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Q1:-

(A): Define the following terms.

(1):- plastic Equilibrium :- The state of stress with in 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 :- The ultimate bearing capacity is the gross pressure at the base of the foundation at which soil fails in shear.

(3):- Angular Distortion :- Angular distortion b/w two points under a structure is equal to the differential settlement b/w the points divided by the distance b/w them. Angular distortion is also known as relative rotation.

(4): Compressive Index :- it is used to find the settlement is the normally consolidated clay. The total stress is applied is longer than the stress in the field to which the soil sample has been under gone in the part. This kind of clayey soil is said to be be normally consolidated clay.

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(5) Poission ratio of Soil & it is the negative ratio of transversal Strain to the axial Strain in an elastic material which is subjected uniaxial Stress.

(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 inclind 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 Rankine theory.

Given data :-

Cohesion = C = 0

Angle of Interval friction = $\phi = 30^\circ$

Unit weight of soil = γ = $19.2 \, KN/m^3$

Horizontal slope = 3

Vertical slope = 1

Required :-

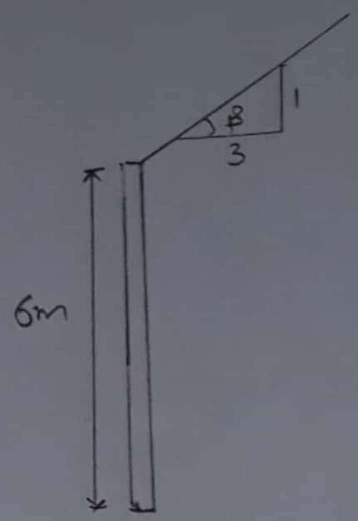
Total normal force = $\frac{N_a}{b}$ = ?

Total Shear force = $\frac{V_a}{b}$ = ?

Sol:

As we know that Active force is given by

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



As $\tan(\beta) = P/B$

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

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

$$\boxed{\beta = 18^\circ}$$

Also K_a is given by

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

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

$$K_a = 0.951 \times \frac{0.951 - \sqrt{0.904 - 0.75}}{0.951 + \sqrt{0.904 - 0.75}}$$

$$K_a = 0.3948$$

$$\boxed{K_a = 0.395}$$

Now by formula

$$\text{Active force} = \frac{P_a}{b} = \frac{\gamma . H^2 . K_a}{2}$$

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

$$\frac{P_a}{b} = 136.512 \text{ KN/m}$$

$$\boxed{P_a/b = 136.52 \text{ KN/m}}$$

As the normal force is

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

$$\frac{N_a}{b} = 136.52 \times \cos(18)$$

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

As the shear force is

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

$$\frac{V_a}{b} = 136.52 \times \sin(18)$$

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

(Q2):-

(A): What is Bearing capacity. Also write factors effecting bearing capacity.

Ans:- Bearing capacity :- In geotechnical Engineering bearing capacity is defined as the engineering property of the Soil due to which it resist the applied load. it is denoted by "q".

In other words the internal strength of the soil is called bearing capacity.

Factors effecting bearing capacity :- They are.

(1):- Relative density of the Soil :- More the relative density of the Soil more will be its angle of friction. More will be the N_q, N_c, N_γ with increase of this (N_q, N_c, N_γ) the bearing capacity will increase.

This will increase more for dense soil/sand as compared with medium and loose.

$N_q, N_c, N_\gamma \rightarrow$ Terzaghi bearing capacity factors.

(2): Depth of the footing :- With the increase of depth (d_f) of the foundation the bearing capacity of Soil will increase.

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

(3): Breath of footing :- The footing / foundation breath is more and also bearing capacity ~~is more~~ of soil is more.
it will be more in case of dense soil/sand as compared with loose or medium soil.

(4): Unit weight of soil :- Bearing capacity 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 ~~near~~ table comes near to footing the bearing capacity get decreases.

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

Given data:

Footing dimensions = 2m x 3m (b=3, h=2)
Facter of Safty = 3
Depth of foundation = D_f = 1.6m
Unit weight of Soil = γ = 18 KN/m^3
Angle of Shear resistance = ϕ = 20°
Unit cohesion = Cu = 20 kN/m^2

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

Required:-

Maximum safe load = q_s = ?

