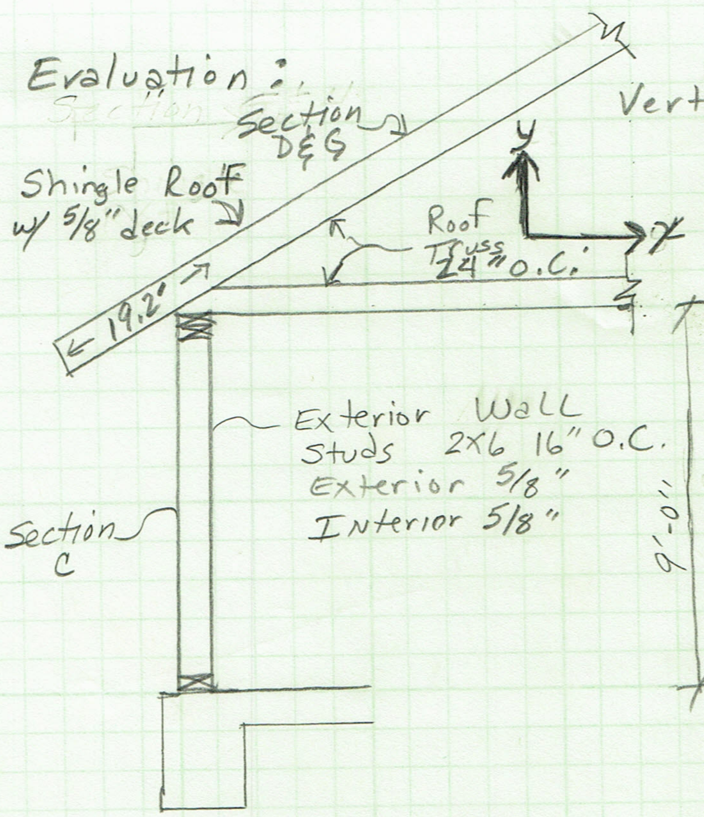
Evaluation of loads expected on Residential Building for Fire House #14

Assumptions:

Using conventional slab
Soil supports 1500 psf

Shingle Roof 2.8 psf
5/8" decking 2.0 psf
5/8" interior & exterior cover 2.75 psf

Evaluation:



Vertical Windoads: Section G = 1.5psf
Section H = -30.2psf

Horizontal Wind: Section C = 46.0
Section D = 31.7

Wind Vertical Roof load = 1.5psf x 19.2'
= 28.79 #/LF

Shingle Vert. Roofload = 2.8psf x 19.2'
= 53.76 #/LF

Decking Vert. Roofload = 2psf x 19.2'
= 38.4 #/LF

Insulation = (.4psf x 8) x 19.2'
= 61.44 #/LF

Roof Truss =

Exterior Wall 2x6 @ 16" o.c.
1.7 psf x 9.0' = 15.3 #/LF

Interior & Exterior Sheathing
(4psf x 2) x 9.0' = 72 #/LF

Batt Insultation Exterior Wall
(.4x6) x 9.0' = 21 #/LF

Vertical distributed Load on Concrete Beam

Wind Load = 28.79 #/LF
Dead Load = (53.76 + 38.4 + 61.44 + 150 + 15.3 + 72 + 21) = 411.86 #/LF
Roof Live Load = 20 psf x 19.2 = 384 #/LF

$U = 1.2D + 1.6L_R + 0.8W$

$U = (1.2 \times 411.86) + (1.6 \times 384) + (0.8 \times 28.79) = 1131.7$ #/LF

unfactored $U = 411.86 + 384 + 28.79 = 824.65$ #/LF

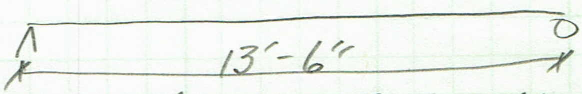
Fire House #14 Residential Slab Design

Assumptions:

Concrete = 4 ksi (f'_c)
Concrete Weight = 145 pcf + 5 pcf (Rebar) = 150 pcf
f_y = 60 ksi
ϕ = 0.9

LL = 100 psf

Maximum Slab length = 13'-6"



Design: Assume Slab Thickness = 5"

Slab weight = $\left(5'' \times \frac{1 ft}{12''}\right) \times 150 pcf = 62.5 psf$

