Zoynul sir

Lateral Earth pressure

Q-2007-08

1(c) for clay $\phi = 0$; $\gamma = 16\ KN/m^3$

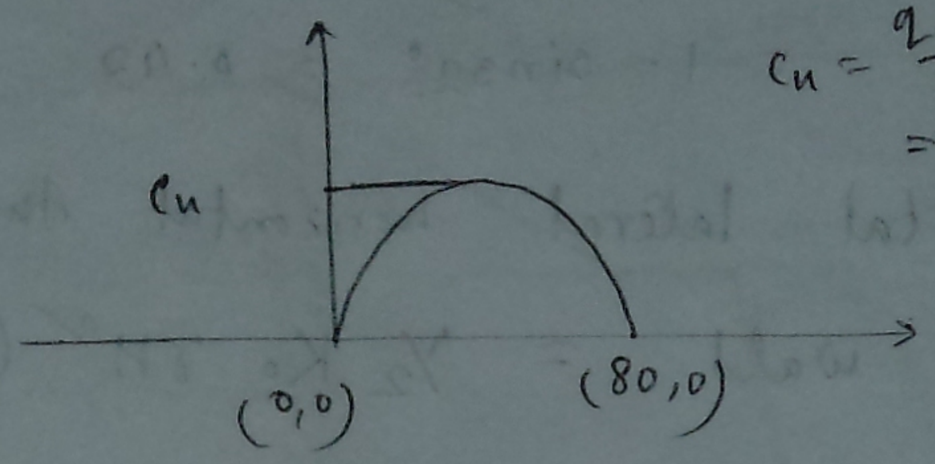
We Know,

$$2h_c = \frac{4c}{\gamma} \tan(45° + \phi/2)$$

$$= \frac{4 \times 40}{16} \tan 45°$$

$$= 10\ m > 6m$$

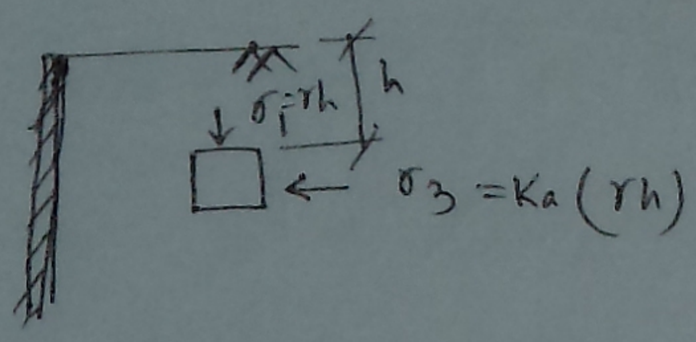
So, no retaining wall required.

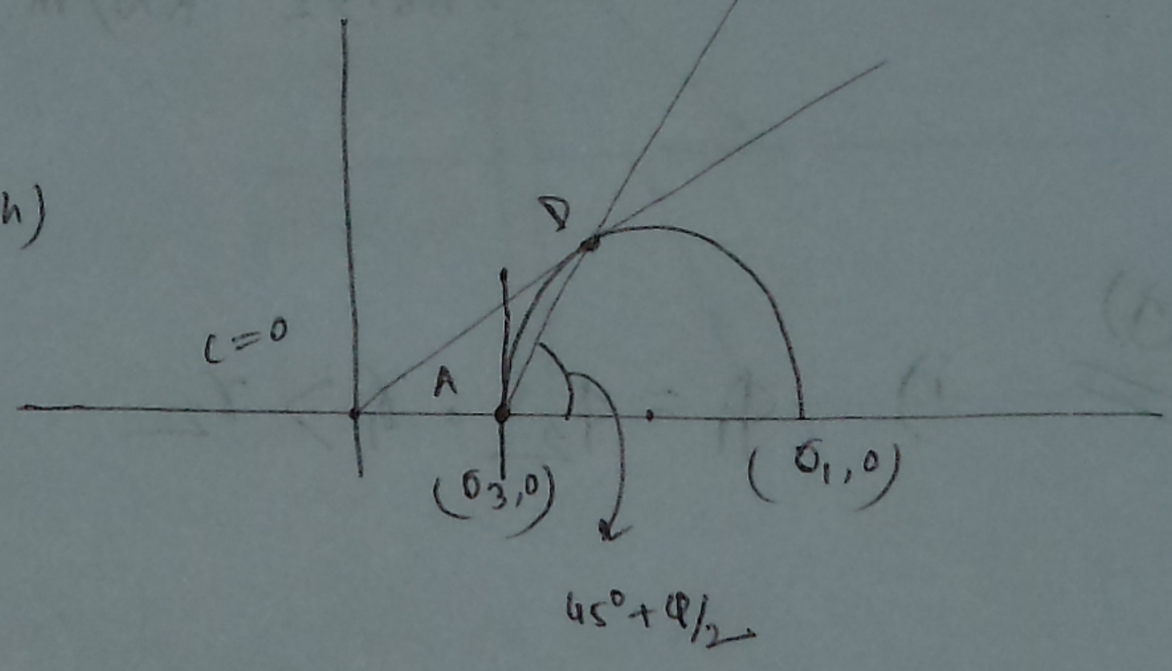


$c_u = \frac{q_u}{2}$

$= 40\ KN/m^2$

1(f)



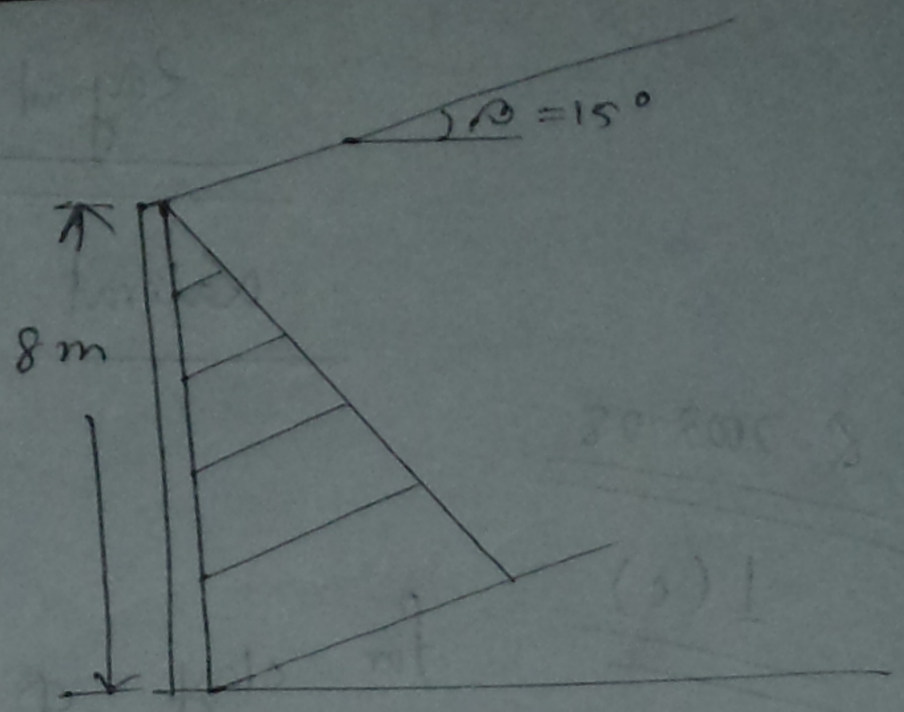


1(h)

$\gamma = 16 \ KN/m^3$

$\varphi = 32°$

$\beta = 15°$



massive retaining wall so earth pressure at rest :

$K_o = (1 - \sin\varphi)$

$= 1 - \sin 32° = 0.47$

total lateral horizontal thrust coming to the wall $= \frac{1}{2} K_o \gamma H^2 (1 + 0.5 \tan\beta)^2 \cos^2\beta$ (According to class lecture)

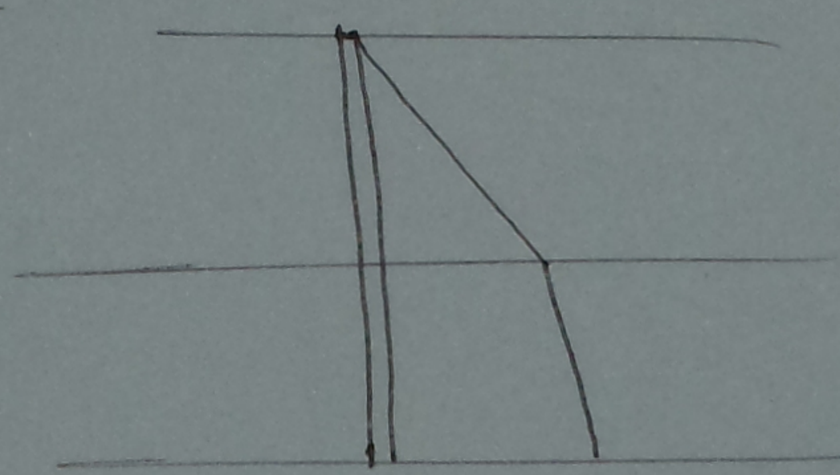
$= \frac{1}{2} \times 0.42 \times 16 \times 8^2 (1 + 0.5 \tan 15°)^2 \cos^2 15°$

$= \cancel{298.894 \ KN/m}$

$= 288.21 \ KN/m.$

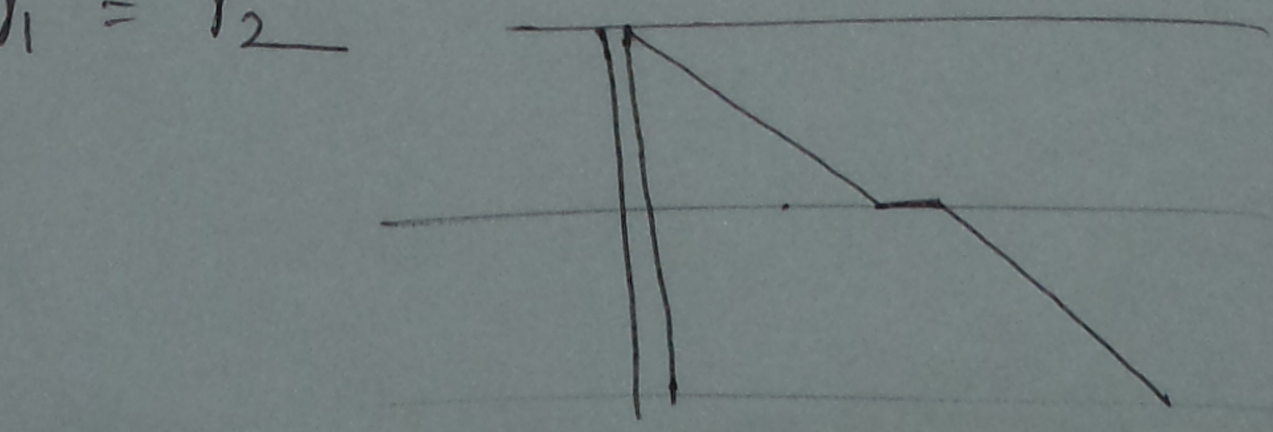
1(i)

i) $\varphi_1 = \varphi_2$, $\gamma_1 > \gamma_2$



ii) $\varphi_1 > \varphi_2$, $\gamma_1 = \gamma_2$

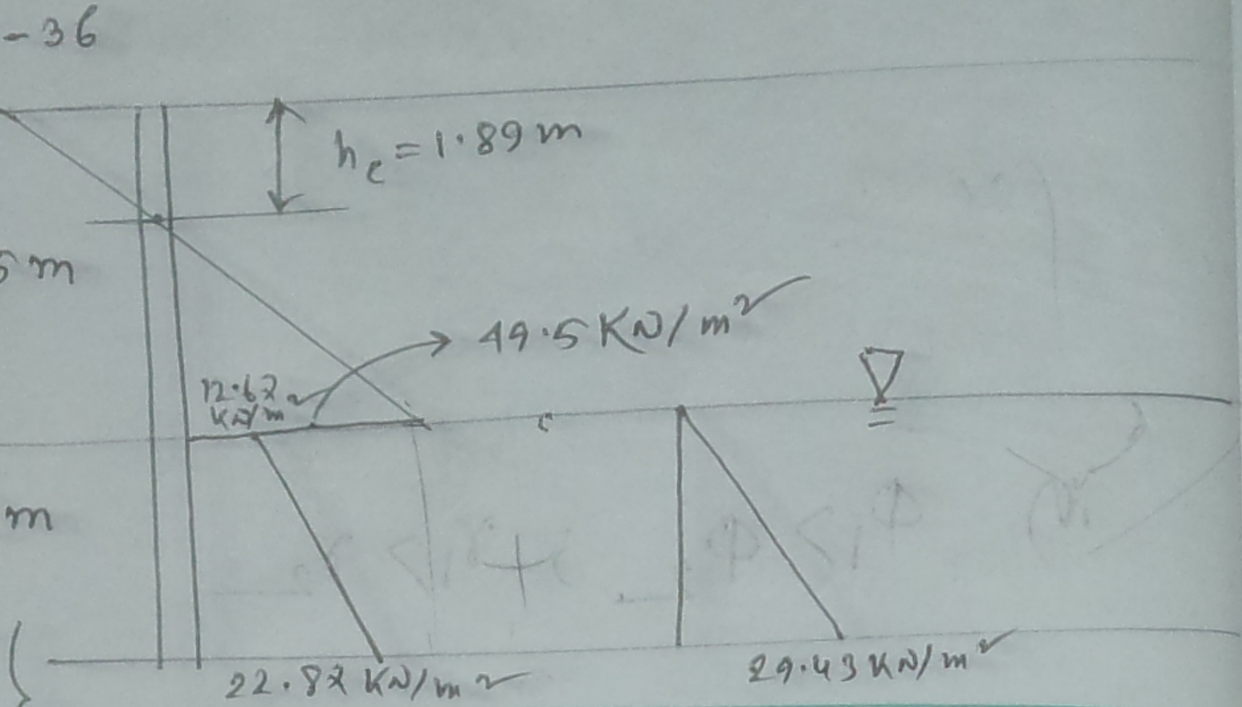
$\varphi_1 \uparrow K_a \downarrow P_a \downarrow$



Q-07-08

3(b)

Draw the pressure distribution diagram :



$\left\{ \begin{array}{l} \gamma_1 = 19 \text{ KN/m}^3 \\ c_1 = 18 \\ \varphi_1 = 0 \end{array} \right\}$ $\left\{ \begin{array}{l} \gamma_2 = 20 \text{ KN/m}^3 \\ c_2 = 0 \\ \varphi_2 = 30^\circ \end{array} \right\}$

$\varphi_1 = 0$ → Cohesive

$\varphi_2 = 30^\circ$ → cohesionless

if water surface is at the surface of the bottom layer then

layer 1: step : 1

$$K_{a_1} = \frac{1 - \sin\varphi_1}{1 + \sin\varphi_1} = \frac{1 - \sin 0^\circ}{1 + \sin 0^\circ} = 1$$

step : 2 :

$$P_{a_1}(h) = (K_{a_1}\gamma_1 h - 2c_1\sqrt{K_{a_1}})$$

$$= (1 \times 19 \times h - 2 \times 18)$$

$$P_{a_1}(h) = 19h - 36 \quad \text{——} (1)$$

step : 3 :

at $h = 0$, $P_a(0) = -36$ KN/m²

at $h = 4.5$ m $P_a(4.5) = 49.5$ KN/m²

and $h_c = 2c_1/\gamma_1 = \frac{2 \times 18}{19} = 1.89$ m.

if water table is on the top surface then

step: 1: $K_{a_1} = \frac{1-\sin\phi}{1+\sin\phi} = 1 \quad (\phi = 0^\circ)$

step: 2: $P_{a_1}(h) = (K_a \gamma h - 2c\sqrt{K_a})$

$= 1(19-9.81) \times 4 - 36$

$= 9.19h - 36$

$h_c = 2c/\gamma$

$= 1.99$

step: 3: $P_{a_1}(h=0) = -36 \text{ KN/m}^2$

$P_{a_2}(h=4.5) = 5.355 \text{ KN/m}^2$

Layer II:

$K_{a_2} = \frac{1-\sin 30^\circ}{1+\sin 30^\circ} = 1/3$

step: 4: layer 1 would be acting as a surcharge on layer 2 ∴ so uniform surcharge,

$q = \gamma_1 H_1 = 19 \times 2.5 = 985.3 \text{ KN/m}^2$

∴ equivalent height, $q/\gamma_2' = \frac{38}{20-9.8} = 3.23 \text{ m}$

∴ $K_{a_2} = \frac{1-\sin\phi_2}{1+\sin\phi_2} = 1/3$

step: 5: $P_{a_2}(h_2) = K_{a_2} \gamma_2' (h_c + h_2)$

$= 1/3 \times (20-9.81)(3.23 + h_2)$

$= 12.62 + 3.4 h_2$

step: 6: $P_{a_2}(\text{at } h_2 = 0) = 12.62 + 3.4 \times 0$

$= 12.62 \text{ KN/m}^2$

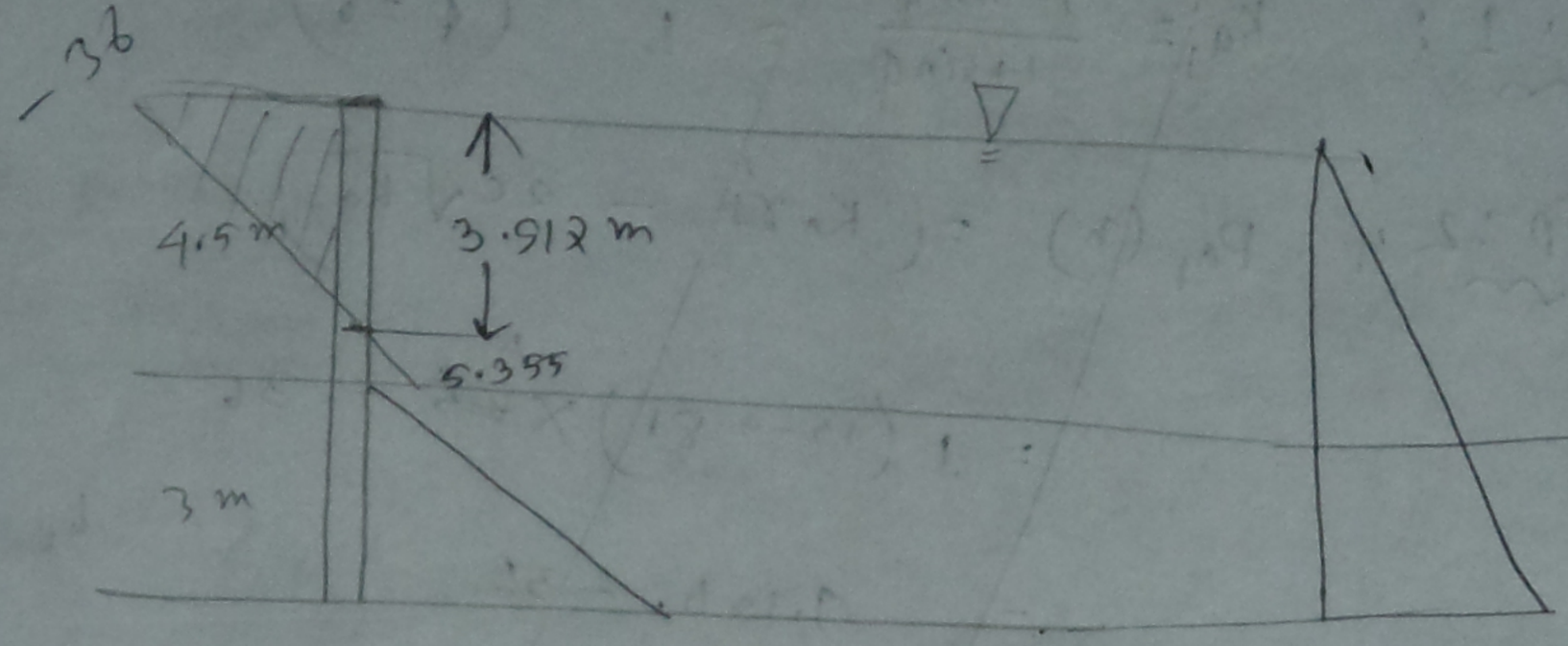
$P_{a_2}(\text{at } h_2 = 3) = 22.82 \text{ KN/m}^2$

So, active thrust

$= \frac{1}{2} \times 49.5 (4.5 - 1.89) + \frac{1}{2} \times 3 \times (10.2) + 3 \times 12.62$

$= 107.21 \text{ KN}$

3b



step: 1 :- $K_{a_1} = \frac{1-\sin\phi_1}{1+\sin\phi_1} = 1$

step: 2 : K_{a_1}

$$P_{a_1}(h) = K_{a_1}\gamma_1' h - 2c\sqrt{K_{a_1}}$$

$$= (19-9.81)h - 36$$

$$= 9.19h - 36. \quad \text{—— (1)}$$

step: 3 :

$$P_{a_1}(h=0) = -36 \text{ KN/m}^2$$

$$P_{a_1}(h=4.5) = 5.355 \text{ KN/m}^2$$

$$h_c = \frac{2c}{\gamma'} = \frac{2\times 18}{9.19} = 3.912 \text{ m.}$$

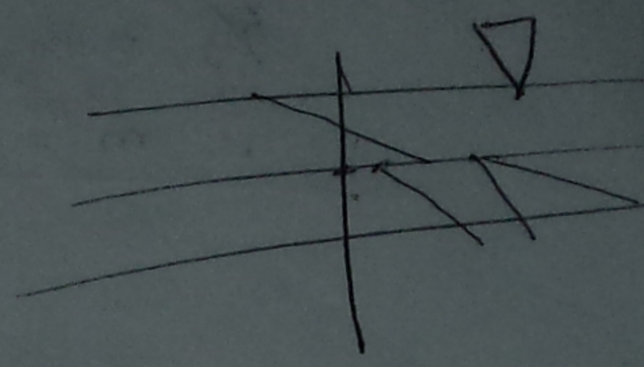
step: 4 :

$$K_{a_2} = \frac{1-\sin\phi_2}{1+\sin\phi_2} = \frac{1-\sin 30^\circ}{1+\sin 30^\circ} = \frac{1}{3}$$

Uniform surcharge load, $q = \gamma_1' H_1$

$= 9.19 \times 4.5 = 41.355$ KN/m²

$\therefore$ equivalent height $= \frac{41.355}{20-9.81} = \frac{41.355}{10.19} = 4.06\ m$



step: 5 :

$$Pa_2(h) = Ka_2\,\gamma_2'\,h_2 - 2C\sqrt{Ka_2}$$

$$= \gamma_3 \times 10.19 \times h_2 - 2 \times 0 \times \sqrt{\gamma_3}$$

$$= 3.4h_2$$

step: 6 :

$$Pa_2(h=0) = 0$$

$$Pa_2(h=3) = 10.2$$

$\therefore$ Active thrust $= \frac{1}{2} \times (4.5 - 3.912) \times 5.355$

$$+ \frac{1}{2} \times 10.2 \times 3$$

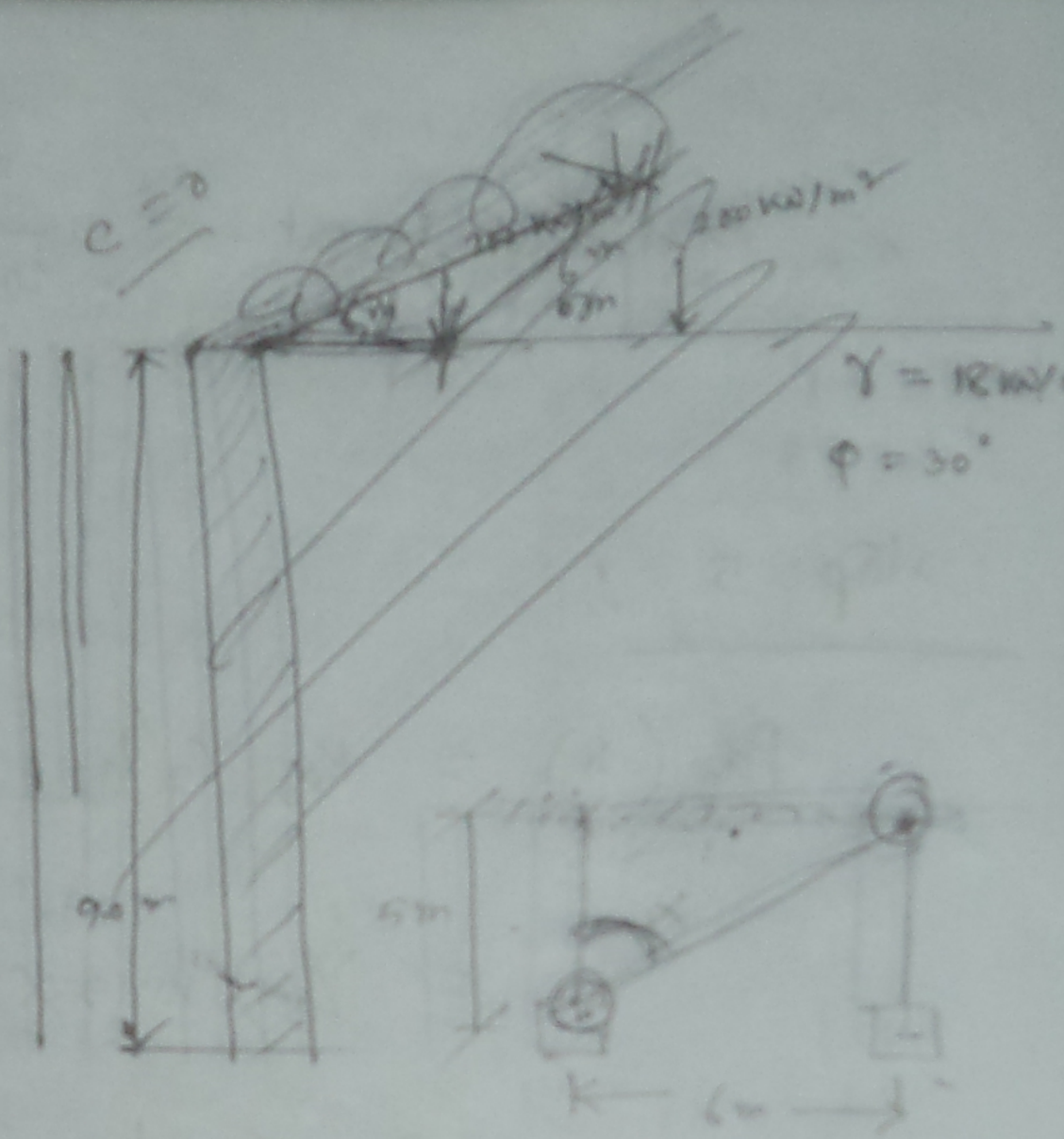
$$= 16.86\ KN/m$$

1(a)

$x = mH$

$z/y = m$

$\therefore m = 0.67 > 0.4$

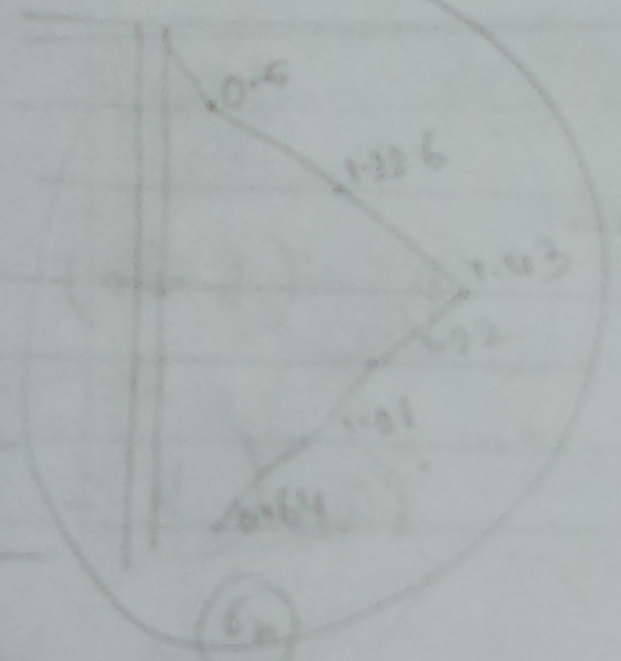


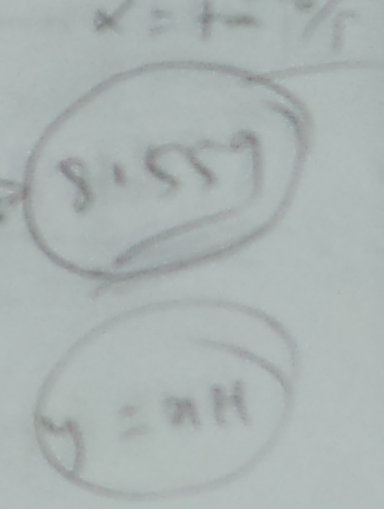
$$\sigma_h = \frac{1.77}{H^2} \frac{m^2 n^2}{(m^2+n^2)^3}$$

$$= \frac{1.77 \times 200}{9^2} \frac{0.62^2 n^2}{(0.62^2+n^2)^3}$$

$$= \frac{1.96\, n^2}{(0.45+n^2)^3}$$

y	n = y/H	σh
0	0	0
1.5	1/6	0.5
3	1/3	1.43
4.5	1/2	1.43
6	2/3	1.08
7.5	5/6	1.01
9	1	0.64







Total active thrust for (δh)

$= \frac{1}{2} \times 1.5 \times 0.16225$

$+ \frac{1}{2} \times 1.5 \left(0.16225 + 0.4\right)$

$+ \frac{1}{2} \times 1.5 \left(0.4 + 0.465\right)$

$+ \frac{1}{2} \times 1.5 \left(0.465 + 0.392\right)$

$+ \frac{1}{2} \times 1.5 \left(0.392 + 0.328\right)$

$+ \frac{1}{2} \times 1.5 \left(0.328 + 0.208\right)$

$= 21.7851 \text{ KN/m}$

(δh) ⇒ Total active thrust $= (8.559 + 2.2851)$

$= 11.3441 \text{ KN/m}$.

