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Subject :- Geotechnical Engineering

Qno I (A)

Define the Following terms:-

Plastic Equilibrium:-

Plastic equilibrium that can be developed simultaneously throughout a semi-infinite mass of soil caused by no force other than gravity

Plastic equilibrium limits for cohesionless soils defined by ratio between major and minor principal stresses:

$$\cdot \sigma_1/\sigma'_3 = N_\phi = \tan^2(45^\circ + \phi/2)$$

Angular Distortion:-

It is defined as the differential settlement between two points divided by the distance between them less the tilt equals rotation of the entire building.

Compressive Index:-

The compressive index is used to find settlement in normal consolutes clay. $C_c = \frac{\Delta e}{\Delta \log_{10} \sigma_{et}}$

The total stress applied is larger then the stress in field, to which the soil sample has been undergone in the past.

Ultimate Bearing Capacity:-

It is the theoretical maximum pressure which can be supported without failure.

The gross pressure intensity at the base of foundation which would cause shear failure is called ultimate bearing capacity.

## Poission Ratio of soil:-

It is the negative ratio of transverse to axial strain. The poission ratio of a stable, isotropic, linear elastic material cannot be less then −1.0 nor greater then 0.5 with the later being a value typically associated with a perfectly incompressible material

$$\mu = \frac{\text{lateral strain}}{\text{longitudinal strain}}$$

Sand $\mu = .15 - .4$

Clay $\mu = .1 - .5$

Qno 1(b)

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

$C = 0 \quad \varnothing = 30^\circ \quad \gamma = 19.2 kN/m^3$

Given:-

$H = 6m, \; C = 0$

$\varnothing = 30^\circ, \; \gamma = 19.2 kN/m^3$

slope $H = 1, \; V = 3$

Required:-

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

Solution:-

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

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

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

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

$\beta = 18^\circ$

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

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

$K = 0.3948$

$K_a = 0.395$

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

$$P_a/_b = 136.512 \text{ kN/m}$$

$$N_a/_b = \frac{P_a}{b} \cos\beta$$

$$= 136.512 \times \cos(18)$$

$$= 129.83 \text{ kN/m}$$

$$V_a/_b = \frac{P_a}{b} \sin\beta$$

$$= 136.512 \times \sin(18)$$

$$= 42.18 \text{ kN/m}$$

Result:

$$N_a/_b = 129.83 \text{ kN/m}$$

$$V_a/_b = 42.18 \text{ kN/m}$$

Qno 2(A)

What is bearing capacity. Also write factors effecting Bearing capacity.

Bearing Capacity:-

In geotechnical engineering, bearing capacity is the capacity of soil to support the loads applied to the grounds. In other words the internal strenght of soil is called bearing capacity.

Denoted by $q_f$.

Factors effecting bearing capacity:-

① Relative Density of soil:-

More relative density of soil more will be its angle of friction More will be $N_q, N_c, N_\gamma$ with increase of this bearing capacity increases.

② Depth of Footing:-

With the increase of depth of foundation the bearing capacity of soil will increase, This increase will be more if soil is dense.

③ Unit weight of soil:

With increase of unit weight the bearing capacity of soil will increase. It is directly proportional to unit-weight of soil.

④ Breadth of Foundation:

More the breadth of foundation more will be bearing capacity of soil.

⑤ water Table:

When the water table reach to the surface the bearing capacity decreases

Qno 2(b)

What is maximum safe load which can be supported by retengular footing 2m by 3m with a safty factor of 3 The base of the footing is at 1.6m below the ground surface. The unit weight of soil is 18kN/m³. The angle of shear resisting $\phi = 20°$ ($N_c = 14.8$, $N_{qr} = 6.4$, $N_r = 2.9$).

Given Datar

$L = 3m$ , $B = 2m$ , $D = 1.6m$, $F.O.S = 3$, $r = 18kN/m^3$

$\phi = 20°$ , $C_u = 20kN/m^2$

$q_s = ?$

Solution:

$$q_u = CN_c S_c d_c + q N_q d_q s_q + \frac{1}{2} r.B.N_r.d_r.S_r$$

For shape factor:

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

$$\alpha = 55°$$

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

$$1.02 (2/3) \tan^2 (55)$$

$$S_c = 1.27 = 1.3$$

$$S_q = S_r = 1 + 0.1 \, B/L \, \tan^2 \alpha$$

$$= 1.1 (2/3) \tan^2 (55)$$

$$S_q = S_r = 1.4$$

Depth Factor:-

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

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

$dc = 1.23$

$dr = dq = 1 + 0.1 (D/B) \tan\alpha$

$1 + 0.1 (1.6/2) \tan(55)$

$= 1.11$

$qu = C.Nc.Sc.dc + q.Nq.dq.Sq + \frac{1}{2} r.B.N\gamma.d\gamma.S\gamma$

$(20 \times 1.48 \times 1.3 \times 1.23) + (18 \times 1.6) \times 64 \times 1.11 \times 1.14)$

$+ 0.5) \times 20 \times 2 \times 2.9 \times 1.11 \times 1.4)$

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

$qn.u = qu - S = 762 - (18 \times 1.6) = 733.2 \text{ KN/m}^2$

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

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

$qs = qn.s + S = 244.4 + (1.6 \times 18)$

$qs = 273.2 \text{ KN/m}^2$

Total safe load on Rectangular Footing

$A \times qs = (2 \times 3) \times 273.2$

$= 1639.2 \text{ KN}$

Qno 3 (A)

What is settlement? Explain types in details.

Settlement:-

Settlement is the downward movemen of the grounds caused by a load consolidating the soil below it.

When load is applied on the ground surface this will produce effective vertical stresses, due to these stresses effective vertical strain will be produced as a result of which the movement will occure in downward direction. This downward movement is called settlement.

Types of settlement:-

① Total settlement:-

In this type of settlement each part of the structure will settle equally. Thus it is also called uniform settlement. In this settlement the failure of the structure is not much considered as with differential settlement. The total settlement mostly take place in the structure.

## Differential Settlement :-

Differential settlement is more danger then total settlement. It cause more damage to the structure.

Differential settlement in different part of same structure is called differential settlement.

It is furthure divided in to two parts.

① Tilt

② Angular Distortion.

Qno 3 (b)

A soil has compressive index $C_c = 0.31$. At a stress 130kN/m², the void ratio was 1.02, .....

Given Data:

$C_c = 0.31$, $P_1 = 130 kN/m^2$, $e_1 = 1.02$ $P_2 = 170 kN/m^2$

$H = 5m$

Void ratio, $= ?$ $Sc = ?$

Solution:-

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

$$C_c = \frac{e_0 - e_1}{\log_{10}(P_2/P_1)}$$

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

$$e_1 = 0.54$$

Now

$$Sc = \frac{H}{1+e_0} + C_c \log_{10}(P_2/P_1)$$

$$= \frac{5}{1+1.02} \times 0.31 \log_{10}(170/130) \times 1000mm$$

$$Sc = 1003.427$$

$$e_1 = 0.54$$

$$Sc = 1003.427$$