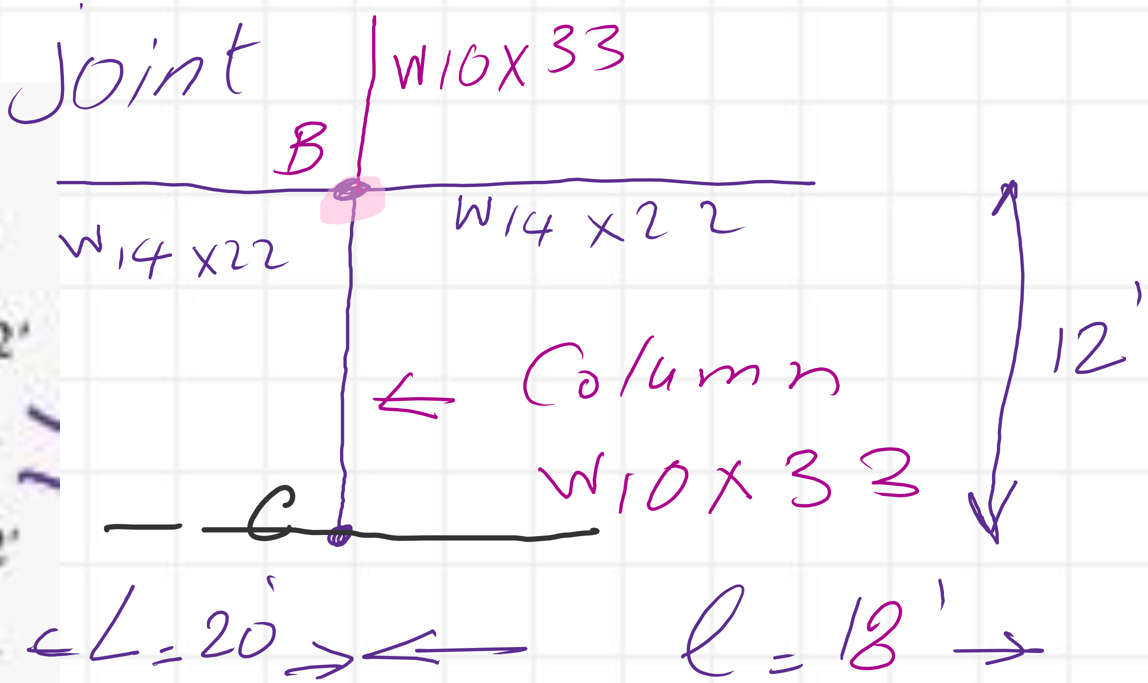


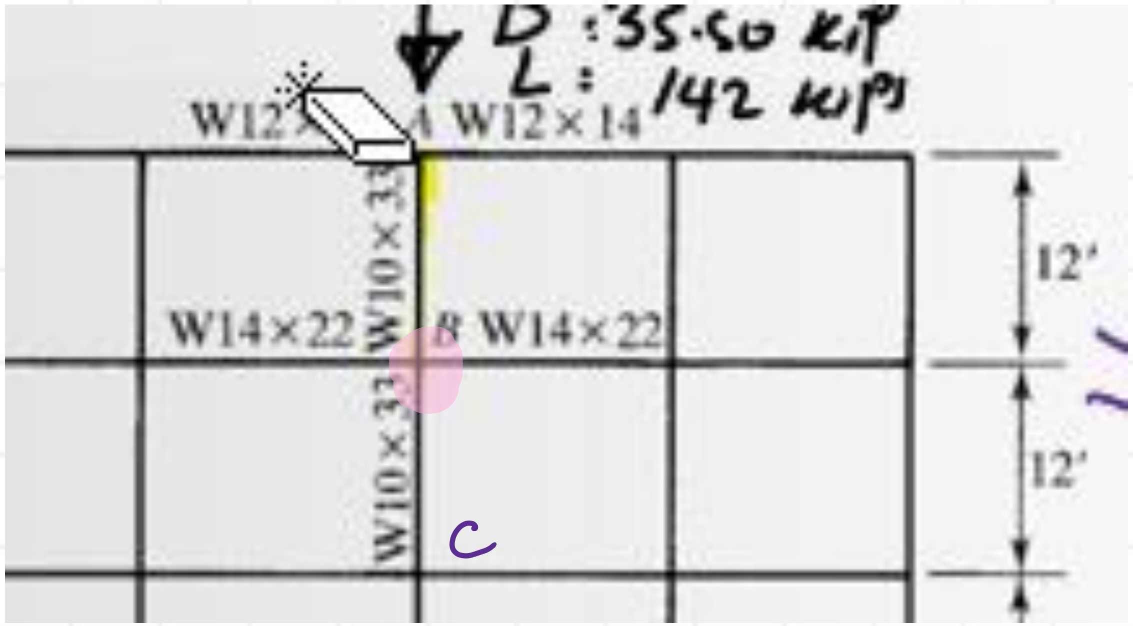
Type	Std_Nomen	AISC_Manual_La	Weigh	A
W	W10X33	W10X33	33.0	9.71

