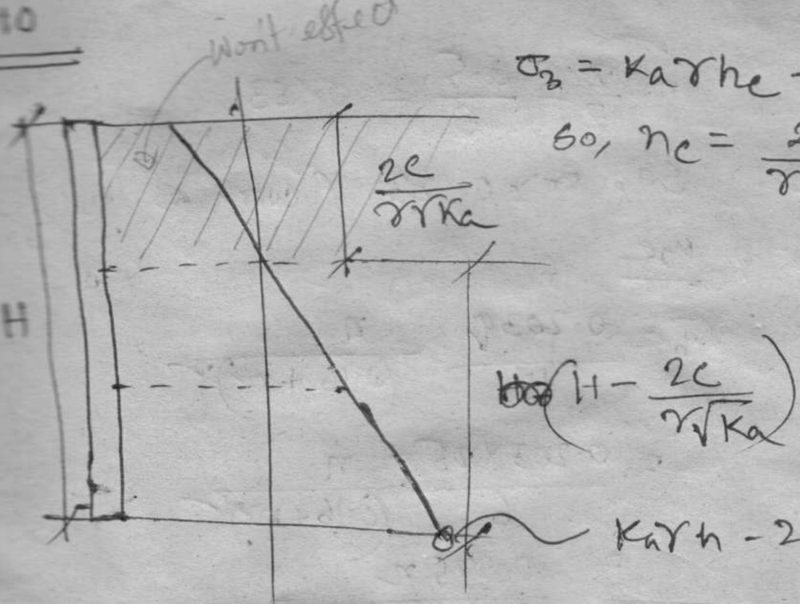
2009 – 2010

1(c)



$\sigma_z = K_a\gamma h_c - 2c\sqrt{K_a}$,

so, $h_c = \frac{2c}{\gamma\sqrt{K_a}}$

(after development of tension crack

So Active Earth ~~pressure~~ thrust = Area under compression

$= \frac{1}{2} \times \text{Base} \times \text{height} = \frac{1}{2} \times \left(H - \frac{2c}{\gamma\sqrt{K_a}}\right) \times \left(K_a\gamma H - 2c\sqrt{K_a}\right)$ (!)

2(c)

% finer

#4 – 4.75 mm = 100

#40 – 0.425 mm = 80

#200 – 0.075 mm = $\underline{\underline{60}}$ ← D_{60}

$C_u = 3 = \frac{D_{60}}{D_{10}}$

$C_c = 1.92 = \frac{D_{30}^2}{D_{60} \times D_{10}}$

LL = 43%

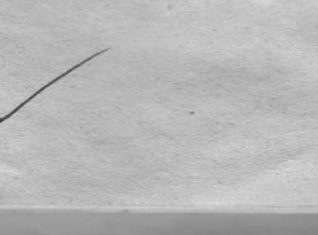
PL = 15%

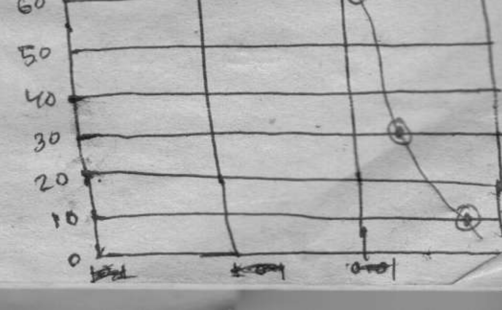
But, $D_{60} = 0.075$ mm

So, $D_{10} = \frac{D_{60}}{C_u} = \frac{0.075}{3} = 0.025$

and, $D_{30} = \sqrt{C_c \times D_{60} \times D_{10}} = \sqrt{1.92 \times 0.075 \times 0.025} = 0.06$ mm

