



Technical Advisory

Revisions to Nail Withdrawal Values In the 2018 National Design Specification (NDS®)

Preface: The National Design Specification® for Wood Construction (NDS®) is published by the American Wood Council. This specification is developed from data derived from laboratory testing and experience regarding matters of wood design and construction of wood structures for the purpose of a national standard of practice.

Background: The NDS is reviewed and published approximately every three to five years for reference in the International Residential Code (IRC) and International Building Code (IBC).

During the 2018 review cycle changes were made in the NDS with respect to the withdrawal (pullout) values of nails in wood and wood products. This advisory will present the changes that were written and approved for the 2018 NDS.

Past Specifications: *Prior to the 2012* edition, the NDS tabulated withdrawal design values for Plain Shank Nails and Spikes were derived from testing that was performed over many years. In addition to the plain shank nails, withdrawal values for a limited number of threaded nails were tabulated. The threaded nails were tabulated with an approximate increase of 10% in withdrawal values versus a plain shank nail of the same nominal diameter.

In addition to the tabulated values, the following equation is applicable for withdrawal values

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

Where:

W= nail or spike withdrawal design values per inch of penetration in main member (lbs)

G= specific gravity of main member based on oven-dry weight and volume, where $0.31 \leq G \leq 0.73$

D= shank diameter of the nail or spike, in. where $0.099 \leq D \leq 0.375$

In the 2012 edition of the NDS an addition was made for Post Frame Ring Shank (PFRS) nails which had been added to the ASTM F1667 Standard Specification for Nails, Spikes and Staples in 2005.

In addition to tabulated values for various wood specific gravities the following equation is applicable for calculating withdrawal values

$$W = 1800 G^2 D$$

Table A lists the tabulated values for Post Frame Ring Shank nails. Table B lists the tabulated values for plain and threaded shank nails.

Specific Gravity G	Tabulated withdrawal Values in pounds per inch of ring shank penetration				
	Post Frame Ring Shank Nails by Diameter				
	0.135 in.	0.148 in.	0.177 in.	0.200 in.	0.207 in.
0.73	129	142	170	192	199
0.71	122	134	161	181	188
0.68	112	123	147	166	172
0.67	109	120	143	162	167
0.58	82	90	107	121	125
0.55	74	81	96	109	113
0.51	63	69	83	94	97
0.50	61	67	80	90	93
0.49	58	64	76	86	89
0.47	54	59	70	80	82
0.46	51	56	67	76	79
0.44	47	52	62	70	72
0.43	45	49	59	67	69
0.42	43	47	56	64	66
0.41	41	45	54	61	63
0.40	39	43	51	58	60
0.39	37	41	48	55	57
0.38	35	38	46	52	54
0.37	33	36	44	49	51
0.36	31	35	41	47	48
0.35	30	33	39	44	46
0.31	23	26	31	35	36

TABLE A



Tabulated Withdrawal Values from (2015 and earlier editions of the NDS for smooth and threaded shank nails)

