Technical Bulletin

How to Read ICC Evaluation Service® ESR-1539©
Part III Fastener Withdrawal & Diaphragm Allowable Shear Tables

Preface:

This is the third 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 III document is to address values of nail and staple withdrawal for a variety of wood specific gravities detailed in Table 4, as well as the allowable shear values for wood structural horizontal diaphragms detailed in Table 5 and 6 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 05/2018.** 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, 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.

Figure A - (Table 4 - Nail and Staple Reference Withdrawal Design Values)

Nail and Staple Reference Withdrawal Design Values for smooth shank nails, deformed shank nails, and staples are provided in Figure A. Values are calculated from the equations provided in Appendix A for nail and staple withdrawal. In the 2018 NDS, a substantial change was made in regards to the withdrawal of deformed shank nails and stainless steel nails.

First: Prior to the 2018 NDS, deformed shank nails were referenced with an approximate 10% increase in withdrawal value over smooth shank nails of the same diameter. This was changed in 2018 to assume that deformed shank nail withdrawal values were equivalent to smooth shank nail withdrawal values.

Second: Withdrawal values for stainless steel nails were established with revised values that are different [lower] in value from carbon steel nails of the same size.

Values presented in Figure A are based on:

1. Specific Gravity of the wood the fastener has been driven into
2. Nominal shank diameter of carbon steel nails (smooth and deformed shank, bright or galvanized)
3. Nominal shank diameter of stainless steel nails (smooth and deformed shank).
4. Gage of staple

1 2 3 4

TABLE 4—NAIL AND STAPLE REFERENCE WITHDGRAWAL DESIGN VALUES[1,2,3] POUNDS PER INCH OF PENETRATION

SPECIFIC GRAVITY[4]	SMOOTH AND DEFORMED[5] SHANK CARBON STEEL NAILS (BRIGHT OR GALVANIZED) DIAMETER IN INCHES										SMOOTH AND DEFORMED SHANK NAILS (STAINLESS STEEL)[5] DIAMETER IN INCHES								STAPLE GAGE AND DIAMETER[6], in inches		
	0.092	0.099	0.113	0.120	0.131	0.135	0.148	0.162	0.180	0.197	0.092	0.099	0.113	0.120	0.131	0.135	0.148	0.162	16 gage	15 gage	14 gage
																			0.063	0.072	0.080
0.31	7	7	9	9	9	10	11	12	13	15	7	8	9	10	11	11	12	13	9	11	12
0.35	9	10	13	13	13	14	15	16	18	20	9	10	11	12	13	13	14	16	13	14	16
0.36	10	10	13	13	13	14	16	17	19	21	9	10	11	12	13	14	15	16	13	15	17
0.37	11	11	14	14	14	16	17	19	21	23	10	10	12	13	14	14	15	17	14	17	18
0.38	11	12	15	15	15	17	18	20	22	24	10	11	12	13	14	15	16	18	15	18	20
0.39	12	13	16	16	16	18	19	21	24	26	10	11	13	14	15	15	17	18	16	19	21
0.40	13	14	17	17	17	19	21	23	25	28	11	12	13	14	15	16	17	19	17	20	22
0.41	14	14	19	19	19	20	22	24	27	29	11	12	14	15	16	16	18	20	19	21	24
0.42	15	15	20	20	20	21	23	26	28	31	12	13	14	15	17	17	19	21	20	23	25
0.43	15	16	21	21	21	23	25	27	30	33	12	13	15	16	17	18	19	21	21	24	27
0.44	16	17	22	22	22	24	26	29	32	35	12	13	15	16	18	18	20	22	22	26	28
0.46	18	19	25	25	25	27	29	32	36	39	13	14	16	17	19	20	21	24	25	29	32
0.47	19	20	26	26	26	28	31	34	38	41	14	15	17	18	20	20	22	24	26	30	33
0.49	21	22	29	29	29	31	34	38	42	46	15	16	18	19	21	22	24	26	29	33	37
0.50	22	24	30	30	30	33	36	40	44	48	15	16	19	20	22	22	24	27	30	35	39
0.51	24	25	32	32	32	35	38	42	46	50	16	17	19	20	22	23	25	27	32	37	41
0.55	28	30	39	39	39	42	46	50	56	61	17	19	21	23	25	26	28	31	39	45	50
0.58	33	34	44	44	44	48	52	57	64	70	19	20	23	25	27	28	30	33	44	51	57
0.67	47	49	63	63	63	68	75	82	91	100	23	25	29	31	33	34	38	41	63	73	81
0.68	48	51	66	66	66	71	78	85	95	104	24	26	29	31	34	35	39	42	66	76	84
0.71	54	57	73	73	73	79	87	95	106	115	26	28	31	33	36	38	41	45	73	84	91
0.73	58	61	79	79	79	85	93	102	113	124	27	29	33	35	38	39	43	47	79	90	101

For **SI:** 1 inch = 25.4 mm, 1 pound per inch = 0.18 N/mm.

