# Shear Strength of Soil

15-16 1, 2, 7
14-15 2, 3
13-14 4, 5
12-13 3, 4, 5
11-12 3(a), 4(b)
10-11 2(a), 4(b)
9-10 4(a)
8-9 1(e), 3(a), 4(b)
7-8 1(c), (d), 2(b), 4(b)

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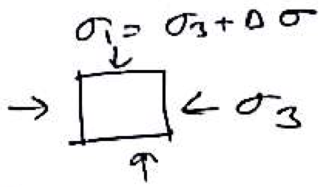
$$\sigma_1' = \sigma_3' \tan^2\left(45 + \frac{\phi'}{2}\right) + 2c' \tan\left(45 + \frac{\phi'}{2}\right).$$

$\theta = 45 + \frac{\phi'}{2}$ (failure plane)




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

↳ stress at failure plane.

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

$$\sigma_{max/min} = \frac{\sigma_1 + \sigma_3}{2} \pm \sqrt{\left(\frac{\sigma_1 - \sigma_3}{2}\right)^2 + \tau_{xy}^2}$$

Vane shear test $T = \pi c_u \cdot \left(\frac{d^2 h}{2} + \frac{d^3}{4}\right)$ | $c_u = \frac{6T}{7\pi d^3}$

$$B = \frac{\Delta u_c}{\Delta \sigma_c} \qquad \Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$$

$$= \Delta u_c + \Delta u_d.$$

$$= B\Delta\sigma_3 + \bar{A}(\Delta\sigma_1 - \Delta\sigma_3)$$

1.2.7

2015-16

(1) $\gamma = 19.6\ KN/m^3$

$\varphi = 35°$

$\tau = ?$

$h = 4m.$

$\sigma = \gamma h = 19.6 \times 4 = 78.4\ KN/m^2$

$\tau = \sigma \tan\varphi = 78.4 \tan 35° = 54.89\ Kpa.$

$\Delta\sigma = 60\ KN/m^2$

$\Delta\tau = 52\ KN/m^2$

NO, ~~yes~~, $\Delta\tau < \tau$, so, ~~exceeds~~ not exceeds

total normal stress $\sigma = \Delta\sigma + \sigma_{old}.$

$= 60 + 78.4$

$= 138.4$

" shear " $\tau = \Delta\tau + \tau_{old}$

$= 52 + 54.89$

$= 106.89$

Factor of Safety $F.S = \dfrac{\tau_{max}}{\tau_f.}$

$= \dfrac{106.89}{54.89}$

$= 1.94.$

15-16

(2) ~~$\sigma_1$ = 45 Kpa.~~

$\sigma_1 = 97$ Kpa. (axial pressure)

$u = 20$ Kpa. (pore water pressure)

$\sigma_3 = 45$ Kpa (confining pressure)

$\varphi_{CD}$

Effective

$\sigma_1' = \sigma_1 - u = 77$ Kpa.

$\sigma_3' = 45 - 20 = 25$ Kpa.

$\sin \varphi_{CD} = \frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'} = \frac{77 - 25}{77 + 25}$

$\varphi_{CD} = 30.65°$.

$\varphi_{cu}$

$\sin \varphi_{cu} = \frac{\sigma_1 - \sigma_3}{\sigma_1 + \sigma_3} = \frac{97 - 45}{97 + 45}$

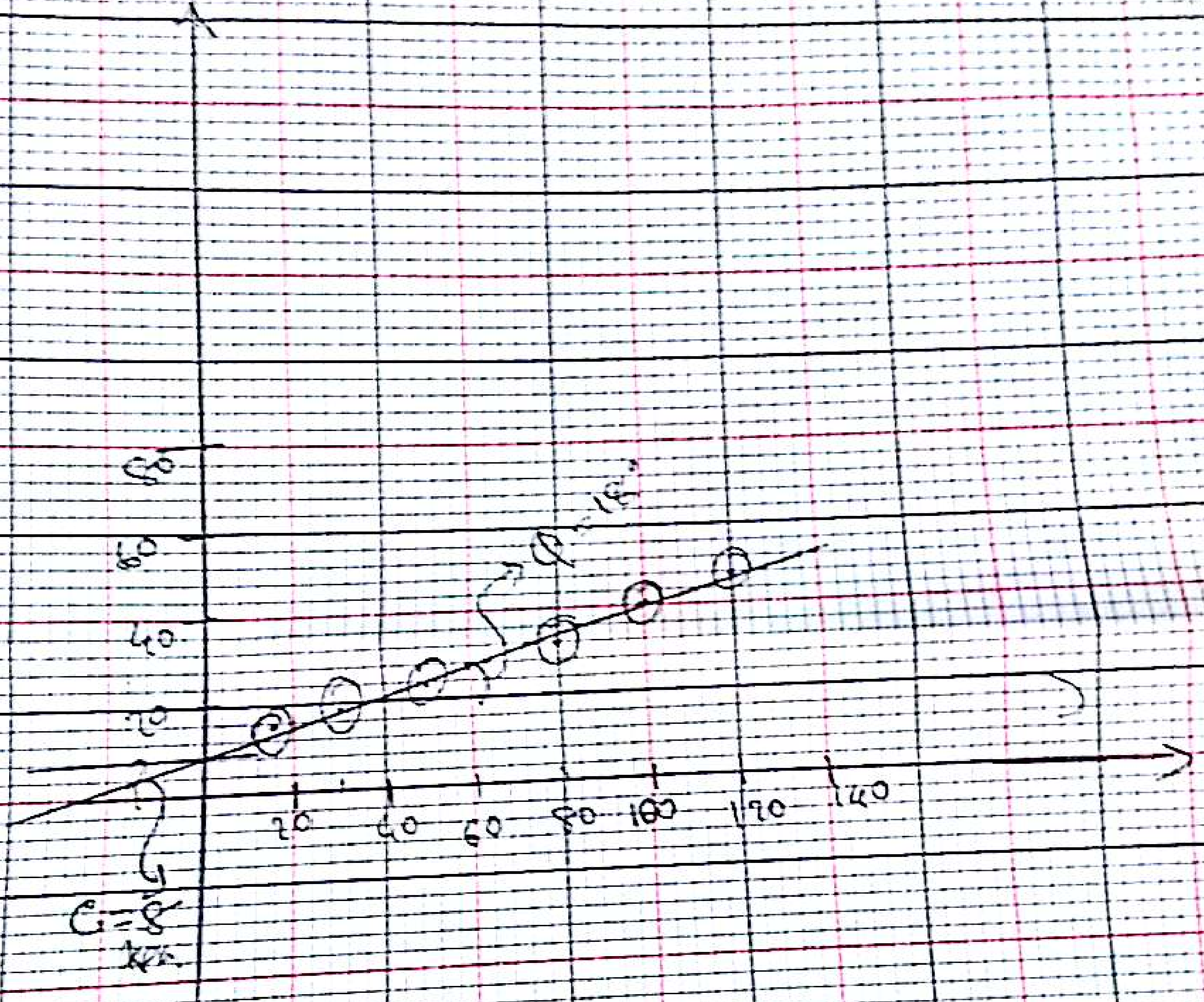
$\Rightarrow \varphi_{cu} = 21.48°$

15-16 (7) $c = 8$ Kpa.

$\varphi_{cu} = 18°$ (from graph using protector)

15-16

7



2014-15

(2) $\phi' = 27°$

~~$\sigma_1$ = 157.1 N~~.

$$\sigma_1 = \frac{157.1 \times 10^{-3}}{\frac{\pi}{4} \times (50 \times 10^{-4})^2} = 40.02 \ KN/m^2$$

$\sigma_3 = 0$.

