2018 *NDS*® Changes

National Design Specification® for Wood Construction (STD120)

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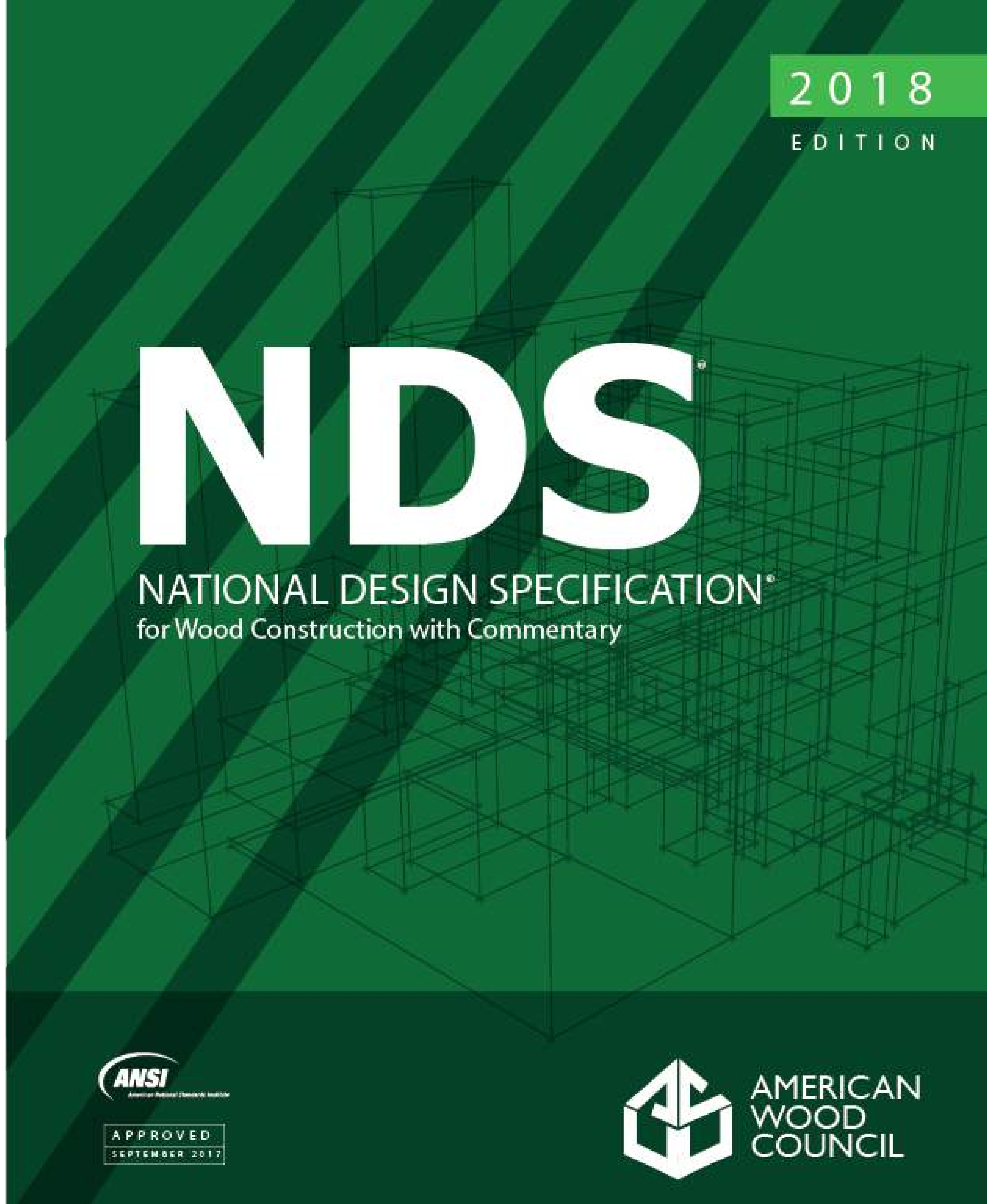
Vice President, Technology Transfer
American Wood Council



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Participants may download the presentation here: https://www.awc.org/education/main/lists/std-awc-standards/std120-2018-nds-changes

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

COURSE DESCRIPTION

This presentation will provide an overview of the significant changes for wood design per AWC's *National Design Specification (NDS) for Wood Construction.* The *2018 NDS* is referenced in the *2018 International Building Code* and *2018 International Residential Code* and used to design wood structures worldwide. The *2018 NDS* references *ASCE/SEI Standard 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures* which includes increased wind loads. Participants will learn about changes in the *2018 NDS* to address increased wind loads and gain an overview of the standard.

LEARNING OBJECTIVES

Upon completion, participants will be better able to identify:

1. **NDS Changes**

   Identify changes in the *2018 NDS*

2. ***ASCE 7-16***

   Identify wind load increases in *ASCE 7-16* that affect wood design and construction

3. **Fasteners**

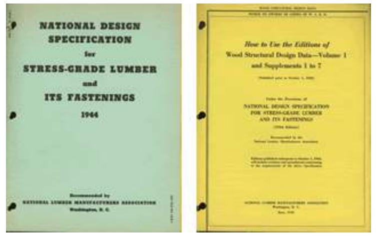
   Identify new fastener provisions developed to address increased wind loads

4. **Nail Design**

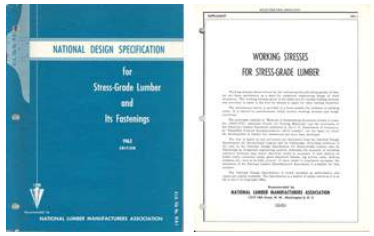
   Design nails for withdrawal and head pull-through to resist new wind loads

NDS HISTORY

1944



1962



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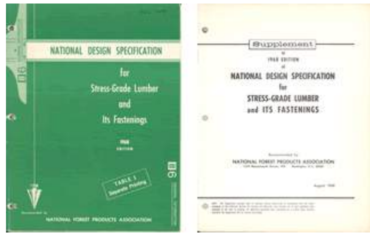

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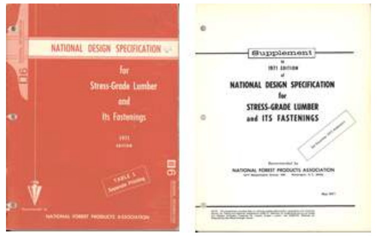
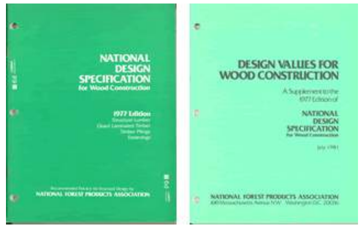


1973

1977

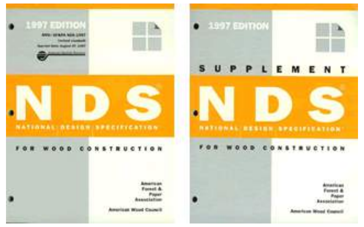


1982

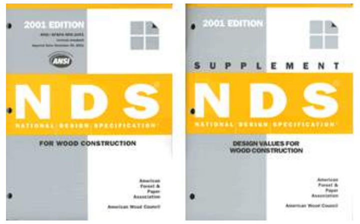
1986

1991

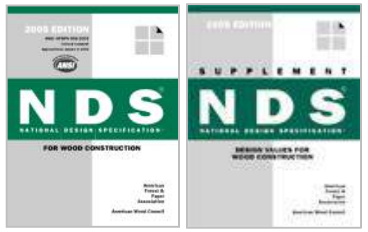
1997



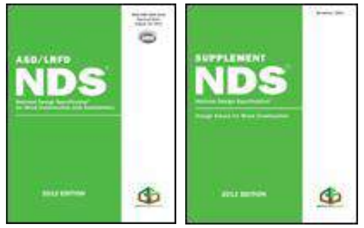
2001



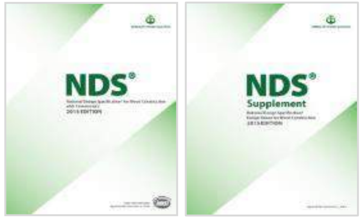
2005



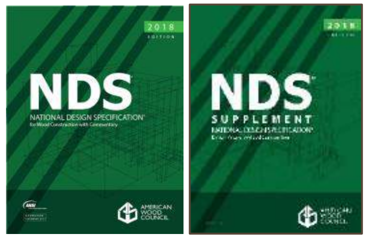
2012



2015



2018



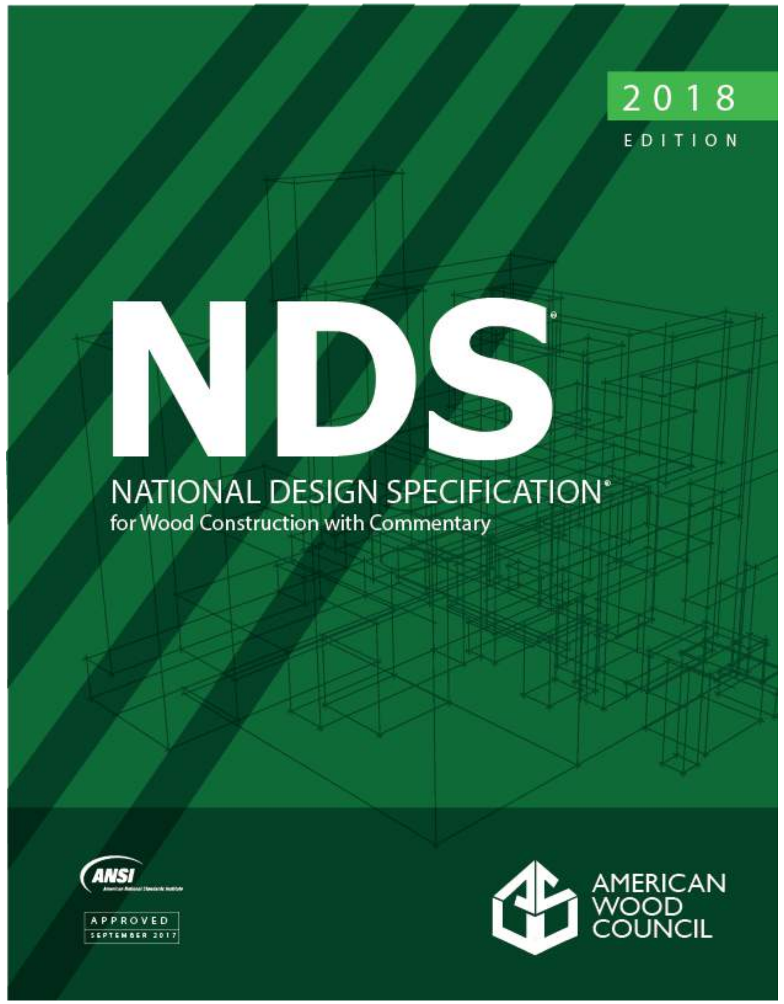
ANSI ACCREDITATION

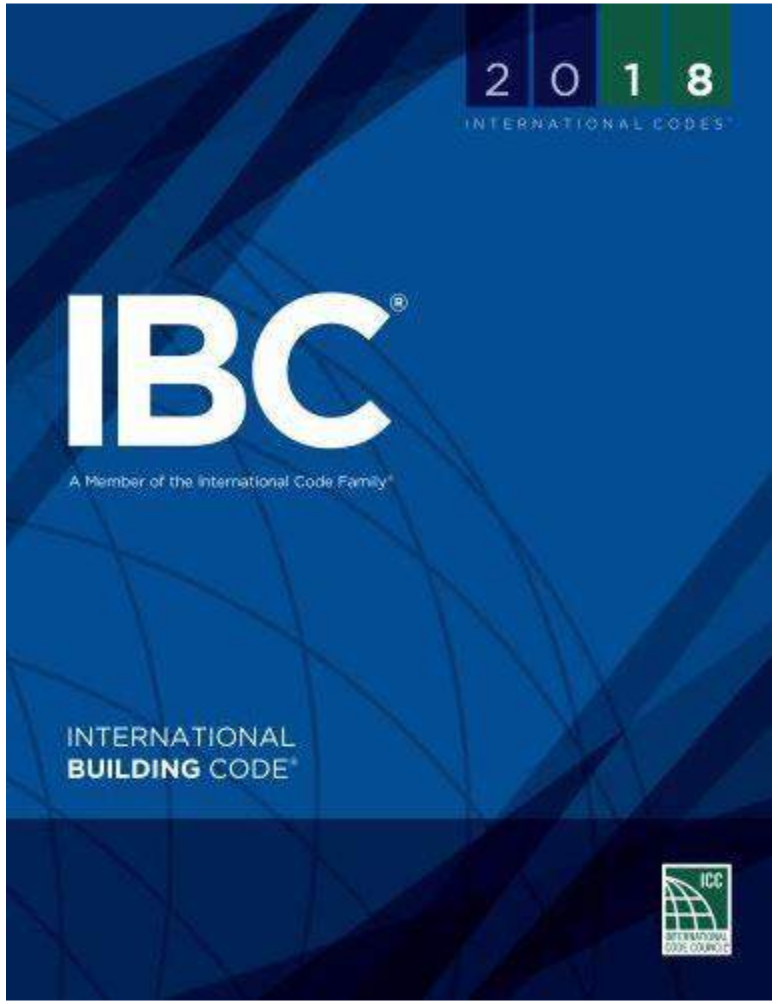
AWC – ANSI-accredited standards developer

- Consensus Body
  - Wood Design Standards Committee

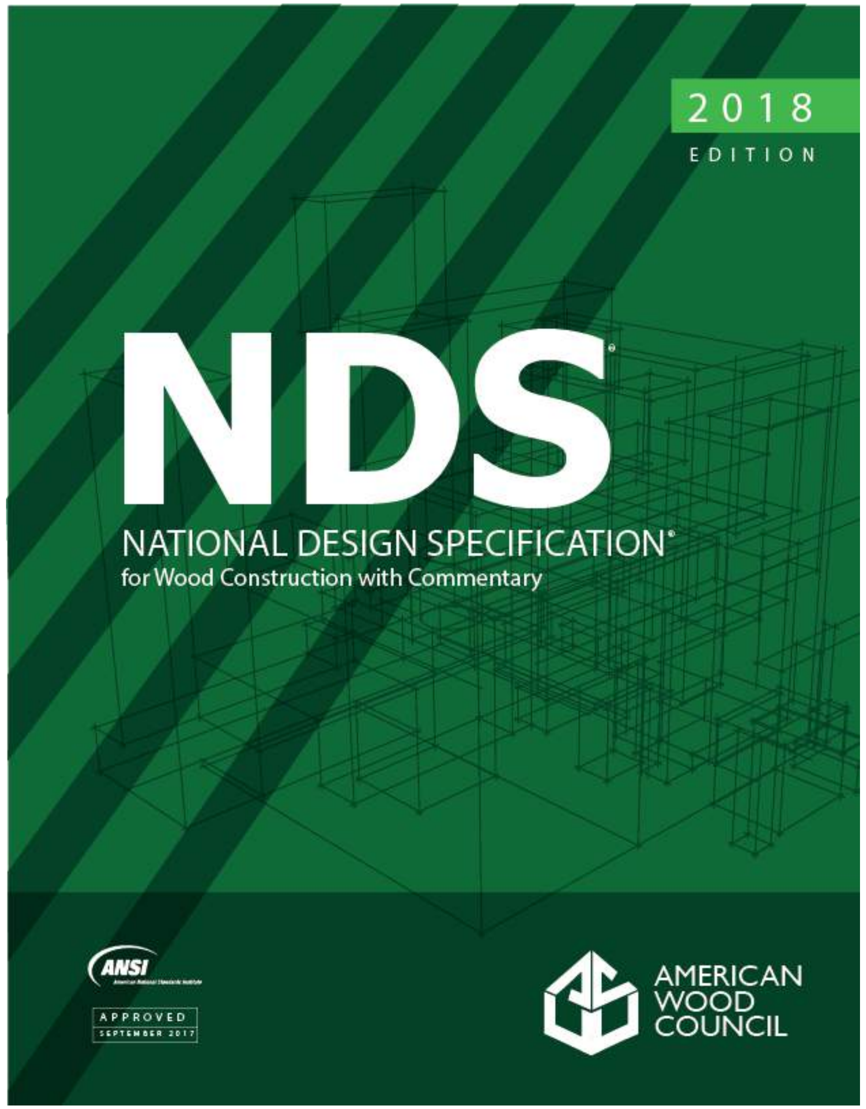
GOVERNING CODES FOR WOOD DESIGN

2018 NDS referenced in 2018 IBC and IRC



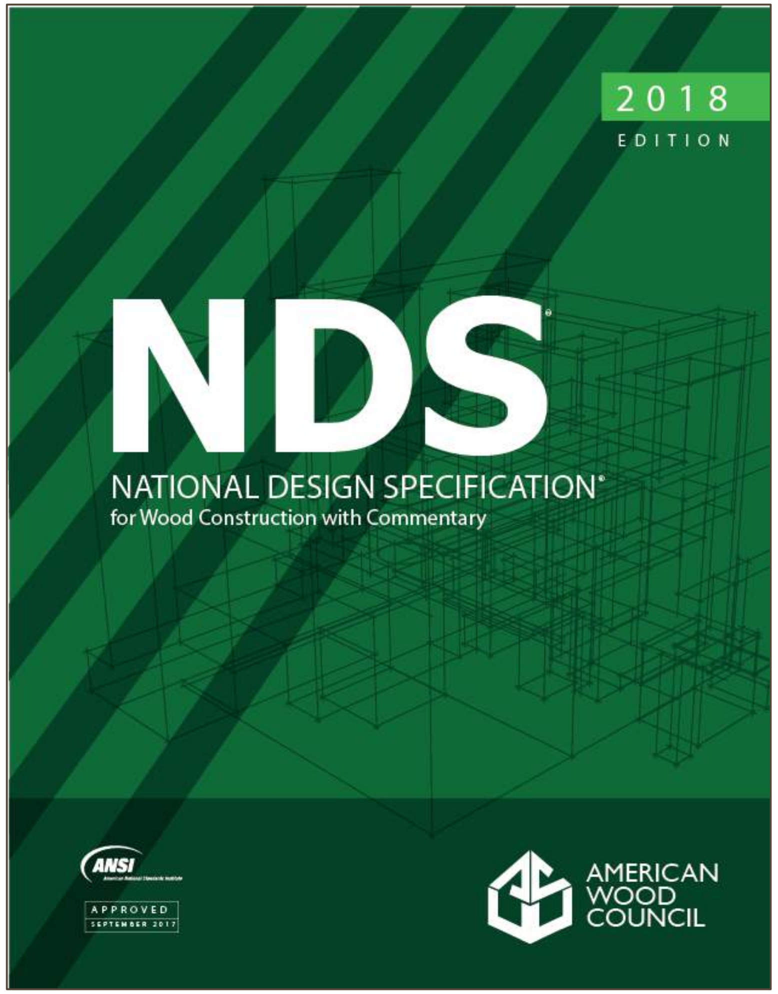


2018 NDS – PRIMARY CHANGES



- References *ASCE 7-16*
- Added equation for withdrawal design values for smooth shank stainless steel nails
- New provisions for Roof Sheathing Ring Shank nails in accordance with *ASTM F 1667*
- New design provisions for fastener head pull-through
- Revision to method for calculating lateral design values for threaded nails
- Revised timber rivet design value tables
- Revised terminology for Fire Design of Wood Members
- *NDS Supplement* design values updated

NDS 2018 CHAPTERS



1. General Requirements for Structural Design
2. Design Values for Structural Members
3. Design Provisions and Equations

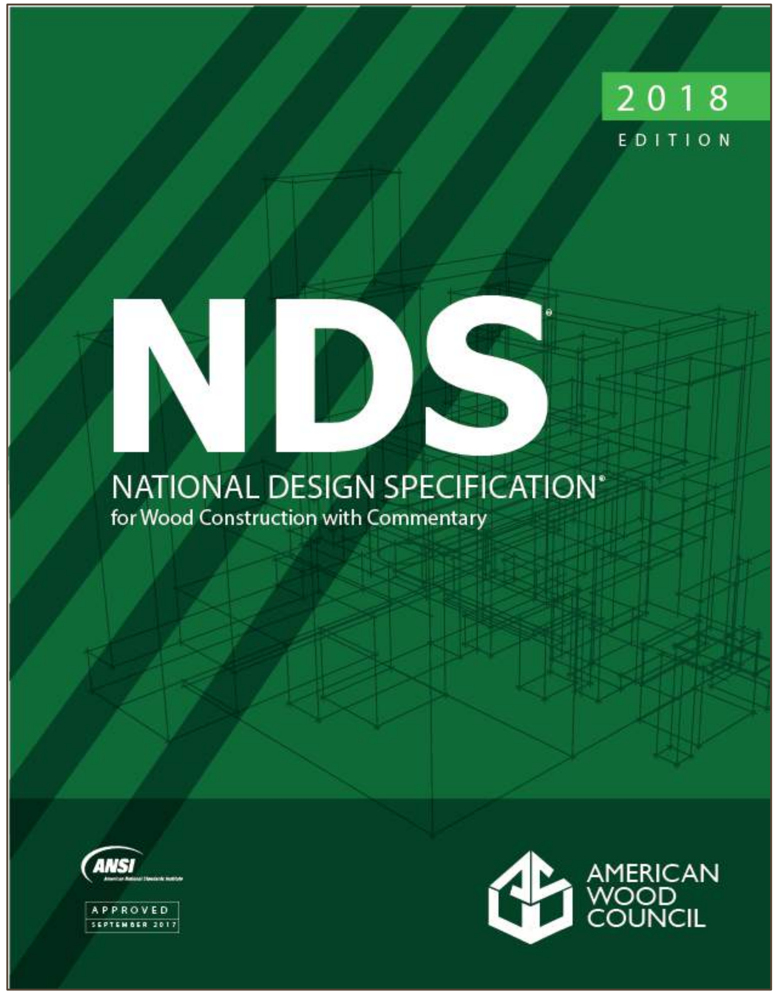
4. Sawn Lumber
5. Structural Glued Laminated Timber
6. Round Timber Poles and Piles*
7. Prefabricated Wood I-Joists*
8. Structural Composite Lumber
9. Wood Structural Panels*
10. Cross-Laminated Timber

