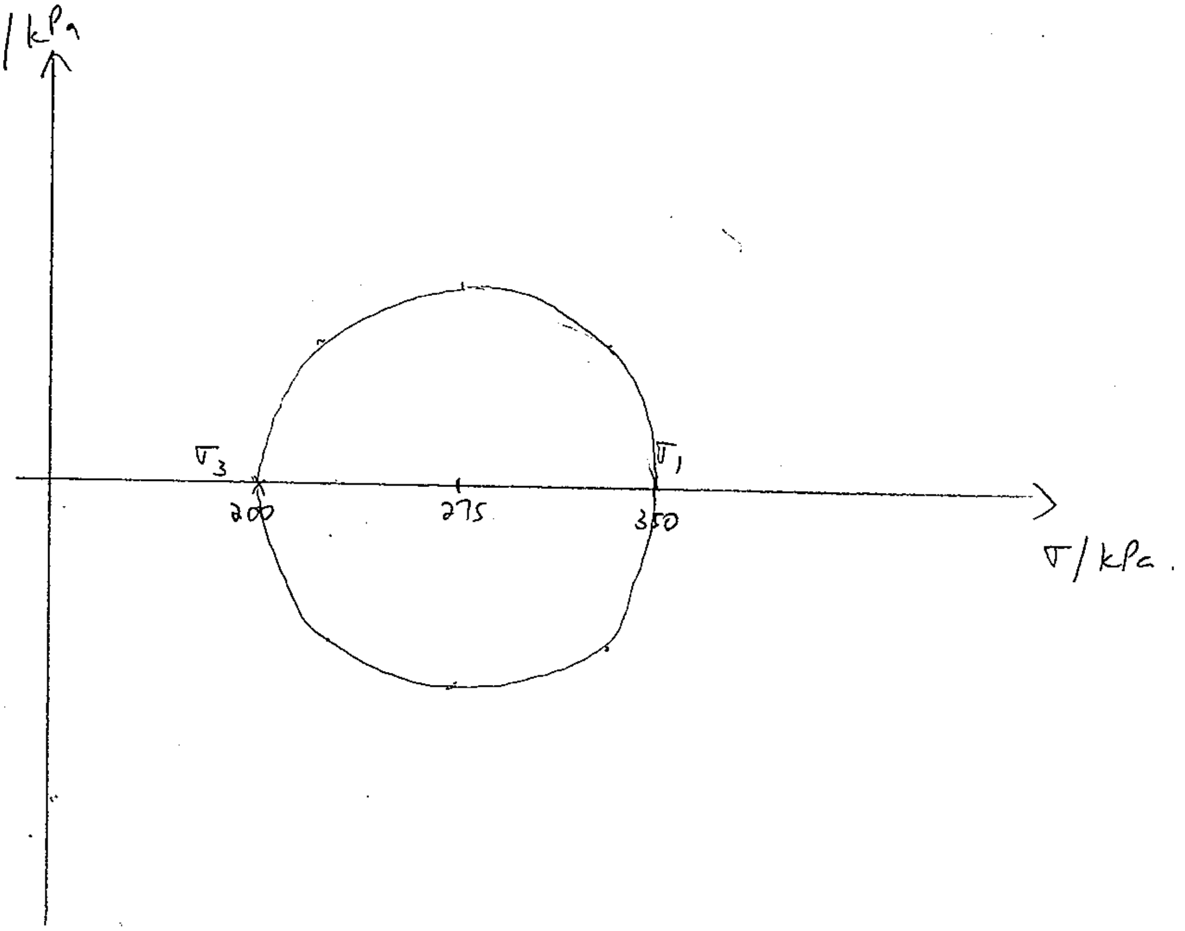
CV 2014 Exam 2013-2014 semester 2.

