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SECTION "A"

Geotechnical Engineering

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Ans 1(A)

1) Plastic Equilibrium:

Plastic equilibrium is a state of permanent change of state when stressed.
But the elastic equilibrium is done when all the element in a volume streached at the same time return to normal when stress force is not there.
Example: The rubber band etc.

2) Compression Index:

The compression index is used to find the settlement in the normally consolidated clay.
The total stress applied is larger than the stress in the feild, to which the soil sample has been undergone in the past.
→ value of compressive index is different between each type of soil.

3) Ultimate Bearing Capacity:

It is the least pressure which could cause shear failure if the supporting soil immediatly below and adjacent to the foundation.

The maximum gross pressure intensity at the base of the foundation at which the soil does not fail in shear

4) Angular Distortion:

When the foundation supports walls / columns settles unequally it means the structure is subjected to angular distortion.

5) Poison ratio of soil:

When the material is streached in one direction it tends to get thinner in the other two directions.

Ans 1 (B)

Given data:

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

$\phi = 30°$, $\gamma = 19.2\, KN/m^3$

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

Required:

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

solution:

First of all

$$\frac{Pa}{b} = \frac{\gamma H^2 Ka}{2} \longrightarrow (A)$$

for β

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

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

$$\beta = 18°$$

As we know that

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

putting values

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

$$\boxed{K_a = 0.3948}$$

Now putting values in (A)

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

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

Now

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

$$\frac{N_a}{b} = 13.6.51 \cos(18)$$

$$\boxed{\frac{N_a}{b} = 129.83 \text{ KN/m}}$$

Now

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

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

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

Ans 2(A)

Bearing Capacity of soil:

Bearing capacity is the capacity of soil to support the loads apply on it. So it is the maximum contact pressure between soil and foundation which should not increase the shear failure on soil.

OR

The maximum load per unit area which the soil or rock can carry without yeilding or displacement is tearmed as the bearing capacity of soil.

Factor affecting:

1) Foundation Width:

Foundation width affects bearing capacity of cohesionless soil. The bearing capacity of a footing placed at the surface of cohesionless where the soil shear strenght is considerably dependent on internal friction, is proportional to the width of the foundation.

2) Spacing b/w foundation:

It is recommended to consider minimum spacing between footings which 1.5 times foundation width, during the design of foundation in order to avoid reduction in bearing capacity.

3) Subsurface Voids:

Bearing capacity of soil decreases due to subsurface voids which are within a crytical depth beneath the foundation. The critical depth is that depth below which the influence of pressure in the soil from the foundation is negligible.

4) Soil reinforcement:

Bearing capacity of soft or weak soil can be increased greatly by installing various form of reinforcement in the soil like metal ties, strips or grids, geotextile fabrics or granular materials.

5) Soil erosion & seepage:

Erosion of soil around & under foundations & seepage can reduce bearing capacity and can cause foundation failure.

Ans 2(B)

Given data:

$L = 3m$ $\gamma = 18\ KN/m^3$

$B = 2m$ $C = 20\ KN/m^2$

$D_f = 1.6m$ $\phi = 20°$

$FOS = 3$

Required:

$q_s = ?$

Solution:

As we know

$$q_u = cN_c s_c d_c i_c + qN_q d_q s_q i_q + \frac{1}{2}\gamma B N_\gamma s_\gamma d_\gamma i_\gamma.$$

$$\because q = D_f \times \gamma_s$$

$$1.6 \times 18$$

$$\boxed{q = 28.8\ KN/m^2}$$

First for the slope factor

$$\alpha = \left(45 + \frac{\phi}{2}\right) = \left(45 + \frac{20}{2}\right)$$

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

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

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

$$S_c = 1.27 = 1.3$$

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

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

$$S_q = S_\gamma = 1.14$$

Depth factor:

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

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

$$d_c = 1.23$$

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

$$= 1 + 0.1\left(\frac{1.6}{2}\right)\tan(55)$$

$$= 1.11$$

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

putting value

$q_u = (1.48 \times 13 \times 1.28 + (18 \times 1.6) \times 6.4 \times 1.1 \times 14) +$

$(0.5 \times 20 \times 2 \times 2.9 \times 1.11 \times 1.14)$

$q_u = 762 \ KN/m^2$

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

$= 762 - (18 \times 1.6) \qquad \bar{\delta} = \gamma = D$

$= 733.2 \ KN/m^2$

$q_{n.s} = \frac{q_{n.s}}{FOS} = \frac{733.2}{3} = 244.4 \ KN/m^2$

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

$\Rightarrow 244.4 + (1.6 \times 8)$

$q_s = 273.2 \ KN/m^2$

Hence

Total safe load on footing

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

$\boxed{= 1639.2 \ KN}$

Ans 3(A):

Settlement:

It is defined as the vertcle movement of the ground generally caused by changes in stresses with in the earth. Settlement is most likely to occur when increased verticle stresses are applied to the ground on or above soft or lose soil strata

Types:

1) Immediate settlement:

Immediate settlement tak at a place as the load is applied or within a time period of about 7 days.

Immediate settlement (analysis) are used for all fine grained soils including silts or clays with a degree of situration

< 90%

Mathematically:

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

2) Consolidation Settlement:

Consolidation settlements are time dependent and take months to years to develop. The principal settlements for most projects occur in 3 to 10 years.

Mathematically:

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

3) Secondary settlement: (ΔHS)

occur under constant effective stress due to continous rearrangement of clay particles into a more stable configuration.

Predominates in highly plastic

clay and organic clays.

Mathematically:

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

Ans 3(B)

Given data:

$C_c = 0.31$

$P_1 = 130 \, KN/m^2$

$e_0 = 1.02$

$P_2 = 170 \, KN/m^2$

$H = 5m$

Required:

$e_1 = ?$

$S_c = ?$

Solution:

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

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

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

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

$$e_1 = 0.984$$

By formula

consolidation settlement is

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

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

$$S_c = 0.0893\,m \times 1000\,mm$$

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