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Section " "A"

Subject " Geotechnical and foundation Engineering

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Q2 Part "B"

A 6m tall contiever wall retaning the soil that has the folloaing porperties;

- $C = 0$
- $\phi = 30^\circ$
- $\gamma = 19.2\ KN/m^3$

and the grand surface behind the wall is Inclined at a slope of 3 horizental and 1 vertical : the wall has moved sufficiently to develop a active condition. Determine the total normal and shear forces acting on the back of this wall using Ranking's theory:-

Given data:-

Cohesion $(c) = 0$

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

unit weight of Soil $(\gamma) = 19.2\ KN/m^3$

Horizontal slop = 3

vertical slop = 1

Required:-

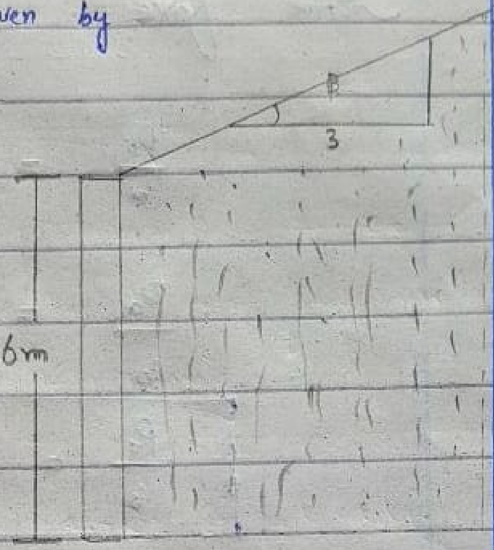
Total normal force $\left(\frac{Na}{b}\right) = ?$

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

Solution:-

As we Know

Active force is given by



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

As $\tan(\beta) = \frac{P}{B}$

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

$$(\beta) = \tan^{-1}\left(\frac{1}{3}\right)$$

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

Also Ka is given by

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

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

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

$$K_a = 0.3948$$

$$\boxed{K_a = 0.395}$$

(B)

Now by formula:-

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

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

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

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

Q1 Part "A"

1) Plastic equillibrium:-

Plastic equillibrium is a stat of parmanent change of stat when stressed. or it is the stage when irrversible strain take place due to the application of constant stress

Example:- is the land mass filling.

2- Angular Distortion:-

→ it is the ratio of the differential sattelment and the distance I b/w two point.

→ It is the unequal settement of two foundation support columns/wall of the structure.

3) Compressive Index

The compression Index used to find the sattlement in the normal conslidation clay. The total stress applied is larger than the stress in the field.

to which the soil sample has been undergone in the past. This kind of clayey soil is called normally consolidated clay.

The expression to find the the compression index is given below.

$$C_c = \frac{\Delta e}{\Delta \log \sigma'}$$

Here C_c = compression index

Δe = void ratio

$\Delta \log \sigma'$ = difference effective stress taken in log scale.

4) **Ultimate Bearing Capacity:-**

The property of soil which the maximum pressure is resist due to applied load with out causing failure.

5) **Poission Ratio:-**

The change in shap ~~but~~ of a material but volume is constant is called Possion ratio

In Soil terminology, poission's ratio also Know as the co-efficient of Lateral expension and is affected by the following factor.

1) The soil is a descrete and stratified medium mostly not elastic and anisotropic
2) The soil is not deformed linearly.

poission's ratio in soil mechanics is a rather conditional parameter.

Q2

Part 'A'

Soil bearing capacity :-

Bearing capacity of soil is maximum load per unit area which the soil can resist safely without displacement. by divide the bearing capacity of soil by factor we will get safe bearing capacity of soil

$$\text{Bearing capacity of soil} = \frac{\text{Max. Load on found. base}}{\text{Area of footing}}$$

$$\text{Soil Bearing Capacity} = P/A = kN/m^2$$

different Soil have different Bearing capacity.

Type of soil	soil Bearing capacity
1) Made up ground	50 KN/m²
2) Black coton soil	50 KN/m²
3) Soft clay	100 KN/m²
4) Sand	100 KN/m²
5) stiff clay	200 KN/m²
6) compact sand	200 KN/m²

Factor Effecting Bearing capacity

1) **Relative density of 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.

2) **Depth of the Footing:-**

with Increase of depth of the foundation the bearing capacity of soil

is called

Increase

3) **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 as medium soil / sand.