0
0.343
0.84
0.98
0.4377
0.6929
0.43904

$= 5.86863$

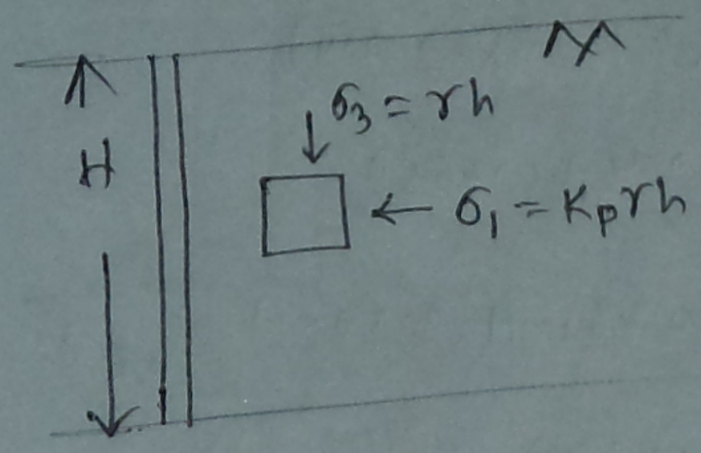
11.37

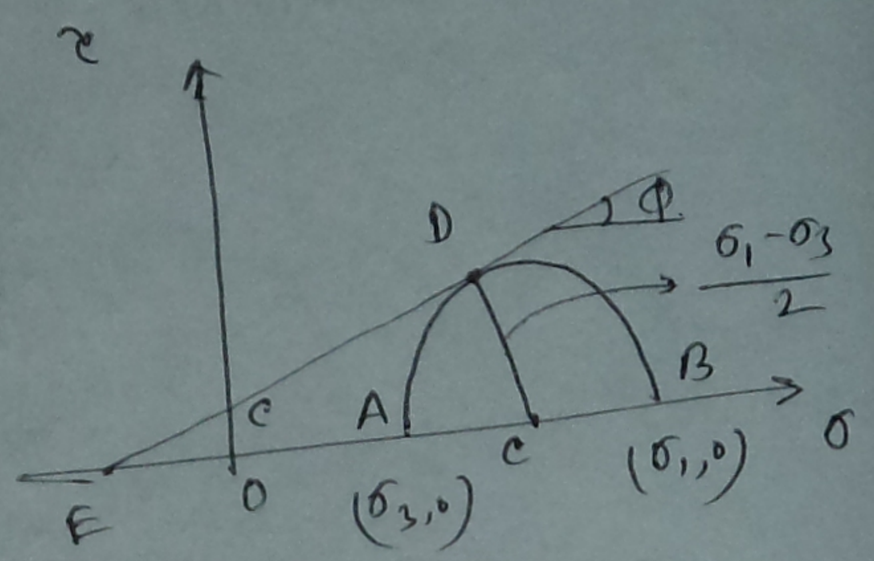
$= 11.24 \text{ KN}$

2006-07

4(a)

Derive an expression for passive pressure in a c-ϕ soil :





$K_p = \sigma_1 / \sigma_3$

$\therefore \boxed{\sigma_1 = K_p \gamma h}$

$$\sin\phi = \frac{CD}{EC} = \frac{\frac{\sigma_1 - \sigma_3}{2}}{c\cot\phi + \frac{\sigma_1 + \sigma_3}{2}}$$

$$= \frac{\sigma_1 - \sigma_3}{2c\cot\phi + (\sigma_1 + \sigma_3)}$$

$$\Rightarrow (\sigma_1 + \sigma_3)\sin\phi + 2c\cot\phi \cdot \sin\phi = \sigma_1 - \sigma_3$$

$$\Rightarrow 2c\cos\phi = \sigma_1(1 - \sin\phi) - \sigma_3(1 + \sin\phi)$$

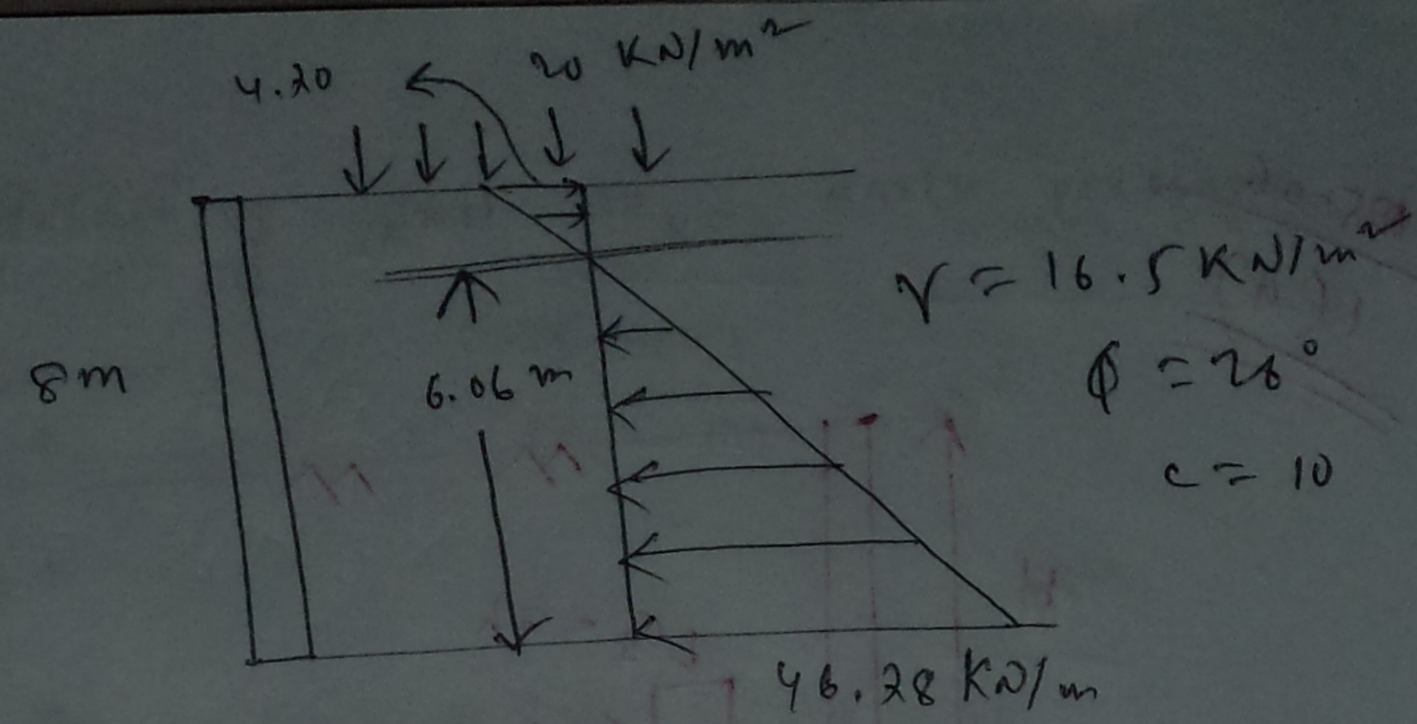
$$\sigma_1 = \sigma_3\left(\frac{1+\sin\phi}{1-\sin\phi}\right) + 2c\sqrt{\frac{1+\sin\phi}{1-\sin\phi}}$$

$$= \sigma_3 \cdot K_p + 2c\sqrt{K_p}$$

$$\sigma_1 = K_p \gamma h + 2c\sqrt{K_p}$$

$$\therefore \boxed{P_{pc} = K_p \gamma h + 2c\sqrt{K_p}}$$

4(b)



Equivalent height,

$h_e = \frac{q}{\gamma}$

$= \frac{20}{16.5} = 1.21$ m

Step: 1: $K_a = \frac{1-\sin\phi}{1+\sin\phi} = \frac{1-\sin 26^\circ}{1+\sin 26^\circ} = 0.39$

Step: 2:

$P_a(h) = K_a \gamma (h + h_e) - 2c\sqrt{K_a}$

$= 0.39 \times 16.5 (h + 1.21) - 2 \times 10 \times \sqrt{0.39}$

$= 6.435h - 4.20$

According to lecture → step: 2

$P_a(h) = K_a \gamma (h + h_e)$

$= 0.39 \times 16.5 (h + 1.21)$

$= 2.2864 + 6.435h$

Step: 3:

Step: 3:

$P_a(h=0) = -4.20$ KN/m²

$P_a(h=8) = 46.28$ KN/m²

$h - h_c = 8 - \frac{2c}{\gamma} \tan(45^\circ + \phi/2)$

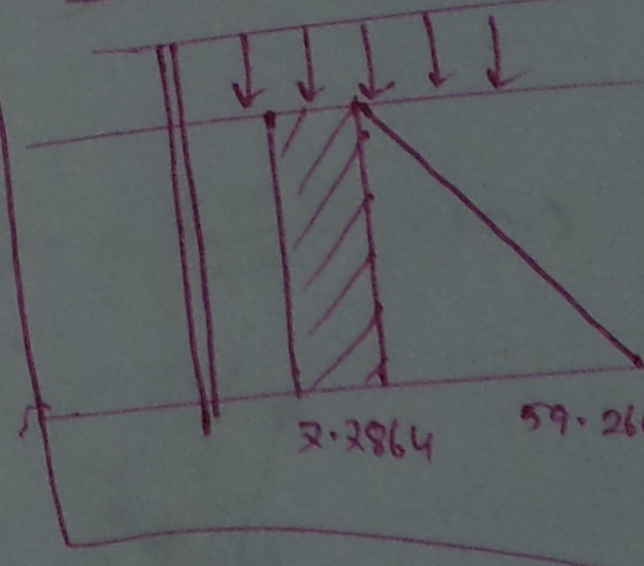
$= 8 - \frac{2 \times 10}{16.5} \tan(45^\circ + 26/2)$

$= 6.06$ m.

Step 3:

$P_a(h=0) = 2.2864$

$P_a(h=8) = 59.2664$

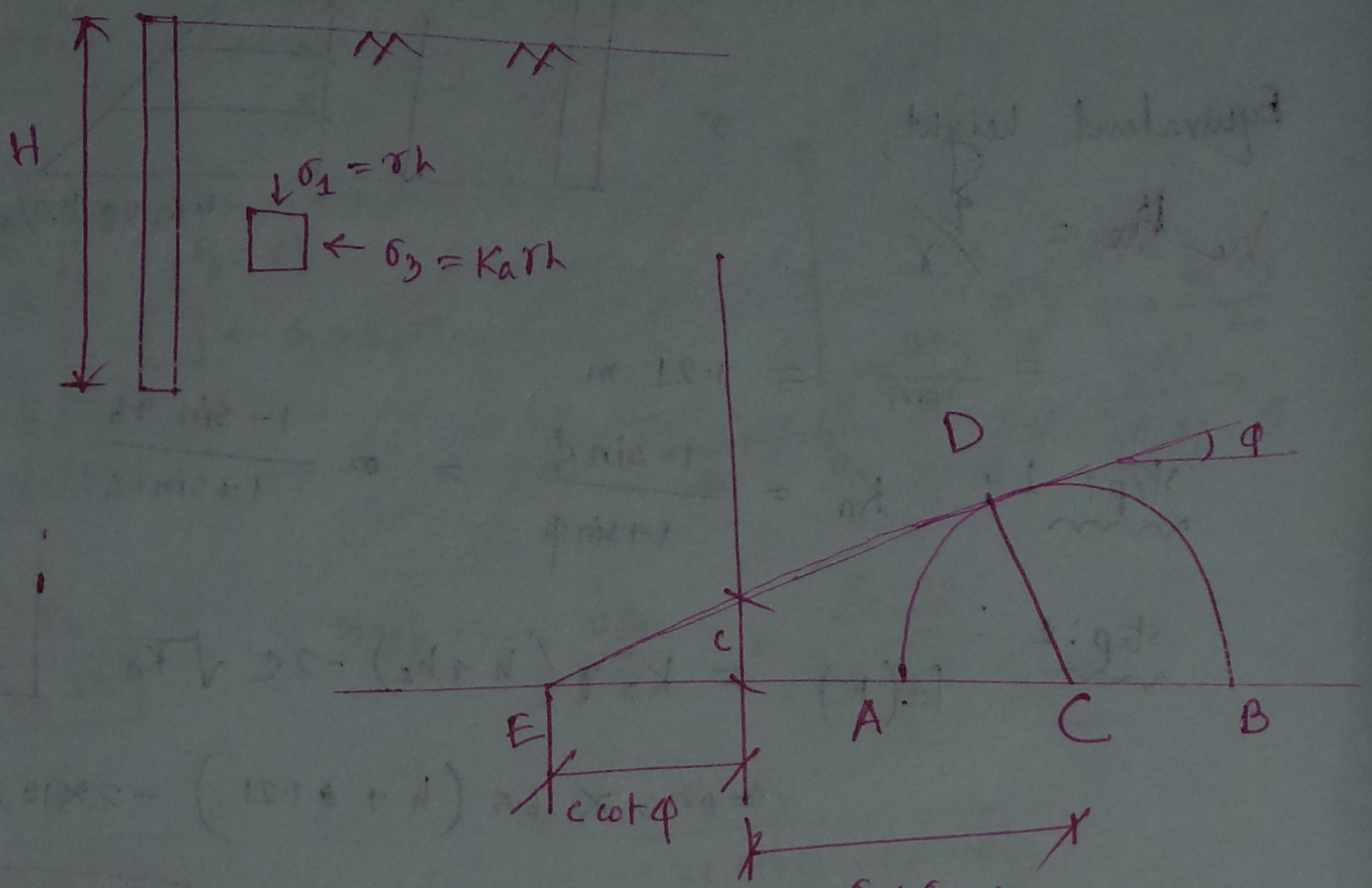


∴ total thrust $= \frac{1}{2} \times 6.06 \times 46.28$

$= 141.248$ KN/m.

2005-06

1(a)



$$\sin\varphi = \frac{\frac{\sigma_1 - \sigma_3}{2}}{c\cot\varphi + \left(\frac{\sigma_1+\sigma_3}{2}\right)}$$

$$(\sigma_1+\sigma_3)\sin\varphi + 2c\cot\varphi.\sin\varphi = \sigma_1 - \sigma_3$$

$$\sigma_1(1-\sin\varphi) - \sigma_3(1+\sin\varphi)$$

$$= 2c\cos\varphi$$

$$\therefore \quad \sigma_3 = \sigma_1 \frac{1-\sin\varphi}{1+\sin\varphi} - 2c\frac{\cos\varphi}{1+\sin\varphi}$$

$$= \sigma_1 K_a - 2c\sqrt{K_a}$$

$$\boxed{P_{ac} = \sigma_3 = K_a\gamma h - 2c\sqrt{K_a}}$$

05-06

3(b) Massive retaining wall so, earth pressure at rest.

$\beta = 12°$

$\phi = 35°$

$OCR = 2$

$H = 6m$

$\gamma = 18\ KN/m^3$

$$K_o = (1-\sin\phi)\, OCR^{\sin\phi}$$

$$= (1-\sin 35°)\, 2^{\sin 35°}$$

$$= 0.635$$

We Know, total horizontal thrust $\longrightarrow$

$$= \tfrac{1}{2} K_o \gamma H^2 (1+0.5\tan\beta)^2 \cdot \cos^2\beta$$

$$= \tfrac{1}{2} \times 0.635 \times 18 \times 6^2 (1+0.5\tan 12°)^2 (\cos 12°)^2$$

$$= 240.91\ KN/m.$$

4(b) $H = 8\ m$

$$h_c = \frac{2c}{\gamma} = \frac{2\times 10}{12.5} = 1.143$$

1st layer:

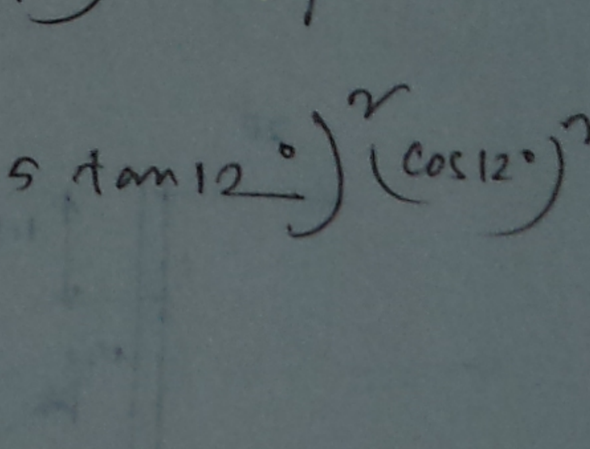
step: 1 : $K_{a_1} = \dfrac{1-\sin\phi}{1+\sin\phi} = \dfrac{1-\sin 0°}{1+\sin 0°} = 1$

step: 2 : $P_{a_1}(h) = K_a \gamma h - 2c\sqrt{K_a}$

$= 12.5h - 20$

step: 3 : $P_{a_1}(h=0) = 10 - 20$

$P_{a_1}(h=2) = 15$



2nd layer : step: 1 : $K_{a2} = \frac{1-\sin\phi_2}{1+\sin\phi_2} = \frac{1-\sin 30^\circ}{1+\sin 30^\circ} = \frac{1}{3}$

$$h_e = \frac{12.6 \times 2}{(19 - 9.81)} = 3.81 \text{ m}$$

step: 2 :

$$P_{a_2}(h) = K_{a_2}\gamma(h+h_1) + 2c\sqrt{K_{a_2}}$$

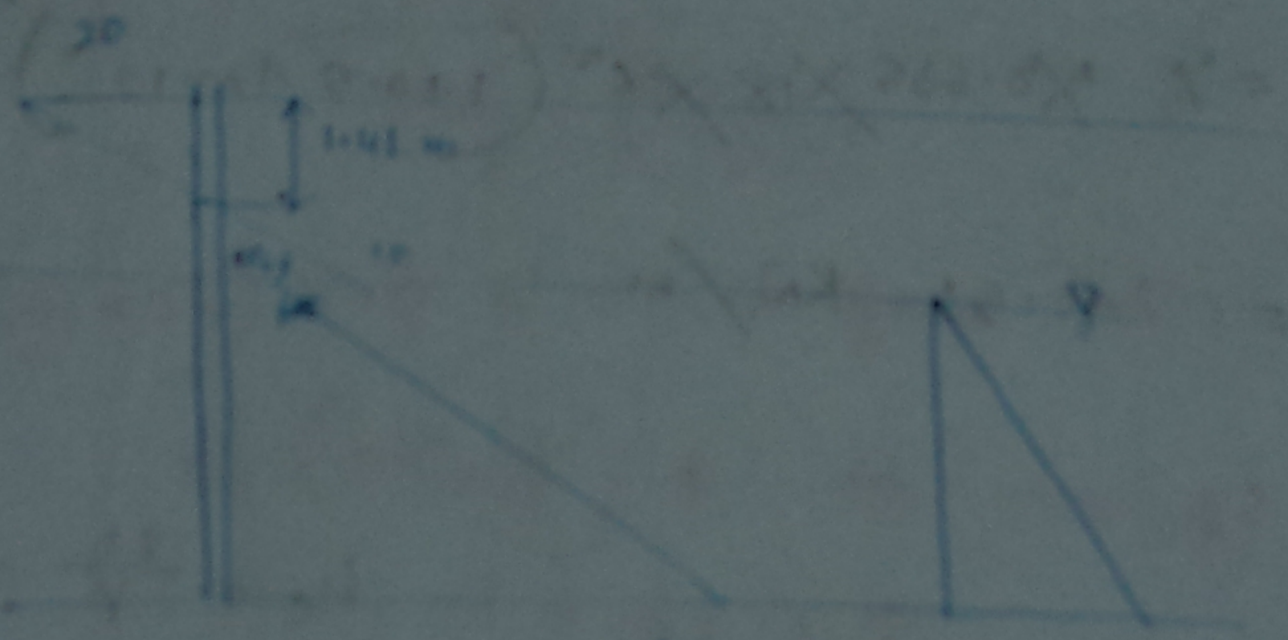
$$= \frac{1}{3} \times (19 - 9.81) \times h - 2 \times 0$$

$$= \frac{1}{3} \times (19 - 9.81)(h + 3.81) - 0$$

$$= 11.62 + 3.06\,h$$

step: 3 : $P_{a_2}(h=0) = 11.62$ (kPa)

$P_{a_2}(h=6) = 30.05$ (kPa)



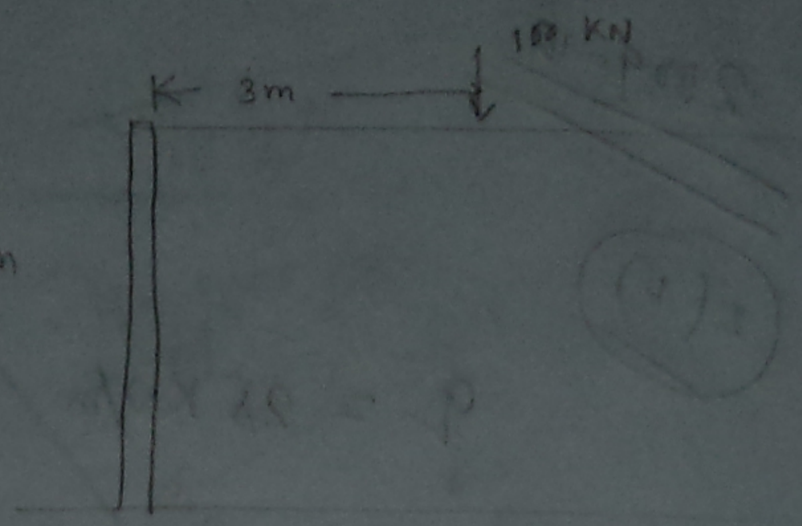
2006-07

3(c)

$\gamma = 18\ KN/m^3$

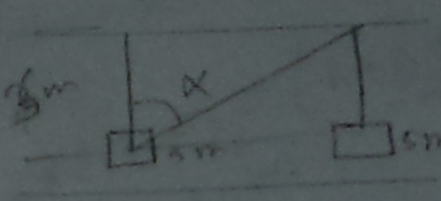
$\mu = 0.50$

$H = 6m$



$x = mH$

$m = x/H = 3/6 = 0.5 > 0.4$



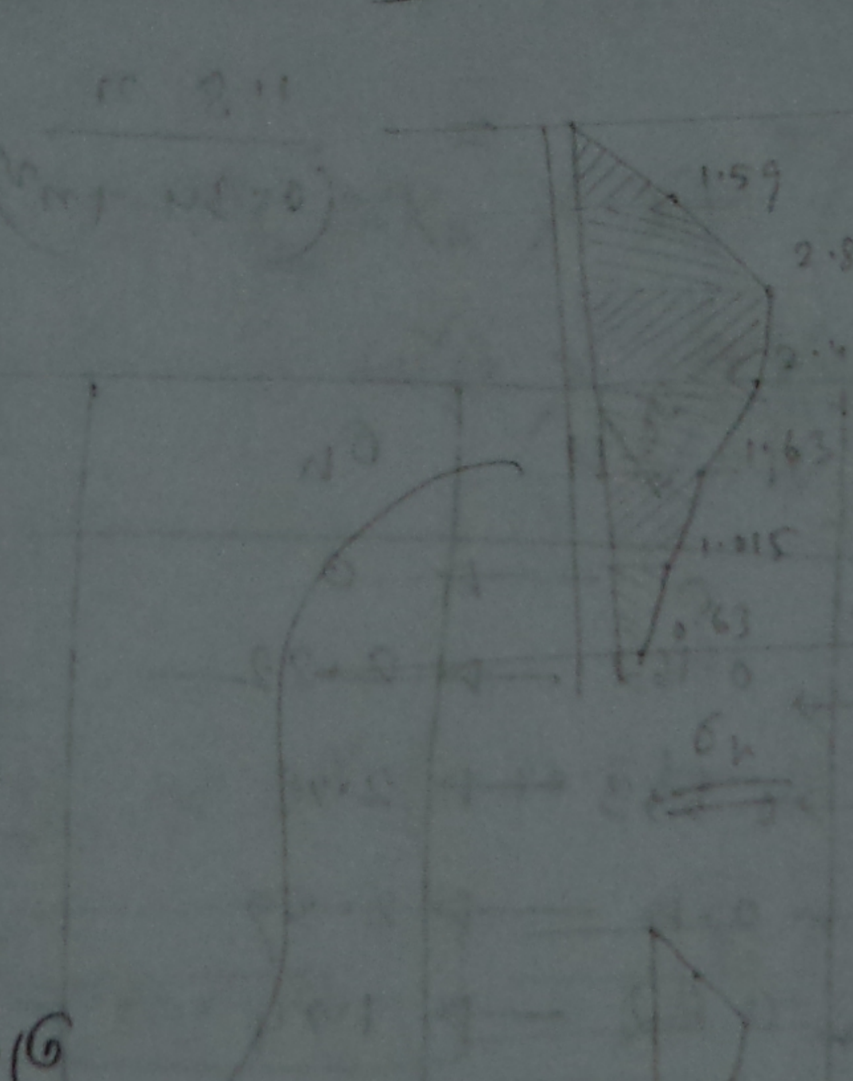
$\tan\alpha = 3/6$

$\alpha = 59.04°$

$$\therefore \sigma_h = \frac{1.22q}{H^2} \frac{m^2n^2}{(m^2+n^2)^3} = \frac{1.22 \times 150}{6^2} \frac{0.5^2 \times n^2}{(0.5^2+n^2)^3}$$

$$= 1.23 \frac{n^2}{(0.25+n^2)^3}$$

y	$n = {}^{2y}/_{H}$	σ_h
0	0	0
1	0.167	1.59408
2	0.33	2.897
3	0.5	2.46
4	0.667	1.63
5	0.833	1.015
6	1	0.63



total thrust (ত্রিভুজের ক্ষেত্রফল)

