Consolidation:

2009 - 2010:

7(c)

$C_c = 0.27$, $K = 3.5 \times 10^{-5}$ cm/sec

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

$\Rightarrow 0.27 = \frac{\Delta e}{\log \frac{187.5}{125}} \Rightarrow \Delta e = 0.0475$

(ii) As one way drainage, $H = 5m$

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

$= \frac{5 \times 0.27}{1+2.04} \log \frac{187.5}{125}$ m

$= 0.07819$ m $= 3.08''$

(iii) $U = 50$ $T_v = \frac{\pi}{4}\left(\frac{U}{100}\right)^2 = 0.197$

$U = \frac{\text{settlement After 50\% consolidation } (S_{t50})}{\text{final settlement}}$

$\Rightarrow S_{t50} = 0.5 \times 3.08 = 1.54''$

$k = m_v \, c_v \, \gamma_w$

$\Rightarrow 3.5 \times 10^{-8} = 2.73059 \times 10^{-5} \times c_v \times 1$

$\Rightarrow c_v = 1.28177 \times 10^{-3}$ cm²/sec

$\cancel{t_{50} = \dfrac{0.197 \, c_v}{H^2} = \dfrac{0.197 \times 1.28177 \times 10^{-3}}{\quad}}$

$$t_{50} = \frac{0.197 \, H^2}{c_v}$$

$$= \frac{0.197 \times (5 \times 100)^2}{1.28177 \times 10^{-3}} \text{ sec}$$

$= 38,423,430.1$ sec

$= 14.824$ month

$= 1.235$ yr.

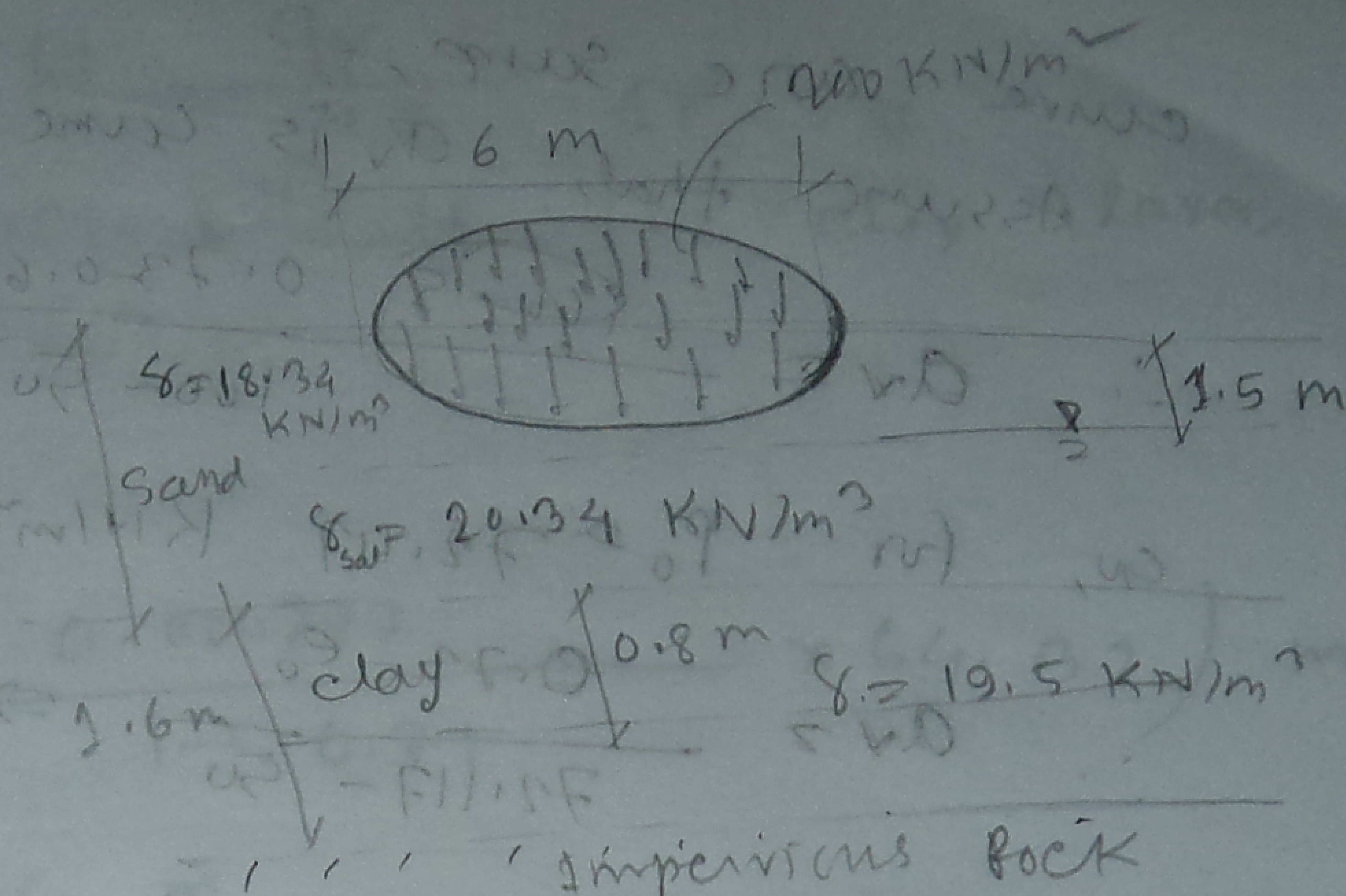
If both way drainage,

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

(ii) No variation is expected. Settlement is a function of initial and final pressure condition of soil, not the condition of rate of consolidation.

2008-09:

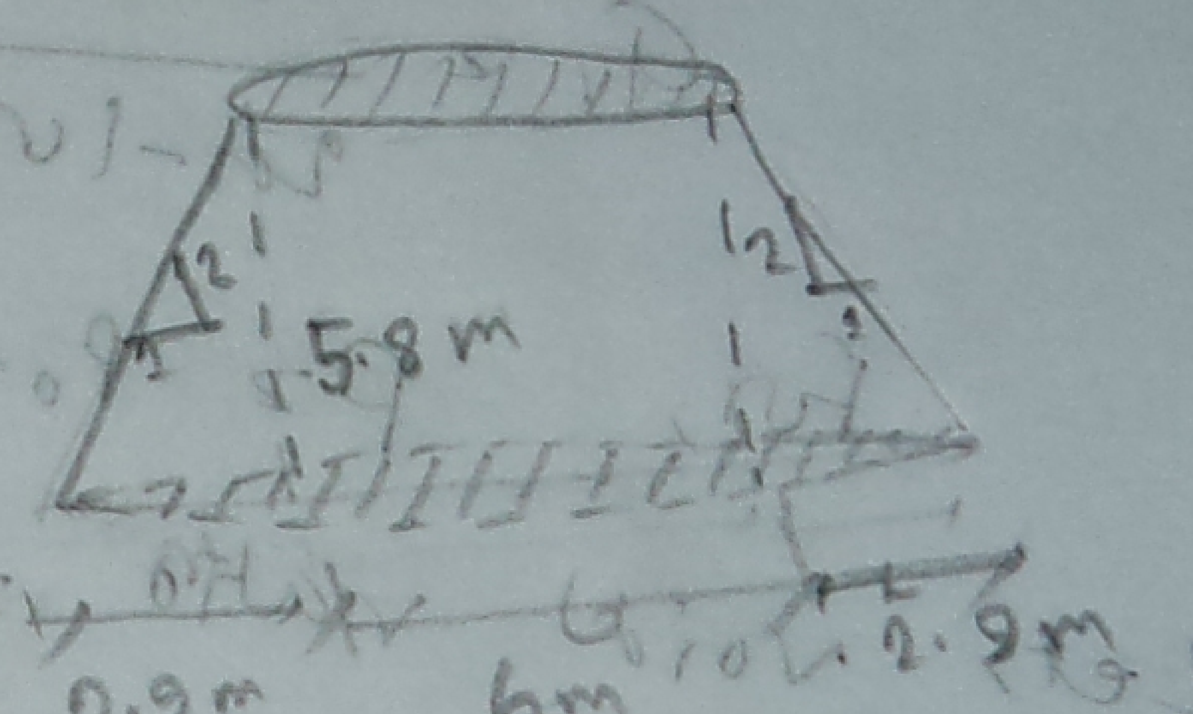
6(b)



At the mid-level of clay,

$P_0 = 1.5 \times 18.34 + (20.34 - 9.81) \times 3.5 + (19.5 - 9.81) \times 0.8$

$= 72.117$ KN/m²



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

$= 64.32$ KN/m²

① Process-1 (check → do process 2)

By a_v ~~Cc~~

Assume that, a_v remains constant for each load increment. As tests are on undisturbed soil sample, so, field and laboratory curve are same.

Assume that, a_v is same from 50 to 100 KPa.

$\therefore a_v = \dfrac{0.73 - 0.68}{100 - 50} = 10^{-3}\ m^2/KN$

So, for $P_0 = 72.117\ KN/m^2$, Void ratio $= e_0$

$\therefore a_v = \dfrac{0.73 - e_0}{72.117 - 50} \Rightarrow e_0 = \cancel{0.708}\ 0.71$

Now, a_v from 100 to 200 KPa,

$a_v = \dfrac{0.68 - 0.625}{200 - 100} = 0.00055\ m^2/KN$

For, $P = P_0 + \Delta P = 72.117 + 64.32 = 136.437\ KN/m^2$

Let, void ratio $= e$.

$\therefore 0.00055 = \dfrac{0.68 - e}{136.437 - 100}$

$\Rightarrow e = 0.66$

Now, for P_0 to P,

$a_v = \dfrac{0.71 - 0.66}{136.437 - 72.117} \left(\dfrac{e_0 - e}{P - P_0} \right)$

$= 0.000777$

Now, Settlement, $S = H \frac{a_v}{1+e_0} \Delta P$

As impervious layer beneath the clay layer,

so, one-way drainage.

$H = 1.6$ m

$\therefore S = \left(1.6 \times \frac{0.000777}{1+0.71} \times 64.32\right)$ m

$= 0.04676$ m

$= 0.04676 \times 3.281 \times 12$ inch

$= 1.84''$

Process-2:

By C_c:

From the graphical plote of the data,

$C_c =$

from the graph,

for, P_0 (72.117 KN/m²), $e_0 =$

for P (136.437 KN/m²), $e =$

SEMI-LOGARITHMIC

(11) $t_{90(s)} = 1$ h 46 min

$= (1\times3600 + 46\times60)$ sec $= 6360$ sec

~~$T_v = 0.197$ 0.848~~

$T_v = 1.781 - 0.933 \log_{10}(100-90)$

$\boxed{\text{for } 90\%,\ U = 90}$

$= 0.848$

$$c_{v(s)} = \frac{0.848 \times H_s^2}{t_{90(s)}} \quad \text{--- (1)}$$

$$c_v(\text{field}) = \frac{0.848 \times H_f^2}{t_{90(f)}} \quad \text{--- (ii)}$$

As same soil, $c_{v(s)} = c_{v(\text{field})}$

$$\Rightarrow \frac{0.848 \times H_s^2}{t_{90(s)}} = \frac{0.848\, H_f^2}{t_{90(f)}}$$

$$\Rightarrow t_{90(f)} = \frac{H_f^2}{H_s^2} \times t_{90(s)}$$

For laboratory, both way drainage,
$\therefore H_s = \frac{20}{2}$ mm
$= 10$ mm
$= 0.01$ m

$H_f = 1.8$ m

$$= \frac{(1.8)^2}{(0.01)^2} \times 6360$$

$= 206064000$ sec

~~$= 6.9$ yr~~

~~$= 0.5445$ yr.~~

$= 6.534$ yr

$K = m_v \, c_v \, \gamma_w$

c_v (from t_{90})

$$\boxed{c_v = \frac{0.848 \, H_t^2}{t_{90}}}$$

$$= \frac{0.848 \times 1.6^2}{206064000} \; m^2/sec$$

$$= 1.0535 \times 10^{-8} \; m^2/sec \quad (i)$$

$$a_v = \frac{e_0 - e}{P_1 - P_0} \quad (ii)$$

$=$

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

$=$

$K = m_v \, c_v \, \gamma_w$

$=$

2007-08:

6(c) (same as 2009-2010 (6(b)))

$e_0 = 2.04$

$C_c = 0.27$, $P_0 = 125$ KN/m^2,

2006-07i 6(c) (same as 2008-09 6(b))

2005-06:

6.

