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CIVIL ENGINEERING

مختبر الهندسة الجيوتقنية
قسم الهندسة المدنية
م. آيات الحدادين
20-6-2018

THE HASHEMITE UNIVERSITY
Zarqa - Jordan
1995

Sieve and Hydrometer Analysis

Student Name: عبدالله طائل المصري

ID#: 1639799

Section: 1

Date: 25/6/2018

19/20

Objective:

- use sieve analysis and Hydrometer anglysis for soil classification.
- sieve analysis → to classify the soil to coarse and fine using sieve # 200, and classify coarse soil into gravel and sand.
- Hydrometer analysis → to classify fine soil into silt and clay.

Equipment:

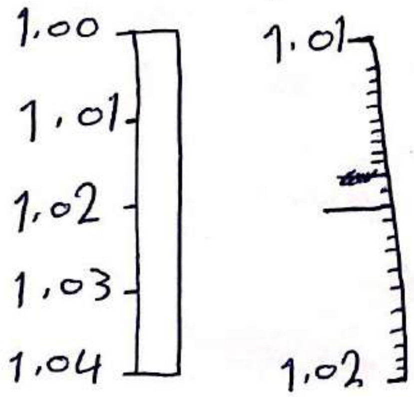
* Mechanical sieve analysis

1. Balance
2. sieve chaker
3. sieve with different sizes.

* Hydrometer analysis

1. Hydrometer device.
2. Thermometer.
3. Timer.
4. Tank.
5. Na_3PO_4 solution.
6. graded glass.

Draw free sketch for hydrometer device and give me one reading at it is.



$$1\,Div = \frac{0.01}{20} = 0.0005$$

$$1.01 + 6(Div) = 1.01 + 6(0.0005) = 1.013$$

Procedure:

mechanical sieve analysis (ASTMD - 421)

Hydrometer analysis (ASTMD - 422)

Sieve analysis:

Sieve No	Sieve Diameter (mm)	Sieve Mass (g)	Sieve Mass + Soil Mass (g)	Retained Soil Mass (g)	Cumulative Retained	%Retained soil	Percentage of Finer Soil Mass % (Pass)
1	25	550.29	617.4	67.11	67.11	6.711	93.289
(3/4)	19	554.70	589.57	34.87	101.98	10.198	89.802
(1/2)	12.500	542.90	588.6	45.7	147.68	14.768	85.232
(3/8)	9.5000	542.60	564.90	22.3	169.98	16.998	83.002
# 4	4.7500	511.40	558.64	47.24	217.22	21.722	78.278
# 10	2.00	486.20	519.5	33.3	250.52	25.052	74.948
# 20	.85	424.80	437.70	12.9	263.42	26.342	73.658
# 40	.425	385.90	391.70	5.8	269.22	26.922	73.078
#60	.25	359.10	360.49	1.39	270.61	27.061	72.939
# 100	0.1500	345.60	353.80	8.2	278.81	27.881	72.119
# 200	0.0750	337.60	344.32	6.72	285.53	28.553	71.447
pan	——	364.35	365.55	1.2	286.73	28.673	71.327
				286.73			

* $M_{tot} = 1000\ g$

% finer = 100 − % Ret

Hydrometer analysis

Elapsed time (min)	Actual Hydrometer reading	Composite correction	R corrected	Temperature (C°)	L (cm)	K	D	%of finer	Actual % of finer
.25 = 15 sec	1.02+18DIV = 1.029	0.0005	1.0285	24°	8.6	0.01282	0.07519	98.86%	70.63%
.5 = 30 sec	1.02+17DIV = 1.0285	0.0005	1.028	24°	8.75	0.01282	0.05363	97.27%	69.49%
1	1.02+16DIV = 1.028	0.0005	1.0275	24°	8.9	0.01282	0.03824	95.68%	68.36%
2	1.02+15DIV = 1.0275	0.0005	1.027	24°	9.05	0.01282	0.02727	94.09%	67.22%
4	1.02+10DIV = 1.025	0.0005	1.0245	24°	9.7	0.01282	0.19963	86.17%	61.56%
8	1.02+8DIV = 1.024	0.0005	1.0235	24°	10	0.01282	0.01433	82.99%	59.29%
15	1.02+7DIV = 1.0235	0.0005	1.023	24°	10.1	0.01282	0.01052	81.41%	58.16%
~~30~~ 19(hrs)	1+ 7DIV = 1.0035	0.0005	1.003	24°	15.35	0.01282	0.00149	17.98%	12.85%
[illegible]									

Sample of calculation: - ***** Hydrometer sample *****
@ 15 min

Temp(C°)	G_w
4	1
16	.99897
17	.99880
18	.99862
19	.99844
20	.99823
21	.99802
22	.99780
23	.99757
24	.99733
25	.99708
26	.99682
27	.99655
28	.99627
29	.99598
30	.99568

*actual Hydrometer reading = 1.02 + 7Div.

= 1.02 + 7(0.0005)

= 1.0235

**Composite Correction @ . $R_1 = 1$, $R_2 = 1 - 1DIV$

c = (W of water + disp) – (Wof water) $R_1 - R_2$

1 – (1 – 0.0005) = 0.0005

*** Hydrometer reading with composite correction applied
= Actual hydraulic – Composite

= 1.0235 – 0.0005

= 1.023

**** Effective depth of hydrometer L (cm) – from table 7-4 = (151H)

L = 10.1 cm at actual reading 1.0235

***** Value of (K) from (table 7.3)

~~K = 0.01284~~ K = 0.01282

at GS = 2.7, T = 24°

****** Diameter of soil particle D (mm) = K*(L/T) ^.5 hint T is time in minutes

$D (mm) = K\sqrt{\frac{L}{T}} = 0.01282\sqrt{\frac{10.1}{15}} = 0.01052$ mm

******* Soil in Suspension

Note W= 50 g GS = 2.7 G_w = 0.99733

P = { ((100,000/W) * GS /(GS – G_w))}*(Rcor – G_w)

$= \left\{ \left(\frac{100000}{50} \times \frac{2.7}{(2.7 - 0.99733)} \right) \right\} \times (1.023 - 0.99733)$