11. Mechanical Connections
12. Dowel-Type Fasteners
13. Split Ring and Shear Plate Connectors*
14. Timber Rivets

15. Special Loading Conditions*
16. Fire Design of Wood Members

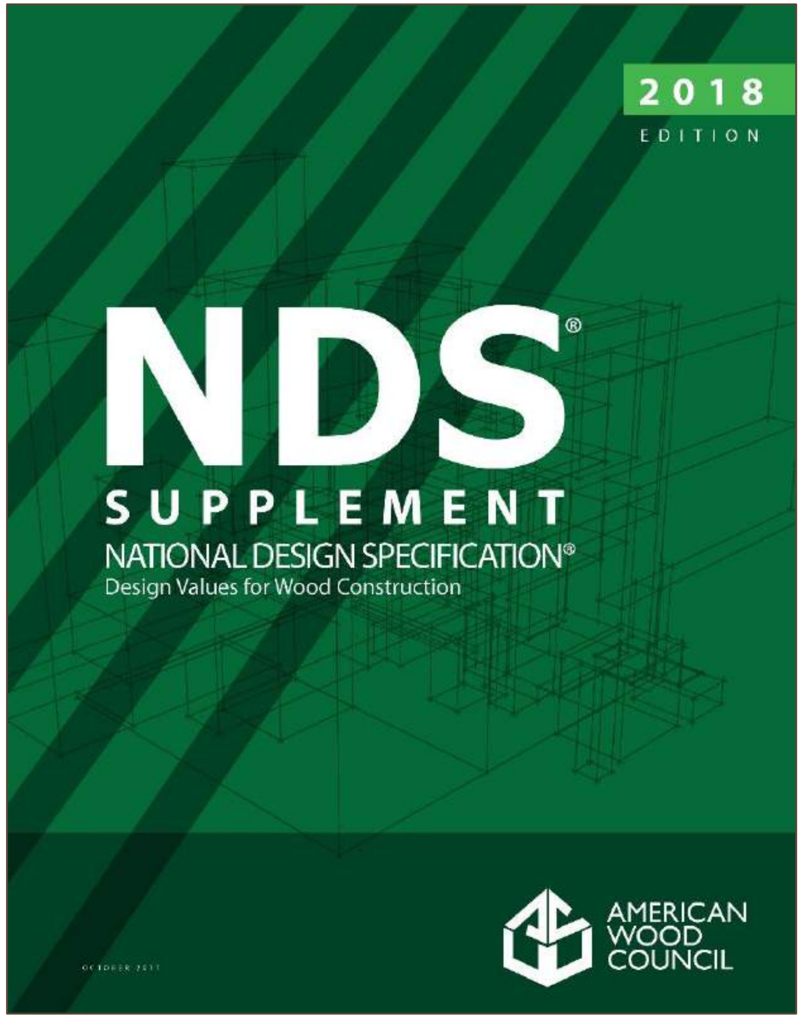
* No changes

NDS 2018 APPENDICES



A. Construction and Design Practices
B. Load Duration (ASD Only)
C. Temperature Effects
D. Lateral Stability of Beams
E. Local Stresses in Fastener Groups
F. Design for Creep and Critical Deflection Applications
G. Effective Column Length
H. Lateral Stability of Columns
I. Yield Limit Equations for Connections
J. Solution of Hankinson Equation
K. Typical Dimensions for Split Ring and Shear Plate Connectors
L. Typical Dimensions for Dowel-Type Fasteners and Washers
M. Manufacturing Tolerances for Rivets and Steel Side Plates for Timber Rivet Connections
N. Appendix for Load and Resistance Factor Design (LRFD) – Mandatory

NDS 2018 SUPPLEMENT



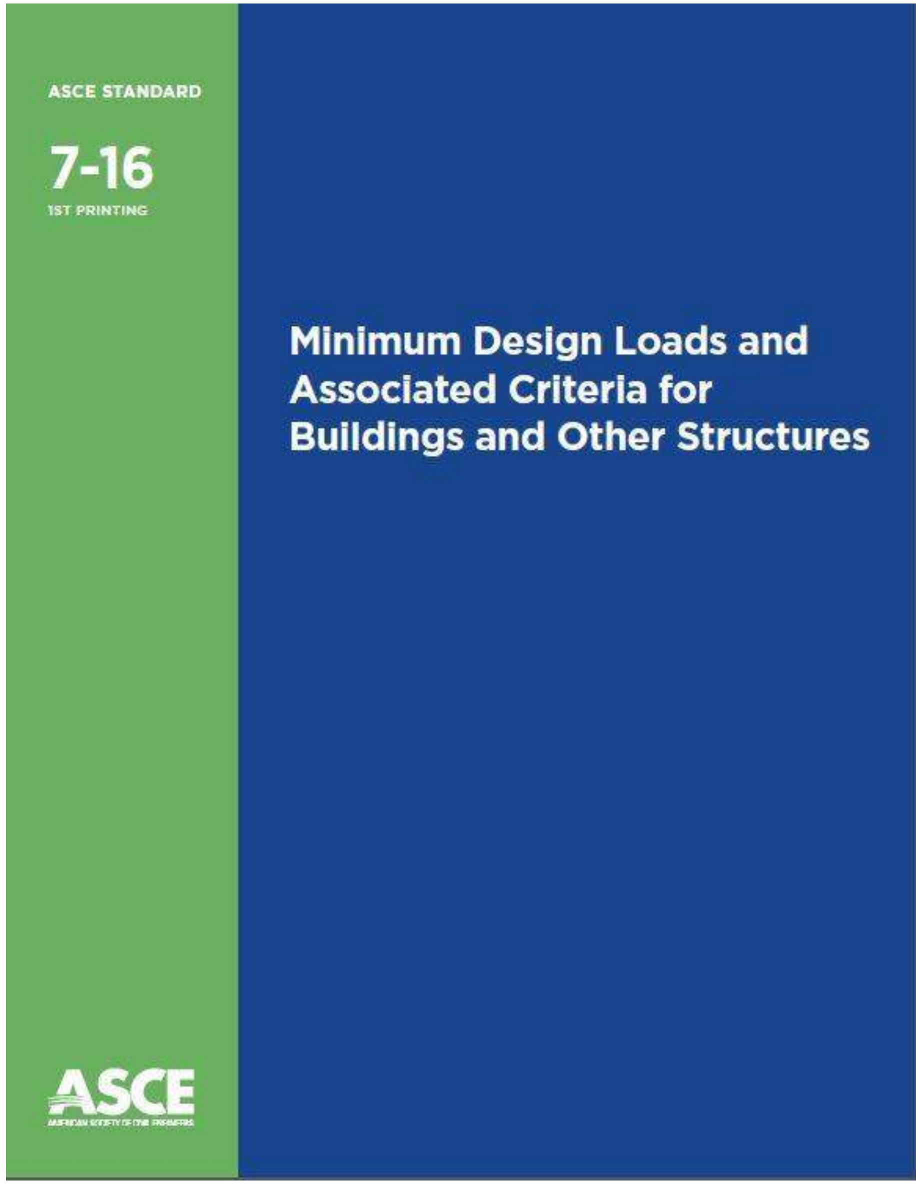
1. **Sawn Lumber Grading Agencies**
2. **Species Combinations**
3. **Section Properties**
4. **Reference Design Values**
   - Sawn Lumber and Timber
   - MSR and MEL
   - Decking
   - Non-North American Sawn Lumber
   - Structural Glued Laminated Timber
   - Timber Poles and Piles

CHAPTER 1

1

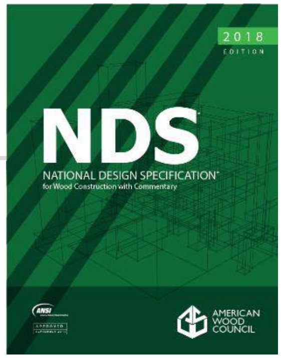
GENERAL REQUIREMENTS FOR STRUCTURAL DESIGN

MINIMUM DESIGN LOADS



- Reference Loads
- Minimum Load Standards
- ASCE 7-16

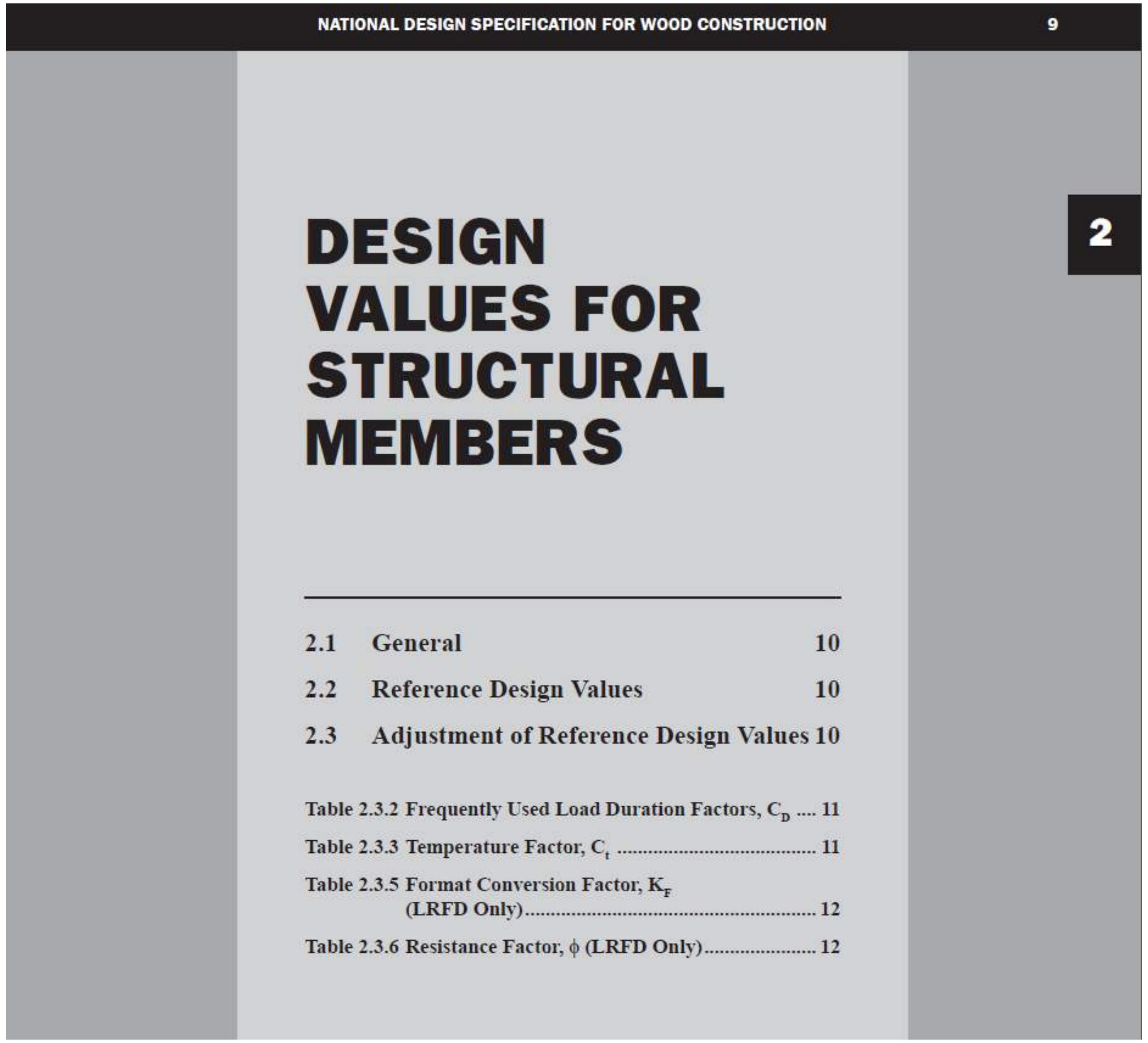
NOTATION



1.6 Notation

- D_H = fastener head diameter, in.
- EI_{eff} = effective bending stiffness of the CLT section, lbs-in.^{2}/ft of panel width
- GA_{eff} = effective shear stiffness of the CLT section, lbs/ft of panel width
- W_H, W_H' = reference and adjusted pull-through design value, lbs
- a_{char} = ~~effective~~ char depth, in
- a_{eff} = effective char depth, in.
- t_{ns} = net side member thickness, in.
- β_t ~~β_{eff}~~ = non-linear ~~effective~~ char rate (in./hr.$^{0.813}$) adjusted for exposure time, t

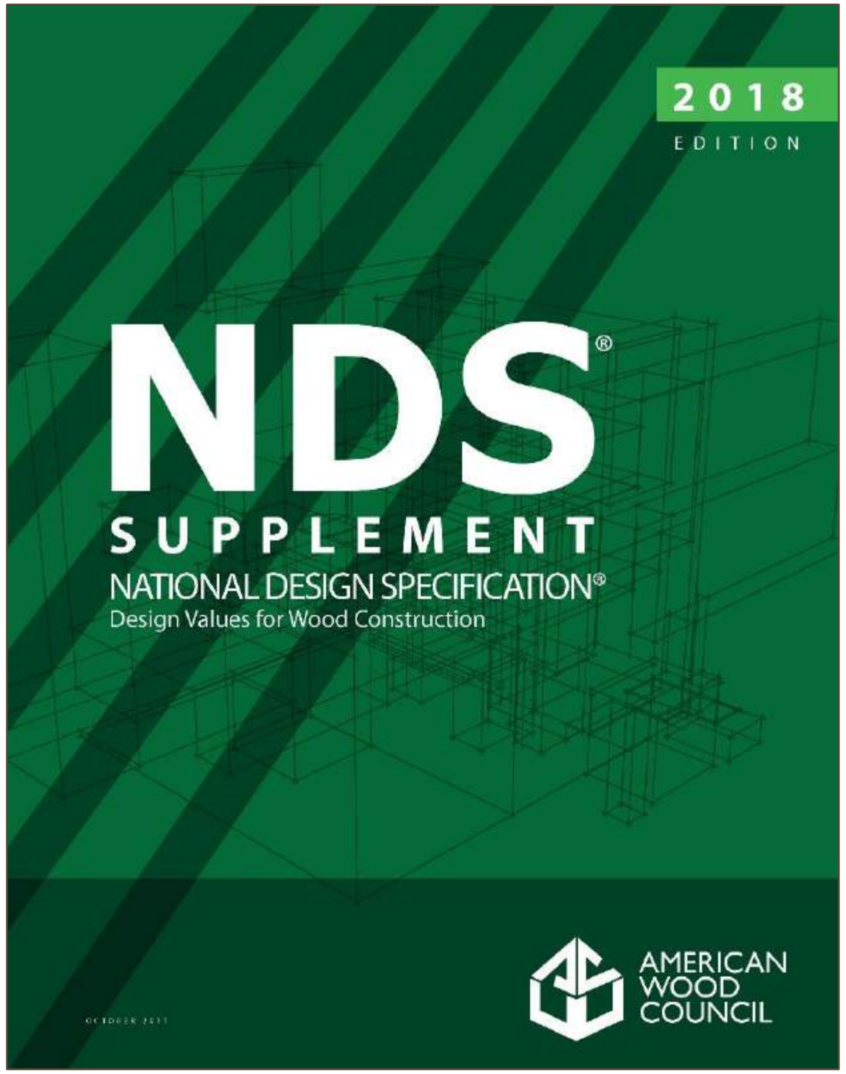
CHAPTER 2



NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 9

2

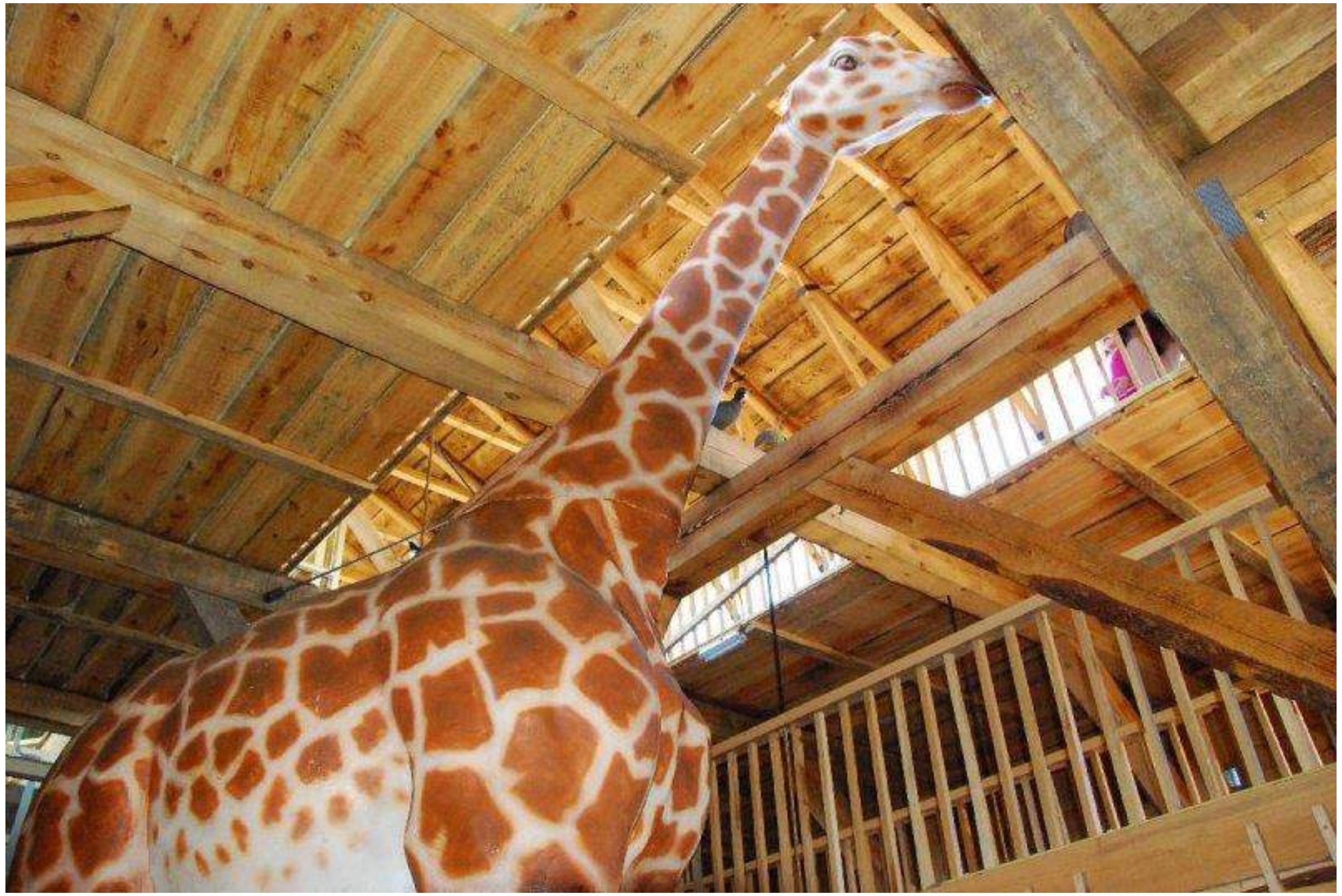
DESIGN VALUES FOR STRUCTURAL MEMBERS



RESPONSIBILITY OF DESIGNER

2.1.2 Responsibility of Designer to Adjust for Conditions of Use

Adjusted design values for wood members and connections in particular end uses, shall be appropriate for the conditions under which the wood products are used, taking into account conditions such as the differences in wood strength properties with different moisture contents, load durations, and types of treatment. Common end use conditions are addressed in this Specification. It shall be the final responsibility of the designer to relate design assumptions with design values, and to make design value adjustments appropriate to the end use conditions.



LOAD DURATION FACTOR

Table 2.3.2 Frequently Used Load Duration Factors, C_D[1]

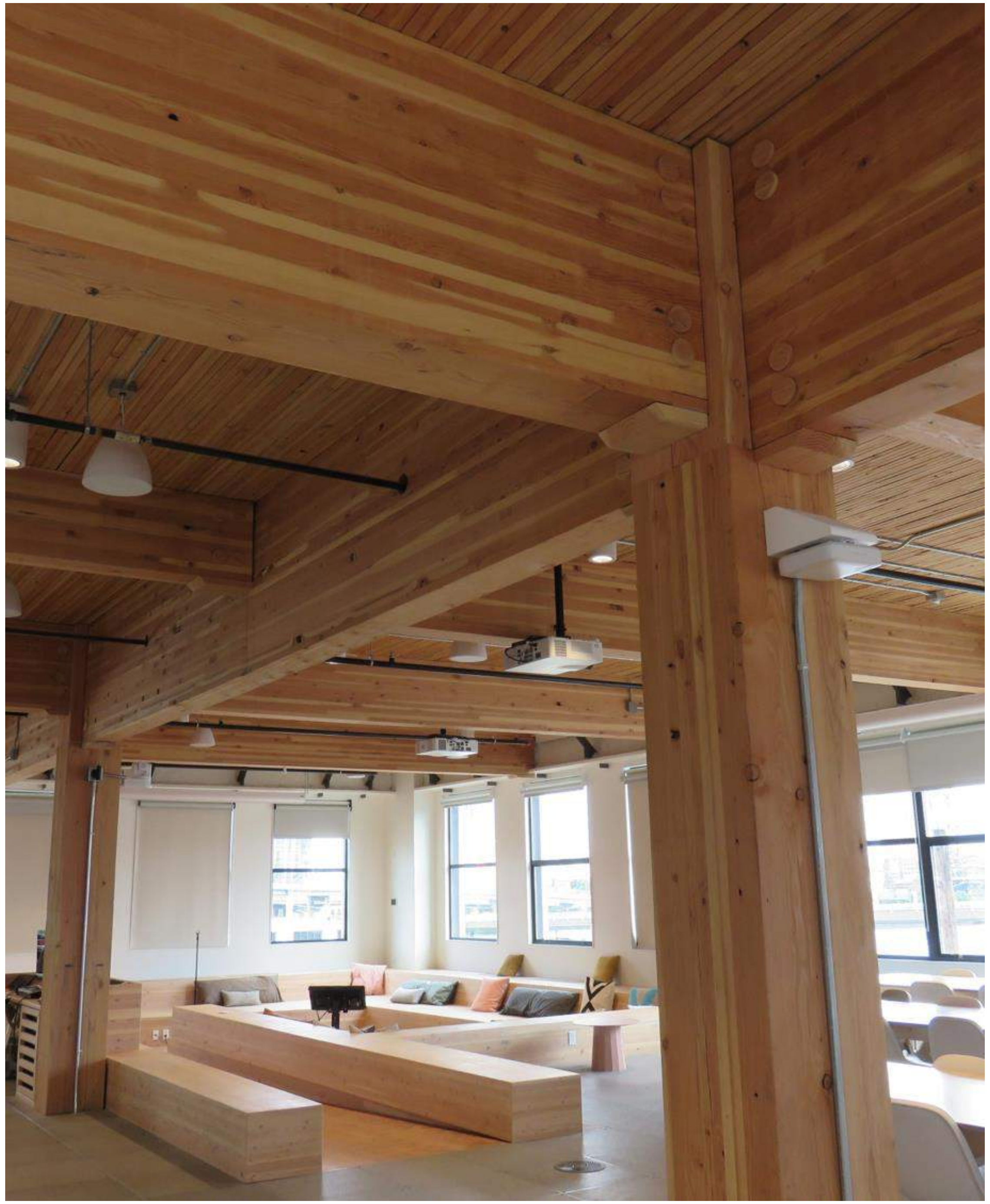
Load Duration	C_D	Typical Design Loads
Permanent	0.9	Dead Load
Ten years	1.0	Occupancy Live Load
Two months	1.15	Snow Load
Seven days	1.25	Construction Load
Ten minutes	1.6	Wind/Earthquake Load
Impact[2]	2.0	Impact Load

1. Load duration factors shall not apply to reference modulus of elasticity, E, reference modulus of elasticity for beam and column stability, E_{min}, nor to reference compression perpendicular to grain design values, $F_{c\perp}$, based on a deformation limit.
2. Load duration factors greater than 1.6 shall not be used in the design of structural members pressure-treated with water-borne preservatives (see Reference 30), or fire retardant chemicals. Load duration factors greater than 1.6 shall not be used in the design of connections or wood structural panels.

