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SECTION = A

PAPER = GEOTECHNICAL ENG

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QUESTION NO=1 (Part=A)

⇒PLASTIC EQUILIBRIUM:-

If body of soil is said to be in a state of plastic Equilibrium. If every part of the on the verge of failure. So this can be visualised by a perfectly Rigid plastic model where with a stress strain Relationship. If we assume that it is Rigid and Perfectly plastic. So here the stress strain behaviour of the soil can be represented here by the Rigid perfectly plastic idealization.

⇒ ANGULAR DISTORTION:-

When two foundation support walls settle unequally It means the structure is subjected to angular

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Angular distortion.
It is also known as Relative distortion.

⇒ **COMPRESSIVE INDEX:-**

Compressive index is used to find settlement in the normally consolidated clay. The total stress is applied is larger than the stress in the field to which the soil sample has been undergone in the past. This type of clay soil is said to be normally consolidated clay.

ULTIMATE BEARING CAPACITY:-

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

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⇒ POISSON RATIO OF SOIL:-

Poisson Ratio is the measure of the soil poisson effect, that describe the expansion of the material is the direction perpendicular to the direction of loading.

The value of the poisson Ratio is Negative of the Ratio of transverse strain to Axial strain.

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QUESTION NO = 01 (Part-B)

GIVEN DATA:-

Cohesion (C) = 0

Angle of internal Friction (ϕ) = 30°

Unit weight of Soil (γ) = 19.2 KN/m²

Horizontal Slope = 3

Vertical Slope = 1

REQUIRED:-

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

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

SOLUTION:-

As we know that

Active force is given by

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

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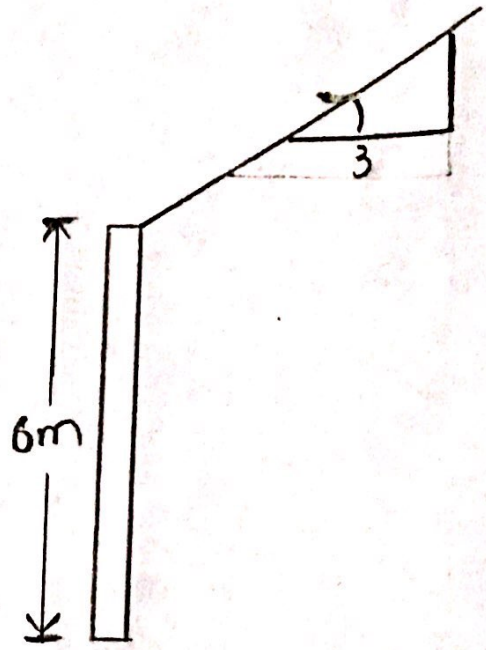
$$\tan(\beta) = \frac{Per}{Base}$$

$$\tan(\beta) = 1/3$$

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

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



Ka is given by

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

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

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

$$\boxed{Ka = 0.395}$$

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Now By formula

Active force $\frac{Pa}{b} = \frac{\gamma \cdot H^2 \cdot Ka}{2}$

Putting the values

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

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

As the Normal force

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

Now put the values

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

$$\frac{Na}{b} = 136.52 \times 0.951$$

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

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Now we have to find Shear force;

$$\frac{Vq}{b} = \frac{pq}{b} \times \sin\beta$$

$$\frac{Vq}{b} = \frac{pq}{b} \times \sin\beta$$

$$\frac{Vq}{b} = 136.52 \times \sin(18)$$

$$\frac{Vq}{b} = 136.52 \times 0.309$$

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

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QUESTION NO=02 (Part=A)

BEARING CAPACITY:-

The Engineering Property of soil because of which when load is applied on the sound surface and this load is Resisted than such of soil is called bearing capacity.

FACTOR AFFECTING BEARING CAPACITY:-

RELATIVE DENSITY:-

Greater the value of relative density of the soil higher will be the value of angle of internal friction (ϕ) higher the value of (ϕ) higher will be the value of Terzagh's bearing capacity factor. Due to which the value of bearing capacity will increase

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⇒ **DEPTH OF FOOTING:-**

With the increase of depth of footing the value of bearing capacity also increase.

