Soil Mechanics
HW6

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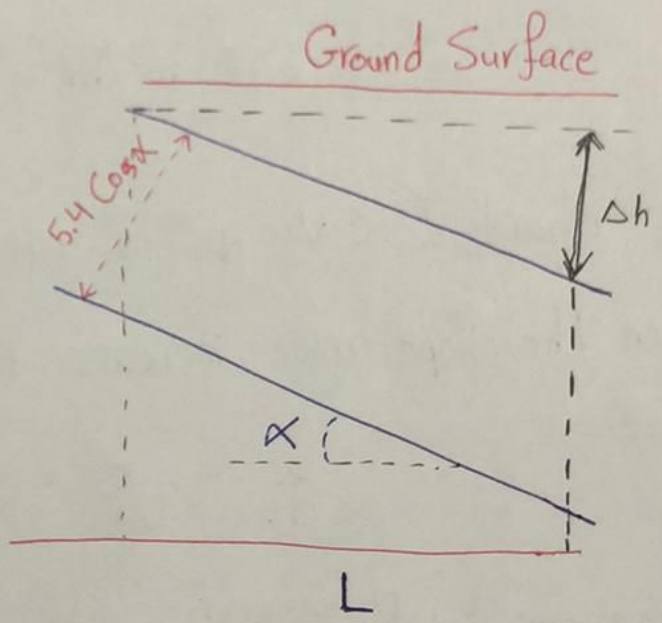
Problem ①:-

$H = 5.4\ m$

$K = 6 * 10^{-3}\ cm/ses$

$= 0.216\ m/hr$



$$i = \frac{\Delta h}{length} = \frac{L \tan\alpha}{\frac{L}{\cos\alpha}} = \tan\alpha \cos\alpha = \sin\alpha$$

$$A = 5.4 \cos\alpha (L) = 5.4 \cos\alpha$$ " Assume L = 1" one unit length

find q when: ① $\alpha = 5°$:

$$q = iAK = \sin(5°)\left(5.4 \cos(5°)\right)(0.216)$$

$$= 0.101\ m^3/hr$$

(II) $\alpha = 7°$: $q = KiA = (0.216)\ \sin 7°\ (5.4 \cos 7°)$

$= 0.141\ m^3/hr$

(III) $\alpha = 9°$: $q = (0.216)\ \sin 9°\ (5.4 \cos 9°)$

$= 0.180\ m^3/hr$

(IV) $\alpha = 12°$: $q = (0.216)\ \sin 12°\ (5.4 \cos 12°)$

$= 0.237\ m^3/hr$

The chart (α VS q) is attached in Excel file

* when the slope angle increase then the flow rate increase.

$\alpha \uparrow \quad q \uparrow \quad / \quad \alpha \downarrow \quad q \downarrow$

the reasons: when α increase then each of i and A increase

then q increase because

$q = KiA$

Problem ② :-

length of levee = 650 m // (q = 13.5 m^3/hr) / thickness = 2.5m

K ?

$$i = \frac{\Delta h}{l} = \frac{175 - 158}{210} = 0.081$$

$$A = (650)(2.5) = 1625\ m^2$$

$$q = K i A$$

$$K = \frac{13.5}{(0.081)(1625)} = 0.103\ m/hr$$

Problem ③: $H_1 = 1.5$ m , $K_1 = 9 * 10^{-4}$ cm/sec

$H_2 = 2.5$m , $K_2 = 7.8 * 10^{-3}$ cm/sec

$H_3 = 3.5$m , $K_3 = 4.5 * 10^{-5}$ cm/sec

$$\frac{K_{H(eq)}}{K_{V(eq)}} \ ?$$

continue →

$$K_{H(eq)} = \frac{K_1 H_1 + K_2 H_2 + K_3 H_3}{H_1 + H_2 + H_3}$$

$$= \frac{(9*10^{-4} * 1.5) + (7.8*10^{-3} * 2.5) + (4.5*10^{-5} * 3.5)}{1.5 + 2.5 + 3.5}$$