= 81.41 %

Actual P = P * (% passing sieve No 200)

= 81.41 × 0.71447

= 58.16 %

Scanned with CamScanner

****** Mechanics Sample ******

@sieve # 100

Weight sieve empty = 345.60 (g)

Weight sieve full = 353.80 (g)

Weight retained = W full - W empty

353.80 − 345.60 = 8.2 (g)

% of Retained = $\frac{\text{Cummulative retain \#100}}{\text{total weight of soil}} * 100\%$

$= \frac{278.81}{1000} * 100\% = 27.881\%$

Commutative of retained = cummulative retained sieve #60 + retained on sieve #100

= 270.61 + 8.2

= 278.81 (g)

% passing = 100% − 27.881

= 72.119 %

Discussion and conclusion

*% Gravel ⇒ Retained on sieve #4

= 21.722 %

**%sand → Retained than sieve #200 and passed on ~~the~~ sieve #4

28.553 − 21.722 = 6.831 %

***%silt → of it passed ~~the~~ sieve #200 and retained above D = 0.0

71.447 − 23.91 = 47.537 %

****%clay → finer than D = 0.002 ⟶ ≃ 23.91 %

*****D10= cannot be determain, D60= 0.018 ,D30= 0.0027 , D85= 12 , D50= 0.007

9 -1.5

******Cc= $\frac{(D_{30})^2}{D_{10} D_{60}}$ ⟶ Can not be determined

*******Cu= $\frac{D_{60}}{D_{10}}$ ⟶ Can not be determined

******** Soil classification the soil is fine graded because the pass on sieve #200 is bigger than 50 %

71.447 > 50 % → Fine Soil

Plot(%of passing)versus(diameter in(mm))for both sieve and hydrometer analysis on the same figure.

Why using the hexameta phosphate (calgon)?

to nutralize the negative charge in the fine grained soil to prevent the soil lumps.

Weight of container plus air-dried soil for hydrometer analysis = 170.49 g

Weight of container = 110.21 g

Sieve Size	Weight Retained (g)
No. 10	0
No. 40	5.13
No. 100	5.31
No. 200	5.19

TABLE 7-4 Values of Effective Depth Based on Hydrometer and Sedimentation Cylinder of Specified Sizes [1]

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Effective Depth, L (cm)	Actual Hydrometer Reading	Effective Depth, L (cm)	Actual Hydrometer Reading	Effective Depth, L (cm)
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5	36	10.4
1.006	14.7	6	15.3	37	10.2
1.007	14.4	7	15.2	38	10.1
1.008	14.2	8	15.0	39	9.9
1.009	13.9	9	14.8	40	9.7
1.010	13.7	10	14.7	41	9.6
1.011	13.4	11	14.5	42	9.4
1.012	13.1	12	14.3	43	9.2
1.013	12.9	13	14.2	44	9.1
1.014	12.6	14	14.0	45	8.9
1.015	12.3	15	13.8	46	8.8
1.016	12.1	16	13.7	47	8.6
1.017	11.8	17	13.5	48	8.4
1.018	11.5	18	13.3	49	8.3
1.019	11.3	19	13.2	50	8.1
1.020	11.0	20	13.0	51	7.9
1.021	10.7	21	12.9	52	7.8
1.022	10.5	22	12.7	53	7.6
1.023	10.2	23	12.5	54	7.4
1.024	10.0	24	12.4	55	7.3
1.025	9.7	25	12.2	56	7.1
1.026	9.4	26	12.0	57	7.0
1.027	9.2	27	11.9	58	6.8
1.028	8.9	28	11.7	59	6.6
1.029	8.6	29	11.5	60	6.5
1.030	8.4	30	11.4		
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

T = interval of time from beginning of sedimentation to the taking of the reading, min

9. Grain-size analysis results are normally presented in graphical form with grain diameter along the abscissa on a logarithmic scale that increases from right to left and "percentage passing" along the ordinate on an arithmetic scale. Such a graph is referred to as the "grain-size distribution curve."

TABLE 7-3 Values of K for Use in Equation for Computing Diameter of Particle in Hydrometer Analysis [1]

Temperature (°C)	Specific Gravity of Soil Particles 2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.01323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01439	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01225	0.01208	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

NUMERICAL EXAMPLE

A laboratory test was conducted according to the procedure described previously. The following data were obtained:

Weight of total air-dried soil = 540.94 g

Weight of fraction retained on No. 10 sieve (washed and oven-dried) = 2.20 g

For sieve analysis:

Sieve Size	Weight Retained (g)
3/8 in.	0
No. 4	0.97
No. 10	1.23

For hygroscopic moisture correction factor:

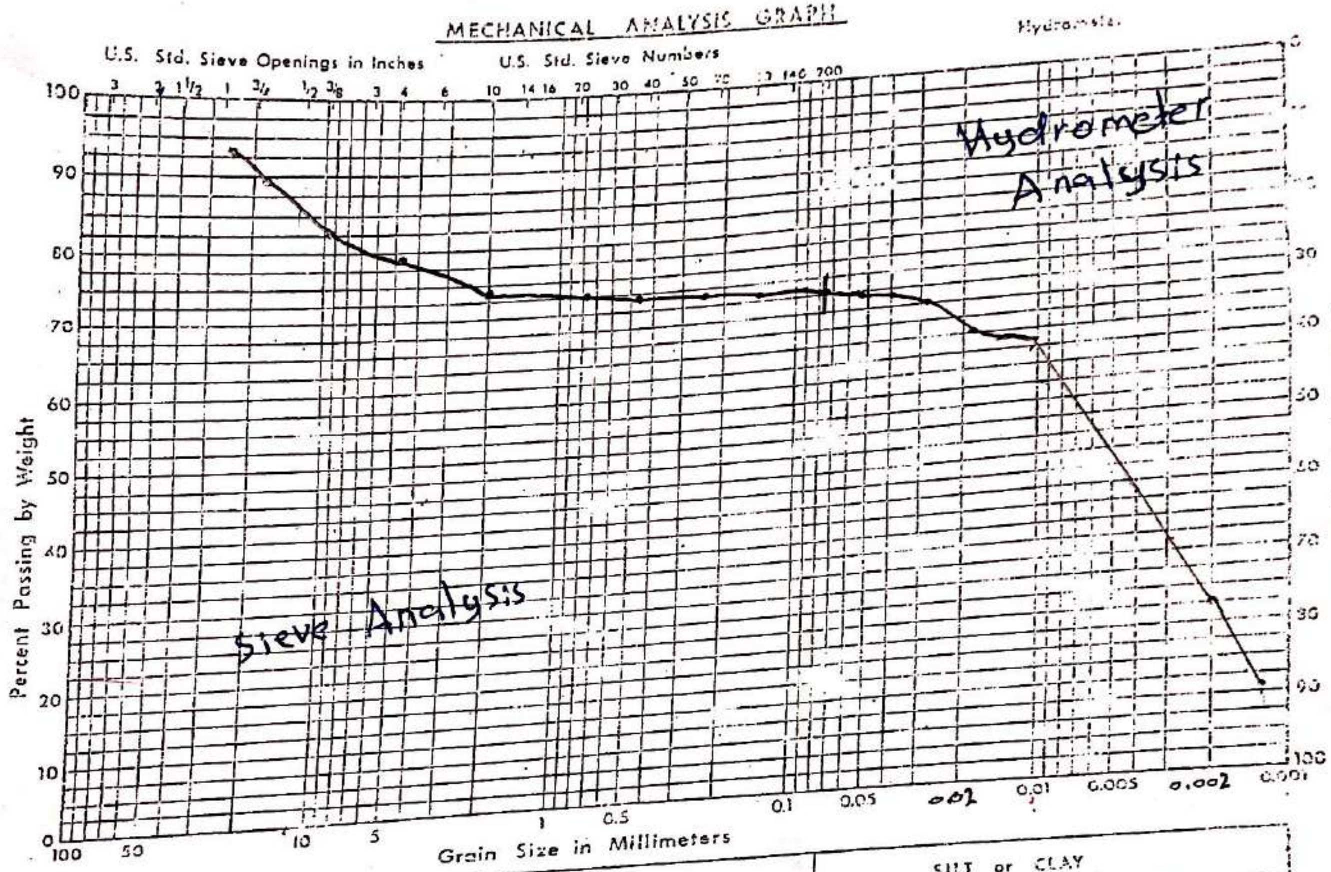
Weight of container plus air-dried soil = 109.57 g

Weight of container plus oven-dried soil = 108.35 g

Weight of container = 59.57 g

For sieve analysis of fine aggregate:

MECHANICAL ANALYSIS GRAPH



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

D_{10} = ______

D_{15} = ______ $5D_{15}$ = ______ $20D_{15}$ = ______

D_{30} = ______

D_{60} = ______

D_{85} = ______ $5D_{85}$ = ______

$C_u = \frac{D_{60}}{D_{10}} = \frac{(\quad)}{(\quad)} =$

$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(\quad)^2}{(\quad)(\quad)} =$

Data sheet

Sieve analysis

Sieve No	Sieve Diameter (mm)	Sieve Mass (g)	Sieve Mass + retained Soil Mass (g)
1	25	550.29	617.4
(3/4)	19	554.70	589.57
(1/2)	12.500	542.90	588.6
(3/8)	9.5000	542.60	564.90
# 4	4.7500	511.40	558.64
# 10	2.00	486.20	519.5
# 20	.85	424.80	437.70
# 40	.425	385.90	391.70
#60	.25	359.10	360.49
# 100	0.1500	354.60	353.80
# 200	0.0750	337.60	344.32
pan		364.35	365.55

Data sheet
Hydrometer analysis

R1= 1 **R2=**1-1DIV **T=** 24°c

elapsed time (min)	actual hydrometer reading	composite correction
15sec=0.25	1.02+ 18DIV	
30sec=0.5	1.02+17DIV	
1	1.02+ 16DIV	
2	1.02+15DIV	
4	1.02+10DIV	
8	1.02+8DIV	
15	1.02+7DIV	
19hours ~~30~~	1 + 7div	

nextday

T=24°c , R_1, R_2 the same.

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م. آيات الحوادمه

25-6-2018

ATTERBERG LIMIT
Liquid and Plastic Limits of a Soil

Student Name: عبدالله خالد المصري

ID#: 1639799

Section: 1

Date: 2/7/2018

9/10

Objective

to know the liquid and plastic limit for the fine grain soil to help us in soil classification and activity of the soil and liquidty index and plastic index.

Equipment

Liquid limit and plastic limit

① Balance
② Bowl
③ groore
④ casagrande bool
⑤ plate (glass)
⑥ seven cups (9B, 5B, A2, 2A), (1A, D1, 6B)
⑦ oven

LL pL

Procedure

According to ASTMD-4318

Data and Results

Table 1

Liquid Limit Determination				
can no.	9B	5B	A2	2A
Mass of wet soil + can	63.22	69.70	53.27	60.91
Mass of dry soil + can	53.8	60.7	46.1	52.6
Mass of can	30.48	31.17	30.84	30.69
Mass of dry soil 32.74	23.32	29.53	15.263	21.912
Mass of moisture	9.42	9	7.17	8.31
Water content ,w%	40.39	30.48	46.99	37.93
No. of blows, N	22	31	18	24

Table 2

Plastic limit Determination			
can no.	1A	D1	6B
Mass of wet soil + can	36.36	35.79	34.79
Mass of dry soil + can	35.6	35.1	34.2
Mass of can	30.86	30.80	30.58
Mass of dry soil	4.74	4.3	3.62
Mass of moisture	0.76	0.69	0.59
Water content ,w%	16.03	16.05	16.29

% clay = 28 % (From the previous Experiment)

W_n (natural water content)= 25

Sample of calculations

Required

(LL) Liquid limit 37% (from the graph)
(PL) Plastic Limit 16.12 %
(PI) Plasticity Index 20.88 %
(LI) Liquidity index 0.4253
One Point liquid Limit 31.28 %
Activity 0.7457

* $PL\ (wc) = \frac{1A + D1 + 6B}{3} = \frac{16.03 + 16.05 + 16.29}{3} = 16.12\ \%$

