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17/ENG03/040 Okpala.
CIVIL ENGINEERING CVE308

STRUCTURAL DESIGN ASSIGNMENT

1a) To design for Safety
b) The design must be economical
c) The deformation of the structure must not impose with the Intensity of the Structure

1b) Limit Slab design considers the disadvantages 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 consuming that the working stress are only a fraction of the elastic limit of the materials

STAIRCASE DESIGN

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

*Load Analysis

A. Waist $= R \times 24KN/m^2 = 0.15 \times 24 = 3.6KN/m^2$

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

C. STEPS $= T \times 1/2 \times 24KN/m^2$
$= 0.275 \times 0.5 \times 24 = 3.3KN/m^2$

D. G.K $= ((A+B) \times SF) + C$
$= (4.8 \times 1.14) + 3.3$
$= 8.77 KN/m$

D.L.F $= 1.4GK + 1.6QK$
$= 1.4(8.77) + 1.6(1.5)$
$= 14.68KN/m^2$

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

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

$= 150 - 25 - 6 = 119mm$

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

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

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

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

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

$A_{sprov} = 452mm$

Provide Y12 @250 c/c $(A_{sprov} = 452mm)$
T

Deflection Check

$f_s = \frac{2}{3} \times 1 \times \frac{A_{req}}{A_{prov}} \times f_{yv}$

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

$M.F = 0.56 + \frac{477 - 154.69}{120\left(0.9 + \frac{18.24 \times 10^6}{1000 \times 119^2}\right)} = 1.78$

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

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

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

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

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

$P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.666 > 2$ = 1way slab

Designing P_2

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

Short Span coefficient = -
0.05

Longspan Coefficient = 0.058
0.044

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

$DL = 1.4G_K + 1.6Q_K$

G_K = Weight of slab = 0.175×24
Partition = 1.0
finishes = 1.2
$6.4KN/m^2$

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

Shortspan Coefficient = 0.044
0.033

Long Span Coefficient = 0.032
0.028

Short span mid = P
$M = B_x wl^2 x = 0.044 \times 17 \times 4$
$= 11.968$

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

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

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

~~Z = Ia~~ $Z = I_a \cdot d = 0.95 \times 144 = 136.8$

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

Provide Y12 @ 377mm

Continous

$M = B_x wl^2 x = 0.033 \times 17 \times 4^2 = 8.976$
$d = 144$

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

$I_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \sqrt{\frac{0.0123}{0.9}}} = 0.83$

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

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

Provide Y12 @ 377mm

Long Span

Mid

$d = d$(Shortspan) Steel thickness $= 144 - 12 = 132mm$

$M = B_x wl^2 x = 0.037 \times 17 \times 4^2 = 10.064$

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

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

$Z = I_a \cdot d = 0.95 \times 1.32 = 125.4$

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

Provide y12 at 377mm

Long span Continuous

$d = 132mm$

$M = B_x wl^2 x = 0.028 \times 17 \times 4^2 = 7.616$

$K = \frac{M}{bd^2 f_{cu}} = \frac{2.616 \times 10^6}{1000 \times 132^2 \times 25} = 0.017$

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

$Z = I_a \cdot d = 125.4$

$A_s = \frac{M}{0.95 f_y z} = \frac{2.616 \times 10^6}{0.95 \times 410 \times 125.4} = 155.93$

Provide y12 @ 377mm

Deflection check

$f_s = \frac{2}{3} P_{yr} \beta \frac{A_{req}}{A_s \text{ approved}}$

$$F_s = \frac{2}{5} \times 250 \times 1$$

$$= \frac{224.61}{377} = 99.3$$

$$M.R = 0.55 + \frac{427 - 99.3}{120(0.9) + \frac{11.968 \times 10^6}{1000 \times 144^2})} = 2.68 > 2$$

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