Prob. 1-1

(a) $\dfrac{16(28)}{144}(150) = 467\text{ lb/ft}$

(b) $\dfrac{12(26-6)}{144}(150) + \dfrac{6(38)}{144}(150) = 488\text{ lb/ft}$

Prob. 1-2

Spreadsheet problem: $E_c = w_c^{1.5}33\sqrt{f_c'}$ Check value for w_c = 145 lb/ft^3 and f_c' = 4000 psi:

E_c = 3,644,000 psi

Prob. 1-3 L = 24 in. with 2100 lb load at midspan.

Beam weight $= \dfrac{6(6)}{144}(0.145) = 0.036\text{ kip/ft}$ $I = \dfrac{1}{12}(6)^4 = 108\text{ in.}^4$

$$M = \frac{0.036(2)^2}{8} + \frac{2.1(2)}{4} = 1.068\text{ ft - kips}$$

$$f = \frac{Mc}{I} = f_r = \frac{1.068(12)(3)}{108} = 0.356\text{ ksi}$$

By ACI formula:

$$f_r = 7.5\sqrt{f_c'} = 7.5\sqrt{3000} = 411\text{ psi}$$

Prob. 1-4 Simply supported beam of length L.

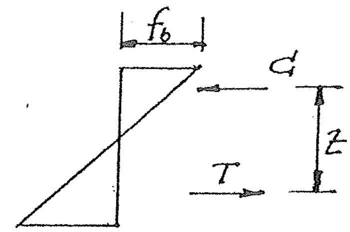
Beam weight $= \dfrac{10(10)}{144}145 = 100.7\text{ lb/ft;}$ $f_r = 350\text{ psi;}$ $I = \dfrac{10(10)^3}{12} = 833\text{ in.}^4$

$$M = \frac{100.7L^2}{8} = 12.59L^2$$

$$f = \frac{Mc}{I} = f_r = \frac{12.59(12)(5)L^2}{833} = 350$$

$L = 19.65\text{ ft}$

Prob. 1-5



$$M = \frac{0.5(10)^2}{8} + \frac{2(10)}{4} = 11.25 \text{ ft - kips}$$

(a) $C = \dfrac{f_b}{2}(8)(8) = 32 f_b \text{ in.}^2$

$M = CZ$

$$11.25 \text{ ft - kips} = 32 f_b \,(\text{in.}^2)\left(\frac{2}{3}\right)(16 \text{ in.})$$

$$f_b = \frac{11.25 \text{ ft - kips}(12 \text{ in./ft})}{32 \text{ in.}^2\left(\frac{2}{3}\right)(16 \text{ in.})} = 0.396 \text{ ksi}$$

(b) $S_x = \dfrac{bh^2}{6} = \dfrac{8(16)^2}{6} = 341 \text{ in.}^3$; $f_b = \dfrac{M}{S_x} = \dfrac{11.25(12)}{341} = 0.396 \text{ ksi}$ (O.K.)

Prob. 1-6

$f_r = 7.5\sqrt{3000} = 411 \text{ psi} = 0.411 \text{ ksi}$

(a) I.C. method: $Z = 16 - 2(2.67) = 10.67$ in.

$C = T = 0.5(0.411)(8)(10) = 16.44$ kips

$$M_{cr} = CT = TZ = \frac{16.44(10.67)}{12} = 14.62 \text{ ft - kips}$$

(b) Flexure formula check:

$$S_x = \frac{10(16)^2}{6} = 427 \text{ in.}^3$$

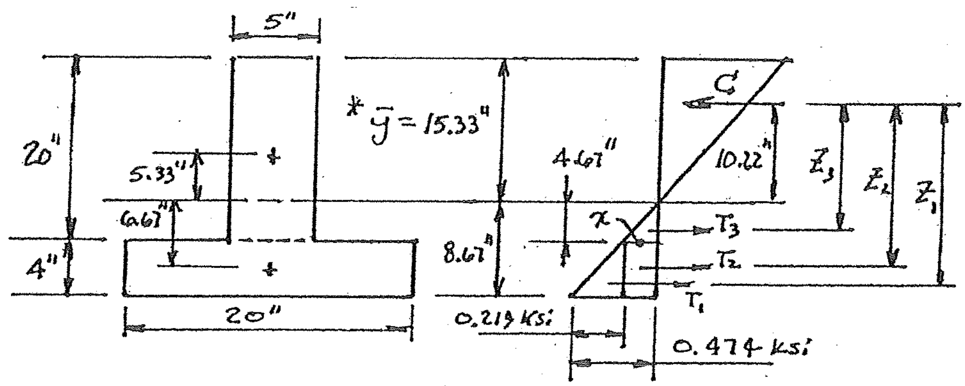
$M_{cr} = f_r S_x = 0.411(427) = 175.5 \text{ in - kips} = 14.62 \text{ ft - kips}$ (O.K.)

Prob. 1-8

(a) $f_c' = 4000$ psi

$$f_r = \frac{7.5\sqrt{4000}}{1000} = 0.474 \text{ ksi}$$

$$x = 0.474\left(\frac{4.67}{8.67}\right) = 0.255 \text{ ksi}$$



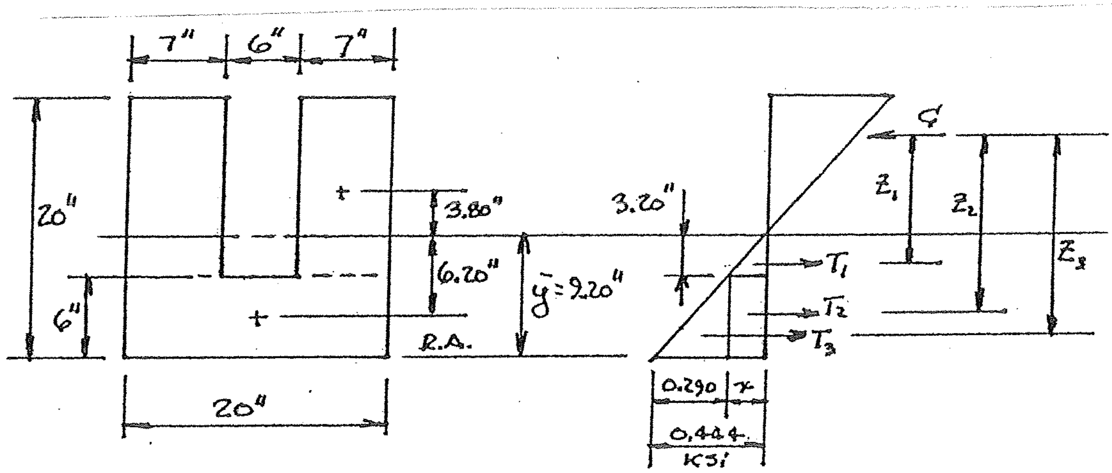
Force	Magnitude (kips)	Moment arm (in.)	I.C. (in.-kips)
T_1	0.5(0.219)(20)(4)=8.76	10.22+(2/3)(4.67) = 17.56	153.8
T_2	0.255(20)(4)=20.4	10.22 +4.67+2=16.89	344.6
T_3	0.5(0.255)(4.67)=2.89	10.22+4.67+(2/3)(4) = 12.33	39.7
		Total :M_{cr} =	538 in-kips

(b) $I = \frac{20(4)^3}{12} + 20(4)(6.67)^2 + \frac{5(20)^3}{12} + 5(20)(5.33)^2 = 9840 \text{ in.}^2$

$c = 8.67$ in. (to tension side.)

$$M_{cr} = \frac{0.474(9840)}{8.67} = 538 \text{ in - kips} \quad \text{(O.K.)}$$

Prob. 1-9



$f_c' = 3500$ psi; $\quad f_r = 7.5\sqrt{3500} = 444 \text{ psi} = 0.444 \text{ ksi}$

