ENCE 355 – Introduction to Structural Design
SOLUTIONS to Homework Set No. 7
Fall 2002

PROB. 5-7   (4/60)   #10 BARS $d_b = 1.27''$

DEVELOPMENT LENGTH AVAILABLE = $4'-1\frac{1}{2}'' = 49\frac{1}{2}''$

① $K_D = 71.2$

② $\alpha = 1.3,\ \beta = 1.0,\ \gamma = 1.0,\ \lambda = 1.0$

③ $\alpha\beta = 1.3 < 1.7$ (ok)

④ COVER: $c = 2.5 + \frac{1.27}{2} = 3.14''$

HALF-SPACE: $c = \frac{3.00 + 1.27}{2} = 2.14''$ ⇐

(MORE)

PROB. 5-7 (CONT.)

⑤ $K_{TR} = 0$

⑥ $\frac{c + K_{TR}}{d_b} = \frac{2.14}{1.27} = 1.685$

⑦ NEGLECT K_{DR}

⑧ $l_d = 71.2 \left(\frac{1.3}{1.685} \right)$ $= 69.8'' > 49.5''$ (N.G.)

CHECK A 180° HOOK:

$$l_{dh} = l_{hb} \times MF$$

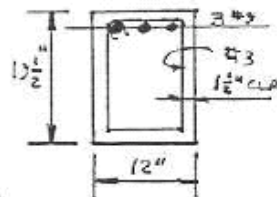$l_{hb} = 24.1''$ (TABLE A-13)   MF (FOR SIDE COVER) = 0.7

$$l_{dh} = 24.1(0.7) = 16.9'' < 49.5''$$ (OK)

REQ'D MINIMUM WIDTH OF COLUMN = $16.9 + 1.5 = 18.4''$
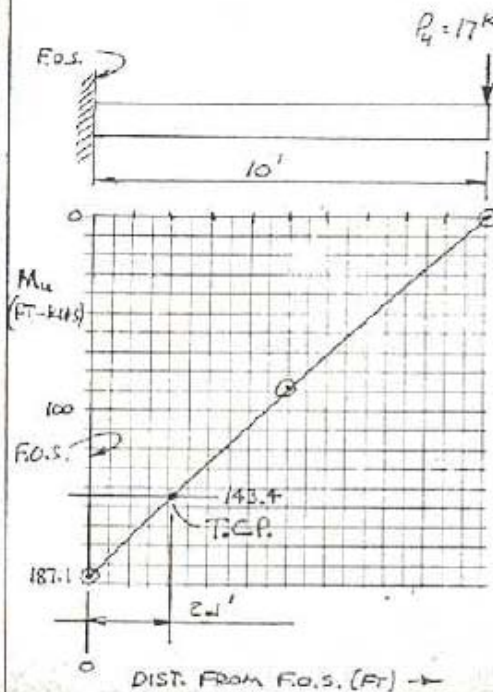
USE A 180° Hook

PROB. 5-12   (5/60)

BEAM WT $= \frac{12(19.5)}{144}(0.150) = 0.244\ ^k/_b$

(MORE)

PROB. 5-12 (CONT.)

USE GRAPHICAL APPROACH:

$M_u = P_u L + \dfrac{W_u L^2}{2}$

@ F.O.S. :

$M_u = 17(10) + \dfrac{1.4(0.244)(10)^2}{2} = 187.1 \text{ ft-k}$

@ MIDSPAN :

$M_u = 17(5) + \dfrac{1.4(0.244)(5)^2}{2} = 89.3 \text{ ft-k}$

[PLOT M_u DIAGRAM]

ϕM_n FOR 2#9 BARS:

$d = 13.5 - 1.5 - 0.38 - \dfrac{1.13}{2} = 17.06''$

$\rho = \dfrac{A_s}{bd} = \dfrac{2.00}{12(17.06)} = 0.0098$

$\qquad \overline{R} = 0.5473 \text{ ksi}$

$A_{s_{min}} = 0.0035(12)(17.06) = 0.72 \text{ in}^2 < 2.00 \text{ in}^2$

$\phi M_n = \phi b d^2 \overline{R} = \dfrac{0.9(12)(17.06)^2(0.5473)}{12}$ ✓OK

$\qquad = 143.4 \text{ ft-k}$

THEORETICAL CUTOFF POINT IS AT APPROX. 2.1 FT FROM F.O.S.

PROB 9-3   5/60

$A_{st} = 6.20 \text{ in}^2 \qquad A_g = 256 \text{ in}^2$

$C_g = \dfrac{A_{st}}{A_g} = \dfrac{6.20}{256} = 0.0244$

$0.01 < C_g < 0.08$ OK

FROM TABLE A-14   4-#11 BARS OK

$\phi P_{n(max)} = 0.80(0.70)[0.85(4)(256 - 6.24) + 60(6.24)] = 685^k$

CHECK TIES:

#3 N.G. MUST USE #4 (ACI CODE)

MAX. SPACING:
$48(0.5) = 24''$
$16(1.41) = 22.5''$
COL. DIMENSION = 16'' ← CONTROLS

REQ'D TIES PER ACI #4 @ 16''

MAX. SERVICE LOADS: (DL & LL ARE EQUAL)

$P_u = 1.4 P_{DL} + 1.7 P_{LL}$

$P_u = 3.1 P_{DL}$ & SINCE P_u AS A LIMIT CAN EQUAL ϕP_n

$\phi P_n = 3.1 P_{DL}$

$P_{DL} = \dfrac{685}{3.1} = 221^k = P_{LL}$

PROB. 9-9 $\rho_g = 0.03$ | $P_u = 552^k$ (9/60)

REQ'D $A_g = \dfrac{552}{0.80(0.70)(0.85(4)(1-0.03)+60(0.03))} = 193.4 \text{ in}^2$

— USE 14" × 14" COLUMN   ($A_g = 196 \text{ in}^2$)

— LOAD ON CONCRETE = 0.80(0.70)(0.85)(4)(196)(1-0.03) = 362^k

LOAD TO BE CARRIED BY STEEL = 552 - 362 = 190^k

REQ'D $A_{st} = \dfrac{190}{0.80(0.70)(60)} = 5.66 \text{ in}^2$

— USE 6-#9 BARS   ($A_{st} = 6.0 \text{ in}^2$)

— FROM TABLE A-14   6-#9 BARS OK

— USE #3 TIES

— MAX. SPACING
   #8(0.375) = 18"
   16(1.13) = 18.1"
COL. DIMENSION = 14" ⇐

USE #3 @ 14" O.C.

CHECK CLEAR SPACE BETWEEN BARS:
$= \dfrac{14-2(1\frac{1}{2})-2(3/8)-3(1.13)}{2}$

$= 3.43" < 6"$ OK