1 a)

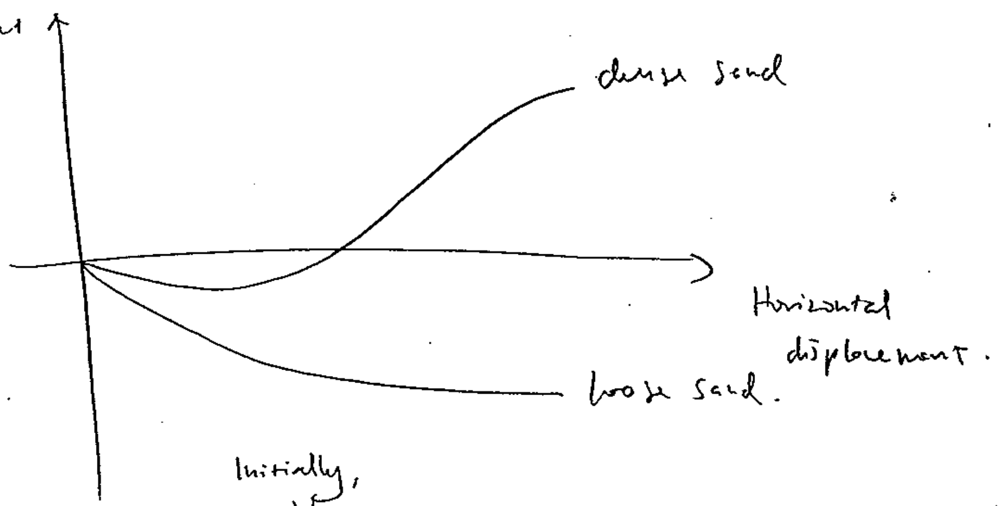


$\sigma_1 - \sigma_3 = 350 - 200 = 150$.

Normal $= \frac{\sigma_1+\sigma_3}{2} + \frac{\sigma_1+\sigma_3}{2} \cos 2\theta = 395.55$ kPa

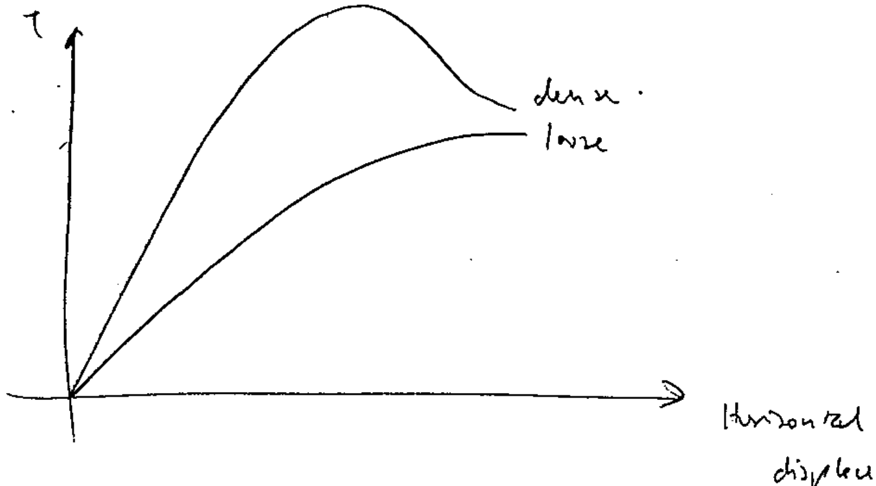
Shear $= \frac{\sigma_1-\sigma_3}{2} \sin 2\theta = 67.41$ kPa

1b.



Dense sand: Initially, Downward displacement due to normal load. Later, experience dilation (expansion when sand particles go over each other).

Loose sand: Experience contraction due to normal load.



Dense sand: Beyond peak τ, no additional shear stress needed to increase horizontal displacement.

Loose sand: τ increase to ~~∅~~ constant value as additional ~~horizontal pressure~~ shear stress needed to increase horizontal displacement.

1c) i)

$a_f = (B \times B) - (\Delta l \times B)$

$\sigma_f = \frac{N}{a_f}$

$\tau_f = \frac{T}{a_f}$.

Test	a_f ($\times 10^{-3}$ m^2)	τ_f (kPa)	σ_f (kPa)
1	3.15	73	100
(2)	3	126	200
3	2.766	179	300

Test 1:

$60 \times 60 = 3600$,

$7.5 \times 60 = 480$.

$1 mm^2 = 0.001^2 = 10^{-6} m^2$.

$a_f = 3600 - 450 = 3.15 \times 10^{-3} m^2$.

