Slab Design

Student No : 2023300229

Given data,

Live load (LL) = 50 psf

Floor finish (FF) = 25 psf

f'_c = 3.5 ksi

f_y = 50 ksi

Dimension, X = 14.5 ft

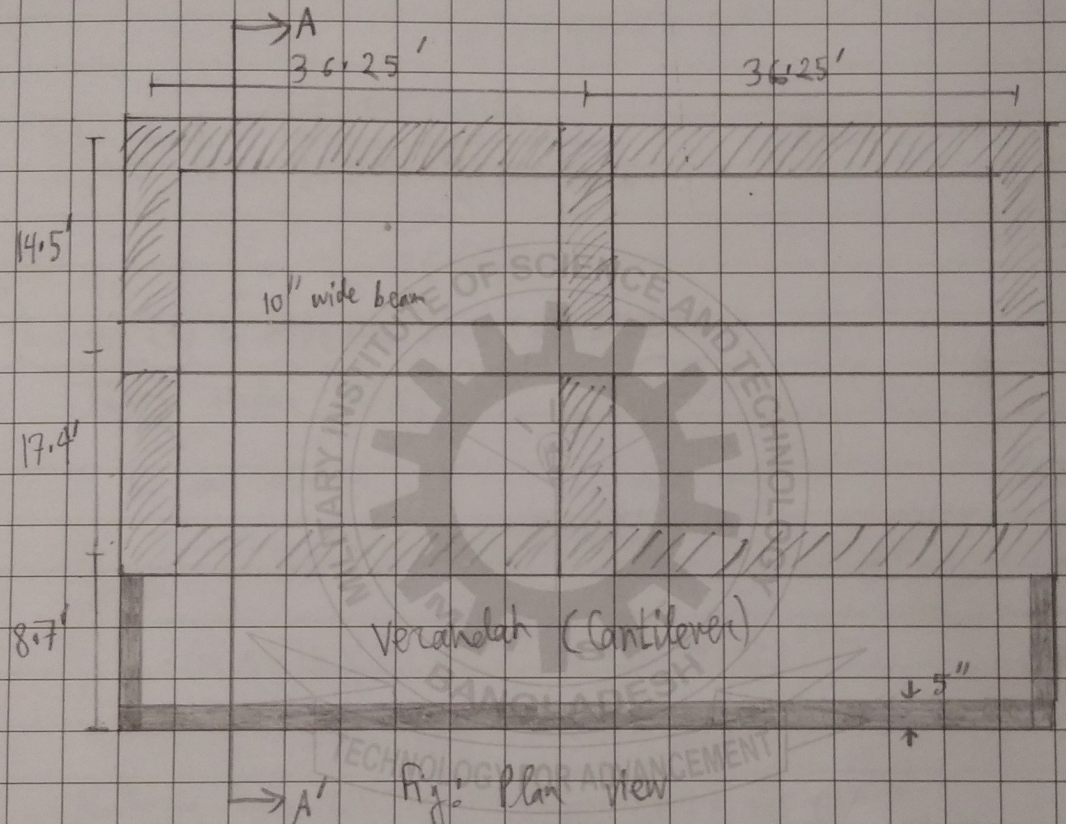


Fig: Plan view

Check for one way slab:

L = 36.25'

B = 14.5'

$\therefore \frac{L}{B} = \frac{36.25'}{14.5'} = 2.5 > 2$

L = 36.25'

B = 17.4'

$\therefore \frac{L}{B} = \frac{36.25'}{17.4'} = 2.08 > 2$

L = 72.5'

B = 8.28'

$\therefore \frac{L}{B} = \frac{72.5'}{8.28'} = 8.76 > 2$

∴ One way slab is to be designed.

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Partition wall load calculation:

Volume of partition walls $= \Big[(36.25+36.25)\times 10\times \frac{10}{12}\times 2\times 0.8$
$+ (14.5+17.4)\times 10\times \frac{10}{12}\times 3\times 0.8$
$+ (36.25+36.25)\times \frac{12}{12}\times \frac{5}{12}$
$+ (8.7\times \frac{12}{12}\times \frac{5}{12})\times 2\Big]\ ft^3$

