American Iron and Steel Institute

North American Standards for Cold-Formed Steel Framing

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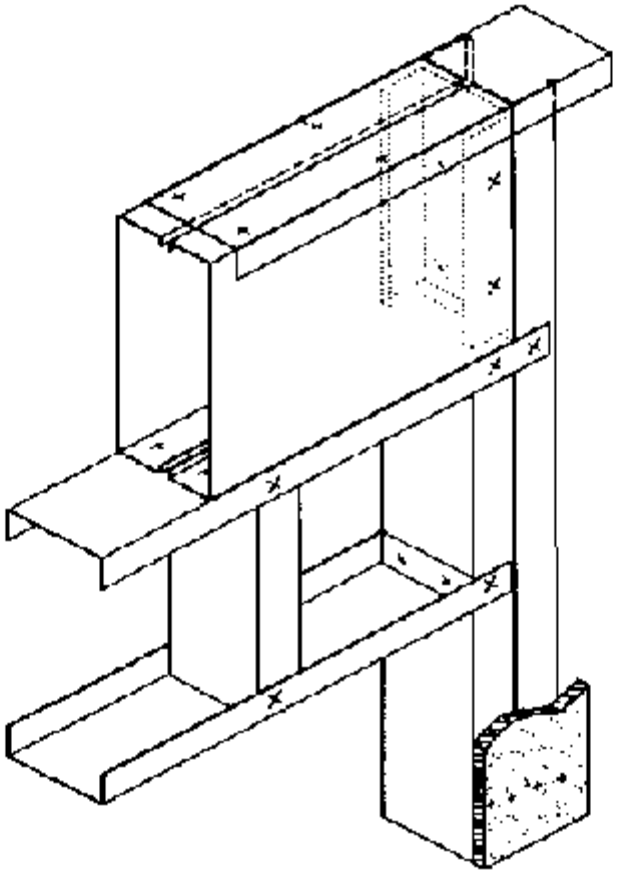
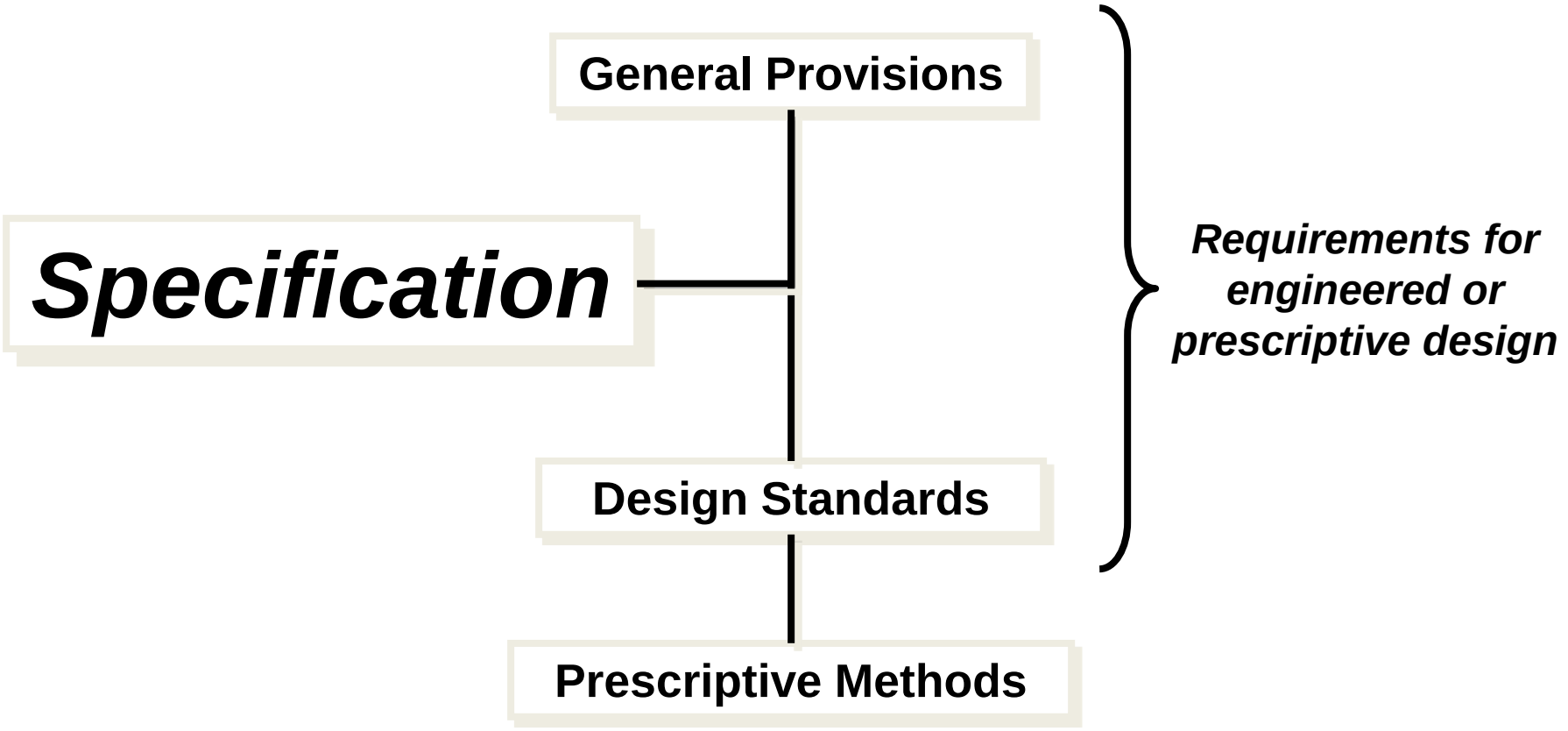
COFS Mission

- To eliminate regulatory barriers and increase the reliability and cost competitiveness of cold-formed steel framing in residential and light commercial building construction through improved ***design*** and ***installation*** standards.

Member versus System Design



AISI Standards Hierarchy



Framing Standards
www.aisistandards.org

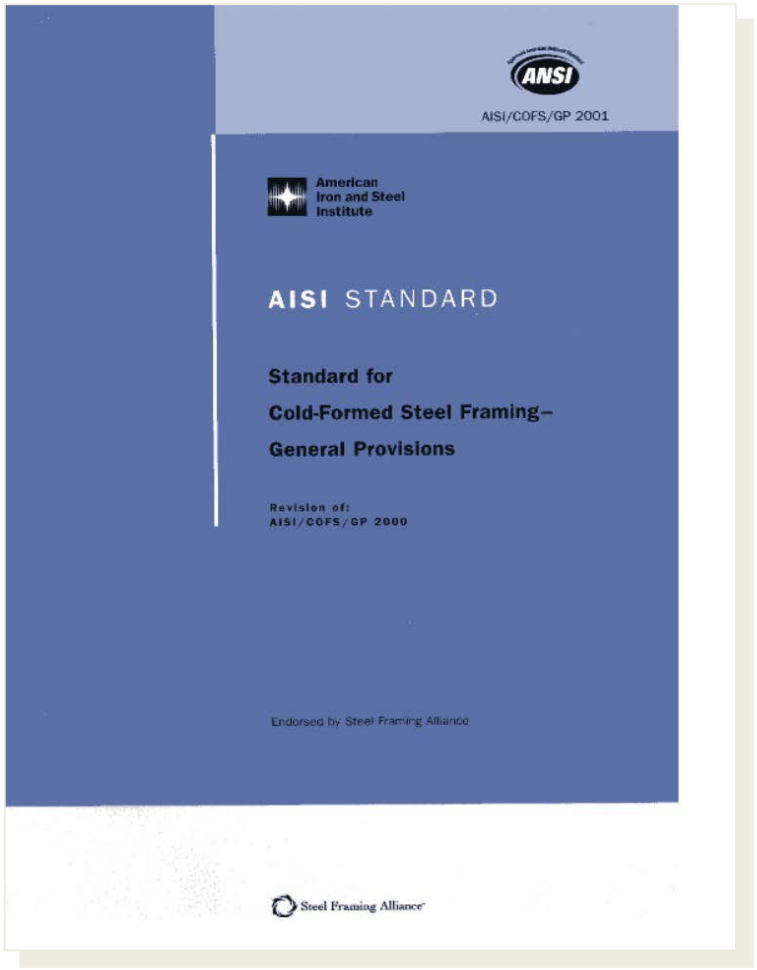
- Existing Standards:
  - AISI S200: General Provisions *
  - AISI S201: Product Standard *
  - AISI S202: Code of Standard Practice
  - AISI S210: Floor and Roof System Design *
  - AISI S211: Wall Stud Design *
  - AISI S212: Header Design *
  - AISI S213: Lateral Design *
  - AISI S214: Truss Design *
  - AISI S230: Prescriptive Method for One and Two Family Dwellings

* North American Standard

AISI Framing Standards

- General:
  - AISI S200: General Provisions
  - AISI S201: Product Standard
  - AISI S202: Code of Standard Practice
- Design Standards:
  - AISI S210: Floor and Roof System Design
  - AISI S211: Wall Stud Design
  - AISI S212: Header Design
  - AISI S213: Lateral Design
  - AISI S214: Truss Design
- Prescriptive Methods:
  - AISI S230: Prescriptive Method for One and Two Family Dwellings

AISI S200: General Provisions



A. GENERAL
B. MEMBER DESIGN
C. INSTALLATION
D. CONNECTIONS
E. MISCELLANEOUS

Member Design

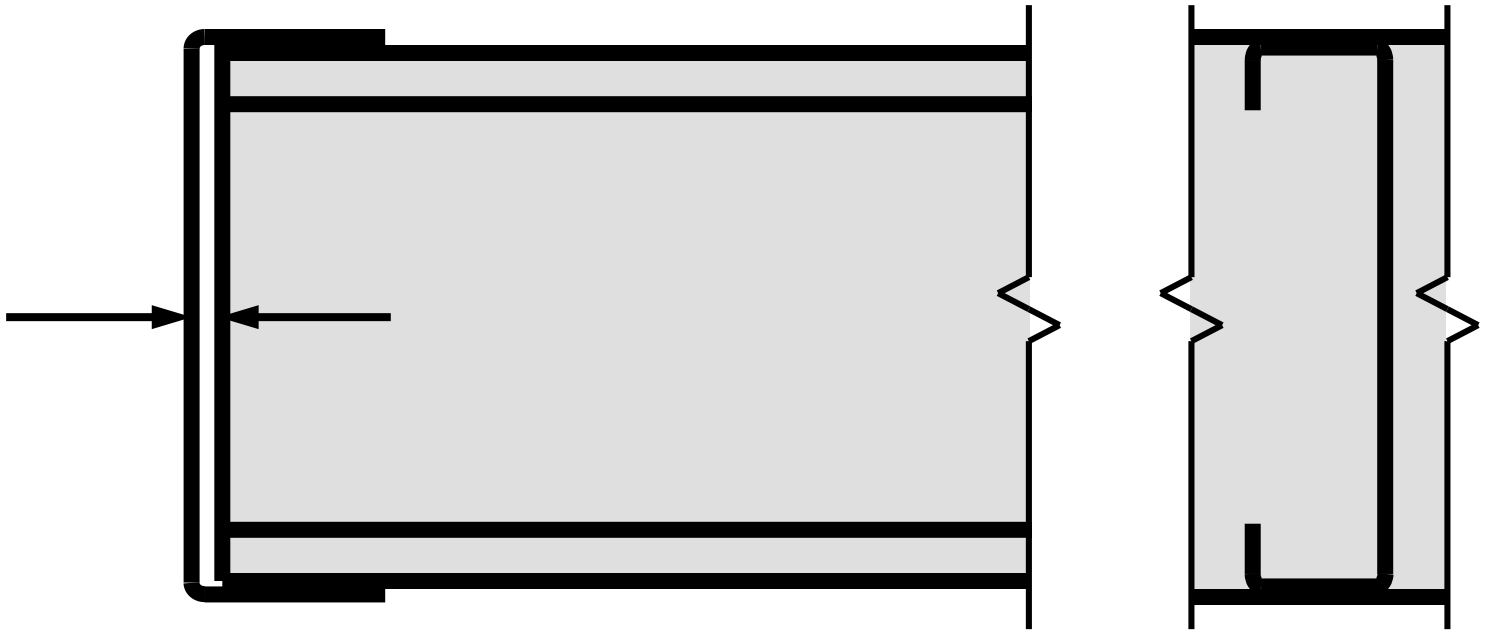
- Member design is to be in accordance with AISI S100: Specification
- Members shall be in good condition
- Damaged members to be replaced/repaired
- Not permitted without approved design:
  - Web holes
  - Cutting or notching of flanges or lips
  - Splicing

