KATIHAR ENGINEERING COLLEGE, KATIHAR
(Department of CIVIL Engineering)
Class Test-02 Solution

Subject: Soil & Rock Mechanics B.Tech 6th Semester

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Q-1. (10 m)

$\gamma = 2\ gm/cm^3$, $\phi = 0$

$q_u = 2\ kg/cm^2$, $ka = 1$

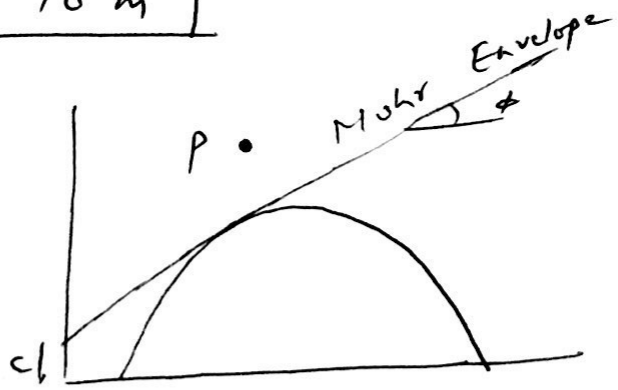
$$\text{Cohesion } (c) = \frac{q_u}{2} = 1\ kg/cm^2$$

$$C = 1000\ g/cm^2$$

$$z_c = \frac{2c}{\gamma\sqrt{ka}} = \frac{2 \times 1000}{2 \times \sqrt{1}} = 1000\ cm$$

$$\boxed{z_c = 10\ m}$$

Q-2. (a)



Q-3 (d)

UCS test is most suitable for to determine

(a) Sensitivity of clay

(b) Strength of fully saturated clay sample

Note:
- It is the special case of triaxial test in which Cell Pressure or Confining pressure is zero. (i.e $\sigma_3 = 0$)
- Mohr's circle passes through the origin

Q-4 (a) → Immediate stability or short term stability purpose we prefered Unconsolidated Undrain test (UU-test)

→ for Long term stability we prefered Consolidated drained (CD test) test.

Q-5. (d) $K_a \rightarrow$ Coeff of AEP $= \frac{1-\sin\phi}{1+\sin\phi}$

$K_p \rightarrow$ Coeff of PEP $= \frac{1+\sin\phi}{1-\sin\phi}$

$K_0 \rightarrow$ Coeff of earth pressure at-rest $= 1-\sin\phi$

(a) $1-\sin\phi \neq \left(\frac{1+\sin\phi}{1-\sin\phi}\right)\cdot\frac{1}{2}$

(b) $\frac{K_A + K_P}{2} = \frac{1}{2}\left[\frac{1-\sin\phi}{1+\sin\phi} + \frac{1+\sin\phi}{1-\sin\phi}\right]$

$= \frac{1}{2}\left[\frac{1+\sin^2\phi - 2\sin\phi + 1+\sin^2\phi + 2\sin\phi}{1-\sin^2\phi}\right]$

$= \frac{1}{2}\left[\frac{2+2\sin^2\phi}{\cos^2\phi}\right]$

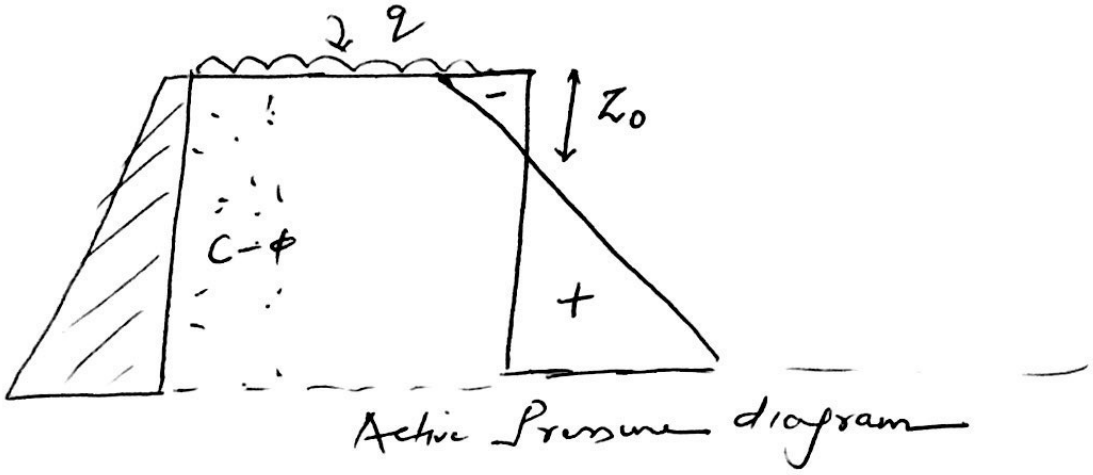
$= \frac{1+\sin^2\phi}{\cos^2\phi} \neq K_0$

(c) $\frac{K_p - K_a}{2} = \frac{1}{2}\left[\frac{1+\sin\phi}{1-\sin\phi} - \frac{1-\sin\phi}{1+\sin\phi}\right]$

$= \frac{1}{2}\left[\frac{1+\sin^2\phi + 2\sin\phi - 1+\sin^2\phi + 2\sin\phi}{1-\sin^2\phi}\right]$

$$= \frac{1}{2}\left[\frac{4\sin\phi}{\cos^2\phi}\right] = \frac{2\sin\phi}{\cos^2\phi} \neq k_o$$

