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Section # A

Paper # Geotechnical

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Q1) Ans (i)

(i) Plastic Equilibrium:-
In this state the soil will near to failure are verge to failure.

(ii) Angular Distortion:-
When two foundation support walls / columns settle unequally it mean the structure is subjected to angular distortion.

(iii) compressive index:-

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

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.

(iv) 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) Poisson Ration:-

The negative ratio of ~~to~~ Transversal Strain to the axial Strain in an elastic material which is Subjected to an un equal stress.

(1) B
Ans 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 ($\frac{Na}{b}$) = ?
Total shear force ($\frac{Va}{b}$) = ?

Solution:-
As we know that
Active force is given by

$$\frac{Pa}{b} = \frac{\gamma \cdot H^2 \cdot Ka}{2}$$

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

$\tan^{-1} = \frac{1}{3}$

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

$\boxed{\beta = 18°}$

Also Ka is given by

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

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

$$Ka = 0.951 \times \frac{0.95 - \sqrt{0.904 - 0.75}}{0.95 + \sqrt{0.904 - 0.75}}$$

$$Ka = 0.3948$$

$$Ka = 0.3945$$

Now by formula.

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

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

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

As the normal force is

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

$$\frac{Na}{b} = 136.52 \times \cos(18)$$

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

Also the shear force is

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

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

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

Q2 (A) Ans:- Bearing capacity:-

in geotechnical Engineering bearing capacity is define 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 Nq, Nc, Nr with increase of this the bearing capacity will increase

(2) Depth of friction:-

with the increase of depth 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) Breath of foundation:-

More the breath of foundation more be the bearing capacity of Soil. It will be more in dense Soil as compared to loose Soil.

(4) unit weight of soil:-

Bearing capacity of soil is directly proportional to unit weight of soil The bearing capacity of soil increase with increase in its unit weight will be more in dense soil and loss and loose soil

(5) water table:-

A water table comes near to the foundation the bearing capacity get decreases.

Q 22 B

Ans

B Given data:-

footing Dimension = 2m x 3m b=3 h=2

factor of safety = 3.

Depth of foundation = 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 (qs) = ?

Solution:-

According to Mayerhofs Analysis

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

for shape factor. S_c, S_q, S_γ

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

$\alpha = (45 \times \frac{\theta}{2})$

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

$\alpha = 55.0°$

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

$S_c = 1.27$

As $\phi > 10°$ so

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

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

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

for depth factor: (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.22}$

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 $Q = 0°$

$i_c = i_q = i_\gamma = 1$

By formula,

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

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

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

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

Net Safe Bearing capacity is

$$q_{ns} = \frac{q_{nu}}{F.O.S} = \frac{733.2}{3} = 244.4 \, kN/m^2$$

Safe Bearing capacity is

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

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

$$q_s = 273.2 \, kN/m^2$$

This safe Bearing capacity over the whole footing will be

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

$$A \times q_s = 1639.2 \, kN$$

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Q3 Ans

Settlement:-
When a 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 occure in the down word direction This downword movement is called settlement.

Types of settlement:-
on the basis of movement of the structure it is divided into two type
(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 eaually in uniform settelement 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.
in this type of settlement the utility services such as water supply be decreased and the structure will remain sound.

~~Liminar~~
limitation for uniform / 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 aming load over a large area.

Differential Settlement:
Different settlement in different part of the some structure is called differential settlement
Differential settlement is more danger or ~~ell~~ undesirable as compare with total uniform settlement, because it cause more damage to a structure as compared to total / uniform settlement.

causes of settlement:
(1) improper Design:
The main cause of the settlement is improper design of the structure, Therefore to reduce the settlement the project should be design properply

(2) weak Bearing Soil:
If the soil is work in bearing capacity. there is more chance of settlement as compared to the soil which is strong in bearing capacity.

(3) pore compaction

The soil which have pore compaction settlement is more plaminant in that soil. while the soil which have proper compaction in that the settlement will be less in the soil

(4) change in moisture content.

The settlement is more prominant in soil which have the the moisture content out of desirable limit therefore it should be within limit of design criteria to avoid settlement

(5) Maturing Tress and vegetation

if there is tress and vegetation in the soil there is more chance of settlement as compared to the soil which have no tress and vegetation.

Q3 B

3(B)
Ans

Given data:-

compressive index of soil (cc) = 0.31
intial stress/pressure P1 = 130 kN/m²
intial void ratio (e0) = 1.02
increased or final stress/pressure = 170 kN/m²
Stration thickness = 5m

Required:-

final void ratio due to increased stress e1 = ?
Total consolidation settlement = Sc = ?

Solution:-

As compressive index is given by

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

$$0.31 = \frac{1.02 - e_1}{\log_{10}\left(\frac{170}{120}\right)} \Rightarrow 0.3 \times 0.1165 = 1.02 - e_1$$

$$e_1 = 0.984.$$

By formula.
consolidation settlement is

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

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

$$= 0.0893 \text{ m} \times 1000 \text{ mm}$$

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