* $PI = LL - PL = 37 - 16.12 = 20.88\ \%$

* $LI = \frac{W_n - PL}{LL - PL} = \frac{25 - 16.12}{37 - 16.12} = 0.4253$

* $Activity\ (A) = \frac{PI}{\%\ clay} = \frac{20.88\%}{28\%} = 0.7457$

(5B) :- (N = 31)

- mass of wet soil + can = 69.7 (g)
- mass of dry soil + can = 60.7 (g)
- mass of can = 31.17 (g)

* mass of dry soil (Ms) = mass of (dry soil + can) − mass of can
 = 60.7 − 31.17 = 29.53 (g)

* mass of moisture (Mw) = Mass of (wet soil + can) − mass of (dry soil + can)
 = 69.7 − 60.7 = 9 (g)

* water content (Wc) = $\frac{M_w}{M_s} * 100\% = \frac{9}{29.53} * 100\% = 30.48\%$

* (LL)

- one point method → $LL = W_c \left(\frac{N}{25}\right)^{0.121}$
 $= 30.48 \left(\frac{31}{25}\right)^{0.121} = 31.28\%$

25 ≤ N ≤ 33

- Multi point Method from graph at 25 blow = 37%

Conclusion and Discussion

Soil classification

$A = 0.7457 < 0.75$ ⟶ In active clay

$LL = 37\% < 50\%$ ⟶ low plastic

$PI = 20.88\%$

$PI_{(line)} = 0.73(37-20) = 12.41$

$PI_{soil} > PI_{(line)}$

$20.88 > 12.41$ ⟶ soil clay CL

$0 < LI < 1$

$0 < 0.4253 < 1$ ⟶ plastic solids

Why using soil pass sieve #40?

If use sieve # 200 then wash the soil, the soil will all became lumps, but if we use # 40, that will avoid lumps after washing and fine grain soil woudn't be loss.

Plot Water content ,w% versus # of blows in log scale for (x axis).

Data sheet

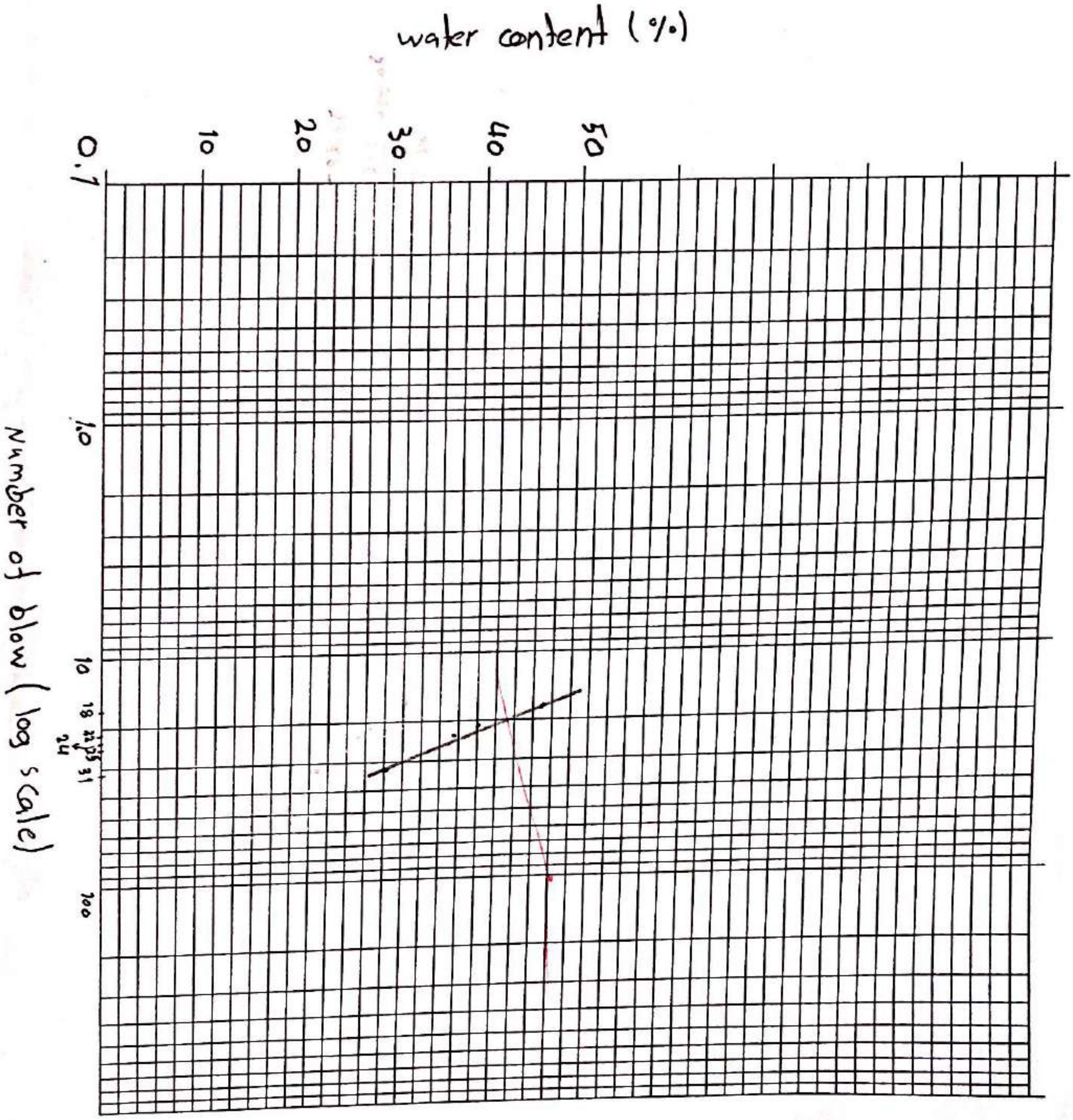
Plastic limit

Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+oven Dry Soil (g)
1A	30.86	36.36	35.6
D1	30.80	35.79	35.1
6B	30.58	34.79	34.2

Liquid limit

Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+oven Dry Soil (g)	Blows #
9B	30.48	63.22	53.8	22
5B	31.17	69.70	60.7	31
A2	30.84	53.27	46.1	18
2A	30.69	60.91	52.6	24

$W_c = 37\%$


water content (%)
0.1
10
20
30
40
50
1.0
10
18
24
31
100
Number of blow (log scale)

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27-6-2018

Compaction

Student Name: عبدالله ظافر المصري

ID#: 1639799

Section: 1

Date: 4/7/2018

8,5/10

Objective

* to determine maximum density and optimum water content of soil that is obtained from compaction test.

