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Section A

Semester 6th

Subject : Geotechenical & Foundation Engineering

Q No 1

A. Define the following terms.

1. Plastic Equilibrium:-

A plastic equilibrium is that state in which a soil mass is on the verge of failure.

When irreversible strain take place at a constant stress or we can say that in state every point in given soil mass is at verge of failure.

2. Angular Distortion:-

It is ratio of differential settlement and distance between two points.

$$B = \delta / l$$

B = Angular distortion

δ = Differential settlement

l = Distance b/w two points.

3. Compressive Index:-

It is used to find the settlement in normal consolidated clay.

$$Cc = \frac{\Delta e}{\Delta \log \bar{\sigma}'}$$

Cc = compressive index

Δ = void ratio

$\Delta \log \bar{\sigma}'$ = Difference in effective stress taken in log scale.

4- Ultimate Bearing Capacity

It is the theortical maximum pressure which can be supported without failure.

OR

The maximum pressure at the base of footing which causes shear failure in soil

It is denoted by "qu"

5- Poission Ratio :-

It is the measure of poission effect, that describes the expansion and contraction of material in direction perpendicular to direction of loading.

The value of poission ratio is ~~measure~~ negative of ratio of transverse strain to axial strain.

Q1(B)

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

$C = 0$

$\phi = 30°$

$\gamma = 19.2 kN/m^3$

And ground surface . . . . . theory.

Given Data

Cohesion $(c) = 0$

Angle of internal friction $(\phi) = 30°$

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

Horizontal slope $= 3$

Vertical slope $= 1$

Required :-

Total normal force $\left(\frac{Na}{b}\right) = ?$

Total shear force $\left(\frac{Va}{b}\right) = ?$

Sol :-

As we know

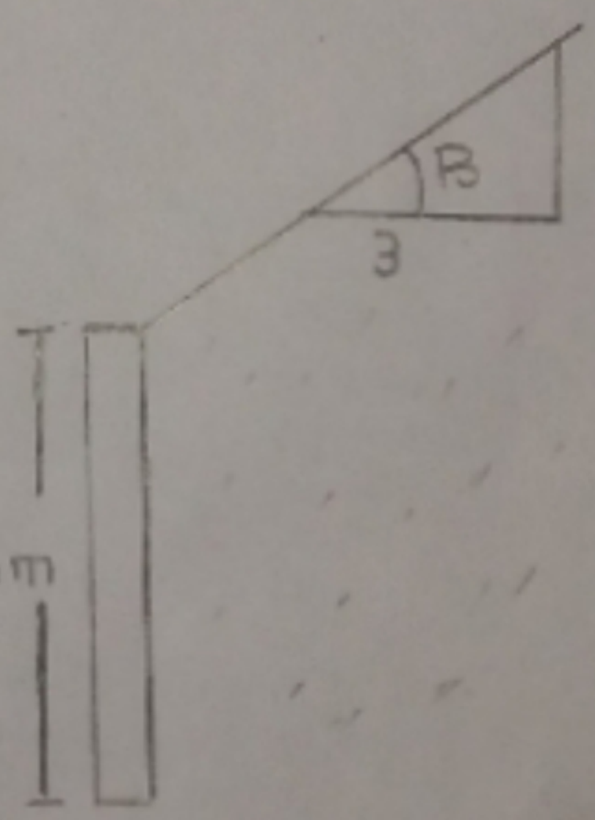
$$\frac{Pa}{b} = \frac{\gamma H^2 ka}{2}$$

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

$\tan(B) = 1/3$

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

$B = 18°$



ka is given

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

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

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

$ka = 0.3948$

$ka = 0.395$

By formula

Active Force. $\frac{Pa}{b} = \frac{\gamma H^2 ka}{2}$

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

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

$\frac{Pa}{b} = 136.52 kN/m.$

To find Normal force.

$\frac{Na}{b} = \frac{Pa}{b} \cos B$

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

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

Shear Force

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

$= 136.52 \times \sin(18)$

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

Q2(A)

What is Bearing capacity. Also write factors affecting bearing capacity.

Bearing Capacity:-

Bearing capacity is the Engineering property of soil because of which load is applied on ground surface and this load is resisted.

It is the capacity of soil to support load applied on the material.

Factors Affecting Bearing capacity:-

1. Relative Density:-

If relative density of soil is greater then greater will be the value of internal friction Higher will be tarazghi bearing capacity factor due to which value of bearing capacity will increase.

2. Depth of footing:-

Bearing capacity increases with increase in depth of footing.

3. Width of footing:-

If width of footing increase then bearing capacily also increases.

