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CVL 222 Soil Mechanics

Minor 1 (4/2/2016)

Please write clear, precise point answers in the space provided

Please write Name, Reg. No., Group No. and sign on each sheet

Without the above information answer script will not be evaluated

Time: 60 minutes

Credit: 25%

-2

1. An airport runway is being extended into a bay and requires a 10 m high embankment above the bottom of the bay. Calculations indicate that, once constructed, the long-term settlement of the soil beneath the embankment will be about 1 m. The sand used to build the embankment is taken from a pit where the sand has a relative density of 40%. The maximum void ratio is 0.7; the minimum void ratio is 0.4. Once compacted in the embankment, the sand will have a relative density of 90%. What height of sand must be obtained from the borrow pit so that, a long time after completion, the embankment will be 10 m above the initial position of the bottom of the bay before construction started? *10 Points*

Relative density = 40% = D_{R_1}

$$D_R = \frac{e_{max} - e}{e_{max} - e_{mini}} \qquad e_{max} = 0.7 \qquad e_{mini} = 0.4$$

10

$$e = \frac{V_V}{V_S}, \qquad 0.4 = \frac{0.7 - e_1}{0.7 - 0.4}$$

$$e = \frac{V - V_S}{V_S} \qquad \Rightarrow e_1 = 0.58$$

D_{R_2} = 90%

$$0.9 = \frac{0.7 - e_2}{0.7 - 0.4}$$

$$e_2 = 0.43$$

$$eV_S = V - V_S$$

$$V_s(e+1) = V$$

$$V_s = \frac{V}{e+1}$$

$$\frac{V_1}{e_1 + 1} = \frac{V_2}{e_2 + 1}$$

$$\frac{V_1}{} = \frac{V_2}{}$$

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2. Two clays A and B have the following properties. Explain: (a) Which of the clays, A or B, would experience larger settlements under identical loads (b) Which of the soil is more plastic? (c) Which soil will be a better foundation material upon *remolding*? *6 Points*

	Clay A	Clay B
Liquid Limit	38	60
Plastic Limit	25	30
Natural Water Content	40	50

(a)

$$C_c = \frac{-\Delta e}{\log \frac{\sigma_2'}{\sigma_1'}}$$

$C_c \propto W_l$ $\quad$ w_l - liquid limit

$w_l(\text{soil-B}) > W_l(\text{soil-A})$

$C_c(\text{soil-B}) > C_c(\text{soil-A})$

So, Clay B would experience larger settlements under identical loads ✓

2

(b)

$P.I._A = 38-25 = W_l - W_p = 13$

$PI_B = 60-30 = 30$ $\quad$ w_p - plastic limit

$w_{P_B} > w_{P_A}$

So, Clay B is more plastic

2

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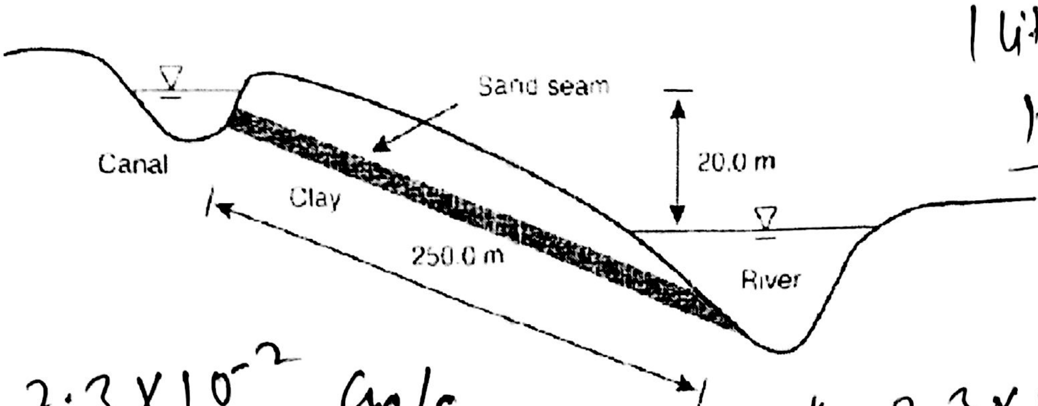
3. An unlined irrigation canal runs parallel to a river and the cross section is shown below. The soils in the region are generally stiff clays that are assumed to be impervious. There is a 200 mm-thick sand seam connecting the canal and river as shown, which continues to a length of 3.0 km along the river. Assuming that the permeability of the sand is 2.3 x10^{-2} cm/s, compute the quantity of water lost from the irrigation canal per day. *10 Points*

1 litre = 10^{-3} m

1 m^3 = 10^3 li



$K = 2.3 \times 10^{-2}$ cm/s $\Rightarrow$ $K = 2.3 \times 10^{-4}$ m/s

$L = 250$ m

$A = (3 \times 10^3) \times (200 \times 10^{-3})$ m^2

$A = 600$ m^2

10

$\Delta H = 20$ m

$i = \frac{\Delta H}{L} = \frac{20}{250} = \frac{2}{25}$

$q = K i A$

$q = 2.3 \times \frac{2}{25} \times 600 \times 10^{-4}$ $\frac{m^3}{sec}$

$q = (2.3 \times 10^{-4}) \times \frac{2}{25} \times (600) \times 60 \times 60 \times 24 \times 10^3$ $\left(\frac{\text{litre}}{\text{day}}\right)$

$q = 953856$ litre per day

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Water is seeping downward through a soil layer as shown below. Two piezometers (A and B) located 2.0 m apart (vertically) showed a head loss of 0.2 m. Calculate the resultant vertical effective stress for a soil element at a depth of 6.0 m as shown below.

