

2.4 IS code method:

General shear failure:

$$q_f = CN_c S_c d_c i_c + \gamma D N_q S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma$$

Local shear failure

$$q_f = \frac{2}{3} CN_c S_c d_c i_c + \gamma D N_q S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma W'$$

S_c, S_q, S_γ = Shape factor

d_c, d_q, d_γ = Depth factor

i_c, i_q, i_γ = inclination factor

W' = water table factor

Shape	S_c	S_q	S_γ
Strip	1	1	1
Rectangle	$1 + 0.2 \frac{B}{L}$	$1 + 0.2 \frac{B}{L}$	$1 - 0.4 \frac{B}{L}$
Square	1.3	1.2	0.8
Circle	1.3	1.2	0.6

For $\phi = 0, i_c = i_q = i_\gamma = 1$

$$i_c = i_q = \left(1 - \frac{\alpha^2}{90}\right)$$

$$i_\gamma = \left(1 - \frac{\alpha^2}{\phi}\right)$$

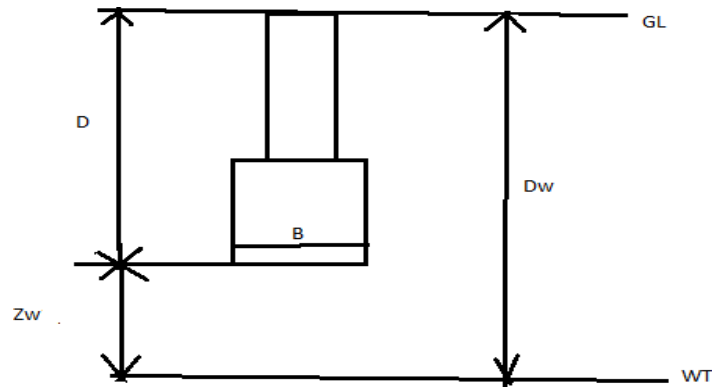
$$N\phi = \tan^2 \left(45 + \frac{\phi}{2}\right)$$

$$\phi > 10^\circ, d_q = d_\gamma = 1 + 0.1 \left(\frac{D_f}{B}\right) \sqrt{N\phi}$$

$$\phi < 10^\circ, d_q = d_\gamma = 1$$

$$d_c = 1 + 0.2 \frac{D}{B} \sqrt{N\phi}$$

Effect of water table(W'):



$$W' = 0.5 \left[1 + \frac{(D_w - D)}{B} \right]$$

$$W' = 0.5 \left[1 + \frac{Z_w}{B} \right]$$

When $Z_w=0, W'=0.5$

$Z_w=B, W'=1$

Table1: Bearing Capacity Factor (Refer IS6403-1981 Page number8)

BEARING CAPACITY FACTORS			
ϕ (Degrees)	N_c	N_q	N_γ
0	5.14	1.00	0.00
5	6.49	1.57	0.45
10	8.35	2.47	1.22
15	10.98	3.94	2.65
20	14.83	6.40	5.39
25	20.72	10.66	10.88
30	30.14	18.40	22.40
35	46.12	33.30	48.03
40	75.31	64.20	109.41
45	138.88	134.88	271.76
50	266.89	319.07	762.89

Problems:

1. A rectangular footing has a size of 1.8m x 3m has to transmit the load of a column at a depth of 1.5m. Calculate the safe load which the footing can carry at a factor of safety 3 against shear failures. Use Is code method. The soil has the following Properties. $n=40\%$, $G=2.67$, $w=15\%$, $c=8\text{ kN/m}^2$, $\Phi=32.5^\circ$

Solution:

$$e = \frac{n}{1 - n}$$

$$= \frac{0.4}{1 - 0.4} = 0.667$$

$$\gamma_d = \frac{G\gamma_w}{1+e}$$

$$= \frac{2.67 \times 9.81}{1+0.667} = 15.71 \text{ kN/m}^3$$

$$\gamma = \gamma_d(1+w)$$

$$= 15.71(1+0.15)$$

$$= 18.07 \text{ kN/m}^3$$

For $\Phi=32.5^\circ$ for Is Method

$$N_c=38.3, N_q=25.85 \text{ and } N_\gamma=35.21$$

$$q_f = CN_c S_c d_c i_c + \gamma D N_q S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma$$

For Rectangular:

Shape Factor

$$s_c = 1 + 0.2 \frac{B}{L}$$

$$= 1 + 0.2 \frac{1.8}{3} = 1.12$$

$$s_q = 1 + 0.2 \frac{B}{L}$$

$$= 1 + 0.2 \frac{1.8}{3} = 1.12$$

$$s_\gamma = 1 - 0.4 \frac{B}{L}$$

$$= 1 - 0.4 \times \frac{1.8}{3} = 0.76$$

Depth factor:

$$\varphi > 10^\circ, d_q = d_\gamma = 1 + 0.1 \left(\frac{D_f}{B} \right) \sqrt{N_\varphi}$$

$$d_c = 1 + 0.2 \frac{D}{B} \sqrt{N_\varphi}$$

$$i_c = i_q = i_\gamma = 1$$

$$N_\varphi = \tan^2 \left(45 + \frac{\varphi}{2} \right) \text{ or } \sqrt{N_\varphi} = \tan \left(45 + \frac{\varphi}{2} \right)$$

$$\sqrt{N_\varphi} = \tan \left(45 + \frac{32.5}{2} \right) = 1.823$$

$$d_c = 1 + 0.2 \frac{1.5}{1.8} \times 1.823 = 1.304$$

$$d_q = d_\gamma = 1 + 0.1 \left(\frac{1.5}{1.8} \right) \times 1.823 = 1.152$$

$$\begin{aligned} q_f &= 8 \times 38.13 \times 1.12 \times 1.304 + 18.07 \times 1.5 \times 25.85 \times 1.12 \times 1.152 \\ &\quad + 0.5 \times 18.07 \times 1.8 \times 35.21 \times 0.76 \times 1.152 \\ &= 445.50 + 904.02 + 501.34 \\ &= 1850.86 \text{ KN/m}^2 \end{aligned}$$

$$\begin{aligned} q_{nf} &= q_f - \gamma D \\ &= 1850.86 - 18.07 \times 1.5 \\ &= 1823.75 \text{ KN/m}^2 \end{aligned}$$

$$\begin{aligned} q_s &= \frac{q_{nu}}{F} + \gamma D \\ &= \frac{1823.75}{3} + (18.07 \times 1.5) \\ &= 635.02 \text{ KN/m}^2 \end{aligned}$$

$$\text{Safe Load} = q_s \times \text{area}$$

$$= 635.02 \times (1.8 \times 3)$$

$$= 3429 \text{ KN}$$