CHAPTER 3

DESIGN PROVISIONS AND EQUATIONS

3



BEAM STABILITY FACTOR

3.3.3 Beam Stability Factor, C_L

3.3.3.6 The slenderness ratio, R_B, for bending members shall be calculated as follows:

$$R_B = \sqrt{\frac{\ell_e d}{b^2}} \quad (3.3\text{-}5)$$

3.3.3.7 The slenderness ratio for bending members, R_B, shall not exceed 50.

3.3.3.8 The beam stability factor shall be calculated as follows:

$$C_L = \frac{1+(F_{bE}/F_b^*)}{1.9} - \sqrt{\left[\frac{1+(F_{bE}/F_b^*)}{1.9}\right]^2 - \frac{F_{bE}/F_b^*}{0.95}} \quad (3.3\text{-}6)$$

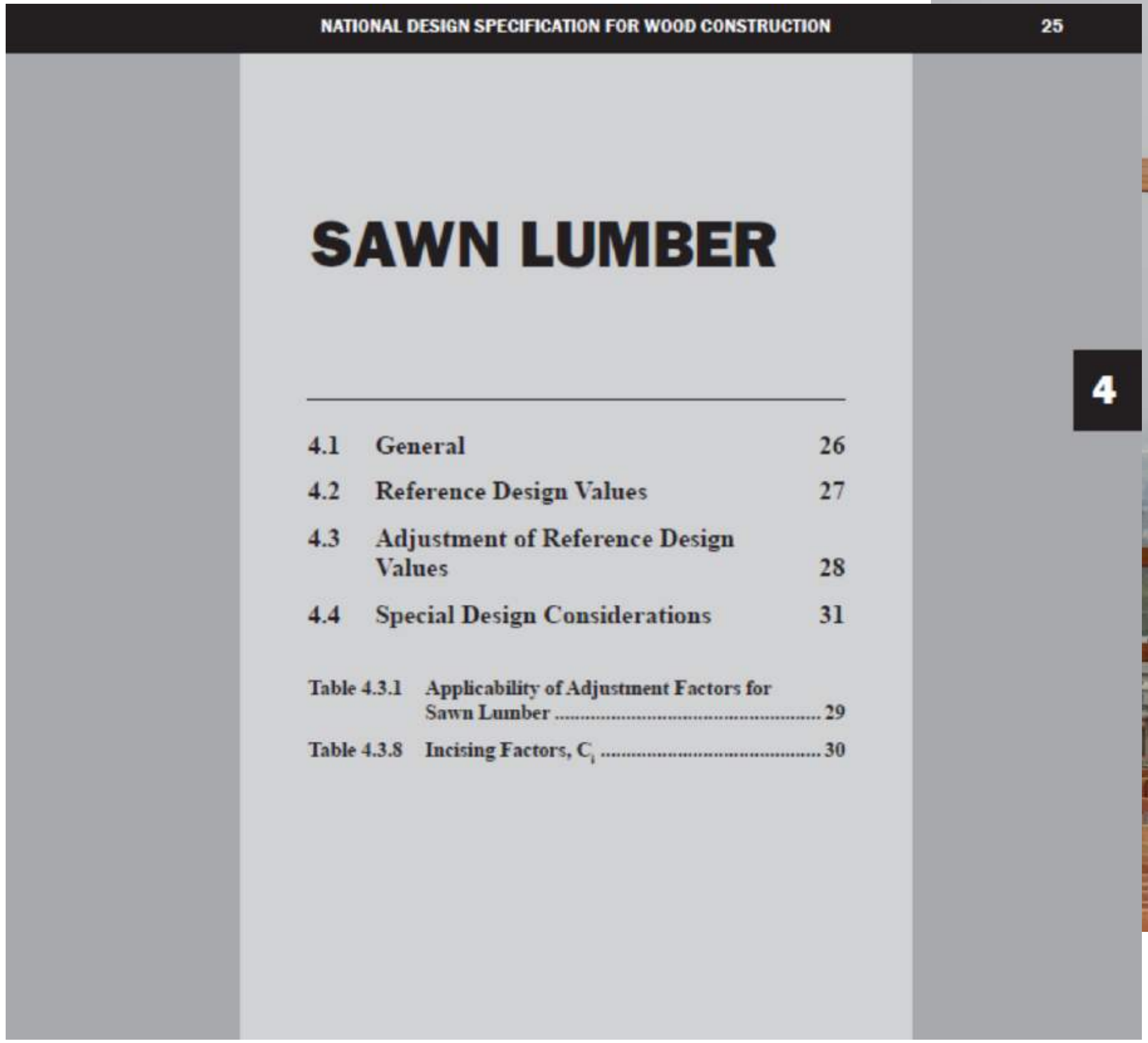
where:

F_b^* = reference bending design value multiplied by all applicable adjustment factors except C_{fu}, C_V (when $C_V \leq 1.0$), and C_L (see 2.3), psi

$$F_{bE} = \frac{1.20\, E_{min}'}{R_B^2}$$

Source: APA

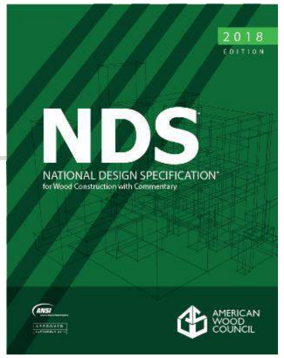
CHAPTER 4

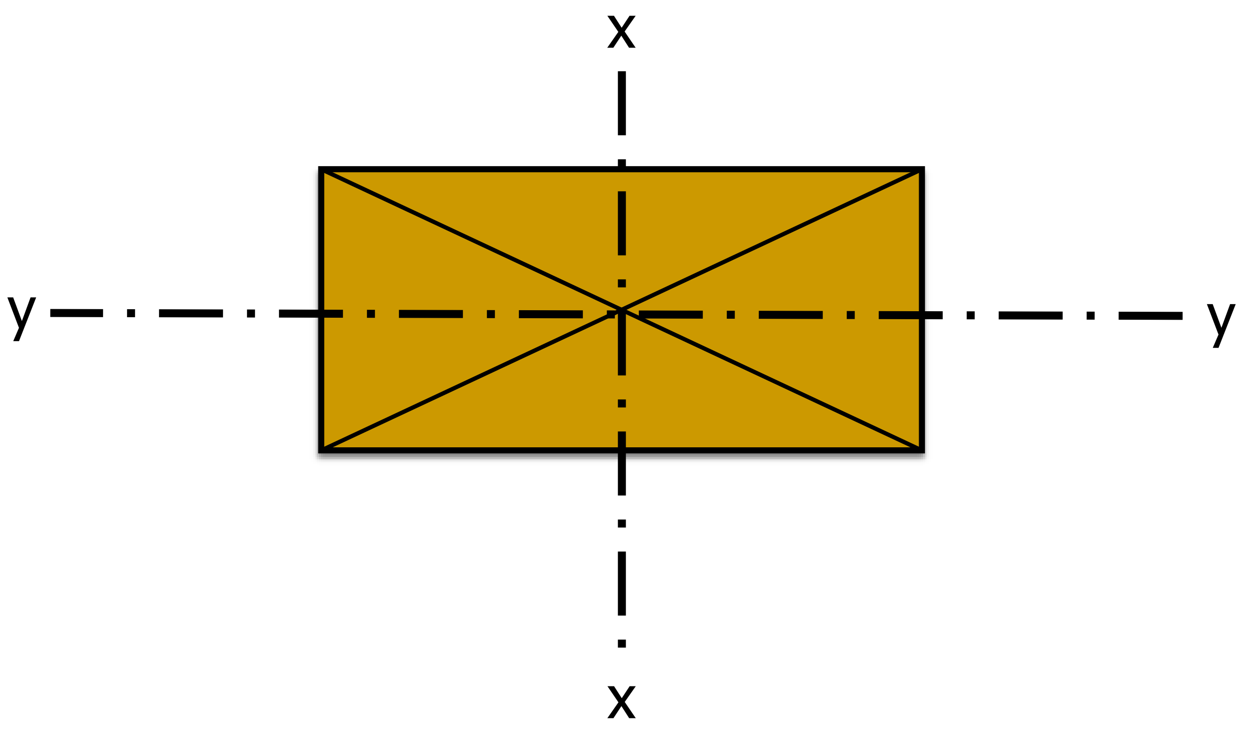


SAWN LUMBER

4

FLAT USE FACTOR



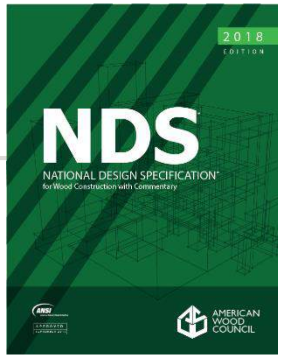


4.3.7 Flat Use Factor, C_{fu}

4.3.7.1 When sawn lumber 2" to 4" thick is loaded on the wide face, multiplying the reference bending design value, F_b, by the flat use factors, C_{fu}, specified in Tables 4A, 4B, 4C, and 4F, shall be permitted.

4.3.7.2 When members classified as Beams and Stringers are loaded on the wide face, the reference bending design value, F_b, and the reference modulus of elasticity, (E or E_{min}), shall be multiplied by the flat use factors, C_{fu}, specified in Table 4D.

INCISING FACTOR

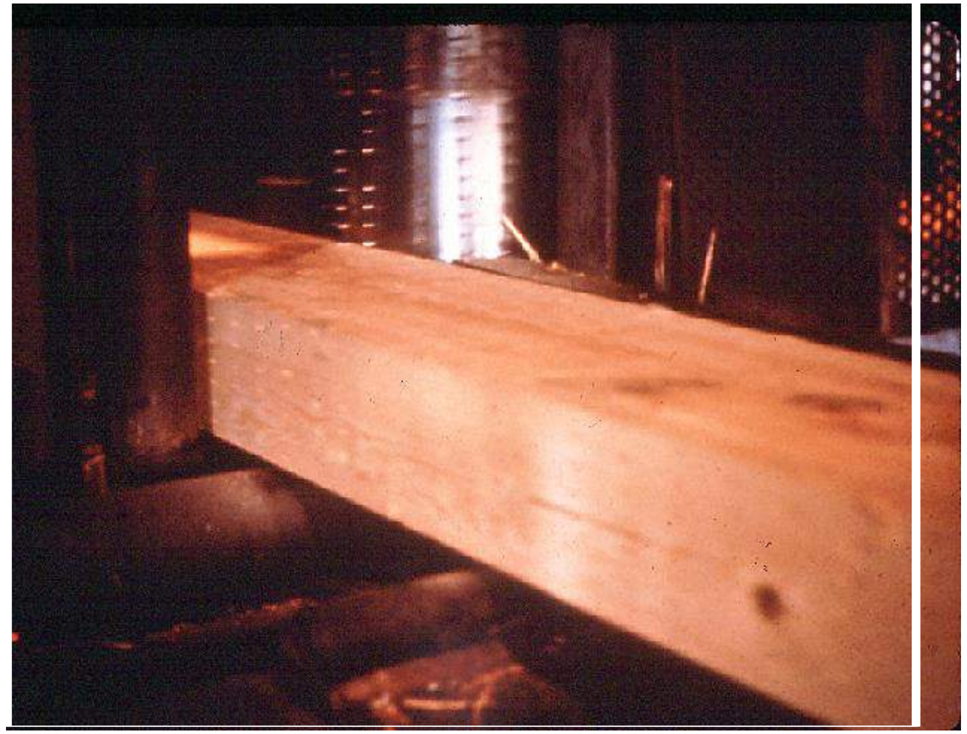


4.3.8 Incising Factor, C_i

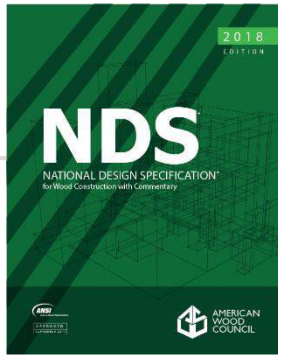
Dimensional lumber - Allowance for incising factors from company providing incising

Table 4.3.8 Incising Factors, C_i

Design Value	C_i
E, E_{min}	0.95
F_b, F_t, F_c, F_v	0.80
$F_{c\perp}$	1.00



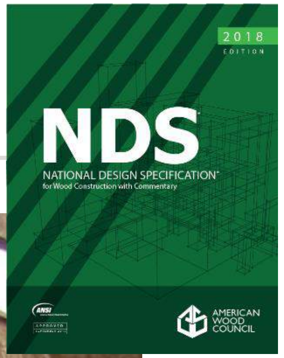
WOOD TRUSSES



4.4.2 Wood Trusses

4.4.2.1 Increased chord stiffness relative to axial loads where a 2" x 4" or smaller sawn lumber truss compression chord is subjected to combined flexure and axial compression under dry service condition and has 3/8" or thicker wood structural panel sheathing nailed to the narrow face of the chord in accordance with code required roof sheathing fastener schedules (see References 32, 33, and 34), shall be permitted to be accounted for by multiplying the reference modulus of elasticity design value for beam and column stability, E_{min}, by the buckling stiffness factor, C_T, in column stability calculations (see 3.7 and Appendix H). When $\ell_e < 96"$, C_T shall be calculated as follows:

CHAPTER 5



NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 33

STRUCTURAL GLUED LAMINATED TIMBER

5

Source: APA

ADJUSTMENT FACTORS

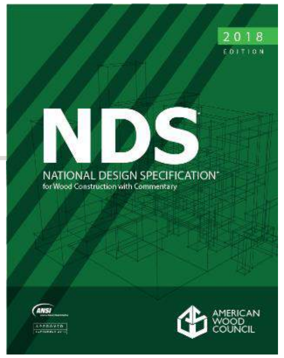


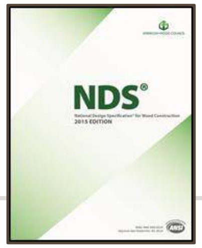
Table 5.3.1 Applicability of Adjustment Factors for Structural Glued Laminated Timber

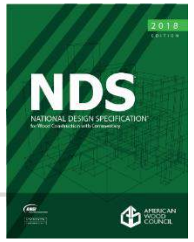
	ASD only	ASD and LRFD										LRFD only		
	Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor [1]	Volume Factor [1]	Flat Use Factor	Curvature Factor	Stress Interaction Factor	Shear Reduction Factor	Column Stability Factor	Bearing Area Factor	Format Conversion Factor K_F	Resistance Factor ϕ	Time Effect Factor
$F_{rt}' = F_{rt}$ x	C_D	C_M [2]	C_t [2]	-	-	-	-	-	-	-	-	2.88	0.75	λ

1. The beam stability factor, C_L, shall not apply simultaneously with the volume factor, C_V, for structural glued laminated timber bending members (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.
2. 2. For radial tension, F_{rt}, the same adjustment factors (C_M and C_t) for shear parallel to grain, F_v, shall be used.

Source: APA

CHAPTER 6



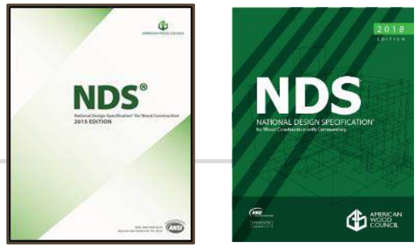


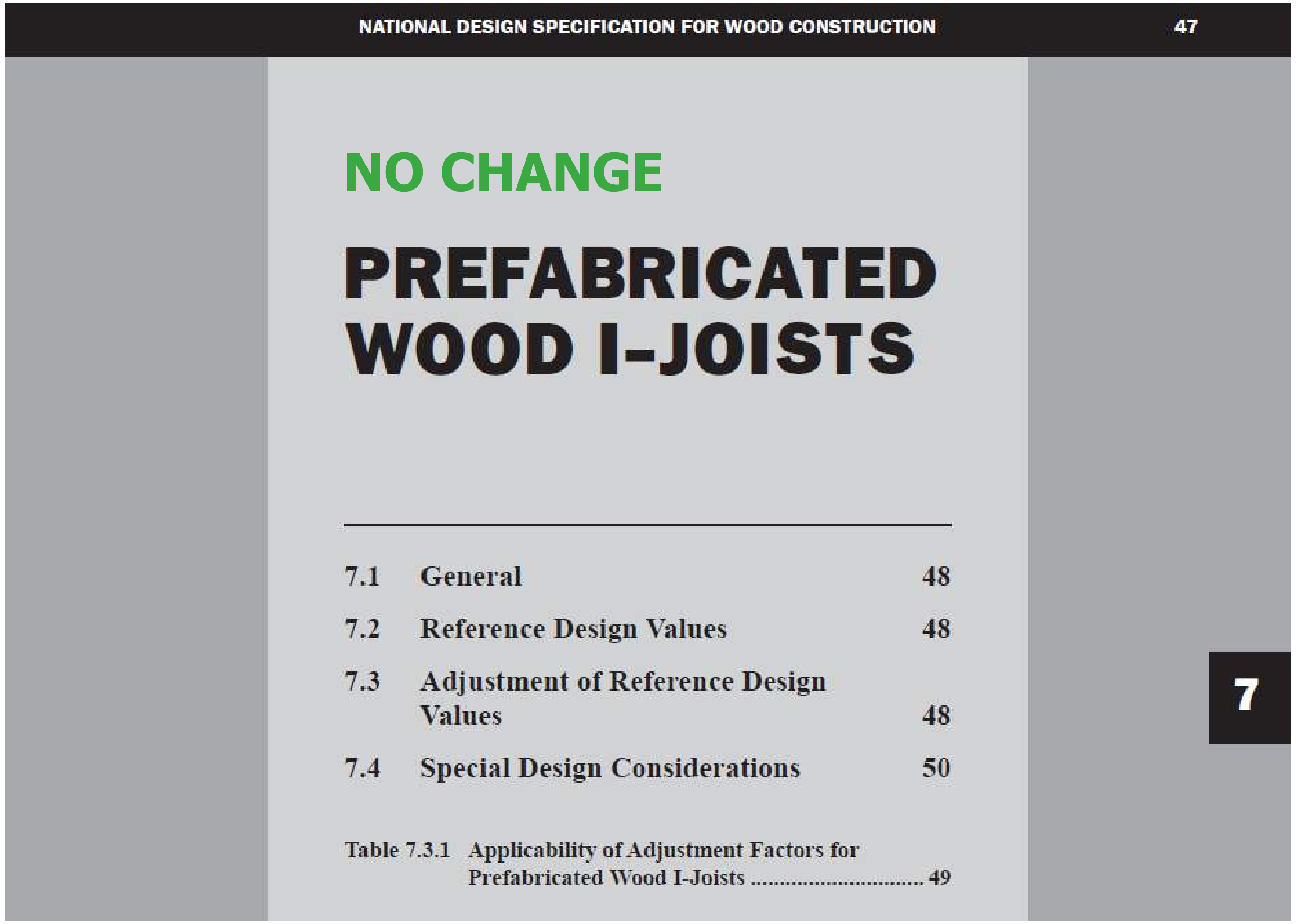
NO CHANGE

ROUND TIMBER POLES AND PILES

6

CHAPTER 7



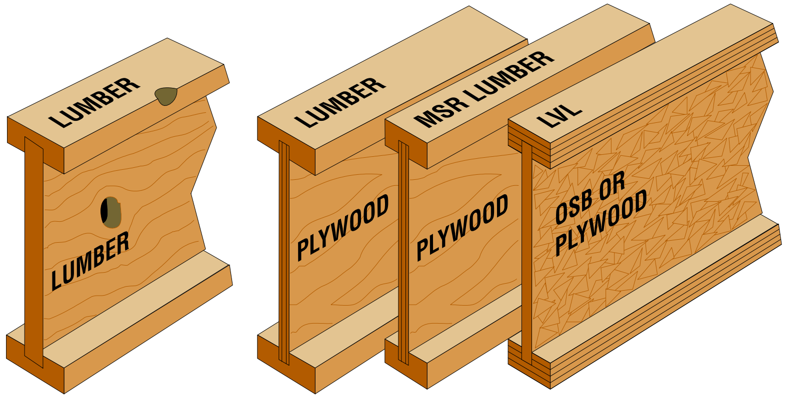


NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 47

NO CHANGE

PREFABRICATED WOOD I-JOISTS

7



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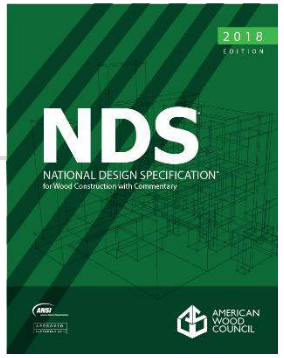
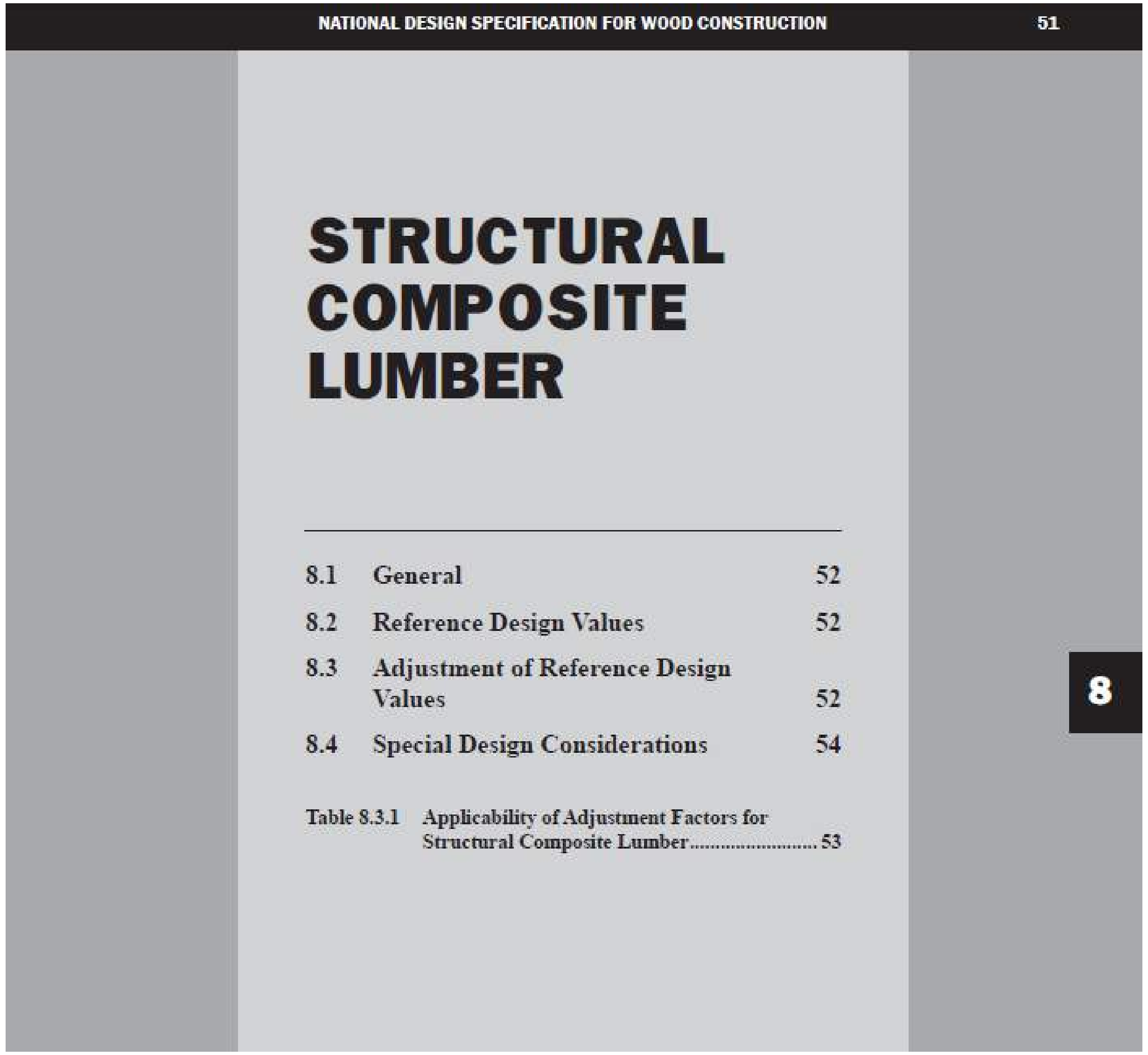
CHAPTER 8





NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 51

STRUCTURAL COMPOSITE LUMBER

8

Source: APA

VOLUME FACTOR

Volume Factor C_v – Tension parallel to grain

8.3.6 Volume Factor, C_V

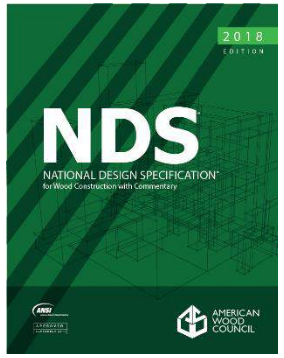
8.3.6.1 Reference bending design values, F_b, for structural composite lumber shall be multiplied by the volume factor, C_V, which shall be obtained from the structural composite lumber manufacturer's literature or code evaluation reports. When $C_V \leq 1.0$, the volume factor, C_V, shall not apply simultaneously with the beam stability factor, C_L (see 3.3.3) and therefore, the lesser value of these adjustment factors shall apply. When $C_V > 1.0$, the volume factor, C_V, shall apply simultaneously with the beam stability factor, C_L (see 3.3.3).