4) **Unit weight of Soil:-**

Bearing capacity of soil is directly proportional to unit weight of soil. The bearing capacity of soil increases with increas in its unit weight

(5) **Water table :-**

As water table come near to footing the bearing capacity get decreases.

Q2 Part 'B'

What is the maximum Safe load which can be supported by rectangular footing 2m x 3m with a safety factor of 3. The base of the footing is at 1.6 m below the groud surface. The unit weight Soil is 18 kN/m³. The angle of shear resistance (ϕ) = 20°

(N_c = 14.8 , N_q = 6.4 ; N_γ = 12.9) = unit cohesion C_o = 20 kN/m², use - Mayerhaf Analysis :-

Given data:-

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

Factor of safty = 3

Depth of foundation (D_f) = 1.6m

Angle of shear resistance (ϕ) = 20°

Unit cohesion (C_u) = 20 kN/m²

N_c = 14.8

N_q = 6.4

N_γ = 2.9

Required :-

Maximum safe load q_s = ?

| is called ...

Solution :-

According to mayerhof's Analysis,

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

⇒ For Shap Factor :- (S_c, S_q, S_γ)

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

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

$= \left(45 + \frac{20}{2}\right)$

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

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

$\boxed{S_c = 1.27}$

As $\phi > 10^\circ$ so

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

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

$S_q = S_\gamma = 1.135$

⇒ For depth Factor :- (d_c, d_q, d_γ)

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

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

$d_c = 1.22$

Also $\phi > 10^\circ$, 1.0

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

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

$d_q = d_\gamma = 1.11$

Inclination Factor :-

For $\theta = 0^\circ$

i.e $= i_q = i_\gamma = 1$

by formula.

$q_u = cN_c \cdot S_c \, d_c + qN_q \cdot S_q \cdot d_q + \frac{1}{2} \gamma B \cdot N_\gamma \, d_\gamma \cdot S_\gamma$

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

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

As net ultimate Bearing capacity is

$q_{n.u} = q_u - \bar{\sigma}$ ∴ ($\bar{\sigma}$ = over burden pressure)

$= 762 - (1.6 \times 18)$

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

Net Safe bearing capacity is,

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

Safe bearing capacity is,

$q_s = q_{n.s} + \gamma$

$= 244.4 + (1.6 \times 18)$

$q_s = 273.2 \ kN/m^2$

This safe bearing capacity over the whole footing will be

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

$= 1639.2 \ kN$

Q3 Part "A"

Settlement:-

when load is applied on the ground surface this will produce effective vertical stress, due to these stresses the effective vertical strain will be produced as result of which the movement will occure in the downward direction this downward movement is called settelment.

Types OF Settlement:-

There are two types:-

1) Total settlement.
2) Differential settlement.

Total settlement:-

It is also called uniform settlement. In this type of settlement each part of strature will settle equally.

In uniform settlement the failure of the structure is not much than differential settlement.

The total settlement mostly take place

in structure which are constructed in rigid footing (soft)

In this type of settlement the utility services such as water supply, electricity, sewege line, telephone etc

2) **Differential Settlement:-**

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

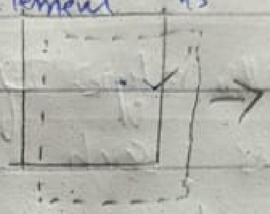
Differential settlement, ~~because~~ it ~~cause~~ is more danger or undesirable as compared with total / uniform settlement because its causes more damage to a structure as compared to total uniform settlement.

differential settlement are divided into two type

1) Tilt
2) Angular Distortion

Tilt :-

if the entire structure rotate due to unequal settlement is called tilt



Angular Distortion

when two foundations support walls / columns settle unequally its mean the structure is subjected to angular distortion.

Q3 Part "B".

A Soil has compressive Index ($C_c = 0.31$). At a stress of 130 KN/m^2, the void ratio was 1.02 calculate.

1) 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 (H) = 5m

Required:-

Final void ratio due to which increased stress (e_f = ?)
Total consolidation settlement (S_c) = ?

Solution:-

As compressive Index is given by

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

$$0.31 = \frac{1.02 - e_1}{\log_{10}\left(\frac{170}{130}\right)} \Rightarrow 0.31 \times 0.1185 = 1.02 - e_1$$

$$\boxed{e_1 = 0.984}$$

by formula,

consolidation sattlement is,

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

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

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

$$S_c = 89.3\,mm.$$

End.