$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{20(6)(3) + 2(7)(14)(13)}{20(6) + 2(7)(14)} = 9.20$ in.; $\quad x = 0.444\left(\frac{3.20}{9.20}\right) = 0.1544$ ksi

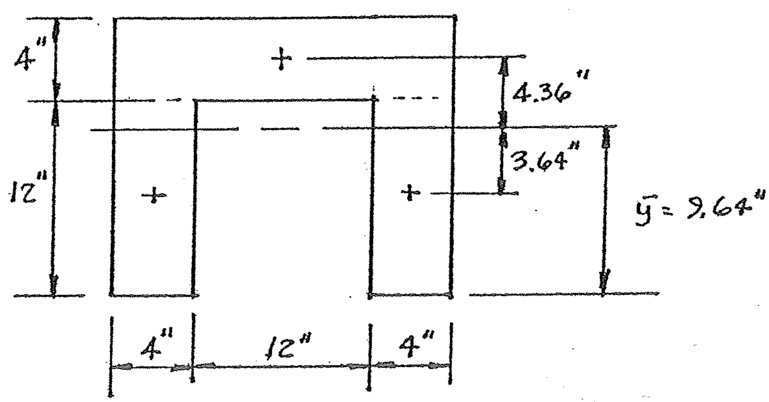
(a)

Force	Magnitude (kips)	Moment arm (in.)	I.C. (in.-kips)
T_1	2(0.5)(0.1544)(7)(3.20)=3.46	7.20+(2/3)(3.20)=9.33	32.3
T_2	0.1544(20)(6)=18.53	7.20+3.20+3=13.40	248.3
T_3	0.5(0.290)(20)(6)=17.40	7.20+3.20+(2/3)(6)=14.40	250.6
		Total :M_{cr} =	531 in-kips

(b) $I = 2\left(\dfrac{7(14)^3}{12}\right) + 2(7)(14)(3.80)^2 + \dfrac{20(6)^3}{12} + 6(20)(6.20)^2 = 11{,}004\text{ in.}^4$

$$M_{cr} = \frac{f_r I}{c} = \frac{0.444(11{,}004)}{9.20} = 531\text{ in - kips (O.K.)}$$

Prob. 1-10



$f_c' = 3000$ psi

$$f_r = \frac{7.5\sqrt{3000}}{1000} = 0.411\text{ ksi}$$

$$\bar{y} = \frac{\Sigma A y}{\Sigma A}$$

$$= \frac{2(4)(12)(6) + 4(20)(14)}{2(4)(12) + 4(20)}$$

$$= 9.64\text{ in.}$$

$$I = 2\left(\frac{4(12)^3}{12}\right) + 2(4)(12)(3.64)^2 + \frac{20(4)^3}{12} + 4(20)(4.36)^2 = 4051\text{ in.}^4$$

(a) $M_{cr} = \dfrac{f_r I}{c} = \dfrac{0.411(4051)}{9.64} = 172.7\text{ in. - kips}$

(b) Beam weight $= \dfrac{4(20) + 2(4)(12)}{144}(0.145) = 0.1772$ kip/ft

$$\text{Beam weight moment} = \frac{0.1772(12)^2}{8} = 3.19\text{ ft - kips} = 38.3\text{ in. - kips}$$

$$\frac{PL}{4} = M_{cr} - 38.3 = 172.7 - 38.3 = 134.4\text{ in - kips;} \qquad P = \frac{4(134.4\text{ in - k})}{12\text{ ft (12 in/ft)}} = 3.73\text{ kips}$$

General notes at beginning of Chapter 2 problem-set apply

Prob. 2-1

(a) 4#9, $A_s = 4.00$ in.^{2}

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{4.00(60)}{0.85(3)(16)} = 5.88\,\text{in.}$$