(i) from graph, $C_c = \frac{0.925-0.75}{\log(10/3)} = 0.335$

(ii) $a_v = \frac{\Delta e}{\Delta p}$

$= \frac{0.929-0.878}{4-2} = 0.0255 \ (Tsf)^{-1}$

$\therefore m_v = \frac{a_v}{1+e_i} = \frac{0.0255}{1+0.929}$

$= 0.013219 \ (Tsf)^{-1}$

$= 1.251776 \times 10^{-4} \ m^2/KN$

(iii) single way drainage, and both way drainage

$H = 16.5$ ft

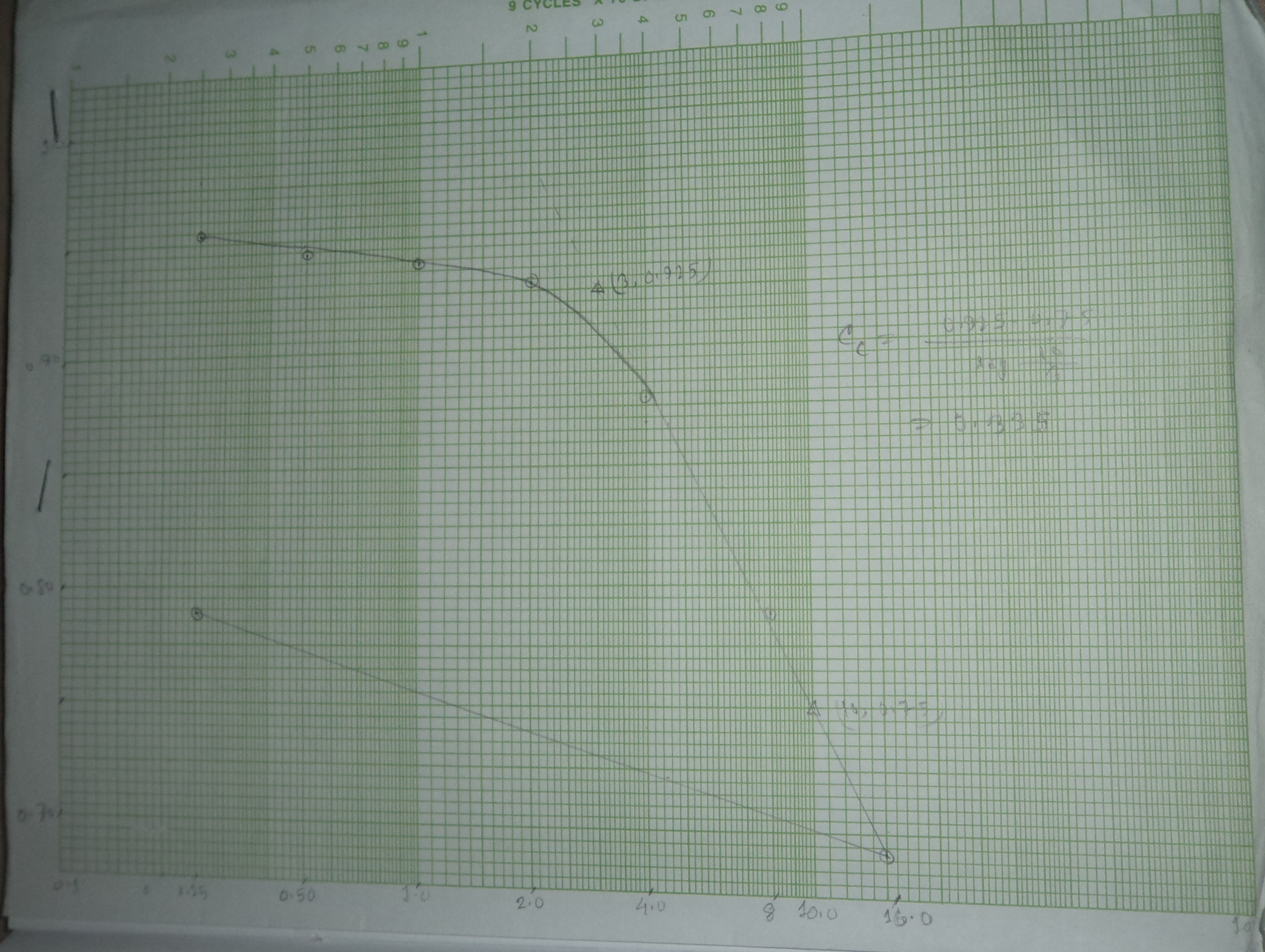
Process 1:
$S = \frac{H C_c}{1+e_0} \log \frac{P_2}{P_1}$

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

$= 0.86259 = 10.35''$

Process-2:
$H = H m_v \Delta p = 16.5 \times 0.013219 \times 2$

$= 0.436227$ ft $= 5.23''$


9 CYCLES
0.90
0.80
0.70
0.25
0.50
1.0
2.0
4.0
8
10.0
16.0
(3, 0.925)
$C_c = $
$\Rightarrow 0.1335$

(N) $c_v = \dfrac{0.197 \times \cancel{\Phi} H_{dr}^2}{t_{50}} = \dfrac{0.197 \times \left(\frac{0.95}{2} \times \frac{1}{12}\right)^2}{10 \times 60}$

$= 5.14446 \times 10^{-7}\ ft^2/sec$

$\cancel{= \dfrac{0.197 \times (8.95/2)^2}{10 \times 60} = 0.022347}\ ft^2/sec.$

$c_v = \dfrac{T_v \times H_{dr}^2}{t}$

For, $t = 0.25$ year $= 7884000$ sec

$\cancel{0.022347 = \dfrac{T_v \times 8.25^2}{7884000}}$

$\Rightarrow \cancel{T_v =}$

$5.14446 \times 10^{-7} = \dfrac{T_v \times 8.25^2}{7884000}$

$\Rightarrow T_v = 0.05959$ | for 60%, $T_v = \frac{\pi}{4}\left(\frac{60}{100}\right)^2 = 0.283$

As $0.05959 < 0.283$

$\frac{\pi}{4}\left(\frac{U}{100}\right)^2 = 0.05959$

$\Rightarrow U = 27.5449$

$\Rightarrow \dfrac{\text{current settlement}}{\text{final settlement}} \times 100 = 27.5449$

$\Rightarrow$ current settlement $= 27.5449 \times \frac{1}{100} \times 5.23$

$= 1.44''$

(v) $K = m_v c_v \gamma_w$

$= \cancel{1} \; 0.613219 \times 5.14446 \times 10^{-7} \times 9.81 \times 9.81^{-1} \times (3.281^3)^{-1}$

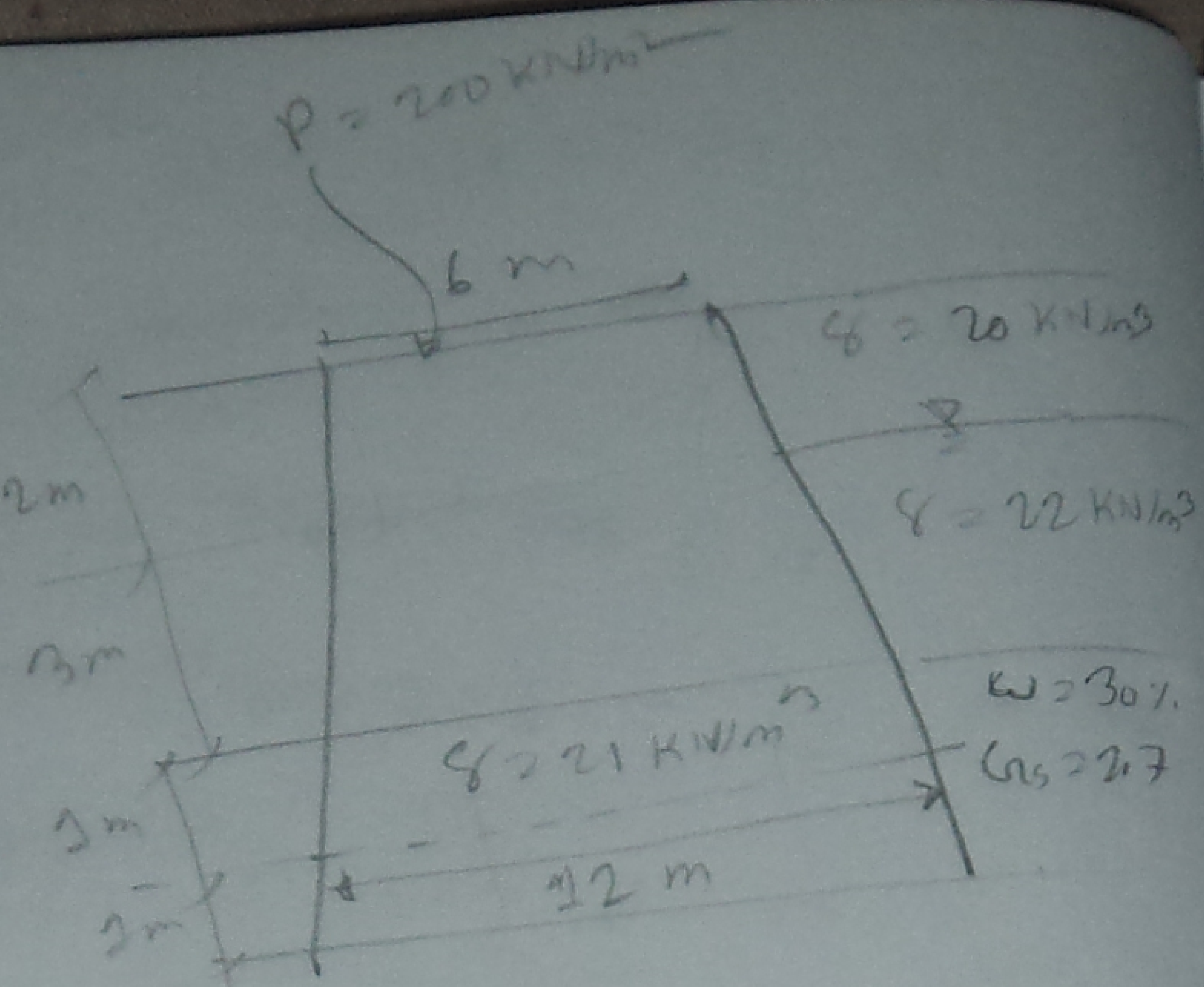
$= 1.925 \times 10^{-10}$ ft/sec

$= 5.868 \times 10^{-11}$ m/sec

$= 5.868 \times 10^{-9}$ cm/sec

2004-05:

1(b)



$e_0 = w_0 G_s = 0.3 \times 2.7 = 0.81$

$P_0 = 2 \times 20 + 3 \times (22 - 9.81) + 1 \times (21 - 9.81) \ KN/m^2$

$= 87.76 \ KN/m^2$

$$\Delta P = \frac{200 \times \frac{\pi}{4} \times 6^2}{\frac{\pi}{4}(6 + 2 \times 3)^2} \ KN/m^2 = 50 \ KN/m^2$$

$C_c = 0.12$

As impervious bedrok at beneath of clay, so, one way drainage.

$\therefore H = 2$ m

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

$$= \frac{2 \times 0.12}{1 + 0.81} \log \frac{87.76 + 50}{50} =$$

2004-05

3 (c)

$C_c = 0.28$, $K = 3.5 \times 10^{-4}$ cm/sec

One way drainage, $H = 6$ m

$e_0 = 1.95$, $P_0 = 150$ KN/m^2

(i) $\Delta e = C_c \times \log \frac{P_2}{P_1}$

$= 0.28 \times \log \frac{210}{150} = 0.0409$

(ii) $a_v = \frac{\Delta e}{\Delta p}$

$= \frac{0.0409}{210-150} = 0.00068$ m^2/KN

$m_v = \frac{0.00068}{1+1.95} = 0.00023$ m^2/KN

$K = c_v m_v \gamma_w$

$\Rightarrow 3.5 \times 10^{-4} = c_v \times 0.00023 \times 100^2 \times 9.81 \times \frac{1}{(100)^3}$

$\Rightarrow c_v = 15.51$ cm^2/sec

$= 15.51 \times 10^{-4}$ m^2/sec

① $c_v = \dfrac{0.197 \times H^2}{t_{50}}$

$\Rightarrow t_{50} = \dfrac{0.197 \times 6^2}{15.51 \times 10^{-4}}$ sec

$= 4572.53$ sec

$= 1.27$ ~~min~~ hour

④ $t_{90} = \dfrac{0.848 \times 6^2}{15.51 \times 10^{-4}}$ sec.

$= 5.47$ ~~min.~~ hour

2007-03

7 (d) $G_s = 2.65$, $w = 0.18$

$e_0 = wG_s = 2.65 \times 0.18 = 0.477$

(As fully saturated)

$2H_0 = 1.9\,cm$,

$2H = 1.9 - \frac{0.5}{10} = 1.55\,cm$

~~change of void ratio =~~ $\cancel{\frac{2H_0 - 2H}{}}$

$e_0 = \frac{2H_0 - 2H_s}{2H_s} \Rightarrow 0.477 = \frac{1.9 - 2H_s}{2H_s}$

$\Rightarrow 2H_s = 1.286\,cm.$

$e_1 = \frac{2H - 2H_s}{2H_s} = \frac{1.55 - 1.286}{1.286} = 0.439$

$\therefore C_c = \frac{e_0 - e_1}{\log(P_2/P_1)} = \frac{0.477 - 0.439}{\log\left(\frac{100}{40}\right)}$

$= 0.095$

$a_v = \frac{\Delta e}{\Delta p} = \frac{0.477 - 0.439}{100 - 40} = 0.000633$ m^2/KN

$m_v = \frac{a_v}{1 + e_1} = \frac{0.000633}{1 + 0.477} =$

$= 0.000429\ m^2/KN$

Boussinesq's Solution, Newmark's chart

See B.M. Das → plm (Example 9.2, 9.3, 9.4, 9.6, 9.7)

2009-2010

8(b) → see cls lecture.

8(c)

By Newmark's chart!

We know,

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

For different value of $\frac{\sigma_z}{q}$, $\frac{R}{z}$ is found as below

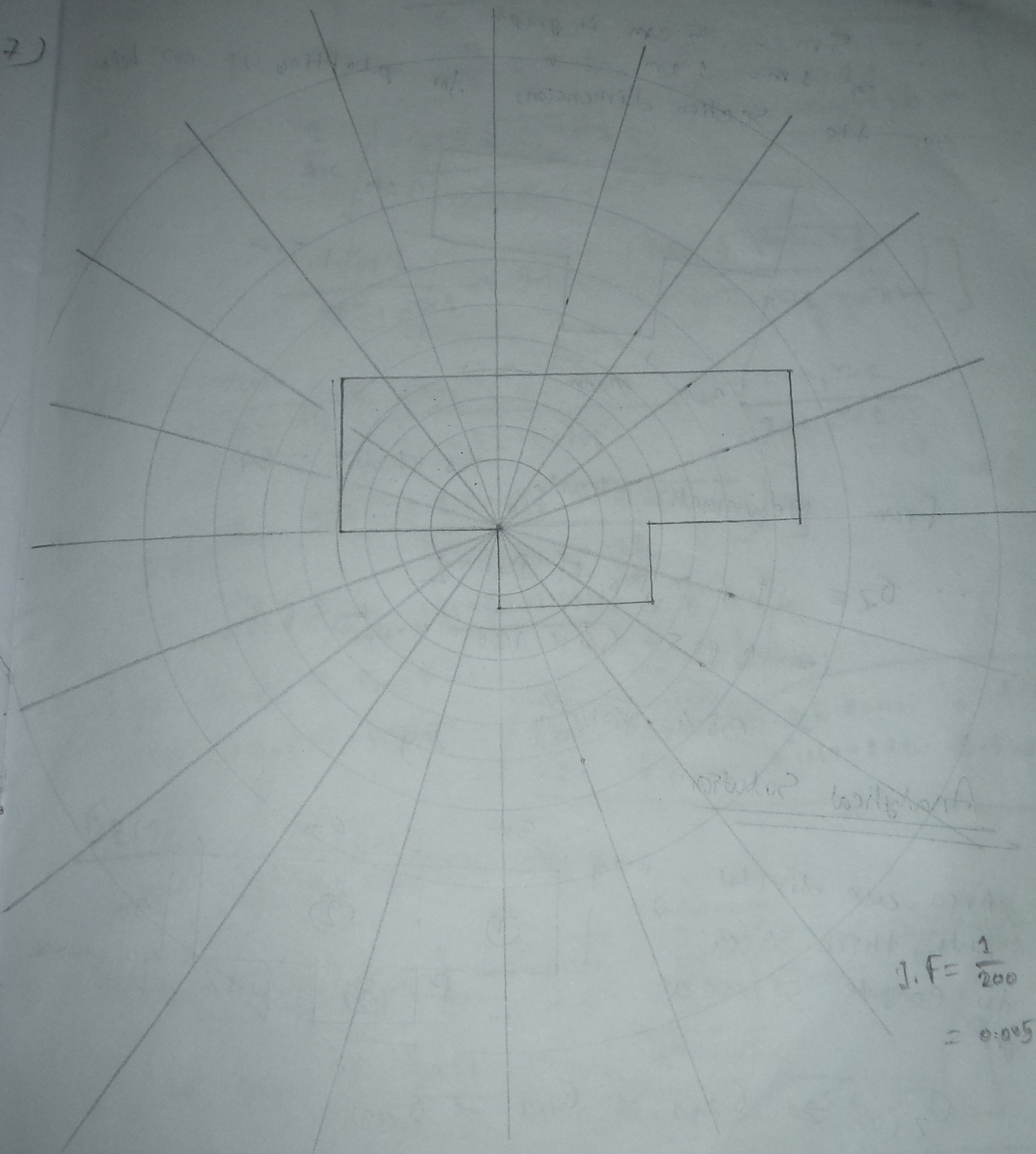
$\frac{\sigma_z}{q}$	$\frac{R}{z}$	$\frac{\sigma_z}{q}$	$\frac{R}{z}$ (R/z)
0	0	0.6	0.92
0.1	0.27	0.7	1.11
0.2	0.40	0.8	1.39
0.3	0.52	0.9	1.91
0.4	0.64	1.0	∞
0.5	0.77		

