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NATIONAL EVALUATION REPORT

NER-272

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POWER-DRIVEN STAPLES AND NAILS FOR USE IN ALL TYPES OF BUILDING CONSTRUCTION

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1.0 SUBJECT

Power-Driven Staples and Nails for Use in All Types of Building Construction.

2.0 PROPERTIES FOR WHICH EVALUATION IS SOUGHT

Structural and nonstructural connections.

This report is limited to the specific product and data and test reports submitted by the applicant in its application requesting this report. No independent tests were performed by the National Evaluation Service (NES), and NES specifically does not make any warranty, either expressed or implied, as to any finding or other matter in this report or as to any product covered by this report. This disclaimer includes, but is not limited to, merchantability. This report is also subject to the limitation listed herein.

3.0 DESCRIPTION

3.1 MANUFACTURER

Fasteners described in this report are manufactured by the above-listed member companies of the International Staple, Nail and Tool Association.

3.2 STAPLES

The staples are manufactured from No. 18, No. 16, No. 15 and No. 14 gage, round, semi-flattened or flattened, plain or zinc-coated steel wire, and are driven with power tools. The staples are available with outside crown widths varying from $\frac{3}{16}$ inch to 1 inch (4.8 mm to 25 mm). Leg lengths vary from $\frac{5}{8}$ inch to $3\frac{1}{2}$ inches (15.9 mm to 89 mm). The staples are collated into strips and coated with polymer coatings. Staples manufactured from aluminum and copper wire are permitted in nonstructural applications only when specifically recognized in the attachments set forth in Tables 39, 40, and 41. Staple crown widths and leg lengths specified in this report are overall dimensions.

3.3 NAILS

3.3.1 General

Nails are manufactured from plain steel wire, galvanized steel wire, aluminum wire, copper wire or stainless steel wire. Aluminum and copper nails are permitted in nonstructural applications only when specifically recognized in the Tables 39, 40, and 41 of this report. Nail heads include full round heads or modified round heads such as clipped heads, "D" heads, notched heads, oval heads or T-shaped heads. Nails are supplied with smooth or deformed (threaded) shanks. Deformed shanks are either annularly threaded (ring shank) or helically threaded (screw shank). Nails are collated and coated into strips, clips or coils for loading into a power driving tool. Nails with T-shaped heads are permitted in nonstructural connections only when specifically recognized in the tables of this report. Some common nail head and shank styles, and other fastener designs, are illustrated on page 6, "Basic Fastener Styles." Minimum dimensions govern fastener recommendations. The penny-weight and style of commonly used nails are typically described in the accompanying tables. Table 1 lists shank lengths and diameters for listed nails. Figure 1 illustrates nail styles and head styles.

3.3.2 Nail Bending Yield Strengths (F_{yb})

For engineered and structural construction, steel nails with the minimum bending yield strength are required. Nails formed from steel wire having a nominal diameter of 0.135 inch (3.4 mm) or less shall have a minimum average bending yield strength of 100 ksi (689 MPa), and nails with diameters greater than 0.135 inch (3.4 mm) shall have a minimum average bending yield strength of 90 ksi (620 MPa). The 20d common nails described in Table 24 shall have a minimum average bending yield strength of 80 ksi (551 MPa).

3.4 COATINGS

The coatings used consist of thermoplastic plastics. Coated fasteners are identified on the fastener carton or other packaging material by the word "coated", or by a trade name implying a coating. Coated fasteners meet or exceed the holding power of the uncoated fasteners, and therefore are alternatives to any uncoated fastener listed in this report.

3.5 CONFORMANCE TO THE 1991 NATIONAL DESIGN SPECIFICATION

The fastening schedules in this report have lateral strength equal to or exceeding the lateral strength of connections

found in the model codes. For nails, analysis was made with the lateral strength model (European Yield Model) incorporated into the model codes and into the 1991 edition of the National Design Specification[®] (NDS[®]), published by the American Forest and Paper Association. For stapled connections, analysis was based on the Proportional Limit Model, which was used in previous editions of the National Design Specification. This model has historically been used in model building codes for calculating the lateral strength of both nailed and stapled connections. The new European Yield Model was calibrated to the values calculated from the Proportional Limit Model.

The tables in this report which use either the European Yield Model or the Proportional Limit Model are based on provisions of the model codes. While every precaution has been taken to ensure the accuracy of these tables, the tables are intended to be used with competent engineering design. It is the final responsibility of the designer to relate design assumptions to design values and to make design value adjustments appropriate to the end use.

3.6 FASTENER TOLERANCES

All staples and nails used in structural and engineered construction shall conform to the tolerances specified in ASTM F 1667, "Standard Specification for Driven Fasteners: Nails, Spikes, and Staples."

3.7 SI UNIT CONVERSIONS

Length: 1 inch = 25.4 mm.
1 foot = 304.8 mm.

Force: 1 lbf = 4.45 N.

Force per unit length: 1 lbf/foot = 14.59 N/m.

Velocity: 1 mile/h = 1.61 km/h.

Bending Yield Strength: 1 ksi = 6.89 Mpa

4.0 INSTALLATION DETAILS

4.1 GENERAL

Nail and staple installation shall comply with the tables in this report. Nail installation shall comply with Part XII of the 1991 National Design Specification and applicable requirements of the model codes.

4.2 HARDENED SCREW-SHANK STEEL NAILS

For attaching subflooring to 0.047-inch (1.2 mm) (No. 14 gage) steel floor joists, collated hardened screw shank nails shall have a minimum shank diameter of 0.120 inch (3 mm), with diamond points. The screw shank flutes of the nail shall begin a maximum distance of $\frac{1}{2}$ inch (12.7 mm) from the underside of the nail head and shall continue to the top of the nail point. Interruptions in shank deformation are permitted for improving and allowing adherence of the shank to the medium that is cohering the nails into a strip, clip or coil. The nails are driven with a power tool to attach the subflooring directly to 0.047-inch (1.2 mm) (No. 14 gage) steel floor joists, providing a minimum penetration through the steel floor joist of $\frac{1}{2}$ inch (12.7 mm). Nail spacing for plywood is 6 inches (152 mm) on center at intermediate supports. Two nails per board are required for tongue-and-groove sheathing.

5.0 IDENTIFICATION

Fasteners are identified by labels, attached to the containers, that show the manufacturer's name and the NES report number.

Labels for staples show the gage and leg length. Labels for nails show the style, diameter, length, and penny designation.

6.0 EVIDENCE SUBMITTED

6.1 Shear resistance calculations for staples and nails in horizontal and vertical diaphragms.

6.2 Withdrawal-resistance and lateral-resistance comparison calculations for staples versus nails.

6.3 Withdrawal-resistance and lateral-resistance tests for staples in wood-to-wood and lath-to-wood applications.

6.4 Reports of bending yield strength tests in accordance with ASTM F 1575, by PFS Corporation, Report No. 9533:

6.4.1 Issued March 17, 1997, for Atlas.

6.4.2 Issued September 4, 1996, for Campbell Hausfeld.

6.4.3 Issued June 10, 1996, revised October 23, 1996, for Duo-Fast.

6.4.4 Issued July 24, 1996, for Falcon.

6.4.5 Issued March 27, 1997, for Fasco.

6.4.6 Issued November 26, 1996, for Halsteel.

6.4.7 Issued January 23, 1996, for Hitachi.

6.4.8 Issued March 27, 1997, for Insteel.

6.4.9 Issued September 7, 1996, for ISM.

6.4.10 Issued June 5, 1997, for ITW/Paslode.

6.4.11 Issued June 3, 1997, for Porter Cable.

6.4.12 Issued September 20, 1995, revised April 7, 1997, for Senco Products.

6.4.13 Issued July 15, 1996, for Specialty Fasteners.

6.4.14 Issued January 24, 1996, for Stanley Bostich.

6.5 Report of bending yield strength tests in accordance with ASTM F 1975 for Hilti, by SGS US Testing, No. 720297-3, dated May 23, 1996.

6.6 Reports of pull-through capacities tests on fasteners, by Clemson University, dated February 6, 1996.

6.7 Reports of lateral and withdrawal strength of nails, by USDA Forest Service Forest Products Laboratory, dated March 1993.

6.8 Reports of slip movement tests on fasteners, by PFS Corporation No. 97-04, dated September 15, 1997.

6.9 Structural calculations by John Tissell, P.E., Report 97-09, dated September 1997.

7.0 CONDITIONS OF USE

The National Evaluation Service Committee finds that fasteners and attachment details noted in this report are alternative methods of attachment to those specified in the BOCA National Building Code/1996, the 1997 SBCCI Standard Building Code, the 1994 Uniform Building Code with 1996 Accumulative Supplement, and the 1995 CABO One and Two Family Dwelling Code, subject to the following conditions:

7.1 The crown width, leg length and gage of staples, and the shank length and diameter of nails, specified in this report, are minimums. When fasteners larger than those specified are used for any application, consideration shall be given to restrictions on edge distance and close spacing of large-diameter nails described in the diaphragm tables.

7.2 Diaphragm and other construction noted in this report shall conform to all applicable provisions of the code.

7.3 All staples attaching diaphragm and non-diaphragm structural-use panels or 1-inch (25 mm) nominal sheathing shall be installed with the crowns of the staple parallel to the long dimension of the framing members, and shall be driven flush with the surface of the sheathing. The spacing, wire gage and leg lengths of the fasteners shall be as set forth in this report.

7.4 Steel nails with T-shaped heads, all aluminum and copper nails, and staples with crowns less than $7/16$ inch (11.1 mm) wide are permitted in non-structural connections only when specifically recognized in Tables 39, 40, and 41 of this report.

7.5 Fasteners for pressure preservative and fire-retardant-treated wood shall be of hot-dipped galvanized steel, stainless steel, or copper.

7.6 This report is subject to periodic re-examination. For information on the current status, consult the evaluation report listing or contact one of the participating members of the NES.

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Basic Fastener Styles

Smooth Shank Nail



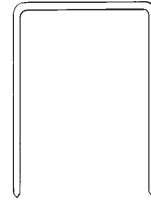
Ring Shank Nail



Screw Shank Nail



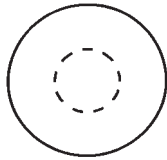
Staple



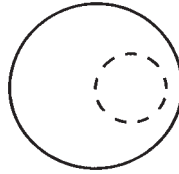
Nail Head Styles

(Solid line represents head perimeter; dashed line represents shank perimeter.)

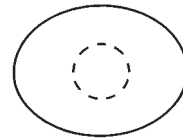
Round



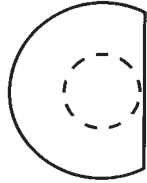
Offset



Oval



Clipped



Notched

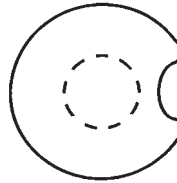


FIGURE 1

**TABLE 1
NOMINAL DIMENSIONS OF NAILS FREQUENTLY LISTED IN MODEL BUILDING CODES**

PENNYWEIGHT	LENGTH, IN INCHES	SHANK DIAMETER, IN INCHES
Box		
6d	2	0.099
8d	2-1/2	0.113
10d	3	0.128
Casing		
6d	2-1/4	0.099
8d	2-1/2	0.113
10d	3	0.128
Common		
6d	2	0.113
8d	2-1/2	0.131
10d	3	0.148
16d	3-1/2	0.162
20d	4	0.192
Cooler		
5d	1-5/8	0.086
6d	1-7/8	0.092
8d	2-3/8	0.113
Deformed¹		
3d	1-1/4	0.099
4d	1-1/2	0.099
6d	2	0.120
8d	2-1/2	0.120
Finish		
8d	2-1/2	0.099
10d	3	0.113
Siding		
6d	1-7/8	0.106
8d	2-3/8	0.128

¹A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

**TABLE 2
STAPLE DIMENSIONS AND NORMAL, LATERAL DESIGN LOADS^{1,2}**

STAPLE ³		LATERAL LOAD	
Gage	Diameter, in inches	Minimum Penetration, ⁴ in inches	Load ⁵ (lbf)
14	0.080	1	75
15	0.072	1	64
16	0.0625	1	52

¹Design values are based on a 10-year "normal" load duration.

²Table values shall be multiplied by applicable adjustment factors such as for load duration, wet service, temperature, end grain, and toe-nailing. Where metal side plates are used, lateral strength values may be increased 25 percent.

³Staples shall have a 7/16-inch minimum outside dimension crown width.

⁴The tabulated penetrations are for staples installed in Group I or II species. Penetration shall be increased to 13 diameters for Group III and 14 diameters for Group IV species.

⁵The tabulated allowable lateral values are for staples installed in Douglas Fir, Larch or Southern Pine (Group II species). Species groups are described in Table A of the Appendix. To determine the allowable values when both the attached wood member and the supporting (main) wood member are in the same group, but are not Group II, multiply the values listed in the above table by the following conversion factors: I-1.23, III-0.82, IV-0.65. If the attached and supporting members are in different groups, use the conversion factor for the wood in the higher group. See Table A of the Appendix for a list of the wood species included in each group.