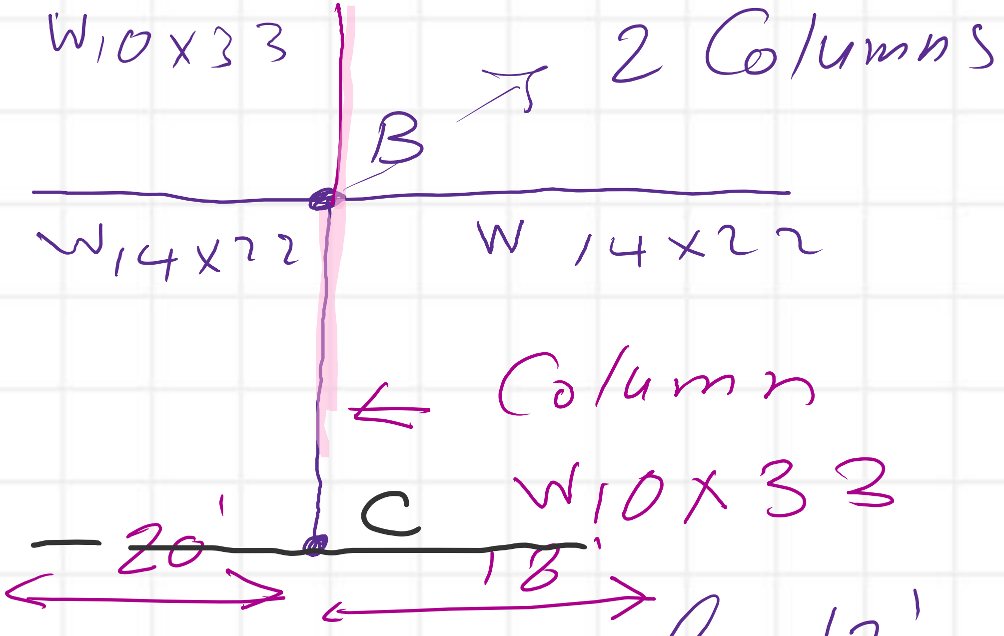
I_x	Z_x	S_x	r_x
171	38.8	35.0	4.19

Colum AB

$$\left(\frac{EI_x}{L_x}\right)_C = E\left(\frac{171}{12(12)}\right)$$

Column BC = Column AB





$l = 12'$

Two Girders (beams) W14X22

AISC_Manual_Label	Weight	A
W14X22	22.0	6.49

I_x	Z_x	S_x	r_x
199	33.2	29.0	5.54

Column BC
Column AB } at joint B

$$\left(\frac{EI_x}{L_x}\right)_{CoL} = E\left(\frac{171}{12}\right)2$$

$$\Sigma\left(\frac{EI}{L_x}\right)_{Beam} = E\left(\frac{199}{18}+\frac{199}{20}\right)$$

