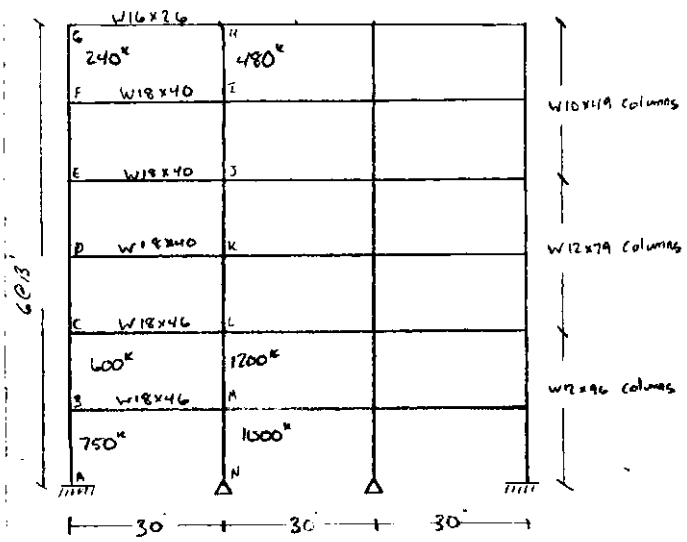
4.5-11



$F_y = 50$ ksi $K_y = 1.0$

Shape	I_x	I_y	t_f	b	t_w	h	A_g	R_x	R_y
W12x96	833	270	.90	12.2	.550	9 1/8	28.2	5.44	3.0
W12x79	662	216	.735	12.1	.470	9 1/8	23.2	5.34	3.0
W10x49	272	93.4	.560	10	.340	7.5	14.4	4.35	2.5
W16x26	301	9.59	~	~	~	~	7.68	6.26	1.
W18x40	612	19.1	~	~	~	~	11.8	7.21	1.1
W18x46	712	22.5	~	~	~	~	13.5	7.25	1.

Column	L_c	G_A	G_B	K_x	K_y	K_xL_x/R_x	K_yL_y/R_y
A - AB W12x96	13·12 = 156"	$\frac{29000\cdot 833\cdot 2/156}{29000\cdot 712/30\cdot 12} = 5.4$	1 (fixed support)	1.57	1.0	$156\cdot 1.57/5.44 = 45.02$	$156/3.09 = 50.5_C$
B - MN W12x96	13·12 = 156"	$\frac{29000\cdot 833\cdot 2/156}{29000\cdot 712\cdot 3/80\cdot 12} = 2.7$	10 (pin support)	2.2	1.0	$2.2\cdot 156/5.44 = 63.09_C$	50.5
C - BC W12x96	13·12 = 156"	$\frac{29000(833+662)/156}{29000\cdot 712/30\cdot 12} = 4.8$	$\frac{29000\cdot 833\cdot 2/156}{29000\cdot 712/30\cdot 12} = 5.4$	2.25	1.0	$2.25\cdot 156/5.44 = 64.52_C$	50.5
D - LM W12x96	13·12 = 156"	$\frac{29000(833+662)/156}{29000\cdot 712\cdot 2/30\cdot 12} = 2.4$	$\frac{29000\cdot 833\cdot 2/156}{29000\cdot 712\cdot 2/30\cdot 12} = 2.7$	1.57	1.0	$157\cdot 156/5.44 = 45.022$	50.5_C
E - FG W10x49	13·12 = 156"	$\frac{29000\cdot 272/156}{29000\cdot 301/30\cdot 12} = 2.1$	$\frac{29000\cdot 2\cdot 272/156}{29000\cdot 612/30\cdot 12} = 2.1$	1.56	1.0	$1.56\cdot 156/14.35 = 56.95$	$156/2.54 = 61.42_C$
F - HI W10x49	13·12 = 156"	$\frac{29000\cdot 272/156}{29000\cdot 2\cdot 301/30\cdot 12} = 1.0$	$\frac{29000\cdot 2\cdot 272/156}{29000\cdot 2\cdot 612/30\cdot 12} = 1.0$	1.3	1.0	$1.3\cdot 156/14.35 = 46.621$	61.42_C