TABLE 3
NAIL AND STAPLE NORMAL WITHDRAWAL DESIGN VALUES 1,2,3,4 POUNDS PER INCH OF PENETRATION

SPECIFIC GRAVITY	SMOOTH SHANK NAILS, DIAMETER IN INCHES									DEFORMED SHANK ⁵ NAILS, DIAMETER IN INCHES							STAPLE GAGE AND DIAMETER, IN INCHES			
	0.091	0.094	0.097	0.105	0.113	0.120	0.131	0.148	0.162	0.091	0.094	0.097	0.113	0.120	0.128	0.135	0.148	16 gage	15 gage	14 gage
			0.099									0.099						0.063	0.072	0.080
0.31	7	7	7	8	8	9	10	11	12	7	8	8	9	10	10	11	12	9	11	12
0.35	9	9	10	11	11	12	13	15	16	10	10	11	12	13	14	15	16	13	14	16
0.36	10	10	11	11	12	13	14	16	17	11	11	11	13	14	15	16	17	13	15	17
0.37	10	11	11	12	13	14	15	17	19	12	12	12	14	15	16	17	19	14	17	18
0.38	11	12	12	13	14	15	16	18	20	12	13	13	15	16	17	18	20	15	18	20
0.39	12	12	13	14	15	16	17	19	21	13	14	14	16	17	18	19	21	16	19	21
0.4	13	13	14	15	16	17	18	21	23	14	14	15	17	18	20	21	23	17	20	22
0.41	14	14	15	16	17	18	19	22	24	15	15	16	18	20	21	22	24	19	21	24
0.42	14	15	16	17	18	19	21	23	26	16	16	17	20	21	22	23	26	20	23	25
0.43	15	16	17	18	19	20	22	25	27	17	17	18	21	22	24	25	27	21	24	27
0.44	16	17	18	19	20	21	23	26	29	18	18	19	22	23	25	26	29	22	26	28
0.46	18	19	20	21	22	24	26	29	32	20	20	21	25	26	28	29	32	25	29	32
0.47	19	20	21	22	24	25	27	31	34	21	22	22	26	28	29	31	34	26	30	33
0.49	21	22	23	24	26	28	30	34	38	23	24	25	29	31	33	34	38	29	33	37
0.5	22	23	24	26	28	29	32	36	40	24	25	26	30	32	34	36	40	30	35	39
0.51	23	24	25	27	29	31	34	38	42	26	27	27	32	34	36	38	42	32	37	41
0.55	28	29	31	33	35	37	41	46	50	31	32	33	38	41	44	46	50	39	45	50
0.58	32	33	35	37	40	42	46	52	57	35	37	38	44	47	50	53	58	44	51	57
0.67	46	48	50	53	57	61	66	75	82	51	52	54	63	67	71	75	83	63	73	81
0.68	48	49	52	55	59	63	69	78	85	53	54	56	65	69	74	78	86	66	76	84
0.71	53	55	58	62	66	70	77	87	95	59	61	63	73	77	83	87	95	73	84	94
0.73	57	59	62	66	71	75	82	93	102	63	65	67	78	83	88	93	102	79	90	101

¹Design values are based on a normal (10 year) duration of load.
²Table values shall be multiplied by applicable adjustment factors such as for load duration, wet service, temperature, and toe-nailing.
³Withdrawal strengths are for fasteners driven perpendicular to the grain.
⁴For connections between solid lumber members, the permitted withdrawal strength of fasteners shall be limited to two times the tabulated values, regardless of increased penetrations. For connections between wood structural panels and solid lumber with a specific gravity up to 0.51, the permitted withdrawal strength shall be limited to 1.34 times the tabulated values, regardless of penetration. For connections between wood structural panels and solid lumber with a specific gravity of 0.55 or greater, permitted withdrawal strength is limited to 1.17 times the tabulated values at 0.55 specific gravity, regardless of increased penetration or greater specific gravity.
⁵A deformed shank (threaded) nail shall have either a helical (screw) shank or an annular (ring) shank.

TABLE 4
NORMAL¹ DESIGN² LATERAL STRENGTH OF FACE-NAILED SINGLE SHEAR CONNECTIONS OF “2-BY” MEMBERS³ TO OTHER MEMBERS⁴ OF THE SAME SPECIES⁵

FASTENER		CONNECTION LATERAL STRENGTH, IN POUNDS, IF BOTH FRAMING MEMBERS HAVE SPECIFIC GRAVITY OF . . .			
Length (in inches)	Nail Shank Diameter ⁶ (in inches), or Staple Gage	0.42 (e.g., Spruce-Pine-Fir)	0.43 (e.g., Hem-Fir)	0.50 (e.g., Douglas Fir-larch)	0.55 (e.g. Southern Pine)
3-1/2	0.162	92	94	109	119
3	0.148	84	86	99	109
3-1/4	0.131	79	80	93	101
3	0.131	79	80	93	101
2-1/2	0.131	52	54	62	67
3-1/4	0.120	69	71	81	89
3	0.120	69	71	81	89
2-3/8	0.113	40	40	47	51
2-1/4	0.105	30	31	37	41
2-1/4	0.099	30	30	35	38
3-1/4	14 gage	61	61	75	75
3	14 gage	61	61	75	75

¹Design values are based on a 10-year “normal” load duration.
²Table values shall be multiplied by applicable adjustment factors such as for load duration, wet service, temperature, and toe-nailing.
³Table is based upon a 1-1/2” actual thickness of both attached member and receiving (“main”) member.
⁴Design values are for connections in which the nail shank or staple leg are driven in side grain with shank/leg axis perpendicular to wood fibers. Tabulated values for nailed connections require that the nail has a minimum fastener bending yield strength (F_{yb}) as listed in Section 3.3.2 of this report.
⁵Calculations are based on a connection in which both members have the same specific gravity. The “European Yield Model” formulas in the Appendix permit calculation of the design lateral strength for nailed connections consisting of different wood species. For stapled connections consisting of different wood species, the “proportional limit theory” formula in the Appendix shall be used with the calculations based on the density of the less-dense wood member.
⁶Nails shall have a smooth shank or deformed shank - with helical (screw) or annular (ring) threads.

TABLE 5
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
5/16" THICK STRUCTURAL I PANEL GRADE ¹¹

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.113 smooth or deformed	1-5/8 2 or 2-3/8	2 3	185 210	250 280	375 420	420 475	165 185	125 140
0.120 smooth	3							
14 gage	3 2-1/2 2-1/4 or 2							
15 gage	2-1/2 2-1/4 2 or 1-3/4							
16 gage	2 1-3/4 or 1-1/2	2 3	155 175	205 230	310 345	350 390	135 155	105 115
0.099 smooth or deformed	2-1/4	2 3	145 165	195 220	295 330	335 375	130 145	100 110
0.092 smooth	2-1/4	2 3	130 145	170 195	260 290	290 330	115 125	85 95

See page 13 for footnote explanations and load diagrams.

TABLE 6
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
3/8" THICK STRUCTURAL I PANEL GRADE ¹¹

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.131 smooth or deformed	1-7/8 or 2-1/2	2 3	270 300	360 400	530 600	600 675	240 265	180 200
0.120 smooth	3	2 3	230 255	305 340	455 510	515 580	200 225	150 170
0.113 smooth or deformed	2-3/8 or 2	2 3	205 230	275 305	410 460	465 520	180 205	135 155
0.099 smooth or deformed	2-1/4	2 3	165 185	215 245	325 365	370 415	145 160	110 120
0.092 smooth	2-1/4	2 3	145 160	190 215	290 325	325 365	130 145	95 110
14 gage	3 2-1/2 2-1/4 or 2	2 3	255 285	340 380	510 575	580 645	225 255	170 190
15 gage	2-1/2 or 2-1/4 2 or 1-3/4	2 3	220 245	290 325	435 490	495 555	195 215	145 165
16 gage	2 1-3/4 or 1-1/2	2 3	175 200	235 265	350 395	400 450	155 175	115 130

See page 13 for footnote explanations and load diagrams.

TABLE 7
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
15/32" THICK STRUCTURAL I PANEL GRADE ^{10,11}

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.148 smooth ⁹	2-1/8 or 3	2	320	425	640	730	285	215
		3	360	480	720	820	320	240
0.131 smooth or deformed	2-1/2	2	270	360	540	610	240	180
		3	305	405	605	685	270	200
0.120 smooth	3	2	230	310	465	525	205	155
		3	260	350	520	590	230	175
0.113 smooth or deformed	2-3/8	2	210	280	420	475	185	140
		3	235	315	470	535	210	155
0.099 smooth or deformed	2-1/4	2	170	225	340	385	150	115
		3	190	255	380	435	170	125
0.092 smooth	2-1/4	2	150	205	305	345	135	100
		3	170	230	340	390	150	115
14 gage	3 or 2-1/2 2-1/4 or 2	2	255	340	510	575	225	170
		3	285	380	570	650	255	190
15 gage	2-1/2 2-1/4 2 or 1-3/4	2	215	290	435	495	195	145
		3	245	325	490	555	215	165
16 gage	2 1-3/4 or 1-1/2	2	175	235	350	400	155	120
		3	200	265	395	450	175	130

See page 13 for footnote explanations and load diagrams.

TABLE 8
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
5/16" THICK RATED SHEATHING ^{3,11}

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.113 smooth	2 or 1-5/8	2						
		3						
0.131 smooth or deformed	2-1/2	2						
		3						
0.120 smooth	3	2						
		3						
0.113 smooth or deformed	2-3/8	2						
		3						
0.113 smooth or deformed	2	2	170	225	335	380	150	110
		3	190	250	380	430	170	125
14 gage	3 2-1/2 2-1/4 or 2	2						
		3						
15 gage	2-1/2 2-1/4 2 or 1-3/4	2						
		3						
16 gage	2 1-3/4 or 1-1/2	2	140	185	275	315	125	90
		3	155	205	310	350	140	105
0.099 smooth or deformed	2-1/4	2	130	175	265	300	120	90
		3	150	200	295	335	130	100
0.092 smooth	2-1/4	2	115	155	230	265	105	75
		3	130	175	260	295	115	85

See page 13 for footnote explanations and load diagrams.

TABLE 9
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
3/8" THICK RATED SHEATHING ^{3,11}

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.131 smooth or deformed	1-7/8 or 2-1/2	2	240	320	480	545	215 240	160 180
		3	270	360	540	610		
14 gage	3 2-1/2 2-1/4 or 2	2	230	305	460	520	205 230	155 170
		3	260	345	515	580		
15 gage	2-1/2 2-1/4 2 or 1-3/4	2	195	260	390	445	175 195	130 145
		3	220	295	440	495		
0.120 smooth	3	2	210	280	420	475	185 210	140 155
		3	235	315	470	530		
0.113 smooth or deformed	1-5/8 or 2 or 2-3/8	2	185	250	375	425	165 185	125 140
		3	210	280	420	475		
16 gage	2 1-3/4 or 1-1/2	2	160	210	315	360	140 160	105 120
		3	180	235	355	400		
0.099 smooth or deformed	2-1/4	2	145	195	295	335	130 145	100 110
		3	165	220	330	375		
0.092 smooth	2-1/4	2	130	170	260	290	115 125	85 95
		3	145	195	290	330		

See page 13 for footnote explanations and load diagrams.

TABLE 10
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
7/16" THICK RATED SHEATHING ^{3,11}

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.131 smooth or threaded	2 or 2-1/2	2	255	340	505	575	230 255	170 190
		3	285	380	570	645		
0.120 smooth	3	2	215	290	435	490	190 215	145 160
		3	245	325	485	550		
0.113 smooth or threaded	2-3/8 or 2	2	195	260	390	440	175 195	130 145
		3	220	290	435	490		
0.099 smooth or threaded	2-1/4	2	155	205	310	350	135 155	105 115
		3	170	230	345	395		
0.092 smooth	2-1/4	2	135	185	275	310	120 135	90 105
		3	155	205	310	350		
14 gage	3 or 2-1/2 2-1/4 or 2	2	240	325	485	550	215 240	160 180
		3	270	365	545	615		
15 gage	2-1/2 2-1/4 2 or 1-3/4	2	205	275	415	470	185 205	140 155
		3	230	310	465	525		
16 gage	2 1-3/4 or 1-1/2	2	165	225	335	380	150 165	110 125
		3	190	250	375	425		

See page 13 for footnote explanations and load diagrams.

TABLE 11
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
15/32" THICK RATED SHEATHING ^{3,11}

NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener 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) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.148 smooth ⁹	2-1/8 or 3	2 3	290	385	575	655	255 290	190 215
			325	430	650	735		
0.131 smooth or deformed	2 or 2-1/2	2 3	265	355	535	605	235 265	180 200
			300	400	600	680		
0.120 smooth	3	2 3	230	305	455	515	200 225	150 170
			255	340	510	580		
0.113 smooth or deformed	2-3/8 or 2	2 3	205	275	410	465	180 205	135 155
			230	305	460	520		
0.099 smooth or deformed	2-1/4	2 3	165	215	325	370	145 160	110 120
			185	245	365	415		
0.092 smooth	2-1/4	2 3	145	190	290	325	130 145	95 110
			160	215	325	365		
14 gage	3 2-1/2 2-1/4 or 2	2 3	230	305	460	520	205 230	155 170
			260	340	515	585		
15 gage	2-1/2 2-1/4 2 or 1-3/4	2 3	195	260	390	445	175 195	130 145
			220	290	440	500		
16 gage	2 1-3/4 or 1-1/2	2 3	160	210	315	360	140 160	105 120
			180	235	355	405		

See page 13 for footnote explanations and load diagrams.

TABLE 12
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL HORIZONTAL
DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR, LARCH, OR SOUTHERN PINE ² FOR
19/32" THICK RATED SHEATHING ^{3,10,11}

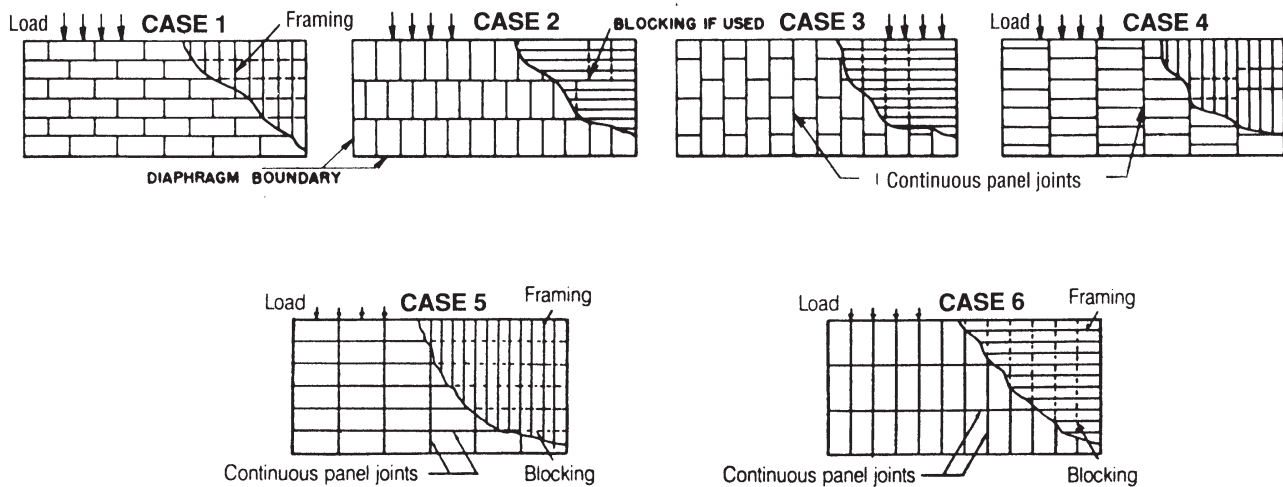
NOMINAL NAIL ⁴ DIAMETER ⁶ (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL NAIL LENGTH ⁶ (in inches)	MINIMUM WIDTH OF FRAMING MEMBER (in inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
			Fastener spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 & 6) ⁷				Fasteners spaced 6" max. at supported edges ⁷	
			6	4	2-1/2 ⁸	2 ⁸	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) ⁷					
6	6	4	3					
0.148 smooth ⁹	2-1/4 or 3	2 3	320	425	640	730	285 320	215 240
			360	480	720	820		
0.131 smooth or deformed	2-1/2	2 3	270	360	540	610	240 270	180 200
			305	405	605	685		
0.120 smooth	3	2 3	230	310	465	525	205 235	155 175
			260	350	520	590		
0.113 smooth or deformed	2-3/8 or 2	2 3	210	280	420	475	185 210	140 155
			235	315	470	535		
0.099 smooth or deformed	2-1/4	2 3	170	225	340	385	150 170	115 125
			190	255	380	435		
0.092 smooth	2-1/4	2 3	150	205	305	345	135 155	100 115
			170	230	340	390		
14 gage	3 2-1/2 2-1/4 or 2	2 3	255	340	510	575	225 255	170 190
			285	380	570	650		
15 gage	2-1/2 2-1/4 2 or 1-3/4	2 3	215	290	435	495	195 215	145 165
			245	325	490	555		
16 gage	2 1-3/4 or 1-1/2	2 3	175	235	350	400	155 175	115 130
			200	265	395	450		

See page 13 for footnote explanations and load diagrams.

