

AISC Live Webinars

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Three-Part Webinar Series: Structural Stainless Steel
Part 2: Design
May 12, 2022



AISC Live Webinars

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AISC Live Webinars

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AISC Live Webinars

Course Description – Submitted for AIA CE Credit

Structural Stainless Steel Design
May 12, 2022

This session will lead the designer through the process of designing stainless steel tension members, beams, and columns in accordance with the new standard, AISC 370 *Specification for Structural Stainless Steel Buildings*, highlighting the differences compared to the rules for carbon steel in AISC 360 *Specification for Structural Steel Buildings*. Methods of analysis unique to structural stainless steel, including the continuous strength method, will be discussed, as will structural performance at elevated temperatures.



AISC Live Webinars

Learning Objectives – Submitted for AIA CE Credit

- Describe the stress-strain behavior of stainless steel.
- Identify the parts of the design curves for flexural buckling and lateral-torsional buckling for stainless steel members.
- Identify the limits of applicability for use of AISC 370 for various types of load effects.
- Explain the continuous strength method and compare the results of the continuous strength method to a conventional design approach for compression members.



Structural Stainless Steel Session 2: Design



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The Steel Construction Institute
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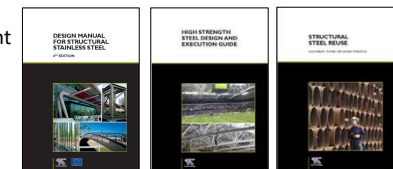


Introducing the Steel Construction Institute (SCI)

SCI is an independent centre of excellence providing technical expertise & disseminator of best practice to the steel construction sector

SCI Activities

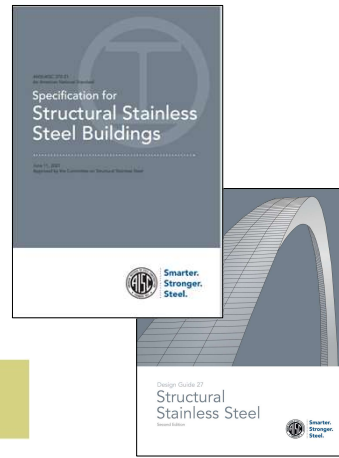
- Technical publications
- Standards development
- Product development
- Independent assessment
- Research & Testing
- Engineering software
- Advisory Service
- Problem resolution



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Objectives of this session

1. Scope of AISC 370
2. Differences in design provisions with respect to AISC 360
3. Background of design provisions not included in AISC 360
4. AISC DG27 2nd Ed.

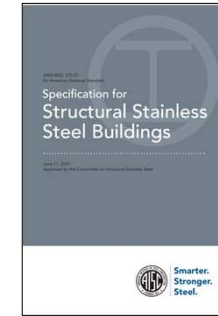


AISC 313: Code of standard practice for Structural Stainless Steel Buildings – next week's webinar!



Outline

1. Introduction
2. Design requirements (Chapter B)
3. Serviceability (Chapter L)
4. Design of members (Chapters D, E, F, G, H, App. 2)
5. Structural analysis (Chapter C and App. 1)
6. Design for fire (Appendix 4)
7. Stainless steel material behaviour (Appendix 7)



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Review of last week's session - what can you remember?

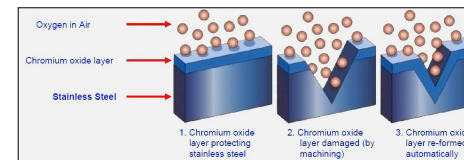
What makes stainless steel 'stainless'?



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What is stainless steel?

Corrosion resistant steel with Cr content >10.5%



Protective passive film forms IF

- Alloy composition is corrosion resistant enough for the environment
- Surface is clean and exposed to oxygen (atmospheric or in fluids)

- More than 200 stainless steel alloys
- Only a few used in construction



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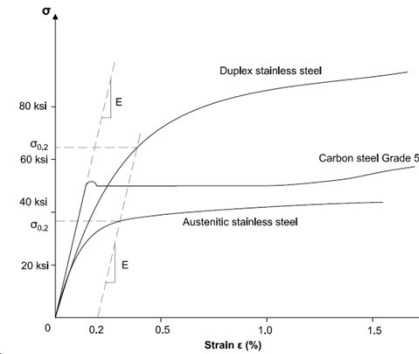
**Review of last week's session
 - what can you remember?**

Are the mechanical properties of stainless and carbon steel the same?



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Stress-strain characteristics: low strains



Modulus of elasticity very similar to carbon steel, but form of stress-strain curve is fundamentally different.

Yield strength, F_y = strength at 0.2% offset permanent strain

F_y values from ASTMs are given in Commentary to Chap A (material in the annealed condition)

F_y = 30 ksi austenitics
 F_y = 65 ksi duplexes



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Structural design of stainless steel



Huge amount of research carried out over the last 30 years studying welded members, cold formed members, hollow sections, decking, welded connections, bolted connections, fatigue, 3D printed members, fire, composite construction....



Economic and comprehensive design standards



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Impact of the non-linear stress-strain curve on buckling

Low slenderness

- Columns attain/exceed yield load (squash load)
- Benefits of strain hardening apparent
- **Stainless steel behaves at least as well as carbon steel column**

Intermediate slenderness

- Average stress in column is between the limit of proportionality and the 0.2% permanent offset strain
- **Stainless steel column less strong than carbon steel column**

High slenderness

- Low axial strength
- Stresses low and in relatively linear region of stress-strain curve
- **Stainless steel behaves similarly to carbon steel**



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Scope of AISC 370

Materials

- Austenitic and duplex alloys
- Precipitation hardening alloys for tension members & fasteners

Use same ϕ and Ω factors as AISC 360

Shapes

- Hot rolled, welded, extruded open structural sections
- Round and rectangular HSS
- Plate and bar

Except G and J4:
Rolled I shapes in shear

Exclusions

- Seismic design
- Shapes: Angles in flexure, unequal angles, equal angles with slender cross-section
- Chapter I: Composite members
- Chapter K: HSS connections (limited scope)

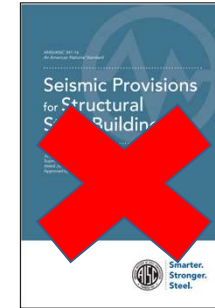


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Stainless steel structures in seismic applications

Stainless steel applications subject to seismic loading
- stairs, railings, catwalks, platforms, pipe and equipment supports, canopies

- Greater ductility of stainless steel → greater energy dissipation
- Outside scope of AISC 370 and AISC 341
- Do not adopt carbon steel R factors (non-linear stress-strain characteristics)
- Work underway to provide better guidance



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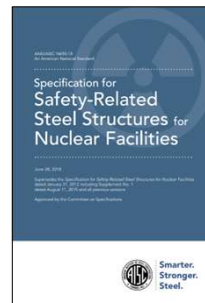
Stainless steel structures in nuclear applications

N690-18 *Specification for Safety-Related Steel Structures for Nuclear Facilities*

Uses AISC 360 as baseline, modifying specific portions to make applicable to structures in nuclear industry.
Refers to AISC 303 for tolerances, contract documents etc

Next edition N690-24

Use AISC 360 and AISC 370 as baseline documents, modifying specific portions to make applicable to structures in nuclear industry
Refer to AISC 303 and AISC 313 for tolerances etc



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Chapter B



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Chapter B – Design Requirements

The chapter is organized as follows:

- B1. General Provisions
- B2. Loads and Load Combinations
- B3. Design Basis
- B4. Member Properties
- B5. Fabrication and Erection
- B6. Quality Control and Quality Assurance
- B7. Evaluation of Existing Structures

Moment redistribution provisions for beams are not included in AISC 370



Chapter B – Design Requirements

B4. Member Properties

- Width-to-thickness limits for elements → More simplified in AISC 370
- Design thickness
- Strength increase in stainless steel → Added to AISC 370



Chapter B – Width-to-thickness limits for elements

AISC 360

AISC 370

Element	Limiting Width-to-Thickness Ratio	Examples
1 Flanges of built-up or rolled I-shaped sections, plates and channels, pipes or angle legs projecting beyond main body or rolled I-shaped sections, and angle legs projecting beyond main body of pipe connected with continuous girths.	$1.49 \sqrt{E/F_y}$	
2 Webs of built-up or rolled I-shaped sections, and channels, and angle legs projecting beyond main body of pipe connected with continuous girths.	$1.49 \sqrt{E/F_y}$	
3 Flanges of built-up or rolled I-shaped sections, plates and channels, pipes or angle legs projecting beyond main body of pipe connected with continuous girths.	$1.49 \sqrt{E/F_y}$	
4 Webs of built-up or rolled I-shaped sections, and channels, and angle legs projecting beyond main body of pipe connected with continuous girths.	$1.49 \sqrt{E/F_y}$	

Element	Limiting Width-to-Thickness Ratio	Examples
1 Flanges of built-up or rolled I-shaped sections, plates and channels, pipes or angle legs projecting beyond main body of pipe connected with continuous girths.	$0.81 \sqrt{E/F_y}$	
2 Webs of built-up or rolled I-shaped sections, and channels, and angle legs projecting beyond main body of pipe connected with continuous girths.	$0.81 \sqrt{E/F_y}$	
3 Flanges of built-up or rolled I-shaped sections, plates and channels, pipes or angle legs projecting beyond main body of pipe connected with continuous girths.	$0.81 \sqrt{E/F_y}$	
4 Webs of built-up or rolled I-shaped sections, and channels, and angle legs projecting beyond main body of pipe connected with continuous girths.	$0.81 \sqrt{E/F_y}$	



Chapter B – Design Thickness

AISC 360

For HSS produced to standards other than A1065/A1065M or A1085/A1085M

$$t_{des} = 0.93t_{nom}$$

AISC 370

For HSS

$$t_{des} = 0.95t_{nom}$$

For built-up, hot-rolled and flat bar sections

$$\text{When } t_{nom} > \frac{3}{16} \text{ in.}$$

$$t_{des} = t_{nom}$$

$$\text{When } t_{nom} \leq \frac{3}{16} \text{ in.}$$

$$t_{des} = 0.95t_{nom}$$

(unless the section has a minimum thickness tolerance less than 0.05 times the nominal thickness, in which case it is permitted to use the nominal thickness.)