$W_u = 1.2(62.5 psf) + 1.6(100 psf) = 235 psf (.235 ksf)$

$M_u = \frac{.235 ksf \times 13.5^2}{8} = 5.35 ft\text{-}k$

$\rho = \frac{0.18 f'_c}{f_y} = \frac{0.18 \ 4 ksi}{60 ksi} = 0.012 > \rho_{min} \ 0.0033$

from Tbl A-13 $\frac{M_u}{\phi b d^2} = 643.5$

$\therefore d = \sqrt{\frac{M_u}{\phi b \ 643.5}} = \sqrt{\frac{5350 \times 12''/ft}{(.9)(12'')(643.5)}} = 3.04''$

Use 5" Slab with d = 3.875"

$\frac{M_u}{\phi b d^2} = \frac{5350 \times 12}{(.9)(12'')(3.875)^2} = 395.88 \ in^2/ft$

From Tbl A-13 $\rho = 0.00933$

$A_s = \rho b d = 0.00933 \times 12'' \times 3.875'' = 0.434 \ in^2/ft$

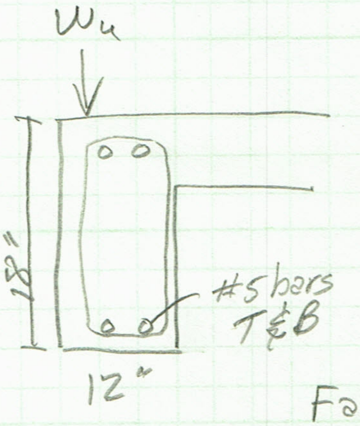
~~Use #6 bars @ 12" O.C. (0.44)~~

Temp & Shrinkage

$A_s = 0.0018 \ b h = (.0018)(12'')(5'') = 0.108$

Use #3 bars @ 12" O.C. (0.11)

Fire House Residential Beam design



Consider 12" length of beam to support load from exterior wall unfactored load 824.65 #/LF & soil bearing capacity ≈ 1900 #/ft² ✓ with FS = 2 capacity = 950 #/ft² ✓

Soil will support loads ✓ ok

Factored $W_u = 1131.7$ #/LF

$$M_u = \frac{W_u(k) \times L^2}{8} = \frac{1.13 \times 1^2}{8} = 0.14125 \text{ ft-k}$$

$$\rho = \frac{0.18 f'_c}{f_y} = \frac{.18\,(4{,}000)}{60{,}000} = 0.0120 > \min 0.0033$$

Tbl A-13 $$\frac{M_u}{\phi b d^2} = 643.5 = \frac{0.14125 \times 12}{(0.9)(12)(d^2)}$$

$d = 0.0156$"

Use 12" wide beam & $d = 15$"

$$R_n = \frac{M_u}{\phi b d^2} = \frac{.14125 \times 12''/\text{ft}}{(.9)(12'')(15)^2} = 0.000697$$

$$\rho = \frac{.85 f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2R_n}{.85 f'_c}}\right)$$

$$\rho = \frac{.85\ 4k}{60k}\left(1 - \sqrt{1 - \frac{2(.000697)}{.85(4{,}000)}}\right)$$

$\rho = 1.162 \times 10^{-7}$ use $\rho_{min} = 0.0033$

$A_s = \rho b d = .0033 \times 12 \times 15 = 0.594$

Use 2 ea #5 T & B

able 3.9.2 Minimum Beam Width (Inches) According to the ACI Code[a]

;IZE OF ;ARS	NUMBER OF BARS IN SINGLE LAYER OF REINFORCEMENT							ADD FOR EACH ADDED BAR
	2	3	4	5	6	7	8	
#4	6.8	8.3	9.8	11.3	12.8	14.3	15.8	1.50
#5	6.9	8.5	10.2	11.8	13.4	15.0	16.7	1.63
#6	7.0	8.8	10.5	12.3	14.0	15.8	17.5	1.75
#7	7.2	9.0	10.9	12.8	14.7	16.5	18.4	1.88
#8	7.3	9.3	11.3	13.3	15.3	17.3	19.3	2.00
#9	7.6	9.8	12.2	14.3	16.6	18.8	21.1	2.26
#10	7.8	10.4	12.9	15.5	18.0	20.5	23.1	2.54
#11	8.1	10.9	13.8	16.6	19.4	22.2	25.0	2.82
#14	8.9	12.3	15.7	19.1	22.5	25.9	29.3	3.40
#18	10.6	15.1	19.6	24.1	28.6	33.1	37.6	4.51

