Assignment 3 & 4 ; Solutions

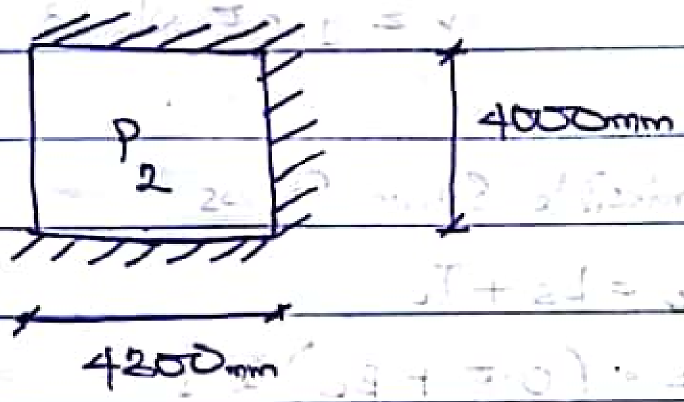
1) Flat Slab

Capital/dropping → 1.2m diameter

grade stress → 25 − 410 N/mm²

Slab thickness :→ 250 mm

Panel 2



Slab Loading

Finishes ; = 1.2 kN/m²

Partition = 1.0 kN/m²

Wt of Slab = 0.25 × 24 = 6 kN/m²

= 8.2 kN/m²

Design Load (D.L) = $1.4G_k + 1.6Q_k$

= $1.4(8.2 \times 17.2) + 1.6(3.0 \times 17.2)$

= 280.016kN

NB; Area of Panel = 4.0 × 4.3 = 17.2m²

Designing for classroom, Q_k = 3.0

$d = h - cover - \frac{1}{2}\phi$

$= 250 - 25 - \frac{1}{2} \times 12 = 219 mm$

Short Span

-Middle Strip;

Span - Effective Span $= l_x - \frac{2}{3} h$

$= 4.0 - \frac{2}{3}(1.2) = 3200 mm$

Moment, $M = 45\% \times 0.071 FL$

$= \frac{45}{100} \times 0.071 \times 280.016 \times 4$

$= 35.79$ KNm

Width, $b = \frac{l_x}{2} = \frac{4}{2} = 2000 mm$

$K = \frac{M}{bd^2 F_{cu}} = \frac{35.79 \times 10^6}{2000 \times 219^2 \times 25} = 0.015$

$I_a = 0.5 + \sqrt{0.25 - \frac{0.015}{0.9}} = 0.98 \quad (\leq 0.95)$

$Z_1 = I_a d = 0.95 \times 219 = 208.05 mm$

$A_s = \frac{M}{0.95 F_y Z_1} = \frac{35.79 \times 10^6}{0.95 \times 410 \times 208.05}$

$= 441.7 mm^2$

Provide Y12 @ 225 c/c [As prov = 502 mm^2]

Support - Effective Span $= l_x - \frac{2}{3} h = 3200 mm$

[b = 2000 mm]

Moment, $M = \frac{25}{100} \times 0.071 \times 280.016 \times 4$

$= 19.88\ kNm$

$K = \frac{M}{bd^2 F_{cu}} = \frac{19.88 \times 10^6}{2000 \times 219^2 \times 25} = 0.0083$

$I_a = 0.5 + \sqrt{0.25 + \frac{0.0083}{0.9}} = 0.99 \quad (\leq 0.95)$

$Z_1 = I_a d = 208.05\ mm$

$A_s = \frac{M}{0.95 f_y Z_e} = \frac{19.88 \times 10^6}{0.95 \times 410 \times 208.05} = 245.32\ mm^2$

– Provide Y12 @ 300 c/c [$A_{s\ prov} = 377 mm^2$]

– Column Strip

Span – Effective Span = $l_x - \frac{2}{3}h$ = 3200mm

Moment, $M = \frac{55}{100} \times 0.071 \times 280.016 \times 4$

[b = 2000mm]

$= 43.74\ kNm$

$K = \frac{M}{bd^2 F_{cu}} = \frac{43.74 \times 10^6}{2000 \times 219^2 \times 25} = 0.0182$

$I_a = 0.5 + \sqrt{0.25 - \frac{0.0182}{0.9}} = 0.97 \quad (\leq 0.95)$

$Z_1 = 208.05\ mm$

$A_s = \frac{M}{0.95 F_y Z_1} = \frac{43.74 \times 10^6}{0.95 \times 410 \times 208.05} = 539.76\ mm^2$

– Provide Y12 @ 200 c/c [$A_{s\ prov} = 566\ mm^2$]

support – Effective span = $l_x - \frac{2}{3}h$ = 3200mm

Moment, $M = \frac{75}{100} \times 0.071 \times 280.016 \times 4$

$= 59.64$ kNm

b = 2000mm

$K = \frac{M}{bd^2 f_{cu}} = \frac{59.64 \times 10^6}{2000 \times 219^2 \times 25} = 0.0248$

$l_a = 0.5 + \sqrt{0.25 - \frac{0.0248}{0.9}} = 0.97$ (≤ 0.95)

