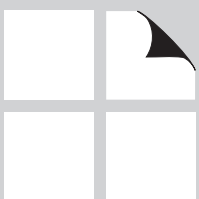
DOWEL-TYPE FASTENERS

(BOLTS, LAG SCREWS, WOOD SCREWS, NAILS/SPIKES, DRIFT BOLTS, AND DRIFT PINS)



AMERICAN WOOD COUNCIL

12.1 General

12.1.1 Scope

Chapter 12 applies to the engineering design of connections using bolts, lag screws, wood screws, nails, spikes, drift bolts, drift pins, or other dowel-type fasteners in sawn lumber, structural glued laminated timber, timber poles, timber piles, structural composite lumber, prefabricated wood I-joists, wood structural panels, and cross-laminated timber.

12.1.2 Terminology

12.1.2.1 "Edge distance" is the distance from the edge of a member to the center of the nearest fastener, measured perpendicular to grain. When a member is loaded perpendicular to grain, the loaded edge shall be defined as the edge in the direction toward which the fastener is acting. The unloaded edge shall be defined as the edge opposite the loaded edge (see Figure 12G).

12.1.2.2 "End distance" is the distance measured parallel to grain from the square-cut end of a member to the center of the nearest bolt (see Figure 12G).

12.1.2.3 "Spacing" is the distance between centers of fasteners measured along a line joining their centers (see Figure 12G).

12.1.2.4 A "row of fasteners" is defined as two or more fasteners aligned with the direction of load (see Figure 12G).

12.1.2.5 End distance, edge distance, and spacing requirements herein are based on wood properties. Wood-to-metal and wood-to-concrete connections are subject to placement provisions as shown in 12.5.1, however, applicable end and edge distance and spacing requirements for metal and concrete, also apply (see 11.2.3 and 11.2.4).

12.1.3 Bolts

12.1.3.1 Installation requirements apply to bolts meeting requirements of ANSI/ASME Standard B18.2.1. See Appendix Table L1 for standard hex bolt dimensions.

12.1.3.2 Holes shall be a minimum of 1/32" to a maximum of 1/16" larger than the bolt diameter. Holes shall be accurately aligned in main members and side plates. Bolts shall not be forcibly driven.

12.1.3.3 A standard cut washer (Appendix Table L6), or metal plate or metal strap of equal or greater dimensions shall be provided between the wood and the bolt head and between the wood and the nut.

12.1.3.4 Edge distances, end distances, and fastener spacings shall not be less than the requirements in Tables 12.5.1A through 12.5.1D.

12.1.4 Lag Screws

12.1.4.1 Installation requirements apply to lag screws meeting requirements of ANSI/ASME Standard B18.2.1. See Appendix Table L2 for standard hex lag screw dimensions.

12.1.4.2 Lead holes for lag screws loaded laterally and in withdrawal shall be bored as follows to avoid splitting of the wood member during connection fabrication:

(a) The clearance hole for the shank shall have the same diameter as the shank, and the same depth of penetration as the length of unthreaded shank.

(b) The lead hole for the threaded portion shall have a diameter equal to 65% to 85% of the shank diameter in wood with $G > 0.6$, 60% to 75% in wood with $0.5 < G \leq 0.6$, and 40% to 70% in wood with $G \leq 0.5$ (see Table 12.3.3A) and a length equal to at least the length of the threaded portion. The larger percentile in each range shall apply to lag screws of greater diameters.

12.1.4.3 Lead holes or clearance holes shall not be required for 3/8" and smaller diameter lag screws loaded primarily in withdrawal in wood with $G \leq 0.5$ (see Table 12.3.3A), provided that edge distances, end distances, and spacing are sufficient to prevent unusual splitting.

12.1.4.4 The threaded portion of the lag screw shall be inserted in its lead hole by turning with a wrench, not by driving with a hammer.

12.1.4.5 No reduction to reference design values is anticipated if soap or other lubricant is used on the lag screw or in the lead holes to facilitate insertion and to prevent damage to the lag screw.

12.1.4.6 The minimum length of lag screw penetration, p_{min}, not including the length of the tapered tip, E, of the lag screw into the main member of single shear connections and the side members of double shear connections shall be 4D.

12.1.4.7 Edge distances, end distances, and fastener spacings shall not be less than the requirements in Tables 12.5.1A through 12.5.1E.

12.1.5 Wood Screws

12.1.5.1 Installation requirements apply to wood screws meeting requirements of ANSI/ASME Standard B18.6.1. See Appendix Table L3 for standard wood screw dimensions.

12.1.5.2 Lead holes for wood screws loaded in withdrawal shall have a diameter equal to approximately 90% of the wood screw root diameter in wood with $G > 0.6$, and approximately 70% of the wood screw root diameter in wood with $0.5 < G \leq 0.6$. Wood with $G \leq 0.5$ (see Table 12.3.3A) is not required to have a lead hole for insertion of wood screws.

12.1.5.3 Lead holes for wood screws loaded laterally shall be bored as follows:

(a) For wood with $G > 0.6$ (see Table 12.3.3A), the part of the lead hole receiving the shank shall have about the same diameter as the shank, and that receiving the threaded portion shall have about the same diameter as the screw at the root of the thread (see Reference 8).

(b) For $G \leq 0.6$ (see Table 12.3.3A), the part of the lead hole receiving the shank shall be about 7/8 the diameter of the shank and that receiving the threaded portion shall be about 7/8 the diameter of the screw at the root of the thread (see Reference 8).

12.1.5.4 The wood screw shall be inserted in its lead hole by turning with a screw driver or other tool, not by driving with a hammer.

12.1.5.5 No reduction to reference design values is anticipated if soap or other lubricant is used on the wood screw or in the lead holes to facilitate insertion and to prevent damage to the wood screw.

12.1.5.6 The minimum length of wood screw penetration, p_{min}, including the length of the tapered tip where part of the penetration into the main member for single shear connections and the side members for double shear connections shall be 6D.

12.1.5.7 Edge distances, end distances, and fastener spacings shall be sufficient to prevent splitting of the wood.

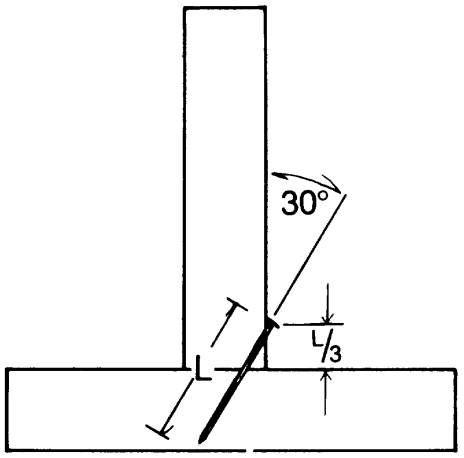
12.1.6 Nails and Spikes

12.1.6.1 Installation requirements apply to common steel wire nails and spikes, box nails, sinker nails, Roof Sheathing Ring Shank nails, and Post-Frame Ring Shank nails meeting requirements in ASTM F1667. Nails and spikes used in engineered construction shall meet the Supplementary Requirements of ASTM F1667 S1 Nail Bending Yield Strength. Nail specifications for engineered construction shall include the minimum lengths, head diameters, and shank diameters for the nails and spikes to be used. See Appendix Table L4 for standard common, box, and sinker nail dimensions, Appendix Table L5 for standard Post-Frame Ring Shank nail dimensions, and Appendix Table L6 for Roof Sheathing Ring Shank nail dimensions.

12.1.6.2 Reference design values herein apply to nailed and spiked connections either with or without bored holes. When a bored hole is desired to prevent splitting of wood, the diameter of the bored hole shall not exceed 90% of the nail or spike diameter for wood with $G > 0.6$, nor 75% of the nail or spike diameter for wood with $G \leq 0.6$ (see Table 12.3.3A).

12.1.6.3 Toe-nails shall be driven at an angle of approximately 30° with the member and started approximately 1/3 the length of the nail from the member end (see Figure 12A).

Figure 12A Toe-Nail Connection



12.1.6.4 The minimum length of nail or spike penetration, p_{min}, including the length of the tapered tip where part of the penetration into the main member for single shear connections and the side members of double shear connections shall be 6D.

Exception: The minimum length of penetration, p_{min}, need not be 6D for symmetric double shear connections where nails with diameter of 0.148" or smaller extend at least three diameters beyond the side member and are clinched, and side members are at least 3/8" thick.

12.1.6.5 Edge distances, end distances, and fastener spacings shall be sufficient to prevent splitting of the wood.

12.1.7 Drift Bolts and Drift Pins

12.1.7.1 Lead holes shall be drilled 0" to 1/32" smaller than the actual pin diameter.

12.1.7.2 Additional penetration of pin into members shall be provided in lieu of the washer, head, and nut on a common bolt (see Reference 53 for additional information).

12.1.7.3 Edge distances, end distances, and fastener spacings shall not be less than the requirements in Tables 12.5.1A through 12.5.1D.

12.1.8 Other Dowel-Type Fasteners

Where fastener type or installation requirements vary from those specified in 12.1.3, 12.1.4, 12.1.5, 12.1.6, and 12.1.7, provisions of 12.2 and 12.3 shall be permitted to be used in the determination of reference withdrawal and lateral design values, respectively, provided allowance is made to account for such variation (see 11.1.1.3). Edge distances, end distances, and spacings shall be sufficient to prevent splitting of the wood.

12.2 Reference Withdrawal and Pull-Through Design Values

12.2.1 Lag Screws

12.2.1.1 The lag screw reference withdrawal design value, W, in lbs/in. of thread penetration, for a single lag screw inserted in the side grain of a wood member, with the lag screw axis perpendicular to the wood fibers, shall be determined from Table 12.2A or Equation 12.2-1, within the range of specific gravities, G, and lag screw diameters, D, given in Table 12.2A. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1800\, G^{3/2} D^{3/4} \qquad (12.2\text{-}1)$$

12.2.1.2 For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of thread penetration from 12.2.1.1 shall be multiplied by the length of thread penetration, p_t, into a wood member, excluding the length of the tapered tip.

12.2.1.3 Where lag screws are loaded in withdrawal from end grain, reference withdrawal design values, W, shall be multiplied by the end grain factor, $C_{eg} = 0.75$.

12.2.1.4 Where lag screws are loaded in withdrawal, the tensile strength of the lag screw at the net section (root diameter, D_r) shall not be exceeded (see 11.2.3 and Appendix Table L2).

12.2.1.5 Where lag screws are loaded in withdrawal from the narrow edge of cross-laminated timber, the reference withdrawal value, W, shall be multiplied by the end grain factor, C_{eg}=0.75, regardless of grain orientation.

12.2.2 Wood Screws

12.2.2.1 The wood screw reference withdrawal design value, W, in lbs/in. of thread penetration, for a single wood screw (cut thread or rolled thread) inserted in the side grain of a wood member, with the wood screw axis perpendicular to the wood fibers, shall be determined from Table 12.2B or Equation 12.2-2, within the range of specific gravities, G, and screw diameters, D, given in Table 12.2B. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 2850\, G^2 D \qquad (12.2\text{-}2)$$

12.2.2.2 For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of thread penetration from 12.2.2.1 shall be multiplied by the length of thread penetration, p_t, into the wood member.

12.2.2.3 Wood screws shall not be loaded in withdrawal from end grain of wood (C_{eg}=0.0).

12.2.2.4 Wood screws shall not be loaded in withdrawal from end-grain of laminations in cross-laminated timber (C_{eg}=0.0).

12.2.2.5 Where wood screws are loaded in withdrawal, the adjusted tensile strength of the wood screw at the net section (root diameter, D_r) shall not be exceeded (see 11.2.3 and Appendix Table L3).

12.2.3 Nails and Spikes

12.2.3.1 Smooth shank nails or spikes

(a) The nail or spike reference withdrawal design value, W, in lbs/in. of penetration, for a smooth shank (bright or galvanized) carbon steel nail or spike driven into the side grain of a wood member, with the nail or spike axis perpendicular to the wood fibers, shall be determined from Table 12.2C or Equation 12.2-3, within the range of specific gravities, G, and nail or spike diameters, D, given in Table 12.2C. Reference withdrawal design values, W, shall be multiplied by all applicable

Table 12.2A Lag Screw Reference Withdrawal Values, W[1]

Tabulated withdrawal design values (W) are in pounds per inch of thread penetration into side grain of wood member. Length of thread penetration in main member shall not include the length of the tapered tip (see 12.2.1.1).

Specific Gravity, G^2	Lag Screw Diameter, D										
	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
0.73	397	469	538	604	668	789	905	1016	1123	1226	1327
0.71	381	450	516	579	640	757	868	974	1077	1176	1273
0.68	357	422	484	543	600	709	813	913	1009	1103	1193
0.67	349	413	473	531	587	694	796	893	987	1078	1167
0.58	281	332	381	428	473	559	641	719	795	869	940
0.55	260	307	352	395	437	516	592	664	734	802	868
0.51	232	274	314	353	390	461	528	593	656	716	775
0.50	225	266	305	342	378	447	513	576	636	695	752
0.49	218	258	296	332	367	434	498	559	617	674	730
0.47	205	242	278	312	345	408	467	525	580	634	686
0.46	199	235	269	302	334	395	453	508	562	613	664
0.44	186	220	252	283	312	369	423	475	525	574	621
0.43	179	212	243	273	302	357	409	459	508	554	600
0.42	173	205	235	264	291	344	395	443	490	535	579
0.41	167	198	226	254	281	332	381	428	473	516	559
0.40	161	190	218	245	271	320	367	412	455	497	538
0.39	155	183	210	236	261	308	353	397	438	479	518
0.38	149	176	202	227	251	296	340	381	422	461	498
0.37	143	169	194	218	241	285	326	367	405	443	479
0.36	137	163	186	209	231	273	313	352	389	425	460
0.35	132	156	179	200	222	262	300	337	373	407	441
0.31	110	130	149	167	185	218	250	281	311	339	367

1. Tabulated withdrawal design values, W, for lag screw connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1380\ G^{5/2}\ D \qquad (12.2\text{-}3)$$

(b) The nail or spike reference withdrawal design value, W, in lbs/in. of penetration, for a smooth shank stainless steel nail or spike driven into the side grain of a wood member, with the nail or spike axis perpendicular to the wood fibers, shall be determined from Table 12.2D or Equation 12.2-4, within the range of specific gravities, G, and nail or spike diameters, D, given in Table 12.2D. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 465\ G^{3/2}\ D \qquad (12.2\text{-}4)$$

(c) For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of fastener penetration from 12.2.3.1a or 12.2.3.1b shall be multiplied by the length of fastener penetration, p_t, into the wood member.

12.2.3.2 Deformed shank nails

(a) The reference withdrawal design value, in lbs/in. of ring shank penetration, for a Roof Sheathing Ring Shank nail or Post-Frame Ring Shank nail driven in the side grain of the main member, with the nail axis perpendicular to the wood fibers, shall be determined from Table 12.2E or Equation 12.2-5, within the range of specific gravities and nail diameters given in Table 12.2E. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1800\ G^2\ D \qquad (12.2\text{-}5)$$

Table 12.2B Cut Thread or Rolled Thread Wood Screw Reference Withdrawal Design Values, W[1]

Tabulated withdrawal design values, W, are in pounds per inch of thread penetration into side grain of wood member (see 12.2.2.1).

Specific Gravity, G[2]	Wood Screw Number										
	6	7	8	9	10	12	14	16	18	20	24
0.73	209	229	249	268	288	327	367	406	446	485	564
0.71	198	216	235	254	272	310	347	384	421	459	533
0.68	181	199	216	233	250	284	318	352	387	421	489
0.67	176	193	209	226	243	276	309	342	375	409	475
0.58	132	144	157	169	182	207	232	256	281	306	356
0.55	119	130	141	152	163	186	208	231	253	275	320
0.51	102	112	121	131	141	160	179	198	217	237	275
0.50	98	107	117	126	135	154	172	191	209	228	264
0.49	94	103	112	121	130	147	165	183	201	219	254
0.47	87	95	103	111	119	136	152	168	185	201	234
0.46	83	91	99	107	114	130	146	161	177	193	224
0.44	76	83	90	97	105	119	133	148	162	176	205
0.43	73	79	86	93	100	114	127	141	155	168	196
0.42	69	76	82	89	95	108	121	134	147	161	187
0.41	66	72	78	85	91	103	116	128	141	153	178
0.40	63	69	75	81	86	98	110	122	134	146	169
0.39	60	65	71	77	82	93	105	116	127	138	161
0.38	57	62	67	73	78	89	99	110	121	131	153
0.37	54	59	64	69	74	84	94	104	114	125	145
0.36	51	56	60	65	70	80	89	99	108	118	137
0.35	48	53	57	62	66	75	84	93	102	111	130
0.31	38	41	45	48	52	59	66	73	80	87	102

1. Tabulated withdrawal design values, W, for wood screw connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

(b) For Roof Sheathing Ring Shank nails (Appendix Table L6) or Post-Frame Ring Shank nails (Appendix Table L5) that are uncoated carbon steel, reference withdrawal design values determined from Table 12.2E or Equation 12.2-5 shall be permitted to be multiplied by 1.25.

(c) For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of ring shank penetration from 12.2.3.2a or 12.2.3.2b shall be multiplied by the length of ring shank penetration, p_t, into the wood member.

(d) For other deformed shank nails, reference withdrawal design values shall be permitted to be calculated in accordance with 12.2.3.1.

12.2.3.3 Nails and spikes shall not be loaded in withdrawal from end grain of wood (C_{eg}=0.0).

12.2.3.4 Nails and spikes shall not be loaded in withdrawal from end-grain of laminations in cross-laminated timber (C_{eg}=0.0).

12.2.4 Drift Bolts and Drift Pins

Reference withdrawal design values, W, for connections using drift bolt and drift pin connections shall be determined in accordance with 11.1.1.3.

12.2.5 Fastener Head Pull-Through

12.2.5.1 For fasteners with round heads, the reference pull-through design value, W_H, in pounds for wood side members shall be determined from Table 12.2F or Equation 12.2-6, within the range of fastener head diameters, D_H, and net side member thicknesses, t_{ns}, given in Table 12.2F. Reference pull-through design values, W_H, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted pull-through design values, W'_H.

Table 12.2C Smooth Shank (Bright or Galvanized) Carbon Steel Nail and Spike Reference Withdrawal Design Values, W[1,3]

Tabulated withdrawal design values, W, are in pounds per inch of fastener penetration into side grain of wood member (see 12.2.3.1)

Specific Gravity[2], G	Smooth Shank (Bright or Galvanized) Carbon Steel Nail and Spike Diameter, D																	
	0.092"	0.099"	0.113"	0.120"	0.128"	0.131"	0.135"	0.148"	0.162"	0.177"	0.192"	0.207"	0.225"	0.244"	0.263"	0.283"	0.312"	0.375"
0.73	58	62	71	75	80	82	85	93	102	111	121	130	141	153	165	178	196	236
0.71	54	58	66	70	75	77	79	87	95	104	113	121	132	143	154	166	183	220
0.68	48	52	59	63	67	69	71	78	85	93	101	109	118	128	138	149	164	197
0.67	47	50	57	61	65	66	68	75	82	90	97	105	114	124	133	144	158	190
0.58	33	35	40	42	45	46	48	52	57	63	68	73	80	86	93	100	110	133
0.55	28	31	35	37	40	41	42	46	50	55	59	64	70	76	81	88	97	116
0.51	24	25	29	31	33	34	35	38	42	45	49	53	58	63	67	73	80	96
0.50	22	24	28	29	31	32	33	36	40	43	47	50	55	60	64	69	76	91
0.49	21	23	26	28	30	30	31	34	38	41	45	48	52	57	61	66	72	87
0.47	19	21	24	25	27	27	28	31	34	37	40	43	47	51	55	59	65	78
0.46	18	20	22	24	25	26	27	29	32	35	38	41	45	48	52	56	62	74
0.44	16	18	20	21	23	23	24	26	29	31	34	37	40	43	47	50	55	66
0.43	15	17	19	20	21	22	23	25	27	30	32	35	38	41	44	47	52	63
0.42	15	16	18	19	20	21	21	23	26	28	30	33	35	38	41	45	49	59
0.41	14	15	17	18	19	19	20	22	24	26	29	31	33	36	39	42	46	56
0.40	13	14	16	17	18	18	19	21	23	25	27	29	31	34	37	40	44	52
0.39	12	13	15	16	17	17	18	19	21	23	25	27	29	32	34	37	41	49
0.38	11	12	14	15	16	16	17	18	20	22	24	25	28	30	32	35	38	46
0.37	11	11	13	14	15	15	16	17	19	20	22	24	26	28	30	33	36	43
0.36	10	11	12	13	14	14	14	16	17	19	21	22	24	26	28	30	33	40
0.35	9	10	11	12	13	13	14	15	16	18	19	21	23	24	26	28	31	38
0.31	7	7	8	9	9	10	10	11	12	13	14	15	17	18	19	21	23	28

1. Tabulated withdrawal design values, W, for nail or spike connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity shall be determined in accordance with Table 12.3.3A.
3. Tabulated withdrawal design values for smooth shank nails are permitted to be used for deformed shank nails of equivalent diameter, D.

Table 12.2D Smooth Shank Stainless Steel Nail and Spike Reference Withdrawal Design Values, W[1,3]

Tabulated withdrawal design values, W, are in pounds per inch of fastener penetration into side grain of wood member (see 12.2.3.1)

Specific Gravity[2], G	Smooth Shank Stainless Steel Nail and Spike Diameter, D																	
	0.092"	0.099"	0.113"	0.120"	0.128"	0.131"	0.135"	0.148"	0.162"	0.177"	0.192"	0.207"	0.225"	0.244"	0.263"	0.283"	0.312"	0.375"
0.73	27	29	33	35	37	38	39	43	47	51	56	60	65	71	76	82	90	109
0.71	26	28	31	33	36	36	38	41	45	49	53	58	63	68	73	79	87	104
0.68	24	26	29	31	33	34	35	39	42	46	50	54	59	64	69	74	81	98
0.67	23	25	29	31	33	33	34	38	41	45	49	53	57	62	67	72	80	96
0.58	19	20	23	25	26	27	28	30	33	36	39	43	46	50	54	58	64	77
0.55	17	19	21	23	24	25	26	28	31	34	36	39	43	46	50	54	59	71
0.51	16	17	19	20	22	22	23	25	27	30	33	35	38	41	45	48	53	64
0.50	15	16	19	20	21	22	22	24	27	29	32	34	37	40	43	47	51	62
0.49	15	16	18	19	20	21	22	24	26	28	31	33	36	39	42	45	50	60
0.47	14	15	17	18	19	20	20	22	24	27	29	31	34	37	39	42	47	56
0.46	13	14	16	17	19	19	20	21	24	26	28	30	33	35	38	41	45	54
0.44	12	13	15	16	17	18	18	20	22	24	26	28	31	33	36	38	42	51
0.43	12	13	15	16	17	17	18	19	21	23	25	27	30	32	34	37	41	49
0.42	12	13	14	15	16	17	17	19	21	22	24	26	28	31	33	36	39	47
0.41	11	12	14	15	16	16	16	18	20	22	23	25	27	30	32	35	38	46
0.40	11	12	13	14	15	15	16	17	19	21	23	24	26	29	31	33	37	44
0.39	10	11	13	14	14	15	15	17	18	20	22	23	25	28	30	32	35	42
0.38	10	11	12	13	14	14	15	16	18	19	21	23	25	27	29	31	34	41
0.37	10	10	12	13	13	14	14	15	17	19	20	22	24	26	28	30	33	39
0.36	9	10	11	12	13	13	14	15	16	18	19	21	23	25	26	28	31	38
0.35	9	10	11	12	12	13	13	14	16	17	18	20	22	23	25	27	30	36
0.31	7	8	9	10	10	11	11	12	13	14	15	17	18	20	21	23	25	30

1. Tabulated withdrawal design values, W, for nail or spike connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).

2. Specific gravity shall be determined in accordance with Table 12.3.3A.

3. Tabulated withdrawal design values for smooth shank stainless steel nails are permitted to be used for deformed shank stainless steel nails of equivalent diameter, D.