8.3.6.2 Reference tension design values, F_t, for structural composite lumber shall be multiplied by the volume factor, C_V, which shall be obtained from the structural composite lumber manufacturer's literature or code evaluation reports.

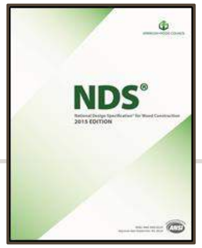
Table 8.3.1 Applicability of Adjustment Factors for Structural Composite Lumber

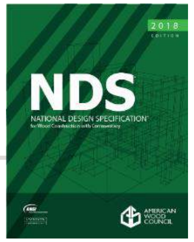
		ASD only	ASD and LRFD								LRFD only		
		Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor	Volume Factor	Repetitive Member Factor	Column Stability Factor	Bearing Area Factor	Format Conversion Factor K_F	Resistance Factor ϕ	Time Effect Factor	
$F_b' = F_b$	x	C_D	C_M	C_t	C_L[1]	C_V[1]	C_r	-	-	2.54	0.85	λ	
$F_t' = F_t$	x	C_D	C_M	C_t	-	C_V	-	-	-	2.70	0.80	λ	
$F_v' = F_v$	x	C_D	C_M	C_t	-	-	-	-	-	2.88	0.75	λ	
$F_c' = F_c$	x	C_D	C_M	C_t	-	-	-	C_P	-	2.40	0.90	λ	
$F_{c\perp}' = F_{c\perp}$	x	-	C_M	C_t	-	-	-	-	C_b	1.67	0.90	-	
$E' = E$	x	-	C_M	C_t	-	-	-	-	-	-	-	-	
$E_{min}' = E_{min}$	x	-	C_M	C_t	-	-	-	-	-	1.76	0.85	-	

1. See 8.3.6.1 for information on simultaneous application of the volume factor, C_V, and the beam stability factor, C_L, to the reference bending design value, F_b.



CHAPTER 9





NO CHANGE

WOOD STRUCTURAL PANELS

9

Source: APA

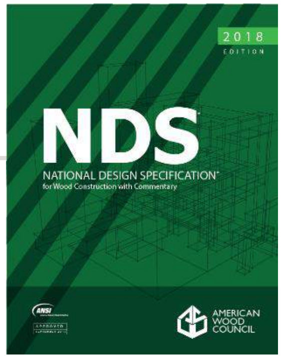
CHAPTER 10

CROSS-LAMINATED TIMBER

10

Source: Seagate

FORMAT CONVERSION FACTOR

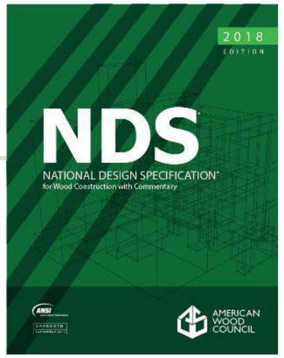


Format Conversion Factor

Table 10.3.1 Applicability of Adjustment Factors for Cross-Laminated Timber

		ASD only	ASD and LRFD					LRFD only		
		Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor	Column Stability Factor	Bearing Area Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor
$F_b(S_{eff})' = F_b(S_{eff})$	x	C_D	C_M	C_t	C_L	-	-	2.54	0.85	λ
$F_t(A_{parallel})' = F_t(A_{parallel})$	x	C_D	C_M	C_t	-	-	-	2.70	0.80	λ
$F_v(t_v)' = F_v(t_v)$	x	C_D	C_M	C_t	-	-	-	2.88	0.75	λ
$F_s(Ib/Q)_{eff}' = F_s(Ib/Q)_{eff}$	x	-	C_M	C_t	-	-	-	2.00	0.75	-

DEFLECTION – EFFECTIVE SHEAR STIFFNESS



Per ANSI/APA PRG 320-2017

$$(EI)_{app} = \frac{EI_{eff}}{1 + \frac{K_s EI_{eff}}{GA_{eff} L^2}} \qquad (10.4\text{-}1)$$

where:

Source: APA

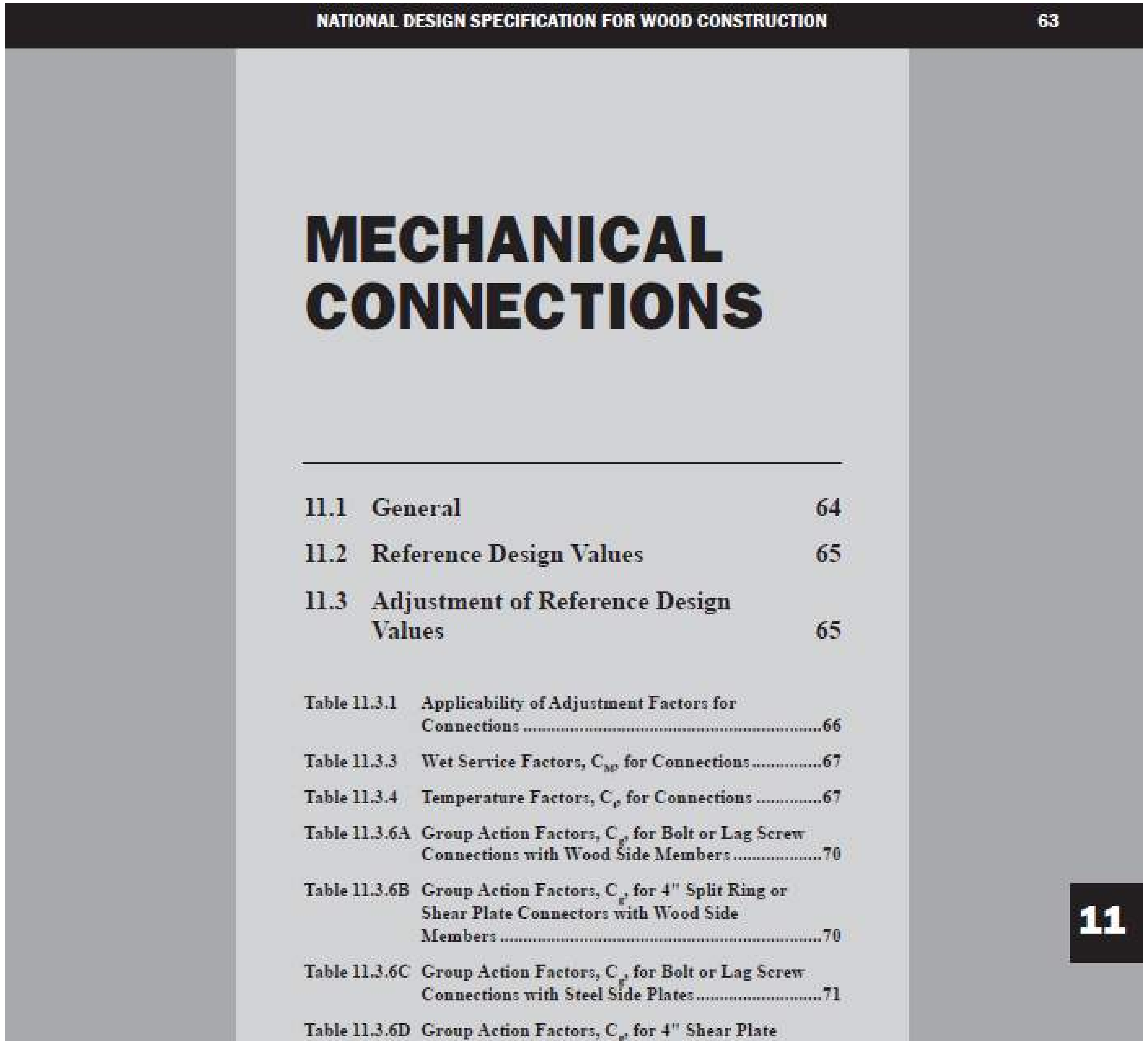
EI_{eff} = Effective bending stiffness of the CLT section, lbs-in.^{2}/ft of panel width

K_s = Shear deformation adjustment factor

GA_{eff} = Effective shear stiffness of the CLT section, lbs/ft of panel width

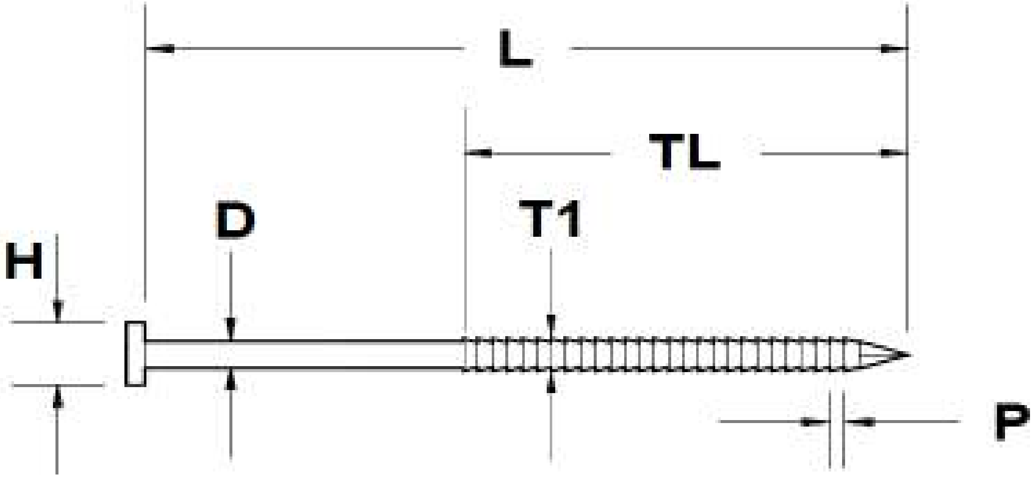
L = Span of the CLT section, in.

CHAPTER 11



MECHANICAL CONNECTIONS

11



Roof Sheathing Ring Shank Nails

Option to address significant increases in ASCE 7-16 C&C roof wind pressures

ADJUSTMENT FACTORS – HEAD PULL-THROUGH

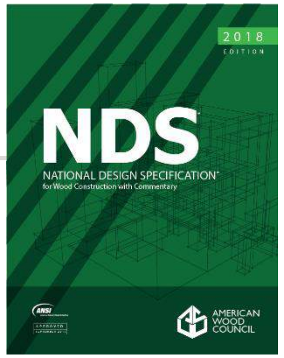


Table 11.3.1 Applicability of Adjustment Factors for Connections

		ASD Only	ASD and LRFD									LRFD Only		
		Load Duration Factor[1]	Wet Service Factor	Temperature Factor	Group Action Factor	Geometry Factor[3]	Penetration Depth Factor[3]	End Grain Factor[3]	Metal Side Plate Factor[3]	Diaphragm Factor[3]	Toe-Nail Factor[3]	Format Conversion Factor	Resistance Factor	Time Effect Factor
												K_F	ϕ	
Lateral Loads														
Dowel-type Fasteners (e.g. bolts, lag screws, wood screws, nails, spikes, drift bolts, & drift pins)	$Z' = Z$ x	C_D	C_M	C_t	C_g	C_Δ	-	C_{eg}	-	C_{di}	C_{tn}	3.32	0.65	λ
Split Ring and Shear Plate Connectors	$P' = P$ x	C_D	C_M	C_t	C_g	C_Δ	C_d	-	C_{st}	-	-	3.32	0.65	λ
	$Q' = Q$ x	C_D	C_M	C_t	C_g	C_Δ	C_d	-	-	-	-	3.32	0.65	λ
Timber Rivets	$P' = P$ x	C_D	C_M	C_t	-	-	-	-	C_{st}[4]	-	-	3.32	0.65	λ
	$Q' = Q$ x	C_D	C_M	C_t	-	C_Δ[5]	-	-	C_{st}[4]	-	-	3.32	0.65	λ
Spike Grids	$Z' = Z$ x	C_D	C_M	C_t	-	C_Δ	-	-	-	-	-	3.32	0.65	λ
Withdrawal Loads														
Nails, spikes, lag screws, wood screws, & drift pins	$W' = W$ x	C_D	C_M[2]	C_t	-	-	-	C_{eg}	-	-	C_{tn}	3.32	0.65	λ
Pull-Through														
Fasteners with Round Heads	$W_H' = W_H$ x	C_D	C_M	C_t	-	-	-	-	-	-	-	3.32	0.65	λ

WET SERVICE FACTORS – HEAD PULL-THROUGH

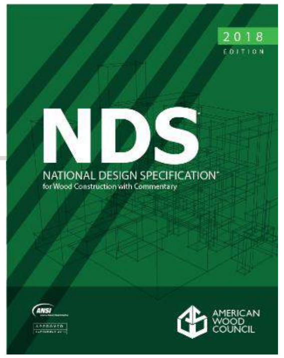
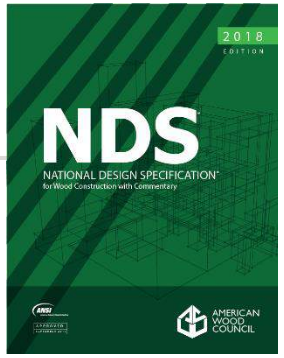


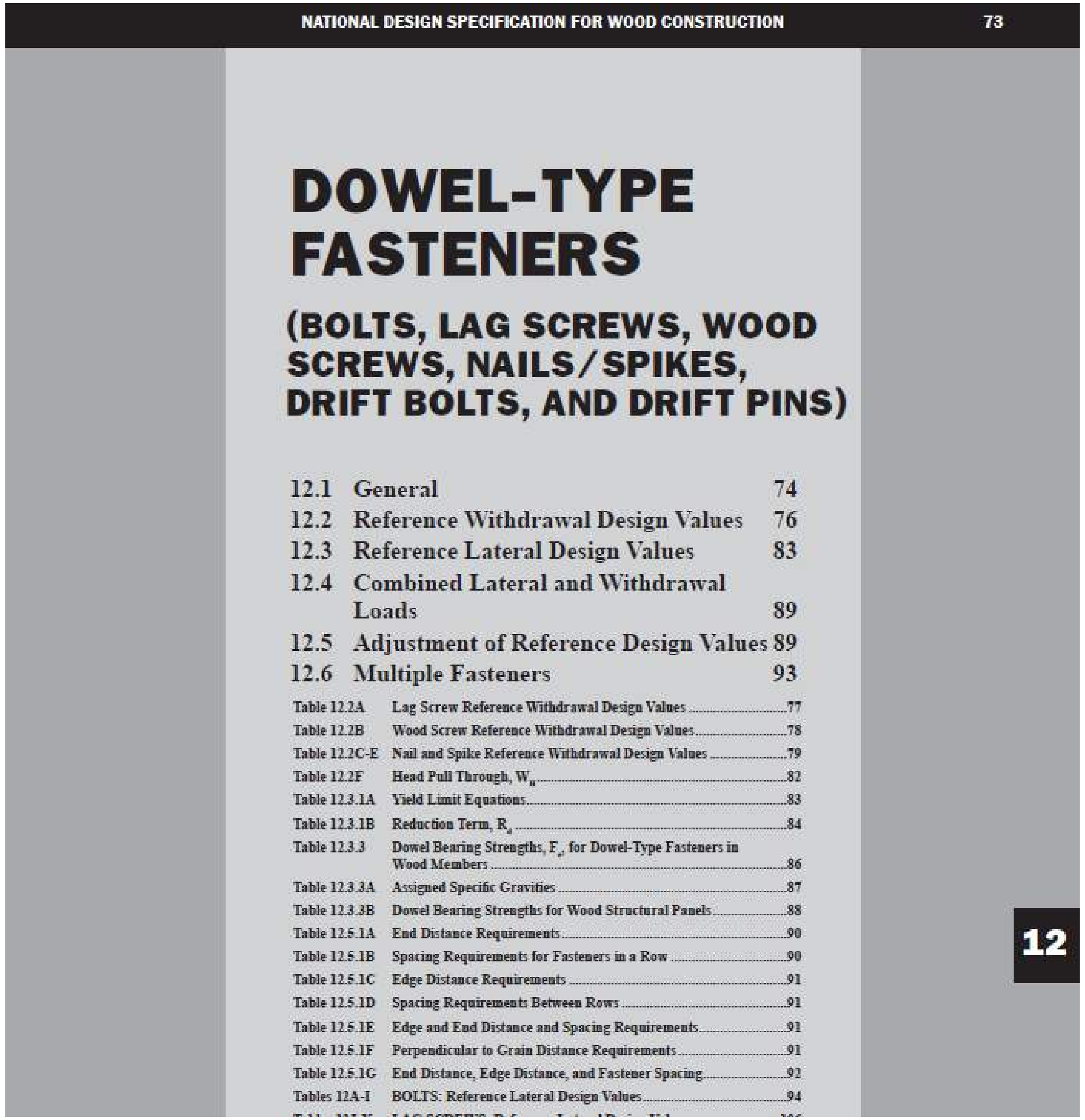
Table 11.3.3 Wet Service Factors, C_M, for Connections

Fastener Type	Moisture Content		C_M
	At Time of Fabrication	In-Service	
Withdrawal Loads			
Lag Screws & Wood Screws	any any	≤ 19% > 19%	1.0 0.7
Nails & Spikes[3]	≤ 19% > 19% ≤ 19% > 19%	≤ 19% ≤ 19% > 19% > 19%	1.0 0.25[3] 0.25[3] 1.0
Pull-Through Loads			
Fasteners with Round Heads	any any	≤ 19% > 19%	1.0 0.7

1. For split ring or shear plate connectors, moisture content limitations apply to a depth of 3/4" below the surface of the wood.
2. C_M = 0.7 for dowel-type fasteners with diameter, D, less than 1/4".
   C_M = 1.0 for dowel-type fastener connections with:
   1) one fastener only, or
   2) two or more fasteners placed in a single row parallel to grain, or
   3) fasteners placed in two or more rows parallel to grain with separate splice plates for each row.
3. For Roof Sheathing Ring Shank (RSRS) and Post-Frame Ring Shank (PF) nails, C_M=1.0.

CHAPTER 12





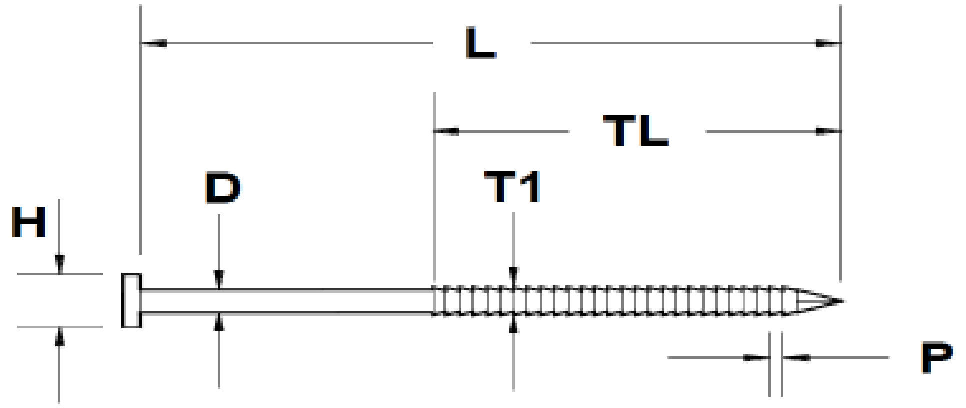
NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 73

DOWEL-TYPE FASTENERS

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

12

Table L6 Roof Sheathing Ring Shank Nails[1]



TYPICAL NAIL HEADS


Full Round

ASTM F1667


Offset Round


D-Head


Notched Head

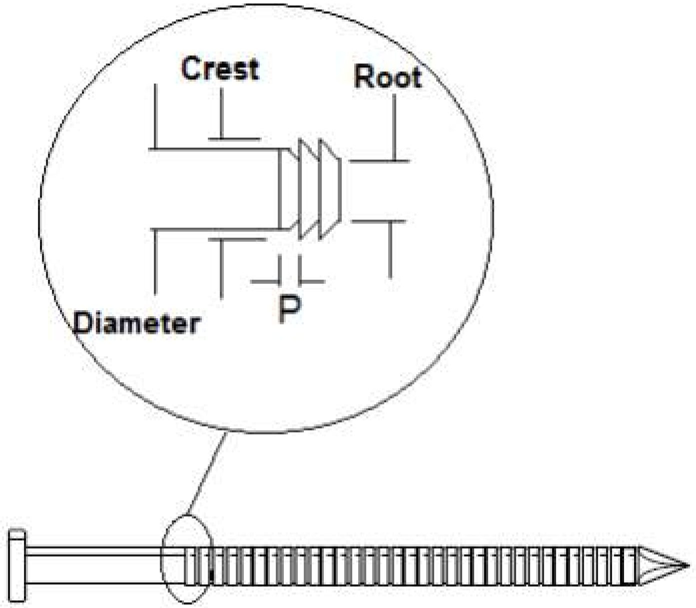
Photos courtesy Falcon Fasteners

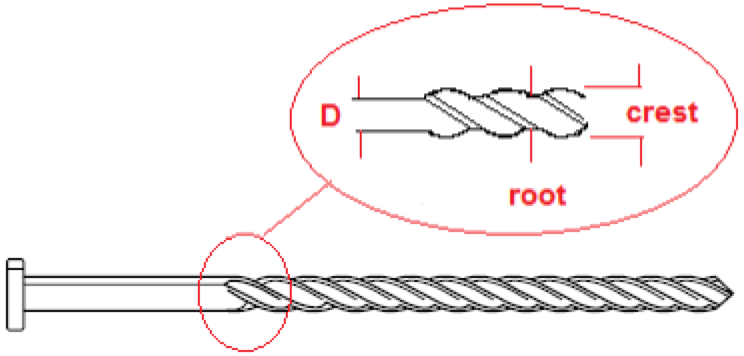
ESR 1539

Photos courtesy of Hitachi – Falcon - Hitachi

TYPICAL NAIL SHANKS

Photos courtesy of Falcon Fasteners





Sketches courtesy ISANTA

ROOF SHEATHING RING SHANK NAILS

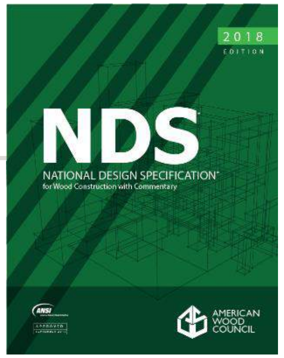
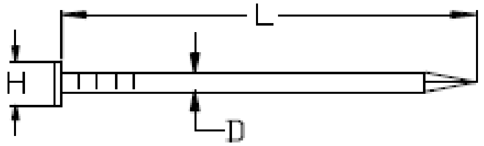
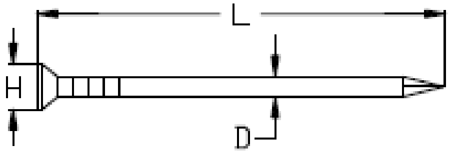


Table L4 Standard Common, Box, and Sinker Steel Wire Nails[1,2]



Common or Box



Sinker

D = diameter, in.
L = length, in.
H = head diameter, in.

