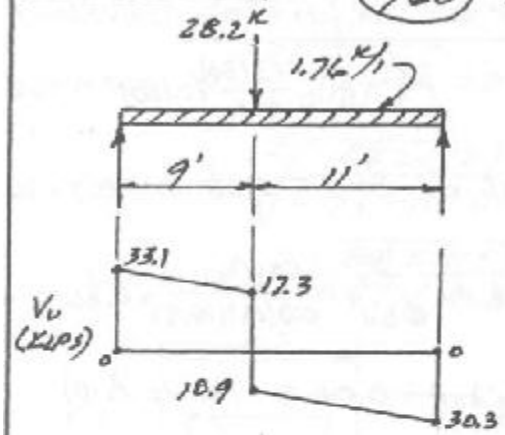
ENCE 355 – Introduction to Structural Design
SOLUTIONS to Homework Set No. 4
Fall 2002

PROB 2-28 (3/60)



ASSUME BEAM WT. OF 350#/'

$P_u = 1.4(8) + 1.7(10) = 28.2^K$

$w_u = 1.4(0.30+0.35) + 1.7(0.5) = 1.76^K/'$

M_u (FROM V_u DIAGRAM) $= 226.8'^K$

USE $\rho = 0.0090$ (WITH $\bar{I}_k = 0.4828 K/in^2$)

MAKE $d/b \approx 2.0$ $\therefore d \approx 2b$

REQ'D $b = \sqrt[3]{\frac{M_u(12)}{\phi(4)\bar{I}_k}} = \sqrt[3]{\frac{226.8(12)}{0.9(4)(0.4828)}} = 11.6"$

USE $b = 12"$

REQ'D $d = \sqrt{\frac{M_u(12)}{\phi b \bar{I}_k}} = \sqrt{\frac{226.8(12)}{0.9(12)(0.4828)}} = 22.9"$

EST. WT $= \frac{12(27)}{12^2}(150) = 338$#/' (OK)

$d/b = 22.9/12 = 1.91$ (OK)

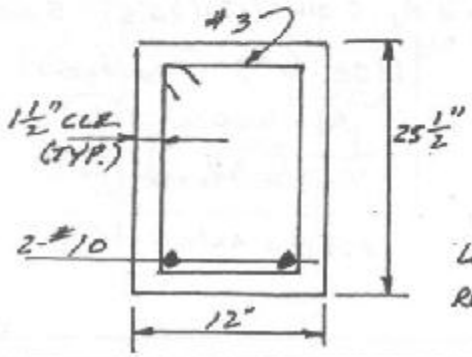
REQ'D $A_s = 0.009(12)(22.9) = 2.47 in.^2$

$A_{s,min} = 0.0033(12)(22.9) = 0.91 in.^2$

USE 2#10, $A_s = 2.54 in.^2$, MIN $b = 8.0"$ (OK)

REQ'D $h = 22.9 + 1.27/2 + 0.38 + 1.5 = 25.4"$

USE $h = 25\frac{1}{2}"$



PROB. 3-1 (4/60)

4-#8 : $A_s = 3.16 in.^2$, $b = 36"$, $b_w = 12"$

FOR $A_{s,min}$ CHECK:

$A_{s,min} = 0.0033(12)(22) = 0.87 in.^2 < 3.16 in.^2$ (OK)

$A_{s,MAX} = 0.0425(4)(36 + 12(\frac{0.503}{d}(22) - 1)) = 9.72 in.^2 > 3.16 in.^2$ (OK)

$N_T = A_s f_y = 3.16(60) = 189.6^K$ FLANGE $N_{cf} = 0.85(4)(4)(36) = 489.6^K$

$\therefore$ RECTANGULAR T-BEAM

FOR FLEXURE:

$\rho = \frac{A_s}{bd} = \frac{3.16}{36(22)} = 0.00399 \longrightarrow \bar{I}_k = 0.2315$ KSI

$\phi M_n = \frac{0.9(36)(22)^2(0.2315)}{12} = 303'^K$

PROB 3-5 (7/60)

(a) $10^{\#}9$ $A_s = 10.0\ in^2$, $b_w = 24"$

DETERMINE b:

$\frac{SPAN}{4} = \frac{20(12)}{4} = 60"$

$16h_f + b_w = 128"$

SPACING = 45" ⇦

FOR $A_{s,min}$ CHECK: ($d = 40 - 1.5 - 0.38 - 1.13 - 0.5 = 36.5"$)

$A_{s,min} = 0.0033(24)(36.5) = 2.89\ in^2 < 10.0\ in.^2$ (ok)

FROM TABLE 3-1 $A_{s,Max} = 0.0319(6.5)\left(45 + 24\left(\frac{0.503}{6.5}(36.5) - 1\right)\right)$

$= 18.41\ in^2 > 10.0\ in^2$ (OK)