Max circle, $\frac{R}{z} = 1.91$

Let $z = 5$ cm $= 0.05$ m.

So, radius are, 1.35, 2, 2.6, 3.2, 3.85, 4.6, 5.55, 6.95, 9.55 cm

(7)



$I.F = \frac{1}{200}$

$= 0.005$

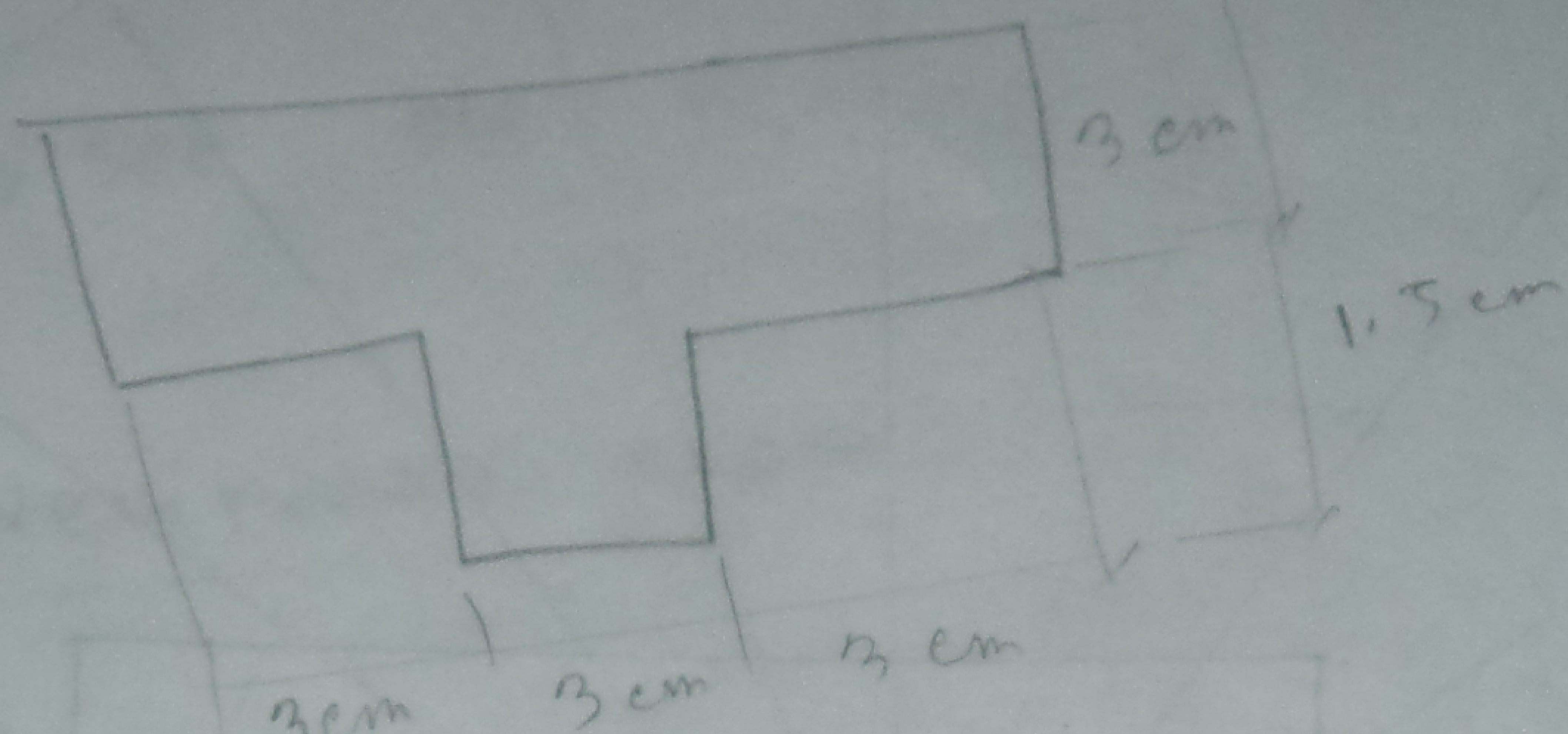
Newmark's Chart

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

$\therefore$ 5m = 5 cm in graph

$\Rightarrow$ 1 m = 1 cm "

so, the section dimensions for plotting is as below



From Newmark's chart, No of div = 64

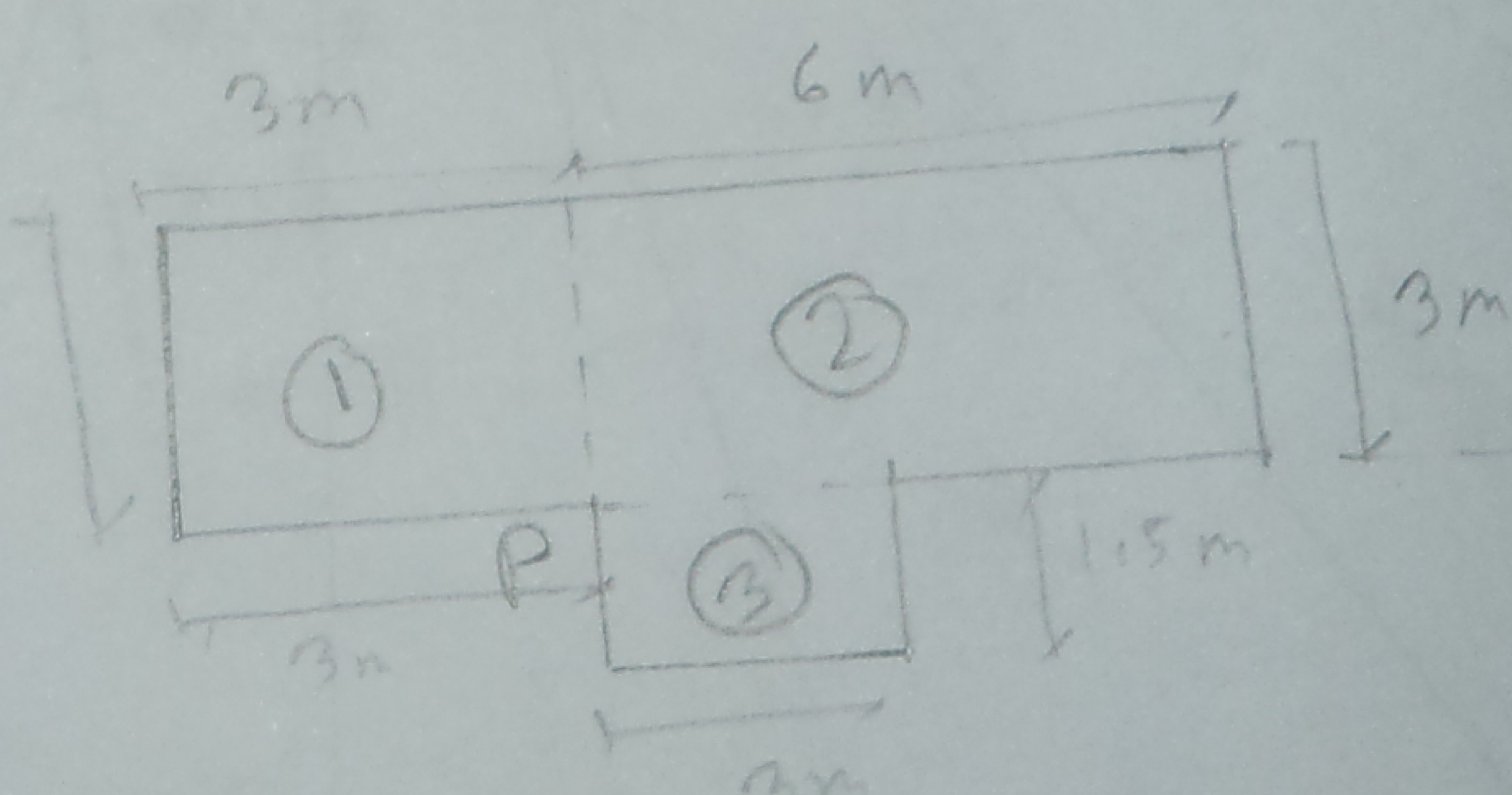
$\therefore \sigma_z = I.F \times \text{No of Div} \times q$

$= 0.005 \times 64 \times 120$ KN/m²

$= 38.4$ KN/m²

Analytical Solution

Area are divided into three Areas to compute stress at P.



$\sigma_{z(0)} = \sigma_{z(1)} + \sigma_{z(2)} + \sigma_{z(3)}$

$\sigma_{z(1)} =$

$\underline{\sigma_{z(1)}}$ $m = \frac{B}{z} = \frac{3}{5} = 0.6$

$n = \frac{L}{z} = \frac{3}{5} = 0.6$

$\boxed{\begin{array}{l} m^2+n^2+1 = 1.72 \\ m^2n^2 = 0.1296 \\ \therefore m^2+n^2+1 > m^2n^2 \end{array}}$

$$\sigma_{z(1)} = \frac{1}{4\pi}\left[\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2} \times \frac{m^2+n^2+2}{m^2+n^2+1} + \sin^{-1}\left(\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+1+m^2n^2}\right)\right]$$

$$= \frac{120}{4\times3.1416}\left[\frac{2\times0.6^2\sqrt{2\times0.6^2+1}}{1.72+0.1296} \times \frac{2\times0.6^2+2}{2\times0.6^2+1} + \sin^{-1}\left(\frac{2\times0.6^2\sqrt{1.72}}{1.72+0.1296}\right)\right]$$

$$= 7.71 + \underline{120\times(4\times3.1416)^{-1}} \times 0.536$$

(in radian)

$= 7.71 + 5.12$

$= 12.83\ KN/m^2$

From chart, $m=0.6$, $n=0.6$, $I_3 = 0.1$
$\therefore \sigma_{z(2)} = 0.1069\times120 = 12.828$

$\underline{\sigma_{z(2)}}$

$m = \frac{6}{5} = 1.2$, $n = \frac{3}{5} = 0.6$,

$$\sigma_{z(2)} = \frac{120}{4\times3.1416}\left[\frac{2\times1.2\times0.6\sqrt{1.2^2+0.6^2+1}}{1.2^2+0.6^2+1+1.2^2\times0.6^2} \times \frac{1.2^2+0.6^2+2}{1.2^2+0.6^2+1} + \sin^{-1}\left(\frac{2\times1.2\times0.6\times\sqrt{1.2^2+0.6^2+1}}{1.2^2+0.6^2+1+1.2^2\times0.6^2}\right)\right]$$

$= 9.41 + 7.76 = 17.17\ KN/m^2$

From chart, $m=1.2$, $n=0.6$, $I_3 = 0.$
$\sigma_{z(2)} = 16.9972\ KN/m$

$\underline{\sigma_{z(3)}}$ $m = \frac{3}{5} = 0.6$, $n = \frac{1.5}{5} = 0.3$

From chart, $I_3 = 0.0629$ [B.M. DAS, page 246]