⇒ **WIDTH OF FOOTING:-**

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

⇒ **UNIT WEIGHT OF SOIL:-**

It increase with increase unit weight of soil.

⇒ **WATER TABLE:-**

It has indirect Relation with the bearing capacity of soil. Due to increase of water table to the footing. The shear strength b/w the soil particles Reduce hence the bearing capacity decrease.

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QUESTION NO=02 (Part=B)

GIVEN DATA:-

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

Depth of foundation (D.f)=1.6m

Factor of safety= 3

unit weight of soil (γ)= 18 KN/m^3

Angle of Shear Resistance = 20°

unit Cohesion (CU)= 20 KN/m^2

NC= 14.8

NQ= 6.4

Nγ= 2.9

REQUIRED :-

Maximum safe load= ?

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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:- ($S_c.S_q.S_\gamma$)

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

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

$$\alpha = (45 + 20/2)$$

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

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

$$\boxed{S_c = 1.27}$$

As $\phi > 10^\circ$; So

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

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

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

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FOR DEPTH FACTOR:- (d_c, d_q, d_γ)

$$d_c = 1 + 0.2\,(D/B)\tan\alpha$$

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

$$\boxed{d_c = 1.22}$$

Also $\phi > 10°$, so

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

$$d_q = d_\gamma = 1 + 0.1\,(1.6/2)\tan(55)$$

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

INCLINATION FACTOR:-

For $\theta = 0$

$$i_c = i_q = i_\gamma = 1$$

By formula

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

$$q_u = (20)(14.8)(1.27)(1.22) + [(1.6 \times 18)](6.4)(1.135)(1.11) + \frac{1}{2}(18)(2)(2.9)(1.11)(1.35)$$

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$$q_U = 762\ KN/m^2$$

Net ultimate Bearing capacity

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

$$q_{n.u} = 762 - (1.6 \times 18)$$

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

Safe Bearing capacity

$$q_{n.s} = \frac{q_{n.u}}{FOS} = \frac{733.2}{3} = 244.4\ KN/m^2$$

$$q_{n.s} = 244.4\ KN/m^2$$

Safe Bearing capacity

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

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

$$q_s = 273.2\ KN/m^2$$

Thus Safe bearing capacity over the Whole footing will be;

$$\Rightarrow A \times q_s = 2732\ (6m^2)$$

$$= 1639.2\ KN$$

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QUESTION NO=03 (Part=a)

SETTLEMENT:-

When load is applied on the ground surface this will produce effective vertical stresses due to this stresses the effective vertical strain will be produce as a Result of which the movement will occure in the downward direction. This downward direction is called settlement

TYPES OF SETTLEMENT:-

TOTAL SETTLEMENT:-

It is also called uniform settlement
This type of settlement each part of structure will settle equally.

=) In uniform settlement the failure of the structure is not much as considered as with differential settlement.

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⇒ The total settlement mostly take place in the structure which are constructed in Rigid footing.

DIFFERENTIAL SETTLEMENT:-

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

⇒ Different settlement is more danger as compared to total settlement because it cause more damage to a structure as compared to total settlement.

TYPES OF DIFFERENTIAL SETTLEMENT:-

⇒ **TILT:-**

If the entire structure Rotate unequal settlement is called tilt.

ANGULAR DISTORTION:-

When two foundation support walls settle unequally, It mean the structure is subjected to Angular Distortion.

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QUESTION NO = 03 (Part = B)

GIVEN DATA:-

Compressive Index of Soil (C_c) = 0.31

Initial Stress/Pressure (P_1) = 130 KN/m^2

Initial void Ratio = 1.02

Increase or final Stress/Pressure = 170 KN/m^2

Strain thickness = 5m

REQUIRED:-

Final void Ratio due to increased stress = ?

Total Consolidation Settlement = ?

SOLUTION:-

As Compressive Index is given by

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

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

$$\boxed{e_1 = 0.984}$$

By formula

Consolidation Settlement is

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

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

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

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

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