Table L5 Post-Frame Ring Shank Nails[1]

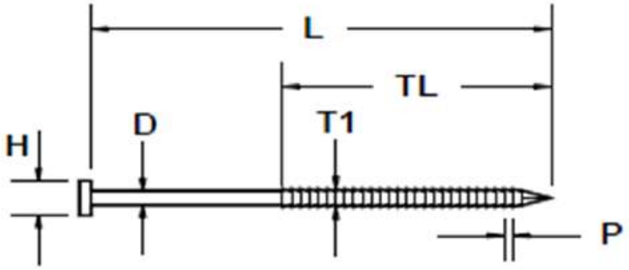
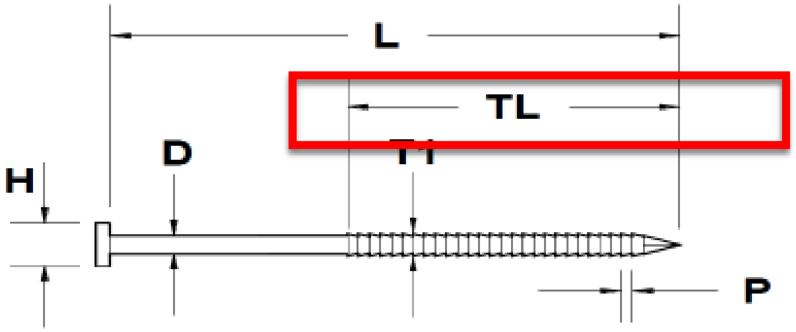


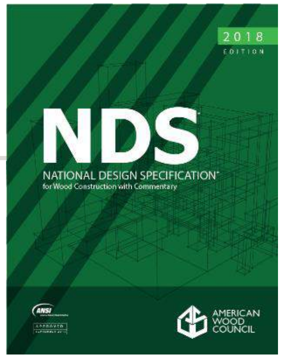
Table L6 Roof Sheathing Ring Shank Nails[1]



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.

SMOOTH SHANK NAILS OR SPIKES



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 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'.

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

CARBON STEEL NAIL WITHDRAWAL

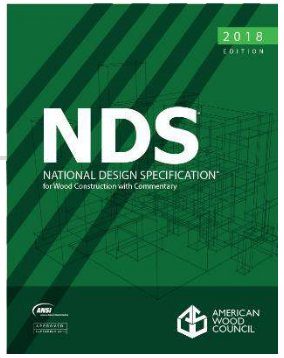


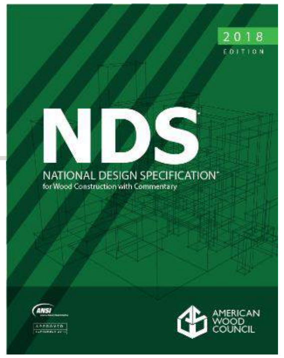
Table 12.2C (Bright or Galvanized) Carbon Steel Nail and Spike Reference Withdrawal Design Values, W[1,3]

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

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.

STAINLESS STEEL NAIL WITHDRAWAL



NEW

Table 12.2D 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)

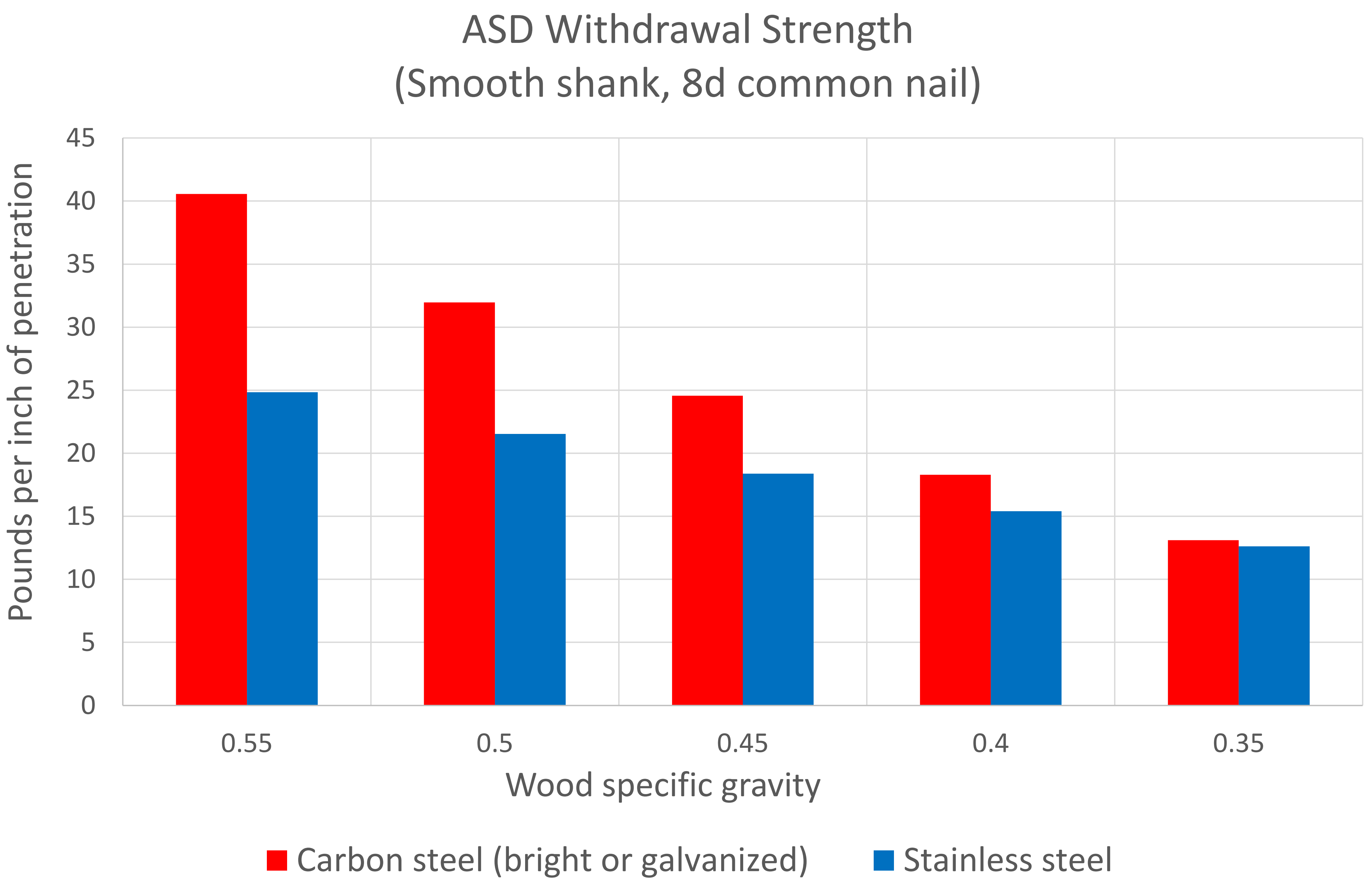
Specific Gravity[2], G	Smooth Shank Stainless Steel Nail and Spike Diameter, D																	
	0.092"	0.099"	0.113"	0.120"	0.128"	0.131"	0.135"	0.148"	0.162"	0.177"	0.192"	0.207"	0.225"	0.244"	0.263"	0.283"	0.312"	0.375"
0.73	27	29	33	35	37	38	39	43	47	51	56	60	65	71	76	82	90	109
0.71	26	28	31	33	36	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

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

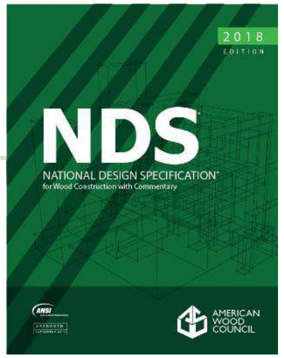
2. Specific gravity shall be determined in accordance with Table 12.3.3A.

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

SMOOTH SHANK NAIL WITHDRAWAL STRENGTH



DEFORMED SHANK NAILS



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'.

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

(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.

RSRS NAIL WITHDRAWAL

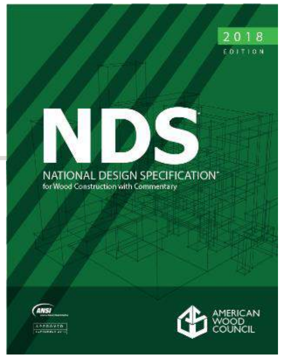


Table 12.2E Roof Sheathing Ring Shank Nail and Post-Frame Ring Shank Nail Reference Withdrawal Design Values, W[1,2]

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

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.

FASTENER HEAD PULL-THROUGH

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.

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

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

Where:

πD_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.

FASTENER HEAD PULL-THROUGH

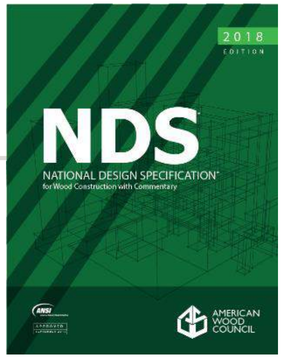


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Table 12.2F Head Pull-Through, W_H[1]

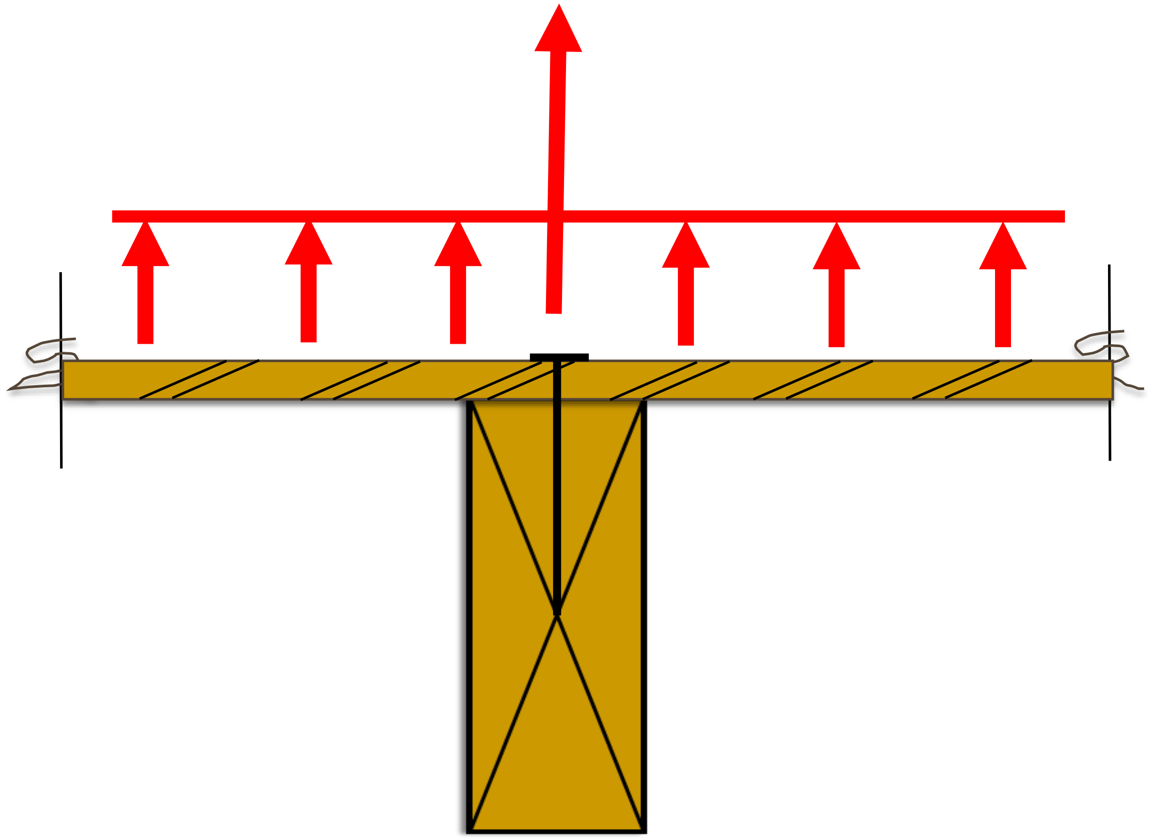
Tabulated pull-through design values, W_H, are in pounds.

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

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.

FASTENER UPLIFT CAPACITY

Fastener Uplift Capacity = lesser of W′ and W_H'



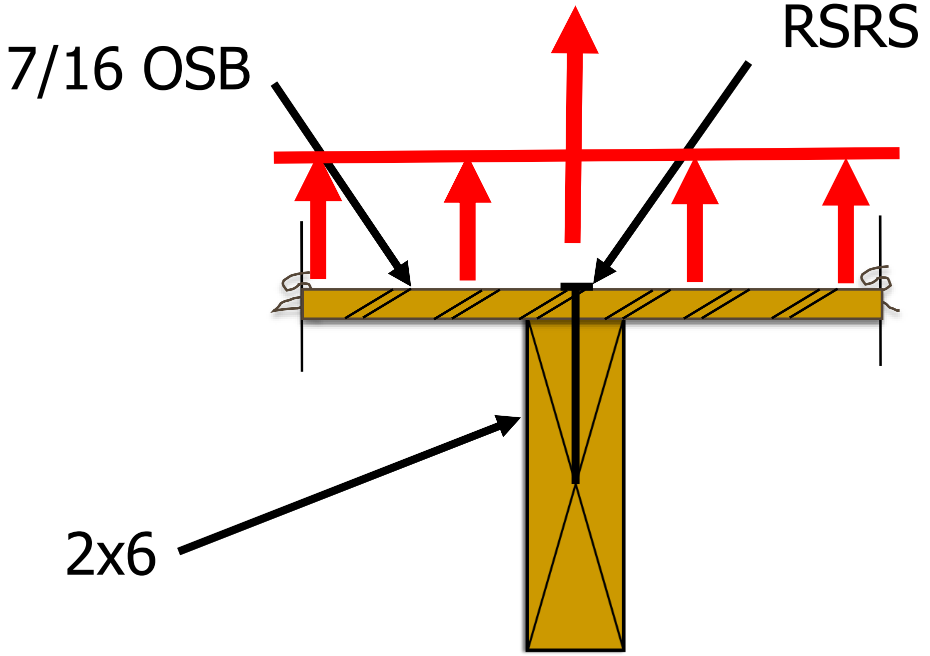
FASTENER UPLIFT DESIGN EXAMPLE

Fastener Uplift Capacity - Roof Sheathing Ring Shank Nail

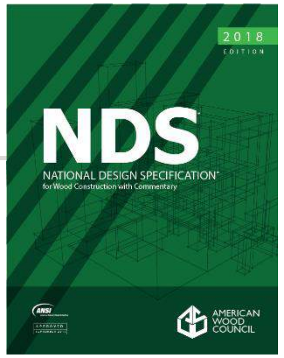
Using 2018 NDS section 12.2, calculate the Allowable Stress Design (ASD) reference withdrawal capacity and head pull-through capacity of a 0.131" diameter, 3" long roof sheathing ring shank (RSRS) nail in the narrow face of a Douglas Fir-Larch 2x6 with a 7/16 in. thick OSB side member.

Main member:
Douglas Fir-Larch (DF-L) 2x6 (G = 0.5)
Side member:
7/16 in. thick Oriented Strand Board (OSB) (G = 0.5)

Fastener Dimensions:
Dash No. 05 (NDS Table L6)
Length = 3 in.
Diameter = 0.131 in.
Head diameter = 0.281 in.
TL = 1.5 in.



FASTENER UPLIFT DESIGN EXAMPLE



Fastener Uplift Capacity - Roof Sheathing Ring Shank Nail (cont.)

$D := 0.131$ — Fastener diameter (in.)

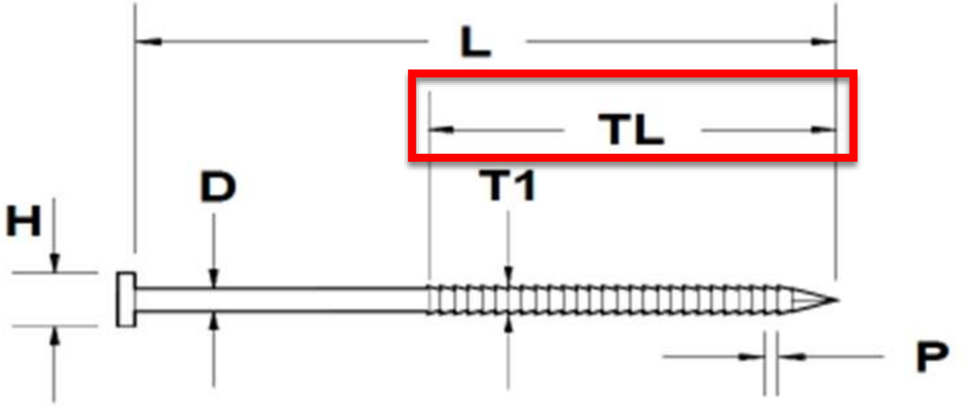
$D_H := 0.281$ — Fastener head diameter (in.)

$TL := 1.5$ — Deformed Shank Length (in.)

$t_{ns} := 0.4375$ — Net Side Member thickness (in.)

$G := 0.5$ — Specific gravity, main and side members (NDS Table 12.3.3A)

Table L6 Roof Sheathing Ring Shank Nails[1]



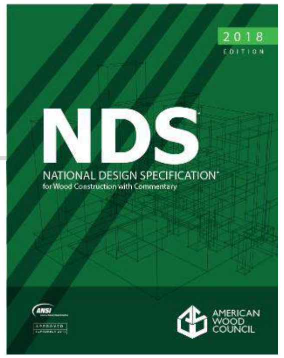
FASTENER UPLIFT DESIGN EXAMPLE

Fastener Uplift Capacity - Roof Sheathing Ring Shank Nail (cont.)

<u>Checking Fastener Withdrawal</u>

$W := 1800 \cdot G^2 \cdot D$	NDS Equation 12.2-5
$W = 59$	Reference withdrawal design value. Compare to NDS Table 12.2E, W = 59 lbs/in
$Resistance := TL \cdot W$	
$Resistance = 88$	Resistance based on main member deformed shank penetration (lbs)

FASTENER UPLIFT DESIGN EXAMPLE



Fastener Uplift Capacity - Roof Sheathing Ring Shank Nail (cont.)

<u>Checking Fastener Head Pull-Through</u>

$t_{ns} = 0.438$

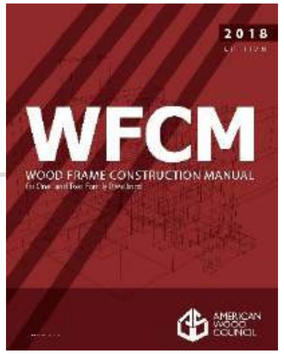
$2.5D_H = 0.703$ — $2.5D_H$ greater than t_{ns}, so NDS Equation 12.2-6a applies

$W_H := 690 \cdot \pi \cdot D_H \cdot G^2 \cdot t_{ns}$ — NDS Equation 12.2-6a

$W_H = 67$ — Head pull-through capacity (lbs). Compare to NDS Table 12.2F, $W_H = 67$ lbs

Fastener head pull-through of 67 lbs is less than withdrawal capacity of 88 lbs and controls design capacity. See NDS Table 11.3.1 for application of additional adjustment factors for connections based on end use conditions.

FASTENER UPLIFT CAPACITY



2018 WFCM Table 3.10

Sheathing Thickness (in.)	Fastener Uplift Capacity[2, 3] (lbs) 3/8		7/16		15/32		19/32		23/32	
Framing Member SG	**0.42**	**0.49**	**0.42**	**0.49**	**0.42**	**0.49**	**0.42**	**0.49**	**0.42**	**0.49**
8d common[4]	70	91	68	100	67	98	63	92	58	86
10d box[4]	84	101	82	118	81	120	77	114	73	108
RSRS-03[5]	91	91	99	106	99	114	99	135	99	135

2 Minimum capacity of withdrawal and fastener head pull-through is tabulated.

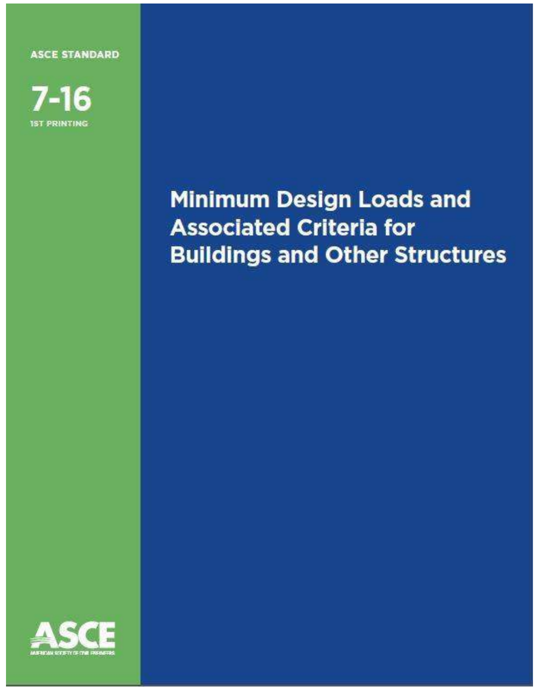
3 Tabulated values include a load duration factor adjustment, C_D=1.6.