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

(b) 4#10, $A_s = 5.08$ in.^{2}

$$a = \frac{5.08(60)}{0.85(3)(16)} = 7.47\,\text{in.} \qquad M_n = \frac{5.08(60)\left(24 - \frac{7.47}{2}\right)}{12} = 515\,\text{ft - kips}$$

% Increase: A_s: +27%; M_n: +22%

(c) 4#9, $A_s = 4.00$ in.^{2}, $a = 5.88$ in. (from part (a))

$$M_n = \frac{4.00(60)\left(28 - \frac{5.88}{2}\right)}{12} = 501\,\text{ft - kips}$$

% Increase: d: +16.7 %; M_n: +19%

(d) $f_c' = 4000$ psi

$$a = \frac{4(60)}{0.85(4)(16)} = 4.41\,\text{in.} \qquad M_n = \frac{4.00(60)\left(24 - \frac{4.41}{2}\right)}{12} = 436\,\text{ft - kips}$$

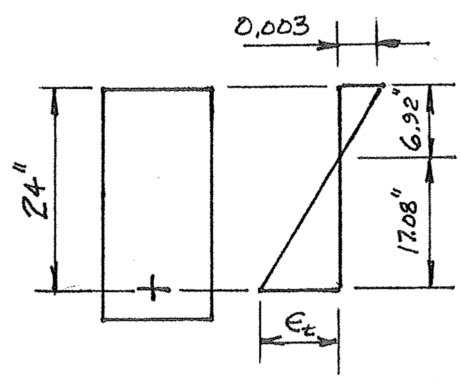
% Increase: f_c' : 33.3%; M_n: 3.6%

Prob. 2-2 Check ε_t for Prob. 2-1(a)

$$c = \frac{a}{\beta_1} = \frac{5.88}{0.85} = 6.92\,\text{in.}$$ then, from a strain diagram :

$$\frac{\varepsilon_t}{(24 - 6.92)} = \frac{0.003}{6.92}$$

$$\varepsilon_t = 0.0074 > \varepsilon_y = 0.00207 \quad \therefore \; f_s = f_y$$



Prob. 2-3

(a) [4/40], 4#8, $A_s = 3.16 \text{ in.}^2$, $b = 13$ in., $d = 24$ in. $\rho = \dfrac{3.16}{13(24)} = 0.0101$

$A_{s,min} = 0.005(13)(24) = 1.56 \text{ in.}^2 < 3.16 \text{ in.}^2$ (O.K.)

(Table A-9) $\bar{k} = 0.3800$ ksi and $\varepsilon_t > 0.005$, $\therefore\ \phi = 0.90$

$$\phi M_n = \phi b d^2 \bar{k} = \frac{0.90(13)(24)^2(0.3800)}{12} = 213 \text{ ft - kips}$$

(b) [4/60], 4#8, $A_s = 3.16 \text{ in.}^2$, $b = 13$ in., $d = 24$ in. $\rho = \dfrac{3.16}{13(24)} = 0.0101$

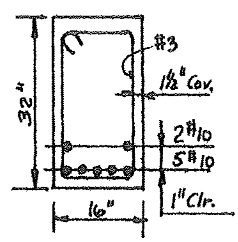
$A_{s,min} = 0.0033(13)(24) = 1.03 \text{ in.}^2 < 3.16 \text{ in.}^2$ (O.K.)

(Table A-10) $\bar{k} = 0.5520$ ksi and $\varepsilon_t > 0.005$, $\therefore\ \phi = 0.90$

$$\phi M_n = \phi b d^2 \bar{k} = \frac{0.90(13)(24)^2(0.5520)}{12} = 310 \text{ ft - kips}$$

% Increase: f_y: +50%; ϕM_n: +45.5%

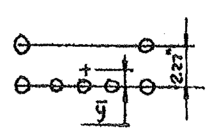
Prob. 2-4 [4/60]



$$\bar{y} = \frac{2A(2.27)}{7A} = 0.649 \text{ in.}$$

$d = 32 - 1.5 - 0.375 - 1.27/2 - 0.649 = 28.8$ in.

