

How to Read ICC Evaluation Service® ESR-1539® Part IV Shear Wall Allowable Shear Tables

Preface:

This is the fourth in a series of technical bulletins designed to provide a greater understanding of the ICC Evaluation Service evaluation report ESR-1539®.

The focus of this Part IV document is to address allowable shear values for shear wall constructed from wood structural and other materials detailed in Tables 7 - 8 of ESR-1539®.

The driven fasteners (nails and staples) described in the evaluation report are used in engineered and non-engineered (prescriptive) structural connections and are primarily installed using power tools. This technical bulletin references **ESR-1539® Reissue Date 01/2019**.
http://www.icc-es.org/Reports/pdf_files/ESR-1539.pdf

Background:

The first technical bulletin in this series Terminology Used In ICC Evaluation Service Report® ESR-1539® provides a brief description of several technical and administrative terms used.

Part I: Basic ESR Information covers the first four pages of ESR-1539® and provides information on the document format, subject matter, and product descriptions.

Part II: Fastener Basics and Table 1-3 covers the Table of Contents, fastener basics, applicable codes and information on the reference lateral design value of nails in some of the common species of wood used in building construction

Part III: Fastener Withdrawal & Diaphragm Allowable Shear Tables addresses values for nail and staple withdrawal for a variety of wood specific gravities and details the allowable shear tables for wood structural products.

Shear Wall Tables:

Figure A (Table 7 from ESR-1539®) represents the first of the Allowable Shear tables for Shear Walls. There are some similarities to the Allowable Shear tables for diaphragms discussed in How to Read ESR-1539® Part III. The shear wall table references type of sheathing, framing material, nominal nail diameter or staple gage, minimum fastener length and values for seismic and wind loading.

In Figure A, Structural 1 sheathing is referenced when used with Douglas-Fir-Larch or Southern Pine framing.

If framing materials are different than the listed materials, then adjustment factors must be made for differences in material specific gravity. Figure C, Footnote 2 details how the adjustment is to be made.

The shear wall tables differ from the diaphragm table in that the values are based on sheathing material being applied directly to:

- A** Wood framing
- B** Applied over ½ or 5/8 inch gypsum sheathing.

Although shear wall panels can be blocked or unblocked as addressed in section 4.3 of AWC's Special Design Provisions for Wind and Seismic (SDPSW)®, the allowable shear wall data in ESR-1539® Tables 7 and 8 only references fastening on panel edges and makes no reference to blocked or unblocked panels. There are no references to any of the "cases" that were seen in the diaphragm tables.

The IBC Table 2308.9.3(3) prescribes a minimum wall sheathing thickness of 3/8 inch. SDPWS referenced material thicknesses listed in Figure A are:

- C** 3/8 inch
- D** 7/16 inch
- E** 15/32 inch

TABLE 7—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)^{1,2,3,4,5,6,7,8,9,10,11}