Equipment

1. balance.
2. compaction mold.
3. compaction hammer.
4. Graduated cylinder.
5. pan for mixing.
6. steel Rod.
7. cans.
8. Jack.

Procedure

According to ASTMD-1557.

Data and Results

Table 1

Group #	M_m (g)	M_{m+s} (g)	Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+Oven Dry Soil (g)
1	3280	4769	5B	31.12	69.75	65.3
2	3308	4903	9B	30.68	74.02	67.88
3	3282	4960	A2	30.88	59.62	54.67
4	3305	5012	5B	30.95	52.53	47.51
5	3280	5069	2A	30.75	55.70	49.6

Table 2

Group #	W %	ρ_{wet} (g/cm³)	ρ_{Dry} (g/cm³)
1	13.079	1.577	1.395
2	16.505	1.69	1.452
3	20.807	1.778	1.472
4	30.314	1.808	1.387
5	32.361	1.9	1.435

-.5

Table3: Zero-air voids curve Determination

Group #	W % Assume □omc	ρ_{Dry} (g/cm³)
1	31	1.46
2	32	1.44
3	33	1.38
4	34	1.33

Sample of calculations

Group (5)

Hint: volume =944cm^3
GS=2.7

$$W_c\% = \frac{m_w}{m_s} * 100\% = \frac{55.7 - 49.6}{49.6 - 30.75} * 100\% = 32.361\%$$

$$\rho_{wet} = \frac{m_{m+s} - m_m}{V} = \frac{5069 - 3280}{944} = 1.9\ g/cm^3$$

$$\rho_{dry} = \frac{\rho_{wet}}{1 + W_c\%} = \frac{1.9}{1 + 32.361\%} = 1.435\ g/cm^3$$

* Table 3 :- assume $W_c = 27.5\%$

$$\rho_d = \frac{\rho_w G_s}{1 + G_s * W} = \frac{1 * 2.7}{1 + (2.7 * 27.5\%)} = 1.55\ g/cm^3$$

* above Wopt :- water starts to replace soil particles in the mold and since $\rho_w << \rho_s$ the dry density starts to decrease.
* at Wopt :- the density become to its maxium value and it doesn't increase after that.

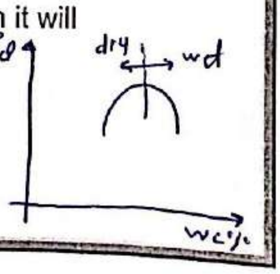
Plot dry density (ρ_{Dry})versus moisture content%(W %) and in the same figure plot the zero air voids curve.

Conclusion and Discussion

Owc = 20.807 %

ρ_{Dry}maximum = 1.472 g/cm³

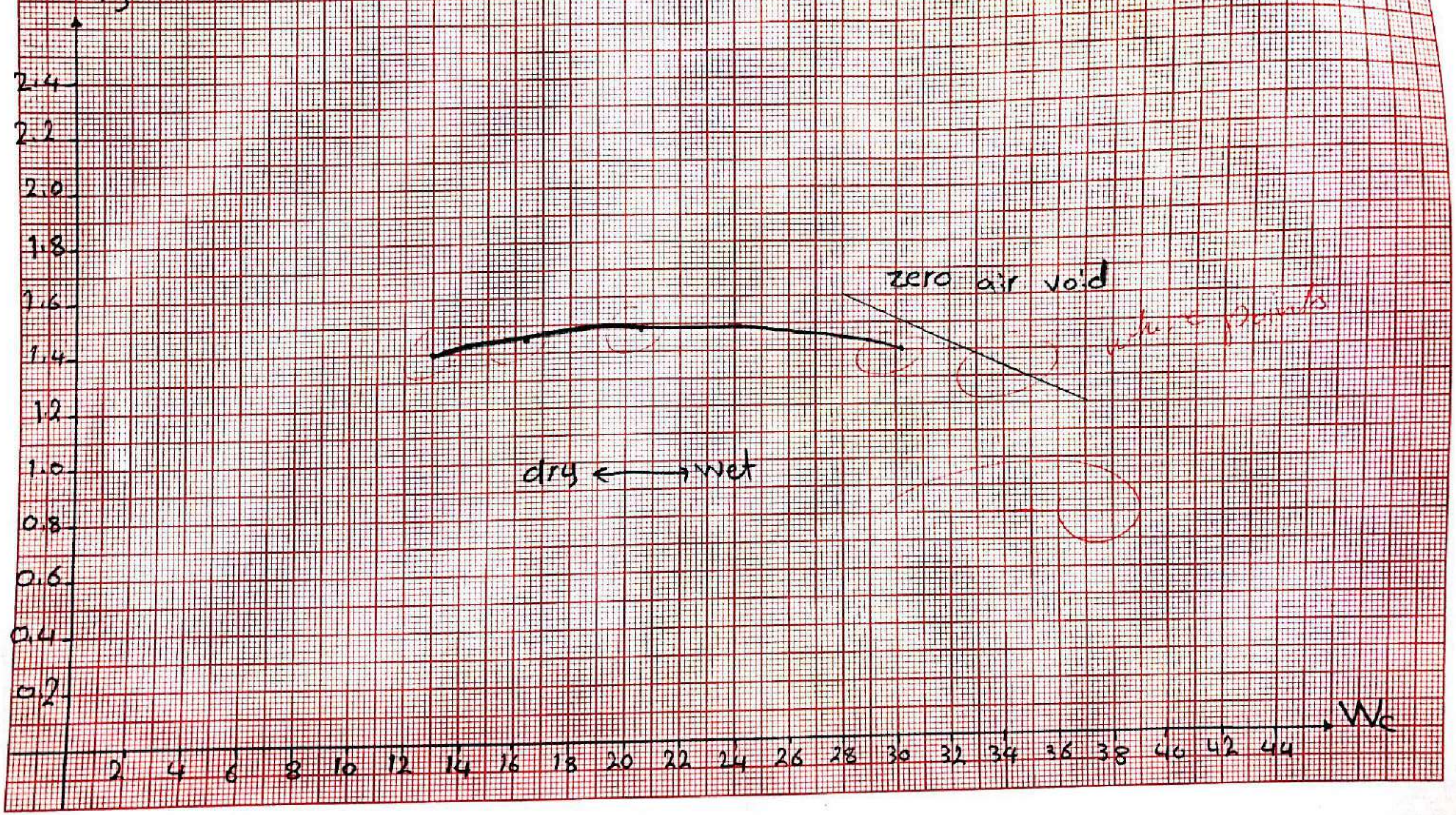
Why the value of dry density will be increase up to the maximum then it will be decrease? As the water content increase, the particles develop larger water films around them which tend to make the particle easier to moved and reoriented into a tenser configuration.