Table 12.2E Roof Sheathing Ring Shank Nail and Post-Frame Ring Shank Nail Reference Withdrawal Design Values, W[1,2]

Tabulated withdrawal design values, W, are in pounds per inch of ring shank penetration into side grain of wood main member (see Appendix Table L5 and Table L6).

Specific Gravity[3], G	Roof Sheathing Ring Shank Nail Diameter, D (in.)			Post-Frame Ring Shank Nail Diameter, D (in.)				
	0.113	0.120	0.131	0.135	0.148	0.177	0.200	0.207
0.73	108	115	126	129	142	170	192	199
0.71	103	109	119	122	134	161	181	188
0.68	94	100	109	112	123	147	166	172
0.67	91	97	106	109	120	143	162	167
0.58	68	73	79	82	90	107	121	125
0.55	62	65	71	74	81	96	109	113
0.51	53	56	61	63	69	83	94	97
0.50	51	54	59	61	67	80	90	93
0.49	49	52	57	58	64	76	86	89
0.47	45	48	52	54	59	70	80	82
0.46	43	46	50	51	56	67	76	79
0.44	39	42	46	47	52	62	70	72
0.43	38	40	44	45	49	59	67	69
0.42	36	38	42	43	47	56	64	66
0.41	34	36	40	41	45	54	61	63
0.40	33	35	38	39	43	51	58	60
0.39	31	33	36	37	41	48	55	57
0.38	29	31	34	35	38	46	52	54
0.37	28	30	32	33	36	44	49	51
0.36	26	28	31	31	35	41	47	48
0.35	25	26	29	30	33	39	44	46
0.31	20	21	23	23	26	31	35	36

1. Tabulated withdrawal design values, W, for Roof Sheathing Ring Shank (RSRS) nails and Post-Frame Ring Shank (PF) nails shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated reference withdrawal design values, W, are only applicable to Roof Sheathing Ring Shank (RSRS) nails or Post-Frame Ring Shank (PF) nails meeting requirements of ASTM F1667.
3. Specific gravity shall be determined in accordance with Table 12.3.3A.

$W_H = 690\ \pi\ D_H\ G^2\ t_{ns}$ for $t_{ns} \le 2.5\ D_H$ (12.2-6a)

$W_H = 1725\ \pi\ D_H^2\ G^2$ for $t_{ns} > 2.5\ D_H$ (12.2-6b)

Where:

$\pi\ D_H$ = perimeter for fasteners with round heads

D_H = fastener head diameter, in.

G = specific gravity of side member

Pull-through for other materials shall be determined in accordance with 11.1.1.3.

Table 12.2F Head Pull-Through, W_H[1]

Tabulated pull-through design values, W_H, are in pounds.

Side Member Specific Gravity[2], G	Head Diameter, D_H (in.)	Net Side Member Thickness, t_{ns} (in.)											
		5/16	3/8	7/16	15/32	1/2	19/32	5/8	23/32	3/4	1	1-1/8	1-1/2
0.50	0.234	40	48	55	59	63	74	74	74	74	74	74	74
	0.250	42	51	59	64	68	80	85	85	85	85	85	85
	0.266	45	54	63	68	72	86	90	96	96	96	96	96
	0.281	48	57	67	71	76	90	95	107	107	107	107	107
	0.297	50	60	70	75	80	96	101	116	120	120	120	120
	0.312	53	63	74	79	85	100	106	122	127	132	132	132
	0.344	58	70	82	87	93	111	117	134	140	160	160	160
	0.375	64	76	89	95	102	121	127	146	152	191	191	191
	0.406	69	83	96	103	110	131	138	158	165	220	223	223
	0.438	74	89	104	111	119	141	148	171	178	237	260	260
	0.469	79	95	111	119	127	151	159	183	191	254	286	298
	0.500	85	102	119	127	135	161	169	195	203	271	305	339
0.42	0.234	28	34	39	42	45	52	52	52	52	52	52	52
	0.250	30	36	42	45	48	57	60	60	60	60	60	60
	0.266	32	38	44	48	51	60	64	68	68	68	68	68
	0.281	34	40	47	50	54	64	67	75	75	75	75	75
	0.297	35	43	50	53	57	67	71	82	84	84	84	84
	0.312	37	45	52	56	60	71	75	86	89	93	93	93
	0.344	41	49	58	62	66	78	82	95	99	113	113	113
	0.375	45	54	63	67	72	85	90	103	108	134	134	134
	0.406	49	58	68	73	78	92	97	112	116	155	158	158
	0.438	52	63	73	79	84	99	105	120	126	167	183	183
	0.469	56	67	78	84	90	106	112	129	135	179	202	210
	0.500	60	72	84	90	96	114	119	137	143	191	215	239

1. Tabulated pull-through design values, W_H, shall be multiplied by all adjustment factors as applicable per Table 11.3.1.
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A for lumber and Table 12.3.3B for panels.

12.3 Reference Lateral Design Values

12.3.1 Yield Limit Equations

Reference lateral design values, Z, for single shear and symmetric double shear connections using dowel-type fasteners shall be the minimum computed yield mode value using equations in Tables 12.3.1A and 12.3.1B (see Figures 12B, 12C, and Appendix I) where:

(a) the faces of the connected members are in contact;
(b) the load acts perpendicular to the axis of the dowel;
(c) edge distances, end distances, and spacing are not less than the requirements in 12.5; and
(d) for lag screws, wood screws, and nails and spikes, the length of fastener penetration, p, into the main member of a single shear connection or the side member of a double shear connection is greater than or equal to p_{min} (see 12.1).

12.3.2 Common Connection Conditions

Reference lateral design values, Z, for connections with bolts (see Tables 12A through 12I), lag screws (see Tables 12J and 12K), wood screws (see Tables 12L and 12M), nails and spikes (see Tables 12N through 12R), and post-frame ring shank nails (see Tables 12S and 12T), are calculated for common connection conditions in accordance with yield mode equations in Tables 12.3.1A and 12.3.1B. Tabulated reference lateral design values, Z, shall be multiplied by applicable Table footnotes to determine an adjusted lateral design value, Z'.

Table 12.3.1A Yield Limit Equations

Yield Mode	Single Shear		Double Shear	
I_m	$Z = \frac{D \ell_m F_{em}}{R_d}$	(12.3-1)	$Z = \frac{D \ell_m F_{em}}{R_d}$	(12.3-7)
I_s	$Z = \frac{D \ell_s F_{es}}{R_d}$	(12.3-2)	$Z = \frac{2 D \ell_s F_{es}}{R_d}$	(12.3-8)
II	$Z = \frac{k_1 D \ell_s F_{es}}{R_d}$	(12.3-3)		
III_m	$Z = \frac{k_2 D \ell_m F_{em}}{(1+2R_e) R_d}$	(12.3-4)		
III_s	$Z = \frac{k_3 D \ell_s F_{em}}{(2+R_e) R_d}$	(12.3-5)	$Z = \frac{2 k_3 D \ell_s F_{em}}{(2+R_e) R_d}$	(12.3-9)
IV	$Z = \frac{D^2}{R_d}\sqrt{\frac{2 F_{em} F_{yb}}{3 (1+R_e)}}$	(12.3-6)	$Z = \frac{2 D^2}{R_d}\sqrt{\frac{2 F_{em} F_{yb}}{3 (1+R_e)}}$	(12.3-10)

Notes:

$$k_1 = \frac{\sqrt{R_e + 2R_e^2(1+R_t+R_t^2) + R_t^2 R_e^3} - R_e(1+R_t)}{(1+R_e)}$$

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

$$k_3 = -1 + \sqrt{\frac{2(1+R_e)}{R_e} + \frac{2F_{yb}(2+R_e)D^2}{3F_{em}\ell_s^2}}$$

D = diameter, in. (see 12.3.7)
F_{yb} = dowel bending yield strength, psi
R_d = reduction term (see Table 12.3.1B)
R_e = F_{em}/F_{es}
R_t = ℓ_m/ℓ_s
ℓ_m = main member dowel bearing length, in.
ℓ_s = side member dowel bearing length, in.
F_{em} = main member dowel bearing strength, psi (see Table 12.3.3)
F_{es} = side member dowel bearing strength, psi (see Table 12.3.3)

Table 12.3.1B Reduction Term, R_d

Fastener Size	Yield Mode	Reduction Term, R_d
0.25" ≤ D ≤ 1"	I_m, I_s	4 K_θ
	II	3.6 K_θ
	III_m, III_s, IV	3.2 K_θ
D < 0.25"	I_m, I_s, II, III_m, III_s, IV	K_D[1]

Notes:
K_θ = $1 + 0.25(\theta/90)$
θ = maximum angle between the direction of load and the direction of grain ($0^\circ \le \theta \le 90^\circ$) for any member in a connection
D = diameter, in. (see 12.3.7)
K_D = 2.2 for D ≤ 0.17"
K_D = 10D + 0.5 for 0.17" < D < 0.25"

1. For threaded fasteners where nominal diameter (see Appendix L) is greater than or equal to 0.25" and root diameter is less than 0.25", $R_d = K_D K_\theta$.

12.3.3 Dowel Bearing Strength

12.3.3.1 Dowel bearing strengths, F_e, for wood members other than wood structural panels and structural composite lumber shall be determined from Table 12.3.3.

12.3.3.2 Dowel bearing strengths, F_e, for dowel-type fasteners with D ≤ 1/4" in wood structural panels shall be determined from Table 12.3.3B.

12.3.3.3 Dowel bearing strengths, F_e, for structural composite lumber shall be determined from the manufacturer's literature or code evaluation report.

12.3.3.4 Where dowel-type fasteners with D ≥ 1/4" are inserted into the end grain of the main member, with the fastener axis parallel to the wood fibers, $F_{e\perp}$ shall be used in the determination of the dowel bearing strength of the main member, F_{em}.

12.3.3.5 Dowel bearing strengths, F_e, for dowel-type fasteners installed into the panel face of cross-laminated timber shall be based on the direction of loading with respect to the grain orientation of the cross-laminated timber ply at the shear plane.

12.3.3.6 Where dowel-type fasteners are installed in the narrow edge of cross-laminated timber panels, the dowel bearing strength shall be $F_{e\perp}$ for D≥1/4" and F_e for D<1/4".

12.3.4 Dowel Bearing Strength at an Angle to Grain

Where a member in a connection is loaded at an angle to grain, the dowel bearing strength, $F_{e\theta}$, for the member shall be determined as follows (see Appendix J):

$$F_{e\theta} = \frac{F_{e\parallel} F_{e\perp}}{F_{e\parallel} \sin^2\theta + F_{e\perp} \cos^2\theta} \qquad (12.3\text{-}11)$$

where:

θ = angle between the direction of load and the direction of grain (longitudinal axis of member)

12.3.5 Dowel Bearing Length

12.3.5.1 Dowel bearing length in the side member(s) and main member, ℓ_s and ℓ_m, shall be determined based on the length of dowel bearing perpendicular to the application of load.

12.3.5.2 For cross-laminated timber where the direction of loading relative to the grain orientation at the shear plane is parallel to grain, the dowel bearing length in the perpendicular plies shall be reduced by multiplying the bearing length of those plies by the ratio of dowel bearing strength perpendicular to grain to dowel bearing strength parallel to grain ($F_{e\perp}$ / $F_{e\parallel}$).

Figure 12B Single Shear Bolted Connections

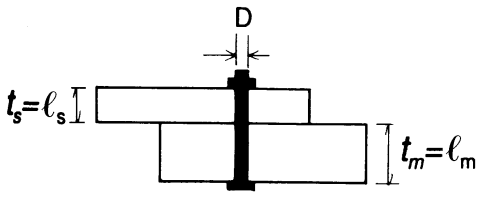
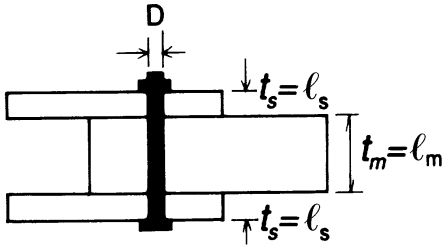


Figure 12C Double Shear Bolted Connections



12.3.5.3 For lag screws, wood screws, nails, spikes, and similar dowel-type fasteners, the dowel bearing length, ℓ_s or ℓ_m, shall not exceed the length of fastener penetration, p, into the wood member. Where p includes the length of a tapered tip, E, the dowel bearing length, ℓ_s or ℓ_m, shall not exceed p - E/2.

(a) For lag screws, E is permitted to be taken from Appendix L, Table L2.

(b) For wood screws, nails, and spikes, E is permitted to be taken as 2D.

12.3.6 Dowel Bending Yield Strength

12.3.6.1 The reference lateral design values, Z, for bolts, lag screws, wood screws, and nails are based on dowel bending yield strengths, F_{yb}, provided in Tables 12A through 12T.

12.3.6.2 Dowel bending yield strengths, F_{yb}, used in the determination of reference lateral design values, Z, shall be based on yield strength derived using the methods provided in ASTM F 1575 or the tensile yield strength derived using the procedures of ASTM F 606.

12.3.7 Dowel Diameter

12.3.7.1 Where used in Tables 12.3.1A and 12.3.1B, the fastener diameter shall be taken as:

(a) D for smooth shank nails and deformed shank nails in accordance with ASTM F1667,

(b) D for unthreaded full-body diameter fasteners, and

(c) D_r for reduced body diameter fasteners or threaded fasteners except as provided in 12.3.7.2.

12.3.7.2 For threaded full-body fasteners (see Appendix L), D shall be permitted to be used in lieu of D_r where the bearing length of the threads does not exceed ¼ of the full bearing length in the member holding the threads. Alternatively, a more detailed analysis accounting for the moment and bearing resistance of the threaded portion of the fastener shall be permitted (see Appendix I).

Table 12.3.3 Dowel Bearing Strengths, F_e, for Dowel-Type Fasteners in Wood Members

Specific[1] Gravity, G	Dowel bearing strength in pounds per square inch (psi) [2]										
	F_e	$F_{e\parallel}$	$F_{e\perp}$								
	D<1/4"	1/4" ≤ D ≤ 1"	D=1/4"	D=5/16"	D=3/8"	D=7/16"	D=1/2"	D=5/8"	D=3/4"	D=7/8"	D=1"
0.73	9300	8200	7750	6900	6300	5850	5450	4900	4450	4150	3850
0.72	9050	8050	7600	6800	6200	5750	5350	4800	4350	4050	3800
0.71	8850	7950	7400	6650	6050	5600	5250	4700	4300	3950	3700
0.70	8600	7850	7250	6500	5950	5500	5150	4600	4200	3900	3650
0.69	8400	7750	7100	6350	5800	5400	5050	4500	4100	3800	3550
0.68	8150	7600	6950	6250	5700	5250	4950	4400	4050	3750	3500
0.67	7950	7500	6850	6100	5550	5150	4850	4300	3950	3650	3400
0.66	7750	7400	6700	5950	5450	5050	4700	4200	3850	3550	3350
0.65	7500	7300	6550	5850	5350	4950	4600	4150	3750	3500	3250
0.64	7300	7150	6400	5700	5200	4850	4500	4050	3700	3400	3200
0.63	7100	7050	6250	5600	5100	4700	4400	3950	3600	3350	3100
0.62	6900	6950	6100	5450	5000	4600	4300	3850	3500	3250	3050
0.61	6700	6850	5950	5350	4850	4500	4200	3750	3450	3200	3000
0.60	6500	6700	5800	5200	4750	4400	4100	3700	3350	3100	2900
0.59	6300	6600	5700	5100	4650	4300	4000	3600	3300	3050	2850
0.58	6100	6500	5550	4950	4500	4200	3900	3500	3200	2950	2750
0.57	5900	6400	5400	4850	4400	4100	3800	3400	3100	2900	2700
0.56	5700	6250	5250	4700	4300	4000	3700	3350	3050	2800	2650
0.55	5550	6150	5150	4600	4200	3900	3650	3250	2950	2750	2550
0.54	5350	6050	5000	4450	4100	3750	3550	3150	2900	2650	2500
0.53	5150	5950	4850	4350	3950	3650	3450	3050	2800	2600	2450
0.52	5000	5800	4750	4250	3850	3550	3350	3000	2750	2550	2350
0.51	4800	5700	4600	4100	3750	3450	3250	2900	2650	2450	2300
0.50	4650	5600	4450	4000	3650	3400	3150	2800	2600	2400	2250
0.49	4450	5500	4350	3900	3550	3300	3050	2750	2500	2300	2150
0.48	4300	5400	4200	3750	3450	3200	3000	2650	2450	2250	2100
0.47	4150	5250	4100	3650	3350	3100	2900	2600	2350	2200	2050
0.46	4000	5150	3950	3550	3250	3000	2800	2500	2300	2100	2000
0.45	3800	5050	3850	3450	3150	2900	2700	2400	2200	2050	1900
0.44	3650	4950	3700	3300	3050	2800	2600	2350	2150	2000	1850
0.43	3500	4800	3600	3200	2950	2700	2550	2250	2050	1900	1800
0.42	3350	4700	3450	3100	2850	2600	2450	2200	2000	1850	1750
0.41	3200	4600	3350	3000	2750	2550	2350	2100	1950	1800	1650
0.40	3100	4500	3250	2900	2650	2450	2300	2050	1850	1750	1600
0.39	2950	4350	3100	2800	2550	2350	2200	1950	1800	1650	1550
0.38	2800	4250	3000	2700	2450	2250	2100	1900	1750	1600	1500
0.37	2650	4150	2900	2600	2350	2200	2050	1850	1650	1550	1450
0.36	2550	4050	2750	2500	2250	2100	1950	1750	1600	1500	1400
0.35	2400	3900	2650	2400	2150	2000	1900	1700	1550	1400	1350
0.34	2300	3800	2550	2300	2100	1950	1800	1600	1450	1350	1300
0.33	2150	3700	2450	2200	2000	1850	1750	1550	1400	1300	1200
0.32	2050	3600	2350	2100	1900	1750	1650	1500	1350	1250	1150
0.31	1900	3450	2250	2000	1800	1700	1600	1400	1300	1200	1100

1. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

2. $F_{e\parallel} = 11200G$; $F_{e\perp} = (6100G^{1.45}) / (D)^{0.5}$; F_e for D < 1/4" = $16600\ G^{1.84}$; Tabulated values are rounded to the nearest 50 psi.

Table 12.3.3A Assigned Specific Gravities

Species Combination	Specific[1] Gravity, G
Alaska Cedar	0.47
Alaska Hemlock	0.46
Alaska Spruce	0.41
Alaska Yellow Cedar	0.46
Aspen	0.39
Balsam Fir	0.36
Beech-Birch-Hickory	0.71
Coast Sitka Spruce	0.39
Cottonwood	0.41
Douglas Fir-Larch	0.50
Douglas Fir-Larch (North)	0.49
Douglas Fir-South	0.46
Eastern Hemlock	0.41
Eastern Hemlock-Balsam Fir	0.36
Eastern Hemlock-Tamarack	0.41
Eastern Hemlock-Tamarack (North)	0.47
Eastern Softwoods	0.36
Eastern Spruce	0.41
Eastern White Pine	0.36
Engelmann Spruce-Lodgepole Pine	0.38
Hem-Fir	0.43
Hem-Fir (North)	0.46
Mixed Maple	0.55
Mixed Oak	0.68
Mixed Southern Pine	0.51
Mountain Hemlock	0.47
Northern Pine	0.42
Northern Red Oak	0.68
Northern Species	0.35
Northern White Cedar	0.31
Ponderosa Pine	0.43
Red Maple	0.58
Red Oak	0.67
Red Pine	0.44
Redwood	0.37
Sitka Spruce	0.43
Southern Pine	0.55
Spruce-Pine-Fir	0.42
Spruce-Pine-Fir (South)	0.36
Western Cedars	0.36
Western Cedars (North)	0.35
Western Hemlock	0.47
Western Hemlock (North)	0.46
Western Juniper	0.42
Western White Pine	0.40
Western Woods	0.36
White Oak	0.73
Yellow Poplar	0.43

Species Combinations of MSR and MEL Lumber	Specific[1] Gravity, G
Douglas Fir-Larch	
E=1,900,000 psi and lower grades of MSR	0.50
E=2,000,000 psi grades of MSR	0.51
E=2,100,000 psi grades of MSR	0.52
E=2,200,000 psi grades of MSR	0.53
E=2,300,000 psi grades of MSR	0.54
E=2,400,000 psi grades of MSR	0.55
Douglas Fir-Larch (North)	
E=1,900,000 psi and lower grades of MSR and MEL	0.49
E=2,000,000 psi to 2,200,000 psi grades of MSR and MEL	0.53
E=2,300,000 psi and higher grades of MSR and MEL	0.57
Douglas Fir-Larch (South)	
E=1,000,000 psi and higher grades of MSR	0.46
Engelmann Spruce-Lodgepole Pine	
E=1,400,000 psi and lower grades of MSR	0.38
E=1,500,000 psi and higher grades of MSR	0.46
Hem-Fir	
E=1,500,000 psi and lower grades of MSR	0.43
E=1,600,000 psi grades of MSR	0.44
E=1,700,000 psi grades of MSR	0.45
E=1,800,000 psi grades of MSR	0.46
E=1,900,000 psi grades of MSR	0.47
E=2,000,000 psi grades of MSR	0.48
E=2,100,000 psi grades of MSR	0.49
E=2,200,000 psi grades of MSR	0.50
E=2,300,000 psi grades of MSR	0.51
E=2,400,000 psi grades of MSR	0.52
Hem-Fir (North)	
E=1,000,000 psi and higher grades of MSR and MEL	0.46
Southern Pine	
E=1,700,000 psi and lower grades of MSR and MEL	0.55
E=1,800,000 psi and higher grades of MSR and MEL	0.57
Spruce-Pine-Fir	
E=1,700,000 psi and lower grades of MSR and MEL	0.42
E=1,800,000 psi and 1,900,000 grades of MSR and MEL	0.46
E=2,000,000 psi and higher grades of MSR and MEL	0.50
Spruce-Pine-Fir (South)	
E=1,100,000 psi and lower grades of MSR	0.36
E=1,200,000 psi to1,900,000 psi grades of MSR	0.42
E=2,000,000 psi and higher grades of MSR	0.50
Western Cedars	
E=1,000,000 psi and higher grades of MSR	0.36
Western Woods	
E=1,000,000 psi and higher grades of MSR	0.36

1. Specific gravity, G, based on weight and volume when oven-dry. Different specific gravities, G, are possible for different grades of MSR and MEL lumber (see Table 4C, Footnote 2).

Table 12.3.3B Dowel Bearing Strengths for Wood Structural Panels

Wood Structural Panel	Specific[1] Gravity, G	Dowel Bearing Strength, F_e, in pounds per square inch (psi) for D≤1/4"
Plywood		
Structural 1, Marine	0.50	4650
Other Grades[1]	0.42	3350
Oriented Strand Board		
All Grades	0.50	4650

1. Use G = 0.42 when species of the plies is not known. When species of the plies is known, specific gravity listed for the actual species and the corresponding dowel bearing strength may be used, or the weighted average may be used for mixed species.