ত্রিভুজের Area (ত্রিভুজের ক্ষেত্রফল)

(মধ্যমা বরাবর) (এই thrust থাকে)

2007-08

2(c)

$q = 25\ KN/m$; $H = 6\ m$

$x = 3.5m$;

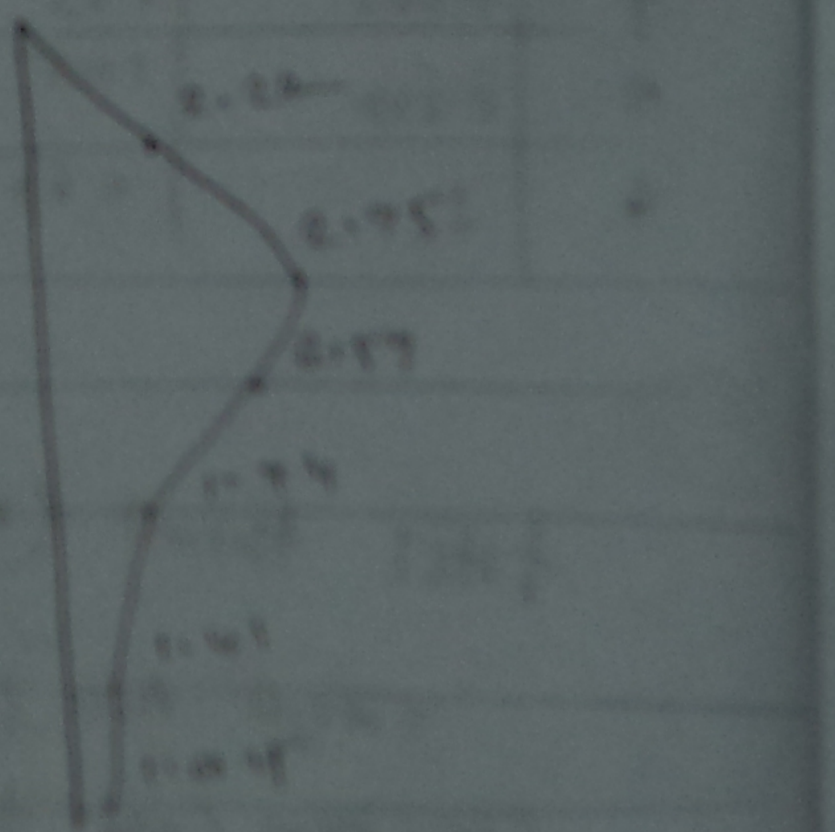
$x = mH$

$m = x/H = 3.5/6 = 0.583 > 0.4$

$$\therefore \sigma_h = \frac{1.28q}{H} \frac{m^2n}{(m^2+n^2)^2}$$

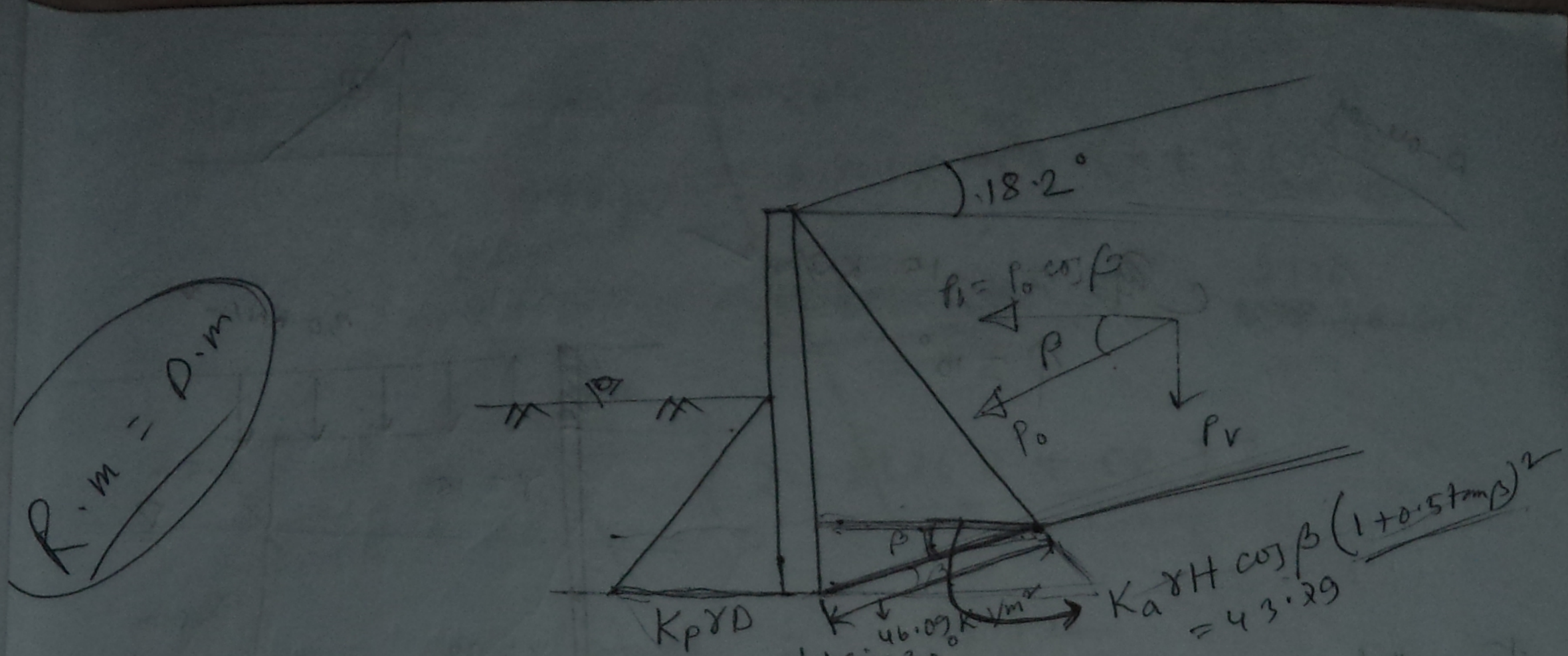
$$= \frac{1.8\ n}{(0.34+n^2)^2}$$

γ	$n = y/H$	σ_h
0	0	0
1	0.167	2.22
2	0.333	2.15
3	0.5	2.07
4	0.62	1.94
5	0.83	1.41
6	1	1.025



total active thrust $= 0.5 \times 6 [(1.11 + 2.48 + 2.17 + 1.77 + 1.41) 2 + 1.025]$

$= 111.81$ KN/m.



$$K_p = \frac{1+\sin\phi}{1-\sin\phi} = \frac{1+\sin 30}{1-\sin 30^\circ} = 3$$

$$\boxed{K_a = \frac{1-\sin\phi}{1+\sin\phi} = \gamma_3}$$

$$K_a = \gamma K_p = \gamma_3$$

$$\gamma_2 K_p \gamma D^2 \times D/3 = \tfrac{1}{2} \times K_a \times \gamma H^2 (1+0.5\tan\beta)^2 \cos^2\beta \times b/3$$

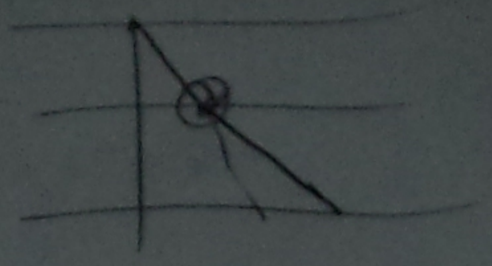
~~$P_o = \tfrac{1}{2}$~~

$$3 \times D^3/3 = 1/3 \times 6^2 (1+0.5\tan 18.2^\circ) \cdot^2 (\cos 18.2)^2 \times 2$$

~~$D = 5.42$ m~~

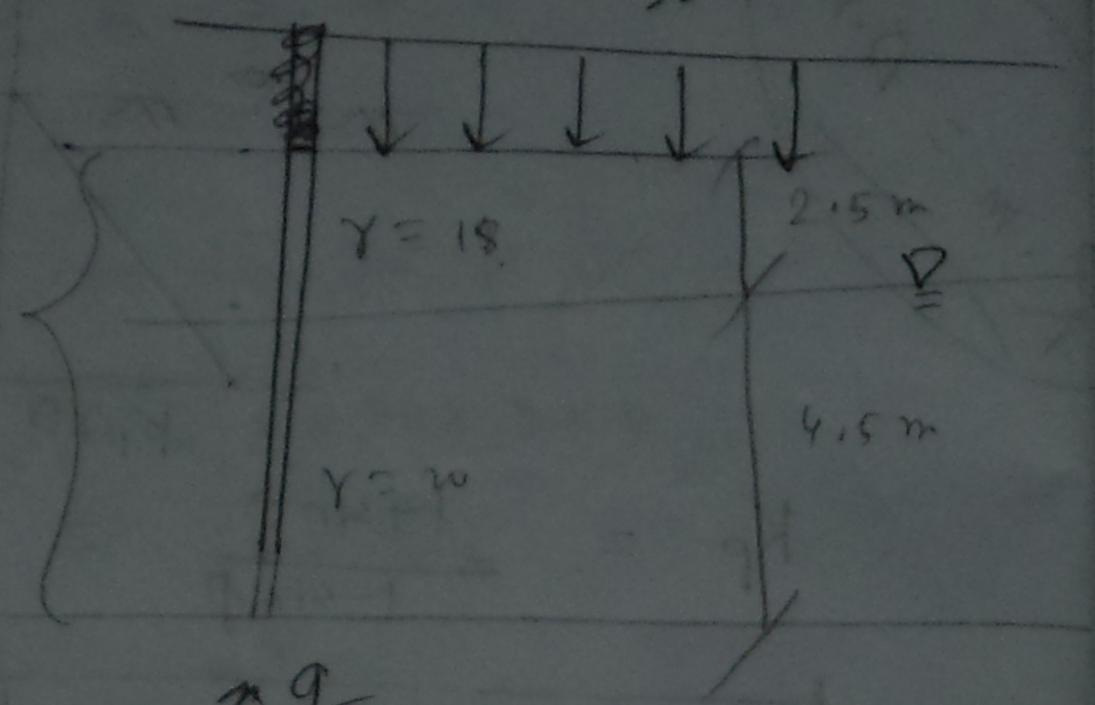
$$\boxed{D = 3.085 \text{ m}}$$

Q-04-05



$c = 15\ KN/m^2$

$\phi = 10^\circ$



step: 1:

$$K_{a_1} = \frac{1-\sin 10^\circ}{1+\sin 10^\circ} = 0.704$$

equivalent height $h_e = \frac{30}{18} = 1.62$ ← q

step: 2:

$$P_a(h) = K_a \gamma_1 (h + h_e)$$

$$= 0.204 \times 18 \times (h + 1.62)$$

$$= 12.622h + 21.124$$

step: 3:

$P_a(h=0) = 21.124$

$P_a(h=2.5) = 52.804$

(2.36)

step : 4 : $K_a = 0.204$

$P_a(h) = 0.204 \times 9.19 \times (h + 8.13)$

$h_e = \frac{52.804 + 30}{20 - 9.81} = \frac{8.126}{40.615}$

$= 2.12326h + 58.32$

$P_a(h=0) = 58.32$

step : 4 : $K_a = 0.204$

(2.36)

equivalent height $h_e = \frac{q}{\gamma_2'}$

Here, $q = (\gamma_1' H_1 + 30)$

$= 18 \times 2.5 + 30$

$= 45 + 30 = 75$ kN/m²

$h_e = \frac{75}{(20 - 9.81)} = 2.36$

step : 5 : $P_a(h) = 0.204 \times 10.19 (h + h_e)$

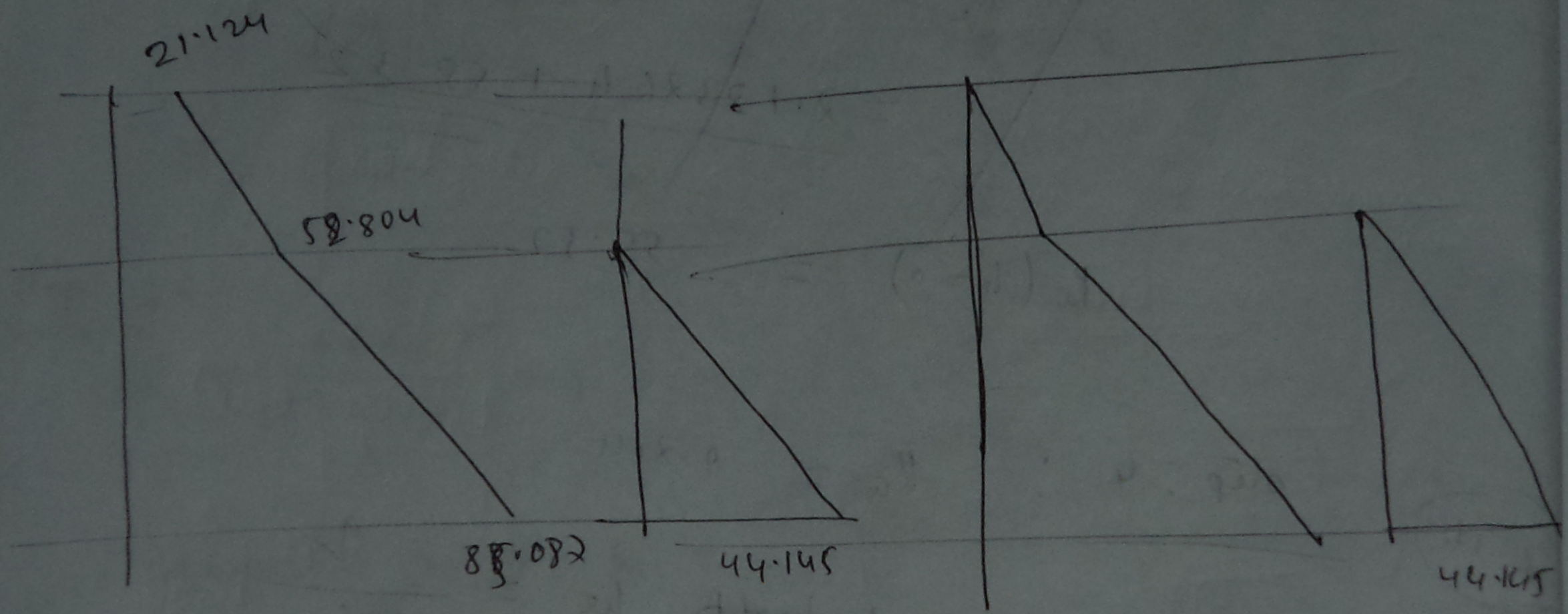
$= 0.204 \times 10.19 (h + 2.36)$

$= 52.804 + 2.124h$

Step : 6 :

$$P_a(h=0) = 52.804$$

$$P_a(h=4.5) = 85.082 \quad KN/m^2$$



∴ total thrust :

$$P_a = \tfrac{1}{2} \times 2.5 (21.124 + 52.804) + \tfrac{1}{2} \times 4.5 (52.804 + 85.082) + \tfrac{1}{2} \times 44.145 \times 4.5$$

$$= 92.41 + 310.25 + 99.33$$

$$= 501.99 \approx 502 \ KN/m.$$

Unified soil classification System:

USCS →

Coarse grained → grain size characterstics

fine grained → plasticity "

more than 50 %

retained

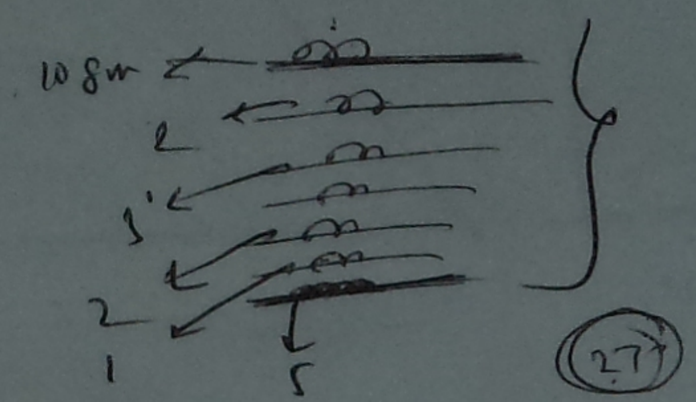
> 50 % → then coarse grained

↓ in #200 sieve

Coarse-grained

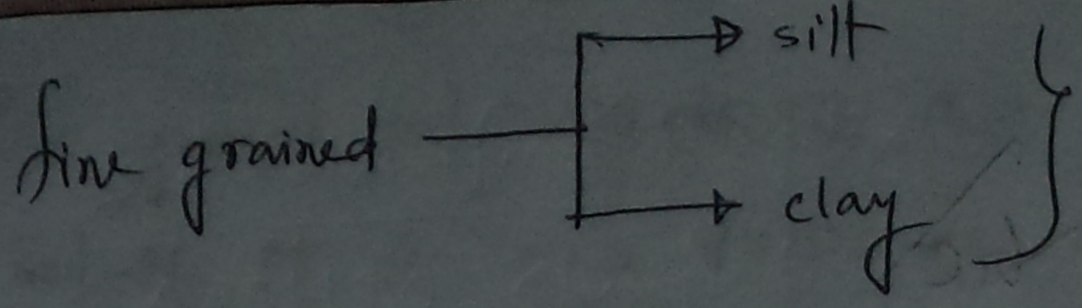
↓ ↓

gravel sand



(*) if 50 % or more of the ~~coarse~~ coarser portion (retained on no. 200 sieve) retains on #4 sieve then the whole → is called gravel.

(*) ~~ﻣﺮﺗﺎﺣ~~ → Gravel ~~ﻟﺎﻗﺗﺳﺍ~~ more ≥ 50 % ~~ﻥﻣ~~ coarse ~~ﻟﺎﻗﺗﺳﺍ~~ ~~NO.4~~ = #200 (~~ﺔﻴﻠﻤﻟﺍ~~ > 50 % retain ~~ﻣﺮﺗﺎﺣ~~ ~~ﻟﺎﻗﺗﺳﺍ~~



#40 sieve passing particle এর plasticity index দিয়ে classification করা হয়।

0.425 mm

1st word → main soil

2nd word → modify first.

< 5% যদি No. 200 দিয়ে pass করে তাহলে soil হবে GW, GP, SW ও SP এর কোন একটি।

> 12% যদি #200 দিয়ে pass করে তাহলে soil হবে ~~SM~~ GM, GC, SM, SC.

5% < * < 12% → dual

GW, GP ও SW, SP

↓ ↙ ↙ ↙

যদি $C_u \geq 4$

$C_z = 1 \sim 3$

তাহলে GW or SW

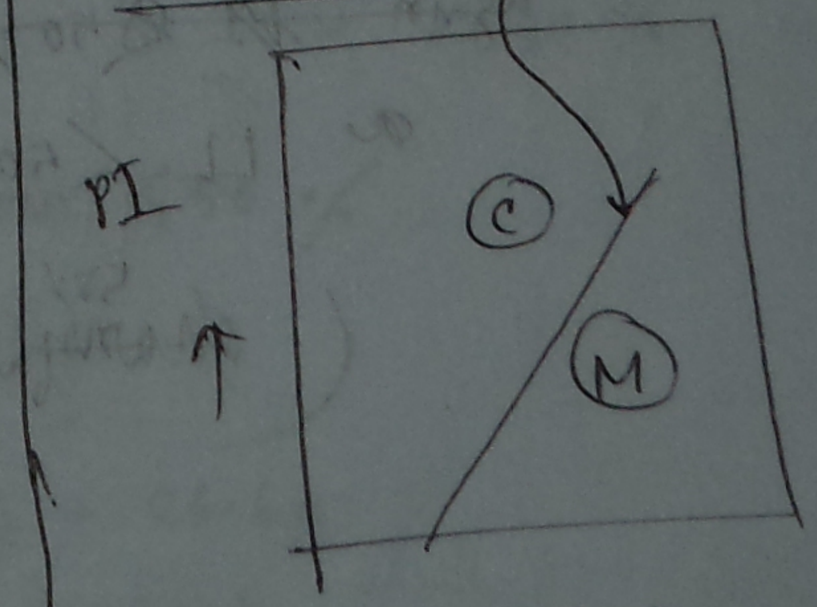
নাহলে GP or SP

তাহলে GW, GP, SW, SP

যদি, GM, GC, SM, SC

তাহলে

PI = 0.23 (LL - 20)



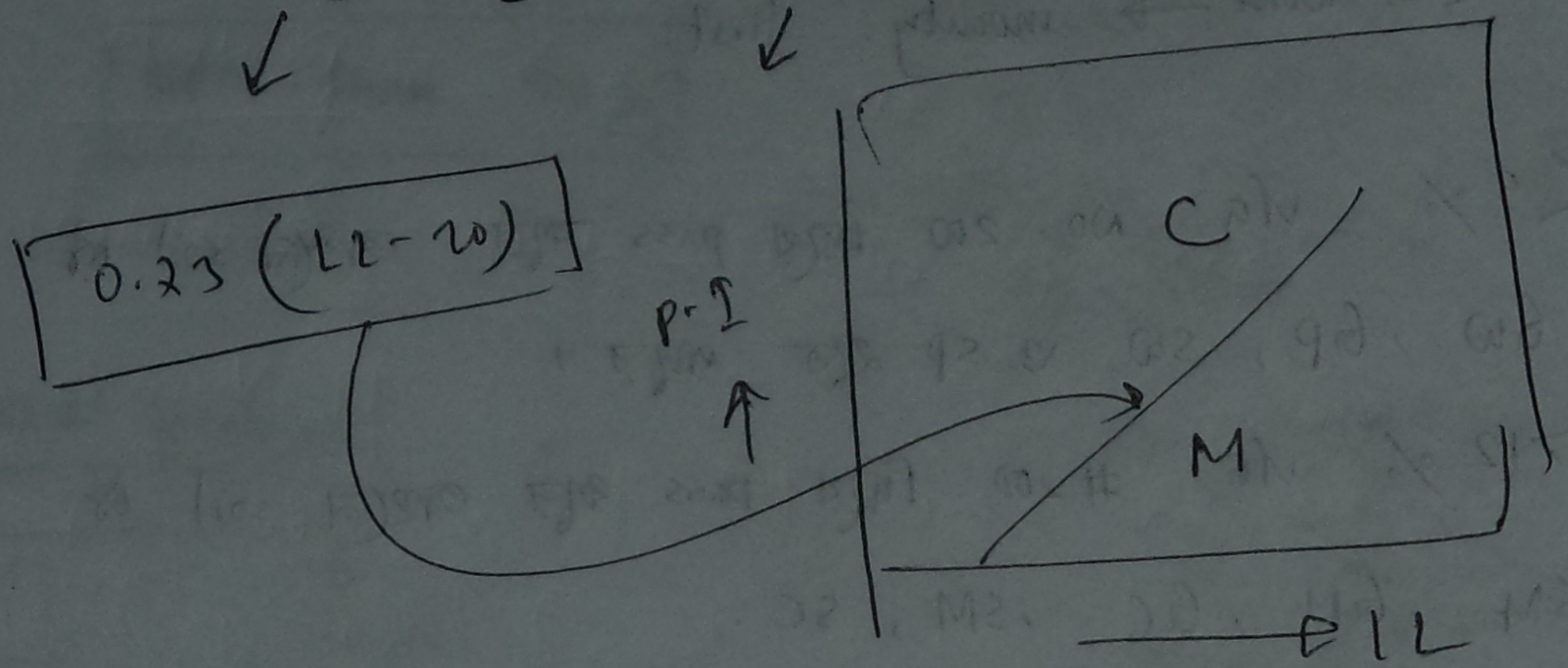
তাহলে Known LL ও PI graph -এ plot করে যদি point টা C and line এর above হয় CM.

Dual সয়েল → coarse grained soil, fine grained soil

fine grained soil → C ও M

(H), (L) → LL

MH, ML → PI



(H) ও or L কি না

plasticity index দেখব।

যদি LL PI > 50% হয় তাহলে High plasticity হবে।

so, CH or MH হবে

again ~~PI < 50%~~ হলে

আর LL < 50% হলে তাহলে, Low plasticity হবে।

(~~Drawing~~ 50% হবে ○ ও হবে)

fine-grained soil এর ক্ষেত্রে dual classification system হতে পারে। soil এর PI যদি 4-7 এর মধ্যে হয় and LL যদি 12-25 এর মধ্যে হয় তাহলে CL-ML। যদি w_L (LL) ও PI values এর যদি A line এর কাছাকাছি হয় যেমন LL = 50 এর কাছাকাছি হয় তাহলে CL-CH, ML-MH, OL-OH, CL-ML, CL-OL, CH-MH ও CH-OH হবে।

Example-4 :

Major division :

% finer than 0.025 mm is 10 (~~<50~~)

i.e. 10 % (~~50~~) passing so the soil is coarse grained.

50 % of the soil is ~~60~~ coarse-grained.

% of coarse-grained soil retained on on 4.25 mm sieve

$= \frac{100-96}{} = \frac{4}{0.9} = 4.44 = \frac{4}{90} \times 100\ \%$

$= 4.44\ \%$.

Which is ~~less than~~ $\leq 50\ \%$

So the soil is sand.

Gradation :

$C_u = \frac{D_{60}}{D_{10}} = \frac{2}{0.025} = 26.62$

$C_z = \frac{D_{30}{}^2}{D_{60} \times D_{10}} = \frac{0.425^2}{2 \times 0.025} = 1.204$

which is betn 1 and 3

So the coarse soil is well-graded so SW.

percentage of fine :

% of fines 10 % which is in bet^n 5 to 12 %. So the whole soil falls into a boarder line classification requiring dual symbol.

Plasticity : LL = 40

Corresponding P.I. = 0.73 (40 - 20) = 14.5

observed PI = 40 - 20 = 20

So the soil falls above A - line

hence the fine soil is clay . i.e. SC

Soil is SW - SC

Q - 2003-09

(b) # 200 ⟶ 60 %

LL ⟶ 14 %

as passing passing 60 % is big # 200 sieve so the soil is sand fine - grained either SM

silt or clay.

Now, A line ⇒

$$PI = 0.23(LL-20) = 0.23(19-20)$$
$$= -0.23$$

$$\boxed{PI = 19-14 = 5}$$

which is above the A. line so the soil is clay and Here, LL < 50% so, it has low plasticity index.

So, the soil is CL ⟹

2(b)

Major division

% finer than # 200 sieve is 8 %
so which is than (≤ 50 %) so it is Coarse-grained.

Now ⟶ % retained in #4 sieve = $\frac{10}{92} \times 100\%$.

$$= 10.86\%$$

which is len than 50 % so, it is sand.

Gradation :

$$C_u = \frac{D_{60}}{D_{10}} = \frac{2}{0.150} = 13.33$$

and $$C_2 = \frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{0.425^2}{2 \times 0.150} = 0.602$$

So, SP

percentage of fines :

% of fines is 8 % which is between 5 to 12 %. So; it requires dual classification.