Data sheet

Group #	M_{mold} (g)	$M_{mold+soil}$ (g)	Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+oven Dry Soil (g)
1	3.280	4.769	5B	31.12	69.75	
2	3.368	4.903	9B	30.68	74.02	
3	3.282	4.96	A2	30.88	59.62	
4	3.305	5.062	~~2~~ 5B	30.95	52.53	
5	3.280	5.069	2A	30.75	55.70	

Figure 1.1
relation between (Wc, ρd)



CIVIL ENGINEERING

مختبر الهندسة الجيوتقنية

قسم الهندسة المدنية

11-7 2018

٣٠ آليات الحادة

Consolidation

Student Name: عبدالله خالد المصري

ID#: 1639799

Section: 1

Date: 29/7/2018

16.5/25

Objective

* Determine the coefficient of permability :-

① voids ratio (e), compression index (C_c), Recompression index (C_r), preconsolidation pressure (σ'_c), coefficient of permability (k) M_v, T_v.

② Determine coefficient of consolidation and O.C.R.

③ Determine C_v by two methods (casegrande, taylor).

Equipment

① loads (Kg).

② can.

③ Balance.

④ consolidation test apparatus (oedometer tester).

⑤ stop watch.

Procedure

consolidation test, ASTMD-2453.

Sample of calculation

$H_s=M_s/(G_s*A*\rho_w)$	$e_0=(H_t-H_s)/H_s$	$Stress_{(MPa)}=P/A$
$\frac{142}{(2.7)*(38.465)*(1)}$ $= 13.67$ mm	$\frac{20-13.67}{13.67}$ $=0.463$	$\frac{50*9.81}{0.003847}$ $=0.128$ Mpa

$H_f=H_t$-deformation	$H_v=H_f-H_s$	$e=H_v/H_s$
$20-(0.01*75)$ $=19.25$	$19.25-13.67$ $=5.58$	$\frac{5.58}{13.67}=0.408$

Consolidation Test

Ms= 142 g Gs=2.70

H= 2cm
D=7cm

A= 38.465 cm^2
0.003847 m^2

Hint:(Div *.01)=Deformation in (mm)

Load= 50kg

Time hr	min	sec	Dial Reading Div	Time (min)	$Time^{0.5}$ ($min^{0.5}$)	Deformation (mm)	Hf	Hv	e
0	0	8	75	0.13	0.37	0.75	19.25	5.58	0.408
0	0	15	81	0.25	0.50	0.81	19.19	5.52	0.404
0	0	30	86	0.5	0.71	0.86	19.14	5.47	0.400
0	1	0	92.5	1	1.00	0.925	19.075	5.405	0.395
0	2	0	97	2	1.41	0.97	19.03	5.36	0.392
0	4	0	102.5	4	2.00	1.025	18.975	5.305	0.388
0	8	0	107.75	8	2.83	1.0775	18.9225	5.2525	0.384
0	16	0	112	16	4.00	1.12	18.88	5.21	0.381
0	30	0	116	30	5.48	1.16	18.84	5.17	0.378
1	0	0	119	60	7.75	1.19	18.81	5.14	0.376
2	0	0	121	120	10.95	1.21	18.79	5.12	0.375
4	0	0	123	240	15.49	1.23	18.77	5.10	0.373
8	0	0	124	480	21.91	1.24	18.76	5.09	0.372
24	0	0	125	1440	37.95	1.25	18.75	5.08	0.371

Load= 100kg

Time hr	min	sec	Dial Reading Div	Time (min)	$Time^{0.5}$ ($min^{0.5}$)	Deformation (mm)	Hf	Hv	e
0	0	8	130	0.13	0.365148	1.30	18.70	5.03	0.368
0	0	15	132	0.25	0.5	1.32	18.68	5.01	0.366
0	0	30	135	0.5	0.707107	1.35	18.65	4.98	0.364
0	1	0	138	1	1	1.38	18.62	4.95	0.362
0	2	0	142	2	1.414214	1.42	18.58	4.91	0.359
0	4	0	146	4	2	1.46	18.54	4.87	0.356
0	8	0	150.5	8	2.828427	1.505	18.495	4.825	0.353
0	16	0	155	16	4	1.55	18.45	4.78	0.350
0	30	0	159	30	5.477226	1.59	18.41	4.74	0.347
1	0	0	163.5	60	7.745967	1.635	18.365	4.695	0.343
2	0	0	167	120	10.95445	1.67	18.33	4.66	0.341
4	0	0	170	240	15.49193	1.70	18.30	4.63	0.339
8	0	0	173	480	21.9089	1.73	18.27	4.60	0.337
24	0	0	176	1440	37.94733	1.76	18.24	4.57	0.334

