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Civil Engineering
17/ENG03/015

Assignment Answers

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.

1(b) Limit State ~~degi~~ design considers the disadvantages of load factor design and any other failure that can cause the structure to be structuraly 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 faction of the elastic limit of the material.

STAIR CASE DESIGN

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

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 $= T \times \frac{1}{2} \times 24 KN/m^2$

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

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

$= (4.8 \times 1.14) + 3.3$

$= 8.77 KN/m$

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

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

$= 14.68 KN/m^2$

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

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

$= 150 - 25 - 6 = 119mm$

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

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

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

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

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

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

Provide M2 at 25a ck ($A_{s\,prov} = 452mm$)

Deflection Check

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

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

$= 154.69 N/mm^2$

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

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

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

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

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

$P_4 = B_5 = P_6 = \frac{4300}{4000} = 1.075 < 2 =$ 2 way slab

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

2(b) Designing for P_2

$\frac{Ly}{Lx} = \frac{4300}{4000} = 1.075 \simeq 1.1$

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

Long span coefficient = 0.058
0.044

Assuming specification of slab thickness = 175mm

$f_{cy} = 25 N/mm^2$
$f_y = 410 N/mm^2$

$DL = 1.4 GK + 1.6 QK$

GK = weight slab = 0.175×24
Partition = 1.0
finishes = 1.2 = $6.41 kN/m^2$

Assuming for factory

$D \cdot L = (1.4 \times 6.4) + (1.6 \times 5)$
$= 16.96 \simeq 17 KN/m^2$

Shortspan coefficient = 0.044
0.033

Long span coefficient = 0.037
0.028

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

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

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

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

$Z = l_a \cdot d = 0.95 \times 1.44 = 136.8$

$A_s = \frac{M}{0.95 f_y} = \frac{11.968 \times 10^6}{0.95 \times 40 \times 136.8} = 224.61$

provide y12 at 377mm

Continous

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

$d = 144$

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

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

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

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

Provide y12 @ 377mm

Long span

M-d

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

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

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

$P_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = \sqrt{0.25 - \frac{0.0231}{0.9}} = 0.97 > 0.95 = 0.95$

$Z = P_a \cdot d = 0.95 \times 132 = 125.4$

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

Provide y12 at 317mm

Long Span continuous

$d = 132mm$

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

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

$C_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.017}{0.9}} = 0.98 > 0.95$

$= 0.95$

$Z = I_a \cdot d = 125.4$

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

Proud y12 at 372mm

Deflection check

$f_s = \frac{2}{3} P_y \quad B = \frac{A_{s req}}{A_{s prov}}$

$f_s = \frac{2}{3} \times 250 \times 1 \times \frac{224.61}{372} = 99.3$

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

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