$$= 2.801 * 10^{-3} \text{ cm/sec}$$

$$K_{V(eq)} = \frac{H_1 + H_2 + H_3}{\frac{H_1}{K_1} + \frac{H_2}{K_2} + \frac{H_3}{K_3}}$$

$$= \frac{7.5}{\frac{1.5}{9*10^{-4}} + \frac{2.5}{7.8*10^{-3}} + \frac{3.5}{4.5*10^{-5}}}$$

$$= 9.403 * 10^{-5} \text{ cm/sec}$$

$$\therefore \frac{K_{H(eq)}}{K_{V(eq)}} = \frac{2.801 * 10^{-3} \text{ cm/sec}}{9.403 * 10^{-5} \text{ cm/sec}} = 29.79$$

$$\longrightarrow \boxed{\frac{K_{H(eq)}}{K_{V(eq)}} = 29.79}$$

Problem (4): (A)

for A: elevation head at A = 0

Pressure head at A = 35 cm

total head at A = 35 cm

for D: elevation head at D = 11 cm

Pressure head at D = 9 cm

total head at D = 20 cm

* head loss A to D = $(\text{Elevation Pressure})_A - (\text{Elevation Pressure})_D$

$= 35 - 9 = 26$ cm

* $i = \frac{15 + 11}{4+7+15} = 1$

* head loss in AB + head loss in BC + head loss in CD = 26

$$\Delta h_{AB} + \Delta h_{BC} + \Delta h_{CD} = 26 \text{ cm} \quad \text{---- (1)}$$

* $q_{AB} = q_{BC} = q_{CD}$ continue →

* $q_{AB} = q_{BC} = q_{CD}$

$K_{AB}\, i_{AB}\, A = K_{BC}\, i_{BC}\, A = K_{CD}\, i_{CD}\, A$

* $K_{AB} = \dfrac{K_1 H_1 + K_2 H_2}{H_1 + H_2} = \dfrac{\left(K_1 + \frac{1.5}{2} K_1\right) 2}{4}$

$\rightarrow K_{AB} = 0.875\, K_1$

$\therefore \quad 0.875\, K_1 \dfrac{\Delta h_{AB}}{4} = \dfrac{K_3\, \Delta h_{BC}}{7} = \dfrac{K_4\, \Delta h_{CD}}{15}$

$\dfrac{0.875\, K_4\, (\Delta h_{AB})}{4 * 1.5} = \dfrac{K_4 (\Delta h_{BC})}{3 * 7} = \dfrac{K_4\, (\Delta h_{CD})}{15}$

$\dfrac{\Delta h_{AB}}{6.857} = \dfrac{\Delta h_{BC}}{21} = \dfrac{\Delta h_{CD}}{15}$

(2) --- $\Delta h_{AB} = 0.327\, \Delta h_{BC} = 0.457\, \Delta h_{CD}$

(1) and (2) : $\Delta h_{AB} + \dfrac{\Delta h_{AB}}{0.327} + \dfrac{\Delta h_{AB}}{0.457} = 26$

$\therefore \quad \Delta h_{AB} = 4.16$ cm

$\therefore \quad \Delta h_{BC} = 12.72 \text{ cm}$

$\Delta h_{CD} = 9.10 \text{ cm}$

(B) Elevation head at $B = \frac{11}{7+4+15} * 4 = 1.692 \text{cm}$

Pressure head at $B = (\text{Elevation Pressure})_A - \Delta h_{AB}$

$= 35 - 4.16$

$= 30.84 \text{ cm}$

total head at $B = 30.84 + 1.692 = 32.532 \text{cm}$

Elevation head at $C = \frac{11}{26} * 11 = 4.654 \text{ cm}$

Pressure head at $C = (\text{Elevation Pressur})_B - \Delta h_{BC}$

$= 30.84 - 12.72$

$= 18.12 \text{ cm}$

total head at $C = 18.12 + 4.654 = 22.774 \text{ cm}$

→ Continue

In general :

	Elevation head	Elevation Pressure	total head
A	0	35	35 cm
B	1.692	30.84	32.532 cm
C	4.654	18.12	22.774 cm
D	11	9	20 cm