Q NO # 01

Part Ⓐ

Ans:→ Define the following Terms.

⇒ **Plastic Equilibrium:-**

→ A body of Soil is in a State of plastic equilibrium if every part of it is on the verge of failure.

→ Plastic equilibrium that can be developed Simultaneously througout a Semi-Infinite mass of Soil caused by no force other than gravity.

⇒ **Angular Distortion:-**

→ Angular Distortion is the ratio of the different Settlements and the distance between two points.

→ Angular distortion is the angular change in relative position of members extending from a weld area.

⇒ **Compressive Index:-**

→ The Compressive Index is used to find the Settlement in the normally Consolidated Clay. The Total Stress applied is larger then the Stress in the field, To which the Soil Sample has been undergone in the Past this kind of clay Soil is Said to be normally consolidated clay.

⇒ Ultimate Bearing Capacity:-

→ The Ultimate Bearing capacity is the value of bearing stress which causes a sudden catastrophic settlement of the foundation (due to shear failure).

⇒ Poisson Ratio of Soil:-

→ poisson's ratio is the negative of ratio of Transversal strain to the axial strain in an elastic material, which is subjected to an uniaxial stress

— * —

Q No # 01

Part B:- problem

Given data:-

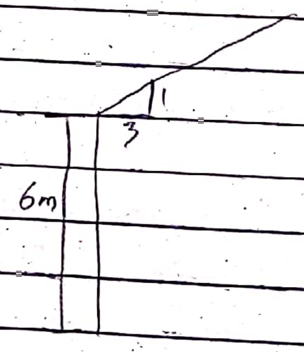
cohesion value = $c = 0$

Angle of internal friction = $\phi = 30^\circ$

unit weight of soil = $\gamma = 19.2\ KN/m^3$

β = slope = 3 : 1

Height of wall = $h = 6m$.



Required data:-

Total normal force = Na/b = ?

" Shear force = Va/b = ?

Solution:-

to find active forces we have formula

$$\text{Active forces} = \frac{Pa}{b} = \frac{\gamma . H^2 Ka}{2} \quad \text{--- (*)}$$

For finding Ka, compute the slope

$$\tan\beta = 1/3$$

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

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

So further we have formula for Ka which is

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

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

By solving further we get:

$$\boxed{K_a = 0.395}$$

So we have equation ⊛

$$\frac{P_a}{b} = \frac{\gamma_1 H^2 \cdot K_a}{2}$$

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

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

For normal force

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

Scanned with CamScanner

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

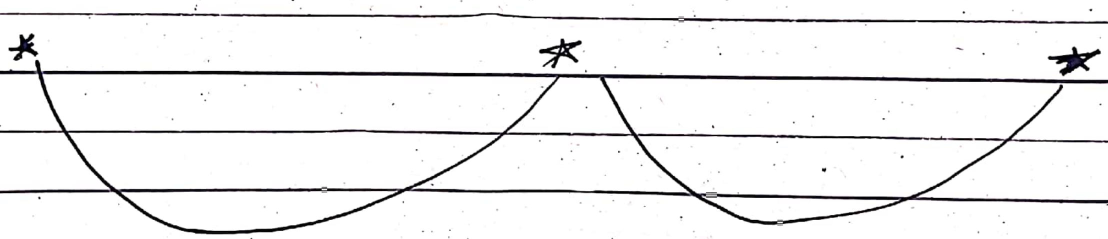
$$\Rightarrow \frac{Na}{b} = 129.83 \text{ KN/m}$$

For Shear force

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

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

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



Q NO # 02

part A :-

Bearing Capacity :-

→ Bearing Capacity is the capacity of Soil to Support the loads applied to the ground. The bearing capacity of Soil is the maximum average content pressure between the foundation and the Soil which should not produce the shear failure in the Soil.