Installation Tolerances

- Foundation:
  - Uniform bearing surface with maximum ***1/4”*** gap between the track and foundation
- Ground Contact:
  - Avoid direct contact with the ground and provide sufficient height above ground
- Framing:
  - Install plumb and level, spacing not to exceed span capacity of sheathing, bearing requirements

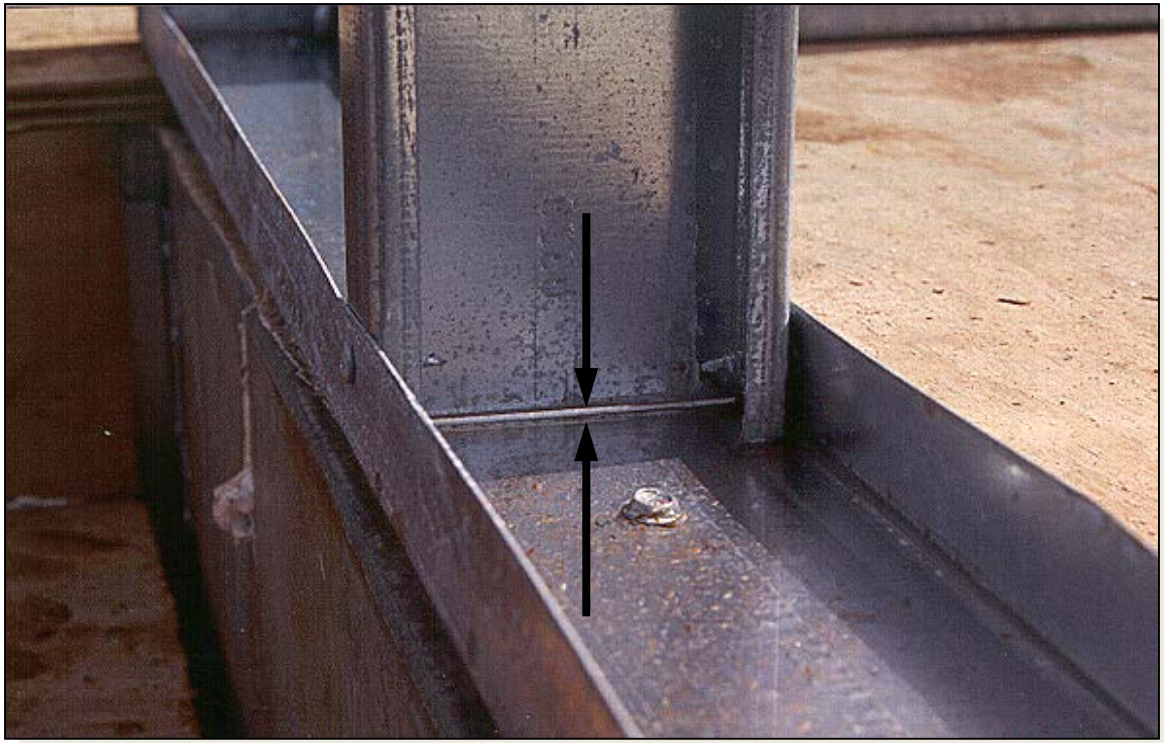
Installation Tolerances

- Floor joist web must not be in contact with rim joist web to prevent squeaks



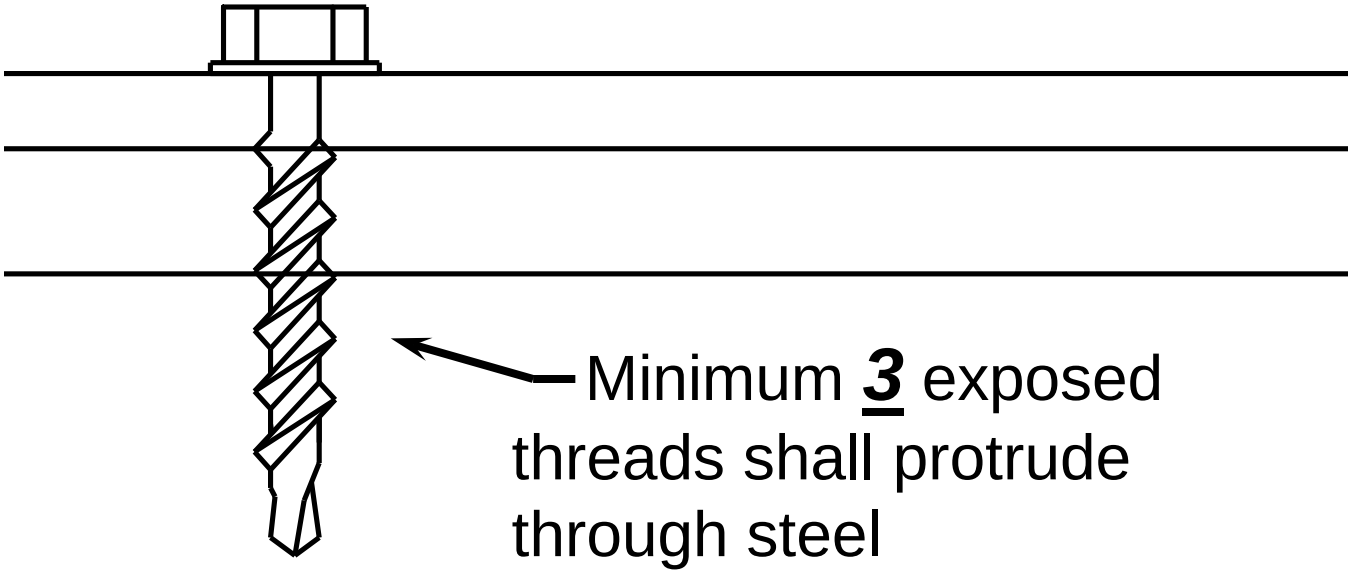
Installation Tolerances

- Wall stud must be seated in track with maximum gap of ***1/8”***



Screw Connections

- Installation:
  - Minimum of ***3*** exposed threads
  - No permanent separation between plies



Screw Connections

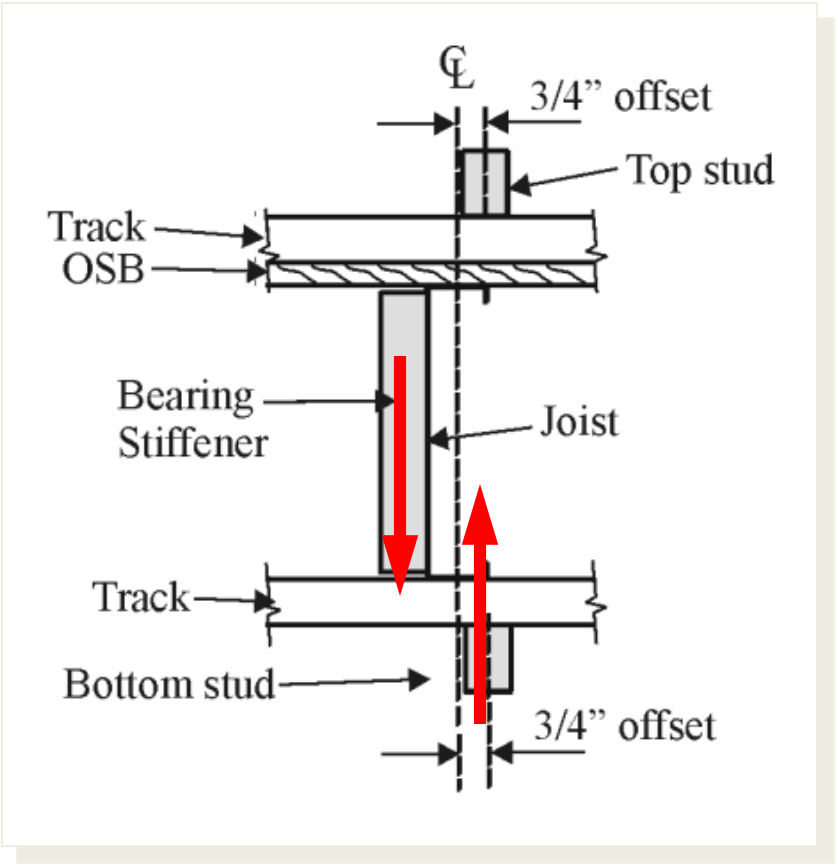
- Stripped Screws:
  - Stripped screw fasteners in direct tension are considered ineffective
  - Stripped screw fasteners in shear may be considered effective (not more than ***25%*** of the total number considered effective)