Chapter B – Strength increase in stainless steel cold-formed HSS

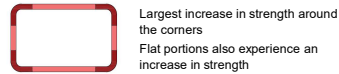
- Take advantage of strain hardening of stainless steel → **Significantly larger than for carbon steel**
- Only applicable to cold-formed square, rectangular and round HSS
- $F_{y,avg}$ can be used in design according to Chapters E, F, and H, and Appendices 1 and 2

(a) For cold-formed rectangular HSS

$$F_{y,avg} = \frac{F_{y,corner} A_{corner} + F_{y,wall} (A_g - A_{corner})}{A_g} \leq F_u$$

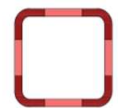
(b) For cold-formed round HSS

$$F_{y,avg} = F_{y,rd}$$



Chapter B – Strength increase in stainless steel cold-formed HSS

Square HSS	b/t	$F_{y,avg} / F_y$	
		Austenitic	Duplex
HSS 4 x 4 x 0.120	33	1.40	1.03
HSS 4 x 4 x 0.250	14	1.60	1.10
HSS 12 x 12 x 0.250	49	1.35	1.02
HSS 12 x 12 x 0.312	38	1.40	1.03



Round HSS	D/t	$F_{y,avg} / F_y$	
		Austenitic	Duplex
HSS 4.5 x 0.12	40	1.16	1
HSS 4.5 x 0.25	19	1.31	1
HSS 7.5 x 0.12	67	1.08	1
HSS 7.5 x 0.25	32	1.20	1



Dimension and property tables

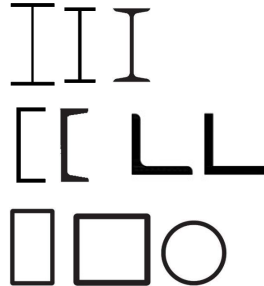


Table B.1
 W-Shapes (Welded)
 Dimensions

Shape	Depth, in.	Depth, mm	Web Thickness, in.	Web Thickness, mm	Flange		Flange Thickness, in.	Flange Thickness, mm	Flange Width, in.	Flange Width, mm	Radius, in.	Radius, mm	Stability Factor
					Width, in.	Width, mm							
W4x13	13	330	0.25	6.4	4.0	0.25	6.4	4.0	13	330	0.25	6.4	0.000

Table B.2 (Continued)
 W-Shapes (Welded)
 Properties

Shape	Area, in. ²	Area, cm ²	I _x , in. ⁴	I _x , cm ⁴	I _y , in. ⁴	I _y , cm ⁴	S _x , in. ³	S _x , cm ³	S _y , in. ³	S _y , cm ³	r _x , in.	r _x , cm	r _y , in.	r _y , cm	J, in. ⁶	J, cm ⁶	C _w , in. ⁶	C _w , cm ⁶	Z _x , in. ³	Z _x , cm ³	Z _y , in. ³	Z _y , cm ³	P _{0.1} , in.	P _{0.1} , mm	P _{0.2} , in.	P _{0.2} , mm	P _{0.5} , in.	P _{0.5} , mm	P _{1.0} , in.	P _{1.0} , mm	P _{2.0} , in.	P _{2.0} , mm	P _{5.0} , in.	P _{5.0} , mm	P _{10.0} , in.	P _{10.0} , mm	
																																					W4x13



Serviceability (Chapter L)



Chapter L – Design for Serviceability

The chapter is organized as follows:

- L1. General Provisions
- L2. Deflections**
- L3. Drift
- L4. Vibration
- L5. Wind-Induced Motion
- L6. Thermal Expansion and Contraction
- L7. Connection Slip



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Chapter L – Design for Serviceability

L2. Deflections

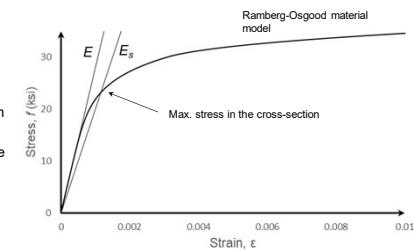
Reduced modulus of elasticity, E_r

$$E_r = \frac{E_{st} + E_{sc}}{2}$$

where

E_{sc} = secant modulus corresponding to the maximum compressive stress in the cross section, ksi (MPa)

E_{st} = secant modulus corresponding to the maximum tensile stress in the cross section, ksi (MPa)



Secant modulus

$$E_s = \frac{E}{1 + 0.002 \frac{E}{f} \left(\frac{f}{F_y} \right)^n}$$



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Member design (Chapter D)



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Chapter D – Design of Members for Tension

The chapter is organized as follows:

- D1. Slenderness Limitations
- D2. Tensile Strength
- D3. Effective Net Area
- D4. Built-Up Members
- D5. Pin-Connected Members

Applicable to

- austenitic and duplex stainless steel members,
- precipitation hardening stainless steel rods.

The design of eye bars is not covered.



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Chapter D – Design of Members for Tension

D2. Design tensile strength (Difference compared to AISC 360)

(a) For tensile yielding in the gross section

$$P_n = F_y A_g$$

For austenitic and duplex stainless steel tension members
 $\phi_t = 0.90$ (LRFD) $\Omega_t = 1.67$ (ASD)

For precipitation hardening stainless steel tension rods
 $\phi_t = 0.80$ (LRFD) $\Omega_t = 1.88$ (ASD)



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Chapter D – Design of Members for Tension

D5. Pin-connected members (Difference compared to AISC 360)

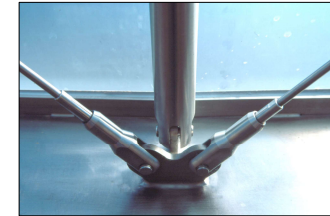
Tensile strength

Given by the lowest limit state of:

- Yielding
- Tensile rupture
- Shear rupture
- Bearing

Dimensional requirements – small differences:

- Greater flexibility in the shape of the pin-connected member beyond the pin hole
- New requirement to check bearing strength of pin (when pin-connected members are high strength)



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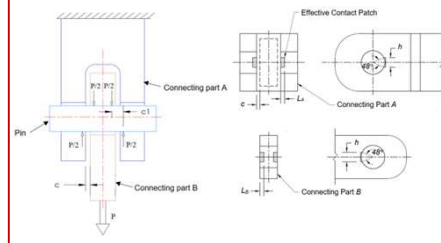
Section J8 – Pins

Design of pins

Given by the lowest limit state of:

- Bearing strength
- Shear rupture
- Flexural strength
- Combined shear and flexure

Commentary to Section J8 - Pins Method for calculating the moment in the pin



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Chapter E



Chapter E – Design of Members for Compression

The chapter is organized as follows:

- E1. General Provisions
- E2. Effective Length
- E3. Flexural Buckling of Members without Slender Elements
- E4. Torsional and Flexural-Torsional Buckling of Single Equal-Leg Angles and Members without Slender Elements
- E5. Single Equal-Leg-Angle Compression Members Without Slender Elements The design of unequal-leg angles is not covered.
- E6. Built-Up Members Built-up members interconnected by cover plates or lacing with tie plates are not covered.
- E7. Members with Slender Elements



Chapter E – Column buckling curve

Comparison between AISC 360 and AISC 370

AISC 360

One buckling curve
 Curve composed of **two** parts:

- Inelastic buckling
- Elastic buckling

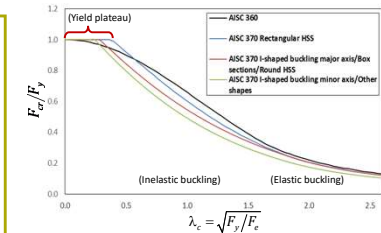
No yield plateau
 Elastic buckling starts at $\lambda_c = 1.50$

AISC 370

Three buckling curves
 Curves composed of **three** parts:

- Yielding
- Inelastic buckling
- Elastic buckling

Yield plateau
 Elastic buckling starts at $\lambda_c = 1.8$



Chapter E – Column buckling curve

Comparison between AISC 360 and AISC 370

$$F_e = \frac{\pi^2 E}{\left(\frac{L}{r}\right)^2} \quad (\text{Euler stress}) \quad \lambda_c = \sqrt{\frac{F_y}{F_e}} \quad (\text{column slenderness})$$

AISC 360

When $\frac{F_y}{F_e} \leq 2.25$ (Inelastic buckling)

$$F_{cr} = \left(0.658^{\frac{F_y}{F_e}}\right) F_y$$

When $\frac{F_y}{F_e} > 2.25$ (Elastic buckling)

$$F_{cr} = 0.877 F_e$$

AISC 370

When $\frac{F_y}{F_e} \leq \left(\frac{\beta_x}{\pi}\right)^2$ (Yielding)

$$F_{cr} = F_y$$

When $\left(\frac{\beta_x}{\pi}\right)^2 < \frac{F_y}{F_e} \leq 3.20$ (Inelastic buckling)

$$F_{cr} = 1.2 \left(\beta_x \left(\frac{F_y}{F_e}\right)^{\nu}\right) F_y$$

When $\frac{F_y}{F_e} > 3.20$ (Elastic buckling)

$$F_{cr} = \beta_x F_e$$



Chapter E – Column buckling curve

Comparison between AISC 360 and AISC 370

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Chapter E – Column buckling curve

