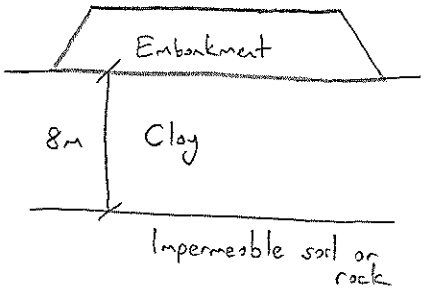
CE464 – GROUND IMPROVEMENT

Homework 3

1)



$c_v = c_h$

drameter of sand drains = 300 mm = 0.3m

S, drain spacing = 3m, square pattern

U% = 25% (without sand drains)

$U\% = 25\% \longrightarrow T_v = 0.049 = \frac{c_v.t}{d^2} = \frac{c_v.t}{8^2} \longrightarrow c_v.t = 3.136$

(from table)

(because the layer is half-closed, so d=8m)

Radial drainage:

$c_v = c_h$

$c_v.t = c_h.t$

$T_h = \frac{c_h.t}{(de)^2} \longrightarrow \begin{cases} de = 1.13S = 1.13 \times 3 = 3.39m \\ c_h.t = c_v.t = 3.136\ m^2 \end{cases} \longrightarrow T_h = \frac{3.136}{(3.39)^2} = 0.273$

$n = \frac{de}{dw} = \frac{1.13 \times S}{0.3} = \frac{1.13 \times 3}{0.3} = \frac{3.33}{0.3} = 11.3$

$U_{radial} = 1 - e^{-\frac{8.T_h}{F(n)}}$, $F(n) = \ln(n) - 0.75$

$= \ln(11.3) - 0.75$

$= 2.423 - 0.75$

$F(n) = 1.673$

$U_{radial} = 1 - e^{-\frac{8 \times 0.273}{1.673}}$

$= 1 - e^{-\frac{2.184}{1.673}}$

$= 1 - \underbrace{e^{-1.305}}_{0.271} \Longrightarrow U_{radial} = 0.729$

Vertical drainage:

$T_v = \frac{c_v.t}{d^2} = \frac{3.136}{8^2} = 0.0049 \longrightarrow U_v\% = 25\%$ (from table)

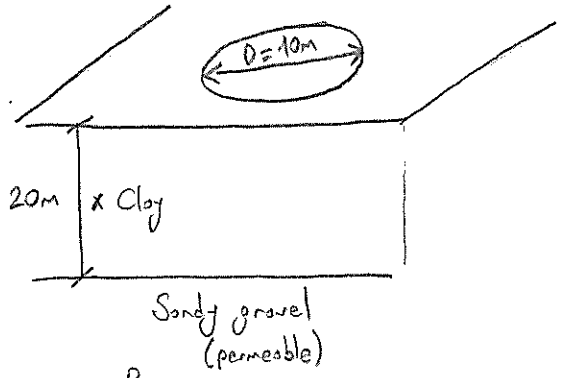
$(1-U) = (1-U_{vertical})(1-U_{radial})$

$= (\underbrace{1-0.25}_{0.75})(\underbrace{1-0.729}_{0.271})$

$1-U = 0.203$

$U = 0.797 \longrightarrow U\% = 79.7\%$

2)



$C_v = 6\,m^2/yr$

$C_h = 10\,m^2/yr$

$m_v = 0.2\,m^2/MN$

diameter of tank, $D = 10\,m$, it apply 200 kPa pressure

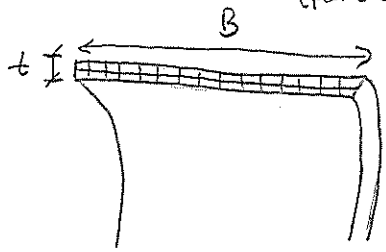
$B = 110\,mm = 0.11\,m$, $t = 7\,mm = 0.007\,m$

Settlement = 18 cm

$t = 4$ months

S, spacing = ?

Use 2V:1H

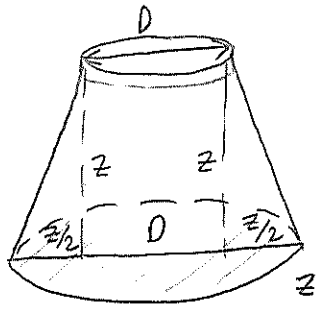


prefabricated vertical drain

$$d_w = \frac{2(B+t)}{\pi}$$

$$d_w = \frac{2(0.11+0.007)}{\pi}$$

$$d_w \tilde{=} 0.075\,m$$



$z = 10\,m$ (mid-depth of clay)

$$\Delta\sigma' = \frac{q \times \left(\frac{\pi D^2}{4}\right)}{\left(\frac{\pi (D+z)^2}{4}\right)} \Rightarrow \Delta\sigma' = \frac{200 \times \left(\frac{\pi \times 10^2}{4}\right)}{\frac{\pi \times (10+10)^2}{4}} = \frac{20000}{400} = 50\,kPa$$

S = settlement

$$S = m_v \cdot H \cdot \Delta\sigma' = \left(0.2\,\frac{m^2}{MN}\right) \times 20\,m \times 50\,kPa = 200\,mm$$

For $t = 4$ months

$$U = \frac{200-18}{200} = 0.91 \rightarrow U\% = 91\%$$

$d = 10\,m$;

$$T_v = \frac{c_v \cdot t}{d^2} = \frac{6\,m^2/yr \times \left(\frac{4}{12}\,yr\right)}{(10\,m)^2} = 0.02 \rightarrow$$

For $U_v < 60\%$, $T_v = \frac{\pi}{4} U_v^2$

$$0.02 = \frac{\pi}{4} U_v^2 \Rightarrow U_v = 0.16$$

$U_v\% = 16\%$

$(1-U) = (1-U_v)(1-U_r)$

$(1-0.91) = (1-0.16)(1-U_r)$

$0.09 = 0.84 \times (1-U_r)$

$0.107 = 1-U_r \Rightarrow U_r = 0.893$

$U_r\% = 89.3\%$

$$T_h = \frac{c_h \times t}{(de)^2} \Rightarrow n = \frac{de}{dw} \rightarrow de = n \times dw = 0.075n \Rightarrow T_h = \frac{10\,m^2/yr \times \frac{4}{12}\,yr}{(0.075n)^2} = \frac{3.33}{(0.075n)^2}$$

$$U_{radial} = 1 - e^{\frac{-8 \times T_h}{F(n)}}, \quad F(n) = \ln(n) - 0.75$$

$$U_{radial} = 1 - e^{\frac{-8 \times \frac{3.33}{(0.075n)^2}}{\ln(n) - 0.75}} = 0.893$$

Using by trial and error: $n = 29$

$$n = \frac{de}{dw} = \frac{1.135}{0.075} = 29 \rightarrow S = 1.925\,m \rightarrow$$ we round up it and $\boxed{S = 2\,m}$

↳ spacing of a square grid of the PVD drains