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Section :- A

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Subject :- Geotechnical & Foundation Engineering

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MID - TERM EXAMINATION
CIVIL ENGINEERING DEPARTMENT

Define the following terms:

1. Plastic Equilibrium:

Plastic Equilibrium is a state where structural modifications arise or where persistent pressure arises due to Continuous tension application.

2. ANGULAR DISTORTION:

This is the resolution of differentials. This is the uneven settlement of two pillars sustaining Concrete walls / Columns.

3. Compressive INDEX:

This is the amount used in the Usually Condensed clay to finde the site. The overall stress added in the area to which the soil sample has been exposed in the past is higher than that imposed. This form of clay soil is commonly known as Condensed clay.

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

4. Ultimate Bearing Capacity:

Due to load added, the full pressure which is a soil resists without triggering loss.

OR

The highest pressure that induces shear Collapse in the soil at the base of the feet.

5.. Poission Ratio of Soil:.

The ratio of poission reflects a substance form shift whereas the volume is held unchanged.

⇒ In soil terms, lateral expansion is caused by the following factors:

a. The soil is descrete and stratified, mostly not elastic or anisotropic

b. Soil shall not be linearly deformed.

The soil dynamics function of poisson is very subjective.

Q1(B)

Question 1 Part B

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

Total shear force ($\frac{V_a}{b}$) = ?

Sol:.

As we know that

Active force is given by

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

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

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

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

$$B = 18^\circ$$

Also Ka is given by,

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

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

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

$$K_a = 0.3948$$

$$\boxed{K_a = 0.395}$$

Now By formula

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

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

$$\therefore \frac{P_a}{b} = 136.512 \text{ kN/m}$$

$$\frac{P_a}{b} = 136.52 \text{ kN/m}$$

As the Normal force is:

$$\frac{N_a}{b} = \frac{P_a}{b} \cdot \cos B$$

$$= 136.52 \times \cos(18)$$

$$\boxed{\frac{N_a}{b} = 129.83 \ KN/m}$$

Also the shear force is.

$$\frac{V_a}{b} = \frac{P_a}{b} \cdot \sin B$$

$$= 136.52 \times \sin(18)$$

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

Question 2 Part A.

Q: What is Bearing Capacity. Also write factors effecting Bearing Capacity.

Ans: Bearing Capacity:

This is an engineering attribute of the soil since, as load is added to the soil surface, the ability of the soil resisting this load added is called the power of the soil to carry.

Denoted with 'q'

The Internal power of the soil is often named.

CONTAINING ABILITY FACTORS:-

1:- Relative Density of the Soil:-

Relative density is closely related to the ability of soil to carry. Higher relative soil density, higher internal friction angle value, and higher terzaghi efficiency factors (Nc, Nq, Nr) resulting in decreased bearing ability

2:- DEPTH OF the FACTOR:-

With the rise in footing depth (Df), the bearing ability rises and this change would be optimom for the factile soil / sand relative to less or mild soil / sand.

3:- Depth of The FOOTING:-

The soil's bearing potential rises with the change in foot depth, and that rise is the optimum for thick sail / sand contrasted with loose or light sand / soil.

4:- UNIT WEIGHT OF THE SOIL:-

It often has a clear connection to a soil's carrying power. Change in unit soil weight allows soil carrying ability to rise, and this change would be optimum for dense sail / sand relative to loose / sand.

5:- WATER TABLE:-

It's indirectly linked to soil bearing power. The shear tension between the soil

Particles reduces while the bearing power due to the bearings of the water table to the feet.

Question 2 Part B

Ans Given Data:

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

Factor of safety = 3

Depth of foundation (Df) = 1.6m

Unit weight of soil (γ) = 18 kN/m³

Angle of shear resistance (ϕ) = 20°

Unit Cohesion (cu) = 20 kN/m²

N_c = 14.8

N_q = 6.4

N_γ = 2.4

Required:-

Maximum Safe load (q_s) = ?

Solution:-

According to Mayerhof's Analysis

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

=> For shape factors:- (S_c, S_q, S_γ)

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

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

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

$$\boxed{\alpha = 55°}$$

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

$$\boxed{S_c = 1.27}$$

As $\phi = 10°$, So

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

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

$\boxed{s_q = s_\gamma = 1.135}$

For Depth factors:- (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.22}$

Also $\phi = 10°$, So

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

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

$\boxed{d_q = d_\gamma = 1.11}$

Inclination factors:-

For $\theta = 0°$

$i_c = i_q = i_\gamma = 1$

By formula

$q_u = cN_c \cdot s_c \cdot d_c + qN_q \cdot s_q \cdot d_q + \frac{1}{2}\gamma \cdot B\, N_\gamma \cdot d_\gamma \cdot s_\gamma$

$= (20)(14.8)(1.27)(1.22) + [(1.6\times18)](6.4)(1.135)(1.11) + \frac{1}{2}(18)(2)(2.9)(1.11)(1.135)$

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

As Net ultimate Bearing Capacity is:

$q_{nu} = q_u - \bar{\sigma}$ $(\because \bar{\sigma} =$ Overburden Pressure$)$

$= 762 - (1.6\times18)$

$q_{nu} = 733.2\ KN/m^2$

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:

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

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

$q_s = 273.2\ KN/m^2$

This Safe Bearing Capacity over the whole footing will be.

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

$$= 1639.2\ KN$$

QUESTION 3 PART A:

Q1a What is settlement. What are its types explian in detail?

Ans: SETTLEMENT:

As packing is added to the ground sheet, powerful vertical pressures in the field arise. Thanks to these strains, upward tension occurs and lateral Pressure occurs. The moment of decline is named settlement

SETTLEMENT TYPES:-

There are two kinds of settlements

1: UNIFORM SETTLEMENT:

A method of settlement is considered Universal settlement, if a building base settlements for the same sum over the whole area, essentially reducing the current frame work.

Total Compensation is often named settlement. related break down of the system is not exactly the same as Unilateral settlement.

II> Uniform setting happens often when Concrete is stiff

LIMITATION FOR Total SETTLEMENT:-

=> Soil will have adequate bearing ability to endure the expected load applied.

=> The load to come really should be widely distributed that over a board area.

2: Differential Settlement::

This form of settlement is called differential settlement if either part of the foundation is damaged by ground loss or part of the foundation is impaired to a significant degree relative to other sections.

Differential Arbitration forms:-
There are two forms of arbitration with differentials

1 TILT:
Due to unfair arrangement, it is rotating of the whole system.

2: ANDGULAR DISTORTION:-
This is the uneven arrangement between two pillars that sustain longitudinal walls / Columns

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QUESTION 3 PART B

Given Data:

Compressive Index of soil (C_c) = 0.31
Initial stress / pressure (P_1) = 130 kN/m^2
Initial Void ratio (e_o) = 1.02
Increased or final stress / pressure : (P_2) = 170 kN/m^2
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,

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

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

$$e_1 = 0.984$$

By formula:

Consolidation settlement is

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

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

$$= 0.0893 \text{ m} \times 1000 \text{ mm}$$

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