ADEPOJU MARY ABIMBOLA

17/ENG03/004

CIVIL ENGINEERING

CVE 308

STRUCTURAL DESIGN

ASSIGNMENT ONE

Question One

(a) Purpose of Structural Design

- Produce a structure which is capable to resist all applied loads without failure during its service life.
- To resist safely the stresses induced by the loads in the various structural members.
- To ensure satisfactory performance under service load conditions.
- Obtain the economical dimensions of structural members.
- To ensure structural safety.

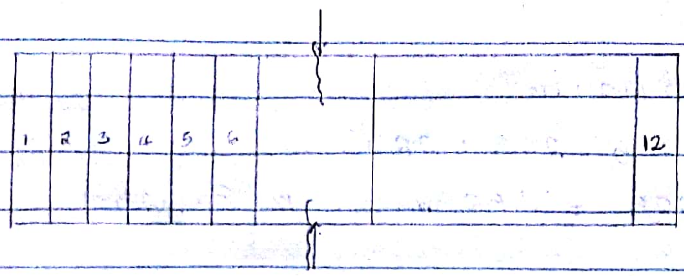
~~b Differences Between Limit State and Elastic Method of Design~~

2) Difference Between Limit State and Elastic Method of Design

NOTE: The elastic method of design is the Working State method.

	Elastic Method of Design	Limit State Method
1	This method is based on the elastic theory.	This method is based on the actual stress-strain curves of steel and concrete.
2)	The factor of safety are applied to the yield stresses to get permissible stresses.	Partial safety factors are applied to get design values of stresses.
3)	No factor of safety is used for loads.	Design loads are obtained by multiplying partial safety factors of load to the working loads.
4)	Exact margin of safety is not known	Exact margin of safety is known.
5)	This method gives thicker sections, so it is less economical.	This method gives thinner sections, so this method is economical.

Q



$F_y = 410 N/mm^2$

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

Rise = 150mm ≃ 0.15m

Thread = 275mm ≃ 0.275m

Slab thickness = 150mm

Solution

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

$= \frac{\sqrt{22500 + 75625}}{150}$

$= 1.14$

Loading

Waist, A : $0.15 \times 24 = 3.6 kN/m^2$

Finishes, B : $1.2 kN/m^2$

Steps, C : $0.275 \times 0.15 \times 24 = 3.3 kN/m^2$

$G_k = ((A + B) \times SF) + C$

$= ((3.6 + 1.2) \times 1.14) + 3.3$

$= (4.8 \times 1.14 + 3.3)$

$= 8.077 kN/m$

D.L, F $= 1.4G_k + 1.6Q_k$

$= 1.4(8.077) + 1.6(1.5)$

$= 14.68 kN/m$

Scanned by CamScanner

$Span = T_{total} + 0.5(la + lb)$

$= (275 \times 12) + 0.5(225 + 225)$

$3300 + 225 = 3525mm \simeq 3.525m$

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

$= 150 - 25 - 6$

$= 119$

$Moment; M = \frac{Fl^2}{10} = \frac{14.68(3.525)^2}{10}$

$= 18.24 kNm$

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

$= 0.052$

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

$= 0.938$

$Z = I_a d = 0.938 \times 119$

$= 111.622mm$

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

$= 419.53$

$A_{sprov} = 452mm$

Provide Y12 @ 300 c/c ($A = 452mm$)

<u>Deflection check</u>

$F_s = \frac{2}{3} \times \frac{1}{\beta} \times \frac{A_{req}}{A_{prov}} \times F_y \leq 2$

Scanned by CamScanner

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

$MF = 0.55 + \frac{477 - 154.69}{120\left(0.9 + \frac{18.24 \times 10^6}{1000 \times 144^2}\right)}$

$= 1.78$

$d_{req} = \frac{Span}{m.f = edf} = \frac{3525}{1.78 \times 26} = 76.17mm$, Deflection is OK

