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Subject : Geotechnical and Foundation Engineer

Semester 6th

Section B

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Q: No: 01: Part a)

Define the following terms

1) Plastic Equilibrium:

It is defined as "The state of stress within a soil mass or a portion there of that has been deformed to such an extent that its ultimate shearing resistance is mobilized.

2) Ultimate Bearing capacity:

It is the least pressure which would cause shear failure of the supporting soil immediately below and adjacent to a foundation. The ultimate bearing capacity is defined as.

The maximum gross pressure intensity at the base of the foundation at which the soil does not fail in shear. when the term bearing capacity is used.

3) Compressive Index:

The compressive Index is used to find the settlement in the normally consolidated clay. The total stress applied is larger than the stress in the field, to which the soil sample has been undergone in the part this kind of clayey soil is said to be normally consolidated clay

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4) **Angular Distortion:**

When two foundations support wall/columns settle unequally it means the structure is subjected to angular distortion.

5) **Puission Ratio of soil:**

It is the negative ratio of transversal strain to the axial strain in an elastic material which is subjected to uniaxial stress.

Q: No:: 01, Part b)

A 6m tall cantilever wall retaining the soil that has the following properties

- $C = 0$
- $\phi = 30^\circ$
- $\gamma = 19.2\ KN/m^3$

And the ground surface behind the wall is inclined at a slope of 3 horizontal and 1 vertical. The wall has moved sufficiently to develop active condition. Determine the total normal and shear forces acting on the back of this wall using Rankine's theory.

Given data:

$H = 6m$

$c = 0$

$\phi = 30^\circ$

$\gamma = 19.2\ kN/m^2$.

slope = Horizontal = 1

vertical = 3

Required:

$\frac{N_a}{b} = ?$

$\frac{V_a}{b} = ?$

Sol:

$$\frac{P_a}{b} = \frac{\gamma \times H^2 \times k_a}{2}$$

$B = \tan B \left(\frac{1}{3}\right)$

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$\beta = 18^{0}$

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

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

$K_a = 0.3948$

$K_a = 0.395$

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

$= 136.512$ kN/M

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

$= 136.512 \times \cos(18)$

$\boxed{\frac{N_a}{b} = 129.83 \text{ kN/m}}$

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

$= 136.512 \times \cos(18)$

$\boxed{\frac{V_a}{b} = 42.18 \text{ kN/M}}$

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Q:No:: 02

Part:: a) : What is Bearing capacity. Also write factor effecting Bearing capacity.

Ans:: Bearing capacity:

The load-carring capacity of foundation soil or rock which enables it to bear and transmit loads from a structure.

OR

It is an engineering property of soil ~~higher will~~ ~~the value~~ due to which the soil resist the applied load.

- The bearing capacity is also known as the internal strength.
- It is denoted by "q"

Factor Affecting Bearing capacity:

Following are the factor that effect Bearing capacity.

1) Relative Density:

- Greater the relative density of soil Higher will be the value of Angle of internal friction "Ø" Higher the value of terzaghi bearing factor. (N_q, N_c, N_γ).
- Greater the value of N_c, N_γ, N_q will result in high value of bearing capacity.

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- The soil having enough relative Density will have enough bearing capacity.

- Relative Density => $\gamma_{relative} = \frac{e_m - e}{e_{max} - e_{min}}$

2) Depth of footing:

The bearing capacity of soil increase with the increase of the depth of footing.

- This increase will be maximum for the dense soil as compared to loose soil.

3) Breath of Footing:

More the breath of footing or foundation more will be the bearing capacity of soil.

- It will be more in case of dense soil/sand as compared with loose or medium soil.

4) Unit weight of soil:

Bearing capacity of soil is directly proportional to unit weight of soil increase with increase in its weight.

- It will be more in case of dense soil.

5) Water Table:

As the water take comes near to footing, the bearing capacity get decrease.

Q:: No:: 02. Part:: b

What is the maximum safe load which can be supported by rectangular footing 2m by 3m with a safety factor of 3. The base of footing is at 1.6m below the ground surface. The unit weight of soil is $18 kN/m^3$, The angle of shear resistance $\phi = 20^\circ$ ($N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 2.9$) unit cohesion $C_u = 20 kN/m^2$ use meyerhof analysis.