AASHTO Classification > 35% not A-2





LL = 43%

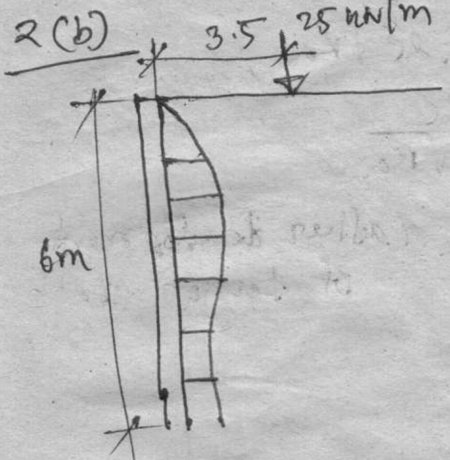
PI = 43 – 15 = 28%

LL – 30 = 13%

So, PI is above LL – 30

So it is A-7-6

2(b)



$m = \frac{x}{z} = \frac{3.5}{6} = 0.583$

So, $m > 0.583$ (work as 0.4)

use $C_{0.16}$

$$\sigma_h = \frac{0.203 q}{H} \cdot \frac{n}{(0.16 + n^2)^2}$$

$$= \frac{0.203 \times 25}{6} \cdot \frac{n}{(0.16 + n^2)^2}$$

$$= \frac{0.845 n}{(0.16 + n^2)^2}$$

y	m	σ_h
0	0	0
1	0.167	3.994
2	0.33	3.8321
3	0.5	2.573
4	0.67	1.54
5	0.833	0.97
6	1	0.63

total lateral thrust $= \frac{1}{2} \times (0 + 2(3.99 + 3.83 + 2.573 + 1.54 + 0.97) + 0.63)$

$= 13.158$ kN/m²

3(a)

By one point method,

$$w_L = \frac{w}{0.65 + 0.0175 D} = \frac{60}{0.65 + 0.0175 \times 22} = 58\%$$

By using penetrator of weight 240 gm

$w_p = 35\%$

$w_n = 40\%$

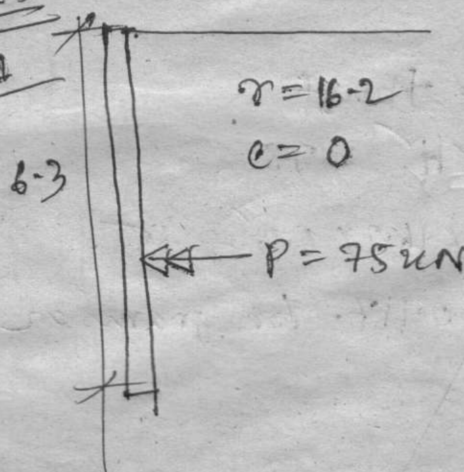
, $I_p = w_L - w_p = 58 - 35 = 23$

liquidity index, $I_L = \frac{w_n - w_p}{I_p} = \frac{40 - 35}{23}$

$= 0.217$

3 (b)

