1a - structure must be economical
- Structure must be safe
- Deformation of the structure must not impair its integrity. ~~of the~~

1b Limit state Design :- This considers the disadvantages of load factor design and any other failure that can cause the structure to be structurally

Elastic design :- This is a method of analysis which the design of the structural members is based on a linear stress-strain relationship assuming that the working stress are only a fraction of the elastic limit.

1c <u>Staircase Design</u>

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

Load Design

A - Waist - R × 24 kN/m²

= 0.15 × 24 = 3.6 kN/m²

B - Finishes = 1.2 kN/m²

C - Steps = T × ½ × 24

= 0.275 × ½ × 24 = 3.3 kN/m²

D - G.k = ((A+B) × S_f) + C

= (4.8 × 1.14) + 3.3 = 8.77 kN/m²

D.L, F = 1.4 Gk + 1.6 Qk

= 1.4 (8.77) + 1.6 (1.5)

= 14.68 kN/m²

Span = T_{total} + 0.5 ($l_a + l_b$) = (275 × 12) + 0.5 (225 + 225) = 3.525 m

d = h - cover - ½ Φ

= 150 - 25 - 6 = 119 mm

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

Scanned with CamScanner

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

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

$$Z = I_a d = 0.938 \times 119 = \underline{111.622mm}$$

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

$A_{s prov} = 452 mm$

provide Y_{12} @ 259 c/c ($A_{s prov} = 452mm$)

Deflection check

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

$$f_s = 2/3 \times 1 \times \frac{419.53}{452} \times 250$$
$$= 154.69 N/mm^2$$

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

$$d_{req} = \frac{Span}{mf \times ed} = \frac{3525}{1.93 \times 26} = 76.17mm$$

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

$P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.66 > 2$ — 1way slab

Designing for P_2:

$\frac{l_y}{l_x} = \frac{4300}{4000} \simeq 1:1$

Shortspan Coefficient = $\frac{-}{0.054}$

longspan coefficient = 0.058
0.044

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

D.L = 1.4Gk + 1.6Qk

G.k = Weight of slab = 0.175 × 24 = 4.2
Partition = 1.0 → 1.0
finishes = 1.2 → 1.2

6.4 kN/m²

Assumming Q.k for factory
D.L = 1.4(6.4) + 1.6(5)
= 16.96 ≃ 17kN/m²

Shortspan Coefficient = 0.044
0.033

longspan Coefficient = 0.037
0.028

Shortspan

mid = p

$M = \beta_x w l_x^2 = 0.044 \times 17 \times 4^2$

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

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

$K = J_a = 0.5 + \sqrt{0.25 - K/0.9} = 0.97 > 0.95$

$Z = J_a d = 0.95 \times 144 = 136.8$

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

Provide Y_{12} @ 377mm

Continuous

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

$$d = 144$$

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

$$I_a = 0.5 + \sqrt{0.25 - \frac{0.0143}{0.9}} = 0.83$$

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

$$A_s = \frac{M}{0.95 f_y Z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 119.52} = 192.87mm$$

provide Y_{12} @ 377mm

Long Span ; mid

$$d = d\,(\text{shortspan}) - \text{Steel thickness} = 144 - 12 = 132$$

$$M = \beta_x w l_x^2 = 0.03 \times 17 \times 4^2 = 10.064$$

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

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

$$Z = I_a d = 0.95 \times 132 = 125.4mm$$

$$A_s = \frac{M}{0.95 f_y Z} = \frac{10.069 \times 10^6}{0.95 \times 410 \times 125.4} = 206.09mm$$

Provide Y_{12} @ 377 mm

Continous

$d = 132mm$

$M = \beta_x w l_x^2 = 0.028 \times 17 \times 4^2 = 7.616$

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

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

$Z = I_a d = 0.95 \times 132 = 125.4$

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

Provide Y_{12} @ 377mm

Deflection Check

$f_s = 2/3 \times f_y \times \beta \times \frac{A_{s\,req}}{A_{s\,prov}}$

$f_s = 2/3 \times \frac{250}{1} \times \frac{1}{1} \times \frac{224.61}{337} = 99.3$

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

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

Deflection is OK