$\tau_f = \frac{230}{3.15 \times 10^{-3}} = 73.0 kPa$, $\sigma_f = \frac{315}{3.15 \times 10^{-3}} = 100 kPa$

Test 2:

$a_f = 3600 - (10 \times 60) = 3 \times 10^{-3} m^2$.

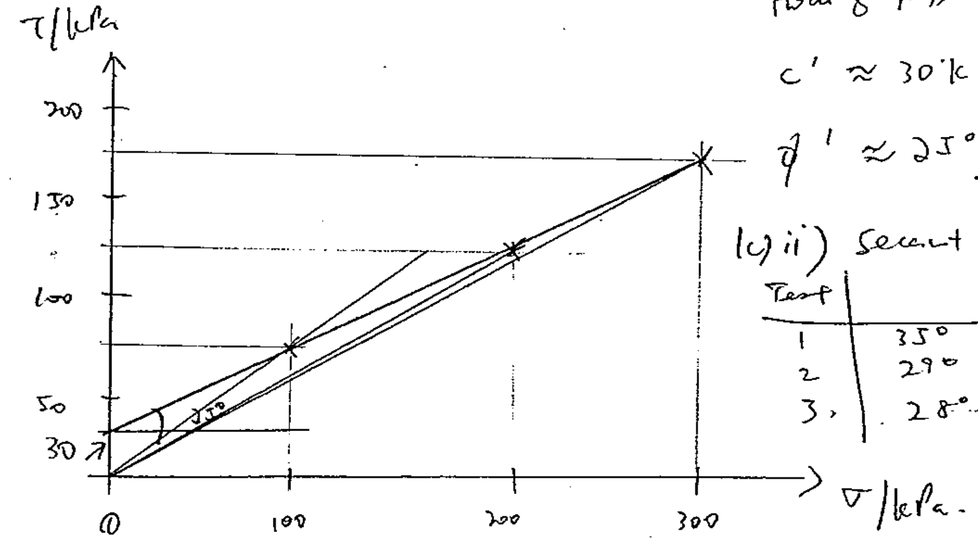
$\tau_f = \frac{379}{3 \times 10^{-3}} = 126 kPa$, $\sigma_f = \frac{600}{3 \times 10^{-3}} = 200 kPa$

Test 3:

$a_f = 3600 - (13.9 \times 60) = 2.766 \times 10^{-3}$

$\tau_f = \frac{496}{2.766 \times 10^{-3}} = 179 kPa$

$\sigma_f = \frac{830}{2.766 \times 10^{-3}} = 300 kPa$



from graph,

$c' \approx 30 kPa$

$\phi' \approx 25°$.

1c) ii) Secant ϕ':

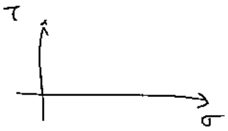
Test	
1	35°
2	29°
3	28°

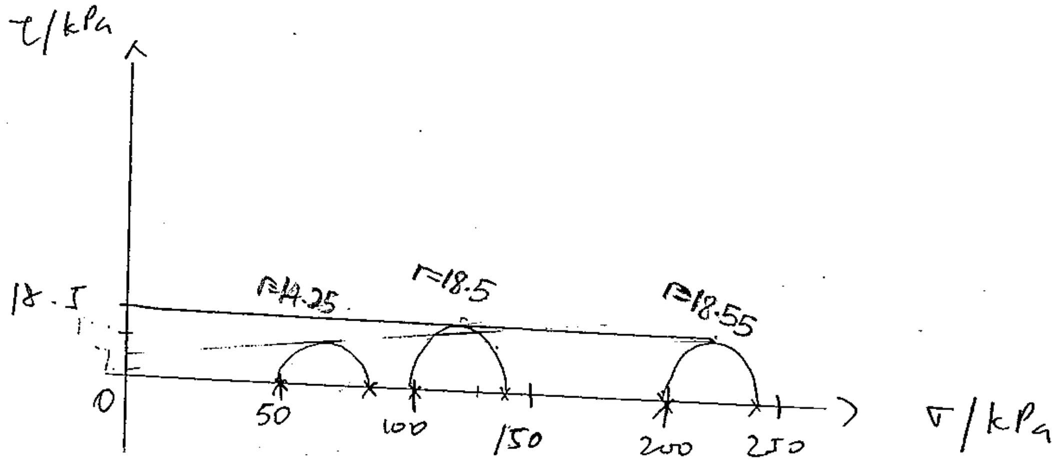
2b) i) $\varepsilon_A = \frac{\Delta l}{l_0}$ $\varepsilon_v = \frac{\Delta V}{V_0}$