Footnote Explanations for Horizontal Diaphragm Tables 5 - 12

- ¹ Tabulated values are for short-term loading due to wind or earthquake and shall be reduced by 25 percent for normal loading based on a duration of load factor of 1.33 and a diaphragm factor of 1.3. For diaphragm deflection analysis, deflections in Appendix Table B or C are used.
- ² The tabulated values are for fasteners installed in Douglas Fir, Larch or Southern Pine. Allowable values for diaphragms framed with wood having a specific gravity equal to or greater than 0.42 but less than 0.50 may be calculated by multiplying the values above by 0.82. For woods with a specific gravity less than 0.42, multiply the values above by 0.65.
- ³ C-D, C-C Exterior Sheathing and other panel grades covered in PS 1 or PS 2.
- ⁴ Nails with "T", brad, finish or casing heads are not permitted. A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.
- ⁵ Staples shall have a minimum 7/16-inch crown width.
- ⁶ Changes to fastener type, size or spacing shall be considered if diaphragms are required to withstand negative pressures of high winds or where prescribed in the model code. Prescriptive fastener schedules are summarized in Tables 29 to 37.
- ⁷ Values are based on 24" o.c. spacing of support framing members. Fasteners shall be spaced maximum 12" o.c. along intermediate framing members (6" o.c. when supports are spaced 48" o.c.)
- ⁸ Framing at adjacent panel edges shall be 3-inch nominal or wider, and fasteners shall be staggered where nails are spaced 2-1/2" on center or closer.
- ⁹ Framing at adjacent panel edges shall be 3-inch nominal or wider, and fasteners shall be staggered where nails with shank diameters of 0.148" or greater and penetrations of 1-5/8 inches or greater are placed 3 inches on center or closer.
- ¹⁰ Plywood not exceeding 1-1/8" in thickness is permitted to be attached, provided the fastener penetration is at least twelve times the fastener shank diameter.
- ¹¹ In addition to requirements presented above for fastening of horizontal diaphragms, all other requirements of the applicable model code pertaining to horizontal diaphragm design and construction shall be met.

Load Diagrams for Horizontal Diaphragm Tables 5 - 12



NOTE: Framing orientation in either direction for diaphragms is permitted, provided sheathing is properly designed for vertical loading.

TABLE 13
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 5/16" THICK STRUCTURAL I SHEATHING ^{3,4,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.113 smooth or deformed	1-5/8 or 2 or 2-3/8	-	200	300	390	510
0.131 smooth or deformed	2-1/2	2-1/2				
0.120 smooth	3	-				
0.120 smooth	-	3	170	250	335	430
0.099 smooth or deformed	2-1/4	-	155	235	310	400
0.113 smooth or deformed	-	2-3/8	150	225	300	385
0.092 smooth	2-1/4	-	135	205	275	350
0.113 smooth or deformed	-	2	120	175	235	300
0.099 smooth or deformed	-	2-1/4				
0.092 smooth	-	2-1/4	105	155	205	265
14 gage	3 or 2-1/2 2-1/4 or 2	-	200	300	390	515
15 gage	2-1/2 2-1/4 2 or 1-3/4					
16 gage	2 1-3/4 or 1-1/2	-	165	245	325	415
14 gage	-	3 or 2-1/2 2-1/4 or 2	180	270	360	455
15 gage	-	2-1/2 2-1/4 or 2	155	230	305	390
16 gage	-	2	125	185	245	315

See page 22 for footnote explanations and typical panel layouts.

TABLE 14
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 3/8" THICK STRUCTURAL I SHEATHING ^{3,4,11,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.131 smooth or deformed	1-7/8 or 2-1/2	-	230	360	460	610
0.148 smooth ¹²	3					
0.148 smooth ¹²	-	2-5/8	285	425	570	725
		3				
0.131 smooth or deformed	-	2-1/2	220	325	435	555
0.120 smooth	3	3	200	305	405	515
0.113 smooth or deformed	2-3/8 or 2	2-3/8	180	270	365	465
	-	2	135	200	270	340
0.099 smooth or deformed	2-1/4	2-1/4	145	220	290	370
0.092 smooth	2-1/4	2-1/4	130	190	255	325
14 gage	3 2-1/2 2-1/4 or 2	-	225	340	455	580
	2-1/2 2-1/4 2 or 1-3/4					
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	195	290	385	495
16 gage	2 1-3/4 or 1-1/2	-	155	235	315	400
14 gage	-	3 2-1/2 2-1/4 or 2	220	340	450	575
15 gage	-	2-1/2 2-1/4 or 2	195	290	385	490
16 gage	-	2	155	235	310	400

See page 22 for footnote explanations and typical panel layouts.

TABLE 15
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 7/16" THICK STRUCTURAL I SHEATHING ^{3,4,11,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.148 smooth ¹²	-	2-3/4 or 3	280	430	550	730
0.131 smooth or deformed	2 or 2-1/2	-	260	390	520	665
0.120 smooth	3	-	220	335	445	565
	-	3	200	305	405	515
0.113 smooth or deformed	2 or 2-3/8	-	200	300	400	510
	-	2-3/8	180	275	365	465
	-	2	125	185	245	315
0.099 smooth or deformed	2-1/4	-	160	240	320	405
	-	2-1/4	145	225	285	380
0.092 smooth	2-1/4	-	140	210	280	360
	-	2-1/4	130	190	255	325
14 gage	3 2-1/2 2-1/4 or 2	-	250	375	500	635
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	210	320	425	540
16 gage	2 1-3/4 or 1-1/2	-	170	260	345	440
14 gage	-	3 2-1/2 or 2-1/4	225	340	450	575
15 gage	-	2-1/2 or 2-1/4	195	290	385	490
16 gage ¹⁴	-	2	155	235	310	400

See page 22 for footnote explanations and typical panel layouts.

TABLE 16
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 15/32" THICK STRUCTURAL I SHEATHING ^{3,4,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁵ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.148 smooth ¹²	2-1/8 or 3	-	340	510	665	870
0.148 smooth ¹²	-	2-3/4 or 3	285	425	570	725
0.131 smooth or deformed	2 or 2-1/2	-				
0.131 smooth or deformed	-	2-1/2	225	325	445	570
0.120 smooth	3	-	240	365	485	620
	-	3	200	305	405	515
0.113 smooth or deformed	2 or 2-3/8	-	220	325	435	555
0.113 smooth or deformed	-	2-3/8	180	270	365	465
		2	130	200	265	335
0.099 smooth or deformed	2-1/4	-	175	260	345	440
	-	2-1/4	145	215	290	370
0.092 smooth	2-1/4	-	155	230	305	390
	-	2-1/4	130	190	255	325
14 gage	3 2-1/2 2-1/4 or 2	-	270	405	540	690
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	230	345	465	590
16 gage	2 1-3/4 or 1-1/2	-	185	280	375	475
14 gage	-	3 2-1/2 or 2-1/4	225	340	450	575
15 gage	-	2-1/2 or 2-1/4	195	290	385	490
16 gage ¹⁴	-	2	155	235	300	400

See page 22 for footnote explanations and typical panel layouts.

TABLE 17
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 5/16" THICK RATED SHEATHING ^{3,4,10,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.131 smooth	2-1/2	2-1/2	180	270	350	450
0.120 smooth	3					
0.113 smooth or deformed	1-5/8 or 2 or 2-3/8	-				
0.099 smooth or deformed	2-1/4	-	140	210	280	360
0.092 smooth	2-1/4	-	125	185	245	315
0.120 smooth	-	3	150	225	305	385
0.113 smooth or deformed	-	2-3/8	135	205	270	345
		2	90	135	180	230
0.099 smooth or deformed	-	2-1/4	105	160	215	270
0.092 smooth	-	2-1/4	95	140	185	240
14 gage	3 2-1/2 2-1/4 or 2	-	180	270	350	450
15 gage	2-1/2 2-1/4 2 or 1-3/4	-				
16 gage	2 1-3/4 or 1-1/2	-	145	220	295	375
14 gage	-	3 2-1/2 2-1/4 or 2	160	240	320	410
15 gage	-	2-1/2 2-1/4 or 2	140	205	275	350
16 gage	-	2	110	165	220	285

See page 22 for footnote explanations and typical panel layouts.

TABLE 18
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 3/8" THICK RATED SHEATHING ^{3,4,10,11,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.131 smooth or deformed	1-7/8 or 2-1/2	-	220	320	410	530
0.148 smooth ¹²	3					
0.148 smooth ¹²	-	2-5/8 or 3	255	385	510	650
0.120 smooth	3	-	180	270	365	465
	-	3	170	255	330	430
0.113 smooth or deformed	1-5/8 or 2 or 2-3/8	-	165	245	325	415
	-	2-3/8	165	245	325	415
		2	120	180	240	305
0.099 smooth or deformed	2-1/4	-	130	195	265	335
	-	2-1/4	120	175	230	300
0.092 smooth	2-1/4	-	115	170	230	295
	-	2-1/4	115	170	230	295
14 gage	3 2-1/2 2-1/4 or 2	-	205	305	410	520
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	175	260	350	445
16 gage	2 1-3/4 or 1-1/2	-	140	210	280	360
14 gage	-	3 2-1/2 2-1/4 or 2	205	305	405	520
15 gage	-	2-1/2 2-1/4 or 2	175	260	345	445
16 gage	-	2	140	210	280	360

See page 22 for footnote explanations and typical panel layouts.

TABLE 19
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 7/16" THICK RATED SHEATHING ^{3,4,10,11, 13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.131 smooth or deformed	2 or 2-1/2	-	240	350	450	585
0.148 smooth ¹²	3					
0.148 smooth ¹²	-	2-3/4 or 3	255	385	510	650
0.120 smooth	3	-	200	300	400	510
	-	3	180	270	365	460
0.113 smooth or deformed	2-3/8 or 2	-	180	270	360	460
	-	2-3/8	165	245	325	415
		2	125	185	245	315
0.099 smooth or deformed	2-1/4	-	145	215	285	365
	-	2-1/4	130	195	260	330
0.092 smooth	2-1/4	-	125	190	255	325
	-	2-1/4	115	170	230	295
14 gage	3 2-1/2 2-1/4 or 2	-	225	335	450	570
15 gage	2-1/2 or 2-1/4 2 or 1-3/4	-	190	285	380	490
16 gage	2 1-3/4 or 1-1/2	-	155	230	310	395
14 gage	-	3 2-1/2 or 2-1/4	205	305	405	520
15 gage	-	2-1/2 or 2-1/4	175	260	345	445
16 gage ¹⁴	-	2	140	210	280	360

See page 22 for footnote explanations and typical panel layouts.

TABLE 20
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 15/32" THICK RATED SHEATHING ^{3,4,10,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.148 smooth ¹²	2-1/8 or 3	-	310	460	600	770
	-	2-3/4 or 3	255	385	510	650
0.131 smooth or deformed	2 or 2-1/2	-	255	385	510	650
	-	2-1/2	215	320	425	545
0.120 smooth	3	-	220	325	435	555
	-	3	180	270	365	465
0.113 smooth or deformed	2-3/8 or 2	-	195	295	390	500
	-	2-3/8	165	245	325	415
		2	120	150	240	305
0.099 smooth or deformed	2-1/4	-	155	235	310	395
	-	2-1/4	130	190	245	320
0.092 smooth	2-1/4	-	140	205	275	350
	-	2-1/4	120	170	220	290
14 gage	3 2-1/2 2-1/4 or 2	-	245	365	490	620
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	210	310	415	530
16 gage	2 1-3/4 or 1-1/2	-	170	255	335	430
14 gage	-	3 2-1/2 or 2-1/4	205	305	405	520
15 gage	-	2-1/2 or 2-1/4	175	260	345	445
16 gage ¹⁴	-	2	140	210	280	360

See page 22 for footnote explanations and typical panel layouts.

TABLE 21
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH
FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ² FOR 19/32" THICK RATED SHEATHING ^{3,4,10,13}

NOMINAL NAIL ⁵ DIAMETER (in inches) OR STAPLE ⁶ GAGE	MINIMUM NOMINAL FASTENER LENGTH ⁷ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Directly to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges ⁸ (in inches)			
			6	4	3	2 ⁹
0.148 smooth ¹²	2-1/4 or 3	-	340	510	665	870
0.131 smooth or deformed	2-1/2	-	285	430	575	730
0.120 smooth	3	-	245	370	495	630
0.113 smooth or deformed	2-3/8 or 2	-	225	335	445	570
0.099 smooth or deformed	2-1/4	-	180	270	360	460
0.092 smooth	2-1/4	-	160	245	325	415
14 gage	3 2-1/2 2-1/4 or 2	-	270	405	540	690
15 gage	2-1/2 2-1/4 2 or 1-3/4	-	230	345	465	590
16 gage	2 or 1-3/4	-	185	280	375	475

See page 22 for footnote explanations.