[1]Design values are based on a normal (10 year) duration of load.

[2]Table values must be multiplied by all applicable adjustment factors in the NDS.

[3]Withdrawal strengths are for fasteners driven perpendicular to the grain.

[4]Specific Gravity values must be the assigned specific gravity from Table A or (2018 or 2015 NDS Table 12.3.3A for the 2018 or 2015 IBC), (2012 NDS-Table 11.3.3A for the 2012 IBC, 2005 NDS Table 11.3.2A for the 2009 and 2006 IBC) or the equivalent specific gravity for engineered wood products, as shown in an ICC-ES evaluation report.

[5]Applies to deformed nails recognized in this report

[6]Values account for both staple legs

Figure A – (Table 4 From ESR-1539©
Annotation added for clarity of design example)

Appendix A of ESR-1539© provides mathematical equations for calculating withdrawal values for carbon steel nails and staples and stainless steel nails.

Figures B-E represents the first of the Allowable Shear tables referenced in ESR-1539© and references Structural I sheathing for use in diaphragms.

Referenced Section 1 Figure B): Indicates the type of sheathing referenced and the framing material that the sheathing is attached to.

If framing materials are different than the listed materials, then adjustment factors must be made for differences in material specific gravity. Footnote 4 on page 9 details how the adjustment is to be made. An explanation of why an adjustment for specific gravity is provided later in this document when discussing (Figure E).

Referenced Section 2 (Figure B): References two of the three Structural I material thicknesses, referenced in SDPWS Table 4.2A. IBC® Section 2304.8 does not reference the $^{5}/_{16}$" thick material, thus the evaluation report is limited to $^{3}/_{8}$" and $^{15}/_{32}$" only.

Referenced Section 3 (Figure B): Addresses the fasteners recognized for diaphragms by material thickness.

Referenced Section 4 (Figure B): Addresses the miniumum fastener length required for the fastener diameter / material thickness.

Example of length determination:
For $^{3}/_{8}$" Structural I wood structural panel, SDPWS calls for an 8d common nail (2½" x 0.131) nail with a miniumum penetration into the main member of $1^{3}/_{8}$".

This equates to minimum required nail length of $1^{3}/_{4}$". The sum of the minimum penetration into the main member + the side member thickness

$$1^{3}/_{8}" + {}^{3}/_{8}" = 1¾".$$

The IBC® & IRC® reference a 16 gage staple with a minimum leg of 1½".

Referenced Section 5 (Figure B) addresses the two minimum (nominal) framing widths, 2 inch and 3 inch, referenced in the IBC® and SDPWS.

Reference Section 6, 7 & 8 (Figure B)

The table is then divided into two main sections:

6 Blocked Diaphragms

7 Unblocked Diaphragms

Each of these types of diaphrgams have their own requirements when determining allowable shear values.

8 The column headers for blocked diaphragms makes references to diaphragm boundaries, continuous panel edges, continuous panel joints and all panel edges.

TABLE 5—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized)	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								UNBLOCKED DIAPHRAGMS FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		$2^1/_2$		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
$^3/_8$-inch Nominal Panel Thickness														
0.131	**$1^3/_4$**	2	270	375	360	505	530	740	600	840	240	335	180	255
		3	300	420	400	560	600	840	675	945	265	370	200	280
0.120	$1^3/_4$	2	230	320	305	435	455	635	515	720	200	290	150	220
		3	255	360	340	480	510	720	580	810	225	320	170	240
0.113	$1^3/_4$	2	205	290	275	390	410	570	465	645	180	260	135	200
		3	230	325	305	430	460	645	520	725	205	285	155	215
14, 15, **16 Gage**	**$1^1/_2$ Leg Length**	2	175	175	235	235	350	350	400	400	155	155	115	115
		3	200	200	265	265	395	395	450	450	175	175	130	130
$^{15}/_{32}$-inch Nominal Panel Thickness														
0.148 smooth	2	2	320	445	425	595	640	895	730	1025	285	400	215	300
		3	360	505	480	670	720	1005	820	1150	320	445	240	335
0.135	2	2	285	395	380	530	570	795	650	910	255	355	195	270
		3	320	450	430	595	640	895	730	1020	285	395	215	300
0.131	2	2	270	375	360	505	540	755	610	865	240	340	180	255
		3	305	425	405	565	605	845	685	970	270	375	200	285
0.120	2	2	230	325	310	435	465	650	525	745	205	290	155	220
		3	260	370	350	490	520	730	590	835	230	325	175	245
0.113	2	2	210	295	280	395	420	590	475	675	185	265	140	200
		3	235	335	315	440	470	660	535	755	210	295	155	220
14, 15, 16 Gage	$1^1/_2$ Leg Length	2	175	175	235	235	350	350	400	400	155	155	120	120
		3	200	200	265	265	395	395	450	450	175	175	130	130