↳ Unconfined compression test

~~$\tau = \sigma$~~

$\tau_{max} = 20 kPa$. (from graph)

Undrained shear strength $C_u = 20 kPa$.

$\sigma_1 = \sigma_3 + u$

pore pressure $\Rightarrow u = \sigma_1 - \sigma_3 = 40 - 0$
$= 40 kPa$.

(2)

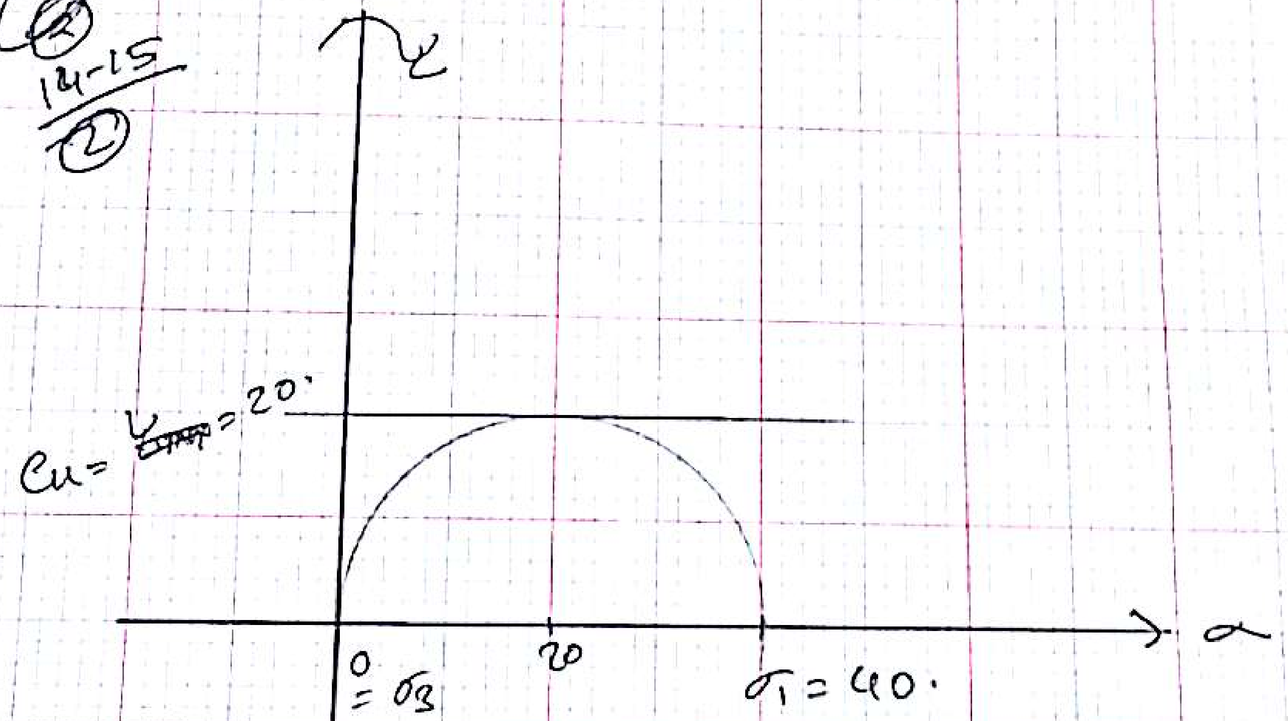
$\varphi' = 27^\circ$

~~$\sigma_1 = 157.1$ N.~~

$\sigma_1 = \dfrac{157.1 \times 10^{-3}}{[illegible] \; .12} = 40.02$ KN/m²

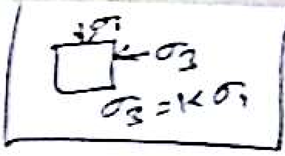
15-16 (2)

14-15 (2)



14+15

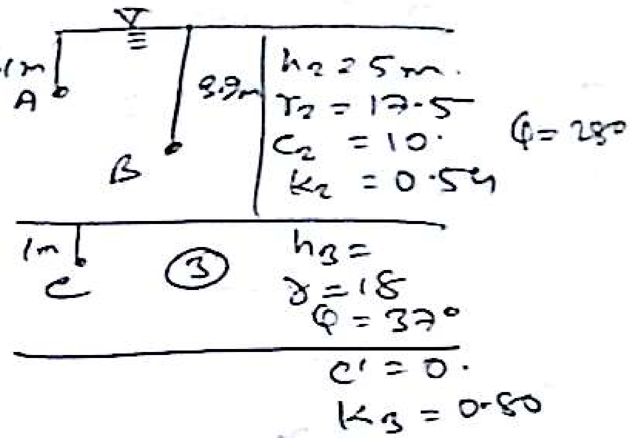
(3)




too much data given to confuse.

(1) $h_1 = 3$

$\gamma_1 = 17$




## At A

$\gamma_2 - \gamma_w$.

$\sigma_A = \gamma_1 h_1 + \gamma_2' h_2 \rightarrow 1.1m$

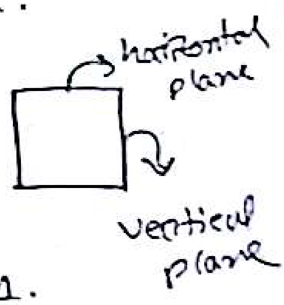
$= 17 \times 3 + (17.5 - 9.8) \times 1.1$

$= 59.47$ Kpa.

## at B

$\sigma_B = \gamma_1 h_1 + \gamma_2' h_2 \rightarrow 3.9m$

$= 17 \times 3 + (17.5 - 9.8) \times 3.9 = 81.03$ Kpa.




## at C

$\sigma_C = \gamma_1 h_1 + \gamma_2' h_2 + \gamma_3' h_3$

$= 17 \times 3 + (17.5 - 9.8) \times 5 + (18 - 9.8) \times 1.$

$= 97.7$ Kpa.

∴ Stress at vertical plane at C $= \sigma_3 \cdot K_3$

$= 97.7 \times 0.80$

$= 76.16$ Kpa.

note

2013-14

(4) $\varphi = 32°$ (angle of shearing resistance)
$\gamma = 19.8\ KN/m^3$

Suppose the sand deposite was at a depth of 1 m

Normal stress $\sigma = (19.8 \times 1) = \gamma h.$
$= 19.8\ KN/m^2$

Shear strength $\tau = \sigma \tan\varphi$
$= 19.8 \tan 32°$
$= 12.4\ KN/m^2$ Ans

when a structure is buit on the site at the same depth.

increase in vertical stress $\sigma' = 65\ KN/m^2$
" " shear " $\tau' = 50\ KN/m^2$

As, ground water table rises to the ground surface

total normal stress $\sigma = \sigma' + \gamma' h$
$= 65 + (19.8 - 9.8) \times 1$
$= 75\ KN/m^2$

total shear stress $= \tau = (50 + 12.4)$
$= 62.4\ KN/m^2$

Angle of shear resistance $\varphi = \tan^{-1}\left(\frac{\tau}{\sigma}\right)$
$= \tan^{-1}\left(\frac{62.4}{75}\right) = 40°$

which is > 32° (structure will not be stable)

2013-14

(5) triaxial test

$\sigma_3' = 100$ Kpa.