Comparison between AISC 360 and AISC 370

$F_e = \frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2}$ (Euler stress) $\lambda_c = \sqrt{\frac{F_y}{F_e}}$ (column slenderness)

AISC 370

When $\frac{F_y}{F_e} \leq \left(\frac{\beta_0}{\pi}\right)^2$ (Yielding)
 $F_{cr} = F_y$

When $\left(\frac{\beta_0}{\pi}\right)^2 < \frac{F_y}{F_e} \leq 3.20$ (Inelastic buckling)
 $F_{cr} = 1.2 \left(\frac{F_y}{\beta_1 \left(\frac{L_c}{r}\right)}\right) F_y$

When $\frac{F_y}{F_e} > 3.20$ (Elastic buckling)
 $F_{cr} = \beta_2 F_e$

Member Type	Alloy Family	Curve	α	β_0	β_1	β_2
Rolled or built-up I-shaped sections buckling about the minor axis, and other sections not specified in this table	Austenitic and duplex	A	0.56	0.759	0.409	0.690
Rolled or built-up I-shaped sections buckling about the major axis, welded box sections, and round HSS	Austenitic and duplex	B	0.58	0.891	0.455	0.820
Rectangular HSS	Austenitic and duplex	C	0.69	1.195	0.501	0.820

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Chapter E – Column buckling curve

Comparison between AISC 360 and AISC 370

$F_e = \frac{\pi^2 E}{\left(\frac{L_c}{r}\right)^2}$ (Euler stress) $\lambda_c = \sqrt{\frac{F_y}{F_e}}$ (column slenderness)

AISC 370

When $\frac{F_y}{F_e} \leq \left(\frac{\beta_0}{\pi}\right)^2$ (Yielding)
 $F_{cr} = F_y$

When $\left(\frac{\beta_0}{\pi}\right)^2 < \frac{F_y}{F_e} \leq 3.20$ (Inelastic buckling)
 $F_{cr} = 1.2 \left(\frac{F_y}{\beta_1 \left(\frac{L_c}{r}\right)}\right) F_y$

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 $F_{cr} = \beta_2 F_e$

Member Type	Alloy Family	Curve	α	β_0	β_1	β_2
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Rectangular HSS	Austenitic and duplex	C	0.69	1.195	0.501	0.820

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Chapter E – Members with slender elements

E7.1 Slender element members excluding round HSS (Effective width method)

AISC 360

$$b_e = b \left(1 - c_1 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b$$

Case	Slender Element	c_1	c_2
(a)	Stiffened elements except walls of square and rectangular HSS	0.18	1.31
(b)	Walls of square and rectangular HSS	0.20	1.38
(c)	All other elements	0.22	1.49

AISC 370

$$b_e = 0.772b \left(1 - 0.10 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b$$

For all type of elements (i.e. stiffened or unstiffened) and sections (i.e. cold-formed or welded)

For cold-formed HSS → may be used with $F_{y,avg}$ ($F_{y,avg} > F_y$)

For other sections → use with F_y

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Chapter E – Members with slender elements

E7.1 Slender element members excluding round HSS (Effective width method)

AISC 360

$$b_e = b \left(1 - c_1 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b$$

Case	Slender Element	c_1	c_2
(a)	Stiffened elements except walls of square and rectangular HSS	0.18	1.31
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AISC 370

$$b_e = 0.772b \left(1 - 0.10 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b$$

For all type of elements (i.e. stiffened or unstiffened) and sections (i.e. cold-formed or welded)

Alternatively, only for cold-formed HSS:

$$b_e = b \left(1 - 0.22 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b \rightarrow \text{use only with } F_y$$

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Chapter E – Members with slender elements

E7.2 Round HSS (Effective area)

AISC 360

(a) When $\frac{D}{t} \leq 0.11 \frac{E}{F_y}$

$A_e = A_g$

(b) When $0.11 \frac{E}{F_y} < \frac{D}{t} < 0.45 \frac{E}{F_y}$

$A_e = \left[\frac{0.038E}{F_y(D/t)} + \frac{2}{3} \right] A_g$



AISC 370

(a) When $\lambda \leq \lambda_r \frac{F_y}{F_{cr}}$, $\lambda_r \frac{F_y}{F_{cr}} = \text{const} \frac{E}{F_y} \frac{F_y}{F_{cr}} = \text{const} \frac{E}{F_{cr}}$

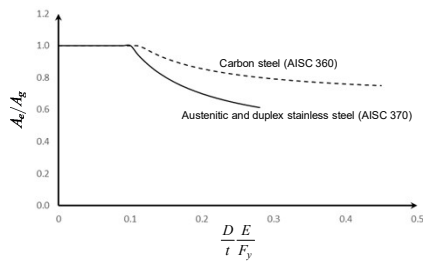
$A_e = A_g$

(b) When $\lambda_r \frac{F_y}{F_{cr}} < \lambda < 2.4 \lambda_r \frac{F_y}{F_{cr}}$

$A_e = \left(\frac{0.6 F_{cr}}{\lambda} \frac{F_y}{F_y} + \frac{2}{5} \right) A_g$

Chapter E – Members with slender elements

E7.2 Round HSS (Effective area)



Design tables:
 Compression

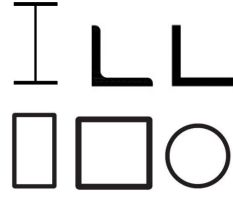
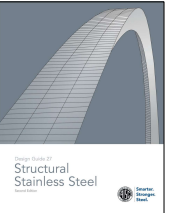


Table E3
 Available Strength in Axial Compression, Kips
 Rectangular HSS

Austenitic Stainless Steel
 $F_y = 30 \text{ ksi}$

Shape	HSS10x10				HSS12x12				HSS14x14				HSS16x16			
	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n
Design	1000	600	1000	600	1000	600	1000	600	1000	600	1000	600	1000	600	1000	600

1-13 (continued)
 Available Strength in Compression, Kips
 (Equal Leg Angles (Hot Rolled))

L	L4x4				L5x5				L6x6				L8x8			
	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n	P_n	ϕP_n
Design	100	60	100	60	100	60	100	60	100	60	100	60	100	60	100	60

Properties

A_g , in ²	2.11	1.66	1.70	1.37	0.944
r_x , in	0.581	0.560	0.601	0.642	0.586
r_y , in	0.581	0.560	0.601	0.642	0.586
r_{xy} , in	0.000	0.000	0.000	0.000	0.000



Chapter F




Chapter F – Design of Members for Flexure

The chapter is organized as follows:

- F1. General Provisions The design of single angles in flexure is not covered.
- F2. Doubly Symmetric Compact I-Shaped Members and Channels Bent about Their Major Axis
- F3. Doubly Symmetric I-Shaped Members **and Channels** with Compact Webs and Noncompact or Slender Flanges Bent about Their Major Axis
- F4. Doubly Symmetric I-Shaped Members with Noncompact Webs Bent about Their Major Axis
- F5. Double Symmetric I-Shaped Members with Slender Webs Bent about Their Major Axis
- F6. I-Shaped Members and Channels Bent about Their Minor Axis
- F7. Square and Rectangular HSS and Box Sections → Only sections with $h/b \leq 3$ are covered. No LTB.
- F8. Round HSS
- F9. Solid rectangular Shapes and Rounds
- F10. Other Shapes → Only sections without slender elements.
- F11. Proportions of Beams and Girders

Specific design provisions for singly symmetric I-shaped members, tees and double angles are not given. However, they are cover under F10.




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Chapter F – Design of Members for Flexure

Main differences between AISC 360 and AISC 370

- Lateral-torsional buckling curve
- Flange local buckling curve
- Other minor differences

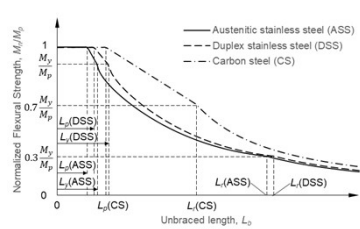



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Chapter F – Lateral-torsional buckling curve

Comparison between AISC 360 and AISC 370

AISC 360	AISC 370
<p>One buckling curve</p> <p>Curve composed of three parts:</p> <ul style="list-style-type: none"> ▪ Yielding ▪ Inelastic buckling ▪ Elastic buckling 	<p>Two buckling curves:</p> <ul style="list-style-type: none"> ▪ Austenitic ▪ Duplex <p>Curves composed of four parts:</p> <ul style="list-style-type: none"> ▪ Yielding ▪ Inelastic buckling ($M_n > M_p$) ▪ Inelastic buckling ($M_n < M_p$) ▪ Elastic buckling

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Chapter F – Lateral-torsional buckling (LTB) curve

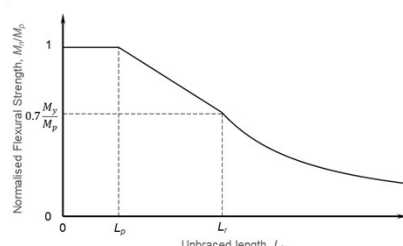

AISC 360 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$ $M_n = M_p$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[M_p - (M_p - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$$

When $L_b > L_r$ $M_n = F_{cr} S_x \leq M_p$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$ $M_n = M_p$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[M_p - (M_p - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$$

When $L_b > L_r$

$$M_n = F_{cr} S_x \leq M_p$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$ $M_n = M_p$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[M_p - (M_p - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$$

When $L_b > L_r$ $M_n = F_{cr} S_x \leq M_p$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$ $M_n = M_p$

When $L_p \leq L_b \leq L_r$

 $M_n = C_b \left[M_p - (M_p - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$

When $L_b > L_r$

$$M_n = F_{cr} S_x \leq M_p$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$ $M_n = M_p$

