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17/ENG03/024
Civil Engineering
CVE 308 (Structural Design) assignment 1

1a) a) Durability: The structure should be able to last for a reasonable period of time.
b) Strength: To resist safely the stresses induced by the loads in the various structural members
c.) Safety: The structure should carry all expected loads safely without failure which implies without breaking or collapsing under the loads.
d.) Stability: To prevent overturning, sliding ~~of~~ or buckling of the structure, or parts of it, under the action of loads.
e.) Serviceability: To ensure satisfactory performance under service load conditions - which implies providing adequate stiffness and reinforcements to contain cracks-widths, deflections and vibrations within acceptable limits.

1b.) Slope factor $= \frac{\sqrt{R^2+T^2}}{T} = \frac{\sqrt{150^2+225^2}}{275} = 1.14$

Span $(l) = T_{total} + 0.5(l_a + l_b)$

$= 275 \times 12 + 0.5(225+225) = 3525_{mm} = 3.52_m$

Loading

A = Waist of stairs $\times 24\,kN/m^3 = 0.150 \times 24 = 3.6\,kN/m$

B = finishes = 1.2 kN/m²

C = Steps × ½ × 24 kN/m² = 0.275 × ½ × 24 = 3.3 kN/m

D = Live load

$G_k = (A + B) \times S_f + C$

$= (3.6 + 1.2) \times 1.14 + 3.3$

$= 8.772\ kN/m^2$

Design load = $1.4G_k + 1.6Q_k$

$= 1.4(8.772) + 1.6(1.5)$

$= 14.6808\ kN/m^2$

$M = \frac{Fl^2}{10} = \frac{14.6808 \times 3.52^2}{10} = 18.19\ kN/m^2$

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

$= 150 - 25 - 6$

$= 119$

$k = \frac{M}{bd^2 f_{cu}} = \frac{18.19 \times 10^6}{1000 \times 119^2 \times 25} = 0.051$

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

$= 0.5 + \sqrt{0.25 - \frac{0.051}{9}}$

$= 0.94 < 0.95 \therefore 0.94$

$z = I_a d$

$= 0.94 \times 119$

$= 111.86$

$A_s = \frac{M}{0.95 f_y z} = \frac{18.19 \times 10^6}{0.95 \times 410 \times 111.86} = 417.53 mm^2$

$A_{s\ approv.} = 452 mm^2$

$d_{req} = \frac{Span}{m.f \times effective\ depth\ ratio}$

$m.f = 0.55 + \frac{477 - f_s}{120(0.9 + \frac{m}{bd^2})} \leq 2$

$f_s = \frac{2}{3} \cdot \frac{1}{\beta} \cdot \frac{Area}{Area\ appr.} \times f_y V$

$= \frac{2}{3} \cdot 1 \cdot \frac{417.53}{452} \times 250 = 153.96$

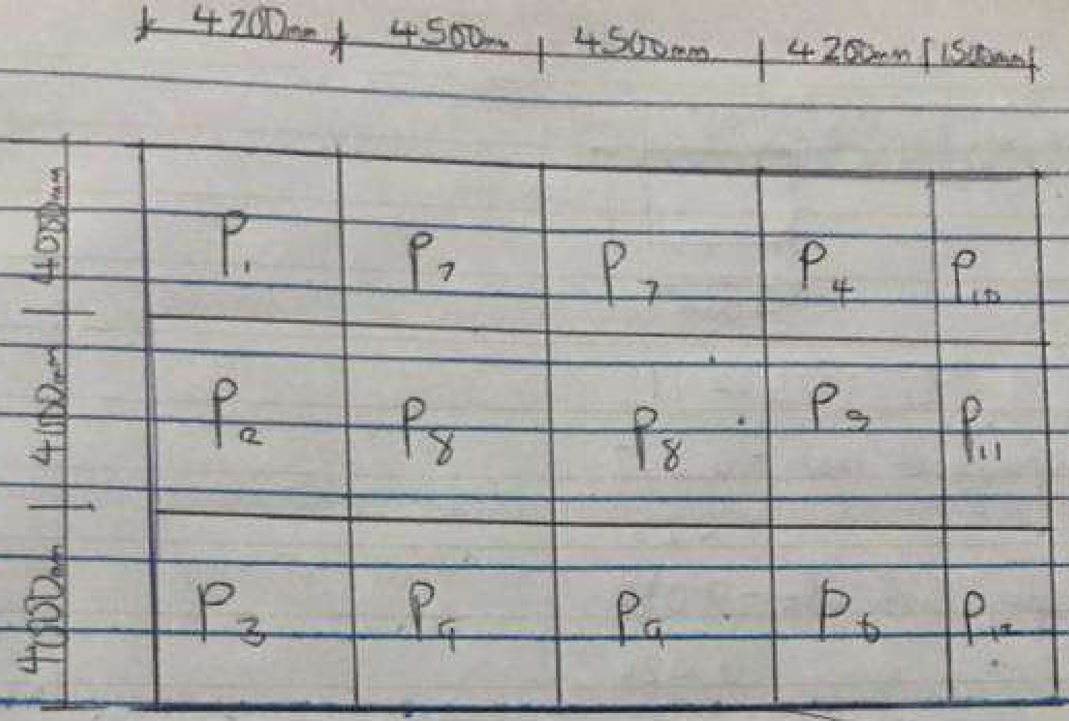
$m.f = 0.55 + \frac{477 - 153.96}{120(0.9 + \frac{18.19 \times 10^6}{1000 \times 119^2})}$