$$\Rightarrow E(7562.0/360)$$

Two Columns

$$G_B = \frac{E(171/12)(2)}{E(7562/360)} = 1.3567$$

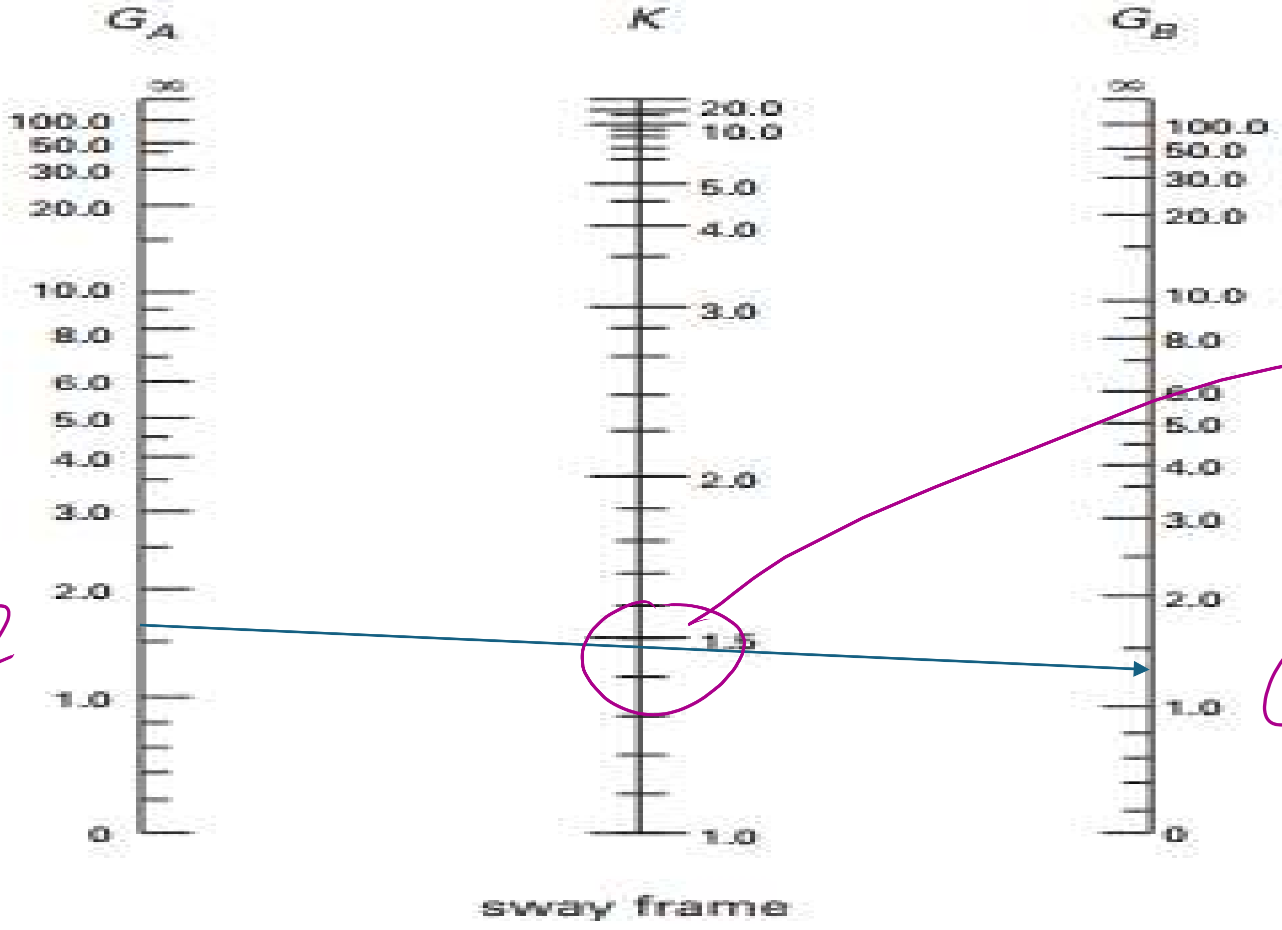
$\rightarrow$ Girder

$G_A = 1.52$

$G_B = 1.36$

Unbraced Frame diagram

$K_x = 1.45$



$G_A = 1.52$

$G_B = 1.36$

Prepared by Eng.Maged Kamel.

