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civil engineering

1a) To design for saftey
b) The design must be economical
c) The deformation of the structure must not impose with the integrity of the structure

1b) Limit state design considers the dis advantages in headfactor 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 at the material

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 x 24 kN/m^2
= 0.15 x 24 = 3.6 kN/m^2
* b Finishes 1.2 kN/m^2
c steps = T x 1/2 R = 24 kN/m^2
= 0.275 x 0.5 x 24 = 3.3 kN/m^2
D. G. k = ((A+b) + SF) + C
= (4.8 x 1.14) + 3.3
= 8.77 kN/m
D.C F = 1.4 Gk + 1.6 Qk
= 1.4 (8.77) + 1.6 (1.5)
= ~~1.4~~ 14.68 kN/m^2

Span = Ttotal + 0.5 (la + lb) = 275 (12) + 0.5 (225 + 225)

= 3.527 m

d = h - cover - ½ φ

= 150 - 25 - 6 = 119 mm

$M = \frac{Fl^2}{10} = \frac{14.68 \times 3.525^2}{12} = 18.24 kNm$

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

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

Z = Z_a d = 0.938 × 119 = 111.622 m

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

As por = 452 mm

Provide 4Y12 @ 250 c/c (As por = 452 mm)

Deflection check

$f_s = \frac{2}{3} \times \frac{1}{\beta} \times \frac{As_{req}}{As_{pro}} \times f_y$

$f_s = \frac{2}{3} \times 1 \times \frac{419.83}{452} \times 250$

= 154.69 N/mm²

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

$d_{req} = \frac{span}{\alpha \times M.F} = \frac{3525}{1.78 \times 28} = 70.17 mm$

Since $d_{req} < d$, deflection is ok

2a) $P1 = P2 = P3 = \frac{4300}{4000} = 1.075 < 2$ = 2 way slab

$P7 = P8 = P9 = \frac{4500}{4000} = 1.125 < 2$ = 2 way slab

$P4 = P5 = P6 = \frac{4300}{4000} = 1.075 < 2$ = 2 way slab

$P10 = P11 = P12 = \frac{4000}{1500} = 2.667 > 2$ = 1 way slab

Designing for P_2

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

Short span coefficient = 0.059

Long span coefficient = 0.051
0.044

Assuming specification of 5196 Pt section as = 175 mm

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

$f_y = 460/mm^2$

$Dc = 1.4Gk + 1.6Qk$

Gk = weight of slab = 0.175 x 24

partition = 1.0

finishes = 1.2

6.4 kN/m².

Assuming for factory

$Dc = (1.4 \times 6.4) + (1.6 \times 5)$

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

Short span coefficient = 0.044

0.033

Long span coefficient = 0.037

0.028

Short span mid = P

$m = \beta_{sx} w l^2 x = 0.044 \times 17 \times 4^2$

$= 11.968$

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

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

$k = la = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.997 \; 0.95 = 0.95$

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

$As = \frac{M}{0.95 f_y z} = \frac{11.968 \times 10^6}{0.95 \times 460 \times 136.8} = 224.61$

Provide Y12 @ 377mm

Continuous
$M = \alpha x w l^2 = 0.033 \times 12 \times 4^2 = 8.976$

$d = 144$

$k = \frac{M}{b^2 d f_{cu}} = \frac{8.976 \times 10^6}{1000 \times 144^2 \times 25} = 0.0173$

$P_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0173}{0.9}}$

$= 0.83$

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

$A_s = \frac{M}{0.95 f_y z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 119.52} = 192.81 mm^2$

Provide Y12 @ 377mm

Long span

MS

$d = d$ (short span) = steel thickness

$= 144 - 12 = 132mm$

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

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

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

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

$A_s = \frac{M}{0.95 f_y z} = \frac{10.064 \times 10^6}{0.95 \times 125.4 \times 410}$ ~~2.06~~

~~= 206.~~04

Provide Y12 at 317 mm

Less span continuous

$d = 132mm$

$M = \beta x w l^2 x = 0.025 \times 12 \times 4^2 = 2.64$

$K = \frac{M}{bd^2 f_{cu}} = \frac{2.616 \times 10^6}{1000 \times 126^2 \times 25} = 0.017$

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

$= 0.95$

$Z = 0.95 \cdot d = 125.4$

$A_s = \frac{M}{0.95 f_y Z} = \frac{2.616 \times 10^6}{0.95 \times 460 \times 125.4} = 153.93$

Provide y12 @ 377mm

Deflection check

$f_s = 2/3 f_y \times B \frac{Area}{As\,provided}$

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

$m.f = 0.55 + \frac{422 - 99.3}{120(0.9 + \frac{11.988 \times 10^6}{1000 \times 126^2})} = 2.6872$

$d_{req} = \frac{4 \times 1000}{2 \times 26} = 79.62 < 126$