ADEPOJU MARY ABIMBOLA

17/ENG03/1004

CIVIL ENGINEERING

CVE 308

STRUCTURAL DESIGN

ASSIGNMENT THREE

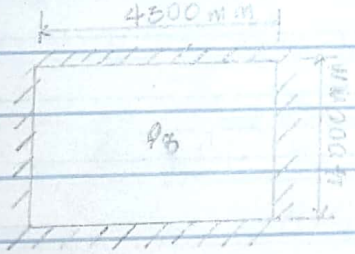
QUESTION ONE

Capital/droppings = 1.2m in diameter

f_{cu} = 25N/mm²

f_y = 410N/mm²

Slab Thickness = 250mm = 0.25m



Weight of slab = 0.25 × 24 = 6KN/m²

Finishes = 1.2KN/m²

Partition = 1.0KN/m²

Total = 8.2KN/m²

Assuming Q.K = 5.0

D.L = 1.4GK + 1.6Q.K

= [(1.4 × 8.2) × (4.5 × 4)] + [(1.6 × 5.0) × (4.5 × 4)]

= 206.64 + 144

= 350.64KN

Short Span

1) Middle Strip

a) Span : • Effective Span $= l_x - \frac{2}{3} h$

$= 4 - \frac{2}{3} \times 1.2$

$= 3.2m \equiv 3200mm$

• Moment$_1$ $= 45\% \times 0.071 FL$

$= \frac{45}{100} \times 0.071 \times 350.64 \times 4$

$= 44.81$

• ~~Width~~ =

• Width $= \frac{l_x}{2} = \frac{4}{2}$

$= 2m \equiv 2000mm$

$d = h - cover - 1/2 \phi$

$= 250 - 25 - \frac{1}{2} \times 1.2$

$= 219 mm$

$k = \frac{M_1}{bd^2 f_{cu}} = \frac{44.81}{2000 \times 219^2 \times 25} \times 10^6$

$= 0.0186$

$I_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0186}{0.9}}$

$= 0.978 \ (\geq 0.95)$

$$Z = Iad = 0.95 \times 219$$
$$= 208.05mm$$

$$A_s = \frac{M_1}{0.95 f_y Z} = \frac{44.81 \times 10^6}{0.95 \times 410 \times 208.05}$$
$$= 552.9 mm^2$$

Provide 412 @ 200 c/c ($A = 566 mm^2$)

(b) Support :

- Moment, $M_2 = 25\% \times 0.071 FL$
$$= \frac{25}{100} \times 0.071 \times 350.64 \times 4$$
$$= 24.9$$
- Width, $b = 2000mm$
- $d = 219mm$

$$k = \frac{M_2}{bd^2 f_{ck}} = \frac{24.9 \times 10^6}{2000 \times 219^2 \times 25}$$
$$= 0.0104$$

$$Ia = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0104}{0.9}}$$
$$= 0.988 \ (\geq 0.95)$$

$$Z = Iad = 0.95 \times 219$$
$$= 208.05mm$$

$$A_s = \frac{M_2}{0.95 f_y Z} = \frac{24.9 \times 10^6}{0.95 \times 410 \times 208.06}$$
$$= 307.2 mm^2$$

Provide 412 @ 300 c/c ($A = 377 mm^2$)

Column Strip

a) Span: • Effective Span = $l_x - \frac{2}{3}h = 4 - \frac{2}{3} \times 1.2$

$= 3200mm$

• Width = $\frac{l_x}{2} = \frac{4000}{2}$

$= 2000mm$

• Moment, $M_1 = 55\% \times 0.071FL = \frac{55}{100} \times 0.071 \times 350.64 \times 4$

$= 54.77$

$k = \frac{M_1}{bd^2 f_{cu}} = \frac{54.77 \times 10^6}{2000 \times 219^2 \times 25}$

$= 0.023$

$Ia = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.023}{0.9}}$

$= 0.97 \ (\geq 0.95)$

$z = Iad = 0.95 \times 219$

$= 208.05mm$

$As = \frac{M_2}{0.95 f_y z} = \frac{54.77 \times 10^6}{0.95 \times 410 \times 208.05}$

$= 675.87mm^2$

Provide 412 @ 150 c/c ($A = 754mm^2$)

b) Support: • $M_2 = 75\% \times 0.071FL = \frac{75}{100} \times 0.071 \times 350.64 \times 4$

$= 74.7$

• Same • Width = 2000mm

$$k = \frac{M_2}{bd^2 f_{cu}} = \frac{74.7 \times 10^6}{2000 \times 219^2 \times 25}$$

$$= 0.0311$$

$$Ia = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0311}{0.9}}$$

$$= 0.96 \ (\geq 0.95)$$

$$Z = Iad = 0.95 \times 219$$

$$= 208.05 mm$$

$$A_s = \frac{M_2}{0.95 f_y Z} = \frac{74.7 \times 10^6}{0.95 \times 410 \times 208.05}$$

$$= 921.82 mm^2$$

Provide 4T2 @ 100 c/c ($A = 1130 mm^2$)

