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7386

GEOTECHNICAL ENGINEERING

Q# 1

Define the following terms.

(1) PLASTIC EQUILIBRIUM:-

The Part of Soil is on verge of failure it is in state of Plastic Equation The stress Strain behaviour of the Soil here is rigid and with idealization of perfectly Plastic.

(2) ANGULAR DISTORTION:-

The Structure is subjected to be angularly distorted if the ~~two~~ foundation Support walls/Columns

(3) 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.

ULTIMATE BEARING CAPACITY

It is denoted by "q_u". It is the maximum Pressure applied on the base of footing that Cause shear failure of Soil.

Poission Ratio Of Soil:-

→ Poisson Ratio Represents a Change in Shape of a material while the Volume is maintained Constant.

→ In Soil terminology, Poisson's Ratio also known as the Co-efficient of Lateral expansion and is affected by the following factors.

→ The Soil is a descrete and Stratified medium. mostly not elastic and anistropic

→ The Soil is not deformed linearly.

Poisson's Ratio in Soil mechanics is a rather Conditional Parameter.

(Q No 1 # Part # B)

Q 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 Condition Determine the total normal and Shear forces acting on the back 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

Horizental Slope = 3

Vertical Slope = 1

REQUIRED:-

Total Normal force (N_a/b) = ?

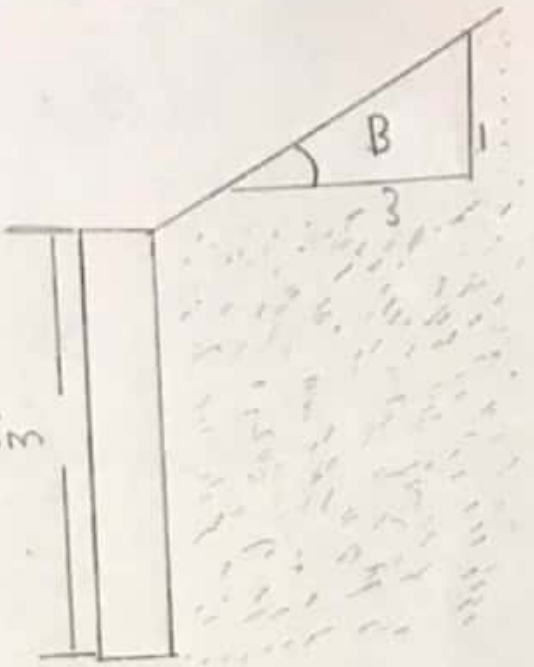
Total Shear force (V_a/b) = ?

Sol:-

As we know that

Active force is given by

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



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

$\tan(B) = 1/3$

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

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

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

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

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

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

As the Normal force is,

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

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

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

Also the shear force is

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

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

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

Factor Affecting Bearing Capacity

(1) Relative Density:-

If the Density of Soil is greater, the value of angle of Internal friction "ϕ" will be higher. The higher the value of "ϕ", higher the value of Terzaghi's Bearing factors. (N_c, N_γ and N_q). Bearing Capacity will be higher if values of N_c, N_γ and N_q are greater.

Hence Enough Bearing Capacity of Soil will have enough Relative Density.

(2) Depth Of Footing:-

The bearing Capacity of Soil is directly Proportional to the Depth of footing. Increase in this will have Maximum effect on dense Soil as Compared to loose Sand.

(3) Breadth Of Footing

The Unit weight of Soil is known as Breadth of footing.

~~(4) Material Part (Q)~~

Bearing Capacity:-

Applying resistance to the load is known as Bearing Capacity. It's also known as Internal Stregth of Soil, which is denoted by "q".

(PART-B)

Q what is the maximum Safe Load which Can be Supported by a rectangular footing 2m×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 18kN/m³. The angle of shear resistance (ϕ) = 20°. (N_c = 14.8) (N_q = 6.4; N_r = 2.9). Unit Cohesion C_u = 20kN/m². Use Mayer hoff Analysis.

Given Data:-

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

Factor of Safety = 3

Depth of foundation (Df) = 1.6m

Unit weight of Soil (γ) = 18kN/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_{vs}) = ?

Solution :-

According to Meyhoff'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)

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

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

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

$$\alpha = 55°$$

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

$$\boxed{S_c = 1.27}$$

As $\phi > 10°$, So

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

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

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

⇒ For Depth Factors:- (d_c, d_q, d_γ)

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

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

$$\boxed{d_c = 1.22}$$

Also $\phi > 10°$, So

$$d_q = d_\gamma = 1 + 0.1 (D/B) \tan \alpha$$

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

$$\boxed{d_q = d_r = 1.11}$$

INCLINATION FACTORS:-

For $\alpha = 0°$

$i_c = i_q = i_r = 1$

By formula

$$q_u = c N_c \cdot s_c \cdot d_c + q N_q \cdot s_q \cdot d_q + \frac{1}{2} \gamma B N_\gamma \cdot d_r \cdot s_r$$

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

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

As Net Ultimate Bearing Capacity is

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

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

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

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

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

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

This Safe Bearing Capacity.

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

$= \boxed{1639.21 KN}$

Q#3 Part-A

SETTLEMENT:-

Load is applied on the ground Surface Causing Stress which lead to vertical Strain. This Vertical Strain Causes movement in downward direction as Settlement.

TYPES:-

(1) TOTAL SETTLEMENT:-

Also known as uniform Settlement because of the fact that each part of the Structure is Settled equally. failure is rare in this Case as structure is tend to be rigid ~~the~~ Utility Services Such as water Supply, electricity is ~~availed~~ in order to keep the Structure firm and Sound.

(2) LIMITATION SETTLEMENT:-

(1) The Soil Should have right bearing Capacity to resist the Load Applied

(2) The load has to Cover the large Area.

DIFFERENTIAL:-

Here the Structure is not uniform as the Settlement is done in different Parts of Structure it's more dangerous then uniform or total Settlement.

Types:-

(1) Tilt:-

The entire structure is rotated and leads to un-equal Settlement.

(2) Angular Distortion:-

The Structure is subjected to be Angularly distorted if the two foundation Supports walls/Columns.

Q: 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

Given Data:-

Compressive Index of Soil (C_c) = 0.31

Initial Stress / Pressure (P_1) = $130\ kN/m^2$

Initial Void Ratio (e_0) = 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,

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

$$0.31 = \frac{1.02 - e_1}{\log_{10}(170/130)} \Rightarrow 0.31 \times 0.1161 = 1.02 - e_1$$

$$\boxed{e_1 = 0.984}$$

By formula

~~Consitatio~~

Consildation Settlement is

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

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

$$= 0.0893m \times 1000mm$$

$$S_c = 89.3m$$