Exam – 2011–2012

2(a) Soil A (USCS)

① 99% / 1% — #200 (0.075 mm) — >50% — coarse grained — total coarse grained 99%.

② 30×100/99 = 30/30 — 70 — #4 (4.75mm) — 30×100/99 = 30/30

② 70% / 30% — #4 (4.75mm) — $\frac{70}{99}\times 100 = 70.71\% > 50\%$ → Gravel

③ fines = 1% < 5% → clean Gravel.

④ $C_u = \frac{D_{60}}{D_{10}} = \frac{14}{1.2} = 11.67 > 4$ (For Gravel) — $D_{60} = 14$, $D_{10} = 1.2$, $D_{30} = 5$

$C_c = \frac{D_{30}^2}{D_{60}\times D_{10}} = \frac{5^2}{14\times 1.2} = 1.48$ $(1 < C_c < 3)$

So it is well graded Gravel.

Ans: (GW)

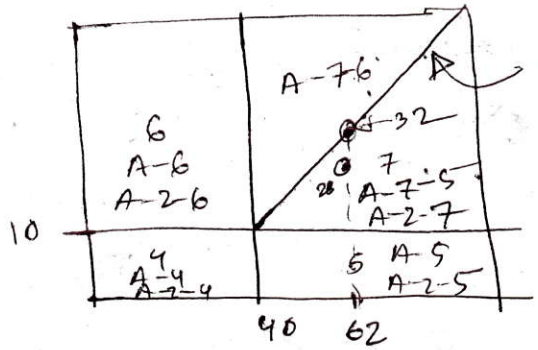
Soil D (যদি PL, LL দেওয়ার কারণে প্লাস্টিসিটি চার্ট ব্যবহার করতে হয় A-1, A-3 হবে না)

LL = 62

PL = 34

$I_p = PI = 62-34 = 28$

LL = 62



Fines = 70% > 35%.

So, A-4, A-5, A-6, A-7

so the soil is A-7-5 (21)

Ans: A-7-5-(21)

GI = (F-35)[0.2+0.005(LL-40)] + 0.01×(F-15)(PI-10)

= (70-35) × [0.2+0.005(62-40)] + 0.01×(70-35)×(28-10) = 20.78 = 21

Soil B

① 100% | 0 — #200 (0.075mm) → Coarse grained soil

② 0% | 100% — #4 (4.75 mm) 0% < 50% — Sand

③ % Fines = 0% < 5% So – clean sand

④ $C_u = \frac{D_{60}}{D_{10}} = \frac{1.3}{1} = 1.3 < 6$ $D_{60} = 1.3$, $D_{10} = 1$

$C_c = \frac{D_{30}^2}{D_{10} \times D_{60}} = \frac{1.1^2}{1 \times 1.3} = 0.93$ $D_{30} = 1.1$

not satisfied

*So poorly graded

⑤ As gravel is <15%. So no gravel

Ans: SP

Soil C

① 62% | 38% — #200 (0.075mm) 62% > 50%, Coarse graded soil

② 0% | 100% — #4 (4.75mm) 0% < 50%, Sand

③ % Fines = 38% > 12%, Sand with fines

④ ~~$C_u = \frac{D_{60}}{D_{10}}$~~

⑤ LL = 40
PL = 16

and, LL < 50%

$I_p = 40 - 16 = 24$

A-line $I_p = 0.73(LL - 20) = 14.6$, So our point is above A-line → Clay

SC - CL Sandy lean clay.

3(a) C-U

Specimen 1. $\sigma_3 = 100,\ \sigma_1 = 100+170 = 270$, $\sigma_3' = 100-40 = 60$, $\sigma_1' = 270-40 = 230$

Specimen 2. $\sigma_3 = 200,\ \sigma_1 = 200+260 = 460$, $\sigma_3' = 200-95 = 105$, $\sigma_1' = 230-95 = 135$

Specimen 3. $\sigma_3 = 300,\ \sigma_1 = 300+360 = 660$, $\sigma_3' = 300-135 = 165$, $\sigma_1' = 660-135 = 525$

