1a) a) To design for safety

b) The design mus be economical

c) The deformation of the structure must not impare with the integrity of the structure

1b Limit state design considers the dis advantages of load 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 fraction of the elastic limit of the material

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STAIR CASE Design

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

- Load Analysis

A. WAIST = R × 24KN/m²

= 0.15 × 24 = 3.6KN/m²

B. FINISHES = 1.2KN/m²

C. STEPS = T × ½ × 24KN/m²

= 0.275 × 0.5 × 24 = 3.3KN/m²

D. G.K = ((A+B) × S.F) + C

= (4.8 × 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 = Ttotal + 0.5(la + lb) = (275 × 12) + 0.5(225 + 225) = 3.525m

d = h − cover − ½ϕ

= 150 − 25 − 6 = 119mm

$M = \frac{Fl^2}{10} = \frac{14.68 \times 3.525^2}{10} = 18.24$ KNm

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

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

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

$A_s = \frac{M}{0.95 f_y Z} = \frac{1824 \times 10^6}{0.95 \times 410 \times 111.622} = 419.53$

$A_{s\,prov}$ = 452mm

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

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Deflection Check

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

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

$$= 154.69 \ N/mm^2$$

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

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

since $d_{req} < d$, Deflection is OK

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l_2 \#

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

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

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

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

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2b

Designing for P2

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

Short span coefficient = $\frac{-}{0.054}$

Long span coefficient = $\frac{0.088}{0.044}$

Assuming specifications of slab thickness = 175mm

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

$f_y = 410N/mm^2$

$DL = 1.4 G_k + 1.6 Q_k$

G_k = weight of slab = 0.175×24

Partition = 1.0

Finishes = 1.2

$6.4kN/m^2$

Assuming for ~~residential~~ factory

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

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

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Shotspan coefficient = 0.044

0.033

Long span coefficient = 0.037

0.028

short span mid = P

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

$= 11.968$

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

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

$k = \beta a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.97 > 0.95 = 0.95$

$z = \beta a \cdot d = 0.95 \times 144 = 136.8$

$A_s = \frac{M}{0.95 f_y z} = ~~146~~ \frac{11.968 \times 10^6}{0.95 \times 410 \times 136.8} = 224.61$

Provide y 12 @ 377mm

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Continuous

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

$d = 144$

$k = \frac{M}{bd^2 f_{cu}} = \frac{8.976 \times 10^6}{1000 \times 144^2 \times 25} = 0.0123$

$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0123}{0.9}} = 0.83$

$z = l_a . d = 0.83 \times 144 = 119.52$

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

provide y12 @ 377mm

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Long span

M.d

d = d(short span) - bar thickness = 144 - 12 = 132 mm

$M = \beta_{sx} w l_x^2 = 0.037 \times 17 \times 4^2 = 10.064$

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

$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.97 > 0.95 = 0.95$

$z = l_a \cdot d = 0.95 \times 132 = 125.4$

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

provide y12 at 377mm

Long span continuous

d = 132mm

$M = \beta_{sx} w l_x^2 = 0.028 \times 17 \times 4^2 = 7.616$

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

$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.98 > 0.95 = 0.95$

$z = l_a \cdot d = 125.4$

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$As = \frac{M}{0.95 f_y z} = \frac{2.616 \times 10^6}{0.95 \times 410 \times 125.9} = 155.93$

provid y 12 @ 327mm

Deflection check

$f_s = \frac{2}{3} f_y \times \beta \quad \frac{As_{req}}{As_{provided}}$

$f_s = \frac{2}{3} \times 250 \times 1 \times \frac{224.61}{327} = 99.3$

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

2.

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

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