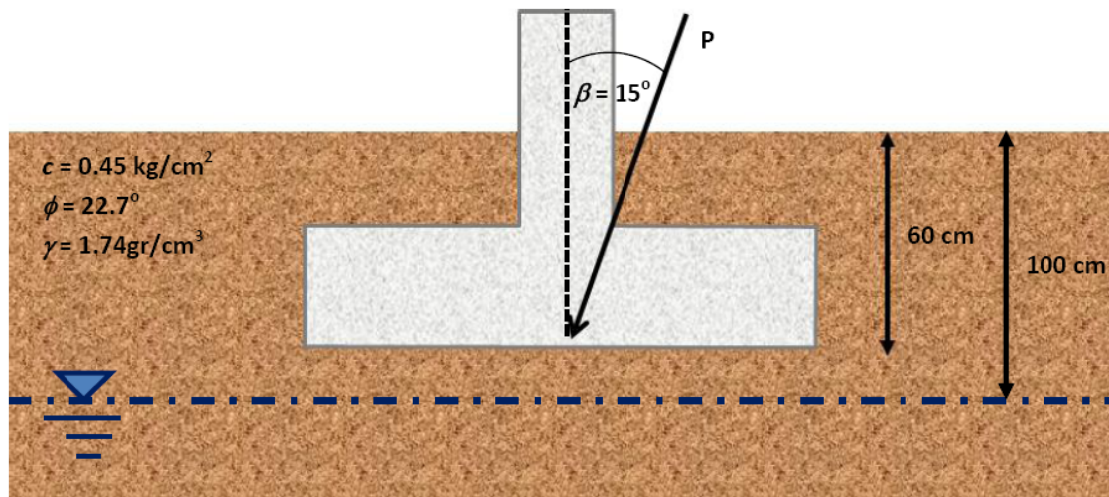


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Soal No. 1

Kasus diilustrasikan pada gambar berikut:



Kedalaman tapak dari permukaan tanah:

$$Df = 0.6 \text{ m}$$

Tegangan vertikal efektif di bawah tapak fondasi:

$$\begin{aligned} q &= \gamma \times Df \\ &= 0.6 \times 1.74 \\ &= 1.044 \text{ ton/m}^2 \end{aligned}$$

Koefisien daya dukung:

$$Nq = 8.4$$

$$Nc = 17.7$$

$$N\gamma = 7.86$$

a. Fondasi persegi dengan dimensi $B \times L = 80 \text{ cm} \times 80 \text{ cm}$

Koreksi berat volume efektif tanah:

$$\begin{aligned} \bar{\gamma} &= \gamma' + (\gamma - \gamma') d/B \\ &= 0.74 + (1.00) 0.4/0.6 \\ &= 1.41 \text{ ton/m}^3 \end{aligned}$$

Faktor Bentuk, dengan $(B/L) = 1$ (persegi)

$$\begin{aligned}
 F_{cs} &= 1 + (B/L) (N_q/N_c) \\
 &= 1 + (1) (8.4/17.7) \\
 &= 1.475
 \end{aligned}$$

$$\begin{aligned}
 F_{qs} &= 1 + (B/L) \tan \phi \\
 &= 1 + 1 \tan 22.7^\circ \\
 &= 1.418
 \end{aligned}$$

$$\begin{aligned}
 F_{\gamma s} &= 1 - 0.4 (B/L) \\
 &= 0.6
 \end{aligned}$$

Faktor Kedalaman (untuk $Df/B \leq 1$)

$$\begin{aligned}
 F_{cd} &= 1 + (0.4)(Df/B) \\
 &= 1 + (0.4) (0.6/0.8) \\
 &= 1.3
 \end{aligned}$$

$$\begin{aligned}
 F_{qd} &= 1 + 2 \tan \phi (1 - \sin \phi)^2 (Df/B) \\
 &= 1 + 2 \tan 22.7^\circ (1 - \sin 22.7^\circ)^2 (0.6/0.8) \\
 &= 1.237
 \end{aligned}$$