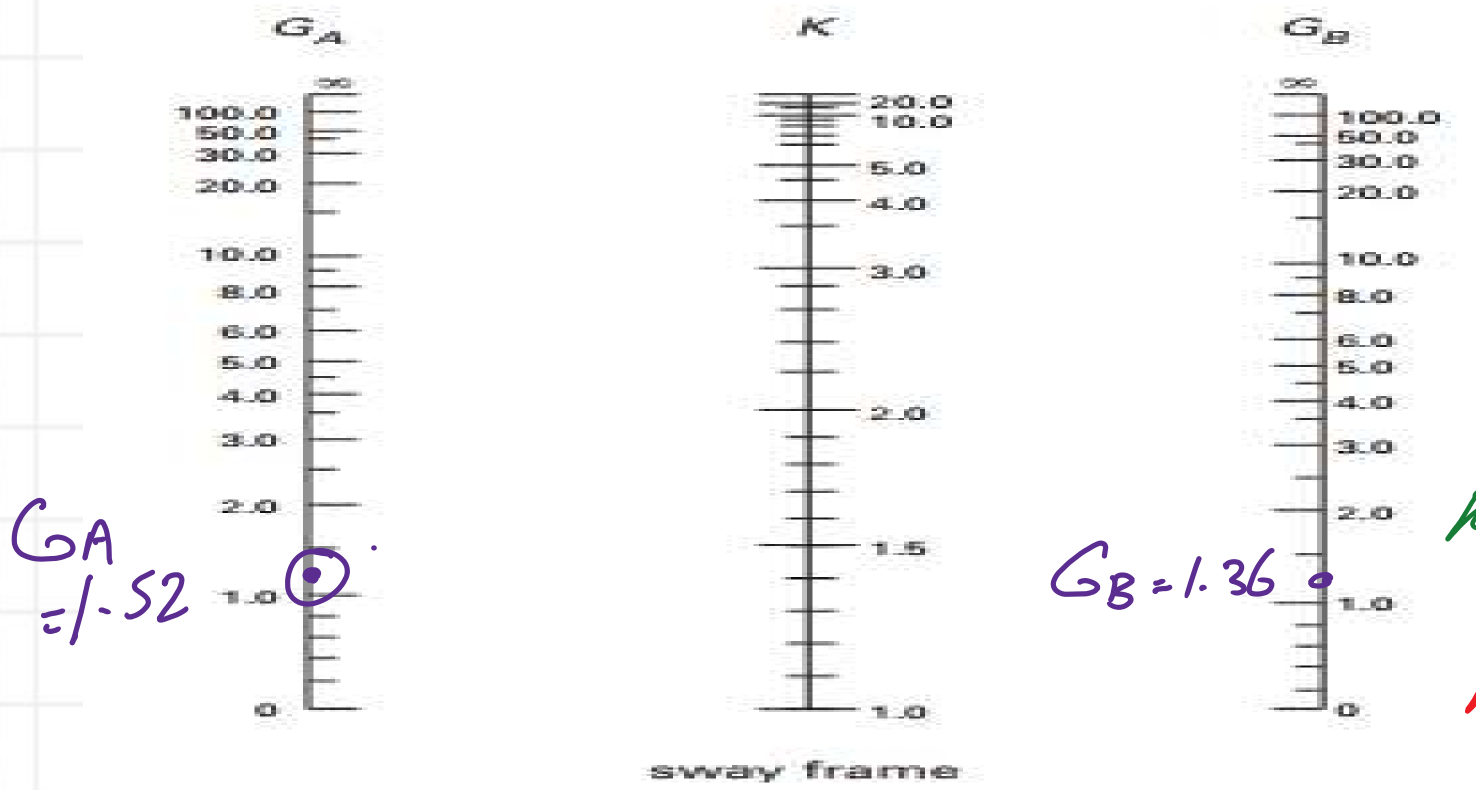
French equation For effective length Factor.

For sidesway uninhibited,

$$K = \sqrt{\frac{1.6G_AG_B + 4(G_A + G_B) + 7.5}{G_A + G_B + 7.5}}$$

$G_A = 1.52$
$G_B = 1.36$

$$K = \sqrt{\frac{1.6(1.52)(1.36) + 4(1.52+1.36) + 7.50}{1.52 + 1.36 + 7.50}}$$



$$K = \sqrt{\frac{3.307 + 11.52 + 7.50}{10.38}}$$

$K = 1.466$

Prepared by Eng.Maged Kamel.

Check wheth Column-Elastic or in-elastic

$W10/33$

$r_x = 4.19$ inch^2

$L = 12'$

$\left(\frac{KL}{r}\right)_x = \frac{l_{ex}}{r_x} = 1.45\left(\frac{(12)(12)}{4.19}\right) = 49.83$

$K \rightarrow$ From Graph

Limiting $4.71\sqrt{\frac{E}{f_y}} = 4.71\sqrt{\frac{29000}{50}} = 113.43$

$\underline{E = 29000 \text{ Ksi}}$

$\left(\frac{KL}{r}\right)_x \left(\frac{Le}{r}\right)_x < 113.43$

Column is inelastic

$\Rightarrow$ I to be Estimated.

<u>For LRFD</u>

<u>LRFD</u>: $D = 35.50$ kips, $L = 142.0$ kips $\left.\begin{matrix} 1.2D \\ 1.6L \end{matrix}\right\} = P_{ult} = 1.2(35.50) + 1.6(142)$

$= 269.80$ kips

$1.4D = 1.4(35.5) = 49.7$ kips

$P_{ult} = \max(269.8, 49.7)$

$= 269.80$ kips

Prepared by Eng.Maged Kamel.

