Note Title 3/20/2007

Exam Thursday every other seat

Steel Ch 3, 4, 5, 6 HW 2, 3, 5, 6

tens. comp.

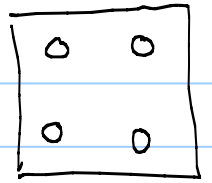
Concrete Ch 9 HW 4

comp.

Equation Sheet

Tables

Concrete Columns



9.10

Design square tied column

$P_D = 280k$, $P_L = 500k$, $f'_c = 4ksi$, $f_y = 60ksi$

$\rho = 0.02$ (2% steel) $\quad 0.01 \le \rho \le 0.08$

eccent. M, critical

$$\phi P_n = \alpha \phi \left[(0.85 f'_c (A_g - A_{st}) + A_{st} f_y \right] \Leftarrow$$

spalling

$\phi P_n \ge P_u$

$P_u = 1.2(280k) + 1.6(500k) = 1,136k$

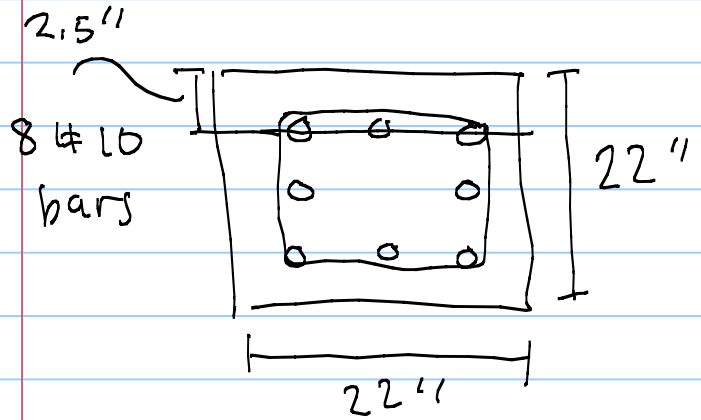
$\alpha_{tied} = 0.80$, $\phi_{tied} = 0.65$

$$1{,}136\text{ k} = (.80)(.65)\left[(0.85\times 4)(A_g - .02A_g) + .02A_g(60)\right]$$

$A_g = 482\text{ in}^2$ $\quad$ $22'' \times 22''$ $\quad$ $A_g = 484\text{ in}^2$

$A_{st} = 0.02(482) = 9.64$ $\quad$ (eg. 9.52)

8 # 10 bars $\quad A_{st} = 10.12\text{ in}^2$



Check

$$\phi P_n = (.8)(.65)\left[(.85\times 4)(484 - 10.12) + (10.12)60\right]$$

$= 1{,}154\text{ k} > 1{,}136\text{ k}$ ✓

$\rho = 10.12/484 = 0.021$ ✓

$.01 \leq \quad \leq .08$

Steel Column Review

Section 5.1 - 5.10
Section 6.1 - 6.2

Column Design

- Hand Calculations
  - Guess $F_{cr} \approx 0.75\% F_y$
  - Choose area
  - Check and iterate

- Design Charts
  - Find $(KL)_y$ and P_u
  - Choose preliminary sections
  - Check strong axis buckling using $KL_{eff} = \frac{(KL)_x}{r_x / r_y}$
  - Check and iterate

Example. 6-15

Find lightest W14 section

$P_u = 912$ k

$L = 24'$

Grade 50

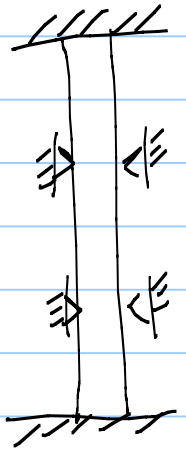
Fixed at top and bottom

Weak axis braced 8' from each end. (pinned)

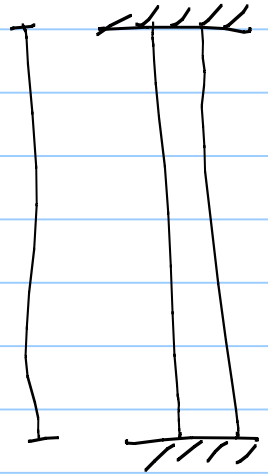
$KL = 6.4'$ $K = 0.8$ 8'

$KL = 8'$ $K = 1.0$ 8'

$KL = 6.4'$ $K = 0.8$ 8'



Weak Axis



Strong Axis

$L_y = 8'$

$(KL)_y = 8'$

Try W14 x 82. $r_x/r_y = 2.44$

Strong Axis: $KL_{eff} = \frac{0.65(24')}{2.44} = 6.39' < 8'$ ∴ ok

Use W14 x 82

Tension Members

Limit States: Yielding, $\phi P_n = \phi F_y A_g$ $(\phi = 0.9)$
Fracture, $\phi P_n = \phi F_u A_e$ $(\phi = 0.75)$

$$A_e = U A_n$$

Slenderness Limit, $L/r < 300$

$$r = r_{min}$$

Tension Rods, $\phi P_n = \phi\, 0.75 F_u A_g$ $(\phi = 0.76)$
Slenderness Limit NA

Tension Member Example (4.11)

Choose lightest W10

$P_u = 264$ kips

Grade 50

Member is connected w/ longitudinal welds, $U = 0.87$

$L = 18'$

Design Based on Yielding

$$\phi P_n = 0.9 F_y A_g \geq P_u$$

$$A_g \geq \frac{P_u}{0.9 F_y} = \frac{264\,k}{0.9(50\,ksi)} = 5.87\,in^2$$

Design Based on Fracture

$$\phi P_n = 0.75 F_u A_e \geq P_u$$

$$0.75 F_u (U A_n) \geq P_u \qquad (A_n = A_g \text{ for welded})$$

$$0.75 F_u U A_g \geq P_u$$

$$A_g \geq \frac{P_u}{0.75 U F_u} = \frac{264 \text{ kips}}{0.75(0.87)(65 \text{ ksi})} = 6.22 \text{ in}^2$$

Choose W10 × 22 $(A_g = 6.49 \text{ in}^2)$

Check slenderness: $\frac{L}{r_{min}} = \frac{(18 \text{ ft})(12 \text{ in/ft})}{1.33 \text{ in}} = 162 < 300$ ✓

Use W10 × 22.