Screw Connections

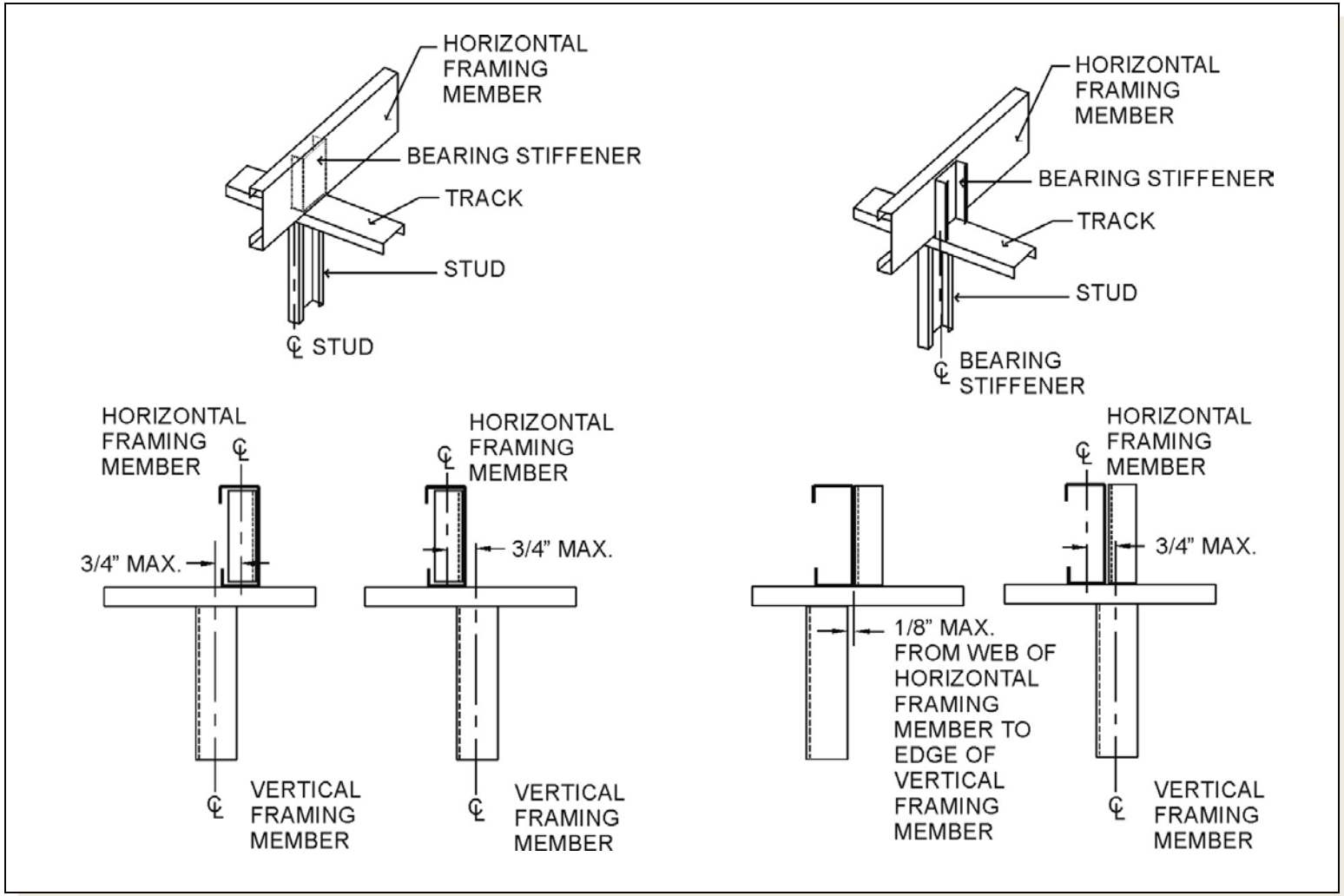
- Spacing:
  - Provides for an allowance if the spacing is less than ***3 times*** screw diameter, as specified by AISI S100: Specification
  - If spacing is greater than ***2 times*** screw diameter, screws can be considered ***80%*** effective

In-Line Framing

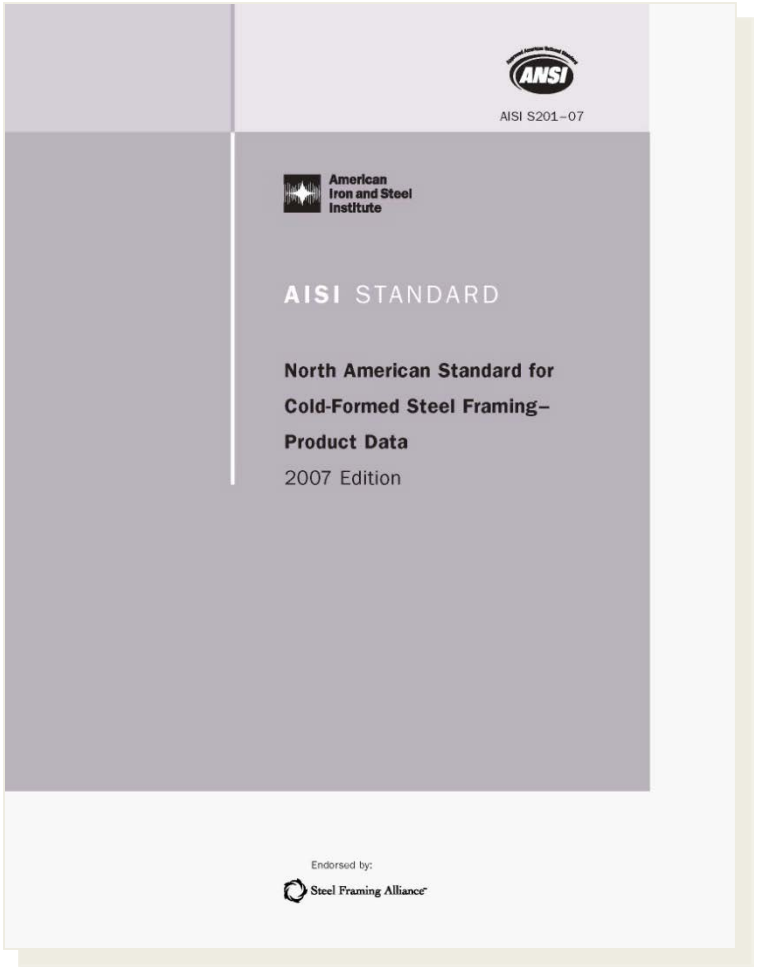
- No restriction existed that specifically addresses the case where the bearing stiffener is attached to the back side of the floor joist