Estimate $P_y = A_g(F_y)$

LRFD

$\alpha = 1.0$

For Column AB W10x33

$A_g = 9.71\ \text{inch}^2$

$F_y = 50$ ksi $\rightarrow P_y = 9.71(50) = 485.50$ kips

Check $\alpha \frac{P_r}{P_y} \leq 0.5$ or > 0.50

$P_{r\,req} = P_{ult} = 269.80$ kips

$\alpha \frac{P_r}{P_y} = 1.0\left(\frac{269.8}{485.5}\right) = 0.5557 > 0.5$

Sect. C3.] CALCULATION OF AVAILABLE STRENGTHS 16.1-27

(1) When $\alpha P_r/P_{ns} \leq 0.5$

$$\tau_b = 1.0 \quad \text{(C2-2a)}$$

(2) When $\alpha P_r/P_{ns} > 0.5$

$$\tau_b = 4(\alpha P_r/P_{ns})[1-(\alpha P_r/P_{ns})] \quad \text{(C2-2b)}$$

where

Use 2nd Equation

LRFD

(1) When $\alpha P_r / P_{ns} \le 0.5$

$$\tau_b = 1.0 \tag{C2-2a}$$

(2) When $\alpha P_r / P_{ns} > 0.5$

$$\tau_b = 4(\alpha P_r / P_{ns})[1-(\alpha P_r / P_{ns})] \tag{C2-2b}$$

where

$P_{req} = 269.80$ kips $= P_{ult}$

$P_y = 485.50$ kips

$\tau_b = 4(0.5557)(1-0.5557)$

$\tau_b = 0.9876$

To Check τ_b using Table 4-13

We need $\dfrac{P_{ult}}{A} = \dfrac{269.80}{9.71} = 27.79$ ksi

$\boxed{P_{ult} = 269.80 \text{ kips} \;\&\; A_g = 9.71 \text{ inch}^2}$

$F_y = 50$ ksi

$P_{ult} = 269.80$ kips

$A_g = 9.71$ inch^2

Table 4-13 CM#15 Page 4-228

LRFD

$$\frac{P_{ult}}{A_g} = \frac{269.80}{9.71} = 27.79 \text{ ksi}$$

0.986

→ 0.994

$$\boxed{\tau_b = 0.9877 \text{ Selected}}$$

Table 4-13
Stiffness Reduction Factor τ_b

ASD P_a/A / LRFD P_u/A	F_y, ksi 35 ASD	35 LRFD	36 ASD	36 LRFD	46 ASD	46 LRFD	50 ASD	50 LRFD	65 ASD	65 LRFD	70 ASD	70 LRFD
36	–	–	–	–	–	0.681	–	0.806	0.404	0.988	0.583	0.999
35	–	–	–	0.108	–	0.728	–	0.840	0.477	0.994	0.640	1.00
34	–	0.111	–	0.210	–	0.771	–	0.870	0.546	0.998	0.693	
33	–	0.216	–	0.306	–	0.811	–	0.898	0.610	1.00	0.741	
32	–	0.313	–	0.395	–	0.847	–	0.922	0.669		0.786	
31	–	0.405	–	0.478	–	0.879	0.0317	0.942	0.723		0.826	
30	–	0.490	–	0.556	–	0.907	0.154	0.960	0.773		0.862	
29	–	0.568	–	0.627	–	0.932	0.267	0.974	0.817		0.894	
28	–	0.640	–	0.691	0.102	0.953	0.373	0.986	0.857		0.922	
27	–	0.705	–	0.750	0.229	0.970	0.470	0.994	0.892		0.945	
26	–	0.764	–	0.802	0.346	0.983	0.559	0.998	0.922		0.964	
25	–	0.816	–	0.849	0.454	0.992	0.640	1.00	0.947		0.980	
24	–	0.862	–	0.889	0.552	0.998	0.713		0.967		0.991	
23	–	0.901	–	0.923	0.640	1.00	0.777		0.982		0.997	
22	–	0.934	0.087	0.951	0.719		0.834		0.993		1.00	
21	0.154	0.960	0.249	0.972	0.788		0.882		0.999			
20	0.313	0.980	0.395	0.988	0.847		0.922		1.00			

LRFD

G_A = inelastic   Not hinged G_{Ael} τ_b = 1.52 (0.9876) = 1.483

Not Fixed G_{Bel} τ_b

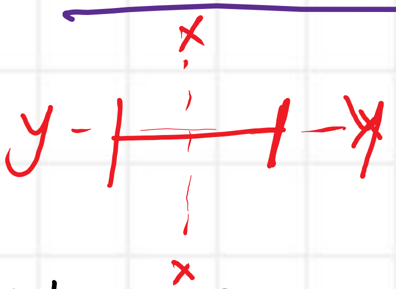
G_B inelatic = 1.36 (0.9876) = 1.3431

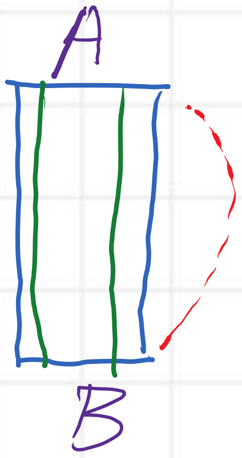
K_x = 1.43 → Prof. SEGui   (1.46) French

K_y = 1.00 braced   – y – direction

Prepared by Eng.Maged Kamel.