$m.f = 1.78 < 2 \therefore 1.78$

$d_{req} = \frac{3520}{1.78 \times 26} = 76.06mm$

(deflection is ok because $d_{req} < d$)

2(a)



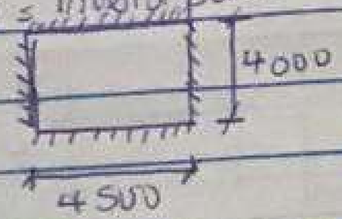
$P_1 = P_2 = P_3 = \frac{4200}{4000} = 1.05 < 2 = 2$way slab

$P_7 = P_8 = P_9 = \frac{4500}{4000} = 1.125 < 2 = 2$ way slab

$P_4 = P_5 = P_6 = \frac{4200}{4000} = 1.05 < 2 = 2$way slab

$P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.667 > 2 = 1$ way slab

- Designing for P8 = Interior panel



$l_y/l_x = 1.125 \simeq 1.1$

Short span coefficient = -0.037
0.028

long span coefficient = -0.032
0.024

Thickness of slab = 175mm

$f_{cu} = 25N/mm^2$

$f_y = 410N/mm^2$

loading

Slab load = $0.175 \times 24 = 4.2kN/m^2$

Partition = $1.6kN/m^2$

finishes = $1.2kN/m^2$

$6.4kN/m^2$

$D.L = 1.4G_k + 1.6Q_k$

$= 1.4(6.4) + 1.6(5) = 16.96 = 17kN/m$

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

$= 175 - 25 - \frac{1}{2}\cdot 2 = 144$

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Short span (mid span)

$M = \beta x w l_x^2$

$= 0.028 \times 17 \times 4^2$

$= 7.616 kNm$

$k = \frac{M}{bd^2 f_{cu}} = \frac{7.616 \times 10^6}{1000 \times 144^2 \times 25}$

$k = 0.015$

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

$= 0.5 + \sqrt{0.25 - \frac{0.015}{9}}$

$= 0.998 > 0.95 \therefore 0.95$

$z = l_a d$

$= 144 \times 0.95$

$= 136.8 mm$

$A_s = \frac{M}{0.95 f_y z} = \frac{7.616 \times 10^6}{0.95 \times 40 \times 136.8} = 142.93 mm^2$

$\therefore$ Provide Y_{12} @ 300 c/c ($A = 377 mm^2$)

Short Span (continous edge)

$M = \beta x w l_x^2$

$= 0.037 \times 17 \times 4^2$

$= 10.064 kNm$

$d = 144 mm$

$k = \frac{M}{bd^2 f_{cu}} = \frac{10.064 \times 10^6}{1000 \times 144^2 \times 25} = 0.019$

$I_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.019}{0.9}}$

$I_a = 0.97 > 0.95 \therefore 0.95$

$z = I_a d = 0.95 \times 144$

$= 136.8$

$A_s = \frac{M}{0.95 f_y z} = \frac{10.064 \times 10^6}{0.95 \times 410 \times 136.8} = 188.9 mm^2$

$\therefore$ Provide Y_{12} @ 300 c/c ($377 m^2$)

Long span (mid span)

$M = \beta_x w l^2$

$= 0.024 \times 17 \times 4^2$

$= 6.528 kNm$

$d = 144 - 12 = 132 mm$

$k = \frac{M}{bd^2 f_{cu}} = \frac{6.528 \times 10^6}{1000 \times 132^2 \times 25} = 0.015$

$I_a = 0.5 + \sqrt{0.25 - \frac{0.015}{0.9}}$

$I_a = 0.98 > 0.95 \therefore 0.95$

$z = I_a d$

$= 132 \times 0.95$

$z = 125.4$

$A_s = \frac{M}{0.95 f_y z} = \frac{6.528 \times 10^6}{0.95 \times 410 \times 125.4} = 133.65 mm^2$

$\therefore$ Provide Y_{12} @ 300 c/c ($377 mm^2$)

Long span (continuous edge)

$M = \beta_x w l^2$

$= 0.032 \times 17 \times 4^2$

$= 8.704\ kNm$

$k = \frac{M}{bd^2 f_{cu}} = \frac{8.704 \times 10^6}{1000 \times 132^2 \times 25} = 0.020$

$l_a = 0.5 + \sqrt{0.25 - \frac{0.020}{0.9}}$

$= 0.98 > 0.95 \therefore 0.95$

$z = 125.4$

$A_s = \frac{M}{0.95 f_y z}$

$= \frac{8.704 \times 10^6}{0.95 \times 410 \times 125.4} = 178.20 mm^2$

$\therefore$ Provide Y_{12} @ 300 c/c ($377 mm^2$)

Deflection check

$d_{req} = \frac{Span}{m.f \times effective\ depth\ ratio}$

$m.f = 0.55 + \frac{477 - f_s}{120(0.9 \frac{M}{bd^2})}$

$f_s = 2/3 \times 1 \times \frac{d_{req}}{area\ app.} \times f_y V$

$f_s = 2/3 \times 1 \times \frac{178.9}{377} \times 250 = 83.510$

$m.f = 0.55 + \frac{477 - 83.510}{120(0.9 + (\frac{10.084 \times 10^6}{1000 \times 144^2}))} = 2.92 > 2 \therefore 2$

$d_{req} = \frac{4000}{2 \times 26} = 76.92$

(deflection is Ok because $d_{req} < d$)

1b Limit state design considers the disadvantages of load factor design and any other disadvantage of or failure that can lead to making a structure unfit while Elastic design is an analysis method in which the design of a structural member is determined by linear stress-strain relationship with the assumption that the working stress are only a fraction of the elastic limit of the material.