AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

Building Engineering Program - Credit Hours Engineering Programs (CHEP)
STUDENT PORTFOLIO - Academic Year 2021/2022

UEL Module Code **EG4005**	*UEL Module Name* **Structural Analysis, Steel Design and Engineering Economy**	
ASU Course Code **CES263**	*ASU Course Name* **Soil mechanics (1)**	
	Semester Spring 2022	**Date of Submission** 6/2022

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Student ID (ASU): 19P1347
Student ID (UEL): 2140744

1- Major Task

AIN SHAMS UNIVERSITY
I-Credit Hours Engineering Programs
(i.CHEP)

University of East London

Course Code:		Course Name:	Soil mechanics	Assignment No.	1	Date:	3/3/22
Student Name:	Carla Rafik Hosny Naguib Ghazal			Student ID:	19P1344 2140744		

	A (89-100)	B (76-88)	C (67-75)	D (60-66)	F (0-59)
	100 96 92 89	88 84 80 76	75 72 69 67	66 64 62 60	59 40 20 0
Calculations (350%)	• Excellent illustrate for all calculations with all data, dimensions and graphics.	• Very Good illustrate for all calculations with all data, dimensions and graphics.	• Good illustrate for all calculations with all data, dimensions and graphics.	• Normal illustrate for all calculations with all data, dimensions and graphics.	• Lack of illustrate for all calculations.
Final Answer (35%)	• All final answers are correct and to the point.	• Most final answers are correct.	• Some final answers are correct.	• Few final answers are incorrect.	• Most final answers are incorrect.
Drawing (30%)	• Accurate drawings with excellent level of precision.	• Clear drawings with high level of accuracy.	• Drawings with moderate level of precision.	• Vague drawing with low level of accuracy.	• Imprecision drawing with a lot of errors.

1st marker Total	10	1st marker Signature		Agreed Mark	6
2nd Marker Total	10	2nd marker Signature			

General Comments:

UEL Grading System	Agreed	ASU Grading Scale	
% equivalent at UEL	**Mark Range**	**% at ASU**	**Grade**
95% and higher		97% and higher	A+
82% to less than 95%		93% to less than 97%	A
70% to less than 82%		89% to less than 93%	A-
66% to less than 70%		84% to less than 89%	B+
63% to less than 66%		80% to less than 84%	B
60% to less than 63%		76% to less than 80%	B-
56% to less than 60%		73% to less than 76%	C+
53% to less than 56%		70% to less than 73%	C
50% to less than 53%		67% to less than 70%	C-
45% to less than 50%		64% to less than 67%	D+
40% to less than 45%		60% to less than 64%	D
Less than 40%		Less than 60%	F

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Assignment 1: Grading Curve:

1) Rocks: It is a natural strongly cemented accumulation of particles of different minerals

Soil: It is the accumulation of solid particles produced by mechanical disintegration of rock and other weathering processes.

Organic soil: is created by the decomposition of plant and animal remains.

Inorganic soil: It is formed by clay, silt, sand, gravel and boulders

Mechanical weathering: It is the process that breaks rocks apart without changing their chemical composition.

Chemical weathering: It is the weakening and subsequent desintegration of rock by chemical reactions (ex: oxidation, hydrolysis and carbonation). These processes either form or destroy minerals.

Effective diameter "D 10": is the sieve opening corresponding to 10% pass.

Uniformity cofficient: "Cu" can be used as useful index for the quality of the soil grading.

$$C_u = \frac{D_{60}}{D_{10}}$$

Coefficient of curvature: "Cc" can be used as a useful index for the quality of the soil grading:

$$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}}$$

$\boxed{1/4}$

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Particle size:

Clay	silt	Sand	Gravel	Boulders
0.002mm	0.06mm	2mm	60mm	

Particle shape: The particle can be angular, round, flaky, elongated and irregular.

2) The organic soil has low strength and high compressibility

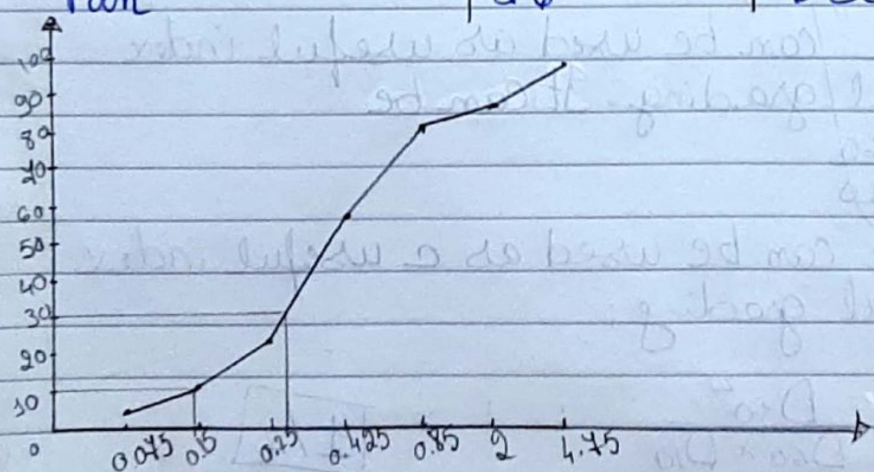
3) → Visual inspection test
→ Feel test → shaking test
→ Shine test
→ Odor test
→ Dry strength
→ Sedimentation

$\left.\begin{array}{l}\text{shaking test}\\ \text{Shine test}\end{array}\right\}$ wet sample.

$\left.\begin{array}{l}\text{Dry strength}\\ \text{Sedimentation}\end{array}\right\}$ Dry sample

4)

Sieve diameter	Weight retained	Total wt. retained	% Wt retai	% Wt passe
4.75	30	30	4.62%	95.38%
2.00	45	75	11.54%	88.46%
0.85	52	127	19.54%	80.46%
0.425	135	262	40.30%	59.7%
0.250	230	492	75.69%	24.31%
0.150	90	582	89.54%	10.46%
0.075	42	624	96%	4%
Pan	26	650	100	0%



a) % Fines = 4%
% Sand = 84.46%
% Gravel = 1 . 54%

b) $D_{10} = 0.145$ mm
$D_{30} = 0.3$ mm
$D_{60} = 0.43$ mm

$\boxed{2/4}$

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c] $C_u = \frac{D_{60}}{D_{10}} = \frac{0.43}{0.145} = 2.97$

$C_c = \frac{D_{30}^2}{D_{60} \cdot D_{10}} = \frac{(0.3)^2}{0.43 \times 0.145} = 1.44$

From C_u & C_c; the soil is poor graded sand.

5]

Sieve opening	Wt retained	Σ Wt retained	% Wt retained	% Wt Passed
5	11.8	11.8	1.18 %	98.82%
2	9.43	21.23	2.12%	97.88%
1	103.62	124.85	12.47%	87.51%
0.5	42.05	166.9	16.69%	83.31%
0.2	66.33	233.23	23.32%	76.68%
0.1	8.56	241.79	24.18%	75.82%
0.075	8.3	250.09	25.01%	74.99%

2) For hydrometer analysis:

Diam (mm)	0.06	0.052	0.043	0.023	0.014	0.0064	0.0027
% Pass	99%	93.7%	91%	89.5%	80.6	55.4	24.33
% Pass corr	71.5%	67.67%	65.72%	64.64%	58.21%	40.01%	17.57%

$\% \text{ Pass corrected} = \% \text{ Pass} \times \frac{W_{fine}}{W_{total\,corrected}} = \% \text{ Pass} \times \frac{650}{\cancel{1000}\ 900}$

