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Section B

Subject Geotechnical Engineering

Semister 6th

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Q.No1:

A Define the following terms:

1. Plastic Equilibrium :-

Plastic Equilibrium State are this State When the Soil will near the to failure or verge to failure.

→ When the retaining Soil is homogeneous, Cohessionless Semiinfinite and dry

The friction resistance b/w the retained Soil and retaining Wall is neglected mean frictional resistance is zero.

The retained soil will be in State of plastic equilibrium.

2) Angular Distortion :-

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

OR

Angular distortion is the ratio of the differential settlement and the distance b/w two point.

$$\beta = \frac{\delta}{\ell}$$

Where

β = Angular distortion

δ = Differential settlement

ℓ = distance b/w two point

3) Compressive Index :-

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

Where

C_c = Compressive index

Δe = Change in Viod Ratio

P_1 = The pressure when the void ratio is e_1

P_2 = The pressure when the void ratio is e_2

Compressive Index in term of Mv

Mv = Change in Volume per unit volume of compressible layer

$Sc = H \times Mv \times \Delta P$

$$Mv = \frac{\Delta e / \Delta P}{1 + e_0}$$

4) Ultimate Bearing Capacity :- The maximum pressure at the base of footing with Shear failure in the Soil. It is donated by q_u.

Formula

$$q_u = CN_c S_c I_c d_c + qN_q S_q I_q d_q + 0.5 \gamma B N_\gamma S_\gamma I_\gamma d_\gamma$$

5) Poission Ratio of Soil :-

Poission Ratio is a measure of the Poission effect, that described the expansion or contraction of a material in the directions perpendicular to the direction of loading.

The value of Poission ratio is negative of the ratio of Transverse Strain to axial Strain.

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

- $C = 0$
- $\emptyset = 30°$
- $\square = 19.2\ kN/m^3$

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

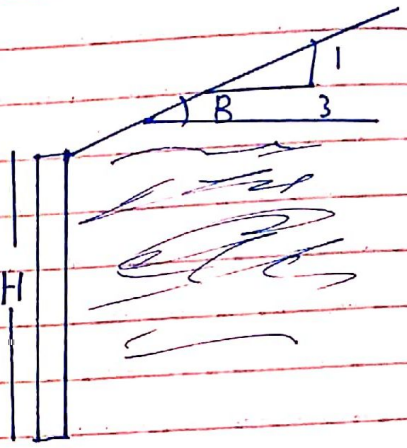
Given Data :-

Height = H = 6m

c = 0

$\Phi = 30^\circ$

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



Slope H = 3, V = 1

Required :

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

Solution :- As we know that

$$\frac{Pa}{b} = \frac{\gamma \times H^2 \times ka}{2} \longrightarrow eq(1)$$

first we find β

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

$$\beta = 18^\circ$$

As we know that

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

Now

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

B. $Ka = 0.3948$

$Ka = \boxed{0.395}$

eq(1) $\Rightarrow$ $\frac{Pa}{b} = \frac{\gamma \times H^2 \times Ka}{2}$

$= \frac{19.2 \times 6^2 \times 0.395}{2}$

$\frac{Pa}{b} = 136.512$ kN/m

To find Normal force $\left(\frac{Na}{b}\right)$

As we know that

$$\frac{Na}{b} = \frac{Pa}{b} \times \cos\beta$$

$$\frac{Na}{b} = 136.512 \times \cos(18)$$

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

To find Shear force $\left(\frac{Va}{b}\right)$

As we know that

$$\frac{Va}{b} = \frac{Pa}{b} \sin\beta$$

$$\frac{Va}{b} = 136.512 \times \sin(18)$$

$$\boxed{\frac{Va}{b} = 42.18 \text{ kN/m}}$$

QNo2)

A. What is Bearing Capacity. Also write factors effecting Bearing capacity

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

Factor Affecting of Bearing Capacity

1) Relative density of soil :- If the Relative density of soil is greater The value of angle of internal friction will be greater, Higher will be Tarzaghi bearing capacity factor due to which the value of bearing capacity will increase

2) Depth of footing :- With the increase of depth of the foundation the bearing capacity of soil will increase This increase will be more in case of dense sand / soil as compared with loose or medium sand / soil

3) Width of footing :- If the width of footing increase the bearing Capacity also increase and Highes will Terzaghi bearing Capacity factor.

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 / sand as compared with loose or medium soil / sand.

5) Water Table :- As water table comes near to footing, the bearing Capacity get decreases.

6) Cohesion of Soil :- If the cohesion of the soil is more cohesion value, the bearing Capacity is also increase with them.

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 resisting $\phi = 20°$ ($N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 2.9$) Unit cohesion $C_u = 20$ kN/m². Use Meyerhof analysis.