$\therefore$ $\sigma_{z(3)} = 0.0629 \times 120 = 7.548$ KN/m²

$\therefore$ $\sigma_{z(P)} = 12.83 + 17.17 + 7.548$

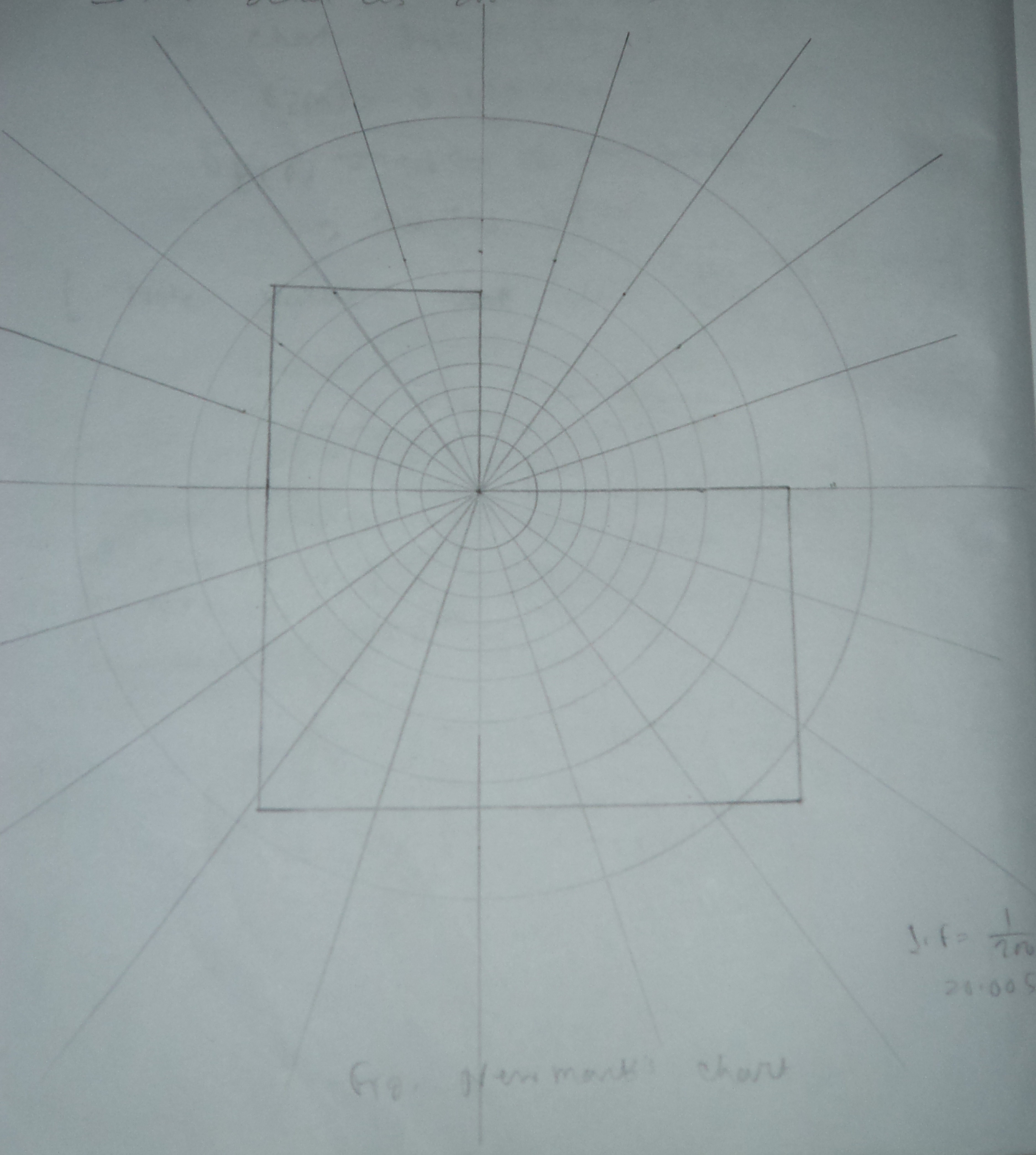
$= 37.548$ KN/m

[Note: Value's are close to each other]

2008-09 7(b)

(use $z = 4\,cm = 0.04\,m$, radius are 1.08, 1.6, 2.08, 2.56, 3.08, 3.68, 4.44, 5.56, 7.64 cm)

→ show detail as 2009-10 → 8(c)



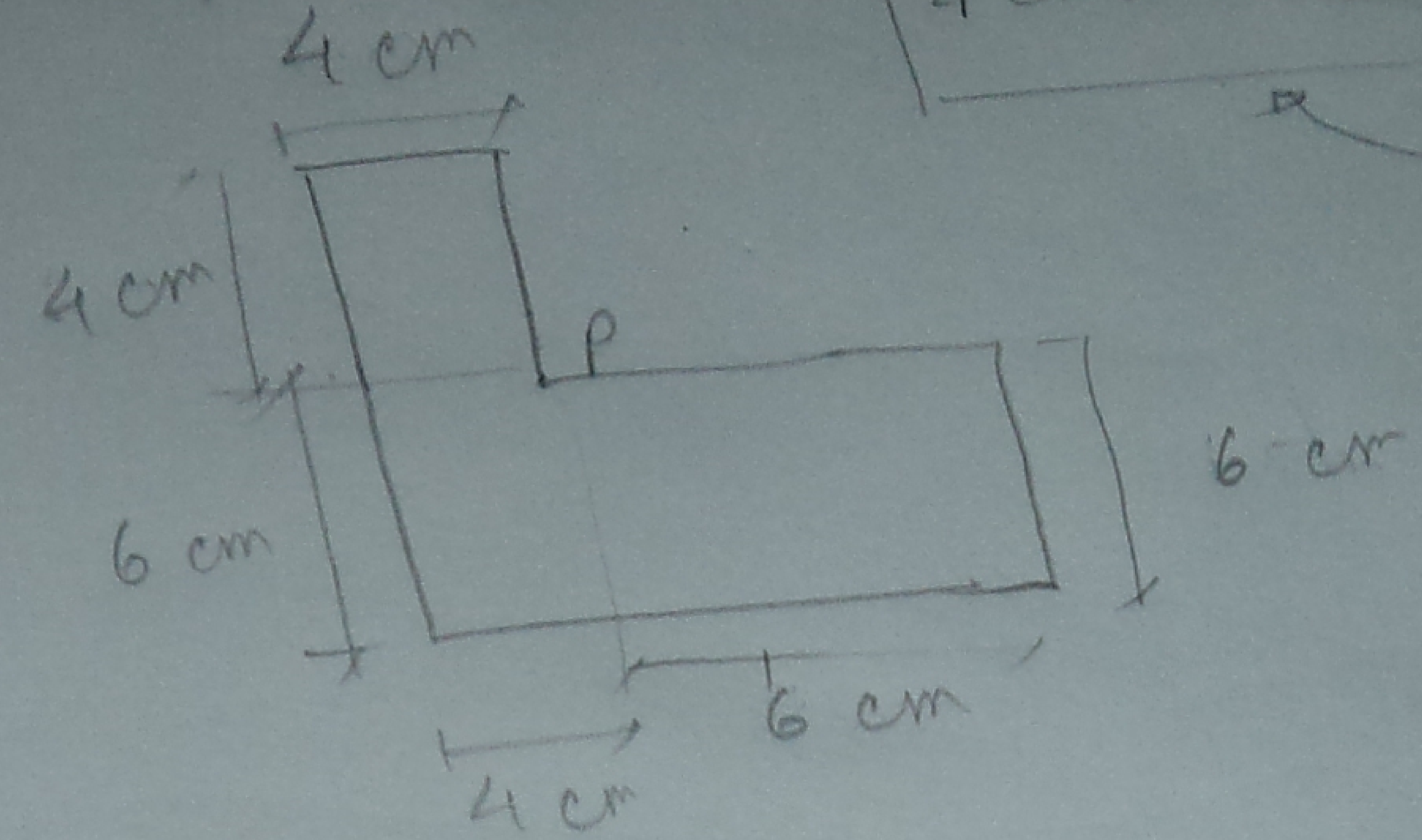
$I.F = \frac{1}{200} = 0.005$

Fig. Newmark's chart

Equivalent dimension of L-shaped building to plot newmark's chart is as below

$4\ cm = 10\ m$

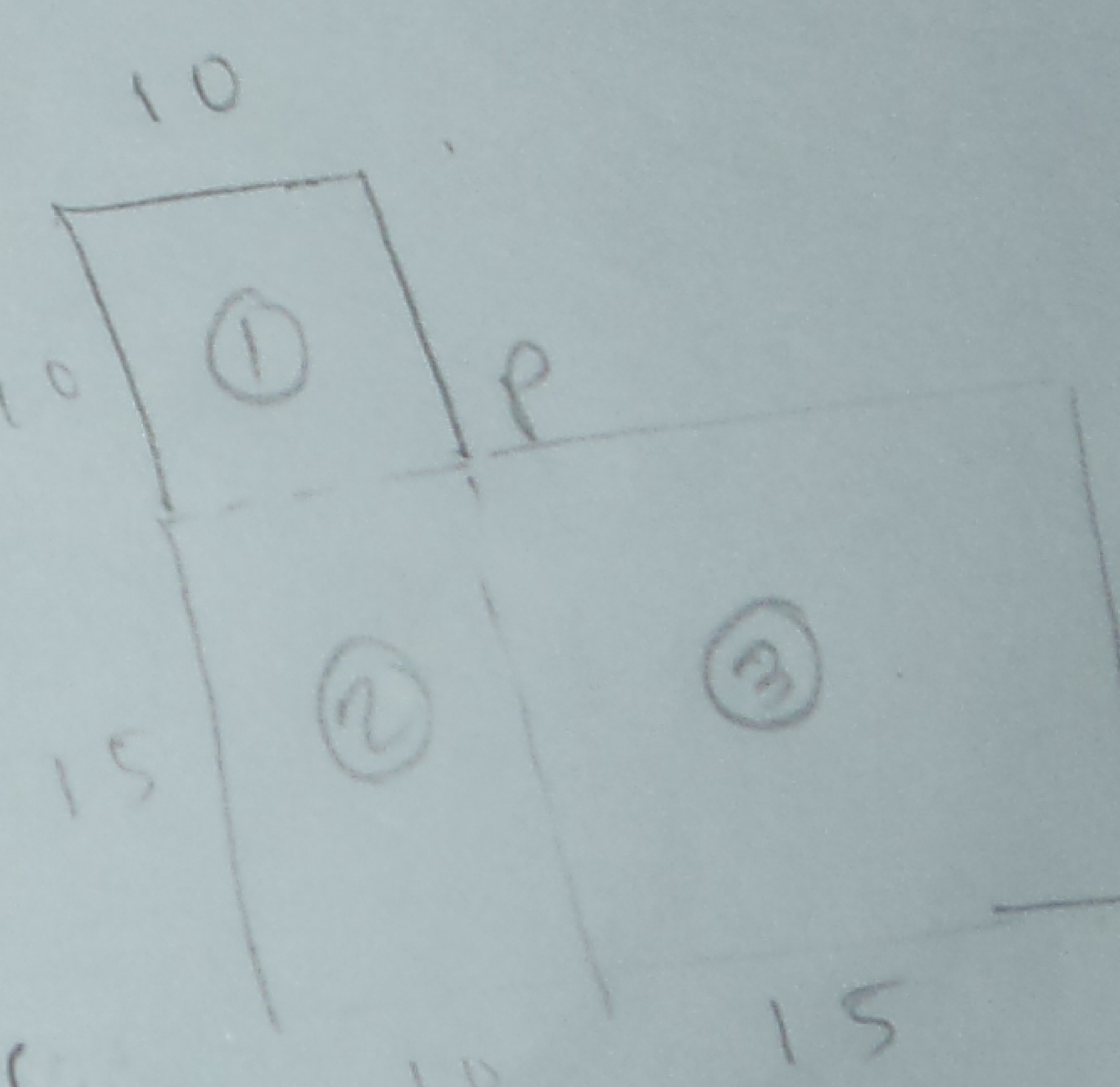
Actual depth $= 10\ m$
in Newmark's chart, $= 4\ cm$
so, $4\ cm = 10\ m$



From Newmark's chart
No of divison $= 116.5$

so, $\sigma_z(P) =$ No of div $\times$ I.F $\times$ q
$= 116.5 \times 0.005 \times 75$ KN/m²
$= 43.6875$ KN/m²

Analytical Solution:



$\sigma_{z(1)}$
$m = \frac{10}{10} = 1$, $n = 1$
From chart (B.M. DAS, page 246)
$I_n = 0.1752$
$\sigma_{z(1)} = 0.1752 \times 75 = 13.14$ KN/m²

$\sigma_{z(2)}$ $m = 1$, $n = 1.5$, $I_n = 0.186$
$\sigma_{z(2)} = 0.186 \times 75 = 13.95$ KN/m²

$\sigma_{z(3)}$ $m = 1.5$, $n = 1.5$, $I_n = 0.2095$
$\sigma_{z(3)} = 15.7125$ $\sigma_{P(z)} = 42.8025$ KN/m²

2021-05:

4 (a) → theory

4 (b)

We know, $\sigma_z = \frac{3Q}{2\pi} \frac{z^3}{(r^2+z^2)^{5/2}}$

here, $z = 1$ m,

$\therefore \sigma_z = \frac{3Q}{2\pi} \cdot \frac{1}{(r^2+1)^{5/2}}$

$= \frac{3Q}{2\pi} \times \cancel{\frac{1}{(r^2+1)^{5/2}}} (r^2+1)^{-5/2}$

For $\sigma_z(max)$, $\frac{d\sigma_z}{dr} = 0$

$\Rightarrow \frac{3Q}{2\pi} \times \left(-\frac{5}{2}\right) \times (r^2+1)^{-6/2} \times (2r) = 0$

$\Rightarrow r \times (r^2+1)^{-6/2} = 0$

$\therefore r = 0$ or $(r^2+1)^{-6/2} = 0 \Rightarrow r^2+1 = 0$

$\Rightarrow r = \sqrt{-1}$, which is impossible

So, for $r = 0$, $\sigma_{z(max)}$ occur.