$$F_{\gamma d} = 1$$

Faktor Inklinasi Beban

$$\begin{aligned}
 F_{ci} &= (1 - \beta / 90)^\beta \\
 &= (1 - 15/90)^\beta \\
 &= 0.694
 \end{aligned}$$

$$\begin{aligned}
 F_{qi} &= F_{ci} \\
 &= 0.694
 \end{aligned}$$

$$\begin{aligned}
 F_{\gamma i} &= (1 - \beta / \phi)^\beta \\
 &= (1 - 15/22.7)^\beta \\
 &= 0.115
 \end{aligned}$$

Daya dukung batas:

$$\begin{aligned}
 q_{ult} &= cN_c F_{cs} F_{cd} F_{ci} + qN_q F_{qs} F_{qd} F_{qi} + 0.5\gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i} \\
 &= (4.5) (17.7) (1.475) (1.3) (0.694) + (1.044) (8.4) (1.418) (1.237) (0.694) + \\
 &\quad 0.5 (1.41) (0.8) (7.68) (0.6) (1) (0.115) \\
 &= 105.994 + 10.675 + 0.3 \\
 &= 116.968 \text{ ton/m}^2
 \end{aligned}$$

Daya dukung netto:

$$\begin{aligned}
 q_{net} &= q_{ult} - q \\
 &= 116.968 - 1.044 \\
 &= 115.924 \text{ ton/m}^2
 \end{aligned}$$

b. Fondasi segi empat dengan dimensi B x L = 40 cm x 160 cm

Koreksi berat volume efektif tanah:

$$\begin{aligned}\bar{\gamma} &= \gamma' + (\gamma - \gamma') d/B \\ &= 0.74 + (1.00) 0.4/0.4 \\ &= 1.74 \text{ ton/m}^3 \quad (\gamma \text{ tidak dikoreksi})\end{aligned}$$

Faktor Bentuk, dengan (B/L) = 40/160 = 0.25

$$\begin{aligned}F_{cs} &= 1 + (B/L) (N_q/N_c) \\ &= 1 + (0.25) (8.4/17.7) \\ &= 1.119 \\ F_{qs} &= 1 + (B/L) \tan \phi \\ &= 1 + (0.25) \tan 22.7^\circ \\ &= 1.105 \\ F_{\gamma s} &= 1 - 0.4 (B/L) \\ &= 1 - 0.4 (0.25) \\ &= 0.9\end{aligned}$$

Faktor Kedalaman (untuk Df/B > 1)

$$\begin{aligned}F_{cd} &= 1 + (0.4) \tan^{-1}(Df/B) \quad (\text{nilai } \tan^{-1} \text{ dalam radian BUKAN derajat}) \\ &= 1 + (0.4) \tan^{-1} (0.6/0.4) \\ &= 1.393 \\ F_{qd} &= 1 + 2 \tan \phi (1 - \sin \phi) \tan^{-1}(Df/B) \\ &= 1 + 2 \tan 22.7^\circ (1 - \sin 22.7^\circ) \tan^{-1} (0.6/0.4) \\ &= 1 + 2 (0.418) (1 - 0.386) (0.983) \\ &= 1.505 \\ F_{\gamma d} &= 1\end{aligned}$$

Faktor Inklinasi Beban

$$\begin{aligned}F_{ci} &= (1 - \beta/90)^2 \\ &= (1 - 15/90)^2 \\ &= 0.694 \\ F_{qi} &= F_{ci} \\ &= 0.694 \\ F_{\gamma i} &= (1 - \beta/\phi)^2 \\ &= (1 - 15/22.7)^2 \\ &= 0.115\end{aligned}$$