When $L_p \leq L_b \leq L_y$

$$M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq M_p$$

When $L_y \leq L_b \leq L_r$

$$M_n = C_b \left[M_y - (M_y - 0.30F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{\alpha_{LT}} \right] \leq M_p$$

$$\alpha_{LT} = 0.60 - 0.40 \left(\frac{L_b - L_y}{L_r - L_y} \right)$$

When $L_b > L_r$

$$M_n = \beta_{LT} F_{cr} S_x \leq M_p$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$
 $M_n = M_p$

When $L_p \leq L_b \leq L_y$
 $M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq M_p$

When $L_y \leq L_b \leq L_r$
 $M_n = C_b \left[M_y - (M_y - 0.30 F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{\alpha_{LT}} \right] \leq M_p$
 $\alpha_{LT} = 0.60 - 0.40 \left(\frac{L_b - L_y}{L_r - L_y} \right)$

When $L_b > L_r$
 $M_n = \beta_{LT} F_{cr} S_x \leq M_p$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$
 $M_n = M_p$

When $L_p \leq L_b \leq L_y$
 $M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq M_p$

When $L_y \leq L_b \leq L_r$
 $M_n = C_b \left[M_y - (M_y - 0.30 F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{\alpha_{LT}} \right] \leq M_p$
 $\alpha_{LT} = 0.60 - 0.40 \left(\frac{L_b - L_y}{L_r - L_y} \right)$

When $L_b > L_r$
 $M_n = \beta_{LT} F_{cr} S_x \leq M_p$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for **compact** I-shaped members and channels

When $L_b \leq L_p$
 $M_n = M_p$

When $L_p \leq L_b \leq L_y$
 $M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq M_p$

When $L_y \leq L_b \leq L_r$
 $M_n = C_b \left[M_y - (M_y - 0.30 F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{\alpha_{LT}} \right] \leq M_p$
 $\alpha_{LT} = 0.60 - 0.40 \left(\frac{L_b - L_y}{L_r - L_y} \right)$

When $L_b > L_r$
 $M_n = \beta_{LT} F_{cr} S_x \leq M_p$

**Table F2.1
 LTB Coefficient**

Alloy Family	β_{LT}
Austenitic	0.82
Duplex	0.88

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Chapter F – Lateral-torsional buckling (LTB) curve

LTB for I-shaped members and channels with **noncompact web**

AISC 360

When $I_{pc}/I_y > 0.23$
 When $\frac{h_c}{t_w} \leq \lambda_{pw}$
 $R_{pc} = \frac{M_p}{M_{yc}}$

When $\frac{h_c}{t_w} > \lambda_{pw}$
 $R_{pc} = \left[\frac{M_p}{M_{yc}} - \left(\frac{M_p}{M_{yc}} - 1 \right) \left(\frac{\lambda - \lambda_{pw}}{\lambda_{rw} - \lambda_{pw}} \right) \right] \leq \frac{M_p}{M_{yc}}$

When $I_{pc}/I_y \leq 0.23$
 $R_{pc} = 1.0$

AISC 370

When $I_{pc}/I_y > 0.23$
 $R_p = \left[\frac{M_p}{M_y} - \left(\frac{M_p}{M_y} - 1 \right) \left(\frac{\lambda - \lambda_{pw}}{\lambda_{rw} - \lambda_{pw}} \right) \right] \leq \frac{M_p}{M_y}$

When $I_{pc}/I_y \leq 0.23$
 $R_p = 1.0$

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Chapter F – Lateral-torsional buckling (LTB) curve

LTB for I-shaped members and channels with **noncompact web**

AISC 360

When $I_{yc}/I_y > 0.23$

When $\frac{h_c}{t_w} \leq \lambda_{pc}$

$$R_{pc} = \frac{M_p}{M_{yc}}$$

When $\frac{h_c}{t_w} > \lambda_{pc}$

$$R_{pc} = \left[\frac{M_p}{M_{yc}} - \left(\frac{M_p}{M_{yc}} - 1 \right) \left(\frac{\lambda - \lambda_{pc}}{\lambda_{rw} - \lambda_{pc}} \right) \right] \leq \frac{M_p}{M_{yc}}$$

When $I_{yc}/I_y \leq 0.23$

$$R_{pc} = 1.0$$

AISC 370

When $I_{yc}/I_y > 0.23$

$$R_p = \left[\frac{M_p}{M_y} - \left(\frac{M_p}{M_y} - 1 \right) \left(\frac{\lambda - \lambda_{pc}}{\lambda_{rw} - \lambda_{pc}} \right) \right] \leq \frac{M_p}{M_y}$$

When $I_{yc}/I_y \leq 0.23$

$$R_p = 1.0$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for I-shaped members with **noncompact web**

When $L_b \leq L_p$ $M_n = R_{pc} M_{yc}$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[R_{pc} M_{yc} - (R_{pc} M_{yc} - 0.7 F_y S_{xc}) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pc} M_{yc}$$

When $L_b > L_r$

$$M_n = F_{cr} S_{xc} \leq R_{pc} M_{yc}$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for I-shaped members with **noncompact web**

When $L_b \leq L_p$ $M_n = R_{pc} M_{yc}$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[R_{pc} M_{yc} - (R_{pc} M_{yc} - 0.7 F_y S_{xc}) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pc} M_{yc}$$

When $L_b > L_r$

$$M_n = F_{cr} S_{xc} \leq R_{pc} M_{yc}$$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for I-shaped members with **noncompact web**

When $L_b \leq L_p$ $M_n = R_{pc} M_{yc}$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[R_{pc} M_{yc} - (R_{pc} M_{yc} - 0.7 F_y S_{xc}) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pc} M_{yc}$$

When $L_b > L_r$

$$M_n = F_{cr} S_{xc} \leq R_{pc} M_{yc}$$

Limiting unbraced length L_p

Compact web	Noncompact web
$L_p = 1.76 r_y \sqrt{\frac{E}{F_y}}$	$L_p = 1.1 r_l \sqrt{\frac{E}{F_y}}$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 360 - LTB for I-shaped members with **noncompact web**

When $L_b \leq L_p$ $M_n = R_{pc}M_{yc}$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[R_{pc}M_{yc} - (R_{pc}M_{yc} - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pc}M_{yc}$$

When $L_b > L_r$ $M_n = F_{cr} S_x \leq R_{pc}M_{yc}$

Limiting unbraced length L_p

Compact web	Noncompact web
$L_p = 1.76r_y \sqrt{\frac{E}{F_y}}$	$L_p = 1.1r_y \sqrt{\frac{E}{F_y}}$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for I-shaped members and channels with **noncompact web**

When $L_b \leq L_p$ $M_n = R_p M_y$

When $L_p \leq L_b \leq L_y$

$$M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq R_p M_y$$

When $L_y \leq L_b \leq L_r$

$$M_n = C_b \left[M_y - (M_y - 0.30F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{alpha_{LT}} \right] \leq R_p M_y$$

When $L_b > L_r$ $M_n = \beta_{LT} F_{cr} S_x \leq R_p M_y$

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Chapter F – Lateral-torsional buckling (LTB) curve

AISC 370 - LTB for I-shaped members and channels with **noncompact web**

AISC 370

When $L_b \leq L_p$ $M_n = R_p M_y$

When $L_p \leq L_b \leq L_y$

$$M_n = C_b \left[M_p - (M_p - F_y S_x) \left(\frac{L_b - L_p}{L_y - L_p} \right) \right] \leq R_p M_y$$

When $L_y \leq L_b \leq L_r$

$$M_n = C_b \left[M_y - (M_y - 0.30F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{alpha_{LT}} \right] \leq R_p M_y$$

When $L_b > L_r$ $M_n = \beta_{LT} F_{cr} S_x \leq R_p M_y$

AISC 360

When $L_b \leq L_p$ $M_n = R_{pc} M_{yc}$

When $L_p \leq L_b \leq L_r$

$$M_n = C_b \left[R_{pc} M_{yc} - (R_{pc} M_{yc} - 0.7F_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pc} M_{yc}$$

When $L_b > L_r$ $M_n = F_{cr} S_x \leq R_{pc} M_{yc}$

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Chapter F – Lateral-torsional buckling (LTB) curve

LTB for I-shaped members with **slender web**

AISC 360

$$R_{pss} = 1 - \frac{a_w}{1.200 + 300a_w} \left(\frac{h_c}{t_w} - 5.7 \sqrt{\frac{E}{F_y}} \right) \leq 1.0$$

AISC 370

$$R_{pss} = 1 - \frac{a_w}{6.75 + 2.12a_w} \left(\frac{\lambda}{\lambda_{rw}} - 1.0 \right) \leq 1.0$$

(the same for austenitic and duplex stainless steel)

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Chapter F – Lateral-torsional buckling (LTB) curve

LTB for I-shaped members with **slender web**

AISC 360

$$R_{pg} = 1 - \frac{\alpha_w}{1,200} \left(\frac{h_c}{t_w} - 5.7 \sqrt{\frac{E}{F_y}} \right) \leq 1.0$$

AISC 370

$$R_{pg} = 1 - \frac{\alpha_w}{6.75} \left(2.12 \frac{\lambda}{\lambda_{rw}} - 1.0 \right) \leq 1.0$$

(the same for austenitic and duplex stainless steel)

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Chapter F – Lateral-torsional buckling (LTB) curve

LTB for I-shaped members with **slender web**

AISC 360

When $L_b \leq L_p$
 $M_n = R_{pg} M_{yc}$

When $L_p \leq L_b \leq L_r$
 $M_n = C_b R_{pg} \left[M_{yc} - (0.3 F_y S_{xc}) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq R_{pg} M_{yc}$