Panel Layouts for Shear Walls Described in Tables 13 - 21



Footnote Explanations for Shear Wall Tables 13 - 21

- ¹Tabulated values are for short-term loading due to wind or earthquake and shall be reduced by 25 percent for normal loading based on a duration of load factor of 1.33 and a diaphragm factor of 1.3. For diaphragm deflection analysis, deflections in Appendix Table B or C are used.
- ²Framing members: All panel edges shall be backed by framing members. Tabulated values are for 2-inch nominal or wider framing members of Douglas-Fir, Larch, Southern Pine or wood species having specific gravities greater than 0.51. For other species: (1) Find specific gravity for species in Appendix. (2) Multiply the value tabulated above by 0.82 for species with a specific gravity of 0.42 or greater, and by 0.65 for species with lower specific gravities.
- ³Panel layout: Install panels either horizontally or vertically.
- ⁴Fastener spacing - intermediate: Space fasteners maximum 6 inches o.c. along intermediate framing members for 3/8" and 7/16" panels installed on studs spaced 24" o.c. For other conditions and panel thicknesses, space fasteners maximum 12" o.c.
- ⁵Nails with "T", brad, finish or casing heads are not permitted. A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.
- ⁶Staples shall have a minimum crown width of 7/16", outside dimension.
- ⁷Changes to fastener type, size or spacing shall be considered if diaphragms are required to withstand negative pressures of high winds or where prescribed in the applicable model code. Prescriptive fastener schedules are summarized in Tables 29 to 37.
- ⁸Where panels are applied on both faces of a wall and nail 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-inch nominal or thicker and nails on each side shall be staggered.
- ⁹Framing at adjoining panel edges shall be 3" nominal or wider, and nails shall be staggered where nails are spaced 2" o.c.
- ¹⁰C-D, C-C Exterior Sheathing and other panel grades covered in PS 1 or PS 2.
- ¹¹The values for 3/8" and 7/16" panels applied directly to framing may be increased to values shown in tables for 15/32" 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.
- ¹²Framing at adjacent panel edges shall be 3-inch nominal or wider, and fasteners shall be staggered where nails with shank diameters of 0.148" or greater and penetration of 1-5/8 inches or greater are placed 3 inches on center or closer.
- ¹³In addition to requirements presented above for fastening of shear walls, all other requirements of the applicable model code pertaining to shear wall design and construction shall be met.
- ¹⁴Two-inch-long staples have insufficient penetration when wood structural sheathing is applied over 5/8" gypsum sheathing and shall only be used if wood structural sheathing is applied directly to framing or over gypsum sheathing having a maximum thickness of 1/2".

TABLE 22
ALLOWABLE SHEAR ¹ FOR WIND OR SEISMIC LOADING (POUNDS PER FOOT) FOR 5/16" and 3/8" PLYWOOD PANEL SIDING SHEAR WALLS WITH FRAMING OF DOUGLAS-FIR, LARCH OR SOUTHERN PINE ^{1,2,6,7,8,9}

NOMINAL NAIL DIAMETER ³ (in inches)	MINIMUM NOMINAL FASTENER LENGTH ⁴ (in inches)		ALLOWABLE WALL SHEAR VALUES			
	Panels Applied Direct to Framing	Panels Applied Over 1/2" or 5/8" Gypsum Sheathing	Fastener Spacing at Panel Edges (in inches)			
			6	4	3	2 ⁵
5/16" Thick Panel Siding						
0.099" casing nail (6d casing)	2	-	140	210	275	360
0.099" finish nail						
0.099" smooth						
0.113" casing nail (8d casing)	-	2-1/2	160	240	310	410
0.113" finish nail						
0.113" smooth						
3/8" Thick Panel Siding						
0.113" casing nail (8d casing)	1-5/8	-	130	200	260	340
0.113" finish nail						
0.113" smooth						
0.128" casing nail (10d casing)	-	2-3/8	160	240	310	410
0.128" finish nail						
0.128" smooth						

See top of this page for typical panel layouts.

- ¹All panel edges backed with 2-inch nominal or wider framing. Panels are oriented either horizontally or vertically. Space fasteners maximum 6 inches o.c. along intermediate framing members for 3/8" panels installed with face grain parallel to studs spaced 24" o.c., and 12 inches o.c. for other conditions and panel thicknesses. These values are for short-term loading due to wind or earthquake, and must be reduced by 25 percent for normal loading.
- ²The tabulated values are for fasteners installed in Douglas Fir, Larch or Southern Pine (Group II species). Species groupings are described in Table A, Appendix A. To determine the allowable values for Groups I, III and IV species, as shown in the Appendix, multiply the value tabulated for the Group II species by the following factors: I-1.00, III-0.82, IV-0.65.
- ³Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip mechanical-deposition or electro-deposition, galvanizing process.
- ⁴The tabulated penetrations are for fasteners installed in species with a specific gravity of 0.50 or greater. Penetration shall be increased to 13 diameters for species with a specific gravity of 0.42 to less than 0.50, and 14 diameters for species with a specific gravity less than 0.42.
- ⁵Framing at adjoining panel edges shall be 3" nominal or wider, and nails shall be staggered where nails are spaced 2" o.c., and where nails 0.148" diameter or more, having penetration into framing of more than 1-5/8 inches, are placed 3 inches on center.
- ⁶Panel thickness is measured at fastener locations.
- ⁷Changes to fastener type, size or spacing shall be considered if diaphragms are required to withstand negative pressures of high winds. See Tables 29 through 37.
- ⁸In addition to requirements presented above for fastening of shear walls, all other requirements of the applicable model code pertaining to shear wall design and construction shall be met.

**TABLE 23
ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES IN POUNDS PER FOOT FOR VERTICAL DIAPHRAGMS OF WALL SHEATHING,
GYPSUM LATH-PLASTER, WALLBOARD AND EXTERIOR PLASTER ATTACHED TO WOOD-FRAMED WALL ASSEMBLIES ^{1,2,3}**

DESCRIPTION OF ATTACHED MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	SPACING ⁴ SPECIFICATIONS (in inches)		SHEAR VALUE ⁵	FASTENER SPECIFICATIONS	
			Edges	Intermediate		Min. Leg Length ⁶ (in inches)	Fastener Style ^{7,8,9,10}
Fiberboard Sheathing	1/2"	Blocked	3	6	125 ¹¹	1-1/2	0.120" Galv. Roofing Nail
					115		14 Ga. Galv. Staple
					95	15 Ga. Galv. Staple	
	25/32"	Blocked	3	6	175	1-3/4	0.120" Galv. Roofing Nail
					160		14 Ga. Galv. Staple
					130	15 Ga. Galv. Staple	
Gypsum ¹² Lath	3/8" lath & 1/2" Plaster	Unblocked	5" On Center	100	1-1/8	0.091" Nail, min 19/64" head	
					1-1/4	16 Ga. Galv. Staple	
Gypsum Sheathing Board	1/2" x 2' x 8'	Unblocked	4" On Center	75	1-3/4	0.120" Nail, min 3/8" head	
	1/2" x 2' x 8'	Blocked		175		16 Ga. Galv. Staple	
Gypsum Wallboard	1/2"	Unlocked	7" On Center	100	1-5/8	5d Cooler Nail	
			4" On Center	125		0.086" Nail	
		Blocked	7" On Center	125	1-1/2	0.120" Nail, min 3/8" head	
			4" On Center	150		16 Gage Staple	
	5/8"	Blocked	4" On Center	175	1-7/8	6d Cooler Nail	
					1-3/4	0.092" Nail	
					1-5/8	0.120" Nail, min 3/8" head	
					1-5/8	16 Ga. Galv. Staple	
		Blocked two-ply	Base ply - 9" - Center	250	1-7/8	6d Cooler Nail	
					1-3/4	0.092" Nail	
					1-5/8	0.120" Nail, min 3/8" head	
					1-5/8	16 Ga. Galv. Staple	
Face ply - 7" - Center	250	2-3/8	8d Cooler Nail				
		2-3/8	0.113" Nail				
		2-3/8	0.120" Nail, min 3/8" head				
		2-1/4	15 Ga. Galv. Staple				
Self-furred ¹² Woven Wire Lath	2" x 4" studs spaced 24" maximum on center. Lath stapled 6" o.c. to all studs, top and bottom plate. Wall finished with 7/8" thick exterior plaster.			180	7/8	16 Ga. Galv. Staple	

¹These vertical diaphragms shall not be used to resist loads imposed by masonry or concrete walls. Values are for short-term loading due to wind or earthquake and must be reduced 25 percent for normal loading. In addition to requirements presented above for fastening of shear walls, all other requirements of the applicable model code pertaining to shear wall design and construction shall be met.

²Shear values are based on a maximum framing spacing of 16 inches on center.

³Shear values shall be doubled where identical materials are applied to both sides of the wall.

⁴Applied to nailing at all studs, top and bottom plates and blocking.

⁵The tabulated values are for fasteners installed in Douglas Fir, Larch or Southern Pine (Group II species). To determine the allowable values for Groups I, III and IV species, as shown in the Appendix, multiply the value tabulated for the Group II species by the following factors: I-1.00, III-0.82, IV-0.65.

⁶The tabulated penetrations are for fasteners installed in Group I or II species. Penetration shall be increased to 13 diameters for Group III species and 14 diameters for Group IV species.

⁷Material attached to redwood and to Group III species of wood with a specific gravity of 0.42 to less than 0.50, add minimum of 3/8 inch to fastener leg lengths.

⁸Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip, mechanical deposition or electro-deposition galvanizing process.

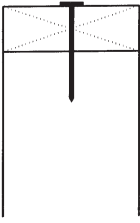
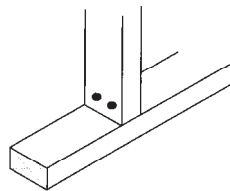
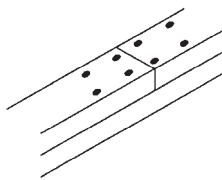
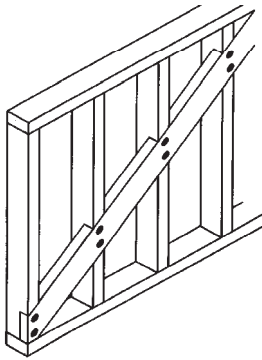
⁹Staples shall have a minimum crown width of 7/16-inch, measured outside the legs.

¹⁰Nails with "T", brad, finish or casing heads are not permitted.

¹¹The shear value may be 175 pounds for 1/2-inch x 4-foot x 8-foot fiberboard nail-base sheathing.


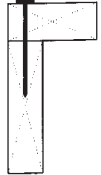
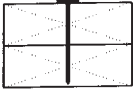
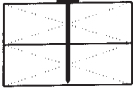
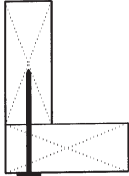
¹²Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of 3/4 inch, measured outside the legs.

**TABLE 24
WALL FRAMING¹**

CONNECTION² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (inches on-center) ⁵
Top or sole plate to stud (face nail) 	3-1/2" x 0.162" nail (16d common) ⁴	2
	3" x 0.148" nail (10d common)	3
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	4
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	3
	3-1/4" 14 gage staple	
	3" 14 gage staple	
Stud to top or sole plate (toe nail) 	2-1/2" x 0.131" nail (8d common) ⁴	4
	3-1/2" x 0.162" nail (16d common)	3
	3" x 0.148" nail (10d common)	4
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	5
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	3
	2-3/8" x 0.113" nail	
	2" x 0.113" nail	5
	2-1/4" x 0.105" nail	
	2-1/4" x 0.099" nail	3
	3-1/4" 14 gage staple	
	3" 14 gage staple	
Cap/top plate laps and intersections 	3-1/2" x 0.162" nail (16d common) ⁴	2 each side of lap
	3" x 0.148" nail	3 each side of lap
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	
	3-1/4" 14 gage staple	
3" 14 gage staple		
Diagonal bracing 	2-1/2" x 0.131" nail (8d common) ⁴	2
	3-1/2" x 0.162" nail (16d common)	
	3" x 0.148" nail (10d common)	3
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	4
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	4
	2-3/8" x 0.113" nail	
	2" x 0.113" nail	2
	2-1/4" x 0.105" nail	
	2-1/4" x 0.099" nail	3
	3-1/4" 14 gage staple	
	3" 14 gage staple	

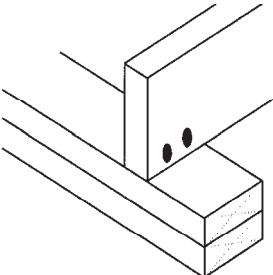
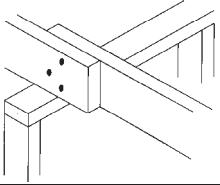
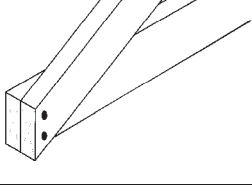
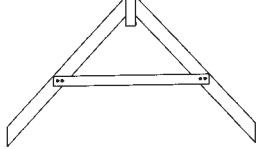
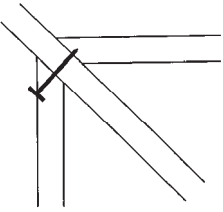
See page 29 for footnotes.

**TABLE 24, continued
WALL FRAMING¹**

CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (inches on-center) ⁵
Sole plate to joist or blocking at braced panels 	3-1/2" x 0.135" nail (16d box) ⁴	3 per 16" space
	3-1/2" x 0.162" nail (16d common)	2 per 16" space
	3" x 0.148" nail (10d common)	3 per 16" space
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	4 per 16" space
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	
	3-1/4" 14 gage staple	
3" 14 gage staple		
Sole plate to joist or blocking 	3-1/2" x 0.162" nail (16d common) ⁴	16" o.c.
	3" x 0.148" nail (10d common)	8" o.c.
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	12" o.c.
	3-1/4" 14 gage staple	
	3" 14 gage staple	
Double top plate 	3" x 0.148" nail (10d common) ⁴	16" o.c.
	3-1/2" x 0.162" nail (16d common)	12" o.c.
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	
	3-1/4" 14 gage staple	
	3" 14 gage staple	
Double studs 	3" x 0.148" nail (10d common) ⁴	12" o.c.
	3-1/2" x 0.162" nail (16d common)	8" o.c.
	3-1/4" x 0.131" nail	
	3" x 0.131" nail	
	3-1/4" x 0.120" nail	
	3" x 0.120" nail	
	3-1/4" 14 gage staple	
	3" 14 gage staple	
Corner studs 	3-1/2" x 0.162" nail (16d common) ⁴	24" o.c.
	3" x 0.148" nail (10d common)	16" o.c.
	3-1/4" x 0.131" nail	12" o.c.
	3" x 0.131" nail	
	3-1/4" x 0.120" nail	16" o.c.
	3" x 0.120" nail	
	3-1/4" 14 gage staple	16" o.c.
	3" 14 gage staple	

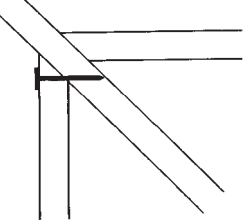
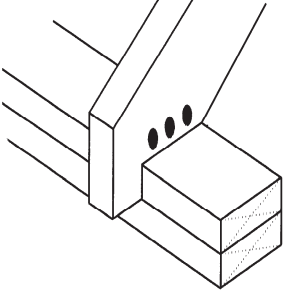
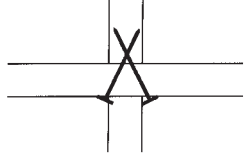
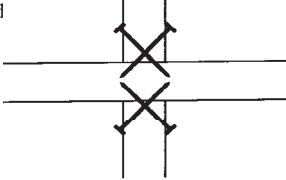
See page 29 for footnotes.