Daya dukung batas:

$$\begin{aligned}q_{ult} &= cN_c F_{cs} F_{cd} F_{ci} + qN_q F_{qs} F_{qd} F_{qi} + 0.5\gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i} \\ &= (4.5) (17.7) (1.119) (1.393) (0.694) + (1.044) (8.4) (1.105) (1.505) (0.694) +\end{aligned}$$

$$\begin{aligned}
 & 0.5 (1.74) (0.4) (7.68) (0.9) (1) (0.115) \\
 & = 86.164 + 9.69 + 0.277 \\
 & = 96.131 \text{ ton/m}^2
 \end{aligned}$$

Daya dukung netto:

$$\begin{aligned}
 q_{net} &= q_{ult} - q \\
 &= 96.131 - 1.044 \\
 &= 95.087 \text{ ton/m}^2
 \end{aligned}$$

Berdasarkan tinjauan tersebut, diperoleh bahwa daya dukung netto untuk fondasi persegi lebih besar dibandingkan fondasi segi empat, walaupun dengan luas yang sama. Namun demikian, **kesimpulan ini belum tentu dapat diberlakukan untuk setiap kasus yang berbeda.**

Soal No. 2

Kedalaman tapak dari permukaan tanah:

$$D_f = 0.6 \text{ m}$$

Tegangan vertikal efektif di bawah tapak fondasi:

$$\begin{aligned} q &= \gamma \times D_f \\ &= 0.4 \times 19.2 \\ &= 7.68 \text{ kPa} \end{aligned}$$

a. Daya dukung dengan metode Terzaghi:

Koefisien daya dukung (dari grafik):

$$\begin{aligned} N_c &= 30 \\ N_q &= 17 \\ N_\gamma &= 13 \end{aligned}$$

Daya dukung tanah dengan kondisi *general shear failure*:

$$\begin{aligned} Q_{ult} &= 1.3 c \cdot N_c + q \cdot N_q + 0.4 \gamma \cdot B \cdot N_\gamma \\ &= (1.3 \times 15.3 \times 30) + (7.68 \times 17) + (0.4 \times 19.2 \times 1.2 \times 13) \\ &= 596.7 + 130.56 + 119.808 \\ &= 847.068 \text{ kPa} \\ q_{net} &= Q_{ult} - q \\ &= 847.068 - 7.68 \\ &= 847 \text{ kPa} \end{aligned}$$

b. Daya dukung dengan metode Meyerhof:

Koefisien daya dukung:

$$\begin{aligned} N_q &= 13.94 \\ N_c &= 24.85 \\ N_\gamma &= 15.55 \end{aligned}$$

Faktor Bentuk, dengan $(B/L) = 1$ (persegi)

$$\begin{aligned} F_{cs} &= 1 + (B/L) (N_q/N_c) \\ &= 1 + (1) (13.94/24.85) \\ &= 1.561 \\ F_{qs} &= 1 + (B/L) \tan \phi \\ &= 1 + (1) \tan 27.5^\circ \\ &= 1.521 \\ F_{\gamma s} &= 1 - 0.4 (B/L) \\ &= 0.6 \end{aligned}$$

Faktor Kedalaman (untuk $D_f/B \leq 1$)

$$\begin{aligned}
 F_{cd} &= 1 + (0.4)(D_f/B) \\
 &= 1 + (0.4)(0.4/1.2) \\
 &= 1.133
 \end{aligned}$$

$$\begin{aligned}
 F_{qd} &= 1 + 2 \tan \phi (1 - \sin \phi)^2 (D_f/B) \\
 &= 1 + 2 \tan 27.5^\circ (1 - \sin 27.5^\circ)^2 (0.4/1.2) \\
 &= 1.101
 \end{aligned}$$

$$F_{\gamma d} = 1$$

Faktor Inklinasi Beban

$$\begin{aligned}
 F_{ci} &= (1 - \beta / 90) ^2 \\
 &= (1 - 0/90) ^2 \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 F_{qi} &= F_{ci} \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 F_{\gamma i} &= (1 - \beta / \phi) ^2 \\
 &= (1 - 0/27.5) ^2 \\
 &= 1
 \end{aligned}$$