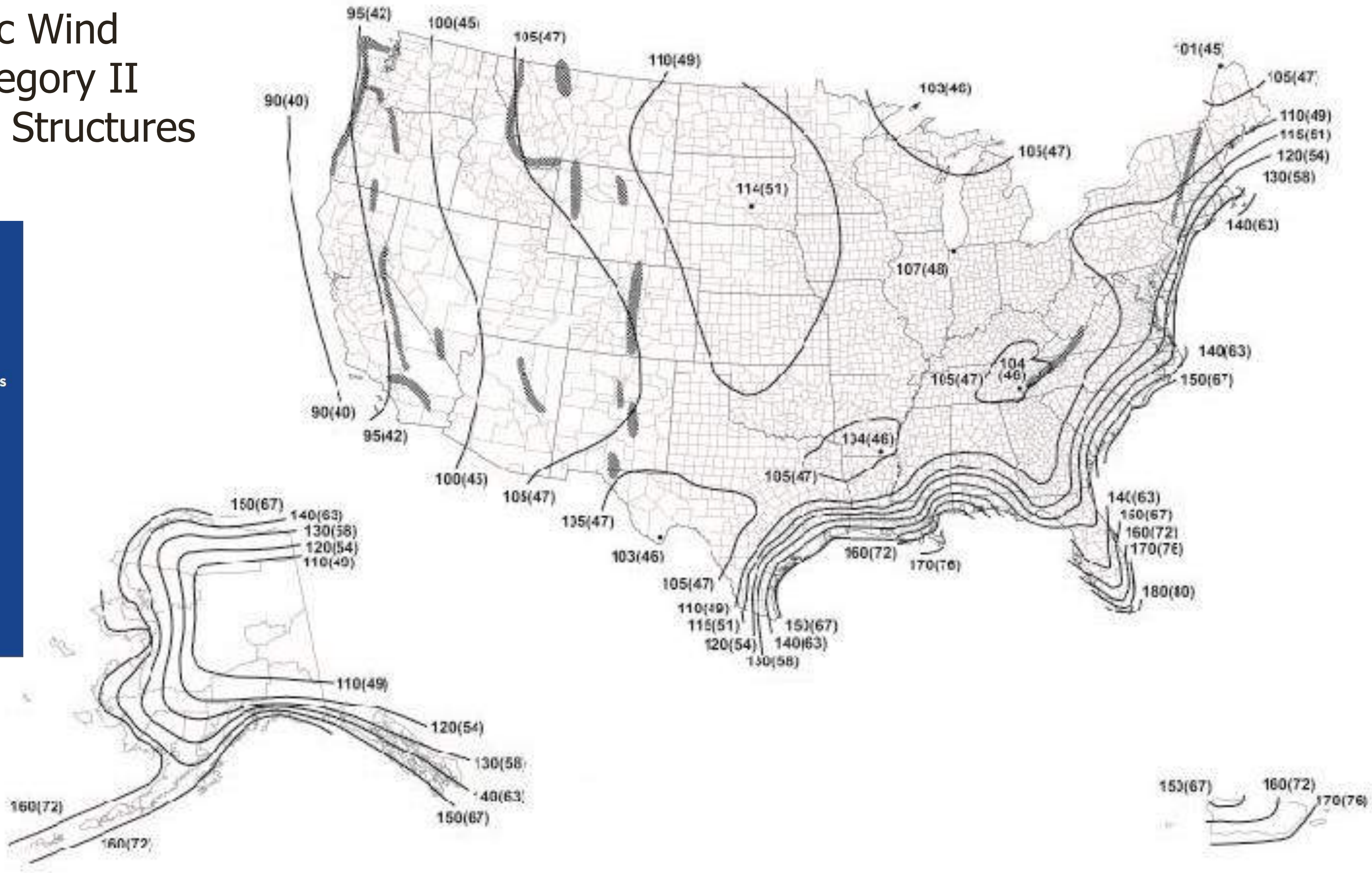
4 Tabulated values for 8d common nails and 10d box nails are applicable to carbon steel nails (bright or galvanized).

5 Tabulated values for RSRS-03 nails are applicable to carbon steel (bright or galvanized) or stainless steel nails.

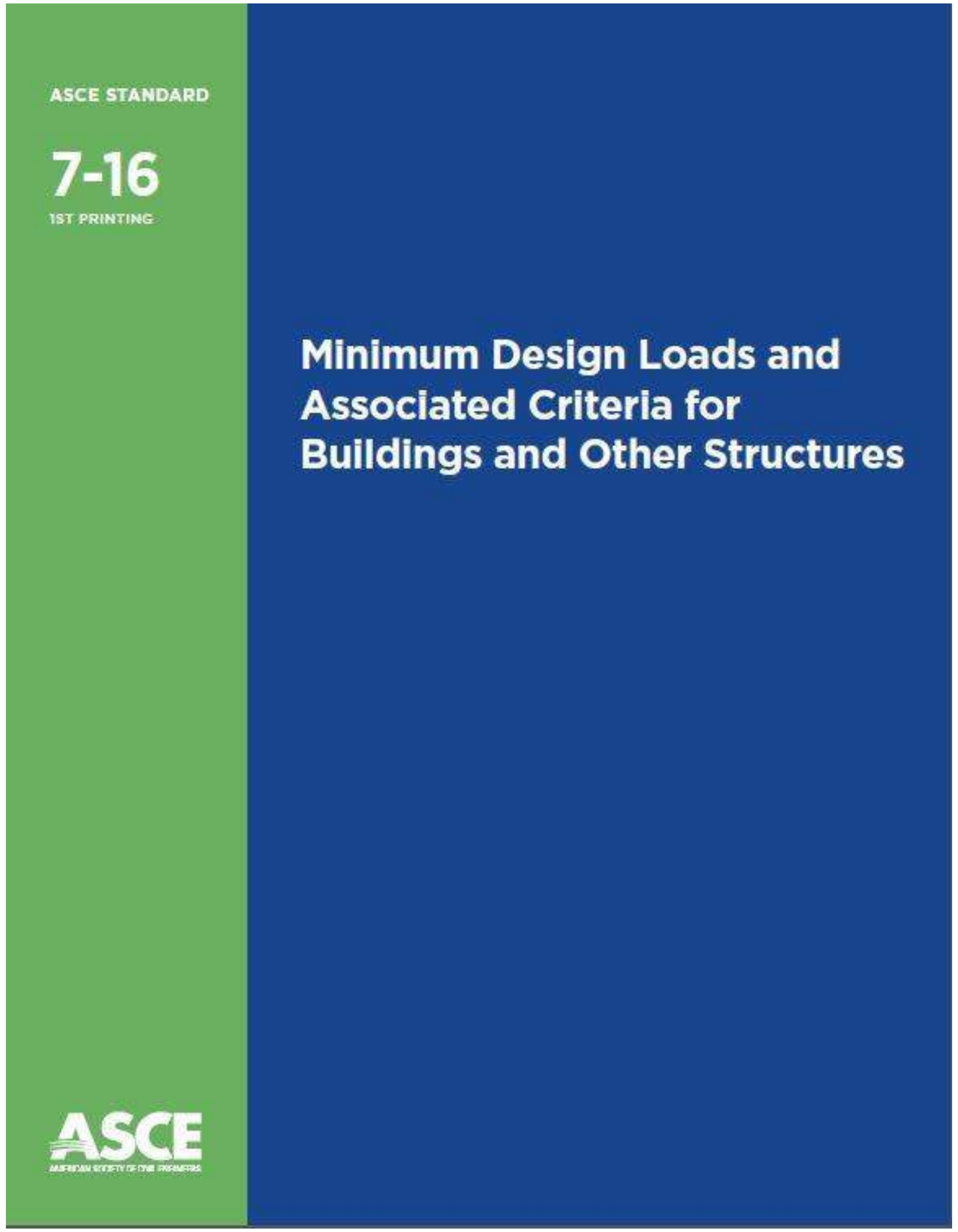
ASCE 7-16 WIND LOAD CHANGES

Figure 26.5-1B Basic Wind Speeds for Risk Category II Buildings and Other Structures



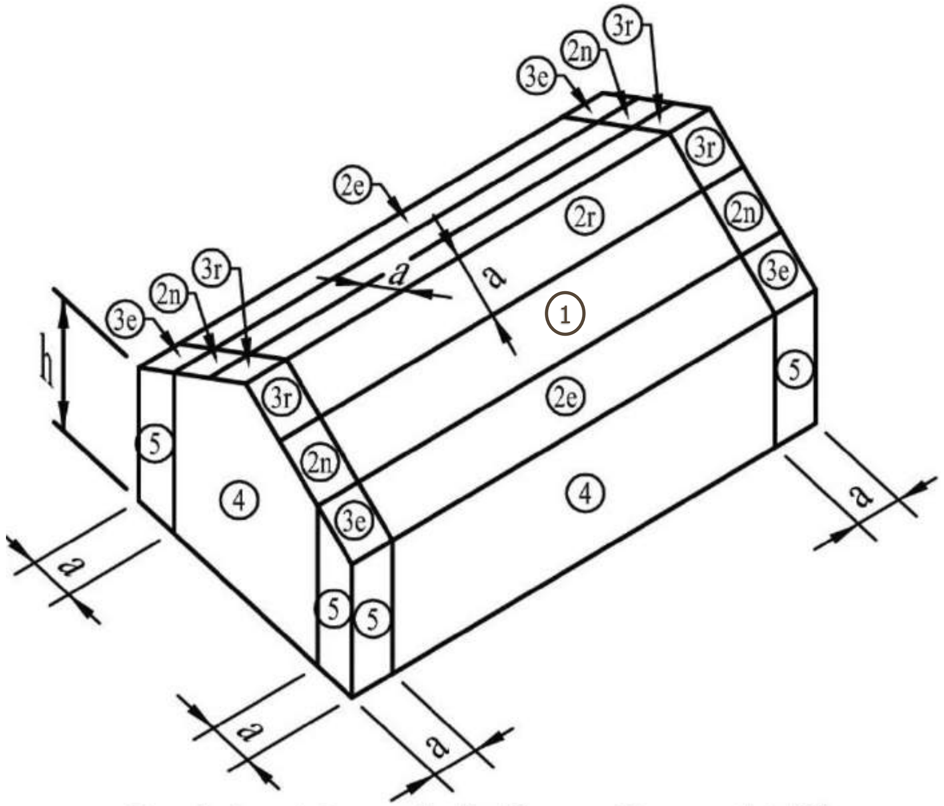


ASCE 7 WIND LOAD CHANGES



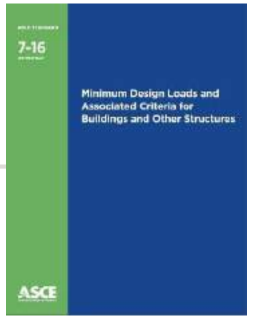
C&C Loads

- Increase in hurricane regions
- Larger roof zones
- Interior roof zones increase most



Gable Roof (7° < Θ ≤ 45°)

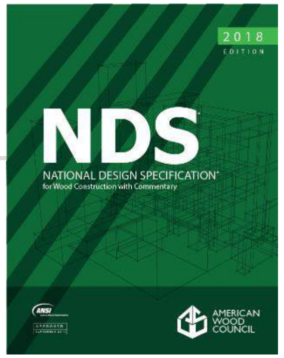
ASCE 7 WIND LOAD CHANGES



C&C Roof Coefficients

Roof Slope	Ratio of ASCE 7-16/ASCE 7-10											
	Roof GC_p - GC_{pi}						Roof Overhang GC_p - GC_{pi}					
	3r	3e	2r	2n	2e	1	3r	3e	2r	2n	2e	1
$7 < \theta \le 20$	1.36	1.14	1.69	1.69	1.16	2.02	1.27	1.11	1.59	1.59	1.14	-
$20 < \theta \le 27$	1.36	0.96	1.43	1.43	0.89	1.56	1.27	0.97	1.36	1.36	0.91	-
$27 < \theta \le 45$	1.58	2.45	1.43	1.58	1.43	1.68	1.40	2.00	1.30	1.40	1.30	-

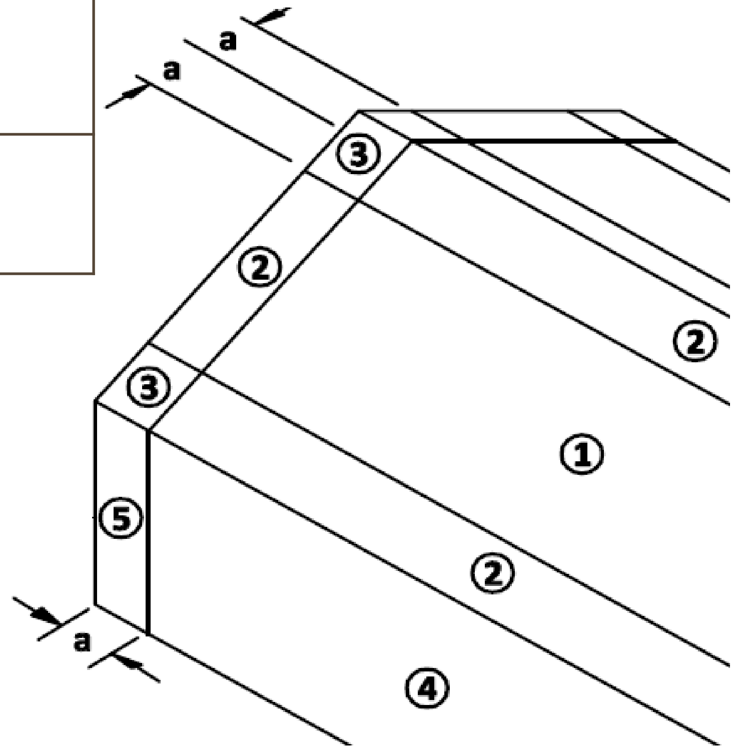
FASTENER UPLIFT CAPACITY COMPARISONS



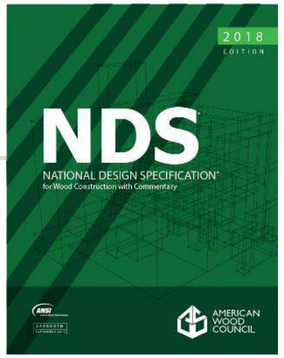
110mph Exposure B, 7/16" WSP, Framing G = 0.42, Rafter spacing = 24”

- For lower wind speed zones and lower G framing, RSRS gives simpler nailing schedule option

Nail Type	Perimeter Nailing (Zones 2 & 3)	Interior Nailing (Zone 1)
RSRS	6/12	6/12
8d Common	6/6	6/12



FASTENER UPLIFT CAPACITY COMPARISONS

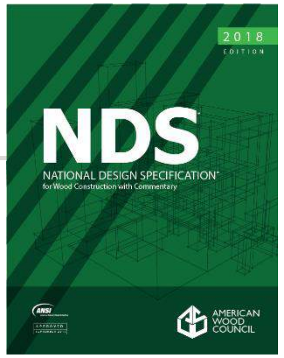


180mph Exposure B, 19/32" WSP, Framing G = 0.55, Rafter spacing = 24”

- Assume complex roof where separating perimeter and interior zones is difficult
- RSRS nails with 19/32" WSP allow 6/6 nailing everywhere – simple
- For higher wind speeds and higher G framing, RSRS provides beneficial options

Nail Type	Perimeter Nailing	Interior Nailing
RSRS	6/6	6/12
8d Common	4/4	6/6

DOWEL DIAMETER



12.3.7 Dowel Diameter

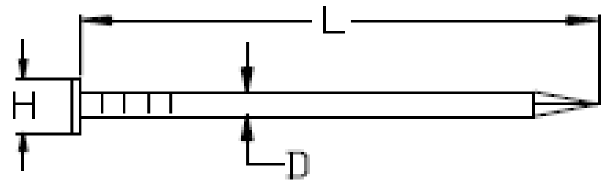
12.3.7.1 Where used in Tables 12.3.1A and 12.3.1B, the fastener diameter shall be taken as:

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

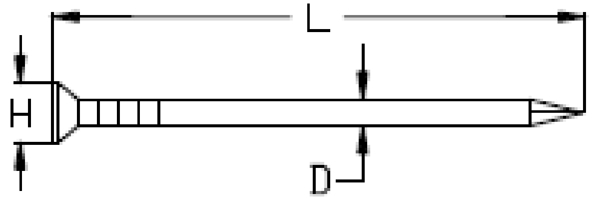
(b) D for unthreaded full-body diameter fasteners, and

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

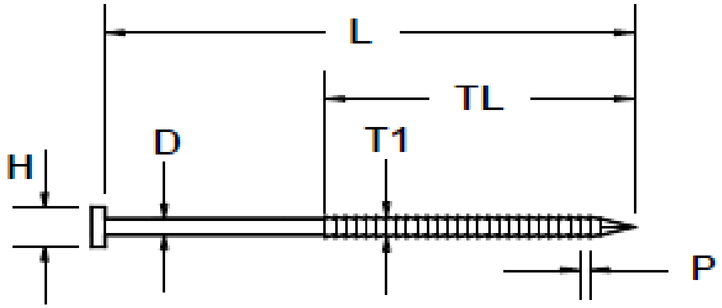
12.3.7.2 For threaded full-body fasteners (see Appendix L), D shall be permitted to be used in lieu of D_r where the bearing length of the threads does not exceed ¼ of the full bearing length in the member holding the threads. Alternatively, a more detailed analysis accounting for the moment and bearing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



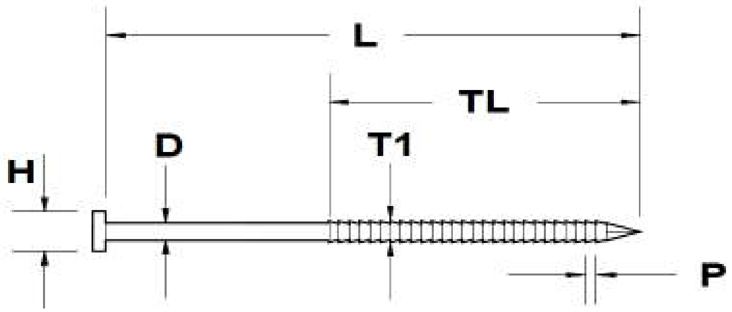
Common or Box



Sinker



Post-Frame Ring Shank



Roof Sheathing Ring Shank

RSRS NAIL LATERAL VALUES

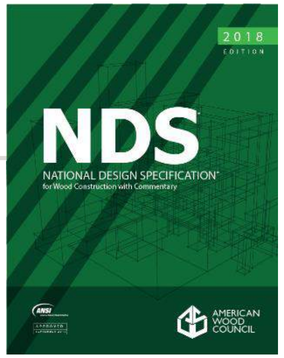
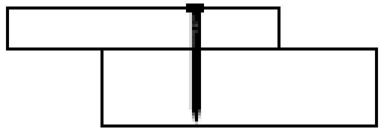


Table 12Q COMMON, BOX, SINKER, or ROOF SHEATHING RING SHANK (RSRS) STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

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 in.	Nail Diameter D in.	Common Wire Nail (Pennyweight)	Box Nail (Pennyweight)	Sinker Nail (Pennyweight)	RSRS (Dash No.)	G=0.67 Red Oak lbs.	G=0.55 Mixed Maple Southern Pine lbs.	G=0.5 Douglas Fir-Larch lbs.	G=0.49 Douglas Fir-Larch (N) lbs.	G=0.46 Douglas Fir(S) Hem-Fir(N) lbs.	G=0.43 Hem-Fir lbs.	G=0.42 Spruce-Pine-Fir lbs.	G=0.37 Redwood lbs.	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods lbs.	G=0.35 Northern Species 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

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" ≤ 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".

RSRS NAIL LATERAL VALUES

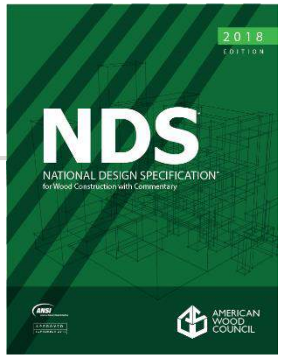
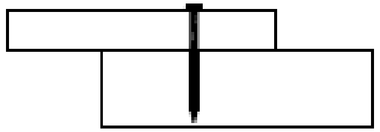


Table 12R COMMON, BOX, SINKER, or ROOF SHEATHING RING SHANK (RSRS) STEEL WIRE NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]

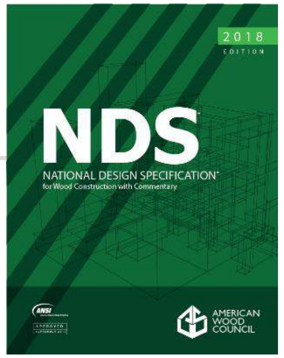
with wood structural panel side members with an effective G=0.42
(tabulated lateral design values are calculated based on an assumed nail penetration, p, into the main member equal to 10D)



Side Member Thickness t_s in.	Nail Diameter D in.	Common Wire Nail (Pennyweight)	Box Nail (Pennyweight)	Sinker Nail (Pennyweight)	RSRS (Dash No.)	G=0.67 Red Oak lbs.	G=0.55 Mixed Maple Southern Pine lbs.	G=0.5 Douglas Fir-Larch lbs.	G=0.49 Douglas Fir-Larch (N) lbs.	G=0.46 Douglas Fir(S) Hem-Fir(N) lbs.	G=0.43 Hem-Fir lbs.	G=0.42 Spruce-Pine-Fir lbs.	G=0.37 Redwood lbs.	G=0.36 Eastern Softwoods Spruce-Pine-Fir(S) Western Cedars Western Woods lbs.	G=0.35 Northern Species 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

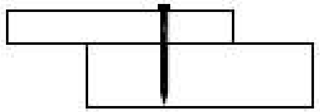
1. Tabulated lateral design values, Z, shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Tabulated lateral design values, Z, are for common, box, or sinker steel wire nails (see Appendix Table L4) and for roof sheathing ring shank nails (see Appendix Table L6) inserted in 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 $0.099" \leq D \leq 0.142"$, 90,000 psi for $0.142" < D \leq 0.177"$, 80,000 psi for $0.177" < D \leq 0.236"$, and 70,000 psi for $0.236" < D \leq 0.273"$.

POST FRAME RING SHANK LATERAL VALUES



REVISED

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 t_s in.	Nail Diameter D in.	Nail Length L in.	G=0.67 Red Oak lb	G=0.55 Mixed Maple Southern Pine lb	G=0.5 Douglas Fir-Larch lb	G=0.49 Douglas Fir-Larch (N) lb	G=0.46 Douglas Fir(S) Hem-Fir(N) lb	G=0.43 Hem-Fir lb	G=0.42 Spruce-Pine-Fir lb	G=0.37 Redwood lb	G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods lb	G=0.35 Northern Species 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. 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.

POST FRAME RING SHANK LATERAL VALUES

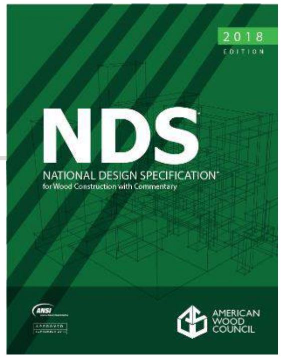


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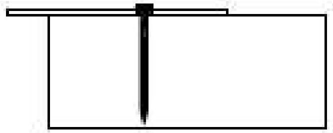
Table 12T **POST FRAME RING SHANK NAILS: Reference Lateral Design Values, Z, for Single Shear (two member) Connections[1,2,3]**

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 in.	Nail Diameter D in.	Nail Length L in.	G=0.67 Red Oak lbs.	G=0.55 Mixed Maple Southern Pine lbs.	G=0.5 Douglas Fir-Larch lbs.	G=0.49 Douglas Fir-Larch (N) lbs.	G=0.46 Douglas Fir(S) Hem-Fir(N) lbs.	G=0.43 Hem-Fir lbs.	G=0.42 Spruce-Pine-Fir lbs.	G=0.37 Redwood lbs.	G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods lbs.	G=0.35 Northern Species lbs.
0.036 (20 gage)	0.135	3, 3.5	127	108	100	98	93	87	86	77	75	73
	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 (18 gage)	0.135	3, 3.5	128	109	101	99	94	88	87	78	76	74
	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

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.

