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Section # A

Subject # Geotechnical & Foundation Engineering.

Semester # 6th

Department # Civil Engineering

Exam # Mid Term

Q1 (A) Define the following terms?

1) Plastic equilibrium.
2) Angular Distoration.
3) Compressive index.
4) Ultimate Bearing Capacity.
5) Poission Ratio of Soil.

1) Plastic equilibrium:- The state of Stress within a Soil mass of a portion therest that has been deformed to such an extent that it ultimat shearing resistance is mobilized.

2) Angular Distortion:- The angular distortion is the angular change in relative position at members extending from a weld area. That there is shorter with of contracting weld Metal at the roof each weld than that at the face.

3) Compressive index:- The compressive is used to find the settlement in the normally consolidated clay the total stress in the field to which the soil sample has been under gone in the past this kind of clay soil is said to be normally consolidated clay.

4) Ultimate Bearing Capacity:- Denoted by (q/u)

The max pressure at the base of the footing which cause shear failure in the soil. The soil can be supported with out failure.

5) Poission Ratio of Soil:- The Poission ratio is the negative ratio of transverse to axial strain. The soil mechanic plainly poission ratio is the negative ratio of elastic material which is subject to an uniaxial stress.

Q1)

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 conditions. Determine the total normal & shear forces acting on the back of this wall using Rankine's Theory.

Given data:-

Cohesion $(c) = 0$

Angle of Internal Friction $(\phi) = 30^\circ$

Unit weight of Soil $(\gamma) = 19.2\ kN/m^3$

Horizontal Slope $= 3$

Verticle Slope $= 1$

Required:-

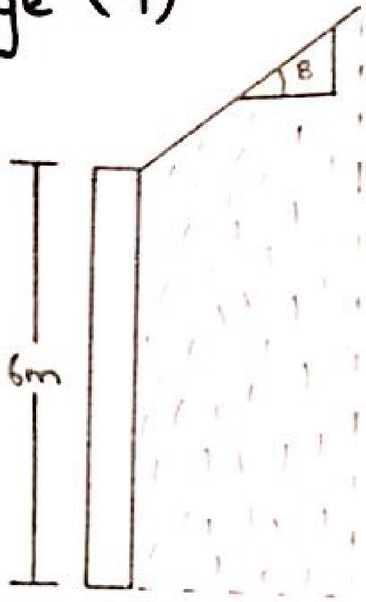
Total Normal Force $(N_a/b) = ?$

Total Shear Force $(V_a/b) = ?$

Solution:- As we know that

Active force is given by,

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



As $\tan(B) = \frac{\text{Perpendicular}}{\text{Base}}$

$\tan(B) = 1/3$

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

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

Also Ka is given by:

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

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

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

$K_a = 0.3948$

$K_a = 0.395$

Now By Formula

Active Force $P_{a/b} = \frac{\gamma \cdot H^2 \cdot k_a}{2}$

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

$P_{a/b} = 136.512 \text{ kN/m}$

$P_{a/b} = 136.52 \text{ kN/m}$

As the Normal Force is,

$N_{a/b} = P_{a/b} \cdot \cos\beta$

$= 136.52 \times \cos(18)$

$\boxed{N_{a/b} = 129.83 \text{ kN/m}}$

Also the Shear Force is,

$V_{a/b} = P_{a/b} \cdot \sin(B)$

$= 136.52 \times \sin(18)$

$\boxed{V_{a/b} = 42.18 \text{ kN/m}}$

Q2 What is Bearing Capacity Also write Factor effecting bearing capacity?

Ans <u>Bearing Capacity:-</u> The engineering property of Soil because of which when load is applied on the ground surface and this load is resisted then such capacity of Soil is called bearing capacity.

It is also called the internal Strength of the soil denoted by "q".

<u>Factors effecting Bearing Capacity.</u>

→ <u>Relative density of the Soil:-</u> Greater the Relative density of Soil higher will be the value of angle of internal friction (ø) and higher will be the Terzaghi bearing capacity Factors, (N_C, N_q, N_γ) due to which the value of Bearing capacity will increase.

→ <u>Depth of the footing:-</u>

As $q_u = C N_c + \gamma D_f N_q + \frac{1}{2} \gamma \cdot B \cdot N_\gamma$

So $q_u \propto D_f$

Soil type → dense
↓
will increase the q_u

The bearing capacity increase with increase of depth of the Footing this increase is maximum For the dense Soil as compared to loose sand.