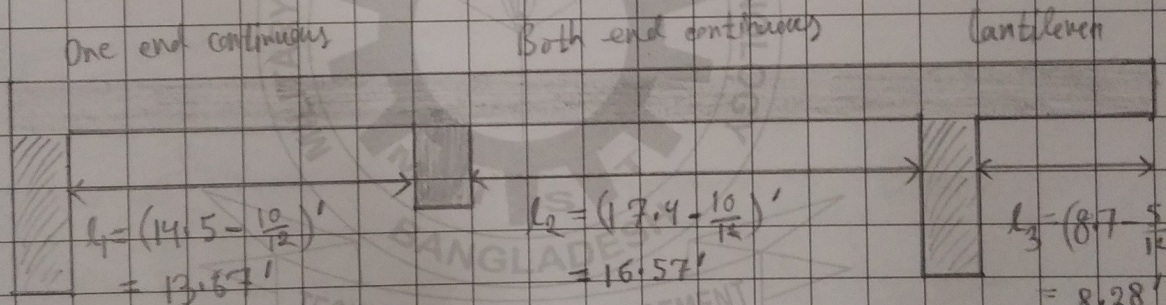
$= 1735.77\ ft^3$

Total load of partition walls $= \frac{1735.77\times 120}{(36.25+36.25)(14.5+17.4+8.7)}$ [Brick's unit weight = 120 lb/ft³]

$= 70.76$ psf

Thickness (t) & effective depth (d) calculation:

Taking section A-A',



Multiplying Factor (MF) $= 0.4 + \frac{f_1}{100} = 0.4 + \frac{50}{100} = 0.9$

$t_1 = \frac{l_1}{24}\times MF = \frac{13.67\times 12}{24}\times 0.9 = 6.15'' \simeq 6.5''$

$t_2 = \frac{l_2}{28}\times MF = \frac{16.57\times 12}{28}\times 0.9 = 6.39'' \simeq 6.5''$

$t_3 = \frac{l_3}{10}\times MF = \frac{8.28\times 12}{10}\times 0.9 = 8.9'' \simeq 9''$

$\therefore t_{max} = t_3 = 9''$.

$\therefore d = (9-1)'' = 8''$

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Factored load calculation:

Self weight of slab $= \frac{9}{12} \times 150$ [Unit wt of normal weight concrete = 150 lb/ft³]

$= 112.5$ psf

FF = 25 psf

PW load = 70.76 psf

∴ Dead load = (112.5 + 25 + 70.76) psf

= 208.26 psf

LL = 50 psf

∴ Factored load, $W_u = 1.2\,DL + 1.6\,LL$

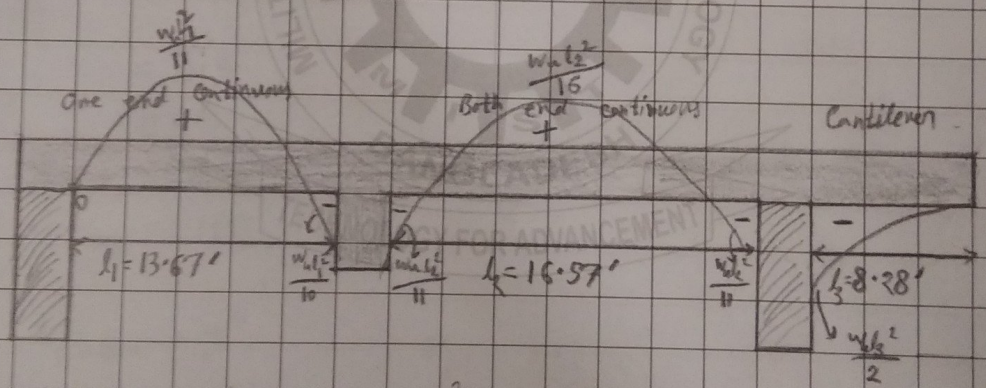
$= (1.2 \times 208.26 + 1.6 \times 50)$ psf

$= 329.9$ psf

≈ 330 psf

W (per linear foot) $= 330 \times 1 = 330$ lb/ft

Maximum Moment Calculation:



(+) $M_{max} = \frac{w_u l_2^2}{16} = \frac{330 \times (16.57)^2}{16} = 5663$ lb-ft/ft

(−) $M_{max} = \frac{w_u l_3^2}{2} = \frac{330 \times (8.28)^2}{2} = 11312.19$ lb-ft/ft

Student No :

Minimum Thickness 't' check :

$$\beta_1 = 0.85 - 0.05 \frac{f_c' - 4000}{1000}$$

$$= 0.85 - 0.05 \frac{3500 - 4000}{1000}$$

$$= 0.875$$

$$\rho_{0.005} = 0.85 \beta_1 \frac{f_c'}{f_y} \frac{\varepsilon_u}{\varepsilon_u + 0.005}$$

$$= 0.85 \times 0.875 \times \frac{3.5}{50} \times \frac{0.003}{0.003 + 0.005}$$

$$= 0.0195$$

$$d_{req} = \sqrt{\frac{(-) M_{max}}{\varphi \rho_{0.005} f_y b \left(1 - 0.59 \rho_{0.005} \frac{f_y}{f_c'}\right)}}$$

$$= \sqrt{\frac{11312.14 \times 12}{0.9 \times 0.0195 \times 50000 \times 12 \times \left(1 - 0.59 \times 0.0195 \frac{50}{3.5}\right)}}$$

$$= 3.9''$$

$$\approx 4''$$

$$\therefore t_{req} = (4 + 1)'' = 5''$$

$t_{provided} = 9''$ $\quad \therefore$ ok.