σ_3	ε_A		$A = \frac{A_0}{1-\varepsilon_a}$	$\sigma_1-\sigma_3$ (kPa) $\frac{N}{A}$	σ_1 = $(\sigma_1-\sigma_3)+\sigma_3$
50	0.067		1142	28.5	78.5
100	0.096		1254	37.0	137.0
200	0.121		1290	37.1	237.1

$V_0 = \frac{\pi (38)^2}{4} \times 76 = 86.2 \times 10^3 \, mm^3$.

$A_0 = \frac{\pi (38)^2}{4} = 1134 \, mm^2$.





Undrained shear strength of clay ≈ 18.5 kPa

~~4b~~

2b) ii) Lower.

At Deeper clay, pore water pressure increase, effective stress decrease (total stress − pore pressure)

→ shear strength decrease.

Sand:

2c) Normally consolidated soil ~~= 1 - sin ϕ'~~ ~~= 1 - sin~~

$K_o = 1 - \sin \phi'$

$= 1 - \sin 28°$

$= 0.531$

$\gamma_w = 9.81 \text{ kN/m}^3$

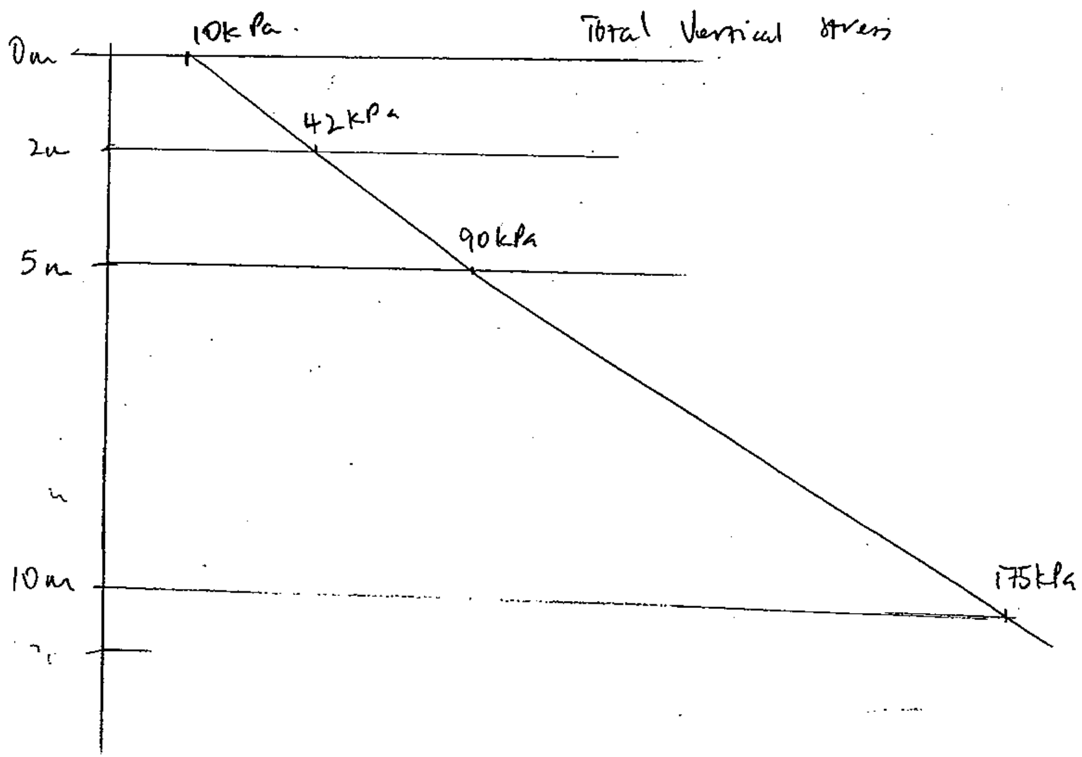
At depth 0m, $\sigma_v = 10 \text{kPa}$.