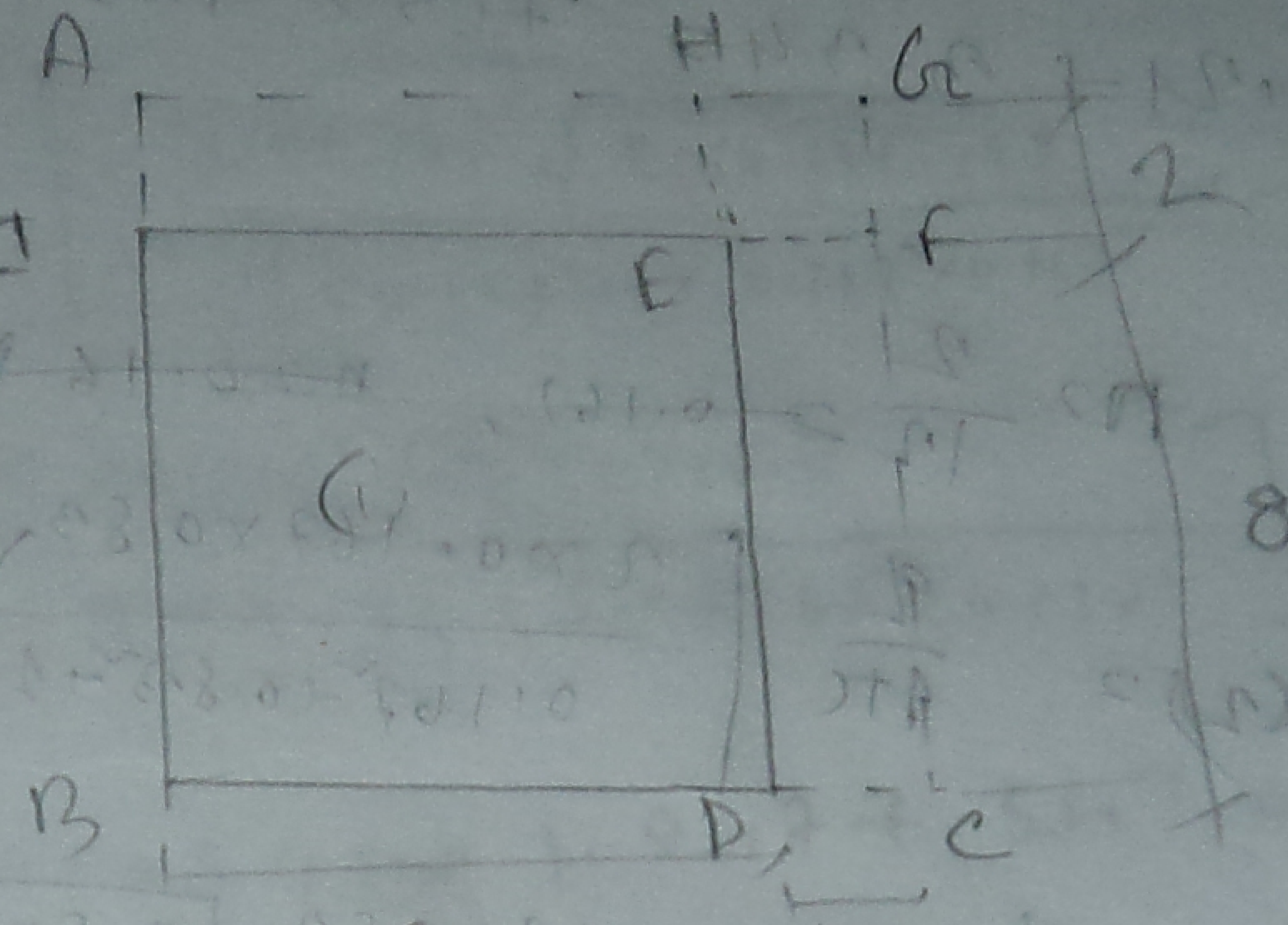
So, $\sigma_{z(max)} = \frac{3Q}{2\pi} \times \frac{1}{(0+1)^{5/2}}$

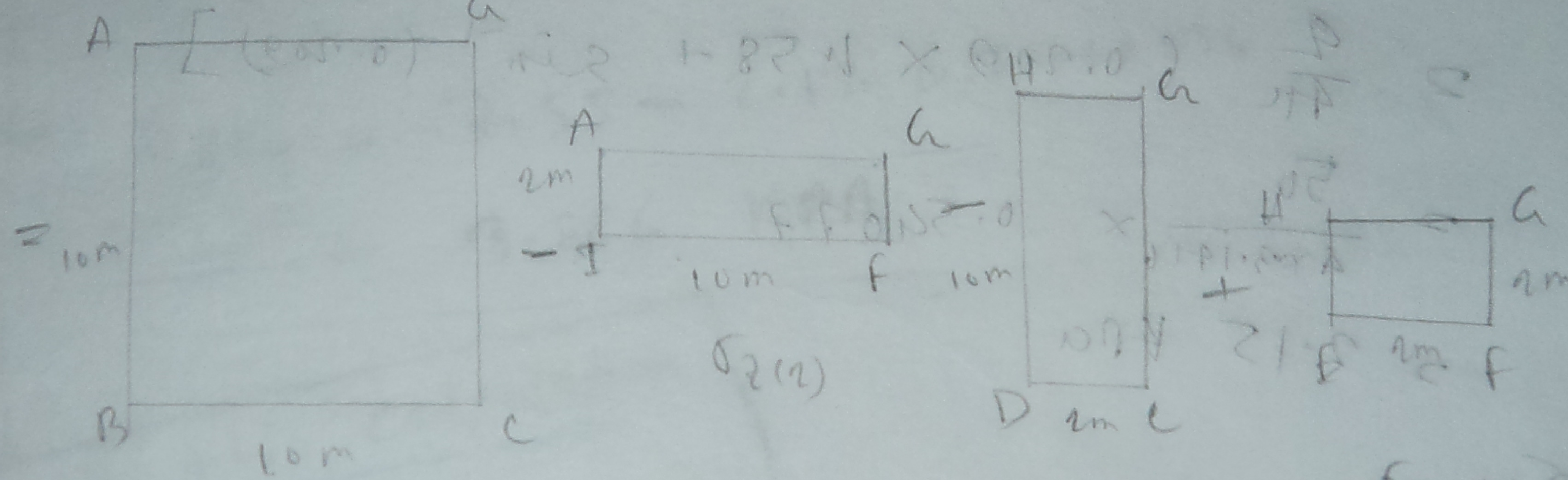
$= \frac{3Q}{2\pi}$.

Ans. $\frac{3Q}{2\pi}$

2004-05:

4(e)





$\therefore \sigma_{z(G)} = \sigma_{z(1)} - \sigma_{z(2)} - \sigma_{z(3)} + \sigma_{z(4)}$

$\sigma_{z(1)}$

$m = \frac{10}{12} = 0.83, \quad n = 0.83..$

$$\sigma_{z(1)} = \frac{q}{4\pi} \times \left[\frac{2\times0.83\times0.83\sqrt{2\times0.83^2+1}}{2\times0.83^2+1+0.83^2\times0.83^2} \times \frac{2\times0.83^2+2}{2\times0.83^2+1} + \sin^{-1}\frac{2\times0.83^2\sqrt{2\times0.\ldots}}{2\times0.83^2+1+0.\ldots} \right.$$

$= \frac{q}{4\pi} \times$

$= 4.21 + 3.34 = 7.55$ KPa

$\sigma_{z(2)}$

$n = \frac{2}{12} = 0.167$, ~~n = 0.16~~ $m = \frac{10}{12} = 0.83$

$$\sigma_{z(2)} = \frac{q}{4\pi}\left[\frac{2\times0.167\times0.83\sqrt{0.83^2+0.167^2+1}}{0.167^2+0.83^2+1+0.83^2\times0.167^2}\times\frac{0.83^2+0.167^2+2}{0.83^2+0.167^2+1}\right.$$

$$\left.+\sin^{-1}\left(\frac{2\times0.167\times0.83\sqrt{0.83^2+0.167^2+1}}{0.167^2+0.83^2+1+0.83^2\times0.167^2}\right)\right]$$

$= \frac{q}{4\pi}\left(0.209\times1.58+\sin^{-1}(0.209)\right]$

$= \frac{50}{4\times3.1416}\times 0.54077$

$= 2.15$ KPa

$\sigma_{z(3)}$

$m = 0.83$, $n = 0.167$

As m and n are interchangable.

so, $m = 0.167$, $n = 0.83 \rightarrow$ same as

$\sigma_{z(2)}$.

$\therefore \sigma_{z(3)} = \sigma_{z(2)} = 2.15$ KPa

$\underline{\sigma_{z(4)}}$

$m = \frac{2}{12} = 0.167, \quad n = 0.167$

$$\sigma_{z(4)} = \frac{50}{4\times3.1416} \times \left[\frac{2\times0.167^2\sqrt{2\times0.167^2+1}}{2\times0.167^2+1+0.167^2\times0.167^2} \times \frac{2\times0.167^2+2}{2\times0.167^2+1} + \sin^{-1}\frac{2\times0.167^2\sqrt{2\times0.167^2+1}}{2\times0.167^2+1+0.167^2\times0.167^2} \right]$$

$$= \frac{50}{4\times3.1416}\left(0.0542 \times 1.947 + \sin^{-1} 0.0542\right)$$

$$= 0.636 \text{ KPa}$$

So, $\sigma_{z(4)} = 7.55 - 2.15 - 2.15 + 0.636$

$= 3.886$ KPA.

Follow this calculation procedure

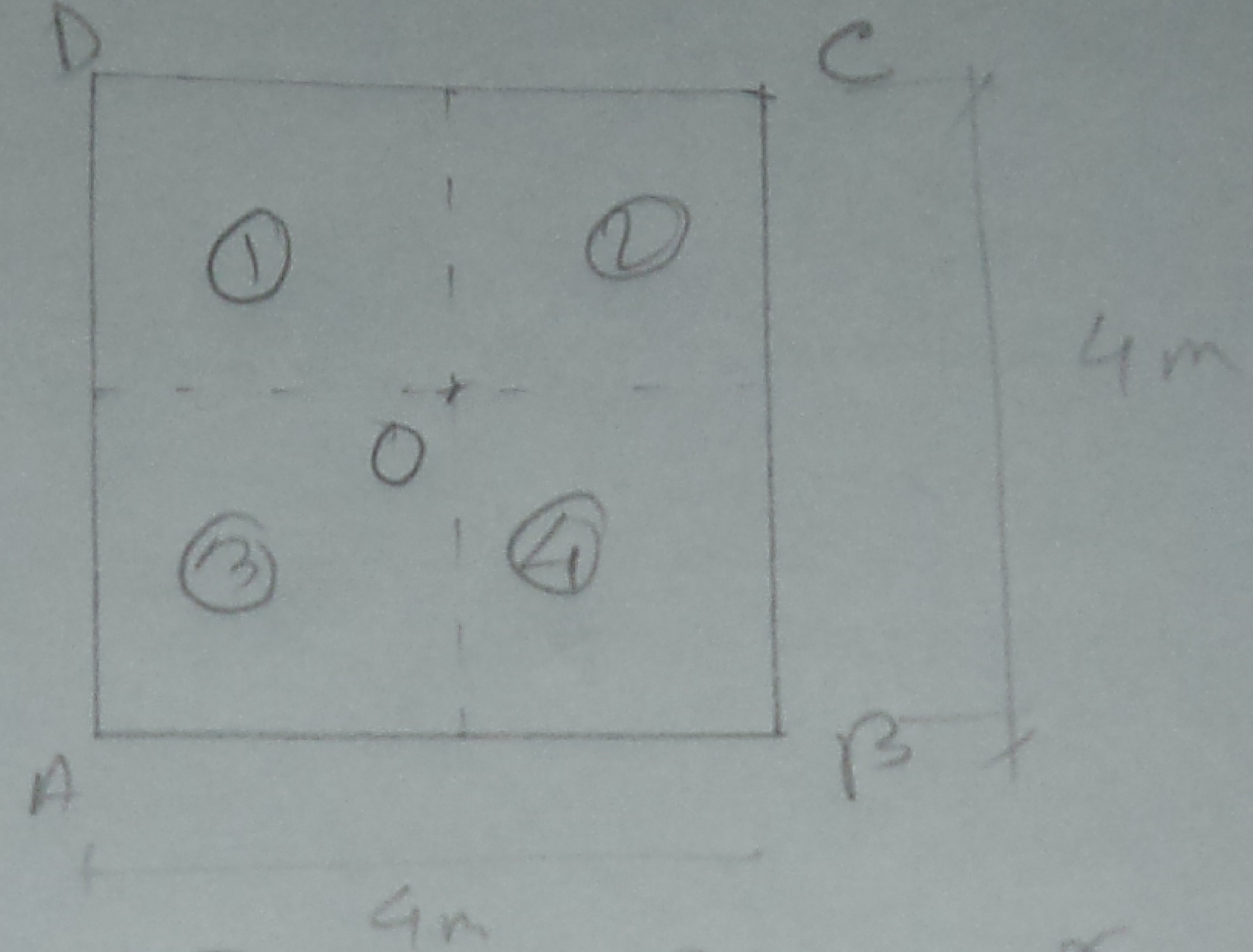
Second way'

By Newmark's chart:

2017-03'

8(a)

At centre



$$\sigma_{z(0)} = \sigma_{z(1)} + \sigma_{z(2)} + \sigma_{z(3)} + \sigma_{z(4)}$$

$\sigma_{z(1)}$

$m = \frac{2}{5} = 0.4, \quad n = \frac{2}{5} = 0.4$

$\sigma_z = 8 \times 0.0602$

$= 0.4816 \text{ ton/m}^2$

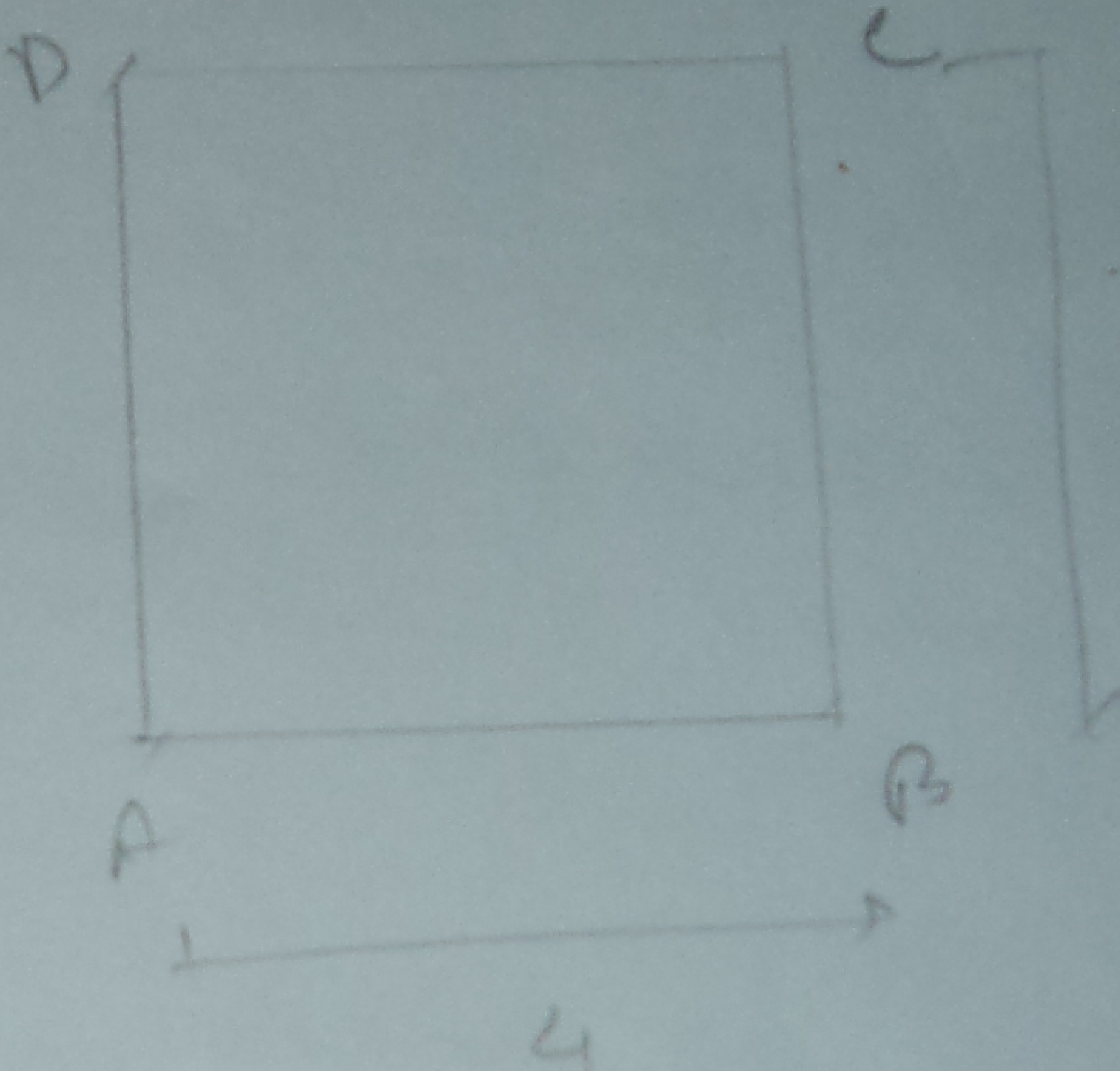
for $\sigma_{z(2)}$, $\sigma_{z(3)}$, $\sigma_{z(4)}$