Limitation for uniform | total Settlement:-

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

To spread the coming load over a large area.

2) Differential Settlement:-

Different Settlement in different parts of the same structure is called different settlement.

Differential Settlement is more danger or undesirable as compared with total uniform settlement because it causes more damage to a structure as compared to total uniform settlement.

Q2)

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 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 $\phi = 20°$ ($N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 2.9$). Unit cohesion $c_u = 20 kN/m^2$. Use Meyerhof analysis.

Given Data:-

Footing Dimensions = 2m x 3m (b=3, h=2)

Factor of Safety = 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 (c_u) = $20 kN/m^2$

$N_c = 14.8$

$N_q = 6.4$

$N_\gamma = 2.9$

Required:-

Maximum safe load (q_s) = ?

Solution:-

According to Meyerhof's Analysis

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

For shape Factors:- (S_c, S_q, S_γ)

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

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

$= 45 + 20/2$

$\boxed{\alpha = 55^0}$

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

$\boxed{S_c = 1.27}$

As $\phi > 10°$, so

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

$= 1 + 0.1\,(2/3)\tan^2(55)$

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

For Depth Factors: (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.22}$

Also $\phi > 10°$, 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 $\theta = 0°$

$i_c = i_q = i_\gamma = 1$

By Formula

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

$= (20)(14.8)(1.27)(1.22) + [(1.6 \times 18)](6.4)(1.135)(1.11) + \frac{1}{2}(18)(2)(2.9)(1.11)(1.135).$

$\boxed{q_u = 762\ kN/m^2}$

As net Ultimate Bearing Capacity is,

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

$= 762 - (1.6 \times 18)$

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

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,

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

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

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

This safe Bearing Capacity over the whole footing will be,

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

$$\boxed{= 1639.2\ kN}$$

Q3) A) What is Settlement what are it types explain in detail?

Ans **Settlement:-** When the load is applied on the ground surface this will produce effective verticle stressess due to which these stresses the effective verticle strain will be produced as result of which the movement will occur in the downward direction this downwald movement is called Settlement.

Types of Settlement:- On that basis of movement of the structure it is divided into two types.

1) Total Settlement
2) Differential Settlement

1) Total Settlement:- It is also called uniform settlement this type of Settlement each part of Structure will equally.

In the total Settlement mostly taue place in the structure which are constructed in rigid footing (ruft).

In this type of settlement the utility services such as water supply electricity Sewage line telephone e.t.c may be decreased & the Struct will Sound.

→ **Widith of the footing:-** The bearing capacity increase of weidth of the footing will increase will be max for the dense soil as compared to base sand.

Footing will be the bearing capacity is also increase.

Unit weight of the Soil:-

$q_u = CN_c + \gamma D_f N_q + 1/2 \gamma . B N_\gamma$

increase γ will increase in q_u.

Bearing capacity of soil the bearing capacity of bearing capacity of soil is directly proportional to unit weight of soil the bearing capacity of soil increase it will be more incase of dense soil/send as compared with or medium soil/sand.

Water table:- A water table come neal to footing the bearing capacity get decrease.

Water table is indirect relation with bearing capacity due to the water shear strength & the soil Particles reduce hence bearing capacity is decrease.

Cohesion of the Soil:- The bearing capacity of soil is more cohesion value to the bearing capacity is increase with this cohesion of the soil.

Q3)

Part (B):- A Soil has compressive index Cc = 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:-

Compressive Index of Soil (C_c) = 0.31

Initial Stress/Pressure (P_1) = 130 kN/m²

Initial void ratio (e_0) = 1.02

Increased or Final Stress/Pressure (P_2) = 170 kN/m²

Stration thickness (H) = 5m

Required:-

Final void ratio due to increased stress (e_1) = ?

Total (Consolidation) Settlement (S_c) = ?

Solution:-

As Compressive Index is given by,

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

$$0.31 = \frac{1.02 - e_1}{\log_{10}(170/130)} \Rightarrow 0.31 \times 0.1165 = 1.02 - e_1$$

$$\boxed{e_1 = 0.984}$$

By Formula:-

Consolidation Settlement is,

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

$$= 5/1+1.02 \times 0.31 \times \log_{10}(170/130)$$

$$= 0.0893m \times 1000mm$$

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