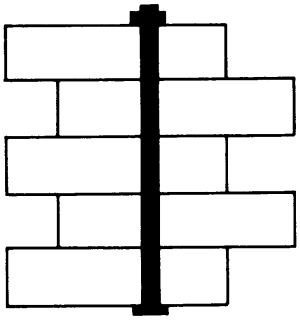
12.3.8 Asymmetric Three Member Connections, Double Shear

Reference lateral design values, Z, for asymmetric three member connections shall be the minimum computed yield mode value for symmetric double shear connections using the smaller dowel bearing length in the side member as ℓ_s and the minimum dowel diameter, D, occurring in either of the connection shear planes.

12.3.9 Multiple Shear Connections

For a connection with four or more members (see Figure 12D), each shear plane shall be evaluated as a single shear connection. The reference lateral design value, Z, for the connection shall be the lowest reference lateral design value for any single shear plane, multiplied by the number of shear planes.

Figure 12D Multiple Shear Bolted Connections



12.3.10 Load at an Angle to Fastener Axis

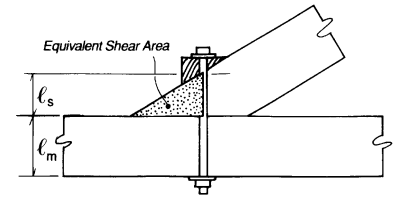
12.3.10.1 When the applied load in a single shear (two member) connection is at an angle (other than 90º) with the fastener axis, the fastener lengths in the two members shall be designated ℓ_s and ℓ_m (see Figure 12E). The component of the load acting at 90° with the fastener axis shall not exceed the adjusted lateral design value, Z', for a connection in which two members at 90° with the fastener axis have thicknesses $t_s = \ell_s$ and $t_m = \ell_m$. Ample bearing area shall be provided to resist the load component acting parallel to the fastener axis.

12.3.10.2 For toe-nailed connections, the minimum of t_s or L/3 shall be used for ℓ_s (see Figure 12A).

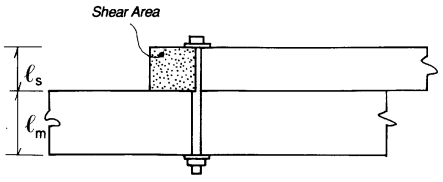
12.3.11 Drift Bolts and Drift Pins

Adjusted lateral design values, Z', for drift bolts and drift pins driven in the side grain of wood shall not exceed 75% of the adjusted lateral design values for common bolts of the same diameter and length in main member.

Figure 12E Shear Area for Bolted Connections



Angled member connection



Parallel member connection

12.4 Combined Lateral and Withdrawal Loads

12.4.1 Lag Screws and Wood Screws

Where a lag screw or wood screw is subjected to combined lateral and withdrawal loading, as when the fastener is inserted perpendicular to the fiber and the load acts at an angle, α, to the wood surface (see Figure 12F), the adjusted design value, Z_α', shall be determined as follows (see Appendix J):

$$Z_\alpha' = \frac{(W'p)Z'}{(W'p)\cos^2\alpha + Z'\sin^2\alpha} \qquad (12.4\text{-}1)$$

where:

α = angle between the wood surface and the direction of applied load, degrees

p = length of thread penetration into the main member, in.

12.4.2 Nails and Spikes

Where a nail or spike is subjected to combined lateral and withdrawal loading, as when the nail or spike is inserted perpendicular to the fiber and the load acts at an angle, α, to the wood surface, the adjusted design value, Z_α', shall be determined as follows:

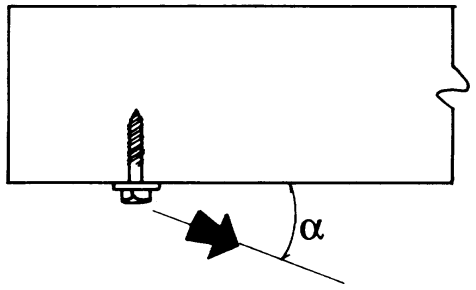
$$Z_\alpha' = \frac{(W'p)Z'}{(W'p)\cos\alpha + Z'\sin\alpha} \qquad (12.4\text{-}2)$$

where:

α = angle between the wood surface and the direction of applied load, degrees

p = length of fastener penetration into the main member, in.

Figure 12F Combined Lateral and Withdrawal Loading



12.5 Adjustment of Reference Design Values

12.5.1 Geometry Factor, C_Δ

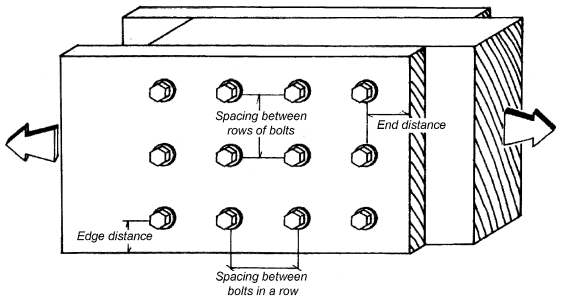
12.5.1.1 For dowel-type fasteners where D < 1/4", $C_\Delta = 1.0$.

12.5.1.2 Where D ≥ 1/4" and the end distance or spacing provided for dowel-type fasteners is less than the minimum required for $C_\Delta = 1.0$ for any condition in (a), (b), or (c), reference lateral design values, Z, shall be multiplied by the smallest applicable geometry factor, C_Δ, determined in (a), (b), or (c). The smallest geometry factor for any fastener in a group shall apply to all fasteners in the group. For multiple shear connections or for asymmetric three member connections, the smallest geometry factor, C_Δ, for any shear plane shall apply to all fasteners in the connection.

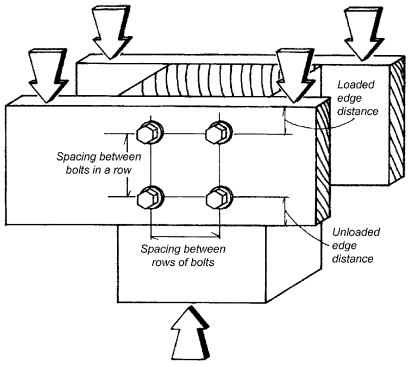
(a) Where dowel-type fasteners are used and the actual end distance for parallel or perpendicular to grain loading is greater than or equal to the minimum end distance (see Table 12.5.1A) for $C_\Delta = 0.5$, but less than the minimum end distance for $C_\Delta = 1.0$, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual end distance}}{\text{minimum end distance for } C_\Delta = 1.0}$$

Figure 12G Bolted Connection Geometry



Parallel to grain loading in all wood members ($Z_{||}$)



Perpendicular to grain loading in the side member and parallel to grain loading in the main member ($Z_{s\perp}$)

Table 12.5.1A End Distance Requirements

Direction of Loading	End Distances: Minimum end distance for $C_\Delta = 0.5$	End Distances: Minimum end distance for $C_\Delta = 1.0$
Perpendicular to Grain	2D	4D
Parallel to Grain, Compression: (fastener bearing away from member end)	2D	4D
Parallel to Grain, Tension: (fastener bearing toward member end)		
for softwoods	3.5D	7D
for hardwoods	2.5D	5D

(b) For loading at an angle to the fastener, where dowel-type fasteners are used, the minimum shear area for $C_\Delta = 1.0$ shall be equivalent to the shear area for a parallel member connection with minimum end distance for $C_\Delta = 1.0$ (see Table 12.5.1A and Figure 12E). The minimum shear area for $C_\Delta = 0.5$ shall be equivalent to ½ the minimum shear area for $C_\Delta = 1.0$. Where the actual shear area is greater than or equal to the minimum shear area for $C_\Delta = 0.5$, but less than the minimum shear area for $C_\Delta = 1.0$, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual shear area}}{\text{minimum shear area for } C_\Delta = 1.0}$$

(c) Where the actual spacing between dowel-type fasteners in a row for parallel or perpendicular to grain loading is greater than or equal to the minimum spacing (see Table 12.5.1B), but less than the minimum spacing for $C_\Delta = 1.0$, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual spacing}}{\text{minimum spacing for } C_\Delta = 1.0}$$

12.5.1.3 Where D ≥ 1/4", edge distance and spacing between rows of fasteners shall be in accordance with Table 12.5.1C and Table 12.5.1D and applicable requirements of 12.1. The perpendicular to grain distance between the outermost fasteners shall not exceed 5" (see Figure 12H) unless special detailing is provided to accommodate cross-grain shrinkage of the wood member. For structural glued laminated timber members, the perpendicular to grain distance between the outermost fasteners shall not exceed the limits in Table 12.5.1F, unless special detailing is provided to accommodate cross-grain shrinkage of the member.

12.5.1.4 Where fasteners are installed in the narrow edge of cross-laminated timber panels and D ≥ 1/4", end distances, edge distances, and fastener spacing in a row shall not be less than the minimum values in Table 12.5.1G.

Table 12.5.1B Spacing Requirements for Fasteners in a Row

Direction of Loading	Spacing: Minimum spacing	Spacing: Minimum spacing for $C_\Delta = 1.0$
Parallel to Grain	3D	4D
Perpendicular to Grain	3D	Required spacing for attached members

12.5.2 End Grain Factor, C_{eg}

12.5.2.1 Where lag screws are loaded in withdrawal from end grain, the reference withdrawal design values, W, shall be multiplied by the end grain factor, $C_{eg} = 0.75$.

12.5.2.2 Where dowel-type fasteners are inserted in the end grain of the main member, with the fastener axis parallel to the wood fibers, reference lateral design values, Z, shall be multiplied by the end grain factor, $C_{eg} = 0.67$.

12.5.2.3 Where dowel-type fasteners with D≥1/4" are loaded laterally in the narrow edge of cross-laminated timber, the reference lateral design value, Z, shall be multiplied by the end grain factor, C_{eg}=0.67, regardless of grain orientation.

Table 12.5.1C Edge Distance Requirements[1,2]

Direction of Loading	Minimum Edge Distance
Parallel to Grain:	
where $\ell/D \le 6$	1.5D
where $\ell/D > 6$	1.5D or ½ the spacing between rows, whichever is greater
Perpendicular to Grain:[2]	
loaded edge	4D
unloaded edge	1.5D

1. The ℓ/D ratio used to determine the minimum spacing between rows shall be the lesser of:
   (a) length of fastener in wood main member/D = ℓ_m/D
   (b) total length of fastener in wood side member(s)/D = ℓ_s/D
2. Heavy or medium concentrated loads shall not be suspended below the neutral axis of a single sawn lumber or structural glued laminated tim-ber beam except where mechanical or equivalent reinforcement is provided to resist tension stresses perpendicular to grain (see 3.8.2 and 11.1.3).

Table 12.5.1D Spacing Requirements Between Rows[1]

Direction of Loading	Minimum Spacing
Parallel to Grain	1.5D
Perpendicular to Grain:	
where $\ell/D \le 2$	2.5D
where $2 < \ell/D < 6$	$(5\ell + 10D) / 8$
where $\ell/D \ge 6$	5D

1. The ℓ/D ratio used to determine the minimum spacing between rows shall be the lesser of:
   (a) length of fastener in wood main member/D = ℓ_m/D
   (b) total length of fastener in wood side member(s)/D = ℓ_s/D

12.5.3 Diaphragm Factor, C_{di}

Where nails or spikes are used in diaphragm construction, reference lateral design values, Z, are permitted to be multiplied by the diaphragm factor, C_{di} = 1.1.

12.5.4 Toe-Nail Factor, C_{tn}

12.5.4.1 Reference withdrawal design values, W, for toe-nailed connections shall be multiplied by the toe-nail factor, $C_{tn} = 0.67$. The wet service factor, C_M, shall not apply.

12.5.4.2 Reference lateral design values, Z, for toe-nailed connections shall be multiplied by the toe-nail factor, $C_{tn} = 0.83$.

Table 12.5.1E Edge and End Distance and Spacing Requirements for Lag Screws Loaded in Withdrawal and Not Loaded Laterally

Orientation	Minimum Distance/Spacing
Edge Distance	1.5D
End Distance	4D
Spacing	4D

Table 12.5.1F Perpendicular to Grain Distance Requirements for Outermost Fasteners in Structural Glued Laminated Timber Members

Fastener Type	Moisture Content		Maximum Distance Between Outer Rows
	At Time of Fabrication	In-Service	
All Fasteners	>16%	<16%	5"
	Any	>16%	5"
Bolts	<16%	<16%	10"
Lag Screws	<16%	<16%	6"
Drift Pins	<16%	<16%	6"

Table 12.5.1G End Distance, Edge Distance and Fastener Spacing Requirements in Narrow Edge of Cross-Laminated Timber (see Figure 12I)

Direction of Loading	Minimum End Distance	Minimum Edge Distance	Minimum Spacing for Fasteners in a Row
Perpendicular to Plane of CLT	4D	3D	4D
Parallel to Plane of CLT, Compression: (fastener bearing away from member end)	4D		
Parallel to Plane of CLT, Tension: (fastener bearing toward member end)	7D		

Figure 12H Spacing Between Outer Rows of Bolts

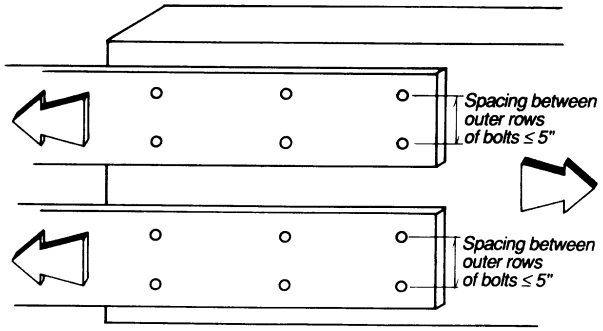
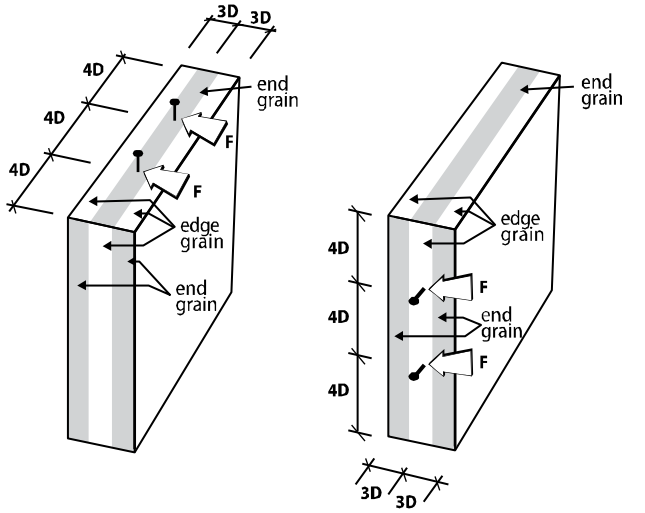
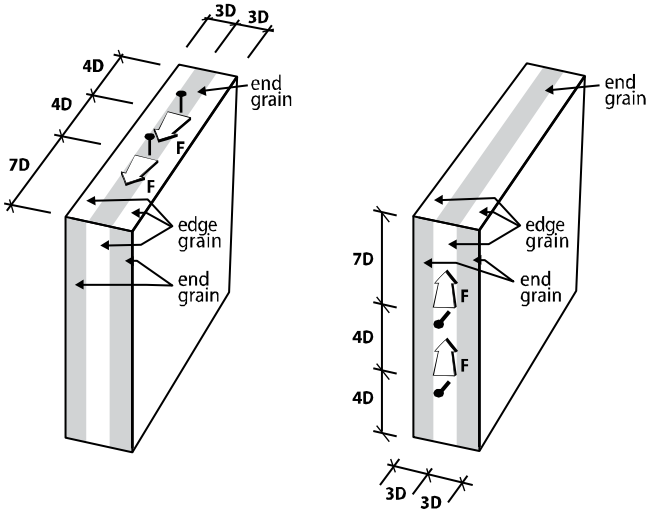


Figure 12I End Distance, Edge Distance and Fastener Spacing Requirements in Narrow Edge of Cross-Laminated Timber



Direction of loading perpendicular to the plane of CLT



Direction of loading parallel to the plane of CLT

12.6 Multiple Fasteners

12.6.1 Symmetrically Staggered Fasteners

Where a connection contains multiple fasteners, fasteners shall be staggered symmetrically in members loaded perpendicular to grain whenever possible (see 11.3.6.2 for special design provisions where bolts, lag screws, or drift pins are staggered).

12.6.2 Fasteners Loaded at an Angle to Grain

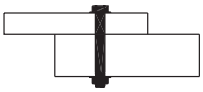
When a multiple fastener connection is loaded at an angle to grain, the gravity axis of each member shall pass through the center of resistance of the group of fasteners to insure uniform stress in the main member and a uniform distribution of load to all fasteners.

12.6.3 Local Stresses in Connections

Local stresses in connections using multiple fasteners shall be evaluated in accordance with principles of engineering mechanics (see 11.1.2).

Table 12A BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2]

for sawn lumber or SCL with both members of identical specific gravity

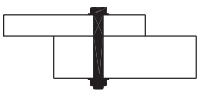


Thickness			G=0.67 Red Oak				G=0.55 Mixed Maple Southern Pine				G=0.50 Douglas Fir-Larch				G=0.49 Douglas Fir-Larch(N)				G=0.46 Douglas Fir(S) Hem-Fir(N)			
Main Member	Side Member	Bolt Diameter																				
t_m	t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1-1/2	1-1/2	1/2	650	420	420	330	530	330	330	250	480	300	300	220	470	290	290	210	440	270	270	190
		5/8	810	500	500	370	660	400	400	280	600	360	360	240	590	350	350	240	560	320	320	220
		3/4	970	580	580	410	800	460	460	310	720	420	420	270	710	400	400	260	670	380	380	240
		7/8	1130	660	660	440	930	520	520	330	850	470	470	290	830	460	460	280	780	420	420	250
		1	1290	740	740	470	1060	580	580	350	970	530	530	310	950	510	510	300	890	480	480	280
1-3/4	1-3/4	1/2	760	490	490	390	620	390	390	290	560	350	350	250	550	340	340	250	520	320	320	230
		5/8	940	590	590	430	770	470	470	330	700	420	420	280	690	410	410	280	650	380	380	250
		3/4	1130	680	680	480	930	540	540	360	850	480	480	310	830	470	470	300	780	440	440	280
		7/8	1320	770	770	510	1080	610	610	390	990	550	550	340	970	530	530	320	910	500	500	300
		1	1510	860	860	550	1240	680	680	410	1130	610	610	360	1110	600	600	350	1040	560	560	320
2-1/2	1-1/2	1/2	770	480	540	440	660	400	420	350	610	370	370	310	610	360	360	300	580	340	330	270
		5/8	1070	660	630	520	930	560	490	390	850	520	430	340	830	520	420	330	780	470	390	300
		3/4	1360	890	720	570	1120	660	560	430	1020	590	500	380	1000	560	480	360	940	520	450	330
		7/8	1590	960	800	620	1300	720	620	470	1190	630	550	410	1170	600	540	390	1090	550	500	360
		1	1820	1020	870	660	1490	770	680	490	1360	680	610	440	1330	650	590	420	1250	600	550	390
3-1/2	1-1/2	1/2	770	480	560	440	660	400	470	360	610	370	430	330	610	360	420	320	580	340	400	310
		5/8	1070	660	760	590	940	560	620	500	880	520	540	460	870	520	530	450	830	470	490	410
		3/4	1450	890	900	770	1270	660	690	580	1200	590	610	510	1190	560	590	490	1140	520	550	450
		7/8	1890	960	990	830	1680	720	770	630	1590	630	680	550	1570	600	650	530	1470	550	600	480
		1	2410	1020	1080	890	2010	770	830	670	1830	680	740	590	1790	650	710	560	1680	600	660	520
	1-3/4	1/2	830	510	590	480	720	420	510	390	670	380	470	350	660	380	460	340	620	360	440	320
		5/8	1160	680	820	620	1000	580	640	520	930	530	560	460	920	530	550	450	880	500	510	410
		3/4	1530	900	940	780	1330	770	720	580	1250	680	640	520	1240	660	620	500	1190	600	580	460
		7/8	1970	1120	1040	840	1730	840	810	640	1620	740	710	550	1590	700	690	530	1490	640	640	490
		1	2480	1190	1130	900	2030	890	880	670	1850	790	780	590	1820	750	760	570	1700	700	700	530
	3-1/2	1/2	830	590	590	530	750	520	520	460	720	490	490	430	710	480	480	420	690	460	460	410
		5/8	1290	880	880	780	1170	780	780	650	1120	700	700	560	1110	690	690	550	1070	650	650	500
		3/4	1860	1190	1190	950	1690	960	960	710	1610	870	870	630	1600	850	850	600	1540	800	800	560
		7/8	2540	1410	1410	1030	2170	1160	1160	780	1970	1060	1060	680	1940	1040	1040	650	1810	980	980	590
		1	3020	1670	1670	1100	2480	1360	1360	820	2260	1230	1230	720	2210	1190	1190	690	2070	1110	1110	640
5-1/4	1-1/2	5/8	1070	660	760	590	940	560	640	500	880	520	590	460	870	520	590	450	830	470	560	430
		3/4	1450	890	990	780	1270	660	850	660	1200	590	790	590	1190	560	780	560	1140	520	740	520
		7/8	1890	960	1260	960	1680	720	1060	720	1590	630	940	630	1570	600	900	600	1520	550	830	550
		1	2410	1020	1500	1020	2150	770	1140	770	2050	680	1010	680	2030	650	970	650	1930	600	910	600
	1-3/4	5/8	1160	680	820	620	1000	580	690	520	930	530	630	470	920	530	630	470	880	500	590	440
		3/4	1530	900	1050	800	1330	770	890	680	1250	680	830	630	1240	660	810	620	1190	600	780	590
		7/8	1970	1120	1320	1020	1730	840	1090	840	1640	740	960	740	1620	700	920	700	1550	640	850	640
		1	2480	1190	1530	1190	2200	890	1170	890	2080	790	1040	790	2060	750	1000	750	1990	700	930	700
	3-1/2	5/8	1290	880	880	780	1170	780	780	680	1120	700	730	630	1110	690	720	620	1070	650	690	580
		3/4	1860	1190	1240	1080	1690	960	1090	850	1610	870	1030	780	1600	850	1010	750	1540	800	970	710
		7/8	2540	1410	1640	1260	2300	1160	1380	1000	2190	1060	1230	870	2170	1040	1190	840	2060	980	1100	770
		1	3310	1670	1940	1420	2870	1390	1520	1060	2660	1290	1360	940	2630	1260	1320	900	2500	1210	1230	830
5-1/2	1-1/2	5/8	1070	660	760	590	940	560	640	500	880	520	590	460	870	520	590	450	830	470	560	430
		3/4	1450	890	990	780	1270	660	850	660	1200	590	790	590	1190	560	780	560	1140	520	740	520
		7/8	1890	960	1260	960	1680	720	1090	720	1590	630	980	630	1570	600	940	600	1520	550	860	550
		1	2410	1020	1560	1020	2150	770	1190	770	2050	680	1060	680	2030	650	1010	650	1930	600	940	600
	3-1/2	5/8	1290	880	880	780	1170	780	780	680	1120	700	730	630	1110	690	720	620	1070	650	690	580
		3/4	1860	1190	1240	1080	1690	960	1090	850	1610	870	1030	780	1600	850	1010	750	1540	800	970	710
		7/8	2540	1410	1640	1260	2300	1160	1410	1020	2190	1060	1260	910	2170	1040	1220	870	2060	980	1130	790
		1	3310	1670	1980	1470	2870	1390	1550	1100	2660	1290	1390	970	2630	1260	1340	930	2500	1210	1250	860
7-1/2	1-1/2	5/8	1070	660	760	590	940	560	640	500	880	520	590	460	870	520	590	450	830	470	560	430
		3/4	1450	890	990	780	1270	660	850	660	1200	590	790	590	1190	560	780	560	1140	520	740	520
		7/8	1890	960	1260	960	1680	720	1090	720	1590	630	1010	630	1570	600	990	600	1520	550	950	550
		1	2410	1020	1560	1020	2150	770	1350	770	2050	680	1270	680	2030	650	1240	650	1930	600	1190	600
	3-1/2	5/8	1290	880	880	780	1170	780	780	680	1120	700	730	630	1110	690	720	620	1070	650	690	580
		3/4	1860	1190	1240	1080	1690	960	1090	850	1610	870	1030	780	1600	850	1010	750	1540	800	970	710
		7/8	2540	1410	1640	1260	2300	1160	1450	1020	2190	1060	1360	930	2170	1040	1340	900	2060	980	1280	850
		1	3310	1670	2090	1470	2870	1390	1830	1210	2660	1290	1630	1110	2630	1260	1570	1080	2500	1210	1470	1030

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.