$m = 0.4$, $n = 0.4$

$\sigma_{z(1)} = \sigma_{z(2)} = \sigma_{z(3)} = \sigma_{z(4)} = 0.4816$ ton/m²

$\therefore \sigma_{z(0)} = 4 \times 0.4816 = 1.9264$ ton/m²

At corner point:



$m = \frac{4}{5} = 0.8$, $n = 0.8$

Weight - Volume Relationship, Compaction

2008-09

5 ~~finished~~ In finished Area

$\gamma_{bulk(f)} = 2$ ton/m³ , $w = 21\% \; 20.21$

$\gamma_{d(f)} = \frac{2}{1+0.21} = 1.65$ ton/m³

$V_f = 4 \times 10^6$ m³

∴ weight of dry soild, $W_s = \gamma_{d(f)} \times V_f$

$= 4 \times 10^6 \times 1.65$ m³

$= 6.6 \times 10^6$ m³

Total water present, $W_f = \gamma_{d(f)} \times V_f \times w_f = 13\,86,000$ KN

~~Excav~~

for Site A:

$e_A = 0.79$, $w_A = 0.18$

$G_s = 2.65$,

$\gamma_{bulk(A)} = \frac{G_s \gamma_w (1+w_A)}{1+e_A} = \frac{2.65 \times 1 \times (1+0.18)}{1+0.79}$

$= 1.75$ ton/m³

$\gamma_{d(A)} = \frac{1.75}{1+0.18} = 1.48$ ton/m³

for 10% increase of ~~to~~ volume

$\frac{\gamma_{d A)}}{\gamma_{d(f_A)}} = \frac{1.1V}{V} \Rightarrow \gamma_{d(f_A)} = \frac{1.48}{1.1} = 1.35$ ton/m³

$\gamma_{d(t_A)} \rightarrow$ dry wt of soil in truck from site A

dry wt of soil remains unchanged.

$\therefore \gamma_{d(t_A)} \times V_{t(A)} = W_s$

$\Rightarrow V_{t(A)} = \frac{6.6\times10^6}{1.35}\ m^3 = 4.89\times10^6\ m^3$

No of truck $N_A = \frac{4.89\times10^6}{10}$

$= 4.89\times10^5$

cost for excavation, transportation and compaction in site $A = 4.89\times10^5 \times 1000$ TK

$= 4.89\times10^8$ TK

Assume that, swelling of soil is due to only change in air (water content is constant)

$\therefore \omega_{t(A)} = 0.18$

$\gamma_{bulk(t_A)} = \gamma_{d(t_A)} \times (1+W_{t(A)})$

$= 1.35\times(1+0.18)$

$= 1.59$ ton/m^3

excess water required to brought soil in finished area condition in $m^3 = \gamma_{bulk(f)} - \gamma_{bulk(t_A)}$ Total water present

$= 2 - 1.59 = 0.41$ ton/m^3

For $4\times10^6\ m^3 = 4\times10^6\times0.41\ m^3$

$= 1.64\times10^6\ m^3$

No of water carrying truck = $\frac{1.64\times10^6}{10} = 1.64\times10^5$

cost for carrying water = $1.64\times10^5 \times 300$ TK

$= 4.92\times10^7$ TK

Total cost for site A = $4.89\times10^8 + 4.92\times10^7$ TK

$= 5.382\times10^8$ TK

For site B:

$e_B = 0.65$, $w_B = 0.15$

$\gamma_{bulk(B)} = \frac{2.65\times1\times(1+0.15)}{1+0.65} = 1.85$ ton/m^3

$\gamma_{d(B)} = 1.61$ ton/m^3

$\gamma_{d(t_B)} = \frac{1.61}{1.1} = 1.46$ ton/m^3

$V_{t(B)} = \frac{6.6\times10^6}{1.46} = 4.5\times10^6$ m^3

$N_B = 4.5\times10^5$

cost for excavation, transportation and compaction for site B = $4.5\times10^5 \times \cancel{1000}\ 1150$ TK

$= \cancel{4.5\times10^8\ TK}\ 5.175\times10^8$

$w_{t(B)} = 0.15$

$V_{bulk(t_B)}$ ~~$= 4.5\times10^6 \times (1+0.15) = 5.18\times10^6$ m^3~~

$= 1.46\ (1+0.15) = 1.68$ ton/m^3

excess water = (2 − 1.68) ton/m^3 = 0.32 ton/m^3

cost for water = $\frac{0.32 \times 4 \times 10^6 \times 300}{10}$ TK

= 3.84 × 10^7 TK.

Total cost at B site B = $\cancel{4.5}$ 5.175 × 10^8 + 3.84 × 10^7 TK

= ~~4.88 × 10^8~~ TK.

= 5.56 × 10^8 TK.

As total cost at site A is less than total cost of site B, so site A is more economical.

2009-10 → 5(a) → theory

5(b) → "

5(c) → "

2007-08

5(a) → theory

5(b)

We know $\frac{V_f}{V_b} = \frac{1+e_f}{1+e_b}$

$\Rightarrow V_b = \frac{1+e_b}{1+e_f} \times V_f$

$= \frac{1+0.7}{1+1.2} \times 3.3 \times 10^5 \text{ m}^3$

$= 2.55 \times 10^5 \text{ m}^3$

in borrow ~~Area~~ area.

$e = 1.2$, $n = \frac{e}{1+e}$

$\Rightarrow \frac{V_{v(b)}}{V_{s(b)}} = 1.2$

$= \frac{1.2}{1+1.2} = 0.545$

$\Rightarrow V_{s(b)} = \frac{V_{v(b)}}{1.2}$

$\frac{V_{v(b)}}{V_b} = 0.545$

$= \frac{1.3898 \times 10^5}{1.2}$

$\Rightarrow V_{v(b)} = 0.545 \times 2.55 \times 10^5 \text{ m}^3$

$= 1.3898 \times 10^5 \text{ m}^3$

$= 1.16 \times 10^5 \text{ m}^3$

~~$= 1.158 \times 10^5 \text{ m}^3$~~

so, wt of soil removed, $W_s = V_s \times G_s \gamma_w$

$= 1.16 \times 10^5 \times 2.7 \times 9.81$ kN

$= 3.0725 \times 10^6$ kN

$= 3.1320 \times 10^{8}$ Kg.

2007-08'

5(c) $n = 0.3$

$\Rightarrow \frac{e}{1+e} = 0.3$

$\Rightarrow e = 0.429$

$\gamma_{d(f)} = \frac{wG_s}{1+e}$

$= \frac{2.67 \times 9.81}{1+0.429}$ KN/m³

$= 18.3$ KN/m³

$$D_r = \frac{\frac{1}{\gamma_{d(f)}} - \frac{1}{\gamma_{d(min)}}}{\frac{1}{\gamma_{d(max)}} - \frac{1}{\gamma_{d(min)}}}$$

$$= \frac{\frac{1}{18.3} - \frac{1}{13.34}}{\frac{1}{21.4} - \frac{1}{13.34}}$$

$= 0.72$

$= 72\%$

Value of relative density (D_r) is 72%, which is in the range 65–85.

So, state of compaction of the soil is dense.

2006-07:

5(a) → theory

5(b) → "

5(c) → "

5(d)

$\gamma_{bulk} = 2.06 \ t/m^3$

$= 20.21 \ KN/m^3$

$\gamma_d = \dfrac{\gamma_{bulk}}{1 + w_{opt}}$

$= \dfrac{20.21}{1 + 0.14} \ KN/m^3$

$= 17.73 \ KN/m^3$

$\gamma_d = \dfrac{G_s \gamma_w}{1+e}, \quad e = \dfrac{wG_s}{S_r}$

$= \dfrac{G_s \gamma_w}{1 + \dfrac{wG_s}{S_r}}$

$\gamma_d = \dfrac{G_s \gamma_w}{1 + \dfrac{wG_s}{S_r}}$

For zero air voids, $S_r = 1.0$

$$\therefore \gamma_d = \frac{2.67 \times 9.81}{1 + \frac{0.14 \times 2.67}{1}} \text{ KN/m}^3$$

$$= 19.07 \text{ KN/m}^3$$

$$\therefore \gamma_d = \frac{G_s \gamma_w}{1+e}$$

$$\Rightarrow 1+e = \frac{G_s \gamma_w}{\gamma_d}$$

$$\Rightarrow e = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{2.67 \times 9.81}{17.73} - 1$$

$$= 0.477$$

$$\gamma_{sat} = \frac{G_s + e}{1+e} \gamma_w$$

$$= \frac{2.67 + 0.477}{1 + 0.477} \times 9.81 \text{ KN/m}^3$$

$$= 20.9 \text{ KN/m}^3$$

2005-06

5(a) → theory

5(b) → "

5(c) → "

5(d)

$n_b = 0.9$,

$\frac{e_b}{1+e_b} = 0.9 \Rightarrow e_b = 9$

$\frac{V_f}{V_b} = \frac{1+e_f}{1+e_b}$

$\Rightarrow V_b = \frac{1+e_b}{1+e_f} \times V_f$

$= \frac{1+9}{1+0.4056} \times 20,000$

$= 1.4229 \times 10^5 \ m^3$

$\gamma_{df} = \frac{G_s \gamma_w}{1+e_f}$

$\Rightarrow \frac{\gamma_{bulk}}{1+w} = \frac{G_s \gamma_w}{1+e_f}$

$\Rightarrow \frac{21.67}{1+0.115} = \frac{2.70 \times 9.81}{1+e_f}$

$\Rightarrow e_f = 0.4056$

$\therefore$ cost of compensation $= 1.4229 \times 10^5 \times 40$ TK

$= 5.6915 \times 10^6$ TK.

$= 5.6915$ lakh.

2004-05:

1 (a)

$V_f = 350,000\ ft^3$

$\gamma_{bulk(f)} = 126\ lb/ft^3,\ \omega_f = 0.14 \Rightarrow \gamma_{d(f)} = 110.53\ lb/ft^3$

$\cancel{\gamma_{bulk(f)} = 126(1+0.14) = 143.64\ lb/ft^3}$

$\gamma_{d(f)} = \frac{G_s \gamma_w}{1+e_f} \Rightarrow e_f = \frac{2.65 \times 62.3}{143.64} - 1$

$= \cancel{2\ 0.153}\ 0.50$

For first site (site A)

$\gamma_{d(A)} = \frac{\gamma_{bulk(A)}}{1+\omega_A}$

$\Rightarrow \frac{G_s \gamma_w}{1+e_A} = \frac{101}{1+0.1}$, $\boxed{G_s = 2.65}$

$\Rightarrow e_A = 0.8$

$\frac{V_A}{V_f} = \frac{1+e_A}{1+e_f} \Rightarrow V_A = \frac{1+e_A}{1+e_f} \times V_f$

$= \frac{1+0.8}{1+0.150} \times 350,000\ ft^3$

$= \cancel{546640.07\ ft^3}$

$= 420,000\ ft^3$

$\cancel{\gamma_{bulk(A)} = 101}$

As water content change, so this soil has to provided with additional water.

cost of site A (including transportation)

$= (5+2.50+1) \times \cancel{546,407.07} \text{ TK } 420,000$

$\cancel{= 4,64,440.6 \text{ TK}} = 3,570,000$ TK

From second site: (site B)

$\gamma_d = \frac{96}{1+0.14} = 84.21 \text{ lb/ft}^3$

$\frac{G_s \gamma_w}{1+e_B} = 84.21$

$\Rightarrow e_B = 0.967$

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

$\Rightarrow V_B = \frac{1+e_B}{1+e_f} \times V_f$

$= \frac{1+0.967}{1+0.5} \times 350,000 \text{ ft}^3$

$= 458,966.67 \text{ ft}^3$

As water content is same, no additional water is needed.

cost of site B

$= (5+2.5) \times 458,966.67$ TK

$= 3,442,250$ TK.

2108-09

In finished Area

$\gamma_{bulk(f)} = 2 \text{ ton}/m^3 = 19.62 \text{ KN}/m^3$

$w_f = 0.21$.

