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ID = 7795

Section = A

Paper = geotechnical Eng

QNO 1:-

Plastic equilibrium:-

=> A body of soil is said to be in a state of plastic equilibrium, if every part of it is on the verge of failure. So this can be visualized 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 behavior of the soil can be represented here by the rigid perfectly plastic idealization.

Angular Distortion:-

=> When two foundations support walls settle unequally it means the structure is subjected to angular distortion.
It is also known as relative rotation.

Ultimate bearing capacity:-

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

Poission ratio of soil:-

poission ratio is a measure of the poission effect, that described the expansion of the material is the directions perpendicular to the direction of loading.
The value of poission ratio is negative of the ratio of tranverse strain to axial strain.

Compressive index:-

Compressive index is used to find the settlement in the normally consolidated 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 said to be normally consolidated clay.

Q No 1
b)

Given:-

⇒ Cohesion $(C) = 0$

⇒ Angle of internal friction $(\varphi) = 30^\circ$

⇒ unit weight of soil $(\gamma) = 19.2\ KN/m^2$

⇒ Horizontal slope $= 3$

⇒ vertical slope $= 1$

Req:-

⇒ Total normal force $(N_a/b) = ?$

⇒ Total shear force $(V_a/b) = ?$

Sol:-

As we know that active force is given by

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

As
$\tan(\beta) = \text{perp} / \text{base}$

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

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

$\beta = 18^\circ$

Also Ka is given by

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

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

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

$K_a = 0.3948$

$\boxed{K_a = 0.395}$

Now by formula
Active force

$P_a/b = \gamma \cdot H^2 \cdot K_a / 2$

$= 19.2 \times (6)^2 \times 0.395 / 2$

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

As the normal force is,

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

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

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

Also the shear force is

$$\frac{Va}{b} = Pa/b \times \sin\beta$$

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

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

QNO2:-

A) Bearing capacity:-

The engineering property of soil because of which when load is applied on the ground surface and this load is resisted then such of soil is called bearing capacity.

Factor effecting 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 tarzaghi's bearing capacity factors. Due to which the value of bearing capacity will increases.

Depth of the footing:-

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

⇒ **Width of the footing:-**

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

Unit weigh of soil:-

⇒ qt increase with increase unit weight of soil.

water table:-

⇒ qu has inverse relation with the water table.

Q No 2, b)

Given:-

⇒ footing dimension = 2m × 3m (b = 3, b = 2)

⇒ Factor of safety = 3

⇒ Df = 1.6 m

⇒ unit weight of soil (γ) = 18 KN/m³

⇒ Angle of shear resistance (ϕ) = 20°

⇒ unit cohesion = 20 KN/m²

⇒ N_c = 14.8

⇒ N_q = 6.4

⇒ N_γ = 2.9

Reqi-

maximum safe load (q_s) = ?

Sol:-

As

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

=> **For shape factors:-**

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

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

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

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

$S_c = 1.27$

As $\varphi > 10^\circ$, so

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

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

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

For depth factors:-

$d_c = 1 + 0.2 (D_f/B) \tan^2\alpha$

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

$\boxed{d_c = 1.22}$

Also $\varphi > 10^\circ$, so

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

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

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

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For $q = 0^\circ$

$i_c = i_q = i_r = 1$

Now

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

$= (20)(14.8)(1.27)(1.22) + [(1.6 \times 18)(6.4)(1.135)(1.11)$

$+ \frac{1}{2}(18)(2)(2.9)(1.11)(1.135)$

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

Now

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

$= 762 - (1.6 \times 18)$

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

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

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

$= 244.4 + (1.6 \times 18)$

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

This safe bearing capacity over the whole footing will be

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

1639.2 KN

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QNo 1

A)

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 result of which the movement will occurs in the downward direction. This downward movement is called settlement.

Types of settlement:-

⇒ Total settlement:-

⇒ It is also called uniform settlement. In 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 the differential settlement.

⇒ 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.

⇒ Differential settlement is more danger as compared with total settlement, because

⇒ It cause more damage to a structure as compared to total settlement.

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Types of differential settlement:-

Tilt:-

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

Angular distortion:-

⇒ When two foundations support walls settle unequally it means the structure is subjected to angular distortion.

Q NO 3

b)

Given:-

⇒ compressive index of soil (cc) = 0.32

⇒ Initial stress (P1) = 130 KN/m².

⇒ Initial void ratio (eo) = 1.02

⇒ final stress P2 = 170 KN/m²

Req:-

⇒ final void ratio due to increased stress (e1) = ?

⇒ Total settlement (Sc) = ?

Sol:- As compressive index is given by

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

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

$\Rightarrow$ 0.31×0.1165
$= 1.02 - e_1$

$e_1 = 0.984$

by formula:-

consolidation settlement is

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

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

$= 0.0893m \times 1000mm$

$S_C = 89.3\,mm$