$$\rho = \frac{8.89}{16(28.8)} = 0.0193, \quad \bar{k} = 0.9609 \text{ ksi}, \quad \varepsilon_t = 0.00449$$



$$\therefore\ \phi = 0.65 + (0.00449 - 0.002)\left(\frac{250}{3}\right) = 0.858$$

$$\phi M_n = \phi b d^2 \bar{k} = \frac{0.858(16)(28.8)^2(0.9609)}{12} = 912 \text{ ft - kips}$$

Prob. 2-5 [3/40], $b = 20$ in., $d = 42$ in., $h = 45$ in., $L = 28$ ft
Beam is adequate if $\phi M_n \geq M_u$

$$\text{Beam weight} = \frac{20(45)}{144}(0.150) = 0.938 \text{ kip/ft}$$

$w_u = 1.2(0.938 + 2.20) + 1.6(3.60) = 9.53$ kips/ft; $\quad M_u = \dfrac{9.53(28)^2}{8} = 939 \text{ ft - kips}$

(a) 6#10, $A_s = 7.62$ in.^{2}, $\rho = \dfrac{7.62}{20(42)} = 0.00907$

$A_{s,min} = 0.005(20)(42) = 4.20\text{in.}^2 < 7.62 \text{ in.}^2$ (O.K.)

(Table A-7) $\bar{k} = 0.3380$ ksi and $\varepsilon_t > 0.005$, $\therefore \phi = 0.90$

$$\phi M_n = \phi b d^2 \bar{k} = \frac{0.90(20)(42)^2(0.3380)}{12} = 894 \text{ ft - kips} < 939 \text{ ft - kips} \quad \text{(N.G.)}$$

(b) 6#11, $A_s = 9.36$ in.^{2}, $\rho = \dfrac{9.36}{20(42)} = 0.0111$

$A_{s,min} = 4.20 \text{ in.}^2 < 9.36 \text{ in.}^2$ (O.K.)

(Table A-7) $\bar{k} = 0.4053$ ksi and $\varepsilon_t > 0.005$, $\therefore \phi = 0.90$

$$\phi M_n = \phi b d^2 \bar{k} = \frac{0.90(20)(42)^2(0.4053)}{12} = 1072 \text{ ft - kips} > 939 \text{ ft - kips} \quad \text{(O.K.)}$$

Prob. 2-7 [4/60] $b = 12$ in., $h = 20$ in., 3#8 ($A_s = 2.37$ in.^{2})

$$\text{Beam weight} = \frac{12(20)}{144}(0.150) = 0.250 \text{ k/ft}$$

$d = 20 - 1.5 - 0.38 - 0.50 = 17.62$ in.; $\quad A_{s,\,min} = 0.0033(12)(17.62) = 0.700$ in.^{2} (O.K.)

$\rho = \dfrac{2.37}{12(17.62)} = 0.0112$; $\quad \bar{k} = 0.6056$ ksi, $\quad \varepsilon_t > 0.005$, $\quad \phi = 0.90$

$$\phi M_n = \frac{0.90(12)(17.62)^2(0.6056)}{12} = 169 \text{ ft - kips}$$

$$M_u = \frac{[1.2(0.7 + 0.250) + 1.6(2.5)](16)^2}{8} = 164.5 \text{ ft - kips} < 169 \text{ ft - kips} \quad \text{(O.K.)}$$

Prob. 2-8

[3/60] $b = 16$ in., $h = 38$ in., $L = 26.5$ ft simple span. Check moment adequacy.

$$\text{Beam weight} = \frac{16(38)}{144}(0.150) = 0.633 \text{ k/ft}$$

$$M_u = \frac{[1.2(1.80 + 0.633) + 1.6(3.20)]}{8}(26.5)^2 = 706 \text{ ft-kips}$$

(a) 5#9, $A_s = 5.00$ in.^{2}, $d = 35$ in., $\rho = \dfrac{5.00}{16(35)} = 0.0089$

$A_{s,\min} = 0.0033(16)(35) = 1.85 \text{ in.}^2 < 5.00 \text{ in.}^2$ (O.K.)