Given Data :-

$L = 3m$, $B = 2m$

$D_f = 1.6m$

$F.O.S = 3$

$\gamma = 18$ kN/m³

$C = 20$ kN/m²

$\phi = 20°$

$N_c = 14.8$, $N_q = 6.4$ $N_\gamma = 2.9$

Required :- $q_s = ?$

Solution:- As we know that

$$q_u = CN_c s_c I_c d_c + q N_q s_q I_q d_q + 0.5 \gamma B N_\gamma s_\gamma d_\gamma I_\gamma$$

Now $I_c = I_q = I_\gamma = 1$

Thus $q_u = CN_c s_c d_c + q N_q s_q d_q + 0.5 \gamma B s_\gamma d_\gamma N_\gamma \rightarrow X$

First for the shape factor

$$\alpha = 45 + \frac{\phi}{2}$$

$$= 45 + \frac{26}{2}$$

$$\alpha = 55^\circ$$

Now

$$s_c = 1 + 0.2 \left(\frac{B}{L}\right) \tan^2 \alpha$$

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

$$s_c = 1.3$$

Q > 10, then $S_\gamma = S_q = 1 + 0.1\left(\frac{B}{L}\right)\tan^2\alpha$

$S_\gamma = S_q = 1 + 0.1\left(\frac{2}{3}\right)\tan^2(55)$

$S_\gamma = S_q = 1.14$

Depth factor:

$d_c = 1 + 0.2\left(\frac{D}{B}\right)\tan\alpha$

$d_c = 1 + 0.2\left(\frac{1.6}{2}\right)\tan(55)$

$d_c = 1.23$

Now

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

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

$d_\gamma = d_q = 1.11$

$q = \gamma \times D$

$q_u = C N_c S_{cd} c + q N_q S_{qd} + 0.5 \gamma B N_\gamma S_{\gamma d} \gamma$

$q_u = (20 \times 14.8 \times 1.3 \times 1.23) + (18 \times 1.6) \times 6.4 \times 1.1 \times 1.14) + (0.5 \times 20 \times 2 \times 2.9 \times 1.11 \times 1.14)$

$q_u = 762 \ kN/m^2$

Now

$q_{n.u} = q_u - \bar{\delta}$ $\quad \bar{\delta} = \gamma \times D$

$q_{n.u} = 762 - (18 \times 1.6)$

$q_{n.u} = 733.2 \ kN/m^2$

Thus

$$q_{n.s} = \frac{q_{n.u}}{FOS}$$

$$= \frac{733.2}{3}$$

$q_{ns} = 244.4 \ kN/m^2$

Now

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

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

$q_s = 273.2 \ KN/m^3$

Total Safe load on Rectangular footing

$A \times q_s$

$(2 \times 3) \times 273.2$

$1639.2 \ KN$

Q No 3.

A. What is Settlement. What are its types explian in detail?

Ans: Settlement:-

When the load is applied on the ground surface this will be produced effective vertical stress. due to these stress the effective vertical Strain will be produced as a result of which the movement will occur

in the downward movement is called Settlement.

Type of Settlement :-

There are two types of settlement on the bases of movement of structure.

1) Total Settlement :-

→ This is the type of settlement also called uniform settlement.

→ In total settlement each part of structure will settle equally

→ In uniform settlement the faiclure of the structure is not much as considered as with the differential settlement.

→ A uniform settlement mostly occur in that structures which are constructed in rigid footing.

→ In this type of settlement the utility services such as water supply, Electricity, Sewerage telephone etc.

Limition 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.

2) Differential Settlement :-

→ Differential Settlement in different part of some structure is called differential Settlement.

→ Differential Settlement are more danger or undesirable as compared with total / uniform Settlement, because it causes more damage to a structure as compalled to total / uniform Settlement.

Types of Differential Settlement

1) Tilt :-

If the entire structure rotate due to unequal settlement is called tilt.

2) Angular Distortion :-

When two foundation support wall or column settle unequally its mean that the structure to angular distortion

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 soil is increased to 170 kN/m².
2. The total settlement of the Stratum of 5m thickness.

Given Data.

$C_c = 0.31$

$P_1 = 130\ kN/m^2$

$e_0 = 1.02$

$P_2 = 170\ kN/m^2$

$H = 5m$

Required:-

$e_1 = ?$

$S_c = ?$

Solution:- As we know that

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

$$C_c = \frac{e_0 - e_1}{\log\left(\frac{P_2}{P_1}\right)}$$

$$0.31 = \frac{1.02 - e_1}{\log\left(\frac{70}{136}\right)}$$

$$0.31 = \frac{1.02 - e_1}{0.1165}$$

$$0.0361 = 1.02 - e_1$$

$$e_1 = 1.02 - 0.0361$$

$$e_1 = 0.984$$

2. $S_c = ?$

$$S_c = \frac{H}{1+e_o} \times C_c \log\left(\frac{P_2}{P_1}\right)$$

$$S_c = \frac{5}{1+1.02} \times 0.31 \log\left(\frac{170}{130}\right)$$

$$S_c = 0.08939\ m$$

$$S_c = 89.3978\ mm$$