**TABLE 25
CEILING AND ROOF FRAMING¹**

CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	QUANTITY PER CONNECTION ⁵	
Ceiling joist to plate 	3-1/2" x 0.162" nail (16d common) ⁴	3	
	3" x 0.148" nail (10d common)	4	
	3-1/4" x 0.131" nail	5	
	3" x 0.131" nail		
	3-1/4" x 0.120" nail		
	3" x 0.120" nail		
	2-3/8" x 0.113" nail		
	3-1/4" 14 gage staple	5	
3" 14 gage staple			
Ceiling joists, laps over partitions 	Ceiling joist to parallel rafter 	3-1/2" x 0.162" nail (16d common) ⁴	3
		3" x 0.148" nail (10d common)	4
		3-1/4" x 0.131" nail	
		3" x 0.131" nail	
		3-1/4" x 0.120" nail	
		3" x 0.120" nail	
		3-1/4" 14 gage staple	
		3" 14 gage staple	
Collar tie to rafter 		3" x 0.148" nail (10d common) ⁴	3
		3-1/2" x 0.162" nail (16d common)	4
		3-1/4" x 0.131" nail	
		3" x 0.131" nail	
		3-1/4" x 0.120" nail	
		3" x 0.120" nail	
		3-1/4" 14 gage staple	
		3" 14 gage staple	
Jack rafter to hip, toe-nailed 		3" x 0.148" nail (10d common) ⁴	3
		3-1/2" x 0.162" nail (16d common)	4
		3-1/4" x 0.131" nail	
		3" x 0.131" nail	
		3-1/4" x 0.120" nail	
		3" x 0.120" nail	
		3-1/4" 14 gage staple	
		3" 14 gage staple	

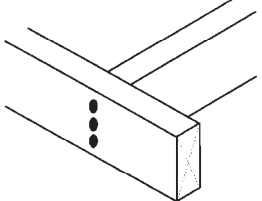
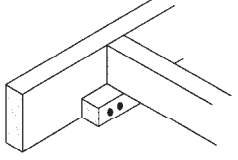
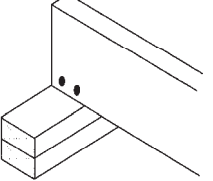
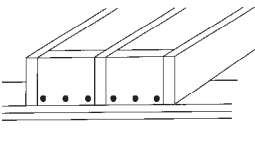
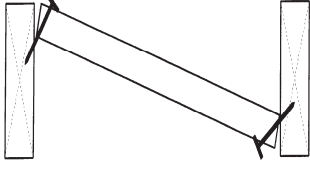
See page 29 for footnotes.

**TABLE 25, continued
CEILING AND ROOF FRAMING¹**

CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	QUANTITY PER CONNECTION ⁵	
Jack rafter to hip, face nailed 	3-1/2" x 0.162" nail (16d common) ⁴	2	
	3" x 0.148" nail (10d common)	3	
	3-1/4" x 0.131" nail		
	3" x 0.131" nail		
	Roof rafter to plate (toe-nailed) 	3-1/4" x 0.120" nail	4
		3" x 0.120" nail	4
3-1/4" x 0.120" nail			
3" x 0.120" nail		5	
2-3/8" x 0.113" nail			
2" x 0.113" nail			
2-1/4" x 0.105" nail		6	
2-1/4" x 0.099" nail			
3-1/4" 14 gage staple		3	
3" 14 gage staple			
Roof rafter to 2-by ridge beam, face nailed  (Only the attachment of the top rafter is illustrated.)		3-1/2" x 0.162" nail (16d common) ⁴	2
		3" x 0.148" nail (10d common)	3
	3-1/4" x 0.131" nail		
	3" x 0.131" nail		
	3-1/4" x 0.120" nail	4	
	3" x 0.120" nail		
	3-1/4" 14 gage staple	3	
	3" 14 gage staple		
Roof rafter to 2-by ridge beam, toe-nailed 	3-1/2" x 0.162" nail (16d common) ⁴	2	
	3" x 0.148" nail (10d common)	3	
	3-1/4" x 0.131" nail		
	3" x 0.131" nail		
	3-1/4" x 0.120" nail	4	
	3" x 0.120" nail		
	3-1/4" 14 gage staple	3	
	3" 14 gage staple		

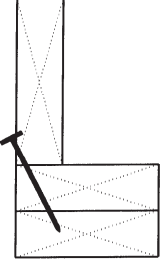
See page 29 for footnotes.

**TABLE 26
FLOOR FRAMING¹**

CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	QUANTITY PER CONNECTION OR MAXIMUM SPACING ⁵	
Joist to band joist 	3-1/2" x 0.162" nail (16d common) ⁴	3	
	3" x 0.148" nail (10d common)		
	3-1/4" x 0.131" nail	5	
	3" x 0.131" nail		
	3-1/4" x 0.120" nail	6	
	3" x 0.120" nail		
	3-1/4" 14 gage staple	5	
	3" 14 gage staple		
Ledger strip 	3-1/2" x 0.162" nail (16d common) ⁴	3	
	3" x 0.148" nail (10d common)		
	3-1/4" x 0.131" nail	4	
	3" x 0.131" nail		
	3-1/4" x 0.120" nail	4	
	3" x 0.120" nail		
	3-1/4" 14 gage staple	4	
	3" 14 gage staple		
Joist to sill or girder (toe-nailed) 	Blocking between joist or rafter to top plate (toe-nailed) 	2-1/2" x 0.131" nail (8d common) ⁴	
		3" x 0.148" nail (10d common)	3
		3-1/4" x 0.131" nail	
		3" x 0.131" nail	
	3-1/4" x 0.120" nail	4	
	3" x 0.120" nail		
	3-1/4" 14 gage staple	3	
	3" 14 gage staple		
	Bridging to joist (listed number of fasteners at each end) 	2-1/2" x 0.131" nail (8d common) ⁴	2
		3-1/4" x 0.120"	
3" x 0.120" nail		3	
2-3/8" x 0.113" nail			
2" x 0.113" nail (6d common)		4	
2-1/4" x 0.105" nail		3	
2-1/4" x 0.099" nail		4	
3-1/4" 14 gage staple			
3" 14 gage staple		2	

See page 29 for footnotes.

**TABLE 26, continued
FLOOR FRAMING¹**

CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)		QUANTITY PER CONNECTION OR MAXIMUM SPACING ⁵	
Rim joist to top plate (toe-nailed) 	2-1/2" x 0.113" nail (8d box) ⁴		6" o.c.	
	3-1/2" x 0.162" nail (16d common)		8" o.c.	
	3" x 0.148" nail (10d common)		6" o.c.	
	3-1/4" x 0.131" nail			
	3" x 0.131" nail			
	3-1/4" x 0.120" nail			
	3" x 0.120" nail			
	2-3/8" x 0.113" nail		6" o.c.	
	2" x 0.113" nail (6d common)		3" o.c.	
	2-1/4" x 0.105" nail			
	2-1/4" x 0.099" nail			
	3-1/4" 14 gage staple		6" o.c.	
	3" 14 gage staple			
CONNECTION ² (Nail size and position exaggerated for purpose of illustration.)	FASTENER (Minimum nominal length in inches x minimum nominal nail diameter in inches, or staple ³ gage.)	SPACING OF FASTENERS ALONG TOP AND BOTTOM OF BEAM, STAGGERED ON EACH SIDE OF EACH LAYER	NUMBER OF FASTENERS AT EACH END AND SPLICE FOR EACH LAYER	
Built-up Girders and Beams 	4" x 0.192" nail (20d common) ⁴		2	
	3-1/2" x 0.162" nail (16d common) 3" x 0.148" nail (10d common) 3-1/4" 14 gage staple 3" 14 gage staple 3-1/4" x 0.131" nail 3" x 0.131" nail		24" o.c.	3
	3-1/4" x 0.120" nail 3" x 0.120" nail		16" o.c.	3
	2-1/2" x 0.131" nail (8d common)		16" o.c.	4

Footnotes for Tables 24 - 26

- ¹This fastening schedule applies to framing members having an actual thickness of 1-1/2" (nominal "2-by" lumber).
- ²Fastenings listed above may also be used for other connections that are not listed but that have the same configuration and the same code requirement for fastener quantity/spacing and fastener size (pennyweight and style; e.g., 8d common, "8-penny common nail").
- ³Staple shall have a minimum nominal crown width of 7/16 inch, outside legs.
- ⁴This fastener, in the quantity or spacing shown in the far-right column, comprises the most stringent fastening of the connection listed in the National, One and Two Family Dwelling, Standard and Uniform Building Codes.
- ⁵Fastening schedule only applies to buildings of conventional wood frame construction where wind or seismic analysis is not required by the applicable code. In areas where wind or seismic analysis is required, required fastening shall be determined by structural analysis. ICBO *Uniform Building Code* requires structural analysis in areas where design wind speeds prescribed by the code are 80 mph or higher. SBCCI *Standard Building Code* requires structural analysis in areas where design wind speeds prescribed by the code exceed 80 mph.

**TABLE 27
SUMMARY OF USE OF FASTENERS FOR FRAMING ¹**

CONNECTION ^{2,4}	NUMBER, OR SPACING, OF FASTENERS REQUIRED PER CONNECTION												
	Nail lengths are minimum, nominal lengths, in inches Nail shank diameters are minimum, nominal diameters, in inches.											14 Gage Staples ³	
	3-1/2 x 0.162	3 x 0.148	3-1/4 x 0.131	3 x 0.131	2-1/2 x 0.131	3-1/4 x 0.120	3 x 0.120	2-3/8 x 0.113	2 x 0.113	2-1/4 x 0.105	2-1/4 x 0.099	3-1/4"	3"
Floor Framing													
Joist to band joist	3	5	5	5	N/A	6	6	N/A	N/A	N/A	N/A	5	5
Ledger strip	3	4	4	4	6	4	4	N/A	N/A	N/A	N/A	4	4
Joist to sill or girder	3	3	3	4	3	4	4	N/A	N/A	N/A	N/A	3	3
Blocking between joist or rafter to top plate	3	3	3	4	3	4	4	N/A	N/A	N/A	N/A	3	3
Bridging to joist	N/A	N/A	N/A	N/A	2	3	3	3	4	3	4	2	2
Rim joist to top plate	8" o.c.	6" o.c.	6" o.c.	6" o.c.	6" o.c.	6" o.c.	4" o.c.	6" o.c.	3" o.c.	3" o.c.	3" o.c.	6" o.c.	6" o.c.
Built-up Girders & Beams - Spacing along edges, - # at ends & splices	24" o.c., 3	24" o.c., 3	24" o.c., 3	24" o.c., 3	16" o.c., 4	16" o.c., 3	16" o.c., 3	N/A	N/A	N/A	N/A	24" o.c., 3	24" o.c., 3
Ceiling and Roof Framing													
Ceiling joist to plate	3	4	5	5	5	5	5	6	N/A	N/A	N/A	5	5
Ceiling joists, laps over partitions	3	4	4	4	6	4	4	N/A	N/A	N/A	N/A	4	4
Ceiling joist to parallel rafter	3	4	4	4	6	4	4	N/A	N/A	N/A	N/A	4	4
Collar tie to rafter	3	3	4	4	5	4	4	N/A	N/A	N/A	N/A	4	4
Jack rafter to hip, toe-nailed	3	3	4	4	5	4	4	N/A	N/A	N/A	N/A	4	4
Jack rafter to hip, face-nailed	2	3	3	3	3	4	4	N/A	N/A	N/A	N/A	3	3
Roof rafter to plate	3	3	3	3	3	4	4	5	5	5	6	3	3
Roof rafter to 2-by ridge beam (driven through beam into end of ridge)	2	3	3	3	N/A	4	4	N/A	N/A	N/A	N/A	3	3
Roof rafter to 2-by ridge beam (toe-nail rafter to beam)	2	3	3	3	3	4	4	N/A	N/A	N/A	N/A	3	3
Wall Framing													
Top or sole plate to stud (end nailed)	2	3	3	3	5	4	4	N/A	N/A	N/A	N/A	3	3
Stud to top or sole plate (toe nailed)	3	4	4	4	4	4	4	5	5	5	5	3	3
Cap/top plate laps and intersections (each side of lap)	2	3	3	3	4	3	3	N/A	N/A	N/A	N/A	3	3
Diagonal bracing	2	2	2	2	2	3	3	3	4	4	4	2	2
Sole plate to joist or blocking at braced panels (number per 16" joist space)	2	3	3	4	N/A	4	4	N/A	N/A	N/A	N/A	4	4
Sole plate to joist or blocking	16" o.c.	8" o.c.	8" o.c.	8" o.c.	6" o.c.	8" o.c.	8" o.c.	N/A	N/A	N/A	N/A	12" o.c.	12" o.c.
Double top plate	16" o.c.	16" o.c.	12" o.c.	12" o.c.	8" o.c.	12" o.c.	12" o.c.	N/A	N/A	N/A	N/A	12" o.c.	12" o.c.
Double studs	12" o.c.	12" o.c.	8" o.c.	8" o.c.	6" o.c.	8" o.c.	8" o.c.	N/A	N/A	N/A	N/A	8" o.c.	8" o.c.
Corner studs	24" o.c.	16" o.c.	16" o.c.	16" o.c.	8" o.c.	12" o.c.	12" o.c.	N/A	N/A	N/A	N/A	16" o.c.	16" o.c.

N/A = Fastener not applicable to connection.

¹This fastening schedule applies to framing members having an actual thickness of 1-1/2" (nominal "2-by" lumber).

²Fastenings listed above may also be used for other connections that are not listed but that have the same configuration and the same code requirement for fastener quantity/spacing and fastener size (pennyweight and style; e.g., 8d common, "8-penny common nail").

³Staple shall have a minimum nominal crown width of 7/16 inch, outside legs.

⁴Fastening schedules only apply to buildings of conventional wood frame construction where wind or seismic analysis is not required by the applicable code. In areas where wind or seismic analysis is required, required fastening shall be determined by structural analysis. ICBO *Uniform Building Code* requires structural analysis in areas where design wind speeds prescribed by the code are 80 mph or higher. SBCCI *Standard Building Code* requires structural analysis in areas where design wind speeds prescribed by the code exceed 80 mph. When applicable, use of prescriptive fastening schedules in SBCCI Standard SSTD 10 is permitted, with alternative fasteners selected from Tables 31 through 37.