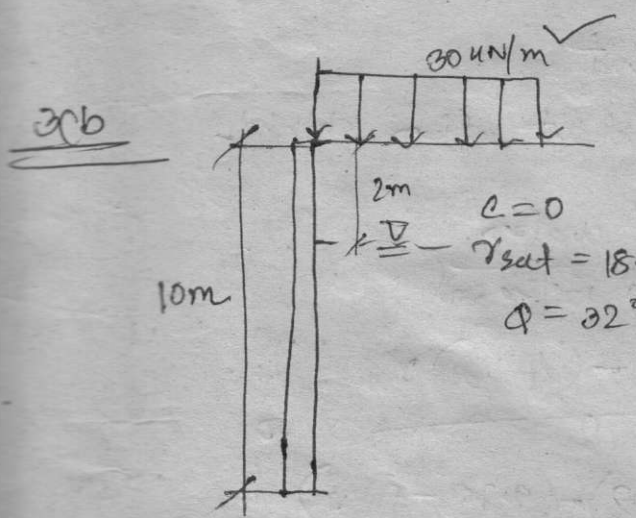
Graph C

Ans

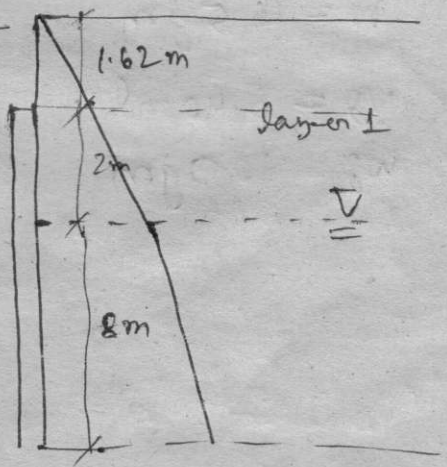
$\phi = 18.43$ $\phi' = 27.95$

$c_d = 25\text{kpa}$ $c_d' = 20\text{kpa}$

3(b)



Assume Active



For layer 1

$$K_a = \frac{1-\sin\phi}{1+\sin\phi} = 0.307$$

$F_{layer\,1} = \frac{1}{2} \times K_a \times \gamma \times$

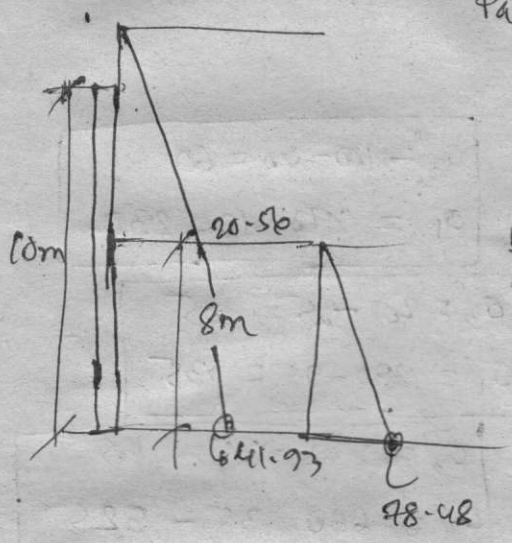
$P_a(h) = K_a \gamma h = 0.307 \times 18.5 \times (1.62+h) = 9.2 + 5.68h$

$P_a(0) = 9.2$

$P_a(2) = 20.56$

$\text{thrust} = \frac{1}{2} \times (9.2+20.56) \times 2 = 29.76\ \text{KN}$

layer 2



$$P_a(h) = k_a \gamma_{sat} \times 3.62 + k_a(\gamma_{sat} - \gamma) \times h$$

$$= 0.307 \times 18.5 \times 3.62 + 0.307 \times 8.7 \times h$$

$$= 20.56 + 2.671h$$

~~$P_a(h) \Rightarrow$~~ $P_a(0) = 20.56$

$P_a(8) = 41.93$

~~Pore water pressure~~ =

Earth thrust $= \frac{1}{2} \times (20.56 + 41.93) \times 8$

$= 250$ kN

Water thrust $= \frac{1}{2} \times 8 \times 78.48 = 313.92$ kN

Total Active thrust $= 29.76 + 250 + 313.92$

$= 593.68$ kN

4(a)