3/4

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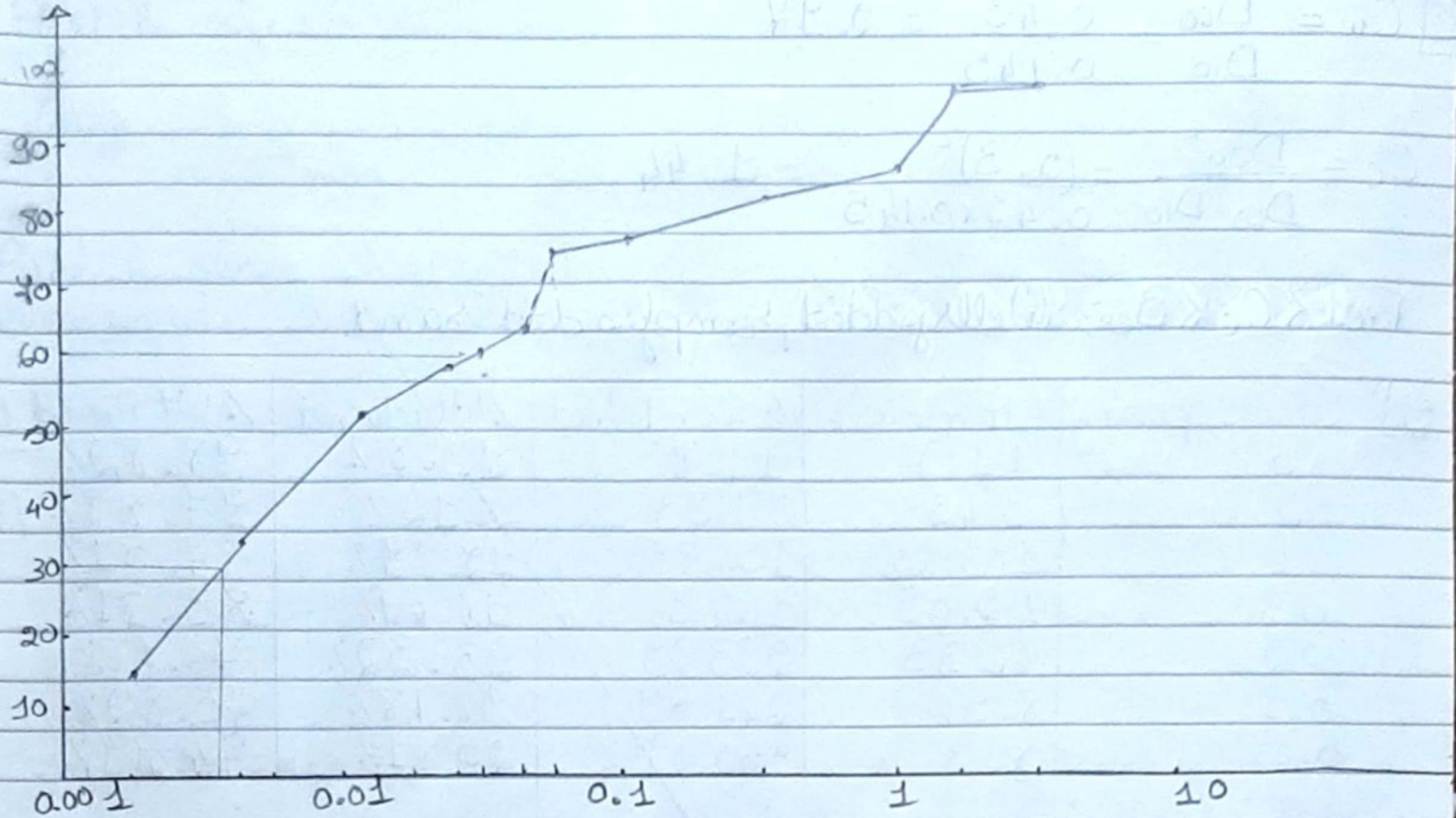


Clay = 0%

Silt = 71.5 %

Sand% = 26.38%

Gravel% = 2.12%

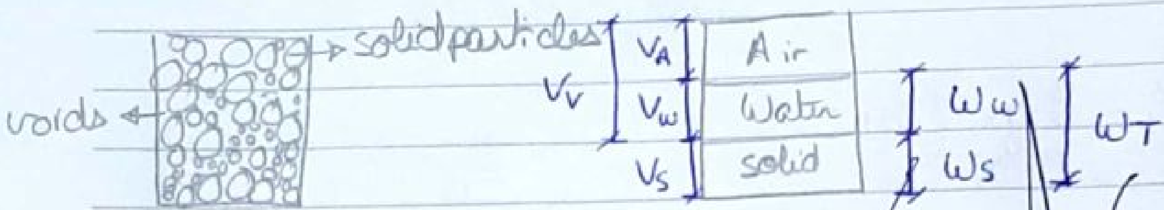
Boulders% = 0%

$D_{10} = 0$

$D_{30} = 0.0055$ mm

$D_{60} = 0.051$ mm.

1 ⓐ 3 phase diagram:



ⓑ Void ratio: $e = \frac{V_V}{V_S}$ $\quad e > 0$

Porosity: $n = \frac{V_V}{V_T}$ $\quad 0 < n < 1$

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

2_ Atterberg or consistency limits: it is the moisture content present that time. They are liquid limits plastic limits and shrinkage limit.

Atterberg limits describe fine grained soils and idicate the water content of the soil

→ soil classification

→ In construction specifications

→ Indicate the strength, compressibility, permeability and shrinkage

3_ → Plasticity index: it indicates the plasticity of the soil and the amount of water that must be added to tranform it from plastic limit to liquid limit

$$PI = L.L - P.L$$

→ Consistency index: It indicate the consistency of the soil

$$CI = \frac{L.L - W.C}{L.L - P.L}$$

c. The activity indicates the type and the effect of the clay mineral in soil

$$Activity = \frac{PI}{\% clay}$$

4. Given: $\gamma_b = 2\ gm/cm^3$

$G_s = 2.8$

$\gamma_d = 1.8\ gm/cm^3$

Required: W_c / S.L / Sr.

$$\gamma_d = \frac{G.S}{1+e} \times 1$$

$$1.8 = \frac{2.8}{1+e} \qquad e = 0.56$$

$$\gamma_b = \frac{G.S \times (1+W_c)}{(1+0.56)} \times 1$$

$$2 = \frac{2.8 \times (1+W_c)}{(1+0.56)} \qquad \boxed{W_c = 0.11 = 11.4\%}$$

$$W_c . G_s = e . S_r$$

$$S.L . 2.8 = 0.56 \times 1 \qquad \boxed{S.L = 0.2 = 20\%}$$

$$W_c . G_s = e . S_r$$

$$0.114 \times 2.8 = 0.56 \times S_r \qquad \boxed{S_r = 0.57}$$

5. $D_r = 0.9$

Soil A: $D_r = \frac{e_{max} - e}{e_{max} - e_{min}}$

$$0.9 = \frac{0.97 - e}{0.97 - 0.44} \qquad e = 0.49$$

$$\frac{V_1}{3600} = \frac{1 + 0.76}{1 + 0.49} \qquad V_1 = 4252.35\ m^3$$

Price = 552799 LE

Soil B:

$$0.9 = \frac{0.89 - e}{0.89 - 0.51} \qquad e = 0.55$$

$$\frac{V_1}{36000} = \frac{1 + 0.64}{1 + 0.55} \qquad V_1 = 38090$$

Price = 609440£

Soil C:

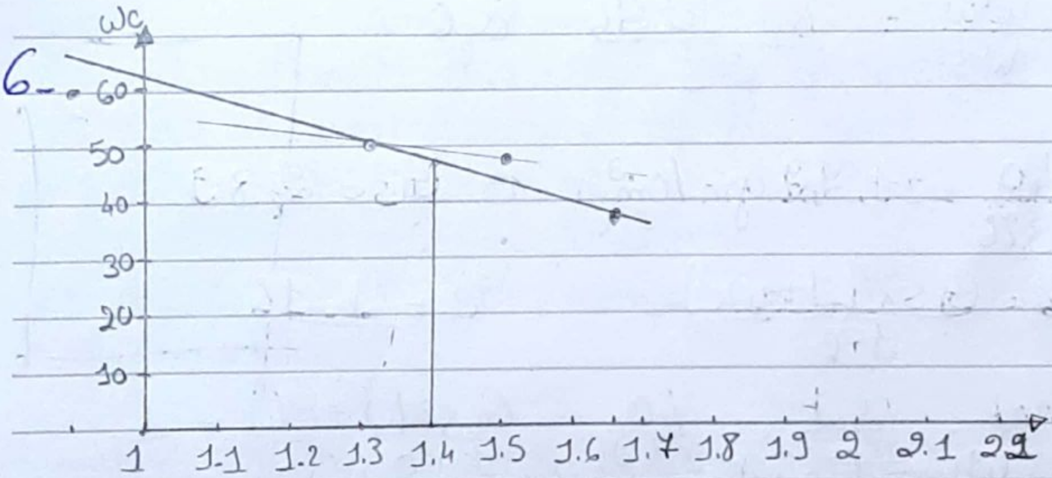
$$0.9 = \frac{1.01 - e}{1.01 - 0.49} \qquad e = 0.54$$

$$\frac{V_1}{36000} = \frac{1 + 0.59}{1 + 0.54} \qquad V_1 = 37168.83$$

Price = 929225£

From economical point of view, soil A is the best.

