Introduction to Local buckling for Columns

- What are stiffened and unstiffend elements
- How to develop Expresion For Local buckling For stiffenend and unstiffened Elements?

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AISC-14

Page 2-48
AISC
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Table 2-4
Applicable ASTM Specifications for Various Structural Shapes

Steel Type	ASTM Designation		F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Applicable Shape Series: W	M	S	HP	C	MC	L	HSS Rect.	HSS Round	Pipe
Carbon	A36		36	58-80[b]										
	A53 Gr. B		35	60										
	A500	Gr. B	42	58										
			46	58										
		Gr. C	46	62										
			50	62										
	A501	Gr. A	36	58										
		Gr. B	50	70										
	A529[c]	Gr. 50	50	65-100										
		Gr. 55	55	70-100										
High-Strength Low-Alloy	A572	Gr. 42	42	60										
		Gr. 50	50	65[d]										
		Gr. 55	55	70										
		Gr. 60[e]	60	75										
		Gr. 65[e]	65	80										
	A618[f]	Gr. I & II	50[g]	70[g]										
		Gr. III	50	65										
	A913	50	50[h]	60[h]										
		60	60	75										
		65	65	80										
		70	70	90										
	A992		50	65[i]										

5 items

A529 C

A618 F

Corrosion 3/4"

50g 70g

h

→ min. values for certain wall thicknes

h: if desired max F_y = 65 ksi

Preferred

A500 Grade B

65d Maximum 70 can be specified

i Max. $\frac{F_y}{F_u} = 0.85$

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Stiffened and Unstiffened Element

Column is Slender

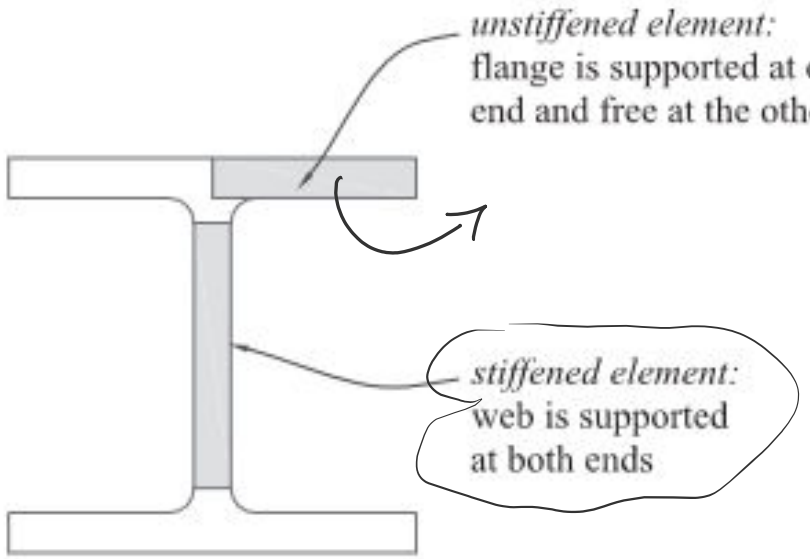


Figure 5-7 Stiffened and unstiffened elements.