$\theta'$ or $\alpha' = 55°$

$\varphi' = ?$

$\sigma_1' = ?$

$$\alpha' = 45 + \frac{\varphi'}{2}$$

$$\Rightarrow 55 = 45 + \frac{\varphi'}{2} \Rightarrow \varphi' = 20° \text{ (Ans)}$$

Now,

$$\sin\varphi' = \frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'} = \frac{\sigma_1' - 100}{\sigma_1' + 100} = \sin 20°$$

$$\Rightarrow \sigma_1' = 203.03 \text{ Kpa.}$$

2012-13

(3) triaxial test

Given initially

$\sigma_{31} = 200\ KN/m^2$

$u_1 = 50\ KN/m^2$

$\sigma_{32} = 300\ KN/m^2$

$u_2 = ?$

we know

$\Delta u = B \Delta \sigma_3$

$\Rightarrow u_2 - u_1 = B(\sigma_{32} - \sigma_{31})$

$\Rightarrow u_2 - 50 = 1 \times (300-200)$

$\Rightarrow u_2 = 150 \text{ KN/m}^2$

$B = 1$ for fully saturated.

deviator stress $u_d = 150 \text{ KN/m}^2$ applied.

$A = 0.5$

then $\sigma_{11} = 300 \text{ KN/m}^2$

$\sigma_{12} = (300+150) = 450 = \sigma_3 + \sigma_d.$

$\Delta u = B \Delta \sigma_3 + A(\Delta \sigma_1 - \Delta \sigma_3)$

$= B \times (300-200) + 0.5 \times [(450-300) - (300-200)]$

$\Delta u = 125 \text{ KN/m}^2$

Pore pressure = ~~50+125~~ 50+125

$= 175 \text{ KN/m}^2$

2012-13

2012

(4) for Sand $c' = 0$.

additional axial stress. ~> deviator stress

$\sigma_d = 250\ KN/m^2$

$\sigma_3' = 100\ KN/m^2$

$\sigma_1' = \sigma_3' + \sigma_d = 350\ KN/m^2$

Now, $\sin\phi' = \frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'} = \frac{350-100}{350+100}$

$\Rightarrow \phi' = 33.7°$

inclination of failure plane to the horizontal

$\alpha = 45 + \frac{\phi'}{2} = 45 + \frac{33.7}{2} = 61.85°$.

shear stress on failure plane

$\tau_f = \frac{\sigma_1' - \sigma_3'}{2} \sin 2\alpha$

$= \frac{350-100}{2} \sin(2 \times 61.85)$

$= 104\ KN/m^2$

$\tau_{max} = \frac{\sigma_1' - \sigma_3'}{2} = \frac{350-100}{2} = 125\ KN/m^2$

the plane of $\tau_{max}$ is oriented at 45° with horizontal.

obliquity of $\tau_{max} = 0°$

Maximum obliquity $= \phi' = 33.7°$

$F.S = \frac{\tau_{max}}{\tau_f} = \frac{125}{104} = 1.2 > 1$

2012-13

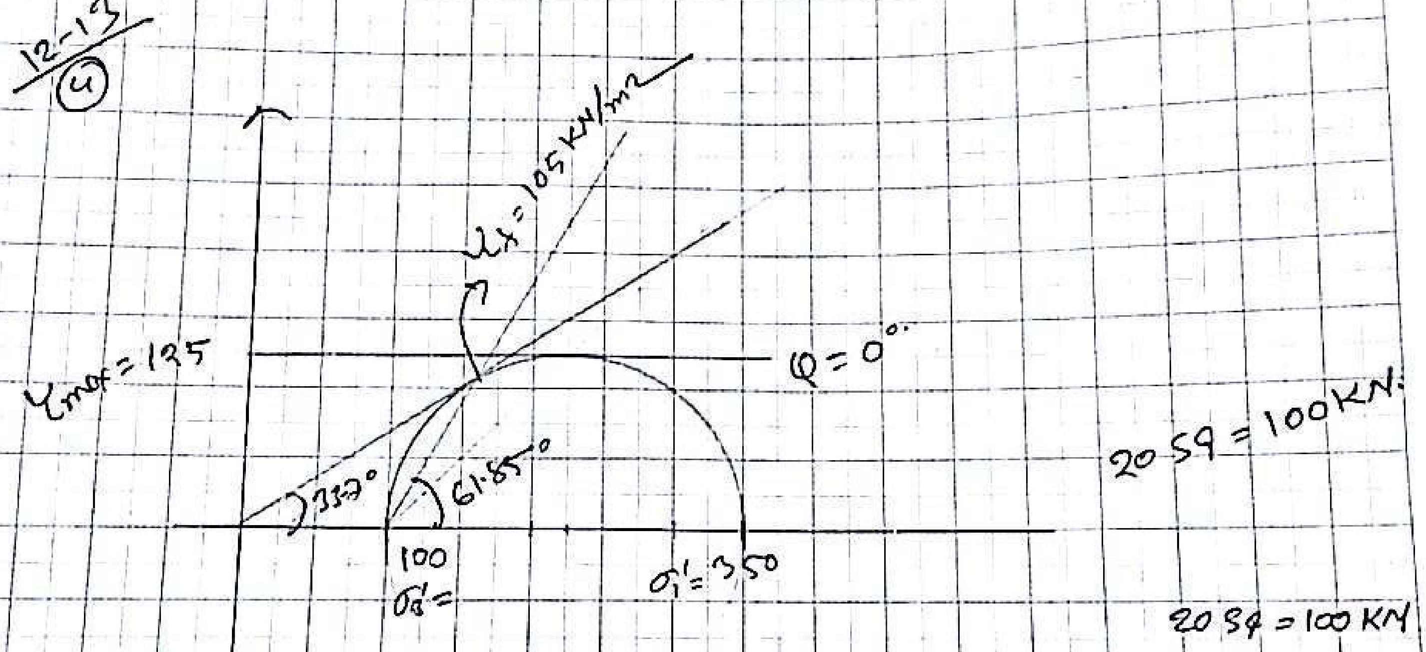
(4) for Sand $c' = 0$.

additional axial stress. ~> deviator stress

$\sigma_d = 250\ KN/m^2$

$\sigma_3' = 100\ KN/m^2$

12-13 (4)




Roll No

$\tau_{max} = \frac{\sigma_1 - \sigma_3'}{2} = \frac{350-100}{2} = 125\ KN/m^2$

the plane of $\tau_{max}$ is oriented at 45° with horizontal.

obliquity of $\tau_{max} = 0°$

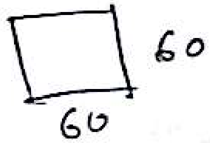
Maximum obliquity $= \varphi' = 33.7°$

$F.S = \frac{\tau_{max}}{\ldots} = 125$

10-11

2012-13 (5)

$\sigma_1 = 0.$
$\tau_1 = 30\ KN/m^2$




$\sigma_2 = 200\ KN/m^2$
$\tau_2 = 130\ KN/m^2$

(i) angle of internal friction $\varphi = \tan^{-1}\left(\frac{\tau_2 - \tau_1}{\sigma_2 - \sigma_1}\right)$

$= \tan^{-1}\left(\frac{130 - 30}{200 - 0}\right)$

$= 26.57^\circ$

(ii) $\sigma_1 = 415\ KN/m^2$
$\sigma_2 = 125\ KN/m^2$

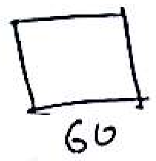
(iv) $\sigma = 200\ KN/m^2$
$\tau = 130\ KN/m^2$

10 - 11

2012-13 (5)

