Name:- Nadir Aziz Semester:- 10th

ID :- 7547 Subject:- Geotechnical Engineering.

: Instructor: Engr. Liaqat Bacha.

Q1:-

(A) Define the following terms.

(a) ~~Plastic limit~~

(i) Plastic Equilibrium.

A body of soil is in a state of plastic equilibrium if every part of it is on the very of failure.

⇒ Plastic equilibrium that can be developed samaltanouly through out a semi finite mass of soil caused by no force other than gravity.

(ii) Angular Distance:-

When two foundations supports wall/columns settles unequally its means the structure is subjected to angular distortion.

(iii) Compressive Index:⇒

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

Where,

Δe = change in void ratio.

P_1 = Is the pressure when the void ratio is e_1

P_2 = Is the pressure when the void ratio is e_2.

(iv) Ultimate bearing capacity:-

The maximum Pressure at the base of footing with shear failure in the soil. It is denoted by q_u.

(v) Poission ratio of Soil:-

It is the ratio of transurse contraction starin in the direction of stretching force. It is also called poisson coefficient

Q1 B:- A 6 m tall contilever 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 slop of 3 horizontal & 1 vertical. - of this wall using Rankine's theory.

*Given Data.

Cohesion (C) = 0

Angle of internal Friction (ϕ) = 30°

Unit weight of Soil (γ) = 19.2 kN/m³

Horizontal Slope = 3

Vertical Slope = 1

* Required:

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

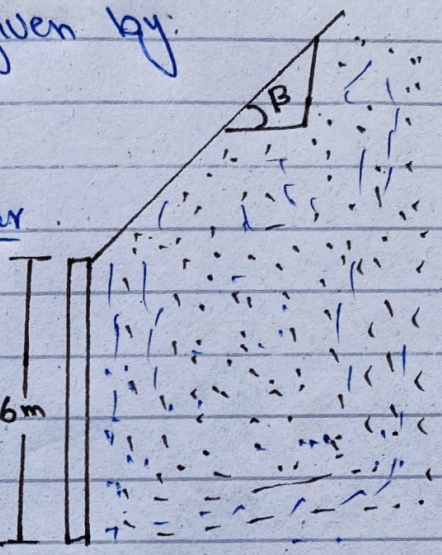
Total shear force $\left(\frac{Va}{b}\right) = ?$

* ~~Sto~~ * Solution.

As we know that:

Active Force is given by:

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



As $\tan(\beta) = \frac{\text{Perpendicular}}{\text{base}}$

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

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

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

Also ka is given by

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

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

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

$ka = 0.3948$ $\boxed{ka = 0.395}$

Now By Formula.

Active Force $\frac{Pa}{b} = \frac{\gamma \cdot H^2 \cdot K}{2}$

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

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

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

As the Normal force is.

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

$$= 136.53 \times \cos(18)$$

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

As the Shear Force is.

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

$$= 136.53 \times \sin(18)$$

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

Q2 A:- What is bearing capacity. Also write factor 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. Denoted by q.
In other words the internal strength of the soil is called bearing capacity.

* Factor Effecting of Bearing capacity.

(i) Relative Density of the Soil:-

More the relative density of the soil more will be its angle of friction. More will be ~~its~~ the N_q, N_c, N_r. With increase of this (N_q, N_c, N_r) the bearing capacity will increase.

This will increase more for dense soil/sand as compared with medium and base, N_q, N_c, N_r = Terzaghi bearing capacity factors.

(ii) Depth of footing:-

The bearing capacity of soil increase with the increase of the depth of footing. This increase will be maximum for the dense soil as compared to loose soil.

(iii) Breadth of the foundation:-

More the breadth of foundation more will be the bearing capacity of soil. It will be more in case of dense soil/sand as compared with loose or ~~medium~~ medium soil.

(iv) Unit weight of Soil:-

Bearing capacity of soil is directly proportional to unit weight of soil increase with increase in it weight.
It will be more in case of dense soil.

(v) Water Table:-

As the water take comes near to footing, the bearing capacity get decrease.