$\bar{k} = 0.4781$ ksi, $\varepsilon_t > 0.005$, $\phi = 0.90$

$$\phi M_n = \frac{0.90(16)(35)^2(0.4781)}{12} = 703 \text{ ft-kips} < 706 \text{ ft-kips} \quad \text{(N.G.)}$$

(a) 6#9, $A_s = 6.00$ in.^{2}, $d = 34.4$ in., $\rho = \dfrac{6.00}{16(34.4)} = 0.0109$

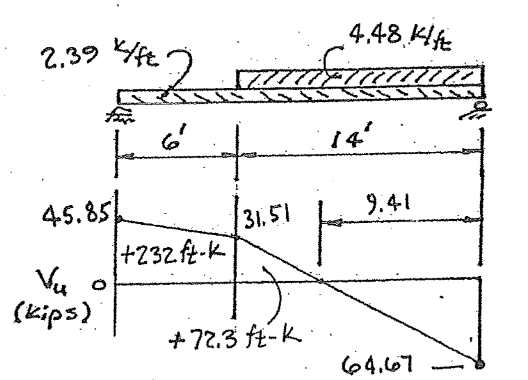
$A_{s,\min} = 0.0033(16)(34.4) = 1.82 \text{ in.}^2 < 6.00 \text{ in.}^2$ (O.K.)

$\bar{k} = 0.5702$ ksi, $\varepsilon_t > 0.005$, $\phi = 0.90$

$$\phi M_n = \frac{0.90(16)(34.4)^2(0.5702)}{12} = 808 \text{ ft-kips} > 706 \text{ ft-kips} \quad \text{(O.K.)}$$

Prob. 2-9 [3/60] 3#10, $A_s = 3.81$ in.^{2}, $b = 14.5$ in., $h = 26$ in. check moment adequacy.

$d = 26 - 1.5 - 0.38 - 1.27/2 = 23.5$ in.
Calculated beam weight = 0.393 k/ft
Max. M_u from diag. = 304 ft-kips



$$\rho = \frac{3.81}{14.5(23.5)} = 0.0112$$

$A_{s,\min} = 0.0033(14.5)(23.5) = 1.12 \text{ in.}^2$

$\bar{k} = 0.5835$, $\varepsilon_t > 0.005$, $\phi = 0.90$

$$\phi M_n = \frac{0.90(14.5)(23.5)^2 0.5835}{12} = 350 \text{ ft-kips} > 304 \text{ ft-kips} \quad \text{(O.K.)}$$

Prob. 2-10 [4/60] 4#9, $b = 14$ in., $h = 24$ in., find max simple span L

$d = 24 - 1.5 - 0.38 - 1.13/2 = 21.6$ in.

Beam wt. $= \dfrac{14(24)}{144}(0.150) = 0.350$ k/ft; $\qquad \rho = \dfrac{4.00}{14(21.6} = 0.0132$

$A_{s,\min} = 0.0033(14)(21.6) = 1.00 \text{ in.}^2$

$\bar{k} = 0.6998 \text{ ksi}, \quad \varepsilon_t > 0.005, \quad \phi = 0.90$

$$\phi M_n = \frac{0.90(14)(21.6)^2 0.6998}{12} = 343 \text{ ft - kips}$$

$$M_u = \frac{[1.2(0.60 + 0.35) + 1.6(1.4)]L^2}{8} = 343 \text{ ft - kips, from which } L = 28.5 \text{ ft}$$

Prob. 2-11 [3/60] One-way slab analysis. #7@6 in., A_s=1.20 in.^{2}/ft, $h = 10$ in., $L = 16$ ft

