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Q1a

Define the following term.

1) **plastic Equilibrium:-** The state of stress within a soil mass or a portion there for that has been deformed to such an extent that is ultimate shearing resistance is mobilized.

(2) **Angular Distortion:-** β is the ratio of the differential settlement δ and the distance l b/w two points. it is crucial before hand the range of tilt to understand distortion that will possibly caused and angular damage to the structure. unacceptable

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 feild, 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:- In geotechnical eng. bearing capicity is the capacity of soil to support the load applied to the ground. Ultimate bearing capicity is the theoritical maximum pressure which can be supported without failure allowable bearing capacity is the ultimate Bearing capacity divide by factor of safety

5) poission Ratio of Soil: plainly poission ratio(n) is the negative of ratio of transversal strain to the axial strain in a plastic material which is subjected to an uniaxial stress.

Material : poission's ratio

Saturated clay : 0.40 – 0.50

Clay : 0.30 — 0.45

Sand : 0.20 — 0.45

Q1b

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 shape of 3 horizental and 1 verticle. The wall has moved suffeciently to develope 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

Verticle = 3

Required

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

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

Sol

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

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

$\beta = 18^\circ$

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

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

$K_a = 0.3948$

$K_a = 0.395$

Now

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

$= 136.512\ KN/m$

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

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

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

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

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

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

Q2 What is Bearing capacity. Also write factor effecting Bearing capacity.

Sol:- **Bearing Capacity:-** In geotechnical engineering bearing capacity is the capacity of soil to support the load applied to the ground. The bearing capacity of soil is the maximum average contact pressure b/w the foundation and the soil which should not produce shear failure in the soil.

Factor Effecting Bearing capacity

1) Effect of shape of footing on Bearing capacity:- The shape of footing is an important parameter which govern the ultimate bearing capacity of soil. In general strip square rectangular and circular shaped footing are used. For soil 1 by keeping other parameter constant the effect of shape of footing on ultimate bearing capacity of soil is studied. The value of ultimate bearing capicity of soil-1 are determined by

method given by Terzaghi and Bureu of Indian Standard.

2) Effect of depth of Footing on Bearing Capicity:-
The depth of footing is important parameter which govern the ultimate bearing capacity of soil For different soil by keeping other paramenter Contant. the effect of depth of strip footing on ultimate bearing capacity of soil is studied. In this study it is assumed that irrespective of variation in depth of foundation the properties of soil remain constant. The value of ultimate bearing capicity determined for different soil by IS code method.

3) Effect of width of footing ON Bearing Capacity:-
The width of footing is important parameter which govern the ultimate bearing capacity of soil. For different soil by keeping other parameter constant. The effect of width of strip footing on ultimate bearing capacity of soil is studied. The value of ultimate bearing capacities determined

for different soil by IS code Method.

Q2b 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 $\phi = 20°$ ($N_c = 14.8$ $N_q = 6.4$, $N_\gamma = 2.9$) unit cohession $C_u = 20 KN/m^2$ use Meherhof analysis.

<u>Given da:-</u>

$L = 3m$

$B = 2m$

$D_f = 1.6m$

$F.O.S = 3$

$\gamma = 18 KN/m^3$

$c = 20 KN/m^2$

$\phi = 20°$

Required:-

$q_s = ?$

Sol

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

First For the shape factor.

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

$\alpha = 45 + \frac{20}{2} = 55°$

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

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

$S_c = 1.27 \simeq 1.3$

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

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

$S_q = 1.14$

Depth Factor:-

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

$d_c = 1 + 0.2 \frac{16}{2} \tan 55$

$d_c = 1.23$

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

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

$= 1.11$

Now putting values

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

$q_u = (20 \times 14.8 \times 1.3 \times 1.23 \times 1) + (18 \times 16 \times 6.4 \times 1.11 \times 1.11 \times 1)$

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

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

Q.No3 What are settlement. Whats are its types in explain?

