UNIT V DESIGN OF FOOTINGS

RECTANGLE COLUMN FOOTING

Problem

Design a rectangular isolated footing of uniform thickness of R.C column, bearings vertical load of 600 KN, have base size 400 x 600 mm, and have SBC of 120 KN/m^2. Use M_{20} and Fe_{415} grades.

Step 1:

b = 400 mm

d = 600 mm

w = 600 KN

S.B.C = 120 KN/m^2

f_y = 415 N/mm^2

f_{ck} = 20 N/mm^2

Step 2:

Size of footing

W = 600 KN (Weight of column)

Self weight of footing = 10% (column load)

= $\frac{10}{100}$ x 600

= 60 KN

Total load = 600 + 60

= 660 KN

Area of footing = $\frac{Load}{S.BC}$

$\frac{660}{120}$

= 5.5 m^2

A = 5.5

B x L = A = 5.5 m^2

B = $\frac{2}{3}$ L

$\frac{2}{3}$ x L x L = 5.5

L = 2.87 m ≅ 3m

B = 1.91 m ≅ 2m

B = 2m , L = 3m

Step 3: Section Design

a) Depth on basis of Bending compression

Net upward pressure P_o = $\frac{Given\ load}{Area\ of\ footing}$

= $\frac{600}{3\times2}$

= 100 KN/m^2

Along x−x axis

M_x = P_o x B x 1.2 x $\frac{1.2^2}{2}$

= 100 x 2 x 1.2 x $\frac{1.2^2}{2}$

M_x = 172.8

M_{ux} = 1.5 x M = 259.2

Along y−y axis

M_y = P_o x L x 0.8 x $\frac{0.8^2}{2}$

= 100 x 3 x 0.8 x $\frac{0.8^2}{2}$

= 76.8

M_{uy} = 115.2

M_u lim = Take greater one

M_u lim = 259.2 ≅ 260 KNm

b) Depth from $M_u$lim

M_u lim = 0.36 $\frac{M_u max}{d}$ f_{ck} (1− $\frac{0.42\ x_u max}{d}$) bd^2

260 x 10^6 = 0.36 x 0.48 x 20 [1− 0.42(0.48)] bd^2

260 x 10^6 = 3.456 (1− 0.2016) bd^2

bd^2 = 94227807.47

$2 \times 10^3 d^2 = 94227807.47$

$d = 217.0 \cong 220$ mm

$D = d + d'$

$= 220 + 60$

$= 280$ mm

c) Depth of basis of one way shear

$a = 1.2 - d$

Shear force, $V_u = 1.5 \times P_o \times B \times a$

$= 1.5 \times 100 \times 2(1.2 - d)$

$V_u = 360 - 300d$

$\tau_v = \frac{Vu}{bd}$

$\tau_v = \frac{360-300d}{2d}$ ⇢ ①

Assume, $P_t = 0.3\%$

(τ_c ref IS 456 Pg No: 73) 0.25 → 0.36

0.50 → 0.48

$\tau_c = 0.38\ N/mm^2$

Permissible shear stress, $\tau_v = \tau_c \times K$

K = 1.05

D=280mm ⇢ (IS 456 Pg: 72)

275 → 1.05

300 → 1.00

$\tau_v = K \times \tau_c$

$= 0.38 \times 1.05$

$= 0.4\ N/mm^2$

$\tau_v = 400\ KN/m^2$ ⇢ ②

Eqn ①&②

$\frac{360-300d}{2d} = 400$

360−300d = 800d

360 = 1100d

d = 0.327 m

d = 3.27 ≅ 330 mm

D = 390 mm

Depth on basis of 2 way shear

Area of footing, AF = $6m^2$ (3 x 2)

BC = $B + \frac{d}{2} + \frac{d}{2}$

= $400 + \frac{330}{2} + \frac{330}{2}$

BC = 730mm

AB = $600 + \frac{330}{2} + \frac{330}{2}$

AB = 930mm

Area = BC x AB

= 730 x 930

= 678900 mm^2

Shear force = P_o [AF – Area of ABCD]