" 2m, $\sigma_v = (16 \times 2) + 10 =$ ~~66kPa~~ ~~66kPa~~ 42 kPa.

" 5m, $\sigma_v = (16 \times 3) + 42 = 90 \text{ kPa}$

" 10m, $\sigma_v = (5 \times 17) + 90 = 175 \text{ kPa}$

$m = \frac{y}{x}$



2c) continued.

Sand: $K_{o_1} = 1 - \sin 28 = 0.531$

Dense Sand: $K_{o_2} = 1 - \sin 42 = 0.331$.

Depth 0m: $\sigma_h = K_{o_1} q = (0.531)(10) = 5.31$ kPa

" 2m: $\sigma_h = K_{o_1}(q + \gamma z) = (0.531)(16)(24\ 5.31)$ [10+16(2)]

$= 22.3$ kPa

" 5m: σ_h (sand) $= K_{o_1}(q + \gamma z) = (0.531)[(16)(3) + 22.3]$

$= 47.8$ kPa

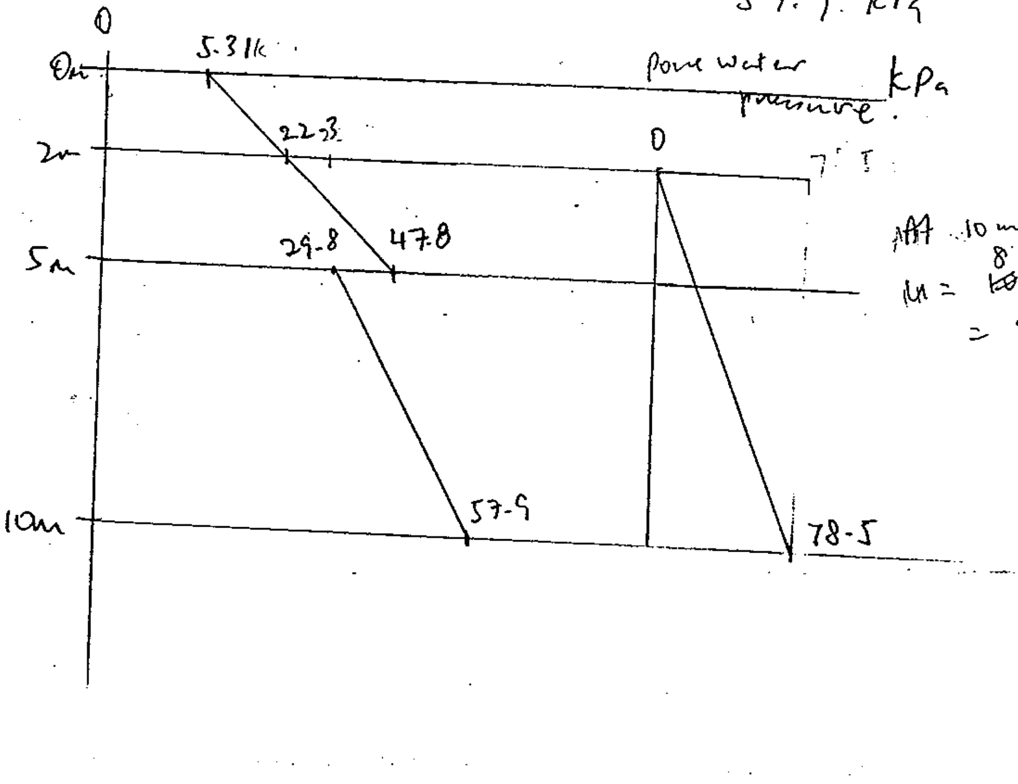
σ_h (dense sand) $= K_{o_2}(q + \gamma z) = (0.331)(10 + ~~17~~ 16 \times 5)$

$= 29.8$ kPa

" 10m: $\sigma_h = K_{o_2}(q + \gamma z) = (0.331)(5)(17) + 29.8$

Total Horizontal Stress

$= 57.9$ kPa



At 10m depth,

$u = ~~10~~\ 8 \times 9.81$

$= ~~98.1~~$ kPa

78.5

3b) continued.

