Chapter 3

David Dammon

\# 3.2 pg 177 A sq. column foundation has to carry a gross allowable load of 1805 kN (Fs=3). $D_f = 1.5m$, $\gamma = 15.9 kN/m^3$, $\phi' = 34°$ & $c' = 0$

Use Terzaghi's equation to determine the size of the foundation (B). Assume general failure.

[3.12] $q_u = q_{all} \times FS = 1805 kN \times 3 = \boxed{5,415 kN}$

[3.7] $q_u = 1.3c' N_c + q N_q + 0.4 \gamma B N_\gamma$

Tbl 3.1 $\phi' = 34°$

N_c	N_q	N_γ
52.64	36.50	38.04

[3.17] $q = \gamma D_f = 15.9 kN/m^3 \times 1.5m = 23.85 kN/m^2$

$\therefore$ $5,415kN - (23.85 kN/m^2 \times 36.50) = (0.4) \times 15.9 kN/m^3 (B)(38.04)$

$5,415 kN - 870.525 kN/m^2 = 241.9344 kN/m^3 (B)$

$B = 18.78 m$ & $L = 18.78 m$ (sq column foundation)

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#3.6 pg 177 For a square foundation $D_f = 2m$; vertical gross allowable load $Q_{all} = 3330 kN$, $\gamma = 16.5 kN/m^3$, $\phi' = 30°$, $c' = 0$, $FS = 4$

Determine the size of foundation using Eq 3.19

[3.19] $q_u = \cancel{c'}^{\nearrow \phi} N_c F_{cs} F_{cd} F_{ci} + q N_q F_{qs} F_{qd} F_{qi} + \frac{1}{2} \gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$

[3.12] [3] $q_{all} = \frac{Q_{all}}{B^2} = \frac{q_u}{FS} \therefore q_u = \frac{(Q_{all})(FS)}{B^2} = (3330 kN)(4)\frac{1}{B^2}$

$\boxed{q_u = 13320 (1/B^2)}$

[3.17] $q = \gamma D_f = (16.5 kN/m^3) \times (2m) = \boxed{33 kN/m^2}$

$\phi' = 30°$

N_c	N_q	N_γ
30.14	18.40	22.40

pg 145 $F_{qs} = 1 + \cancel{\frac{B}{L}}^{\nearrow 1} \tan \phi' = 1 + \tan 30° = 1.577$

$\phi' > 0$ $F_{qd} = 1 + 2 \tan \phi' (1 - \sin \phi')^2 \left(\frac{D_f}{B}\right) = 1 + 2 \underbrace{\tan 30°}_{1.1547} (1 - \underbrace{\sin 30°}_{0.25})^2 \left(\frac{2m}{B}\right)$ $= 1 + 0.577/B$

$F_{qi} = \left[1 - \left(\frac{\beta°}{90°}\right)\right]^2 = [1 - 1]^2 = 1$

pg 145 $F_{\gamma s}$ $1 - 0.4 \left(\frac{B}{L}\right)^{\nearrow 1} = 1 - 0.4 = 0.6$

$\phi' > 0$ $F_{\gamma d} = 1$

$F_{\gamma i} = \left(1 - \frac{\beta}{\phi'}\right) = 1 - \left(\frac{90}{30}\right) = (-)2$

$\therefore$ $13,320/B^2 = (33)(18.4)(1.577)(1 + 0.577/B)(1) + \frac{1}{2}(16.5)(B)(22.40)(0.6)(-2)$

$0 = 957.6 B^2 + 552.5 B - 221.76 B^3 - 13,320$

$\boxed{B = 3.033 \ m}$

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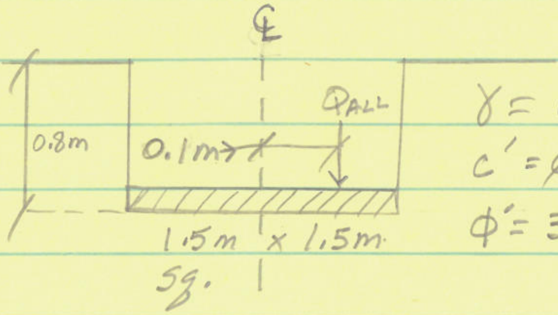
#3.9 An eccentrically loaded foundation shown below.
pg 178 Use $FS = 4$

Determine the maximum allowable load the foundation can carry, Use Prakash & Saran's method



$\gamma = 17 kN/m^3$

$c' = \emptyset$

$\phi' = 32°$

[3.43] $Q_{ult} = BL\left[\cancel{c'}^{\emptyset} N_{c(e)} F_{cs(e)} + q N_{q(e)} F_{qs(e)} + \frac{1}{2}\gamma B N_{\gamma(e)} F_{\gamma s(e)}\right]$