$V = 9.75$ ml

$W = 16.5$ gm

$V_d = 5.40$ ml

$W_d = 10.9$ gm

Shrinkage limit

- water content after shrinkage

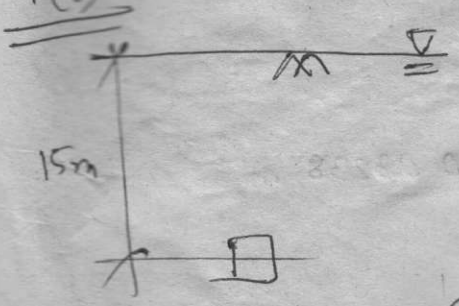
$$w_s = \frac{\text{weight of water}}{\text{weight of the soil}}$$

$$= \frac{(W_1 - W_d) - (V_1 - V_d)\gamma_w}{W_d} \times 100$$

$$= \frac{(16.5 - 10.9) - (9.75 - 5.40)}{10.9} \times 100$$

$= 0\ 11.47\ \%$

4(b)



$c_u = 48.3\ kN/m^2$ ✓, $\phi_{cu} = 13°$ → rapidly

$c'_d = 41.4\ kN/m^2$ ✓, $\phi = 23°$ → slowly

use $\gamma_{sat} = 19.8\ kN/m^3$

0.B.8 = 15X

(i) $\tau_{rapid} = c_{cu} + \gamma_{sat} \times 15 \times \tan\phi_{cu}$

$= 48.3 + (19.8 - 9.81) \times 15 \times \tan 13$

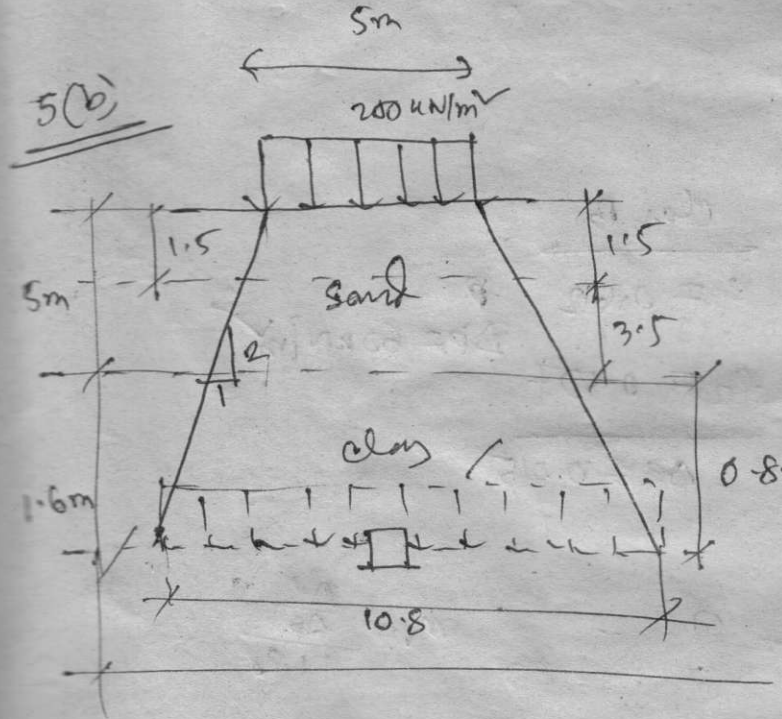
$= 82.896\ kN/m^2$ ✓

c2

(ii) $\tau_{slow} = \cancel{c'_d}^{41.4} + (19.8 - 9.81) \times 15 \times \tan 23°$

$= 41.4 + 63.671 = 105.071\ kN/m^2$ ✓

5(b)



যদি γ_{sat} দেয়া না থাকে তবে

$p_o = 1.5 \times 19.2 + 3.5 \times (20.8 - 9.81) + 0.8 \times (20.0 - 9.81) = 75.417\ kN/m^2$

(If γ_{sat} not give only γ and w is given, then, use, $e = w G_s$ → at SR=100%, then use $\gamma_{sat} = \frac{G_s + e}{1+e} \cdot \gamma_w$ to get the γ_{sat} then use it to calculate 0.B.P.)

