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Section

A

Semester

6th

Paper

mid term

Subject

Geotechnical Engineering

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Date

17/04/2020

Q.No (01) Part (a)

Define the following terms

① Angular Distortion
② Plastic Equilibrium
③ Compressive index
④ Ultimate Bearing capacity
⑤ poison Ratio of soil

① Angular Distortion:

When two foundation support wall/column settle unequally it means the structure is subjected to angular distortion

(OR)

Angular distortion is the ratio of the differential settelement and distance b/w two point

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

Where

ℓ = distance b/w two point
δ = Defferential Settlement
β = Angular distrotion

② Compressive index:

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

Where

C_c = Compressive index
Δe = Change in void Ratio

P_1 = The pressure when the void ratio is e_1
P_2 = The pressure when the void ratio is e_2

Compressive index in term of m_v

m_v = change in volume per unit volume of compressible layer

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

$m_v = \frac{\Delta e / \Delta P}{1 + e_0}$

③ Plastic Equilibrium:

The plastic Equilibrium state are this state when the soil will near the failure or verge to the failure.

⇒ When the retaining soil is homogenous cohessionless semi-infinite and dry
The friction resestance b/w the retained soil and retaining wall is neglected mean frictional resistance is zero
The retained soil will be state of plastic equilibrium.

④ Ultimate Bearing capacity:

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

By formula

$q_u = CN_c S_c I_c d_c + \bar{q} N_q S_q I_q d_q + 0.5 \gamma B N_\gamma S_\gamma I_\gamma d_\gamma$

⑤ Possion Ratio of Soil :-

Possion Ratio is a measure of the possion effect that described the expansion or contraction of a material in all direction perpendicular to the direction of loading.

The value of poission ratio is negative of the ratio of transverse strain to axial strain.

QNo (01) Part (B)

A 6m tall cantilever wall retaining the soil that has the following properties

→ $C = 0$, $\Phi = 30°$, $\gamma = 19.2\ kN/m^3$

And the ground surface behind the wall is inclined at a slope of 3 horizontal and 1 vertical. The wall has moved sufficiently to develop active condition.

Determine the total normal and shear force acting on the back of this wall using Rankine's Theorey.

Given Data:

$C = 0$

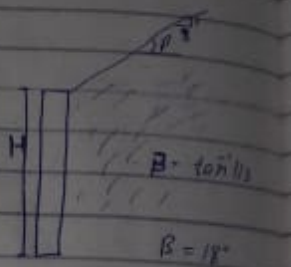
$\gamma = 19.2\ kN/m^3$

$H = 6m$

$\Phi = 30°$

Slope $H = 3$

$V = 1$



Required

$\frac{Va}{b} = ?$ $\frac{Na}{b} = ?$

Solution:

As we know that

$$\frac{Pa}{b} = \frac{\gamma \times H^2 \times K_a}{2} \rightarrow eq\ (1)$$

First we find "β"

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

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

As we know that

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

Now

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

$K_a = 0.3948$

Round up

$\boxed{K_a = 0.395}$

Eq ① $\frac{P_a}{b} = \frac{\gamma \times H^2 \times K_a}{2} = \frac{19.2 \times 6^2 \times 0.395}{2}$

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

Now we find Normal force $\left(\frac{N_a}{b}\right)$

As we know that

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

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

$$\frac{Na}{b} = 136.513 \times \cos(18)$$

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

To find shear force $\left(\frac{Va}{b}\right)$

As we know that

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

$$\frac{Va}{b} = 136.512 \times \sin(18)$$

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

Q No (3) Part (a)

What is bearing capacity. Also write factor affecting bearing capacity.

Bearing capacity:

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

Factor Affecting of Bearing capacity

① Relative density of soil:

If the relative density of soil is greater. The value of angle of internal friction will be greater Heigher will be Terzaghi bearing capacity factor due to which the value of bearing capacity will increase

② Unit weight of soil:

The unit weight of the soil increase the bearing capacity also increase. It mean the that the unit weight of soil is directly proportional to the bearing capacity

③ Depth of footing:

The bearing capacity increase with increase of depth of footing. higher will be Terzaghi bearing capacity factor.

④ Width of footing :-

If the width of footing increase the bearing capacity also increase and higher will Terzaghi bearing capacity factor.

⑤ Cohession of soil

If the cohesion of the soil is more cohesion. The bearing capacity is also increase with them.

⑥ Water Table :-

Water table is indirect relation with the bearing capacity due to water is the shear strength b/w the soil particle reduce have bearing capacity is decrease.

Q NO 03) Part (B)

What is the minimum safe load which can be supported by rectangular footing 3m by 3m with a safety factor of 3. The base of the footing is at 1.6m below the ground surface. The unit weight of soil is $18\ KN/m^3$.
The angle of sheor resisting $\phi = 30°$
$N_c = 14.8$, $N_q = 6.4$, $N_\gamma = 3.9$
Unit cohesion $C_u = 30\ KN/m^2$, use meyerhof Analysis.

