ENCE 355 – Introduction to Structural Design
SOLUTIONS to Homework Set No. 12
Fall 2002

PROB #5-10

(a) Using a W14X53

$KL = (0.65)(15.5) = 10.07$ ft

$\phi_c P_n =$ **496 k**

(b) Using a W12X45

$KL = (1.0)(14) = 14$ ft

$\phi_c P_n =$ **324 k**

(c) Using a W10X33

$KL = (0.80)(16.5) = 13.2$ ft

$\phi_c P_n =$ **253 k**

(d) Using a W14X109 ($A = 32.0$ in.^{2}, $r_y = 3.73$ in.)

$$\frac{KL}{r} = \frac{(0.65)(12 \times 24.0)}{3.73} = 50.19$$

$$\lambda_c = \frac{50.19}{\pi}\sqrt{\frac{65}{29{,}000}} = 0.756 < 1.5$$

∴ Use LRFD Equation 2-2

$F_{cr} = (0.658^{0.756^2})65 = 51.17$ ksi

$\phi_c P_n = (0.85)(51.17)(32.0) =$ **1392 k**

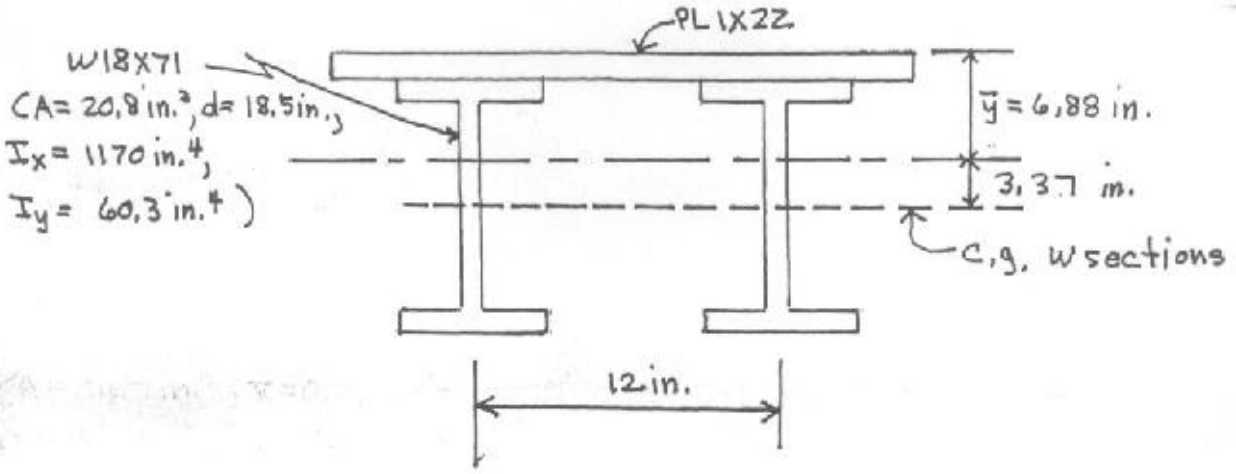
(e) Using an XS steel pipe 12.

$KL = 18.0$ ft

$\phi_c P_n =$ **503 k**

✓ JCMC

PROB # 5-15 (a)



$$A = (1)(22) + (2)(20.8) = 63.6 \text{ in.}^2$$

$$\bar{y} = \frac{(22)(0.5) + (2)(20.8)(10.25)}{63.6} = 6.88 \text{ in.}$$

$$I_x = 2\left[1170 + (20.8)(3.37)^2\right] + \left(\frac{1}{12}\right)(22)(1)^3 + (22)(6.38)^2\Big]$$

$$= 3710 \text{ in.}^4$$

$$I_y = \left(\frac{1}{12}\right)(1)(22)^3 + 2\left[60.3 + (20.8)(6)^2\right] = \underline{2505.5 \text{ in.}^4}$$