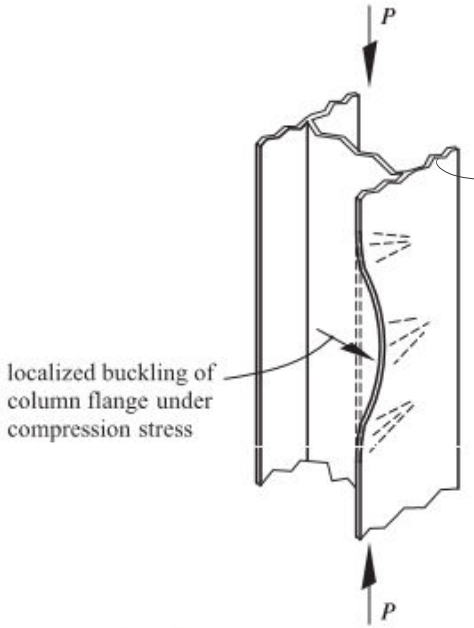


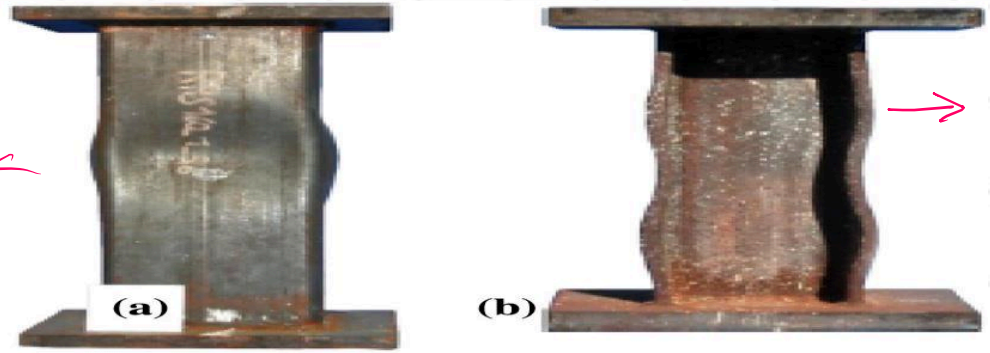
Figure 5-6 Local buckling of column under axial compression load.

Flange → Local buckling

Local buckling For Column

Local buckling

Unstiffend Part ←



→ local buckling For web

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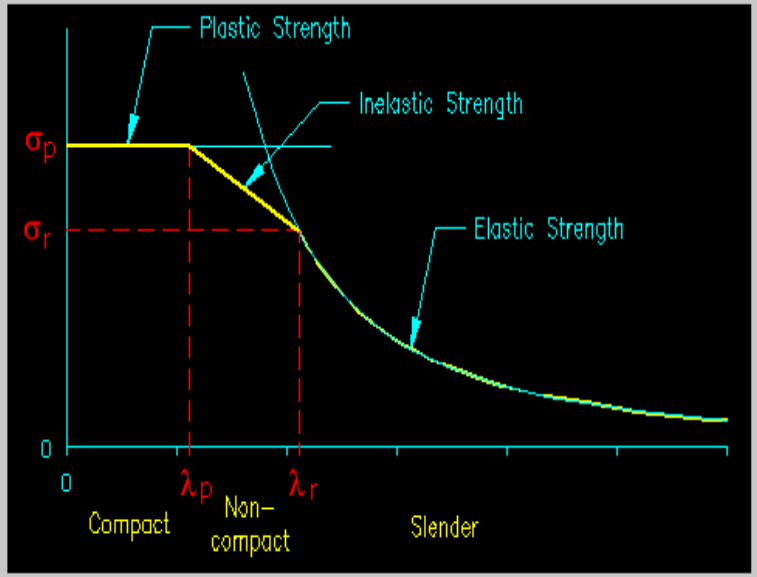
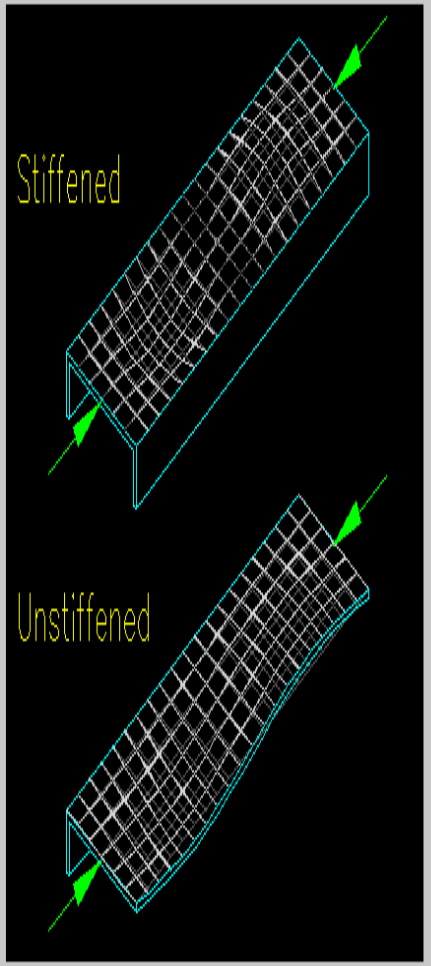
Figure 6.1.3
Theoretical Maximum Compressive Stress
Click on image for larger view