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Reinforcement area calculation :

Minimum reinforcement area for shrinkage & temperature, $A_{s_{min}} = 0.002\,bt$

$= 0.002 \times 12 \times 9$

$= 0.216\ in^2/ft$ [#3 bar]

For (+)M_{max} :-

1st trial,

$$A_s = \frac{(+)M_{max}}{\varphi f_y (d - a/2)} = \frac{5663 \times 12}{0.9 \times 50 \times 10^3 \left(8 - \frac{0.1}{2}\right)} = 0.18995\ in^2/ft$$

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.18995 \times 50 \times 10^3}{0.85 \times 3500 \times 12} = 0.256''$$

2nd trial,

$$A_s = \frac{5663 \times 12}{0.9 \times 50 \times 10^3 \left(8 - \frac{0.27}{2}\right)} = 0.19\ in^2/ft$$

$$a = \frac{0.19 \times 50 \times 10^3}{0.85 \times 3500 \times 12} = 0.27''$$

Area of (+)ve Main bar $= 0.19\ in^2/ft < A_{s_{min}}$

$\therefore$ Required area of (+)ve Main bar $= 0.216\ in^2/ft$ [#3 bar]

For (−)M_{max} :-

1st trial,

$$A_s = \frac{(-)M_{max}}{\varphi f_y (d - a/2)} = \frac{11312.14 \times 12}{0.9 \times 50 \times 10^3 \left(8 - \frac{0.4}{2}\right)} = 0.3867\ in^2/ft$$

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.3867 \times 50}{0.85 \times 3.5 \times 12} = 0.54''$$

2nd trial,

$$A_s = \frac{11312.14 \times 12}{0.9 \times 50 \times 10^3 \times \left(8 - \frac{0.55}{2}\right)} = 0.39\ in^2/ft$$

$$a = \frac{0.39 \times 50}{0.85 \times 3.5 \times 12} = 0.55''$$

Area of (−)ve Main bar $= 0.39\ in^2/ft > A_{s_{min}}$

$\therefore$ Required area of (−)ve Main bar $= 0.39\ in^2/ft$ [#3 bar]

Student No :

Reinforcement spacing :

Along Shorter direction :-

For (+)ve bars,

$$S = 12 \times \frac{A_{provided}}{A_{required}} = 12 \times \frac{0.11}{0.216} = 6.11'' \approx 6''$$

For (-)ve bars,

$$S = 12 \times \frac{A_{provided}}{A_{required}} = 12 \times \frac{0.11}{0.39} = 3.3'' \approx 3''$$

∴ (+)ve bar : #3 bar @ 6" c/c is provided.

∴ (-)ve bar : #3 bar @ 3" c/c is provided.

Along Longer direction :-

For temperature & shrinkage bar,

$$S = 12 \times \frac{A_{provided}}{A_{required}} = 12 \times \frac{0.11}{0.216} = 6.11'' = 6''$$

∴ #3 bar @ 6" c/c is provided.