Check Column





W10 x 33

$r_x = 4.19 \text{ inch}^2$

$L = 12'$

$\left(\frac{KL}{r}\right)_x = \frac{l_{ex}}{r_x} = \overset{K}{1.45}\left(\frac{(12)(12)}{4.19}\right) = 49.83$

Limiting $4.71\sqrt{\frac{E}{f_y}} = 4.71\sqrt{\frac{29000}{50}} = 113.43$

$E = 29000$ ksi

$\left(\frac{KL}{r}\right)_x \left(\frac{Le}{r}\right)_x < 113.43$

Column is inelastic

For ASD

→ I to be Estimated.

D = 35.50 kips
L = 142 kips

D + L = 35.5 + 142

$P_T = 177.50$ kips

Prepared by Eng.Maged Kamel.

Estimate $P_y = A_g F_y$

ASD

$\alpha = 1.60$

For Column AB W10x33 $A_g = 9.71$ inch^2

$F_y = 50$ ksi $\rightarrow P_y = 9.71(50) = 485.50$ kips

Check $\alpha \frac{P_r}{P_y} \leq 0.5$ or > 0.50

$P_{r\,req} = P_T = 177.5$ kips

$\alpha \frac{P_r}{P_y} = 1.6\left(\frac{177.5}{485.5}\right) = 0.585 > 0.5$

Sect. C3.] CALCULATION OF AVAILABLE STRENGTHS 16.1-27

(1) When $\alpha P_r/P_{ns} \leq 0.5$

$$\tau_b = 1.0 \quad \text{(C2-2a)}$$

(2) When $\alpha P_r/P_{ns} > 0.5$

$$\tau_b = 4(\alpha P_r/P_{ns})[1-(\alpha P_r/P_{ns})] \quad \text{(C2-2b)}$$

where

Use 2nd Equation

ASD

(1) When $\alpha P_r / P_{ns} \leq 0.5$

$$\tau_b = 1.0 \quad \text{(C2-2a)}$$

(2) When $\alpha P_r / P_{ns} > 0.5$

$$\tau_b = 4(\alpha P_r / P_{ns})[1 - (\alpha P_r / P_{ns})] \quad \text{(C2-2b)}$$