Specific Gravity G	Tabulated Withdrawal Values in pounds of nail shank penetration																			
	Plain Shank Nail and Spike by Diameter															Threaded Nail by Diameter				
	0.099	0.113	0.128	0.131	0.135	0.148	0.162	0.192	0.207	0.225	0.244	0.263	0.283	0.312	0.375	0.120	0.135	0.148	0.177	0.207
0.73	62	71	80	82	85	93	102	119	130	141	153	165	178	196	236	82	93	102	121	141
0.71	58	66	75	77	79	87	95	111	121	132	143	154	166	183	220	77	87	95	113	132
0.68	52	59	67	69	71	78	85	100	109	118	128	138	149	164	197	69	78	85	101	118
0.67	50	57	65	66	68	75	82	96	105	114	124	133	144	158	190	66	75	82	97	114
0.58	35	40	45	46	48	52	57	67	73	80	86	93	100	110	133	46	52	57	68	80
0.55	31	35	40	41	42	46	50	59	64	70	76	81	88	97	116	41	46	50	59	70
0.51	25	29	33	34	35	38	42	49	53	58	63	67	73	80	96	34	38	42	49	58
0.50	24	28	31	32	33	36	40	46	50	55	60	64	69	76	91	32	36	40	47	55
0.49	23	26	30	30	31	34	38	44	48	52	57	61	66	72	87	30	34	38	45	52
0.47	21	24	27	27	28	31	34	40	43	47	51	55	59	65	78	27	31	34	40	47
0.46	20	22	25	26	27	29	32	38	41	45	48	52	56	62	74	26	29	32	38	45
0.44	18	20	23	23	24	26	29	34	37	40	43	47	50	55	66	23	26	29	34	40
0.43	17	19	21	22	23	25	27	32	35	38	41	44	47	52	63	22	25	27	32	38
0.42	16	18	20	21	21	23	26	30	33	35	38	41	45	49	59	21	23	26	30	35
0.41	15	17	19	19	20	22	24	28	31	33	36	39	42	46	56	19	22	24	29	33
0.40	14	16	18	18	19	21	23	27	29	31	34	37	40	44	52	18	21	23	27	31
0.39	13	15	17	17	18	19	21	25	27	29	32	34	37	41	49	17	19	21	25	29
0.38	12	14	16	16	17	18	20	23	25	28	30	32	35	38	46	16	18	20	24	28
0.37	11	13	15	15	16	17	19	22	24	26	28	30	33	36	43	15	17	19	22	26
0.36	11	12	14	14	14	16	17	20	22	24	26	28	30	33	40	14	16	17	21	24
0.35	10	11	13	13	14	15	16	19	21	23	24	26	28	31	38	13	15	16	19	23
0.31	7	8	9	10	10	11	12	14	15	17	18	19	21	23	28	10	11	12	14	17

TABLE B



In the 2018 edition there were 5 areas of change with regards to nail withdrawal.

- Terminology
- Added design values for Roof Sheathing Ring Shank nails which were added to ASTM F1667 in 2015.
- A clarification to the Post Frame Ring Shank nail withdrawal values.
- A clarification in the design values for carbon steel nails
- Addition of design values for stainless steel nails

Terminology:

- In the nail industry there are essentially two styles of nail shanks: smooth and deformed (not including cut nails). Most nails are made from wire that is drawn, cut and formed into nails. During the process of manufacturing, these nails can be made with either smooth shanks or deformed shanks. Deformed shanks would be ring shank, screw shank, barbed shank or a proprietary design unique to a manufacturer.

In the past, the NDS used the term threaded shank. Because certain types of deformation are not threaded, this term was changed to deformed shanks for general terminology and to ring shank when applicable.

- Plain shank is now referenced as smooth shank to be in line with ASTM F1667 and industry practices.
- Past references to material of construction of a nail had been 'steel'. Because of the need for separately tabulated stainless steel nail withdrawal values, the specification now references 'carbon steel' and 'stainless steel' when referring to steel nails.

Roof Sheathing Ring Shank Nails

In 2015 a new classification of nails was added to ASTM F1667. This new classification is referred to as Roof Sheathing Ring Shank nails (RSRS). Unlike generic ring shank nails, there are minimum requirements on the RSRS nails with regards to:

- nominal nail diameter
- minimum overall length of the nails
- minimum head diameters
- ring growth (the difference of the ring crest diameter – the measured diameter of the undeformed section of the shank)
- ring pitch (distance between the rings on the shank)
- minimum length of the deformation on the shank (thread length)
- materials (carbon steel or stainless steel)
- coatings (galvanized carbon steel)

When the standards for the RSRS nails were established, certain aspects of the designs were taken from the PFRS Nail.

- ring pitch of 0.077 to 0.050 inches or 13 to 20 rings / inch
- a minimum ring growth over the measured undeformed diameter of 0.005 inches
- materials and coatings

Key provisions regarding RSRS nails:

- Withdrawal values are based on the length of ring shank penetration into the wood not the overall length of the nail penetration.
- Bright carbon steel and stainless steel RSRS nails are permitted to have a 25% increase in withdrawal value over galvanized carbon steel RSRS nails. [See Table C for values related to galvanized and non-galvanized nails].