1 2 3 4 5 6 7 8

Figure B – (Table 5 From ESR-1539©
Annotation added for clarity of design example)

An 8d common (2½" x 0.131") nail and a 16 gage staple are the prescribed fasteners for 3/8" Structural 1 sheathing when used in diaphragms. These fasteners have established allowable shear values taken from the IBC and/or SDPWS and are indicated in Figure C.

For ESR-1539©, provisions allowing for alternative fasteners were developed and published by ICC-ES in two specific documents known as Acceptance Criteria: AC116 Acceptance Criteria for Nails and AC201 Acceptance Criteria for Staples.

The allowable shear tables in Table 5 make reference to "**cases**". Cases are the standard wood structural panel diaphragm configurations used in design and construction. See Appendix 1 for a brief description on each of the six cases.

TABLE 5—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized)	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS								UNBLOCKED DIAPHRAGMS			
			FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		2½		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
3/8-inch Nominal Panel Thickness														
0.131	1 3/4	2	270	375	360	505	530	740	600	840	240	335	180	255
		3	300	420	400	560	600	840	675	945	265	370	200	280
0.120	1 3/4	2	230	320	305	435	455	635	515	720	200	290	150	220
		3	255	360	340	480	510	720	580	810	225	320	170	240
0.113	1 3/4	2	205	290	275	390	410	570	465	645	180	260	135	200
		3	230	325	305	430	460	645	520	725	205	285	155	215
14, 15, 16 Gage	1 1/2 Leg Length	2	175	175	235	235	350	350	400	400	155	155	115	115
		3	200	200	265	265	395	395	450	450	175	175	130	130
15/32-inch Nominal Panel Thickness														
0.148	2	2	320	445	425	595	640	895	730	1025	285	400	215	300
		3	360	505	480	670	720	1005	820	1150	320	445	240	335
0.135	2	2	285	395	380	530	570	795	650	910	255	355	195	270
		3	320	450	430	595	640	895	730	1020	285	395	215	300
0.131	2	2	270	375	360	505	540	755	610	865	240	340	180	255
		3	305	425	405	565	605	845	685	970	270	375	200	285
0.120	2	2	230	325	310	435	465	650	525	745	205	290	155	220
		3	260	370	350	490	520	730	590	835	230	325	175	245
0.113	2	2	210	295	280	395	420	590	475	675	185	265	140	200
		3	235	335	315	440	470	660	535	755	210	295	155	220
14, 15, 16 Gage	1 1/2 Leg Length	2	175	175	235	235	350	350	400	400	155	155	120	120
		3	200	200	265	265	395	395	450	450	175	175	130	130

Figure C – (Table 5 from ESR-1539© Annotation added for clarity of design example)

AC116 has provisions that allow for the lateral connection strength of an alternate nail to be compared to the closest but larger code prescribed nail. This process requires the calculation of the Reference Lateral Design Value 'Z'.

Calculating 'Z' requires using the dowel bearing strength which is dependent on wood specific gravity. Thus a change in the wood specific gravity would change the values in the tabulated values in Figure D. This is taken into consideration when the adjustment factor referenced in footnote 4 is taken. These principles have been used to develop the shear strength values for the alternative diameter nails in Figure D. The 0.131 inch diameter nail is the larger code prescribed nail for use in $^{3}/_{8}$" Structural I sheathing while the 0.148 inch nail is prescribed for $^{15}/_{32}$" Structural I.

AC201 does not provide a similar provision for staples. The values for staples in this table are based strictly on the code prescribed 16 gage staples.