Table 12A (Cont.) **BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2]**

for sawn lumber or SCL with both members of identical specific gravity

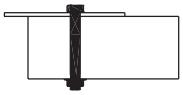


Thickness		Bolt Diameter	G=0.43 Hem-Fir				G=0.42 Spruce-Pine-Fir				G=0.37 Redwood				G=0.36 Eastern Softwoods Spruce-Pine-Fir(S), Western Cedars, Western Woods				G=0.35 Northern Species			
Main Member	Side Member																					
t_m	t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
		1/2	410	250	250	180	410	240	240	170	360	210	210	140	350	200	200	130	340	200	200	130
		5/8	520	300	300	190	510	290	290	190	450	250	250	160	440	240	240	150	420	240	240	150
1-1/2	1-1/2	3/4	620	350	350	210	610	340	340	210	540	290	290	170	520	280	280	170	500	270	270	160
		7/8	720	390	390	230	710	380	380	220	630	330	330	190	610	320	320	180	590	310	310	170
		1	830	440	440	250	810	430	430	240	720	370	370	200	700	360	360	190	670	350	350	190
		1/2	480	290	290	210	470	280	280	200	420	250	250	170	410	240	240	160	390	230	230	150
		5/8	600	350	350	230	590	340	340	220	520	290	290	190	510	280	280	180	490	270	270	170
1-3/4	1-3/4	3/4	720	400	400	250	710	390	390	240	630	340	340	200	610	330	330	190	590	320	320	190
		7/8	850	460	460	270	830	450	450	260	730	390	390	220	710	380	380	210	690	360	360	200
		1	970	510	510	290	950	500	500	280	840	430	430	230	820	420	420	230	790	410	410	220
		1/2	550	320	310	250	540	320	300	240	500	290	250	200	490	280	240	190	470	280	240	180
		5/8	730	420	360	270	710	410	350	270	630	350	300	220	610	330	290	210	590	320	280	210
2-1/2	1-1/2	3/4	870	460	410	300	850	450	400	290	750	370	340	240	740	360	330	230	710	350	320	230
		7/8	1020	500	450	320	1000	490	440	310	880	410	380	260	860	390	370	250	830	370	350	240
		1	1160	540	500	350	1140	530	490	340	1010	440	420	280	980	420	410	270	940	410	390	260
		1/2	550	320	380	290	540	320	370	280	500	290	320	250	490	280	300	250	480	280	290	240
		5/8	790	420	440	370	780	410	430	360	720	350	370	300	710	330	350	290	700	320	340	280
	1-1/2	3/4	1100	460	500	400	1080	450	480	390	1010	370	410	320	990	360	400	310	950	350	380	300
		7/8	1370	500	550	430	1340	490	540	420	1180	410	460	350	1160	390	440	340	1110	370	420	320
		1	1570	540	600	470	1530	530	590	460	1350	440	500	380	1320	420	480	370	1270	410	470	350
		1/2	590	340	400	300	580	330	390	290	530	300	330	260	520	290	320	250	510	280	310	250
		5/8	840	480	460	370	820	470	450	360	760	400	390	310	740	380	370	290	730	370	360	280
3-1/2	1-3/4	3/4	1130	540	520	410	1120	530	510	400	1030	430	430	330	1000	420	420	320	970	410	410	310
		7/8	1390	580	580	440	1360	570	570	430	1200	470	480	360	1170	460	470	350	1130	430	440	320
		1	1590	630	640	480	1550	610	630	460	1370	510	530	380	1340	490	520	370	1290	470	500	360
		1/2	660	440	440	390	660	430	430	380	620	400	400	330	610	390	390	310	600	380	380	310
		5/8	1040	600	600	450	1020	590	590	440	960	520	520	370	950	500	500	350	930	490	490	340
	3-1/2	3/4	1450	740	740	500	1420	730	730	480	1250	650	650	400	1220	630	630	390	1180	620	620	370
		7/8	1690	910	910	540	1660	890	890	520	1460	770	770	440	1430	750	750	420	1370	720	720	390
		1	1930	1030	1030	580	1890	1000	1000	560	1670	870	870	470	1630	840	840	450	1570	810	810	430
		5/8	790	420	530	410	780	410	520	400	720	350	470	350	710	330	460	330	700	320	450	320
	1-1/2	3/4	1100	460	690	460	1080	450	670	450	1010	370	560	370	990	360	540	360	970	350	530	350
		7/8	1460	500	750	500	1440	490	730	490	1350	410	620	410	1330	390	600	390	1280	370	560	370
		1	1800	540	820	540	1760	530	800	530	1560	440	670	440	1520	420	650	420	1460	410	630	410
		5/8	840	480	560	410	820	470	550	410	760	400	500	370	740	380	480	360	730	370	470	350
		3/4	1130	540	700	540	1120	530	680	530	1040	430	570	430	1020	420	560	420	1000	410	540	410
5-1/4	1-3/4	7/8	1490	580	770	580	1470	570	750	570	1370	470	640	470	1350	460	620	460	1320	430	580	430
		1	1910	630	850	630	1890	610	820	610	1760	510	690	510	1740	490	670	490	1700	470	650	470
		5/8	1040	600	660	530	1020	590	650	520	960	520	610	460	950	500	590	440	930	490	580	430
		3/4	1490	740	900	640	1480	730	880	620	1390	650	750	520	1370	630	730	500	1330	620	710	480
	3-1/2	7/8	1950	920	1010	690	1920	910	990	670	1740	820	850	560	1710	800	830	550	1660	770	780	510
		1	2370	1140	1130	750	2330	1120	1100	730	2120	1020	940	600	2080	980	910	580	2030	950	880	560
		5/8	790	420	530	410	780	410	520	400	720	350	470	350	710	330	460	330	700	320	450	320
	1-1/2	3/4	1100	460	700	460	1080	450	690	450	1010	370	580	370	990	360	570	360	970	350	550	350
		7/8	1460	500	780	500	1440	490	760	490	1350	410	650	410	1330	390	630	390	1280	370	590	370
5-1/2		1	1800	540	860	540	1760	530	830	530	1560	440	700	440	1520	420	680	420	1460	410	650	410
		5/8	1040	600	660	530	1020	590	650	520	960	520	610	460	950	500	590	440	930	490	580	430
		3/4	1490	740	920	650	1480	730	900	640	1390	650	770	530	1370	630	750	520	1330	620	720	500
	3-1/2	7/8	1950	920	1030	720	1920	910	1010	700	1740	820	870	590	1710	800	840	570	1660	770	800	530
		1	2370	1140	1150	780	2330	1120	1120	760	2120	1020	960	630	2080	980	930	600	2030	950	890	580
		5/8	790	420	530	410	780	410	520	400	720	350	470	350	710	330	460	330	700	320	450	320
	1-1/2	3/4	1100	460	700	460	1080	450	690	450	1010	370	630	370	990	360	620	360	970	350	600	350
		7/8	1460	500	900	500	1440	490	890	490	1350	410	810	410	1330	390	800	390	1280	370	770	370
7-1/2		1	1800	540	1130	540	1760	530	1110	530	1560	440	920	440	1520	420	890	420	1460	410	860	410
		5/8	1040	600	660	530	1020	590	650	520	960	520	610	460	950	500	590	440	930	490	580	430
		3/4	1490	740	920	650	1480	730	910	640	1390	650	840	560	1370	630	820	550	1330	620	810	540
	3-1/2	7/8	1950	920	1210	790	1920	910	1180	780	1740	820	1010	700	1710	800	980	680	1660	770	920	650
		1	2370	1140	1340	970	2330	1120	1300	950	2120	1020	1100	820	2080	980	1070	790	2030	950	1030	760

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.

Table 12B BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2]

for sawn lumber or SCL main member with 1/4" ASTM A 36 steel side plate

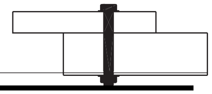


Thickness			G=0.67 Red Oak		G=0.55 Mixed Maple Southern Pine		G=0.50 Douglas Fir-Larch		G=0.49 Douglas Fir-Larch(N)		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.37 Redwood		G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods		G=0.35 Northern Species	
Main Member	Side Member	Bolt Diameter																				
t_m	t_s	D	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1-1/2	1/4	1/2	730	420	620	350	580	310	580	310	550	290	520	280	510	270	470	240	460	240	450	230
		5/8	910	480	780	400	730	360	720	360	690	340	650	320	640	320	590	290	580	280	560	270
		3/4	1090	550	940	450	870	420	860	410	820	390	780	360	770	360	710	320	690	320	680	310
		7/8	1270	600	1090	510	1020	470	1010	450	960	430	910	410	900	400	820	370	810	360	790	350
		1	1460	660	1250	550	1170	510	1150	500	1100	480	1040	450	1030	450	940	400	930	400	900	390
1-3/4	1/4	1/2	810	460	690	370	640	340	630	330	600	310	570	290	560	280	510	250	500	250	490	240
		5/8	1020	520	870	430	800	390	790	380	750	360	710	340	700	330	640	300	630	290	610	280
		3/4	1220	590	1040	480	960	440	950	430	900	410	860	380	840	370	770	330	750	330	730	320
		7/8	1420	650	1210	540	1130	490	1110	480	1050	450	1000	420	980	420	890	380	880	370	850	360
		1	1630	710	1380	580	1290	540	1270	520	1200	500	1140	470	1120	460	1020	410	1000	410	980	400
2-1/2	1/4	1/2	930	600	860	470	830	410	820	400	780	380	740	350	720	340	650	300	640	290	620	280
		5/8	1370	670	1150	530	1050	470	1040	470	980	430	920	400	910	390	810	340	800	330	770	320
		3/4	1640	750	1370	590	1270	530	1250	520	1180	490	1110	450	1090	440	980	380	960	370	930	360
		7/8	1910	820	1600	650	1480	590	1450	570	1370	530	1290	490	1270	480	1140	420	1120	410	1080	400
		1	2190	880	1830	700	1690	640	1660	620	1570	580	1480	540	1450	530	1300	460	1280	450	1240	440
3-1/2	1/4	1/2	930	620	860	550	830	510	820	510	800	480	770	450	770	430	720	370	720	360	710	350
		5/8	1370	860	1260	690	1210	610	1200	600	1160	550	1130	500	1120	490	1060	420	1050	410	1020	400
		3/4	1900	990	1740	760	1670	680	1660	660	1580	610	1480	560	1450	540	1290	460	1260	450	1220	440
		7/8	2530	1070	2170	840	1990	740	1950	710	1840	660	1720	610	1690	590	1510	510	1480	500	1430	470
		1	2980	1150	2480	890	2270	800	2230	770	2100	730	1970	660	1930	650	1720	560	1690	540	1630	530
5-1/4	1/4	5/8	1370	860	1260	760	1210	710	1200	700	1160	670	1130	640	1120	630	1060	580	1050	560	1030	540
		3/4	1900	1140	1740	1000	1670	940	1660	930	1610	860	1560	770	1550	760	1460	640	1450	620	1420	600
		7/8	2530	1460	2320	1190	2220	1050	2200	1010	2140	920	2070	840	2050	820	1940	700	1920	680	1890	640
		1	3260	1660	2980	1270	2860	1130	2840	1080	2750	1010	2670	920	2640	890	2490	750	2450	730	2360	710
5-1/2	1/4	5/8	1370	860	1260	760	1210	710	1200	700	1160	670	1130	640	1120	630	1060	580	1050	570	1030	560
		3/4	1900	1140	1740	1000	1670	940	1660	930	1610	890	1560	810	1550	790	1460	660	1450	640	1420	620
		7/8	2530	1460	2320	1240	2220	1090	2200	1050	2140	960	2070	880	2050	860	1940	730	1920	710	1890	660
		1	3260	1730	2980	1320	2860	1170	2840	1130	2750	1050	2670	950	2640	930	2490	780	2470	760	2420	740
7-1/2	1/4	5/8	1370	860	1260	760	1210	710	1200	700	1160	670	1130	640	1120	630	1060	580	1050	570	1030	560
		3/4	1900	1140	1740	1000	1670	940	1660	930	1610	890	1560	850	1550	840	1460	760	1450	750	1420	740
		7/8	2530	1460	2320	1280	2220	1210	2200	1180	2140	1130	2070	1080	2050	1070	1940	960	1920	930	1890	870
		1	3260	1820	2980	1590	2860	1500	2840	1470	2750	1400	2670	1270	2640	1230	2490	1030	2470	1000	2420	960
9-1/2	1/4	3/4	1900	1140	1740	1000	1670	940	1660	930	1610	890	1560	850	1550	840	1460	760	1450	750	1420	740
		7/8	2530	1460	2320	1280	2220	1210	2200	1180	2140	1130	2070	1080	2050	1070	1940	980	1920	970	1890	930
		1	3260	1820	2980	1590	2860	1500	2840	1470	2750	1420	2670	1350	2640	1330	2490	1220	2470	1200	2420	1180
11-1/2	1/4	7/8	2530	1460	2320	1280	2220	1210	2200	1180	2140	1130	2070	1080	2050	1070	1940	980	1920	970	1890	930
		1	3260	1820	2980	1590	2860	1500	2840	1470	2750	1420	2670	1350	2640	1330	2490	1220	2470	1200	2420	1180
13-1/2	1/4	1	3260	1820	2980	1590	2860	1500	2840	1470	2750	1420	2670	1350	2640	1330	2490	1220	2470	1200	2420	1180

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi and dowel bearing strength, F_e, of 87,000 psi for ASTM A36 steel.

Table 12C BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2]

for structural glued laminated timber main member with sawn lumber side member of identical specific gravity

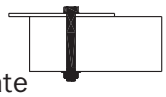


Thickness Main Member t_m in.	Thickness Side Member t_s in.	Bolt Diameter D in.	G=0.55 Southern Pine $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.	G=0.50 Douglas Fir-Larch $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.	G=0.46 Douglas Fir(S) $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.	G=0.43 Hem-Fir $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.	G=0.42 Spruce-Pine-Fir $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.	G=0.36 Spruce-Pine-Fir(S) Western Woods $Z_{\parallel}$ lbs.	$Z_{s\perp}$ lbs.	$Z_{m\perp}$ lbs.	$Z_{\perp}$ lbs.
2-1/2	1-1/2	1/2	-	-	-	-	610	370	370	310	580	340	330	270	550	320	310	250	540	320	300	240	490	280	240	190
		5/8	-	-	-	-	850	520	430	340	780	470	390	300	730	420	360	270	710	410	350	270	610	330	290	210
		3/4	-	-	-	-	1020	590	500	380	940	520	450	330	870	460	410	300	850	450	400	290	740	360	330	230
		7/8	-	-	-	-	1190	630	550	410	1090	550	500	360	1020	500	450	320	1000	490	440	310	860	390	370	250
		1	-	-	-	-	1360	680	610	440	1250	600	550	390	1160	540	500	350	1140	530	490	340	980	420	410	270
3	1-1/2	1/2	660	400	470	360	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		5/8	940	560	550	460	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3/4	1270	660	620	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7/8	1520	720	690	540	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	1740	770	750	580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3-1/8	1-1/2	1/2	-	-	-	-	610	370	430	330	580	340	390	310	550	320	360	290	540	320	340	280	490	280	280	230
		5/8	-	-	-	-	880	520	500	410	830	470	450	370	790	420	410	330	780	410	400	320	710	330	330	260
		3/4	-	-	-	-	1200	590	570	460	1130	520	510	410	1060	460	460	360	1040	450	450	350	890	360	370	280
		7/8	-	-	-	-	1440	630	630	490	1320	550	560	430	1230	500	510	390	1210	490	500	380	1040	390	410	310
		1	-	-	-	-	1640	680	690	530	1510	600	620	470	1410	540	560	420	1380	530	550	410	1190	420	450	330
5	1-1/2	5/8	940	560	640	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3/4	1270	660	850	660	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7/8	1680	720	1020	720	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	2150	770	1100	770	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5-1/8	1-1/2	5/8	-	-	-	-	880	520	590	460	830	470	560	430	790	420	530	410	780	410	520	400	710	330	460	330
		3/4	-	-	-	-	1200	590	790	590	1140	520	740	520	1100	460	670	460	1080	450	660	450	990	360	530	360
		7/8	-	-	-	-	1590	630	920	630	1520	550	810	550	1460	500	740	500	1440	490	720	490	1330	390	590	390
		1	-	-	-	-	2050	680	990	680	1930	600	890	600	1800	540	810	540	1760	530	780	530	1520	420	640	420
6-3/4	1-1/2	5/8	940	560	640	500	880	520	590	460	830	470	560	430	790	420	530	410	780	410	520	400	710	330	460	330
		3/4	1270	660	850	660	1200	590	790	590	1140	520	740	520	1100	460	700	460	1080	450	690	450	990	360	620	360
		7/8	1680	720	1090	720	1590	630	1010	630	1520	550	950	550	1460	500	900	500	1440	490	890	490	1330	390	750	390
		1	2150	770	1350	770	2050	680	1270	680	1930	600	1140	600	1800	540	1030	540	1760	530	1000	530	1520	420	810	420

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength , F_{yb}, of 45,000 psi.

Table 12D BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2]

for structural glued laminated timber main member with 1/4" ASTM A 36 steel side plate

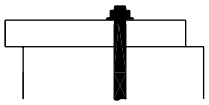


Thickness			G=0.55 Southern Pine		G=0.50 Douglas Fir-Larch		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.36 Spruce-Pine-Fir(S) Western Woods	
Main Member	Side Member	Bolt Diameter												
t_m	t_s	D	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
2-1/2	1/4	1/2	-	-	830	410	780	380	740	350	720	340	640	290
		5/8	-	-	1050	470	980	430	920	400	910	390	800	330
		3/4	-	-	1270	530	1180	490	1110	450	1090	440	960	370
		7/8	-	-	1480	590	1370	530	1290	490	1270	480	1120	410
		1	-	-	1690	640	1570	580	1480	540	1450	530	1280	450
3	1/4	1/2	860	540	-	-	-	-	-	-	-	-	-	-
		5/8	1260	610	-	-	-	-	-	-	-	-	-	-
		3/4	1610	670	-	-	-	-	-	-	-	-	-	-
		7/8	1880	740	-	-	-	-	-	-	-	-	-	-
		1	2150	790	-	-	-	-	-	-	-	-	-	-
3-1/8	1/4	1/2	-	-	830	490	800	440	770	410	770	400	720	330
		5/8	-	-	1210	550	1160	500	1110	460	1090	450	960	380
		3/4	-	-	1540	620	1420	560	1340	510	1310	500	1150	420
		7/8	-	-	1790	680	1660	610	1560	560	1530	550	1340	470
		1	-	-	2050	740	1900	670	1780	610	1750	600	1530	510
5	1/4	5/8	1260	760	-	-	-	-	-	-	-	-	-	-
		3/4	1740	1000	-	-	-	-	-	-	-	-	-	-
		7/8	2320	1140	-	-	-	-	-	-	-	-	-	-
		1	2980	1210	-	-	-	-	-	-	-	-	-	-
5-1/8	1/4	5/8	-	-	1210	710	1160	670	1130	640	1120	630	1050	550
		3/4	-	-	1670	940	1610	840	1560	760	1550	740	1450	610
		7/8	-	-	2220	1020	2140	900	2070	830	2050	810	1920	670
		1	-	-	2860	1100	2750	990	2670	900	2640	880	2390	720
6-3/4	1/4	5/8	1260	760	1210	710	1160	670	1130	640	1120	630	1050	570
		3/4	1740	1000	1670	940	1610	890	1560	850	1550	840	1450	750
		7/8	2320	1280	2220	1210	2140	1130	2070	1060	2050	1030	1920	850
		1	2980	1590	2860	1420	2750	1270	2670	1150	2640	1120	2470	910
8-1/2	1/4	3/4	1740	1000	-	-	-	-	-	-	-	-	-	-
		7/8	2320	1280	-	-	-	-	-	-	-	-	-	-
		1	2980	1590	-	-	-	-	-	-	-	-	-	-
8-3/4	1/4	3/4	-	-	1670	940	1610	890	1560	850	1550	840	1450	750
		7/8	-	-	2220	1210	2140	1130	2070	1080	2050	1070	1920	970
		1	-	-	2860	1500	2750	1420	2670	1350	2640	1330	2470	1150
10-1/2	1/4	7/8	2320	1280	-	-	-	-	-	-	-	-	-	-
		1	2980	1590	-	-	-	-	-	-	-	-	-	-
10-3/4	1/4	7/8	-	-	2220	1210	2140	1130	2070	1080	2050	1070	1920	970
		1	-	-	2860	1500	2750	1420	2670	1350	2640	1330	2470	1200
12-1/4	1/4	7/8	-	-	2220	1210	2140	1130	2070	1080	2050	1070	1920	970
		1	-	-	2860	1500	2750	1420	2670	1350	2640	1330	2470	1200
14-1/4	1/4	1	-	-	2860	1500	2750	1420	2670	1350	2640	1330	2470	1200

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi and dowel bearing strength, F_e, of 87,000 psi for ASTM A36 steel.