When $L_b > L_r$
 $M_n = R_{pg} F_{cr} S_{xc} \leq R_{pg} M_{yc}$

AISC 370

When $L_b \leq L_y$
 $M_n = R_{pg} M_y$

When $L_p \leq L_b \leq L_r$
 $M_n = C_b R_{pg} \left[M_y - (M_y - 0.3 F_y S_x) \left(\frac{L_b - L_y}{L_r - L_y} \right)^{\alpha_{LT}} \right] \leq R_{pg} M_y$

When $L_b > L_r$
 $M_n = \beta_{LT} R_{pg} F_{cr} S_x \leq R_{pg} M_y$

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Chapter F – Flange local buckling curve

Noncompact flanges:
 AISC 370 follows the same principle as AISC 360

Slender flanges:
 AISC 370 → Effective width method (accounts for post buckling strength)
 AISC 360 → Elastic local buckling (no post buckling strength)

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Chapter F – Flange local buckling curve

Noncompact flanges:
 AISC 370 follows the same principle as AISC 360

Slender flanges:
 AISC 370 → Effective width method (accounts for post buckling strength)
 AISC 360 → Elastic local buckling (no post buckling strength)

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Chapter F – Flange local buckling curve

Noncompact flanges:
 AISC 370 follows the same principle as AISC 360

Slender flanges:
 AISC 370 → Effective width method (accounts for post buckling strength)
 AISC 360 → Elastic local buckling (no post buckling strength)

Normalized Flexural Strength, M_x/M_p

Normalized Slenderness, $\lambda = \frac{b_f/2t_f}{\sqrt{E/F_y}}$

Stainless steel (SS)
 Carbon steel (CS)

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Chapter F – Flange local buckling curve

Noncompact flanges:
 AISC 370 follows the same principle as AISC 360

Slender flanges:
 AISC 370 → Effective width method (accounts for post buckling strength)
 AISC 360 → Elastic local buckling (no post buckling strength)

Normalized Flexural Strength, M_y/M_p

Normalized Slenderness, $\lambda = \frac{b_f/2t_f}{\sqrt{E/F_y}}$

Stainless steel (SS)
 Carbon steel (CS)

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Chapter F – Flange local buckling curve

AISC 370 - Flange local buckling for sections with **slender flanges**

Effective width method

$$b_e = 0.772b \left(1 - 0.10 \sqrt{\frac{F_{cl}}{F_{cr}}} \right) \sqrt{\frac{F_{cl}}{F_{cr}}} \leq b$$

where:
 $M_n = F_y S_{xe}$
 S_{xe} = effective section modulus, in.³ (mm³)
 $= \frac{I_{xe}}{y_e}$

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Design tables: Flexural members

Table 7-2 (continued) W-Shapes (Welded) Selection by Z_x

Table 7-19 Available Flexural Strength, kip-ft Round HSS

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Chapter G



Chapter G – Design of Members for Shear and Torsion

The chapter is organized as follows:

- G1. General Provisions
- G2. I-Shaped Members and Channels Subject to Major-Axis Shear
- G3. Rectangular HSS and Box Sections Subject to Shear
- G4. Round HSS Subject to Shear
- G5. Doubly Symmetric I-Shaped Members and Channels Subject to Minor-Axis Shear
- G6. Other Singly or Doubly Symmetric Shapes Subject to Shear
- G7. Beams and Girders with Web Openings Subject to Shear
- G8. **Round and Rectangular HSS, and Box Sections Subject to Torsion**
- G9. **Doubly Symmetric I-Shaped Members and Channels Subject to Torsion**

The design of single angles in shear is not covered.

Angles, tees, and singly symmetric I-shaped members subject to torsion are also not included.



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Chapter G – Design of Members for Shear and Torsion

Main differences between AISC 360 and AISC 370

- Shear buckling coefficients C_{v1} and C_{v2}
- Shear strength of Round HSS
- Torsional strength of Round HSS
- Torsional strength of Rectangular HSS
- Other minor differences



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Chapter G – Shear buckling coefficients

- G2. I-Shaped Members and Channels Subject to Major-Axis Shear
 - TFA → C_{v2}
 - No TFA: → C_{v1}
 - G3. Rectangular HSS and Box Sections Subject to Shear
 - G5. Doubly Symmetric I-Shaped Members and Channels Subject to Minor-Axis Shear
 - G6. Other Singly or Doubly Symmetric Shapes Subject to Shear
- No TFA, but C_{v2}



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Chapter G – Shear buckling coefficients

G2. I-Shaped Members and Channels Subject to Major-Axis Shear

1. Shear Strength of Webs without Tension Field Action

$$V_n = 0.6F_y A_w C_{v1}$$

<p>AISC 360</p> <p>When $h/t_w \leq 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.0$ <p>When $h/t_w > 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.10\sqrt{k_v E / F_y}}{h / t_w}$	<p>AISC 370</p> <p>When $\lambda \leq 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.2$ <p>When $\lambda > 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.55\sqrt{k_v E / F_y}}{0.7\sqrt{k_v E / F_y} + \lambda}$
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Chapter G – Shear buckling coefficients

G2. I-Shaped Members and Channels Subject to Major-Axis Shear

1. Shear Strength of Webs without Tension Field Action

$$V_n = 0.6F_y A_w C_{v1}$$

<p>AISC 360</p> <p>When $h/t_w \leq 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.0$ <p>When $h/t_w > 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.10\sqrt{k_v E / F_y}}{h / t_w}$	<p>AISC 370</p> <p>When $\lambda \leq 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.2$ <p>When $\lambda > 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.55\sqrt{k_v E / F_y}}{0.7\sqrt{k_v E / F_y} + \lambda}$
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Chapter G – Shear buckling coefficients

G2. I-Shaped Members and Channels Subject to Major-Axis Shear

1. Shear Strength of Webs without Tension Field Action

$$V_n = 0.6F_y A_w C_{v1}$$

<p>AISC 360</p> <p>When $h/t_w \leq 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.0$ <p>When $h/t_w > 1.10\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.10\sqrt{k_v E / F_y}}{h / t_w}$	<p>AISC 370</p> <p>When $\lambda \leq 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = 1.2$ <p>When $\lambda > 0.59\sqrt{k_v E / F_y}$</p> $C_{v1} = \frac{1.55\sqrt{k_v E / F_y}}{0.7\sqrt{k_v E / F_y} + \lambda}$
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Chapter G – Shear buckling coefficients

Definition of C_{v2} in AISC 360 and AISC 370

<p>AISC 360</p> <p>When $h/t_w \leq 1.10\sqrt{k_v E / F_y}$</p> $C_{v2} = 1.0$ <p>When $1.10\sqrt{k_v E / F_y} < h/t_w \leq 1.37\sqrt{k_v E / F_y}$</p> $C_{v2} = \frac{1.10\sqrt{k_v E / F_y}}{h / t_w}$ <p>When $h/t_w > 1.37\sqrt{k_v E / F_y}$</p> $C_{v2} = \frac{1.51k_v E}{(h / t_w)^2 F_y}$	<p>AISC 370</p> <p>When $\lambda \leq 0.33\sqrt{k_v E / F_y}$</p> $C_{v2} = 1.2$ <p>When $0.33\sqrt{k_v E / F_y} < \lambda \leq 0.97\sqrt{k_v E / F_y}$</p> $C_{v2} = 1.2 - 0.62 \left(\frac{\lambda}{\sqrt{k_v E / F_y}} - 0.33 \right)$ <p>When $0.97\sqrt{k_v E / F_y} < \lambda \leq 2.68\sqrt{k_v E / F_y}$</p> $C_{v2} = \frac{5.02\sqrt{k_v E / F_y} - \lambda}{1.62\sqrt{k_v E / F_y} + 3.55\lambda}$ <p>When $\lambda > 2.68\sqrt{k_v E / F_y}$</p> $C_{v2} = \frac{1.51k_v E}{\lambda^2 F_y}$
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Chapter G – Shear buckling coefficients

Definition of C_{v2} in AISC 360 and AISC 370

AISC 360	AISC 370
When $h/t_w \leq 1.10\sqrt{k_v E/F_y}$ $C_{v2} = 1.0$	When $\lambda \leq 0.33\sqrt{k_v E/F_y}$ $C_{v2} = 1.2$
When $1.10\sqrt{k_v E/F_y} < h/t_w \leq 1.37\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.10\sqrt{k_v E/F_y}}{h/t_w}$	When $0.33\sqrt{k_v E/F_y} < \lambda \leq 0.97\sqrt{k_v E/F_y}$ $C_{v2} = 1.2 - 0.62 \left(\frac{\lambda}{\sqrt{k_v E/F_y}} - 0.33 \right)$
When $h/t_w > 1.37\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.51k_v E}{(h/t_w)^2 F_y}$	When $0.97\sqrt{k_v E/F_y} < \lambda \leq 2.68\sqrt{k_v E/F_y}$ $C_{v2} = \frac{5.02\sqrt{k_v E/F_y} - \lambda}{1.62\sqrt{k_v E/F_y} + 3.55\lambda}$
	When $\lambda > 2.68\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.51k_v E}{\lambda^2 F_y}$

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Chapter G – Shear buckling coefficients

Definition of C_{v2} in AISC 360 and AISC 370

AISC 360	AISC 370
When $h/t_w \leq 1.10\sqrt{k_v E/F_y}$ $C_{v2} = 1.0$	When $\lambda \leq 0.33\sqrt{k_v E/F_y}$ $C_{v2} = 1.2$
When $1.10\sqrt{k_v E/F_y} < h/t_w \leq 1.37\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.10\sqrt{k_v E/F_y}}{h/t_w}$	When $0.33\sqrt{k_v E/F_y} < \lambda \leq 0.97\sqrt{k_v E/F_y}$ $C_{v2} = 1.2 - 0.62 \left(\frac{\lambda}{\sqrt{k_v E/F_y}} - 0.33 \right)$
When $h/t_w > 1.37\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.51k_v E}{(h/t_w)^2 F_y}$	When $0.97\sqrt{k_v E/F_y} < \lambda \leq 2.68\sqrt{k_v E/F_y}$ $C_{v2} = \frac{5.02\sqrt{k_v E/F_y} - \lambda}{1.62\sqrt{k_v E/F_y} + 3.55\lambda}$
	When $\lambda > 2.68\sqrt{k_v E/F_y}$ $C_{v2} = \frac{1.51k_v E}{\lambda^2 F_y}$