Sol:- According to Mayerhof's Analysis

$$q_u = C \cdot N_c \cdot S_c \cdot d_c + q \cdot N_q \cdot S_q \cdot d_q + \frac{1}{2} \gamma B N_\gamma S_\gamma d_\gamma$$

For Shape factors:- (S_c, S_q, S_γ)

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

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

$$\alpha = (45 + 20/2) \Rightarrow \boxed{\alpha = 55°}$$

put in eq (i)

$$S_c = 1 + 0.2 (2/3) \tan^2 (55)$$

$$\boxed{S_c = 1.27}$$

As $\phi > 10^\circ$, So

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

$$S_q = S_\gamma = 1 + 0.1 (2/3) \tan^2(55)$$

$$\boxed{S_q = S_\gamma = 1.135}$$

For depth factors :- (d_c, d_q, d_γ)

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

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

$$\boxed{d_c = 1.22}$$

Also $\phi > 10^\circ$ So

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

$$d_q = d_\gamma = 1 + 0.1 (1.6/2) \tan 55$$

$$\boxed{d_q = d_\gamma = 1.11}$$

Inclination factors :-

For $\theta = 0^\circ$

$$i_c = i_q = i_\gamma = 1$$

By formula

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

$$= (20)(14.8)(1.27)(1.22) + [(1.6 \times 18)](6.4)(1.135)(1.11)$$

$$+ \frac{1}{2}(18)(2)(2.9)(1.11)(1.135)$$

$q_u = 762\ KN/m^2$

As Net ultimate bearing capacity is

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

$q_{n.u} = 762 - (1.6 \times 18)$ ∵ $\bar{\sigma}$ = overburden pressure

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

Net Safe bearing capacity is

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

Safe bearing capacity is

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

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

$\boxed{q_s = 273.2\ KN/m^2}$

This Safe bearing capacity over the whole footing will be

$A \times q_s = 273.2\ (6m^2)$

$= \boxed{1639.2\ KN}$

Q3:

(A) What is settlement. what are its types explain in detail?

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

Types of settlement :- On the basis of movement of the structure divide into two types.

(1) Total Settlement
(2) Differential settlement.

(1) Total Settlement :- When all the point settle with an equal amount the settlement is known as uniform settlement it is also known as Total settlement.

In uniform settlement the failure of the structure is not much as considered as with the differential settlement.
it is mostly take place in the structure which are constructed in rigid footing/raft.
The utility services such as water supply electricity, sewage line, telephone etc. may be decreased and the structure will remain sound.

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 alarge area.

(2): Differential settlement:- When different parts of a structure settle by different magnitude the settlement is called differential settlement it is very danger as compared to total settlement because it causes more damage as compared to total settlement / uniform settlement.

Types of differential settlement:- Differential settlement is of two types

(i) Tilt:- If the entire structure rotate due to unequal settlement is called tilt.

(ii): Angular Distortion:- When two foundations support walls/columns settle unequally it means the structure is subjected to angular distortion.

Q3(B): A soil has compressive index $C_c = 0.31$. At a stress $130\ KN/m^2$ the void ratio was 1.02 calculate

(i) 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:

Compressive Index of soil $= C_c = 0.31$

Initial stress/ Pressure $= P_1 = 130\ KN/m^2$

Initial void ratio $= e_0 = 1.02$

Increased or Final stress/pressure (P_2):

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

Stratum thickness $= H = 5m$

Required:-

$e_1 = ?$

$S_c = ?$

Sol:- As compressive index is given by

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

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

$$0.31 \times 0.1165 = 1.02 - e_1$$

~~$e_1 = 0.31 \times 0.1165$~~

$$\boxed{e_1 = 0.984}$$

By formula

consolidation settlement is

$$S_c = \frac{H}{1+e_o} \times C_c (\log_{10}) (P_2/P_1)$$

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

$$S_c = 0.0893m \times 1000 mm$$

$$\boxed{S_c = 89.3 m}$$

The End