Load= 200kg

Time			Dial Reading	Time	$Time^{0.5}$	Deformation	Hf	Hv	e
hr	min	sec	Div	(min)	$(min^{0.5})$	(mm)			
0	0	8	204	0.13	0.365148	2.04	17.96	4.29	0.314
0	0	15	209	0.25	0.5	2.09	17.91	4.24	0.310
0	0	30	213	0.5	0.707107	2.13	17.87	4.20	0.307
0	1	0	217	1	1	2.17	17.83	4.16	0.304
0	2	0	221.5	2	1.414214	2.215	17.785	4.115	0.301
0	4	0	226.5	4	2	2.265	17.735	4.065	0.297
0	8	0	233	8	2.828427	2.33	17.67	4.00	0.293
0	16	0	240.5	16	4	2.405	17.595	3.925	0.287
0	30	0	249	30	5.477226	2.49	17.51	3.84	0.281
1	0	0	259	60	7.745967	2.59	17.41	3.74	0.274
2	0	0	267.5	120	10.95445	2.675	17.325	3.655	0.267
4	0	0	273	240	15.49193	2.73	17.27	3.60	0.263
8	0	0	275.5	480	21.9089	2.755	17.245	3.575	0.261
22	14	0	277	1334	36.52396	2.77	17.23	3.56	0.260

Load= 500kg

Time			Dial Reading	Time	$Time^{0.5}$	Deformation	Hf	Hv	e
hr	min	sec	Div	(min)	$(min^{0.5})$	(mm)			
0	0	8	304	0.13	0.365148	3.04	16.96	3.29	0.241
0	0	15	307	0.25	0.5	3.07	16.93	3.26	0.238
0	0	30	309	0.5	0.707107	3.09	16.91	3.24	0.237
0	1	0	312	1	1	3.12	16.88	3.21	0.235
0	2	0	315.5	2	1.414214	3.155	16.845	3.175	0.232
0	4	0	319.5	4	2	3.195	16.805	3.135	0.299
0	8	0	324.5	8	2.828427	3.245	16.755	3.085	0.226
0	16	0	330.5	16	4	3.305	16.695	3.025	0.221
0	30	0	339	30	5.477226	3.39	16.61	2.94	0.215
1	0	0	350	60	7.745967	3.50	16.50	2.83	0.207
2	0	0	364	120	10.95445	3.64	16.36	2.69	0.197
4	0	0	373	240	15.49193	3.73	16.27	2.60	0.190
8	0	0	381	480	21.9089	3.81	16.19	2.52	0.184
23	30	0	385	1410	37.54997	3.85	16.15	2.48	0.181