$\gamma_{d(f)} = \frac{19.62}{1+0.21} = 16.21 \text{ KN}/m^3$

$V_f = 4 \times 10^6 \ m^3$

$\frac{G_s \gamma_w}{1+e_f} = 16.21 \Rightarrow e_f = \frac{2.65 \times 9.81}{16.21} - 1$

$e_f = 0.6$

Total water present $\Rightarrow W_{w(f)} = \gamma_{d(f)} \times V_f \times w = 16.21 \times 4 \times 10^6 \times 0.21$

$= 1.3616 \times 10^7$ KN

For site A

$e_A = 0.79$, $w_A = 0.18$

$\gamma_{bulk(A)} = \frac{G_s \gamma_w (1+w_A)}{1+e_A}$

$= \frac{2.65 \times 9.81 (1+0.18)}{1+0.79} = 17.14 \text{ KN}/m^3$

$\gamma_{d(A)} = \frac{17.14}{1+\cancel{0.18}\ 0.18}$ $\gamma_{d(A)} = 14.52 \text{ KN}/m^3$

$\Rightarrow \frac{G_s \gamma_w}{1+e_A} = \frac{17.14}{1+0.18}$

$e_A =$

$\frac{\gamma_{d(tA)}}{\gamma_{d(A)}} = \frac{\frac{W_s}{V_{tA}}}{\frac{W_s}{V_A}}$

$V_{tA} = 1.1 V_A$

$W_s \to$ wt of soil

$\Rightarrow \gamma_{d(tA)} = \frac{1.0}{1.1} \gamma_{d(A)}$

$\gamma_{d(tA)} = 13.2 \ KN/m^3$

$\Rightarrow \dfrac{G_s \gamma_w}{1+e_{tA}} = 13.2$

$\Rightarrow e_{tA} = 0.969$

Assume that, water content does not change due to swelling of water.

$\therefore \omega_{tA} = \omega_A = 0.18$

$\dfrac{V_{t(A)}}{V_f} = \dfrac{1+e_{tA}}{1+e_f}$

$\Rightarrow V_{t(A)} = \dfrac{(1+e_{tA})}{1+e_f} \times V_f$

$= \dfrac{1+0.969}{1+0.6} \times 4\times10^6 \ m^3$

$= 4.9225 \times 10^6 \ m^3$

Total amount of water $= 13.2 \times 4.9225\times10^6 \times 0.18 \ KN$

$= 1.1696 \times 10^7 \ KN$

No of truck for soil $= \dfrac{4.9225\times10^6}{10} = 4.9225\times10^5$

water truck $= \dfrac{(1.3616 - 1.1696)\times10^7}{10}$

$= 0.192 \times 10^6$

Total cost for site A = $(4.9225 \times 10^5 \times 1050 + 0.192 \times 10^6 \times 300)$ TK

$= 5.4985 \times 10^8$

$= 5.5 \times 10^8$ TK

$= 5.5$ crore

For site B:

$e_B = 0.65$, $\omega_B = 0.15$

$\gamma_{d(B)} = \frac{2.65 \times 9.81}{1+0.65} = 15.76$ KN/m^3

$\gamma_{d(fB)} = \frac{1}{1.1} \times 15.76 = 14.32$ KN/m^3

$e_{fB} = \frac{2.65 \times 9.81}{14.32} - 1 = 0.815$

$\omega_{fB} = \omega_B = 0.15$,

$V_{f(B)} = \frac{1+0.815}{1+0.6} \times 4 \times 10^6 = 4.5375 \times 10^6$ m^3

$W_{w(B)} = 14.32 \times 4.5375 \times 10^6 \times 0.15$ KN

$= 9.7466 \times 10^6$ KN

No of truck for $= \frac{4.5375 \times 10^6}{10} = 4.5375 \times 10^5$

water truck $= \frac{1.3616 \times 10^7 - 9.7466 \times 10^6}{10}$

$= 3.8694 \times 10^5$

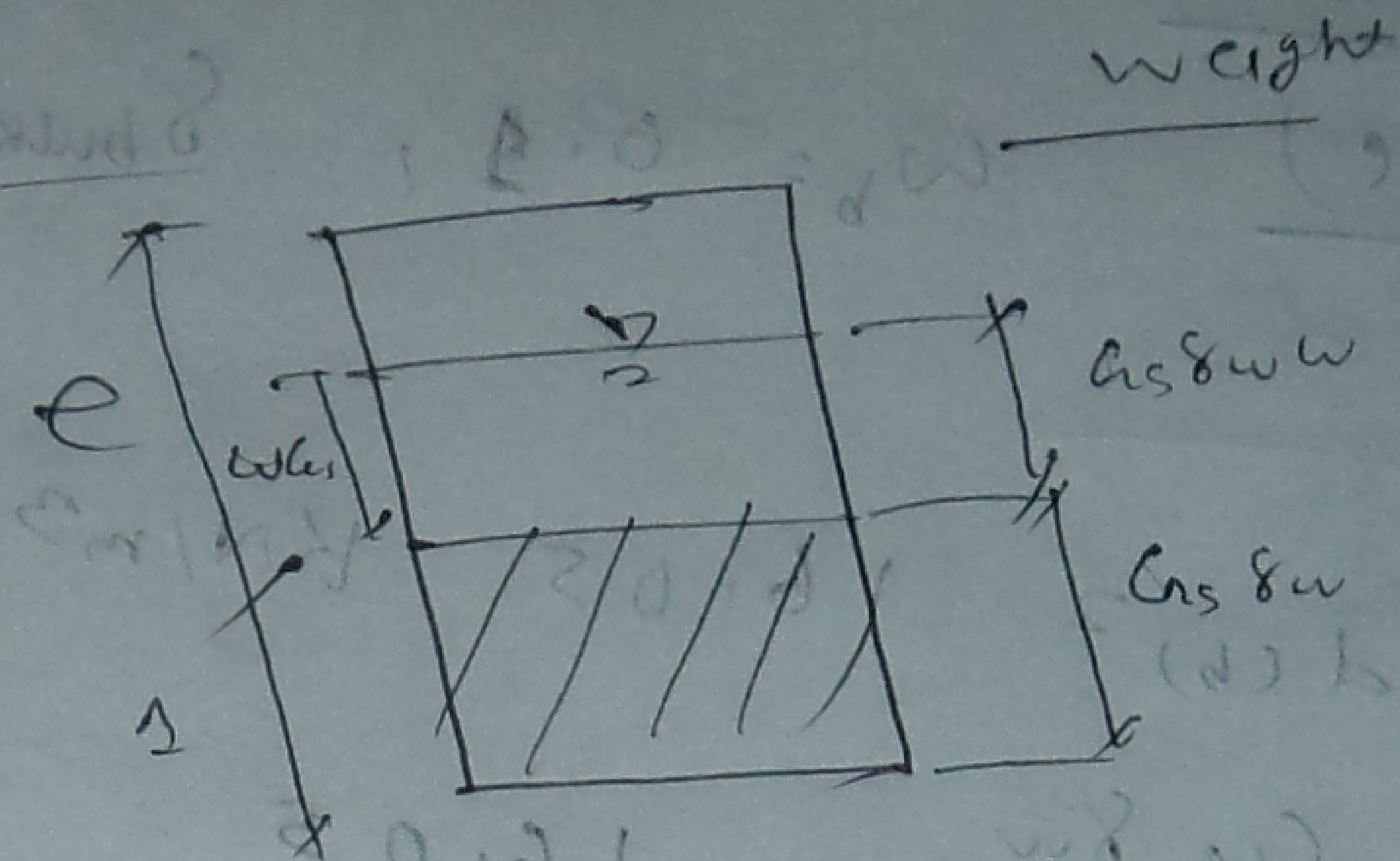
$\therefore$ cost of site B $= 4.5375 \times 10^5 \times 1150 + 3.8694 \times 10^5 \times 300$ TK

$= 6.3289 \times 10^8$ TK

As cost of site B is more so, site A is more economical.

2008-09

5(b)



$\gamma = \gamma_{bulk} = \dfrac{wG_s\gamma_w + G_s\gamma_w}{1+e}$ (from phase diagram)

$\Rightarrow \gamma = \dfrac{wG_s\gamma_w + G_s\gamma_w}{1+e}$

We know, $S_r = \dfrac{wG_s}{e}$

$\Rightarrow e = \dfrac{wG_s}{S_r}$

$\gamma = \dfrac{wG_s\gamma_w + G_s\gamma_w}{1+\frac{wG_s}{S_r}}$

$1+\dfrac{wG_s}{S_r} = \dfrac{wG_s\gamma_w + G_s\gamma_w}{\gamma}$

$\dfrac{wG_s}{S_r} = \dfrac{G_s\gamma_w(1+w) - \gamma}{\gamma}$

$\Rightarrow S_r = \dfrac{wG_s\gamma}{G_s\gamma_w(1+w) - \gamma} = \dfrac{w}{\frac{\gamma_w}{\gamma}(1+w) - \frac{1}{G_s}}$

$\Rightarrow S_r = \dfrac{w}{\frac{\gamma_w}{\gamma}(1+w) - \frac{1}{G_s}}$ (proved)

2008-09

5(e) $\omega_b = 0.1$, $\gamma_{bulk(b)} = 1.8 \times 9.81$ KN/m³ $= 17.658$ KN/m³

$\gamma_{d(b)} = 16.05$ KN/m³

$\frac{G_s \gamma_w}{1+e_b} = 16.05$, ($G_s = 2.65$ (assumed))

$\Rightarrow e_b = 0.62$.

$\omega_f = 0.18$, $\gamma_{d(f)} = 18.1483$ KN/m³

$\Rightarrow \frac{G_s \gamma_w}{1+e_f} = 18.1483$

$\Rightarrow e_f = 0.43$

Let, $V_b = 1$ m³

$\frac{V_f}{V_b} = \frac{1+e_f}{1+e_b}$

$\Rightarrow V_f = 0.8827$ m³

water ~~present~~ or needed in finished material

$\Rightarrow W_{f(w)} = V_f \times \gamma_{d(f)} \times \omega_f$

$= 2.8835$ KN

water present in borrow material, $W_{b(w)} = V_b \times \gamma_{d(b)} \times \omega_b$

$= 1 \times 16.05 \times 0.1 = 1.605$ KN

So, required water for 1 m^3 borrow soil

$= (2.8835 - 1.605)$ KN

$= 1.2785$ KN

$= 130.3326$ Kg

$= 0.13$ m^3 of water

$\boxed{V = \frac{M}{\rho}}$

$V_f = 1 m^3$

$\frac{V_b}{V_f} = \frac{1+e_b}{1+e_f}$

$\Rightarrow V_b = \frac{1+0.62}{1+0.43} \times 1 = 1.13$ m^3

So, 1.13 m^3 excavation is needed for 1 m^3 compacted embankment.

2019-09

5 (d) → theory

Hydraulic Property Of Soil:

2009-10

6(a) → theory # 6(b) → cls lechure

6(c)

$$\gamma_{sat} = \frac{G_s + e}{1+e}\gamma_w$$

$$= \frac{2.65+0.538}{1+0.538} \times 9.81$$

$$= 20.33\ KN/m^3$$

$n = \frac{e}{1+e}$

$\Rightarrow 0.352 = \frac{e}{1+e}$

$\Rightarrow e = 0.538$

$$\gamma' = \gamma_{sat} - \gamma_w$$

$$= 20.33 - 9.81$$

$$= 10.524\ KN/m^3$$

$$i_c = \frac{\gamma'}{\gamma_w}$$

$$= \frac{10.524}{9.81}$$

$$= 1.0728$$

We know, $f.s = \dfrac{i_c}{i_{avg}}$

$$i_{avg} = \cancel{\frac{i_c}{2}} \; \frac{i_c}{f.s}$$

$$= \frac{1.0728}{2} = 0.5364$$

Let, depth of sand (having same porosity i.e same i_c) and G_s i.e same e'

$= h_1$

$\therefore$ $i_{avg} = \dfrac{h}{h_1+2}$ $\left(\dfrac{\text{head}}{\text{length}}\right)$

$$\Rightarrow 0.5364 = \frac{1.90}{h_1+2}$$

$$\Rightarrow h_1+2 = 3.542$$

$$\Rightarrow h_1 = 1.542 \text{ m}$$

So, 1.542 m depth is required to secure $f.s = 2$ against piping.

Hydraulic Property Of soil

2009-10 → see in Geotech-I

2008-09 → " " "

2007-08

7(a) → theory

7(b) → theory

7(c)

$G_s = 2.68$, $e = 0.80$

$\therefore \gamma_{sat} = \frac{G_s + e}{1+e} \cdot \gamma_w$

$= \frac{2.68 + 0.80}{1 + 0.80} \times 9.81$ KN/m³

$= 18.966$ KN/m³

$\gamma' = \gamma_{sat} - \gamma_w$

$= 18.966 - 9.81$

$= 9.156$ KN/m³

$\therefore i_c = \frac{\gamma'}{\gamma_w}$

$= \frac{9.156}{9.81}$

$= 0.933$

7(d) → c/s lecture (theory)

2007-08:

8(a) → theory

8(b) → theory

8(c)

(a) $N_d = 12$, 10

$H = 10 - 0 = 10$ m

$N_f = 4$.

(i) seepage loss means seepage flow (q)

$K = 10^{-4}$ cm/sec

$q = K H \frac{N_f}{N_d}$

$= 10^{-4} \times 10 \times \frac{4}{12}$ cm³/sec

$= 3.3333 \times 10^{-4}$ cm³/sec. (per unit ~~length~~ width of sheet pile)

Let, seepage loss in one year = Q

$Q = q \times t$

$= 3.3333 \times 10^{-4} \times 365 \times 24 \times 3600$ cm³

$= 1.0512 \times 10^{4}$ cm³ / per unit length

(ii) ~~u_A~~

Remaining head at A = $5.5 \times \frac{10}{12}$

$= 4.58$ m

As upward flow at A.

$u_A = 2\gamma_w + 4.58 \times \gamma_w$

$= 6.5833\ \gamma_w$

$= 64.58$ KN/m²

(iii). At B, remaining head $= 1.5 \times \frac{10}{12}$

$= 1.25$ m

∴ seepage pressure $1.25\gamma_w$.