Given data:

$L = 3m$

$B = 2m$

$D_f = 1.6m$

$F.O.S = 3$

$\gamma = 18 kN/m^3$

$c = 20 kN/m^2$

$\phi = 20^\circ$

Required:

$q_s = ?$

Solution:

$$q_u = cN_c \cdot s_c d_c i_c + qN_q \cdot s_q d_q i_q + \frac{1}{2} \gamma N_\gamma \cdot s_\gamma d_\gamma i_\gamma$$

First For the Slope Factor.

$$\alpha = \left(45 + \frac{\phi}{2}\right)$$

$$= \left(45 + \frac{20}{2}\right)$$

$$= 55^\circ$$

$$S_c = 1 + 0.2 \frac{B}{L} \tan^2\alpha$$

$$= 1 + 0.2 \left(\frac{2}{3}\right) \tan^2 55$$

$$= 1.27 \approx 1.3$$

$$S_q = S_\gamma = 1 + 0.1 \frac{B}{L} \tan^2\alpha$$

$$= 1 + 0.1 \frac{2}{3} \tan^2 55$$

$$= 1.14$$

Depth factor:

$$d_c = 1 + 0.2 \frac{D}{B} \tan\alpha$$

$$= 1 + 0.2 \frac{1.6}{2} \tan 55$$

$$= 1.23$$

$$d_\gamma = d_q = 1 + 0.1 \frac{D}{B} \tan\alpha$$

$$= 1 + 0.1 \left(\frac{1.6}{2}\right) \tan 55$$

$$= 1.11$$

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Now putting values

$q_u = (c N_c \cdot s_c \cdot d_c \cdot i_c + q N_q \cdot d_q \cdot s_q \cdot i_q + \frac{1}{2} \gamma N_\gamma \cdot s_\gamma \cdot d_\gamma \cdot i_\gamma)$

$= (20 \times 14.8 \times 1.3 \times 1.23 \times 1) + (18 \times 1.6 \times 6.4 \times 1.11 \times 1.11 \times 1)$

$+ (0.5 \times 20 \times 2 \times 2.9 \times 1.11 \times 1.14 \times 1)$

$q_u = 762 \ kN/m^2$

$q_{n.u} = q_u - \bar{\sigma}$

$= 762 - (18 \times 1.6)$

$= 733.2 \ kN/m^2$

$q_{n.s} = \frac{q_{n.u}}{F.O.S} = \frac{733.2}{3} = 244.4 \ kN/m^2$

$q_s = q_{n.s} + \bar{\sigma}$

$= 244.4 + (18 \times 1.6)$

$= 273.2 \ kN/m^2$

Total safe load on rectangular footing:

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

$= 1639.2 \ kN$

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Q:No:03
Part:2
What is settlement. What are its types Explain in detail?

Ans:

Settlement:

Definition:

When a soil deposite is loaded, deformation will occur due to change in stress. The total vertical downward deformation at the surface resulting from the load is called settlement.

Type of settlement:

ON the basis of movement of structure it is divided into two types

- Total settlement
- Diffrential settlement

- **Total settlement:**

- Also known as a uniform settlement.
- When all the points settle with an equal amount, the settlement is known as uniform settlement.

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This type of settlement may not endanger the structure stability but generally affects the utility of the structure by jamming doors and damaging the utility lines (sewers, water supply, mains etc)

Limitation For Total settlement:

The soil layer to which the load is to be transfer should be sufficient in bearing to resist the load which is to be applied on it.

- To spread the comming load load over large area.

Differential settlement:

- When different parts of a structure settle by different magnitude, the settlement is called differential settlement.
- Differential settlement is more danger or considerable as compared with total or uniform settlement, because it causes more damage to a structure as compared to total settlement.
- if soil is granular, then differential settlement will be 2/3 of the total maximum settlement.

Types of Differential settlement:

Differential settlement is of two types.

- Tilt
- Angular Distortion

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Q:No: 3
Part b:

A soil has compressive index $C_c = 0.31$, At a stress 130 KN/m², the void ratio was 1.02. calculate

1) The void ratio if the stress on the soil is increased to 170 KN/m²

2) The total settlement of the stratum of 5m thickness.

Given data:

$C_c = 0.31$

$P_1 = 130 \, kN/m^2$

$P_2 = 170 \, KN/m^2$

$e_0 = 1.02$

$H = 5m$

Required:

$e_1 = ?$

$S_c = ?$

Solution:

$$C_c = \frac{\Delta e}{\log\left(\frac{P_2}{P_1}\right)}$$

$$\frac{e_0 - e_1}{\log_{10}\left(\frac{P_2}{P_1}\right)}$$

$$0.31 = \frac{1.02 - e_1}{\log_{10}\left(\frac{170}{130}\right)}$$

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$$e_1 = 0.983$$

Now

$$S_c = \frac{H}{1+Se} \times C_c \log_{10}\left(\frac{P_2}{P_1}\right)$$

$$= \frac{5}{1+0.2} \times 0.31 \log_{10}\left(\frac{170}{130}\right) \times 1000$$

$$= 2.417 \times 0.03611 \times 1000$$

$$= 0.08920 \times 1000$$

$$S_c = 89.39\,mm$$

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