In-Line Framing

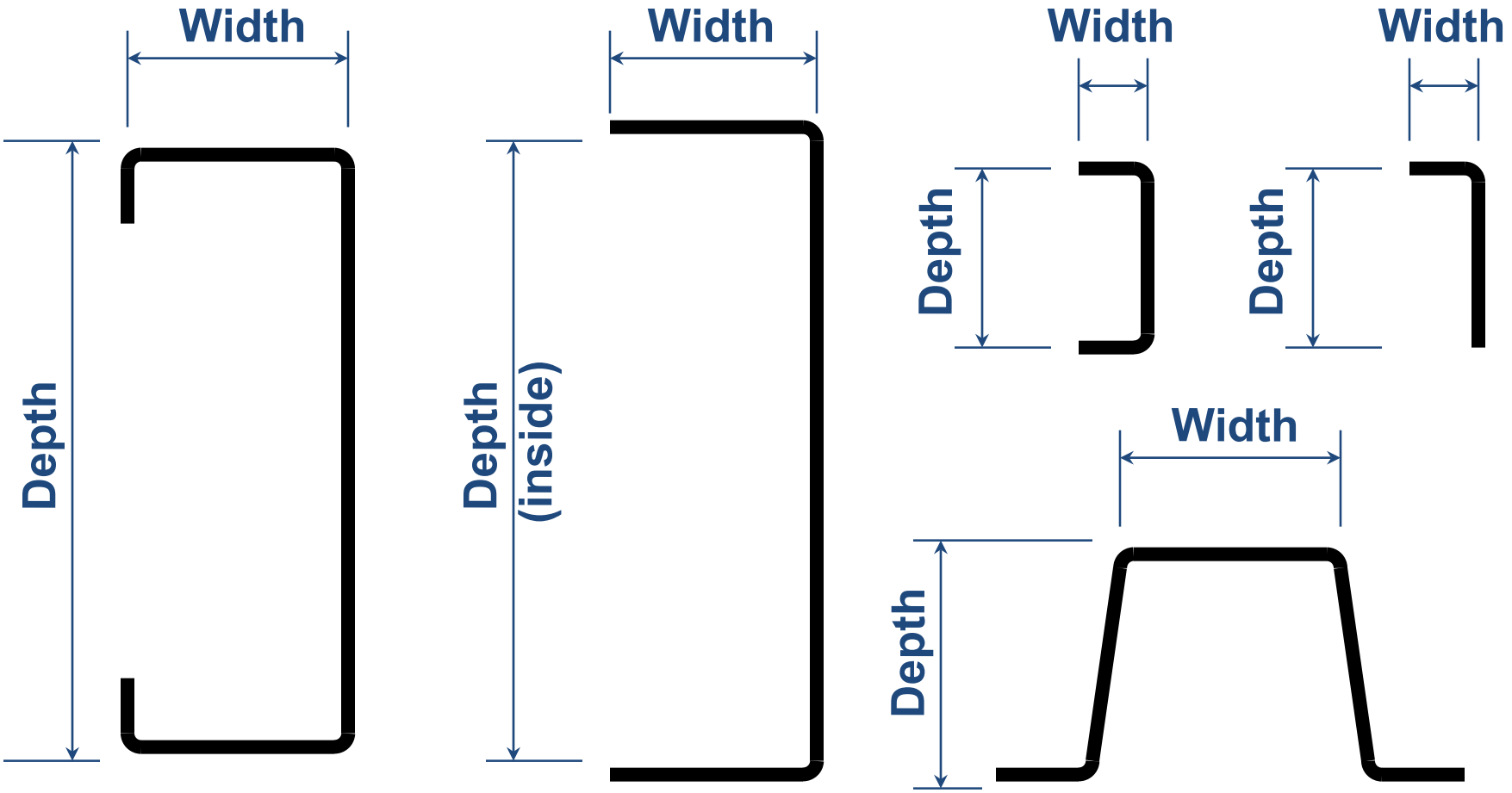


AISI S201: Product Data



A. GENERAL
B. MATERIALS
C. PRODUCTS
D. QUALITY ASSURANCE

Shapes


Width
Depth
Width
Depth
(inside)
Width
Depth
Width
Depth
Width
Depth

Shapes

S = C-shaped stud or joist

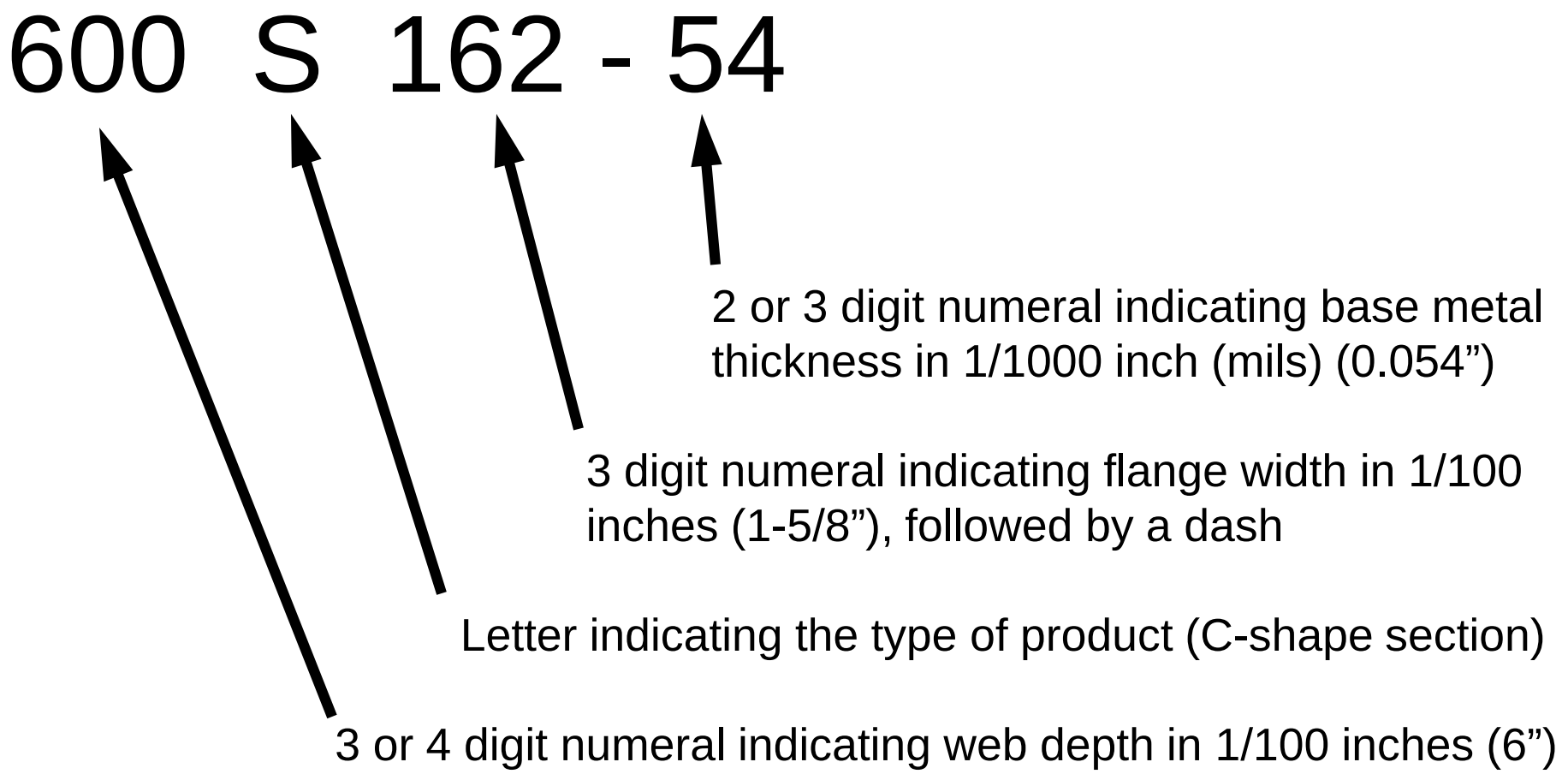
T = Track

U = Cold rolled channel

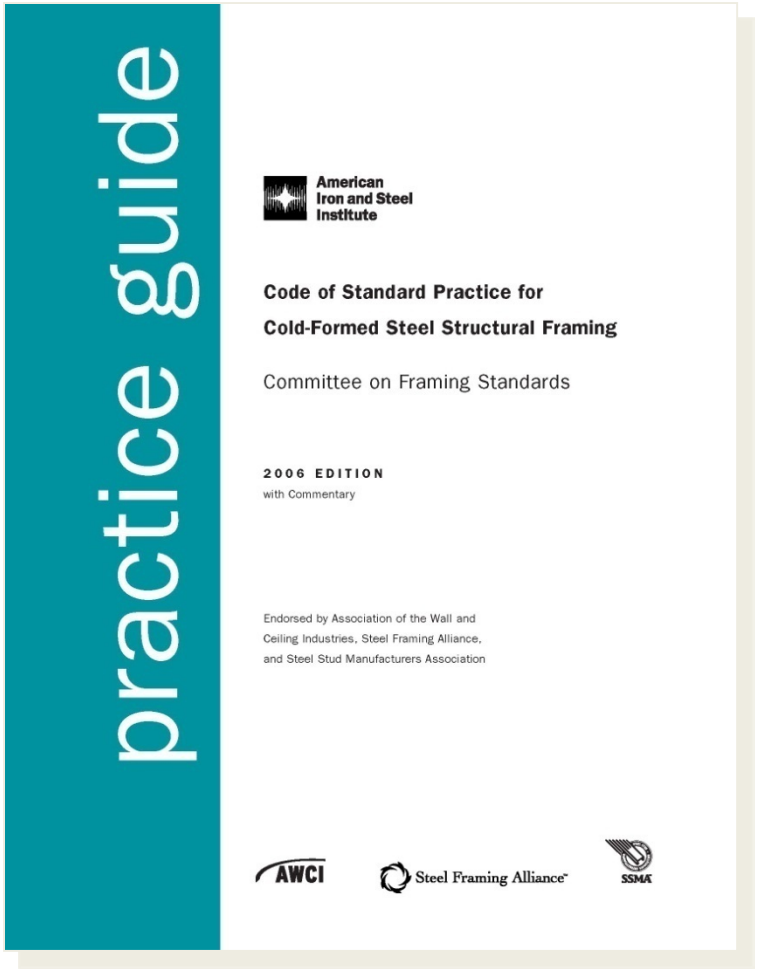
F = Furring (hat) channel

L = Angle or L-header

Product Designator



AISI S202: Code of Standard Practice



A. GENERAL
B. CLASSIFICATION OF MATERIALS
C. CONTRACT DOCUMENTS
D. INSTALLATION DRAWINGS
E. MATERIALS
F. INSTALLATION
G. QUALITY CONTROL
H. CONTRACTUAL RELATIONS

Scope

- Defines and sets forth accepted norms of good practice for fabrication and installation of cold-formed steel structural framing
- Supplement to legal building regulation
- Would be used unless differing instructions in the contract documents
- Voluntary document

Example

- Responsibilities for field modifications and repairs must be clearly defined and communicated

AISI S210: Floor and Roof System Design

- Load Combinations
- Member Design:
  - Discretely Braced Design
  - Continuously Braced Design
- Connection Design:
  - Bearing Stiffeners
- Bracing Design

Member Design

- Discretely braced design:
  - Neglect attached sheathings
  - Discrete braces provided along member length
- Continuously braced design:
  - Sheathing or deck attached to compression side
  - Continuous or discrete bracing attached to tension side

Bracing Design

- Provides a “prescriptive” approach for compression side bracing:
  - 3/8 inch wood structural sheathing or 9/16” x 0.0269” thickness steel deck
  - attached with No. 8 screws at 12 inches o.c.
- Adapts requirements for tension side bracing from AISI S100 (Specification) requirements for members where neither flange is attached to sheathing

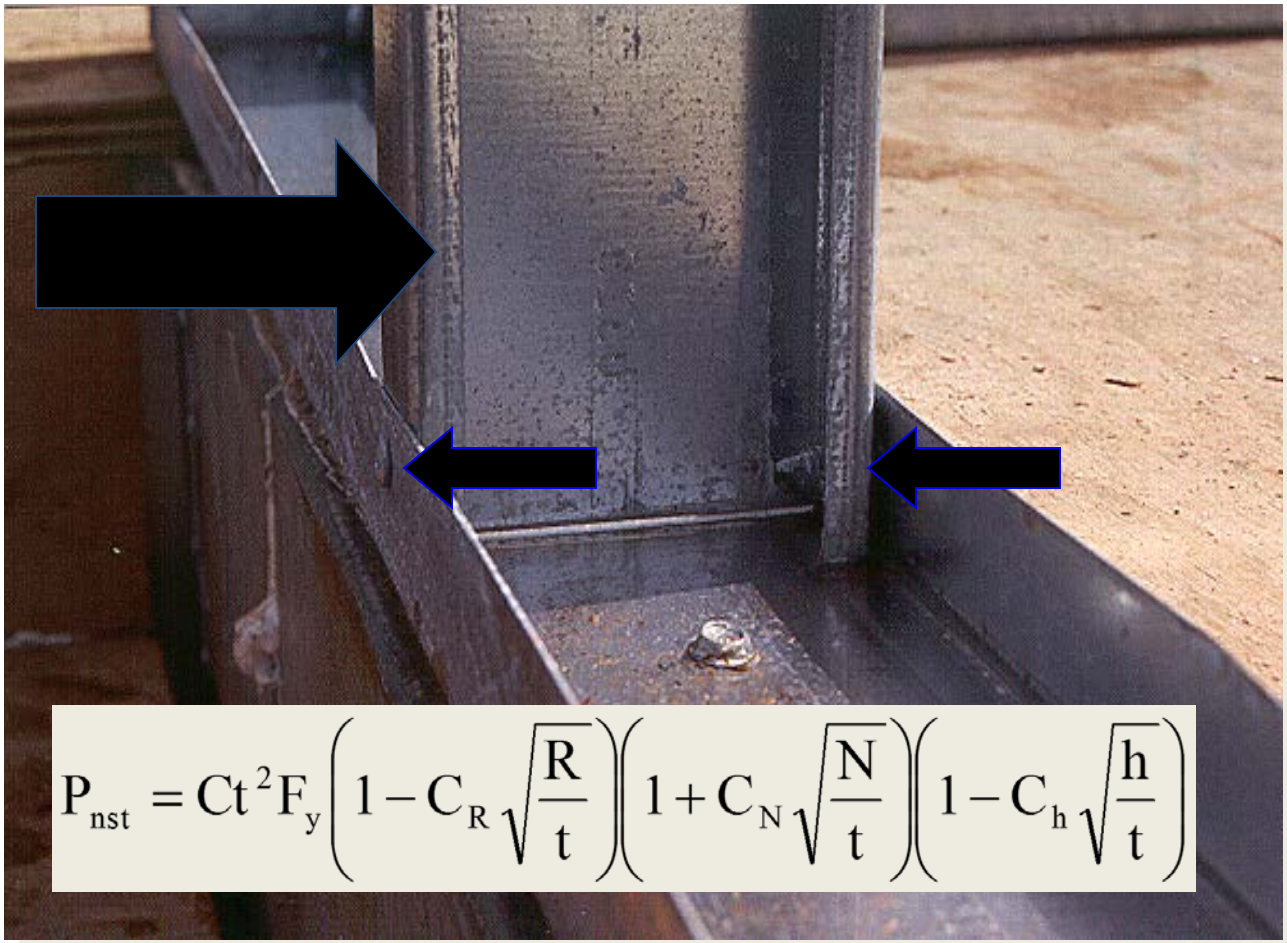
AISI S211: Wall Stud Design

- Load Combinations
- Sheathing Braced Design
- Stud-to-Track Connection
- Deflection Track Connection