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized) nails	MINIMUM NOMINAL FASTENER LENGTH (inches)		SEISMIC				WIND			
	Panels Applied Directly to Framing	Panels Applied Over 1/2 inch or 5/8 inch Gypsum Sheathing	Fastener Spacing at Panel Edges (inches)				Fastener Spacing at Panel Edges (inches)			
			6	4	3	2	6	4	3	2
3/8-inch Nominal Panel Thickness ← C										
0.148	A 2	—	230	360	460	610	320	505	645	855
	—	2 1/2	280	430	550	730	390	600	770	1020
0.135	2	—	230	360	460	610	320	505	645	855
	—	2 1/2	280	430	550	730	390	600	770	1020
0.131	1 3/4	—	230	360	460	610	320	505	645	855
	—	2 1/2	235	360	460	610	330	505	645	855
0.120	1 3/4	—	200	310	395	520	275	435	550	730
	—	2 1/2	200	310	395	520	280	430	550	725
0.113	1 3/4	—	180	280	355	470	245	390	495	655
	—	2 1/2	180	275	355	470	250	385	495	655
14, 15, 16 Gage	1 1/2	—	155	235	315	400	155	235	315	400
14, 15, 16 Gage	—	2	155	235	310	400	155	235	310	400
7/16-inch Nominal Panel Thickness ← D										
0.148	2	—	260	395	505	670	355	550	705	935
	—	2 1/2	280	430	550	730	390	600	770	1020
0.135	2	—	260	395	505	670	355	550	705	935
	—	2 1/2	250	385	490	650	345	535	685	905
0.131	2	—	260	395	505	670	355	550	705	935
	—	2 1/2	235	365	465	615	330	505	650	860
0.120	2	—	225	340	435	580	305	475	610	805
	—	2 1/2	205	310	400	530	285	435	555	735
0.113	2	—	205	310	395	520	280	430	550	730
	—	2 1/2	170	260	330	440	235	360	460	610
14, 15, 16 Gage	1 1/2	—	170	260	345	440	170	260	345	440
14, 15, 16 Gage	—	2	155	235	310	400	155	235	310	400
15/32-inch Nominal Panel Thickness ← E										
0.148	2	—	340	510	665	870	475	715	930	1215
	—	2 1/2	280	430	550	730	390	600	770	1020
0.135	2	—	305	455	590	775	425	635	825	1080
	—	2 1/2	250	385	490	650	345	535	685	905
0.131	2	—	280	430	550	730	390	600	770	1020
	—	2 1/2	240	365	465	615	330	505	650	860
0.120	2	—	245	375	475	630	340	520	665	880
	—	2 1/2	205	315	400	530	285	435	560	740
0.113	2	—	220	340	430	570	305	470	605	800
	—	2 1/2	185	285	365	480	260	395	510	670
14, 15, 16 Gage	1 1/2	—	185	280	375	475	185	280	375	475
14, 15, 16 Gage	—	2	155	235	300	400	155	235	300	400

Figure A – (Table 7 from ESR-1539© Annotation added for clarity of design example)

SDPWS references

- A** An 8d common nail (2½ x 0.131 inch) for use with ¾, 7/16 inch Structural 1 sheathing when nailed directly to framing
- B** An 8d common and a 10d common (3 x 0.148) nail for 15/32 inch Structural 1 sheathing when nailed directly to framing
- C** When applied over ½ or 5/8 inch gypsum wallboard or gypsum sheathing board a 10d common nail is prescribed for all three material thicknesses.

The minimum nominal fastener lengths listed in Figure A are calculated from the requirements of SDPWS.

ICC-ES® Acceptance Criteria, AC116 has provisions within the principles of mechanics that allow for the lateral connection strength of an alternate nail to be compared to the closest but larger code-prescribed nail. These principles were used to develop the shear strength values for the 0.135, 0.120 and 0.113 inch diameter nails when applied directly to framing for all three sheathing thicknesses in Figure A.

Because the AC116 provisions are for the closest but larger code-prescribed nail, a comparison cannot be extended for the 0.135 and 0.148 inch nail as it is larger than the code-prescribed 0.131 diameter nail applied directly to framing for ¾ & 7/16 inch Structural 1. The allowable shear values listed for the 0.131 inch nail must be used for the 0.148 inch nail. (Figure **B** Item D)

AC201 Acceptance Criteria for Staples does not have a method of comparison for lateral connection strength, thus the most restrictive values (those for 16 gage staples), must be applied to the 14 & 15 gage staples.

Staple allowable shear values in Figures A & B are permitted to be increased 40 percent for wind design per Sections 2306.2 & 2306.3 of the IBC®.