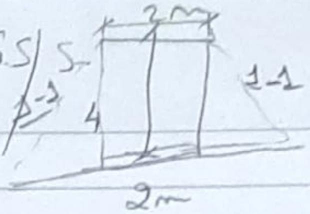
6-



L.L = 48%

$$\text{Consistency state} = \frac{48 - 30}{20} = 0.9\%$$

γ Dr   S | γ_d | γ_{sat} | G.S | S



1-1 V_T Emp 2 $= \frac{2+10}{2} \times 4 \times 1 = 24\ m^3/m'$

$?? \frac{V_1}{V_2} = \frac{1+e_1}{1+e_2}$ ✓

$V_2\ m^3/m'$ 24

7- $\begin{cases} \gamma_b = 18\ kN/m^3 \\ W_c = 0.08 \end{cases}$

$\begin{cases} \gamma_d = 15\ kN/m^3 \\ W_c = 0.1 \end{cases}$

$G_s = 2.67$

$wc = \frac{w}{\ }$ $\gamma_b = \frac{G_s(1+wc)}{1+e}$

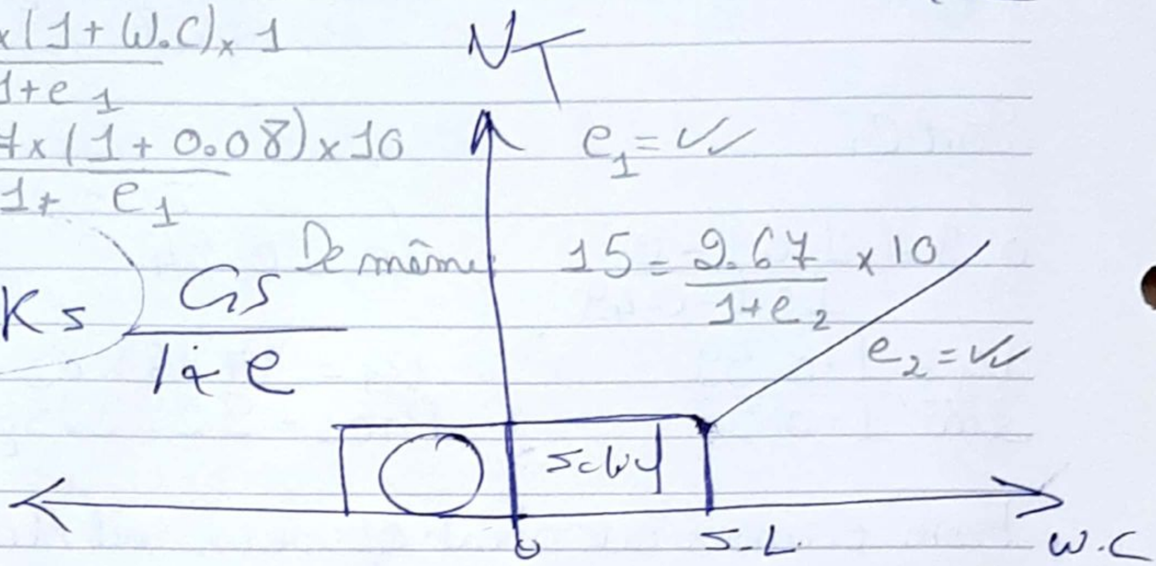
Case 1:

$\gamma_b = \frac{G_s \times (1 + W.C)}{1+e_1} \times 1$

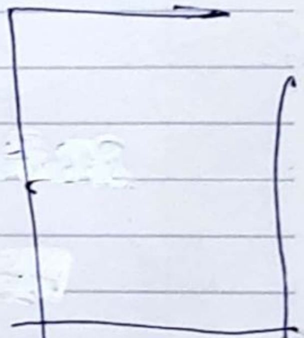
$18 = \frac{2.67 \times (1 + 0.08) \times 10}{1 + e_1}$ $e_1 = $ ✓✓

De même $15 = \frac{2.67}{1+e_2} \times 10$ $e_2 = $ ✓✓

$\gamma_{BULK} = \frac{G_s}{1+e}$



8- ① $W_c = \frac{W_w}{W_s} = \frac{40 - 25}{25} = 0.6$



② $G_s \cdot W_c = e \cdot S_r$ $S_r = 0$

$e = 0.6\, G_s$

③ $\gamma_{sat} = \frac{W_{sat}}{V_{sat}} = \frac{40}{23.26} = \frac{G_s \cdot (1 + 0.6)}{1 + 0.6 G_s} \cdot 1$

$-\left(\frac{1}{\gamma_{min}} - \frac{1}{\gamma_c}\right)$

$\boxed{G_s = 3.03}$ $e = 1.82$

$-\left(\frac{1}{\gamma_{min}} - \frac{1}{\gamma_c}\right)$

④ $\gamma_d = \frac{W_d}{V_d} = \frac{25}{10.76} = 2.32 = \frac{G_s}{1+e_d} \times 1 = \frac{3.03}{1 + e_d} \times y$

$e_d = 0.31 \rightarrow S.L = \frac{e_d}{G.S} = \frac{0.31}{3.03} \boxed{= 0.1 = 10\%}$

1) Soil water:
→ free water
→ held water.

Absorbed water: It is the water naturally absorbed by the soil by attraction force. The soil is negatively charged and the water is positevely charged.

Neutral stress: It is the pressure transmitted through the pore fluid.

Capillary fringe: the water rise, against the gravitational force, in a thin tube. The narrower the tube, the higher the liquid rises due to the forces of adhesion & cohe

Critical hydraulic gradient: It is the head loss per unit length of soil. $i = \frac{\Delta h}{L}$

Boiling / quicksand: When flow takes place in an upward direction, the seepage pressure also acts in the upward direction and the effective pressure is reduced. It is the phenomenon of lifting of soil particles.

2) The coefficient of permeability: is a measure indicating the capacity of soil to allow fluids to pass through it.

Discharge velocity: is the rate of flow per unit cross sectional area of soil perpendicular to flow direction

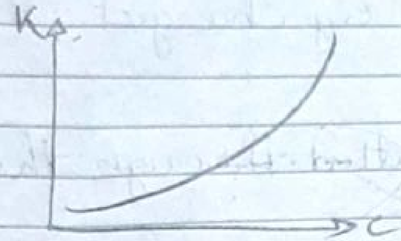
Seepage velocity: is the rate of flow per unit cross sectional area of void of soil perpendicular to flow direction

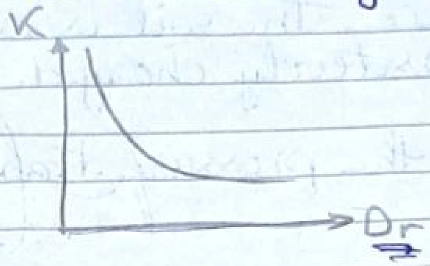
$$V_s = \frac{V}{n}$$

Coefficient of percolation: is the seepage velocity of water through soil per unit hydraulic gradient. $V_s = K_s \cdot i$

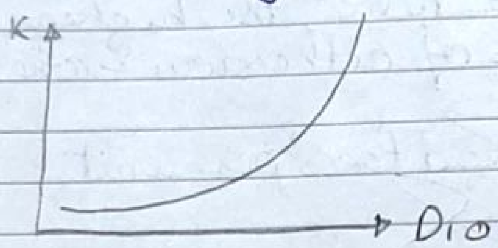
Factors affecting soil permeability:

→ Void ratio (e) & relative density.