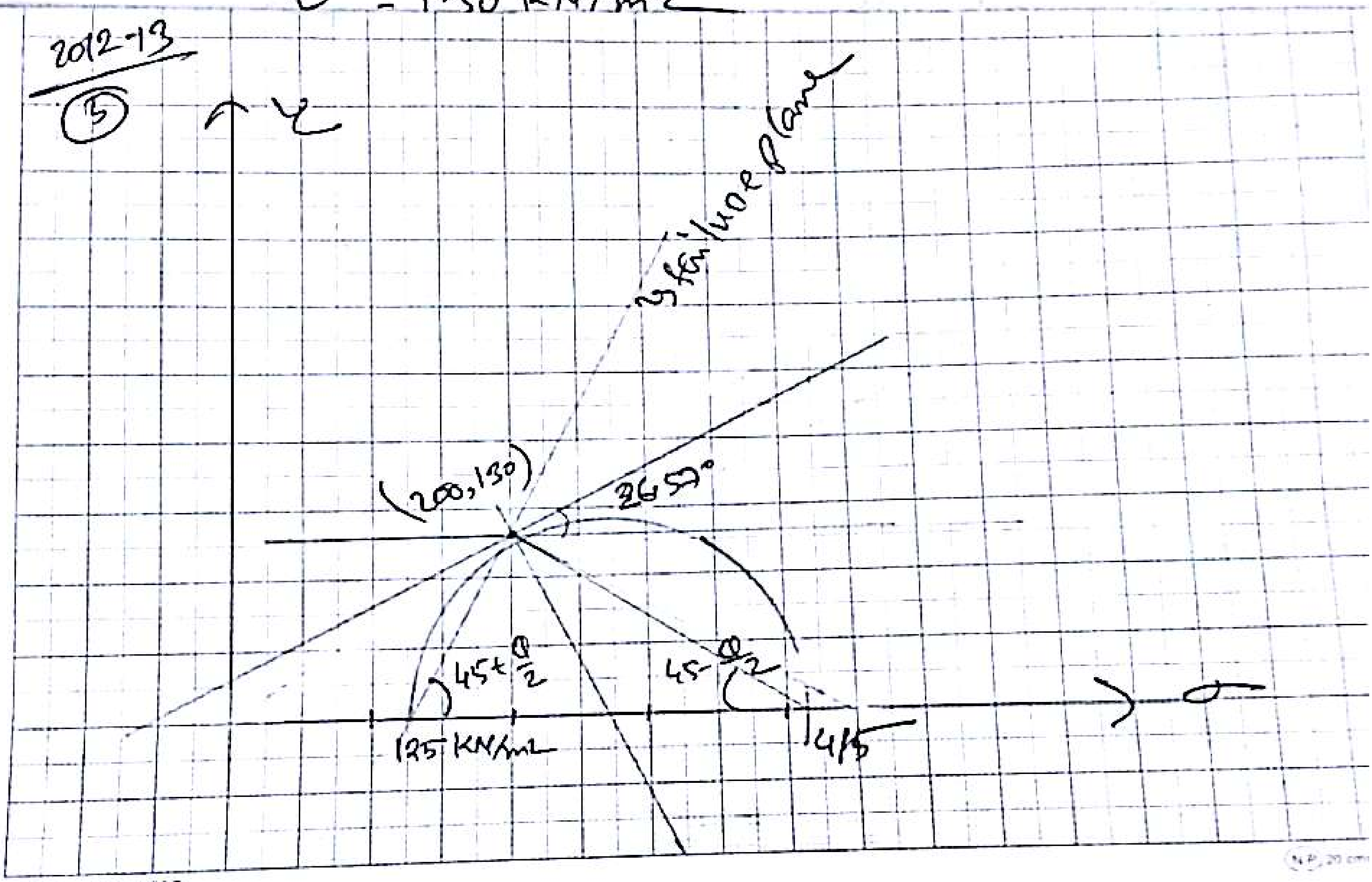
$\sigma_1 = 0.$

$\tau_1 = 30\ KN/m^2$




$\sigma_2 = 200\ KN/m^2$

$\tau_2 = 130\ KN/m^2$



## 11-12

### 3(a)

| specimen | cell pressure $\sigma_3$ | deviator stress $\sigma_d$ | pore pressure $u$ | $\sigma_1 = \sigma_3 + \sigma_d$ | $\sigma_1' = \sigma_1 - u$ | $\sigma_3' = \sigma_3 - u$ |
|---|---|---|---|---|---|---|
| 1 | 100 | 170 | 40 | 270 | 230 | 60 |
| 2 | 200 | 260 | 95 | 460 | 365 | 105 |
| 3 | 300 | 360 | 135 | 660 | 525 | 165 |

For total stress

$$\sigma_1 = \sigma_3 \tan^2(45+\frac{\varphi}{2}) + 2c\tan(45+\frac{\varphi}{2})$$

$$\Rightarrow 270 = 100\tan^2(45+\frac{\varphi}{2}) + 2c\tan(45+\frac{\varphi}{2}) \quad \text{(i)}$$

$$460 = 200\tan^2(45+\frac{\varphi}{2}) + 2c\tan(45+\frac{\varphi}{2}) \quad \text{(ii)}$$

(ii) − (i)

$$460-270 = 100\tan^2(45+\frac{\varphi}{2})$$

$$\Rightarrow \varphi = 18.08° \approx 18°$$

in (i) putting $\varphi = 18°$

$$\Rightarrow 270 = 100\tan^2(45+\frac{18}{2}) + 2c\tan(45+\frac{18}{2})$$

$$\Rightarrow c = 29 \text{ KPa}.$$

For effective stress:

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

$$\Rightarrow 230 = 60 \tan^2(45+\frac{\phi'}{2}) + 2c' \tan^2(45+\frac{\phi'}{2}) \quad \text{--- (III)}$$