CHAPTER 13

Figure 13A **Split Ring Connector**

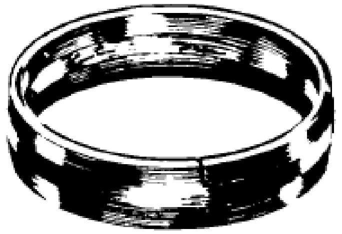


Figure 13B **Pressed Steel Shear Plate Connector**

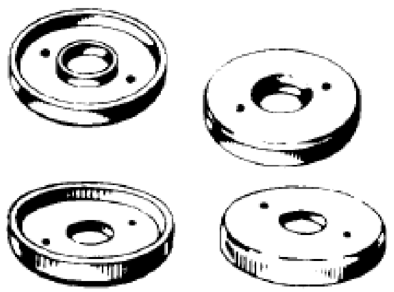
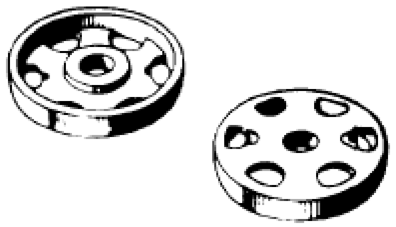


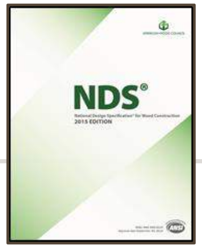
Figure 13C **Malleable Iron Shear Plate Connector**

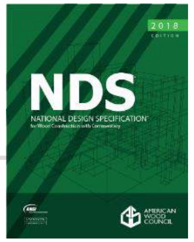


NO CHANGE

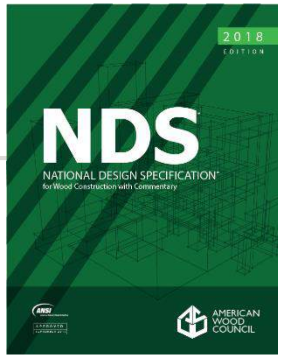
SPLIT RING AND SHEAR PLATE CONNECTORS

13

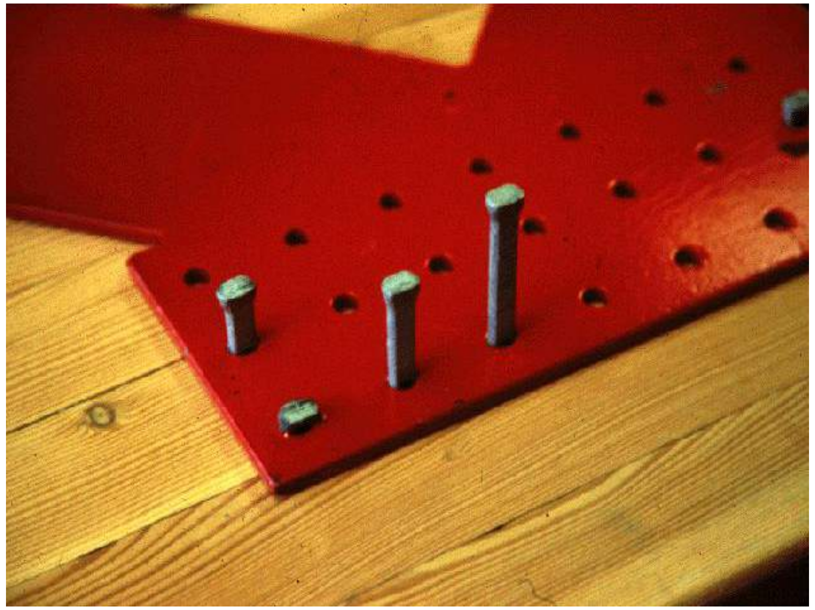


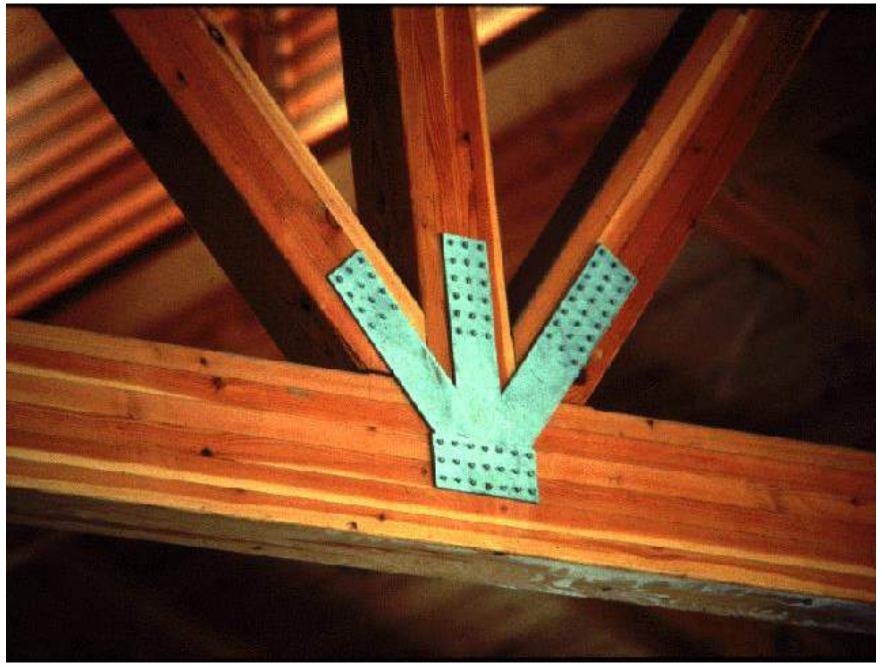


CHAPTER 14

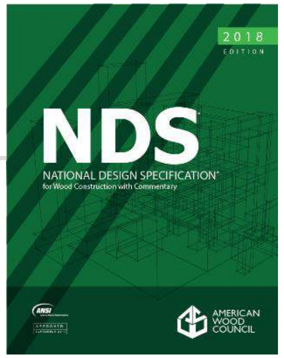


TIMBER RIVETS





WOOD CAPACITY PARALLEL-TO-GRAIN



Limits max distance perp-to-grain between outermost rivet rows to 12

Table 14.2.1A Reference Wood Capacity Design Values Parallel to Grain, P_w, for Timber Rivets

Rivet Length = 1-1/2" s_p = 1" s_q = 1"

Member Thickness in.	Rivets per row	P_w (lbs.) No. of rows per side					
		2	4	6	8	10	12
3	2	2050	4900	7650	10770	14100	17050
	4	3010	6460	9700	13530	17450	20840
	6	4040	8010	11770	16320	20870	24770
	8	5110	9480	13970	18840	23910	28230

Table 14.2.1F Reference Wood Capacity Design Values Parallel to Grain, P_w, for Timber Rivets

Rivet Length = 3-1/2" s_p = 1-1/2" s_q = 1"

Member Thickness in.	Rivets per row	P_w (lbs.) No. of rows per side					
		2	4	6	8	10	12
5	2	2770	6740	10490	14650	19100	23630
	4	4080	8890	13310	18410	23640	28880
	6	5470	11020	16160	22200	28280	34330
	8	6930	13040	19170	25640	32410	39130
	10	8000	15040	21780	29110	36510	44380
	12	9040	16640	24370	32630	40630	48520
	14	9900	18630	26630	35900	44380	53520
	16	10390	20590	29340	38460	48080	57770
	18	11550	22350	31950	41420	51510	61680
	20	12230	24450	34230	43960	54430	64990

WOOD CAPACITY PERPENDICULAR-TO-GRAIN

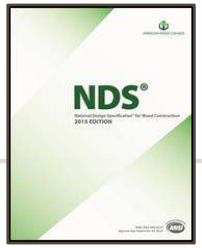
Limits rivets per row

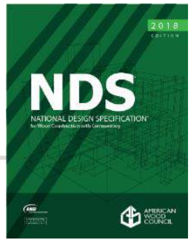
Table 14.2.2A Values of q_w (lbs) Perpendicular to Grain for Timber Rivets

sp = 1"

s_q in.	Rivets per row	Number of rows 2	4	6	8	10
1	2	776	809	927	1089	1255
	3	768	806	910	1056	1202
	4	821	870	963	1098	1232
	5	874	923	1013	1147	1284
	6	959	1007	1094	1228	1371
	7	1048	1082	1163	1297	1436
	8	1173	1184	1256	1391	1525
	9	1237	1277	1345	1467	1624
	10	1318	1397	1460	1563	1752
	11	1420	1486	1536	1663	1850
	12	1548	1597	1628	1786	1970
	13	1711	1690	1741	1882	2062
1-1/2	2	905	921	1042	1211	1395
	3	896	918	1024	1174	1337
	4	958	990	1083	1221	1370
	5	1020	1051	1140	1276	1428
	6	1119	1146	1231	1365	1524
	7	1223	1232	1308	1442	1597
	8	1368	1348	1413	1547	1695
	9	1811	1731	1772	1905	2110

CHAPTER 15

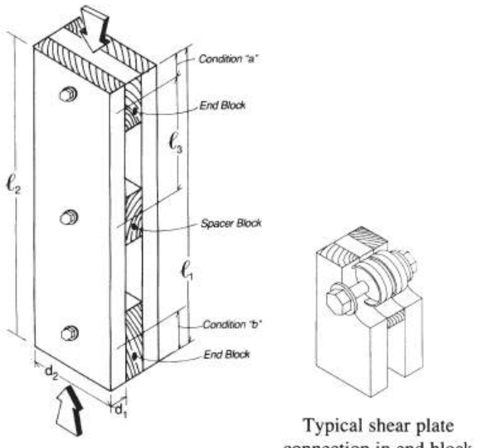




NO CHANGE

SPECIAL LOADING CONDITIONS

Figure 15A Spaced Column Joined by Split Ring or Shear Plate Connectors



Spaced column

Typical shear plate connection in end block of spaced column

Figure 15B Mechanically Laminated Built-Up Columns

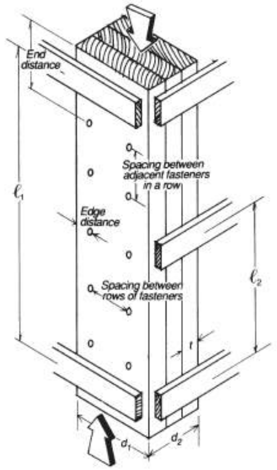
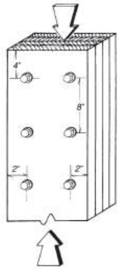
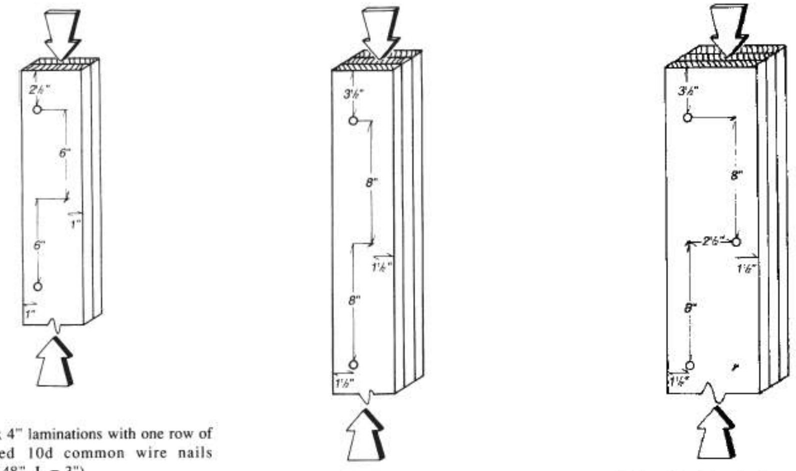


Figure 15D Typical Bolting Schedules for Built-Up Columns



Four 2" x 8" laminations (softwoods) with two rows of ½" diameter bolts.

Figure 15C Typical Nailing Schedules for Built-Up Columns

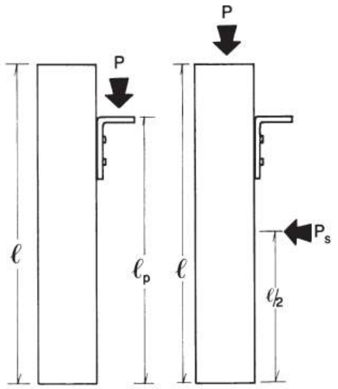


Two 2"x 4" laminations with one row of staggered 10d common wire nails (D = 0.148", L = 3")

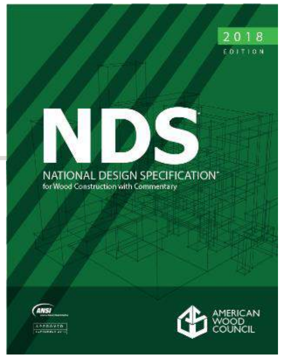
Three 2"x 4" laminations with one row of staggered 30d common wire nails (D = 0.207", L = 4-1/2")

Three 2"x 6" laminations with two rows of 30d common wire nails (D = 0.207", L = 4-1/2")

Figure 15E Eccentrically Loaded Column

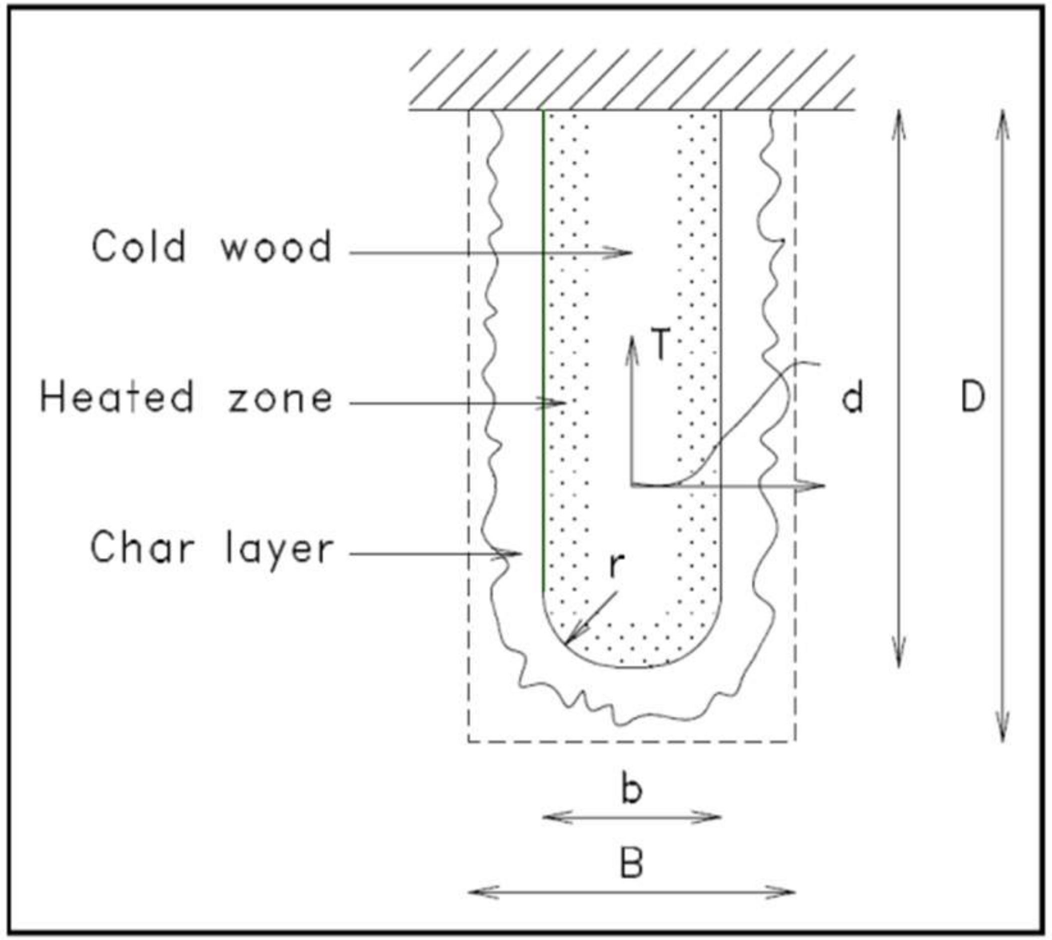


CHAPTER 16



NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 153

FIRE DESIGN OF WOOD MEMBERS



CHAR RATE

16.2.1 Char Rate

16.2.1.1 The non-linear char rate to be used in this procedure can be estimated from published nominal 1-hour char rate data using the following equation:

$$\beta_t = \beta_n \text{ at one hour} \qquad (16.2\text{-}1)$$

where:

β_t = non-linear char rate (in./hr.$^{0.813}$), adjusted for exposure time, t

β_n = nominal char rate (in./hr.), linear char rate based on 1-hour exposure

t = exposure time (hr.)

A nominal char rate, β_n, of 1.5 in./hr. is commonly assumed for sawn lumber, structural glued laminated softwood timber, laminated veneer lumber, parallel strand lumber, laminated strand lumber, and cross-laminated timber.

16.2.1.2 For sawn lumber, structural glued laminated softwood timber, laminated veneer lumber, parallel strand lumber, and laminated strand lumber, the char depth, a_{char}, for each exposed surface shall be calculated as:

$$a_{char} = \beta_t t^{0.813} \qquad (16.2\text{-}2)$$

CHAR DEPTH

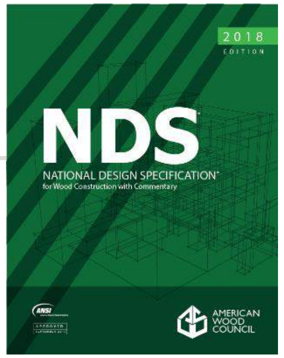


Table 16.2.1A Char Depth and Effective Char Depth (for β_n = 1.5 in./hr.)

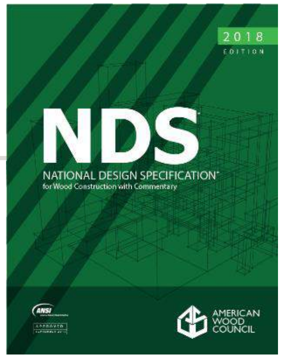
Required Fire Resistance (hr.)	Char Depth, a_{char} (in.)	Effective Char Depth, a_{eff} (in.)
1-Hour	1.5	1.8
1½-Hour	2.1	2.5
2-Hour	2.6	3.2

Structural Fire Design

For sawn lumber, structural glued laminated softwood timber, laminated veneer lumber, parallel strand lumber, and laminated strand lumber, assuming a nominal char rate, β_n = 1.5 in./hr., the char depth, a_{char}, and effective char depth, a_{eff}, are shown in Table 16.2.1A.

For cross-laminated timber manufactured with laminations of equal thickness and assuming a nominal char rate, β_n, of 1.5 in./hr., the effective char depth, a_{eff}, for each exposed surface is shown in Table 16.2.1B.

CONNECTIONS



16.3 Wood Connections

Wood connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. Protection shall be provided by wood, fire-rated gypsum board, other approved materials, or a combination thereof.

Photo courtesy of Softwood Lumber Board

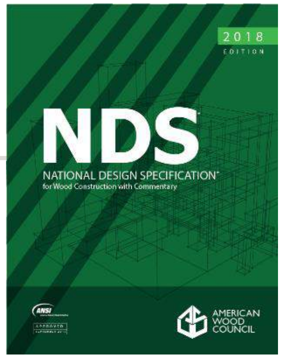
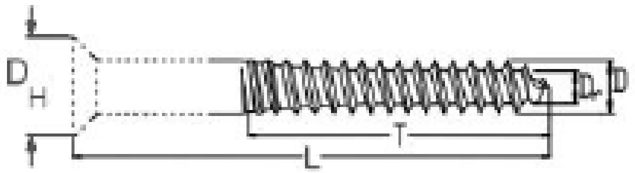
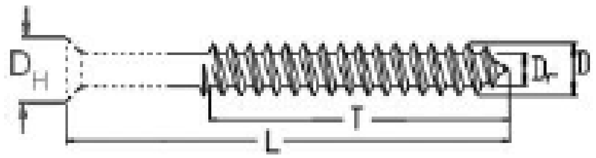


Table L3 Standard Wood Screws[1,6]



Cut Thread[2]



Rolled Thread[3]

D = diameter, in.

D_H = head diameter[5], in.

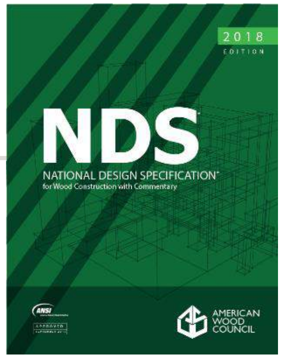
D_r = root diameter, in.

L = screw length, in.

T = thread length, in.

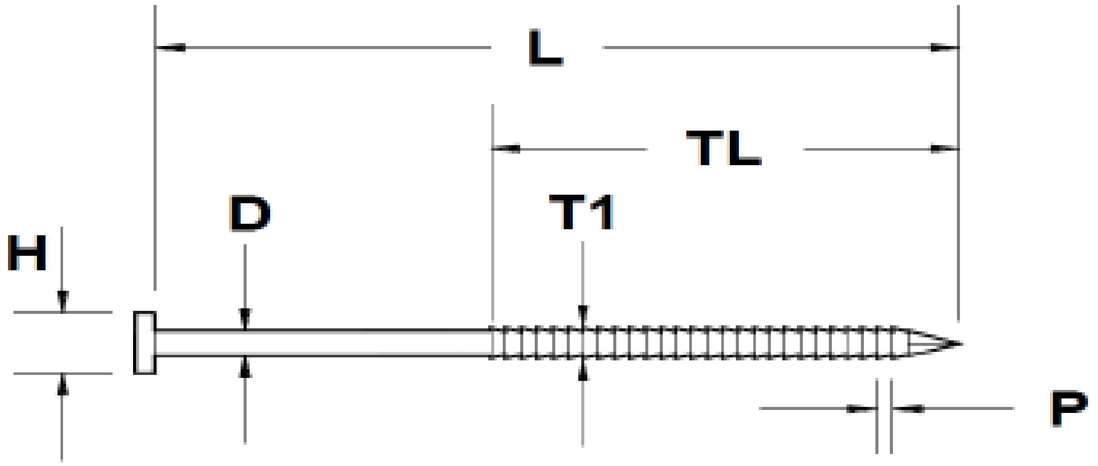
	Wood Screw Number										
	6	7	8	9	10	12	14	16	18	20	24
D	0.138	0.151	0.164	0.177	0.19	0.216	0.242	0.268	0.294	0.32	0.372
D_r[4]	0.113	0.122	0.131	0.142	0.152	0.171	0.196	0.209	0.232	0.255	0.298
D_H[5]	0.262	0.287	0.312	0.337	0.363	0.414	0.480	0.515	0.602	0.616	0.724

1. Tolerances specified in ANSI/ASME B18.6.1
2. Thread length on cut thread wood screws is approximately 2/3 of the wood screw length, L.
3. Single lead thread shown. Thread length is at least four times the screw diameter or 2/3 of the wood screw length, whichever is greater. Wood screws which are too short to accommodate the minimum thread length, have threads extending as close to the underside of the head as practicable.
4. Taken as the average of the specified maximum and minimum limits for body diameter of rolled thread wood screws.
5. Taken as the average of the specified maximum and minimum limits for head diameter.
6. It is permitted to assume the length of the tapered tip is 2D.



NEW

Table L6 Roof Sheathing Ring Shank Nails[1]



D = diameter, in.

L = length, in.

H = head diameter, in.

TL = minimum length of threaded shank, in.

T1 = crest diameter, in.

$D + 0.005$ in. $\le T1 \le D + 0.012$ in.