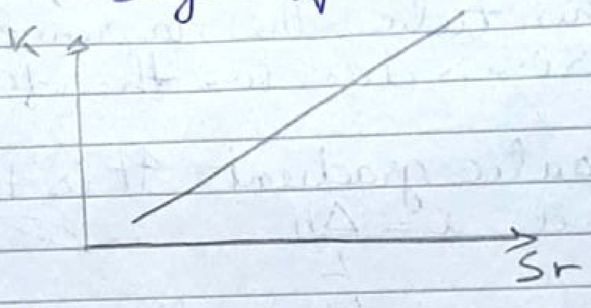




→ Grain size



→ Degree of saturation:

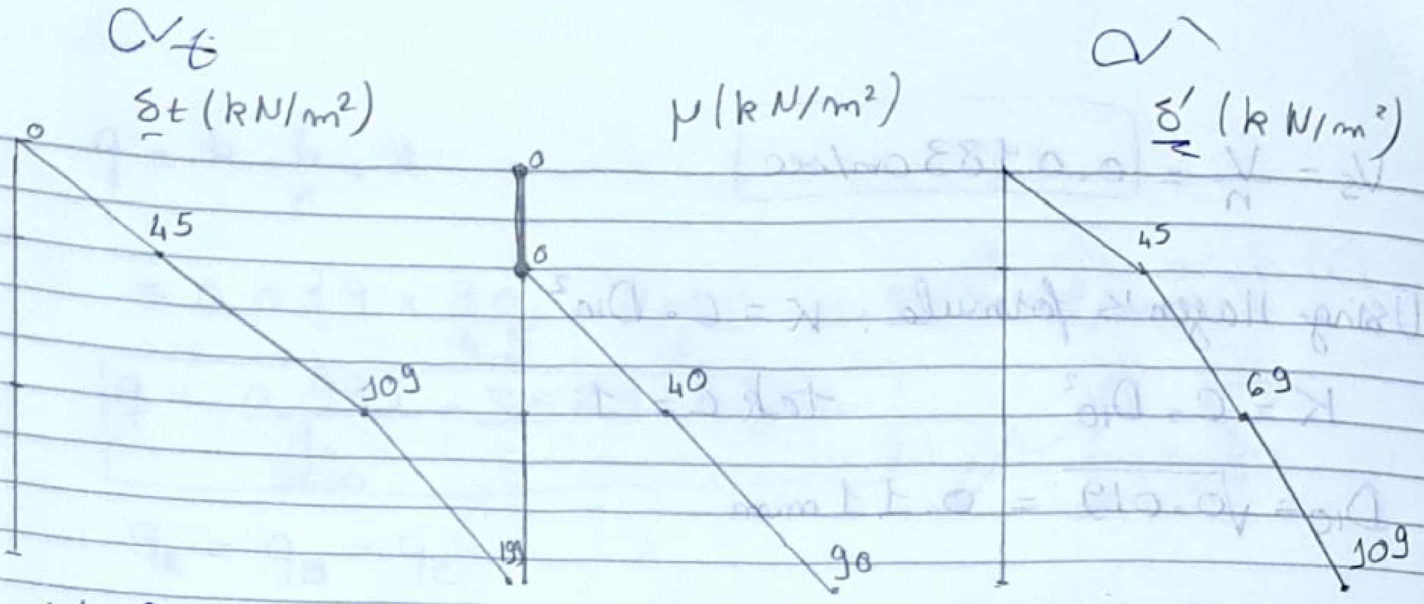


→ Temperature $K \propto \frac{1}{T}$

→ Arrangement of particles → foreign materials

3)

Point	γ_t	μ	σ'
1	0	0	0
2	45	0	45
3	109	40	69
4	199	90	109



4) $G.s = 2.65$ $\quad Wc = 0.35$ $\quad F.O.S = 1.25$

$G.s.\,wc = e.\,Sr$, $Sr = 1$ $\quad e = 0.9275$

$2.65 \times 0.35 = e$

$$\gamma_{sat} = \frac{Gs.(1+wc)}{1+e} = \frac{2.65 \times (1+0.35)}{1+0.9275} = 1.856\ t/m^3$$

$\delta_T = 1.856 \times (6.5 - h)$ $\quad \mu = 5.5 \times 1 = 5.5\ t/m^3$

At boiling $\delta_o = 0 \longrightarrow \mu = \delta_T$ $\quad 5.5 = 1.856 \times (6.5-h)$

$h = 3.54\ m$ $\quad \boxed{h_{saf} = \frac{3.54}{1.25} = 2.832\ m}$

5) $V = 173\ ml \rightarrow 5\ min$ $\quad d = 10\ cm$ $\quad \Delta h = 6.1\ cm$
$l = 10\ cm$ $\quad n = 0.4$

$$K = \frac{Q.\,l}{h.\,A.} = \frac{173 \times 10}{6.1 \times \frac{\pi \cdot 10^2}{4} \times 5 \times 60} = 0.012\ cm/sec$$

$$V = k.\,i = 0.012 \times \frac{6.1}{10} = 7.32 \times 10^{-3}\ cm/sec$$

$$V_s = \frac{V}{n} = \boxed{0.0183\ cm/sec}$$

Using Hazen's formula : $K = C \cdot D_{10}^2$

$K = C \cdot D_{10}^2$ tak $C = 1$

$D_{10} = \sqrt{0.012} = 0.11\ mm$

6- $h_1 = 100\ cm$ $d = 1.10\ cm$ $t = 3\ hrs$

$h_2 = 66\ cm$ $D = 8\ cm$ $L = 20\ cm.$

$q = V_{standpipe} \cdot a = V_{soil} \cdot A$

$$\frac{dh}{dt} \cdot a = K \cdot \frac{h}{\ell} \cdot A$$

$$\int_{h_2}^{h_1} \frac{dh}{dh} = \frac{K \cdot A}{\ell \cdot a} \int_0^t dt$$

$$\ln \frac{h_1}{h_2} = \frac{K \cdot A}{\ell \cdot a} \cdot t$$

$$K = \frac{a \cdot \ell}{A \cdot t} \ln\left(\frac{h_1}{h_2}\right)$$

$$K = \frac{1.1^2 \times 20}{8^2 \times 3 \times 3600} \times \ln\left(\frac{100}{66}\right) = 1.45 \times 10^{-5}\ cm/sec$$

7- $$K_{eq} = \frac{15 + 15 + 15}{\frac{15}{10^{-2}} + \frac{15}{3\times10^{-2}} + \frac{15}{4\times10^{-2}}} = 0.019\ cm/sec$$

$q = k \cdot \frac{h}{l} \cdot A$

$= 0.019 \times \frac{30}{45} \times \frac{\pi \times 10^2}{4} = 0.995 \ cm^3/sec$

$$\boxed{q = \frac{0.995}{\frac{1}{3600}} = 3582 \ cm^3/hr}$$

$q_A = q_B = q_C$

$k_A \cdot \frac{h_A}{l} \cdot \cancel{A} = k_B \cdot \frac{h_B}{l} \cdot \cancel{A} = k_C \cdot \frac{h_C}{l} \cdot \cancel{A}$

$10^{-2} \times \frac{h_A}{15} = 3 \times 10^{-2} \times \frac{h_B}{15} = 4 \times 10^{-2} \frac{h_C}{15}$

$h_A + h_B + h_C = 30 \ cm$

$h_A = 3 h_B \qquad h_C = 0.75 h_B$

$h_B + 3 h_B + 0.75 h_B = 4.75 h_B$

$h_B = 6.32 \ cm \qquad h_A = 18.96 \ cm \qquad h_C = 4.74 \ cm$

8. → head loss in each layer:

$q_A = q_B$

$K_A \cdot \frac{h_A}{L_A} \cdot A_A = K_B \cdot \frac{h_B}{L_B} \cdot A_B$

$\frac{k_A}{k_B} = \frac{e_A^2}{e_B^2}$

$\frac{1 \times 10^{-4}}{k_B} = \frac{0.5^2}{0.8^2}$

$\boxed{k_B = 2.56 \times 10^{-4} \ cm/sec}$

$1 \times 10^{-4} \cdot \frac{h_A}{0.5} \cdot \frac{\pi}{4} \times 0.5^2 = 2.56 \times 10^{-4} \cdot \frac{h_B}{0.5} \cdot \frac{\pi}{4} \times (0.25)^2$

$h_A = 0.64 h_B \qquad h_A + h_B = 0.5$

$\boxed{h_A = 0.195m}$ $\boxed{h_B = 0.305m}$

→ Discharge velocity:

$V_A = K_A \cdot \frac{h_A}{L_A} = 1 \times 10^{-4} \times \frac{0.195}{0.5} = 3.9 \times 10^{-5} \ cm/sec$

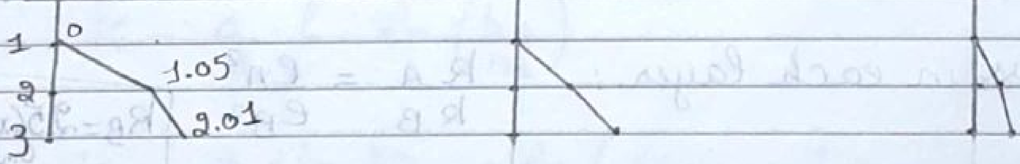
$V_B = K_B \cdot \frac{h_B}{L_B} = 2.56 \times 10^{-4} \times \frac{0.305}{0.5} = 1.56 \times 10^{-4} \ cm/sec$

→ Seepage Velocity:

$V_{SA} = \frac{V_A}{n_A} = \frac{3.9 \times 10^{-5}}{\frac{0.5}{1+0.5}} = 1.17 \times 10^{-4} \ cm/sec$

$V_{SA} = \frac{V_B}{n_B} = \frac{1.56 \times 10^{-4}}{\frac{0.8}{1+0.8}} = 3.5\cancel{1}4 \times 10^{-4} \ cm/sec$

→	σ_T (t/m^2)	u (t/m^2)	σ' (t/m^2)
1	0	0	0
2	$2.1 \times 0.5 = 1.05$	$1 \times (1 - h_B) = 0.7$	0.305
3	$1.05 + 1.92 \times 0.5 = 2.01$	$1.5 \times 1 = 1.5$	0.5



9) D = 50 cm   h = 8 m $q = 4.0 \ m^3/min$
$d_0 = 4.5$ R = 150 m.

$K = \frac{q}{\pi \cdot (Z_2^2 - Z_1^2)} \cdot \ln\left[\frac{r_2}{r_1}\right] = \frac{4}{\pi \cdot (8^2 - (8-4.5)^2)} \times \ln\left[\frac{150}{0.25}\right]$

$= 0.1574 \ m/min$

$$\frac{0.1574}{\frac{1}{60\times 24}} = 226.656 \ m/day$$

n m

1-a) Type of load:

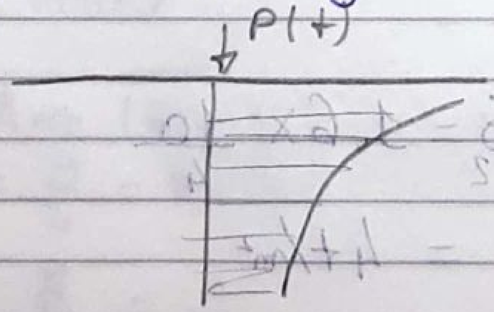
→ Point load
→ line load
→ Uniform distribution load
→ Non " " "

Type of soil
→ Cohesive soil
→ ~~Cohesiveless~~ soil

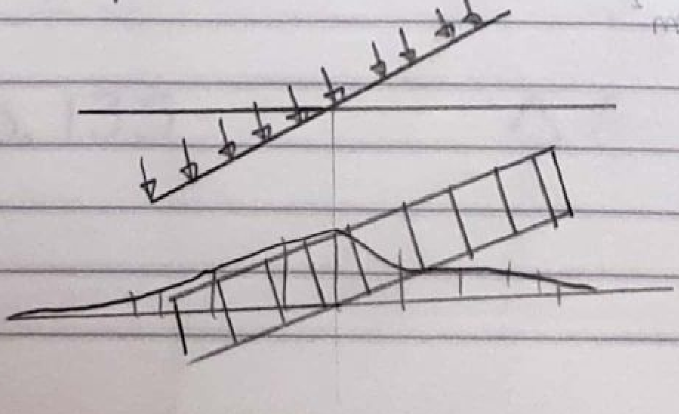
Shape of footing
→ Square footing
→ Rectangular footing
→ Circular "
→ Irregular shaped "

Rigidity of footing
→ Rigid footing
→ flexible footing.

b)



c)



1) Boussinesq's theory assumptions:

→ the soil medium is an elastic, homogenous, isotropic and semi-infinite

→ the self-weight of soil is ignored

→ the soil is initially unstressed

→ the change in volume of soil upon application of the loads on to it is neglected.

2) $\Delta \delta_z = I_1 \times \frac{P}{Z^2}$ $\quad I = \frac{3}{2\pi} \times \left[\frac{1}{1+[(\frac{r}{z})^2]}\right]^{5/2}$

Point n°	P(t)	r(m)	Z(m)	r/z	I_1	$\Delta\delta$(t/m²)
1	40	1	3	1/3	0.367	1.631
2	90	3.16	3	1.053	0.0439	0.439
3	80	5.59	3	1.863	0.0113	0.100
4	30	8.56	3	2.853	1.891×10^{-3}	6.303×10^{-3}

$\Sigma \delta_1 = 2.476$

Fence load $\Delta\delta = I_2 \times \frac{P}{Z}$

$X = 4m \quad Z = 4m \quad \frac{X}{Z} = 1$

From chart: $I_2 = 1.6$

$\Delta\delta_2 = 1.6 \times \frac{10}{4}$

$= 4 t/m^2$

$\Delta\delta = \Delta\delta_1 + \Delta\delta_2 = 6.476\ t/m^2$

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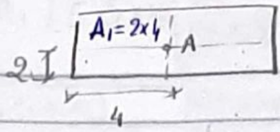
3- For point A: $A_1 [2 \times 4]$



$m = \frac{2}{4} = 0.5$

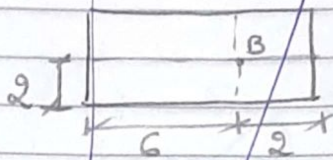
$n = \frac{4}{4} = 1$

$I_{41} = 0.121$

$\Delta \delta_A = 4 \times 0.121 \times 20 = 9.68\ t/m^2$

For Point B:

Area $1 [2 \times 6]$



$m = \frac{2}{4} = 0.5$

$n = \frac{6}{4} = 1.5$

$I_{41} = 0.131$

Area $2 [2 \times 2]$

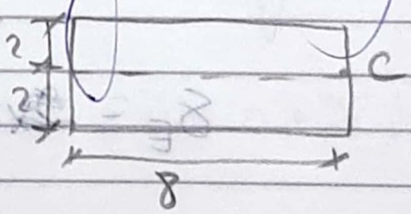
$m = \frac{2}{4} = 0.5$

$n = \frac{2}{4} = 0.5$

$I_{42} = 0.085$

$\Delta \delta_B = 2 \times [0.131 + 0.085] \times 20.$
$= 8.64\ t/m^2$

For Point C:



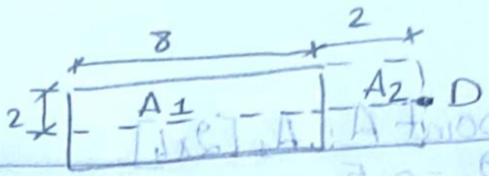
For Area (2×8)

$m = \frac{2}{4} = 0.5$

$n = \frac{8}{4} = 2$

$I_4 = 0.135$

$\Delta \delta_C = 2 \times 0.135 \times 20 = 5.4\ t/$



For Point D:

For Area 1 [2x8]:

$m = \frac{2}{4} = 0.5$

$n = \frac{8}{4} = 2$

$I_{4(1)} = 0.135$

For Area 2 [2x2]:

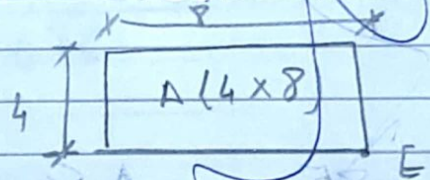
$m = \frac{2}{4} = 0.5$

$n = \frac{2}{4} = 0.5$

$I_{42} = 0.085$

$\delta_D = 2 \times [0.135 - 0.085] \times 20$
$= 2 \ t/m^2$

For point E:
Area [4x8]

