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Q NO! 01

Part-A : Define the following terms :

1- Plastic Equilibrium :

A plastic equilibrium is that state in which a soil mass is on the verge of failure.

When irreversible Strain take place at a Constant stress or We Can say that in State every point in given soil mass is at verge of failure.

2- Angular Distortion :-

It is ratio of differential Settlement and distance b/w two points.

$$\beta = \frac{\delta}{l}$$

When Two foundation Support wall/colums Settle unequally its means the Structure is Subjected to angular distortion.

3- Compressive Index:

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

In the term of m_v

m_v = Change in volume per unit volume of Compressible layer

$$S_c = H \times M_v \times \Delta P$$

$$m_v = \frac{\Delta e / \Delta P}{1 + e_o}$$

4- Ultimate Bearing Capacity :

It is theortical maximum pressure which can be supported without failure.

OR

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

it is denoted by "qu".

5- Poission Ratio:-

It is the measure of poission effect, material that describes the expansion and contraction of material in direction perpendicular to direction of loading.

The value of poission ratio is negative of ratio of transverse Stoain to axial Strain.

Q No! 01

Part (B)

Given data :

Cohesion (C) = 0

Angle of Internal friction (ϕ) = 30°

unit weight of soil (γ) = 19.2 KN/m^3

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

$$\frac{Pa}{b} = \frac{\gamma . H^2 . K_a}{2}$$

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

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

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

$$\beta = 18^\circ$$

Also K_a is given by

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

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

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

$$K_a = 0.3948$$

$$\boxed{K_a = 0.395}$$

Now By formula :

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

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

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

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

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

$\frac{V_a}{b} = \frac{P_a}{b} \cdot \sin\beta \Rightarrow 136.52 \times \sin(18)$

$= 42.18 \text{ Kn/m}$

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

Q NO1 02

Bearing Capacity :-

Engineering properties of soil because of which when load is applied on the Ground Surface and this load is resisted than Such Capacity of soil is called Bearing Capacity.

It is also called the internal strength of the soil.

It is denoted by "q"

Factor effecting Bearing Capacity.

⇒ **Relative density of the Soil :-**

Greater the Relative density of soil, higher will be the value angle of internal friction (ϕ) and higher will be Terzaghi

bearing capacity factor (N_c, N_q, N_γ) due to which the value of Bearing capacity will increase.

⇒ Depth of the footing :-

As $q_u = cN_c + \gamma D_f N_q + \frac{1}{2}\gamma . B . N_\gamma$

So $q_u \propto D_f$

Soil type → dense → will be increase the q_u.

⇒ The bearing capacity increase with increase of depth of footing. This increase is maximum for the dense soil as compared to loose Sand.

⇒ Width of the footing :-

The bearing capacity increase with the increase the width of the footing. This will increase will be maximum for the dense soil as

Compared to loose Sand.

⇒ Unit Weight of The Soil :-

$$q_u = cN_c + \gamma D_f N_q + \frac{1}{2} \gamma . B . N_\gamma$$

Increase in γ will increase in q_u

⇒ Cohesion of The Soil :- it is more cohesion value the bearing capacity is also increase with them.

Water Table :-

It has indirected relation with bearing Capacity, Due to water The Shear Strength b/w The Soil particles reduce hence q_u decreases.

Q NO! 02

PART (B)

Given data

Footing dimension = 2m x 3m

b = 3 , h = 2

FOS = 3

depth of foundation (Df) = 1.6 m

unit weight of soil (γ) = 18 KN/m³

Angle of Shear resistance (ϕ) = 20°

unit Cohesion (Cu) = 20 KN/m²

$N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 2.9$

Required:

Maximum Safe load (q_s) = ?

Solution: According to mayerhof's Analysis,

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

Shape factor : (S_c, S_q, S_γ)

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

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

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

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

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

$$\boxed{S_c = 1.27 \cong 1.3}$$

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

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

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

$$\boxed{S_q = S_\gamma = 1.135 \cong 1.4}$$

For Depth factors :- (d_c, d_q, d_γ)

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

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

$$\boxed{d_c = 1.228 \cong 1.3}$$

Also $\phi > 10^\circ$, So

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

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

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

Inclination factors:

for $\theta = 0^\circ$

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

By formula

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

$$= (20)(14.8)(1.27)(1.22) + [(1.6 \times 18)](6.4)(1.135)(1.11) + \frac{1}{2}(18)(2)(29)(1.11)(1.135)$$

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

As Net ultimate Bearing Capacity is

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

$$= 762 - (1.6 \times 18) \quad (\because \bar{s} = \text{over burden pressure})$$

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

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

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

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

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

This Safe Bearing Capacity over the whole footing will be

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

$$\Rightarrow \boxed{1639.2 \text{ KN}}$$

Q No! 03

Part-(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 a result of which movement will occure in the downward direction. This downward movement is called Settlement.

Types of Settlement :-

1- Total Settlement.

2- Differental Settlement.

1- 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 is constructed in rigid footing (raft).

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

limitation for Total Settlement :

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

Ex. spread the coming load over a large area.

2- Differential Settlement

Differential Settlement in different parts of the same structure is called differential Settlement.

Differential Settlement is more danger or considrable as compared with Total / uniform Settlement, because it cause more damage

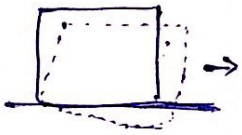
To the structure as compared to the total/uniform settlement.

Types of differential settlement:

i- Tilt

ii- Angular distortion.

i- **Tilt**:-

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

Angular distortion:

When two foundations support wall/colums settle unequally it means the structure is subjected to angular distortion.

Q NO! 03

Part (B)

Given data:

Compressive Index of soil (CC) = 0.31

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

Initial void ratio (e0) = 1.02

Increased or final Stress / Pressure (P_2) = 170 KN/m^2

Stratum Thickness (H) = 5 m

Required:

Final void ratio due to increase Stress (e1) = ?

Total (consolidation) Settlement (Sc) = ?

Solution:

As Compressive Index is given by;

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

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

$$\Rightarrow \quad 0.31 \times 0.1165 = 1.02 - e_1$$

$$\boxed{e_1 = 0.984}$$

By formula;

Consolidation Settlement is;

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

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

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

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