Table 12E BOLTS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3,4]

for sawn lumber or SCL to concrete



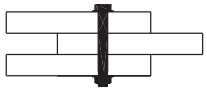
Embedment Depth in Concrete	Thickness Side Member	Bolt Diameter	G=0.67 Red Oak		G=0.55 Mixed Maple Southern Pine		G=0.50 Douglas Fir-Larch		G=0.49 Douglas Fir-Larch(N)		G=0.46 Douglas Fir(S) Hem-Fir(N)	
t_m in.	t_s in.	D in.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.
6.0 and greater	1-1/2	1/2	770	480	680	410	650	380	640	380	620	360
		5/8	1070	660	970	580	930	530	920	520	890	470
		3/4	1450	890	1330	660	1270	590	1260	560	1230	520
		7/8	1890	960	1750	720	1690	630	1680	600	1640	550
		1	2410	1020	2250	770	2100	680	2060	650	1930	600
	1-3/4	1/2	830	510	740	430	700	400	690	390	670	370
		5/8	1160	680	1030	600	980	550	970	550	940	530
		3/4	1530	900	1390	770	1330	680	1310	660	1270	600
		7/8	1970	1120	1800	840	1730	740	1720	700	1680	640
		1	2480	1190	2290	890	2210	790	2200	750	2150	700
	2-1/2	1/2	830	590	790	520	770	470	760	460	750	440
		5/8	1290	800	1230	670	1180	610	1170	610	1120	570
		3/4	1840	1000	1630	850	1540	800	1520	780	1460	750
		7/8	2290	1240	2050	1080	1940	1020	1920	1000	1860	920
		1	2800	1520	2530	1280	2410	1130	2390	1080	2310	1000
	3-1/2	1/2	830	590	790	540	770	510	760	500	750	490
		5/8	1290	880	1230	810	1200	730	1190	720	1170	670
		3/4	1860	1190	1770	980	1720	900	1720	880	1680	830
		7/8	2540	1410	2410	1190	2320	1100	2290	1070	2200	1020
		1	3310	1670	2970	1420	2800	1330	2770	1300	2660	1260

Embedment Depth in Concrete	Thickness Side Member	Bolt Diameter	G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.37 Redwood		G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods		G=0.35 Northern Species	
t_m in.	t_s in.	D in.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.
6.0 and greater	1-1/2	1/2	590	340	590	340	550	310	540	290	530	290
		5/8	860	420	850	410	810	350	800	330	780	320
		3/4	1200	460	1190	450	1130	370	1120	360	1100	350
		7/8	1580	500	1540	490	1360	410	1330	390	1280	370
		1	1800	540	1760	530	1560	440	1520	420	1460	410
	1-3/4	1/2	640	360	630	350	580	320	580	310	560	310
		5/8	910	490	900	480	840	400	830	380	810	370
		3/4	1230	540	1220	530	1160	430	1140	420	1120	410
		7/8	1630	580	1610	570	1540	470	1520	460	1490	430
		1	2090	630	2060	610	1820	510	1770	490	1710	470
	2-1/2	1/2	730	410	730	400	700	360	690	340	680	340
		5/8	1070	540	1060	530	980	480	960	470	940	460
		3/4	1400	710	1380	700	1290	620	1270	600	1240	580
		7/8	1790	830	1770	810	1660	680	1640	660	1600	610
		1	2230	900	2210	880	2080	730	2060	700	2030	680
	3-1/2	1/2	730	470	730	470	700	430	690	410	690	400
		5/8	1140	620	1140	610	1090	550	1080	530	1070	520
		3/4	1650	780	1640	770	1540	680	1510	670	1470	660
		7/8	2100	960	2070	950	1910	870	1880	850	1840	820
		1	2550	1190	2520	1180	2340	1020	2310	980	2260	950

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.
3. Tabulated lateral design values, Z, are based on dowel bearing strength, F_e, of 7,500 psi for concrete with minimum f'_c=2,500 psi.
4. Six inch anchor embedment assumed.

Table 12F BOLTS: Reference Lateral Design Values, Z, for Double Shear (three member) Connections[1,2]

for sawn lumber or SCL with all members of identical specific gravity

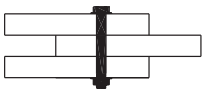


Thickness			G=0.67 Red Oak			G=0.55 Mixed Maple Southern Pine			G=0.50 Douglas Fir-Larch			G=0.49 Douglas Fir-Larch(N)			G=0.46 Douglas Fir(S) Hem-Fir(N)		
Main Member	Side Member	Bolt Diameter															
t_m	t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
		1/2	1410	960	730	1150	800	550	1050	730	470	1030	720	460	970	680	420
		5/8	1760	1310	810	1440	1130	610	1310	1040	530	1290	1030	520	1210	940	470
1-1/2	1-1/2	3/4	2110	1690	890	1730	1330	660	1580	1170	590	1550	1130	560	1450	1040	520
		7/8	2460	1920	960	2020	1440	720	1840	1260	630	1800	1210	600	1690	1100	550
		1	2810	2040	1020	2310	1530	770	2100	1350	680	2060	1290	650	1930	1200	600
		1/2	1640	1030	850	1350	850	640	1230	770	550	1200	750	530	1130	710	490
		5/8	2050	1370	940	1680	1160	710	1530	1070	610	1500	1060	600	1410	1000	550
1-3/4	1-3/4	3/4	2460	1810	1040	2020	1550	770	1840	1370	680	1800	1310	660	1690	1210	600
		7/8	2870	2240	1120	2350	1680	840	2140	1470	740	2110	1410	700	1970	1290	640
		1	3280	2380	1190	2690	1790	890	2450	1580	790	2410	1510	750	2250	1400	700
		1/2	1530	960	1120	1320	800	910	1230	730	790	1210	720	760	1160	680	700
		5/8	2150	1310	1340	1870	1130	1020	1760	1040	880	1740	1030	860	1660	940	780
2-1/2	1-1/2	3/4	2890	1770	1480	2550	1330	1110	2400	1170	980	2380	1130	940	2280	1040	860
		7/8	3780	1920	1600	3360	1440	1200	3060	1260	1050	3010	1210	1010	2820	1100	920
		1	4690	2040	1700	3840	1530	1280	3500	1350	1130	3440	1290	1080	3220	1200	1000
		1/2	1530	960	1120	1320	800	940	1230	730	860	1210	720	850	1160	680	810
		5/8	2150	1310	1510	1870	1130	1290	1760	1040	1190	1740	1030	1170	1660	940	1090
	1-1/2	3/4	2890	1770	1980	2550	1330	1550	2400	1170	1370	2380	1130	1310	2280	1040	1210
		7/8	3780	1920	2240	3360	1440	1680	3180	1260	1470	3150	1210	1410	3030	1100	1290
		1	4820	2040	2380	4310	1530	1790	4090	1350	1580	4050	1290	1510	3860	1200	1400
		1/2	1660	1030	1180	1430	850	1030	1330	770	940	1310	750	920	1250	710	870
		5/8	2310	1370	1630	1990	1160	1380	1860	1070	1230	1840	1060	1200	1760	1000	1090
3-1/2	1-3/4	3/4	3060	1810	2070	2670	1550	1550	2510	1370	1370	2480	1310	1310	2370	1210	1210
		7/8	3940	2240	2240	3470	1680	1680	3270	1470	1470	3240	1410	1410	3110	1290	1290
		1	4960	2380	2380	4400	1790	1790	4170	1580	1580	4120	1510	1510	3970	1400	1400
		1/2	1660	1180	1180	1500	1040	1040	1430	970	970	1420	960	960	1370	920	920
		5/8	2590	1770	1770	2340	1560	1420	2240	1410	1230	2220	1390	1200	2150	1290	1090
	3-1/2	3/4	3730	2380	2070	3380	1910	1550	3220	1750	1370	3190	1700	1310	3090	1610	1210
		7/8	5080	2820	2240	4600	2330	1680	4290	2130	1470	4210	2070	1410	3940	1960	1290
		1	6560	3340	2380	5380	2780	1790	4900	2580	1580	4810	2520	1510	4510	2410	1400
		5/8	2150	1310	1510	1870	1130	1290	1760	1040	1190	1740	1030	1170	1660	940	1110
	1-1/2	3/4	2890	1770	1980	2550	1330	1690	2400	1170	1580	2380	1130	1550	2280	1040	1480
		7/8	3780	1920	2520	3360	1440	2170	3180	1260	2030	3150	1210	1990	3030	1100	1900
		1	4820	2040	3120	4310	1530	2680	4090	1350	2360	4050	1290	2260	3860	1200	2100
		5/8	2310	1370	1630	1990	1160	1380	1860	1070	1270	1840	1060	1250	1760	1000	1180
5-1/4	1-3/4	3/4	3060	1810	2110	2670	1550	1790	2510	1370	1660	2480	1310	1630	2370	1210	1550
		7/8	3940	2240	2640	3470	1680	2260	3270	1470	2100	3240	1410	2060	3110	1290	1930
		1	4960	2380	3240	4400	1790	2680	4170	1580	2360	4120	1510	2260	3970	1400	2100
		5/8	2590	1770	1770	2340	1560	1560	2240	1410	1460	2220	1390	1450	2150	1290	1390
	3-1/2	3/4	3730	2380	2480	3380	1910	2180	3220	1750	2050	3190	1700	1970	3090	1610	1810
		7/8	5080	2820	3290	4600	2330	2530	4390	2130	2210	4350	2070	2110	4130	1960	1930
		1	6630	3340	3570	5740	2780	2680	5330	2580	2360	5250	2520	2260	4990	2410	2100
		5/8	2150	1310	1510	1870	1130	1290	1760	1040	1190	1740	1030	1170	1660	940	1110
	1-1/2	3/4	2890	1770	1980	2550	1330	1690	2400	1170	1580	2380	1130	1550	2280	1040	1480
		7/8	3780	1920	2520	3360	1440	2170	3180	1260	2030	3150	1210	1990	3030	1100	1900
5-1/2		1	4820	2040	3120	4310	1530	2700	4090	1350	2480	4050	1290	2370	3860	1200	2200
		5/8	2590	1770	1770	2340	1560	1560	2240	1410	1460	2220	1390	1450	2150	1290	1390
	3-1/2	3/4	3730	2380	2480	3380	1910	2180	3220	1750	2050	3190	1700	2020	3090	1610	1900
		7/8	5080	2820	3290	4600	2330	2650	4390	2130	2310	4350	2070	2210	4130	1960	2020
		1	6630	3340	3740	5740	2780	2810	5330	2580	2480	5250	2520	2370	4990	2410	2200
		5/8	2150	1310	1510	1870	1130	1290	1760	1040	1190	1740	1030	1170	1660	940	1110
	1-1/2	3/4	2890	1770	1980	2550	1330	1690	2400	1170	1580	2380	1130	1550	2280	1040	1480
		7/8	3780	1920	2520	3360	1440	2170	3180	1260	2030	3150	1210	1990	3030	1100	1900
7-1/2		1	4820	2040	3120	4310	1530	2700	4090	1350	2530	4050	1290	2480	3860	1200	2390
		5/8	2590	1770	1770	2340	1560	1560	2240	1410	1460	2220	1390	1450	2150	1290	1390
	3-1/2	3/4	3730	2380	2480	3380	1910	2180	3220	1750	2050	3190	1700	2020	3090	1610	1940
		7/8	5080	2820	3290	4600	2330	2890	4390	2130	2720	4350	2070	2670	4130	1960	2560
		1	6630	3340	4190	5740	2780	3680	5330	2580	3380	5250	2520	3230	4990	2410	3000

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.

Table 12F (Cont.) BOLTS: Reference Lateral Design Values, Z, for Double Shear (three member) Connections[1,2]

for sawn lumber or SCL with all members of identical specific gravity

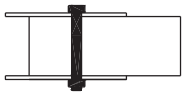


Thickness			G=0.43 Hem-Fir			G=0.42 Spruce-Pine-Fir			G=0.37 Redwood			G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods			G=0.35 Northern Species		
Main Member	Side Member	Bolt Diameter															
t_m	t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
		1/2	900	650	380	880	640	370	780	580	310	760	560	290	730	550	290
		5/8	1130	840	420	1100	830	410	970	690	350	950	660	330	910	640	320
1-1/2	1-1/2	3/4	1350	920	460	1320	900	450	1170	740	370	1140	720	360	1100	700	350
		7/8	1580	1000	500	1540	970	490	1360	810	410	1330	790	390	1280	740	370
		1	1800	1080	540	1760	1050	530	1560	870	440	1520	840	420	1460	810	410
		1/2	1050	670	450	1030	660	430	910	590	360	890	580	340	850	570	330
		5/8	1310	950	490	1290	940	480	1130	810	400	1110	770	380	1070	740	370
1-3/4	1-3/4	3/4	1580	1080	540	1540	1050	530	1360	870	430	1330	840	420	1280	810	410
		7/8	1840	1160	580	1800	1130	570	1590	950	470	1550	920	460	1490	860	430
		1	2100	1260	630	2060	1230	610	1820	1020	510	1770	980	490	1710	950	470
		1/2	1100	650	640	1080	640	610	990	580	510	980	560	490	950	550	480
		5/8	1590	840	700	1570	830	690	1450	690	580	1430	660	550	1390	640	530
2-1/2	1-1/2	3/4	2190	920	770	2160	900	750	1950	740	620	1900	720	600	1830	700	580
		7/8	2630	1000	830	2570	970	810	2270	810	680	2210	790	660	2130	740	610
		1	3000	1080	900	2940	1050	880	2590	870	730	2530	840	700	2440	810	680
		1/2	1100	650	760	1080	640	740	990	580	670	980	560	660	950	550	640
		5/8	1590	840	980	1570	830	960	1450	690	810	1430	660	770	1390	640	740
	1-1/2	3/4	2190	920	1080	2160	900	1050	2010	740	870	1990	720	840	1940	700	810
		7/8	2920	1000	1160	2880	970	1130	2690	810	950	2660	790	920	2560	740	860
		1	3600	1080	1260	3530	1050	1230	3110	870	1020	3040	840	980	2930	810	950
		1/2	1180	670	820	1160	660	800	1060	590	720	1040	580	680	1010	570	670
		5/8	1670	950	980	1650	940	960	1510	810	810	1490	770	770	1450	740	740
3-1/2	1-3/4	3/4	2270	1080	1080	2240	1050	1050	2070	870	870	2040	840	840	1990	810	810
		7/8	2980	1160	1160	2950	1130	1130	2740	950	950	2700	920	920	2640	860	860
		1	3820	1260	1260	3770	1230	1230	3520	1020	1020	3480	980	980	3410	950	950
		1/2	1330	880	880	1310	870	860	1230	800	720	1220	780	680	1200	760	670
		5/8	2070	1190	980	2050	1170	960	1930	1030	810	1900	1000	770	1870	970	740
	3-1/2	3/4	2980	1490	1080	2950	1460	1050	2720	1290	870	2660	1270	840	2560	1240	810
		7/8	3680	1840	1160	3600	1810	1130	3180	1640	950	3100	1610	920	2990	1550	860
		1	4200	2280	1260	4110	2240	1230	3630	2030	1020	3540	1960	980	3410	1890	950
		5/8	1590	840	1050	1570	830	1040	1450	690	940	1430	660	920	1390	640	900
	1-1/2	3/4	2190	920	1400	2160	900	1380	2010	740	1250	1990	720	1230	1940	700	1210
		7/8	2920	1000	1750	2880	970	1700	2690	810	1420	2660	790	1380	2560	740	1290
		1	3600	1080	1890	3530	1050	1840	3110	870	1520	3040	840	1470	2930	810	1420
		5/8	1670	950	1110	1650	940	1100	1510	810	990	1490	770	970	1450	740	940
5-1/4	1-3/4	3/4	2270	1080	1460	2240	1050	1440	2070	870	1300	2040	840	1260	1990	810	1220
		7/8	2980	1160	1750	2950	1130	1700	2740	950	1420	2700	920	1380	2640	860	1290
		1	3820	1260	1890	3770	1230	1840	3520	1020	1520	3480	980	1470	3410	950	1420
		5/8	2070	1190	1320	2050	1170	1310	1930	1030	1210	1900	1000	1150	1870	970	1120
	3-1/2	3/4	2980	1490	1610	2950	1460	1580	2770	1290	1300	2740	1270	1260	2660	1240	1220
		7/8	3900	1840	1750	3840	1810	1700	3480	1640	1420	3410	1610	1380	3320	1550	1290
		1	4730	2280	1890	4660	2240	1840	4240	2030	1520	4170	1960	1470	4050	1890	1420
		5/8	1590	840	1050	1570	830	1040	1450	690	940	1430	660	920	1390	640	900
	1-1/2	3/4	2190	920	1400	2160	900	1380	2010	740	1250	1990	720	1230	1940	700	1210
		7/8	2920	1000	1800	2880	970	1780	2690	810	1490	2660	790	1440	2560	740	1350
5-1/2		1	3600	1080	1980	3530	1050	1930	3110	870	1600	3040	840	1540	2930	810	1490
		5/8	2070	1190	1320	2050	1170	1310	1930	1030	1210	1900	1000	1180	1870	970	1160
	3-1/2	3/4	2980	1490	1690	2950	1460	1650	2770	1290	1360	2740	1270	1320	2660	1240	1280
		7/8	3900	1840	1830	3840	1810	1780	3480	1640	1490	3410	1610	1440	3320	1550	1350
		1	4730	2280	1980	4660	2240	1930	4240	2030	1600	4170	1960	1540	4050	1890	1490
		5/8	1590	840	1050	1570	830	1040	1450	690	940	1430	660	920	1390	640	900
	1-1/2	3/4	2190	920	1400	2160	900	1380	2010	740	1250	1990	720	1230	1940	700	1210
		7/8	2920	1000	1800	2880	970	1780	2690	810	1630	2660	790	1600	2560	740	1550
7-1/2		1	3600	1080	2270	3530	1050	2240	3110	870	2040	3040	840	2010	2930	810	1970
		5/8	2070	1190	1320	2050	1170	1310	1930	1030	1210	1900	1000	1180	1870	970	1160
	3-1/2	3/4	2980	1490	1850	2950	1460	1820	2770	1290	1670	2740	1270	1650	2660	1240	1620
		7/8	3900	1840	2450	3840	1810	2420	3480	1640	2030	3410	1610	1970	3320	1550	1840
		1	4730	2280	2700	4660	2240	2630	4240	2030	2180	4170	1960	2100	4050	1890	2030

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.

Table 12G BOLTS: Reference Lateral Design Values, Z, for Double Shear (three member) Connections[1,2]

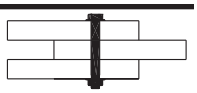
for sawn lumber or SCL main member with 1/4" ASTM A 36 steel side plates



Thickness			G=0.67 Red Oak		G=0.55 Mixed Maple Southern Pine		G=0.50 Douglas Fir-Larch		G=0.49 Douglas Fir-Larch (N)		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.37 Redwood		G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods		G=0.35 Northern Species	
Main Member	Side Member	Bolt Diameter																				
t_m	t_s	D	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1-1/2	1/4	1/2	1410	730	1150	550	1050	470	1030	460	970	420	900	380	880	370	780	310	760	290	730	290
		5/8	1760	810	1440	610	1310	530	1290	520	1210	470	1130	420	1100	410	970	350	950	330	910	320
		3/4	2110	890	1730	660	1580	590	1550	560	1450	520	1350	460	1320	450	1170	370	1140	360	1100	350
		7/8	2460	960	2020	720	1840	630	1800	600	1690	550	1580	500	1540	490	1360	410	1330	390	1280	370
		1	2810	1020	2310	770	2100	680	2060	650	1930	600	1800	540	1760	530	1560	440	1520	420	1460	410
1-3/4	1/4	1/2	1640	850	1350	640	1230	550	1200	530	1130	490	1050	450	1030	430	910	360	890	340	850	330
		5/8	2050	940	1680	710	1530	610	1500	600	1410	550	1310	490	1290	480	1130	400	1110	380	1070	370
		3/4	2460	1040	2020	770	1840	680	1800	660	1690	600	1580	540	1540	530	1360	430	1330	420	1280	410
		7/8	2870	1120	2350	840	2140	740	2110	700	1970	640	1840	580	1800	570	1590	470	1550	460	1490	430
		1	3280	1190	2690	890	2450	790	2410	750	2250	700	2100	630	2060	610	1820	510	1770	490	1710	470
2-1/2	1/4	1/2	1870	1210	1720	910	1650	790	1640	760	1590	700	1500	640	1470	610	1300	510	1270	490	1220	480
		5/8	2740	1340	2400	1020	2190	880	2150	860	2010	780	1880	700	1840	690	1620	580	1580	550	1520	530
		3/4	3520	1480	2880	1110	2630	980	2580	940	2410	860	2250	770	2200	750	1950	620	1900	600	1830	580
		7/8	4100	1600	3360	1200	3060	1050	3010	1010	2820	920	2630	830	2570	810	2270	680	2210	660	2130	610
		1	4690	1700	3840	1280	3500	1130	3440	1080	3220	1000	3000	900	2940	880	2590	730	2530	700	2440	680
3-1/2	1/4	1/2	1870	1240	1720	1100	1650	1030	1640	1010	1590	970	1540	890	1530	860	1450	720	1430	680	1410	670
		5/8	2740	1720	2510	1420	2410	1230	2390	1200	2330	1090	2260	980	2230	960	2110	810	2090	770	2060	740
		3/4	3800	2070	3480	1550	3340	1370	3320	1310	3220	1210	3120	1080	3080	1050	2720	870	2660	840	2560	810
		7/8	5060	2240	4630	1680	4290	1470	4210	1410	3940	1290	3680	1160	3600	1130	3180	950	3100	920	2990	860
		1	6520	2380	5380	1790	4900	1580	4810	1510	4510	1400	4200	1260	4110	1230	3630	1020	3540	980	3410	950
5-1/4	1/4	5/8	2740	1720	2510	1510	2410	1420	2390	1400	2330	1340	2260	1280	2230	1270	2110	1170	2090	1140	2060	1120
		3/4	3800	2290	3480	2000	3340	1890	3320	1850	3220	1780	3120	1610	3090	1580	2920	1300	2890	1260	2840	1220
		7/8	5060	2930	4630	2530	4440	2210	4410	2110	4280	1930	4150	1750	4110	1700	3880	1420	3840	1380	3770	1290
		1	6520	3570	5960	2680	5720	2360	5670	2260	5510	2100	5330	1890	5280	1840	4990	1520	4930	1470	4850	1420
5-1/2	1/4	5/8	2740	1720	2510	1510	2410	1420	2390	1400	2330	1340	2260	1280	2230	1270	2110	1170	2090	1140	2060	1120
		3/4	3800	2290	3480	2000	3340	1890	3320	1850	3220	1780	3120	1690	3090	1650	2920	1360	2890	1320	2840	1280
		7/8	5060	2930	4630	2570	4440	2310	4410	2210	4280	2020	4150	1830	4110	1780	3880	1490	3840	1440	3770	1350
		1	6520	3640	5960	2810	5720	2480	5670	2370	5510	2200	5330	1980	5280	1930	4990	1600	4930	1540	4850	1490
7-1/2	1/4	5/8	2740	1720	2510	1510	2410	1420	2390	1400	2330	1340	2260	1280	2230	1270	2110	1170	2090	1140	2060	1120
		3/4	3800	2290	3480	2000	3340	1890	3320	1850	3220	1780	3120	1690	3090	1670	2920	1530	2890	1500	2840	1480
		7/8	5060	2930	4630	2570	4440	2410	4410	2360	4280	2260	4150	2160	4110	2130	3880	1960	3840	1930	3770	1840
		1	6520	3640	5960	3180	5720	3000	5670	2940	5510	2840	5330	2700	5280	2630	4990	2180	4930	2100	4850	2030
9-1/2	1/4	3/4	3800	2290	3480	2000	3340	1890	3320	1850	3220	1780	3120	1690	3090	1670	2920	1530	2890	1500	2840	1480
		7/8	5060	2930	4630	2570	4440	2410	4410	2360	4280	2260	4150	2160	4110	2130	3880	1960	3840	1930	3770	1870
		1	6520	3640	5960	3180	5720	3000	5670	2940	5510	2840	5330	2700	5280	2660	4990	2440	4930	2400	4850	2350
11-1/2	1/4	7/8	5060	2930	4630	2570	4440	2410	4410	2360	4280	2260	4150	2160	4110	2130	3880	1960	3840	1930	3770	1870
		1	6520	3640	5960	3180	5720	3000	5670	2940	5510	2840	5330	2700	5280	2660	4990	2440	4930	2400	4850	2350
13-1/2	1/4	1	6520	3640	5960	3180	5720	3000	5670	2940	5510	2840	5330	2700	5280	2660	4990	2440	4930	2400	4850	2350

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi and dowel bearing strength, F_e, of 87,000 psi for ASTM A36 steel.