Question Two

a) 1 $P_1 = P_2 = P_3 = \frac{4300}{4000} = 1.075$

∴ It is a 2 way slab because $1.075 < 2$

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

∴ It is a 2 way slab because $1.075 < 2$

3 $P_7 = P_8 = P_9 = \frac{4500}{4000} = 1.125$

∴ It is a 2 way slab because $1.125 < 2$

4 $P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.67$

∴ It is a 1 way slab because $2.67 > 2$

b) Designing P_2

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

~~Short span coefficient = 0.054~~

~~Longspan coefficient = 0.058 , 0.044~~

Assuming

Slab thickness = 175mm ≃ 0.175m

F_{cu} = 25N/mm² ≃ ~~0.220~~

F_y = 410N/mm²

DL = 1.4Gk + 1.6Qk

Gk Weight of slab = 0.175 x 24 = 4.2 kN/m²
Partition = 1.0 kN/m²
Finishes = 1.2 kN/m²
6.4 kN/m²

DL = (1.4 x 6.4) + (1.6 x 5)
= 16.96 kN/m² ≃ 17 kN/m²

Short span coefficient = 0.044 , 0.033

Longspan coefficient = 0.037 , 0.028

Short span

Midspan

$M = \beta_x w l_x^2 = 0.033 \times 17 \times 4^2$
= 8.976 kNm

d = h - cover - ½ φ = 175 - 25 - (½ x 12)
= 144

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

$= 0.0173$

$l_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0173}{0.9}}$

$= 0.98 \ (\leq 0.95)$

$Z = l_a d = 0.95 \times 144$

$= 136.8mm$

$A_s = \frac{M}{0.95 f_y z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 136.8}$

$= 168.288 mm^2$

Provide Y12 @ 300 c/c (A = 377mm)

Continous Edge

$M = \beta x\, w l x^2 = 0.044 \times 17 \times 4^2 = 11.968$

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

$= 0.023$

$l_a = 0.5 + \sqrt{0.25 - \frac{K}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.023}{0.9}}$

$= 0.97 \ (\leq 0.95)$

$Z = l_a d = 0.97 \times 144$

$= 136.8$

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

$=$ ~~219.99mm²~~ $224.61 mm^2$

Scanned by CamScanner

Provide $\phi 12$ @ 300 c/c ($A = 377 mm^2$)

Long Span

Mid Span

$M = \beta x \, w l x^2 = 0.028 \times 17 \times 4^2$

$= 7.616$

$d = 144 - 12$

$= 132 mm$

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

$= 0.017$

$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.017}{0.9}}$

$= 0.98 \ (\leq 0.95)$

$Z = l_a d = 0.95 \times 132$

$= 125.4$

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

$= 155.93$

Provide $\phi 12$ @ 300 c/c ($A = 377 mm^2$)

Continuous Edge

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

$= 10.064$

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

~~= 0.0024~~

$$= 0.0231$$

$$l_a = 0.5 + \sqrt{0.25 - \frac{x}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0231}{0.9}}$$

$$= 0.97 \; (\leq 0.95)$$

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

$$= 125.4$$

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

$$= 206.05$$

Provide 4T12 @ 300 c/c (A = 377 mm^2)

Deflection check

$$d_{req} = \frac{\text{Span}}{M.F \times \text{effective depth ratio}}$$

$$M.F = 0.55 + \frac{477 - f_s}{120\left(0.9 + \frac{M}{bd^2}\right)} \leq 2$$

$$f_s = \frac{2}{3} \cdot \frac{1}{\beta} \cdot \frac{A_{req}}{A_{prov}} > f_y$$

$$\beta = 1$$

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

$$= 98.33$$

~~M.F = 0.55 + $\frac{477 - 98.33}{120\left(\frac{0.9 + 11.968 \times 10^6}{1000 \times 144^2}\right)}$~~

$$= 0.55 + \frac{477 \cdot 98.33}{120\left(0.9 + \frac{11.968 \times 10^6}{1000 \times 144^2}\right)}$$

~~= 2.68 ≤ 2~~

$$= 2.68 > 2$$

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

$$= 76.92$$

∴ Deflection is OK