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SECTION B

SUBJECT GEOTECHNICAL ENGINEERING

SUBMITTED TO : ENGR. LIAQAT

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MID EXAM

QUESTION 01 (a)

Define the following terms

PLASTIC EQUILIBRIUM:

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

2) ANGULAR DISTORTION:

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

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 past This kind of clayey soil is said to be normally consolidated clay.

4) ULTIMATE BEARING CAPACITY:

It is the least pressure which whould cause shear failure if 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.

5) POISSION RATIO OF SOIL:

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

QUESTION 01 (b)

A 6m tall contilever 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 horizental 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 Rankin's theory.

GIVEN DATA:

$H = 6m$

$C = 0$

$\phi = 30^\circ$

$\gamma = 19.2 \, KN/m^3$

Slope = Horizental = 1

Vertical = 3

REQUIRED:

$\frac{Na}{b} = ?$,

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

SOLUTION:

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

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

$$\beta = 18^0$$

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

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

$$K_a = 0.3948$$

$$K_a = 0.395$$

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

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

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

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

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

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

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

$$\boxed{\frac{V_a}{b} = 42.18 \text{ KN/m.}}$$

Question 02 (a)

What is bearing Capacity, Also write factors effecting bearing capacity.

Bearing Capacity:

The load-carrying 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 due to which the soil resist the applied load.

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

Factors Affecting Bearing Capacity:

Following are the factors that effect Bearing Capacity

1) Relative Density

- Greator the relative density of soil higher will be the value of angle of internal friction "ϕ" Higher the value of internal friction higher will be the value of terzaghi bearing factors (N_q, N_c, N_γ).
- Greator the value of N_c, N_γ, N_q will result in high value of bearing capacity.

- 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) BREADTH OF FOOTING:

More the breadth 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. The bearing capacity of soil increases with increase in its unit weight.

- It will be more in case of dense soil.

5) WATER TABLE

As The water table comes near to footing, the bearing capacity get decreases.

QUESTION 02 (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/m³, The angle of shear resistance $\phi = 20^\circ$ ($N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 2.9$) Unit cohesion ~~Cu = 20~~ $C_u = 20\ kN/m^2$ 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 Shape 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 :

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

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

$$= 1.23$$

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

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

$$= 1.11$$

Now Putting Values.

$$q_u = (c N_c \cdot S_c \cdot d_c \cdot i_c + \bar{q} N_q \cdot d_q \cdot S_q \cdot i_q + \tfrac{1}{2} \gamma B N_\gamma \cdot S_\gamma \cdot d_\gamma \cdot i_\gamma$$

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

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

$$q_u = 762 \text{ KN/m}^2$$

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

$$= 762 - (18 \times 1.6)$$

$$= 733.2 \text{ KN/m}^2$$

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

$$= \frac{733.2}{3} = 244.4 \text{ KN/m}^2$$

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

$$= 244.4 + (18 \times 1.6)$$

$$= 273.2 \text{ KN/m}^2.$$

Total safe load on rectangular Footing :

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

$$= 1639.2 \text{ KN}$$

QUESTION 03 (a)

What is settlement. What are its types explain in detail?

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.

OR

When load is applied on the ground surface this will produce effective vertical stresses, due to these stresses the 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:

On the basis of movement of structure it is divided into two types.

- Total Settlement
- Differential Settlement

TOTAL SETTLEMENT :

- Also known as uniform settlement.
- When all the points settle with an equal amount, the settlement is known as uniform settlement.
- This type of settlement is possible only under rigid foundation loaded with uniform pressure and resting on uniform soil deposite, which is very rare possibility.
- 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 (sewer, 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 coming load over a 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
- In case of coheive soil, possible differential settlement is about 1/3 of the maximum settlement.

Types Of Differential Settlement:

Differential Settlement is of two types

- Tilt
- Angular Distortion.

QUESTION 03 (b)

A soil has compressive index $C_c = 0.31$. At a stress $130\ kN/m^2$, the void ratio was 1.02 Calculate.

1. The void ratio if the stress on the soil is increased to $170\ kN/m^2$.
2. The total settlement of the stratum of 5m thickness.

GIVEN DATA

$C_c = 0.31$

$P_1 = 130\ kN/m^2$

$e_0 = 1.02$

$P_2 = 170\ kN/m^2$

$H = 5m.$

REQUIRED :

$e_1 = ?$

$S_c = ?$

SOLUTION :

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

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

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

$$\boxed{e_1 = 0.983.}$$

Now

$$S_c = \frac{H}{1+e_0} \times C_c \log_{10}\left(\frac{P_2}{P_1}\right)$$

$$= \frac{5}{1+1.02} \times 0.31 \log_{10}\left(\frac{170}{130}\right) \times 1000$$

$$= 2.47 \times 0.03611 \times 1000$$

$$= 0.08920 \times 1000$$

$$\boxed{S_c = 89.29\,mm.}$$