
			3	325	430	290	215
19/32	2	320	425	285	215		
	3	360	480	320	240		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 lbf = 4.448 N, 1 lb/ft = 0.0146 N/mm.

¹For wind load applications, the values in the table above shall be permitted to be multiplied by 1.4.

²For shear loads of normal or permanent load duration as defined by the NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

³The tabulated allowable shear capacities are for I-Joist series with flanges having a specific gravity (G) of 0.50 or higher (see Table 5). For G < 0.50 the allowable shear capacities shall be reduced by multiplying the allowable shear capacities by the Specific Gravity Adjustment Factor = [1-(0.5-G)]. The Specific Gravity Adjustment Factor shall not be greater than 1.

⁴See Table 1 for equivalent minimum nominal framing width of the flanges for PWT Joists (formerly SolidStart®).

⁵The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.

⁶Space nails maximum 12 inches o.c. along intermediate framing members (6 inches o.c. when supports are spaced 48 inches o.c. or greater). Fasteners shall be located 3/8 inch minimum from panel edges.

⁷When nail spacing is closer than 6 inches on center at diaphragm boundaries, adjacent nails within a row must be offset (staggered) 1/2 inch:

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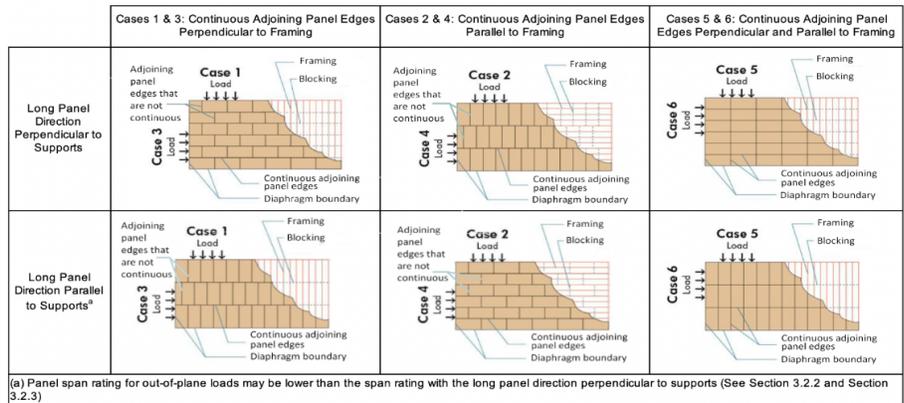
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Wood Diaphragm Assemblies with PWT I-Joist Framing for Seismic or Wind Loading
 Isolating just one section of Table 7 from ESR-1305 to see the affect of the
 Specific Gravity Adjustment Factor on each series of PWT I-Joists.

Common Nail Size	Minimum Nominal Panel Thickness (in)	Minimum Nominal Width of Framing Members at Adjoining Panel Edges and Boundaries (in)	Blocked Diaphragms		Unblocked Diaphragms		Specific Gravity Adjustment Application
			Nail spacing (in) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6)				
			6	4	Case 1 (No unblocked edges or continuous joints parallel to load)	All other conditions (Cases 2, 3, 4, 5, & 6)	
			Nail spacing (in) at other panel edges (Cases 1, 2, 3, & 4)				
6	6						
PWI 53L/LPI 530 and PWI 36L/LPI 36, SG = 0.50							
8d	3/8	2	240	320	215	160	Specific Gravity Adjustment Factor (SGAF) SGAF = (1 - (0.5 - 0.5)) = 1.00 Nominal Framing Width = 2"
	7/16	2	255	340	230	170	
	15/32	2	270	360	240	180	
PWI 56L/LPI 56, SG = 0.50							
8d	3/8	3	270	360	240	180	Specific Gravity Adjustment Factor (SGAF) SGAF = (1 - (0.5 - 0.5)) = 1.00 Nominal Framing Width = 3"
	7/16	3	285	380	255	190	
	15/32	3	300	400	265	200	
PWI 18S/LPI 18 and PWI 20S/LPI 20Plus, SG = 0.42							
8d	3/8	3	248.4	331.2	220.8	165.6	Specific Gravity Adjustment Factor (SGAF) SGAF = (1 - (0.5 - 0.42)) = 0.92 Nominal Framing Width = 3"
	7/16	3	262.2	349.6	234.6	174.8	
	15/32	3	276	368	243.8	184	
PWI 32S/LPI 32Plus and PWI 42S/LPI 42Plus, SG = 0.46							
8d	3/8	3	253.8	338.4	225.6	169.2	Specific Gravity Adjustment Factor (SGAF) SGAF = (1 - (0.5 - 0.46)) = 0.94 Nominal Framing Width = 3"
	7/16	3	267.9	357.2	239.7	178.6	
	15/32	3	282	376	249.1	188	

Diaphragm Loading and Boundary Cases:



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