STRUCTURES II - HW #2 ANSWER KEY

10.3.A

$$\frac{Kl}{r} = \frac{(1.0)(15\text{ ft.})(12\text{ in/ft})}{2.54\text{ in}} = 70.87$$

∴ for A36 steel, $F_c = 27.6$ ksi

$A = 14.4\text{ in}^2$

+3 $P_n = \phi_c F_c A = (.85)(27.6\text{ ksi})(14.4\text{ in}^2) = 337.82\text{ K}$

10.3.C

x-axis: $\frac{Kl}{r} = \frac{1(15\text{ ft.})(12\text{ in/ft})}{4.35\text{ in}} = 41.3$

y-axis: $\frac{Kl}{r} = \frac{1(8\text{ ft.})(12\text{ in/ft})}{2.54\text{ in}} = 37.8$

+3 $F_c = 33$ ksi

$A = 14.4\text{ in}^2$

$P_n = (0.85)(33\text{ ksi})(14.4\text{ in}^2) = 404\text{ K}$

10.4.A

$P_u = 1.2(60\text{ K}) + 1.6(88\text{ K}) = 212.8\text{ K}$

+2 $L_x = L_y = 12'$ ∴ $KL = (1.0)(12') = 12'$

W8x31 $\phi_c P_n = 214\text{ K} > 212.8\text{ K}$ ✓

10.4.C

$P_u = 1.2(142\text{ K}) + 1.6(213\text{ K}) = 511.2\text{ K}$

+2 $\frac{L_x}{L_y} = \frac{20'}{10'} = 2 \rightarrow KL = \frac{20'}{1.75} = 11.4'$

W10 x 68 → $\phi_c P_n$ = 520 K > 511.2 K ✓

$\frac{KX}{M}$ = 1.71 < 3 ✓

10.4.E

P_u = 1.2 (20 K) + 1.6 (30K) = 72 K

×2 KL = 8'

Pipe + STD → $\phi_c P_n$ = 77 K

10.4.G

P_u = 72 K

×2 KL = 18'

Pipe & STD → $\phi_c P_n$ = 104 K

10.4.I

×2 $\phi_c P_n$ = 98 K

10.4.K

P_u = 1.2 (30K) + 1.6 (34K) = 90.4 K

×2 KL = 10'

HSS 6x6x5/16 → $\phi_c P_n$ = 121 K > 90.4 K ✓

10.4.M

KLx = 8 ft → $\phi_c P_n$ = 112 K

×2 KLy = 8 ft → $\phi_c P_n$ = **104 K**

10.4.O

×2 P_u = 1.2 (25 K) + 1.6 (25 K) = 70 K

KLx = 10' KLy = 10'

4 x 3 x 5/16 → $\phi_c P_{nx}$ = 80 K > 70 K ✓

$\phi_c P_{ny}$ = 72 K > 70 K ✓

10.5.A

$m = 1.8$

$P_u' = P_u + m \cdot M_{ux} = 200\,K + 30\,K + (1.8 \cdot 30\,k \cdot 6\,in \cdot 1'/12'')$

$P_u' = 257\,K$

$\frac{P_u}{P_u'} = \frac{230\,K}{257\,K} = 0.895 > 0.2$

W12 x 45 $\rightarrow$ $\phi_c P_n = 271\,K > 257\,K$ ✓

$\frac{P_u}{\phi_c P_n} = \frac{230\,K}{271\,K} = 0.849 > 0.2$

$0.849 + \frac{8}{9}\left(\frac{15\,K\cdot ft}{173\,K\cdot ft} + 0\right) = 0.926 < 1.0$ ✓

$L_b = 14'$

$L_p = 8.13'$ $\quad M_p = 193\,K\cdot ft$

$L_r = 28.3'$ $\quad M_r = 125\,K\cdot ft$

$L_p < L_b < L_r$

$M_u = M_p - (M_p - M_r)\left(\frac{L_b - L_p}{L_r - L_p}\right) = 193 - 68\left(\frac{5.87}{20.17}\right) = 173\,K\cdot ft$

10.5 c) load = 485 k
beam = 100 k
Length = 18'

12" W shape

$m = 1.6$

$P_u' = P_u + m \times M_{ux}$

$= (485\,k + 100\,k) + (1.6 \times 100 \times 6/12')$

$= 585\,k + 80\,k$

$= 665\,k$

$P_u / P_u' = .879 > .2 \rightarrow$ Ok

From table 10.2:

W12 x 96: $\phi_c P_n = 667\,k$

$667_k > 665_k \rightarrow$ ok

$P_u / \phi_c P_n = .87$

Since $.87 > .2$, use:

$$\frac{P_u}{\phi_c P_n} + \frac{8}{9}\left(\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}}\right) \leq 1.0$$

$P_u = 585\,k$

$M_{ux} = (100\,k \times 6/12\,ft) = 50\,k\text{-}ft$

$\phi P_n = 667\,k$

$\phi_b M_{nx}$ = Equation, page 298:

$L_b = 18'$, Since $L_p < L_b \leq L_r$, (Table 9.1)

our equation is:

$$M_n = M_p - (M_p - M_r) \times \left(\frac{L_b - L_p}{L_r - L_p}\right)$$

From table 9.1:

$L_p = 12.9$ ft.
$L_r = 61.4$ ft.
$M_p = 441$ k-ft.
$M_r = 284$ k-ft.

$$M_n = 441\,k\text{-}ft - (441 - 284) \times \left(\frac{18' - 12.9'}{61.4' - 12.9'}\right)$$

$= 441 - 157 \times (.105)$

$M_n = 424.5$ → Since the chart (9.1) is for x axis, then this is M_n and also M_{nx}

$\phi_b M_{nx} = (.9)(M_{nx})$

$= (.9)(424.5)$

$\phi_b M_{nx} = 382.1$

$$\frac{P_u}{\phi_c P_n} + \frac{8}{9}\left(\frac{M_{ux}}{\phi_b M_{nx}}\right) \leq 1.0$$

$$\frac{585\,k}{667\,k} + \frac{8}{9}\left(\frac{50\,k\text{-}ft}{382.1\,k\text{-}}\right) =$$

$$.877 + .888(.13) = .992 \leq 1.0$$

ok!