case 1



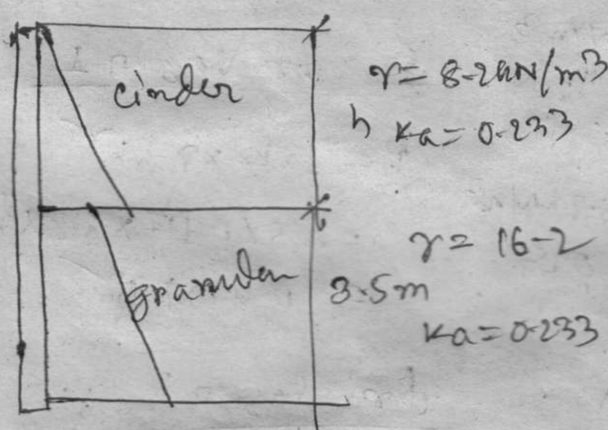
Active thrust,

$P = \frac{1}{2} k_a \gamma H^2 = 75$

$\Rightarrow \frac{1}{2} * k_a * 16.2 * 6.3^2 = 75$

$k_a = 0.233$

case 2



$\cancel{h_e = \frac{8.2h}{16.2} = 0.5062}$

For cinder

$P_a = \frac{1}{2} k_a \gamma h^2$

$= 0.5 * 8.2 * 0.233 * h^2$

$= 0.9553 h^2$

For granular

$P_a(h) = k_a \gamma (0.5062h + h_2)$

$= 3.77 (0.5062h + h_2)$

$= 1.911h + 3.77h$

$P_a(0) = 0.233 \times 16.2 \times 0.5062 h$

$= 1.911 h$

$P_a(3.5) = 1.911h + 13.195$

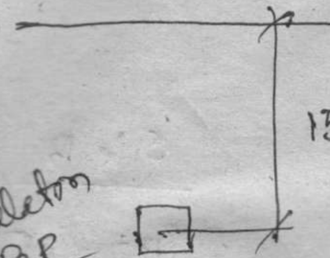
Total thrust,

$P = 0.9553 h^2 + \frac{1}{2} \times (1.911h + 1.911h + 13.195) \times 3.5$

$= 0.9553 h^2 + 23.091 + 6.69h = 75$

So, solving the eqn, $h = 4.659$ m

4(a)



effective overburden pressure $= 15 \times (19.8 - 9.8) = 150\ kN/m^2$

$\sigma_n = 150\ kN/m^2$

when shear stress build up rapidly $\rightarrow$ undrained condition

so, $\tau = C_{cu} + \sigma_n \tan \phi_{cu} = 48.3 + 150 \times \tan 13^\circ$

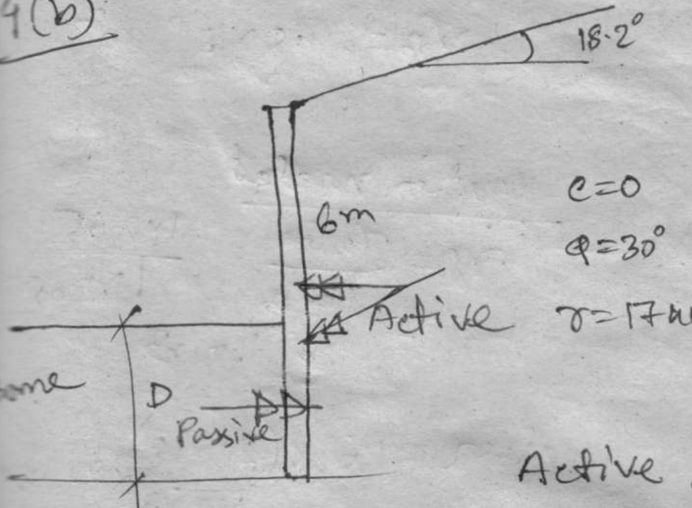
$= 82.93\ kN/m^2$

For slowly $\rightarrow$ drained condition

$\tau = C_d + \sigma_n \tan \phi_d = 41.4 + 150 \times \tan 23^\circ$

$= 105.07\ kN/m^2$

4(b)



$c = 0$

$\phi = 30^\circ$

$\gamma = 17\ kN/m^3$

Active thrust

$$K_a = \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

$$= \frac{\cos 18.2 - \sqrt{\cos^2 18.2 - \cos^2 30^\circ}}{\cos 18.2 + \sqrt{\cos^2 18.2 - \cos^2 30^\circ}}$$

$= 0.417$

Active so,

Horz thrust $P = \frac{1}{2} K_a \gamma H^2 \cos\beta$

$= 0.5 * 0.417 * 17 * 6^2 * \cos 18.2$

$= 115.154$

Passive thrust

$P = \frac{1}{2} K_p \gamma D^2$, $K_p = \frac{1+\sin\phi}{1-\sin\phi} = 3$

$= 0.5 * 3 * 17 * D^2$

$= 25.5\, D^2$

But, $25.5\, D^2 = 115.154$ $[\because \Sigma F_x = 0]$

$D = 2.125 m$

5. (d)