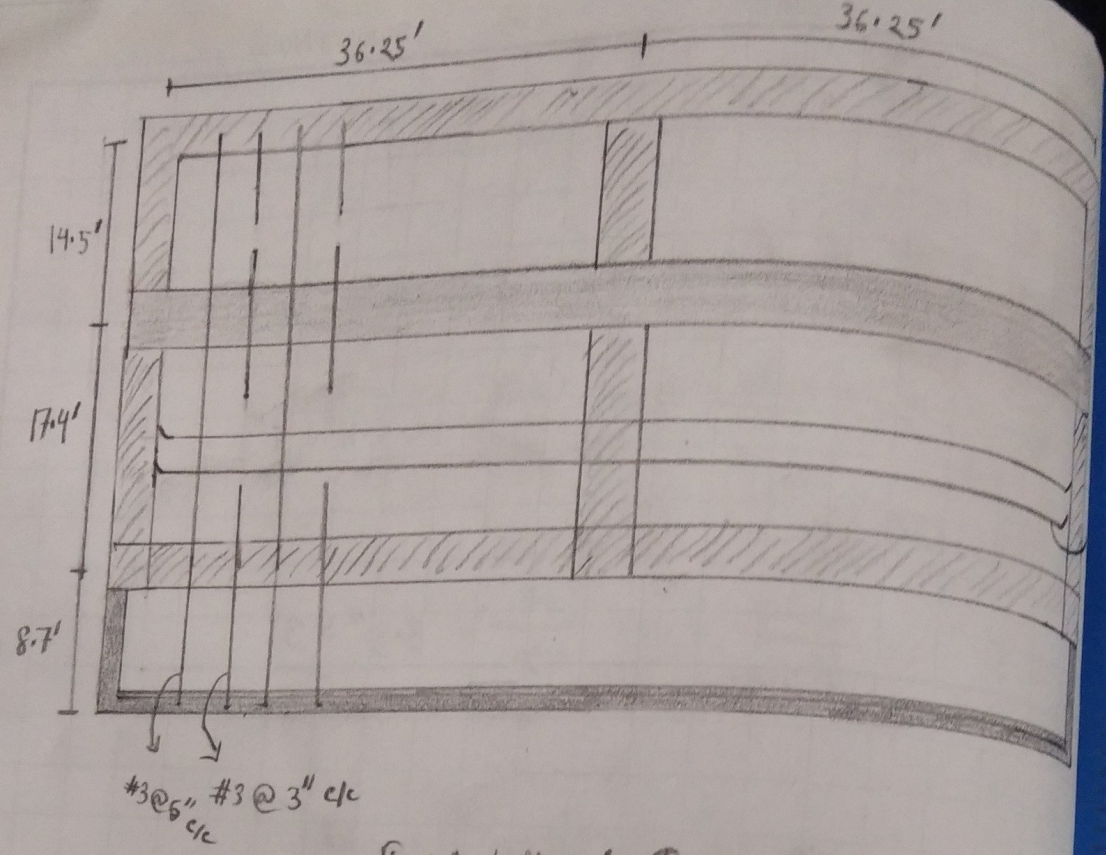


Fig: Detailing in Top View

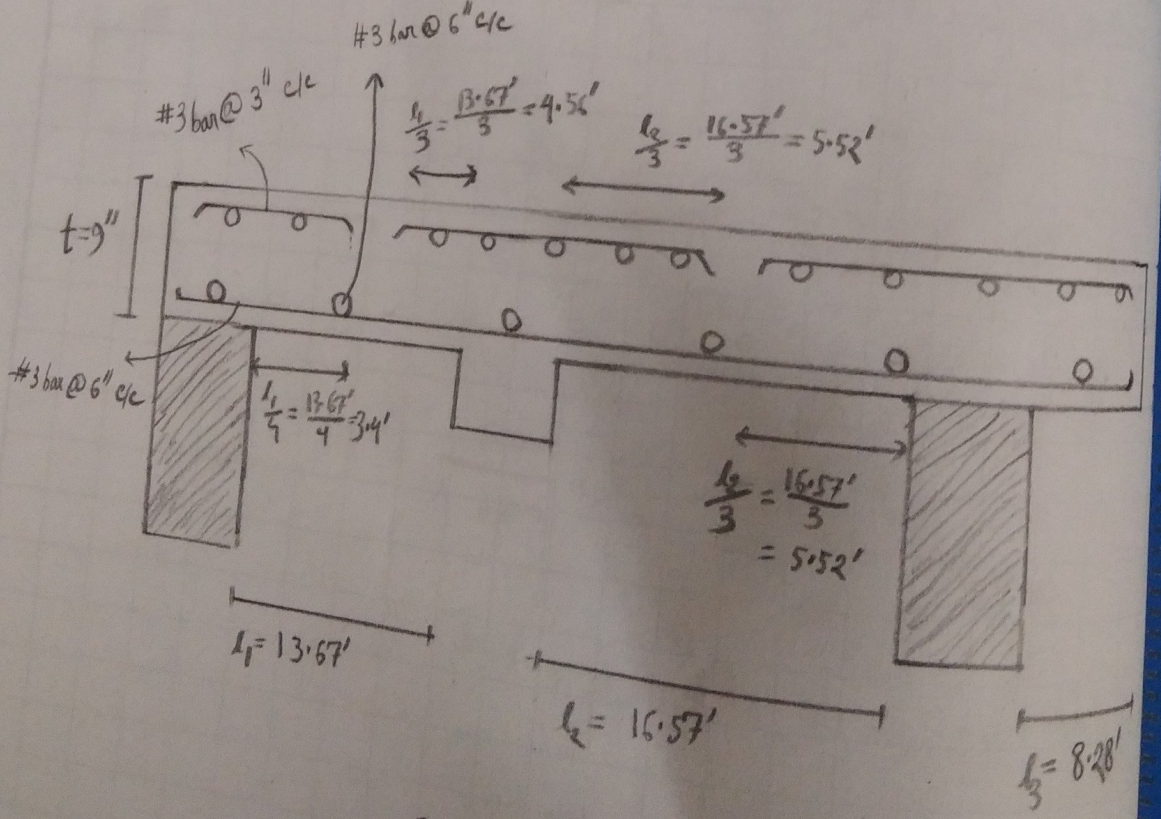


Fig: Detailing in Section view (Section A-