($\frac{b}{t}$) # 2010

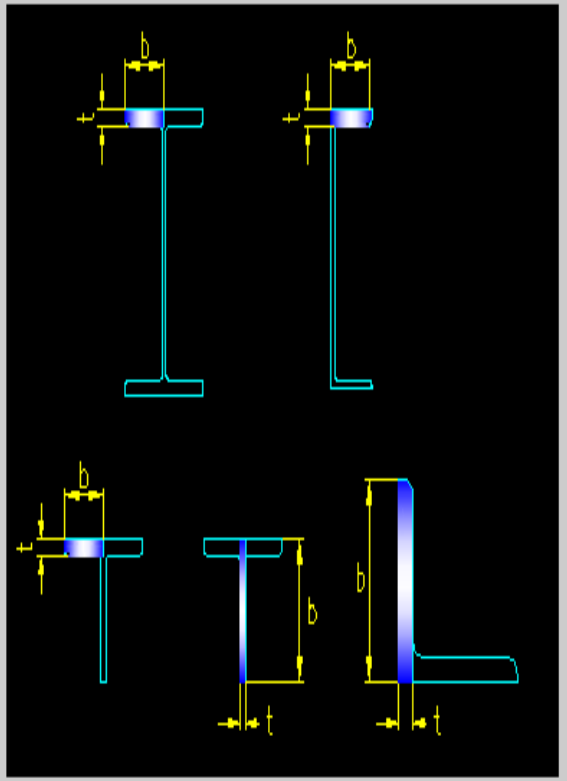
http://www.bgstructuralengineering.com/BGSCM14/BGSCM006/BGSCM00603.htm

Figure 6.3.3
Plate Buckling Modes
Click on image for larger view



Unstiffend elements

Figure 6.3.5
Unstiffened Elements
Click on image for larger view



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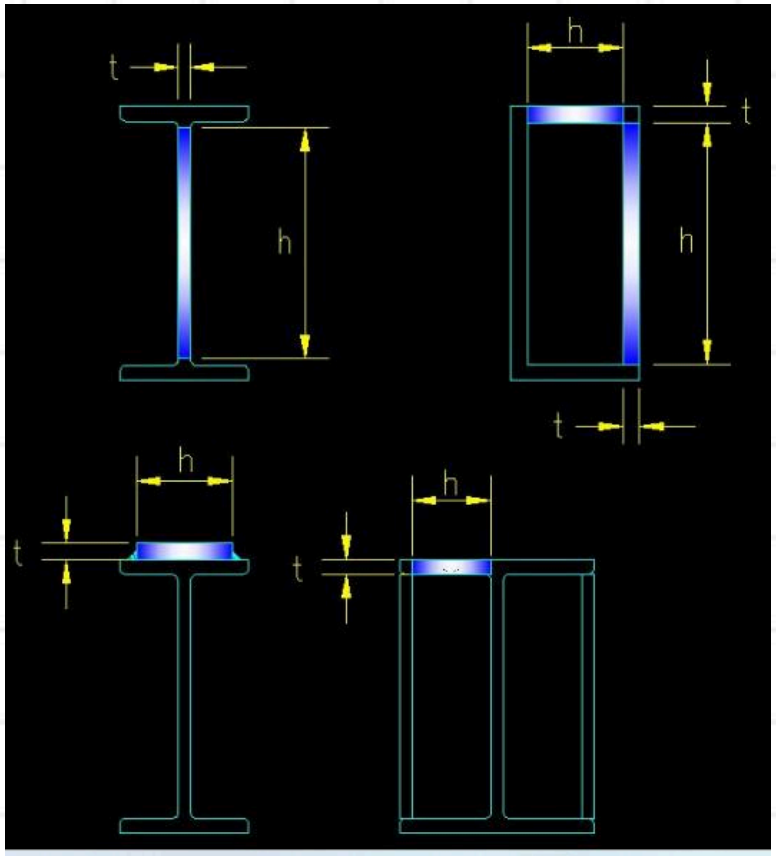
Samples

Figure 6.3.6 shows the *stiffened elements* on some typical steel sections and the measurement of the element width, h, and thickness, t. Note that "W" shapes and channels each have one stiffened plate element in their cross-section. A square or rectangular HSS has four stiffened elements in its cross-section. Normally, unstiffened plate elements can be stiffened with the addition of plate elements as seen in the figure.