TABLE 7—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)^{1,2,3,4,5,6,7,8,9,10,11}

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized) nails	MINIMUM NOMINAL FASTENER LENGTH (inches)		SEISMIC				WIND			
	Panels Applied Directly to Framing	Panels Applied Over 1/2 inch or 5/8 inch Gypsum Sheathing	Fastener Spacing at Panel Edges (inches)				Fastener Spacing at Panel Edges (inches)			
			6	4	3	2	6	4	3	2
3/8-inch Nominal Panel Thickness										
0.148	B → 2	—	230	360	460	610	320	505	645	855
	—	→ 2 1/2	280	430	550	730	390	600	770	1020
0.135	2	—	230	360	460	610	320	505	645	855
	—	→ 2 1/2	250	380	485	645	345	530	680	900
0.131	A → 1 3/4	—	230	360	460	610	320	505	645	855
	—	→ 2 1/2	235	360	460	610	330	505	645	855
0.120	1 3/4	—	200	310	395	520	275	435	550	730
	—	→ 2 1/2	200	310	395	520	280	430	550	725
0.113	1 3/4	—	180	280	355	470	245	390	495	655
	—	→ 2 1/2	180	275	355	470	250	385	495	655
14, 15, 16 Gage	1 1/2	—	155	235	315	400	155	235	315	400
14, 15, 16 Gage	—	2	155	235	310	400	155	235	310	400
7/16-inch Nominal Panel Thickness										
0.148	C → 2	—	260	395	505	670	355	550	705	935
	—	→ 2 1/2	280	430	550	730	390	600	770	1020
0.135	2	—	260	395	505	670	355	550	705	935
	—	→ 2 1/2	250	385	490	650	345	535	685	905
0.131	A → 2	—	260	395	505	670	355	550	705	935
	—	→ 2 1/2	235	365	465	615	330	505	650	860
0.120	2	—	225	340	435	580	305	475	610	805
	—	→ 2 1/2	205	310	400	530	285	435	555	735
0.113	2	—	205	310	395	520	280	430	550	730
	—	→ 2 1/2	170	260	330	440	235	360	460	610
14, 15, 16 Gage	1 1/2	—	170	260	345	440	170	260	345	440
14, 15, 16 Gage	—	2	155	235	310	400	155	235	310	400
15/32-inch Nominal Panel Thickness										
0.148 smooth	B → 2	—	340	510	665	870	475	715	930	1215
	—	→ 2 1/2	280	430	550	730	390	600	770	1020
0.135	C → 2	—	305	455	590	775	425	635	825	1080
	—	→ 2 1/2	250	385	490	650	345	535	685	905
0.131	B → 2	—	280	430	550	730	390	600	770	1020
	—	→ 2 1/2	240	365	465	615	330	505	650	860
0.120	2	—	245	375	475	630	340	520	665	880
	—	→ 2 1/2	205	315	400	530	285	435	560	740
0.113	2	—	220	340	430	570	305	470	605	800
	—	→ 2 1/2	185	285	365	480	260	395	510	670
14, 15, 16 Gage	1 1/2	—	185	280	375	475	185	280	375	475
14, 15, 16 Gage	—	2	155	235	300	400	155	235	300	400

Figure B – (Table 7 from ESR-1539© Annotation added for clarity of example)

Table 8 in ESR-1539[®] [not shown in this bulletin] addresses allowable shear for wind and seismic loading for Rated Sheathing used in shear walls. This table was developed for 3/8, 7/16, 15/32 and 19/32 inch materials.

The same process and procedures used to determine values in ESR-1539[®] Table 7 were used in determining the information in Table 8.

FOOTNOTE EXPLANATIONS FOR SHEAR WALL TABLES 7 AND 8

¹For **SI**: 1 inch = 25.4 mm, 1 plf = 14.6 N/m.

²Shear wall construction using nails must be in accordance with Section 4.3.6 and 4.3.7 of the 2015 and 2008 AF&PA Special Design Provisions for Wind and Seismic (SDPWS), and shear wall construction using staples must be in accordance with 2018 and 2015 IBC Table 2306.3(1) (similar for earlier codes), as applicable.