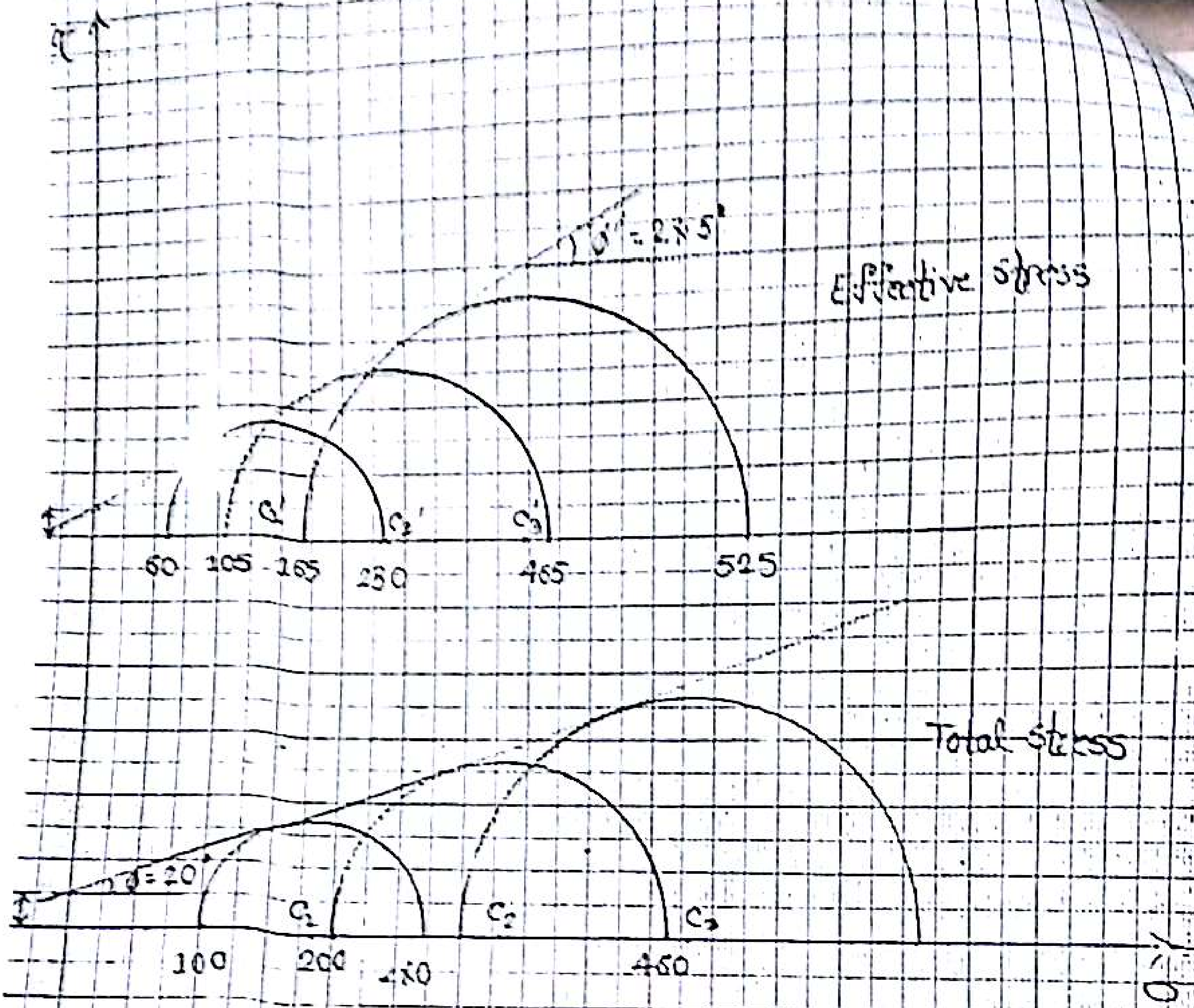
$$365 = 105 \tan^2(45+\frac{\phi'}{2}) + 2c' \tan^{\omega}(45+\frac{\phi}{2}) \quad \text{--- (IV)}$$

from (IV) − (III)

$$135 = 45 \tan^2(45+\frac{\phi'}{2})$$

$$\Rightarrow \phi' = 30^\circ$$

from (III) $\Rightarrow$ $c' = 14.4^\circ$.


τ
φ' = 27.5°
Effective stress
c1'
c2'
c3'
60
105
165
250
465
525
Total stress
φ = 20°
c1
c2
c3
100
200
450
σ

11-12

4(b)

$h = 15 m$

$\gamma_{dry} = 15.5\ KN/m^3$

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

$w = 28\%$

$C_{cu} = 48.3$

$\varphi_{cu} = 13°$

$C_d' = 41.4\ KN/m^2$

$\varphi_d' = 23°$

$\tau = ?$

$\sigma_0 = \gamma h = 19.8 \times 15 = 297\ KPa.$

$\sigma' = (\gamma - \gamma_w) h = (19.8 - 9.8) 15$

$= 149.85\ KPa.$

(i) when shearing stress builds reapidly

↳ Undrained condition.

$\tau = C_{cu} + \sigma \tan\varphi_{cu}.$

$= 48.3 + 297 \times \tan 13$

$= 116.87\ KPa.$

(ii) when Shearing stress builds slowly

10-11

drained ~~to~~ condition.

$\tau' = c_d' + \sigma' \tan \phi_d'$

$= 41.4 + 149.85 \times \tan 23$

$= 105$ Kpa.

2010-11

2(a) $\sigma_3 = 50$ Kpa.

$\sigma_1 = 86.2$ Kpa.

$\therefore \sigma_1 = \sigma_3 + \sigma_d \Rightarrow \sigma_d = 86.2 - 50 = 36.2$ Kpa.

For unconfined compression test

" " strength $q_u = \sigma_d$ (axial stress)

$= 36.2$ Kpa.

Alternative:

For saturated clay sample $\phi = 0$

By drawing mohr circle.

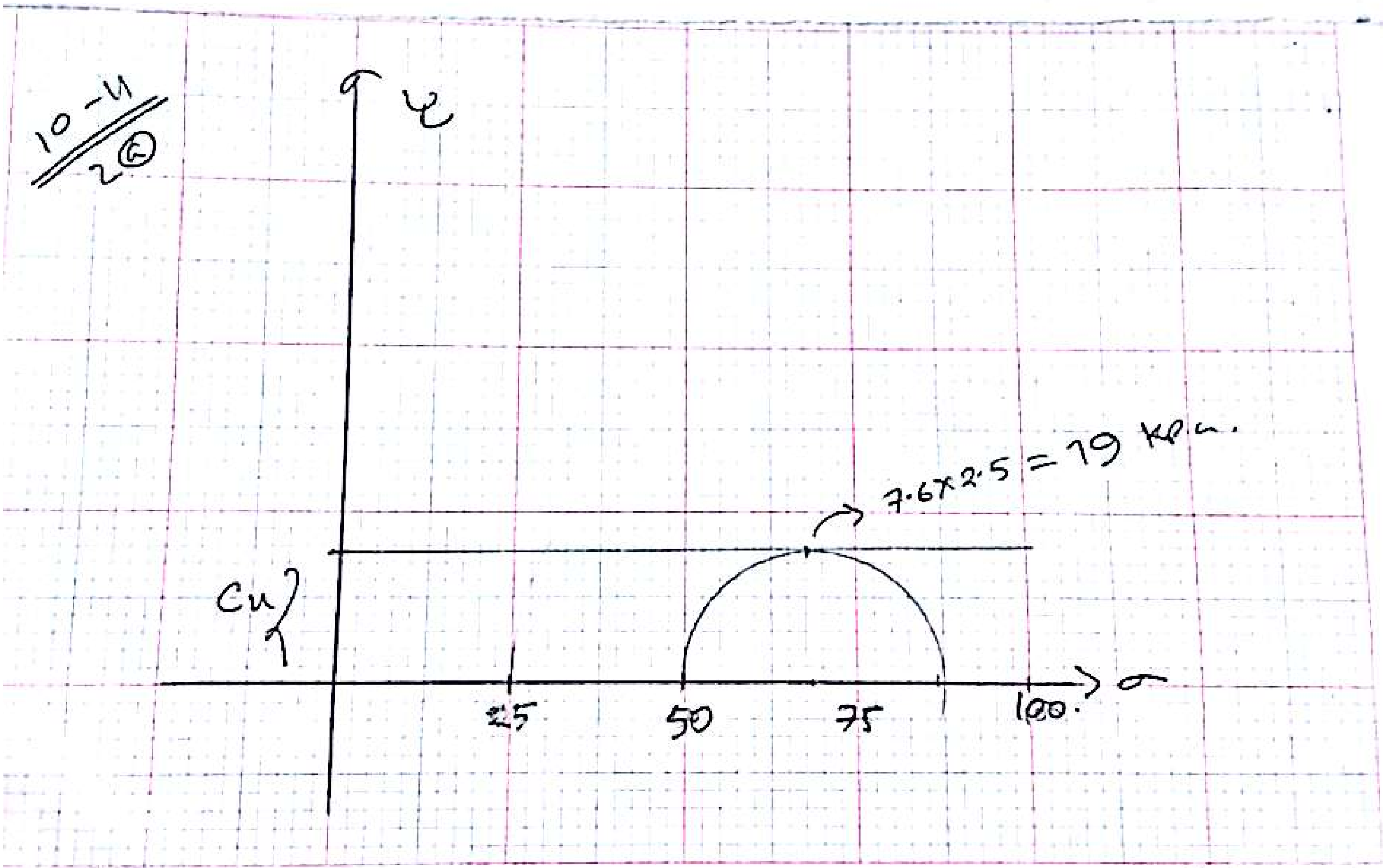
$q_u = 2c_u = 2 \times 19 = 38$ Kpa.