Wall Stud Design

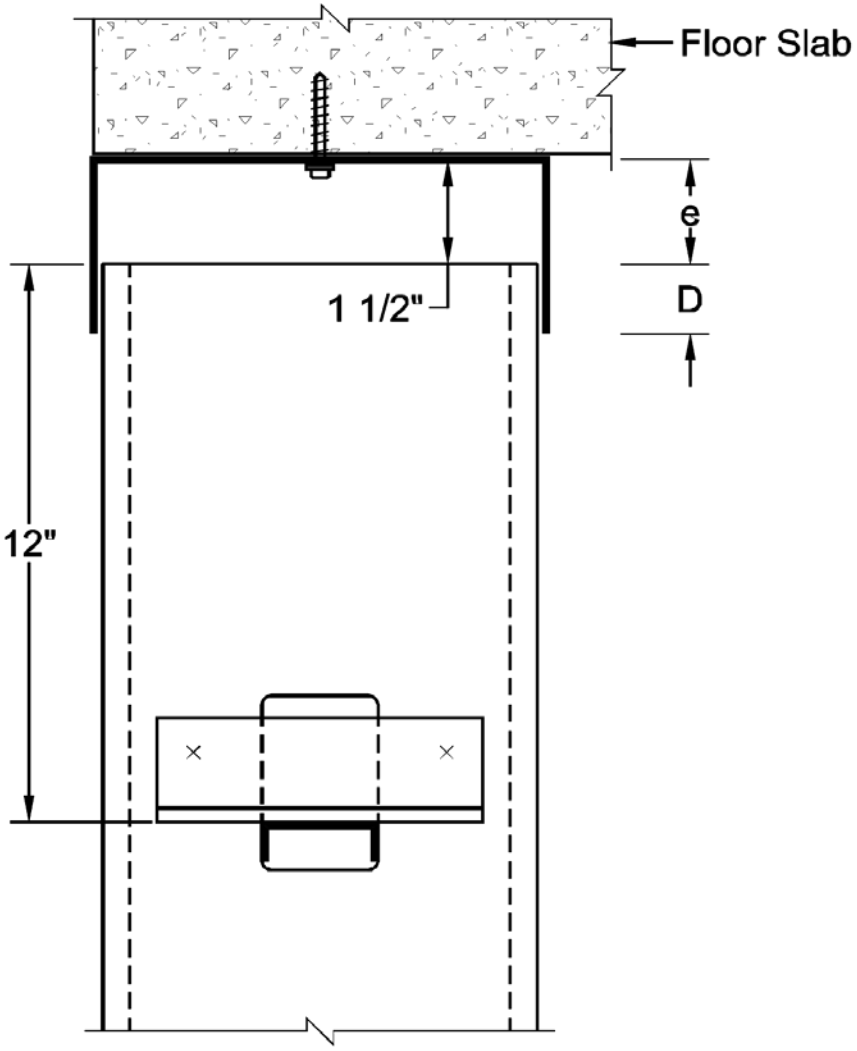
- All-steel design:
  - Neglect attached sheathings
- Sheathing braced design:
  - Sheathing attached to flanges

Stud-to-Track Connection

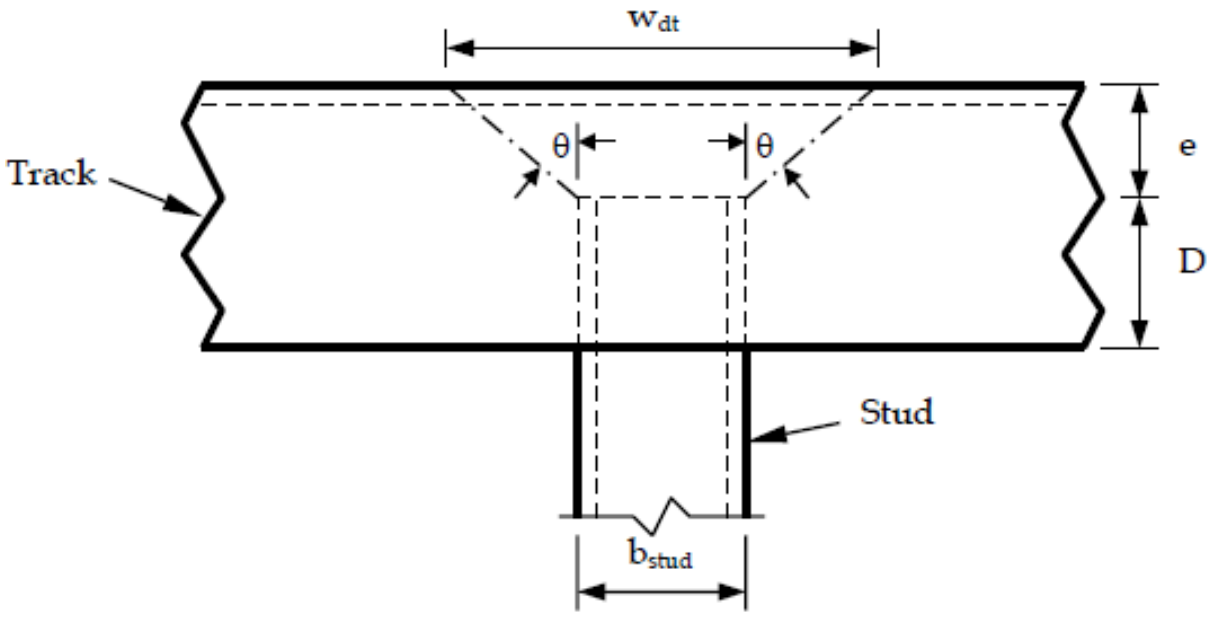


$$P_{nst} = Ct^2 F_y \left(1 - C_R \sqrt{\frac{R}{t}}\right)\left(1 + C_N \sqrt{\frac{N}{t}}\right)\left(1 - C_h \sqrt{\frac{h}{t}}\right)$$

Single Deflection Track

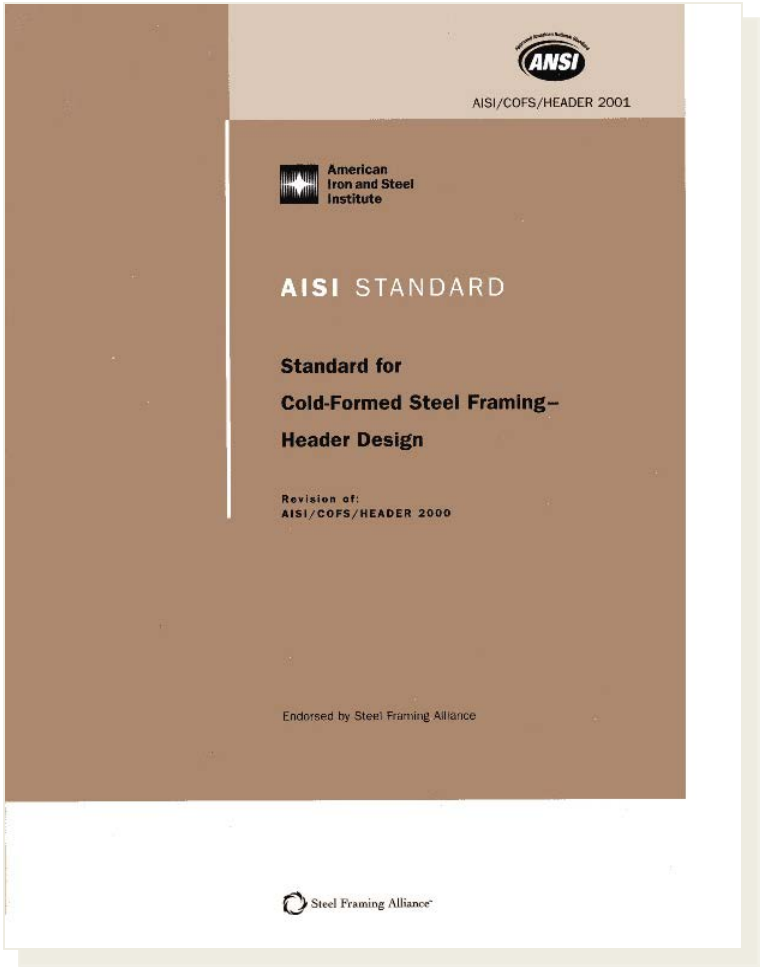


Deflection Track Connection



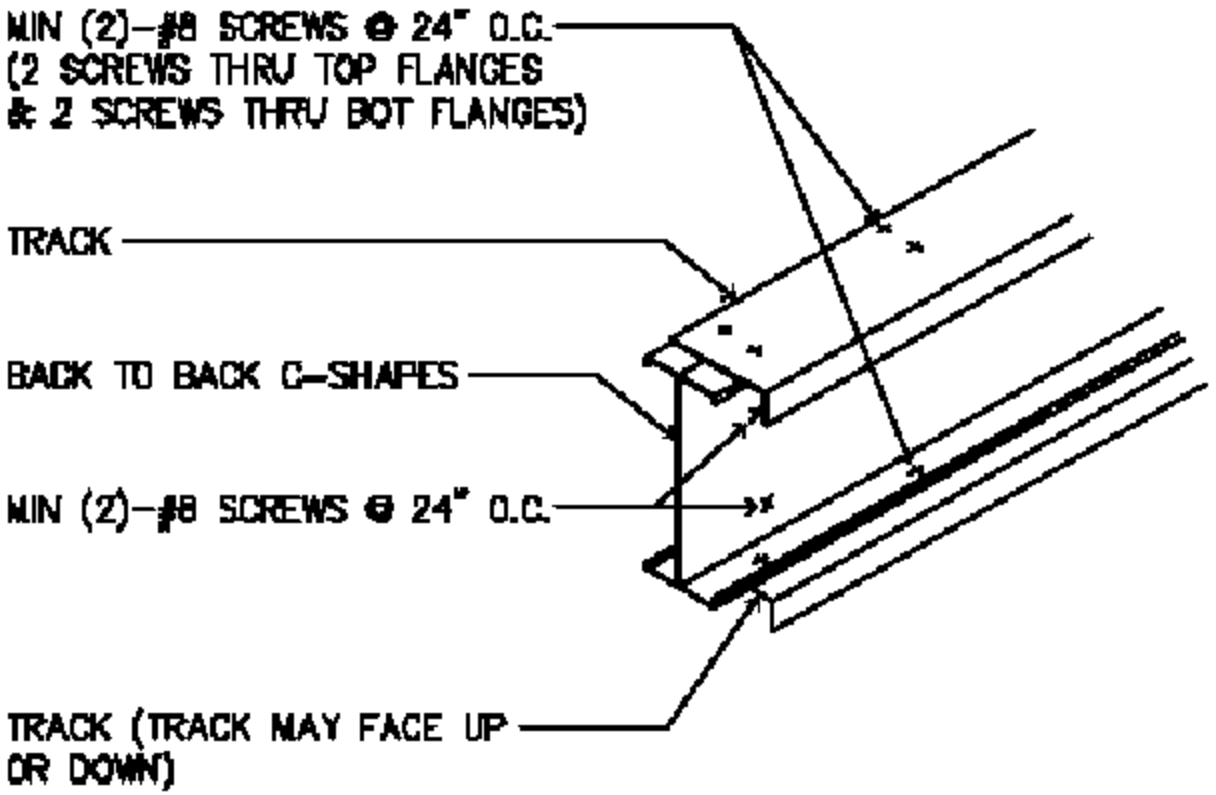
$$w_{dt} = 0.11(\alpha^2)(e^{0.5}/t^{1.5}) + 5.5\alpha \leq S$$