where

$P_{req} = P_T = 177.50$ kips

$P_y = 485.50$ kips

$\tau_b = 4(0.585)(1-0.585)$

$\tau_b = 0.9711$

To check τ_b using Table 4-13

We need $\dfrac{P_n}{A} = \dfrac{177.5}{9.71} = 18.28$ ksi

ASD

$F_y = 50$ ksi

$\frac{P_n}{A} = 18.28$ ksi

18 ksi
19 ksi

$\tau_b = 0.977$

$\tau_b = 0.953$

$\tau_b = \left[0.977 - \left(\frac{0.024}{1}\right)(0.28)\right] = 0.9703$

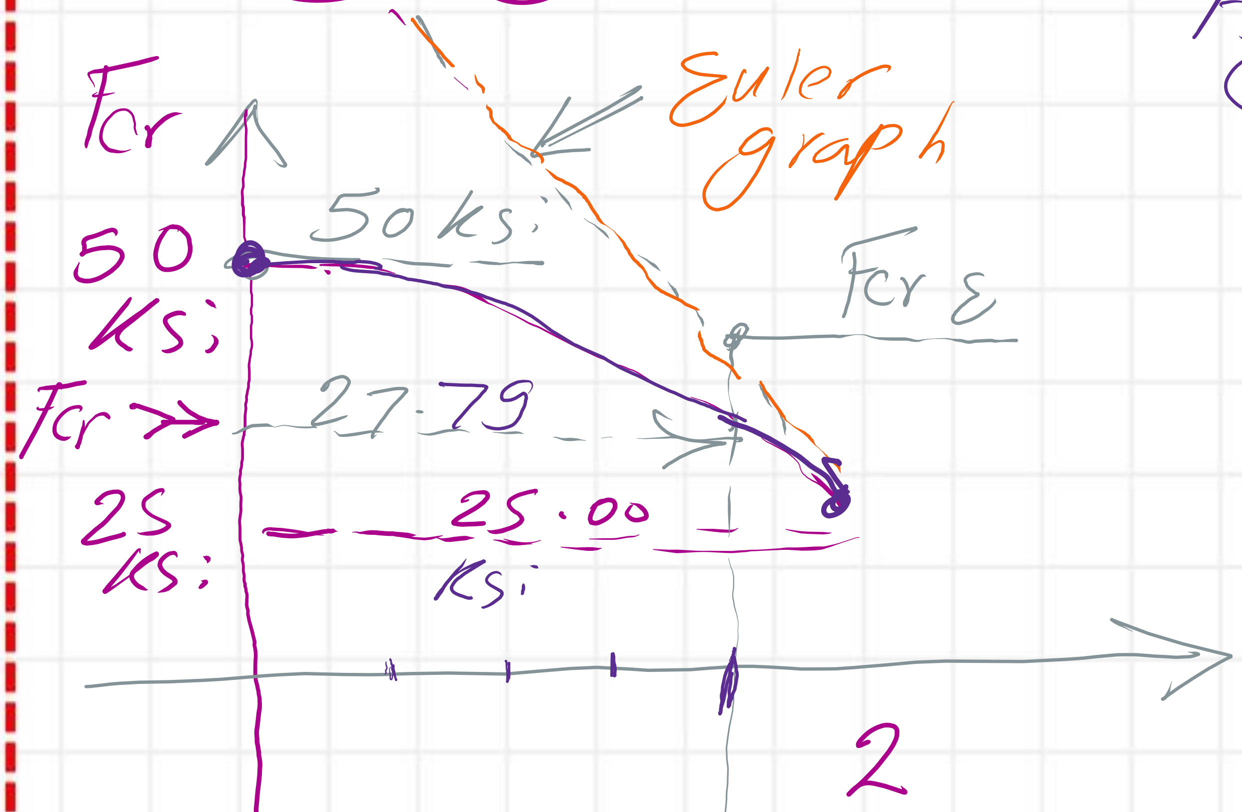
Table 4-13
Stiffness Reduction Factor τ_b

ASD	LRFD	F_y, ksi											
$\frac{P_a}{A}$	$\frac{P_u}{A}$	35		36		46		50		65		70	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
19		0.457	0.993	0.525	0.997	0.896		0.953					
18		0.583	0.999	0.640	1.00	0.936		0.977					
17		0.693	1.00	0.739		0.967		0.992					
16		0.786	1.00	0.822		0.987		0.999					
15		0.862	1.00	0.889		0.998		1.00					
14		0.922	1.00	0.940		0.999							
13		0.964	1.00	0.976		1.00							
12		0.991	1.00	0.996									
11		1.00	1.00	1.00									
10		1.00	1.00	1.00									

– Indicates the stiffness reduction parameter is not applicable because the required strength exceeds the available strength for $L_c/r = 0$.
$A = A_g$ for members not controlled by slender element buckling, in.^{2}
$= A_e$ as defined in AISC *Specification* Section E7 for members controlled by slender element buckling, in.^{2}

Prepared by Eng.Maged Kamel.

For LRFD



$P_{ult} = 269.8$ Kips

$A_g = 9.71$ inch²

$\frac{P_{ult}}{A_g}$

$F_{cr} = 27.79$ ksi

$F_y = 50$ ksi

$$F_{cr} = F_y\left(1 - \frac{\lambda^2}{4}\right)$$

$$\frac{27.79}{50} = 1\left(1 - \frac{\lambda^2}{4}\right)$$

$$\lambda^2 = 4\left(1 - \frac{27.79}{50}\right)$$

$$\lambda^2 = 1.777$$

Get λ

↓ Felastic

λ^2?