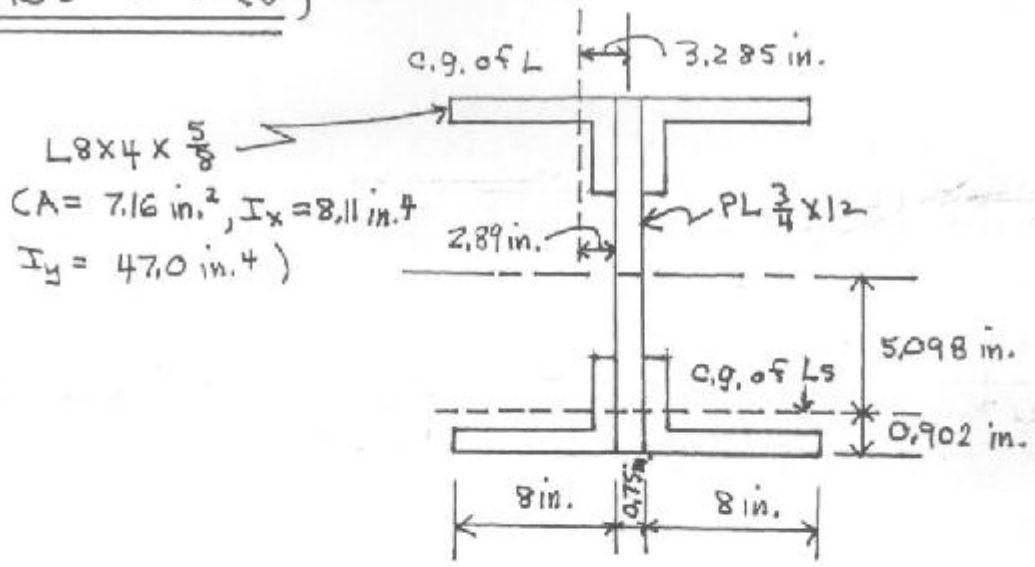
$$r_y = \sqrt{\frac{2505.5}{63.6}} = 6.28 \text{ in.}$$

$$\left(\frac{KL}{r}\right)_y = \frac{(0.8)(12 \times 20)}{6.28} = 30.57$$

$$\phi_c F_{cr} = 39.69 \text{ ksi}$$

$$\phi_c P_n = (39.69)(63.6) = \boxed{2524 \text{ k}} \quad \checkmark \text{ OK}$$

PROB # 5-15(b)



$A = \left(\frac{3}{4}\right)(12) + (4)(7.16) = 37.64 \text{ in.}^2$

$I_x = \left(\frac{1}{12}\right)\left(\frac{3}{4}\right)(12)^3 + 4\left[8.11 + (7.16)(5.095)^2\right] = 883.9 \text{ in.}^4$

$I_y = \left(\frac{1}{12}\right)(12)\left(\frac{3}{4}\right)^3 + 4\left[47.0 + (7.16)(3.265)^2\right] = 493.7 \text{ in.}^4$

$r_y = \sqrt{\frac{493.7}{37.64}} = 3.62 \text{ in.}$

$\left(\frac{KL}{r}\right)_y = \frac{(2.1)(12 \times 28)}{3.62} = 194.92$

$\phi_c F_{cr} = 5.61 \text{ ksi}$

$\phi_c P_n = (5.61)(37.64) = \boxed{211.2 \text{ k}}$ ← gcms

PROB # 5-17

Using a W12X87 ($A_g = 25.6\ in.^2$, $r_x = 5.38\ in.$, $r_y = 3.07\ in.$)

$$\left(\frac{KL}{r}\right)_x = \frac{(12)(24)}{5.38} = 53.53 \leftarrow$$

$$\left(\frac{KL}{r}\right)_y = \frac{(12)(12)}{3.07} = 46.91$$

$\phi_c F_{cr} = 34.44$ ksi

$\phi_c P_n = (34.44)(25.6) =$ **881.6 k**

rgcm

PROB # 6-2

$P_u = (1.2)(220) + (1.6)(280) = 712$ k

Assume $\frac{KL}{r} = 55$

$\phi_c F_{cr} = 34.1$ ksi from Table 3-50 in Part 16 of Manual

$A_{reqd} = \frac{712}{34.1} = 20.88\ in.^2$

Try W12X72 ($A_g = 21.1\ in.^2$, $r_y = 3.04\ in.$)

$$\left(\frac{KL}{r}\right)_y = \frac{(12)(14)}{3.04} = 55.26$$

$\phi_c F_{cr} = 34.02$ ksi

$\phi_c P_n = (34.02)(21.1) = 717.8\ k > 712\ k$ ok

USE W12X72

rgcm

PROB# 6-8

Substituting into applicable load combinations

(1) $P_u = (1.4)(300) = 420$ k

(3) $P_u = (1.2)(300) + (0.8)(350) = 640$ k

(4) $P_u = (1.2)(300) + (1.6)(350) = 920$ k ←

(6) $P_u = (0.9)(300) + (1.6)(350) = 830$ k

Entering tables with $P_u = 920$ k, $F_y = 50$ ksi and $KL = 12$ ft

W14X90 ($\phi_c P_n = 1010$ k)

W12X87 ($\phi_c P_n = 926$ k)

W10X100 ($\phi_c P_n = 1010$ k)