AISI S212: Header Design



A. GENERAL
B. DESIGN
C. INSTALLATION

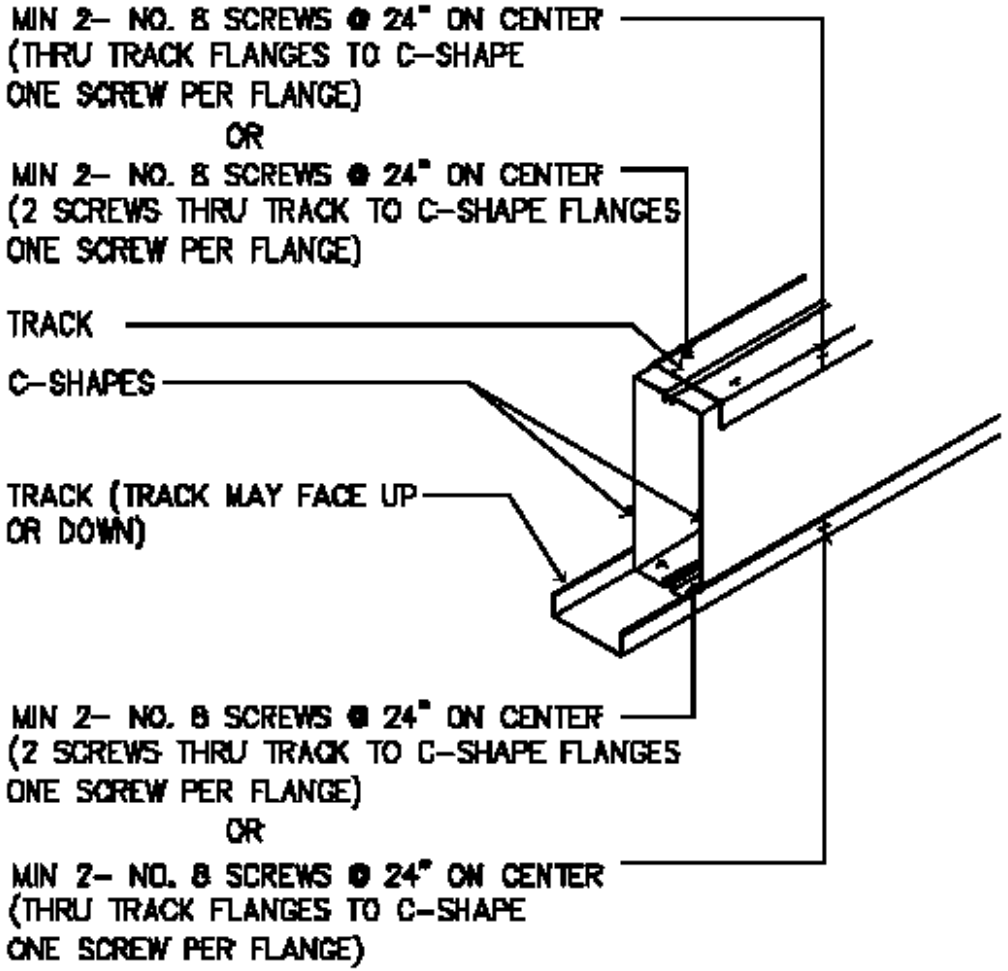
Back-to-Back Headers



Back-to-Back Headers

- Moment Capacity:
  - Specification C3.1.1 for C-sections alone
- Shear and Web Crippling Capacity:
  - Shear Capacity C3.2
  - Web Crippling Capacity:
  - Specification C3.4 for I-sections
- Bending and Web Crippling:
  - Specification C3.5 for I-sections

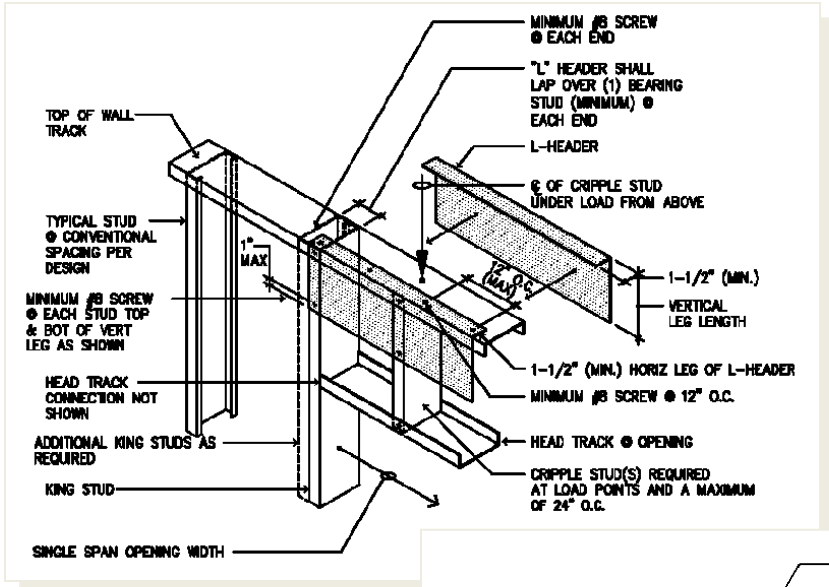
Box Headers

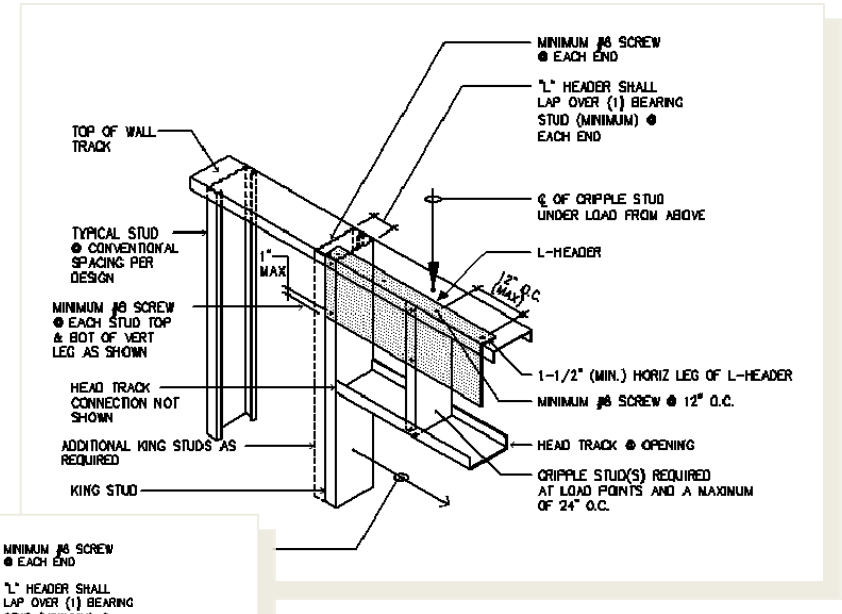

MIN 2– NO. 8 SCREWS @ 24" ON CENTER
(THRU TRACK FLANGES TO C–SHAPE
ONE SCREW PER FLANGE)
OR
MIN 2– NO. 8 SCREWS @ 24" ON CENTER
(2 SCREWS THRU TRACK TO C–SHAPE FLANGES
ONE SCREW PER FLANGE)
TRACK
C–SHAPES
TRACK (TRACK MAY FACE UP
OR DOWN)
MIN 2– NO. 8 SCREWS @ 24" ON CENTER
(2 SCREWS THRU TRACK TO C–SHAPE FLANGES
ONE SCREW PER FLANGE)
OR
MIN 2– NO. 8 SCREWS @ 24" ON CENTER
(THRU TRACK FLANGES TO C–SHAPE
ONE SCREW PER FLANGE)

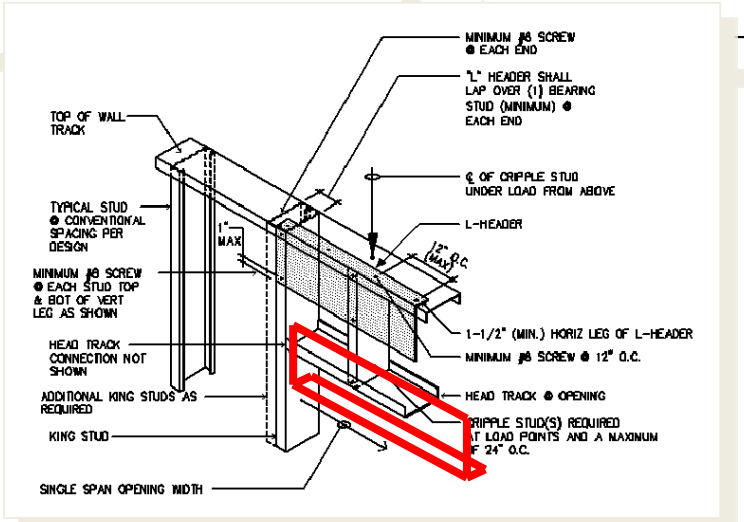
Box Headers

- Moment Capacity:
  - Specification C3.1.1 for C-sections alone
- Shear Capacity:
  - Specification C3.2
- Web Crippling Capacity:
  - Specification C3.4 for single-web sections
  - Modification is permitted to recognize presence of the track

L-Headers



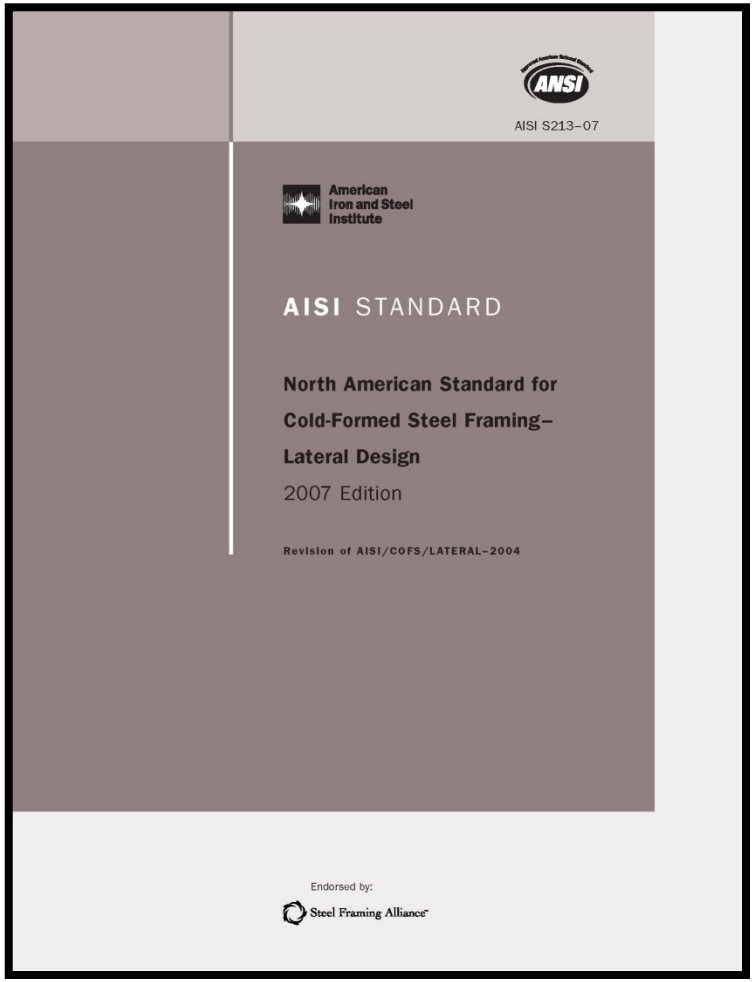




Double L-Header
Single L-Header
Inverted L-Header

AISI S213: Lateral Design

- Type 1 Shear Walls
- Type 2 Shear Walls
- Diagonal Strap Bracing
- Wall Anchorage
- Diaphragms



Type 1 Shear Walls

TABLE C2.1-1
NOMINAL SHEAR STRENGTH (R_n) FOR WIND LOADS FOR SHEAR WALLS[1,4,6,7]
(Pounds Per Foot)