TABLE 28
ALLOWABLE SPACING OF ALTERNATE FASTENINGS¹ FOR THE ATTACHMENT OF 19/32", 5/8", 23/32" & 3/4"
WOOD STRUCTURAL PANEL AND PARTICLEBOARD COMBINATION SUBFLOOR/UNDERLAYMENT TO WOOD FRAMING MEMBERS

FASTENER TYPE (Minimum Nominal Nail ² Shank Diameter, in Inches, or Staple ³ Gage) ⁴	MINIMUM NOMINAL LENGTH, INCHES	SPACING OF FASTENERS	
		At Edges, and At Intermediate Supports Where Spans Are 48" or More	At Intermediate Supports
0.131" nail (8 common nail)	2-1/2	6	12
0.120" deformed shank nail	2		
0.092" nail	2-1/4	3	6
0.099" nail	2-1/4	4	8
0.099" deformed shank nail	2-1/4	4	8
0.113" nail	2	3	6
0.113" deformed shank nail	2	4	8
0.113" nail (8d cooler)	2-3/8	4	8
0.113" deformed shank nail	2-3/8	4	8
0.120" nail	3	4	8
0.131" deformed shank nail	2-1/2	6	12
16 gage staple	1-3/4	3	6
	2	4	8
15 gage staple	1-3/4	3	6
	2	4	8
	2-1/4		
	2-1/2		
14 gage staple	2	4	8
	2-1/4		
	2-1/2		
	3		

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 12 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

⁴In areas using the *Standard Building Code*, only deformed shank nails are permitted to fasten combination subfloor/underlayment.

HOW TO USE THE PRESCRIPTIVE SHEATHING TABLES

Prescriptive sheathing tables give fastening requirements for conventional construction where design is not necessary. The prescriptive tables for sheathing are found in these model code tables:

- BOCA *National Building Code* Table 2305.2
- SBCCI *Standard Building Code* Table 2306.1
- ICBO *Uniform Building Code* Table 23-I-Q
- CABO *One and Two Family Building Code* Tables 602.3a and 602.3a(1)

Use Table 29 for wall and roof sheathing and Table 30 for floor (subfloor) sheathing to determine which fasteners the applicable model code lists, and on what spacing. Select the table (from Tables 31 through 37) which lists the nail that the code lists and the attachment thickness being used.

STEP 1 - Determining Code Requirements

The model code requirements are summarized in Table 29 for wall and roof sheathing and Table 30 for floor (subfloor) sheathing.

Requirements consist of a fastener (e.g. 8d common nail) and its spacing (e.g. 12" o.c. at panel edges). Fasteners attaching the "edges" of sheathing to framing members are usually spaced tighter than the fasteners attaching interior surfaces of the sheathing to "intermediate" supports (framing members).

Requirements vary with the model code.

High wind requirements may depend on additional considerations. High wind requirements vary across the country. For a particular part of the country, the fastening requirements may vary with the area's "basic wind speed". In high wind areas, the fastening requirements may vary with average roof height, roof slope, roof style (hip roof versus gable-end roof) and the spacing between framing members. Requirements may be different for different parts of the roof, such as areas near ridges, eaves, rakes and gable ends. High wind requirements are found in footnotes to Table 29.

STEP 2 - Equivalent Fastening Tables

After code requirements are determined, in the form of a fastener and its spacing, from Table 29 or 30, Tables 31 through 37 may be used to determine the spacing of other fasteners which will result in the same or larger withdrawal strengths along each framing member. Each table applies to one sheathing thickness or a limited range of sheathing thicknesses. Each table presents, for one fastener listed in the model codes, the allowable maximum spacings of listed alternate fasteners.

Example

The BOCA *National Building Code* requirement for fastening 1/2" structural panels for floors (subfloors) (Table 30) is a 6d common nail spaced 6" o.c. at panel edges and 12" o.c. at intermediate framing members. (See the upper-left-hand corner of the table.) Table 32 lists a 1-1/2" 16 gage staple spaced 4" o.c. at panel edges and 8" o.c. at intermediate framing members as an allowable equivalent.

**TABLE 29
MODEL CODE WALL AND ROOF SHEATHING PRESCRIPTIVE REQUIREMENTS 1,2
FOR USE IN SELECTING ALTERNATE FASTENINGS WITH TABLES 31 THROUGH 37**

WOOD STRUCTURAL PANEL NOMINAL THICKNESS	MODEL CODE FASTENER AND SPACING (at panel edges/intermediate)				
	BOCA <i>National Building Code</i> Table 2305.2	SBCCI <i>Standard Building Code</i> Table 2306.1 ⁵	ICBO <i>Uniform Building Code</i> Table 23-I-Q		CABO <i>One and Two Family Dwelling Code</i> ⁷ Tables 602.3a & 602.3a(1)
1/2" or less	<p>Walls 6d common nail (see Table 32), 6" o.c./ 12" o.c.</p> <p>Roofs 8d common nail (see Table 33) 6" o.c./ 12" o.c.^{3,4}</p> <p>Walls & Roofs 16 gage staple⁵ 1" minimum penetration 4" o.c./ 8" o.c.</p>	<p>6d common nail (see Table 32), 6" o.c./ 12" o.c.</p> <p>16 gage staple⁶ 1" minimum penetration 4" o.c./ 8" o.c.</p>	<p>Walls 6d common nail (see Table 32) or, 6d box nail (see Table 31) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>Roofs 6d common nail (see Table 32) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>Walls 6d common nail (see Table 32) 6" o.c./ 12" o.c.</p> <p>1-5/8" 0.099" nail 6" o.c./ 12" o.c.</p> <p>Roofs 8d common nail (see Table 33), 6" o.c./ 12" o.c.</p> <p>1-1/2" 15 gage staple, 6" o.c./ 12" o.c.^{8,9}</p> <p>1-5/8" 0.099" nail 6" o.c./ 12" o.c.</p>
19/32" to 5/8"	<p>8d common nail (see Table 36) 6" o.c./ 12" o.c.^{3,4}</p> <p>16 gage staple⁵ 1" minimum penetration 2-1/2" o.c./ 5" o.c.</p>	<p>8d common nail (see Table 36) 6" o.c./ 12" o.c.</p> <p>or,</p> <p>16 gage staple⁶ 1" minimum penetration 2" o.c./ 5" o.c.</p>	<p>Walls 8d common nail (see Table 36) or, 8d box nail (see Table 35) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>Roofs 8d common nail (see Table 36) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>8d common nail (see Table 36), or 1-7/8" 0.113" nail, or 1-5/8" 15 or 16 gage staple 6" o.c./ 12" o.c.⁹</p> <p>or,</p> <p>1-3/4" 0.099" nail 3" o.c./ 6" o.c.</p>
23/32" to 3/4"	<p>8d common nail (see Table 36) 6" o.c./ 12" o.c.^{3,4}</p>	<p>8d common nail (see Table 36) 6" o.c./ 12" o.c.</p> <p>or,</p> <p>16 gage staple⁶ 1" minimum penetration 2" o.c./ 5" o.c.</p>	<p>Walls 8d common nail (see Table 36) or, 8d box nail (see Table 35) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>Roofs 8d common nail (see Table 36) or, 6d deformed nail</p> <p>6" o.c./ 12" o.c.⁷</p>	<p>8d common nail (see Table 36) 1-3/4" 14 gage staple 6" o.c./ 12" o.c.</p> <p>or,</p> <p>1-3/4" 15 gage staple 5" o.c./ 10" o.c.</p> <p>or,</p> <p>1-7/8" 0.099" nail 3" o.c./ 6" o.c.</p>

¹A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

²Staples shall have minimum 7/16" crown width, measured outside the legs, unless otherwise specified.

³For regions having a basic wind speed of 90 miles per hour or greater where the mean roof height is less than 25 feet, and for regions having a basic wind speed of 80 miles per hour or less, nails which attach wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where basic wind speed is greater than 80 miles per hour, nails which attach panel roof sheathing to intermediate supports shall be spaced 6 inches on center for a minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

⁴For regions having a basic wind speed of 90 miles per hour or greater, 8d deformed shank nails shall be utilized to attach wood structural panel roof sheathing to framing for a minimum 48-inch distance from gable end walls, provided the mean roof height is between 25 feet and 35 feet. See Table 34 or 37 for fastening alternates, depending on panel thickness. For roof heights greater than 35 feet in a 90-mile-per-hour, or greater, wind region, attachment of wood structural panel roof sheathing shall be designed for the wind loads in Section 1609.0 of the BOCA 1996 *National Building Code*.

⁵In areas using the *Standard Building Code*, use of this table is limited to buildings of conventional wood frame construction where wind or seismic analysis is not required by the code. In areas where design wind speeds prescribed by the code exceed 80 mph, or where seismic analysis is required, required fastening shall be determined by structural analysis, based on the allowable fastener loads and allowable diaphragm capacities noted in this report. When applicable, use of prescriptive fastening schedules in SBCCI Standard SSTD 10 is permitted, with alternative fasteners selected from Tables 31 through 37.

⁶Staples shall have a minimum 3/8" crown width, measured outside the legs.

⁷Fasteners shall be spaced 6 inches on center at panel edges and 6 inches on center at intermediate supports where panel spans are 48 inches on center or greater.

⁸For regions having a basic wind speed of 90 mph or greater, 8d deformed shank nails shall be used for attaching plywood and wood structural panel roof sheathing to framing within minimum 48-inch distance from gable end walls, if mean roof height is more than 25 feet, up to 35 feet maximum. See Tables 34 or 37 for fastening alternates, depending on panel thickness.

⁹For regions having a basic wind speed of 80 mph or less, nails for attaching plywood and wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches o.c. When basic wind speed is greater than 80 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches o.c. for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches o.c. to gable end wall framing.

**TABLE 30
MODEL CODE FLOOR SHEATHING PRESCRIPTIVE REQUIREMENTS 1,3,6
FOR USE IN SELECTING ALTERNATE FASTENINGS WITH TABLES 31 THROUGH 37**

WOOD STRUCTURAL PANEL NOMINAL THICKNESS	MODEL CODE FASTENER AND SPACING (at panel edges/intermediate)			
	BOCA <i>National Building Code</i> Table 2305.2	SBCCI <i>Standard Building Code</i> Table 2306.1 ⁴	ICBO <i>Uniform Building Code</i> Table 23-I-Q	CABO <i>One and Two Family Dwelling Code</i> Tables 602.3a & 602.3a(1)
1/2" or less	6d common nail (see Table 32), or 6d deformed shank nail 6" o.c./ 12" o.c. or, 1-5/8" 16 gage staple ⁵ , 4" o.c./ 7" o.c.	6d common nail (see Table 32), or 6d deformed shank nail 6" o.c./ 12" o.c. or, 1-5/8" 16 gage staple ⁵ , 4" o.c./ 7" o.c.	6d common nail (see Table 32), or, 6d deformed shank nail 6" o.c./ 12" o.c. ²	6d common nail (see Table 32) 6" o.c./ 12" o.c. ² or, 1-1/2" 15 gage staple 6" o.c./ 10" o.c. ² or, 1-5/8" 0.099 Nail 3" o.c./ 6" o.c.
19/32 - 5/8	8d common nail (see Table 36), or 6d deformed shank nail 6" o.c./ 12" o.c. or, 1-5/8" 16 gage staple ⁵ , 2-1/2" o.c./ 4" o.c.	8d common nail (see Table 36), or 6d deformed shank nail 6" o.c./ 12" o.c. or, 1-5/8" 16 gage staple ⁵ , 2-1/2" o.c./ 4" o.c.	8d common nail (see Table 36), or 6d deformed shank nail 6" o.c./ 12" o.c. ²	8d common nail (see Table 36) 6" o.c./ 12" o.c. ² or, 1-7/8" 0.113 nail, or 1-5/8" 15 or 16 ga. staple 6" o.c./ 10" o.c. ² or, 1-3/4" 0.099 Nail 3" o.c./ 6" o.c.
3/4	8d common nail (see Table 36), or 6d deformed shank nail 6" o.c./ 12" o.c.	8d common nail (see Table 36), or 6d deformed shank nail 6" o.c./ 12" o.c.		8d common nail (see Table 36) 6" o.c./ 12" o.c. ² or, 1-3/4" 14 gage staple 6" o.c./ 10" o.c. ² or, 1-3/4" 15 gage staple 5" o.c./ 10" o.c. ² or, 1-7/8" 0.099 Nail 3" o.c./ 6" o.c.

¹A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

²Intermediate spacing shall be 6" on center at supports when spans are 48" or more.

³Staple crown shall be a minimum 7/16" width, overall, unless otherwise stated.

⁴In areas using the *Standard Building Code*, use of this table is limited to buildings of conventional wood frame construction where wind or seismic analysis is not required by the code. In areas where design wind speeds prescribed by the code exceed 80 mph, or where seismic analysis is required, required fastening shall be determined by structural analysis based on the allowable fastener loads and allowable diaphragm capacities noted in this report. When applicable, use of prescriptive fastening schedules in SBCCI Standard SSTD 10 is permitted, with alternative fasteners selected from Tables 31 through 37.

⁵Staple crown shall be a minimum 3/8" width, overall.

⁶In areas using the *Standard Building Code*, only deformed shank nails are permitted to fasten combination subfloor/underlayment.