Force // slip plane = W sin 25° = (90+10m) sin 25

For failure of slope:

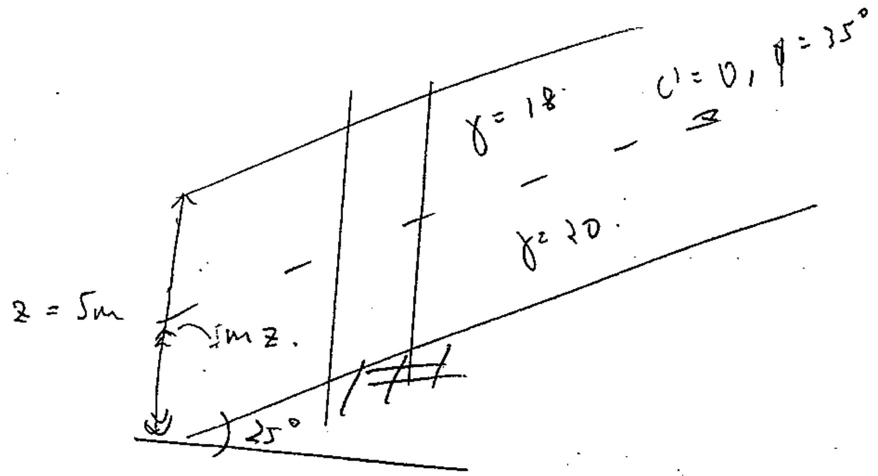
$W \sin 25 = \tau \times l_d$

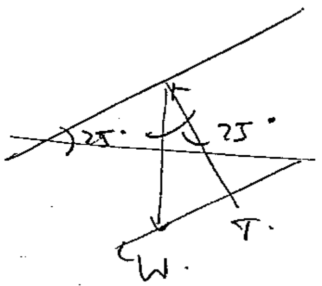
$(90+10m) \sin 25 = 0.473 (90+10m) \times 1.10.$

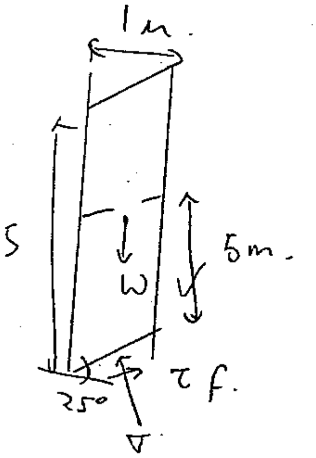
$$\Rightarrow 1 = \frac{[((1-m)(18)+m(20))(5)(\cos 25)^2 - m(5)(9.81)(\cos 25)^2]\tan 35}{[(1-m)(18)+m(20)](5)\sin 25 \cos 25}$$

m = 0.5739

3b) -







$\tau = c' + \sigma \sin\phi$

$\cos 25° = \frac{1}{H}$

$H = \frac{1}{\cos 25}$

$\gamma_w = 9.81$.

diagonal length of slice $= \frac{1}{\cos 25} = 1.10$

$W = (5m)(1)(20) + (5-5m)(1)(18)$

$= 100m + 5(18 - 18m) = 90 + 10m$

Force to slip plane $= W\cos 25 = (90 + 10m)\cos 25$

$\sigma = \frac{W\cos 25}{1.10} = \frac{(90+10m)\cos 25}{1.10} = 0.824(90+10m)$

$\tau = c' + \sigma \sin\phi$

$= 0 + (0.824)(90 + 10m)(\sin 35)$

$= 0.473(90 + 10m)$

$\tau = c' + \sigma$

4a) Soil compaction: Benefits:

- increase unit weight of soil by reducing air.
- ~~increased~~ higher unit weight increase soil normal stress.
- ~~the~~ higher normal stress increase shear strength of soil. ($\tau = c' + \sigma \tan \phi'$)

Compaction;

Applied stress to soil to cause air to be displaced (removed)

Consolidation:

~~Applied stress~~ Stress applied to soil to cause water to be displaced (removed)

4b) Field tests:

1. Find in-situ density using,
   - sand-cone method or
   - rubber bladder field density test.

Lab tests;

1. Relative density test (purpose: to find maximum & minimum density)
2. Grain size distribution test (purpose: find particle sizes in soil)
3. Water content test.