TABLE 5—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized)	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS								UNBLOCKED DIAPHRAGMS			
			FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		$2^{1}/_{2}$		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
$^{3}/_{8}$-inch Nominal Panel Thickness														
0.131	$1^{3}/_{4}$	2	270	375	360	505	530	740	600	840	240	335	180	255
		3	300	420	400	560	600	840	675	945	265	370	200	280
0.120	$1^{3}/_{4}$	2	230	320	305	435	455	635	515	720	200	290	150	220
		3	255	360	340	480	510	720	580	810	225	320	170	240
0.113	$1^{3}/_{4}$	2	205	290	275	390	410	570	465	645	180	260	135	200
		3	230	325	305	430	460	645	520	725	205	285	155	215
14, 15, 16 Gage	$1^{1}/_{2}$ Leg Length	2	175	175	235	235	350	350	400	400	155	155	115	115
		3	200	200	265	265	395	395	450	450	175	175	130	130
$^{15}/_{32}$-inch Nominal Panel Thickness														
0.148	2	2	320	445	425	595	640	895	730	1025	285	400	215	300
		3	360	505	480	670	720	1005	820	1150	320	445	240	335
0.135	2	2	285	395	380	530	570	795	650	910	255	355	195	270
		3	320	450	430	595	640	895	730	1020	285	395	215	300
0.131	2	2	270	375	360	505	540	755	610	865	240	340	180	255
		3	305	425	405	565	605	845	685	970	270	375	200	285
0.120	2	2	230	325	310	435	465	650	525	745	205	290	155	220
		3	260	370	350	490	520	730	590	835	230	325	175	245
0.113	2	2	210	295	280	395	420	590	475	675	185	265	140	200
		3	235	335	315	440	470	660	535	755	210	295	155	220
14, 15, 16 Gage	$1^{1}/_{2}$ Leg Length	2	175	175	235	235	350	350	400	400	155	155	120	120
		3	200	200	265	265	395	395	450	450	175	175	130	130

Figure D – (Table 5 from ESR-1539© Annotation added for clarity of design example)

Table 6 – Addresses allowable shear for wind and seismic loading in Rated Sheathing. With rated sheathing for use in diaphragms, four material thicknesss ($^{3}/_{8}$", $^{7}/_{16}$", $^{15}/_{32}$" and $^{19}/_{32}$") are addressed.

The same process and procedures used to develop Table 5 are used in determining the information provided in Table 6.

FOOTNOTE EXPLANATIONS FOR HORIZONTAL DIAPHRAGM TABLES 5 and 6

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

[2]Diaphragm construction using nails must be in accordance with Section 4.2.6 and 4.2.7 of the 2015 and 2008 AWC Special Design Provisions for Wind and Seismic (SPDWS), and diaphragm construction using staples must be in accordance with 2018 and 2015 IBC Tables 2306.2(1) and 2306.2(2) (similar for earlier codes), as applicable.

[3]Tabulated 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.

[4]The tabulated values are for fasteners installed in Douglas Fir-larch or Southern Pine framing. For framing of other species: (1) Find the assigned specific gravity for the applicable species of lumber (see Section A1.3). (2) For staples find the shear value from Table 5 (regardless of actual sheathing grade) and multiply the value by 0.82 for species with specific gravity of 0.42 or greater, or by 0.65 for all other species. (3) For nails find the shear value from the applicable table and multiply value by the Specific Gravity Adjustment Factor = [1- (0.5 – G)], where *G* = Specific Gravity of the framing lumber. This adjustment factor must not be greater than 1.

[5]Diaphragm deflection must be determined in accordance with Section A3.0.

[6]Structural I panels must comply with DOC PS1 or PS2. Rated Sheathing includes Sheathing and Single-Floor grades and must comply with DOC PS1 or PS2.

[7]Nails must be bright or galvanized carbon steel, 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. Diaphragm values for stainless steel nails are outside the scope of this report.

[8]Staples must have a $^{7}/_{16}$-inch minimum crown width and must be installed with their crowns parallel to the long dimension of the framing members and must be driven flush with the surface of the sheathing.

[9]Space fasteners maximum 12" o.c. along intermediate framing members (6 in. o.c. when supports are spaced 48 inches o.c.).

Figure E - Footnote Explanations for Horizontal Diaphragms Tables 5 and 6 from ESR-1539©

How to use the allowable shear tables for diaphragms

Example A:

A blocked diaphragm is to be built using **$^{15}/_{32}$**" rated sheathing applied over 2' x 10" truss chords that are 16" on-center. It has been calculated that the diaphragm must resist a unit shear of 400 plf due to wind loading. Nails are to be used for fastening the sheathing.