Long Span

I) Middle Strip

a) Span: • Effective span $= l_y - \frac{2}{3}h = 4.5 - \frac{2}{3} \times 1.2$

$$= 3.7m = 3700mm$$

• Width, $b = l_y - \frac{l_x}{2} = 4.5 - \frac{4}{2}$

$$= 2.5m = 2500mm$$

• Moment, $M_1 = 45\% \times 0.071 FL$

$$= \frac{45}{100} \times 0.071 \times 350.64 \times 4.5$$

$$= 50.41$$

• $d = 219 mm$

$$K = \frac{M_1}{bd^2 f_{cu}} = \frac{50.41 \times 10^6}{2500 \times 219^2 \times 25}$$

$$= 0.017$$

$$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.017}{0.9}}$$

$$= 0.98 \; (\geq 0.95)$$

$$L = I_a d = 0.95 \times 219$$

$$= 208.05 mm$$

$$A_s = \frac{M_1}{0.95 f_y Z} = \frac{50.41 \times 10^6}{0.95 \times 410 \times 208.05}$$

$$= 622.07 mm^2$$

Provide 12 @ 175 c/c ($A = 646 mm^2$)

Support : Moment, $M_2 = 25\% \times 0.071 FL$

$= \cancel{50.41 \times 10^6}$

$$= \frac{25}{100} \times 0.071 \times 350.04 \times 4.5$$

$$= 28.01$$

- Width, $b = 2500 mm$
- $d = 219 mm$

$$K = \frac{M_2}{bd^2 f_{cu}} = \frac{28.01 \times 10^6}{2500 \times 219^2 \times 25}$$

$$= 0.0093$$

$$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0093}{0.9}}$$

$$= 0.99 \; (\geq 0.95)$$

$$Z = I_{ad} = 0.95 \times 219$$
$$= 208.05 mm$$

$$A_S = \frac{M_2}{0.95 f_y Z} = \frac{28.01 \times 10^6}{0.95 \times 410 \times}$$
$$= 348.7 mm^2$$

Provide 412 @ 300 c/c ($A = 377 mm^2$)

2) Column Strip

a) Span: • Effective Span = 3700mm

• Width $= \frac{2x}{2} = \frac{4}{2}$

$= 2m \equiv 2000 mm$

• Moment, $M_1 = 0.55\% \times 0.071 FL$

$= \frac{55}{100} \times 0.0.71 \times 350.64 \times 4.5$

$= 61.62$

$$K = \frac{M_1}{bd^2 f_{cu}} = \frac{61.62 \times 10^6}{2000 \times 219^2 \times 25}$$
$$= 0.026$$

$$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.026}{0.9}}$$
$$= 0.97 \ (\geq 0.95)$$

$$Z = I_{ad} = 0.95 \times 219$$
$$= 208.05 mm$$

$$A_S = \frac{M_2}{0.95 f_y Z} = \frac{61.62 \times 10^6}{0.95 \times 410 \times 208.05}$$

$= 760.41 mm^2$

Provide 412 @ 125 c/c ($A = 905 mm^2$)

(b) Support : • Moment, $M_2 = 75\% \times 0.071 FL$

$= \frac{75}{100} \times 0.071 \times 350.64 \times 4.5$

$= 84.02$

• Width, $b = 2000 mm$

• Depth $= 219 mm$

$K = \frac{M_2}{bd^2 f_{cu}} = \frac{84.02 \times 10^6}{2000 \times 219^2 \times 25}$

