PROB # 4.28

$$\text{Beam wt} = \left(\frac{bd}{144}\right)(150) = 1.04167\ bd\ \#/ft$$

Using ACI Load Factor Equation 9-1

$$w_u = (1.4)(1.04167)(bd) \doteq 1.4583\ bd\ \#/ft$$

$$M_u = \frac{(1.4583)(200)^2 bd}{8} = 7291.67\,bd\ \text{ft-lbs.}$$

Using $\rho = 0.0136$ (Table A.7)

$$\frac{M_u}{\phi bd^2} = 685.0 \text{ from Appendix Table A.12}$$

$$bd^2 = \frac{(12)(7291.67\,bd)}{(0.90)(685)} = 141.9\ bd$$

$$d = 141.9 \text{ in.} = \boxed{11.83 \text{ ft}}$$

✓ gcm

PROB # 4.29

$$\text{Beam wt} = \left(\frac{bd}{144}\right)(150) = 1.04167\ bd$$

neglect beam wt. below steel

Using ACI Load Factor Equation 9-1

$$w_u = (1.4)(1.04167\ bd) = 1.4583\ bd\ \#/ft$$

$$M_u = \frac{(1.4583\,bd)(100)^2}{8} = 1822.9\,bd$$

using $\rho = \frac{1}{2}\rho_b = \left(\frac{1}{2}\right)(0.0285) = 0.01425$

$$\frac{M_u}{\phi bd^2} \quad \text{Appendix Table A.13} = 747.15$$

$$bd^2 = \frac{(12)(1822.9\ bd)}{(0.90)(747.15)} = 32.53\ bd$$

$$d = 32.53 \text{ in} = \boxed{2.71 \text{ ft}}$$

✓ gcm

PROB #5.6

Using 4#10 bars ($5.06\ in.^2$)

$$\rho = \frac{A_s}{b_w d} = \frac{5.06}{16(24)} = 0.0132$$

$> \rho_{min} = 0.0033$ from Appendix Table A.13

$$T = A_s f_y = (5.06)(60) = 303.6\ k$$

$$A_c = \frac{T}{0.85 f'_c} = \frac{303.6}{(0.85)(4)} = 89.29\ in.^2$$

$<$ flange area $= (3)(36) = 108\ in.^2$

$\therefore$ N.A. is in flange

$$a = \frac{A_c}{b_f} = \frac{89.29}{36} = 2.48\ in.$$

$$c = \frac{a}{\beta_1} = \frac{2.48}{0.85} = 2.92\ in.$$

$$\epsilon_t = \left(\frac{d-c}{c}\right)(0.003) = \left(\frac{24-2.92}{2.92}\right)(0.003)$$

$$= 0.0216 > 0.0050$$

$\therefore$ Section is ductile and $\phi = 0.90$

$$\phi M_n = \phi T\left(d - \frac{a}{2}\right) = (0.90)(303.6)\left(24 - \frac{2.48}{2}\right)$$

$$= 6219\ in.\text{-}k = \boxed{518.2\ ft\text{-}k}$$

✓ JCMc

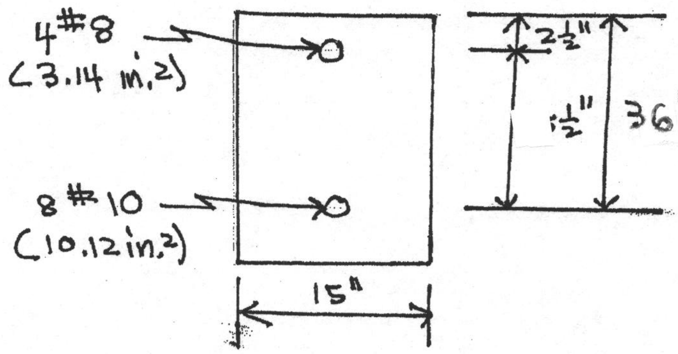
PROB # 5.26

Assuming compression steel yields

$A_{s2} = 3.14 \text{ in.}^2 = A'_s$

$A_{s1} = 10.12 - 3.14 = 6.98 \text{ in.}^2$

$$a = \frac{A_{s1} f_y}{0.85 f'_c b} = \frac{(6.98)(60)}{(0.85)(4)(15)} = 8.21 \text{ in.}$$