From graph $e_o = 0.7045$

and, $\Delta p = \frac{200 \times 5^2}{10.8^2} = 42.87\ kN/m^2$ ✓

$p = p_o + \Delta p = 75.417 + 42.87 = 118.287\ kN/m^2$ ✓

$e = 0.67$

we know that, $S = \frac{\Delta e}{1+e_0} \times H$

$= \frac{0.7045 - 0.67}{1+0.7045} \times 1.6 = 0.03238\ m$

$\approx 32.385\ mm$

(11)

$\frac{t_1}{t_2} = \frac{Hdr_1^2}{Hdr_2^2} = \left(\frac{20}{1600}\right)^2$ $\quad Hdr_1 = 10 \leftarrow Sdr$

$Hdr_2 = 1600 - Sdr$

$t_2 = \frac{110}{\left(\frac{20}{1600}\right)^2} = 7044000\ min = 999\ years$

$2816000 \qquad 5.36$

6(b)

Clay A		Clay B	
$e_1 = 0.572$	$P_1 = 120\ kN/m^2$	$e_1 = 0.612$	$\Delta P = 60\ kN/m^2$
$e_2 = 0.505$	$P_2 = 180\ kN/m^2$	$e_2 = 0.597$	
$\Delta e = 0.067$	$\Delta P = 60\ kN/m^2$	$\Delta e = 0.015$	

$t_A = 1.5\ t_B \Rightarrow$

$t_{50_B} = 3\ t_{50_A}$

$C_V = \frac{0.196 \times Hdr^2}{t_{50}}$

$Hdr_A = 1.5\ Hdr_B$

$\frac{K_A}{K_B} = ?$

$m_V = \frac{\frac{\Delta e}{\Delta P}}{1+e_0}$

$\frac{K_A}{K_B} = \frac{C_{V_A} \times \gamma_w \times m_{V_A}}{C_{V_B} \times m_{V_B} \times \gamma_w}$

$= \frac{\frac{0.196 \times Hdr_A^2}{t_{50_A}} \times \frac{\Delta e_A}{\Delta P_A}}{1+e_{0_A}}$

$\frac{\frac{0.196 \times Hdr_B^2}{t_{50_B}} \times \frac{\Delta e_B}{\Delta P_B}}{1+e_{0_B}}$

$$= \left(\frac{H\delta r_A}{H\delta r_B}\right)^{\sim} \times \left(\frac{t_{50B}}{t_{50A}}\right) \times \left(\frac{\Delta e_A}{\Delta e_B}\right) \times \frac{(1+e_{0B})}{(1+e_{0A})}$$

$$= (1.5)^{\sim} \times (3) \times \left(\frac{0.067}{0.015}\right) \times \left(\frac{1+0.612}{1+0.592}\right)$$

$$= 32.246$$

7(b)

$V = 150\,m^3$

$G_s = 2.70$

$\gamma = 2.00\ ton/m^3$

$w = 8\%$

$$\gamma_d = \frac{2}{1+0.08} = 1.85\ ton/m^3$$

additional water/m^3

$$= 1.85 \times \frac{(11-8)}{100} = 0.0555\ ton/m^3$$

(i) total water $= 0.0555 \times 150$

$= 8.325\ ton = 8.325 \times 10^3\ kg$

$= 8.325$ litre

(ii)

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

$$= \frac{1 \times 2.70}{1.85} - 1 = 0.459$$

$$S_R = \frac{w}{e} G_s$$

$$= \frac{12}{0.459} \times 2.70$$

$= 70.588\ \%$

(iii) $S_R = 1 \Rightarrow$ ~~$w = e G_s = 0.459 \times 2.70 = 1.239$~~ $\quad w = \frac{e}{G_s}$

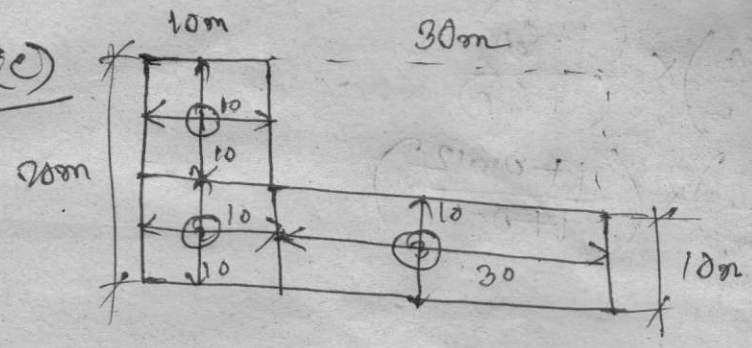
~~water $= 1.85 \times (1.239 - 8)$~~ $\quad w = \frac{e}{G_s} = \frac{0.459}{2.70} = 0.17$

~~water $= 1.85 \times \frac{(17-8)}{100} \times 150 =$~~

Dry sample to fully sat $= 1.85 \times \frac{17}{100} \times 150 = 47.175\ ton$

$= 47.175$ litre

7(c)