Column	F_e	$4.71\sqrt{E/F_y}$	F_{cr}	b/t	$\lambda_{r\,case1}$	$\lambda_{r\,case3}$	h/t_w	$\lambda_{r\,case9}$	$\lambda_{r\,case10}$
A - AB	$\pi^2\cdot 29000/50.5^2 = 112.23$	113.43	$.658^{50/112.23}\cdot 50 = 41.49$ ksi	$12.2/2\cdot 9 = 6.8$	24.1	13.5	$9.125/.55 = 16.6$	137.3	35.9
B - MN	$\pi^2\cdot 29000/68.09^2 = 71.91$	113.43	$.658^{50/71.91}\cdot 50 = 37.38$ ksi	6.8	24.1	13.5	16.6	137.3	35.9
C - BC	$\pi^2\cdot 29000/64.52^2 = 68.76$	113.43	$.658^{50/68.76}\cdot 50 = 36.88$ ksi	6.8	24.1	13.5	16.6	137.3	35.9
D - LM	$\pi^2\cdot 29000/50.5^2 = 112.23$	113.43	41.49 ksi	6.8	24.1	13.5	16.6	137.3	35.9
E - FG	$\pi^2\cdot 29000/61.42^2 = 75.87$	113.43	$.658^{50/75.87}\cdot 50 = 37.95$ ksi	$10/2\cdot 5.8 = 8.9$	24.1	13.5	$7.5/3.4 = 2.2$	137.3	35.9
F - HI	$\pi^2\cdot 29000/61.42^2 = 75.87$	113.43	37.95 ksi	8.9	24.1	13.5	2.2	137.3	35.9

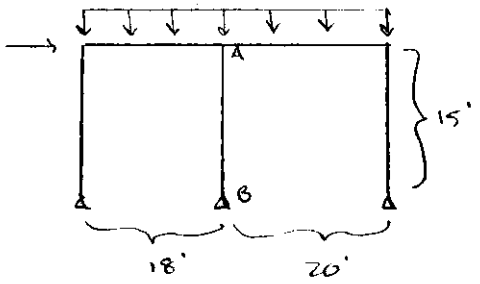
NO stiffness reduction factors needed for any case

Column	$\phi_c P_n$	P_u	Adequate?
A - AB	$.9\cdot 28.2\cdot 41.49 = 1053$	750^K	yes
B - MN	$.9\cdot 28.2\cdot 37.38 = 959.36$	1000^K	NO
C - BC	$.9\cdot 28.2\cdot 36.88 = 936.01$	600^K	yes
D - LM	$.9\cdot 28.2\cdot 41.49 = 1053$	1200^K	NO
E - FG	$.9\cdot 14.4\cdot 37.95 = 491.83$	240^K	yes
F - HI	$.9\cdot 14.4\cdot 37.95 = 491.83$	480^K	yes

4.5.10 unbraced bending about strong axis (kx) $K_y = 1.0$

beams - W18x50 Columns - W12x72 A992 steel $F_y = 50$

$P = 300$ kips (factored)



beams - W18x50 - $I_y = 40.1$ $t_f = .57$ $t_w = .355$ $h = 15.5$ $I_x = 800 in^4$

Colums - W12x72 - $I_y = 195$ $t_f = .67$ $h = 9\frac{1}{8}$ $t_w = .43$

$I_x = 597 in^4$

$G_A = 10$ (Pin Support)

$$G_B = \frac{597/(15 \cdot 12)}{800/(20 \cdot 12) + 800/(18 \cdot 12)} = .47$$

$K_x = 1.8$ A-B $\begin{cases} r_x = 5.31" \\ r_y = 3.04" \end{cases}$

$$P_{cr_x} = \frac{\pi^2 \cdot 29000^{ksi} \cdot 195 in^4}{(2.3 \cdot 15 \cdot 12)^2} = 325.6^{k}$$

$$P_{cr_y} = \frac{\pi^2 \cdot 29000 \ 597^{in^4}}{(1 \cdot 15 \cdot 12)^2} = 2623.7^{k}$$