Assembly Description	Maximum Aspect Ratio (h/w)	Fastener Spacing at Panel Edges[2] (inches)			
		6	4	3	2
15/32" Structural 1 sheathing (4-ply), one side	2:1	1065 [3]	-	-	-
7/16" rated sheathing (OSB), one side	2:1	910 [3]	1410	1735	1910
7/16" rated sheathing (OSB), one side oriented perpendicular to framing	2:1	1020	-	-	-
7/16" rated sheathing (OSB), one side	2:1 [5]	-	1025	1425	1825
0.018" steel sheet, one side	2:1	485	-	-	-
0.027" steel sheet, one side	2:1 [5]	-	1,000	1085	1170

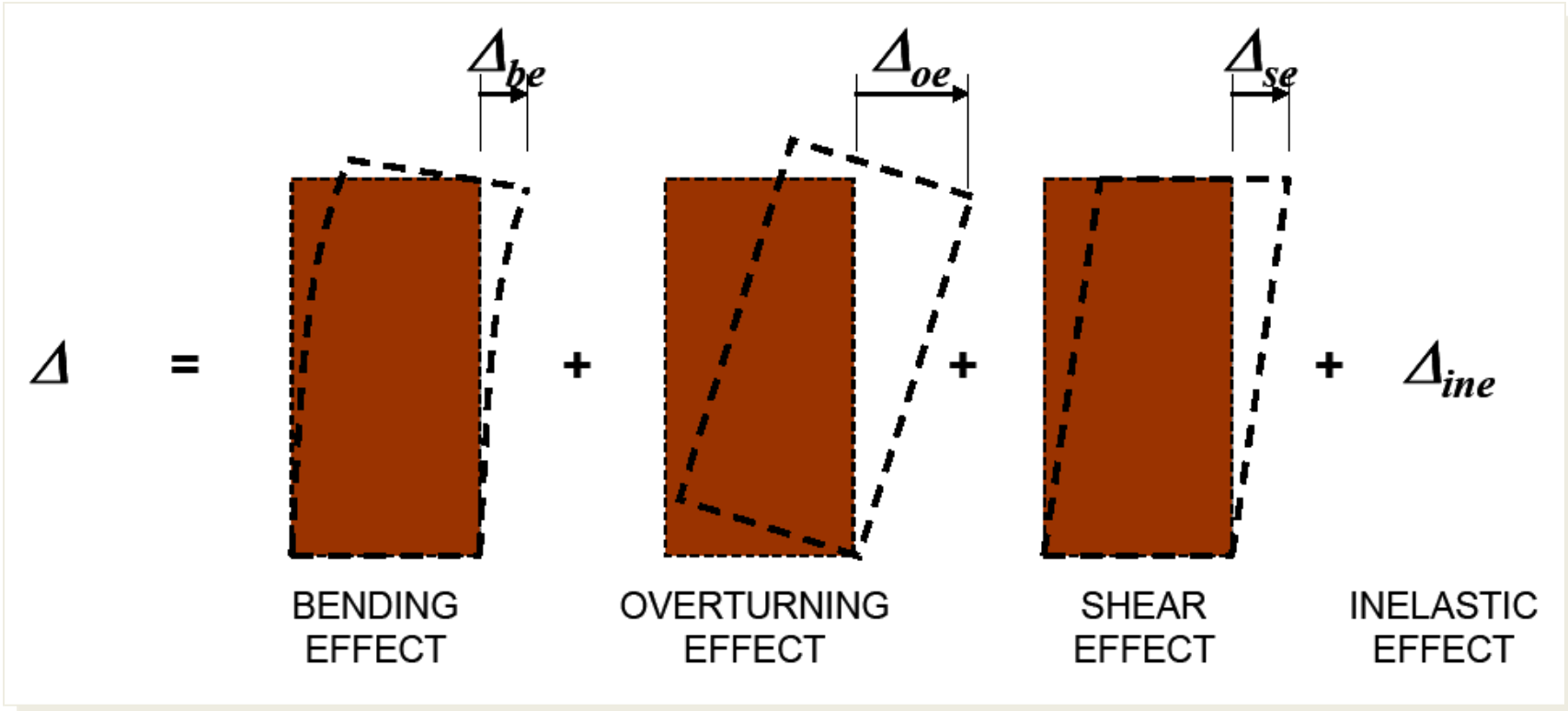
TABLE C2.1-2
NOMINAL SHEAR STENGTH, (R_n), FOR WIND AND SEISMIC LOADS FOR SHEAR WALLS FACED WITH GYPSUM BOARD[1,2,3,4]
(Pounds Per Foot)

Wall Construction	Max. Aspect Ratio (h/w)	Orientation	Screw Spacing (inches o.c.)		Nominal Shear Strength (lb/ft)
			Edge	Field	
½" gypsum board on one side of wall; studs max. 24" o/c	2:1	Gypsum board applied perpendicular to framing with strap blocking behind the horizontal joint and with solid blocking between the first two end studs or applied vertically with all edges attached to framing members	7	7	290
			4	4	425
			4	12	295
			8	12	230

TABLE C2.1-3
NOMINAL SHEAR STRENGTH, (R_n), FOR SEISMIC LOADS FOR SHEAR WALLS [1,4,7]
(Pounds Per Foot)

Assembly Description	Max. Aspect Ratio (h/w)	Fastener Spacing at Panel Edges[2] (inches)				Designation Thickness[5,6] of Stud and Track (mils)	Required Sheathing Screw Size
		6	4	3	2		
15/32" Structural 1 sheathing (4-ply), one side	2:1[3]	780	990	-	-	33 or 43	8
	2:1	890	1330	1775	2190	43 or 54	8
7/16" OSB, one side	2:1[3]	700	915	-	-	33	8
	2:1[3]	825	1235	1545	2060	43 or 54	8
	2:1	940	1410	1760	2350	54	8
	2:1	1232	1848	2310	3080	68	10
0.018" steel sheet, one side	2:1	390	-	-	-	33 (min.)	8
0.027" steel sheet, one side	4:1	-	1000	1085	1170	33 (min.)	8

Type 1 Shear Walls



$$\delta = \frac{8vh^3}{E_s A_c b} + \omega_1 \omega_2 \frac{vh}{\rho G t_{sheathing}} + \omega_1^{5/4} \omega_2 \omega_3 \omega_4 \left(\frac{v}{\beta}\right)^2 + \delta_a$$

Type 2 Shear Walls

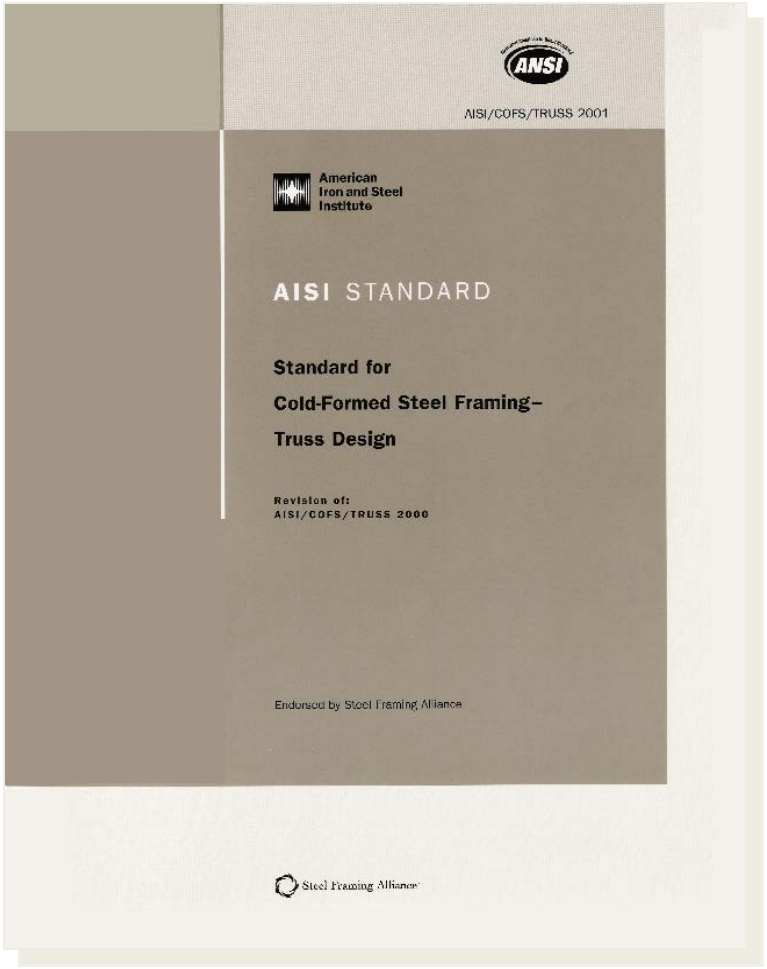
Table C3.2-1
SHEAR RESISTANCE ADJUSTMENT FACTOR-C_a

Wall Height (h)	Maximum Opening Height Ratio [1] and Height				
	h/3	h/2	2h/3	5h/6	h
8'-0" (2440 mm)	2'-8" (810 mm)	4'-0" (1220 mm)	5'-4" (1630 mm)	6'-8" (2030 mm)	8'-0" (2440 mm)
10'-0" (3050 mm)	3'-4" (1020 mm)	5'-0" (1530 mm)	6'-8" (2030 mm)	8'-4" (2540 mm)	10'-0" (3050 mm)
Percent Full-Height Sheathing [2]	**Shear Resistance Adjustment Factor**				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