Plasticity :

LL = 22

PL = 15

A line → PI = $0.73(LL - 20) = 0.73 \times 2 = 5.11$

observed value of PI is $(22 - 15) = 12$

which is above the A-line.

So, it is the finer soil is clay.

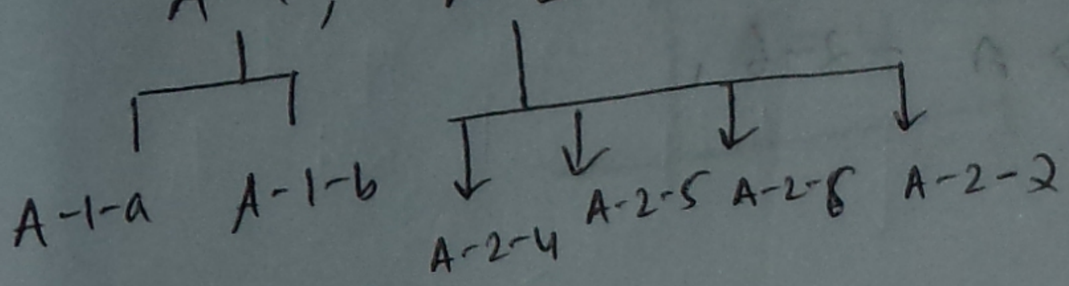
So, That is SC

whole classification will be SP-SC

R-2007-08

(b) So, it will be coarse-grained passing #200 sieve is 130 which is (≤50) so it may be G or sa Gravel or sand.

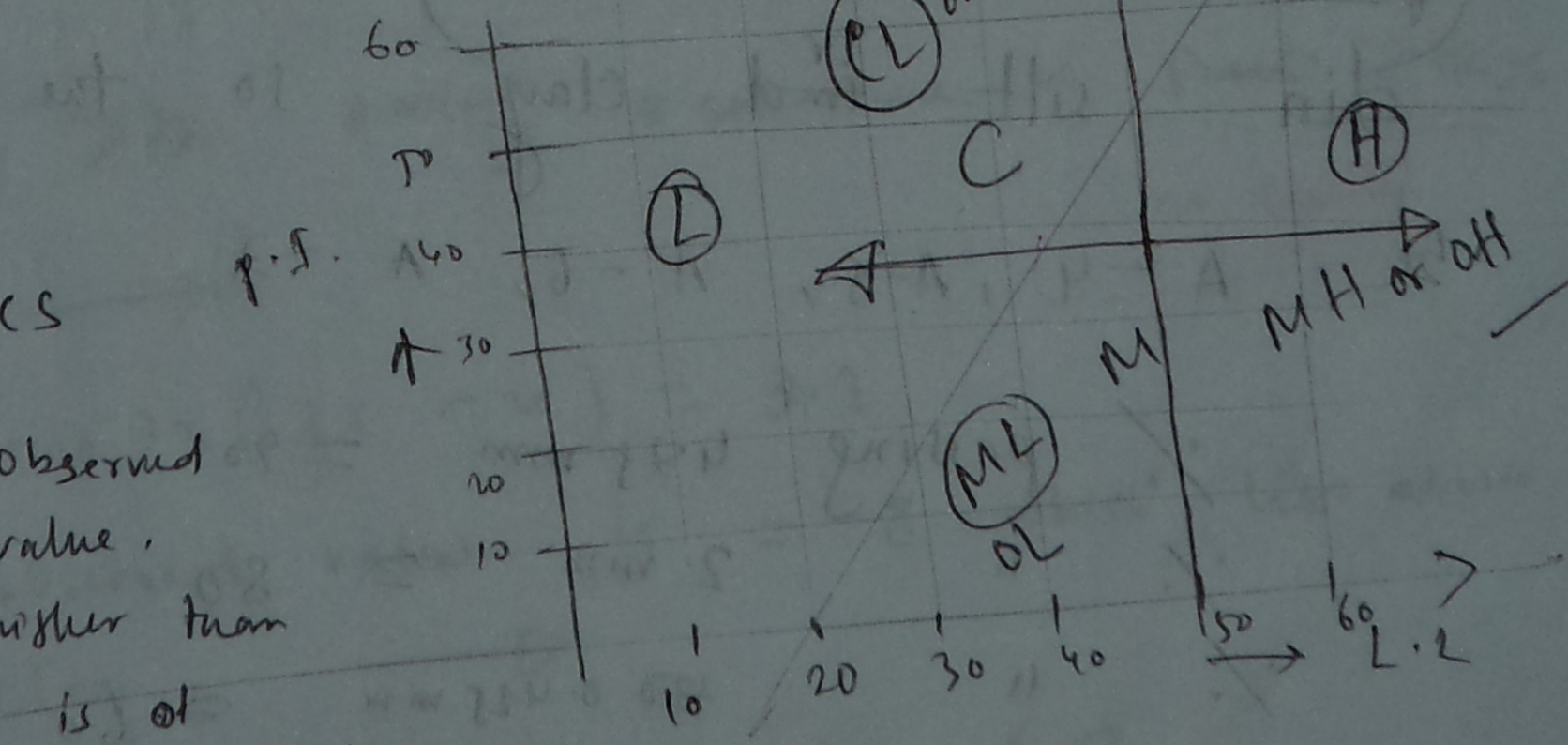
passing #200 sieve is 30 which is less than (≤35) so, it may be A-1, A-2 or A-3.



3(a) Same as 2008-09 2(b)

2006-07

3(a) In USCS



we compare the observed value with theoritical value. If observed value is higher than theoritical value then it is of clay type and if lower then silt. again if LL > 50% then higher plasticity index and if LL < 50% then lower " " for USCS

In AASHTO classification of soil

for A-2 (silty clay)

we compare, ~~PL > 0.2 (LL-30)~~ with

$$PI = LL - PL$$

with $(LL-30)$ so,

if $PI \leq (LL-30)$ then A-2-5

and $PI > (LL-30)$ → A-2-6.

Q-2018-03

4(c)

% passing #200 sieve is 40 which is (Z36)

~~(greater than 36%)~~ so, it is

~~in~~ silt ~~and~~ or clay so the soil may

be A-4, A-5, A-6, A-2

% passing 4.75 mm = 90 LL = 30

% " 2 mm = 80 PL = 22

% " ~~150~~ 0.425 mm = 60

% " 2w = 40

LL is 30 % which is (≤ 40 %)

so, it may be A-4 or A-6.

again PI = LL - PL = 30 - 22 = 8

which (≤ 10 %) so, the it may

be A-4 or A-5

∴ Now the whole clanification willbe

A-4 so, the soil is silty

Uses :

Coarsen type as paning #200 sieve is 40

$$\frac{10}{60} \times 100\% = 16.62\%$$

So, Sand S

as > paning #200 sieve is Sand > 12 %

no duality

So, ⟶

PI = 0.73 (LL - 20) = 2.3

and observed value is = 8 which lies above

so. clay ⟶

the possible soil type is SC

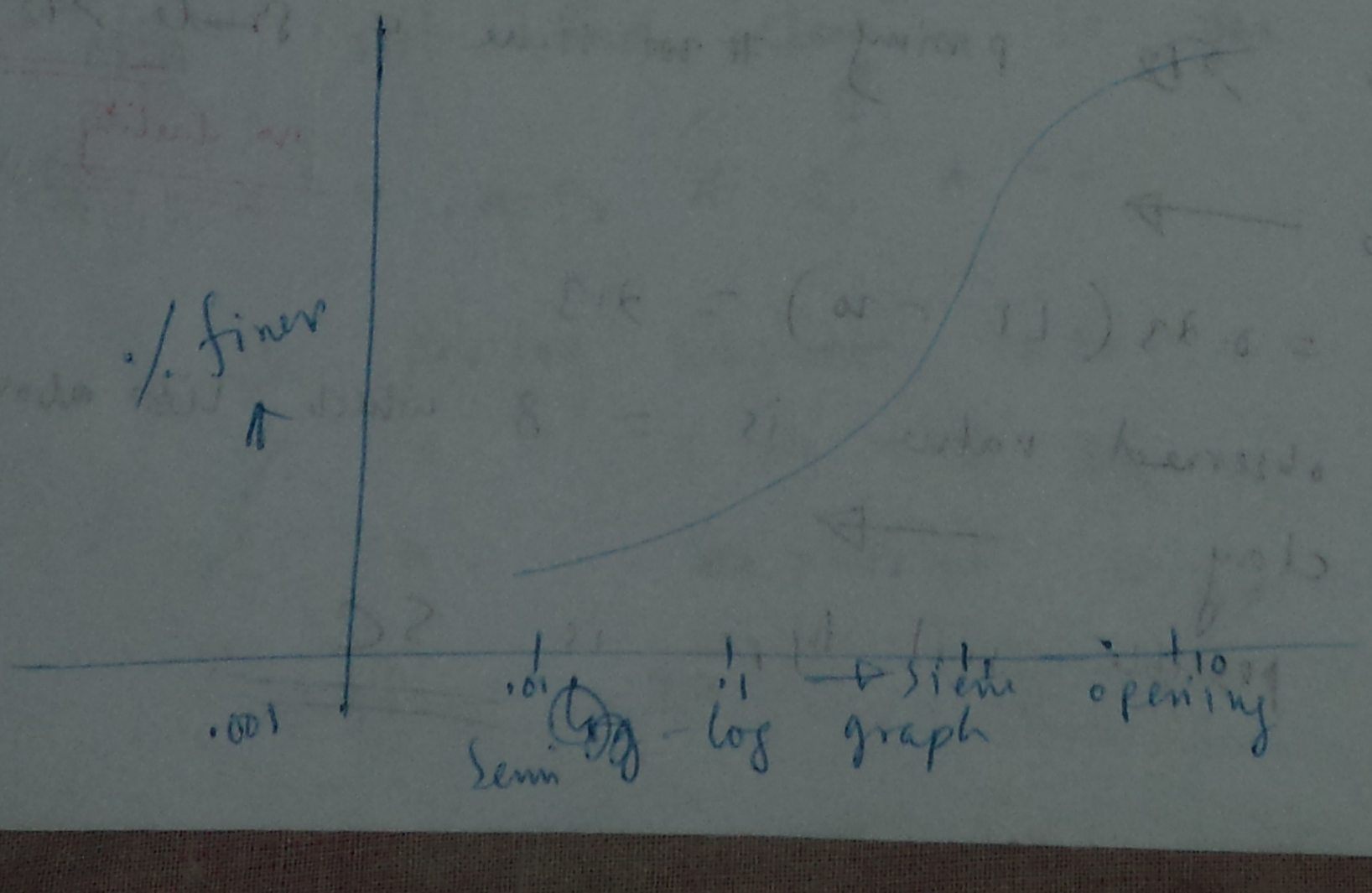
05-06

1 (c)

LL = 42 —— PI = 23
PL = 19

Major division :

S.O. (mm)	Mass of soil retained	% retained	Cumulative % retained	% finer
4.25	0	0	0	100
2.00	15	4	4	96
0.85	98	23	22	23
0.425	90	21	48	52
0.075	182	43	91	9
pan	36	9	100	0
	421 gm			



04-05

(5) (c)

USCS :

% of retained in #4 sieve $= \frac{5}{92} \times 100\ \% = 5.43$

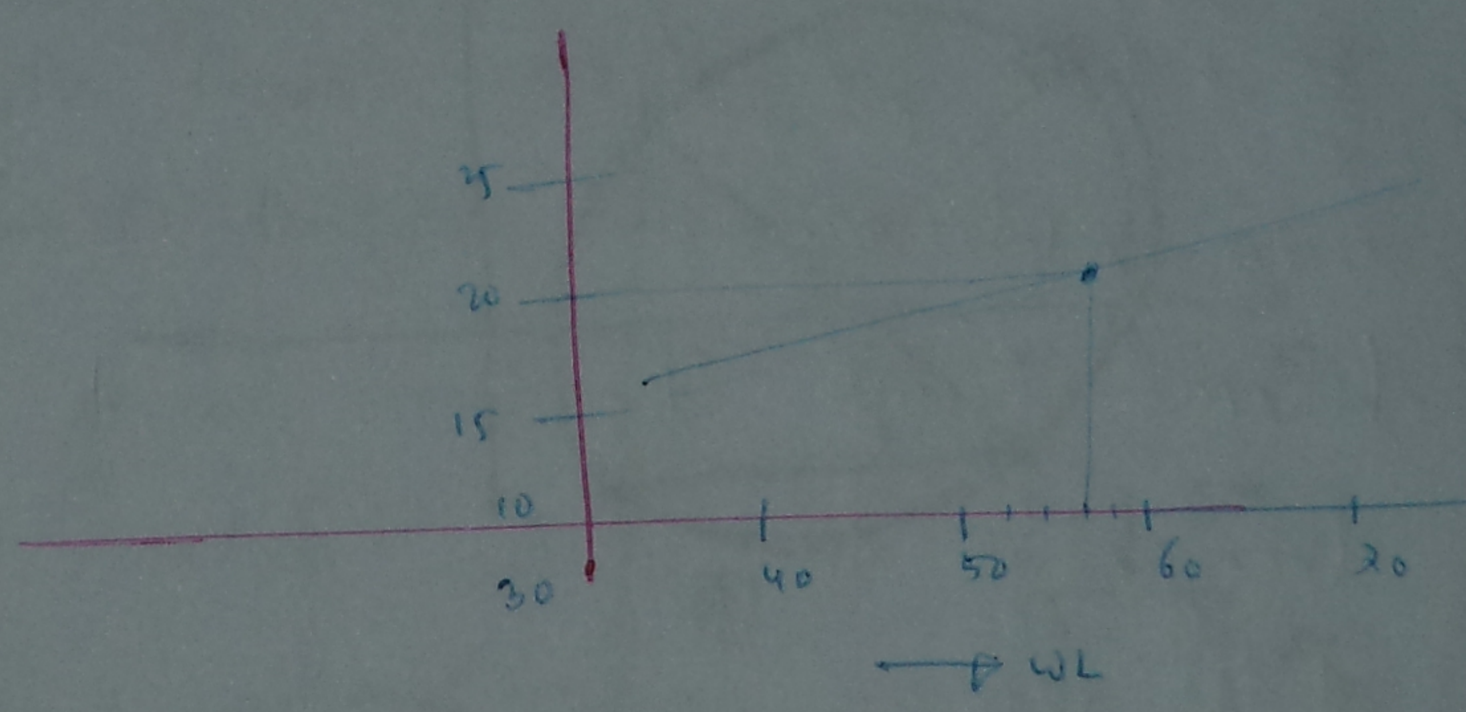
∴ So, sand

it will fall under dual classification

so that it may be SW-SC ;

SP-SC ; SW-SM ; SP SP-SM .

(6) (a)



$\frac{x-15.9}{15.9-12.9} = \frac{y-33}{}$

$\frac{x-52}{52-60} = \frac{y-19.1}{19.1-20.3}$

$\frac{x-52}{-8} = \frac{y-19.1}{-1.2}$

$1.2x - 62.4 = 8y - 152.8$

$1.2x - 8y = -90.4$

$x = \frac{8y-90.4}{1.2}$

$= \frac{8\times 20 - 90.4}{1.2} = 58$

LL = 58

PL = 25

Now same as previous

Shear strength

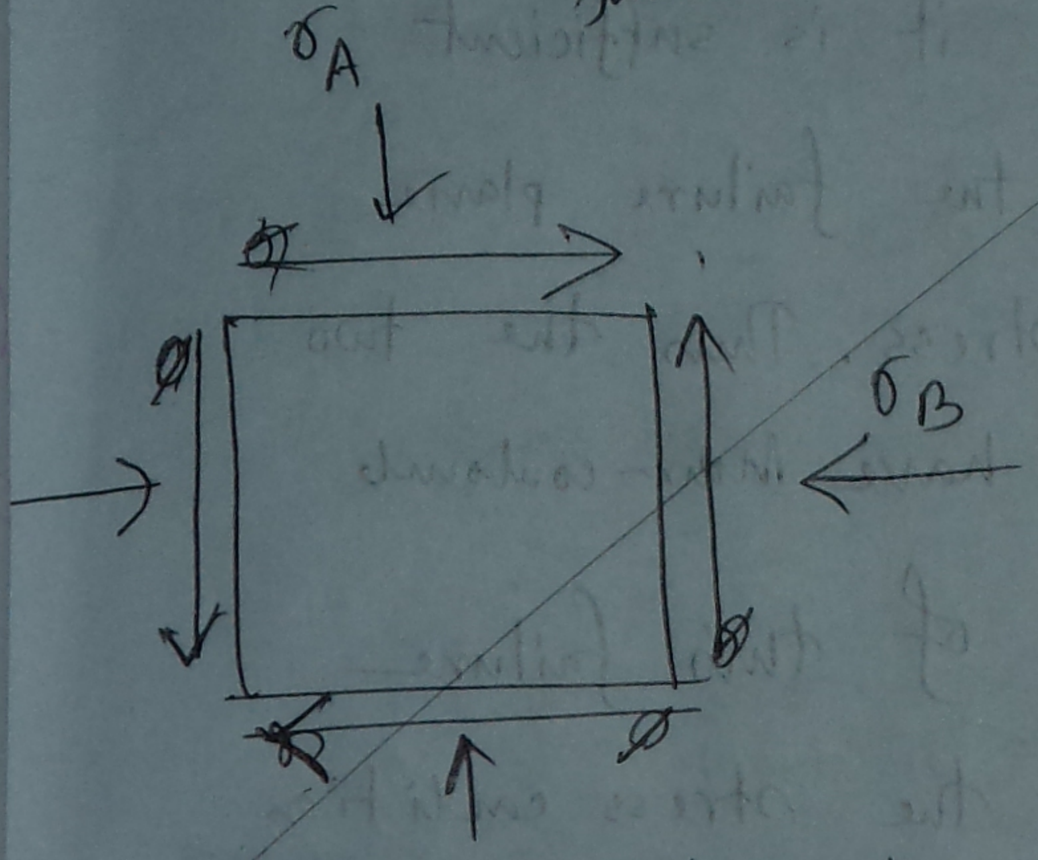
Mohr - coulomb theory:

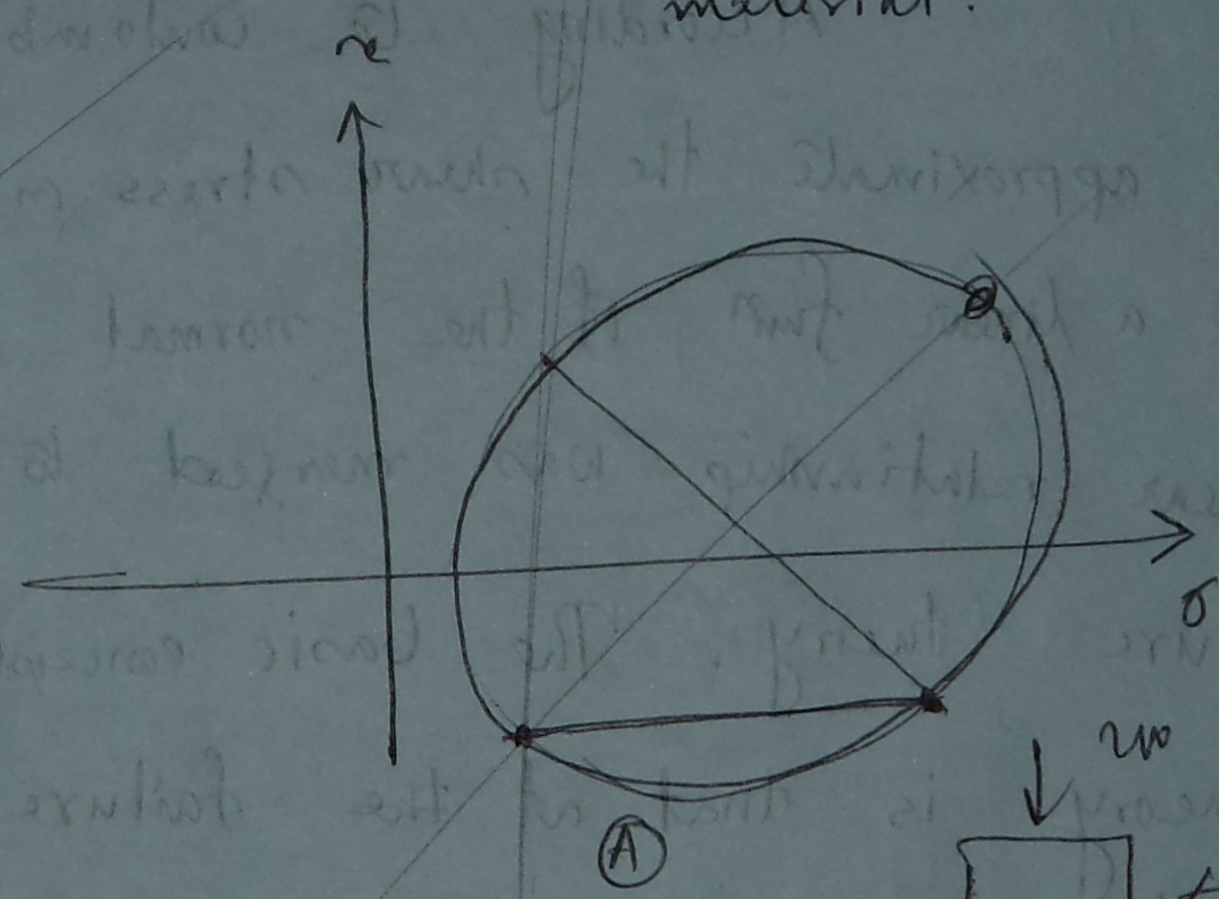
failure not occur by solely the max^m normal or max^m shear stress rather it occurs by a critical $\overset{\text{unique}}{\wedge}$ combinatim of normal and shear stress.

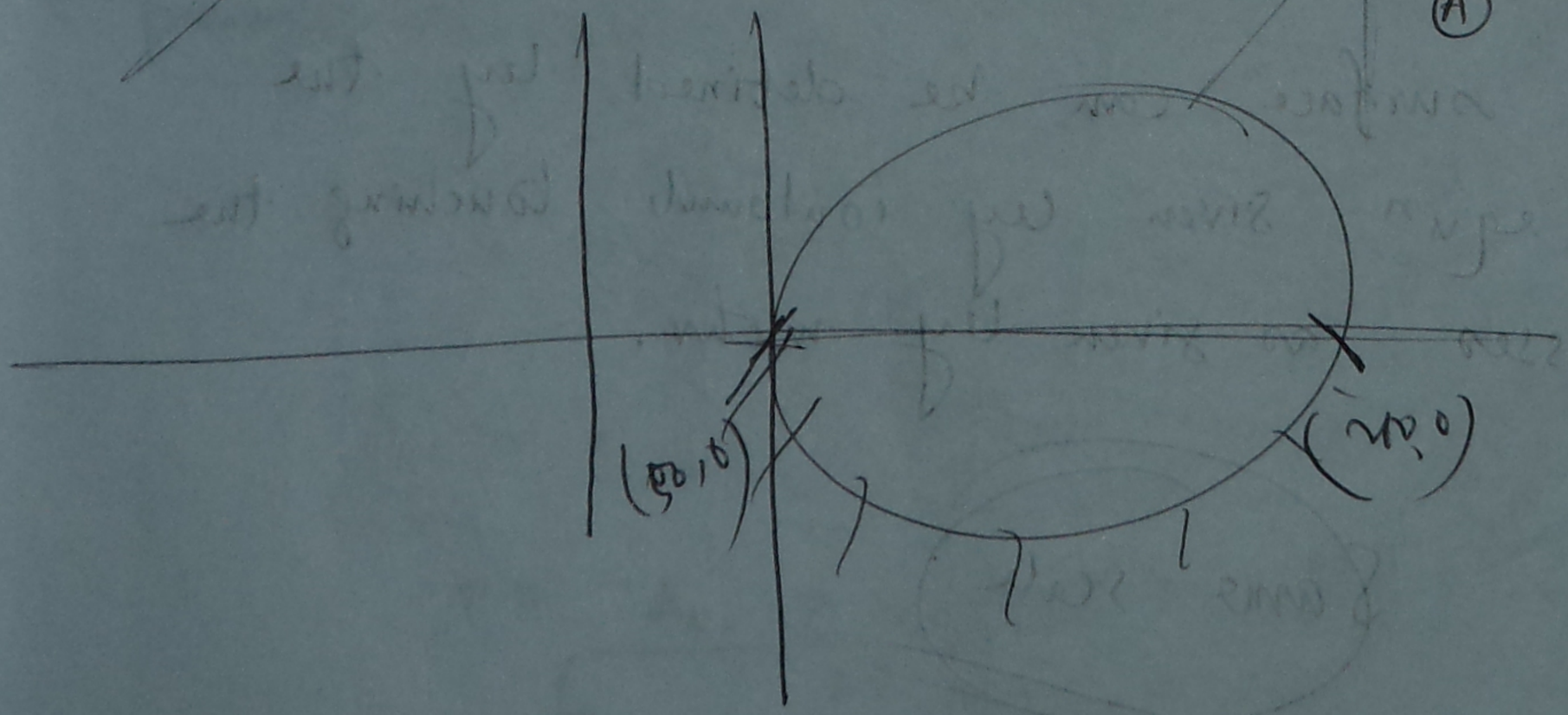
$$\boxed{\tau_f = f(\sigma_f)}$$

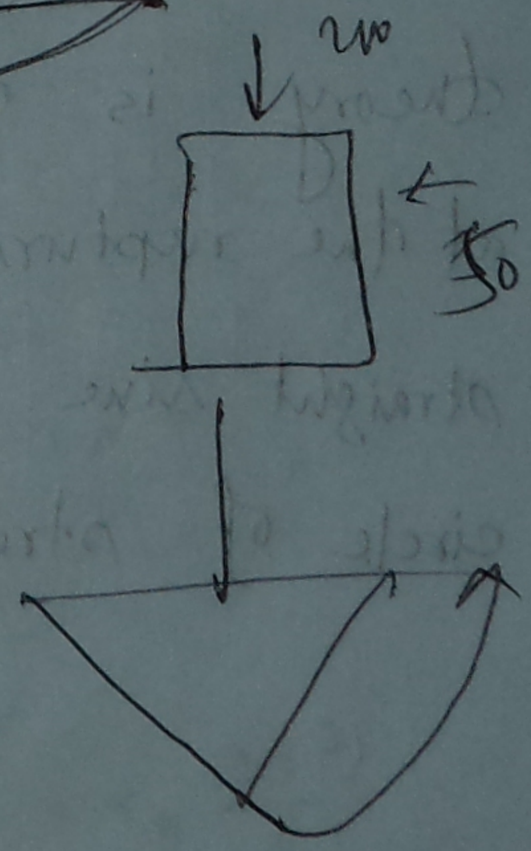
σ_f = stress at failure

τ_f = shear strength of the material.









Mohr failure hypothesis states that the point of tangency of the ~~mark~~ mohr failure envelop with the mohr circle at failure determines the inclination of the failure plane.