The withdrawal equation is the same as the equation for PFRS nails

$$W= 1800 G^2 D$$

This equation calculates the withdrawal values associated with the galvanized nails in the NDS tabulated tables not the bright or stainless steel nails.

Post Frame Ring Shank Nail

Effective with the 2018 NDS, a clarification on withdrawal values for PFRS nails has been included. Withdrawal values for bright carbon steel or stainless steel PFRS nails are permitted to be increased by 25% over values for galvanized PFRS nails. This is a new provision over prior editions of the NDS

[Note: The withdrawal equation $W= 1800 G^2 D$ provides the withdrawal values associated with the galvanized nails in the NDS tabulated tables and not the bright or stainless steel nails]

[See Table C for values related to galvanized and non-galvanized nails.]

Carbon Steel Nail Withdrawal

In the 2018 NDS withdrawal values will **only** be tabulated for smooth shank nails [bright or galvanized] and *PFRS and RSRS nails as defined in ASTM F1667*. There is no separate withdrawal design value table for generic threaded, deformed or ring shank nails.

The tabulated withdrawal design values for smooth shank carbon steel nails are permitted to be used for deformed shank carbon steel nails of equivalent diameter. The NDS also added three new diameters (0.092, 0.120 and 0.177) to the tabulated table of values. (See TABLE D)

Additionally, no differentiation is made for withdrawal values of smooth shank carbon steel galvanized nails.

The equation for withdrawal of smooth shank carbon steel nails will continue to be

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

Stainless Steel Nail Withdrawal

2018 NDS tabulated withdrawal values and withdrawal equation for smooth shank stainless steel nails are added. In most nail sizes across the spectrum of wood specific gravities, the smooth shank stainless steel tabulated withdrawal values are **lower than those of carbon steel**. In some cases up to 50%.

As with smooth shank carbon steel nails, the tabulated withdrawal design values for smooth shank stainless steel nails are permitted to be used for deformed shank stainless steel nails of equivalent diameter. (See Table E)

The equation for withdrawal of stainless steel nails is

$$W= 465 G^{3/2} D$$

Comparison

Table F provides a comparison of withdrawal values for bright RSRS nails, galvanized RSRS nails, smooth shank carbon steel nails (in the same diameters defined for the RSRS in ASTM F1667) and smooth shank carbon steel nails.

Similar reductions are seen between other diameters of smooth shank carbon steel and stainless steel nails.

Tabulated Withdrawal Values from (2018 edition of the NDS for Post Frame and Roof Sheathing Ring Shank Nails)

Specific Gravity G	Tabulated withdrawal Values in pounds per inch of penetration of Ring Shank															
	Post Frame Ring Shank Nails Bright by Diameter					Roof Sheathing Ring Shank Nails by Diameter										
	Galvanized Carbon Steel					Bright Carbon Steel or Stainless Steel					Galvanized Carbon Steel			Bright Carbon Steel or Stainless		
	0.135	0.148	0.177	0.200	0.207	0.135	0.148	0.177	0.200	0.207	0.113	0.120	0.131	0.113	0.120	0.131
0.73	129	142	170	192	199	162	177	212	240	248	108	115	126	135	144	157
0.71	122	134	161	181	188	153	168	201	227	235	103	109	119	128	136	149
0.68	112	123	147	166	172	140	154	184	208	215	94	100	109	118	125	136
0.67	109	120	143	162	167	136	149	179	202	209	91	97	106	114	121	132
0.58	82	90	107	121	125	102	112	134	151	157	68	73	79	86	91	99
0.55	74	81	96	109	113	92	101	120	136	141	62	65	71	77	82	89
0.51	63	69	83	94	97	79	87	104	117	121	53	56	61	66	70	77
0.50	61	67	80	90	93	76	83	100	113	116	51	54	59	64	68	74
0.49	58	64	76	86	89	73	80	96	108	112	49	52	57	61	65	71
0.47	54	59	70	80	82	67	74	88	99	103	45	48	52	56	60	65
0.46	51	56	67	76	79	64	70	84	95	99	43	46	50	54	57	62
0.44	47	52	62	70	72	59	64	77	87	90	39	42	46	49	52	57
0.43	45	49	59	67	69	56	62	74	83	86	38	40	44	47	50	54
0.42	43	47	56	64	66	54	59	70	79	82	36	38	42	45	48	52
0.41	41	45	54	61	63	51	56	67	76	78	34	36	40	43	45	50
0.40	39	43	51	58	60	49	53	64	72	75	33	35	38	41	43	47
0.39	37	41	48	55	57	46	51	61	68	71	31	33	36	39	41	45
0.38	35	38	46	52	54	44	48	58	65	67	29	31	34	37	39	43
0.37	33	36	44	49	51	42	46	55	62	64	28	30	32	35	37	40
0.36	31	35	41	47	48	39	43	52	58	60	26	28	31	33	35	38
0.35	30	33	39	44	46	37	41	49	55	57	25	26	29	31	33	36
0.31	23	26	31	35	36	29	32	38	43	45	20	21	23	24	26	28