Diaphragms

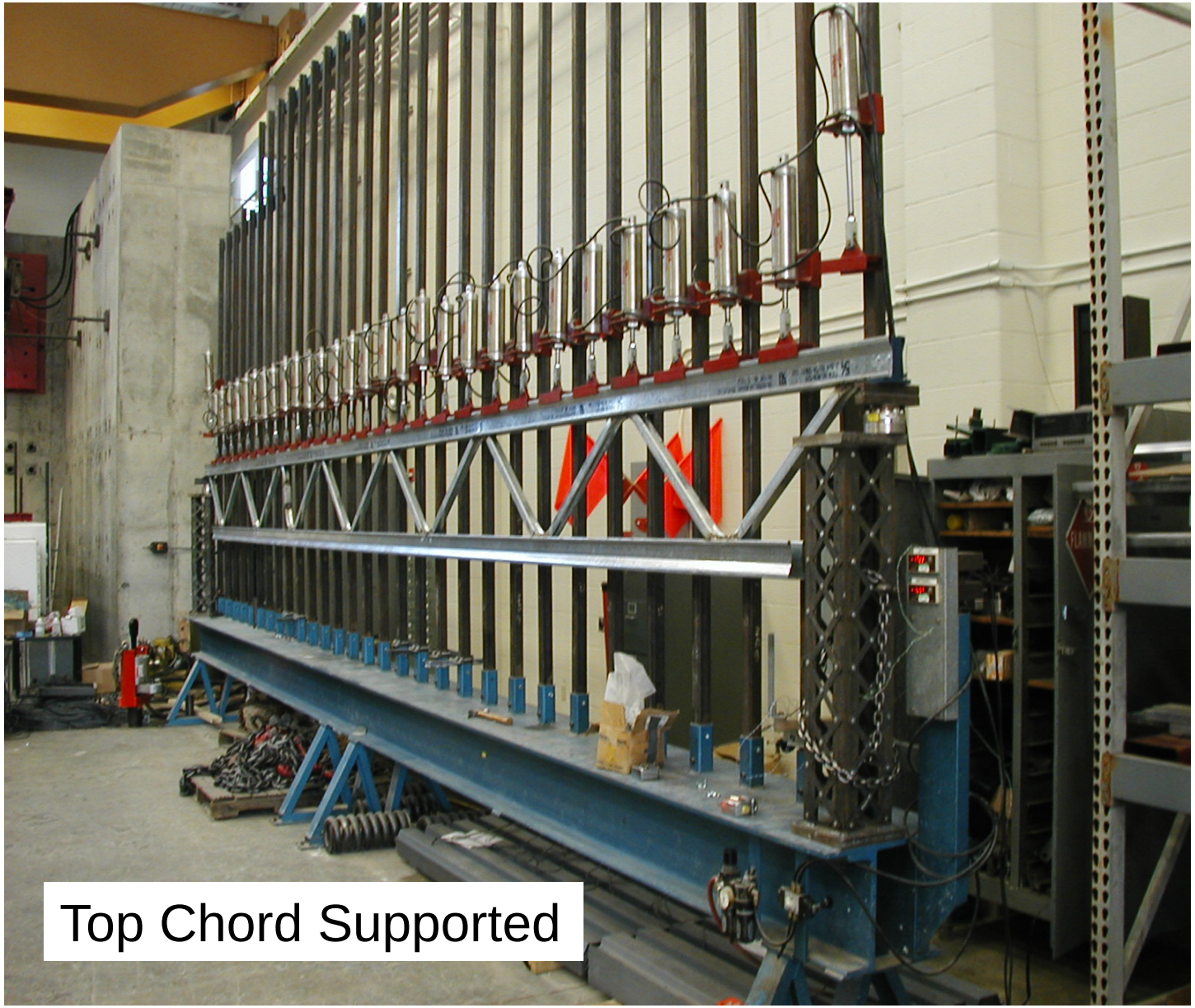
- Design Values for Wood Structural Panel Sheathing
- Design Deflections

AISI S214: Truss Design

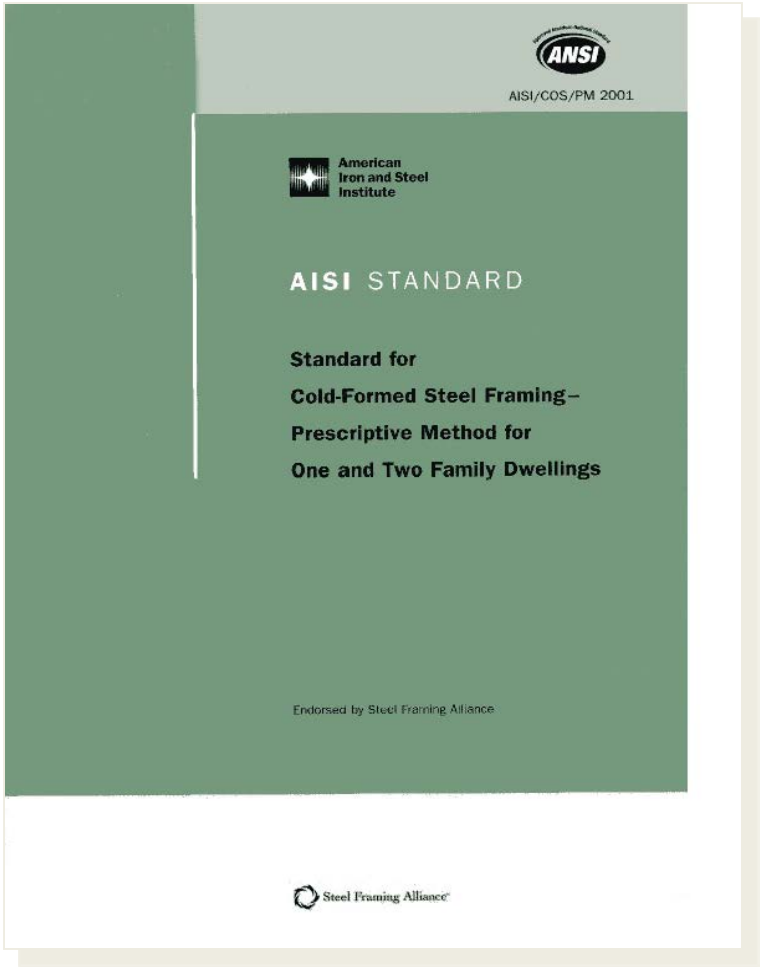


A. GENERAL
B. DESIGN RESPONSIBILITIES
C. Reserved
D. TRUSS DESIGN
E. QUALITY CRITERIA
F. TRUSS INSTALLATION
G. TEST METHODS

Confirmatory Truss Test



AISI S230: Prescriptive Method



A. GENERAL
B. CONNECTIONS
C. FOUNDATION
D. FLOOR FRAMING
E. WALL FRAMING
F. ROOF FRAMING

Tables and Details

33 KSI

Table E3-1a
Stud Thickness
24-Foot Wide Building Supporting Roof and Ceiling Only[1,2,3]
F_y = 33 ksi

Wind Speed		Member Size	Stud Spacing (inch)	Minimum Stud Thickness							
				8-Foot Studs				9-Foot Studs			
				Ground Snow Load (psf)							
Exp. A/B	Exp. C			20	30	50	70	20	30	50	70
85 mph		350S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
		550S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
90 mph		350S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
		550S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
100 mph	85 mph	350S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
		550S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33
110 mph	90 mph	350S162	16	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43
			16	33	33	33	33	33	33	33	33

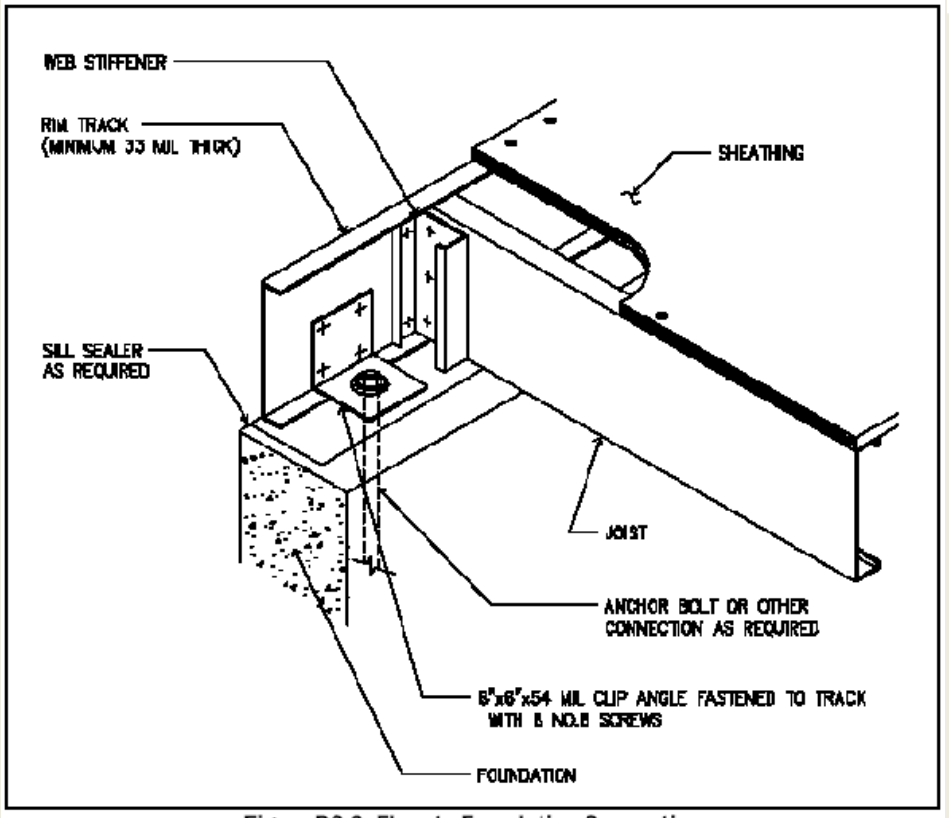


Figure D2-3 Floor to Foundation Connection

Available AISI Design Aids
https://shop.steel.org/c/34/steel-framing-alliance

- AISI D100, Cold-Formed Steel Design Manual
- AISI D110, Cold-Formed Steel Framing Design Guide
- AISI D111, Cold-Formed Steel Purlin Roof Framing Systems (being updated)
- AISI D112, Brick Veneer Cold-Formed Steel Framing Design Guide
- AISI D113, Design Guide for Cold-Formed Steel Framed Shear Wall Assemblies (being updated)

CFSEI
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40+ Existing Technical Notes

http://www.cfsei.org/technical-publications

- D001-13, Durability of CFS Framing Members
- D100-13, Corrosion Protection of Fasteners
- D200-12, Corrosion Protection for CFS Framing in Coastal Areas
- F100-09, Design of Clip Angle Bearing Stiffeners
- F101-12, Screws for Attachment of Steel-To-Wood and Wood-Steel
- F102-11, Screw Fastener Selection
- F140-10, Welding CFS
- F300-09, Pneumatically Driven Pins for Wood-Based Panel Attachment
- F501-11, CFS Truss to Bearing Connections
- F701-12, Evaluation of Screw Strength Capacity
- G000-08, CFS Design Software
- G100-07, Using Chapter F of the NA Specification for the Design of CFS Structural Members
- G101-08, Design Aids & Examples for Distortional Buckling
- G102-09, Designing CFS using the Direct Strength Method
- G103-11a, Tabulated Local and Distortional Elastic Buckling Solutions for Standard Shapes
- G104-14, Welded Boxed-Beam Design
- G200-15, Chase the Loads - Load Path Considerations for CFS Light-Frame Construction
- G500-11, Guidelines for Inspecting CFS Structural Framing in Low Rise Buildings
- G800-12, ASTM Standards for CFS
- G801-13, ASTM A1003 - No Cause for Rejection
- G802-13, AISI Section A2.2 - Other Steels
- G900-15, Design Methodology for Hole Reinforcement of CFS Bending Members
- J100-11, CFS Floor Joists
- L001-10, Design of Diagonal Strap Bracing Lateral Force Resisting Systems for the 2006 IBC
- L200-09, Roof Framing Anchorage Forces: MWFRS or C&C
- L202-12, Diaphragm Design with Pneumatically Driven Pins
- L300-09, Design of End Posts for Diaphragm Shear Walls
- S100-16, Antiterrorism Design Requirements for CFS Framing
- T001-09, Fire and Acoustic-Rated Assemblies for Multi-Unit Structures
- T100-12, Fire-Rated Assemblies for CFS Construction
- W100-08a, Single Slip Track Design
- W101-09, Common Design Issues for Deflection Track
- W102-12, Introduction to Curtain Wall Design Using CFS
- W103-11, Design of By-Pass Slip Connectors in CFS Construction
- W104-10, Top Track Load Distribution Members
- W105-13, Design of Nonstructural Members
- W106-16, Design for Splicing of CFS Wall Studs
- W200-09, Header Design
- W400-16, Mechanical Bridging and Bridging Anchorage of Axially Loaded CFS Studs
- W500-12, Construction Bracing for Walls

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QUESTIONS?