What nail sizes and spacing are appropriate for the design?

Note: This example does not take into consideration any adjustment factors referenced in the NDS or SDPWS. It is the responsibility of the designer to ensure this has been addressed.

Step 1: Diaphragm of rated sheathing. Choose Table 6.
Step 2: Choose an appropriate material thickness in this case, **$^{15}/_{32}$**".
Step 3: Nails were being specified; thus, eliminate staples.
Step 4: Blocked diaphragm was specified for this application; eliminate the unblock diaphragms.
Step 5: Framing is 2" x 10"; eliminate 3" framing members.
Step 6: Example is for Wind Loading eliminate Seismic Loading
Step 7: The exercise states that the design meet a 400 plf. wind load. Choose values greater than 400 plf.

(1) TABLE 6—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND RATED SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) or STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized)	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS								UNBLOCKED DIAPHRAGMS			
			FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		2½		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
5/8-Inch Nominal Panel Thickness														
0.131	1¾	2 3	240 270	335 375	320 360	445 505	480 540	670 755	545 610	760 855	215 240	300 335	160 180	225 250
0.120	1¾	2 3	205 230	285 315	270 305	375 425	405 455	565 640	460 515	640 720	180 205	255 285	135 150	190 210
0.113	1¾	2 3	180 205	255 285	240 270	335 380	360 405	505 570	410 460	575 645	160 180	225 255	120 135	170 190
14, 15,16 Gage	1½ Leg Length	2 3	160 180	225 250	210 235	295 330	315 355	440 495	360 400	505 560	140 160	195 225	105 120	145 170
7/16-Inch Nominal Panel Thickness														
0.131	2	2 3	255 285	360 400	340 380	475 530	505 570	705 800	575 645	805 900	230 255	320 355	170 190	235 265
0.120	2	2 3	215 240	305 340	290 325	405 450	430 485	600 680	490 550	685 765	190 215	270 300	145 160	200 225
0.113	2	2 3	195 215	275 305	260 290	360 405	385 435	540 610	440 490	615 685	175 195	245 270	130 145	180 200
14, 15, 16 Gage	1½ Leg Length	2 3	165 190	230 265	225 250	315 350	335 375	470 525	380 425	530 595	150 165	210 230	110 125	155 175
15/32-Inch Nominal Panel Thickness														
0.148	2	2 3	~~290~~ ~~325~~	~~405~~ ~~455~~	~~385~~ ~~430~~	~~540~~ ~~605~~	~~675~~ ~~650~~	~~805~~ ~~910~~	~~665~~ ~~735~~	~~920~~ ~~1030~~	~~265~~ ~~290~~	~~360~~ ~~405~~	~~190~~ ~~215~~	~~265~~ ~~300~~
0.135	2	2 3	~~265~~ ~~285~~	~~365~~ ~~400~~	~~340~~ ~~380~~	~~475~~ ~~530~~	~~605~~ ~~575~~	~~710~~ ~~800~~	~~580~~ ~~650~~	~~810~~ ~~910~~	~~205~~ ~~265~~	~~315~~ ~~365~~	~~170~~ ~~190~~	~~235~~ ~~265~~
0.131	2	2 3	~~270~~ ~~300~~	~~380~~ ~~420~~	~~360~~ ~~400~~	~~505~~ ~~560~~	~~630~~ ~~600~~	~~740~~ ~~840~~	~~600~~ ~~675~~	~~840~~ ~~945~~	~~240~~ ~~265~~	~~335~~ ~~370~~	~~180~~ ~~200~~	~~255~~ ~~280~~
0.120	2	2 3	~~230~~ ~~255~~	~~325~~ ~~360~~	~~305~~ ~~340~~	~~430~~ ~~480~~	~~460~~ ~~510~~	~~630~~ ~~715~~	~~510~~ ~~575~~	~~715~~ ~~805~~	~~205~~ ~~225~~	~~285~~ ~~315~~	~~155~~ ~~170~~	~~220~~ ~~240~~
0.113	2	2 3	~~205~~ ~~230~~	~~290~~ ~~320~~	~~275~~ ~~305~~	~~385~~ ~~430~~	~~405~~ ~~460~~	~~570~~ ~~645~~	~~460~~ ~~520~~	~~645~~ ~~725~~	~~185~~ ~~205~~	~~255~~ ~~285~~	~~140~~ ~~155~~	~~195~~ ~~215~~
~~14, 15, 16 Gage~~	~~1½ Leg Length~~	2 3	~~160~~ ~~180~~	~~225~~ ~~250~~	~~210~~ ~~235~~	~~295~~ ~~330~~	~~315~~ ~~355~~	~~440~~ ~~495~~	~~360~~ ~~405~~	~~505~~ ~~565~~	~~140~~ ~~160~~	~~195~~ ~~225~~	~~105~~ ~~120~~	~~145~~ ~~170~~
15/32-Inch Nominal Panel Thickness[10]														
0.148	2¼	2 3	320 360	445 505	425 480	595 675	640 720	895 1010	730 820	1025 1150	285 320	400 445	215 240	300 335
0.135	2¼	2 3	285 320	395 450	375 425	525 595	565 640	795 895	645 725	905 1020	255 285	355 395	190 215	265 295
0.131	2¼	2 3	270 305	375 425	360 405	500 565	540 605	755 850	615 690	860 965	240 270	335 375	180 200	255 285
0.120	2¼	2 3	235 260	325 365	310 350	435 490	465 525	650 735	530 595	745 835	205 235	290 325	155 175	220 245
0.113	2¼	2 3	210 240	295 335	280 315	395 445	420 475	590 665	480 540	675 760	190 210	265 295	140 160	200 220
14, 15, 16 Gage	1½ Leg Length	2 3	175 200	245 280	235 265	330 370	350 395	490 555	400 450	560 630	155 175	215 245	115 130	160 180

