Structural design assignment

1a (a) To design for safety

(b) The design must be economical

(c) The deformation of the structure must not impos with the intensity of the structure.

(b) limit state designs considers the disadvantages of load factor design and any other failure that can cause the structure to be structurally onfit 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.

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 $= R \times 24\,KN/m^2$

$= 0.15 \times 24 = 3.6\,KN/m^2$

B. Finishes $= 1.2\,KN/m^2$

C. STEPS $= T \times 1/2 \times 24\,KN/m^2$

$= 0.275 \times 0.5 \times 24 = 3.3\,KN/m^2$

D. G.K $= ((A+B) \times S_f) + C$

$= (4.8 \times 1.14) + 3.3$

Deflection check

$f_s = 2/3 \times 1/\beta \times Area/A_{sper} \times f_{yr}$

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

$= 154.69\ N/mm^2$.

$M.F = 0.55 + \frac{477 - 154.69}{120\left(0.9 + \left(\frac{18.24 \times 10^6}{1000 \times 114^2}\right)\right)} = 1.78$

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

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

(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.

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

$= 3.77\ KN/m.$

$D.L, F = 1.4GK + 1.6GK$

$= 1.4(8.77) + 1.6(1.5)$

$= 14.68\ KN/m^2$

$Span = T + 0 + 0l + 0.5(la + lb) = (275 \times 12) + 0.5(255 + 255)$

$= 3.525m$

$d = n - cover - \frac{1}{2}\theta$

$= 150 - 25 - 6 = 119m$

$M = \frac{Fl^2}{10} = \frac{14.68 \times 3.525^2}{10} = 18.24\ KN/m$

$K = \frac{M}{bd^2 f_{cu}} = \frac{18.24 \times 10^6}{1000 \times 19^2 \times 25} = 0.052$

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

$Z = I_a d = 0.938 \times 1.19 = 111.622mm$

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

$A_{sper} = 452mm$

Provide Y_{12} @ 259 c/c ($A_{sper} = 452mm$)

Short span Co-efficient = 0.044

0.033

long Span Coefficient = 0.037

0.028

short span mid = P

$M = Bx \; w l^2 x = 0.044 \times 17 \times 4^2$

$= 11.968$

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

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

$la = 0.5 + \sqrt{0.25 - k/0.9} = 0.97 > 0.95 = OBS$

$z = la \cdot d = 0.95 \times 144 = 136.8$

$As = \frac{M}{0.95 f_y z} = \frac{11.96 \times 10^6}{0.95 \times 410 \times 136.8} = 224.61$

Provide y^{12} @ 377mm.

Designing for P2

$\frac{ly}{lx} = \frac{4300}{4000} = 1.075 \simeq 1.1$

Short span Co-efficient = ——
0.054

long Span Co-efficient = 0.058
0.044

Assuming Specification of slab thickness = 175mm
$f_{cu} = 25 N/mm^2$
$f_y = 410 N/mm^2$

$1.4 G_k + 1.6 G_k$

G_k = weight of slab = 0.175×24
Portion = 1.0
finishes = 1.2
$6.4 kN/m^2$

Assuming for factory
$D.L = (1.4 \times 6.4) + (1.6 \times 5)$
$= 16.96 \simeq 17 kN/m^2$

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

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

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

Provide y12 @ 377mm.

Long Span Cont.

$d = 132mm$

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

$K = \frac{M}{bd^2 f_{cu}} = \frac{7616 \times 10^6}{1000 \times 132^2 \times 25} = 0.017$

$= 0.5 + \sqrt{0.25 - K/0.9} = 0.98 > 0.95 = 0.95$

$Z = I_a \cdot d = 125.4$

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

$d = 144$

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

$l_a = 0.5 + \sqrt{0.25 - K/0.9} = 0.5 + \sqrt{0.25 - \dfrac{0.0173}{0.9}} = 0.83$

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

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

Provide y12 @ 377mm.

Long Span

Mid

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

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

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

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

Provide y 12 @ 377mm.

Deflection check

$$f_s = \frac{2}{3} f_{yr} \quad B \quad \frac{A_{s\,eq}}{A_s \text{ provided}}$$

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

$$m_iR = 0.55 + \frac{477 - 99.3}{120\left(0.9 + \frac{11.468 \times 10^6}{1000 \times 144^2}\right)} = 2.68 > 2$$

$= 2$

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