(*) **Define Mohr - coulomb failure theory :**

According to coulomb it is sufficient to approximate the shear stress on the failure plane as a linear fun of the normal stress. Thus the two linear relationship was merged to have Mohr-coulomb failure theory. The basic concept of this failure theory is that at ~~the~~ failure the stress condition at the rupture surface can be defined by the straight line equ^n given by coulomb touching the circle of stresses as given by mohr.

same scale

Direct shear Test :

Vane shear test :

suitable for soft clays. $h/d = 2:1$

The vane is pushed into the soil to a predetermined depth and rotated rapidly until shear takes place over the surface area approximately equal to that generated by the vane. The strength is ~~st~~ estimated from the max^m measured torque required to shear the cylindrical surface.

$$T = M_{side} + 2 \times M_{edge}$$

$$= \pi d h c_u \frac{d}{2} + 2 \times \pi c_u \frac{a d^3}{4}$$

the value of a is $2/3$ (normally uniform distribution)

$a = 1/2$ for triangular and $3/5$ for parabolic distribution.

$$= \pi c_u \left(\frac{d^2 h}{2} + \frac{a d^3}{4} \right)$$

$$= \pi c_u \left(\frac{2 d^3}{2} + 2/3 \; a d^3/4 \right)$$

$$T = \pi c_u \left(d^3 + \frac{d^3}{6} \right) = \pi c_u \frac{7 d^3}{6}$$

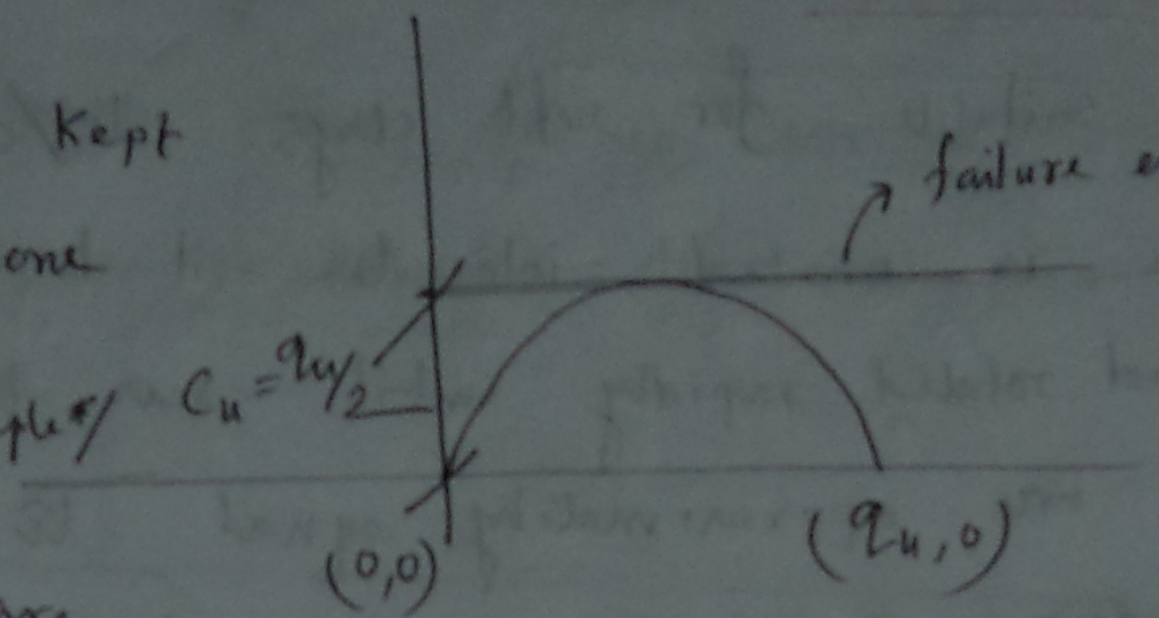
$$\boxed{c_u = \frac{6T}{7 \pi d^3}}$$

2008-09

1(a)

$$C_u = q_u/2$$

Cell pressure is kept zero/* If can be done on unsaturated soil sample/ $C_u = q_u/2$

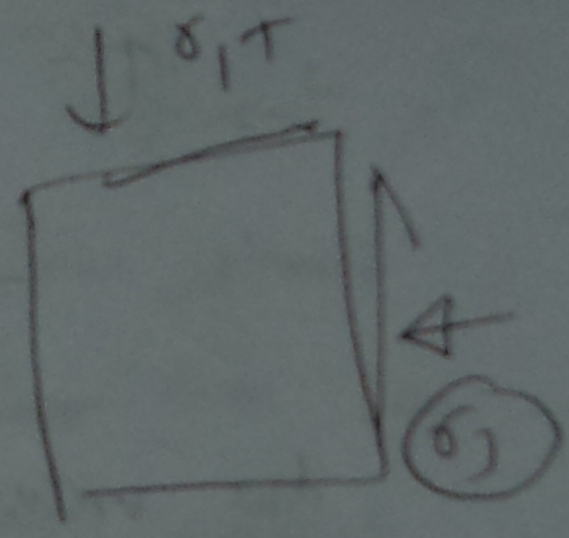


So, initial stress are (0,0) and max^m failure strength is q_u i.e. $(q_u, 0)$ → with the help of this two coordinate →

(e) $\sigma_3 = 100$ Kpa $= \tau_f$

$\Delta\sigma = 200$ Kpa

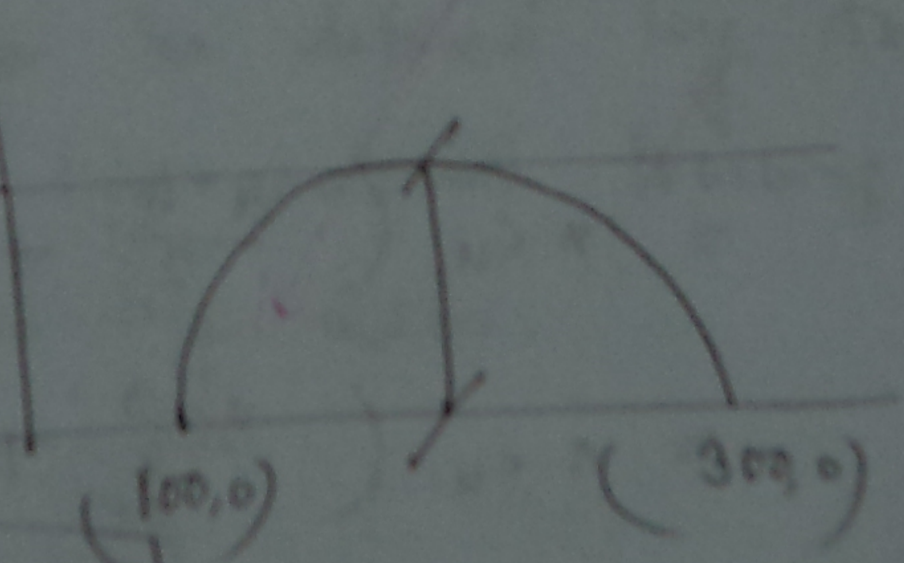
$\Delta\sigma_1 = \sigma_3 + \Delta\sigma = 300$ Kpa



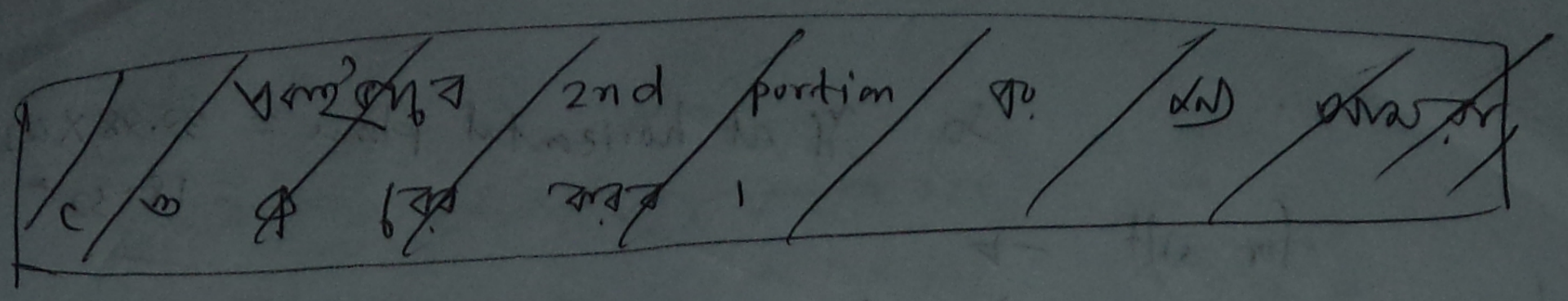
$C = ?$
$\phi = ?$ ($\phi = 0$ as for clay)

$\tau_f = C$

$C = 100$



$C = \frac{300 - 100}{2} = 100$ KN/m²



2nd portion ক্ষেত্রে A :

$\Delta\sigma_3 = 430\ KN/m^2$

$\Delta\sigma_1 = (430+310)\ KN/m^2$

$= 740\ KN/m^2$

$\Delta u_d = 220\ KN/m^2$

$\Delta u_c = 430$

$220 + 430 = 34\ 430 + A(240-430)$

$\therefore$ $\boxed{A = 0.82}$

$\boxed{A = \dfrac{\Delta u_d}{(\Delta\sigma_1 - \Delta\sigma_3)}}$

4(b)

$\gamma = 19.8\ KN/m^3$

$\phi = 32^\circ$

$\sigma = 4.5 \times 19.8 = \sigma_1$

$= 89.1\ KN/m^2$

$\tau_f = ?$

$\boxed{c = 0}$

$\theta = 45^\circ + \left(\frac{32}{2}\right)^\circ = 61^\circ$

$\boxed{\tau_f = c + \sigma' \tan\phi = 89.1 \tan 32^\circ = 55.68\ KN/m^2}$

Here, $\sigma_3 = 0$ $\therefore$ $\tau_f = \frac{\sigma_1}{2}\sin 2\theta$

$= 37.38\ KPa$

2007-08

(a)

~~$u' = 150 + 100 = 250$ Kpa~~

$\sigma = 350$ Kpa

$\sigma' = \sigma - u'$

~~$\sigma' = 1000$ Kpa~~.

Here, $u' = u = 150$

$\therefore \quad \sigma' = \sigma - u = 350 - 150$

$= 200$ Kpa

As water content will not change.

(g)

(i) $\sigma = \frac{0.36}{36 \times 10^{-4}} = 100$ Kpa

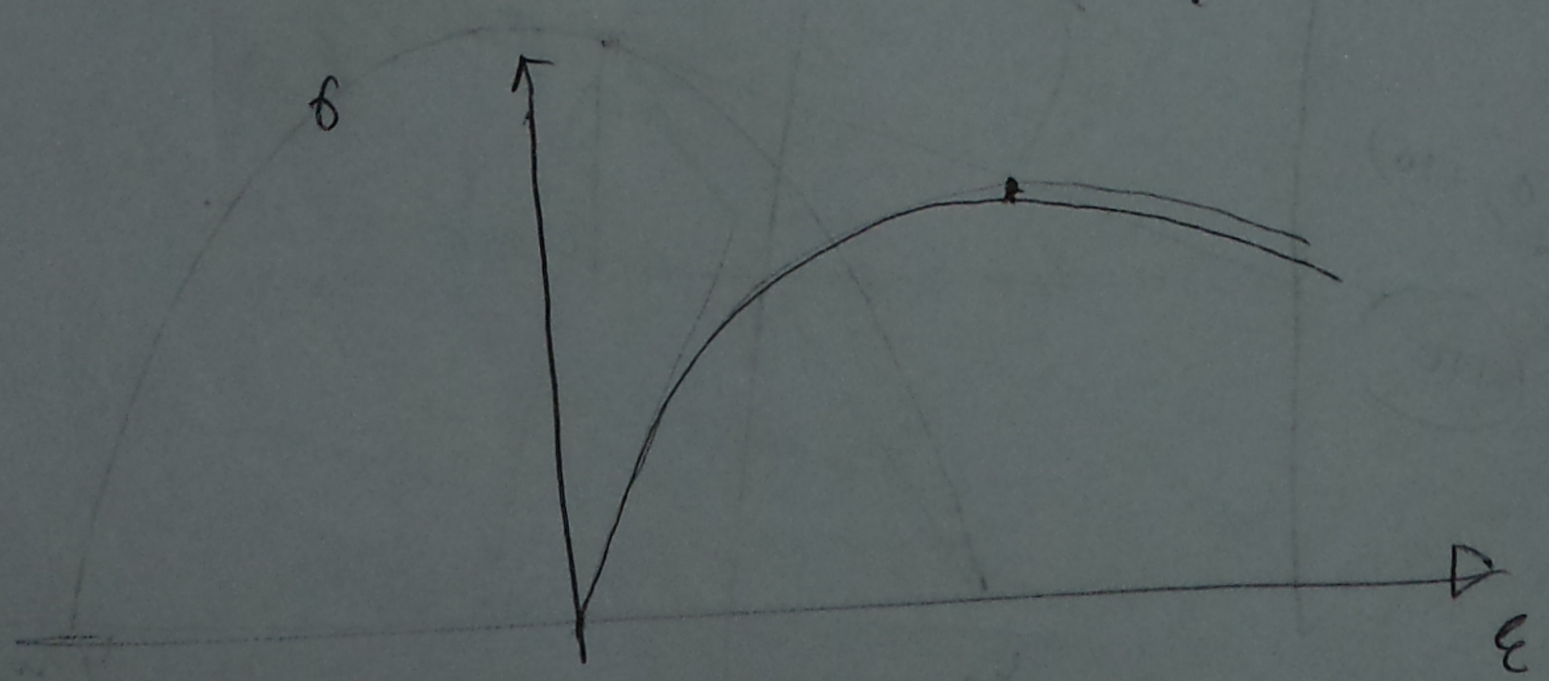
$\tau_f = \frac{0.18}{36 \times 10^{-4}} = $ ~~200~~ 50 Kpa

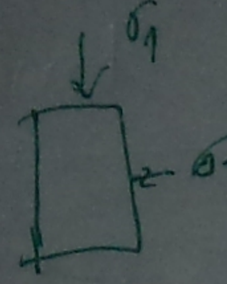
$C = 0$

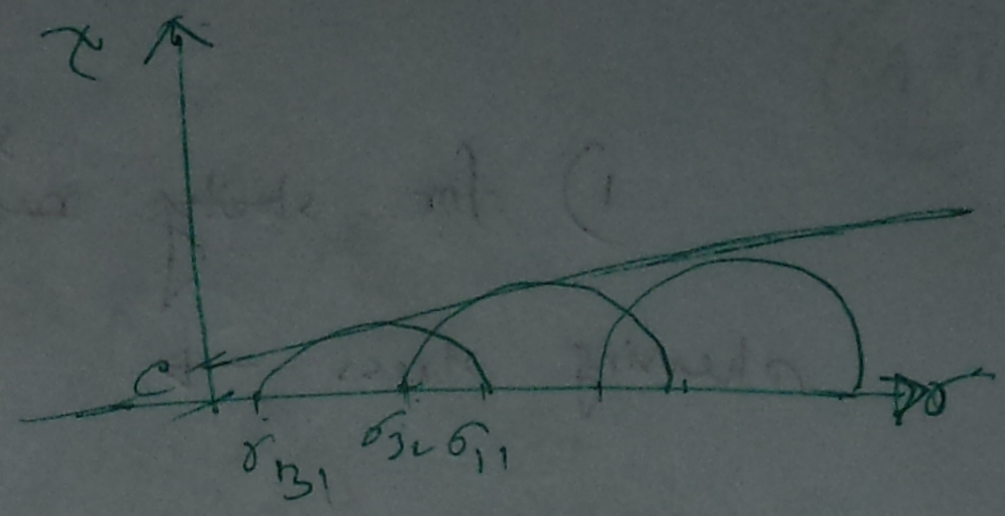
$\phi = \tan^{-1}\left(\tau_f / \sigma\right) = \tan^{-1}\left(1/2\right)$

$= 26.56°$.

(ii)

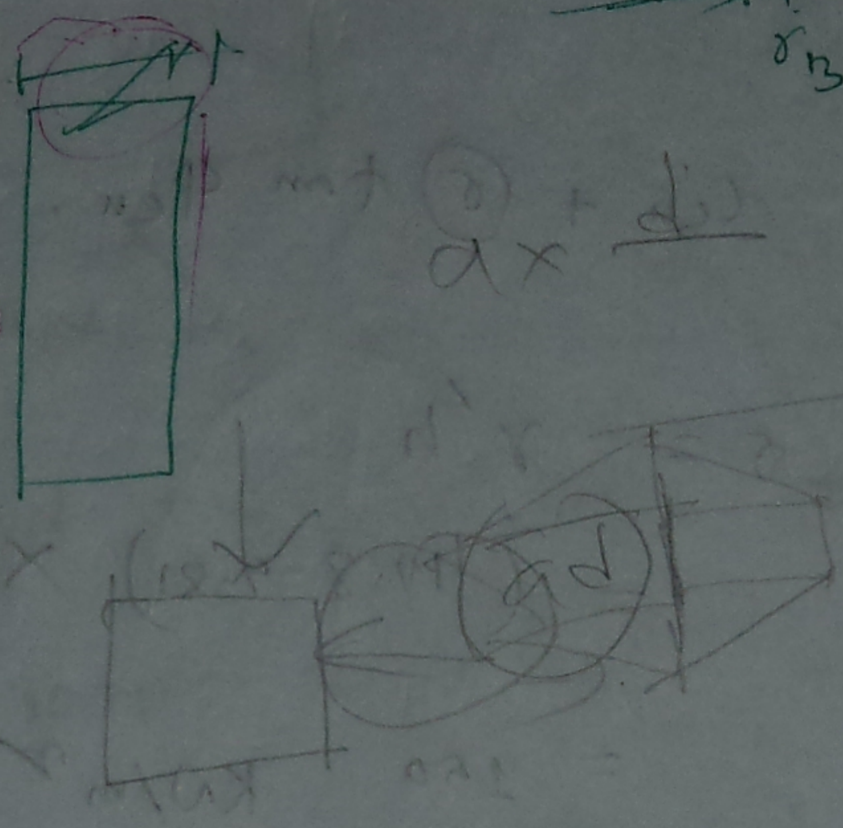




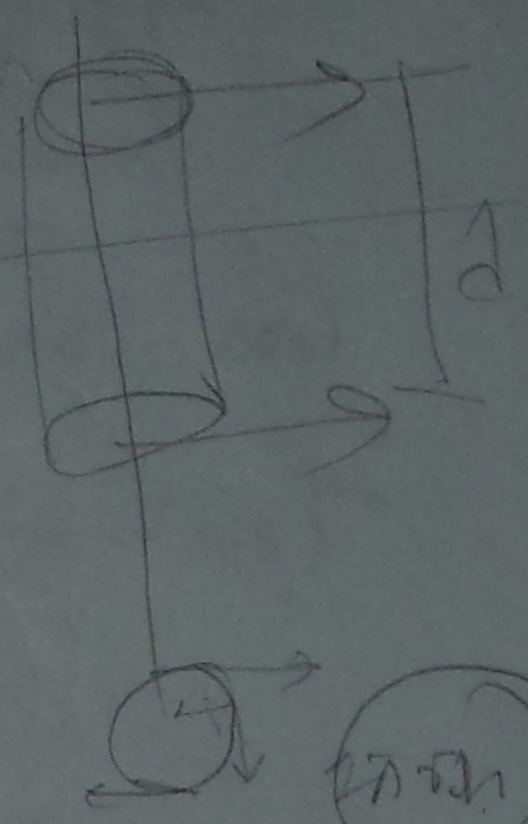


T_2 Medge + Mside

$= \frac{\pi d^2}{4} \times \frac{2}{3} \times c_u$



$a \times \frac{d}{2}$



2009 -10

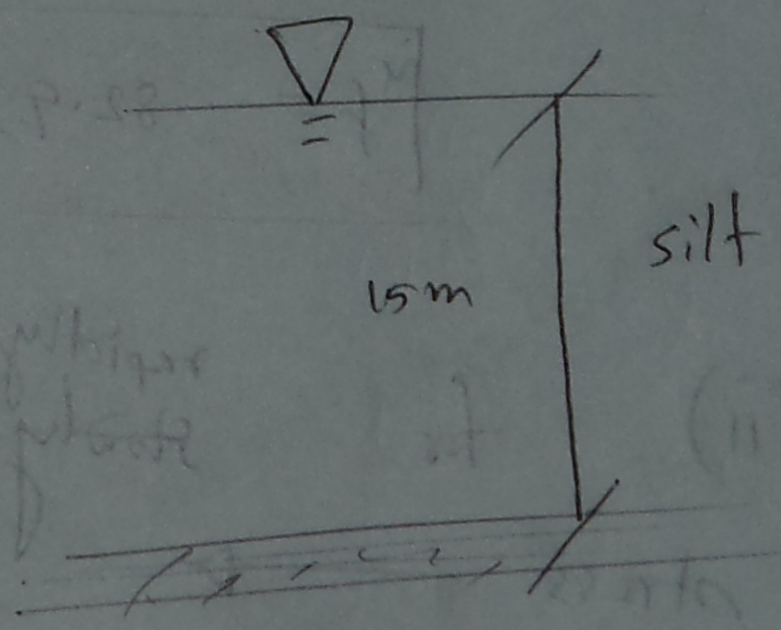
4(a)

$\gamma_{sat} = 19.8$ KN/m²

$= 48.3$ KN/m²

$\begin{cases} c_{cu} = 13^\circ \\ \phi_{cu} = 41.4 \text{ KN/m}^2 \\ c_d = 23^\circ \end{cases}$

ϕ_d



i) for slowly / rapidly building up shearing stress →

□

$$\tau_f = c_{cu} + \sigma \tan \phi_{cu}.$$

$$\sigma = \gamma' h$$

$$= (19.8 - 9.81) \times 15$$

$$= 150 \quad KN/m^2$$

$$\tau_f = 48.3 + 150 \tan 13°$$

$$\boxed{\tau_f = 82.93 \quad KN/m^2}$$

ii) for slowly / rapidly building up shearing stress →

$$\tau_f = c_d + \sigma \tan \phi_d$$

$$= 41.4 + 150 \tan 21°$$

$$= ~~48.98~~ \quad 105.02 \quad KN/m^2$$

2008-09

3(a)

$\Delta u_{ic} = \Delta\sigma_3 =$

u_d

$\Delta u_d = 110$ Kpa

$B = \dfrac{\Delta u_c}{\Delta\sigma_3}$

$\Delta u_c = \Delta\sigma_3$

$= 125$ Kpa

$\Delta\sigma_1$

$\Delta u = \Delta u_d + \Delta u_c = \Delta u_3 + A(\Delta\sigma_1 - \Delta\sigma_3)$

or $110 + 125 = + A(170 - 125)$

3(a)

$\Delta\sigma_3 = 120$ Kpa

$\Delta\sigma_1 = \Delta\sigma_3 + 125$

$= 120 + 125 = 295$ Kpa.

$\Delta u_c = 120$ Kpa

$= 110$ Kpa

Δu_d

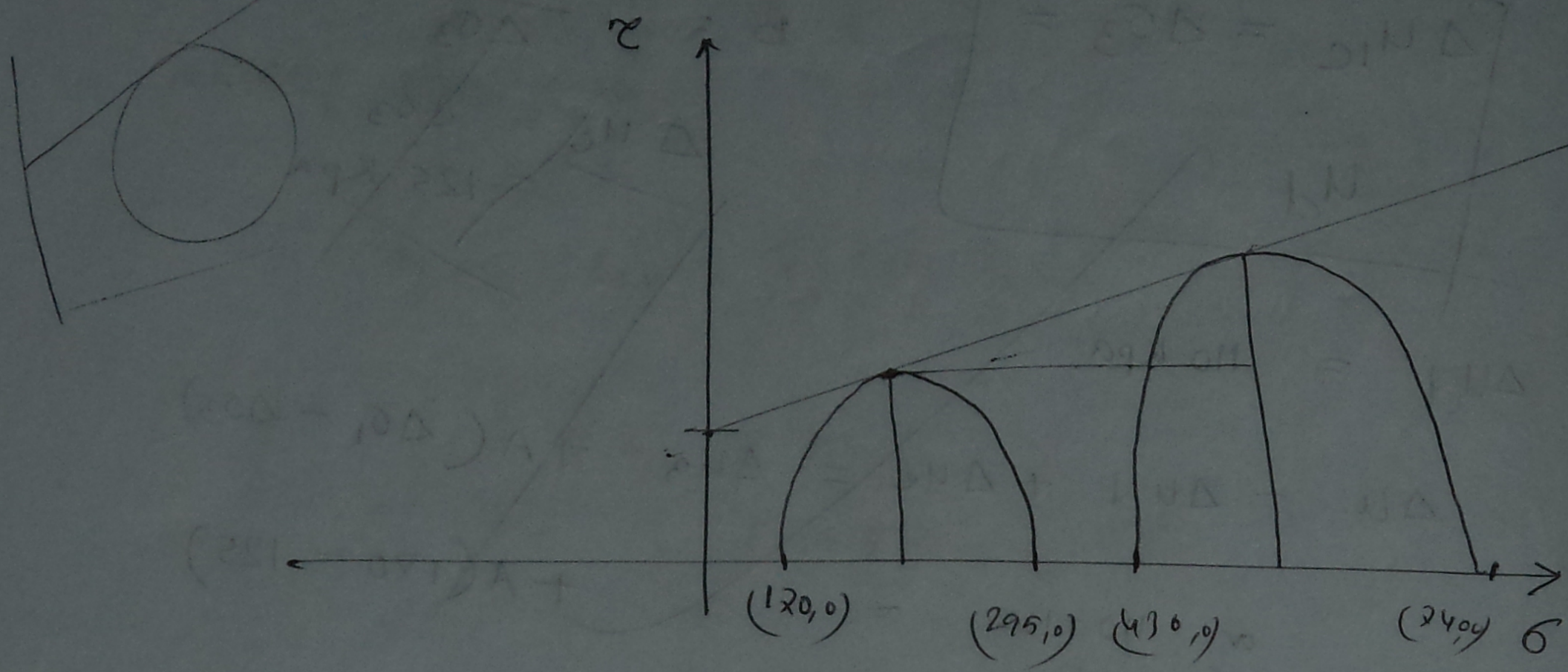
$\Delta u = \Delta u_c + \Delta u_d = 120 + 110 = \Delta\sigma_3 + A(295 - 120)$