Given Data

$\gamma = 18\ KN/m^3$
$L = 3m$
$B = 3m$
$D_f = 1.6m$
$FOS = 3$
$\phi = 30°$
$c = 30 KN/m^2$
$N_c = 14.8$
$N_q = 6.4$
$N_\gamma = 3.9$

Required :

$q_s = ?$

Solution :

As we know that

$$q_u = cN_c S_c I_c d_c + qN_q S_q I_q d_q + 0.5\gamma B N_\gamma S_\gamma d_\gamma I_\gamma$$

Now $I_c = I_q = I_\gamma = 1$

Then we use

2H= CNc Sc dc + 2N2 S2 d2 + 0.5 γ0 SB dγ Nγ → (1)

First for the shape factor

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

$\boxed{\alpha = 55°}$

NOW

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

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

$\boxed{S_c = 1.3}$

① >10. Then $S_\gamma = S_2 = 1 + 0.1 \left(\frac{B}{L}\right) \tan^2 \alpha$

$S_\gamma = S_2 = 1 + 0.1 \left(\frac{2}{3}\right) \tan^2 (55)$

$\boxed{S_\gamma = S_2 = 1.14}$

Depth factor :-

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

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

$\boxed{d_c = 1.23}$

NOW

$d_r = d_z = 1 + 0.1 \left(\frac{12}{15}\right) \tan 2$

$d_r = d_z = 1 + 0.1 \left(\frac{1.6}{3}\right) \tan(55)$

$\boxed{d_r = d_z = 1.11}$

$\rightarrow$ $\bar{\gamma} = \gamma x D$

eq ①

$q_u = CN_c S_c d_c + \bar{q} N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$

$q_u = (30 \times 14.8 \times 1.3 \times 1.33) + (18 \times 16) \times 6.4 \times 1.1 \times 1.14) +$

$(0.5 \times 20 \times 2.39 \times 1.11 \times 1.44)$

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

Now

$q_{nu} = q_u - \bar{\delta}$

$\rightarrow$ $\boxed{\bar{\delta} = \gamma x D}$

$q_{nu} = 762 - (18 \times 1.6)$

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

Then

$q_{ns} = \frac{q_{nu}}{FOS} = \frac{733.2}{3}$

$\boxed{q_{ns} = 244.4 \text{ KN/m}^2}$

Now

$q_s = q_{ns} + \bar{\delta}$

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

q_s = 273.2 KN/m²

Total safe load on Rectangular footing

A × q_s

(3 × 3) × 273.2

1639.2KN

Q No (03) Part (A)

Q. What is Settlement what are the its type explain in detail

Ans

Settlement:-

When the load is applied on the ground surface this will be produced effective Vertical Stress due to those Stress the effective Vertical Strain will be produced as a result of which the movement will occure in the downword movement is called Settlement

Types of Settlement:-

There are two types of Settlement on the bass of movement of structure.

① Differential Settlement

Differential Settlement is different part of same structure is called differential Settlement

OR

Differential Settlement are more dangerious or undesirable as compare to total Settlement because they cause more demage of a structure.

Type of Differential Settlement:-

There are two type of Differential Settlement

ⓐ Tilt

ⓑ Angular Distortion

④ Tilt :- If the entire structure rotate due to unequal settlement is called tilt.

⑤ Angular distortion

When two foundation support wall or column settle unequally it means that the structure is of angular distortion.

② Total Settlement:

↳ This type of settlement also called uniform settlement.

↳ If total settlement each part of structure will equally settle.

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

↳ A uniform settlement mostly occur in that structure which are constructed in rigid footing.

↳ In this type of settlement the utility services such as water supply Electricity, sewage line telephone etc.

Limitation for total settlement:

The soil layer to which the load is to be transfer should be sufficient in bearing to resist the load which is to be applied on it. To spread the coming load over a large area

Q NO (05) Part (15)

A soil has compressive index $C_c = 0.31$ At a stress $130 KN/m^2$ the void ratio was 1.02. Calculate

① The void ratio if the stress on the soil is increased to $170 KN/m^2$

② The total settlement of the stratum of 5m thickness.

Given Data

$H = 5m$

$e_o = 1.02$

$C_c = 0.31$

$P_1 = 130 KN/m^2$

$P_2 = 170 KN/m^2$

Required

$e_1 = ?$

$S_c = ?$

Solution

As we know that

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

$$C_c = \frac{e_o - e_1}{\log(P_2/P_1)}$$

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

$$0.31 = \frac{1.02 - e_1}{0.1165}$$

$$0.036 = 1.02 - e_1$$

$$e_1 = 1.02 - 0.036$$

$$\boxed{e_1 = 0.984}$$

(2) $Sc = ?$

As we know that

$$Sc = \frac{H}{1+e_0} \times C_c \log\left(\frac{P_2}{P_1}\right)$$

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

$$Sc = 0.08934\,m$$

$$\boxed{Sc = 89.3478\,mm}$$