Slab weight$= \dfrac{10(12)}{144}(0.150) = 0.125$ k/ft;

$$M_u = \frac{[1.2(0.125) + 1.6(0.600)]16^2}{8} = 35.5 \text{ ft - kips}$$

$d = 10 - 0.75 - 0.875/2 = 8.81$ in.; $\qquad \rho = \dfrac{1.20}{12(8.81)} = 0.0113$

$A_{s,\min} = 0.0018(12)(8.81) = 0.19 \text{ in.}^2/\text{ft}$ (O.K.); $\bar{k} = 0.5879$ ksi, $\varepsilon_t > 0.005$, $\phi = 0.90$

$$\phi M_n = \frac{0.90(12)(8.81)^2(0.5879)}{12} = 41.4 \text{ ft - kips} > 35.5 \text{ ft - kips} \quad \text{(O.K.)}$$

Prob. 2-12 [3/40] One-way slab analysis, $h = 8$ in., #8@6 in., $A_s = 1.58$ in.^{2}/ft, $L = 12$ ft

Slab weight$= \dfrac{8(12)}{144}(0.150) = 0.100$ k/ft;

$d = 8 - 0.75 - 1.00/2 = 6.75$ in.; $\qquad A_{s,\min} = 0.0020(12)(6.75) = 0.16 \text{ in.}^2/\text{ft}$ (O.K.)

$\rho = \dfrac{1.20}{12(6.75)} = 0.0195, \quad \bar{k} = 0.6608 \text{ ksi}, \quad \varepsilon_t > 0.005, \ \phi = 0.90$

$$\phi M_n = \frac{0.90(12)(6.75)^2(0.6608)}{12} = 27.1 \text{ ft - kips}$$

$M_{u(\text{D.L.})} = \dfrac{1.2(0.100)(12)^2}{8} = 2.16 \text{ ft - kips}, \quad M_{u(\text{L.L.})} = \dfrac{1.6 w_{\text{LL}} L^2}{8} = 27.1 - 2.16 = 24.9 \text{ ft - kips}$

From which, $w_{LL} = 0.865$ k/ft $= 865$ psf

Prob. 2-13 [4/60] One-way slab w/ construction errors.

As designed: #7@11, $A_s = 0.65$ in.^{2}/ft, $d = 8.5 - 1 - 0.875/2 = 7.06$ in.
$A_{s,\min} = 0.0018(12)(8.50) = 0.18$ in.^{2}/ft (O.K.)

$$\rho = \frac{0.65}{12(7.06)} = 0.0077; \quad \bar{k} = 0.4306\,\text{ksi}, \quad \varepsilon_t > 0.005, \quad \phi = 0.90$$

$$\phi M_n = \frac{0.90(12)(7.06)^2(0.4306)}{12} = 19.3\,\text{ft-kips}$$

As built: $d = 8.5 - 3.5 - 0.875/2 = 4.56$ in.

$$\rho = \frac{0.65}{12(4.56)} = 0.0119; \quad \bar{k} = 0.6391\,\text{ksi}, \quad \varepsilon_t > 0.005, \quad \phi = 0.90$$

$$\phi M_n = \frac{0.90(12)(4.56)^2(0.6391)}{12} = 11.96\,\text{ft-kips} \qquad (\%\,\text{Change} = -38\%)$$

Prob. 2-14 Design. [3/60] $M_u = 133$ ft-kips, $b = 11\frac{1}{2}$ in., $h = 23$ in.
Est. $d = 20$ in., Assume $\phi = 0.90$.

$$\text{Required } \bar{k} = \frac{133(12)}{0.90(11.5)(20)^2} = 0.3855\,\text{ksi}$$

Required $\rho = 0.0070$ ($\varepsilon_t > 0.005$, $\phi = 0.90$)

Required $A_s = 0.007(11.5)(20) = 1.61\,\text{in.}^2$, $A_{s,\min} = 0.0033(11.5)(20) = 0.76\,\text{in.}^2$ (O.K.)