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Chapter G – Shear strength of Round HSS

AISC 360 - Round HSS Subject to Shear

$$V_n = F_{cr} A_g / 2$$

where F_{cr} shall be the larger of:

$$F_{cr} = \frac{1.60E}{\sqrt{\frac{L_w}{D} \left(\frac{D}{t} \right)^{5/4}}} \quad \text{(For round HSS with intermediate length)}$$

$$F_{cr} = \frac{0.78E}{\left(\frac{D}{t} \right)^{3/2}} \quad \text{(For round HSS with long length)}$$

but $F_{cr} \leq 0.6F_y$

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Chapter G – Shear strength of Round HSS

AISC 360 - Round HSS Subject to Shear

$$V_n = 0.6C_v F_y A_g / 2$$

where C_v shall be the larger of:

$$C_v = \frac{2.67E}{\sqrt{L_w/D} \lambda^{1.25} F_y} \quad \text{(For round HSS with intermediate length)}$$

$$C_v = \frac{1.30E}{\lambda^{1.5} F_y} \quad \text{(For round HSS with long length)}$$

but $C_v \leq 1.0$

$$\lambda = \frac{D}{t}$$

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Chapter G – Shear strength of Round HSS

AISC 370 - Round HSS Subject to Shear

$$V_n = 0.6C_v F_y A_g / 2$$

where

When $\frac{L_v}{D} \leq 4.21\sqrt{\lambda}$ (Intermediate length)

$$C_v = C_{vM}$$

When $\frac{L_v}{D} > 4.21\sqrt{\lambda}$ (Long length)

$$C_v = C_{vL}$$

Intermediate length C_{vM}	Long length C_{vL}
When $\lambda \leq 0.32 \left(\frac{E/F_y}{\sqrt{L_v/D}} \right)^{0.80}$ $C_{vM} = 1.0$	When $\lambda \leq 0.24 (E/F_y)^{0.67}$ $C_{vL} = 1.0$
When $0.32 \left(\frac{E/F_y}{\sqrt{L_v/D}} \right)^{0.80} < \lambda \leq 4.65 \left(\frac{E/F_y}{\sqrt{L_v/D}} \right)^{0.80}$ $C_{vM} = 1 - 0.61 \left(0.47 \sqrt{\frac{L_v/D \lambda^{1.25}}{E/F_y}} - 0.23 \right)$	When $0.24 (E/F_y)^{0.67} < \lambda \leq 2.23 (E/F_y)^{0.67}$ $C_{vL} = 1 - 0.61 \left(0.68 \sqrt{\frac{\lambda^{1.50}}{E/F_y}} - 0.23 \right)$
When $\lambda > 4.65 \left(\frac{E/F_y}{\sqrt{L_v/D}} \right)^{0.80}$ $C_{vM} = \frac{2.67E}{\sqrt{L_v/D} \lambda^{1.25} F_y}$	When $\lambda > 2.23 (E/F_y)^{0.67}$ $C_{vL} = \frac{1.30E}{\lambda^{1.50} F_y}$

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Chapter G – Shear strength of Round HSS

Comparison between AISC 360 and AISC 370

$$\lambda_x = \sqrt{\frac{0.6F_y}{F_{cr}}}$$

where

$$F_{cr} = \frac{1.60E}{\sqrt{\frac{L_v}{D} \left(\frac{D}{t} \right)^2}}$$

Or

$$F_{cr} = \frac{0.78E}{\left(\frac{D}{t} \right)^2}$$

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Chapter G – Torsional strength of Round HSS

AISC 370 - Round HSS Subject to Torsion

$$T_n = 0.6CC_v F_y$$

where

When $\frac{L}{D} \leq 4.21\sqrt{\lambda}$ (Intermediate length)

$$C_v = C_{vM}$$

When $\frac{L}{D} > 4.21\sqrt{\lambda}$ (Long length)

$$C_v = C_{vL}$$

Intermediate length C_{vM}	Long length C_{vL}
When $\lambda \leq 0.26 \left(\frac{E/F_y}{\sqrt{L/D}} \right)^{0.80}$ $C_{vM} = 1.0$	When $\lambda \leq 0.20 (E/F_y)^{0.67}$ $C_{vL} = 1.0$
When $0.26 \left(\frac{E/F_y}{\sqrt{L/D}} \right)^{0.80} < \lambda \leq 3.77 \left(\frac{E/F_y}{\sqrt{L/D}} \right)^{0.80}$ $C_{vM} = 1 - 0.61 \left(0.54 \sqrt{\frac{L/D \lambda^{1.25}}{E/F_y}} - 0.23 \right)$	When $0.20 (E/F_y)^{0.67} < \lambda \leq 1.87 (E/F_y)^{0.67}$ $C_{vL} = 1 - 0.61 \left(0.77 \sqrt{\frac{\lambda^{1.50}}{E/F_y}} - 0.23 \right)$
When $\lambda > 3.77 \left(\frac{E/F_y}{\sqrt{L/D}} \right)^{0.80}$ $C_{vM} = \frac{2.05E}{\sqrt{L/D} \lambda^{1.25} F_y}$	When $\lambda > 1.87 (E/F_y)^{0.67}$ $C_{vL} = \frac{E}{\lambda^{1.50} F_y}$

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Chapter G – Torsional strength of Rectangular HSS and Box sections

AISC 370 – Rectangular HSS and Box Sections Subject to Torsion

$$T_n = 0.6CC_v F_y$$

When $\lambda \leq 0.74 \sqrt{E/F_y}$ $C_{t2} = 1.2$	}	Same as for shear (with $k_v = 5.0$)
When $0.74 \sqrt{E/F_y} < \lambda \leq 2.17 \sqrt{E/F_y}$ $C_{t2} = 1.2 - 0.28 \left(\frac{\lambda}{\sqrt{E/F_y}} - 0.74 \right)$		
When $2.17 \sqrt{E/F_y} < \lambda \leq 5.99 \sqrt{E/F_y}$ $C_{t2} = \frac{11.23 \sqrt{E/F_y} - \lambda}{3.62 \sqrt{E/F_y} + 3.55}$		
When $\lambda > 5.99 \sqrt{E/F_y}$ $C_{t2} = \frac{7.56E}{\lambda^2 F_y}$		

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Chapter H



Chapter H – Design of Members for Combined Forces ~~and Torsion~~

The chapter is organized as follows:

- H1. Doubly Symmetric I-Shaped Members, Channels, HSS, and Box Sections Subject to Flexure and Axial Force
- H2. Doubly Symmetric I-Shaped Members, Channels, HSS, and Box Sections Subject to Combined Torsion, Flexure, Shear, and/or Axial Force
- H3. Rupture of Flanges with Holes Subjected to Tension

The design of tees, single equal-leg angles, and double angles used in compression when other forces are present is outside the scope of this chapter.



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Chapter I (Design of Composite members)

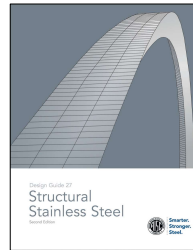


Appendix 2



Appendix 2 – The Continuous Strength Method

- The CSM is a new design method.
- Only applicable to members not susceptible to global buckling.
- Particularly beneficial for compact or nonslender sections.
- Account for the beneficial effect of strain hardening. **Higher strengths can be achieved**
- Can also be used with slender sections.



Appendix 2 – The Continuous Strength Method

The appendix is organized as follows:

- 2.1. Limitations
- 2.2. Material Modeling
- 2.3. Deformation Capacity
- 2.4. Tensile Strength
- 2.5. Compressive Strength
- 2.6. Flexural Strength
- 2.7. Combined Flexure and Compression



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Appendix 2 – The Continuous Strength Method

The appendix is organized as follows:

- 2.1. Limitations
- 2.2. Material Modeling
- 2.3. Deformation Capacity
- 2.4. Tensile Strength
- 2.5. Compressive Strength
- 2.6. Flexural Strength
- 2.7. Combined Flexure and Compression

- The CSM is applicable to:
- Doubly-symmetric I-shaped members
 - HSS and box sections
 - Channels, angles and tees

Range of applicability of the CSM			
	Compression members	Flexural members	Combined loading
I-shaped, channels, angles, tees, square and rectangular HSS, and box sections	$\frac{L_c}{r} \leq 0.63 \sqrt{\frac{E}{F_y}}$ or $\frac{L_c}{F_y} \leq 0.04$ and $\lambda_1 \leq 1.6$	$L_b \leq 0.50 L_p$ and $\lambda_1 \leq 1.6$	Requirements for both compression and flexural members shall be satisfied
Round HSS	$\frac{L_c}{r} \leq 0.63 \sqrt{\frac{E}{F_y}}$ or $\frac{L_c}{F_y} \leq 0.04$ and $\lambda_1 \leq 0.6$	$\lambda_1 \leq 0.6$	Requirements for both compression and flexural members shall be satisfied



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Appendix 2 – The Continuous Strength Method

The appendix is organized as follows:

- 2.1. Limitations
- 2.2. Material Modeling
- 2.3. Deformation Capacity
- 2.4. Tensile Strength
- 2.5. Compressive Strength
- 2.6. Flexural Strength
- 2.7. Combined Flexure and Compression

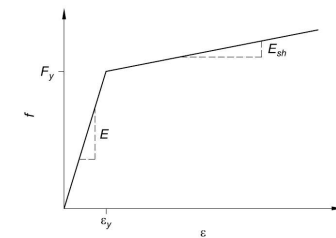


Fig. A-2.2.1. CSM material model.