$\Delta u = \Delta u_c + \Delta u_d = \dfrac{120}{280} + A\,125$

or, $280 = 120 + A\,125$

or, $\dfrac{280 - 120}{125} = A$

or, $A = 1.24$ 0.88



$$\tan\phi = \frac{\frac{310}{2} - \frac{125}{2}}{(430+155) - (120+\frac{125}{2})}$$

$$= \frac{92.5}{352.5}$$

$$\boxed{\phi = 14.2^\circ}$$

Now,

$$62.5 = C + 232.5 \tan 14.2$$

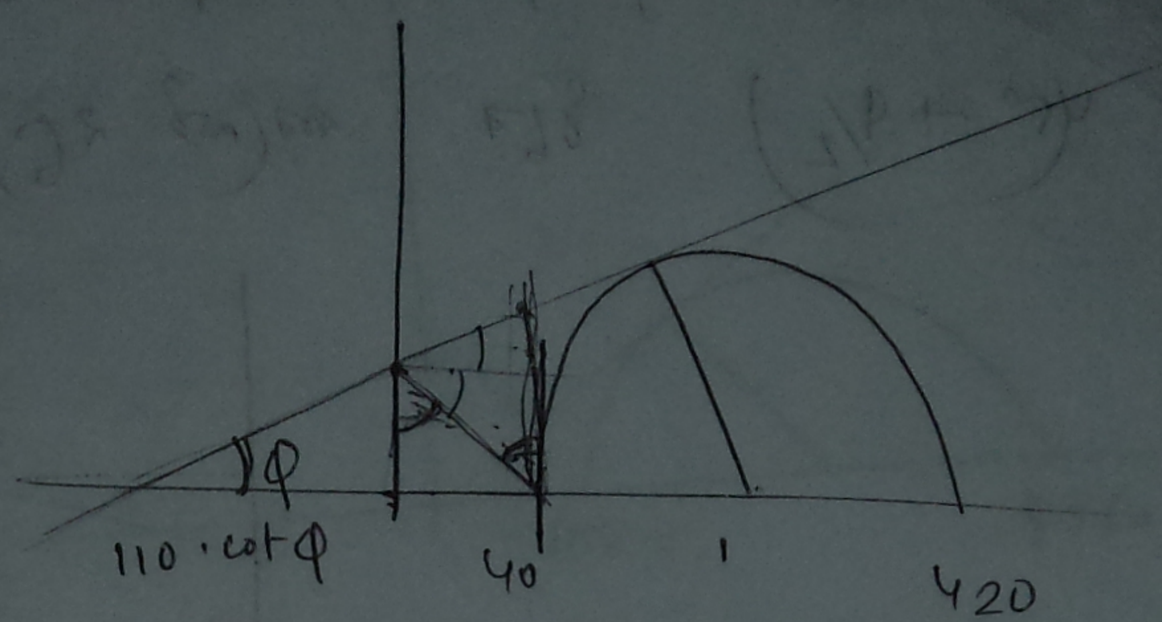
$$\boxed{C = 1.50 \quad KN/m^2}$$

$q_u = 220$

$C_u = 110$

$\sigma_1 = 220 + 40 + 160$

$= 420$



$$\boxed{\sigma_1 = \sigma_3 \tan^2(45° + \phi/2) + 2c \tan(45° + \phi/2)}$$

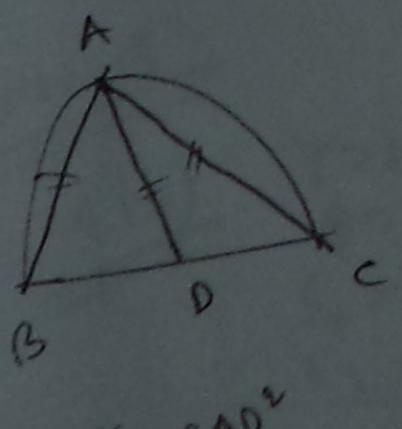
$$\frac{190}{110 \cot\phi + 230} = \sin\phi$$

$$19 = 11 \cot\phi \cdot \sin\phi + 23 \sin\phi$$

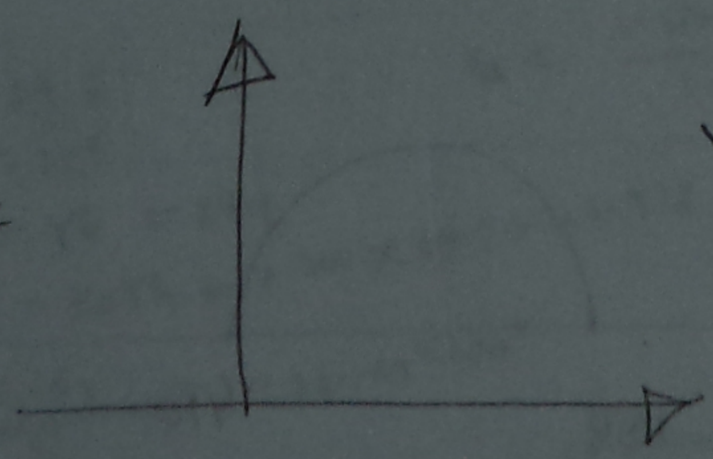
$$\boxed{19 = 11 \cos\phi + 23 \sin\phi}$$

$$19^2 = 11^2 \cos^2\phi + 23^2 \sin^2\phi + 2 \times 11 \times 23 \cos\phi \sin\phi$$

$$\boxed{19 = 11 \sin(90° - \phi) + 23 \sin\phi}$$



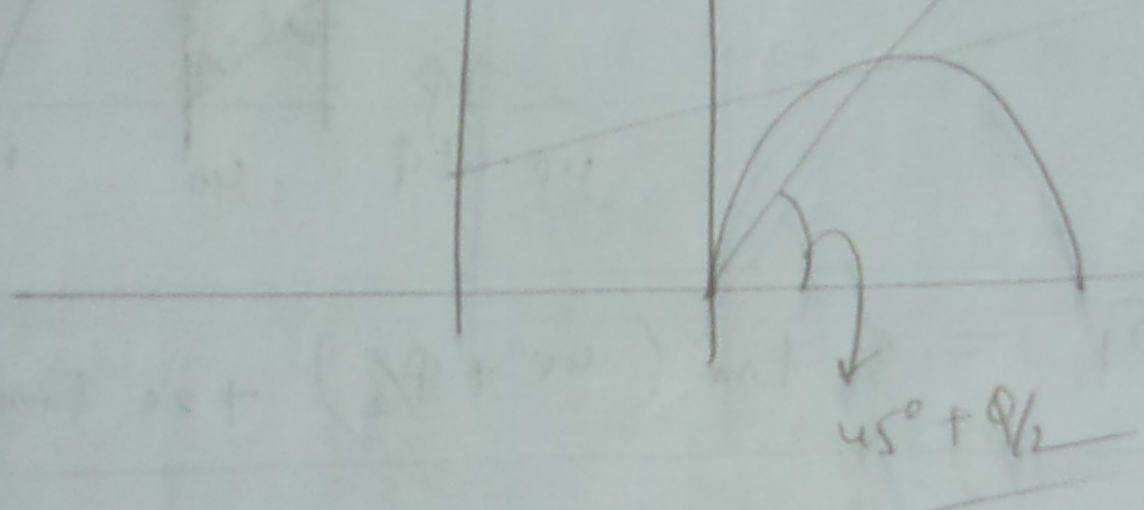
$+AC^2 = 2AD^2$



graph

angle of failure plane means simply

$45° + \phi/2$



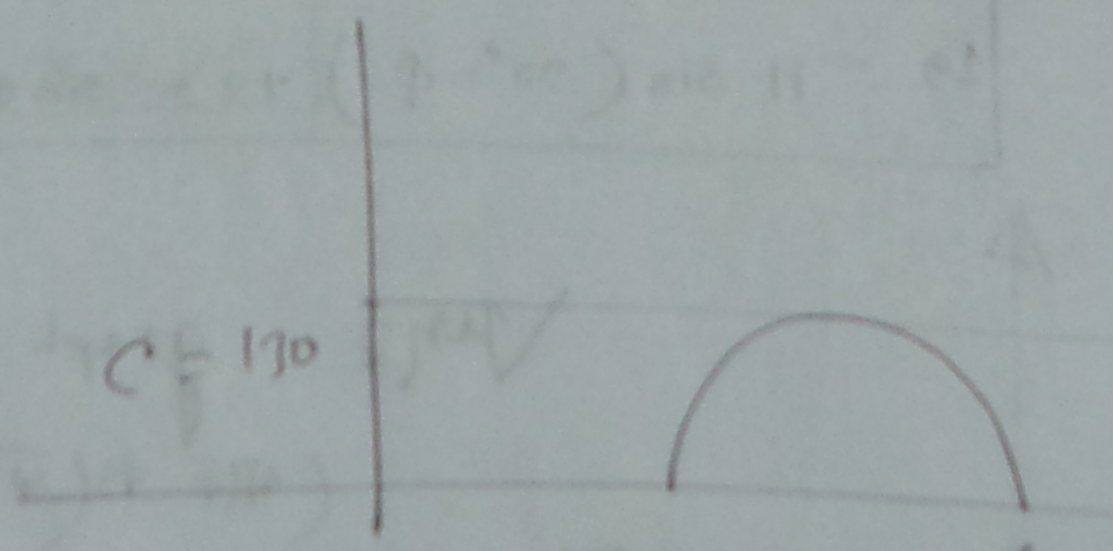
9(b)

$\Delta\sigma_3 = 150$ kpa ; $\Delta\sigma = 260$

$\sigma_1 = (150 + 260) = 410$ kpa

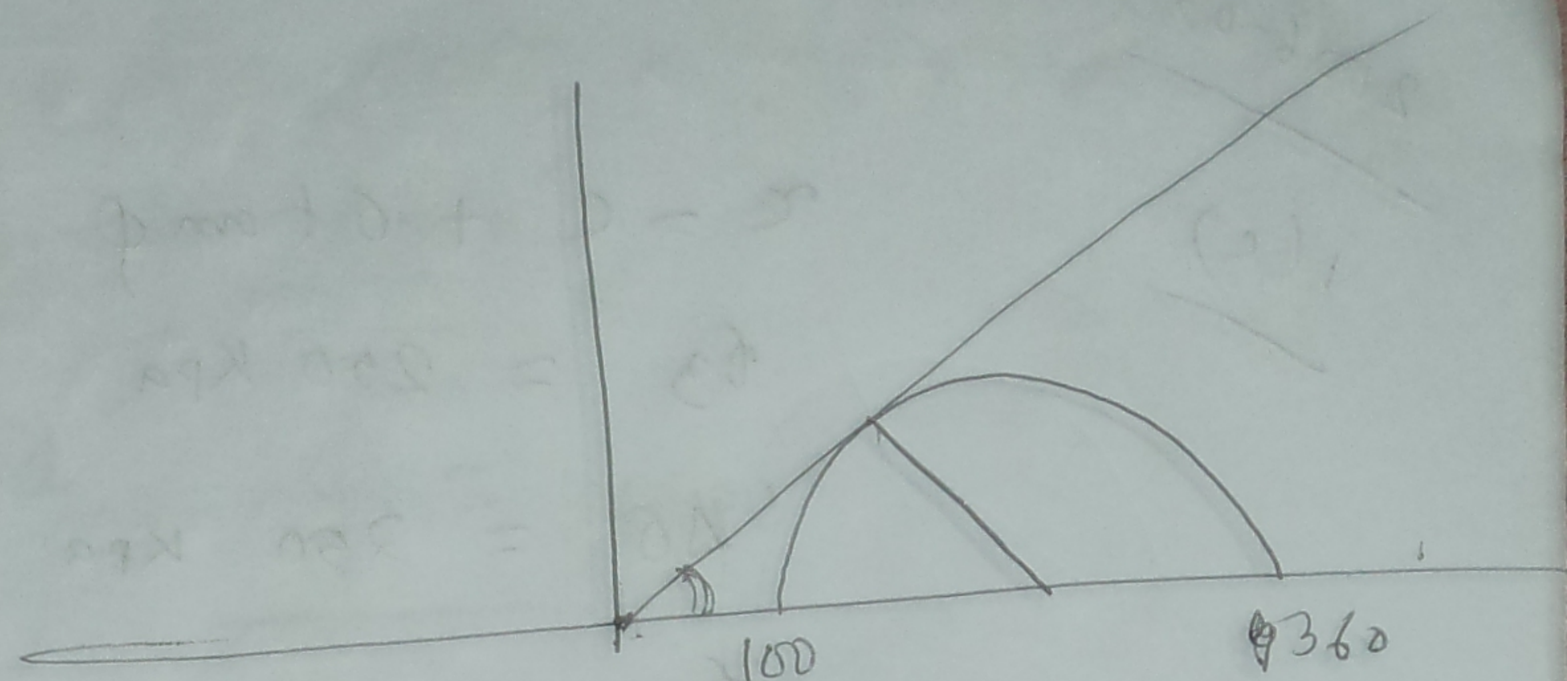
$u_d = 50$ kpa

i) $\phi_u = 0$



$\therefore \boxed{C = 130 \text{ kpa}}$

(11) $c' = 0$



Cont

$$\sigma = \sigma' + u$$

$$410 = \sigma' + 50$$

$$\boxed{\sigma' = 360 \text{ Kpa}}$$

$$\sigma_3' = \sigma_3 - u$$

$$= 150 - 50$$

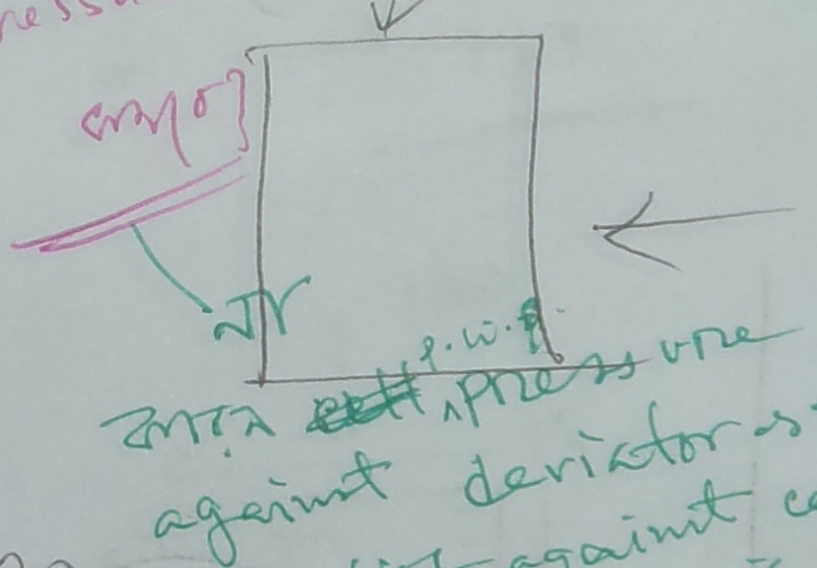
$$= 100$$

Cell pressure ⟶

confusion

cell pressure (a error)

$$\sigma_3 = (\sigma_3') + (u)$$



ආරම්භ ~~cell~~ pressure against deviator stress ~~වලින්~~ develops

Not against cell pressure since it is ~~use~~ consolidation Mohib

$$\sin\phi' = \frac{130}{230}$$

$$\boxed{\phi' = 34.42^\circ}$$

2002-08

4(b) $\gamma = 19.8$

$\phi = 32^\circ$

$\sigma_1 = \gamma h = 89.1$

$\sigma_3 = K_a \gamma h = 0.302 \times 89.1 = 27.326$

$\theta = 45^\circ + \phi/2$

$= 61^\circ$

$\tau_f = \frac{\sigma_1 - \sigma_3}{2} \sin 2\theta = 26.123 \text{ kN/m}^2$

on Horizontal plane, $\tau_f \cos\theta = 12.68 \text{ kN/m}^2$

again ⟶ $\sigma_1 = 89.1 + 65 = 154.1$ Kpa

$\sigma_3 = 27.326$

$\tau_f = 26.123 + 50$

$\boxed{\tau_f = 26.123}$

$\therefore \sigma' = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2} \cos 2\theta = 52.16$

$\therefore \frac{26.123}{52.16} = \tan\phi$

$\boxed{\phi = 53.11^\circ}$

2006-07

1(c)

$\tau = c + \sigma \tan\phi$

$\sigma_3 = 250$ Kpa

$\Delta\sigma = 250$ Kpa

$\sigma_1 = 1000$ Kpa

Another method :

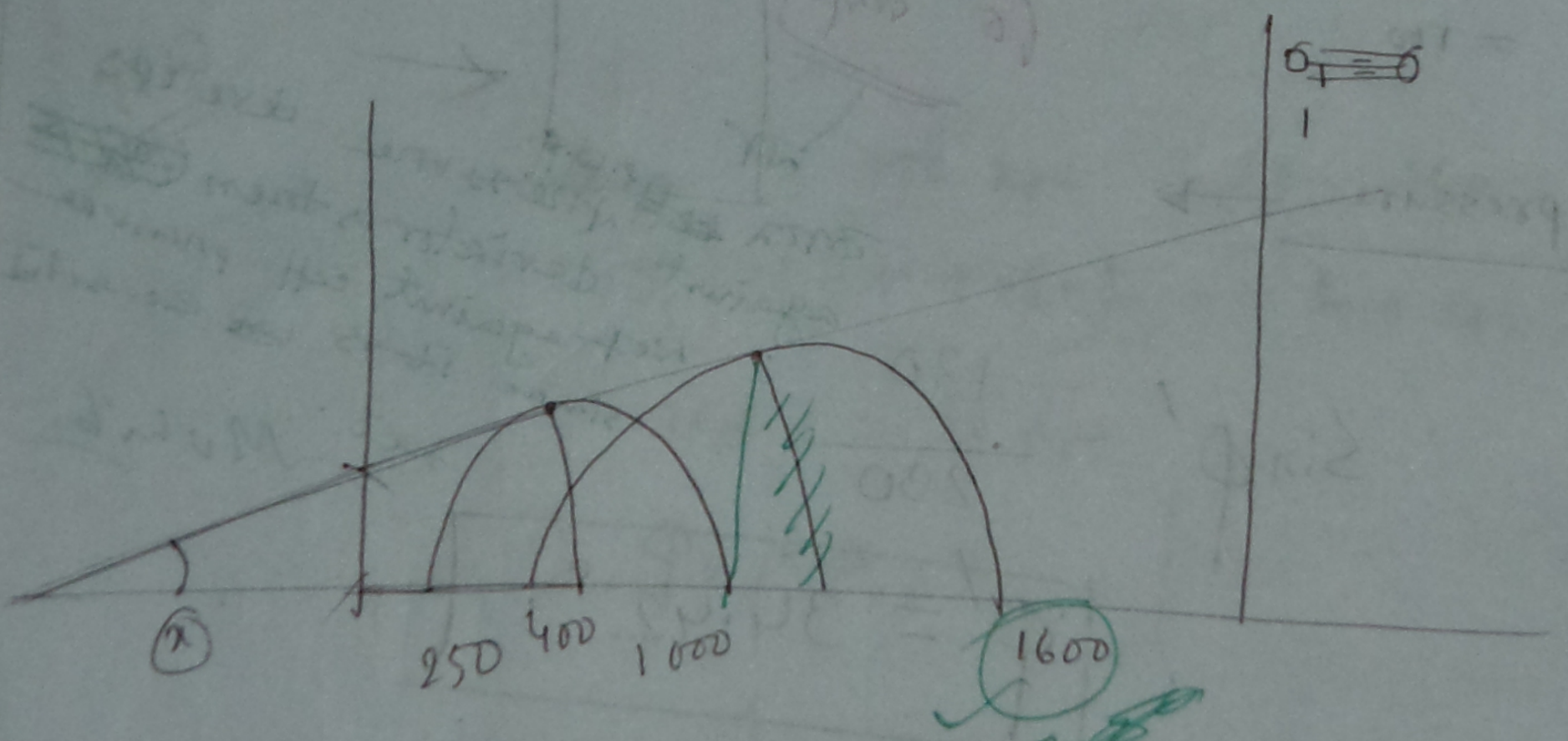
$1000 = 250 \tan^2(45° + \phi/2) + 2c \tan(45° + \phi/2)$

$1600 = 400 \tan^2(45° + \phi/2) + 2c \tan(45° + \phi/2)$

$\phi = 36.87°$ and $c = 0$

Another case →

$\sigma_3 = 400$ Kpa ; $\sigma_1 = 1600$ Kpa



$\sin\phi = \frac{325}{x + 625}$; $\sin\phi = \frac{600}{x + 1000}$

$\sin\phi \cdot x + 625 \sin\phi = 325$

$\frac{325}{x + 625} = \frac{600}{x + 1000}$

$225x = 0$

$x = 0$

(b)

$x =$

σ

$\sigma = \sigma$

σ

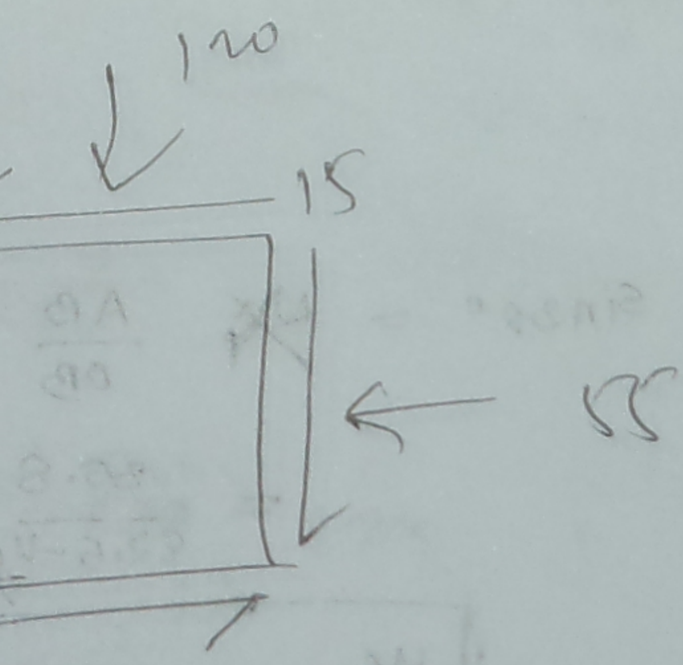
So, $C = 0$

By formula $C = 0$

and $\phi = 36.82°$

But if we ~~draw~~ found the ϕ value from graph then ⟶

$C = 0$ and $\phi = 36.82°$



2(b)

$C' = 0$

$\phi' = 32°$

$\Delta u = ?$

$\tau = \sigma' \tan\phi'$

$15 = \sigma' \tan 32°$

$\sigma' = 24$

$\sigma = \sigma' + u$

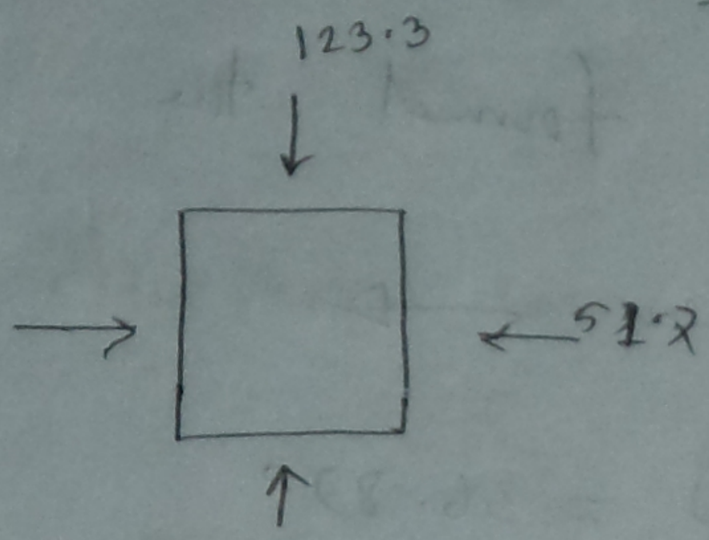
$\sigma u = 96$

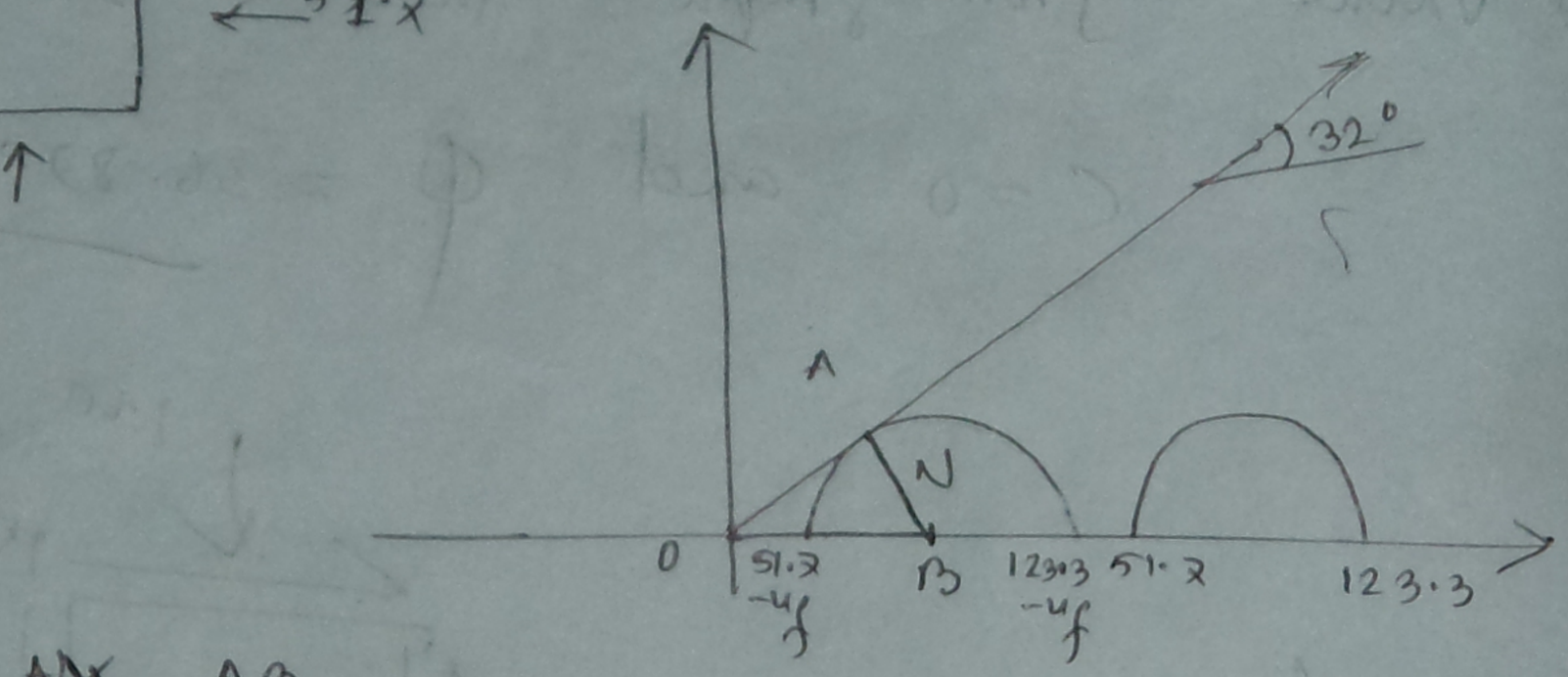
principal stresses ~~σ_1 or σ_3~~ are $\rightarrow \left(\frac{\sigma_1 + \sigma_3}{2}\right) \pm \sqrt{\left(\frac{\sigma_1 + - \sigma_3}{2}\right)^2 + (\tau_{xy})^2}$

$$= \frac{120 + 55}{2} \pm \sqrt{\frac{(120-55)^2}{1} + 15^2}$$ (b)

$$= 82.5 \pm 35.29$$

$$= 123.3 \text{ , } 51.2 \text{ Kpa.}$$

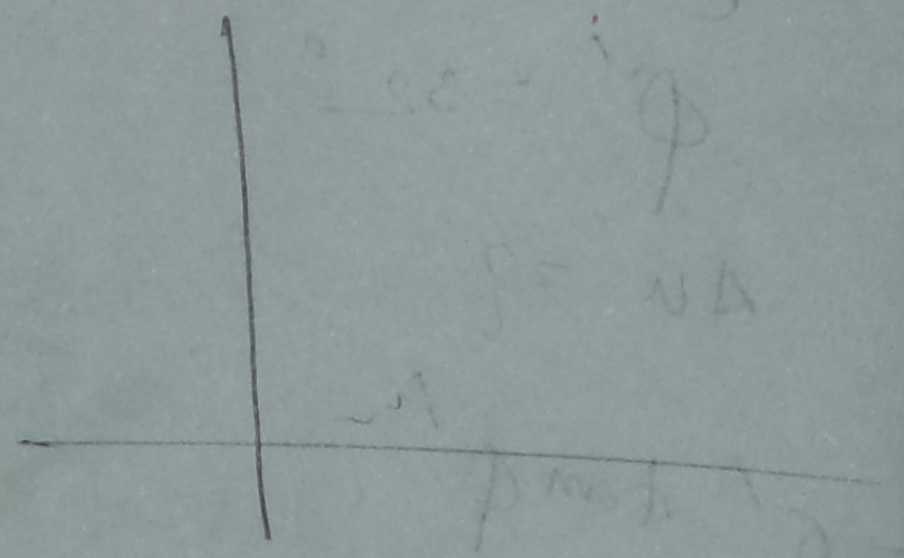




$\sin 32^\circ = \frac{AB}{OB}$

$= \frac{35.8}{82.5 - u_f}$

$\therefore \boxed{u_f = 19.94 \text{ Kpa}}$



$$B = \frac{\Delta u_c}{\Delta \sigma_3} \qquad \frac{80 - 55}{} = 25$$

3(b)

	cell pressure	Back pressure	Pore pressure
①	0	0	-4
②	50	0	2
③	50	40	39
④	100	~~90~~	62
⑤	100	90	89
⑥	150	~~140~~	126
⑦	150	140	137
⑧	200	~~190~~	182
⑨	200	190	190
⑩	300	~~290~~	285
⑪	300	290	290
⑫	400	~~390~~	388