**TABLE 31
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 1/2" AND THINNER WALL WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING A 6D BOX NAIL**

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		6d Box Nail Spaced 4" o.c.	6d Box Nail Spaced 6" o.c.	6d Box Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to a 6d Box Nail (inches)		
0.099" nail (6d box nail)	2	4	6	12
0.092" nail	2-1/4	3	4	8
0.099" nail	2-1/4	4	6	12
0.099" deformed shank nail	2-1/4	4	6	12
0.113" nail	2	4	6	12
0.113" deformed shank nail	2	4	6	12
0.113" nail (8d cooler)	2-3/8	4	6	12
0.113" deformed shank nail	2-3/8	4	6	12
0.120" nail	3	4	8	16
0.131" nail (8d common)	2-1/2	6	8	16
0.131" deformed shank nail	2-1/2	6	8	16
16 gage staple	1-1/2	3	4	8
	1-3/4	4	6	12
	2			
2-1/4				
15 gage staple	1-3/4	4	6	12
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	4	8	16
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 5 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

**TABLE 32
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 1/2" AND THINNER WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING A 6D COMMON NAIL**

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		6d Common Nail Spaced 4" o.c.	6d Common Nail Spaced 6" o.c.	6d Common Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to a 6d Common Nail (inches)		
0.113" nail (6d common nail)	2	4	6	12
0.092" nail	2-1/4	2	4	8
0.099" nail	2-1/4	3	4	8
0.099" deformed shank nail	2-1/4	3	4	8
0.113" nail	2	4	6	12
0.113" deformed shank nail	2	4	6	12
0.113" nail (8d cooler)	2-3/8	4	6	12
0.113" deformed shank nail	2-3/8	4	6	12
0.120" nail	3	4	6	12
0.131" nail (8d common)	2-1/2	4	8	12
0.131" deformed shank nail	2-1/2	4	8	12
16 gage staple	1-1/2	3	4	8
	1-3/4	3	4	8
	2			
2-1/4				
15 gage staple	1-3/4	4	6	12
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	4	6	12
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 5 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

**TABLE 33
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 1/2" AND THINNER WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING AN 8D COMMON NAIL**

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		8d Common Nail Spaced 4" o.c.	8d Common Nail Spaced 6" o.c.	8d Common Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to an 8d Common Nail (inches)		
0.131" nail (8d common nail)	2-1/2	4	6	12
0.092" nail	2-1/4	2	3	6
0.099" nail	2-1/4	2	3	6
0.099" deformed shank nail	2-1/4	2	3	6
0.113" nail	2	2	4	8
0.113" deformed shank nail	2	2	4	8
0.113" nail (8d cooler)	2-3/8	3	4	8
0.113" deformed shank nail	2-3/8	3	4	8
0.120" nail	3	3	4	8
0.131" deformed shank nail	2-1/2	4	6	12
16 gage staple	1-3/4	2	3	6
	2			
15 gage staple	1-3/4	2	4	8
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	3	4	8
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 5 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

**TABLE 34
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 1/2" AND THINNER WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING AN 8D DEFORMED SHANK NAIL**

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		8d Deformed Shank Nail Spaced 4" o.c.	8d Deformed Shank Nail Spaced 6" o.c.	8d Deformed Shank Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to an 8d Deformed Shank Nail (inches)		
0.120" nail (8d deformed shank nail)	2-1/2	4	6	12
0.092" nail	2-1/4	2	3	6
0.099" nail	2-1/4	2	4	8
0.099" deformed shank nail	2-1/4	3	4	8
0.113" nail	2	2	3	6
0.113" deformed shank nail	2	2	4	8
0.113" nail (8d cooler)	2-3/8	3	4	8
0.113" deformed shank nail	2-3/8	3	4	8
0.120" nail	3	4	6	12
0.131" nail (8d common)	2-1/2	4	6	12
0.131" deformed shank nail	2-1/2	4	6	12
16 gage staple	1-3/4	2	3	6
	2			
15 gage staple	1-3/4	2	4	8
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	3	4	8
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 5 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

TABLE 35
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 19/32", 5/8", 23/32" AND 3/4" WALL WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING AN 8D BOX NAIL

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		8d Box Nail Spaced 4" o.c.	8d Box Nail Spaced 6" o.c.	8d Box Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to an 8d Box Nail (inches)		
0.113" nail (8d box nail)	2-1/2	4	6	12
0.092" nail	2-1/4	2	4	8
0.099" nail	2-1/4	3	4	8
0.099" deformed shank nail	2-1/4	3	4	8
0.113" nail	2	2 (See Footnote 4)	4	8
0.113" deformed shank nail	2	3	4	8
0.113" nail (8d cooler)	2-3/8	3	4	8
0.113" deformed shank nail	2-3/8	4	6	12
0.120" nail	3	4	6	12
0.131" nail (8d common)	2-1/2	4	6	12
0.131" deformed shank nail	2-1/2	4	6	12
16 gage staple	1-3/4	2	3 (See Footnote 5)	6 (See Footnote 6)
	2	3	4	8
15 gage staple	1-3/4	3	4	8
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	4	6	12
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 12 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

⁴For 19/32" and 5/8" panel thicknesses, spacing up to 3" o.c. is permitted.

⁵For 19/32" and 5/8" panel thicknesses, spacing up to 4" o.c. is permitted.

⁶For 19/32" and 5/8" panel thicknesses, spacing up to 8" o.c. is permitted.

TABLE 36
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 19/32", 5/8", 23/32" & 3/4" WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING AN 8D COMMON NAIL

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		8d Common Nail Spaced 4" o.c.	8d Common Nail Spaced 6" o.c.	8d Common Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to an 8d Common Nail (inches)		
0.131" nail (8d common nail)	2-1/2	4	6	12
0.092" nail	2-1/4	2	3	6
0.099" nail	2-1/4	2	4	8
0.099" deformed shank nail	2-1/4	2	4	8
0.113" nail	2	2	3	6
0.113" deformed shank nail	2	2	4	8
0.113" nail (8d cooler)	2-3/8	3	4	8
0.113" deformed shank nail	2-3/8	3	4	8
0.120" nail	3	3	4	8
0.131" deformed shank nail	2-1/2	4	6	12
16 gage staple	1-3/4	2	3	6
	2	2	4	8
15 gage staple	1-3/4	2	3 (See Footnote 4)	6 (See Footnote 5)
	2			
	2-1/4			
	2-1/2			
14 gage staple	2	3	4	8
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 12 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

⁴For 19/32" and 5/8" panel thicknesses, spacing up to 4" o.c. is permitted.

⁵For 19/32" and 5/8" panel thicknesses, spacing up to 8" o.c. is permitted.

TABLE 37
ALLOWABLE SPACING OF ALTERNATE FASTENINGS ¹ EQUIVALENT TO THE ATTACHMENT OF 19/32", 5/8", 23/32" AND 3/4" WOOD STRUCTURAL PANEL AND PARTICLEBOARD SHEATHING TO WOOD FRAMING MEMBERS USING AN 8D DEFORMED SHANK NAIL

FASTENER TYPE (minimum nominal nail ² shank diameter, in inches, or staple ³ gage)	MINIMUM NOMINAL LENGTH, INCHES	IF MODEL CODE REQUIRES		
		8d Deformed Shank Nail Spaced 4" o.c.	8d Deformed Shank Nail Spaced 6" o.c.	8d Deformed Shank Nail Spaced 12" o.c.
		Spacings of Fasteners to Achieve Equivalent Withdrawal and Lateral Strength to an 8d Deformed Shank Nail (inches)		
0.120" nail (8d deformed shank nail)	2-1/2	4	6	12
0.092" nail	2-1/4	2	3	6
0.099" nail	2-1/4	2	3 (See Footnote 5)	6 (See Footnote 4)
0.099" deformed shank nail	2-1/4	2	4	8
0.113" nail	2	2	3	6
0.113" deformed shank nail	2	2	4	8
0.113" nail (8d cooler)	2-3/8	3	4	8
0.113" deformed shank nail	2-3/8	3	4	8
0.120" nail	3	4	6	12
0.131" nail (8d common)	2-1/2	4	6	12
0.131" deformed shank nail	2-1/2	4	6	12
16 gage staple	1-3/4	2	3	6
	2	2	4	8
15 gage staple	1-3/4	2	3 (See Footnote 5)	6 (See Footnote 4)
	2	3	4	8
	2-1/4			
	2-1/2			
14 gage staple	2	3	4	8
	2-1/4			
	2-1/2			
	3			

¹For fastening of wood structural panel horizontal diaphragms and shear walls, refer to design tables (Tables 12 through 21) for sufficient lateral strength.

²A deformed shank nail shall have either a helical (screw) shank or an annular (ring) shank.

³Staples shall have minimum 7/16" crown widths.

⁴For 19/32" and 5/8" panel thicknesses, spacing up to 8" o.c. is permitted.

⁵For 19/32" and 5/8" panel thicknesses, spacing up to 4" o.c. is permitted.

**TABLE 38
WALL SHEATHING, PANEL SIDING AND FLOOR UNDERLAYMENT ATTACHED TO WOOD MEMBERS**

DESCRIPTION OF ATTACHED MATERIAL	ATTACHED MATERIAL NOMINAL THICKNESS (in inches)	SPACING SPECIFICATIONS (in inches) ⁴		FASTENER SPECIFICATIONS ^{1,2}	
		Edges	Intermediate	Minimum Leg Length (in inches)	Fastener Style ³
Plywood Panel Siding	3/8	6	12	1-1/2	6d Galv. Casing Nail
					6d Galv. Siding Nail
					0.097 Galv. Finish Nail
	1/2	6	12	1-5/8	6d Galv. Casing Nail
					6d Galv. Siding Nail
					0.097 Galv. Finish Nail
	5/8	6	12	1-7/8	8d Galv. Casing Nail
					8d Galv. Siding Nail
					0.113 Galv. Finish Nail
Fiberboard Wall Sheathing	1/2	6	12	1-1/2	14 Gage Staple
		4	10		15 Gage Staple
		16 Gage Staple			
	25/32	5	10	1-3/4	14 Gage Staple
		4	8		15 Gage Staple
		16 Gage Staple			
Gypsum Wall Sheathing	1/2	5	10	1-1/2	14 Gage Staple
		4	8		15 Gage Staple
		16 Gage Staple			
Floor Underlayment	1/4	3	6-Grid	1-1/4	3d Ring Shank Nail
		2	5-Grid	7/8	18 Gage Staple 3/16" Crown Width
		2	4-Grid	1-1/4	0.080 Nail
	11/32	6	8-Grid	1-1/4	3d Ring Shank Nail
		4	6-Grid		16 Gage Staple
	15/32 - 19/32	6	8-Grid	1-1/4	0.080 Nail
		6	8-Grid		3d Ring Shank Nail
		5	6-Grid		16 Gage Staple
	3/4	6	8-Grid	1-1/2	0.097" Nail
		6	8-Grid		4d Ring Shank Nail
		5	6-Grid		16 Gage Staple

¹Except as noted above, all staples shall have a minimum crown width of 7/16 inch.

²Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip, mechanical-deposition or electro-deposition galvanizing process.

³0.080 nails and No. 18 gage staples are not listed in Tables 1 through 4, and are for nonstructural use only as tabulated above.

⁴Fastening schedule only applies to buildings of conventional wood frame construction where wind or seismic analysis is not required by the applicable code. In areas where wind or seismic analysis is required, required fastening shall be determined by structural analysis. The ICBO *Uniform Building Code* requires structural analysis in areas where design wind speeds prescribed by the code are 80 mph or higher. The SBCCI *Standard Building Code* requires structural analysis in areas where the design wind speed exceeds 80 mph.

**TABLE 39
FASTENERS FOR ATTACHING WALL AND ROOF COVERING MATERIALS ¹**

SPACING SPECIFICATIONS	FASTENER SPECIFICATIONS ²		
	Fastener Style	Minimum Crown Width, or Nail Head Diameter	Minimum Leg Length ³
Composition Roof Shingles and Wall Shingles			
A Minimum of Four Fasteners Per Each 36"-40" Section of Shingle ⁴	16 Gage Staples	15/16"	See Footnotes 3 & 5
	0.120" Roof Nail	3/8"	See Footnote 3
Composition Ridge and Hip Caps			
A Minimum of Two Fasteners Per Cap	16 Gage Staples	15/16"	See Footnotes 3 & 5
	0.120" Roof Nail	3/8"	See Footnote 3
Wood Roof and Wall Shingles ^{6, 7, 8}			
A Minimum of Two Fasteners Per Shingle	16 Gage Staples	7/16"	1-1/4"
	0.080" Nail	-	1-1/4"
Wood Shakes ^{6, 7, 8}			
A Minimum of Two Fasteners Per Shingle	16 Gage Staples	7/16"	1-3/4"
	0.080" Nail	-	1-3/4"
Tin Capping for Roof Felts			
All tin caps placed and fastened 12 inches on center	16 Gage Staples	7/16"	7/8"
	0.120" Roof Nail	3/8"	7/8"
Aluminum and Vinyl Siding ⁹			
Vertical Siding 10" o.c., ¹⁰ Horizontal Siding 16" o.c. ¹⁰	16 Gage Staples	7/16"	See Footnote 9
	0.120" Nail	3/8"	2"
Built-Up Roof Base Sheets to Wood Substrates			
Staples spaced 12" o.c. straddling 1/4-inch-wide rayon cord tape ¹¹	16 Gage Staples	7/16"	See Footnote 11

¹In areas covered by the *Standard Building Code*, use of this table is limited to areas where design wind speeds prescribed by the code do not exceed 80 mph and building heights do not exceed 30 feet.

²Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip, mechanical deposition or electro-deposition galvanizing process. Fasteners manufactured from aluminum 5056 or 6061 alloy wire or other nonferrous alloys do not require protective coatings.

³The staples or nail leg length shall be long enough to penetrate through the sheathing and extend beyond 1/8 inch or penetrate the sheathing 3/4 inch, whichever is less; all other provisions of this table will prevail.

⁴The *BOCA National Building Code* requires that asphalt strip shingles shall have a minimum of six fasteners per shingle where the structure is located in hurricane ocean-line areas along the Atlantic and Gulf of Mexico coastal areas and 100 miles inland where the basic wind speed is 80 miles per hour or greater, determined in accordance with the Basic Wind Speed map in the Code (Figure 1609.3).

⁵Composition shingles shall be attached with staples that are driven so that the staple crown bears tightly against the shingle but does not cut the shingle surface. The crown is parallel to the long dimension of the shingle course.

⁶Wood shingles and shakes shall be attached with staples that are driven so that the staple crown is parallel to the butt edge, compressing the wood surface no more than the total thickness of the staple crown wire.

⁷Nails for wood shingles and shakes shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less.

⁸No. 18 gage staples with a 7/16-inch crown may be used to attach roof and wall shingles, provided the butt ends do not exceed 3/4 inch. The staple leg length shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less. Two staples shall be used to attach each shingle or shake.

⁹Staples shall be corrosion resistant and have a minimum penetration of 3/4 inch into the wood supporting member. One leg of the staple shall be driven through the pre-punched hole in the sealing rib, with the crown perpendicular to the width of the siding. The staple shall not deform the siding.

¹⁰As required by manufacturer and approved by the building official.

¹¹Legs of sufficient length to penetrate the opposite side of the roof deck 1/8-inch or penetrate into the sheathing 3/4 inch, whichever is less. The rayon cord tape is located 16 inches on center, parallel to the long dimension of the base sheet. At points where the head lap occurs between base sheets, the tape is installed below the center of the overlapping portion of the base sheets.

**TABLE 40
STAPLES FOR ATTACHING WALL, CEILING AND SOFFIT COVERING MATERIALS TO WOOD RECEIVING MEMBERS ONLY ¹**

MINIMUM LEG LENGTH (O.D.) (in inches)	DESCRIPTION OF COVERING MATERIALS ^{2, 3, 5, 6, 7}		MAXIMUM SPACING (in inches)	
			Vertical Surfaces	Horizontal Surfaces
7/8	3/8-inch Gypsum Lath - Plain, Type X		8 ⁸	8 ⁸
1	3/8-inch Gypsum Lath and Metal or Wire Stripping		-	5
1-1/2	1/2-inch Gypsum Lath - Plain, Type X		8 ⁸	8 ⁸
	1/2-inch Fiber Insulation Lath		4	4
1-3/4	1-inch Fiber Insulation Lath		5	-
	Laminating 3/8-inch Gypsum Lath and 3/8-inch Gypsum Wallboard			
7/8	3/8-inch Gypsum Lath Panels, Wallboard and Backer Board		7	7
1-1/8	1/2-inch Gypsum Lath Panels, Wallboard and Backer Board			
1-1/4	5/8-inch Gypsum Wallboard and Backer Board			
1-3/4	Laminating 1/2-inch and 1/2-inch Type X Wallboard			
2	Laminating 5/8-inch and 5/8-inch Type X Wallboard			
7/8	Metallic Plaster Reinforcement	Welded or woven wire fabric	6	6
		Expanded metal lath		
1-1/4	Metallic Plaster Reinforcement	Expanded metal lath	at ribs	at ribs
1-3/4				

¹Staples shall be manufactured from No. 16 gage round, semi-round or flattened wire and shall have, if used for attaching gypsum wallboard or gypsum lath, a minimum 3/4-inch crown, measured outside the legs.

