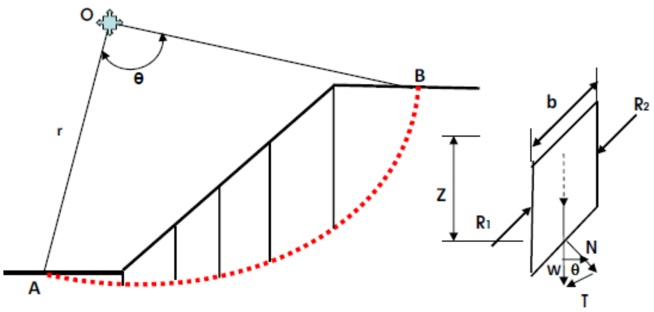
IAT-3-SOLUTION

APPLIED GEOTECHNICAL ENGINEERING (18CV62)

1.a.



For C-Φ soils the undrained strength envelope shows both c and Φ values. The total stress analysis can be adopted. The procedure is follows

1. Draw the slope to scale
2. A trail slip circle such as AB with radius „r‟ is drawn from the center of rotation O.
3. Divide the soil mass above the slip surface into convenient number of slices (more than 5 is preferred)
4. Determine the area of each slice A1, A2, -------, An; where A = width of the slice X mid height = b X Z
5. Determine the total weight W including external load if any as
W = ɣ b Z = ɣ A ; Where, ɣ = unit weight, b = width of slice, Z = height of slice.
The reactions R1 and R2 on the sides of the slice are assumed equal and therefore do not have any effect on stability.
6. The weight W of the slice is set –off at the base of the slice. The directions of its normal component „N‟ and the tangential component „T‟ are drawn to complete the vector triangle.
N = W Cosδ, T= W Sinδ
7. The values of N and T are scaled off for each of the slices.

1.b.

Given H =15m, C= 20 kPa, S_n = 0.06, ɣ=18 kN/m^3.

$$F_c = \frac{C}{C_m}$$

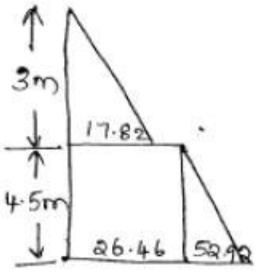
$$S_n = \frac{C_m}{\gamma H}$$

$$C_m = S_n \gamma H_c$$

$$C_m = 0.06 \times 18 \times 15 = 16.2\ kPa$$

$$\boldsymbol{F_c} = \frac{20}{16.2} = \mathbf{1.234}$$

2.a.



Ans: $K_{a_1} = \frac{1-\sin 30^\circ}{1+\sin 30^\circ} = 0.33$

$K_{a_2} = \frac{1-\sin 20^\circ}{1+\sin 20^\circ} = 0.49$

$p_1 = K_{a_1}\gamma_1 H_1 = 0.33 \times 18 \times 3 = 17.82\ kN/m^2$

$p_2 = K_{a_2}\gamma_1 H_1 = 0.49 \times 18 \times 3 = 26.46\ kN/m^2$

$p_3 = K_{a_2}\gamma_2 H_2 = 0.49 \times 24 \times 4.5 = 52.92\ kN/m^2$.

$P_1 = \frac{1}{2} \times 17.82 \times 3 = 26.73\ kN/m$

$P_2 = 26.46 \times 4.5 = 119.07\ kN/m$

$P_3 = \frac{1}{2} \times 52.92 \times 4.5 = 119.07\ kN/m$.

Total active pressure $= P_1 + P_2 + P_3 = 264.87\ kN/m$

$\bar{x} = \frac{26.73\left(4.5 + \frac{3}{3}\right) + \left(119.07 \times \frac{4.5}{2}\right) + \left(119.07 \times \frac{4.5}{3}\right)}{264.87}$

$= 2.24m$ from base

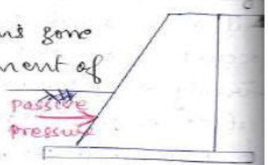
2.b.

③ Passive Pressure

→ Occurs when the wall movement tend to compress the soil horizontally.

→ It is a condition of limiting equilibrium.

→ Develops on the left side of the wall below the g[round] level. because the soil in this zone is compressed when the movement of the wall is towards left.



→ Develops on the right side of the wall when the movement of the wall is towards right.

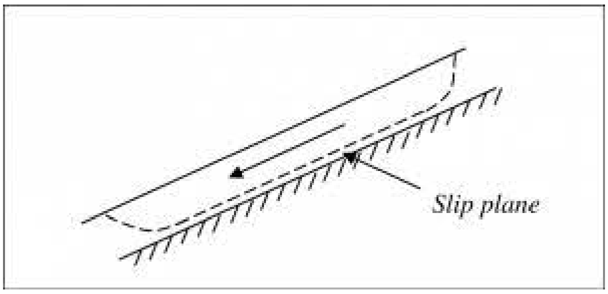
Eg. Pressure acting on anchor block.

3.a.

Soil slope failures are generally of five types:

1. Translational Failure
2. Rotational Failure
3. Wedge Failure
4. Compound Failure
5. Miscellaneous failure

Translational Failure



- Translation failure occurs in the case of infinite slopes and here the failure surface is parallel to the slope surface.

Rotational Failure

- In the case of rotational failure, the failure occurs by rotation along a slip surface and the shape thus obtained in slip surface is curved. Failed surface moves outwards and downwards.
- Rotational failure may occur in three different ways:

1. ***Face failure or slope failure:*** It occurs when soil above the toe contains weak stratum. In this case the failure plane intersects the slope above toe.
2. ***Toe failure:*** Toe failure is the most common failure in which failure plane passes through toe of slope.
3. ***Base failure:*** Base failure occurs when there is a weak soil stratum under the toe and failure plane passes through base of slope.

