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COURSE: STRUCTURAL DESIGN CVE 308
MATRIC NO: 17/ENG03/054
TOPIC: LMS ASSIGNMENT 1:

1\. a) i) To design for safety.
ii) The design must be economical.
iii) The deformation of the structure must not impose with the integrity of the structure.

b) Limit state design considers the disadvantages of head factor design and any other failure that can cause the structure to be structurally unfit while Elastic design is a method of analysis which the design of a structural member is based on a linear stress-strain relationship assuming that the working stress are only a factors of the elastic limit of the material.

c) STAIR-CASE DESIGN

$$\text{Slope factor} = \frac{\sqrt{R^2+T^2}}{T} = \frac{\sqrt{150^2+275^2}}{275} = 1.14$$

Load analysis

A. Waist = R x 24 kN/m²
= 0.15 x 24 = 3.6 kN/m²

B. Finishes = 1.2 kN/m²

C. Steps = T x ½ x 24 kN/m²
= 0.275 x 0.5 x 24 = 3.3 kN/m²

D.G.K = ((A+B) x S_f) + C
= (4.8 x 1.14) + 3.3
= 8.77 kN/m.

D.L, F = 1.4Gk + 1.6Qk
= 1.4(8.77) + 1.6(1.5)
= 14.68 kN/m²

$$Span = T_{total} + 0.5(l_a + l_b) = (275 \times 12) + 0.5(225 + 225) = 3.525m$$

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

$$= 150 - 25 - 6 = 119mm$$

$$M = \frac{FL^2}{10} = \frac{14.88 \times 3.525^2}{10} = 18.24 kNm$$

$$K = \frac{M}{bd^2 f_{cu}} = \frac{18.24 \times 10^6}{1000 \times 119^2 \times 25} = 0.052$$

$$l_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.052}{0.9}} = 0.938$$

$$Z = l_a d = 0.938 \times 119 = 111.622mm$$

$$A_s = \frac{M}{0.95 f_y Z} = \frac{18.24 \times 10^6}{0.95 \times 410 \times 111.622} = 419.53$$

$$A_{s.prov} = 452mm$$

Provide Y12 @ 259 c/c ($A_{s prov} = 452mm$).

Deflection check

$$f_s = \frac{2}{3} \times \frac{1}{\beta} \times \frac{A_{req}}{A_{s prov}} \times f_y$$

$$f_s = \frac{2}{3} \times 1 \times \frac{419.53}{452} \times 250$$

$$= 154.69 N/mm^2$$

$$M.F = 0.55 + \frac{477 - 154.69}{120\left(0.9 + \frac{18.24 \times 10^6}{1000 \times 119^2}\right)} = 1.78$$

$$d_{req} = \frac{span}{mf \times edr} = \frac{3525}{1.78 \times 26} = 76.17mm$$

Since $d_{req} < d$, Deflection is OK.

2) a) $P_1 = P_2 = P_3 = \frac{4300}{4000} = 1.075 < 2 = $ 2 way slab.

$P_2 = P_8 = P_9 = \frac{4500}{4000} = 1.125 < 2 = $ 2 way slab

$P_4 = P_5 = P_6 = \frac{4300}{4000} = 1.075 < 2 = $ 2 way slab

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

b) Designing for P_2

$\frac{l_y}{l_x} = \frac{4300}{4000} = 1.075 \approx 1.1$

Shortspan coefficient = 0.054

longspan coefficient = 0.058 / 0.044

Assuming specifications of slab thickness = 175mm

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

$f_y = 410 N/mm^2$

$D.L = 1.4 G_K + 1.6 Q_K$

G_K = weight of slab = 0.175×24

Partition = 1.0

finishes = 1.2

6.4 kN/m²

Assuming for factory.

$D.L = (1.4 \times 6.4) + (1.6 \times 5)$

$= 16.96 \approx 17 kN/m^2$

Shortspan coefficient = 0.044
0.033

longspan coefficient = 0.037
0.028

Short span mid

$M = \beta x w l^2 x = 0.044 \times 17 \times 4^2$
$= 11.968$

$d = h - cover - \frac{1}{2}\phi = 144$

$K = \frac{M}{bd^2 f_{cu}} = \frac{11.968 \times 10^6}{1000 \times 144^2 \times 25} = 0.023$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.97 > 0.95 \therefore = 0.95$

$Z = I_a d = 0.95 \times 144 = 136.8$

$A_s = \frac{M}{0.95 f_y Z} = \frac{11.968 \times 10^6}{0.95 \times 410 \times 136.8} = 224.61$

Provide Y12 @ 377mm

Continuous

$M = \beta x w l^2 x = 0.033 \times 17 \times 4^2 = 8.976$

$d = 144$

$K = \frac{M}{bd^2 f_{cu}} = \frac{8.976 \times 10^6}{1000 \times 144^2 \times 25} = 0.0173$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0173}{0.9}} = 0.83$

$Z = I_a d = 0.83 \times 144 = 119.52$

$A_s = \frac{M}{0.95 f_y Z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 119.52} = 192.81 mm$

Provide Y12 @ 377mm

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Long span
Mid

$d = d(\text{short span}) - \text{steel thickness} = 144 - 12 = 132mm$

$M = \beta x w l^2 x = 0.037 \times 17 \times 4^2 = 10.064$

$K = \frac{M}{bd^2 f_{cu}} = \frac{10.064 \times 10^6}{1000 \times 132^2 \times 25} = 0.0231$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.97 > 0.95 \therefore 0.95$

$Z = I_a d = 0.95 \times 132 = 125.4$

$A_s = \frac{M}{0.95 f_y Z} = \frac{10.064 \times 10^6}{0.95 \times 125.4 \times 410} = 206.04$

Provide Y12 @ 317mm.

Long span continuous

$d = 132mm$

$M = \beta x w l^2 x = 0.028 \times 17 \times 4^2 = 7.616.$

$K = \frac{M}{bd^2 f_{cu}} = \frac{7.616 \times 10^6}{1000 \times 132^2 \times 25} = 0.017$

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.98 > 0.95 \therefore = 0.95$

$Z = I_a d = 125.4$

$A_s = \frac{M}{0.95 f_y Z} = \frac{7.616 \times 10^6}{0.95 \times 410 \times 125.4} = 155.93$

Provide Y12 @ 377mm

Deflection check

$f_s = \frac{2}{3} f_{yr} \beta \frac{A_{req}}{A_{s.prov}}$

$f_s = \frac{2}{3} \times 250 \times 1 \times \frac{224.61}{377} = 99.3$

$m.f. = 0.55 + \frac{477 - 99.3}{120\left(0.9 + \frac{11.968 \times 10^6}{1000 \times 144^2}\right)} = 2.68 > 2 \therefore = 2$

$d_{req} = \frac{4 \times 1000}{2 \times 26} = 76.92 \therefore OK$

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