(2) (3) (4) (5) (6)

(Example A –Table 6 From ESR-1539© Annotation added for clarity of design example)

Example B:

From the previous example, what changes would be seen if the framing material was specified as another common lumber species, Spruce-Pine-Fir (SPF)?

Steps 1, 2, 3 would be the same as above.

-Use of Table 6 for rated sheathing

-Choice of the $^{15}/_{32}$" thick material

-Elimination of the Seismic Values, 3-inch framing members, unblocked diaphragm columns, staples, and values less than 400 plf.

Step 4 After determining which values exceed 400 plf the required adjustment factor for changes in framing material specific gravity must be made. From foot note 4 for ESR-1539© Table 6:

"Find the assigned specific gravity for the applicable species of lumber **= 0.42 (for SPF from Table A of the ESR-1539©)**

"For nails, find the shear value from the applicable table and multiply the value by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G= Specific Gravity of the framing lumber. This adjustment factor must not be greater than 1."

Specific Gravity Adjustment Factor - [1-(0.5-0.42)] = 0.92

The values exceeding 400 plf are multiplied by 0.92 resulting in the following changes.

In Example B below the newly recalculated values are rounded to the nearest 5 plf.
Two of the values no longer exceeds 400 plf, the minimum level, and would be eliminated from consideration.