$N_T = A_s f_y = 10.0(60) = 600^k$, FULL FLANGE $N_{cf} = 0.85(3)(6.5)(45)$

$= 745.9^k$

∴ RECTANGULAR T-BEAM

FOR FLEXURE:

$\rho = \frac{10.0}{45(36.5)} = 0.00609 \longrightarrow f_c = 0.3397\ ksi$

$\phi M_n = \frac{0.9(45)(36.5)^2(0.3397)}{12} = 1527^{ik}$

(b) $A_s f_y$ = FULL FLANGE $N_{cf} = 745.9^k$

REQ'D $A_s = \frac{745.9}{60} = 12.43\ in^2$

PROB. 3-6 (3/60) $3\#10$ $A_s = 3.81\ in.^2$

$d = 16 - 1.5 - 0.38 - \frac{1.27}{2} = 13.49\ in.$

b: ① $span/4 = \frac{24(12)}{4} = 72\ in.$

② $b_w + 16h_f = 12 + 16(4) = 76\ in.$

③ $Spacing = 6'-0 = 72\ in.$ ←

Table 3-1: $A_{s\,max} = 0.0319\, h_f \left(b + b_w \left(\frac{0.503}{h_f}(d) - 1\right)\right) = 10.25\ in^2 > 3.81\ in^2$ (OK)

Table A-5: $A_{s\,min} = 0.0033\, b_w d = 0.0033(12)(13.49) = 0.53\ in^2 < 3.81\ in^2$ (OK)

$N_T = 3.81(60) = 229\ kips$

$N_{cf} = 0.85(3)(72)(4) = 734\ kips$

$N_{cf} > N_T \therefore$ RECT. T-BEAM

$\rho = \frac{A_s}{bd} = \frac{3.81}{72(13.49)} = 0.00392$

$\bar{k} = 0.2233\ ksi$ (Table A-8)

$\phi M_n = \phi b d^2 \bar{k} = \frac{0.9(72)(13.49)^2(0.2233)}{12} = 219\ ft\text{-}k$

PROB. 3-12 (4/60)

WEIGHT OF SLAB & BEAM

$\left(\frac{96(4)}{144} + \frac{22(15)}{144}\right)0.150 = 0.74\ k/'$

$w_{u(DL)} = 1.4\left(0.74 + 8(0.05)\right) = 1.60\ k/'$

$w_{u(LL)} = 1.7(8)(0.325) = 4.42\ k/'$

$6.02\ k/'$

(MORE)

PROB. 3-12 (CONT.)

$M_u = \frac{6.02(18)^2}{8} = 243.9^{IK}$

ASSUME $d = 26-3 = 23"$

DETERMINE b:

SPAN/4 $= \frac{18(12)}{4} = 54"$ ⇦

$16h_f + b_W = 79"$

SPACING $= 96"$

FOR TOTAL EFFECTIVE FLANGE IN COMPRESSION

$\phi M_{n_f} = \frac{0.9(0.85)(4)(54)(4)(23-\frac{4}{2})}{12} = 1156^{IK}$

$1156^{IK} > 243.9^{IK}$ ∴ RECTANGULAR T-BEAM

REQ'D $k = \frac{M_u}{\phi b d^2} = \frac{243.9(12)}{0.9(54)(23)^2} = 0.1138$ KSI

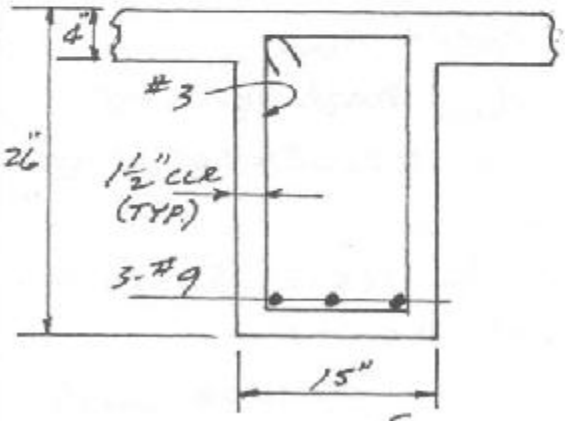
FROM TABLE A-10, REQ'D $\rho = 0.0020$

REQ'D $A_s = 0.0020(54)(23) = 2.48in^2$ USE 3-#9 ($A_s = 3.0in^2$)

MIN $b = 9.5"$

ACTUAL $d = 26 - 1.5 - 0.38 - \frac{1.13}{2}$

$= 23.6 > 23.0$ (OK)



CHECK $A_{s,min}$

$A_{s,min} = 0.0033(15)(23.6)$

$= 1.17in^2 < 3.0in^2$ (OK)

$A_{s,max} = 0.0425(4)\left[54 + 15\left(\frac{0.503}{4}(23.6) - 1\right)\right] = 14.2in^2$

$14.2in^2 > 3.00in^2$ (OK)