Table 12H BOLTS: Reference Lateral Design Values, Z, for Double Shear (three member) Connections[1,2]



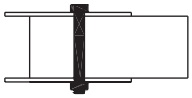
for structural glued laminated timber main member with sawn lumber side members of identical specific gravity

Thickness			G=0.55 Southern Pine			G=0.50 Douglas Fir-Larch			G=0.46 Douglas Fir(S) Hem-Fir(N)			G=0.43 Hem-Fir			G=0.42 Spruce-Pine-Fir			G=0.36 Spruce-Pine-Fir(S) Western Woods		
Main Member	Side Member	Bolt Diameter																			
t_m	t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
		1/2	-	-	-	1230	730	790	1160	680	700	1100	650	640	1080	640	610	980	560	490
		5/8	-	-	-	1760	1040	880	1660	940	780	1590	840	700	1570	830	690	1430	660	550
2-1/2	1-1/2	3/4	-	-	-	2400	1170	980	2280	1040	860	2190	920	770	2160	900	750	1900	720	600
		7/8	-	-	-	3060	1260	1050	2820	1100	920	2630	1000	830	2570	970	810	2210	790	660
		1	-	-	-	3500	1350	1130	3220	1200	1000	3000	1080	900	2940	1050	880	2530	840	700
		1/2	1320	800	940	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		5/8	1870	1130	1220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1-1/2	3/4	2550	1330	1330	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7/8	3360	1440	1440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	4310	1530	1530	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1/2	-	-	-	1230	730	860	1160	680	810	1100	650	760	1080	640	740	980	560	610
		5/8	-	-	-	1760	1040	1090	1660	940	980	1590	840	880	1570	830	860	1430	660	680
3-1/8	1-1/2	3/4	-	-	-	2400	1170	1220	2280	1040	1080	2190	920	960	2160	900	940	1990	720	750
		7/8	-	-	-	3180	1260	1310	3030	1100	1150	2920	1000	1040	2880	970	1010	2660	790	820
		1	-	-	-	4090	1350	1410	3860	1200	1250	3600	1080	1130	3530	1050	1090	3040	840	880
		5/8	1870	1130	1290	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1-1/2	3/4	2550	1330	1690	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7/8	3360	1440	2170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	4310	1530	2550	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		5/8	-	-	-	1760	1040	1190	1660	940	1110	1590	840	1050	1570	830	1040	1430	660	920
5-1/8	1-1/2	3/4	-	-	-	2400	1170	1580	2280	1040	1480	2190	920	1400	2160	900	1380	1990	720	1230
		7/8	-	-	-	3180	1260	2030	3030	1100	1880	2920	1000	1700	2880	970	1660	2660	790	1350
		1	-	-	-	4090	1350	2310	3860	1200	2050	3600	1080	1850	3530	1050	1790	3040	840	1440
		5/8	1870	1130	1290	1760	1040	1190	1660	940	1110	1590	840	1050	1570	830	1040	1430	660	920
6-3/4	1-1/2	3/4	2550	1330	1690	2400	1170	1580	2280	1040	1480	2190	920	1400	2160	900	1380	1990	720	1230
		7/8	3360	1440	2170	3180	1260	2030	3030	1100	1900	2920	1000	1800	2880	970	1780	2660	790	1600
		1	4310	1530	2700	4090	1350	2530	3860	1200	2390	3600	1080	2270	3530	1050	2240	3040	840	1890

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi.

Table 12I BOLTS: Reference Lateral Design Values, Z, for Double Shear (three member) Connections[1,2]

for structural glued laminated timber main member with 1/4" ASTM A 36 steel side plates



Thickness			G=0.55 Southern Pine		G=0.50 Douglas Fir-Larch		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.36 Spruce-Pine-Fir(S) Western Woods	
Main Member	Side Member	Bolt Diameter												
t_m in.	t_s in.	D in.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.
2-1/2	1/4	1/2	-	-	1650	790	1590	700	1500	640	1470	610	1270	490
		5/8	-	-	2190	880	2010	780	1880	700	1840	690	1580	550
		3/4	-	-	2630	980	2410	860	2250	770	2200	750	1900	600
		7/8	-	-	3060	1050	2820	920	2630	830	2570	810	2210	660
		1	-	-	3500	1130	3220	1000	3000	900	2940	880	2530	700
3	1/4	1/2	1720	1100	-	-	-	-	-	-	-	-	-	-
		5/8	2510	1220	-	-	-	-	-	-	-	-	-	-
		3/4	3460	1330	-	-	-	-	-	-	-	-	-	-
		7/8	4040	1440	-	-	-	-	-	-	-	-	-	-
		1	4610	1530	-	-	-	-	-	-	-	-	-	-
3-1/8	1/4	1/2	-	-	1650	980	1590	880	1540	800	1530	770	1430	610
		5/8	-	-	2410	1090	2330	980	2260	880	2230	860	1980	680
		3/4	-	-	3280	1220	3020	1080	2810	960	2750	940	2370	750
		7/8	-	-	3830	1310	3520	1150	3280	1040	3210	1010	2770	820
		1	-	-	4380	1410	4020	1250	3750	1130	3670	1090	3160	880
5	1/4	5/8	2510	1510	-	-	-	-	-	-	-	-	-	-
		3/4	3480	2000	-	-	-	-	-	-	-	-	-	-
		7/8	4630	2410	-	-	-	-	-	-	-	-	-	-
		1	5960	2550	-	-	-	-	-	-	-	-	-	-
5-1/8	1/4	5/8	-	-	2410	1420	2330	1340	2260	1280	2230	1270	2090	1120
		3/4	-	-	3340	1890	3220	1770	3120	1580	3090	1540	2890	1230
		7/8	-	-	4440	2150	4280	1880	4150	1700	4110	1660	3840	1350
		1	-	-	5720	2310	5510	2050	5330	1850	5280	1790	4930	1440
6-3/4	1/4	5/8	2510	1510	2410	1420	2330	1340	2260	1280	2230	1270	2090	1140
		3/4	3480	2000	3340	1890	3220	1780	3120	1690	3090	1670	2890	1500
		7/8	4630	2570	4440	2410	4280	2260	4150	2160	4110	2130	3840	1770
		1	5960	3180	5720	3000	5510	2700	5330	2430	5280	2360	4930	1890
8-1/2	1/4	3/4	3480	2000	-	-	-	-	-	-	-	-	-	-
		7/8	4630	2570	-	-	-	-	-	-	-	-	-	-
		1	5960	3180	-	-	-	-	-	-	-	-	-	-
8-3/4	1/4	3/4	-	-	3340	1890	3220	1780	3120	1690	3090	1670	2890	1500
		7/8	-	-	4440	2410	4280	2260	4150	2160	4110	2130	3840	1930
		1	-	-	5720	3000	5510	2840	5330	2700	5280	2660	4930	2400
10-1/2	1/4	7/8	4630	2570	-	-	-	-	-	-	-	-	-	-
		1	5960	3180	-	-	-	-	-	-	-	-	-	-
10-3/4	1/4	7/8	-	-	4440	2410	4280	2260	4150	2160	4110	2130	3840	1930
		1	-	-	5720	3000	5510	2840	5330	2700	5280	2660	4930	2400
12-1/4	1/4	7/8	-	-	4440	2410	4280	2260	4150	2160	4110	2130	3840	1930
		1	-	-	5720	3000	5510	2840	5330	2700	5280	2660	4930	2400
14-1/4	1/4	1	-	-	5720	3000	5510	2840	5330	2700	5280	2660	4930	2400

1. Tabulated lateral design values, Z, for bolted connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "full-body diameter" bolts (see Appendix Table L1) with bolt bending yield strength, F_{yb}, of 45,000 psi and dowel bearing strength, F_e, of 87,000 psi for ASTM A36 steel.

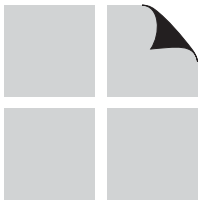


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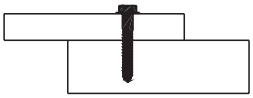
Table 12J LAG SCREWS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3,4]



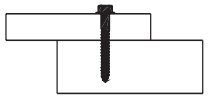
for sawn lumber or SCL with both members of identical specific gravity (tabulated lateral design values are calculated based on an assumed length of lag screw penetration, p, into the main member equal to 8D)

Side Member Thickness	Lag Screw Diameter	G=0.67 Red Oak				G=0.55 Mixed Maple Southern Pine				G=0.50 Douglas Fir-Larch				G=0.49 Douglas Fir-Larch(N)				G=0.46 Douglas Fir(S) Hem-Fir(N)			
t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$
in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1/2	1/4	150	110	110	110	130	90	100	90	120	90	90	80	120	90	90	80	110	80	90	80
	5/16	170	130	130	120	150	110	120	100	150	100	110	100	140	100	110	90	140	100	100	90
	3/8	180	130	130	120	160	110	110	100	150	100	110	90	150	90	110	90	140	90	100	90
5/8	1/4	160	120	130	120	140	100	110	100	130	90	100	90	130	90	100	90	120	90	90	80
	5/16	190	140	140	130	160	110	120	110	150	110	110	100	150	100	110	100	150	100	110	90
	3/8	190	130	140	120	170	110	120	100	160	100	110	100	160	100	110	90	150	100	110	90
3/4	1/4	180	140	140	130	150	110	120	110	140	100	110	100	140	100	110	90	130	90	100	90
	5/16	210	150	160	140	180	120	130	120	170	110	120	100	160	110	120	100	160	100	110	100
	3/8	210	140	160	130	180	120	130	110	170	110	120	100	170	110	120	100	160	100	110	90
1	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	140	150	130	190	130	140	120	190	120	140	120	180	120	130	110
	3/8	230	160	170	160	210	130	150	120	200	120	140	110	190	120	140	110	180	110	130	100
1-1/4	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	130	140	120
	3/8	230	170	170	160	210	150	150	140	200	140	140	130	200	130	140	120	190	120	140	120
1-1/2	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	130
	3/8	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	120
	7/16	360	260	260	240	320	220	230	200	310	200	210	180	310	190	210	180	300	180	200	160
	1/2	460	310	320	280	410	250	290	230	390	220	270	200	390	220	260	200	370	210	250	190
	5/8	700	410	500	370	600	340	420	310	560	310	380	280	550	310	380	270	530	290	360	260
	3/4	950	550	660	490	830	470	560	410	770	440	510	380	760	430	510	370	730	400	480	360
	7/8	1240	720	830	630	1080	560	710	540	1020	490	660	490	1010	470	650	470	970	430	610	430
	1	1550	800	1010	780	1360	600	870	600	1290	530	810	530	1280	500	790	500	1230	470	760	470
1-3/4	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	130
	3/8	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	120
	7/16	360	260	260	240	320	230	230	210	310	210	210	190	310	210	210	190	300	200	200	180
	1/2	460	320	320	290	410	270	290	250	390	240	270	220	390	240	260	220	380	220	250	200
	5/8	740	440	500	400	660	360	440	320	610	330	420	290	600	320	410	290	570	300	390	270
	3/4	1030	580	720	520	890	480	600	430	830	450	550	390	820	440	540	380	780	420	510	360
	7/8	1320	740	890	650	1150	630	750	550	1070	570	700	510	1060	550	680	490	1010	500	650	470
	1	1630	910	1070	790	1420	700	910	670	1340	610	850	610	1320	590	830	590	1270	550	790	550
2-1/2	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	130
	3/8	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	120
	7/16	360	260	260	240	320	230	230	210	310	210	210	190	310	210	210	190	300	200	200	180
	1/2	460	320	320	290	410	290	290	250	390	270	270	240	390	260	260	230	380	250	250	220
	5/8	740	500	500	450	670	430	440	390	640	390	420	350	630	380	410	340	610	360	390	320
	3/4	1110	680	740	610	1010	550	650	490	960	500	610	450	950	490	600	430	920	460	580	410
	7/8	1550	830	1000	740	1370	690	880	600	1280	630	830	550	1260	620	810	530	1190	580	770	500
	1	1940	980	1270	860	1660	830	1080	720	1550	770	990	660	1520	750	970	640	1450	720	920	620
3-1/2	1/4	180	140	140	140	160	120	120	120	150	120	120	110	150	110	110	110	150	110	110	100
	5/16	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	130
	3/8	230	170	170	160	210	150	150	140	200	140	140	130	200	140	140	130	190	140	140	120
	7/16	360	260	260	240	320	230	230	210	310	210	210	190	310	210	210	190	300	200	200	180
	1/2	460	320	320	290	410	290	290	250	390	270	270	240	390	260	260	230	380	250	250	220
	5/8	740	500	500	450	670	440	440	390	640	420	420	360	630	410	410	360	610	390	390	340
	3/4	1110	740	740	650	1010	650	650	560	960	600	610	520	950	580	600	510	920	550	580	490
	7/8	1550	990	1000	860	1400	800	880	710	1340	720	830	640	1320	700	810	620	1280	660	780	570
	1	2020	1140	1270	1010	1830	930	1120	810	1740	850	1060	740	1730	830	1040	720	1670	790	1000	680

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "reduced body diameter" lag screws (see Appendix Table L2) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 8D; screw bending yield strengths, F_{yb},of 70,000 psi for D = 1/4", 60,000 psi for D = 5/16", and 45,000 psi for D ≥3/8".
3. Where the lag screw penetration, p, is less than 8D but not less than 4D, tabulated lateral design values, Z, shall be multiplied by p/8D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. The length of lag screw penetration, p, not including the length of the tapered tip, E (see Appendix Table L2), of the lag screw into the main member shall not be less than 4D. See 12.1.4.6 for minimum length of penetration, p_{min}.

Table 12J (Cont.) LAG SCREWS: Reference Lateral Design Values (Z) for Single Shear (two member) Connections[1,2,3,4]

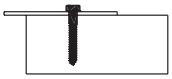
for sawn lumber or SCL with both members of identical specific gravity (tabulated lateral design values are calculated based on an assumed length of lag screw penetration, p, into the main member equal to 8D)



Side Member Thickness	Lag Screw Diameter	G=0.43 Hem-Fir				G=0.42 Spruce-Pine-Fir				G=0.37 Redwood				G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods				G=0.35 Northern Species			
t_s	D	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{s\perp}$	$Z_{m\perp}$	$Z_{\perp}$
in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1/2	1/4	110	80	80	70	110	80	80	70	100	70	70	60	100	70	70	60	90	70	70	60
	5/16	130	90	100	80	130	90	90	80	120	80	90	80	120	80	90	70	120	80	80	70
	3/8	140	80	100	80	130	80	90	80	120	60	90	60	120	60	80	60	120	60	80	60
5/8	1/4	120	80	90	80	110	80	90	70	110	70	80	70	100	70	80	60	100	70	70	60
	5/16	140	90	100	90	140	90	100	90	130	80	90	80	130	80	90	80	120	80	90	70
	3/8	140	90	100	80	140	90	100	80	130	80	90	70	130	70	90	70	120	70	90	70
3/4	1/4	130	90	100	80	120	80	90	80	110	80	80	70	110	70	80	70	110	70	80	70
	5/16	150	100	110	90	150	100	110	90	130	90	100	80	130	90	90	80	130	80	90	80
	3/8	150	100	110	90	150	90	110	90	140	90	100	80	130	80	90	70	130	80	90	70
1	1/4	140	100	110	90	140	100	100	90	130	90	100	80	130	80	90	80	130	80	90	70
	5/16	170	110	130	100	170	110	120	100	150	90	110	90	150	90	110	80	150	90	100	80
	3/8	170	100	120	100	170	100	120	90	150	90	110	80	150	90	110	80	150	90	100	80
1-1/4	1/4	140	110	110	100	140	100	100	100	130	100	100	90	130	90	90	90	130	90	90	80
	5/16	180	120	130	110	180	120	130	110	170	100	120	100	170	100	120	90	160	100	110	90
	3/8	190	120	130	110	180	110	130	100	170	100	120	90	170	100	120	90	170	90	110	80
1-1/2	1/4	140	110	110	100	140	100	100	100	130	100	100	90	130	90	90	90	130	90	90	80
	5/16	180	130	130	120	180	130	130	120	170	110	120	110	170	110	120	100	160	110	110	100
	3/8	190	130	130	120	180	130	130	110	170	110	120	100	170	110	120	100	170	100	110	90
	7/16	290	170	190	150	280	160	190	150	260	140	180	130	260	140	170	130	250	140	170	120
	1/2	350	190	240	180	350	190	240	170	310	170	210	150	310	160	210	150	300	160	200	140
	5/8	500	280	340	240	490	270	330	240	450	250	300	210	440	240	290	210	430	240	280	200
	3/4	700	360	450	330	690	350	440	330	630	290	400	290	620	280	390	280	610	270	380	270
	7/8	930	390	580	390	910	380	570	380	850	320	520	320	840	310	510	310	820	290	490	290
	1	1180	420	720	420	1160	410	710	410	1080	340	640	340	1070	330	630	330	1050	320	620	320
1-3/4	1/4	140	110	110	100	140	100	100	100	130	100	100	90	130	90	90	90	130	90	90	80
	5/16	180	130	130	120	180	130	130	120	170	120	120	110	170	120	120	110	160	110	110	100
	3/8	190	130	130	120	180	130	130	110	170	120	120	100	170	120	120	100	170	110	110	100
	7/16	290	180	190	160	280	180	190	160	270	160	180	140	260	150	170	140	260	140	170	130
	1/2	360	210	240	190	360	200	240	180	340	180	220	160	340	170	220	150	330	170	210	150
	5/8	540	290	360	250	530	280	360	250	480	250	320	220	480	250	310	210	460	240	300	210
	3/4	740	400	480	340	730	390	470	340	670	330	420	300	660	320	420	300	640	310	410	290
	7/8	970	450	610	440	950	440	600	440	880	370	540	370	870	360	530	360	850	330	520	330
	1	1210	490	750	490	1200	480	740	480	1110	400	670	400	1090	380	650	380	1070	370	640	370
2-1/2	1/4	140	110	110	100	140	100	100	100	130	100	100	90	130	90	90	90	130	90	90	80
	5/16	180	130	130	120	180	130	130	120	170	120	120	110	170	120	120	110	160	110	110	100
	3/8	190	130	130	120	180	130	130	110	170	120	120	100	170	120	120	100	170	110	110	100
	7/16	290	190	190	170	280	190	190	170	270	180	180	150	260	170	170	150	260	170	170	150
	1/2	360	240	240	210	360	240	240	210	340	220	220	190	340	210	220	190	330	200	210	180
	5/8	590	330	380	290	580	320	370	290	550	290	340	250	540	280	340	240	530	270	330	240
	3/4	890	430	550	380	880	420	540	370	800	380	500	320	780	370	490	320	760	360	480	310
	7/8	1130	550	730	470	1110	540	710	460	1010	490	640	420	990	480	620	410	970	470	600	390
	1	1380	680	870	580	1360	670	850	570	1240	570	760	510	1220	550	750	500	1190	530	730	490
3-1/2	1/4	140	110	110	100	140	100	100	100	130	100	100	90	130	90	90	90	130	90	90	80
	5/16	180	130	130	120	180	130	130	120	170	120	120	110	170	120	120	110	160	110	110	100
	3/8	190	130	130	120	180	130	130	110	170	120	120	100	170	120	120	100	170	110	110	100
	7/16	290	190	190	170	280	190	190	170	270	180	180	150	260	170	170	150	260	170	170	150
	1/2	360	240	240	210	360	240	240	210	340	220	220	190	340	220	220	190	330	210	210	180
	5/8	590	380	380	320	580	370	370	320	550	340	340	290	540	330	340	280	530	320	330	280
	3/4	890	500	550	440	880	490	540	430	830	430	500	370	820	420	490	370	800	410	480	360
	7/8	1240	610	750	530	1220	600	740	520	1150	530	680	460	1140	520	670	450	1110	500	650	430
	1	1610	740	950	630	1600	720	940	620	1480	650	860	550	1450	630	850	540	1410	620	830	520

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "reduced body diameter" lag screws (see Appendix Table L2) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 8D; screw bending yield strengths, F_{yb},of 70,000 psi for D = 1/4", 60,000 psi for D = 5/16", and 45,000 psi for D ≥3/8".
3. Where the lag screw penetration, p, is less than 8D but not less than 4D, tabulated lateral design values, Z, shall be multiplied by p/8D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. The length of lag screw penetration, p, not including the length of the tapered tip, E (see Appendix Table L2), of the lag screw into the main member shall not be less than 4D. See 12.1.4.6 for minimum length of penetration, p_{min}.

Table 12K LAG SCREWS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3,4]

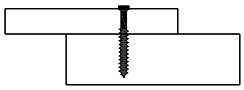


for sawn lumber or SCL with ASTM A653, Grade 33 steel side plate (for t_s<1/4") or ASTM A 36 steel side plate (for t_s=1/4")
(tabulated lateral design values are calculated based on an assumed length of lag screw penetration, p, into the main member equal to 8D)

Side Member Thickness	Lag Screw Diameter	G=0.67 Red Oak		G=0.55 Mixed Maple Southern Pine		G=0.5 Douglas Fir-Larch		G=0.49 Douglas Fir-Larch (N)		G=0.46 Douglas Fir(S) Hem-Fir(N)		G=0.43 Hem-Fir		G=0.42 Spruce-Pine-Fir		G=0.37 Redwood		G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods		G=0.35 Northern Species	
t_s	D	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$
in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.075	1/4	170	130	160	120	150	110	150	110	150	100	140	100	140	100	130	90	130	90	130	90
(14 gage)	5/16	220	160	200	140	190	130	190	130	190	130	180	120	180	120	170	110	170	110	160	100
	3/8	220	160	200	140	200	130	190	130	190	120	180	120	180	120	170	110	170	100	170	100
0.105	1/4	180	140	170	130	160	120	160	120	160	110	150	110	150	110	140	100	140	100	140	90
(12 gage)	5/16	230	170	210	150	200	140	200	140	190	130	190	130	190	120	180	110	170	110	170	110
	3/8	230	160	210	140	200	140	200	130	200	130	190	120	190	120	180	110	180	110	170	110
0.120	1/4	190	150	180	130	170	120	170	120	160	120	160	110	160	110	150	100	150	100	140	100
(11 gage)	5/16	230	170	210	150	210	140	200	140	200	140	190	130	190	130	180	120	180	120	180	110
	3/8	240	170	220	150	210	140	210	140	200	130	200	130	190	120	180	110	180	110	180	110
0.134	1/4	200	150	180	140	180	130	170	130	170	120	160	120	160	110	150	110	150	100	150	100
(10 gage)	5/16	240	180	220	160	210	150	210	140	200	140	200	130	200	130	190	120	180	120	180	120
	3/8	240	170	220	150	220	140	210	140	210	140	200	130	200	130	190	120	190	120	180	110
0.179	1/4	220	170	210	150	200	150	200	140	190	140	190	130	190	130	180	120	170	120	170	120
(7 gage)	5/16	260	190	240	170	230	160	230	160	230	150	220	150	220	150	210	130	200	130	200	130
	3/8	270	190	250	170	240	160	240	160	230	150	220	140	220	140	210	130	210	130	200	130
0.239	1/4	240	180	220	160	210	150	210	150	200	140	190	140	190	130	180	120	180	120	180	120
(3 gage)	5/16	300	220	280	190	270	180	260	180	260	170	250	160	250	160	230	150	230	150	230	140
	3/8	310	220	280	190	270	180	270	180	260	170	250	160	250	160	240	140	230	140	230	140
	7/16	420	290	390	260	380	240	370	240	360	230	350	220	350	220	330	200	330	200	320	190
	1/2	510	340	470	300	460	290	450	280	440	270	430	260	420	260	400	240	400	230	390	230
	5/8	770	490	710	430	680	400	680	400	660	380	640	370	630	360	600	330	590	330	580	320
	3/4	1110	670	1020	590	980	560	970	550	950	530	920	500	910	500	860	450	850	450	840	440
	7/8	1510	880	1390	780	1330	730	1320	710	1280	690	1250	650	1230	650	1170	590	1160	590	1140	570
	1	1940	1100	1780	960	1710	910	1700	890	1650	860	1600	820	1590	810	1500	740	1480	730	1460	710
1/4	1/4	240	180	220	160	210	150	210	150	200	140	200	140	190	130	180	120	180	120	180	120
	5/16	310	220	280	200	270	180	270	180	260	170	250	170	250	160	230	150	230	150	230	140
	3/8	320	220	290	190	280	180	270	180	270	170	260	160	250	160	240	150	240	140	230	140
	7/16	480	320	440	280	420	270	420	260	410	250	390	240	390	230	370	220	360	210	360	210
	1/2	580	390	540	340	520	320	510	320	500	310	480	290	480	290	460	270	450	260	440	260
	5/8	850	530	780	470	750	440	740	440	720	420	700	400	690	400	660	370	650	360	640	350
	3/4	1200	730	1100	640	1060	600	1050	590	1020	570	990	540	980	530	930	490	920	480	900	470
	7/8	1600	930	1470	820	1410	770	1400	750	1360	720	1320	690	1310	680	1240	630	1220	620	1200	600
	1	2040	1150	1870	1000	1800	950	1780	930	1730	900	1680	850	1660	840	1570	770	1550	760	1530	740

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for "reduced body diameter" lag screws (see Appendix Table L2) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 8D; dowel bearing strengths, F_e, of 61,850 psi for ASTM A653, Grade 33 steel and 87,000 psi for ASTM A36 steel and screw bending yield strengths, F_{yb}, of 70,000 psi for D = 1/4", 60,000 psi for D = 5/16", and 45,000 psi for D ≥3/8".
3. Where the lag screw penetration, p, is less than 8D but not less than 4D, tabulated lateral design values, Z, shall be multiplied by p/8D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. The length of lag screw penetration, p, not including the length of the tapered tip, E (see Appendix Table L2), of the lag screw into the main member shall not be less than 4D. See 12.1.4.6 for minimum length of penetration, p_{min}.