Locating neutral axis and checking strain in comp. steel

$$c = \frac{a}{\beta_1} = \frac{8.21}{0.85} = 9.66 \text{ in.}, \quad a = .85(9.66) = 8.21 \text{ in}$$

$$\epsilon'_s = \left(\frac{9.66 - 2.50}{9.66}\right)(0.003) = 0.00222 > 0.00207$$

$\therefore$ **Compression steel yields**

Design strength of member

$$\phi M_n = \phi A_{s1} f_y \left(d - \frac{a}{2}\right) + \phi A_{s2} f_y (d - d')$$

$$= (0.9)(6.98)(60)\left(36 - \frac{8.21}{2}\right) + (0.9)(3.14)(60)(36 - 2.5)$$

$$= 17{,}702 \text{ in.-k} = \boxed{1475 \text{ ft-k}}$$ rgcmc

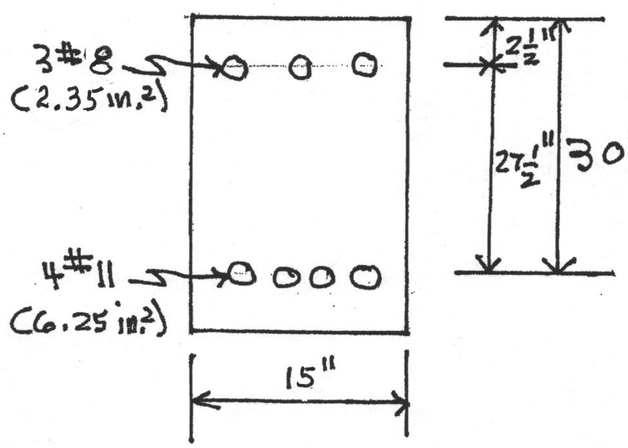
Checking Tensile Steel Strain

$$\varepsilon_t = \left(\frac{d-c}{c}\right)(.003) = \left(\frac{36 - 9.66}{9.66}\right)(.003)$$

$$= 0.0082 > .005 \therefore \phi = 0.9$$

ok

PROB # 5.28 (1)



Assuming compression steel yields

$A_{s2} = 2.35 \text{ in.}^2 = A'_s$

$A_{s1} = 6.25 - 2.35 = 3.90 \text{ in.}^2$

$$a = \frac{A_{s1} f_y}{0.85 f'_c b} = \frac{(3.90)(60)}{(0.85)(4)(15)} = 4.59 \text{ in.}$$

Locating N.A. and checking strain in comp. steel

$$c = \frac{a}{\beta_1} = \frac{4.59}{0.85} = 5.40 \text{ in.}$$

$$\epsilon'_s = \frac{5.40 - 2.50}{5.40}(0.003) = 0.00161 < 0.00207$$

∴ Compression steel does not yield

Locating N.A. and computing f'_s

$$C + C' = T$$

$$(0.85)(4)(15)(0.85c) + 2.35\left[(0.003)(29{,}000)\left(\frac{c-2.5}{c}\right)\right] = (6.25)(60)$$

$$43.35c + 204.45 - \frac{511.13}{c} = 375$$

PROB # 5.28 (2)

$$43.35c^2 + 204c - 511 = 375c$$

$$43.35c^2 - 171c = 511$$

$$c = 5.92 \text{ in.}$$

$$f'_s = \left(\frac{5.92 - 2.50}{5.92}\right)(0.003)(29{,}000) = 50.26 \text{ ksi}$$

Is section ductile?

$$\epsilon_t = \frac{d-c}{c}(0.003) = \left(\frac{30-5.92}{5.92}\right)(0.003) = 0.0122$$

$$> 0.0050 \quad \therefore \text{ Its ductile and } \phi = 0.9$$

Design strength of member

$$A'_s f'_s = A_{s2} f_y$$

$$A_{s2} = \frac{A'_s f'_s}{f_y} = \frac{(2.35)(50.26)}{60} = 1.97 \text{ in.}^2$$

$$A_{s1} = A_s - A_{s2} = 6.25 - 1.97 = 4.28 \text{ in.}^2$$

$$a = \beta_1 c = (0.85)(5.92) = 5.03 \text{ in.}$$

$$\phi M_n = \phi\left[A_{s1} f_y \left(d - \frac{a}{2}\right) + A_{s2} f_y (d - d')\right]$$

$$= 0.9\left[(4.28)(60)\left(30 - \frac{5.03}{2}\right) + (1.97)(60)(30 - 2.5)\right]$$

$$= 9277 \text{ in.-k} = \boxed{773.1 \text{ ft-k}}$$