① $B = 0$

② $B = \frac{39 - 40/2}{50 - 40/2} = \frac{39 - 20}{50}$

② $B = \frac{2-(-4)}{50} = 11/50 = 0.22$

③ $B = \frac{39 - 40/2}{50 - 40/2} = 0.633$

④ $B = \frac{62-39}{100-50} = 0.46$

⑤ $B = \frac{(89 - 50/2) - (62 - 40/2)}{\left(\frac{90-40}{2}\right)}$

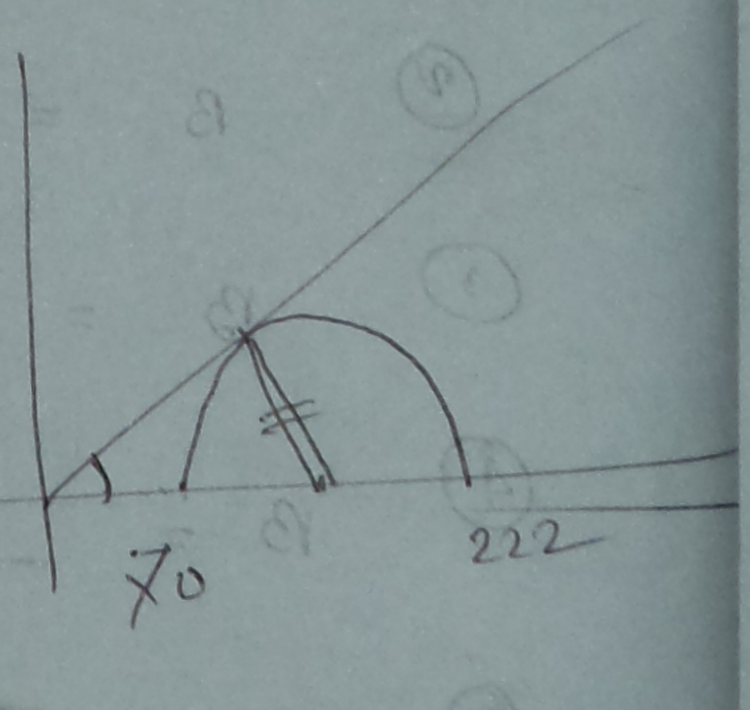
$= 0.48$

2(b)

	C.P	B.P	P.P
1.	0	0	-4
2.	50	-	~~X~~
3.	50	40	39
4.	100	-	62
5.	100	90	89
6.	150	-	126
7.	150	140	139
8.	200	-	~~139~~ 182
9.	200	190	~~182~~ 190
10.	300	~~290~~	285
11.	~~300~~	290	290
12.	400	-	388

i) $B = \frac{\Delta u_c}{\Delta \sigma_3} = \frac{-4}{0}$

ii) $B = \frac{\Delta u_c}{\Delta u_3} = \frac{7}{50} =$



$$\sin\varphi = \frac{\frac{222-20}{2}}{\frac{222+20}{2}} = 0.52$$

$$\varphi = 31.32^\circ$$

2005-06

3(a)

4(a)

(Cu test)

NCC → C = 0

$\Delta\sigma$ = 152 Kpa

σ_3' = 20 Kpa

$\sigma_1' = (152 + 20) = 222$ Kpa

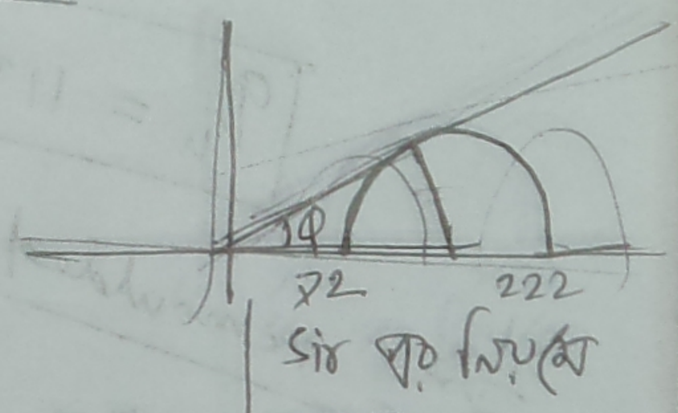


i) angle of internal shearing resistance (stress) ϕ

$\sigma_1' = \sigma_3' \tan^2(45^\circ + \phi'/2)$

or, $222 = 20 \tan^2(45^\circ + \phi'/2)$

$\therefore \boxed{\phi = 40^\circ}$ $\boxed{\phi' = 31.32^\circ}$



Sir এর নিয়ম

$\sin\phi = \dfrac{\frac{\sigma_1' - \sigma_3'}{2}}{\frac{\sigma_1' + \sigma_3'}{2}}$

$\boxed{\phi = 31.32^\circ}$

ii) Orientation of failure plane, $\theta = 45^\circ + \phi'/2$

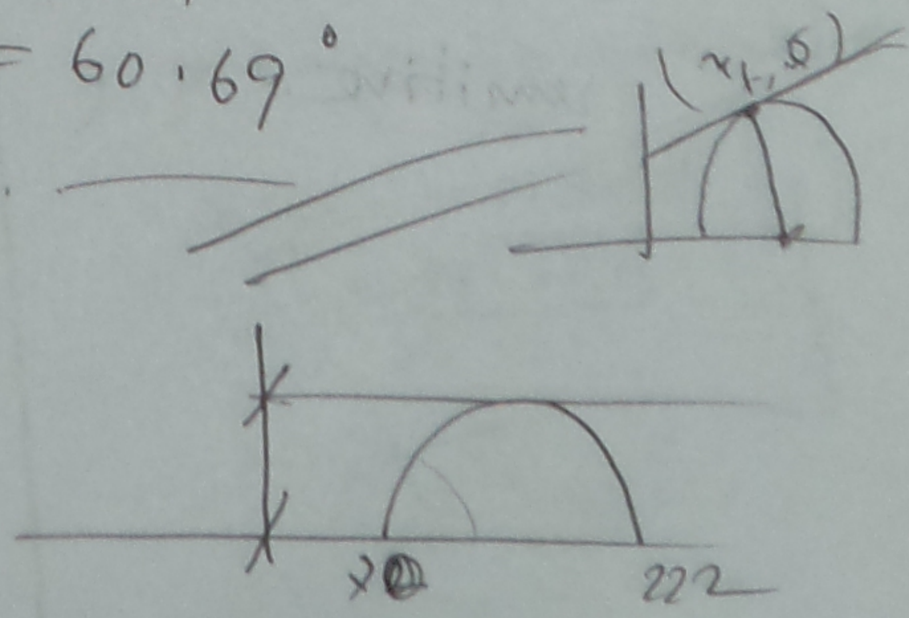
$= 45^\circ + \dfrac{31.32^\circ}{2}$

$= 45^\circ +$

$= 60.69^\circ$

$\tau_f = c + \sigma^* \tan\phi$

iii) $C_u = \dfrac{222 - 20}{2} = 26$



$\tau_f = c_u + \sigma \tan\phi_{cu}$

$[\phi_{cu} = 21.32^\circ]$

$= 26 + 222 \times \tan 21.32^\circ = 162.87$ Kpa.

2004-05

5(a)

$h = 120$ mm

$d = 60$ mm

$T = 45$ KN-mm

for undisturbed

$$c_u = \frac{6T}{2\pi d^3} = \frac{6\times 45}{2\times\pi\times 60^3} = 5.684 \times 10^{-5} \text{ KN/mm}^2$$

$$= 56.84 \text{ KN/m}^2$$

$\boxed{q_u = 113.68}$

for remoulded

$T = 20$ KN-mm

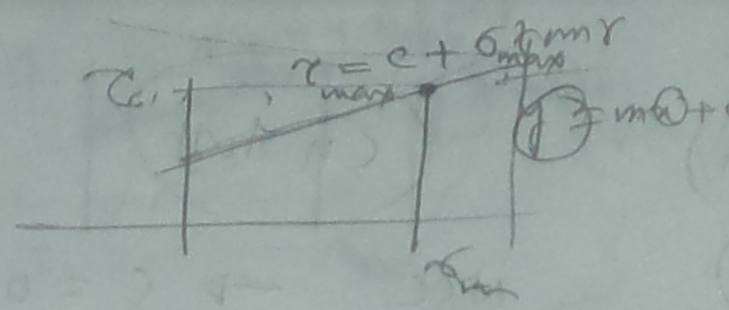
$\therefore c_u = 25.26$ KN/m^2

$q_u = 50.52$ KN/m^2

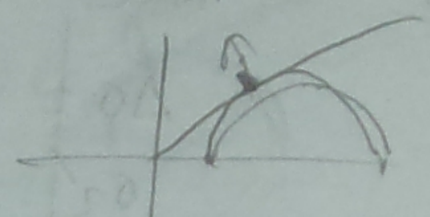
Now,

$$\text{Sensitivity} = \frac{113.68}{50.52} = 2.25$$

So, the soil is medium sensitive.



6(b)



$\sigma' = \sigma_1$

=

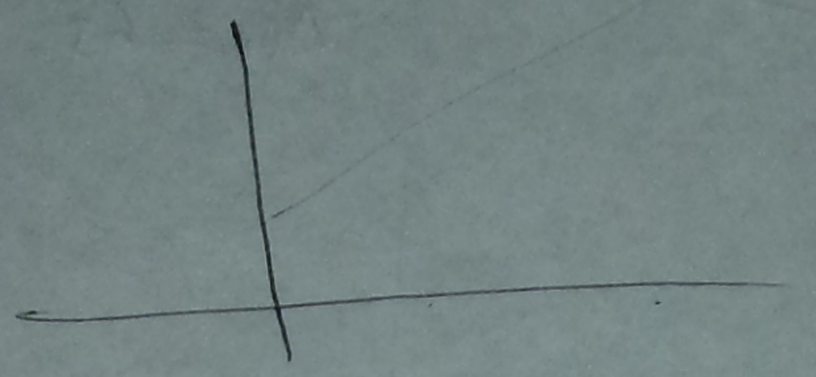
6(b)

$\tau_f = 90$ Kpa

$\sigma_1 = 180$ Kpa

$c' = 25$ Kpa

$\phi' = 22°$



ultimate pore water pressure ?

$\tau_f = c' + \sigma' \tan\phi'$

$90 = 25 + \sigma' \tan 22°$

$\therefore \boxed{\sigma' = 122.52 \text{ Kpa}}$

$\therefore u_p = \sigma - \sigma' = 180 - 122.52$

$\boxed{u_p = 52.43 \text{ Kpa}}$

(a)

$\theta = 45° + \phi'/2 = 58.5°$

~~$\theta = 45° + 22°/2 \quad 58.5$~~

$\tau_f = \dfrac{\sigma_1' - \sigma_3'}{2} \sin 2\theta$

$\sigma_1' - \sigma_3' = 202.0 \quad \sigma_3' =$

~~88.165~~

$\therefore \sigma_3' = 180 - 88.165$ ~~1.83 Kpa~~ 91.83 Kpa

$-x$

$\sigma_1' = \sigma_3' \tan^2(45° + \frac{\phi'}{2}) + 2c' \tan(45° + \phi/2)$

$\Rightarrow (180 - x) = (91.83 - x) 2.66 + 81.5$

$\Rightarrow 180 - x = 244.22 - 2.66x + 81.5$

$\therefore 1.66x = 145.3628$

$\boxed{x = 87.8119}$

: Consolidation :

2009-10

2(c) Given,

$C_c = 0.22$

$K = 3.5 \times 10^{-8}$ cm/sec

i) We Know,

$$C_c = \frac{\Delta e}{\log P_2/P_1}$$

or, $0.22 = \frac{\Delta e}{\log \frac{182.5}{125}}$ $\therefore \Delta e = 0.0425$

ii) As one way drainage $\rightarrow$ $H = 5$ m

$$S = \frac{H C_c}{1+e} \log P_2/P_1$$

$$= \frac{5 \times 0.22}{1+2.04} \log \frac{182.5}{125}$$

$= 0.02819$ m $= 3.08$ "

iii) $U = 50$ We Know, $T_v = \frac{\pi}{4}\left(\frac{U}{100}\right)^2$

$= 0.196$

$$U = \frac{\text{current settlement}}{\text{Final settlement}}$$

$$U_{50} = \frac{\text{settlement after 50 \% consolidation } (S_{t50})}{3.08}$$

$\therefore S_{t50} = 3.08 \times 0.5 = 1.54$ "

We Know that, $S = \frac{H C_c}{1+e} \log P_2/P_1$

$\therefore 1.54 = \frac{5 \times 0.22}{1+2.04} \log \frac{P_2}{125}$

$\therefore$ **$P_2 = 153.1$ KN/m^2**

again, $C_c = \frac{\Delta e}{\log P_2/P_1}$

$t_{50} = \frac{0.192 \times H_{dr}^2}{C_v}$

$\therefore \Delta e = 0.22 \log \frac{153.1}{125}$

$= 0.02328$

$a_v = \frac{\Delta e}{\Delta P} = \frac{0.02328}{153.1 - 121 \, 125} = 8.46128 \times 10^{-4} \, m^2/KN$

$m_v = \frac{a_v}{1+e_i} = \frac{8.46128 \times 10^{-4}}{1+2.04} = 2.78 \times 10^{-4} \, m^2/KN$

$= 2.78 \times 10^{-4} \times (100)^2 \, cm^2/gm$

$= \frac{}{\frac{1000}{9.81} \times 1000}$

again, $K = m_v C_v \gamma_w$ $= 2.222 \times 10^{-3} \, cm^2/gm$

$\therefore 9.5 \times 10^{-8} = 2.222 \times 10^{-3} \times C_v \times 1$

$\therefore C_v = 1.28122 \times 10^{-3} \, cm^2/sec.$

Now, $C_v = \frac{0.192 H^2}{t_{50}}$

$\therefore t_{50} = \frac{0.192 H^2}{C_v} = \frac{0.192 \times (5 \times 100)^2}{1.28122 \times 10^{-3}}$

$= 384\,23430 \, sec$

$= 1.22 \text{ year}$ (Ans)

If bothway drainage then

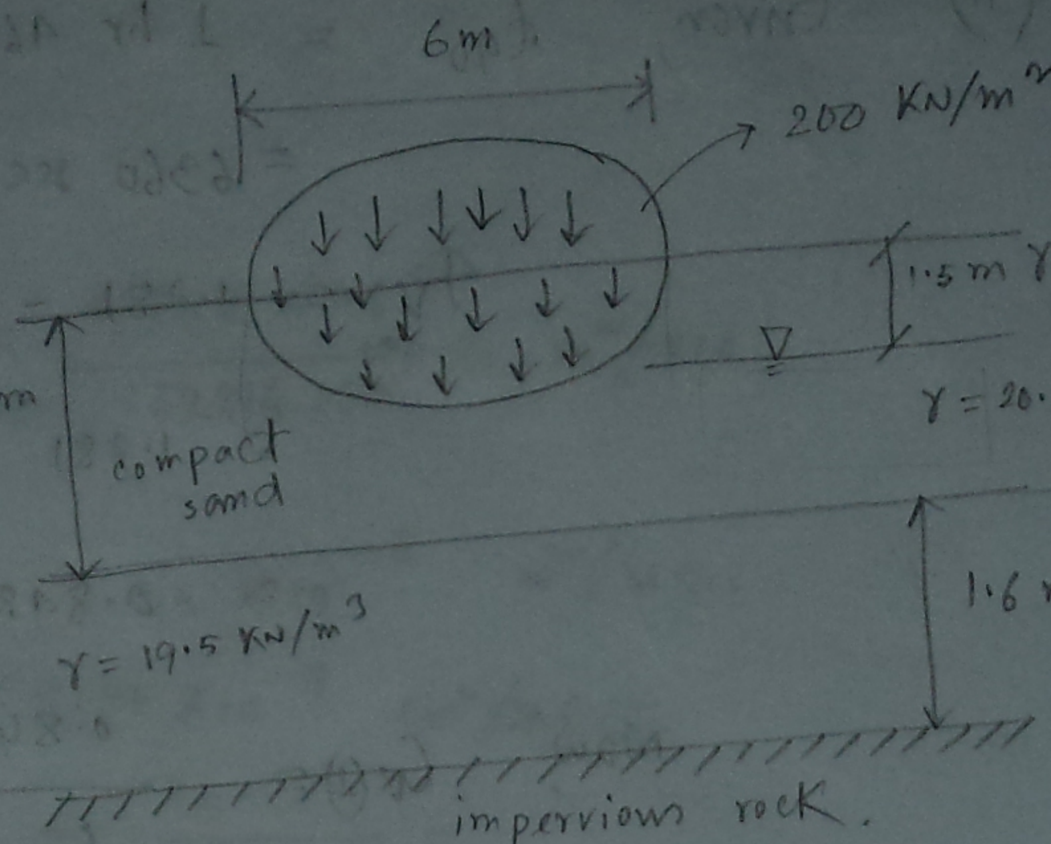
i) No change as void ratio change depends on on pressure variation and the value of C_c.

ii) ~~se~~ No change as settlement is independent of on drainage.

iii)

Question 2008-09

6(b)



At the mid level of clay →

$P_o = 1.5 \times 18.34$

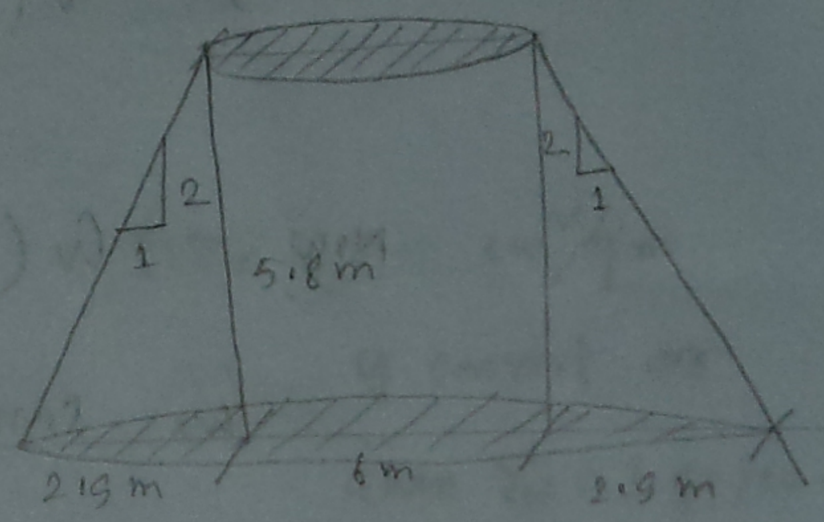
$+ 3.5 (20.4 - 9.81)$

$+ 0.8 \times 19.5$

$= 72.112 \ KN/m^2$

$$\Delta p = \frac{200 \times \pi/4 \times 6^2}{\pi/4 (6 + 2 \times 2.9)^2}$$

$= 64.32 \ KN/m^2$



(i)

From the graphical plot of the data we found the value of

$$C_c = \frac{\Delta e}{\log P_2/P_1}$$

From the semi-log graph we will found the value of e_o from corresponding P_o ($= 72.112 \ KN/m^2$)

Now, we know

$$S = \frac{H C_c}{1 + e_o} \log \frac{P_1}{P_o} \quad (P_1 = P_o + \Delta P)$$

~~$P_2 = P_1 + \Delta P$~~

(Here one way drainage so $H = H$)

$H = 1.6 m$

(ii) Given, $t_{90} = 1 \text{ hr } 46 \text{ min}$

$= 6360 \text{ sec}$

$T_{V_{90}} = 1.781 - 0.933 \log_{10}(100 - U)$

$= 1.781 - 0.933 \log_{10} 10$

$= 0.848$

Now, $C_{V(1)} = \dfrac{0.848 H_1^2}{t_{90(1)}}$

and, $C_{V(f)} = \dfrac{0.848 \times H_f^2}{t_{90(f)}}$

Now, $C_{V(1)} = C_{V(f)}$

as same soil so, $C_{V(f)} = C_{V(1)}$

$\therefore \dfrac{0.848 H_1^2}{t_{90(1)}} = \dfrac{0.848 H_f^2}{t_{90(f)}}$

$t_{90(f)} = \dfrac{H_f^2}{H_1^2} \times t_{90}$

for laboratory both way drainage so,

$H_1 = 20/2 = 10 \text{ mm}$

$= 0.01 \text{ m}$

$H_f = 1.6 \text{ m}.$

$\therefore t_{90(f)} = \dfrac{1.6^2}{0.01^2} \times 6360$

$= 5.16 \text{ year}.$

iii) Calculate K :

$$K = C_v m_v \gamma_w$$

$$C_v = \frac{0.848 \times H^2}{t_{90}} = \frac{0.848 \times 1.6^2}{162816\,000} \text{ m}^2/\text{sec}$$

$$= 1.33 \times 10^{-8} \text{ m}^2/\text{sec.}$$

$$= 1.33 \times 10^{-4} \text{ cm}^2/\text{sec}$$

$$a_v = \frac{\Delta e}{\Delta p} = \frac{e_0 - e_1}{p_1 - p} =$$

$$m_v = \frac{a_v}{1 + e_0} =$$

$\therefore K = C_v m_v \gamma_w$ (m_v ⇐ cm^2/gm ⇒ convert करा then $\gamma_w = 1$ gm/cc)

2006-07 : Same

Question 2005-06 :→

(B)

(i) From graph, $C_c = 0.335$

(ii) $a_v = \frac{\Delta e}{\Delta P} = \frac{\quad}{4-2}$

$\therefore m_v = \frac{a_v}{1+e_0}$

Here, e_0 = void ratio corresponding to 2 Tsf

(iii) single way, $H = 16.5'$

settlement,

$S = H m_v \Delta p$

$= 16.5 \times 0.0132 \times 2$

$= 0.436'$

Or, $S = \frac{H C_c}{1+e_0} \log P_2/P_1$

$= \frac{16.5 \times 0.335}{1+0.929} \log 4/2$

for both way drainage settlement will be same.

(iv) $C_v = \frac{0.192 \times H^2}{t_{50}} = \frac{0.192 \left(\frac{0.95}{2} \times 1/12\right)^2}{10 \times 60}$

$= 5.1445 \times 10^{-7}$ ft/sec.

for, $t = 0.25$ year

$= 7884000$ sec

$\therefore 5.1445 \times 10^{-7} = \frac{T_v \times \left(\frac{16.5}{2}\right)^2}{7884000}$

$\therefore T_v = 0.05959$

Now for 60 % $T_v = \pi/4 \left(u/100\right)^2$

$= 0.283$

$\therefore 0.05959 = \pi/4 \left(u/100\right)^2$

$\boxed{u = 22.55\ \%}$

again, $u = \frac{\text{Current settlement}}{\text{final settlement}}$

$22.55\ \% = \frac{\text{Current settlement}}{0.46}$

$\therefore$ Current settlement $= 0.1276'$

for, $t = 1$ year, Settlement $= 0.25465'$

for $t = 8$ year

$= 252288000$ sec.

