GOMBA-SAKA PHILIP NWOLU
16/ENG03/029
STRUCTURAL DESIGN ASSIGNMENT 1

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

1b) Limit State design considers the disadvantage of the load factor 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 of the material.

STAIR CASE DESIGN.

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

Load of 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 $= T \times \frac{1}{2} \times 24\ kN/m^2$
$= 0.275 \times 0.5 \times 24 = 3.3\ kN/m^2$

$D.G.K = ((A+B) \times SF) + C$
$= (4.8 \times 1.14) + 3.3$
$= 8.77\ kN/m$

$D.L.F = 1.4 G_K + 1.6 Q_K$
~~= 1.4Gk + 1~~
$= 1.4(8.77) + 1.6(1.5)$
$= 14.68\ kN/m^2$

Span = T to tol + 0.5(10+16) = (275 × 12) + 0.5 (225 + 225) = 3.525m

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

$= 150 - 25 - 6 = 119mm$

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

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

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

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

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

$A_{spr} = 452mm$

provide Y12 @ 259 c/c ($A_{spr} = 452mm$)

Deflection check.

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

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

$= 154.69 \, N/mm^2$

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

$d_{req} = \frac{\text{Span}}{af \times edr} = \frac{8525}{1.78 \times 26} = 76.17mm$

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

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

$P_2 = P_8 = P_9 = \frac{4500}{4000} = 1.125 < 2 =$ 2 way Slab

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

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

2b) Design for P_2

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

Short Span Coefficient $= \frac{\quad}{0.054}$

Long Span Coefficant $= \frac{0.058}{0.044}$

Assuming specification of Slab thickness = 175mm

$f_{cy} = 25 N mm^2$

$P_y = 410 N/mm^2$

$D.L = 1.4 G_K + 1.6 Q_K$

G_K = weigut of Slab = 0.175×24

partition = 1.0

finishes = 1.2

$6.4 kN/m^2$

Assuming for factory

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

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

Short span Coefficent $= 0.044$

0.033

long span coefficient $= 0.037$

0.028

Short span mid = P

$M = \beta_{sx} w l^2 x = 0.004 \times 17 \times 4^2$

$= 11.968$

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

$k = \frac{M}{bd^2 k_u} = \frac{11.968 \times 11^0}{1000 \times 144^2 \times 25} = 0.023$

$k = 8a = 0.5 + \sqrt{0.75 - \frac{k}{0.9}} = 0.97 > 0.95 = 0.95$

$z = 8a \cdot d = 0.95 \times 144 = 136.8$

$A_s = \frac{M}{0.95 f_y z} = \frac{11.968 \times 10^0}{0.95 \times \cancel{410} \times 136.8} = 224.61$

Provide Y12 @ 377mm

Continous

$M = \beta_{sx} w l^2 x = 0.033 \times 17 \times 4^2 = 8.976$

$d = 144$

$h = \frac{M}{bd^2 f_{cu}} = \frac{8.970 \times 10^6}{1000 \times 144^2 \times 25} = 0.0173$

$8a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.5 + \sqrt{0.25 - \frac{0.0173}{0.9}} = 0.83$

$8a \quad z = 8a \cdot d = 0.83 \times 144 = 119.52$

$A_s = \frac{M}{0.95 f_y z} = \frac{8.976 \times 10^0}{0.95 \times 410 \times 119.52} = 192.81$ mm

Provide Y12 @ 377mm

Long span

M.d

$d = d(\text{Short Span}) - \text{Steel thickness} = 144 - 12 = 132mm$

$M = \beta x\, wL^2x = 0.037 \times 17 \times 4^2 = 10.064$

$$k = \frac{M}{bd^2 f_{cu}} = \frac{10.064 \times 10^6}{1000 \times 137^2 \times 25} = 0.0231$$

$$l_a = 0.5 + \sqrt{0.25 - \frac{k}{0.4}} = 0.97 > 0.95 = 0.95$$

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

$$A_s = \frac{M}{0.95 f_y z} = \frac{10.064 \times 10^6}{0.95 \times 125.4 \times 460} = 206.04$$

Provide y12 at 377mm

Long span Continous

$d = 132mm$

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

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

$$l_a\; 0.5 + \sqrt{0.25 \times \frac{k}{0.9}} = 0.98 > 0.95 = 0.95$$

$z = l_a \cdot d = 125.4$

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

Provide y12 @ 377mm

Deflection check

$$f_s = \frac{2}{3} f_{yr}\, \beta\, \frac{A_{req}}{A_{s\,provided}}$$

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

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

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