$Z = l_a d = 208.05$mm

$A_s = \frac{M}{0.95 f_y Z} = \frac{59.64 \times 10^6}{0.95 \times 410 \times 208.05}$

$= 735.97$ mm^2

– Provide Y12 @ 150 c/c [$A_{s\,prov} = 754$ mm^2]

Long Span

– Middle Strip

Span – Effective span = $l_y - \frac{2}{3}h = 4.3 - \frac{2}{3}(1.2)$ =

= 3500mm

Moment, $M = \frac{45}{100} \times 0.071 \times 280.016 \times 4.3$

$= 38.47$ KN/m

$b = l_y - \frac{l_x}{2} = 4.3 - \frac{4.0}{2} = 2300$mm

$K = \frac{M}{bd^2 f_{cu}} = \frac{38.47 \times 10^6}{2300 \times 219^2 \times 25} = 0.0139$

$$I_a = 0.5 + \sqrt{0.25 - \frac{0.0139}{0.9}} = 0.98 \quad (< 0.95)$$

$$Z_1 = I_a d = 0.95 \times 219 = 208.05 \text{ mm}$$

$$A_s = \frac{M}{0.95 f_y Z_1} = \frac{38.47 \times 10^6}{0.95 \times 410 \times 208.05} = 474.73 \text{ mm}^2$$

- Provide Y12 @ 225 c/c [$A_{s\,prov} = 502 \text{ mm}^2$]

support – Effective span $= l_y - \frac{2}{3}h = 3500$ mm

Moment, $M = \frac{25}{100} \times 0.071 \times 280.016 \times 4.3$

$= 21.37$ kNm

width, $b = l_y - \frac{l_x}{2} = 2300$ mm

$$K = \frac{M}{bd^2 f_{cu}} = \frac{21.37 \times 10^6}{2300 \times 219^2 \times 25} = 0.0077$$

$$I_a = 0.5 + \sqrt{0.25 - \frac{0.077}{0.9}} = 0.99 \quad (< 0.95)$$

$$Z_1 = I_a d = 208.05 \text{ mm}$$

$$A_s = \frac{M}{0.95 f_y Z_1} = \frac{21.37 \times 10^6}{0.95 \times 410 \times 208.05}$$

$= 263.7 \text{ mm}^2$

- Provide Y12 @ 300 c/c [$A_{s\,prov} = 377 \text{ mm}^2$]

- Column Strip

span – Effective span = 3500 mm

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Moment, $M = \frac{55}{100} \times 0.071 \times 280.016 \times 4.3$

$= 47.02$ kNm

width, $b = l_y - l_x/2 = 2300$ mm

$K = \frac{M}{bd^2 f_{cu}} = \frac{47.02 \times 10^6}{2300 \times 219^2 \times 25} = 0.017$

$l_a = 0.5 + \sqrt{0.25 - \frac{0.017}{0.9}} = 0.98 \quad (\leq 0.95)$

$Z = l_a d = 208.05$

$A_s = \frac{47.02 \times 10^6}{0.95 \times 410 \times 208.05} = 580.24 \text{ mm}^2$

– Provide Y12 @ 175 c/c [$A_{s\,prov} = 646 \text{mm}^2$]

support – Effective Span = 3500 mm

Moment, $M = \frac{75}{100} \times 0.071 \times 280.016 \times 4.3$

$= 64.12$ kNm

width, $b = l_y - l_x/2 = 2300$ mm

$K = \frac{M}{bd^2 f_{cu}} = \frac{64.12 \times 10^6}{2300 \times 219^2 \times 25} = 0.023$

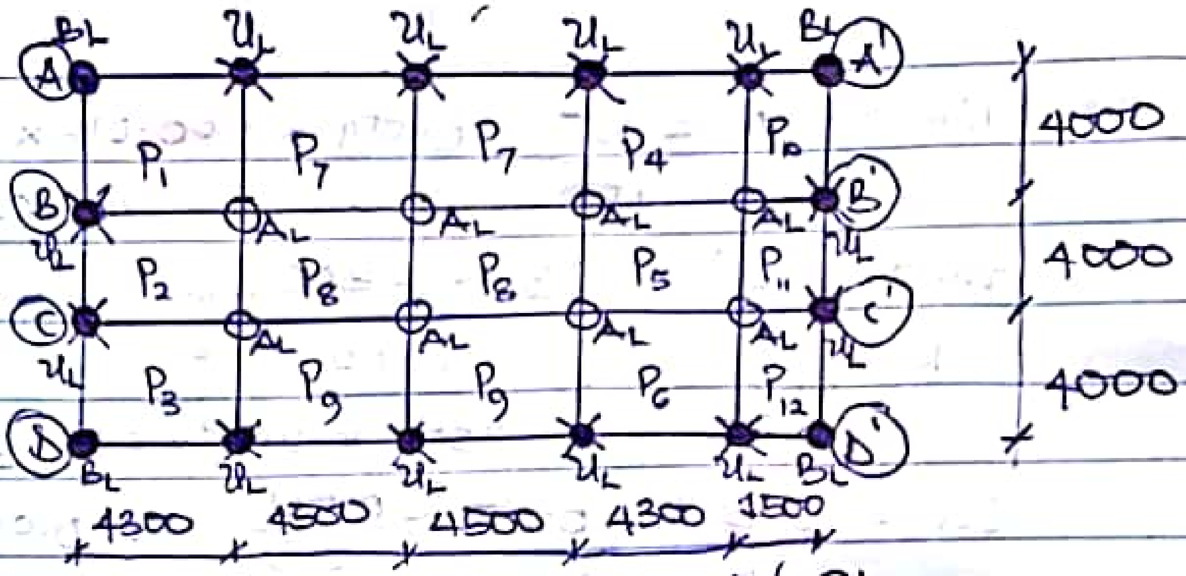
$l_a = 0.5 + \sqrt{0.25 - \frac{0.023}{0.9}} = 0.97 \quad (\leq 0.95)$