Wedge Failure

- Wedge failure, also known as block failure or plane failure, generates a failure plane that is inclined.
- This type of failure occurs when there are fissures, joints, or weak soil layers in slope, or when a slope is made of two different materials.

Compound Failure

- A Compound failure is a combination of translational slide and rotational slide.

- In this case, the slip surface is curved at two ends like rotational slip surface and flat at central portion like in translational failure.

Miscellaneous Failure

- These occur in the form of spreads and flows may also occur.

4.

$k_a = \frac{(1-\sin 30)}{(1+\sin 30)}$=0.333

$$\gamma_d = \frac{G\gamma_w}{1+e}$$

$$\gamma_d = \frac{2.65\times 9.81}{1+0.65} = 15.755\ kN/m3$$

$$\gamma_{sub} = \frac{(G-1)\gamma_w}{1+e}$$

$$\gamma_{sub} = \frac{(2.65-1)9.81}{1+0.65} = 9.81\ kN/m3$$

$p_{a1} = k_a \times q$

$$p_{a1} = 0.333 \times 14 = 4.662\ kN/m2$$

$$p_{a2} = k_a \times \gamma_d \times d_1$$

$$p_{a2} = 0.333 \times 15.755 \times 3 = 15.597\ kN/m2$$

$$p_{a3} = k_a \times \gamma_d \times d_1$$

$$p_{a3} = 0.333 \times 15.755 \times 3 = 15.597\ kN/m2$$

$$p_{a4} = [k_a \times \gamma_{sub} \times d_2]$$

$$p_{a4} = [0.333 \times 9.81 \times 7] = 22.66\ kN/m2$$

$$p_{a5} = [\gamma_w \times d_2]$$

$$p_{a5} = [9.81 \times 7] = 68.67\ kN/m2$$

Total pressure,

$$P_1 = [p_{a1} \times H] = 4.662 \times 10 = 46.62\ kN/m$$

$$P_2 = \left[\frac{1}{2} \times p_{a2} \times d_1\right] = \frac{1}{2} \times 15.597 \times 3 = 23.395\ kN/m$$

$$P_3 = [p_{a3} \times d_2] = 15.597 \times 7 = 109.179\ kN/m$$

$$P_4 = \left[\frac{1}{2} \times p_{a4} \times d_2\right] = \frac{1}{2} \times 22.66 \times 7 = 79.31\ kN/m$$

$$P_5 = \left[\frac{1}{2} \times p_{a5} \times d_2\right] = \frac{1}{2} \times 68.67 \times 7 = 240.345\ kN/m$$

Total active pressure per unit length of the wall $P = P_1 + P_2 + P_3 + P_4$

$$\boldsymbol{P = 498.849 \frac{kN}{m} OR\ 501.08\ kN/m}$$

Taking moments about the base,

$$P \times Z = P_1\left(\frac{H}{2}\right) + P_2\left(d_2 + \frac{d_1}{3}\right) + P_3\left(\frac{d_2}{2}\right) + P_4\left(\frac{d_2}{3}\right) + P_5\left(\frac{d_2}{3}\right)$$

$$498.849 \times Z = 46.62\left(\frac{10}{2}\right) + 23.395\left(7 + \frac{3}{3}\right) + 109.179\left(\frac{7}{2}\right) + 79.31\left(\frac{7}{3}\right) + 240.345\left(\frac{7}{3}\right)$$

$$\boldsymbol{Z = 3.103\ m\ from\ the\ base}$$

5.***Permissible settlement:***

For a settlement of 40 mm,

$$q_{ns} = 55(N-3)\left[\frac{B+0.3}{2B}\right]^2 W_\gamma R_d$$

$$W_\gamma = \frac{1}{2}\left[1 + \frac{Zw2}{B}\right] = \frac{1}{2}\left[1 + \frac{0}{B}\right] = 0.5$$

$$R_d = \left[1 + \frac{0.2D_f}{B}\right] \le 1.2$$

Assuming R_d = 1.2.

$$\boldsymbol{q_s = \frac{1200}{B^2}}$$

$$\boldsymbol{q_s = q_{ns} + \gamma D_f}$$

Equating both q_s,

$$\frac{1200}{B^2} = 55(N-3)\left[\frac{B+0.3}{2B}\right]^2 W_\gamma R_d + (\gamma D_f)$$

$$\frac{1200}{B^2} = 55(25-3)\left[\frac{B+0.3}{2B}\right]^2 \times 0.5 \times 1.2 + (16 \times 1.5)$$

$$\frac{1200}{B^2} = 55(25-3)\left[\frac{B^2 + 0.6B + 0.09}{4B^2}\right] \times 0.5 \times 1.2 \ + \ 24$$

On solving we get, B=2.152 m

Shear failure criterion:

$$q_s = \frac{q_{nu}}{F} + \gamma D_f$$

$$q_s = \frac{0.33N^2BW_\gamma + (100 + N^2)\, D_f W_q}{F} + \ \gamma D_f$$

$$\frac{1200}{B^2} = \frac{0.33 \times 25^2 \times B \times 0.5 \ + (100 + 25^2) \ \times 1.5 \times 1}{2} + (16 \times 1.5)$$

$$q_s = \frac{0.33 \times 25^2 \times B \times 0.5 \ + (100 + 25^2) \ \times 1.5 \times 1}{3} + (16 \times 1.5)$$

On solving we get, B=1.37 m

Provide a footing of width 2.152 m since settlement criterion is critical for the design.