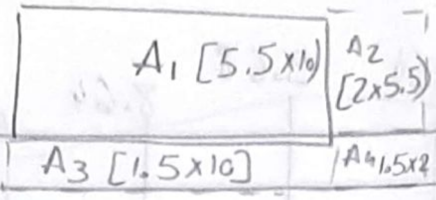


$m = \frac{4}{4} = 1$

$n = \frac{8}{4} = 2$

$I_{41} = 0.2$

$\delta_E = 0.2 \times 20 = 4 \ t/m^2$



For Point F:

A_1 [5.5x10]

$m = \frac{5.5}{4} = 1.375$

$n = \frac{10}{4} = 2.5$

$I_{41} = 0.25$

A_2 x [2 x 5.5]

$m = \frac{2}{4} = 0.5$

$n = \frac{5.5}{4} = 1.375$

$I_{42} = 0.123$

Area 3 [1.5x10]

$m = \frac{1.5}{4} = 0.375$

$n = \frac{10}{4} = 2.5$

$I_{43} = 0.11$

Area 4 [1.5x2]

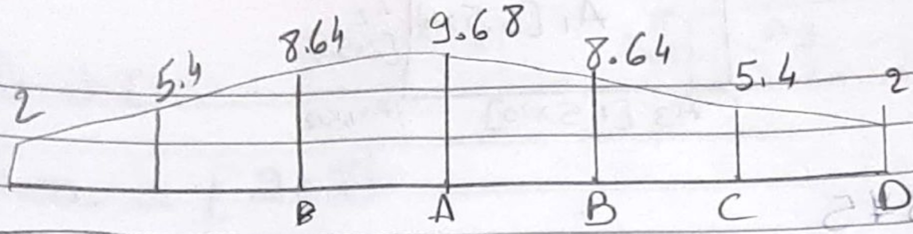
$m = \frac{1.5}{4} = 0.0375$

$n = \frac{2}{4} = 0.5$

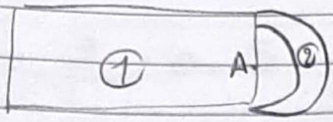
$I_{44} = 0.073$

$\Delta \delta = [0.25 - 0.123 - 0.11 + 0.073] \times 20$

$= 1.8$



4



For Area 1:

$X = 27m \quad y = 4.5 \quad Z = 4m$

$n = 1.125$

$m = 6.75$

$I_4 = 0.211$

$A = 27 \times 9 + \frac{\pi \times 4.5^2}{4} - \frac{\pi \times 4^2}{4} = 249.7 m^2$

$q = \frac{440}{249.7} = 1.762 t/m^2$

$\Delta \delta_1 = 2 \times 0.211 \times 1.762 = 0.7436 t/m^2$

For Area 2:

$\Delta \delta_2 = 1.762 \times 0.5 \times [1 - [\frac{1}{1+(\frac{4.5}{4})^2}]^{3/2} - [1 - [\frac{1}{1+(\frac{4}{4})^2}]^{3/2}]$

$= 0.053$

$\Delta \delta_{total} = 0.7436 + 0.053 = 0.8 t/m^2$

I- 1- Compressibility: the deformation that is caused by applying any loads or stresses on the soil

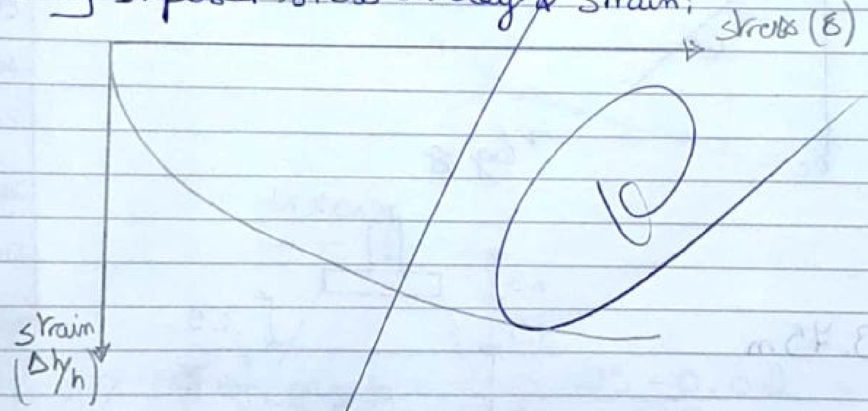
2- Consolidation: It occurs in saturated fine-grained soils, occurs due to the reduction of the volume of water that fills the voids between the soil particles

3- Coefficient of volume Compressibility $(m_v) = \dfrac{\Delta h / h}{\Delta \sigma}$

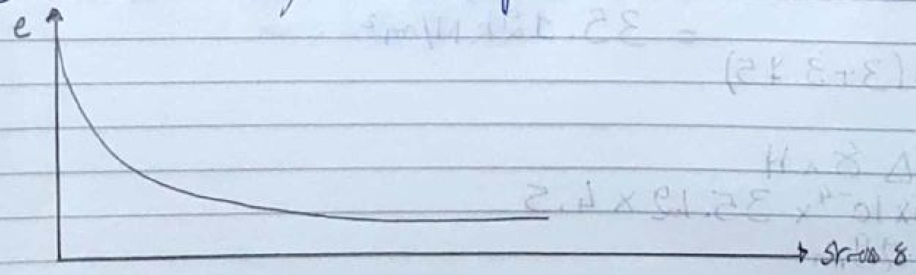
It is the change in soil volume with respect to the original volume due to a unit increase in stress

4- Compression index $C_c = \dfrac{\Delta e}{\log\left(\dfrac{\sigma_0 + \Delta\sigma}{\sigma_0}\right)}$

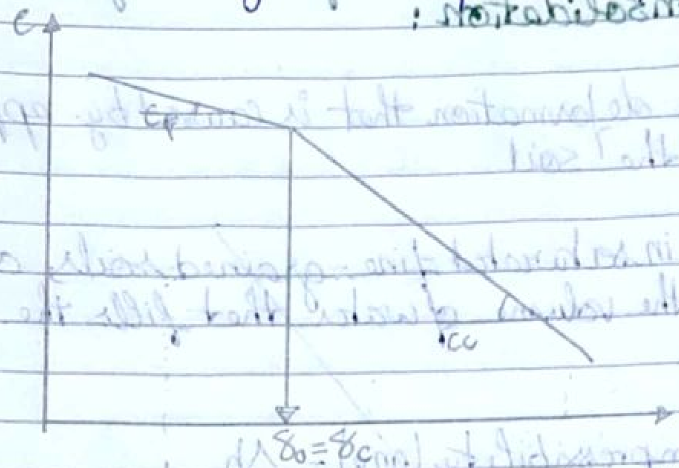
2- a) Imposed stress on clay & strain:



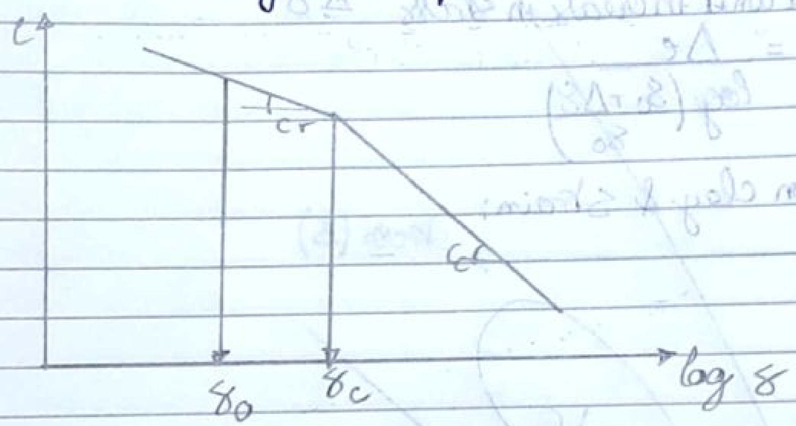
b) Stress - Void ratio relationship:



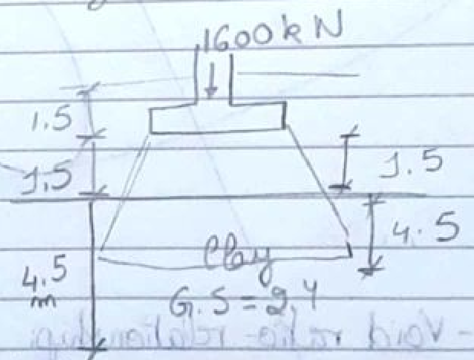
c. Void ratio & logarithm of stress of N.C soil



d) Void ratio & logarithm of stress of preloaded soil.



