IBRAHIM BALA ABDUL-SALAM
17/SC101/038

1a) to design for safety
it must be economical
the deformation of the structure must not
impose structure

1b limit state design considers the dis-
advantage of load factor design a
1b limit state design considers all the dis-
advantages of elastic and load factor design
and any other failure that can cause the
structure to be structural unfit while An
elastic design method, is a method of analysis in
which the design of a structural member is based
on a linear stress strain relationship, assuming that
the working stresses are only the fraction of
the elastic limit of the material.

Stair case design

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

Load Analysis

A. weight $= h \times 24kN/m^3 = 0.15 \times 24 = 3.6kN/m^2$

B. finishes $= 1.2kN/m^2$

C. Steps $= T \times 1/2\, R\, 24kN/m^3 = 0.275 \times 0.15 \times 24 = \cancel{3.3kN}$

~~D. Gk = ((AxB) x sf) + C~~ $= 3.3 kN/m^2$

D. $G_k = ((A \times B) \times S_f) + C = (4.8 \times 1.14) + 3.3$

$= 8.77kN/m$

$D.L.f = 1.4 Q_k + 1.6 Q_k$

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

$= 14.68 kN/m^2$

Span $= 1 + 0.5 (l_a + l_b) = (275 \times 12) + 0.5 (225 + 225) = 3.525m.$

$d = h - \text{cover} - 1/2 \varnothing$

$= 150 - 25 - 6 = 119mm$

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

$l_a = 0.5 + \sqrt{0.25 - \frac{0.002}{0.9}} = 0.938$

$z = Iad = 0.938 \times \cancel{119} \; 119 = 111.622mm$

$As = \dfrac{M}{0.95 f y z} = \dfrac{18.24 \times 10^{2}}{0.95 \times 410 \times 111.622}$

$As_{prv} = 452mm$

Provide $Y12$ @ 259 c/c

($As_{prv} = 452mm$)

Deflection check

$fs = \dfrac{2}{3} \times \dfrac{1}{f} \times \dfrac{Area}{A_{prv}} \times fyd$

$\dfrac{2}{3} \times 1 \times \dfrac{419.53}{452} \times 250 = 154.69 n/mm^2$

$mf = 0.55 + \dfrac{477 - 154.64}{120\left(0.4 + \dfrac{18.24 \times 10^{6}}{1000 \times 119^{2}}\right)}$

$d\,req = \dfrac{Span}{af \times cdr} = \dfrac{8525}{1.78 \times 26} = 76.17mm$

Since $d\,req < d$, Deflection is OK.

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

$P_7 = P_8 = P_9 = \frac{4500}{4000} = 1.125 < 2$
2way slab

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

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

Designing for $P_1$

$\frac{l_y}{l_x} = \frac{4300}{4000} = 1.075 = 1.1$ 2way slab

Shortspan coefficient = —

0.054

Long span coefficient = 0.058

0.044

Specification of slab thickness = 175 mm

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

$f_y = 410\ N/mm^2$

$DL = 1.4\,G_k + 1.6\,Q_k$

$G_k$ = weight . slab = $0.175 \times 24$

partition = . $1.0$

finishes = $1.2$

$6.4\,kN/m^2$

Assuming for factory

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

$= 16.96 \approx 17\,kN/m^2$

Short span coefficient = $0.044$

$= 0.033$

long span coefficient = $0.037$

$= 0.028$

Short span mid = $P$

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

$= 11.968$

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

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

$l_a = 0.5 + \sqrt{0.25 - \dfrac{0.02^2}{0.9}} = 0.97 > 0.95 = 0.85$

$z = l_a d = 0.95 \times 144$

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

Provide Y12C00 $ST$ 7 mm

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

$d = 144$

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

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

$Z = Z_a \cdot d = 0.83 \times 144$

$A_s = \frac{M}{0.95 f_y z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 119.52} = 192.89 mm$

Provide Y12 c/c 377mm

Long span

M.d

$d = d(\text{short span}) = \text{steel thickness}$

$144 - 12 = 132mm$

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

$= 10.064$

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

$J_a = 0.5 + \sqrt{0.25 + \frac{0.023}{0.9}} = 0.97 > 0.95$
$= 0.95$

$z = J_a d = 0.95 \times 132 = 125.4$

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

Provide Y12 at 317mm

Long span continuous

$d = 132mm$

$M = \beta_{sx} w l^2 x = 0.028 \times 17 \times 4^2 = 7.616$

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

$J_a = 0.5 + \sqrt{0.25 + \frac{0.017}{0.9}} = 0.98 > 0.95$
$= 0.95$

$z = J_a d = 0.95 \times 132 = 125.4$

$A_s = \frac{M}{0.95 f_y z} = \frac{7.616 \times 10^6}{0.95 \times 460 \times 125.4} = 155.93$

Provd Y12 @ 377mm

Deflection Check

$f_s = \frac{2}{3} f_y \times \frac{A_{st\,req}}{A_{st\,provided}}$

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

$M.F = 0.55 + \frac{477 - 99.3}{120\left(0.9 + \frac{11.968 \times 10^6}{1000 \times 146^2}\right)}$

$= 2.68$

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

since $d_{req} < d$, Deflection is ok.