Ladan Fidateh
17/ENG05/033
Civil Engineering

Structural Design
Assignment 1

(1a) (a) To design for safety
(b) The deformation of the structure must not impose with the intensity of the structure.
(c) The design must be economical.

(1b) Limit state 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 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 of 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 $= h \times 24 KN/m^2$

$= 0.15 \times 24 = 3.6 KN/m^2$

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

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

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

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

$= (4.8 \times 1.14) + 3.3$

$= 8.77 KN/m$

D.L.F $= 1.4 G_K + 1.6 Q_K$

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

$= 14.68 KN/m^2$

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

$d = h - cover - 1/2 \phi$

$= 150 - 25 - 6 = 119 mm$

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

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

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

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

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

A_s prov $= 452 mm$

Provide Y12 @ 250 c/c (A_s prov $= 452 mm$)

Deflection Check

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

$f_s = \frac{2}{3} \times 1 \times \frac{419.55}{452} \times 250$

$= 154.69 \, N/mm^2$

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

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

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

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

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

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

$P_{10} = P_{11} = P_{12} = \frac{4000}{1500} = 2.660 > 2 = 1$ way slab.

(25) Designing of P_2

$\frac{L_y}{L_x} = \frac{4300}{4000} = 1.075 \approx 1.1$

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

Long span coefficient = $\frac{0.058}{0.044}$

Assuming specifications of slab thickness = 175mm

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

$F_y = 410N/mm^2$

$D_f = 1.4G_K + 1.6Q_K$

G_K = weight of slab = 0.175 x 24

Partition = 1.0

Finishes = 1.2

6.4 kN/m²

Assuming for factory.

$D.L = (1.4 \times 6.4) + (1.6 \times 5)$

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

Short span coefficient = $\frac{0.044}{0.033}$

Long span coefficient = $\frac{0.037}{0.028}$

Short span mid = P

$M = \beta_{sx} w l_x^2 = 0.044 \times 17 \times 4^2$

$= 11.968$

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

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

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

$Z = P_a \cdot d = 0.95 \times 144 = 136.8$

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

Provide Y12 @ 377mm.

Continuous

$M = B \times wl^2x = 0.033 \times 17 \times 4^2 = 8.976$

$d = 144$

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

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

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

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

Provide X12 @ 377mm

Long Span

Mid

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

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

$K = \frac{M}{bd^2 f_{cu}} = \frac{10.064 \times 10^6}{1000 \times 132^2 \times 25} = 0.0251$

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

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

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

Provide X12 @ 377mm

Long Span Continuous

$d = 132mm$

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

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

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

$Z = l_a \cdot d = 125.4$

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

Provide Y12 @ 377mm

Deflection check.

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

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

$$m.f = 0.55 + \frac{477 - 99.3}{120\left(0.9 + \frac{4.968 \times 10^6}{1000 \times 144^2}\right)} = 2.68 > 2$$

2.

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