³Tabulated values are for short-time loading due to wind or seismic. The tabulated seismic values must be reduced by 37 percent and 44 percent for normal and permanent load duration, respectively.

⁴The tabulated values are for fasteners installed in Douglas Fir-larch or Southern Pine. For framing of other species: (1) Find the assigned specific gravity for species of lumber (see Section A1.3) (2) For staples find shear value from the Table 7 (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. (3) For nails find shear value from the applicable table and multiply by the following Specific Gravity Adjustment Factor = $[1-(0.5 - G)]$, where G = Assigned Specific Gravity of the framing lumber. This adjustment factor must not be greater than 1.

⁵Shear wall deflection must be determined in accordance with Section A3.0.

⁶Structural I and Rated Sheathing panels must comply with DOC PS1 or PS2. Install panels either horizontally or vertically. All panel edges must be backed by framing members.

⁷In structures assigned to Seismic Design category D, E, or F, where the allowable shear design value exceeds 350 plf, all framing members receiving edge nailing from abutting panels must not be less than a single 3-inch nominal member. Panel joint and sill plate nailing must be staggered in all cases. See Section 4.3.6.4 of SDPWS, or 2006 IBC Section 2305.3.11 for sill plate size and anchorage requirements, as applicable.

⁸Space fasteners maximum 6 inches on center along intermediate framing members - Exception: When panel thickness is greater than 7/16-inch or studs are spaced less than 24 inches on center, space fasteners maximum 12 inches on center.

⁹Nails must be flat head nails denoted in Appendix B as meeting the head area ratio requirements for lateral force resisting assemblies. A deformed shank nail must have either a helical (screw) shank or an annular (ring) shank.

¹⁰Staples must have a 7/16-inch minimum crown width and must be installed with their crown parallel to the long dimension of the framing members, and must be driven flush with the surface of the sheathing.

¹¹The values for 3/8-inch and 7/16-inch panels applied directly to framing using nails may be increased to values shown for 15/32-inch-thick panels of the same panel grade, provided studs are spaced a maximum of 16 inches on center or panels are applied with long dimension across studs.

Figure C – Footnote Explanation for Shear Wall Tables 7 and 8 taken from ESR-1539[®]

Figure D (Table 9 of ESR-1539[®]) provides the Allowable Shear for Wind or Seismic loading for shear wall constructed with a variety of other structural materials. As most of the nails prescribed in the codes are not products listed in ESR-1539[®], this table deals primarily with staples:

Column **1** describes the various sheathing material (Fiberboard, Gypsum Lath, Gypsum Sheathing, Gypsum Wallboard, Expanded Metal or woven wire lath and Portland cement plaster & Plywood panel siding)

Column **2** describes the nominal sheathing material thickness.

Column **3** indicates the type of wall construction (blocked, unblocked, applied direct to framing, or over gypsum sheathing)

Column **4**: Required spacing of fasteners on panel edge and panel field if applicable.

Column **5**: Provides the shear values for the connection.

Column **6**: Provides fastener specification

Column **7**: Due to the large number of notes associated with the various connections the reader is directed to the codes and SDPWS to read the associated notes.

1**2****3****4****5****6****7****TABLE 9 —ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR SHEAR WALLS WITH FIBERBOARD SHEATHING, GYPSUM LATH, GYPSUM SHEATHING, GYPSUM WALLBOARD, LATH AND PLASTER OR PLYWOOD SIDING OVER WOOD FRAMING (plf)^{1,3,4}**

