ENCE 355 – Introduction to Structural Design
SOLUTIONS to Homework Set No. 3
Fall 2002

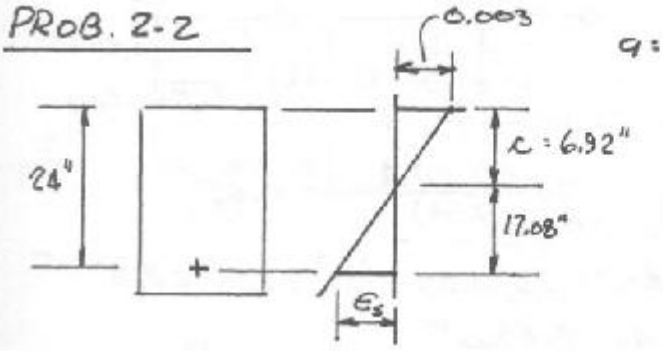
PROB. 2-1

(a) $4\#9$ $A_s = 4.00\ in.^2$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{4(60)}{0.85(3)(16)} = 5.88\ in.$$

$$M_n = A_s f_y \left(d - \frac{a}{2}\right) = \frac{4.00(60)\left(24 - \frac{5.88}{2}\right)}{12} = 421\ ft\text{-}k$$

PROB. 2-2



$$a = \beta_1 c \Rightarrow c = \frac{a}{\beta_1} = \frac{5.88}{0.85} = 6.92\ in.$$

$$\frac{\epsilon_s}{17.08} = \frac{0.003}{6.92}$$

$$\epsilon_s = 0.0074 > f_y = 0.00207$$

$$\therefore f_s = f_y$$

PROB. 2-5 (CONT.)

(a) 6 #10 $A_s = 7.62\ in^2$ $\rho = \frac{7.62}{20(42)} = 0.0091 < 0.0278$ (OK)

$A_{s,min} = 0.0050(20)(42) = 4.20\ in^2 < 7.62\ in^2$ (OK)

$\bar{f}_c = 0.3380\ ksi$

$\phi M_n = \phi b d^2 \bar{f}_c = \frac{0.90(20)(42)^2(0.3380)}{12} = 894\ ft\text{-}k < 1031\ ft\text{-}k$ (N.G.)

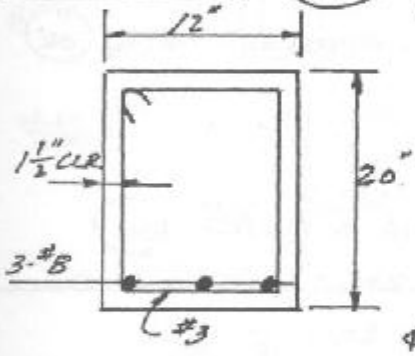
(b) 6 #11 $A_s = 9.36\ in^2$ $\rho = \frac{9.36}{20(42} = 0.0111 < 0.0278$ (OK)

$A_{s,min} = 4.20\ in^2$ (FROM PART (a)) $< 9.36\ in^2$ (OK)

$\bar{f}_c = 0.4053\ ksi$

$\phi M_n = \frac{0.90(20)(42)^2(0.4053)}{12} = 1072\ ft\text{-}k > 1031\ ft\text{-}k$ (OK)

PROB. 2-7 (4/60)



$d = 20 - 1.5 - 0.38 - \frac{1.00}{2} = 17.6"$

$A_s = 2.37\ in^2$ $\rho = \frac{2.37}{12(17.6)} = 0.0112$

$\rho_{max} = 0.0214 > 0.0112$ (OK)

$A_{s,min} = 0.0033(12)(17.6) = 0.70\ in^2 < 2.37\ in^2$ (OK)

BEAM WEIGHT $= \frac{12(20)}{144}(0.150) = 0.250\ k/ft$

ϕM_n: $a = \frac{2.37(60)}{0.85(4)(12)} = 3.49"$

$\phi M_n = \frac{0.9(2.37)(60)(17.6 - \frac{3.49}{2})}{12} = 169\ ft\text{-}k$

M_u: $w_u = 1.4(0.25 + 0.7) + 1.7(2.5) = 5.58\ k/ft$

$M_u = \frac{w_u L^2}{8} = \frac{5.58(16)^2}{8} = 178.6\ ft\text{-}k$

$178.6 > 169$ (NG)

PROB. 2-11 (3/60)

ASSUME 3/4" COVER

$d = 10 - 0.75 - \frac{0.88}{2} = 8.81"$

MIN $h = \frac{L}{20} = \frac{16(12)}{20} = 9.6"$ (OK)

$A_s = 1.20 in^2$, $\rho = \frac{1.20}{12(8.81)} = 0.0114$ $\rho_{MAX} = 0.0161$ (OK)

$A_{s_{MIN}} = 0.0018(12)(10) = 0.22 in^2$ (OK)

ϕM_n: $a = \frac{1.20(60)}{0.85(3)(12)} = 2.35"$

$\phi M_n = \frac{0.9(1.20)(60)(8.81 - \frac{2.35}{2})}{12} = 41.2^{IK}$

PROB. 2-11 (CONT.)

M_u: SLAB WEIGHT $= \frac{10}{12}(0.150) = 0.125^{K}/_{FT^2}$

$w_u = 1.4(0.125) + 1.7(0.60) = 1.20^{K}/_{'}$

$M_u = \frac{w_u L^2}{8} = \frac{1.20(16)^2}{8} = 38.4^{IK}$

$\phi M_n > M_u$ (OK)

PROB 2-14 (3/60)

EST. $d = 23 - 3 = 20"$

REQ'D $\bar{k} = \frac{M_u}{\phi b d^2} = \frac{133(12)}{0.9(11.5)(20.0)^2} = 0.3855$ ksi

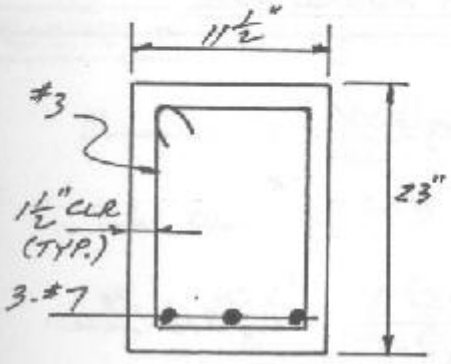
FROM TABLE A-8: REQ'D $\rho = 0.0070 < \rho_{max} = 0.0161$ (OK)

REQ'D $A_s = 0.0070(11.5)(20) = 1.61 in^2$

$A_{s,min} = 0.0033(11.5)(20) = 0.76 in^2 < 1.61 in^2$ (OK)

USE 3-#7 BARS ($A_s = 1.80 in^2$)

$b_{MIN} = 8\frac{1}{2}"$ (OK)



CHECK:

ACTUAL $d = 23 - 1.5 - 0.38 - \frac{0.88}{2}$

$= 20.7" > 20"$ (OK)