https://www.bgstructuralengineering.com/BGSCM15/BGSCM006/BGSCM00603.htm

→ Sample of stiffened elements

https://www.bgstructuralengineering.com/BGSCM15/BGSCM006/Stiff.jpg

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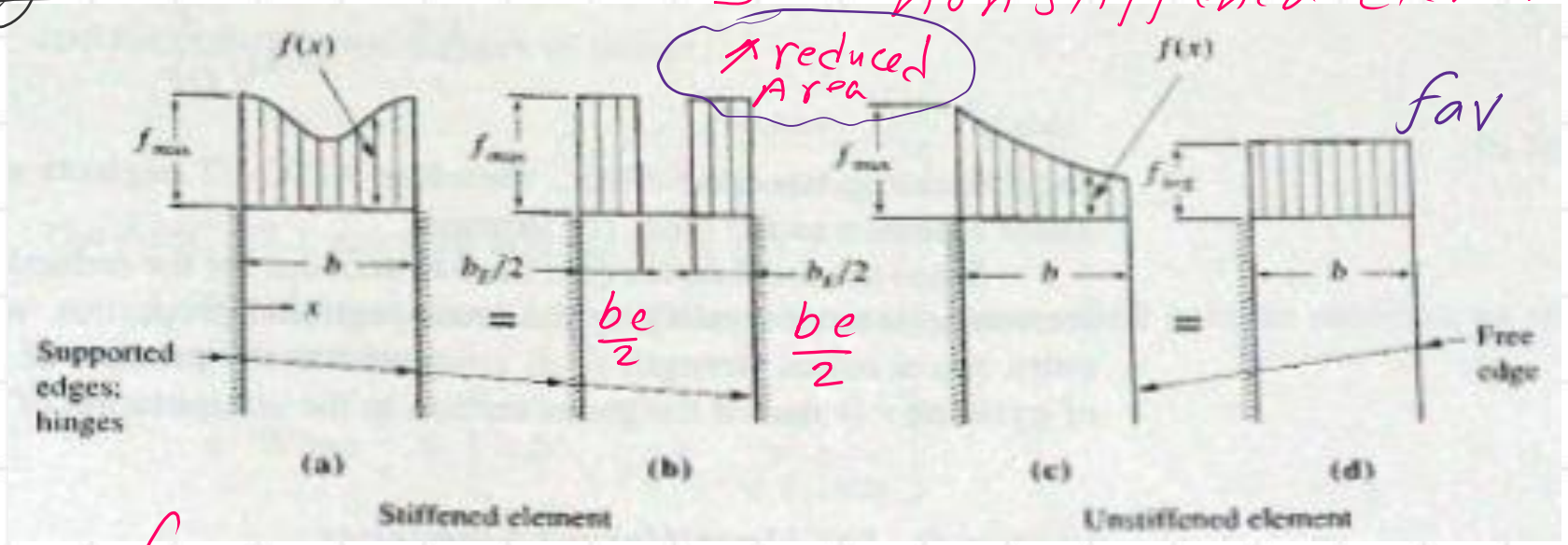
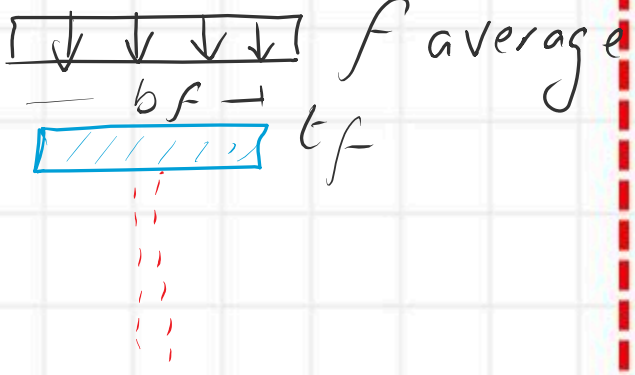
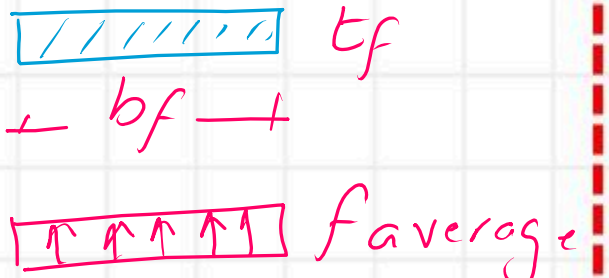
Pg-317