drained ~~to~~ condition.

$$\tau' = c_d' + \sigma' \tan\phi_d'$$

$$= 41.4 + 149.85 \times \tan 23$$

$$= 105 \text{ Kpa.}$$




$$q_u = 2c_u = 2 \times 19 = 38 \text{ Kpa.}$$

2010-11

4 (b)

$\sigma_d' = 250 \, KN/m^2$

$\sigma_3' = 100 \, KN/m^2$

$\sigma_1' = \sigma_3 + \sigma_d = 350 \, KN/m^2$

Saturated Sand $c = 0$. Ans

$$\sin \phi' = \frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'} = \frac{350 - 100}{350 + 100}$$

$= 33.7^\circ$ Ans

Theoritical inclination of failure plane to the horizontal

$$\alpha' = 45^\circ + \frac{\phi'}{2} = 61.85^\circ$$

Shear stress at failure plane

$$\tau_f = \frac{\sigma_1' - \sigma_3'}{2} \sin 2\alpha$$

$$= \frac{350 - 100}{2} \sin(2 \times 61.85)$$

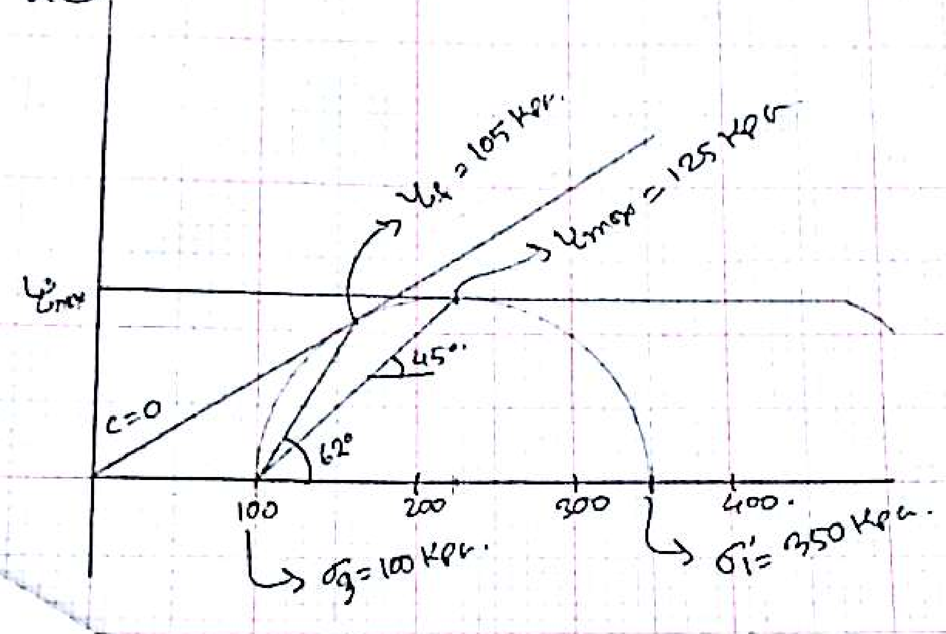
$= 103.99 \, Kpa$.

$$\tau_{max} = \frac{\sigma_1' - \sigma_3'}{2}$$

$$= \frac{350 - 100}{2} = 125 \, Kpa.$$

10-11

4(b)




9-10

4(a)

$h = 15m.$

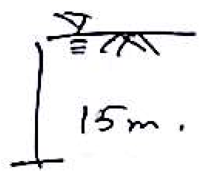
$\gamma_{sat} = 19.8\ KN/m^3$

$C_{cu} = 48.3\ KN/m^2$

$\varphi_{cu} = 13°$

$C_d = 41.4\ KN/m^2$

$\varphi_d = 23°$




① Shearing stress buids up rapidly (undrained)

$\tau = C_{cu} + \sigma \tan\varphi_{cu}.$

$= 48.3 + 279 \tan 13$

$= 116.87$ Kpa.

$\sigma = \gamma h$

$= 15 \times 19.8 = 297$ Kpa.

$\sigma' = (\gamma - \gamma_w)\ h$

$= (19.8 - 9.8) \times 15$

$= 150$ ·Kpa.

(11) Shearing stress builds very slowly (drained)

$$\tau' = c_d + \sigma' \tan \varphi_d$$

$$= 41.4 + 150 \tan(23)$$

$$= 105.07 \text{ kPa.}$$

8-9

+ (e) Saturated clay sample

$\varphi = 0$. Ans

$\sigma_3 = 100 \text{ KN/m}^2$

$\sigma_d = 200 \text{ KN/m}^2$

$\sigma_1 = \sigma_3 + \sigma_d = 300 \text{ KN/m}^2$

$$C_u = \frac{\sigma_1 - \sigma_3}{2}$$

$$= \frac{300 - 200}{2} = 100 \text{ KN/m}^2 \quad \text{Ans}$$

8-0
3 (ii)

1st Sample

$\sigma_{31} = 170\ KN/m^2$
$\sigma_{d1} = 125\ KN/m^2$
$u_1 = 110\ KN/m^2$

$\sigma_{11} = \sigma_{31} + \sigma_{d1}$
$= 170 + 125$
$= 295\ KN/m^2$

$\sigma_{11}' = \sigma_{11} - u_1$
$= 295 - 110$
$= 185\ KN/m^2$

$\sigma_{31}' = \sigma_{31} - u_1$
$= 170 - 110$
$= 60\ KN/m^2$

2nd Sample

$\sigma_{32} = 430\ KN/m^2$
$\sigma_{d2} = 310\ KN/m^2$
$u_2 = 270\ KN/m^2$

$\sigma_{12} = \sigma_{32} + \sigma_{d2}$
$= 430 + 310$
$= 740\ KN/m^2$

$\sigma_{12}' = \sigma_{12} - u_2$
$= 740 - 270$
$= 470\ KN/m^2$

$\sigma_{32}' = \sigma_{32} - u_2$
$= 430 - 270$
$= 160\ KN/m^2$

∴ total stress $\sigma_1 = \sigma_3 \tan^2(45 + \frac{\varphi}{2}) + 2c \tan(45 + \frac{\varphi}{2})$

for sample-1
$$295 = 170 \tan^2(45 + \frac{\varphi}{2}) + 2c\tan(45 + \frac{\varphi}{2}) \quad \text{---(i)}$$

for sample-2
$$740 = 430 \tan^2(45 + \frac{\varphi}{2}) + 2c\tan(45 + \frac{\varphi}{2}) \quad \text{---(ii)}$$

from (ii) − (i) ~~$\varphi = 15.2°$~~

$$740 - 295 = (430 - 170)\tan^2(45 + \frac{\varphi}{2})$$

$\varphi = 15.2°$

putting $\phi$ value in (I) we get

$$c = 1.6 \ KN/m^2$$

For effective stress:

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

Sample-1

$$185 = 60 \tan^2\left(45 + \frac{\phi}{2}\right) + 2c' \tan\left(45 + \frac{\phi'}{2}\right) \quad \text{---(III)}$$

Sample-2

$$470 = 160 \tan^2\left(45 + \frac{\phi'}{2}\right) + 2c' \tan\left(45 + \frac{\phi'}{2}\right) \quad \text{---(IV)}$$

(IV) − (III)

$$470 - 185 = (160 - 60) \tan^2\left(45 + \frac{\phi'}{2}\right)$$

$$\phi' = 28.7^\circ$$

putting $\phi'$ value in (III)

$$c' = 4.2 \ KN/m^2$$

pore water pressure parameter A $\quad B = 1$ saturated.

$$\Delta u = B\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)$$

Sample-1

$$110 = 1 \times (0) + A(295 - 170) \Rightarrow A = 0.88$$

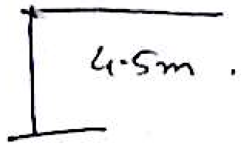
Sample-2

$$270 = 1 \times 0 + A(740 - 430)$$

$$\Rightarrow A = 0.87$$

Q-9
4 (b)

$h = 4.5 m.$
$\gamma = 19.8\ KN/m^3$
$\varphi = 32°$
$\tau = ?$




$\sigma = \gamma h = 19.8 \times 4.5 = 89.1\ KN/m^2$
$\tau = \sigma \tan\varphi = 89.1 \tan 32 = 55.7\ KN/m^2$

After building Structure.

total Normal stress, $\sigma = 65 + 89.1 = \Delta\sigma + \sigma$
$= 154.1\ KN/m^2$

" Shear " $\tau = 50 + 55.7 = \Delta\tau + \tau.$
$= 105.7\ KN/m^2$

[ Here no water rise like 13-14 (4), So normal stress will not be changed, we do not have to calculate effective normal stress ]

angle of shearing resistance $\varphi = \tan^{-1}\left(\frac{\tau}{\sigma}\right)$
$= \tan^{-1}\left(\frac{105.7}{154.1}\right)$
$= 34.4°$ $\boxed{> 32°}$

Structure will not be stable.

07-08

1 (a)

$\sigma = 250\ KN/m^2 \rightarrow \sigma_{old}$

$u = 150\ KN/m^2 \rightarrow u_{old}$

$\sigma' = 100\ KN/m^2$

triaxial

$\sigma_3 = 100\ KN/m^2$ (cell pressure)

$\therefore \sigma_{new} = \sigma_{old} + \sigma_3$

$= 250 + 100 = 350\ KN/m^2$

Saturated sample $B = 1$

$\Delta u = B\ \Delta\sigma_3$

$\Rightarrow \quad = 1 \times 100 = 100\ KN/m^2$

$u = u_{old} + \Delta u = 150 + 100 = 250\ KN/m^2$

$\sigma' = \sigma - u$

$= 350 - 250 = 100\ KN/m^2$

07-08

1 (b)

$\sigma = \frac{0.36}{36\times10^{-4}}$

$= 100$ Kpa.

$A = 36 cm^2$
$= 36\times10^{-4} m^2$

$\tau = \frac{0.18}{36\times10^{-4}} = 50$ Kpa.

$\tau = c + \sigma \tan\varphi$.

$\Rightarrow 50 = 0 + 100 \tan\varphi$

$\Rightarrow \varphi = 26.57°$.

Sand $c = 0$.

2 (b) Unconfined compression test

$q_u =$ ~~220~~ 120 $KN/m^2$ , $\sigma_3 = 0$.
$\sigma_1 = q_u = 120$.

triaxial test $\sigma_3 = 40 KN/m^2$

$\sigma_d = 160 KN/m^2$

$\sigma_1 = \sigma_3 + \sigma_d$

$= 200 KN/m^2$

Here $q_u = 120$. 220, without this this math can not be done.

if $q_u = 220$. then ~~120~~ ques vul.

from graph. $c = 45 KN/m^2$
$\varphi = 20°$

(i) angle of failure plane

$\alpha = 45 + \frac{\varphi}{2}$

$= 55°$

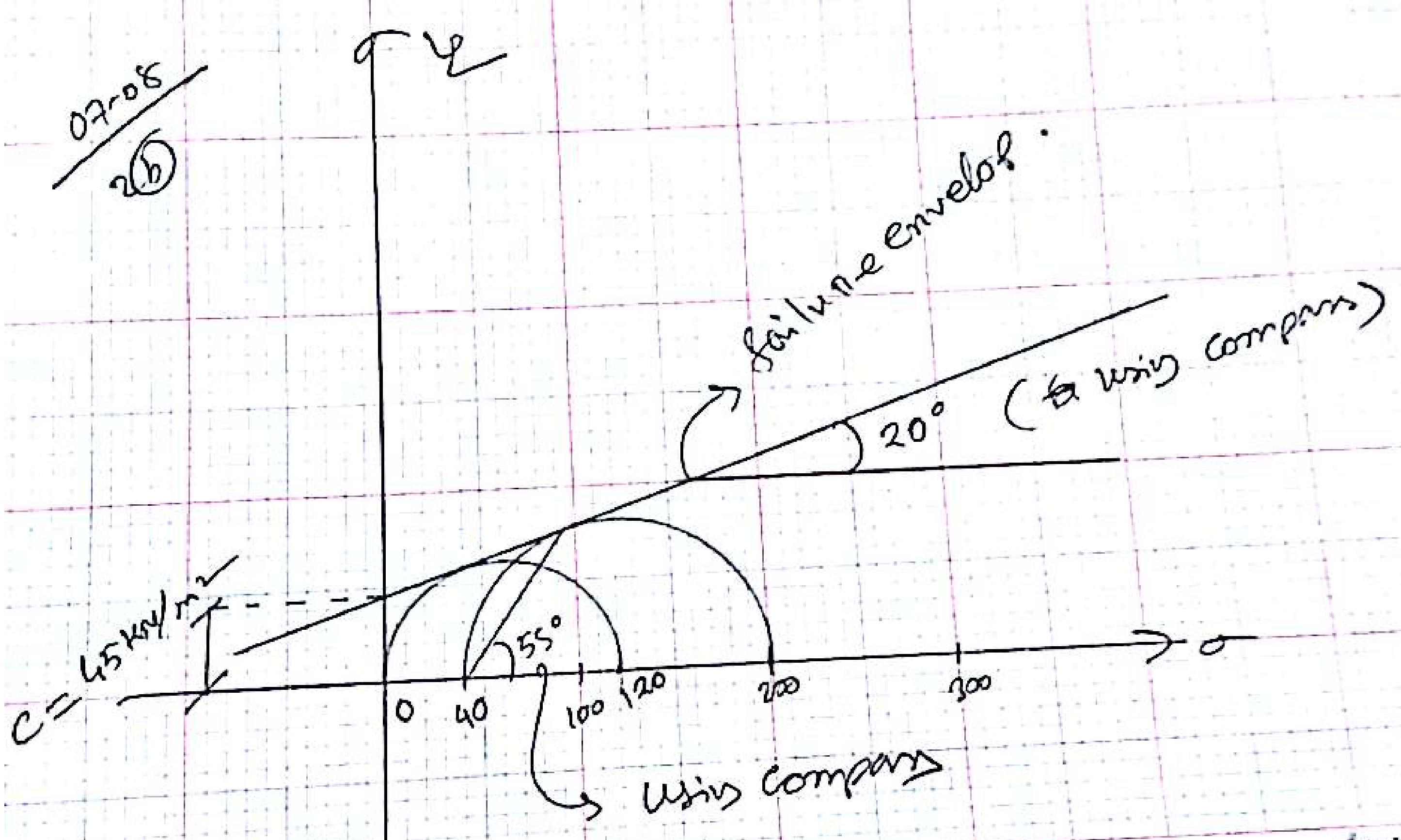
from graph $\alpha = 55°$.