$Z = l_a d = 208.05$

$A_s = \frac{64.12 \times 10^6}{0.95 \times 410 \times 208.05} = 791.26 \text{ mm}^2$

– Provide Y12 @ 125 c/c [$A_{s\,prov} = 905 \text{mm}^2$]

2a)

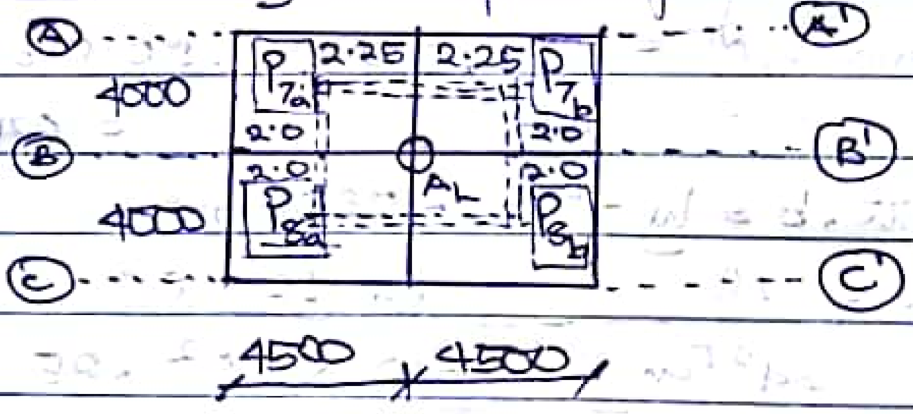


, where ⊕ A_L ⟶ Axially Loaded Columns

● B_L ⟶ Biaxially Loaded Columns

✱ U_L ⟶ Uniaxially Loaded Columns

b) Locate & Design an axially Loaded column
— Assuming 3 suspended floors.



Area of panels ⇒ $4.5 \times 4.0 = 18 m^2$

Beam Perimeter = $4.5 + 4.0 = 8.5 m$

Analysis ⇒ Loading ; Slab loading → Wt. of Slab = 0.15×24

$= 3.6 kN/m^2$

Scanned by CamScanner

Partition = 1.0 KN/m²
Finishes = 1.2 KN/m²
Gk, 5.8 KN/m²

Design Load, D.L = 1.4Gk + 1.6Qk
= [1.4 × 5.8] + [1.6 × 3.0]
= 12.92 KN/m²

Beam Loading; Wt. of Beam = 0.225 × 0.600 × 24
= 3.24 KN/m²
Wall = 3.47 × 3 = 10.41 KN/m²
13.65 KN/m²

Design Load, D.L = 1.4Gk = 1.4 (13.65)
= 19.11 KN/m²

Design Roof - 3rd floor;
Roof Load = Area × 1.5²
= 18 × 1.5² = 40.5 KN

Roof beam = 0.225 × 0.450 × 24
= 2.43 KN/m²
Finishes = 1.0 KN/m²
3.43 KN/m²

Roof Beam = 3.43 [8.5] × 1.4 = 40.82 kN
Column Load = 10 kN

Total Load = 91.32 kN

3rd floor - 2nd floor
Load from above = 91.32 kN
Column load = 10 kN
Slab Load = 18 × 12.12 = 218.16 kN
Beam Load = 19.11 × 8.5 = 162.435 kN

Total load = 481.915 kN

2nd floor - 1st floor
Load from above = 481.915 kN
column Load = 10 kN
Slab Load = 218.16 kN
Beam Load = 162.435 kN

Total Load = 872.51 kN

1st floor - Ground floor
Load from above = 872.51 kN
Column load = 10 kN
Slab Load = 218.16 kN

Beam Load = 162.435 kN

Total Load = 1263.105 ≈ 1300 kN

$A_s = \dfrac{N - 0.35 f_{cu} bh}{0.7 f_y - 0.35 f_{cu}}$

→ 25 - 410 N/mm²

N = 1300 kN

b × h ⇒ 225 × 225 mm

$\therefore A_s = \dfrac{1300 \times 10^6 - 0.35 \times 25 [225 \times 225]}{0.7 \times 410 - 0.35 \times 25}$

$= 3080.08 mm^2$

- Provide Y25 @ 125 c/c [As provided = 3930 mm²]