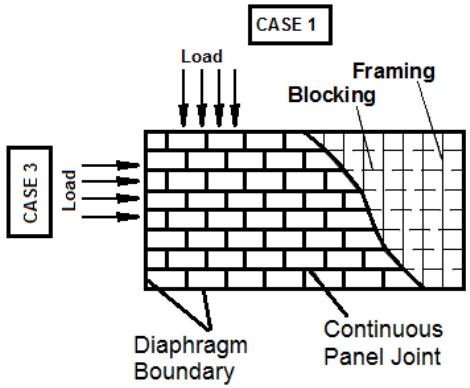
TABLE 6—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND RATED SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (Inch) or STAPLE GAGE Nails must be smooth or deformed, carbon steel (bright or galvanized)	MINIMUM REQUIRED FASTENER LENGTH (Inches)	MINIMUM WIDTH OF FRAMING MEMBER (Inches)	BLOCKED DIAPHRAGMS								UNBLOCKED DIAPHRAGMS			
			FASTENER SPACING (Inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		2½		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
7/8-Inch Nominal Panel Thickness														
0.131	1¾	2 3	240 270	335 375	320 360	445 505	480 540	670 755	545 610	760 855	215 240	300 335	160 180	225 250
0.120	1¾	2 3	205 230	285 315	270 305	375 425	405 455	565 640	460 515	640 720	180 205	255 285	135 150	190 210
0.113	1¾	2 3	180 205	255 285	240 270	335 380	360 405	505 570	410 460	575 645	160 180	225 255	120 135	170 190
14, 15,16 Gage	1½ Leg Length	2 3	160 180	225 250	210 235	295 330	315 355	440 495	360 400	505 560	140 160	195 225	105 120	145 170
15/16-Inch Nominal Panel Thickness														
0.131	2	2 3	255 285	360 400	340 380	475 530	505 570	705 800	575 645	805 900	230 255	320 355	170 190	235 265
0.120	2	2 3	215 240	305 340	290 325	405 450	430 485	600 680	490 550	685 765	190 215	270 300	145 160	200 225
0.113	2	2 3	195 215	275 305	260 290	360 405	385 435	540 610	440 490	615 685	175 195	245 270	130 145	180 200
14, 15, 16 Gage	1½ Leg Length	2 3	165 190	230 265	225 250	315 350	335 375	470 525	380 425	530 595	150 165	210 230	110 125	155 175
~~1 1/16~~-Inch Nominal Panel Thickness														
0.148	2	2 3	~~290~~ ~~325~~	405 ~~455~~	~~385~~ ~~430~~	540 ~~605~~	~~575~~ ~~650~~	805 ~~910~~	~~665~~ ~~735~~	920 ~~1030~~	~~255~~ ~~290~~	~~360~~ ~~405~~	~~190~~ ~~215~~	~~265~~ ~~300~~
0.135	2	2 3	~~255~~ ~~285~~	~~355~~ ~~400~~	~~340~~ ~~380~~	475 ~~530~~	~~505~~ ~~575~~	710 ~~800~~	~~580~~ ~~660~~	810 ~~910~~	~~225~~ ~~255~~	~~315~~ ~~355~~	~~170~~ ~~190~~	~~235~~ ~~265~~
0.131	2	2 3	~~270~~ ~~300~~	~~380~~ ~~420~~	~~360~~ ~~400~~	505 ~~560~~	~~530~~ ~~600~~	740 ~~845~~	~~600~~ ~~675~~	840 ~~945~~	~~240~~ ~~265~~	~~335~~ ~~370~~	~~180~~ ~~200~~	~~255~~ ~~280~~
0.120	2	2 3	~~230~~ ~~255~~	~~325~~ ~~360~~	~~305~~ ~~340~~	430 ~~480~~	~~460~~ ~~510~~	630 ~~715~~	~~510~~ ~~575~~	715 ~~805~~	~~205~~ ~~225~~	~~285~~ ~~315~~	~~155~~ ~~170~~	~~220~~ ~~240~~
0.113	2	2 3	~~205~~ ~~230~~	~~290~~ ~~320~~	~~275~~ ~~305~~	~~385~~ ~~430~~	~~405~~ ~~460~~	570 ~~645~~	~~450~~ ~~520~~	645 ~~725~~	~~185~~ ~~205~~	~~255~~ ~~285~~	~~140~~ ~~155~~	~~195~~ ~~215~~
~~14, 15, 16 Gage~~	~~1½ Leg Length~~	2 3	~~160~~ ~~180~~	~~225~~ ~~250~~	~~210~~ ~~235~~	~~295~~ ~~330~~	~~315~~ ~~355~~	~~440~~ ~~495~~	~~360~~ ~~405~~	~~505~~ ~~565~~	~~140~~ ~~160~~	~~195~~ ~~225~~	~~105~~ ~~120~~	~~145~~ ~~170~~
1 1/16-Inch Nominal Panel Thickness[10]														
0.148	2¼	2 3	320 360	445 505	425 480	595 675	640 720	895 1010	730 820	1025 1150	285 320	400 445	215 240	300 335
0.135	2¼	2 3	285 320	395 450	375 425	525 595	565 640	795 895	645 725	905 1020	255 285	355 395	190 215	265 295
0.131	2¼	2 3	270 305	375 425	360 405	500 565	540 605	755 850	615 690	860 965	240 270	335 375	180 200	255 285
0.120	2¼	2 3	235 260	325 365	310 350	435 490	465 525	650 735	530 595	745 835	205 235	290 325	155 175	220 245
0.113	2¼	2 3	210 240	295 335	280 315	395 445	420 475	590 665	480 540	675 760	190 210	265 295	140 160	200 220
14, 15, 16 Gage	1½ Leg Length	2 3	175 200	245 280	235 265	330 370	350 395	490 555	400 450	560 630	155 175	215 245	115 130	160 180

