

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

PROB #5-10

(a) using a W14X53

$$KL = (0.65)(15.5) = 10.07 \text{ ft}$$

$$\phi_c P_m = \boxed{496 \text{ k}}$$

(b) using a W12X45

$$KL = (1.0)(14) = 14 \text{ ft}$$

$$\phi_c P_m = \boxed{324 \text{ k}}$$

(c) using a W10X33

$$KL = (0.80)(16.5) = 13.2 \text{ ft}$$

$$\phi_c P_m = \boxed{253 \text{ k}}$$

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

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

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

∴ Use LRFD Equation 2-2

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

$$\phi_c P_m = (0.85)(51.17)(32.0) = \boxed{1392 \text{ k}}$$

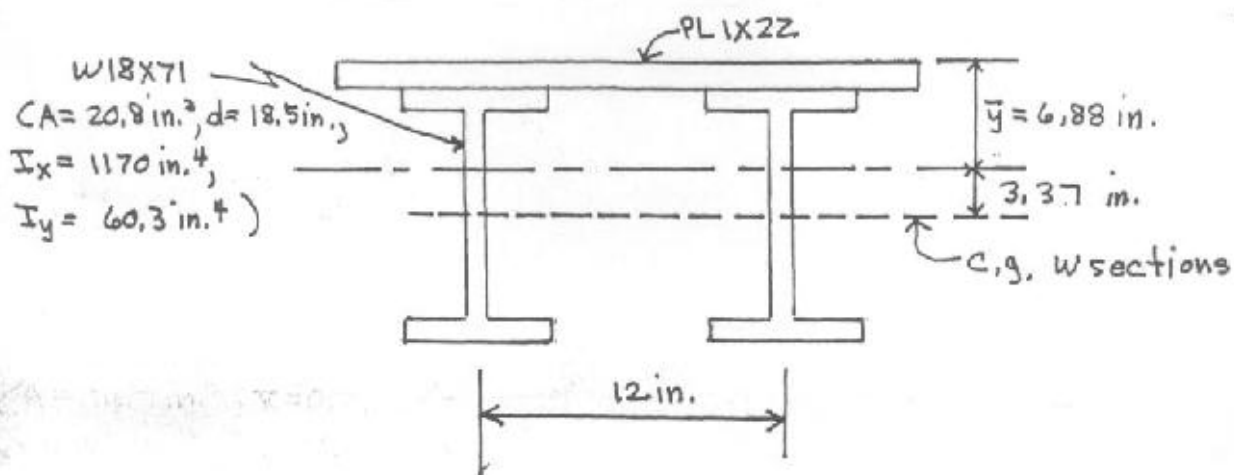
(e) using an X5 steel pipe 12

$$KL = 18.0 \text{ ft}$$

$$\phi_c P_m = \boxed{503 \text{ k}}$$

✓ JCMC

PROB # 5-15 (a)



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

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

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

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

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

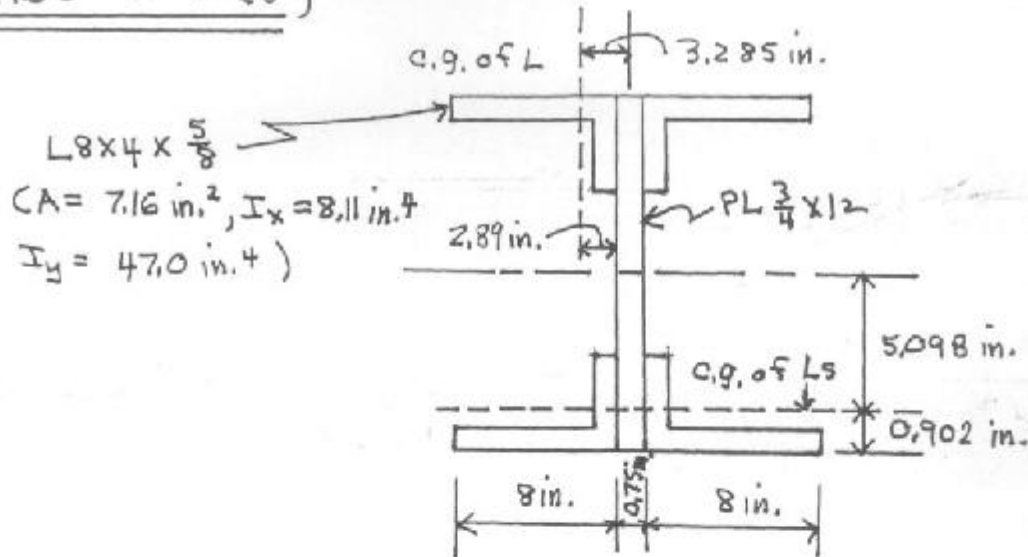
$$r_y = \sqrt{\frac{2505.5}{63.6}} = 6.28 \text{ in.}$$

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

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

$$\phi_c P_n = (39.69)(63.6) = \boxed{2524 \text{ k}} \quad \checkmark \text{ } \phi_c P_n < \phi_c F_{cr} A_g$$

PROB # 5-15(b)



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

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

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

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

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

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

$$\phi_c P_n = (5.61)(37.64) = \boxed{211.2 \text{ k}} \quad \checkmark \text{ JCMS}$$

PROB # 5-17

Using a W12x87 ($A_g = 25.6 \text{ in.}^2$, $r_x = 5.38 \text{ in.}$, $r_y = 3.07 \text{ in.}$)

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

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

$$\phi_c F_{cr} = 34.44 \text{ ksi}$$

$$\phi_c P_n = (34.44)(25.6) = \boxed{881.6 \text{ k}}$$

✓ $\phi_c P_n > P_u$

PROB # 6-2

$$P_u = (1.2)(220) + (1.6)(280) = 712 \text{ k}$$

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

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

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

Try W12x72 ($A_g = 21.1 \text{ in.}^2$, $r_y = 3.04 \text{ in.}$)

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

$$\phi_c F_{cr} = 34.02 \text{ ksi}$$

$$\phi_c P_n = (34.02)(21.1) = 717.8 \text{ k} > 712 \text{ k} \quad \text{OK}$$

$\boxed{\text{USE W12X72}}$

✓ $\phi_c P_n > P_u$

PROB#6-8

Substituting into applicable load combinations

$$(1) P_u = (1.4)(300) = 420 \text{ k}$$

$$(3) P_u = (1.2)(300) + (0.8)(350) = 640 \text{ k}$$

$$(4) P_u = (1.2)(300) + (1.6)(350) = 920 \text{ k} \leftarrow$$

$$(6) P_u = (0.9)(300) + (1.6)(350) = 830 \text{ k}$$

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

$$W14 \times 90 \quad (\phi_c P_n = 1010 \text{ k})$$

$$W12 \times 87 \quad (\phi_c P_n = 926 \text{ k})$$

$$W10 \times 100 \quad (\phi_c P_n = 1010 \text{ k})$$

✓ g cm $\underline{\underline{C}}$