Select 3#7, one layer ($A_s = 1.80\,\text{in.}^2$, $b_{\min} = 8.5$ in.)

$$\text{Calculated } d = 23 - 1.5 - 0.38 - \frac{0.875}{2} = 20.7\,\text{in.} > 20\,\text{in.} \quad \text{(O.K.)}$$

Prob. 2-15 Design. [4/60] $M_u = 400$ ft-kips, $b = 16$ in., $h = 28$ in.

Est. $d = 25$ in., Assume $\phi = 0.90$.

$$\text{Required } \bar{k} = \frac{400(12)}{0.90(16)(25)^2} = 0.5333\,\text{ksi}$$

Required $\rho = 0.0098$ ($\varepsilon_t > 0.005$, $\phi = 0.90$)

Required $A_s = 0.0098(16)(25) = 3.92\,\text{in.}^2$, $A_{s,\min} = 0.0033(16)(25) = 1.32\,\text{in.}^2$ (O.K.)

Select 4#9, one layer ($A_s = 4.00\,\text{in.}^2$, $b_{\min} = 12$ in.)

$$\text{Calculated } d = 28 - 1.5 - 0.38 - \frac{1.13}{2} = 25.6\,\text{in.} > 25\,\text{in.} \quad \text{(O.K.)}$$

Prob. 2-16 (Prob. 2-15 with incorrectly placed steel making $d = 24$ in.)
[4/60] $M_u = 400$ ft-kips, $b = 16$ in.,

$d = 24$ in., Assume $\phi = 0.90$.

$$\rho = \frac{4.00}{16(24)} = 0.0104$$

$$A_{s,\min} = 0.0033(16)(24) = 1.27 \text{ in.}^2$$

$$\bar{k} = 0.5667, \quad \varepsilon_t > 0.005, \quad \phi = 0.90$$

$$\phi M_n = \frac{0.90(16)(24)^2 0.5667}{12} = 392 \text{ ft-kips} < 400 \text{ ft-kips} \quad \text{(N.G.)}$$

Prob. 2-17 [4/60] $L = 32$ ft, $b = 11\frac{1}{2}$ in., $h = 26$ in.

Beam weight $= \dfrac{11.5(26)}{144}(0.150) = 0.312$ kip/ft Assume $\phi = 0.90$

$$M_u = \frac{[1.2(0.85 + 0.312) + 1.6(1.0)](32)^2}{8} = 383 \text{ ft-kips}$$

Estimated $d = 23$ in.

$$\text{Required } \bar{k} = \frac{383(12)}{0.90(11.5)(23)^2} = 0.8394 \text{ ksi} \quad (\varepsilon_t > 0.005, \ \phi = 0.90)$$

Required $\rho = 0.0164$

Required $A_s = 0.0164(11.5)(23) = 4.34$ in.^{2} $A_{s,\min} = 0.0033(11.5)(23) = 0.87$ in.^{2}

Select 3#11 in one layer ($A_s = 4.68$ in.^{2}, $b_{\min} = 11$ in.)

Calculated $d = 26 - 1.5 - 0.38 - 1.41/2 = 23.4$ in. > 23 in. (O.K.)

Check ϕM_n:

$$\rho = \frac{4.68}{11.5(23.4)} = 0.0174, \quad \bar{k} = 0.8838 \text{ ksi}, \quad (\varepsilon_t > 0.005, \ \phi = 0.90)$$

$$\phi M_n = \frac{0.90(11.5)(23.4)^2(0.8838)}{12} = 417 \text{ ft-kips} \quad > 383 \text{ ft-kips} \quad \text{(O.K.)}$$

Prob. 2-18 [5/60] $L = 30$ ft, $b = 12$ in., $h = 27$ in.

Beam weight $= \dfrac{12(27)}{144} = 0.338$ k/ft

Estimated $d = 24$ in., assume $\phi = 0.90$

$$M_u = \frac{[1.2(0.338) + 1.6(1.35)30^2}{8} = 289 \text{ ft-kips}$$