=> Factor effecting bearing Capacity :-

Following are the Factors which can effect bearing capacity

1- Effect of Shape of footing on Bearing Capacity :-

→ The Shape of footing is an important parameter which governs the Ultimate bearing capacity of the Soil. In general strip, squar rectangular and Circular Shaped footing are used. For Soil 1 by keeping other parameter constant, the effect of shape of footing on Ultimate bearing capacity of the Soil is Studied. the values of Ultimate capacity for Soil-1 are determined by method given by Terzaghi and Bureau of Indian Standard.

2 :- Soil Strength :-

→ Bearing Capacity of Cohesionless Soil and mixed

Soil increases unproportionally with the increase of in the effective friction angle. However, bearing capacity of cohesive soil varies linearly with soil cohesion provided that the effective friction angle is zero.

3 Soil weight and Surcharge:-

→ The contribution of surface and surcharge soil, which are influenced by water table, to the bearing capacity cannot be ignored. The water table should not be above the base of the foundation to avoid construction, seepage, and uplift problems. If the water table is below the depth of the failure surface then it has no influence on the bearing capacity.

4- Foundation width:-

→ The bearing capacity of a footing placed at the surface of a cohesionless soil, where the soil shear strength is considerably dependent on the internal friction, is proportion to the width of foundation.

→ Bearing capacity of cohesive soil of constant shear strength and infinite depth is independent of foundation width.

5. Foundation Depth:-

→ The deeper the foundation the greater will be the bearing capacity.

→ This is specifically obvious in a uniform cohesionless soil. In contrary, if the foundation is caried down to a weak soil layer then bearing capacity is declined.

6. Frost Action:-

→ Frost have in certain soils in contact with water and subject to freezing temprature or loss of strength of frozen soil upon thawing can alter bearing capacity over time. Low cohesion material containing a high percentage of silt sized particles are mostly susceptible to frost action.

7. Subsurface voids:-

→ Bearing capacity of soil decreases due to subsurface voids which are within a critical depth beneath the foundation.

→ The criticle depth is that depth below which the influence of pressure in the soil from the foundation is negligible.

—— ★ ——

Q.No # 02

Part B problem:

Given data:-

→ Factor of Safety = F.O.S = 3
Demension of footing = $(2 \times 3)m$
Depth of footing = D_f = 1.6m
Unit weight of Soil = γ = 18 KN/m^3
Angle of Shear resistance = ϕ = 20

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

Unit Cohesion = C_u = 20 KN/m^2

Required data:-
Max Safe load = q_s = ?

Solution:-
According to Meyerhof's Analysis

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

For Shape factors (S_c, S_q, S_γ)

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

So

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

By Solving

$$\alpha = 55^\circ$$

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

$\Rightarrow \quad \boxed{S_c = 1.272}$

we have given $\phi > 10^\circ$

So

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

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

$\boxed{S_q = S_\gamma = 1.136}$

For Depth factor (d_c, d_q, d_γ)

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

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

$\boxed{d_c = 1.228}$

$\Rightarrow$ given That $\phi > 10^\circ$

So

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

$\Rightarrow \quad \boxed{d_q = d_\gamma = 1.114}$

(i)

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

$= (20)(14.8)(1.272)(1.228) + [(1.6 \times 18)](6.4)(1.36)(1.114)$

$+ \frac{1}{2}(18)(2)(2.9)(1.136)(1.114)$

Simplifying

$\boxed{q_u = 782.874 \ KN/m^3}$

Further

$$q_{n.u} = q_u - \bar{\sigma} \qquad (\bar{\sigma} = d_f \times \gamma)$$

$$= 761.674 - (1.6 \times 18)$$

$$q_{n.u} = 732.874 \ kN/m^3$$

Further

$$q_{ns} = \frac{q_{n.u}}{F.O.S} = \frac{732.874}{3}$$

$$q_{ns} = 244.291 \ kN/m^2$$

For Safe bearing capacity:-

$$q_s = q_{ns} + \sigma = 244.291 + (1.6 \times 18)$$

$$q_s = 273.091 \ kN/m^2$$

So This is the maximum Safe Bearing capacity per Squar meter of the footing.