$u_A = 5\gamma_w + 1.25\gamma_w$

$= 6.25\ \gamma_w$

$= 61.3125$ KN/m²

$\sigma_A = 5 \times \gamma_{sat} = 5 \times 21 = 105$ KN/m²

∴ $\sigma'_A = \sigma_A - u_A$

$= 105 - 61.3125$

$= 43.6875$ KN/m²

2005-06

7(a)

$$\gamma_{d\,(sand)} = \frac{117-10}{1}\ lb/ft^3 = 107\ lb/ft^3$$

$$\gamma_{sat\,(sand)} = \frac{117+20-10}{1} = 127\ lb/ft^3$$

$$\gamma' = 127 - 62.4\ lb/ft^3$$

$$= 64.6\ lb/ft^3$$

$$i_c = \frac{\gamma'}{\gamma_w}$$

$$= \frac{64.6}{62.4} = 1.035$$

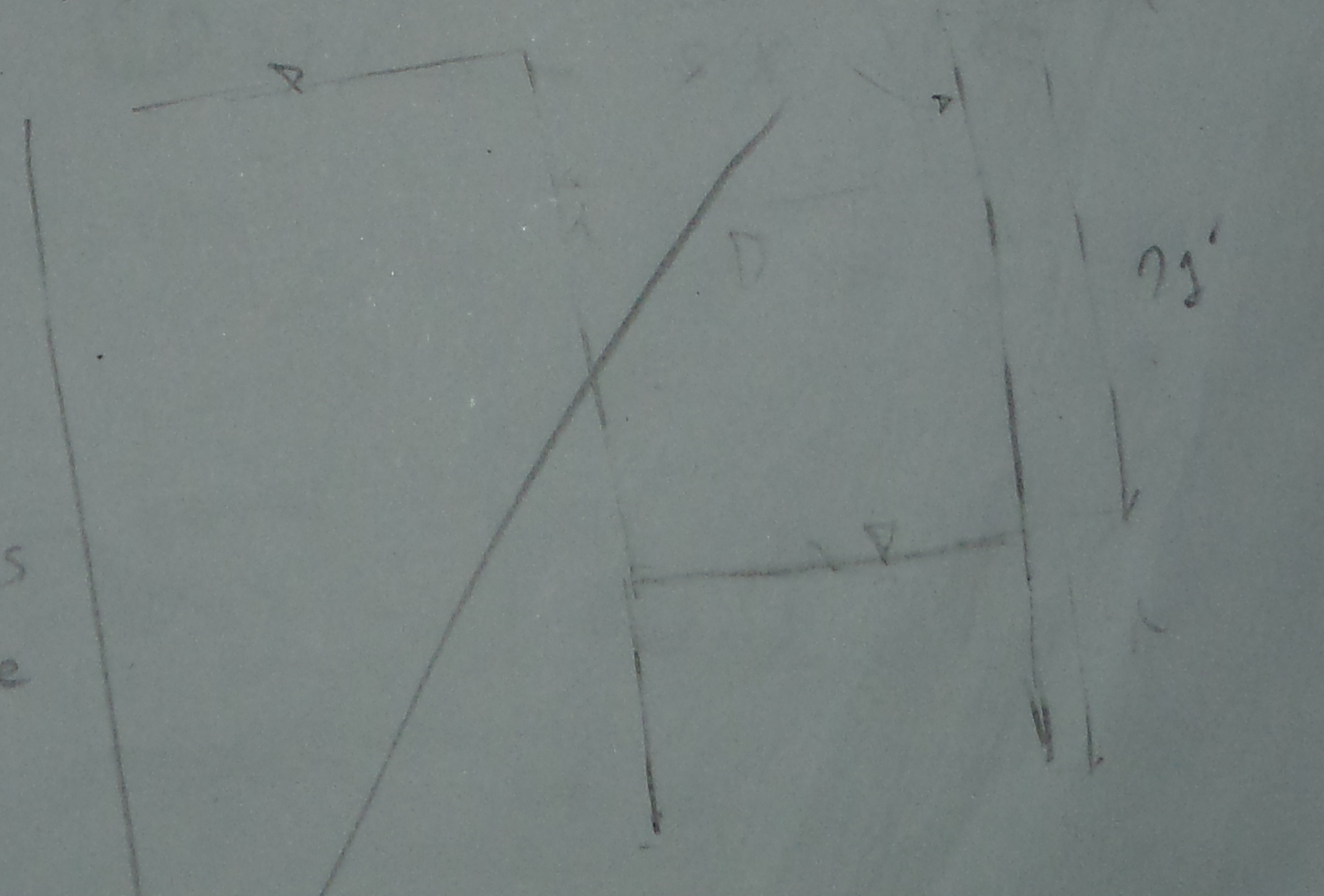
For impending quick sand condition

$$i_e = i_{avg}$$

$$\therefore i_{avg} = i_c$$

$$= 1.035$$

~~Let, consider the ... adjacent to the sheet pile and assume that head loss is proportional to the length of flow of~~



For flow line adjacent to the sheet pile L is minimum. so, i ~~is max~~ minimum length of sheet pile will be found.

head difference $H = 21$ ft

Total length $= 21 + 2x$

head loss for $(21+x) = \frac{21+x}{21+2x} \times 21$

Remainging head, $h = 21 - \frac{21+x}{21+2x} \times 21$

$= 21 \frac{x}{21+2x}$

$= \frac{21x}{21+2x}$

Length to be passed, $L = x$

$\therefore \frac{h}{L} = i_{avg}$

$\Rightarrow \frac{\frac{21x}{21+2x}}{x} = 1.035$

$\Rightarrow \frac{21}{21+2x} = 1.035$

$\Rightarrow x = -0.355$??

2005-06

7(b)

(i) $K = 2.2 \times 10^{-3}$ cm/sec

$N_d = 10$

$N_f = 4$

$H = 7$ m $= 700$ cm

$\therefore q = K H N_f \times \frac{1}{N_d}$

$= 2.2 \times 10^{-3} \times 7 \times 100 \times 4 \times \frac{1}{10}$ cm³/sec

$= 0.616$ cm³/sec (per unit width)

$Q = q \times t$, $t =$ one year $= 365 \times 24 \times 3600$

$= 0.616 \times 365 \times 24 \times 3600$ cm³

$= 19.43$ m³ (per unit width)

$\therefore$ seepage loss per year $= 19.43$ m³

(ii) at pt 1.

piezometer surface ~~pressure~~ head $= 7$ m (from ground level) (above)

~~From pt 1~~, pressure head $= 0$

at pt 2

piezometer surface (above) ~~pressure~~ head $= 7$ m (from GL)

~~From pt 2~~, pressure head $= 7$ m

at pt 3

piezometer surface position ~~pressure~~ head $= 7 - \frac{7}{10} = 6.3$ (from GL) (above)

~~from pt 3~~, pressure head = 6.3 + (93 − 91.4)

= 7.9 m

~~pt 4.~~

~~from GL, pressure head = 7 − 2 × 7/10 = 5.6 m~~

~~from pt~~

pt 4'

from GL, position of pizometer surface = $7 - 2 \times \frac{7}{10}$

= 5.6 m

∴ pressure head = 5.6 + (93 − 89.4)

= 9.2 m

pt 5:

From GL, position of pizometer surface = 7 − 3 × 0.7

= 4.9 m

∴ pressure head = 4.9 + (93 − 87.4) = 10.5 m

Points	position of pizometer surface from GL	pressure head
1	7.0 m above	0 m
2	7.0 m above	7 m
3	6.3 m above	7.9 m
4	5.6 m above	9.2 m
5	4.9 m above	10.5 m
6	4.2 m above	10.9 m
7	3.5 m above	10.5 m
8	2.8 m above	9.5 m
9	2.1 m above	7.7 m
10	1.4 m above	5.0 m
11	0.7 m above	2.3 m

~~from pt A~~, pressure head = 6.3 + (93 − 91.4)

= 7.9 m

pt. 4.

~~from GL, pressure head = 7 − 2 × 7/10 = 5.6 m~~

~~from pt~~

pt 4'

from GL, position of pizometer surface = $7 - 2 \times \frac{7}{10}$

= 5.6 m

∴ pressure head = 5.6 + (93 − 89.4)

= 9.2 m

pt 5:

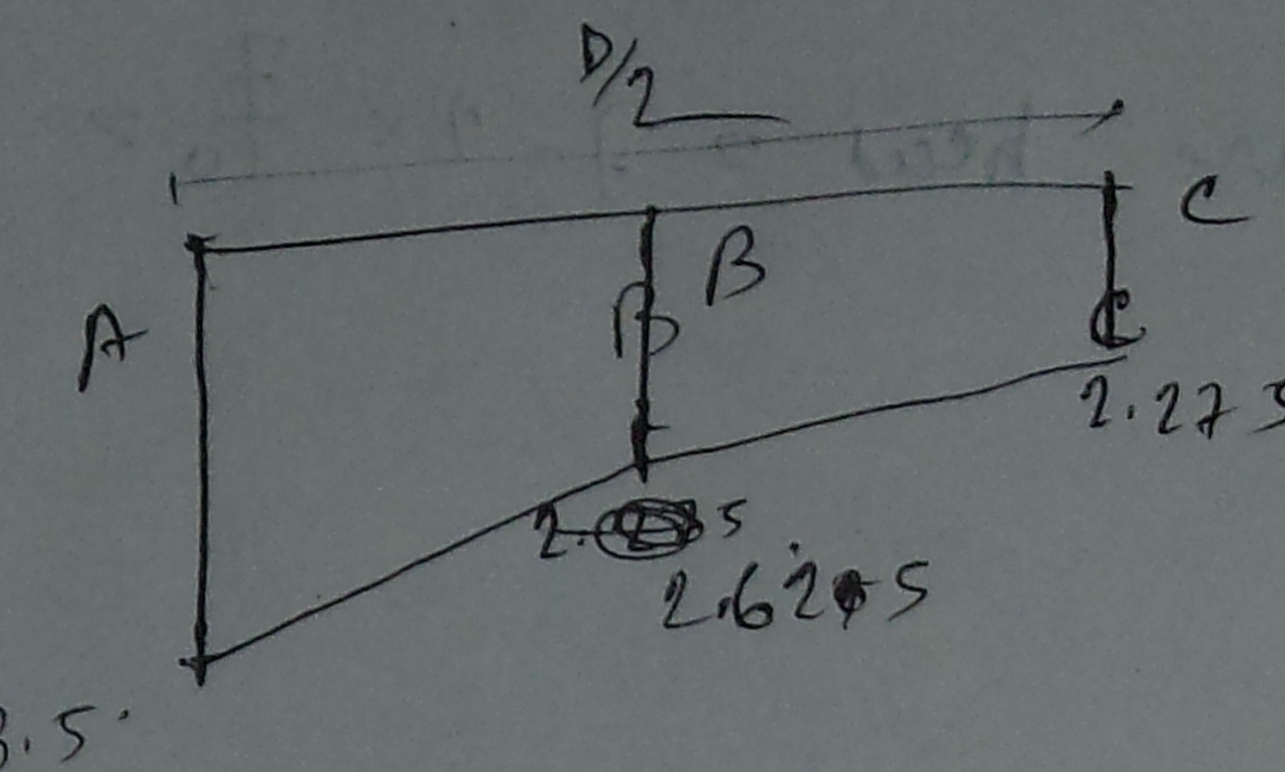
from GL, position of pizometer surface = 7 − 3 × 0.7

= 4.9 m

∴ pressure head = 4.9 + (93 − 87.4) = 10.5 m

Points	position of pizometer surface from GL	pressure head
1	7.0 m above	0 m
2	7.0 m above	7 m
3	6.3 m above	7.9 m
4	5.6 m above	9.2 m
5	4.9 m above	10.5 m
6	4.2 m above	10.9 m
7	3.5 m above	10.5 m
8	2.8 m above	9.5 m
9	2.1 m above	7.7 m
10	1.4 m above	5.0 m
11	0.7 m above	2.3 m
12	0	

(hi)



For A, remaining head = $7 - 5 \times 0.7 = 3.5$ m

" B, " " = $7 - 6.25 \times 0.7 = 2.625$ "

" C " " = $7 - 6.75 \times 0.7 = 2.275$ m

$\therefore h_{avg} = \dfrac{3.5 + 2.625 + 2.275}{3}$

$= 2.8$ m

$\therefore i_{avg} = \dfrac{2.8}{7}$

$= 0.4$

$i_c = \dfrac{\gamma'}{\gamma_w} = \dfrac{21.3 - 9.81}{9.81} = 1.19$

$\therefore F.S = \dfrac{i_c}{i_{avg}} = \dfrac{1.19}{0.4}$

$= 3$

2004-05:

2(a) → cls lecture (theory)

2(b) → cls lecture

2(c) → theory.

2(d) → theory

2(e)

$$n = 40\%$$

$$= 0.4$$

$$\frac{e}{1+e} = 0.4$$

$$\Rightarrow e = 0.67$$

$$\gamma_{bulk} = \frac{G_s \gamma_w (1+w)}{(1+e)}$$

$$\Rightarrow 21 = \frac{G_s \times 9.81 \ (1+0.31)}{1+0.667}$$

$$\Rightarrow G_s = 2.72$$

$$i_c = \frac{G_s - 1}{1+e} = \frac{2.72-1}{1+0.667}$$

$$= 1.03$$

$$\Rightarrow \frac{h_c}{L} = 1.03$$

$$\Rightarrow h_c = 1.03 \times L$$

$$= 1.03 \times 3 \text{ m}$$

$$= 3.095 \text{ m}$$

$q_c = K i_c A$

$= 3\times10^{-7} \times 1.03 \times 1 \ m^3/sec$

$= 3.09\times10^{-7} \ m^3/sec$

$= \cancel{0.309} \ \cancel{cm^3/sec}$

$= 0.309 \ cm^3/sec$

2002-03:

6(a) →

6(b) →

6(c) →

6(d)

$$K = \frac{qL}{hA}$$

$$\Rightarrow h = \frac{qL}{KA}$$

$$= \frac{0.06 \times 12}{0.002 \times 50} \text{ cm}$$

$$= 7.2 \text{ cm}$$

$$i = \frac{h}{L}$$

$$= \frac{7.2}{12}$$

$$= 0.6$$

At middle of the sample

As upward flow, so, effective pressure will decrease

$z = L/2 = 6$ cm

$\gamma' = \gamma_{sat} - \gamma_w = 19.1 - 9.81$

$= 9.29 \ KN/m^3$

$\therefore p'_{middle} = z\gamma' - iz\gamma_w$

$= \frac{6}{100} \times 9.29 - 0.6 \times \frac{6}{100} \times 9.81 \ KN/m^2$

$= 0.20424 \ KN/m^2$

At bottom

$z = L = 12 \ cm = 0.12 \ m$

$\therefore p'_{bottom} = 0.12 \times 9.29 - 0.6 \times 0.12 \times 9.81$

$= 0.40848 \ KN/m^2$

→ See Example 8.1 to 8.3 → B.M. Das
→ Peck hanson
→ craige