$= 0.035$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.035}{0.9}}$

$= 0.96 (\geq 0.95)$

$Z = I_a d = 0.95 \times 219$

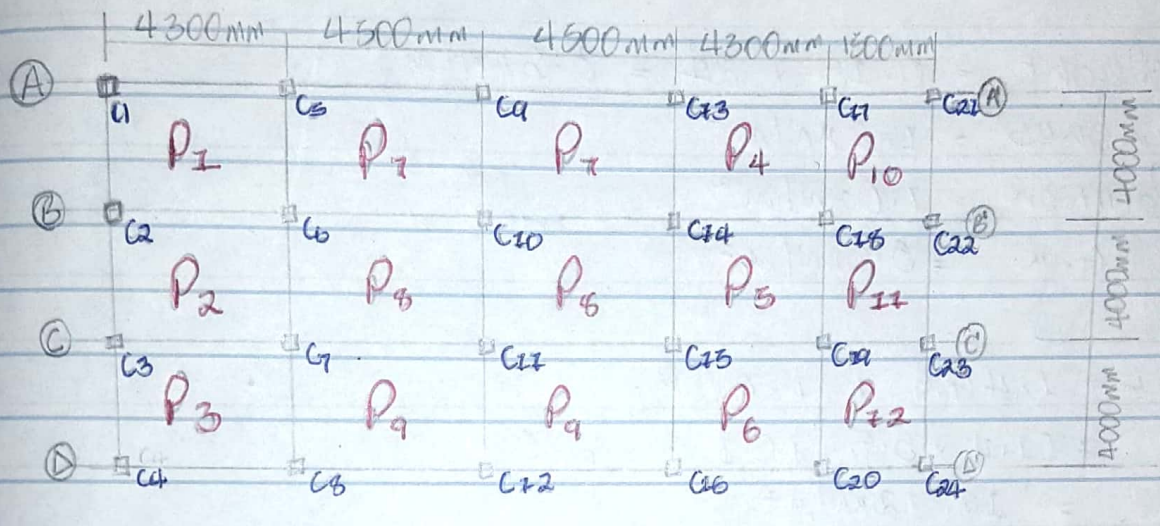
$= 208.05 mm$

$A_S = \frac{M_2}{0.95 f_y Z} = \frac{84.02 \times 10^6}{0.95 \times 410 \times 208.05}$

$= 1036.83 mm^2$

Provide 412 @ 100 c/c ($A = 1130 mm^2$)

QUESTION TWO

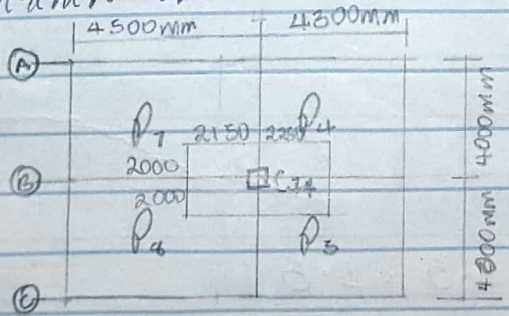


. The axially loaded columns includes:
C_6, C_7, C_{10}, C_{11}, C_{14}, C_{15}, C_{18} and C_{19}

. The uniaxally loaded columns includes:
C_2, C_3, C_5, C_9, C_{13}, C_{17}, C_8, C_{12}, C_{16}, C_{20}, C_{22}, C_{23}

. The biaxially loaded columns includes:
C_1, C_4, C_{21} and C_{24}

Design for column 14



Area of floor = 4×4.35
= $17.4 m^2$

Loading

Slab Loading

Slab Weight = $0.15 \times 24 = 3.6 kN/m^2$

Finishes = $1.2 kN/m^2$

Partition = $1.0 kN/m^2$

Total G.K = $5.8 kN/m^2$

D.L = 1.4GK + 1.6QK

= (1.4 × 5.8) + (1.6 × 2.5)

= $12.12 kN/m^2$

Beam Loading

Self Weight = $0.6 \times 0.225 \times 24 = 3.24 kN/m^2$

Wall Load = $3.47 \times 3 = 10.41 kN/m^2$

Total G.K = $13.65 kN/m^2$

DL = 1.4G.K

= (1.4 × 13.65)

= $19.11 kN/m^2$

Column Design

Roof - 3rd floor

Roof load = $17.4 \times 1.5 \times 1.5$

= 39.2kN

Roof beam = br × 1.4 (DL + 6)

~~br = 0.45 ×~~

br = $0.45 \times 0.225 \times 24 = 2.43 kN/m^2$

Finishes = $1.0 kN/m^2$

$3.43 kN/m^2$

Roof beam = 3.43 × 1.4 (DL + 6)

= 3.43 × 1.4 (4 + 4.4) = 40.34kN

Column load = 10kN

Total = ~~50.34kN~~ 89.54kN

3rd floor - 2nd floor

load from above = 89.54kN

Column Load = 10kN

~~Slab load = 3x 17.4 x 1.5 x 1.5~~

Slab Load = 17.4 x 12.12 = 211kN

Wall & Beam Loading = 19.11 x 8.4 = 160.52kN

Total = 471.06kN ≡ 471kN

2nd floor - 1st floor

Load from above = 471kN

Column load = 10kN

Slab load = 17.4 x 12.12 = 211kN

Wall & Beam load = 19.11 x 8.4 = 160.52kN

Total = 852.52kN

1st floor - Ground floor

Load from above = 852.52kN

Column Load = 10kN

Slab Load = 211kN

Wall & Beam Load = 160.52kN

= 1234.04kN ≡ 1234kN

$$A_s = \frac{N - 0.35 f_{cu} bh}{0.9 f_y - 0.35 f_{cu}} = \frac{1234 \times 10^6 - 0.35 \times 25 \times (225 \times 225)}{0.9 \times 410 - 0.35 \times 25}$$

$= 3424.12 mm^2$

Provide 8Y25 (As = 3930 mm²)

$A_{s,min} = 0.4\% bh = 0.004 \times 225 \times 225 = 202.5 mm^2$