Daya dukung batas:

$$\begin{aligned}
 Q_{ult} &= cN_c F_{cs} F_{cd} F_{ci} + qN_q F_{qs} F_{qd} F_{qi} + 0.5\gamma B N_{\gamma} F_{\gamma s} F_{\gamma d} F_{\gamma i} \\
 &= (15.3) (24.85) (1.561) (1.133) (1) + (7.68) (13.94) (1.521) (1.101) (1) + \\
 &\quad 0.5 (19.2) (1.2) (15.55) (0.6) (1) (1) \\
 &= 672.436 + 179.284 + 107.482 \\
 &= 959.202 \text{ ton/m}^2
 \end{aligned}$$

Daya dukung netto:

$$\begin{aligned}
 q_{net} &= q_{ult} - q \\
 &= 959.202 - 7.86 \\
 &= 951.342 \text{ kPa}
 \end{aligned}$$

Pada kasus ini, daya dukung yang diperoleh melalui persamaan Meyerhof lebih besar dari metode Terzaghi. Namun demikian, **kesimpulan pada kasus ini ini belum tentu dapat diterapkan dalam kasus lain.**

Soal No. 3

Tegangan vertikal efektif di bawah tapak fondasi:

$$\begin{aligned} q &= (\gamma_1 \times Z_1) + (\gamma_2 \times Z_2) \\ &= (17.8 \times 1.0) + (18.7 \times 0.4) \\ &= 25.28 \text{ kPa} \end{aligned}$$

Parameter tanah ekuivalen ditentukan sebagai berikut:

$$\begin{aligned} \gamma_{eq} &= \frac{\gamma_1 B_1 + \gamma_2 B_2}{B_1 + B_2} \\ &= \frac{(18.7)(0.6) + (18.1)(0.6)}{0.6 + 0.6} \\ &= 18.4 \text{ kN/m}^3 \\ \tan \phi_{eq} &= \frac{B_1 \tan \phi_1 + B_2 \tan \phi_2}{B_1 + B_2} \\ &= \frac{(0.6)(\tan 35^\circ) + (0.6)(\tan 32^\circ)}{0.6 + 0.6} \\ &= 0.6625 \\ \phi_{eq} &= \tan^{-1} (0.6625) \\ &= 33.53^\circ \\ c_{eq} &= \frac{c_1 B_1 + c_2 B_2}{B_1 + B_2} \\ &= \frac{(0)(0.6) + (4)(0.6)}{0.6 + 0.6} \\ &= 2 \text{ kPa} \end{aligned}$$

Koreksi nilai berat volume efektif ekuivalen:

$$\begin{aligned} \bar{\gamma} &= 8.4 + (10) (1.1/1.2) \\ &= 17.57 \text{ kN/m}^3 \end{aligned}$$

Koefisien daya dukung untuk $\phi = 33.53^\circ$ (lihat grafik):

$$\begin{aligned} Nc' &= 22 \\ Nq' &= 10.5 \\ Ny' &= 8 \end{aligned}$$

Daya dukung batas dengan metode Terzaghi:

$$\begin{aligned}q_{ult} &= 0.867cN_c + qN_q + 0.4 \gamma B N_\gamma \\&= (0.867) (2) (22) + (25.28) (10.5) + (0.4) (17.57) (1.2) (8) \\&= 38.15 + 265.44 + 67.47 \\&= 371.06 \text{ kPa}\end{aligned}$$

Daya dukung izin yang diperoleh:

$$\begin{aligned}q_{izin} &= (q_{ult} - q) / FK \\&= (371.06 - 25.28) / 2.5 \\&= 138.31 \text{ kPa}\end{aligned}$$

Beban yang diizinkan untuk sistem ini:

$$\begin{aligned}P_{izin} &= q_{izin} \times A \\&= 138.31 \times (1.2 \times 1.2) \\&= 200 \text{ kN}\end{aligned}$$