$z = 8m$

$q = 75 kN/m^2$

(I). $m = \frac{L}{z} = \frac{10}{8} = 1.25$

$n = \frac{B}{z} = \frac{10}{8} = 1.25$

$m^2+n^2+1 = 4.125$

$m^2n^2 = 2.441$

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

$\sigma_z = \frac{q}{4\pi}\left(AXB + \sin^{-1}A\right)$

$A = \frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}$

$= 0.967$

$B = \frac{m^2+n^2+2}{m^2+n^2+1}$

$= 1.242$

$= \frac{75}{4\pi} X \left(0.967 X 1.242 + \sin^{-1}0.967\right)$

$= 15 kN$

(II) $\sigma_z = 15 kN$

(III) $m = \frac{30}{8} = 3.75$

$n = \frac{10}{8} = 1.25$

$m^2+n^2+1 = 16.625$

$m^2n^2 = 21.97$

$m^2+n^2+1 < m^2n^2$

$A = 0.99$

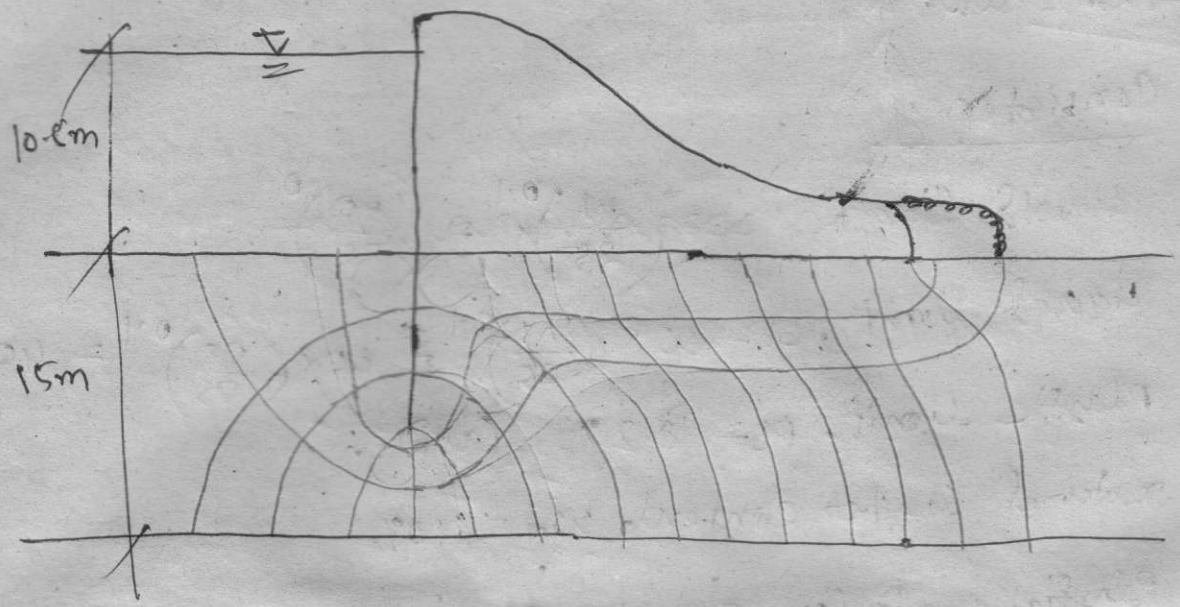
$B = 1.045$

$\sigma_z = \frac{q}{4\pi}\left(AXB + \pi - \sin^{-1}A\right)$

$= \frac{75}{4\pi} X \left(0.99 X 1.045 + \pi - \sin^{-1}0.99\right)$

$= 16.39$

Sol total stress $= 15X2 + 16.39 = 46.39 kN/m^2$



$N_d = 15$

$N_f = 3$

$k = 2.5 \times 10^{-4}$ m/sec

$$q = k \frac{H}{N_d} N_f = 2.5 \times 10^{-4} \times \frac{10.5}{15} \times 3$$

$$= 5.25 \times 10^{-4} \text{ m}^3/\text{sec}$$

$$Q = q \times t$$

$$= 5.25 \times 10^{-4} \times 6 \times 30 \times 24 \times 60 \times 60$$

$$= 8164.8 \text{ m}^3$$