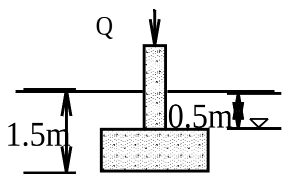
Example 1

A 1.5m wide wall footing is located 1m below ground level in a sand with $\gamma = 17.5 kN/m^3$ and $\phi = 32°$. Determine its ultimate bearing capacity using:
Solution
$N_q = 23.18$, $N_\gamma = 30.22$
$q_u = 1\times17.5\times23.18+17.5\times1.5\times32.22/2 = 829\ kN/m^2$

Example 2

A square footing is resting 1.5m below ground in sand with $\gamma = 16.5 kN/m^3$, $\gamma_{sat} = 18.3\ kN/m^3$, and $\phi = 40°$. Water table is at 0.5m depth. The footing must carry an ultimate load of Q_{ult} = 8MN. Determine its size.



Solution:

$q_{ult} = Q_{ult}/area = 8x10^6/ B^2 = q_{ult}$ (A)
c = 0
$q_{ult} = qN_qF_{qs}F_{qd} + 0.5\ \gamma BN_\gamma F_{\gamma s}F_{\gamma d}$
$q = 0.5\times16.5 + (18.3 - 9.81)\times1 = 16.7$ psf
$N_q = 64.2$

$$F_{qs} = 1 + \frac{B}{B}\tan 40 = 1.84$$

$N_\gamma = 109.4$
$F_{\gamma s} = 0.6$

$$F_{qd} = 1 + 2\tan40(1 - \sin40)^2\left(\frac{4}{B}\right)$$

Assume $D_f/B < 1$
$F_{\gamma d} = 1$
Combining with (a) with the above and solving for B
B= 1.714m
$D_f/B < 1$, our assumption is OK

Example 3

$B = 1.5$ m, $L = 1.5$ m; $e_L = 0.3$ m and $e_B = 0.15$. $D_f = 0.7$ m, $\phi = 30$, $c = 0$, $\gamma = 18\ kN/m^3$
Determine Q_{ult}.

Solution

B' = 1.5 - 2x0.3 = 0.9 m

L' = 1.5 - 2x0.15 = 1.2 m

[1]For shape factors, B = B′

$$F_{qs} = 1 + \frac{B'}{L'}\tan\phi = 1 + \frac{0.9}{1.2}\tan 30 = 1.433$$

≥ 0.6, OK

$$F_{\lambda s} = 1 - 0.4\left(\frac{B'}{L'}\right) = 1 - 0.4\left(\frac{0.9}{1.2}\right) = 0.7$$

For depth factors, B = B

$D_f/B = 0.7/1.5 < 1$

q = 18×0.7 = 12.6 kPa

$$F_{qd} = 1 + 2\tan 30(1 - \sin 30)^2 \frac{0.7}{1.5}$$

= 1.135

$F_{\gamma d} = 1$

For $\phi = 30$, [2]$N_q = 18.4$ and $N_\gamma = 22.4$

$$q_u = 16.74 \cdot 64.2 \cdot 1.84\left(1 + 2\tan 40(1 - \sin 40)^2\left(\frac{4}{B}\right)\right) + \frac{1}{2}\cdot(18.3 - 9.81)\cdot B \cdot 109.4 \cdot 0.6 \cdot 1$$

$q_{ult} = qN_qF_{qs}F_{qd}F_{qi} + 0.5\,\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$

$q_{ult} = 12.6\times18.4\times1.433\times1.135 + 0.5\times18\times0.9\times22.4\times0.7\times1$

$q_{ult} = 504.1$ kPa

$Q_{ult} = q_{ult} \times B'\times L' = 0.9\times1.2\times504.1 =$ **542 kN**

Other method 605.95 kN

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[1] *From* Table *11.2*

[2] Table *11.1*