Ans **Settlement:-** In geotechnical Engineering settlement is defined as The verticle moment of the ground generally caused by changes in stress with in the earth. Settlement is mostly likely to occur when increased verticle stresses are applied to the graund on or above soft or loose soil stala.

Types:

1) Immediate settlement.
2) Consolidation settlement (ΔHC)
3) Secondary settlement / creep (ΔHC)
4) Immediate settlement compaction.
5) Secondary compression/creep.
6) Sand.
7) clays.

1) **Immediate settlement:-** Immediate settlement take place as the load is applied or whith in a time period of about 7 days. predominate in cohesion less soil and unsaturated clay. Immediate settlement analyses are used for all fined-grained soil including silt and clay ~~with~~ with a degree of saturation 9%. and for all coarse grained soil with a large coefficient of permeability

2) Consolidation settlement: (ΔH_C)

consolidation settlement are time depadent and take month to year to develop The leaning tower of pisa in italy has been has been undergoing consolidaten settlement for over 700 yrs. The lean is caused by consolidation settlement being greater on one side This howeever is an extreme case The principle settlement for most project occur in 3 to 10 year. Dominate in saturated/nearly saturated fimed grained soil. When consolidation theory applies.
Here we are interested to estimated both consolidation settlement and how long a time it will take or most of the settlement to occur.

3) Secondary settlement/creep (ΔH_C).

occur under constant effective stress due to contineous rearrangement of clay particles into a more stable configuration. predominated in highly plastic clays and organic clay.

(4) Imediate settlement calculation:-
Immediate settlement computation
Formula.

$$\Delta H_I = q_o B \frac{1-\mu^2}{E_s} m I_s I_E$$

$$I_s = I_1 + \frac{1-2\mu}{1-\mu} I_2$$

The above equation Is is strictly applicable to flexible bases on the half space In practice most foundation are flexible because even every thick footing deflecte when loaded by superstructure load. If the base is rigid, reduce Is factor by about 7% The half space may consist of either cohession less material or any water content, or unsaturated cohessive soil.

(5) Secondary compressive/creep.

After primary consolidation The soil structure contineous to adjust the load for some addition time. The settlement is termed secondary consolidation / Secondary compression. At the end secondary The soil is reached to a new Ko-State

To find secondary consolidation settlement in the field (ΔH_s)

$$\Delta H_s = \Delta C_\alpha \log \frac{t_{100(f)} + \Delta t}{t_{100(f)}}$$

6) Sands:-

Maximumum total settlement = 40mm for isolated footing 40 to 65 mm for rafts

Maximum differential settlement b/w adjacent columns = 25mm

(7) Clays:-

Maximum total settlement = 65mm for isolated footings = 65 to 100mm.

Maximum differential settlement b/w adjacent columns = 40mm.

The different settlement may also be evaluated in term of the angular distortion given by: $(\Delta H_{diff}) = \Delta / L$

Where Δ = relative settlement b/w two point and L = Horizontal distance b/w the two point.

Q3(B) A soil has compressive index ($C_c = 0.31$) at a stress of 120 kN/m² The void ratio was 1.02

Calculate

The void ratio if the stress on the soil is incread to 170 kN/m²

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/m²

Initial void ratio e_o = 0.21

Incresed or final stress/pressure P_2 = 170 kN/m²

Stratum thickness H = 5m

Required:

Final void ratio due to increased stress

$e_1 = ?$

Total consolidation settlement (S_c) = ?

Sol.

As compressive Index is given by

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

$$0.31 = \frac{1.02}{\log_{10}\left(\frac{170}{130}\right)} \Rightarrow 0.31 \times 0.1165$$

$$= 1.02 - e_1$$

$$e_1 = 0.984$$

By formula

Consolidation settlement

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

$$= \frac{5}{1+1.02} \times 0.31 \times \log_{10} \frac{170}{130}$$

$$= 0.0893 m \times 1000 mm$$

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