$f = 300/21.1 = 14.218^{ksi}$

$f_y = 50 ksi = 50 \cdot 21.1 = 1055^{k}$

$L = (15 \times 12) = 180"$

$\frac{K_x L_x}{r_x} = \frac{1.8 \cdot 180}{5.31"} = 61.017$ ← governs

$\frac{K_y L_y}{r_y} = \frac{1 \cdot 180}{3.04"} = 59.211$

$$F_e = \frac{\pi^2 \cdot 29,000}{(61.02)^2} = 76.87^{ksi}$$

$$4.71\sqrt{\frac{29,000}{50}} = 113.43 \qquad 76.87 \leq 113.43$$

$$F_{cr} = .658^{50/76.87} \cdot 50 = 38.08^{ksi}$$

$\phi_c P_n = .9 (38.08 \cdot 21.1) = 723.2^{kips}$ ∴ AISC is ok

Case 1 $\lambda_r = 1\sqrt{29000/50} = 24$ $\quad b/t = 6/.67 = 8.96$

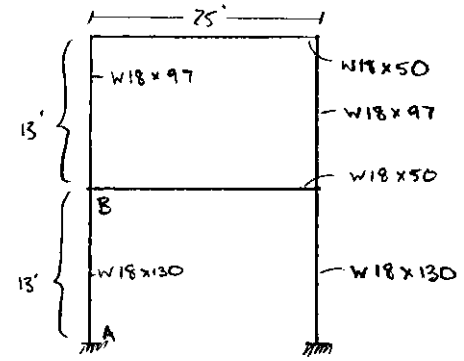
Case 3 $\lambda_r = .56\sqrt{29000/50} = 13$

Case 9 $\lambda_r = 5.7\sqrt{29000/50} = 137.3$ $\quad h/t_w = (9\frac{1}{8})/.43 = 21.22$

Case 10 $\lambda = 1.49\sqrt{29000/50} = 36$

Stiffness reduction factor not needed.

45-9



determine K_x for AB P = 900 F_y = 50

G_A = 1.0 (Fixed Support)

$$G_B = \frac{2460/(13\cdot12) + 1750/(13\cdot12)}{800/(25\cdot12)} = 10.12$$

W18x130 => I_{xx} = 2460 in^4
W18x97 => I_{xx} = 1750 in^4
W18x50 => I_{xx} = 800 in^4

K_x = 1.9

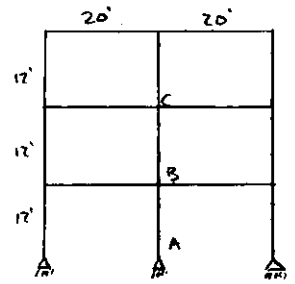
$\lambda_r = 0.56\sqrt{E/F_y} = .56\sqrt{29{,}000/50} = 13.5$ $\lambda_r = \sqrt{29000/50}\cdot 1.49 = 35$

W18x97 => b/t = 11.1/2 / .87 = 6.44 h/tw = 15.125/(9/16) = 26.89
W18x130 => b/t = 11.2/2 / 1.2 = 4.67 h/tw = 15.125/(11/16) = 22

Since 6.44, 4.67 ≤ 13.5, and 27, 22 ≤ 35, shape is non compact

NO stiffness reduction factor needed

4.5.8



Unbraced, bends about x-axis beams - W18×35
columns - W10×54

a.) K_x for AB

W18×35
$I_{xx} = 510\ in^4$

W10×54
$I_{xx} = 303\ in^4$

$G_A = 10$ (pin support)

$$G_B = \frac{2 \cdot 303/(12 \cdot 12)}{2 \cdot 510/(20 \cdot 12)} = .99 \simeq 1$$

∴ Fig. C-C2.4 → $K_x = 1.9$

b.) BC $G_A = G_B$ from part a = .99

$G_B = G_B$ from part a = .99

∴ $K_x = 1.3$

c.) $F_y = 50$ ksi

$\lambda_r = 1.0\sqrt{29000/50} = 24$

Case 1 $b/t = \frac{(10/2)}{.615} = 8.13$ Since $8.13 \leq 24$, → non compact

Case 3 $\lambda_r = .56\sqrt{29000/50} = 13.5$

Since $8.13 \leq 13.5$, cases 1,3 pass ∴ non-compact

$\lambda_r = 1.49\sqrt{29000/50} = 36$ (worst case out of 9,10)

Case 9,10 $h/t_w = (7.5)/(.37) = 20.27$

Since $20.27 \leq 36$, cases 9 and 10 will be okay

Stiffness reduction factor is not applicable