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Section ⇒ Senior.

Subject Name ⇒ Geotech & Foundation Engineering.

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QNo# 01:- Define the following Terms :- (1)

(A)

(1) Plastic Equilibrium :-

In this state the soil will real to failure or verge to failure.

(2) Angular Distortion :-

When two foundations support walls/columns settle unequally it means 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.

IN TERM OF Mv :-

Mv = Change in volume per unit volume of compressible layer.

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

$$M_v = \frac{\frac{\Delta e}{\Delta P}}{1 + e_0}.$$

4) ULTIMATE BEARING CAPACITY:- (2)
The maximum pressure at the base of footing with shear failure in the soil is denoted by q_u.

5) Poissim Ratio of Soil:-
(n) is the negative of ratio of transversal strain to the axial strain in an elastic material, which is subjected to an uniaxial stress poissim ratio of soil. poisson's ratio

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Q NO# 04.:
part "B".

(B):- Given Data:

Colesim (c) = 0
Angle of Internal friction (ϕ) = 30°
unit weight of soil (γ) = 19.2 KN/m³
Horizontal slope = 3.
vertical slope = 1.

Required:-

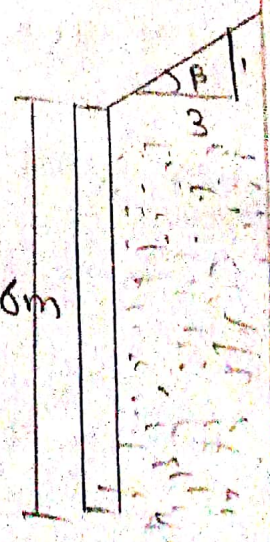
Total Normal force ($\frac{N_q}{D}$) = ?
Total Shear force ($\frac{V_q}{D}$) = ?

Sol:-
As we know that:-
Active force to given by;

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

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

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



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

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

Also K_a is given by;

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

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

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

$K_a = 0.3948.$

$K_a = 0.395$

Now By formula, Active force

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

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

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

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

As the Normal force is,

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

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

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

Also the Shear force is,

$$\frac{N_q}{b} = \frac{P_q}{b} \cdot \sin\beta.$$

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

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

QNO# 02:-

(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 will be its angle of friction more will be its angle of friction. More will be the N_q, N_c, N_γ with increase of this (N_q, N_c, N_γ) the bearing Capacity will be increase this will be increase more for dense soil sand as Compared with medium sand. N_γ = Terzaghi bearing Capacity factor.

2) Depth of the footing:-
With the increase of depth (d_f) of the

foundation the bearing capacity of soil will increase. this increase will be more in case of dense sand/soil as compared with loose or medium sand/soil.

3) BREDTH OF THE FOUNDATION:-

~~with the increase of depth~~

More the breadth of foundation more will the bearing capacity of soil. It will be more incase of dense soil/sand as compared with loose as medium soil/sand.

4) UNIT WEIGHT OF SOIL:-

Bearing capacity is directly proportional to unit weight of soil.
It will be more increase in its unit weight soil/sand as compared with loose as medium soil/sand.

5) WATER TABLE:-

As water table comes near to footing, the bearing capacity of decreases.

QNO#02:

(B) Given Data:-

Footing Dimension = 2m x 3m (b=3, h=2)
Factor of safety = 3
Depth of foundation = (Df) = 1.6m
unit weight of soil = (γ) = 18 KN/m³
Angle of shear resistance (φ) = 20°
unit cohesion (Cu) = 20 KN/m²
Nc = 14.8
Nq = 6.4
Nγ = 2.9

Required:-

Maximum Safe load (q_u) = ?

Solution:-

According to Mayerhof's Analysis.

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

⇒ For Shape factors :- (S_c, S_q, S_γ)

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

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

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

$\alpha = 55°$

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

$S_c = \boxed{1.27}$

As $\phi > 10°$, so

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

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

$S_q = S_\gamma = 1.135$

⇒ For Depth Factors :- (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.22}$

Also $\phi > 10°$, so

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

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

$$d_q = d_\gamma = 1.11$$

Inclination Factors:-

For $\alpha = 0°$

$i_c = i_q = i_\gamma = 1$

By Formula:

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

$$= (20)(14.8)(1.27)(1.22) + [(1.6\times18)](6.4)(1.135)(1.11) + \frac{1}{2}(18)(2)(2.9)(1.11)(1.135)$$

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

As Net Ultimate Bearing Capacity is,

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

$$= 762 - (1.6\times18) \qquad (\because \bar{\sigma} = \text{over burden pressure})$$

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

Safe Bearing Capacity as,

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

$$= 244.4 + (1.6\times18)$$

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

this Safe Bearing Capacity over the whole footing will be,

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

$$= 1639.2\ KN$$

QNO # 03:

(A) Settlement :-

When load is applied on the ground surface this will produce effective vertical strain will be produced as result of which the ~~moment~~ movement will occure in the downward direction. this downword moment is called Settlement.

Types of Settlements :-

On the basis of movement of the Structure it is divided into two types.

1) Total Settlement.
2) Differential Settlement.

Total Settlement :-

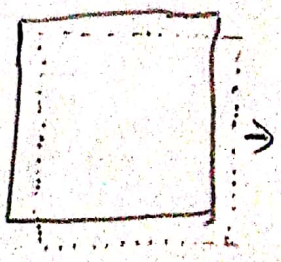
It is also called uniform Settlement. In this type of Settlement each part of Structure will Settle equally in uniform Settlement the failure of the Structure is not much as Considered as with the differential Settlements.
the total Settlement mostly take place in the Structure which are Constructed in rigid footing (raft).
In this type of settlement the utility services such as water supply, electricity sewage line, telephone etc may be decreased cy the Structure will remain sound.

P.T.O.

Limitation For Uniform/Total Settlement:-
the Soil layer to which the load is to be transfer should be sufficient in bearing to east the load which is to bel applied on it.
⇒ To Spread the Coming load over a large area.

1) Differential Settlement:-
Different Settlement in different parts of the same Structure is called differential Settlement.
Differential Settlement is more danger or considerable as Compared with total uniform Settlement, because it Causes more damage to a Structure as Compared to total / uniform Settlement.

Types of differential Settlement:-
Differential Settlement is of two types
1) Tilt:- if the entire Structure rotate due to unequal Settlement is called tilt.



2) Angular distortion:-
When two foundation Support walls/column settle unequally it means the Structure is Subjected is called angular distortion.

QNO# 03:
Part (B):

Given Data:-

Compressive index of soil (C_c) = 0.31
initial stress/pressure (P_1) = 130 KN/m².
Initial void ratio (e_0) = 1.02
Increased or final stress/pressure (P_2)
= 170 KN/m².
Stratum 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,

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

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

$$\boxed{e_1 = 0.984}$$

By formula:
Consolidation settlement is,

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

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

$$= 0.0893\,m \times 1000\,mm. \quad \boxed{S_c = 89.3mm}$$