4. Unit Weight of soil:-

Bearing capacity is directly proportional to unit weight of soil which means with increase in unit weight of soil bearing capacity increases.

5. Water Table:-

Bearing capacity is indirectly related with water table. due to water the shear strength b/w soil reduces hence bearing capacity got decrease.

Q2 (B)

What is maximum safe load which can . . . . . analysis?

Given Data

Footing Dimension = 2m × 3m (b=3, h=2)
Factor of safety = 3.
Unit weight of soil (γ) = 18kN/m³
Depth of foundation Df = 1.6m
Angle of shear resistance (∅) = 20°
Unit cohesion (Cu) = 20kN/m²
Nc = 14.8
Nq = 6.4
Nγ = 2.9

Required

Maximum safe load (qs) = ?

Sol:-

According to Mayerhof's analysis

$$q_u = CN_c S_c t_c d_c + qN_q f_q d_q + \frac{1}{2}\gamma B N_\gamma f_\gamma d_\gamma$$

For slope Factor (S_c, S_q, S_γ)

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

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

$$\alpha = 45 + \frac{20}{2}$$

$$\alpha = 55^\circ$$

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

$$S_c = 1.27$$

As $\emptyset > 10°$, so

$S_q = S_r = 1 + 0.1 \left(\frac{B}{L}\right) \tan^2 \alpha$

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

$S_q = S_r = 1.135$

Now For Depth factor (d_c, d_q, d_r).

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

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

$d_c = 1.22.$

Also $\emptyset > 10°$, so

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

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

$d_q = d_r = 1.11$

Inclination Factor

For $\theta = 0°$

$i_c = i_q = i_\gamma = 1$

By formula.

$q_u = CN_c s_c . d_c + qN_q s_q d_q + \frac{1}{2} \gamma B N_\gamma d_r S_r$

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

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

$q_u = 762 kN/m^2$

Also net Bearing capacity

$q_s = q_{ns} + \bar{\gamma}$

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

$q_s = 273.2 kN/m^2$

Safe bearing capacity over whole footing

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

$A \times q_s = 1639.2 kN.$

Q3(A)

What is Settlement. What are its type write in detail?

Settlement:-

Settlement is downward movement of the ground caused by a load consolidating the soil below it or causing displacement of the soil. Settlement often refers to downward movement of ground.

When load is applied on ground it produces effective vertical stress because of these stresses effective vertical strain is produced as a result of which settlement occur.

Types:-

Total Settlement:-

- It is also called uniform settlement.
- Each part of structure will settle equally in total settlement
- In uniform settlement the failure is not much as compared to differential settlement.
- It mostly occus in that structure which are constructe-d in rigid footing.
- Utility services such as water supply, electricity, sewage line, telephone line may be decreased and structure remains sound in such type of settlement.

Limitation for uniform Settlement

The Soil layer to which load is applied should be sufficient in bearing to resist the load.
- To spread the load over a large area.

2) Differential Settlement:-

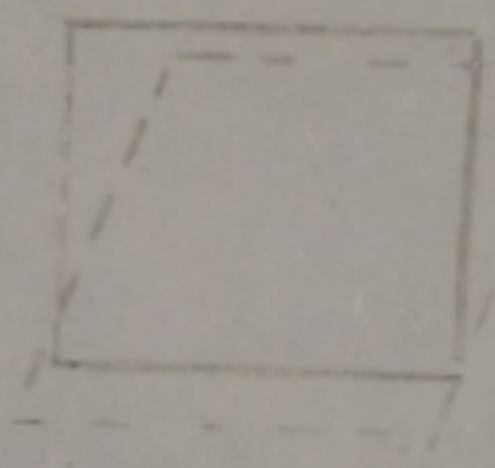
When different settlement occur in different parts of structure is called differential settlement.

Differential settlement is more dangerous as compared to uniform settlement.

Types of Differential Settlement:-

1) Tilt:-

In this type of settlement the entire structure rotates due to unequal settlement.



Angular Distorion:-

When two foundations wall settle unequally it means the structure is subjected to angular distorion.

Q3(B)

A soil has compressive index . . . . . thickness?

Given Data:-

Compressive index of soil (C_c) = 0.31

Initial Pressure (P_i) = 130kN/m²

Initial void ratio (e_o) = 1.02

Final pressure (P_2) = 170kN/m²

Stratum thickness (H) = 5m

Required:-

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

Total Settlement (S_c) = ?

Sol:-

Compressive Index is given by

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

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

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

$$e_1 = 0.984$$

NOW S_c :-

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

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

$$= 0.0893\,m \times 1000\,m$$

$$S_c = 89.3\,mm$$