$G = 2.65$

Site - A

$e_A = 0.79$

$\%w = 18$

$\frac{V_A}{V_F} = \frac{1+e_A}{1+e_f}$

$V_A = \frac{1+0.79}{1+0.6} \times 4 \times 10^6$

$= 4.475 \times 10^6 \; m^3$

After increasing volume

$V_A' = 1.1 \times V_A$

$= 4.9225 \times 10^6$

water needed

$\gamma_d = \frac{\gamma_w G_s}{1+e_A} = \frac{1 \times 2.65}{1+0.79}$

$= 1.48$

so, water $= 1.48 \times \left(\frac{21-18}{100}\right) \times 4.475 \times 10^6$

$= 198.69 \times 10^3 \; m^3$

Fill

$V = 4.0 \times 10^6 \; m^3$

$\gamma = 2.0 \; ton/m^3$

$w = 21\%$

$\gamma_d = \frac{\gamma}{1+w} = 1.65 \; ton/m^3$

$e_f = \frac{\gamma_w G_s}{\gamma_d} - 1$

$= 0.61$

Site B

$e_B = 0.65$

$\%w = 15$

$\frac{V_B}{V_F} = \frac{1+e_B}{1+e_f}$

$= \frac{1+0.65}{1+0.61}$

$V_B = \frac{1.65}{1.61} \times 4 \times 10^6$

$= 4.0994 \times 10^6 \; m^3$

$V_B' = 4.5 \times 10^6 \; m^3$

water needed

$\gamma_d = \frac{\gamma_w G_s}{1+e_B} = \frac{1 \times 2.65}{1+0.65}$

$= 1.61 \; ton/m^3$

water $= 1.61 \times \left(\frac{21-15}{100}\right) \times 4.0994 \times 10^6$

$= 396$ ton

$= 396 \; m^3$ water

Site A cont

$$= \frac{4.9225\times10^6}{1000}\times 1000 + \frac{198.69\times10^3}{1000}\times 300$$

$$= 4,982,107$$

Site-B

$$\text{cont} = \frac{4.5\times10^6}{1000}\times 1150 + \frac{396\times10^3}{1000}\times 300$$

$$= 5293800$$

6(c)

$H = 2m$

$G_s = 2.65$

$n = 0.35$

$h = 1.90m$

$\boxed{\text{upward seepage head}}$

quick condition হবে না

$n = 0.35$

$e = \frac{n}{1-n} = 0.538$

$\gamma_d = \frac{\gamma_w G_s}{1+e} = 1.732\ gm/cc$

$= 17\ kN/m^3$

According to terzagis formula,

$F.S. = \frac{i_c}{i_{exit}}$

$i_c = \frac{G_s - 1}{1+e} = \frac{2.65-1}{1.538}$

$= 1.07$

$i_{exit} = \frac{h}{D} = \frac{1.90}{2} = 0.95$

Seepage force per unit volume $= i\,\gamma_w$

$= 0.95\times 9.81 =$

$$F.S. = 2 = \frac{\text{Weight of the block + Extra weight}}{\text{seepage force}}$$

$$= \frac{(17-9.81)\times 2 + E.W.}{i\,\gamma_w} = 2$$

$$= \frac{14.4 + B.W.}{0.95 \times 9.8} = 2$$

$$\Rightarrow 14.4 + B.W. = 18.639$$

$$B.W. = 18.639 - 14.4$$

$$= 4.239 \text{ kN}$$

$$B.W. = H \times (17 - 9.8) = 4.239$$

$$H = 0.5888 \text{ m}$$

$$= \underline{58.9 \text{ cm}}$$

7(i)

$C_c = 0.27$

$e = 2.04$, $\Delta p = 125 \text{ kN/m}^2$,

$k = 3.5 \times 10^{-8} \text{ cm/sec} = 3.5 \times 10^{-10} \text{ m/sec}$

$k = C_v m_v \gamma_w$ $\qquad \Delta p = 187.5 \text{ kN/m}^2$

$$S = \cancel{H} \cdot \frac{C_c}{\cancel{1+e_0}} \cdot \log \frac{p_0 + \Delta p}{p_0} = \cancel{H} \frac{\Delta e}{\cancel{1+e_0}}, \quad C_c = \frac{\Delta e}{\log \frac{p_0 + \Delta p}{p_0}}$$