SALmon → stiffened elements
non stiffened elements



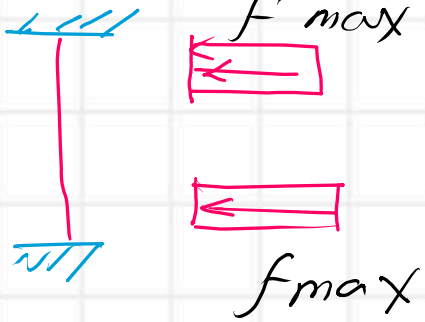
Unstiffend





Unstiffend

stiffened



$$P_n = (b_g t) f_{av}$$

$$P_n = (b_e t) f_{max}$$

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Page 318 - chapter 6 Salmon Q_A & Q_s terms

Compresion members composed of both stiffened and unstiffened shall be treated as unstiffened for estabishing f_{av} : then the effective width For the stiffened is determined using $f_{av} = f_{max}$

unstiffened

$$P_n = A_g \cdot f_{av}$$

$$P_n = A_g f_{av} \left(\frac{f_{max}}{f_{max}}\right)$$

$$= f_{max} (Q_s) A_{gross}$$

$$Q_s = A_{av} / f_{max}$$

stiffened

$$P_n = A_{eff} \cdot f_{max} \left(\frac{A_{gross}}{A_{gross}}\right)$$

$$= \left(\frac{A_{eff}}{A_g}\right) \cdot (f_{max} \cdot A_{gross})$$

$$P_n = Q_A (f_{max})(A_{gross})$$

$$Q_A = A_{eff} / A_{gross}$$

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Page 318 - chapter 6 Salmon

$P_n = f_{av} \cdot A_{eff}$ Whole Section

$P_n = f_{av} \cdot A_{eff} \left(\frac{f_{max}}{f_{max}}\right)\left(\frac{A_g}{A_g}\right)$

A_g: gross area

f_{max}: maximum stress

$Q_A = \frac{A_{eff}}{A_g}$

$Q_s = \frac{f_{av}}{f_{max}}$

Q_s ← → Q_A

$P_n = Q_s \cdot Q_A \cdot f_{max} \cdot A_{gross}$

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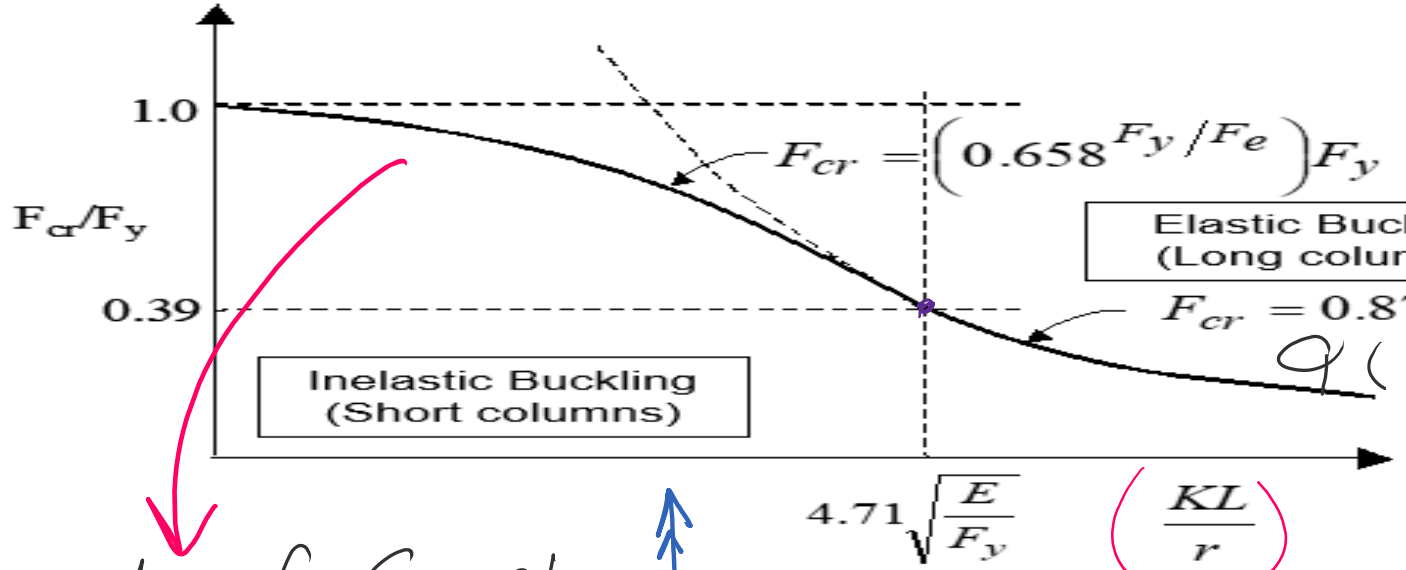