SHEATHING MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	REQUIRED SPACING (inches on center)		SHEAR VALUE (plf)		FASTENER SPECIFICATIONS	COMMENTS			
			Panel Edges	Field	Seismic	Wind					
Fiberboard Sheathing	1/2"	Blocked	4	6	150	210	1 1/4" long, 16, 15 & 14 gage staple	Reference 2018, 2015 and 2012 IBC Table 2306.3(2) [2009 IBC Table 2306.6] for applicable notes			
			3		200	280					
			2		225	315					
			4		220	310					
			3		290	405					
			2		325	455					
	25/32"	Blocked	4	6	150	210	1 1/2" long, 16, 15 & 14 gage staple				
			3		200	280					
			2		225	315					
			4		220	310					
			3		290	405					
			2		325	455					
Gypsum Lath	3/8" + 1/2" Plaster	Unblocked	5		100		1 1/8" long, 3/4" crown, 16, 15 & 14 gage staple				
Gypsum Sheathing	1/2" x 2' x 8'	Unblocked	4		75		1 3/4" long, 16, 15 & 14 gage staple				
		Blocked			175 ²						
	Unblocked	7		100							
Gypsum Wallboard	1/2"	Unblocked	7	6	75 ²	100	1 1/2" long, 16, 15 & 14 gage staple	Reference 2018, 2015 and 2012 IBC Table 2306.3(3) [2009 IBC Table 2306.7] for applicable notes			
			4		110 ²						
					125						
					125						
		Blocked	7		125						
	5/8"	Unblocked	7	6	115 ²	150			1 5/8" long, 16, 15 & 14 gage staple		
			4		145 ²						
			Blocked		7					145	
					4					175	
		Blocked two-ply	Base Ply - 9		250					1 5/8" long, 16, 15 & 14 gage staple	
Face Ply - 7	2 1/4" long, 15 & 14 gage staple										
Expanded metal or woven wire lath and Portland cement plaster	7/8"	Unblocked	6" On Center @ Each Framing Member		180		7/8" long, 3/4" crown, 16, 15 & 14 gage staple				
Plywood Panel Siding Shear Walls with Framing of Douglas Fir-Larch or Southern Pine ²	3/8"	Panels Applied Directly To Framing	6	6	160	225	2 1/2 x 0.113 smooth	Reference SDPWS Table 4.3A for applicable notes			
			4		240	335					
			3		310	435					
			2		410	575					
			6	6	140	195			1 1/2" long, 16, 15 & 14 gage staple	Reference 2018, 2015 and 2012 IBC Table 2306.3(1) [2009 IBC Table 2306.3] for applicable notes	
			4		210	295					
			3		280	390					
			2		360	505					
		Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	6	6	6	160	225	3 x 0.131 smooth nail			Reference SDPWS Table 4.3B for applicable notes
				4		240	335				
				3		310	435				
			2	410		575					
			6	6		140	195		2" long, 16, 15 & 14 gage staple	Reference 2018, 2015 and 2012 IBC Table 2306.3(1) [2009 IBC Table 2306.3] for applicable notes	
			4			210	295				
3	280	390									
2	360	505									

For SI: 1 inch = 25.4 mm; 1 foot = 305 mm; 1 plf = 14.6 N/m.

¹Shear values are based on maximum framing spacing of 16 inches on center, unless otherwise noted.²Shear values are based on maximum framing spacing of 24 inches on center.³Staples must have a minimum crown width of 7/16 inch, measured outside the legs, unless otherwise noted.⁴In addition to requirements presented above for fastening of shear walls all other requirements of the applicable model code (such as, but not limited to, conditions of use and modification of design values for certain Seismic Design Categories) pertaining to shear wall design and construction must be met.**Figure D – Table 9 taken from ESR-1539[®] Annotation added for Clarity of Example**

Referenced Documents:

ANSI/AWC NDS-2018 National Design Specification for Wood © American Wood Council 2017

ANSI/AWC SDPWS – 2015 Special Design Provisions for Wind and Seismic © American Wood Council 2014

ASTM F1667-18a Standard Specifications for Driven Fasteners: Nails, Spikes and Staples
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AC116 ICC-ES Acceptance Criteria for Nails
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AC201 ICC-ES Acceptance Criteria for Staples
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