07-08
1(b)

$\sigma = \frac{0.36}{36 \times 10^{-4}}$

$= 100 \text{ Kpa}.$

$A = 36 \text{ cm}^2$
$= 36 \times 10^{-4} \text{ m}^2$




Victoria

MICRO

$\varphi = 20°$

then
~~120~~
ques
vul

(ii) angle of failure plane

$\alpha = 45 + \frac{\varphi}{2}$

$= 55°$

...ph $\alpha = 55°$.

07-08

4 (b)

$\sigma_3 = 150 KN/m^2$

$\sigma_d = 260 KN/m^2$

$\sigma_1 = \sigma_3 + \sigma_d$

$= 410 KN/m^2$

$u = 50 KN/m^2$

(i) when $\phi_u = 0$

$C_u = \frac{\sigma_1 - \sigma_3}{2} = \frac{410-150}{2} = 130 Kpa.$

from graph $C_u = 130$ Kpa.

(ii) when $c' = 0$

$\sigma_1' = \sigma_1 - u = 360 KN/m^2$

$\sigma_3' = \sigma_3 - u = 100 KN/m^2$

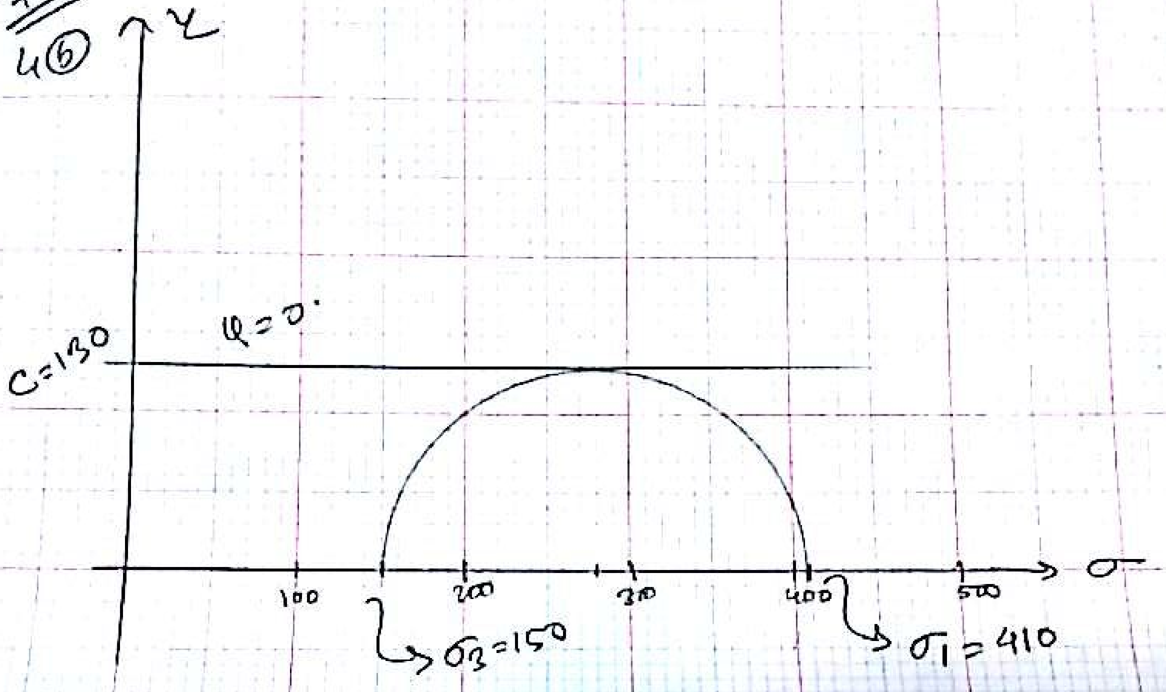
$\sin \phi' = \frac{\sigma_1' - \sigma_3'}{\sigma_1' + \sigma_3'}$

$= \frac{360-100}{360+100} =$

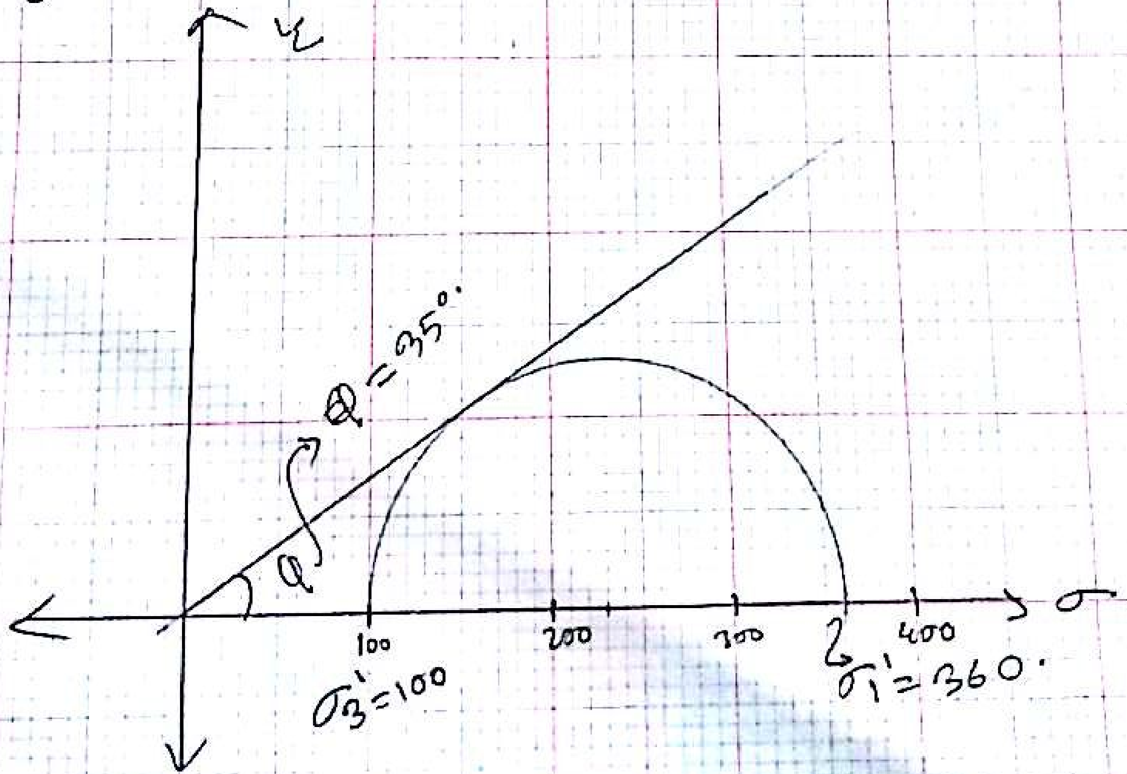
$\phi' = 34.4°$

7-8

4(b)


τ
C=130
φ=0.
100
200
300
400
500
σ
σ3=150
σ1=410

(ii) c'=0.


τ
φ=35°.
φ
100
200
300
400
σ
σ3'=100
σ1'=360.