Name : Sarmad Mahmood

ID : 7828

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Teacher : Engr. Liaquat

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Q # 1a

Define the following terms:

- **Plastic Equilibrium:** A body of soil is said to be in state of plastic equilibrium if every part of soil is on the verge of failure.

- **Angular Distortion:** It is defined as the ratio between the relative deflection between the 2 points in a foundation and the distance between them is called angular distortion.

- **Ultimate Bearing Capacity:** It is defined as the gross pressure intensity at the base of foundation which would cause shear failure and is called ultimate bearing capacity.

- **Poission Ratio of Soil:** It is defined as, poission ratio (n) is the -ve ratio of transversal strain to the axial strain in an elastic material which is subjected to an un-axial stress.

Q#1b

→ **Given data:**

$H = 6\ cm$

$C = 0$

$\phi = 30^\circ$

$\gamma = 19.2\ kN/m^3$

Slope $H = 1$ $V = 3$

→ **Required:**

$N_a/b = ?$

$V_a/b = ?$

→ **Solution:**

$$\frac{P_a}{b} = \frac{\gamma + H^2 + ka}{2}$$

$$\beta = \tan \beta = 1/3$$

$$\beta = \tan^{-1}(1/3)$$

$$= 18^\circ$$

$$Ka = \cos\beta \times \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

$$= \cos(18) \times \frac{\cos(18) - \sqrt{\cos^2(18) - \cos^2(30)}}{\cos(18) + \sqrt{\cos^2(18) - \cos^2(30)}}$$

$$Ka = 0.3948 = 0.395$$

$$P_a/b = \frac{19.2 \times (6)^2 \times 0.395}{2}$$

$$= 136.512 \text{ KN/m}$$

$$\frac{N_a}{b} = \frac{P_a}{b} \cos \beta$$

$$= 136.512 \times \cos(18)$$

$$= 129.83 \text{ KN/m}$$

$$\frac{V_a}{b} = \frac{P_a}{b} \sin \beta$$

$$= 136.512 \times \sin(18)$$

$$= 42.18 \text{ KN/m}$$

Result:

→ $\frac{N_a}{b} = 129.83$ KN/m

→ $\frac{V_a}{b} = 42.18$ KN/m

Q# 2 a

→ **Bearing Capacity:-** The engineering property of soil due to which it resist the applied load. Denoted by "q".
In other words the internal strength of soil is called bearing capacity.

→ **Factors effecting bearing capacity:**
① Relative density of soil
② Depth of footing.
③ Breadth of footing.
④ Unit weight of soil
⑤ Water Table.

→ **Relative Density of soil:** More relative density of soil more will be its angle of friction and more will be Nq, Nc and Nr. With increase of this bearing capacity increases.

→ **Depth of footing:** With the increase of depth of foundation the bearing capacity of soil will increase. This increase will be more if soil is dense.

→ **Breadth of foundation:-** More the breadth of foundation more will be the bearing capacity of soil.

→ **Unit weight of soil:** Bearing capacity of soil is directly propotional to unit weight of soil. The bearing capacity of soil increase with increase in unit weight.

→ **Water table:** As water table comes near the surface bearing capacity decreases.

Scanned with CamScanner

Q# 2b

Given data: $L = 3m$, $B = 2m$, $D = 1.6m$

$F.O.S = 3$, $\gamma = 18 kN/m^3$, $\phi = 20^\circ$, $C_u = 20$ kN/m^3

Requirement: $q_s = ?$

Solution:

$q_u = CN_c S_c d_c + qN_q S_q d_q + \frac{1}{2}\gamma \cdot B \cdot N_\gamma \cdot d_\gamma \cdot S_\gamma$

First for shape factor:

$\alpha = (45 + \phi/2) = (45 + 20/2)$

$= 55^\circ$

$S_c = 1 + 0.2(B/L)\tan^2\alpha$ $\therefore B/L = 2/3$

$S_c = 1.27 = 1.3$ $\alpha = 55$

$S_q = S_\gamma = 1 + 0.1 \, B/L \tan^2\alpha$

$= 1.14$

Depth factor :-

$d_c = 1 + 0.2\,(D/B)\tan\alpha$

$= 1 + 0.2\,(1.6/2)\tan 55$

$d_c = 1.23$

$d_\gamma = d_q = 1 + 0.1\,(D/B)\tan\alpha$

$= 1.11$

$q_u = C \cdot N_c \cdot S_c \cdot d_c \times q \cdot N_q \cdot d_q \cdot S_q + 1/2\,\gamma \cdot B \cdot N_\gamma \cdot d_\gamma \cdot S_\gamma$

$= (20 \times 1.42 \times 1.3 \times 1.23) + ((18 \times 1.6) \times 64 \times 1.11 \times 1.14)$

$+ ((0.5)\,20 \times 2 \times 2.9 \times 1.11 \times 1.14)$

$q_u = 762\ kN/m^2$

$q_{n-u} = q_u - \bar{S} \qquad \bar{S} = \gamma \times D$

$= 762\ kN/m^2 - (18 \times 1.6)$

$= 733.2\ kN/m^2$

$q_{n-s} = \dfrac{q_{n-u}}{F.O.S}$

$= 244.4\ kN/m^2$

$q_s = q_{n.s} + \gamma$

$= 244.4 + (1.6 \times 18)$

$= 273.2\ kN/m^2$

Total safe load on rectangular footing.

$A \times q_s = (2 \times 3) \times 273.2$

$= 1639.2\ kN$

Q# 3a

→ **Settlement:** When load is applied on the ground surface it will produce effective vertical stresses, due to these stresses effective vertical strain will be produced as a result of which the movement will occur in the downward direction. This downward movement is called settlement.

→ **Types of settlement:**

1) Total settlement
2) Differential settlement

Divided on the basis of movement of structure.

1) **Total settlement:** Also called uniform settlement. A type in which each part of the structure will settle equally. In Uniform settlement the failure of the structure is not much considered as with differential settlement.

2) Differential settlement: Settlement in different parts of the same structure is known as differential settlement. It is more dangerous than total settlement. Causes more damage to the structure.

→ **Types of differential settlement:**

There are two types
1) Tilt
2) Angular distortion.

Q# 3b

→ Given data :

$C_c = 0.31$, $P_1 = 130\ kN/m^2$ $e_o = 1.02$

$P_2 = 170\ kN/m^2$ $H = 5\ m$

→ Required : void ratio , $e_1 = ?$

$S_c = ?$

→ Solution :

$$C_c = \frac{\Delta e}{\log_{10}(P_2/P_1)}$$

$$= \frac{e_0 - e_1}{\log_{10}(P_2/P_1)}$$

$$0.31 = \frac{1.02 - e_1}{\log_{10}(170/130)} \longrightarrow e_1 = 0.54$$

Now $S_c = \frac{H}{1+e_o} \times 0.31 \log_{10}(170/130) \times 1000\ mm$

$S_c = 1003.427$

→ Result :

$e_1 = 0.54$

$S_c = 1003.427$.

End of paper.