$T_v = 1.908$

$T_v = 1.781 - 0.933 \log_{10}(100-u)$

$u = 99.25\ \%$ $\therefore S = 0.459'$

(v)

$$K = c_v m_v \gamma_w$$

~~$= 0.01329 \times 5.1445 \times 10^{-2} \times 9.81$~~

$$\begin{cases} m_v = 0.01329 \ ft^2/Ton \\ = \dfrac{0.01329 \times ft^2}{2210 \ lb} = 5.89 \times 10^{-6} \ ft^2/lb \\ \gamma_w = 62.4 \ lb/ft^3 \\ \text{and } c_v = 5.1445 \times 10^{-2} \ ft/sec \end{cases}$$

$$= 5.1445 \times 10^{-2} \times 5.89 \times 10^{-6} \times 62.4$$

$$= 1.89 \times 10^{-10} \ ft/sec$$

Question 05-06
8(c)

Sample A

$e_0 = 0.522$

$\Delta e = 0.522 - 0.505$

$= 0.062$

$P_0 = 122\ KN/m^2$

$P_1 = 180\ KN/m^2$

$\Delta P = 58\ KN/m^2$

$$a_v = \frac{\Delta e}{\Delta P}$$

$$= \frac{0.062}{58}$$

$$= 1.155 \times 10^{-3}\ m^2/KN$$

$$m_{vA} = \frac{a_v}{1+e_0}$$

$$= \frac{1.155 \times 10^{-3}}{1+0.522}$$

$$= 2.348 \times 10^{-4}\ m^2/KN$$

$$K_A = C_v\ m_v\ \gamma_w$$

$$T_{VA} = \frac{C_{VA} \times t_{A(50)}}{H_A^2}$$

$T_{VA(50)} = T_{VB(50)}$; $H_A = 1.5 H_B$ and $3 t_{50A} = 8 t_{50B}$

$$\therefore \frac{C_{VA} \times t_{50A}}{H_A^2} = \frac{C_{VB} \times t_{50B}}{H_B^2}$$

$$\frac{C_{VA}}{C_{VB}} = \frac{t_{50B}}{t_{50A}} \cdot \frac{H_A^2}{H_B^2} = \frac{3 t_{50B}}{8 t_{50B}} \times \frac{1.5^2 H_B^2}{H_B^2} = \frac{2.25 \times 3}{3} = 6.75$$

$$\therefore \frac{K_A}{K_B} = \frac{C_{VA}}{C_{VB}} \cdot \frac{m_{VA}}{m_{VB}} = 6.75 \times \frac{2.348}{5.626} = 8.24$$

$\therefore K_A = 8.24 K_B$

Sample B

$e_0 = 0.610$

$\Delta e = 0.610 - 0.557$

$= 0.053$

$\Delta P = 58\ KN/m^2$

$$a_v = \frac{\Delta e}{\Delta P}$$

$$= \frac{0.053}{58}$$

$$= 9.13 \times 10^{-4}\ m^2/KN$$

$$m_{vB} = \frac{a_v}{1+e_0}$$

$$= \frac{9.13 \times 10}{1+0.610}$$

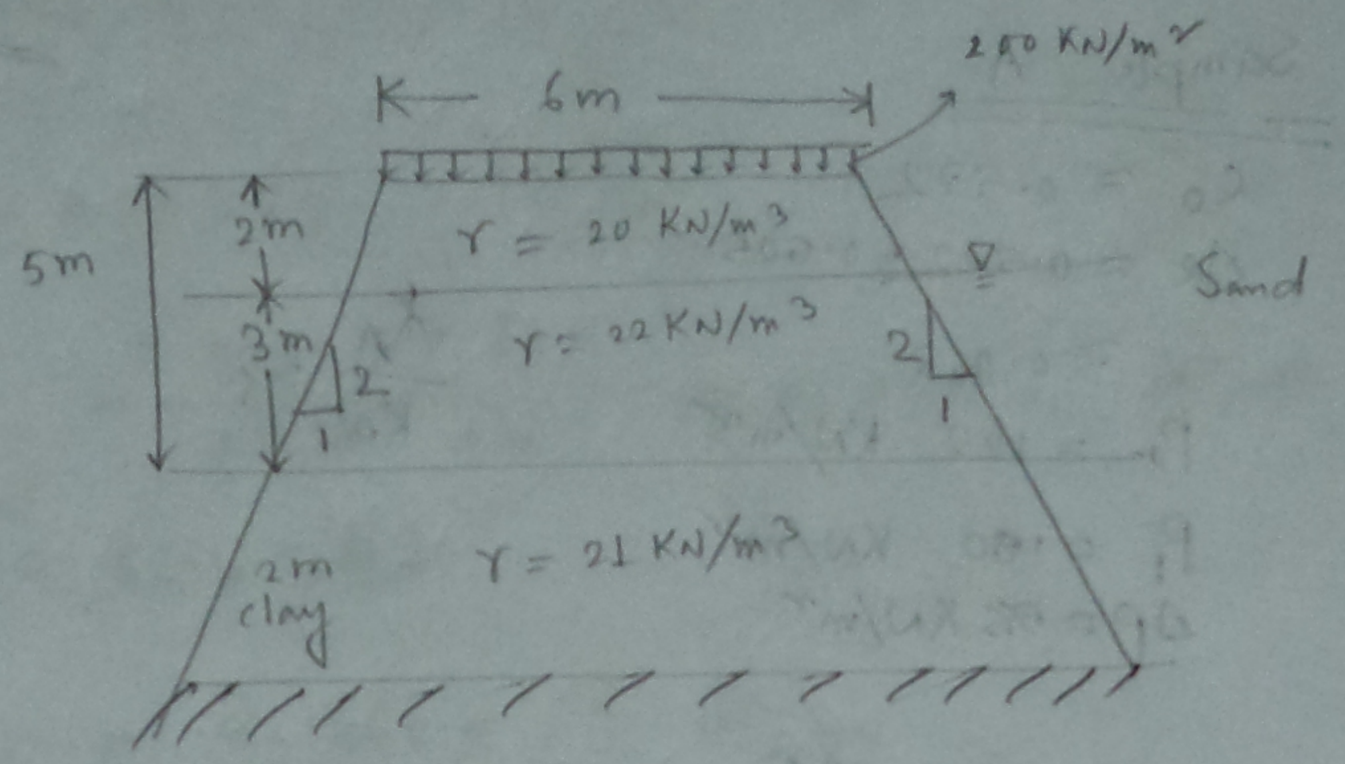
$$= 5.626 \times 10^{-4}\ m^2/KN$$

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

Question 2004-05

1(b)

$w = 30\%$
$G_s = 2.7$



$e_o = wG_s$
$= 0.3 \times 2.7$
$= 0.81$

$P_o = 2\times20 + 3(22-9.8) + 12(21-9.8) = 82.36$ KN/m²

$\Delta P = \dfrac{200 \times \pi/4 \times 6^2}{\pi/4 (6+6)^2} = 50$ KN/m²

$e_c = 0.12$

As imperriows layer beneath the clay layer so here is one way drainage so $H = 2$ m

$$S = \frac{H C_c}{1+e_o} \log \frac{P_o + \Delta P}{P_o}$$

$$= \frac{2 \times 0.12}{1+0.81} \log \frac{82.36+50}{82.36}$$

$= 0.09836$ m $= 2.3''$

Q→04-09

3(c)

$H = 6$ m (one way drainage) $C_c = 0.28$; $K = 3.5 \times 10^{-4}$ cm/sec
$P = 150$ KN/m², $e = 1.95$

i) $\Delta e = ?$, $\Delta P = (210 - 150) = 60$ KN/m²

$$S = \frac{H C_c}{1+e_0} \log \frac{P_0 + \Delta P}{P_0}$$

$$= \frac{6 \times 0.28}{1+1.95} \log \frac{210}{150}$$

$$= 0.0832 \text{ m}$$

Now $S = H m_v \Delta p$

$$= H \frac{a_v}{1+e_0} \Delta p \qquad m_v = \frac{a_v}{1+e_0}$$

$$0.0832 = 6 \times \frac{a_v}{1+1.95} \times 60 \qquad = \frac{6.82 \times 10^{-4}}{1+1.95}$$

$$a_v = 6.82 \times 10^{-4} \text{ m}^2/\text{KN} \qquad = 2.31 \times 10^{-4} \text{ m}^2/\text{KN}$$

$$\therefore a_v = \frac{\Delta e}{\Delta p} \qquad = 2.31 \times 10^{-4} \times \frac{100^2}{\frac{1000 \times 1000}{9.81}}$$

$$\therefore \Delta e = 6.82 \times 10^{-4} \times 60 = 0.04091$$

ii) time required for 50 % consolidation →

(t_{50}) →

$$t_{50} = \frac{T_v \times H^2}{c_v} = \frac{0.192 \times 5^2}{c_v} \qquad = 2.268 \times 10^{-5} \text{ cm}^2/\text{sec}$$

$$\left(c_v = \frac{K}{m_v \gamma_w} = \frac{3.5 \times 10^{-4} \text{ cm/sec}}{2.268 \times 10^{-5} \times 1} \right)$$

$$= 15.43 \text{ cm}^2/\text{sec}$$

$$\therefore t_{50} = \frac{0.192 \times 600^2}{15.43} \qquad = 4596.24 \text{ sec}$$

$$= 1.277 \text{ hour}$$

$$t_{90} = \frac{0.848 \times 600^2}{15.43} = 5.496 \text{ hour}$$

Q 2002-03

3(d)

$G_s = 2.65$; $w = 18\%$

$H_A = 1.9\,cm = 1.9 \times 10^{-2}\ m$

$e_o = w\,G_s = 0.18 \times 2.65 = 0.477$

$\Delta P = 60\ KN/m^2$; $P_o = 40\ KN/m^2$

$C_c = ?$ $m_v = ?$

~~$S = (1.9 \times 10^{-2} - 0.5 \times 10^{-3})\ m$~~

~~$= 0.0185\ m$~~ $S = 0.5\ mm$

$= 0.5 \times 10^{-3}\ m$

$$S = \frac{H C_c}{1+e_o} \log \frac{100}{40}$$

$$\therefore \frac{0.05 \times 10^{-3}}{0.0185} = \frac{1.9 \times 10^{-2}}{1.9 \times 10^{-2}} \times \frac{C_c}{1+0.477} \log 2.5$$

$\therefore C_c = 0.0977$

$$\boxed{a_v = \frac{\Delta e}{\Delta p}}$$

again, $S = H m_v \Delta p$

$0.5 \times 10^{-3} = 1.9 \times 10^{-2} \times m_v \times 60$

$\therefore m_v = 4.3859 \times 10^{-4}\ m^2/kN.$

Stress distribution :

Q → 09-10

8 (c)

By newmark's chart :

We Know →

$$\sigma_z/q = \left[\left(1 - \frac{\sigma_z}{q}\right)^{-2/3} - 1\right]^{1/2}$$

for different value of σ_z/q we will found σ_z/q.

σ_z/q	σ_z/q
0 →	0
0.1 →	0.22
0.2 →	0.4
0.3 →	0.52
0.4 →	0.64
0.5 →	0.22
0.6 →	0.92
0.2 →	1.11
0.8 →	1.39
0.9 →	1.91
1 →	∞

max^m circle → $\sigma_z/q = 1.91$ (∴ a = 1.91 × z we assume z = 5 cm

= 1.91 × 0.055

= 9.55 cm)

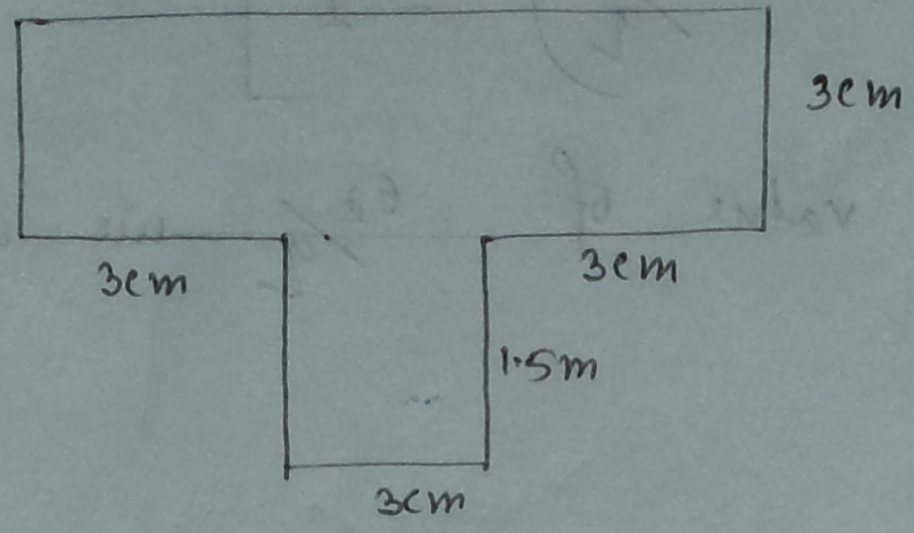
∴ So radius are 1.35 cm ; 2 ; 2.6 ; 3.2 ; 3.85 ; 4.6 ; 5.35 ; 6.95 ; 9.55 cm.

we have to find out stress for $z = 5m$

$\therefore 5m = 5cm$ in graph

$\therefore 1m = 1cm$

So the section dimension will be as below



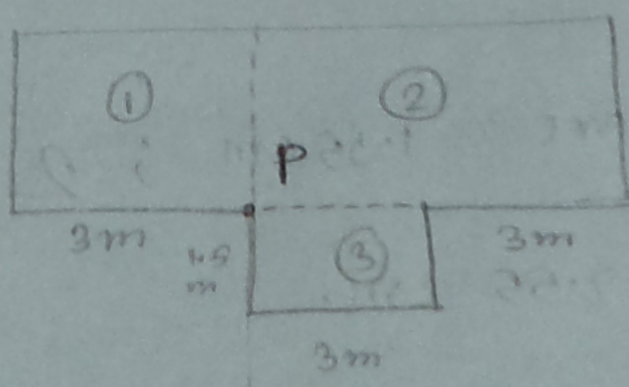
From newmarks chart $\longrightarrow$ No. of division = 60

$\therefore \sigma_z = I.F. \times No. of division \times q$

$= 0 \frac{1}{200} \times 60 \times 120 \quad KN/m^2$

$= 36 \quad KN/m^2$

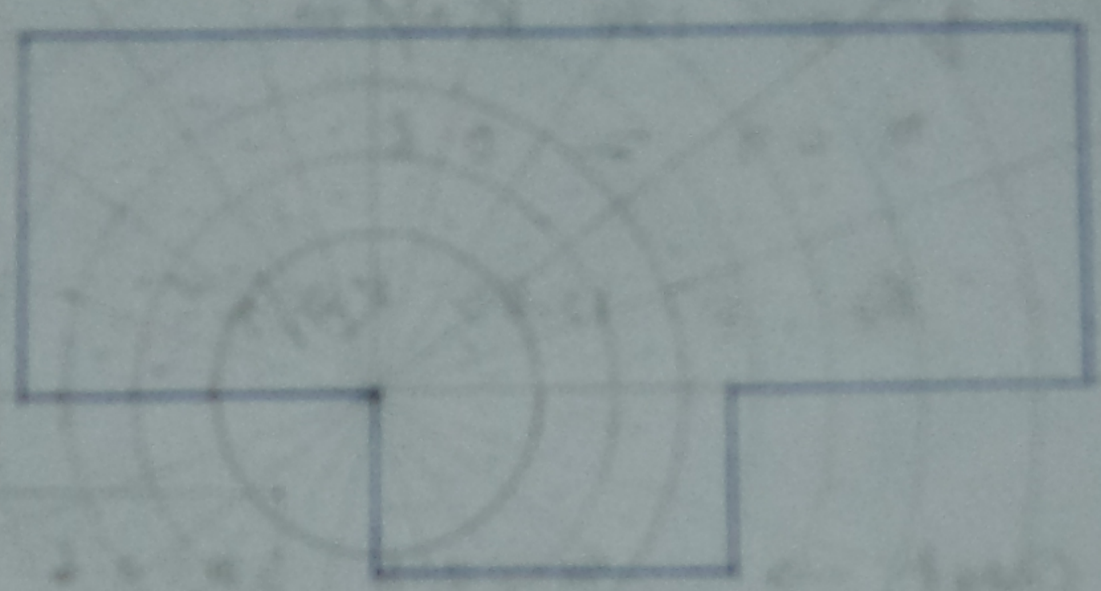
Analytical solution :



Area can be divided into 3 parts → to calculate stress at P

$\therefore \sigma_{z(P)} = \sigma_{z(1)} + \sigma_{z(2)} + \sigma_{z(3)}$

$\sigma_{z(1)}$: $m = B/z = 3/5 = 0.6$; $n = L/6 = 3/5 = 0.6$



Here, $m^2 + n^2 + 1 = 0.6^2 + 0.6^2 + 1 = 1.22$

$m^2 n^2 = (0.6)^2 2 = 0.22$

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

$$\therefore \sigma_2 = \frac{q}{4\pi}\left[\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}\cdot\frac{m^2+n^2+2}{m^2+n^2+1} + \sin^{-1}\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}\right]$$

$= \frac{120}{4 \times 3.1416}$ [Here, $\sin^{-1}( )$ এর value radian-এ নিতে হবে]

Here, $q = 120\ KN/m^2$

$m = n = 0.6$

$\therefore \sigma_2 = 12.83\ KN/m^2$

From chart $\rightarrow$ $m = 0.6$; $n = 0.6$; $I_3 = 0.1069$

$\therefore \sigma_2 = I_3 \times 120 = 120 \times 0.1069$

$= 12.83$

$\sigma_{2(2)}$: $m = 3/5$; $n = 6/5 = 1.2$

$= 0.6$

$\sigma_{2(2)} = 12.12\ KN/m^2$

From chart, $\sigma_{2(2)} = 120 \times 0.1431 = 16.95\ KN/m^2$

$\sigma_2(3)$: m = 1.5/5 ; n = 3/5

= 0.3 = 0.6

From chart → $\sigma_2(3)$ = 2.0 2.448 kN/m²

$\therefore \sigma_2(P) = \sigma_2(1) + \sigma_2(2) + \sigma_2(3)$

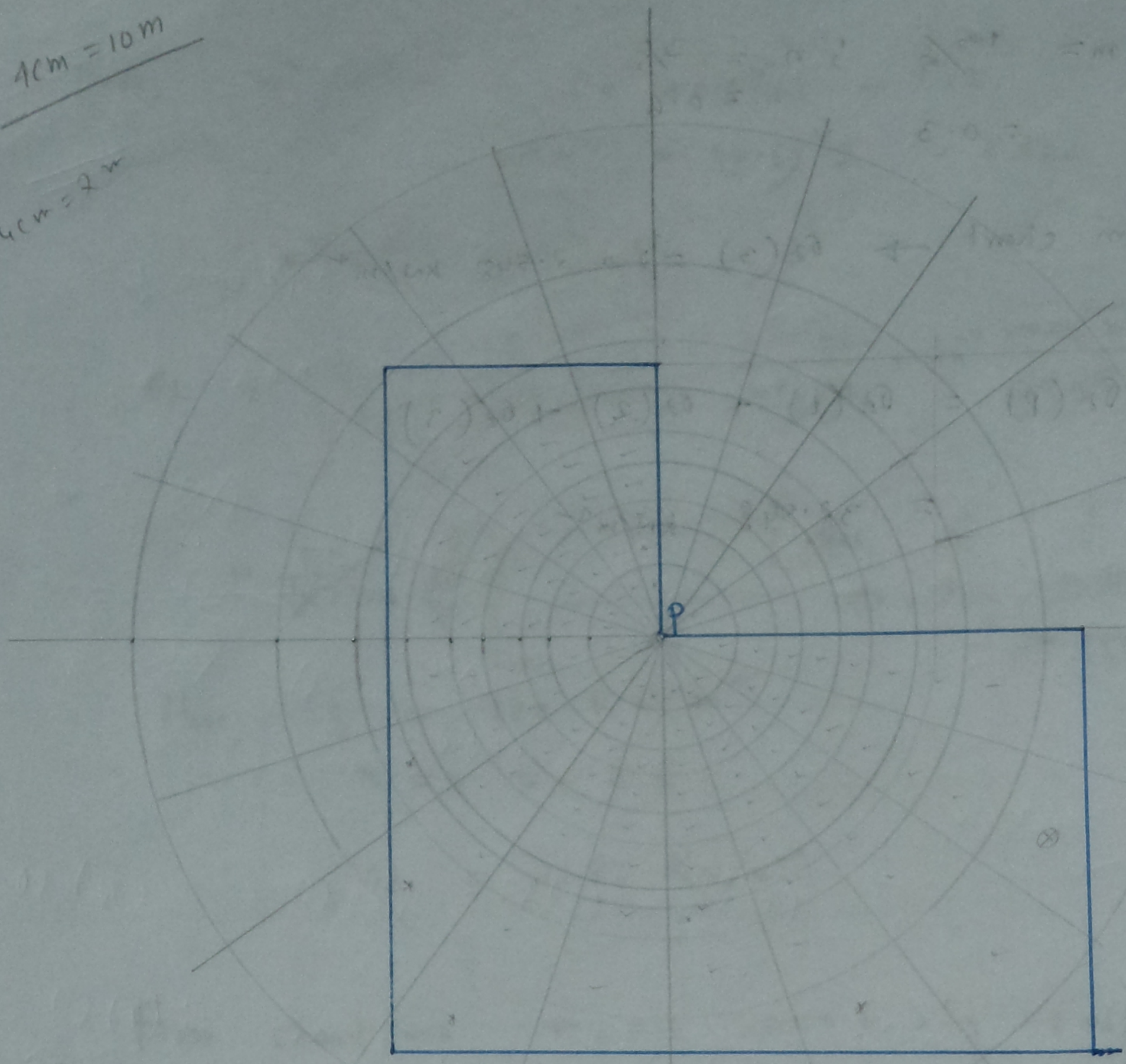
= 32.548 kN/m²

Q-4 [8+8=16]

a(i)

1cm = 10m

4cm = 2m

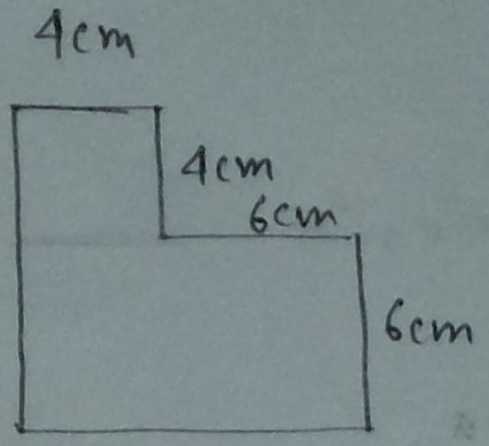


I.f. = 1/200

we z = 4 cm = 0'04 m

∴ radius are, 1·02 , 1·6 ; 2·08 ; 2·56 ; 3·08 ; 4·44 ; 5·56 ; 7·64 cm)

Equivalent dimension →



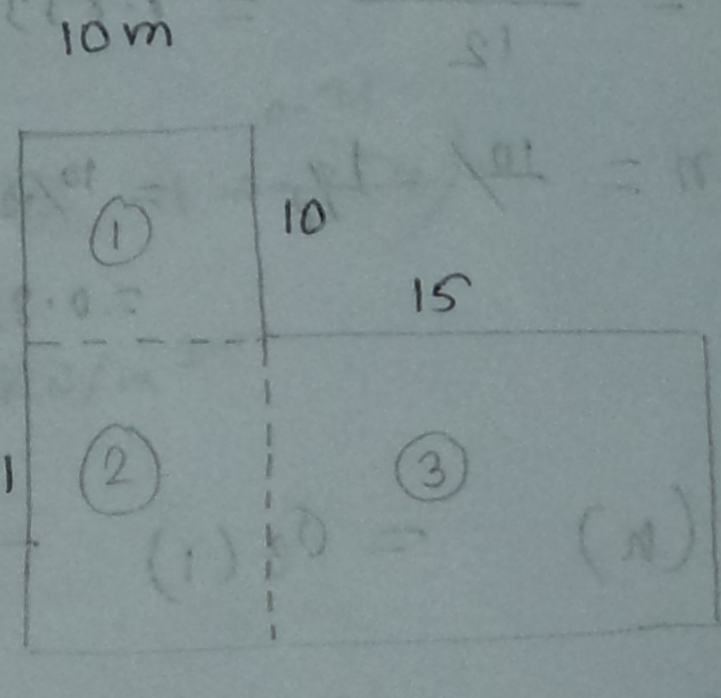
So, From newmarks chart →

No. of division = 116

So, $\sigma_z(P) = 116 \times 25 \times {}^{Y}/_{200}$

$= 43.5 \text{ KN/m}^2$

Analytical solution :



~~$\sigma_z(P) \Rightarrow$~~ $\sigma_z(P) = \sigma_z(1) + \sigma_z(2) + \sigma_z(3)$

$\sigma_z(1)$: $m = {}^{B}/_{2} = \frac{10}{10} = 1$; $n = \frac{10}{10} = 1$

From chart → ~~$\sigma_z(1) \Rightarrow$~~

$I_3 = 0.1252$ ∴ $\sigma_z(1) = 0.1252 \times 25 = 13.14 \text{ KN/m}^2$

$\sigma_z(2)$: $m = {}^{15}/_{10} = 1.5$ and $n = \frac{10}{10} = 1$

~~or, m =~~

From chart → $I_3 = $ ~~0.19345~~ 0.186

∴ $\sigma_z(2) = $ ~~0.19345~~ $\times 25 = $ ~~14.50825~~ KN/m^2

$= 13.95$

$\sigma_z(3)$: $m = 1.5$; $n = 1.5$; $I_3 = $ ~~0.21625~~ 0.20925

0.20925

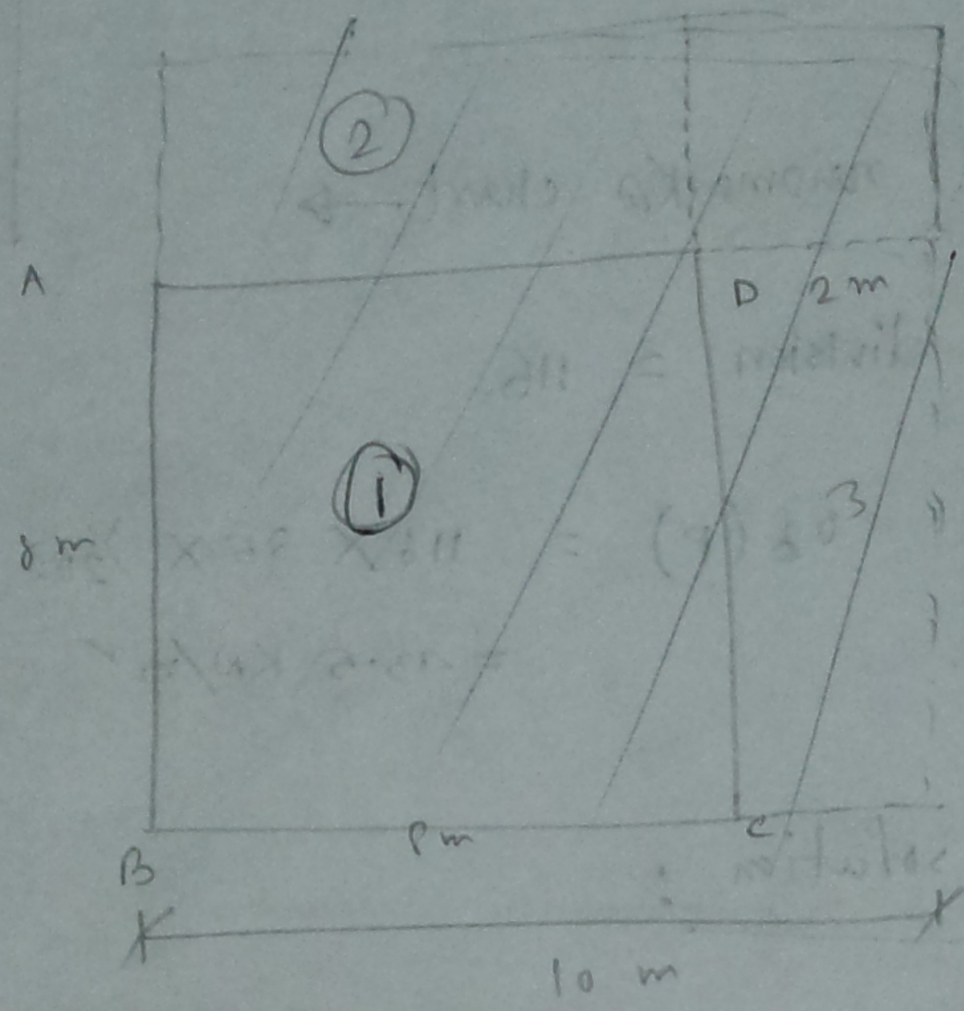
∴ $\sigma_z(3) = $ ~~0.21625~~ $\times 25$

$= $ ~~15.94825~~ 15.2125 KN/m^2

∴ $\sigma_p(2) = 42.8025 \text{ KN/m}^2$

2004-05

4(c)



$q = 50$ Kpa

$z = 12.0$ m

$m = B/z$

$= \frac{10}{12} = 0.833$

$n = 10/L/z = 10/12$

$= 0.833$

$m^2+n^2+1 = 2.389$

$\sigma_z(n) = \sigma_z(1) - \sigma_z(2) - \sigma_z(3)$

$\sigma_z(1)$:

$$\sigma_z(1) = \frac{q}{4\pi}\left\{\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}\cdot\frac{m^2+n^2+2}{m^2+n^2+1}+\sin^{-1}\frac{2mn\sqrt{m^2+n^2}}{m^2+n^2+1+m}\right.$$

$$= \frac{50}{4\times3.1416}\left\{\frac{2\times0.83^2\sqrt{2\times0.83^2+1}}{(0.83)^2\cdot2+1+(0.83)^4}\cdot\frac{(0.83)^2\cdot2+2}{(0.83)^2+1}+\sin^{-1}\right($$

$$= \frac{50}{4\pi}\left[0.242\times1.419+\sin^{-1}0.242\right.$$

$$= \frac{50}{4\pi}\left(1.0599+0.844\right) = 5.25$$

$\delta z(2)$:

$m = B/z = \frac{10}{12} = 0.833$

$n = L/z = 2/12 = 0.162$

$m^2 + n^2 + 1 = 1.222$

$\delta z(2) = \frac{50}{4\pi} \left\{ \frac{0.2096}{0.254} \times 1.58 + \sin^{-1} \left(\frac{0.2096}{0.254} \right) \right\}$

$= \frac{50}{4\pi} \left(\frac{0.2096}{0.254} \times 1.58 + 0.84 \right)$

$= 8.139$ 2.16 KN/m^2

$\delta z\ (3)$:

$m = B/z = 8/12 = 0.62$

$n = L/z = 2/12 = 0.162$

$m^2 + n^2 + 1 = 1.42$

$\delta z(3) = \frac{50}{4\pi} \left[1.42 \quad 0.221 \times 1.68 + \sin^{-1} 0.221 \right.$

$= 50/4\pi \left(0.221 \times 1.68 + 0.223 \right)$

$= 2.36 \quad KN/m^2$

$\therefore \quad \delta z(n) = \delta z(1) - \delta z(2) - \delta z(3)$

$= 9.58 - 2.16 - 2.36 \quad = 7.06 \ KN/m^2$