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Appendix 2 – The Continuous Strength Method

The appendix is organized as follows:

- 2.1. Limitations
- 2.2. Material Modeling
- 2.3. Deformation Capacity
- 2.4. Tensile Strength
- 2.5. Compressive Strength
- 2.6. Flexural Strength
- 2.7. Combined Flexure and Compression



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Appendix 2 – The Continuous Strength Method

The CSM base curves

For I-Shaped, channels, angles, tees, square and rectangular HSS, and box sections

(a) When $\lambda_t \leq 0.68$

$$\frac{\epsilon_{csm}}{\epsilon_y} = \frac{0.25}{\lambda_t^{1.5}} \leq \text{minimum} \left(15, \frac{0.10(1-F_y/F_u)}{\epsilon_y} \right)$$

(b) When $\lambda_t > 0.68$

$$\frac{\epsilon_{csm}}{\epsilon_y} = \left(1 - \frac{0.222}{\lambda_t^{1.05}} \right) \frac{1}{\lambda_t^{1.05}}$$

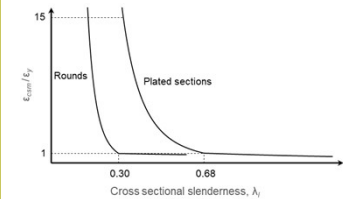
For rounds

(a) When $\lambda_t \leq 0.30$

$$\frac{\epsilon_{csm}}{\epsilon_y} = \frac{4.44 \times 10^{-3}}{\lambda_t^{4.5}} \leq \text{minimum} \left(15, \frac{0.10(1-F_y/F_u)}{\epsilon_y} \right)$$

(b) When $\lambda_t > 0.30$

$$\frac{\epsilon_{csm}}{\epsilon_y} = \left(1 - \frac{0.224}{\lambda_t^{0.342}} \right) \frac{1}{\lambda_t^{0.342}}$$



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Appendix 2 – The Continuous Strength Method

Tensile strength

(a) For tensile yielding in the gross section

$$P_n = f_{csm,t} A_g$$

where

$$f_{csm,t} = F_y + E_{sh} (\epsilon_{csm,t} - \epsilon_y)$$

$$\epsilon_{csm,t} = \text{minimum} [15\epsilon_y, 0.10(1-F_y/F_u)]$$

$$E_{sh} = \frac{F_u - F_y}{0.16(1-F_y/F_u) - \epsilon_y}$$

$$\phi_t = 0.90 \text{ (LRFD)} \quad \Omega_t = 1.67 \text{ (ASD)}$$

(b) For tensile rupture in the net section

$$P_n = F_u A_e$$

F_u may be replaced with f_{max} as given in Chapter D



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Appendix 2 – The Continuous Strength Method

Compressive strength

When $\epsilon_{csm} / \epsilon_y < 1.0$

$$P_n = \frac{\epsilon_{csm}}{\epsilon_y} F_y A_g$$

Local buckling takes place before F_y is reached. No benefit from strain hardening.

When $\epsilon_{csm} / \epsilon_y \geq 1.0$

$$P_n = f_{csm} A_g$$

Compressive strength $> P_y$ due to strain hardening.

where

$$f_{csm} = F_y + E_{sh} \epsilon_y \left(\frac{\epsilon_{csm}}{\epsilon_y} - 1 \right)$$

$$\phi_c = 0.90 \text{ (LRFD)} \quad \Omega_c = 1.67 \text{ (ASD)}$$



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Appendix 2 – The Continuous Strength Method

Flexural strength

When $\epsilon_{CSM} / \epsilon_y < 1.0$

$$M_n = \frac{\epsilon_{CSM}}{\epsilon_y} M_y$$


Local buckling takes place before M_y is reached. No benefit from strain hardening.

When $\epsilon_{CSM} / \epsilon_y \geq 1.0$

$$M_n = M_p \left[1 + \frac{E_{sh}}{E} \frac{S}{Z} \left(\frac{\epsilon_{CSM}}{\epsilon_y} - 1 \right) - \left(1 - \frac{S}{Z} \right) \left/ \left(\frac{\epsilon_{CSM}}{\epsilon_y} \right)^n \right. \right]$$

Flexural strength > M_y due to strain hardening.

$\phi_b = 0.90$ (LRFD) $\Omega_b = 1.67$ (ASD)




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Appendix 2 – The Continuous Strength Method

Combined flexure and compression

For I-Shaped, channels, angles, tees, square and rectangular HSS, and box sections	For rounds
When $\lambda_t \leq 0.60$	When $\lambda_t \leq 0.27$
$\frac{P_r}{P_c} + \frac{8}{9} \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0$ or $\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0$ (From Chapter H)	
When $\lambda_t > 0.60$	When $\lambda_t > 0.27$
$\frac{P_r}{P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0$	

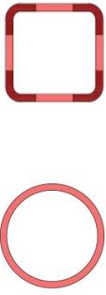



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Appendix 2 – The Continuous Strength Method


Comparison of CSM and Chapter E design provisions

	$P_n(CSM - F_{y,avg}) / P_n(Chap E - F_y)$		$P_n(CSM - F_y) / P_n(Chap E - F_y)$	
	Austenitic	Duplex	Austenitic	Duplex
Square hollow sections				
HSS 4 x 4 x 0.180	1.62	1.10	1.17	1.04
HSS 4 x 4 x 0.250	1.98	1.31	1.24	1.23
HSS 12 x 12 x 0.250	1.31	1.13	1.07	1.12
HSS 12 x 12 x 0.500	1.60	1.09	1.12	1.02
Round hollow sections				
HSS4.500 x 0.109	1.22	1.01	1.10	1.01
HSS4.500 x 0.250	1.62	1.16	1.24	1.15
HSS7.500 x 0.120	1.10	1.21	1.03	1.21
HSS7.500 x 0.250	1.37	1.03	1.22	1.03

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Structural analysis (Chapter C)




Chapter C – Design for Stability

The chapter is organized as follows:

- C1. General Stability Requirements
- C2. Calculation of Required Strengths
- C3. Calculation of Available Strengths

Based on the direct analysis method, similar to AISC 360




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Chapter C – Design for Stability

General Stability Requirements in AISC 370 and AISC 360

- Type of deformations to be accounted (i.e. flexural, shear and axial member deformations, etc.)
- Requirements for accounting for second order effects
- Type of loading to consider
- LRFD and ASD load combination allowed
- Modeling of system imperfections (i.e. direct modeling or using notional loads)
- Adjustment of stiffness → **Similar to AISC 360. Only differ in the expressions for τ_g and τ_b**

} Same as the requirements in AISC 360

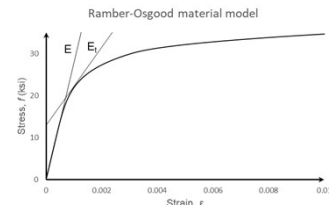


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Chapter C – Design for Stability

Adjustment of stiffness in AISC 360 and AISC 370

AISC 360	AISC 370
$\tau_g = 0.80$	$\tau_g = 0.70$
When $\alpha P_r / P_{ns} \leq 0.5$ $\tau_b = 1.0$	$\tau_b = \frac{1.0}{1.0 + 0.002 n_{eff} \frac{E}{F_y} \left(\frac{\alpha P_r}{P_{ns}} \right)^{n_{eff}-1}}$
When $\alpha P_r / P_{ns} > 0.5$ $\tau_b = 4(\alpha P_r / P_{ns}) [1 - (\alpha P_r / P_{ns})]$	



where
 $\alpha = 1.0$ (LRFD); $\alpha = 1.6$ (ASD)
 P_r = required axial compressive strength using LRFD or ASD load combinations, kips
 P_{ns} = cross-section compressive strength, kips
 n_{eff} = auxiliary coefficient (depends on the alloy family)

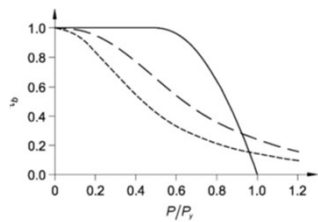


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Chapter C – Design for Stability

Adjustment of stiffness in AISC 360 and AISC 370

AISC 360	AISC 370
$\tau_g = 0.80$	$\tau_g = 0.70$
When $\alpha P_r / P_{ns} \leq 0.5$ $\tau_b = 1.0$	$\tau_b = \frac{1.0}{1.0 + 0.002 n_{eff} \frac{E}{F_y} \left(\frac{\alpha P_r}{P_{ns}} \right)^{n_{eff}-1}}$
When $\alpha P_r / P_{ns} > 0.5$ $\tau_b = 4(\alpha P_r / P_{ns}) [1 - (\alpha P_r / P_{ns})]$	



where
 $\alpha = 1.0$ (LRFD); $\alpha = 1.6$ (ASD)
 P_r = required axial compressive strength using LRFD or ASD load combinations, kips
 P_{ns} = cross-section compressive strength, kips
 n_{eff} = auxiliary coefficient (depends on the alloy family)



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Appendix 1



Appendix 1 – Design by Advanced Analysis

The appendix is organized as follows:

- 1.1 General Requirements
- 1.2 Design by Elastic Analysis
- 1.3 Design by Inelastic Analysis

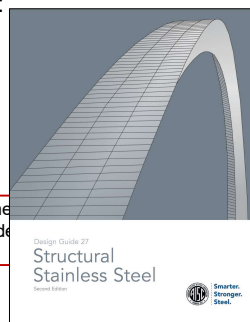
The strength of the member can be determined using the CSM design rules given in Appendix 2.