For Total footing the max Bearing capacity will be,

$$q_s = 273.091 \times 2 \times 3$$

$$\Rightarrow q_s = 1638.546 \ kN$$

QNO # 03

part A :-

Q:- What is Settlement

Ans:→ In geotechnical Engineering, Settlement is defined as the vertical movement of the ground, generally caused by changes in Stresses within the earth

→ Settlement is most likely to occure when increased vertical Stresses are aplied to the ground on or above Soft or loose Soil Stata.

⇒ Types of Settlement :-

Following are the different types of Settlement.

1→ Immediate Settlement:

→ Immediate Settlement takes place as the load is applied or within a time Period of about 7 days.

→ Predominates in Cohesion less Soil and unsaturated clay.

→ Immediate Settlement analysis are used for all fine-grained Soils, including Silts and Clays with a degree of Saturation < 90% and for all Coarse grained Soil with large co-efficient of Permeability (Say above 10.2 m/s)

2→ Consolidation Settlement :-

→ Consolidation Settlements are time dependent and take months

To years to develop. The leaning tower of pisa in Italy has been undergoing consolidation settlement for over 700 years. The lean is caused by consolidation settlement being greater on one side.

3 → Secondary Settlement/creep

Secondry Settlement occurs under constant effective Stress due to continues rearrangement of clay predominates in highly plastic clay and organic clays.

4 → Immediate Settlement Calculation :-

$$\Delta H_i = q_0 B \frac{1-\mu^2}{E_s} m I_s I_F$$

$$I_s = I_1 + \frac{1-2\mu}{1-\mu} I_2$$

The above equation for Is strictly applicable to flexible bases on the half space. In practice, most foundations are flexible because even every thick footing deflects when loaded by space may consist of either cohesion material or any water content, or understurated cohesive soil.

5 → Secondary Compression/creep

→ After primary consolidation the soil structure continues to adjust to the load for some additional time. This settlement is termed secondary consolidation/secondary compression. At the end of secondary consolidation the soil has reached a new K_0 - state (at-rest state)

To find secondary consolidation settlement in the field (ΔH_s)

$$\Delta H_s = \Delta C_\alpha \log \frac{t_{100(f)} + \Delta t}{t_{100(f)}}$$

6 → Sands :-

→ Maximum total settlement = 40 mm for isolated footing = 40 to 65 mm for rafts maximum differential settlement between adjacent column = 25 mm.

7 → Clays :-

Maximum total settlement = 65 mm for isolated footings = 65 to 100 mm for rafts maximum differential settlement between adjacent column = 40 mm.

The differential settlement may be also evaluated in terms of the angular distortion given by

$$(\Delta H_{diff}) = \Delta/L$$

— * —

Q.No 3

Part B :-

Given data :-

Compressive Index = C_c = 0.31

Initial Stress = P_1 = 130 KN/m²

Initial void ratio = e_o = 1.02

Final Stress = P_2 = 170 KN/m²

Thickness = H = 5m

Required data :-

Final void ratio = e_1 = ?

Final settlement = S_c = ?

Solution :-

i→ By Compressive Index C_c

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

$$= \frac{e_o - e_1}{\log_{10}(P_2/P_1)}$$

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

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

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

$$= 1.02 - e_1 = 0.036$$

Scanned with CamScanner

$$-e_1 = 0.036 - 1.02$$

$$e_1 = 0.984$$

$$\boxed{e_1 = 0.984}$$

ii → So by S_c

$$S_c = \frac{H}{1+e_0} \times C_c \times \log_{10}\left(\frac{170}{130}\right)$$

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

By Solving we get

$$= 0.0894 \text{ m}$$

& So

$$\boxed{S_c = 89.4 \text{ mm}}$$