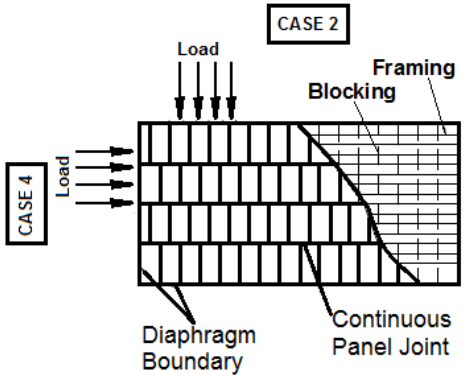
Calculate Values for SPF 405 x 0.92 = 370 Less than 400 plf. Required

Calculated Values for SPF 430 x 0.92= 395 Less than 400 plf. Required

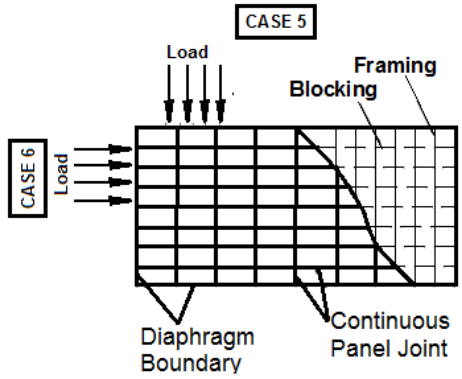
APPENDIX 1



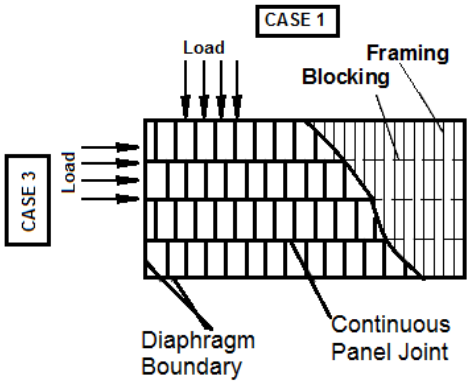
Continuous Panel Joints Perpendicular to Framing
Long Panel Direction Perpendicular to Support



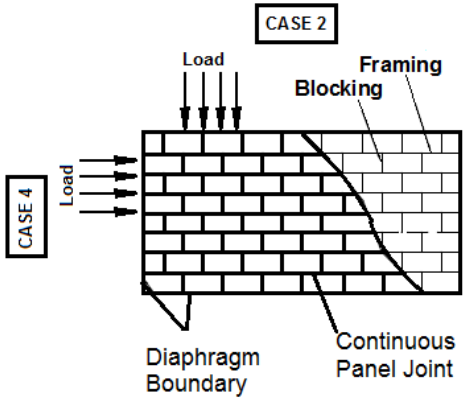
Continuous Panel Joints Parallel to Framing
Long Panel Direction Perpendicular to Supports



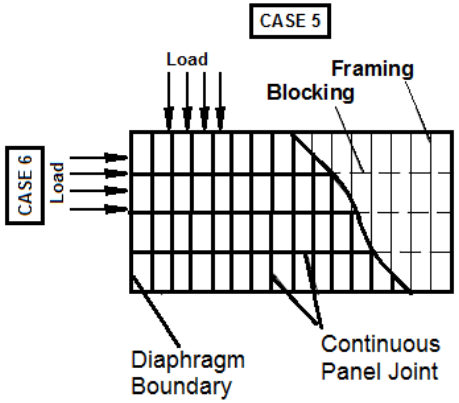
Continuous Panel Joints Perpendicular and Parallel To Framing
Long Panel Direction Perpendicular to Supports



Continuous Panel Joints Perpendicular to Framing
Long Panel Direction Parallel to Supports



Continuous Panel Joints Parallel to Framing
Long Panel Direction Parallel to Supports



Continuous Panel Joints Perpendicular and Parallel To Framing
Long Panel Direction Parallel to Supports

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 F1667-17 Standard Specifications for Driven Fasteners: Nails, Spikes and Staples © ASTM International April 2017

2018, 2015, 2012, 2009, 2006 International Building Code (IBC) © International Code Council Inc. ®

2018, 2015, 2012, 2009, 2006 International Residential Code (IRC) © International Code Council Inc. ®

AC116 ICC-ES Acceptance Criteria for Nails © ICC Evaluation Service (ICC-ES) ® March 2018

AC201 ICC-ES Acceptance Criteria for Staples © ICC Evaluation Service (ICC-ES) ® March 2018

ICC-ES Evaluation Report ESR-1539© © ICC Evaluation Service (ICC-ES) ® March 2018

Thank you to William J. Kalker, JR., PE of Monroe, CT for his assistance in reviewing the example: How to use the allowable shear tables for diaphragms.

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