Ans 51 *6 Points*

u - Pore water Pressure

$i = 0.1$

$\Delta H = 0.2$

$L = 2\,m$

$i_w = 0.1$

$\gamma_{sat} = 18.5\ kN/m^3$

6.8 $\gamma_w = 10\ kN/m^3$

$u = u_B + i\gamma_w$

$u_A = \gamma_w h_A = 10(6.8-2) = 10(4.8)$

$u_A = 48\ kN/m^2$

$u_B = \gamma_w h_B = 10(6.8) = 68\ kN/m^2$

2

$u = \gamma_w z \pm k_w h$

$\frac{du}{dz} = \gamma_w \pm \gamma_w \frac{dh}{dz}$

$du = \gamma_w (1 \pm i_w) dz$

$\Delta u = 10(1-0.1)6$

$\Delta u = 54$

$111 - 54$

$\sigma = \gamma_s h = (18.5)(6) = 111\ kN/m^2$

$\sigma' = \sigma - (u - \Delta u)$

$u_A = (10)(5) = 50$

$u_B = 68$

$u - 50 = \left(\frac{68-50}{2}\right)(h-5)$

$u = \left(\frac{u_B - u_A}{h_B - h_A}\right) h$

$u = \left(\frac{68-48}{2}\right) h = 10h$

$u = 10h$

u at $h = 6\,m$ $= 60\ kN/m^2$

So, $\sigma' = \sigma - u = 111 - 60 = 51\ kN/m^2$

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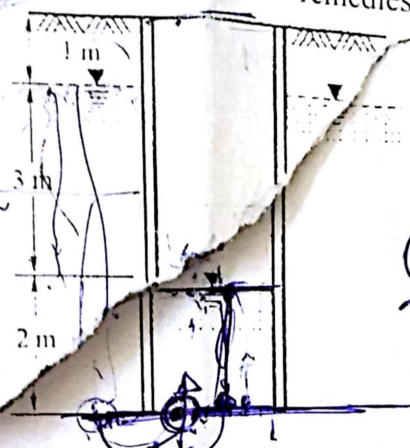
. A trench is excavated in fine sand for a building foundation, up to a depth of 4 m. The excavatio[n] carried out by providing the necessary side supports for pumping water. The water levels at the sides [and] the bottom of the trench are shown below. Examine whether the bottom of the trench is subjected to quick condition if $G_s = 2.64$ and $e = 0.7$. If so, suggest few remedies.

8 Points



$\gamma_{sat} = \left(\frac{G_s + e}{1+e}\right)\gamma_w$

$= \left(\frac{2.64+0.7}{1.7}\right)\gamma_w$

$= 19.4$

$G_s = 2.64$

$e = 0.7$

$\gamma_w = 10\ kN/m^3$

$S = 1$

Ans $\gamma_{total} = \left(\frac{Se + G_s}{1+e}\right)\gamma_w$

$\gamma = \left(\frac{0.7+2.64}{1+0.7}\right)$

$\gamma = 1.94 \times 10\ kN/m^3$

σ'

$u = 20$

$G_s \gamma_w$

50

$\sigma' = \sigma - u$

$\gamma_s = G_s \gamma_w$

$\gamma_s = 2.64 \times 10$

$\gamma_s = 26.4$

For Quick Condition — $\sigma' = 0$

$5\gamma_w > \gamma_{sat} \times 2$

$\sigma = \gamma h$

$\frac{48}{2}$

5×10

$50 > 4$

$19.6 = \gamma$

$1.5 > 1$

$\frac{\gamma_b}{\gamma_w}$

$\sigma =$

$\sigma = 19.6 \times 5 + 26.4 \times 1 \left(\frac{G_s + e}{1+e}\right)$

$G_s + e - (1+e)$

$\sigma_1' = 2\gamma_{sat} - 2\gamma_w$

$= 2(\gamma_{sat} - \gamma_w)$

$u = 10 \times 2$

$\frac{\gamma_b}{\gamma_w}$

$\frac{G_s - 1}{1+e} = \frac{1.64}{1.7}$

$\sigma_2' = 6\gamma_{sat} - 5\gamma_w$

$= \gamma_{sat} + 5(\gamma_{sat} - \gamma_w)$