Table 12L WOOD SCREWS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

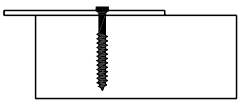


for sawn lumber or SCL with both members of identical specific gravity (tabulated lateral design values are calculated based on an assumed length of wood screw penetration, p, into the main member equal to 10D)

Side Member Thickness	Wood Screw Diameter	Wood Screw Number	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch(N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
t_s	D											
in.	in.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1/2	0.138	6	88	67	59	57	53	49	47	41	40	38
	0.151	7	96	74	65	63	59	54	52	45	44	42
	0.164	8	107	82	73	71	66	61	59	51	50	48
	0.177	9	121	94	83	81	76	70	68	59	58	56
	0.190	10	130	101	90	87	82	75	73	64	63	60
	0.216	12	156	123	110	107	100	93	91	79	78	75
	0.242	14	168	133	120	117	110	102	99	87	86	83
5/8	0.138	6	94	76	66	64	59	53	52	44	43	41
	0.151	7	104	83	72	70	64	58	56	48	47	45
	0.164	8	120	92	80	77	72	65	63	54	53	51
	0.177	9	136	103	91	88	81	74	72	62	61	58
	0.190	10	146	111	97	94	88	80	78	67	65	63
	0.216	12	173	133	117	114	106	97	95	82	80	77
	0.242	14	184	142	126	123	115	106	103	89	87	84
3/4	0.138	6	94	79	72	71	65	58	57	47	46	44
	0.151	7	104	87	80	77	71	64	62	52	50	48
	0.164	8	120	101	88	85	78	71	69	58	56	54
	0.177	9	142	114	99	96	88	80	78	66	64	61
	0.190	10	153	122	107	103	95	86	83	71	69	66
	0.216	12	192	144	126	122	113	103	100	86	84	80
	0.242	14	203	154	135	131	122	111	108	93	91	87
1	0.138	6	94	79	72	71	67	63	61	55	54	51
	0.151	7	104	87	80	78	74	69	68	60	59	56
	0.164	8	120	101	92	90	85	80	78	67	65	62
	0.177	9	142	118	108	106	100	94	90	75	73	70
	0.190	10	153	128	117	114	108	101	97	81	78	75
	0.216	12	193	161	147	143	131	118	114	96	93	89
	0.242	14	213	178	157	152	139	126	122	102	100	95
1-1/4	0.138	6	94	79	72	71	67	63	61	55	54	52
	0.151	7	104	87	80	78	74	69	68	60	59	57
	0.164	8	120	101	92	90	85	80	78	70	68	66
	0.177	9	142	118	108	106	100	94	92	82	80	78
	0.190	10	153	128	117	114	108	101	99	88	87	84
	0.216	12	193	161	147	144	137	128	125	108	105	100
	0.242	14	213	178	163	159	151	141	138	115	111	106
1-1/2	0.138	6	94	79	72	71	67	63	61	55	54	52
	0.151	7	104	87	80	78	74	69	68	60	59	57
	0.164	8	120	101	92	90	85	80	78	70	68	66
	0.177	9	142	118	108	106	100	94	92	82	80	78
	0.190	10	153	128	117	114	108	101	99	88	87	84
	0.216	12	193	161	147	144	137	128	125	111	109	106
	0.242	14	213	178	163	159	151	141	138	123	120	117
1-3/4	0.138	6	94	79	72	71	67	63	61	55	54	52
	0.151	7	104	87	80	78	74	69	68	60	59	57
	0.164	8	120	101	92	90	85	80	78	70	68	66
	0.177	9	142	118	108	106	100	94	92	82	80	78
	0.190	10	153	128	117	114	108	101	99	88	87	84
	0.216	12	193	161	147	144	137	128	125	111	109	106
	0.242	14	213	178	163	159	151	141	138	123	120	117

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for rolled thread wood screws (see Appendix Table L3) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 10D; and screw bending yield strengths, F_{yb}, of 100,000 psi for $0.099" \le D \le 0.142"$, 90,000 psi for $0.142" < D \le 0.177"$, 80,000 psi for $0.177" < D \le 0.236"$, and 70,000 psi for $0.236" < D \le 0.273"$.
3. Where the wood screw penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.

Table 12M WOOD SCREWS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

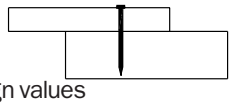


for sawn lumber or SCL with ASTM 653, Grade 33 steel side plate
(tabulated lateral design values are calculated based on an assumed length of wood screw penetration, p, into the main member equal to 10D)

Side Member Thickness t_s	Wood Screw Diameter D	Wood Screw Number	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch(N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
in.	in.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.036	0.138	6	89	76	70	69	66	62	60	54	53	52
(20 gage)	0.151	7	99	84	78	76	72	68	67	60	59	57
	0.164	8	113	97	89	87	83	78	77	69	67	66
0.048	0.138	6	90	77	71	70	67	63	61	55	54	53
(18 gage)	0.151	7	100	85	79	77	74	69	68	61	60	58
	0.164	8	114	98	90	89	84	79	78	70	69	67
0.060	0.138	6	92	79	73	72	68	64	63	57	56	54
(16 gage)	0.151	7	101	87	81	79	75	71	70	63	61	60
	0.164	8	116	100	92	90	86	81	79	71	70	68
	0.177	9	136	116	107	105	100	94	93	83	82	79
	0.190	10	146	125	116	114	108	102	100	90	88	86
0.075	0.138	6	95	82	76	75	71	67	66	59	58	57
(14 gage)	0.151	7	105	90	84	82	78	74	72	65	64	62
	0.164	8	119	103	95	93	89	84	82	74	73	71
	0.177	9	139	119	110	108	103	97	95	86	84	82
	0.190	10	150	128	119	117	111	105	103	92	91	88
	0.216	12	186	159	147	145	138	130	127	114	112	109
	0.242	14	204	175	162	158	151	142	139	125	123	120
0.105	0.138	6	104	90	84	82	79	74	73	66	65	63
(12 gage)	0.151	7	114	99	92	90	86	81	80	72	71	69
	0.164	8	129	111	103	102	97	92	90	81	80	77
	0.177	9	148	128	119	116	111	105	103	93	91	89
	0.190	10	160	138	128	125	120	113	111	100	98	96
	0.216	12	196	168	156	153	146	138	135	122	120	116
	0.242	14	213	183	170	167	159	150	147	132	130	126
0.120	0.138	6	110	95	89	87	83	79	77	70	68	67
(11 gage)	0.151	7	120	104	97	95	91	86	84	76	75	73
	0.164	8	135	117	109	107	102	96	94	85	84	82
	0.177	9	154	133	124	121	116	110	107	97	95	93
	0.190	10	166	144	133	131	125	118	116	104	103	100
	0.216	12	202	174	162	159	152	143	140	126	124	121
	0.242	14	219	189	175	172	164	155	152	137	134	131
0.134	0.138	6	116	100	93	92	88	83	81	73	72	70
(10 gage)	0.151	7	126	110	102	100	96	91	89	80	79	77
	0.164	8	141	122	114	112	107	101	99	89	88	86
	0.177	9	160	139	129	127	121	114	112	101	100	97
	0.190	10	173	149	139	136	130	123	121	109	107	104
	0.216	12	209	180	167	164	157	148	145	131	129	126
	0.242	14	226	195	181	177	169	160	157	141	139	135
0.179	0.138	6	126	107	99	97	92	86	84	76	74	72
(7 gage)	0.151	7	139	118	109	107	102	95	93	84	82	80
	0.164	8	160	136	126	123	117	110	108	96	95	92
	0.177	9	184	160	148	145	138	129	127	113	111	108
	0.190	10	198	172	159	156	149	140	137	122	120	117
	0.216	12	234	203	189	186	178	168	165	149	146	143
	0.242	14	251	217	202	198	190	179	176	159	156	152
0.239	0.138	6	126	107	99	97	92	86	84	76	74	72
(3 gage)	0.151	7	139	118	109	107	102	95	93	84	82	80
	0.164	8	160	136	126	123	117	110	108	96	95	92
	0.177	9	188	160	148	145	138	129	127	113	111	108
	0.190	10	204	173	159	156	149	140	137	122	120	117
	0.216	12	256	218	201	197	187	176	172	154	151	147
	0.242	14	283	241	222	217	207	194	190	170	167	162

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for rolled thread wood screws (see Appendix L) inserted in side grain with screw axis perpendicular to wood fibers; screw penetration, p, into the main member equal to 10D; dowel bearing strength, F_e, of 61,850 psi for ASTM A653, Grade 33 steel and screw bending yield strengths, F_{yb}, of 100,000 psi for $0.099" \le D \le 0.142"$, 90,000 psi for $0.142" < D \le 0.177"$, 80,000 psi for $0.177" < D \le 0.236"$, 70,000 psi for $0.236" < D \le 0.273"$.
3. Where the wood screw penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.

Table 12N COMMON, BOX, or SINKER STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]



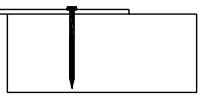
for sawn lumber or SCL with both members of identical specific gravity (tabulated lateral design values are calculated based on an assumed length of nail penetration, p, into the main member equal to 10D)

Side Member Thickness	Nail Diameter	Common Wire Nail	Box Nail	Sinker Nail	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
t_s	D	Pennyweight												
in.	in.				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
3/4	0.099		6d	7d	73	61	55	54	51	48	47	39	38	36
	0.113	6d	8d	8d	94	79	72	71	65	58	57	47	46	44
	0.120			10d	107	89	80	77	71	64	62	52	50	48
	0.128		10d		121	101	87	84	78	70	68	57	56	54
	0.131	8d			127	104	90	87	80	73	70	60	58	56
	0.135		16d	12d	135	108	94	91	84	76	74	63	61	58
	0.148	10d	20d	16d	154	121	105	102	94	85	83	70	69	66
	0.162	16d	40d		183	138	121	117	108	99	96	82	80	77
	0.177			20d	200	153	134	130	121	111	107	92	90	87
	0.192	20d		30d	206	157	138	134	125	114	111	96	93	90
	0.207	30d		40d	216	166	147	143	133	122	119	103	101	97
	0.225	40d			229	178	158	154	144	132	129	112	110	106
	0.244	50d		60d	234	182	162	158	147	136	132	115	113	109
1	0.099		6d	7d	73	61	55	54	51	48	47	42	41	40
	0.113	6d[4]	8d	8d	94	79	72	71	67	63	61	55	54	51
	0.120			10d	107	89	81	80	76	71	69	60	59	56
	0.128		10d		121	101	93	91	86	80	79	66	64	61
	0.131	8d			127	106	97	95	90	84	82	68	66	63
	0.135		16d	12d	135	113	103	101	96	89	86	71	69	66
	0.148	10d	20d	16d	154	128	118	115	109	99	96	80	77	74
	0.162	16d	40d		184	154	141	137	125	113	109	91	89	85
	0.177			20d	213	178	155	150	138	125	121	102	99	95
	0.192	20d		30d	222	183	159	154	142	128	124	105	102	98
	0.207	30d		40d	243	192	167	162	149	135	131	111	109	104
	0.225	40d			268	202	177	171	159	144	140	120	117	112
	0.244	50d		60d	274	207	181	175	162	148	143	123	120	115
1-1/4	0.099		6d[4]	7d[4]	73	61	55	54	51	48	47	42	41	40
	0.113	6d[4]	8d	8d[4]	94	79	72	71	67	63	61	55	54	52
	0.120			10d	107	89	81	80	76	71	69	62	60	59
	0.128		10d		121	101	93	91	86	80	79	70	69	67
	0.131	8d[4]			127	106	97	95	90	84	82	73	72	70
	0.135		16d	12d	135	113	103	101	96	89	88	78	76	74
	0.148	10d	20d	16d	154	128	118	115	109	102	100	89	87	84
	0.162	16d	40d		184	154	141	138	131	122	120	103	100	95
	0.177			20d	213	178	163	159	151	141	136	113	110	105
	0.192	20d		30d	222	185	170	166	157	145	140	116	113	108
	0.207	30d		40d	243	203	186	182	169	152	147	123	119	114
	0.225	40d			268	224	200	193	177	160	155	130	127	121
	0.244	50d		60d	276	230	204	197	181	163	158	133	129	124
1-1/2	0.099			7d[4]	73	61	55	54	51	48	47	42	41	40
	0.113		8d[4]	8d[4]	94	79	72	71	67	63	61	55	54	52
	0.120			10d	107	89	81	80	76	71	69	62	60	59
	0.128		10d		121	101	93	91	86	80	79	70	69	67
	0.131	8d[4]			127	106	97	95	90	84	82	73	72	70
	0.135		16d	12d	135	113	103	101	96	89	88	78	76	74
	0.148	10d	20d	16d	154	128	118	115	109	102	100	89	87	84
	0.162	16d	40d		184	154	141	138	131	122	120	106	104	101
	0.177			20d	213	178	163	159	151	141	138	123	121	117
	0.192	20d		30d	222	185	170	166	157	147	144	128	126	120
	0.207	30d		40d	243	203	186	182	172	161	158	135	131	125
	0.225	40d			268	224	205	201	190	178	172	143	138	132
	0.244	50d		60d	276	230	211	206	196	181	175	146	141	135
1-3/4	0.113		8d[4]		94	79	72	71	67	63	61	55	54	52
	0.120			10d[4]	107	89	81	80	76	71	69	62	60	59
	0.128		10d[4]		121	101	93	91	86	80	79	70	69	67
	0.135		16d	12d	135	113	103	101	96	89	88	78	76	74
	0.148	10d[4]	20d	16d	154	128	118	115	109	102	100	89	87	84
	0.162	16d	40d		184	154	141	138	131	122	120	106	104	101
	0.177			20d	213	178	163	159	151	141	138	123	121	117
	0.192	20d		30d	222	185	170	166	157	147	144	128	126	122
	0.207	30d		40d	243	203	186	182	172	161	158	140	137	133
	0.225	40d			268	224	205	201	190	178	174	155	151	144
	0.244	50d		60d	276	230	211	206	196	183	179	159	154	147

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D; and nail bending yield strengths, F_{yb}, of 100,000 psi for 0.099" ≤ D ≤ 0.142", 90,000 psi for 0.142" < D ≤ 0.177", 80,000 psi for 0.177" < D ≤ 0.236", and 70,000 psi for 0.236" < D ≤ 0.273".
3. Where the nail or spike penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. Nail length is insufficient to provide 10D penetration. Tabulated lateral design values, Z, shall be adjusted per footnote 3.

NAILS

Table 12P COMMON, BOX, or SINKER STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

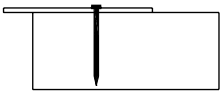


for sawn lumber or SCL with ASTM 653, Grade 33 steel side plate
(tabulated lateral design values are calculated based on an assumed length of nail penetration, p, into the main member equal to 10D)

Side Member Thickness	Nail Diameter	Common Wire Nail	Box Nail	Sinker Nail	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
t_s	D	Pennyweight												
in.	in.				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.036	0.099		6d	7d	69	59	54	53	51	48	47	42	41	40
(20 gage)	0.113	6d	8d	8d	89	76	70	69	66	62	60	54	53	52
	0.120			10d	100	86	79	77	74	69	68	61	60	58
	0.128		10d		114	97	90	88	84	79	77	69	68	66
	0.131	8d			120	102	94	92	88	82	81	72	71	69
	0.135		16d	12d	127	108	100	98	93	87	86	77	75	73
	0.148	10d	20d	16d	145	123	114	111	106	100	98	87	86	83
0.048	0.099		6d	7d	70	60	55	54	52	49	48	43	42	41
(18 gage)	0.113	6d	8d	8d	90	77	71	70	67	63	61	55	54	53
	0.120			10d	101	87	80	78	75	70	69	62	61	59
	0.128		10d		115	98	91	89	85	80	78	70	69	67
	0.131	8d			120	103	95	93	89	83	82	73	72	70
	0.135		16d	12d	128	109	101	99	94	88	87	78	76	74
	0.148	10d	20d	16d	145	124	115	112	107	101	99	88	87	84
	0.162	16d	40d		174	148	137	134	128	120	118	105	104	101
	0.177			20d	201	171	158	155	147	138	136	122	119	116
	0.192	20d		30d	209	178	164	161	153	144	141	126	124	121
	0.207	30d		40d	229	195	179	176	167	157	154	138	136	132
0.060	0.099		6d	7d	72	62	57	56	54	51	50	45	44	43
(16 gage)	0.113	6d	8d	8d	92	79	73	72	68	64	63	57	56	54
	0.120			10d	103	88	82	80	76	72	71	63	62	61
	0.128		10d		117	100	92	91	86	81	80	72	70	68
	0.131	8d			122	104	97	95	90	85	83	75	73	71
	0.135		16d	12d	129	111	102	100	96	90	88	79	78	76
	0.148	10d	20d	16d	147	126	116	114	109	102	100	90	88	86
	0.162	16d	40d		175	150	138	135	129	121	119	107	105	102
	0.177			20d	202	172	159	156	149	140	137	123	121	117
	0.192	20d		30d	210	179	165	162	154	145	142	128	125	122
	0.207	30d		40d	229	195	180	177	168	158	155	139	137	133
	0.225	40d			253	215	199	195	185	174	171	153	150	146
	0.244	50d		60d	260	221	204	200	191	179	176	157	155	150
0.075	0.099		6d	7d	75	65	60	59	56	53	52	47	46	45
(14 gage)	0.113	6d	8d	8d	95	82	76	75	71	67	66	59	58	57
	0.120			10d	106	91	85	83	79	75	73	66	65	63
	0.128		10d		120	103	95	93	89	84	82	74	73	71
	0.131	8d			125	107	99	97	93	88	86	77	76	74
	0.135		16d	12d	132	113	105	103	98	93	91	82	80	78
	0.148	10d	20d	16d	150	129	119	117	111	105	103	92	91	88
	0.162	16d	40d		178	152	141	138	132	124	122	109	107	104
	0.177			20d	204	175	162	158	151	142	139	125	123	120
	0.192	20d		30d	212	182	168	165	157	148	145	130	128	124
	0.207	30d		40d	231	198	183	179	171	161	157	141	139	135
	0.225	40d			254	217	201	197	187	176	173	155	152	148
	0.244	50d		60d	261	223	206	202	193	181	178	159	156	152
0.105	0.099		6d	7d	84	73	68	67	64	60	59	53	53	51
(12 gage)	0.113	6d	8d	8d	104	90	84	82	79	74	73	66	65	63
	0.120			10d	115	100	93	91	87	82	80	73	71	69
	0.128		10d		129	111	103	101	97	91	90	81	79	77
	0.131	8d			134	116	107	105	101	95	93	84	82	80
	0.135		16d	12d	141	122	113	111	106	100	98	88	87	84
	0.148	10d	20d	16d	159	137	127	125	119	113	110	99	98	95
	0.162	16d	40d		187	161	149	146	140	132	129	116	114	111
	0.177			20d	213	183	169	166	159	149	147	132	130	126
	0.192	20d		30d	220	189	175	172	164	155	152	137	134	131
	0.207	30d		40d	238	205	190	186	177	167	164	147	145	141
	0.225	40d			260	223	207	203	193	182	179	161	158	153
	0.244	50d		60d	268	230	212	208	199	187	183	165	162	158

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D; dowel bearing strength, F_e, of 61,850 psi for ASTM A653, Grade 33 steel and nail bending yield strengths, F_{yb}, of 100,000 psi for $0.099" \le D \le 0.142"$, 90,000 psi for $0.142" < D \le 0.177"$, 80,000 psi for $0.177" < D \le 0.236"$, 70,000 psi for $0.236" < D \le 0.273"$.
3. Where the nail or spike penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.

Table 12P (Cont.) **COMMON, BOX, or SINKER STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]**



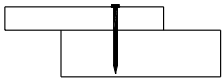
for sawn lumber or SCL with ASTM 653, Grade 33 steel side plate
(tabulated lateral design values are calculated based on an assumed length of nail penetration, p, into the main member equal to 10D)

Side Member Thickness	Nail Diameter	Common Wire Nail	Box Nail	Sinker Nail	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
t_s	D	Pennyweight												
in.	in.				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.120	0.099		6d	7d	90	78	72	71	68	64	63	57	56	53
(11 gage)	0.113	6d	8d	8d	110	95	89	87	83	79	77	70	68	66
	0.120			10d	121	105	97	96	91	86	85	76	75	73
	0.128		10d		134	116	108	106	101	96	94	85	83	81
	0.131	8d			140	121	112	110	105	99	97	88	86	84
	0.135		16d	12d	147	127	118	116	110	104	102	92	91	88
	0.148	10d	20d	16d	165	143	133	130	124	117	115	104	102	99
	0.162	16d	40d		193	166	154	152	145	137	134	121	119	115
	0.177			20d	218	188	174	171	163	154	151	136	134	130
	0.192	20d		30d	226	195	181	177	169	159	156	141	138	135
	0.207	30d		40d	244	210	194	191	182	172	168	151	149	145
	0.225	40d			265	228	211	207	198	186	183	164	161	157
	0.244	50d		60d	272	234	217	213	203	191	187	169	166	161
0.134	0.099		6d	7d	95	82	76	74	71	66	65	58	56	54
(10 gage)	0.113	6d	8d	8d	116	100	93	92	88	83	81	73	72	69
	0.120			10d	127	110	102	100	96	91	89	80	79	76
	0.128		10d		140	122	113	111	106	100	98	89	87	85
	0.131	8d			146	126	117	115	110	104	102	92	90	88
	0.135		16d	12d	153	132	123	121	115	109	107	96	95	92
	0.148	10d	20d	16d	172	148	138	135	129	122	120	108	106	104
	0.162	16d	40d		199	172	160	157	150	142	139	125	123	120
	0.177			20d	224	194	180	176	169	159	156	141	138	135
	0.192	20d		30d	232	200	186	182	174	164	161	145	143	139
	0.207	30d		40d	249	215	199	196	187	176	173	156	153	149
	0.225	40d			270	233	216	212	202	191	187	168	165	161
	0.244	50d		60d	277	239	221	217	207	195	192	173	170	165
0.179	0.099		6d	7d	97	82	76	74	71	66	65	58	56	54
(7 gage)	0.113	6d	8d	8d	126	107	99	97	92	86	84	76	74	70
	0.120			10d	142	121	111	109	104	97	95	85	83	79
	0.128		10d		161	137	126	124	118	111	108	97	94	90
	0.131	8d			168	144	132	130	123	116	114	102	99	94
	0.135		16d	12d	175	152	141	138	131	123	121	108	105	100
	0.148	10d	20d	16d	195	170	158	155	148	140	137	123	121	117
	0.162	16d	40d		224	194	180	177	169	160	157	142	140	136
	0.177			20d	249	215	200	197	188	178	174	157	155	151
	0.192	20d		30d	256	222	206	203	194	183	179	162	159	155
	0.207	30d		40d	272	236	219	215	205	194	190	172	169	164
	0.225	40d			292	252	234	230	220	207	203	184	180	176
	0.244	50d		60d	299	258	240	235	225	212	208	188	185	180
0.239	0.099		6d	7d	97	82	76	74	71	66	65	58	56	54
(3 gage)	0.113	6d	8d	8d	126	107	99	97	92	86	84	76	74	70
	0.120			10d	142	121	111	109	104	97	95	85	83	79
	0.128		10d		161	137	126	124	118	111	108	97	94	90
	0.131	8d			169	144	132	130	123	116	114	102	99	94
	0.135		16d	12d	180	153	141	138	131	123	121	108	105	100
	0.148	10d	20d	16d	205	174	160	157	149	140	137	123	121	117
	0.162	16d	40d		245	209	192	188	179	168	165	147	145	140
	0.177			20d	284	241	222	218	207	195	191	170	167	162
	0.192	20d		30d	295	251	231	227	216	202	198	177	174	169
	0.207	30d		40d	310	270	251	246	236	222	217	194	191	185
	0.225	40d			328	285	265	260	249	235	231	209	205	200
	0.244	50d		60d	336	291	271	266	254	240	236	213	210	204

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D; dowel bearing strength, F_e, of 61,850 psi for ASTM A653, Grade 33 steel and nail bending yield strengths, F_{yb}, of 100,000 psi for 0.099" ≤ D ≤ 0.142", 90,000 psi for 0.142" < D ≤ 0.177", 80,000 psi for 0.177" < D ≤ 0.236", 70,000 psi for 0.236" < D ≤ 0.273".
3. Where the nail or spike penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.

