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Section B

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Subject - "Geotechnical Engineering"

Submitted To,

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Q.1 part (a)

(1) Plastic Equilibrium :-

It can be define as;
A body of a soil is said to be in plastic Equilibrium if every points of it on the verge of Failure.
And other word plastic Equilibrium is the state of stress with in a soil mass or portion there of that has been deformed to such on extent that its ultimate shearing resistence is mobilized.

(2) Angular Distortion :- (β)

Angular distortion is the Angular ratio of differential settlement 'δ' and the discharge dischance 'l' b/w two points.
For Example;
When two Foundations Support walls/colums Settle

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UneQually it means the Structure is Subjected to Angular distortion.

(3) Compressive Index :-

Compressive index is use 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

Mathematical Form;

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

- Δe = change in void Ratio.
- P_1 = Is the Pressure when the void Ratio is 'e_1'
- P_2 = Is the Pressure when void Ratio is "e_2'
- C_c denoted Compressive Index

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(4) Ultimate bearing Capacity :-

It is define as;

The maximum Pressure at the base of footing that causes Shear failure it is called Ultimate bearing Capacity

- It is denoted by "q_u"

Mathematical Form

$$q_u = q_{nu} + \bar{q}$$

- q_{nu} = Net Ultimate bearing Capacity.
- $\bar{q}$ = Over burden Pressure
  $\therefore \bar{q} = \gamma * D_f$
- γ = Unit wt of Soil
- D_f = Depth of Footing.

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(5) Poission Ratio of Soil :-

poission Ratio is the negative ratio of transverse to axial Strain.

- The poission Ratio of Stable, Isotropic and a linear material Can not be less than -1.0 nor greater than 0.5 with the later being a value typically associated with a perfectly incompressible material.

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part (b)

Given Data :-

- Height OF Wall = "H" = 6m
- $C = 0$
- $\phi = 30^\circ$
- $\gamma = 19.2\ kN/m^3$
- Slops
  - H = 3
  - V = 1

Required :-

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

Solution :-

We Know that

$$Pa/b = \frac{\gamma * H^2 * Ka}{2} \quad \text{— eq (i)}$$

Also we Know

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

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

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

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As

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

put ⊙ $\beta = 18°$ ⊙ $\phi = 30°$

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

$Ka = 0.3948$ (Rounding OFF)

$$\boxed{Ka = 0.395}$$

Now eq (i)

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

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

$$\boxed{Pa/b = 136.512 \ KN/m} \quad \text{— (ii)}$$

And

⊙ $$Na/b = Pa/b * \cos\beta \quad \text{— (iii)}$$

put eq (ii) in (iii)

$$Na/b = 136.152 * \cos(18)$$

$$\boxed{Na/b = 129.83 \ KN/m}$$

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$\odot \quad V_a/_b = P_a/_b \sin\beta$ —— (iv)

put valus in eq (iv)

$V_a/_b = 136.152 \times \sin(18)$

$$\boxed{V_a/_b = 42.18 \ KN/m}$$

thus the Reqcired results of $V_a/_b$ and $N_a/_b$

Q.2 part (a)

Bearing Capacity :-

It is a engineering property of Soil due to which the Soil resist the applied load.

- It is also called the internal Strength of Soil.
- It is denoted by "q"

Factors Effecting bearing Capacity:

(1) Relative Density of Soil :-

If the relative density of a Soil greater then their will be Higher value of angle of internal friction "ϕ". As high value of angle of internal friction as a result higher value of Tarzughi bearing factors (N_c, N_q, and N_γ)

- (N_c, N_q and N_γ) is higher valuse as a Result high value of bearing capacity.

- Soil having having enough relative density will have enough bearing capacity.

$\therefore \gamma_{relative} = \frac{e_{max} - e}{e_{max} - e_{min}}$

(2) Depth OF Footing:-

The bearing capacity is increase with increase the footing i.e when we increase footing as a result higher value of bearing capacity.

$\therefore D_f \uparrow$

$\therefore q \uparrow$

- This increase will be maximum for dense soil as campared with lose soil.

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(3) Width of Footing :-

The bearing capacity is increase when we increased with of the footing.

- if the base of the footing increases then it Sustained more load because area(width) is increased.

(4) Unit weight of Soil :-

As unit weight of Soil increases then the bearing capacity also increased.

(5) Cohesion of Soil :-

If the Soil is more Coshessive then the bearing Capacity also more value.

(6) Water table :-

If water table rises then bearing Capacity reduced to half.

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part (b)

Given Data :-

- Dimension $= B*L$
  $= 2m*3m$
- Depth of footing $= D_f = 1.6m$
- $F.O.S = 3$
- Unit wt of Soil $\gamma = 18 KN/m^3$
- Angle of Shear Resistence $\phi = 20^\circ$
- Cohesion $C_u = 20 KN/m^2$
- Used Meyerho Analysis.