Appendix 1 – Design by Advanced Analysis

The appendix is organized as follows:

- 1.1 General Requirements
- 1.2 Design by Elastic Analysis
- 1.3 Design by Inelastic Analysis



Only applicable to doubly symmetric members, I-shaped members, square and rectangular HSS, and box sections, unless evidence is provided to other member types.



Appendix 1 – Design by Advanced Analysis

The appendix is organized as follows:

- 1.1 General Requirements
- 1.2 Design by Elastic Analysis
- 1.3 Design by Inelastic Analysis

Only applicable to doubly symmetric I-shaped members, square and rectangular HSS, and box sections.



Appendix 1 – Design by Advanced Analysis

Design by Inelastic Analysis

Carbon steel frame

Stainless steel frame

Appendix 1 – Design by Advanced Analysis

Design by Inelastic Analysis

Carbon steel frame

Stainless steel frame

● Plastic hinge
 — Carbon steel frame
 - - - Stainless steel frame

Appendix 1 – Design by Advanced Analysis

Design by Inelastic Analysis

CSM strain limits

$$\frac{\epsilon_r}{\epsilon_y} \leq \frac{\epsilon_{CSM}}{\epsilon_y}$$

When $\lambda_l \leq 0.68$

$$\frac{\epsilon_{CSM}}{\epsilon_y} = \frac{0.25}{\lambda_l^{3.6}} + \frac{0.002}{\epsilon_y} \leq \Lambda$$

When $0.68 < \lambda_l < 1.00$

$$\frac{\epsilon_{CSM}}{\epsilon_y} = \left(1 - \frac{0.222}{\lambda_l^{1.05}}\right) \frac{1}{\lambda_l^{1.05}} + \frac{0.002(f/F_y)^n}{\epsilon_y}$$

where

- F_y = specified minimum yield stress, ksi (MPa)
- f = stress at outer compressive fiber, ksi (MPa)
- ϵ_{CSM} = CSM strain limit
- $\epsilon_y = F_y/E$
- λ_l = local cross-section slenderness
- $= \sqrt{\frac{F_y}{F_{el}}}$
- F_{el} = elastic local buckling stress of full cross section, ksi (MPa)
- Λ = upper bound strain limit with a recommended value of 15

Appendix 1 – Design by Advanced Analysis

Design by Inelastic Analysis

CSM strain limits

$$\frac{\epsilon_r}{\epsilon_y} \leq \frac{\epsilon_{CSM}}{\epsilon_y}$$

When $\lambda_l \leq 0.68$

$$\frac{\epsilon_{CSM}}{\epsilon_y} = \frac{0.25}{\lambda_l^{3.6}} + \frac{0.002}{\epsilon_y} \leq \Lambda$$

When $0.68 < \lambda_l < 1.00$

$$\frac{\epsilon_{CSM}}{\epsilon_y} = \left(1 - \frac{0.222}{\lambda_l^{1.05}}\right) \frac{1}{\lambda_l^{1.05}} + \frac{0.002(f/F_y)^n}{\epsilon_y}$$

where


- F_y/f (ksi (MPa))
- $\epsilon_{CSM}/\epsilon_y$
- ϵ_y
- λ_l

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ksi (MPa)
 recommended value of 15

Appendix 4




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Appendix 4 – Structural Design for Fire Conditions


The appendix is organized as follows:

- 4.1. General Provisions
- 4.2. Structural Design for Fire Conditions by Analysis
- 4.3. Design by Qualification Testing

The scope of the appendix has been reduced because composite members are not covered in AISC 370



Stainless steel offshore escape tunnel
 © Booth Industries




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Appendix 4 – Structural Design for Fire Conditions

4.2. Structural Design for Fire Conditions by Analysis

Coefficient of Thermal Elongation

For carbon steel:	$7.8 \times 10^{-6} / ^\circ\text{F}$	
For austenitic stainless steel:	$11 \times 10^{-6} / ^\circ\text{F}$	(41% larger than for carbon steel)
For duplex stainless steel:	$9.0 \times 10^{-6} / ^\circ\text{F}$	(15% larger than for carbon steel)

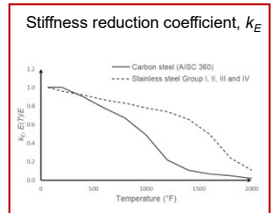
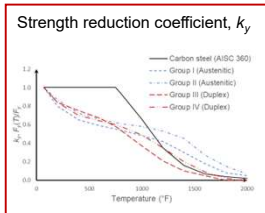



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Appendix 4 – Structural Design for Fire Conditions

4.2. Structural Design for Fire Conditions by Analysis

Deterioration of strength and stiffness at elevated temperatures

	Austenitic	Group I: S30400/S30403 Group II: S31600/S31603 and S32100	<div style="border: 1px solid red; padding: 5px;"> <p>Stiffness reduction coefficient, k_E</p>  </div>	<div style="border: 1px solid red; padding: 5px;"> <p>Strength reduction coefficient, k_y</p>  </div>
	Duplex	Group III: S32202 and S32304 Group IV: S32003, S32101, S32205 and S82441		



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Appendix 7



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Appendix 7 – Modeling of Material Behavior

The appendix is organized as follows:

- 7.1. Material Behavior at Ambient Temperature
- 7.2. Material Behavior at Elevated Temperatures



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Appendix 7 – Modeling of Material Behavior

7.1. Material Behavior at Ambient Temperature

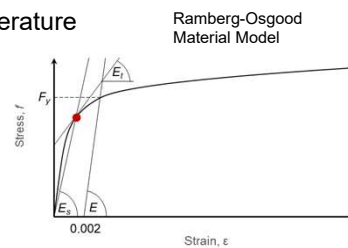
Stress-Strain Behavior

For $f \leq F_y$

$$\epsilon = \frac{f}{E} + 0.002 \left(\frac{f}{F_y} \right)^n$$

For $F_y < f \leq F_u$

$$\epsilon = 0.002 + \frac{F_y}{E} + \frac{f - F_y}{E_{ty}} + \left(\epsilon_u - 0.002 - \frac{F_y}{E} - \frac{F_u - F_y}{E_{ty}} \right) \left(\frac{f - F_y}{F_u - F_y} \right)^m$$



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Summary

- Structural performance is similar to carbon steel but some modifications needed due to the non-linear stress-strain curve.
- Scope and contents in AISC 370 is aligned to those in AISC 360.
- AISC 360 should not be used for the design of stainless steel members that are outside the scope of AISC 370.



19 May: Jason Provines and Benjamin Baer

- Connections
- Fabrication
- Code of Standard Practice



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AISC | Questions?




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CEU / PDH Certificates

For those participating at their own connection...

- Reporting attendance is not necessary.
- Certificates will be issued based on AISC's attendance record.
- You will be receiving certificates via email from registration@aisc.org.




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CEU / PDH Certificates

For those participating at one connection with a group...

- Main registrant will report attendance via an online form. (The link will be provided in an email from registration@aisc.org)
 - Username: Same as AISC website username.
 - Password: Same as AISC website password.
- Once attendance has been reported, each group member will be receiving certificates via email from registration@aisc.org.




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3-Session Registrants

CEU / PDH Certificates

One certificate will be issued at the conclusion of the course.



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Attendance and PDH Certificates

- You have two options to receive credit for each session.
 - Option 1: Watch the live session.
 - Option 2: Watch the recording and pass the associated quiz.

Videos and Quizzes

- For each session, find access within two business days after the live air date. (An email will be sent from webinars@aisc.org.)
- Quiz scores are displayed in the Course Resources table.

Distribution of Certificates

- All certificates will be issued after the course is completed.
- Only the registrant will receive a certificate for the course.



3-Session Registrants

Course Resources

Access to video recordings and quizzes can be found on your AISC account.



3-Session Registrants

Course Resources

Go to www.aisc.org and sign in.


3-Session Registrants

Course Resources

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Course Resources



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Course Resources

Event	Start Date
Seismic Design in Steel	1/1/1900 12:00:00 AM
8-Session Package-Design of Facade Attachments	5/9/2019 1:30:00 PM
US 15 8-Session Package-Night School 15 - Fundamentals of Connection Design	10/3/2017 7:00:00 PM
US 16 8-Session Package-Night School 16 - Seismic Design in Steel	4/9/2018 7:00:00 PM
US 17 4-Session Package-Night School 17-Design of Facade Attachments	7/16/2018 7:00:00 PM
US 18 8-Session Package-Night School 18-Steel Construction, Mill To Tensioning Out	10/15/2018 7:00:00 PM
US 19 8-Session Package-Night School 19-Connection Design	2/4/2019 7:00:00 PM
US 20 8-Session Package-Night School 20-Classical Methods of Structural Analysis	6/3/2019 7:00:00 PM
8-Session Package-Seismic Design in Steel - Concepts & Examples	7/16/2018 1:30:00 PM

3-Session Registrants

Course Resources




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Design of Facade Attachments

4-SESSION PACKAGE RESOURCES

Event	Date	Handouts	Video	Quiz	Attendance
R1: Facade Fundamentals	N/A	Handouts	Video Passcode: 42N5175	Pass Score: 100	N/A
L1: Facade Attachments Part 1	May 9 2019 1:30PM EDT	Handouts	Available 05/11/2019 5:00PM EDT	Available 05/11/2019 5:00 PM EDT	Pending
L2: Facade Attachments Part 2	May 16 2019 1:30PM EDT	Handouts	Available 05/18/2019 5:00PM EDT	Available 05/18/2019 5:00 PM EDT	Pending
L3: Facade Attachments - Building Lateral Drifts	May 23 2019 1:30PM EDT	Handouts	Available 05/25/2019 5:00PM EDT	Available 05/25/2019 5:00 PM EDT	Pending
Final Exam	N/A			Available 5/27/2019 5:00 PM EDT	



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