²Staples for attachment of exterior lath must be galvanized. When attached over fiberboard, rigid, expanded polystyrene or gypsum sheathing, the leg length shall be sufficient to provide a 1-inch penetration into the stud.

³Lath shall be furred and provided with backing when required by the applicable model code. The welded or woven wire netting shall be pre-hung by conventional temporary nailing prior to staple installation.

⁴Supports spaced 24 inches o.c. Four attachments per 16-inch-wide lath per bearing. Five attachments per 24-inch-wide lath per bearing.

⁵Staples attaching metal or wire lath, stucco mesh and welded or woven wire netting shall have a minimum 7/16-inch crown, measured outside the legs.

⁶For attaching covering materials to redwood supporting members, add a minimum of 3/8-inch to fastener leg length.

⁷Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip, mechanical-deposition or electro-deposition galvanizing process. Fasteners manufactured from aluminum 5056 or 6061 alloy wire or other nonferrous alloys do not require protective coatings.

⁸Three attachments per 16-inch-wide lath per bearing. Four attachments per 24-inch-wide lath per bearing.

**TABLE 41
STAPLES FOR ATTACHING WALL, CEILING AND SOFFIT COVERING MATERIALS TO METAL RECEIVING MEMBERS ONLY**

WIRE GAGE NO.	MINIMUM LEG LENGTH (O.D.) (in inches)	DESCRIPTION OF COVERING MATERIALS ¹	STAPLE ² SPACING (in inches)	TYPE OF RECEIVING MEMBER
16	1-1/8	3/8-Inch Gypsum Lath	5	Approved Load and Nonload-bearing Nailable Studs "Only" Designed for Receiving Round Wire Staples or Conventional Nails
14			8	
16	1-1/4	1/2-Inch Gypsum Lath, Panels & Wallboard ³	5	
14			8	
16	1-3/8	1/2-Inch Gypsum Lath, Panels & Wallboard	5	
14			8	
16	1-1/4	Metal Lath & Welded or Woven Wire Lath & Masonry Veneer Wire Mesh	6	
16	1-3/8	3/8-Inch High Rib Metal Lath	At Ribs	
16	1-3/4	3/4-Inch High Rib Metal Lath		

¹Staples shall be manufactured from round, semi-round or flat wire and shall have a minimum 7/16-inch crown.

²Steel wire fasteners exposed to the weather in service shall be zinc-coated by a hot-dip, mechanical-deposition or electro-deposition galvanizing process. Fasteners manufactured from aluminum 5056 or 6061 alloy wire or other nonferrous alloys do not require protective coatings.

APPENDIX

Reference

1991 National Design Specification® (NDS®), American Forest and Paper Association (AF&PA).

Development of Report Fastening Schedules

Fastening schedules in this report are based on fastening schedules found in model building codes. Fastening schedules in this report have connection strengths greater than or equal to the strength of the connection listed in the model building codes. Connection strength was analyzed based on lateral strength, withdrawal strength, or both, as appropriate.

The same model for connection withdrawal strength was used for both nailed and stapled connections. Different lateral strength models were used for nails and staples.

Withdrawal Strength Values

The allowable withdrawal loads per inch of penetration of a staple or smooth shank nail driven in side grain (perpendicular to the fiber) of seasoned wood, or unseasoned wood which will remain wet, is calculated using the following formula:

$$W = 1380 G^{5/2} D$$

where:

- W = The allowable load per lineal inch of penetration into the member holding the nail point.
- G = The specific gravity of the wood (See Table A).
- D = The diameter of the fastener shank in inches.

Threaded nails have design withdrawal strengths 10% greater than smooth shank nails of the same diameter.

Staple withdrawal strengths are calculated by doubling the calculated withdrawal strength of one leg.

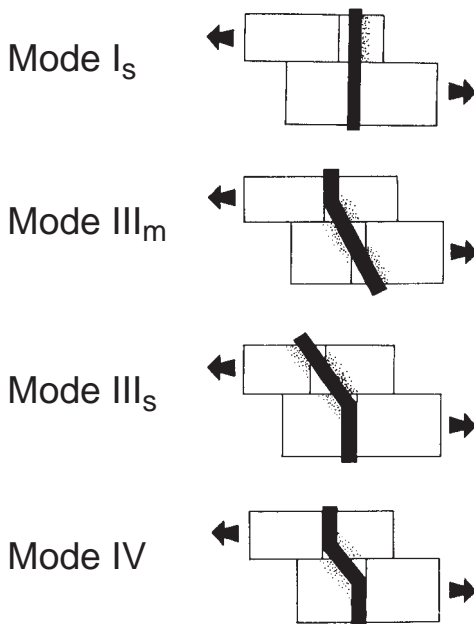
Nail Lateral Strength Calculations

Lateral strength values for nailed connections in this report are based on a model (The "European Yield Model") that was incorporated into the 1991 edition of the National Design Specification (NDS) published by the American Forest and Paper Association (AF&PA). BOCA, ICBO and SBCCI have adopted the 1991 NDS for preparation of all National Evaluation Reports.

The model considers wood fiber crushing and fastener shank bending. Four combinations of wood crushing and fastener bending are typical:

Figure A

Connection Yield Modes for Two-Member, Single-Shear Connections



Equations describe connection lateral design loads for each failure mode:

Yield Mode Equation

for Mode I_s
$$Z = \frac{D t_s F_{es}}{K_D}$$

for Mode III_m
$$Z = \frac{k_1 D p F_{em}}{K_D(1 + 2R_e)}$$

Yield Mode Equation

for Mode III_s
$$Z = \frac{k_2 D t_s F_{em}}{K_D(2 + R_e)}$$

for Mode IV
$$Z = \frac{D^2}{K_D} \sqrt{\frac{2F_{em}F_{yb}}{3(1 + R_e)}}$$

in which:

$$k_1 = -1 + \sqrt{2(1 + R_e) + \frac{2F_{yb}(1 + 2R_e)D^2}{3F_{em}p^2}}$$

$$k_2 = -1 + \sqrt{\frac{2(1 + R_e)}{R_e} + \frac{2F_{yb}(2 + R_e)D^2}{3F_{em}t_s^2}}$$

- $R_e = F_{em} / F_{es}$
- p = Penetration of nail or staple in main member (member holding point), inches.
- t_s = Thickness of side member, inches.
- F_{em} = Dowel bearing strength of main member (member holding point), psi (see Table A).
- F_{es} = Dowel bearing strength of side member, psi (see Table A).
- F_{yb} = Bending yield strength of nail or staple, psi.
- D = Nail diameter, inches, or wire diameter of wire from which staple is produced, inches. (When annularly threaded nails are used with threads at the shear plane, D = root diameter of threaded portion of nail.)
- $K_D = 2.2$ for $D \leq 0.17''$
- $K_D = 10 D + 0.5$ for $0.17'' < D < 0.25''$
- $K_D = 3.0$ for $D \geq 0.25''$

Adjustment factors for connections (such as load duration factor, wet service factor, etc.) must be applied to the computed Z values to obtain allowable connection lateral strength values.

Staple Lateral Strength Calculations

Research is presently being conducted to verify the applicability of the new connection lateral strength model to stapled connections. Until that research is completed, the Proportional Limit Model shall continue to be used for stapled connections. The Proportional Limit Model has historically been used for calculating the lateral strength of both nailed and stapled connections. The new model was calibrated to yield essentially the same design values yielded by the old model.

Calculations of alternate strengths, numbers of staples per connection, and staple spacings were made the same as for nails, but were based on the Proportional Limit Model.

The Proportional Limit Model uses the following formula to calculate the allowable load of wood-to-wood nailed and stapled connections:

$$p = KD^{3/2}$$

where:

- p = Lateral load in pounds per fastener shank at a joint slip of 0.015 inch (approximate proportional limit load).
- K = A coefficient dependent upon wood species and class (hardwood or softwood).
- D = Fastener shank diameter, in inches.

For stapled connections, the value is calculated for the diameter of the wire from which the staple was made, and then doubled to reflect the additive performance of the staple's two legs.

As with the European Yield Model, adjustment factors for connections (such as load duration factor, wet service factor, etc.) must be applied to the computed Z values to obtain allowable connection lateral strength values.

Appendix Table A presents values of K for wood species used in construction. Report Table 2 presents allowable lateral strengths for stapled connections.

**TABLE A
WOOD SPECIES' SPECIFIC GRAVITY, DOWEL BEARING STRENGTH AND GROUP NUMBERS**

GROUP	SPECIES	SPECIFIC GRAVITY ¹ , G	DOWEL-BEARING STRENGTH IN POUNDS PER SQUARE INCH (psi), F _e	"K" VALUES FOR STAPLE LATERAL STRENGTH CALCULATIONS
I	Beech-birch-hickory	0.71	8,850	2,040
	Red Oak	0.67	7,950	
	White Oak	0.73	9,300	
II	Douglas Fir-larch	0.50	4,650	1,650
	Southern Pine	0.55	5,550	
III	Douglas Fir-south	0.46	4,000	1,350
	Eastern Hemlock	0.41	3,200	
	Eastern Hemlock-tamarack	0.41	3,200	
	Eastern Hemlock-tamarack (north)	0.47	4,150	
	Eastern softwoods	0.36	2,550	
	Eastern Spruce	0.41	3,200	
	Hem-Fir	0.43	3,500	
	Mountain Hemlock	0.47	4,150	
	Northern Pine	0.42	3,350	
	Ponderosa Pine	0.43	3,500	
	Red Pine	0.44	3,650	
	Sitka Spruce	0.43	3,500	
	Spruce-Pine-Fir	0.42	3,350	
IV	Western Hemlock	0.47	4,150	1,080
	Yellow Poplar	0.43	3,500	
	Aspen	0.39	2,950	
	Balsam Fir	0.36	2,550	
	Coast Sitka Spruce	0.39	2,950	
	Eastern White Pine	0.36	2,550	
	Engelmann Spruce - Alpine Fir ² (MSR 1650f and higher grades)	0.46	4,000	
	Engelmann Spruce - Alpine Fir ² (MSR 1500f and lower grades)	0.38	2,800	
	Northern Species	0.35	2,400	
	Northern White Cedar	0.31	1,900	
	Western Cedars	0.36	2,550	
	Western Cedars	0.35	2,400	
	Western White Pine	0.40	3,600	
White Woods	0.36	2,550		

¹Specific gravity based on weight and volume when oven-dry.

²Applies only to Engelmann spruce-lodgepole pine machine stress-rated (MSR) structural lumber.

**TABLE B
CONNECTION DEFLECTION VALUES FOR USE IN DIAPHRAGM DEFLECTION ANALYSIS¹
Nailed Connections**

—	SMOOTH SHANK NAILS							DEFORMED SHANK NAILS					
	0.092	0.097/0.099		0.113		0.120	0.131	0.148	0.097/ 0.098	0.113		0.120	0.131
Diameter (inches)	0.092	0.097	0.099	0.113	0.113	0.120	0.131	0.148	0.097/0.098	0.113	0.113	0.120	0.131
Length (inches)	2-1/4	2	2-1/4	2	2-3/8	3	2-1/2	3	2-1/4	2	2-3/8	2-1/2	2-1/2
Load Per Fastener ² (pounds)	Connection Deflection ³ , In Inches												
60	0.003	0.006	0.002	0.002	0.001	0.001	0.002	0.001	0.007	0.003	0.001	0.007	0.006
80	0.008	0.012	0.005	0.004	0.003	0.002	0.003	0.002	0.010	0.006	0.003	0.012	0.007
100	0.016	0.025	0.009	0.009	0.006	0.003	0.005	0.003	0.020	0.010	0.006	0.019	0.008
120	0.033	0.046	0.016	0.015	0.009	0.006	0.007	0.005	0.037	0.014	0.009	0.028	0.009
140	0.060	0.079	0.027	0.030	0.014	0.009	0.011	0.007	0.061	0.024	0.013	0.039	0.009
160	0.090	0.137	0.046	0.054	0.023	0.014	0.017	0.010	0.089	0.040	0.020	0.053	0.010
180	0.117	0.286	0.075	0.087	0.037	0.021	0.025	0.015	0.121	0.063	0.030	0.074	0.014
200	0.151	—	0.100	0.116	0.057	0.032	0.040	0.021	0.193	0.089	0.043	0.094	0.019
220	0.186	—	0.132	0.156	0.086	0.049	0.064	0.030	0.354	0.100	0.061	0.116	0.024
240	0.228	—	0.163	0.200	0.100	0.078	0.097	0.044	0.548	0.130	0.082	0.148	0.028

¹Decrease slip value by 17% for Structural I sheathing.

²Load per fastener is the diaphragm's maximum shear per foot, divided by the number of fasteners per foot at interior panel edges.

³Values should be doubled for unseasoned lumber.

TABLE C
CONNECTION DEFLECTION VALUES FOR USE IN DIAPHRAGM DEFLECTION ANALYSIS ¹
Stapled Connections

—	STAPLE GAGE					
	16		15		14	
Length (inches)	1-1/2	2	1-3/4	2-1/2	2	2-1/2
Load Per Fastener ² (pounds)	Connection Deflection ³ , In Inches					
60	0.008	0.003	0.008	0.005	0.005	0.003
80	0.016	0.006	0.016	0.010	0.011	0.006
100	0.032	0.008	0.028	0.015	0.019	0.009
120	0.055	0.010	0.048	0.025	0.032	0.014
140	0.087	0.024	0.077	0.040	0.050	0.021
160	0.135	0.037	0.118	0.060	0.077	0.031
180	0.205	0.052	0.173	0.088	0.113	0.044
200	—	0.092	0.244	0.127	0.157	0.060
220	—	0.198	0.299	0.178	0.219	0.080
240	—	—	0.346	0.220	0.287	0.097

¹Decrease slip value by 17% for Structural I sheathing.

²Load per fastener is the diaphragm's maximum shear per foot, divided by the number of fasteners per foot at interior panel edges.

³Values should be doubled for unseasoned lumber.