= $100[6 - 678900 \times (10^{-3})^2]$

= 532.11 KN

F_u = 1.5 x 532.11

= 798.17 KN

Length of ABCD = (930 x 2) + (730 x 2)

= 3320 mm

τ_v = $\frac{F_u}{Length\ of\ ABCD \times d}$

= $\frac{798.17 \times 10^6}{3320 \times 330}$ = 0.73 N/mm^2

Permissible stress = $k_s \times \tau_c$

k_s = $0.5 + \beta_c$

$\beta_c = \frac{Short\ side\ of\ column}{Long\ side\ of\ column}$

$= \frac{400}{600} = 0.667$

$k_s = 0.5 + 0.667$

$= 1.167$

But k_s is not greater than one, so $k_s = 1$

$\tau_c = 0.25\sqrt{f_{ck}}$

$= 0.25 \times \sqrt{20}$

$= 1.118$ N/mm^2

$k_s\tau_c = 1.167 \times 1.118$

$= 1.3$ N/mm^2

$\tau_v < k_s\tau_c$

Hence safe

Step 4: Design of Reinforcement

Find Ast_x :

$Mu_x = 0.87\ f_y\ Ast_x\ d\ [1 - \frac{f_y Ast_x}{bd\ f_{ck}}]$

$260 \times 10^6 = 0.87 \times 415 \times Ast_x \times 330\ [1 - \frac{415\ Ast_x}{20 \times 2000 \times 330}]$

$Ast_x = 2356.82$ mm^2

12mm Ø bar @ 50mm in x- direction C/C spacing.

$Mu_y = 0.87\ f_y\ Ast_y\ d\ [1 - \frac{f_y Ast_y}{bd\ f_{ck}}]$

$120 \times 10^6 = 0.87 \times 415 \times Ast_y \times 330\ [1 - \frac{415\ Ast_y}{20 \times 2000 \times 330}]$

$Ast_y = 987$ mm^2

12mm Ø bar @ 110mm spacing.

Check of development length

i. $L_d = 47 \times Ø$

$= 47 \times 12 = 564$ mm

ii. Length of bar,

$L_o = \frac{1}{2} \times (B - b) - d_c$

$= \frac{1}{2} \times (2000 - 400) - 60$

$= 740mm$

$L_o > L_d$ Hence safe.

$A_1 = 2160 \times 1960$

$A_2 = 600 \times 400$

$\sqrt{\frac{A_1}{A_2}} = \sqrt{\frac{2160 \times 1960}{600 \times 400}}$

$= 4.2$

Adopt values, $\sqrt{\frac{A_1}{A_2}} = 2$

Permissible bearing stress $= 0.45\, f_{ck}\sqrt{\frac{A_1}{A_2}}$

$= 0.45 \times 20 \times 2$

$= 18\ N/mm^2$

Actual bearing pressure $= \frac{Load}{Area}$

$= \frac{600 \times 10^3}{600 \times 400}$

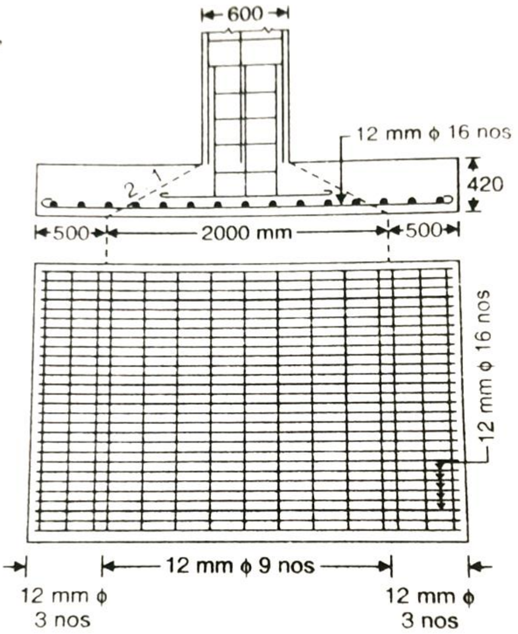
$= 2.5\ N/mm^2$

Actual bearing pressure < Permissible bearing stress

$2.5 < 18\ N/mm^2$

Hence safe.

Reinforcement details



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