$\tau = F_{cr\,in} / F_{cr\,E}$

$$F_{cr_E} = F_y / \lambda^2$$

$$= \frac{50}{1.777} = 28.14 \text{ ksi}$$

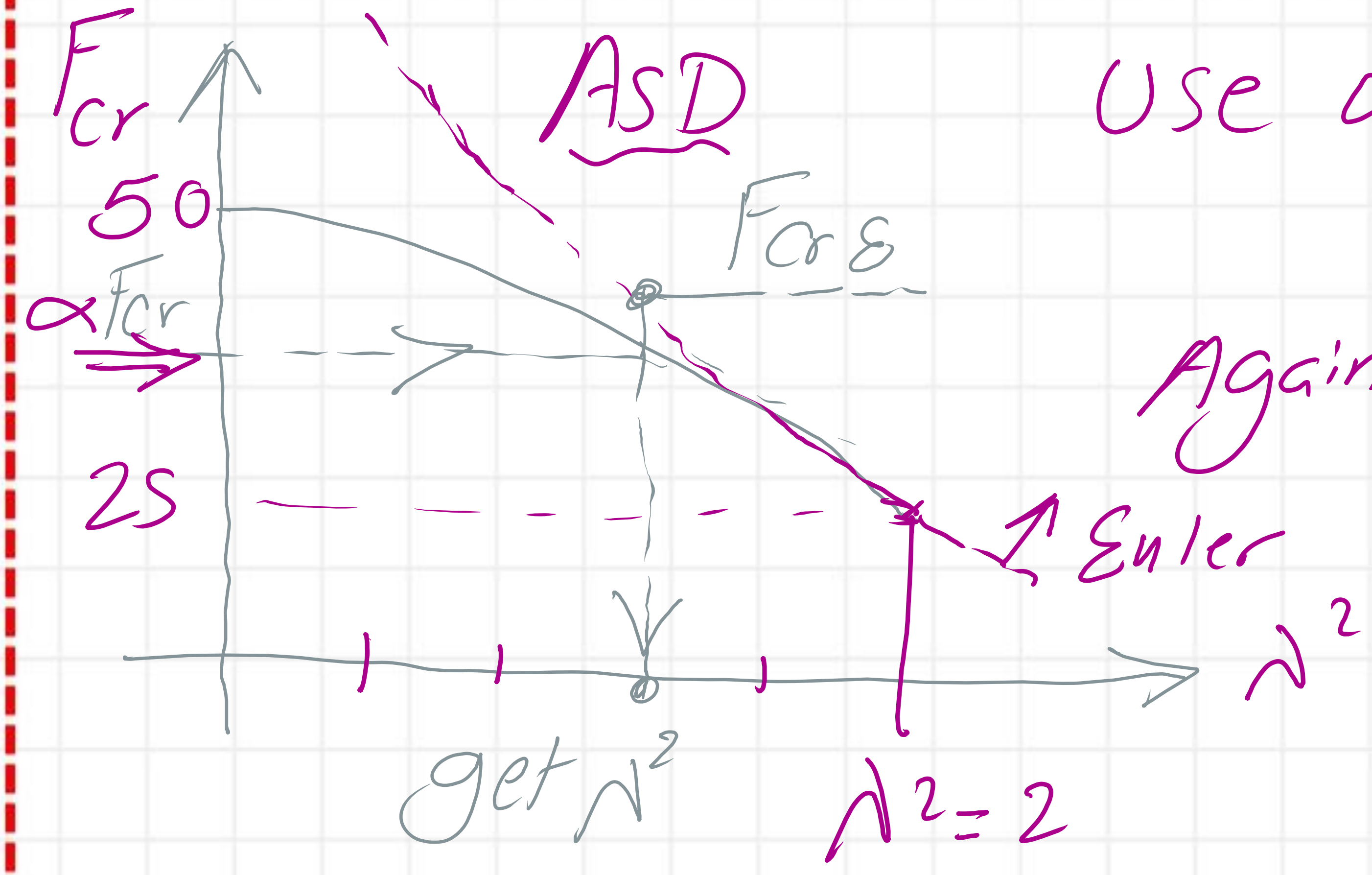
$$\tau = \frac{F_{cr\,in}}{F_{cr\,E}} = \frac{27.79}{28.14} = 0.9875 \Rightarrow \text{matches}$$

While For ASD

$P_T = 177.5$ Kips

$A_g = 9.71$ Kips

$$F_{cr_{in}} = \frac{177.5}{9.71} = 18.28 \text{ ksi}$$



Use $\alpha \dfrac{P_n}{A} = 1.6(18.28)$ ksi

$= 29.25$

Again $(\alpha F_{cr}) = F_y\left(1 - \dfrac{\lambda^2}{4}\right)$

$\dfrac{29.25}{50} = 1\left(1 - \dfrac{\lambda^2}{4}\right)$

$\lambda^2 = 4\left(1 - \dfrac{29.25}{50}\right)$

$\lambda^2 = 1.66$

$F_{cr\,Elastic} = \dfrac{F_y}{\lambda^2} = \dfrac{50}{1.66} = 30.12$ ksi

$\tau = \dfrac{F_{cr\,in}}{F_{crE}} = \dfrac{29.25}{30.12} = 0.9711 \Rightarrow$ matches

Prepared by Eng.Maged Kamel.

$G_{A\,inelastic}$ = Not hinged = $1.52\,(0.9703) = 1.475$ ($G_{A\,el}$, τ_b)

ASD

Not Fixed

$G_{B\,inelatic} = 1.36\,(0.9703) = 1.3120$ ($G_{B\,el}$, τ_b)

$K_x = 1.43$ → Prof. SEGUi

$K_{x\,French} = 1.455$

$K_y = 1.00$ braced

Prepared by Eng.Maged Kamel.

Prepared by Eng.Maged Kamel.