CM # 14

Spec. 2010

Q (0.877) fe

right side by Q

Left side of Graph

$F_{cr} = Q_s Q_a (0.658^{\frac{Q f_y}{f_e}}) f_y$

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

For parameters of stiffened and unstiffened

$Q_s \cdot Q_a = Q$

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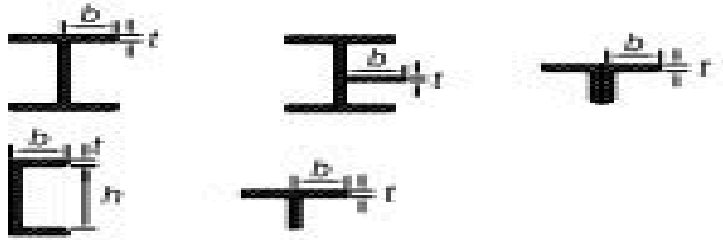
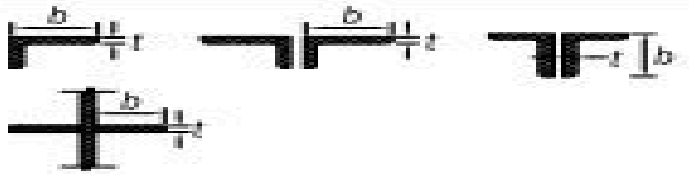
16.1-16 AISC-360-10 λ_r

Limiting

TABLE B4.1a
Width-to-Thickness Ratios: Compression Elements Members Subject to Axial Compression

	Case	Description of Element	Width-to-Thickness Ratio	Limiting Width-to-Thickness Ratio λ_r (nonslender/slender)	Examples
Unstiffened Elements	1	Flanges of rolled I-shaped sections, plates projecting from rolled I-shaped sections; outstanding legs of pairs of angles connected with continuous contact, flanges of channels, and flanges of tees	b/t	$0.56\sqrt{\frac{E}{F_y}}$	
	2	Flanges of built-up I-shaped sections and plates or angle legs projecting from built-up I-shaped sections	b/t	$0.64\sqrt{\frac{k_c E}{F_y}}$ [a]	
	3	Legs of single angles, legs of double angles with separators, and all other unstiffened elements	b/t	$0.45\sqrt{\frac{E}{F_y}}$	
	4	Stems of tees	d/t	$0.75\sqrt{\frac{E}{F_y}}$	

Un-stiffened

b/t

b/t

b/t

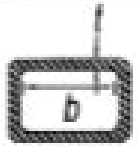
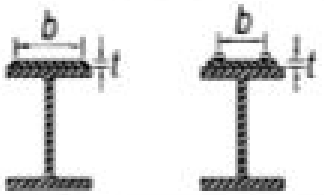
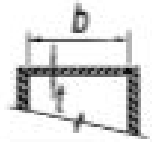
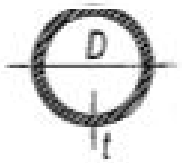
Stiffened Elements From 5 → 9

stiffened part

Cases from Table B 4.1b part-2

CM # 14

Spec. 2010

Stiffened Elements	5	Webs of doubly-symmetric I-shaped sections and channels	h/t_w	$1.49\sqrt{\frac{E}{F_y}}$	
	6	Walls of rectangular HSS and boxes of uniform thickness	b/t	$1.40\sqrt{\frac{E}{F_y}}$	
	7	Flange cover plates and diaphragm plates between lines of fasteners or welds	b/t	$1.40\sqrt{\frac{E}{F_y}}$	
	8	All other stiffened elements	b/t	$1.49\sqrt{\frac{E}{F_y}}$	
	9	Round HSS	D/t	$0.11\frac{E}{F_y}$	

↓ Flexure

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