Required :-

Maximum Safe load $= q_s = ?$

Solution :-

We Know that.

$$q_u = C N_c S_c d_c i_c + q N_q S_q d_q i_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma$$

As

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

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Then

$q_u = C N_c S_c d_c + q N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$

First we will Find

Slop Factors:-

For Slop α =?

$\alpha = 45 + \phi/2 = 45 + 20/2$

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

Now

$S_c = 1 + 0.2 (B/L) \tan^2 \alpha$

$S_c = 1 + 0.2 (2/3) \tan^2 (55)$

$\boxed{S_c = 1.3}$

$\phi > 10$ So

$S_\gamma = S_q = 1 + 0.1 (B/L) \tan^2 \alpha$

$S_\gamma = S_q = 1 + 0.1 (2/3) \tan^2 (55)$

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

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Now Depth Factors:-

$d_\gamma = d_q = 1 + 0.1 (D/B) \tan\alpha$

$d_\gamma = d_q = 1 + 0.1 (1.6/2) \tan(55)$

$d_\gamma = d_q = 1.11$

$d_c = 1 + 0.2 (D/B) \tan\alpha$

$d_c = 1 + 0.2 (1.6/2) \tan(55)$

$d_c = 1.23$

As

$q_u = C N_c S_c d_c + q N_q S_q d_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma$

put values $\therefore B = 2m$

$q_u = (20 * 14.8 * 1.3 * 1.23) + (18 * 1.6) * (6.4 * 1.1 * 1.14) + 0.5 * 20 * 2 * 2.9 * 1.11 * 1.14)$

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

$q_{n.u} = q_u - \bar{q} \quad \therefore \bar{q} = \gamma * D_f$

$q_{n.u} = 762 - (18 * 1.6)$

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

We know that

$$q_{n.s} = \frac{q_{n.u}}{F.O.S} = \frac{733.2}{3}$$

$q_{n.s} = 244.4 \ KN/m^2$

As Safe bearing Capacity

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

$q_s = 244.4 + (18 * 1.6)$

$q_s = 273.2 \ KN/m^2$

Total Safe load on Rectangular Footing

$= q_s * Area$ —∵ $A = 2*3$

$= 273.2 * (2*3)$

$= 1639.2 \ KN$

Thus the Required Result.

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Q.3 part (a)

Settlement :-

When a load is Applied on the ground Surface this will produce effective vertical Stresses due to which the effective vertical Strain will be produce as a result of which the movement will occur in downward direction. This downward moment is called Settlement.

Types of Settlement :-

On the bases of movement of Structure it is divided into two type.

1. Total Settlement or Uniform Settlement
2. Differential Settlement.

(1) Total Settlement :-

- In this types of Settlement each part of Structure will Settlement equally.

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- In Failure in total Settlement not much danger as Campare to Differential Settlement. Because total Settlement Sink. in equal magnitude.

- Mostly Occure in rigid footing.

- It effect the following utility Services.
  - water Supply
  - electricity.
  - Sewage line
  - Telephone
  - also may be decrease and Structure will remain Sound (Beam. Column, Slab Settle in Same magnitude)

Limitation For Total Settlement:-

- The Soil layer to which the Load is to be transfer Should be Sufficent in bearing to resist the load which is to be applied on it.

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- To Spread the Coming load over larger area.

(2) Differential Settlement :-

- In differential Settlement each parts of a Structure Settle "Unequally".

- More danger then total Settlement.
Because it cause more demage to a Structure as Compared to total Settlement.

"Types OF Differential Settlement"

There are two types OF Differential Settlement.

1. Tilt
2. Angular Distortion

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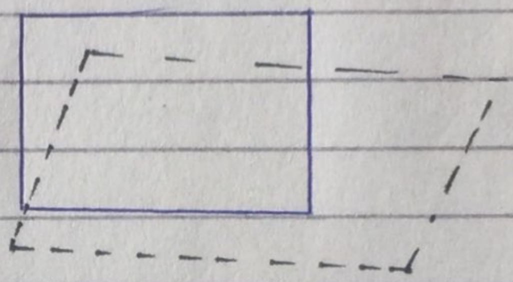
(1) Tilt :-
If the entire Structure rotates due to Unequal Settlement is called tilt.



Tilt Fig (a)

(2) Angular Distortion :-
When the two Structurs wall/column Settle Unequally it means that the Structure is Subjected to Angular Distortion.

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part (b)

Given Data :-

- Compressive Index = $C_c = 0.31$
- $P_1 = 130\ KN/m^2$
- $e_0 = 1.02$
- $P_2 = 170\ KN/m^2$
- thickness = H = 5m

Required :-

$e_1 = ?$

$S_c = ?$

Solution :-

We know that:

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

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

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

$$\boxed{e_1 = 0.983}$$

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(c) $S_c = ?$

We have

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

$$S_c = \frac{6.5}{1+0.02} * 0.31 \log_{10}\left(\frac{170}{130}\right)$$

$$S_c = 0.0893\,m$$

$\therefore 1m = 1000mm$

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

Thus the Required Results

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