Question 3:



$$Z = 1.5 + \frac{4.5}{2} = 3.75\,m$$

$$\Delta\delta = \frac{P}{(B+Z)(L+Z)}$$

$$= \frac{1600}{(3+3.75)\times(3+3.75)} = 35.12\,kN/m^2$$

$$\Delta H = m_v \times \Delta\delta \times H$$

$$= 1.85\times10^{-4} \times 35.12 \times 4.5$$

$$= 0.029\,m$$

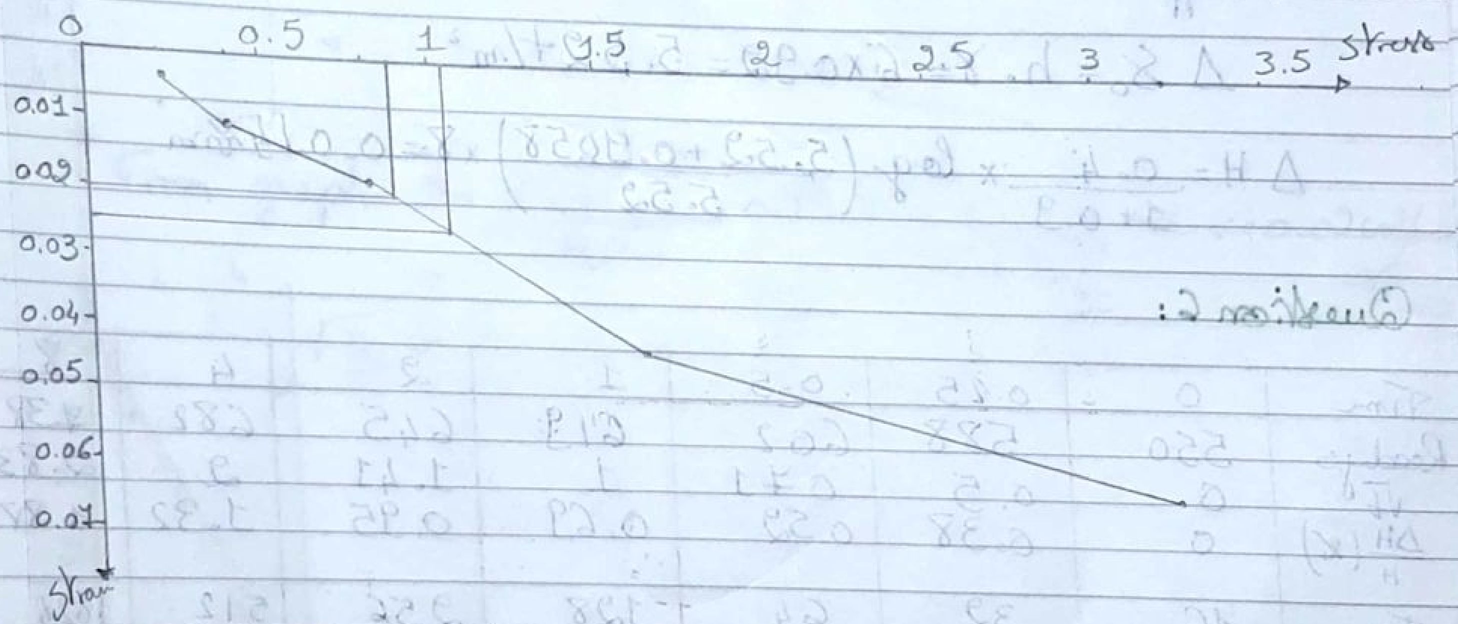
0.5 → 2.5
0.? 4.4

Question 4:

$\sigma_o = 4 \times (1.84-1) + (1.95-1) \times \frac{4}{2} = 5.26\ t/m^2$

$\Delta\sigma = \frac{240}{(5+4.5)\times(3+4.5)} = 3.368\ t/m^2$

Stress	0.2	0.4	0.8	1.6	3.2
settlement/mm	0.08	0.19	0.35	0.81	1.2
Strain($\Delta h/h$)	0.004	0.01	0.018	0.043	0.064

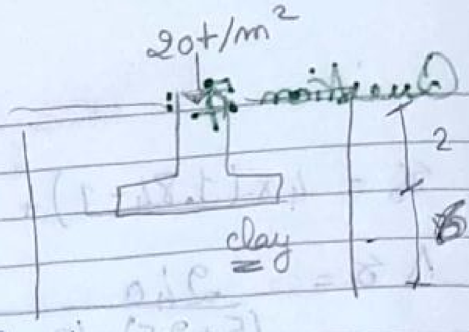


?? From graph: $m_v = \frac{0.025-0.02}{3.368} = 1.484 \times 10^{-3}\ m^2/t$

$\Delta H = 1.484 \times 10^{-3} \times 3.368 \times 4 = 0.01999\ m.$

$= m_v \times \Delta\sigma \times h$

Question 5:



$$\Delta h = \frac{C_c}{1+e_0} \times \log\left(\frac{\gamma_0 + \Delta\gamma}{\gamma_0}\right) \times h$$

$$\Delta \gamma = \frac{20}{(3+3)\times(3.5\times 3)} = 0.513 \ t/m^2$$

$$\gamma_{sat} = \frac{2.75+0.9}{1+0.9} \times 1 = 1.92 \ t/m^2$$

$$\gamma_{eff} = \gamma_{sat} - \gamma_{wat} = 0.92 \ t/m^2$$

$$\Delta \gamma_0 = h.\gamma = 5 \times 0.92 = 4.6 \ t/m^2$$

$$\Delta H = \frac{0.4}{1+0.9} \times \log\left(\frac{4.6+0.513}{4.6}\right) \times 6 = 0.058 m$$

Question 6:

Time	0	0.25	0.5	1	2	4	8
Readings	550	588	602	619	645	682	738
$\sqrt{t}$	0	0.5	0.71	1	1.41	2	2.83
$\frac{\Delta H}{H}$ (%)	0	0.38	0.52	0.69	0.95	1.32	1.87
Time	16	32	64	128	256	512	1024
Readings	808	866	914	955	977	993	1006
$\sqrt{t}$	4	5.66	16	11.3	16	22.6	32
$\frac{\Delta h}{4}$	2.58	3.16	3.64	4.05	4.27	4.43	4.56

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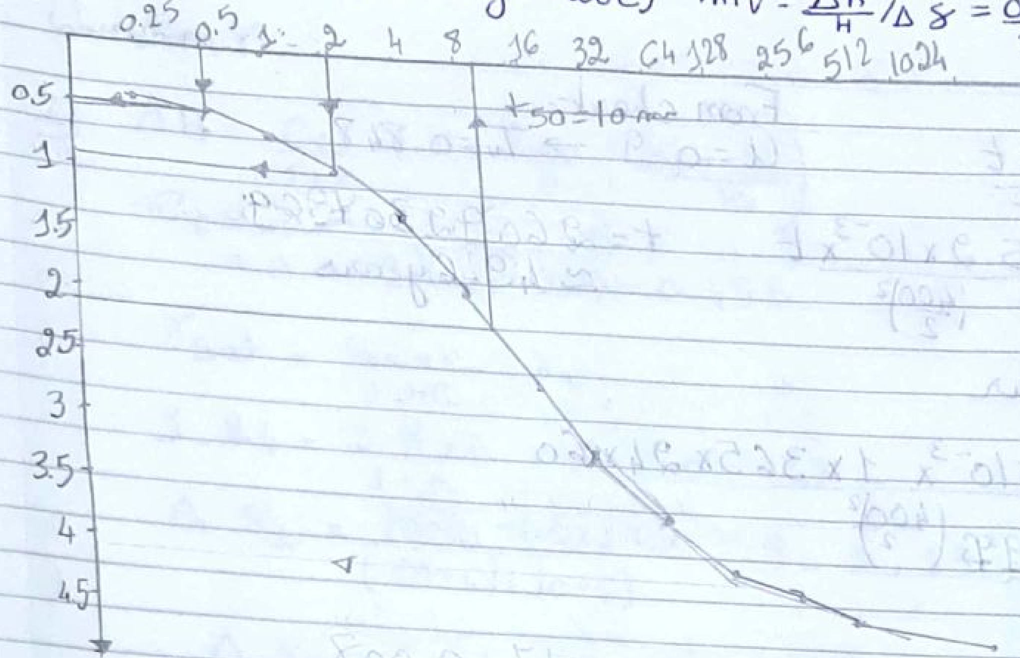
3- Average coefficient of permeability:

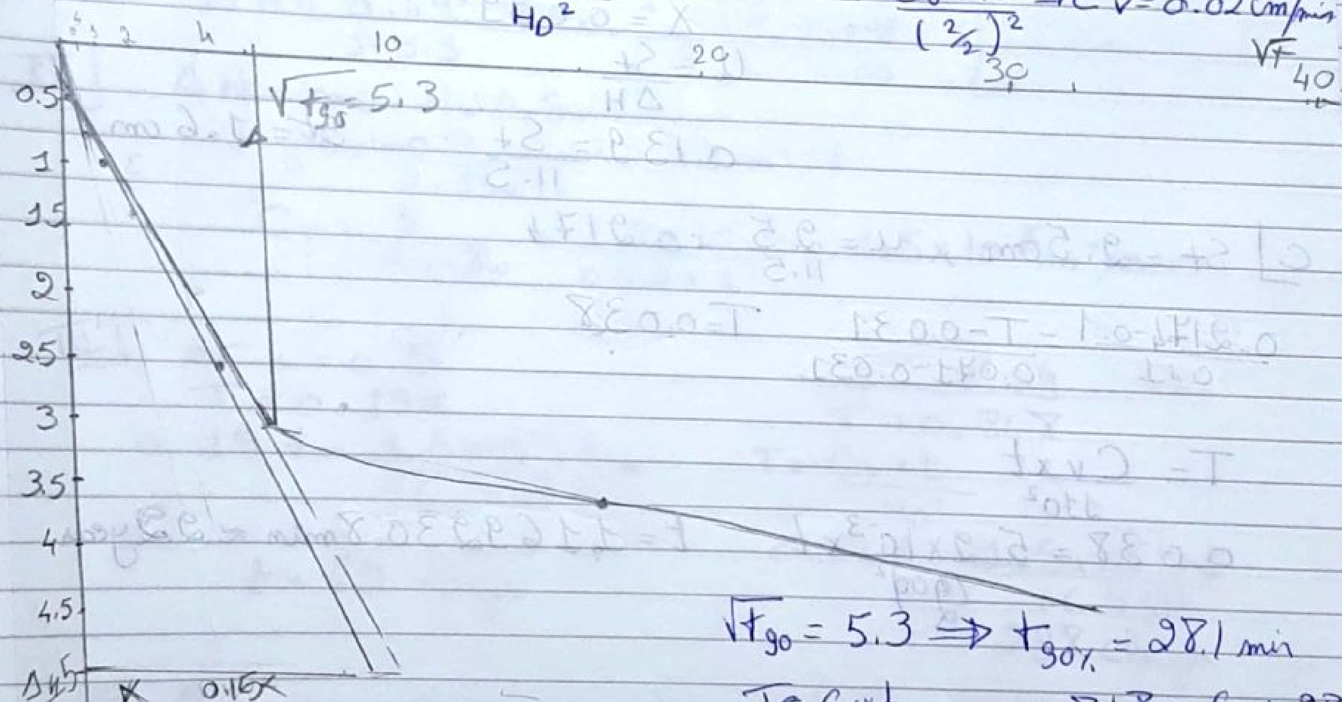
$C_{v\,ar} = \frac{0.02 + 0.03}{2} = 0.025\,cm^2/min \times \frac{10^{-4}}{60} = 4.2 \times 10^{-8}\,m^2/sec$

$\frac{\Delta H}{H} = 4.1\%$ (From log t curve) $m_v = \frac{\Delta h}{H} / \Delta \sigma = \frac{0.041}{20-10} = 0.0041\,m^2/$

$\therefore k_{av} = C_v \cdot m_v \cdot \gamma_w = 1.7 \times 10^{-8}\,m/sec$



From graph $T = \frac{C_v \times t}{H_0^2} \Rightarrow 0.197 = \frac{C_v \times 10}{(2/2)^2} \Rightarrow C_v = 0.02\,cm^2/min$



$\sqrt{t_{90}} = 5.3 \Rightarrow t_{90\%} = 28.1$ min

$T = \frac{C_v \times t}{H_0^2} \Rightarrow 0.848 = \frac{C_v \times 28.1}{(2/2)^2}$

$\Rightarrow C_v = 0.03\,cm^2/min$

Question 4:

a] $T_v = \frac{C_v \cdot t}{H_D^2}$

From chart
$U = 0.9 \rightarrow T_v = 0.848$

$0.848 = \frac{5.2 \times 10^{-3} \times t}{\left(\frac{400}{2}\right)^2}$ $t = 6523076.923$
≈ 12.4 years.

b] $t = 1$ year

$T = \frac{5.2 \times 10^{-3} \times 1 \times 365 \times 24 \times 60}{\left(\frac{400}{2}\right)^2}$
$= 0.0683$

$U = \frac{S_t}{\Delta H}$

$0.1 = \frac{S_t}{11.5}$ $S_t = 1.6$ cm

3

c] $S_t = 2.5$ cm ; $u = \frac{2.5}{11.5} = 0.2174$

$T = 0.0\ 6$

$T = \frac{C_v \times t}{H_D^2}$

$0.038 = \frac{5.2 \times 10^{-3} \times t}{\left(\frac{400}{2}\right)^2}$ $t = 461538$ min ≈ 0.9 year

Question 8:

i) $\Delta H = \frac{C_c}{1+e} \times H \times \log_{10}\left(\frac{\delta_1 + \delta_0}{\delta_0}\right)$

$C_c = 0.009\,(L.L - 10)$

$= 0.009\,(65-10) = 0.495$

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

$1.74 = \frac{2.4 + e}{1+e} \times 1 \qquad e = 1.3$

$\Delta \delta_1 = \frac{\left(\frac{550}{10 \times 10} - 1.5 \times 1.74\right) \times 10 \times 10}{(10+6)(10+6)} = 1.13\ t/m^2$

$\Delta \delta_0 = 6 \times (1.74 - 1) + 1.5 \times 1.74 = 4.05\ t/m^2$

$\Delta H = \frac{0.495}{1+1.3} \times 12 \times \log\left(\frac{1.13 + 4.05}{4.05}\right) = 0.167m$

II) $\Delta H = m_v \cdot H \cdot \Delta \delta_0$

$m_v = \frac{0.3}{2.15 \times 12} = 0.012\ m^2/t$

$C_v = \frac{k}{m_v \times \gamma_w} = \frac{1.8 \times 10^{-8}}{0.012 \times 1} = 1.5 \times 10^{-6}\ m^2/sec$

III) at $u = 0.5$

$T = 0.197$

$0.197 = \frac{1.5 \times 10^{-6} \times t_{50\%}}{(6.45)^2}$

$t = 69$ days

at $u = 0.9$

$T = 0.848$

$T = \frac{C_v \times t}{H_D^2}$

$0.848 = \frac{1.5 \times 10^{-6} \times t}{(6.45)^2}$

$t = 298$ days

IV Over consolidated will increase & under-consolidated will decrease.

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9) i) $\Delta H = m_v . H . \Delta \sigma = 0.005 \times 4.5 \times \frac{240}{(5+4.5)(3+4.5)} = 0.076\ m$

ii) $t = 5\ yrs$

$T = \frac{C_v \times t}{H_D^2} = \frac{0.615 \times 10^{-5} \times 5 \times 365 \times 24 \times 60}{4^2} = 0.246$

$U = 0.56$

$0.56 = \frac{\Delta H}{0.076} \Rightarrow \Delta H = 0.04256\ m$

iii) $u = 0.8$

$T = 0.567$

$T = \frac{C_v \times t}{H_D^2}$; $0.567 = \frac{0.015 \times t}{400^2}$; $t = 6048000\ min$

$t = 11.5\ years$