Q-6 (b)



Active Pressure diagram

Let at any depth Z, the active pressure due to c−ϕ soil is

$$p_a = \sigma_v \cdot k_a - 2c\sqrt{k_a}$$

Where σ_v is the vertical stress at point Z.

$$\sigma_v = (\gamma \cdot Z + q)$$

$$p_a = (\gamma Z + q)\, k_a - 2c\sqrt{k_a} \quad \text{——(1)}$$

The depth at which active pressure is zero, called depth of tension crack (Z_o)

$$p_a = (\gamma Z_o + q)\, k_a - 2c\sqrt{k_a} = 0$$

$$(\gamma Z_o + q)\, k_a = 2c\sqrt{k_a}$$

$$(\gamma Z_o + q)\sqrt{k_a} = 2c$$

$$Z_o = \frac{2c}{\gamma\sqrt{k_a}} - \frac{q}{\gamma}$$

$$Z_o = \frac{2c}{\gamma\sqrt{\tan^2\left(45-\frac{\phi}{2}\right)}} - \frac{q}{\gamma}$$

$$= \frac{2c}{\gamma \tan\left(45-\frac{\phi}{2}\right)} - \frac{q}{\gamma}$$

$$K_a = \frac{1-\sin\phi}{1+\sin\phi} = \tan^2\left(45-\frac{\phi}{2}\right)$$

$$Z_0 = \frac{2c}{\gamma \tan\left(45-\frac{\phi}{2}\right)} \times \frac{\tan\left(45+\frac{\phi}{2}\right)}{\tan\left(45+\frac{\phi}{2}\right)} - \frac{q}{\gamma}$$

$$Z_0 = \frac{2c}{\gamma}\tan(\alpha) - \frac{q}{\gamma}$$

Q-7. (11.44 m)

$\beta = 30^\circ$

$c = 15\ kN/m^2$, $\phi = 22.5^\circ$

$S_n = 0.046$, $FOS = 1.5$

Mobilised cohesion $(C_m) = \frac{c}{FOS} = \frac{150}{1.5} = 10\ \frac{kN}{m^2}$

Taylor stability No $(S_n) = \frac{C_m}{\gamma H_c}$

$$H_c = \frac{C_m}{\gamma \cdot S_n} = \frac{10}{19 \times 0.046}$$

$$H_c = 11.44\ m$$

Q-8 (0.50)

$\Delta\sigma_3 = 0.26 - 0.10 = 0.16\ N/mm^2$

$\Delta U = 0.15 - 0.07 = 0.08\ N/mm^2$

$$B = \frac{\Delta U}{\Delta\sigma_3} = \frac{0.08}{0.16} = 0.50$$

Q-9 (b)

$$\sigma_1 = \sigma_3 N_\phi + 2c\sqrt{N_\phi}$$

$$N_\phi = \tan^2\alpha = \tan^2\left(45+\frac{\phi}{2}\right) = \frac{1+\sin\phi}{1-\sin\phi}$$

Q-10. (d)

Q-11 (a)

Q-12 (37.2°) For c - ϕ soil

$$\text{Factor of safety (FOS)} = \frac{c}{\gamma H \sin\beta \cdot \cos\beta} + \frac{\tan\phi}{\tan\beta} \geq 1$$

$c = 20\ kpa$, $\gamma = 16\ \frac{kN}{m^3}$, $\beta = 50°$, $H = 7m$

$$\frac{20}{16 \times 7 \times \sin 50 \cdot \cos 50} + \frac{\tan\phi}{\tan\beta} \geq 1$$

$$0.363 + \frac{\tan\phi}{\tan 50} \geq 1$$

$$\frac{\tan\phi}{\tan 50} \geq 0.637$$

$$\tan\phi \geq 0.759$$

$$\boxed{\phi \geq 37.2°}$$

Q-13. (0.84) $\phi' = 40°$

Let τ be the shear stress and σ_n' be normal effective stress then

$$\tau = \sigma_n' \tan\phi'$$

$$\frac{\tau}{\sigma_n'} = \tan\phi' = \tan(40°)$$

$$= 0.84$$

Q-14. (4) Let H_c be the height of unsupported height then $H_c = \frac{4c}{\gamma\sqrt{K_a}}$

For $\phi = 0$, $K_a = 1$

$$H_c = \frac{4 \times 120}{20 \times \sqrt{1}} = 24 \text{ m}$$

$$FOS = \frac{H_c}{H} = \frac{24}{6} = 4$$

FOS = 4

Q-15 ($10.7 \frac{kN}{m^2}$) Diameter = 37.5 mm

Length = 80 mm

P_f = 28 N

Initial area of specimen (A_0) = $\frac{\pi}{4} \times 37.5^2$

= 1105 mm^2

Axial strain (ϵ_L) = $\frac{13}{80}$ = 0.162

Corrected Area (A_c) = $\frac{A_0}{1-\epsilon_L} = \frac{1105}{1-0.162}$

= 1315 mm^2

Unconfined compressive strength (q_u) = $\frac{28}{1315}$

= 21.3 kN/m^2

Undrain shear strength of clay (c_u) = $\frac{q_u}{2} = \frac{21.3}{2}$

c_u = 10.7 kN/m^2

< END OF THE SOLUTION >