Q2

B What is the maximum safe load which can be supported by rectangular footing 2m by 3m with a safety factor of 3. - The angle of shear resisting $\phi = 20^\circ$. ($N_c = 14.8$, $N_q = 6.4$, $N_r = 2.9$) Unit cohesion $C_u = 20 kN/m^2$. Use Meychrof analysis.

*Given Data.

Footing dimension = 2m x 3m (b=3, h=2)
Factor of Safty = 3
Depth of foundation (Df) = 1.6m
Unit weight of Soil (γ) = 18 kN/m³
Angle of Shear resistance (ϕ) = 20°
Unit cohesion (C_u) = 20 kN/m²
N_c = 14.8
N_q = 6.4
N_r = 2.9

* Required:-

Maximum Safe load (q_s) = ?

* Solution

According to Mayerhof's Analysis,

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

=> For Shape Factor:- (S_c, S_q, S_γ)

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

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

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

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

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

$\boxed{S_c = 1.27}$

As $\phi > 10$, So

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

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

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

For depth Factor:- d_c, d_q, d_γ

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

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

$\boxed{d_c = 1.22}$

Also $\phi > 10$, So

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

d_{q_2} $dr = 1 + 0.1 \left(\frac{1.6}{2}\right) \tan(55)$

$\boxed{d_q = dr = 1.11}$

Inclination Factor:.

For $\theta = 0°$

$i_c = i_q = i_r = 1$

By formula

$q_u = c N_c . S_c . d_c + q_0 N_q . S_q . d_q + \frac{1}{2} \gamma . B . N_r . d_r . S_r .$

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

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

As Net ultimate Bearing Capacity is.

$q_{n.u} = q_u - \bar{5}$

$= 762 - (1.6 \times 18)$ $\because \bar{5}$ = over burden pressure

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

Net Safe Bearing Capacity is.

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

Safe Bearing Capacity is.

$q_s = q_{n.s} + \bar{3}$

$= 244.4 + (1.6 \times 18) \Rightarrow \boxed{q_s = 273.2 \text{ kN/m}^2}$

This Safe Bearing Capacity over the whole footing will be.

$\Rightarrow A \times q_s = 273.2 (6 \text{ m}^2)$

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

Q3

A= What is Settlement. What are its types explain in detail?

Ans. **Settlement:-**

When load is applied on the ground surface this will produce effective vertical stresses, due to these stresses the effective vertical strain will be produced as a result of which the movement of soil will occur in downward direction. The downward movement is called Settlement.

Types:.

(i) Total Settlement.

(ii) Differential Settlement.

* **(i) Total Settlement:-**

It is also called uniform settlement and in this type of settlement the structure will equally settle.

In uniform Settlement the failure of the structure not much as compared to the differential settlement.

The total Settlement mostly take place in the structure which are constructed on rigid footing (raft).

In this type of Settlement the utility services such as water supply, electricity, sewerage line telephone etc maybe decreased and the structure will remain sound/uneffected.

* Limitation for total Settlement:-

⇒ The soil layer to which the load is to be transferred should be sufficient in bearing to resist the load which is to be applied on it.

⇒ To spread a coming load over a large area.

(ii) Differential Settlement:-

Differential settlement is different part of the same structure is called differential settlment.

⇒ It is more dangrous than total settlement beacuse it causes more demage to a structure as compared to total settlement.

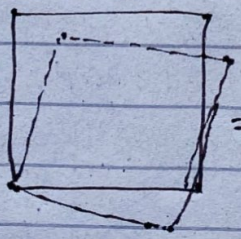
Types.

① Tilt

② Angular Distortion.

① Tilt :-

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



⇒ Base wise tilting.

② Angular Distortion:-

When two foundation suports wall/columns settles unequally it means the structure is subjected to angular distortion.

Q3B: A Soil have compressive index $C_c = 0.31$. At a stress 130 kN/m², the void ratio was 1.02 calculate.

i) The void ratio if the stress on the Soil increased to 170 kN/m².

(ii) 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:

$e_1 = ?$

$S_1 = ?$

* Solution

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

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

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

$$e = 0.983$$

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

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

$$= 0.0893m \times 1000mm$$

$$S_c = 89.3mm$$

The end.