Table 12Q COMMON, BOX, SINKER, or ROOF SHEATHING RING SHANK (RSRS) STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

for sawn lumber or SCL with wood structural panel side members with an effective G=0.50 (tabulated lateral design values are calculated based on an assumed length of nail penetration, p, into the main member equal to 10D)

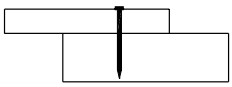


Side Member Thickness t_s	Nail Diameter D	Common Wire Nail	Box Nail	Sinker Nail	RSRS (Dash No.)	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
in.	in.	Pennyweight				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
3/8	0.099		6d	7d		47	45	43	43	42	40	40	38	37	37
	0.113	6d	8d	8d	01	60	56	54	54	52	51	50	47	47	46
	0.120			10d	02	67	62	60	60	58	56	56	52	52	51
	0.128		10d			75	70	68	67	65	63	63	59	58	57
	0.131	8d			03	78	73	71	70	68	66	65	61	61	60
	0.135		16d	12d		83	78	75	74	72	70	69	65	64	63
	0.148	10d	20d	16d		94	88	85	84	82	79	78	73	72	71
7/16	0.099		6d	7d		50	47	45	45	44	43	42	40	40	39
	0.113	6d	8d	8d	01	62	58	56	56	55	53	52	49	49	48
	0.120			10d	02	69	65	63	62	60	59	58	55	54	53
	0.128		10d			77	72	70	69	68	66	65	61	60	59
	0.131	8d			03	80	75	73	72	70	68	67	63	63	62
	0.135		16d	12d		85	80	77	76	74	72	71	67	66	65
	0.148	10d	20d	16d		96	90	87	86	84	81	80	76	75	73
	0.162	16d	40d			114	106	102	101	99	96	95	89	88	86
15/32	0.099		6d	7d		51	48	47	46	45	44	44	41	41	40
	0.113	6d	8d	8d	01	64	60	58	57	56	54	54	51	50	49
	0.120			10d	02	70	66	64	63	62	60	59	56	55	54
	0.128		10d			78	74	71	71	69	67	66	62	62	61
	0.131	8d			03	82	77	74	73	72	70	69	65	64	63
	0.135		16d	12d		86	81	78	77	76	73	72	68	67	66
	0.148	10d	20d	16d		97	91	88	87	85	83	82	77	76	75
	0.162	16d	40d			115	108	104	103	100	97	96	90	89	88
19/32	0.099		6d	7d		58	55	53	53	51	50	50	47	46	46
	0.113	6d	8d	8d	01	70	66	64	64	62	61	60	57	56	55
	0.120			10d	02	77	73	70	70	68	66	66	62	61	60
	0.128		10d			85	80	78	77	75	73	72	68	68	67
	0.131	8d			03	88	83	80	80	78	76	75	71	70	69
	0.135		16d	12d		93	87	84	84	82	79	79	74	73	72
	0.148	10d	20d	16d		104	98	95	94	92	89	88	83	82	81
	0.162	16d	40d			121	114	110	109	107	103	102	96	95	94
	0.177			20d		137	128	124	123	120	116	115	108	107	105
	0.192	20d		30d		142	133	128	127	124	120	119	112	111	109
23/32	0.099		6d	7d		62	58	55	55	53	51	51	47	47	46
	0.113	6d	8d	8d	01	78	74	72	71	69	67	66	62	61	60
	0.120			10d	02	85	80	78	77	76	73	73	69	68	67
	0.128		10d			93	88	85	85	83	80	80	75	75	74
	0.131	8d			03	96	91	88	87	86	83	82	78	77	76
	0.135		16d	12d		101	95	92	91	89	87	86	81	81	79
	0.148	10d	20d	16d		113	106	103	102	100	97	96	91	90	89
	0.162	16d	40d			130	122	118	117	115	111	110	104	103	102
	0.177			20d		145	137	132	131	128	124	123	116	115	113
	0.192	20d		30d		150	141	136	135	132	128	127	120	118	116
1	0.099[5]		6d	7d		62	58	55	55	53	51	51	47	47	46
	0.113[5]	6d[4]	8d	8d	01	81	75	72	71	69	67	66	62	61	60
	0.120[5]			10d	02	92	85	81	81	78	76	75	69	69	67
	0.128		10d			104	97	93	92	89	86	85	79	78	77
	0.131	8d			03	109	101	97	96	93	90	89	83	82	80
	0.135		16d	12d		116	108	103	102	99	96	94	88	87	85
	0.148	10d	20d	16d		132	123	118	116	113	109	108	100	99	97
	0.162	16d	40d			154	146	141	139	135	131	129	120	119	116
	0.177			20d		169	160	155	154	151	146	145	137	136	134
	0.192	20d		30d		174	164	159	158	155	150	149	141	140	138
1-1/8	0.128[5]		10d			104	97	93	92	89	86	85	79	78	77
	0.131[5]	8d			03	109	101	97	96	93	90	89	83	82	80
	0.135[5]		16d	12d		116	108	103	102	99	96	94	88	87	85
	0.148[5]	10d	20d	16d		132	123	118	116	113	109	108	100	99	97
	0.162	16d	40d			158	147	141	139	135	131	129	120	119	116
	0.177			20d		181	170	163	161	157	151	149	139	137	135
	0.192	20d		30d		186	176	170	168	163	157	155	145	143	140
1-1/4	0.148	10d	20d	16d		132	123	118	116	113	109	108	100	99	97
	0.162	16d	40d			158	147	141	139	135	131	129	120	119	116
	0.177			20d		183	170	163	161	157	151	149	139	137	135
	0.192	20d		30d		191	177	170	168	163	157	155	145	143	140

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) and for roof sheathing ring shank nails (see Appendix Table L6) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D and nail bending yield strengths, F_{yb}, of 100,000 psi for $0.099" \le D \le 0.142"$, 90,000 psi for $0.142" < D \le 0.177"$, 80,000 psi for $0.177" < D \le 0.236"$, and 70,000 psi for $0.236" < D \le 0.273"$.
3. Where the nail or spike penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. Nail length is insufficient to provide 10D penetration. Tabulated lateral design values, Z, shall be adjusted per footnote 3.
5. Tabulated lateral design values, Z, shall be permitted to apply for greater side member thickness when adjusted per footnote 3.

Table 12R COMMON, BOX, SINKER, or ROOF SHEATHING RING SHANK (RSRS) STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

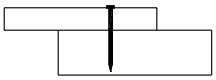
with wood structural panel side members with an effective G=0.42
(tabulated lateral design values are calculated based on an assumed nail penetration, p, into the main member equal to 10D)



Side Member Thickness t_s	Nail Diameter D	Common Wire Nail	Box Nail	Sinker Nail	RSRS (Dash No.)	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods	G=0.35 Northern Species
in.	in.	Pennyweight				lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
3/8	0.099		6d	7d		41	39	37	37	36	35	35	33	33	32
	0.113	6d	8d	8d	01	52	49	48	47	46	45	45	42	42	41
	0.120			10d	02	58	55	53	53	52	50	50	47	47	46
	0.128		10d			66	62	60	60	59	57	56	53	53	52
	0.131	8d			03	69	65	63	63	61	59	59	56	55	54
	0.135		16d	12d		73	69	67	66	65	63	62	59	58	57
	0.148	10d	20d	16d		84	79	76	76	74	72	71	67	66	65
7/16	0.099		6d	7d		42	40	39	38	38	37	36	35	34	34
	0.113	6d	8d	8d	01	53	50	49	48	48	46	46	43	43	42
	0.120			10d	02	59	56	54	54	53	51	51	48	48	47
	0.128		10d			67	63	61	61	60	58	57	54	54	53
	0.131	8d			03	70	66	64	64	62	60	60	57	56	55
	0.135		16d	12d		74	70	68	67	66	64	63	60	59	58
	0.148	10d	20d	16d		84	80	77	76	75	73	72	68	67	66
	0.162	16d	40d			100	95	92	91	89	86	85	81	80	78
15/32	0.099		6d	7d		43	41	40	39	39	38	37	35	35	35
	0.113	6d	8d	8d	01	54	51	50	49	48	47	47	44	44	43
	0.120			10d	02	60	57	55	55	54	52	52	49	49	48
	0.128		10d			68	64	62	62	60	59	58	55	55	54
	0.131	8d			03	70	67	65	64	63	61	61	57	57	56
	0.135		16d	12d		75	71	68	68	66	65	64	61	60	59
	0.148	10d	20d	16d		85	80	78	77	75	73	72	69	68	67
	0.162	16d	40d			101	95	92	91	89	87	86	81	80	79
19/32	0.099		6d	7d		47	45	44	43	43	41	41	39	39	38
	0.113	6d	8d	8d	01	58	55	54	53	52	51	50	48	48	47
	0.120			10d	02	64	61	59	59	58	56	56	53	52	52
	0.128		10d			71	68	66	65	64	62	62	59	58	57
	0.131	8d			03	74	70	68	68	67	65	64	61	61	60
	0.135		16d	12d		78	74	72	71	70	68	68	64	64	63
	0.148	10d	20d	16d		88	84	81	81	79	77	76	72	72	71
	0.162	16d	40d			103	98	95	94	93	90	89	85	84	83
	0.177			20d		118	112	108	108	105	102	101	96	95	94
	0.192	20d		30d		123	116	112	112	109	106	105	100	99	97
23/32	0.099		6d	7d		52	50	48	48	47	46	46	44	43	43
	0.113	6d	8d	8d	01	63	60	58	58	57	56	55	53	52	52
	0.120			10d	02	69	66	64	64	62	61	60	58	57	56
	0.128		10d			76	73	71	70	69	67	67	63	63	62
	0.131	8d			03	79	75	73	73	71	70	69	66	65	64
	0.135		16d	12d		83	79	77	76	75	73	72	69	68	67
	0.148	10d	20d	16d		93	89	86	86	84	82	81	77	77	76
	0.162	16d	40d			108	103	100	99	98	95	94	90	89	87
	0.177			20d		122	116	113	112	110	107	106	101	100	98
	0.192	20d		30d		127	120	117	116	114	111	110	104	103	102
1	0.099[5]		6d	7d		56	53	51	50	49	48	47	44	44	43
	0.113[5]	6d[4]	8d	8d	01	73	68	66	66	64	62	61	58	57	56
	0.120[5]			10d	02	82	77	75	74	72	70	69	65	64	63
	0.128		10d			91	87	85	84	82	80	79	74	73	72
	0.131	8d			03	93	89	87	87	85	83	82	77	77	75
	0.135		16d	12d		97	93	91	90	89	87	86	82	81	80
	0.148	10d	20d	16d		109	104	101	101	99	97	96	91	91	90
	0.162	16d	40d			124	118	115	115	113	110	109	104	103	102
	0.177			20d		137	131	128	127	125	122	121	115	114	112
	0.192	20d		30d		141	135	131	131	128	125	124	118	117	116
1-1/8	0.128[5]		10d			93	88	85	84	82	80	79	74	73	72
	0.131[5]	8d			03	98	92	89	88	86	83	82	77	77	75
	0.135[5]		16d	12d		104	98	94	94	91	88	88	82	81	80
	0.148[5]	10d	20d	16d		117	111	108	107	104	101	100	94	93	91
	0.162	16d	40d			132	127	123	123	120	118	117	111	110	109
	0.177			20d		146	139	136	135	132	129	128	122	121	120
	0.192	20d		30d		150	143	139	138	136	133	132	126	125	123
1-1/4	0.148	10d	20d	16d		118	111	108	107	104	101	100	94	93	91
	0.162	16d	40d			141	134	129	128	125	121	120	112	111	109
	0.177			20d		155	148	144	143	141	138	136	130	129	126
	0.192	20d		30d		159	152	148	147	144	141	140	134	133	131

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) and for roof sheathing ring shank nails (see Appendix Table L6) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D and nail bending yield strengths, F_{yb}, of 100,000 psi for $0.099" \le D \le 0.142"$, 90,000 psi for $0.142" < D \le 0.177"$, 80,000 psi for $0.177" < D \le 0.236"$, and 70,000 psi for $0.236" < D \le 0.273"$.
3. Where the nail or spike penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. Nail length is insufficient to provide 10D penetration. Tabulated lateral design values, Z, shall be adjusted per footnote 3.
5. Tabulated lateral design values, Z, shall be permitted to apply for greater side member thickness when adjusted per footnote 3.

Table 12S POST FRAME RING SHANK NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

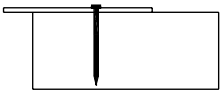


for sawn lumber or SCL with both members of identical specific gravity (tabulated lateral design values are calculated based on an assumed length of nail penetration, p, into the main member equal to 10D)

Side Member Thickness	Nail Diameter	Nail Length	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods	G=0.35 Northern Species
t_s	D	L										
in.	in.	in.	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
1/2	0.135	3, 3.5	115	89	79	77	72	66	65	56	55	53
	0.148	3 - 4.5	129	101	90	87	82	75	73	64	63	61
	0.177	3 - 8	167	133	119	116	109	102	99	87	86	83
	0.200	3.5 - 8	179	143	129	126	119	110	108	95	93	91
	0.207	4 - 8	185	148	134	131	123	115	112	99	97	94
3/4	0.135	3, 3.5	135	108	94	91	84	76	74	63	61	58
	0.148	3 - 4.5	154	121	105	102	94	85	83	70	69	66
	0.177	3 - 8	200	153	134	130	121	111	107	92	90	87
	0.200	3.5 - 8	212	162	143	139	129	118	115	100	97	94
	0.207	4 - 8	216	166	147	143	133	122	119	103	101	97
1	0.135	3, 3.5	135	113	103	101	96	89	86	71	69	66
	0.148	3 - 4.5	154	128	118	115	109	99	96	80	77	74
	0.177	3 - 8	213	178	155	150	138	125	121	102	99	95
	0.200	3.5 - 8	233	188	164	158	146	132	128	108	105	101
	0.207	4 - 8	243	192	167	162	149	135	131	111	109	104
1 1/4	0.135	3, 3.5	135	113	103	101	96	89	88	78	76	74
	0.148	3 - 4.5	154	128	118	115	109	102	100	89	87	84
	0.177	3 - 8	213	178	163	159	151	141	136	113	110	105
	0.200	3.5 - 8	233	195	178	174	165	149	144	120	116	111
	0.207	4 - 8	243	203	186	182	169	152	147	123	119	114
1 1/2	0.135	3, 3.5	135	113	103	101	96	89	88	78	76	74
	0.148	3 - 4.5	154	128	118	115	109	102	100	89	87	84
	0.177	3 - 8	213	178	163	159	151	141	138	123	121	117
	0.200	3.5 - 8	233	195	178	174	165	155	151	133	129	123
	0.207	4 - 8	243	203	186	182	172	161	158	135	131	125
1 3/4	0.135	3, 3.5	135	113	103	101	96	89	88	78	76	74
	0.148	3 - 4.5	154	128	118	115	109	102	100	89	87	84
	0.177	3[4], 3.5[4],4 - 8	213	178	163	159	151	141	138	123	121	117
	0.200	3.5[4], 4 - 8	233	195	178	174	165	155	151	135	132	128
	0.207	4 - 8	243	203	186	182	172	161	158	140	137	133
2 1/2	0.135	3.5[4]	135	113	103	101	96	89	88	78	76	74
	0.148	3.5[4], 4, 4.5	154	128	118	115	109	102	100	89	87	84
	0.177	4[4], 4.5, 5, 6, 8	213	178	163	159	151	141	138	123	121	117
	0.200	4[4], 4.5, 5, 6, 8	233	195	178	174	165	155	151	135	132	128
	0.207	4[4], 4.5[4], 5, 6, 8	243	203	186	182	172	161	158	140	137	133
3 1/2	0.148	4.5[4]	154	128	118	115	109	102	100	89	87	84
	0.177	5[4], 6, 8	213	178	163	159	151	141	138	123	121	117
	0.200	5[4], 6, 8	233	195	178	174	165	155	151	135	132	128
	0.207	5[4], 6, 8	243	203	186	182	172	161	158	140	137	133

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for post frame ring shank nails (see Appendix Table L5) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D; and nail bending yield strengths, F_{yb}, of 100,000 psi for 0.120"< D ≤0.142", 90,000 psi for 0.142"< D ≤0.192", and 80,000 psi for 0.192"< D ≤0.207".
3. Where the post-frame ring shank nail penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.
4. Nail length is insufficient to provide 10D penetration. Tabulated lateral design values, Z, shall be adjusted per footnote 3.

Table 12T POST FRAME RING SHANK NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]



for sawn lumber or SCL with ASTM A653, Grade 33 steel side plates
(tabulated lateral design values are calculated based on an assumed nail penetration, p, into the main member equal to 10D)

Side Member Thickness t_s	Nail Diameter D	Nail Length L	G=0.67 Red Oak	G=0.55 Mixed Maple Southern Pine	G=0.5 Douglas Fir-Larch	G=0.49 Douglas Fir-Larch (N)	G=0.46 Douglas Fir(S) Hem-Fir(N)	G=0.43 Hem-Fir	G=0.42 Spruce-Pine-Fir	G=0.37 Redwood	G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods	G=0.35 Northern Species
in.	in.	in.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0.036	0.135	3, 3.5	127	108	100	98	93	87	86	77	75	73
(20 gage)	0.148	3 - 4.5	145	123	114	111	106	100	98	87	86	83
	0.177	3 - 8	174	171	157	154	147	138	135	121	119	115
	0.200	3.5 - 8	178	178	172	168	160	150	147	132	129	126
	0.207	4 - 8	179	179	179	175	167	157	154	137	135	131
0.048	0.135	3, 3.5	128	109	101	99	94	88	87	78	76	74
(18 gage)	0.148	3 - 4.5	145	124	115	112	107	101	99	88	87	84
	0.177	3 - 8	201	171	158	155	147	138	136	122	119	116
	0.200	3.5 - 8	219	187	172	169	161	151	148	133	130	126
	0.207	4 - 8	229	195	179	176	167	157	154	138	136	132
0.060	0.135	3, 3.5	129	111	102	100	96	90	88	79	78	76
(16 gage)	0.148	3 - 4.5	147	126	116	114	109	102	100	90	88	86
	0.177	3 - 8	202	172	159	156	149	140	137	123	121	117
	0.200	3.5 - 8	220	188	173	170	162	152	149	134	131	128
	0.207	4 - 8	229	195	180	177	168	158	155	139	137	133
0.075	0.135	3, 3.5	132	113	105	103	98	93	91	82	80	78
(14 gage)	0.148	3 - 4.5	150	129	119	117	111	105	103	92	91	88
	0.177	3 - 8	204	175	162	158	151	142	139	125	123	120
	0.200	3.5 - 8	222	190	176	172	164	154	151	136	134	130
	0.207	4 - 8	231	198	183	179	171	161	157	141	139	135
0.105	0.135	3, 3.5	141	122	113	111	106	100	98	88	87	84
(12 gage)	0.148	3 - 4.5	159	137	127	125	119	113	110	99	98	95
	0.177	3 - 8	213	183	169	166	159	149	147	132	130	126
	0.200	3.5 - 8	230	198	183	179	171	161	158	142	140	136
	0.207	4 - 8	238	205	190	186	177	167	164	147	145	141
0.120	0.135	3, 3.5	147	127	118	116	110	104	102	92	91	88
(11 gage)	0.148	3 - 4.5	165	143	133	130	124	117	115	104	102	99
	0.177	3 - 8	218	188	174	171	163	154	151	136	134	130
	0.200	3.5 - 8	235	203	188	184	176	166	163	146	144	140
	0.207	4 - 8	244	210	194	191	182	172	168	151	149	145
0.134	0.135	3, 3.5	153	132	123	121	115	109	107	96	95	92
(10 gage)	0.148	3 - 4.5	172	148	138	135	129	122	120	108	106	104
	0.177	3 - 8	224	194	180	176	169	159	156	141	138	135
	0.200	3.5 - 8	241	208	193	189	181	171	167	151	148	144
	0.207	4 - 8	249	215	199	196	187	176	173	156	153	149
0.179	0.135	3, 3.5	175	152	141	138	131	123	121	108	105	100
(7 gage)	0.148	3 - 4.5	195	170	158	155	148	140	137	123	121	117
	0.177	3 - 8	249	215	200	197	188	178	174	157	155	151
	0.200	3.5 - 8	265	229	213	209	200	189	185	167	164	160
	0.207	4 - 8	272	236	219	215	205	194	190	172	169	164
0.239	0.135	3, 3.5	180	153	141	138	131	123	121	108	105	100
(3 gage)	0.148	3 - 4.5	205	174	160	157	149	140	137	123	121	117
	0.177	3 - 8	284	241	222	218	207	195	191	170	167	162
	0.200	3.5 - 8	303	264	243	238	226	213	208	186	183	178
	0.207	4 - 8	310	270	251	246	236	222	217	194	191	185

1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for post frame ring shank nails (see Appendix Table L5) inserted in side grain with nail axis perpendicular to wood fibers; nail penetration, p, into the main member equal to 10D; and nail bending yield strengths, F_{yb}, of 100,000 psi for 0.120"< D ≤0.142" 90,000 psi for 0.142"< D ≤0.192", and 80,000 psi for 0.192"< D ≤0.207".
3. Where the post-frame ring shank nail penetration, p, is less than 10D but not less than 6D, tabulated lateral design values, Z, shall be multiplied by p/10D or lateral design values shall be calculated using the provisions of 12.3 for the reduced penetration.