(i) $\Rightarrow \Delta e = 0.27 \times \log \frac{125 + 187.5}{125}$

$= 0.107$

(ii) settlement, $S = 5 \times \frac{0.107}{1 + 2.04} = 0.175 \text{ m} = 175 \text{ mm}$

(iii) $S = H m_v \Delta p = 5 \times m_v \times 187.5$

$0.175 = 5 \times m_v \times 187.5$

$m_v = 1.87 \times 10^{-4} \text{ m}^2/\text{kN}$

$K = C_v m_v \gamma_w \Rightarrow 3.5 \times 10^{-10} = C_v \times 1.87 \times 10^{-4} \times 9.81$

$C_v = 1.907 \text{ m}^2/\text{sec} \times 10^{-7}$

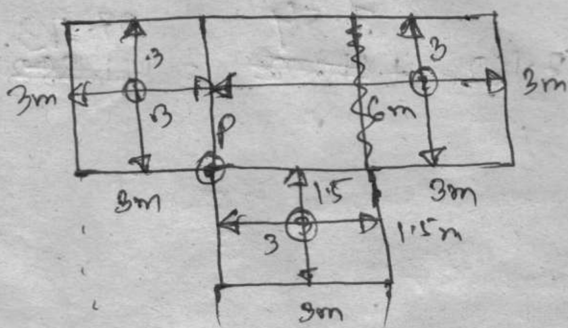
$T_v = 0.197 = \frac{C_v \times t}{H_{dr}^2} = \frac{1.907 \times 10^{-? } \times t}{5^2}$

$t = 25825904$ sec $= 0.81$ year $= 810$ month

For both way (a), (b) no change

just $t = \frac{1}{4} \times 10$ month $= 2.5$ month.

3(c)



$z = 5m$

$q = 120$ kN/m^2

(i) $m = \frac{3}{5} = 0.6$ $\quad m^2+n^2+1 = 1.72$

$n = \frac{3}{5} = 0.6$ $\quad m^2n^2 = 0.1296$

$m^2+n^2+1 > m^2n^2$

$\sigma_z = \frac{q}{4\pi}\left(\cancel{\sin^{-1}A}\ A \times B + \sin^{-1}A\right)$ $\quad A = \frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}$

$= \frac{120}{4 \times \pi} * (0.5705 * 1.58 + 0.535)$ $\quad = 0.5705$

$= 12.811$ kN/m^2 $\quad B = \frac{m^2+n^2+2}{m^2+n^2+1} = 1.58$

$\sin^{-1}A = 0.535$

(ii) $m = \frac{6}{5} = 1.2$

$n = \frac{3}{6} = 0.6$

$m^2+n^2+1 = 2.8$ $\quad \sigma_z = \frac{q}{4\pi} * (A \times B + \sin^{-1}A) = 17.162$ kN/m^2

$m^2n^2 = 0.5784$

$A = 0.726$ $\quad \sin^{-1}A = 0.812$

$B = 1.357$

(iii) $\cancel{\frac{q}{4\pi}} = \frac{q}{4\pi}$

$m^2+n^2+1 = 1.45$

$m = \frac{3}{5} = 0.6$

$m^2 n^2 = 0.0324$

$n = \frac{1.5}{5} = 0.3$

$A = \cancel{0.41335}$ 0.292

$\sin^{-1} A = \cancel{0.4489}$ 0.296

$B = 1.6896$

$\sigma_z = \frac{120}{4\pi} \times \left(\cancel{0.41335}\ 0.292 \times 1.6896 + \cancel{0.4489}\ 0.296 \right)$

$= \cancel{11.28}\ 7.54\ kN/m^2$

So, $\sigma_{total} = 12.811 + 17.162 + \cancel{11.28}\ 7.54 = \cancel{41.283}\ 37.573\ kN/m^2$