ıble shows minimum beam widths when #3 stirrups are used.
ɪr additional bars, add dimension in last column for each added bar.
ɪr bars of different size, determine from table the beam width for smaller size bars and en add last column figure for each larger bar used.

ssumes maximum aggregate size does not exceed three-fourths of the clear space tween bars (ACI-3.3.2). Table computation procedure is in agreement with the ACI Code erpretation of ACI Committee 340, as used in the *Strength Design Handbook* [2.20].

Table 3.9.1 Total Areas for Various Numbers of Reinforcing Bars

BAR SIZE	NOMINAL DIAMETER (in.)	WEIGHT (lb/ft)	NUMBER OF BARS 1	2	3	4	5	6	7	8	9	10
#3	0.375	0.376	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10
#4	0.500	0.668	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
#5	0.625	1.043	0.31	0.62	0.93	1.24	1.55	1.86	2.17	2.48	2.79	3.10
#6	0.750	1.502	0.44	0.88	1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40
#7	0.875	2.044	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
#8	1.000	2.670	0.79	1.58	2.37	3.16	3.95	4.74	5.53	6.32	7.11	7.90
#9	1.128	3.400	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
#10	1.270	4.303	1.27	2.54	3.81	5.08	6.35	7.62	8.89	10.16	11.43	12.70
#11	1.410	5.313	1.56	3.12	4.68	6.24	7.80	9.36	10.92	12.48	14.04	15.60
#14[a]	1.693	7.65	2.25	4.50	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50
#18[a]	2.257	13.60	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00	36.00	40.00

[a] #14 and #18 bars are used primarily as column reinforcement and are rarely used in beams.

Table 3.9.3 Minimum Beam Wid
Diameters Clear Spacing

BAR SIZE	NUMBER OF BARS 2	3	4	
#4	6.8	8.3	9.8	11
#5	7.1	9.0	10.9	12
#6	7.5	9.8	12.0	14
#7	7.9	10.5	13.1	15
#8	8.3	11.3	14.3	17
#9	8.6	12.0	15.4	18
#10	9.1	12.9	16.7	20
#11	9.5	13.7	17.9	22
#14	12.2	15.9	20.9	26
#18	15.0	19.8	26.6	33

Table Assumptions:

a. Side cover 1.5 in. each side.
b. #3 stirrups for bars #11 and smaller.
c. #4 stirrups for bars #14 and #18.
d. Since stirrups are bent around 4 stirrup I centroid of bar nearest side face of bea taken as 0.75 in. for bars #11 and smal for #14 and #18 bars.

Table 3.9.4 Minimum Beam Widtl
3 Bar Diameters Clear Spacing

BAR SIZE	NUMBER OF BARS 2	3	4	5
#4	7.3	9.3	11.3	13
#5	7.8	10.3	12.8	15
#6	8.3	11.3	14.3	17
#7	8.8	12.3	15.8	19
#8	9.3	13.3	17.3	21
#9	9.8	14.3	18.8	23
#10	10.3	15.4	20.5	25
#11	10.9	16.5	22.2	27
#14	12.5	19.2	26.0	32
#18	15.3	24.3	33.3	42

*Table Assumptions:

a. Side cover 1.5 in. each side.
b. #3 stirrups for bars #11 and smaller.
c. #4 stirrups for bars #14 and #18.
d. Since stirrups are bent around 4 stirrup I centroid of bar nearest side face of bea taken as 0.75 in. for bars #11 and smal for #14 and #18 bars.

$A = 1\frac{1}{2}$-in. clear cover to stirrup

$B = \frac{3}{8}$-in. stirrup bar diameter

$C =$ For #11 and smaller bars, use twice the diameter of #3 stirrups (i.e., $C = 0.75$ in.). For #14 and #18 bars, use $C = 0.5d_b$

$D =$ clear distance between bars $= d_b$ or 1 in., whichever is greater (where d_b is the diameter of the larger adjacent longitudinal bar)