(Fig 3.16) $e/B = \frac{0.1m}{1.5m} = 0.07,\ \phi' = 32°,\ N_{q(e)} = 27.3$

[3.45] $F_{qs(e)} = 1$

(Fig 3.12) $e/B = 0.07,\ \phi' = 32°,\ N_{\gamma(e)} = 19.3$

[3.46] $F_{\gamma s(e)} = 1 + \left(\frac{2e}{B} - 0.68\right)\frac{B}{L} + \left[0.43 - \left(\frac{3}{2}\right)\left(\frac{e}{B}\right)\right]\left(\frac{B}{L}\right)^2$

$= 1 + \left(\frac{2(0.1)}{1.5} - 0.68\right)(1) + \left[0.43 - \frac{(1.5)(0.1)}{1.5}\right] 1^2$

$= 1 + (0.1333 - 0.68) + [0.43 - 0.1] = 0.7833$

[3.17] $q = \gamma D_f = 17 kN/m^3 \times 0.8 m = 13.6 kN/m^2$

$Q_{ULT} = (1.5)^2(\emptyset + (13.6)(27.3)(1) + (0.5)(17)(19.3)(0.7833))$

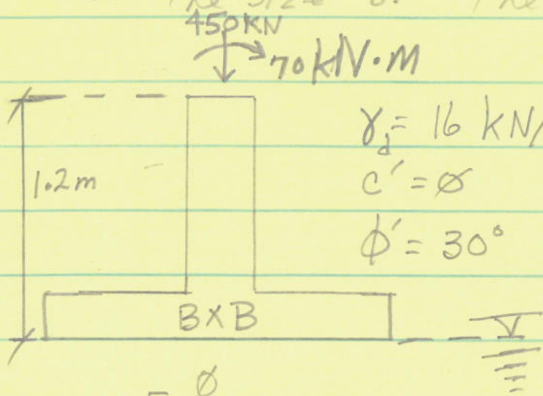
$Q_{ULT} = 1124.4 kN$

[3.39] $Q_{ALL} = \frac{Q_{ULT}}{FS} = \frac{1124.4 kN}{4} = \boxed{281.1 kN}$

3.12 A square footing below, FS=6

pg 178

Determine the size of the footing use Prakash & Saran



$\gamma_d = 16\ kN/m^3$ $\quad$ $\gamma_{sat} = 19\ kN/m^3$

$c' = \varnothing$ $\quad$ $c' = \varnothing$

$\phi' = 30°$ $\quad$ $\phi' = 30°$

[3.43] $Q_{ULT} = BL\left[\cancel{c'}^{\,\varnothing} N_{c(e)} F_{cs(e)} + q N_{q(e)} F_{qs(e)} + \frac{1}{2}\gamma B N_{\gamma(e)} F_{\gamma s(e)}\right]$

Assume $e/B = 0.2$

[3.17] $q = \gamma D_f = 16\,kN/m^3 \times 1.2m = 19.2\,kN/m^2$

Fig 3.16 $e/B = 0.2,\ \phi' = 30°,\ N_{q(e)} = 12.5$

[3.45] $F_{qs(e)} = 1$

Fig 3.17 $N_{\gamma s(e)} = 6.0$

[3.46] $F_{\gamma s(e)} = 1.0 + \left(\frac{2e}{B} - 0.68\right)\left(\frac{B}{L}\right)^{1} + \left[0.43 - \left(\frac{3}{2}\right)\left(\frac{e}{B}\right)\right]\left(\frac{B}{L}\right)^{2}$

$= 1 + [2(0.2) - 0.68](1) + [0.43 - (1.5)(0.2)](1)^2$

$= 0.85$

$\therefore$ $450\,kN = [\varnothing + (19.2)(12.5)(1) + (0.5)(16)\,B\,(6.0)(0.85)]$

$450\,kN = 240 + 40.8B$

$B = 5.15\,m$

Check Assumption $\quad$ Moment = 70 kN·m

[3.35] $e = 70/450 = 0.156$ $\quad$ $e/B = \frac{0.156}{5.15} = 0.03 \neq 0.2$ NOT OK

3.12 Cont.

Change $e/B = 0.1$ recalulate $N_{q(e)}$ & $N_{\gamma s(e)}$

$N_{q(e)} = 18.2$

$N_{\gamma s(e)} = 12.5$

[3.46] $F_{\gamma s(e)} = 1 + \left[2\left(\frac{e}{B}\right) - 0.68\right]\frac{B}{L} + \left[0.43 - \left(\frac{3}{2}\right)\left(\frac{e}{B}\right)\right]\left(\frac{B}{L}\right)^2$

$\frac{B}{L} \rightarrow 1$

$= 1 + [2(0.1) - 0.68](1) + [0.43 - 1.5(0.1)](1)^2$

$= 1 + (-)0.48 + 0.28 = 0.8$

$\therefore$ $450kN = [\phi + (19.2)(18.2)(1) + (0.5)(16)B(12.5)(0.8)]$

$450kN = 349.44kN + 80B$

$\boxed{B = 1.257}$

Check $e/B = \frac{0.156}{1.257} = 0.124 \approx 0.1$ $\boxed{OK ✓}$