TABLE C



Tabulated Withdrawal Values from 2018 edition of the NDS for smooth shank carbon steel nails

Specific Gravity G	Tabulated Withdrawal Values (lb/in) of nail shank penetration																	
	Smooth Shank Bright or Galvanized Carbon Steel Nails by Diameter																	
	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

TABLE D



Tabulated Withdrawal Values from 2018 edition of the NDS for smooth shank stainless steel nails

Specific Gravity G	Tabulated Withdrawal Values (lb/in) of nail shank penetration																	
	Smooth Shank Stainless Steel Nails by Diameter																	
	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

TABLE E



Side by Side Comparison of Select Nail Diameters

Specific Gravity	RSRS Bright or Stainless	RSRS Galvanized	Carbon Steel Smooth	Stainless Steel Smooth	RSRS Bright or Stainless	RSRS Galvanized	Carbon Steel Smooth	Stainless Steel Smooth	RSRS Bright or Stainless	RSRS Galvanized	Carbon Steel Smooth	Stainless Steel Smooth
	0.113 Diameter				0.120 Diameter				0.131 Diameter			
0.73	135	108	71	33	144	115	75	35	157	126	82	38
0.71	128	103	66	31	136	109	70	33	149	119	77	36
0.68	118	94	59	29	125	100	63	31	136	109	69	34
0.67	114	91	57	29	121	97	61	31	132	106	66	33
0.58	86	68	40	23	91	73	42	25	99	79	46	27
0.55	77	62	35	21	82	65	37	23	89	71	41	25
0.51	66	53	29	19	70	56	31	20	77	61	34	22
0.50	64	51	28	19	68	54	29	20	74	59	32	22
0.49	61	49	26	18	65	52	28	19	71	57	30	21
0.47	56	45	24	17	60	48	25	18	65	52	27	20
0.46	54	43	22	16	57	46	24	17	62	50	26	19
0.44	49	39	20	15	52	42	21	16	57	46	23	18
0.43	47	38	19	15	50	40	20	16	54	44	22	17
0.42	45	36	18	14	48	38	19	15	52	42	21	17
0.41	43	34	17	14	45	36	18	15	50	40	19	16
0.40	41	33	16	13	43	35	17	14	47	38	18	15
0.39	39	31	15	13	41	33	16	14	45	36	17	15
0.38	37	29	14	12	39	31	15	13	43	34	16	14
0.37	35	28	13	12	37	30	14	13	40	32	15	14
0.36	33	26	12	11	35	28	13	12	38	31	14	13
0.35	31	25	11	11	33	26	12	12	36	29	13	13
0.31	24	20	8	9	26	21	9	10	28	23	10	11

TABLE F

NOTE: RSRS values are based on per inch length of **ring shank penetration** into the member.

Carbon steel and stainless steel values are based on per inch penetration of **nail shank** into the member

Referenced Documents:

*National Design Specification® for Wood Construction
2012, 2015 and 2018 Editions. Published by the
American Wood Council
222 Catoclin Circle, SE, Suite 201
Leesburg, VA 20175*

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