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Q no 1

Ans A) 1.) Plastic Equilibrium:-

In this state the soil will near to faliure or verge to faliure.

2.) Angular Distortion:-

When two foundations support walls/ colomns settle unequally it mean the structure is subjected to angular distortion.

3) Compressive index:-

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

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

4) Ultimate Bearing Capacity:-

The maximum pressure at the base of the footing with shear failure in the soil. It is denoted by q_u.

5) Poison Ratio:-

The negative ratio of transversal strain to the axial strain in an elastic material which is subjected to an unaxial stress.

Qno 1)

Ans 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 (N_a/b) = ?

Total shear Force (V_a/b) = ?

Sol:-

As

Active force is given by

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

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

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

$$\boxed{B = 18°}$$

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Also ka is given by

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

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

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

$$ka = 0.3948$$

$$\boxed{ka = 0.395}$$

Now by formula

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

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

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

$$\boxed{\frac{Pa}{b} = 136.5 \text{ kN/m}}$$

As the Normal Force is,

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

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

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

Also shear force is,

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

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

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

Qno 2)

Ans A) Bearing capacity:-

In Geotechnical Engineering bearing capacity is defined as the engineering property of the soil due to which it resist the applied load. Denoted by q. In other word the internal strength of the soil is called bearing capacity.

Factor effecting bearing capacity:-

1) Relative Density of the soil:-

more the relative Density of the soil more be its angle of friction. More will be the N_q, N_c, N_γ. with increase of this the bearing capacity will increase.

2) Depth of the footing:-
With the increase of depth (df) of the foundation the bearing capacity of soil will increase. This increase will be more in case of dense soil as compared with loose or medium soil

3) Breadth of foundation:-
More the breath of foundation more be the bearing capacity of soil. At will be more in dense soil as compared to loose soil.

4) Unit of weight of soil:-
Bearing capacity of soil is directly proportional to unit weight of soil. The bearing capacity of soil increases with increase in its unit weight. will be more in dense soil & less in loose soil.

5) Water table:-
As water table comes near to the foundation the bearing capacity get decreases.

Q no 2)

Ans B) Given:-

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

Factor of safety = 3

Depth of foundation (D_f) = 1.6m

Unit wt of soil (γ) = 18 KN/m^3

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:-

max safe load (q_s) = ?

Solution:-

According to Meyerhof 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 factor (S_c, S_q, S_γ)

$$S_c = 1 + 0.8 \left(\frac{B}{L}\right) \tan^2 \alpha$$

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

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

$$\boxed{\alpha = 55°}$$

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

$\boxed{s_c = 1.27}$

As $\phi > 10^\circ$ so

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

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

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

⇒ For Depth Factors:- (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.22}$

Also $\phi \geq 10^\circ$ 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 $\theta = 0^\circ$

$i_c = i_q = i_\gamma = 1$

By formula

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

$$= (20)(14.8)(1.27)(1.22) + [(1.6\times 18)](6.4)(1.85)(1.11) + \tfrac{1}{2}(18)(2)(2.9)(1.11)(1.135)$$

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

As Net Bearing capacity is

$$q_{n.u} = q_u - \bar{q} \qquad (\because \bar{q} = \text{over burden Pressure})$$

$$= 762 - (1.6\times 18)$$

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

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

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

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

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

This safe Bearing capacity over the whole footing will be

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

$$\boxed{= 1639.2\ KN}$$

Qno3)

Ans A) Settlement:-

When the load is applied on the ground surface this will produce effective vertical stresses due to these stresses the effective vertical strain will be produced at a result of which movement will occur in the downward direction. This downward movement is called settlement.

Types of settlement:-

On the basis of movement of the structure it is divided int two types;

Total settlement

Differential settlement

Total Settlement:-

In this type of settlement each part of structure will settle equally.

In total settlement the faliure ~~the~~ 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.

In this type of settlement the utility service such as water supply, electricity, sewage line, telephone etc may be decreased & the structure will remain sound.

Limitation for total settlement:-

The soil layer to which the load is to be transfer should be sufficent in bearing to resist the load which is to be applied on it.

→ To spread the coming load over a large area.

2) Differential Settlement:-

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

Differential settlement is more danger as compared to total settlement because it causes more damage to a structure as compared to total settlement.

It is further divided into two types.

1) Tilt

2) Angular Distortion.

Qno3)

AnsB) Given:- compressive index $(C_c) = 0.31$

Initial pressure $(P_1) =$ 130 kN/m²

Initial void ratio $(e_0) = 1.02$

Increased or final pressure $(P_2) = 170$ kN/m²

Stratum thickness $(H) = 5$ m.

Required:-

Final void ratio due to increase stress = ? $(e_1 = ?)$

Total settlement = $(S_c) = ?$

Solution:-

As

compressive index is given by

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

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

$$\boxed{e_1 = 0.984}$$

By formula

consolidation settlement is,

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

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

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

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