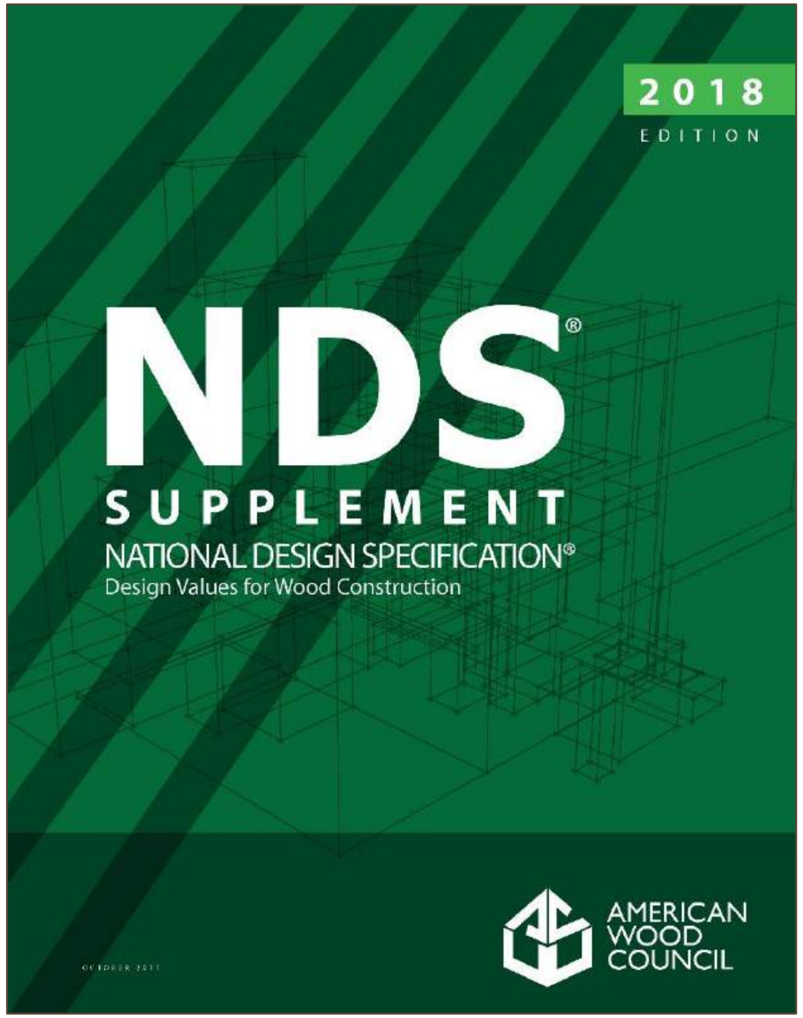
P = pitch or spacing of threads, in.

0.05 in. $\le P \le 0.077$ in.

Dash No.	D	L	TL	H
01	0.113	2-3/8	1-1/2	0.281
02	0.120	2-1/2	1-1/2	0.281
03	0.131	2-1/2	1-1/2	0.281
04	0.120	3	1-1/2	0.281
05	0.131	3	1-1/2	0.281

1. Tolerances are specified in ASTM F1667.

NDS 2018 SUPPLEMENT

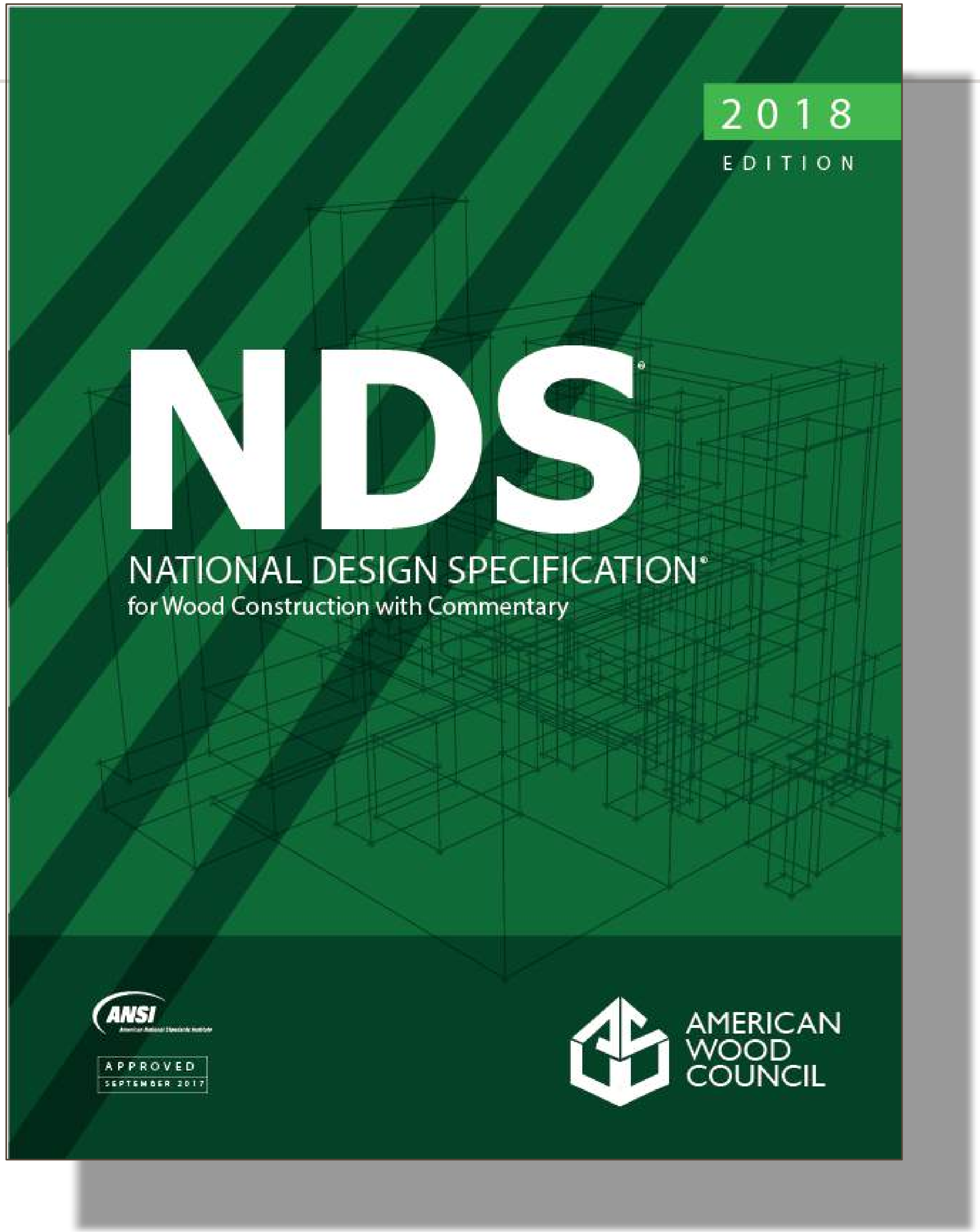


- New and revised grades of MSR & MEL
- Redwood grades requiring "close grain," removed
- Addition of Norway Spruce (from Norway) to foreign species dimension lumber
- Addition of shear-free moduli of elasticity for structural glulam

MORE INFO???

What's Changed?

http://awc.org/codes-standards/publications



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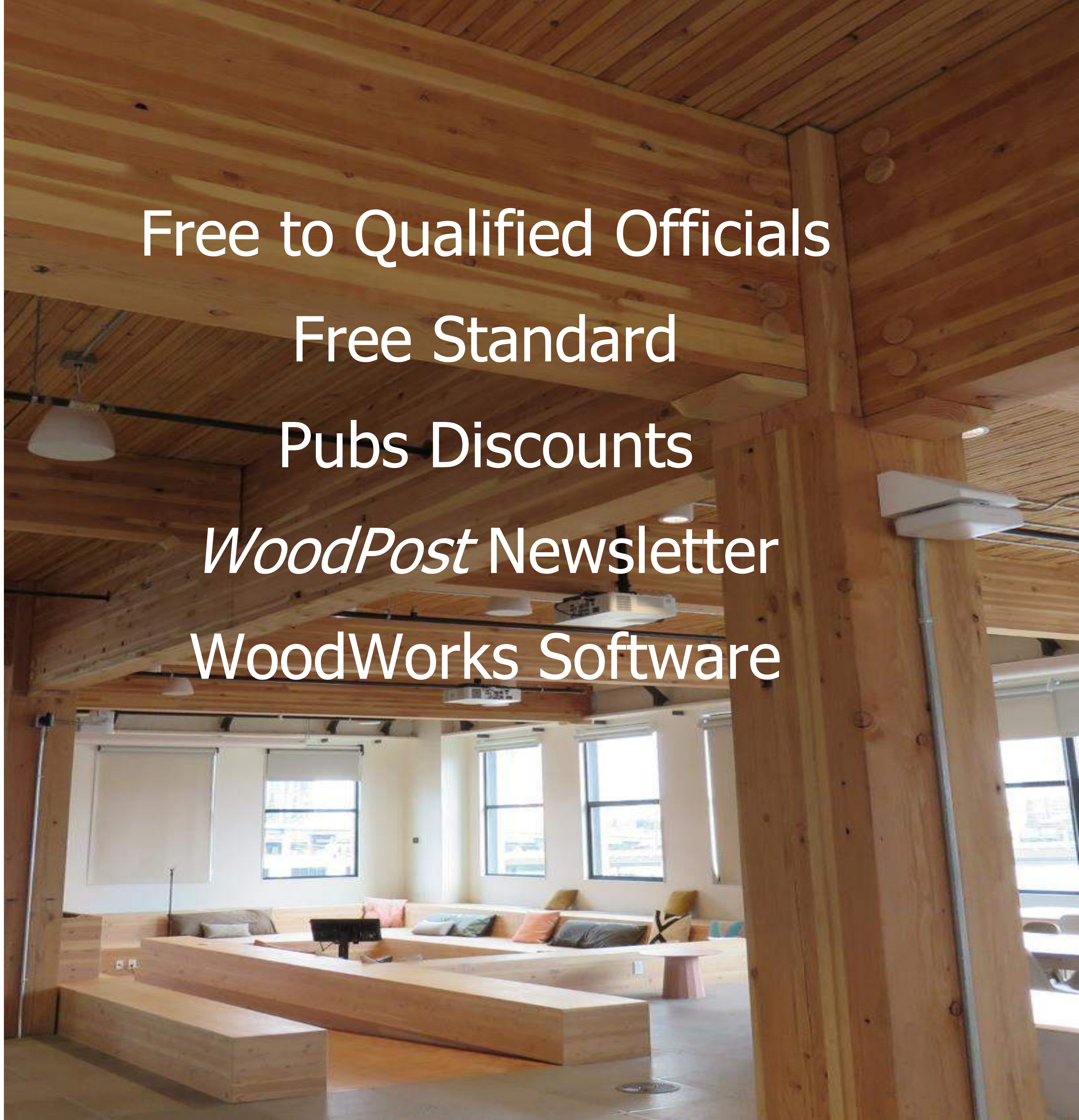


CONSTRUCTION FIRE SAFETY COALITION

www.constructionfiresafety.org

Free to Qualified Officials

Fire Safety Manuals

Links & Resources

Webinars

Checklists & Guidance Documents

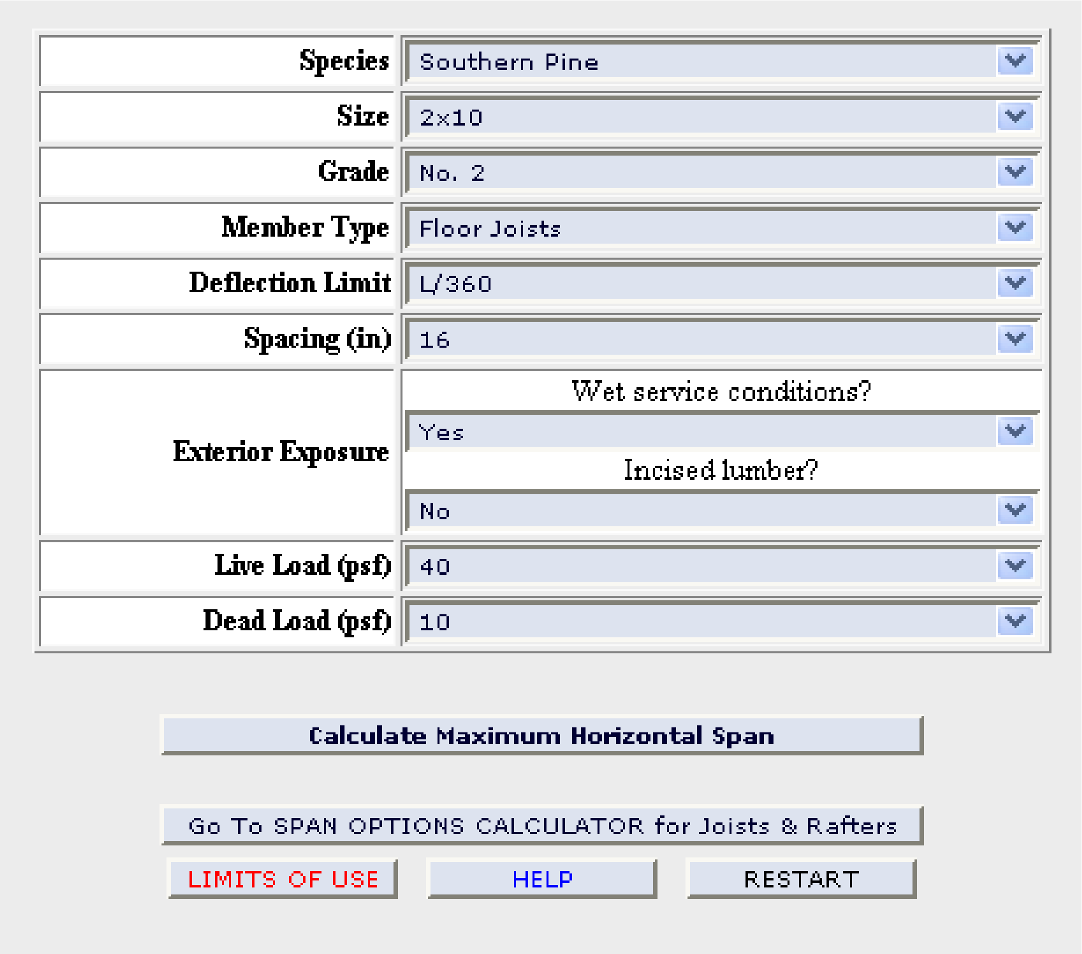
Quarterly Newsletters

CODE CONFORMING WOOD DESIGN (CCWD)

- Allowable building size
- Special occupancies
- Fire resistance
- Building features
- Wood in noncombustible construction types
- Structural considerations
- Precautions during construction

Free Download

WOOD JOIST AND RAFTER SPAN CALCULATOR



- Simple spans (no cantilever)
- Uniform loads
- Wet service conditions
- Incising factor
- Free at www.awc.org

The Maximum Horizontal Span is:

15 ft. 10 in.

with a minimum bearing length of **0.93 in.** required at each end of the member.

Property	Value
Species	Southern Pine
Grade	No. 2
Size	2x10
Modulus of Elasticity (E)	1440000 psi
Bending Strength (F_b)	1207.5 psi
Bearing Strength (F_{cp})	378.55 psi
Shear Strength (F_v)	169.75 psi

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CONNECTION CALCULATOR

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Bolt
Loading Scenario	Double Shear - Wood Main Member

Main Member Type	Southern Pine
Main Member Thickness	1.5 in.
Main Member: Angle of Load to Grain	0
Side Member Type	Southern Pine
Side Member Thickness	1.5 in.
Side Member: Angle of Load to Grain	0
Fastener Diameter	1 in.
Load Duration Factor	C_D = 1.0
Wet Service Factor	C_M = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	2306 lbs.
Is	4612 lbs.
IIIs	4307 lbs.
IV	6003 lbs.

Adjusted ASD Capacity	**2306 lbs.**

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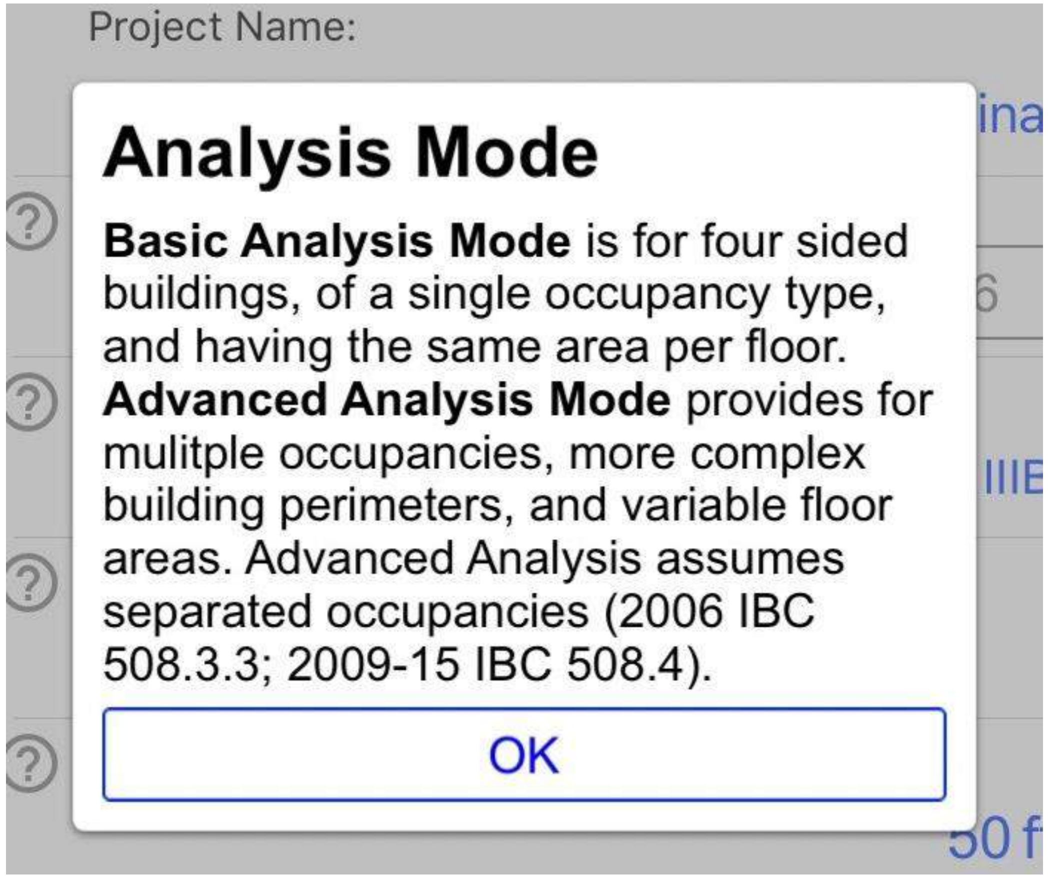
HEIGHTS & AREAS CALCULATOR

2 Analysis Modes

- Basic
- Advanced



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ENERGY UA CALCULATOR

AMERICAN WOOD COUNCIL

ENERGY UA CALCULATOR

Climate Information:

Climate Zone: Zone 3

Req'd Wall U (Btu/ hr·ft²·°F): 0.057

Req'd Fenestration U (Btu/ hr·ft²·°F): 0.35

Design Parameters:

Percent Fenestration (%): 18

Calculation Method:

Calculated needed: Wall **Fenestration**

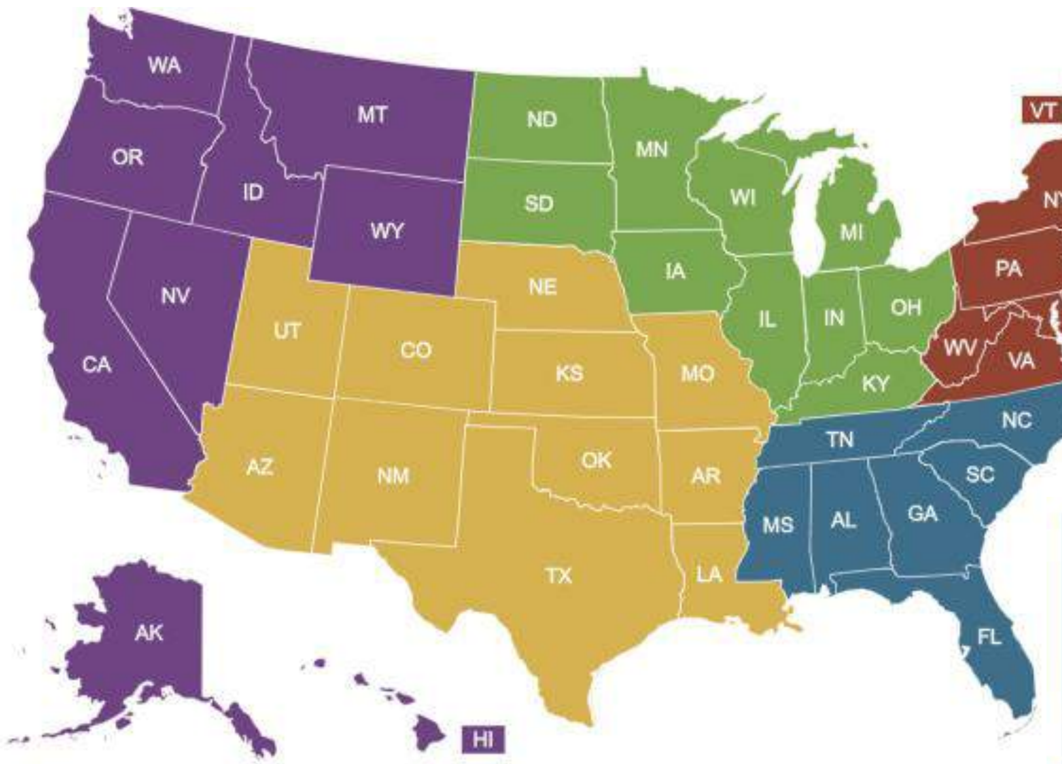
Actual Wall U (Btu/ hr·ft²·°F): 0.068

Results:

Calculated Fenestration U-factor: 0.3 Btu/ hr·ft²·°F

Stud Size	Spacing	Sheathing	Vinyl /steel / aluminum: uninsulated (hollow-back)	Vinyl /steel / aluminum: insulated (R2)	Vinyl /steel / aluminum: insulated (R3)	brick veneer: 3/4" air space	hardboard siding	plywood siding: edges - lapped	wood siding: drop - 8"	wood siding: bevel - 8", lapped	wood siding: bevel - 10", lapped
2x4	16in	3/8in OSB	R 22	R 17	R 14	R 19	R 22	R 22	R 21	R 21	R 20
2x6	16in	3/8in OSB	R 16	R 13	R 12	R 15	R 16	R 16	R 16	R 16	R 15
2x4	24in	3/8in OSB	R 20	R 16	R 13	R 18	R 20	R 20	R 19	R 19	R 18
2x6	24in	3/8in OSB	R 16	R 13	R 12	R 14	R 16	R 16	R 15	R 15	R 15
2x4	16in	1/2in SFB	R 20	R 15	R 13	R 17	R 19	R 20	R 19	R 19	R 18
2x6	16in	1/2in SFB	R 15	R 13	R 11	R 14	R 15	R 15	R 15	R 15	R 14
2x4	24in	1/2in SFB	R 18	R 14	R 12	R 16	R 18	R 18	R 17	R 17	R 17
2x6	24in	1/2in SFB	R 15	R 12	R 11	R 14	R 15	R 15	R 14	R 14	R 14
2x4	16in	25/32in SFB	R 17	R 13	R 11	R 15	R 17	R 17	R 16	R 16	R 16
2x6	16in	25/32in SFB	R 14	R 11	R 10	R 12	R 13	R 14	R 13	R 13	R 13
2x4	24in	25/32in SFB	R 16	R 13	R 11	R 14	R 16	R 16	R 15	R 15	R 15
2x6	24in	25/32in SFB	R 13	R 11	R 10	R 12	R 13	R 13	R 13	R 13	R 13

AWC FIELD STAFF



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