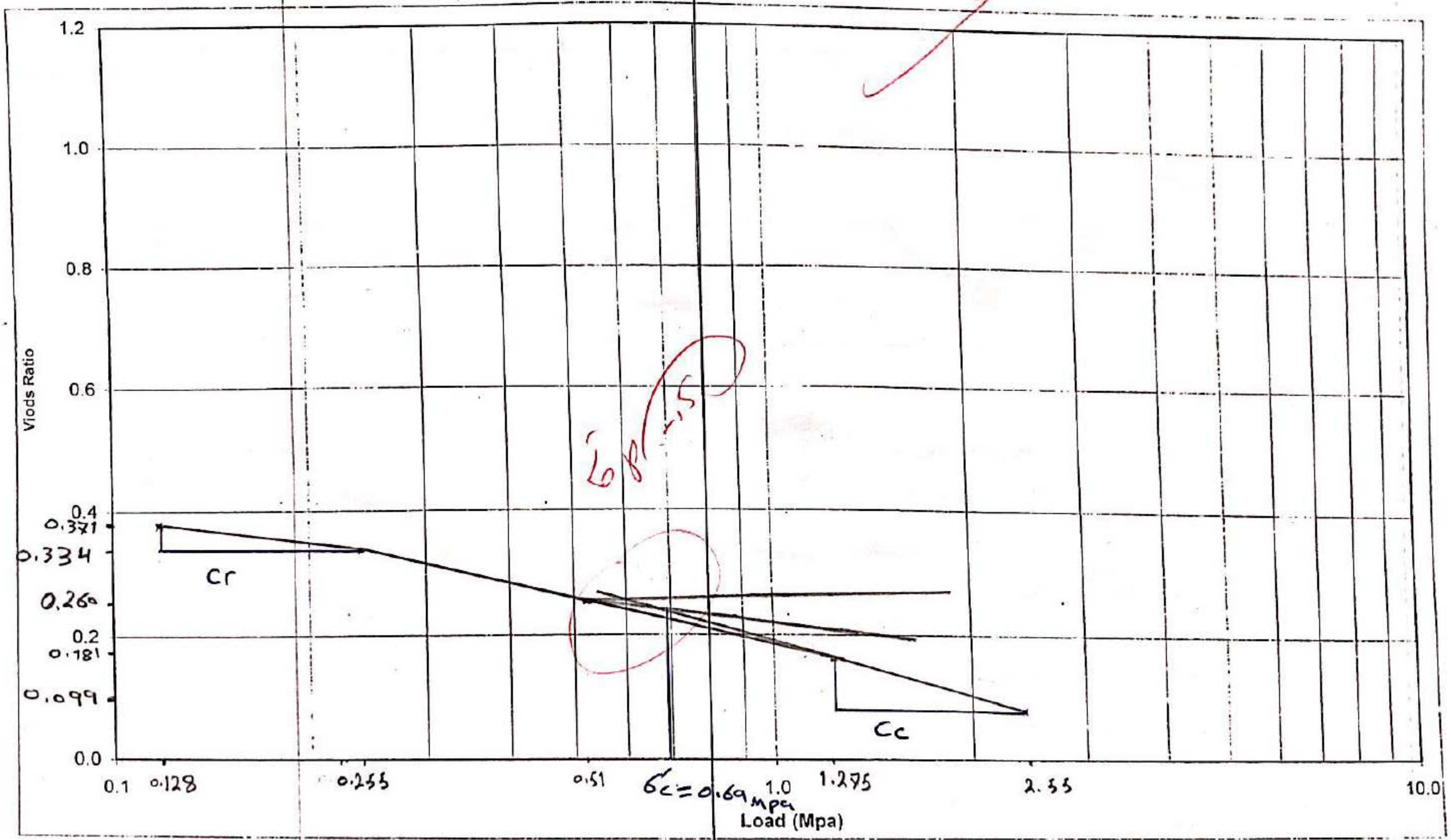
Load= 1000kg

Time			Dial Reading	Time	$Time^{0.5}$	Deformation	Hf	Hv	e
hr	min	sec	Div	(min)	$(min^{0.5})$	(mm)			
0	0	8	416	0.13	0.365148	4.16	15.84	2.17	0.159
0	0	15	419	0.25	0.5	4.19	15.81	2.14	0.157
0	0	30	422	0.5	0.707107	4.22	15.78	2.11	0.154
0	1	0	426	1	1	4.26	15.74	2.07	0.151
0	2	0	432	2	1.414214	4.32	15.68	2.01	0.147
0	4	0	438	4	2	4.38	15.62	1.95	0.143
0	8	0	445	8	2.828427	4.45	15.55	1.88	0.138
0	16	0	455	16	4	4.55	15.45	1.78	0.130
0	30	0	465	30	5.477226	4.65	15.35	1.68	0.123
1	0	0	478	60	7.745967	4.78	15.22	1.55	0.113
2	0	0	487	120	10.95445	4.87	15.13	1.46	0.107
4	0	0	493	240	15.49193	4.93	15.07	1.40	0.102
8	0	0	495	480	21.9089	4.95	15.05	1.38	0.101
24	0	0	497	1440	37.94733	4.97	15.03	1.36	0.099

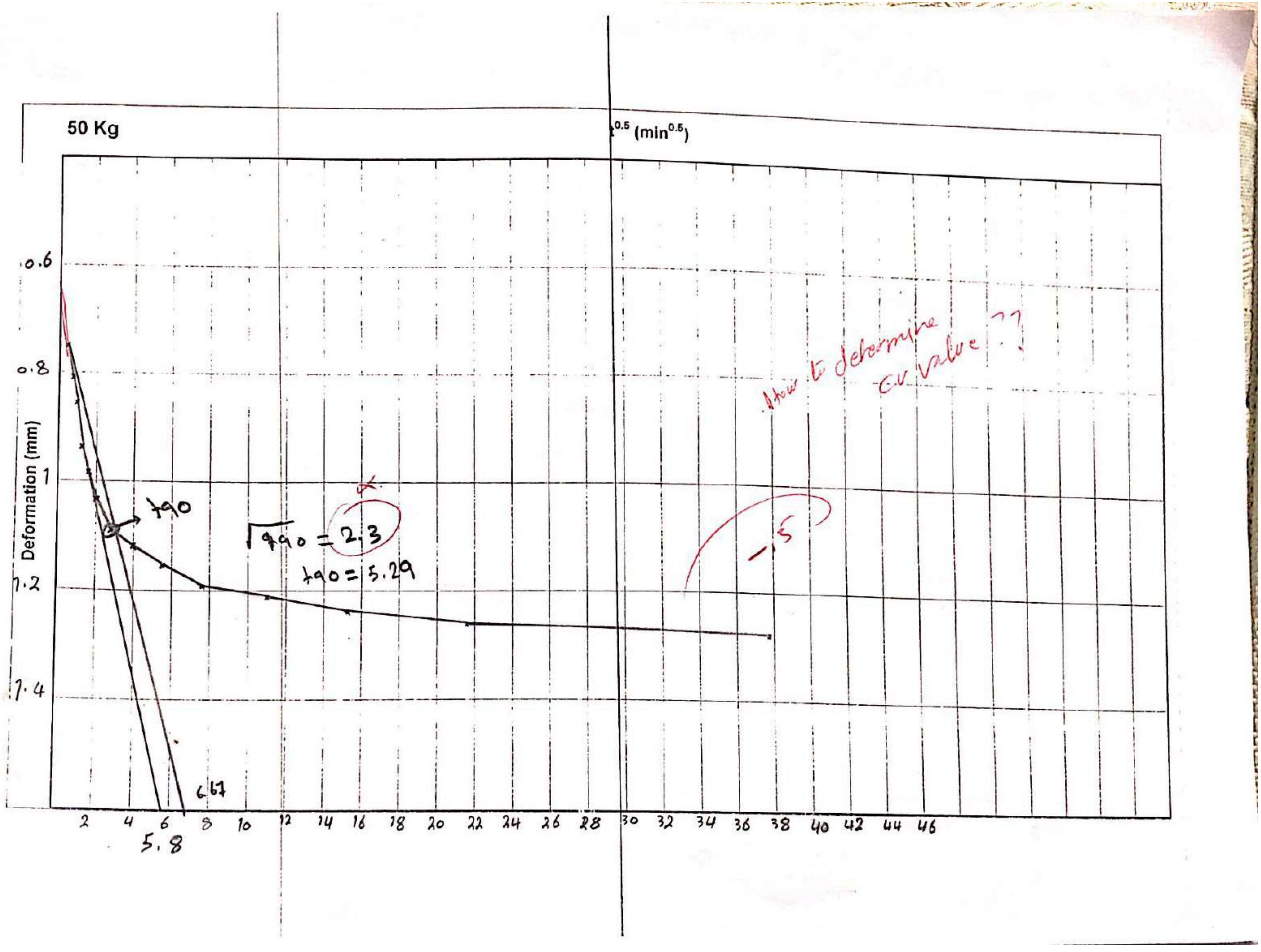
P/A		Cum.	$H_F - H_S$	$(H_F - H_S)/H_S$	$(H_{F(n-1)} + H_{F(n)})/2$	Figures		0.848*H^2$_{avg}$/(4*t_{90}) 0.197*H^2$_{avg}$/(4*t_{50})	
						Fitting Time (Min)		Cv (mm^2/min) from	
Load kg	Load MPa	Final Def. ΔH_{cum} (mm)	Height of voids (mm)	Final voids ratio	Avg. Height (mm)	t_{90}	t_{50}	t_{90}	t_{50}
50	0.128	1.25	~~18.75~~	~~5.08~~	~~0.371~~	5.29	1.2	15.04	15.42
100	0.255	1.76	~~18.24~~	~~4.57~~	~~0.334~~	4	4	18.13	4.2
200	0.510	2.77	~~17.23~~	~~3.56~~	~~0.260~~	4	12	16.67	1.3
500	1.275	3.85	~~16.15~~	~~2.48~~	~~0.181~~	5.67	25	10.42	0.55
1000	2.550	4.97	~~15.03~~	~~1.36~~	~~0.099~~	4	15	12.88	0.79

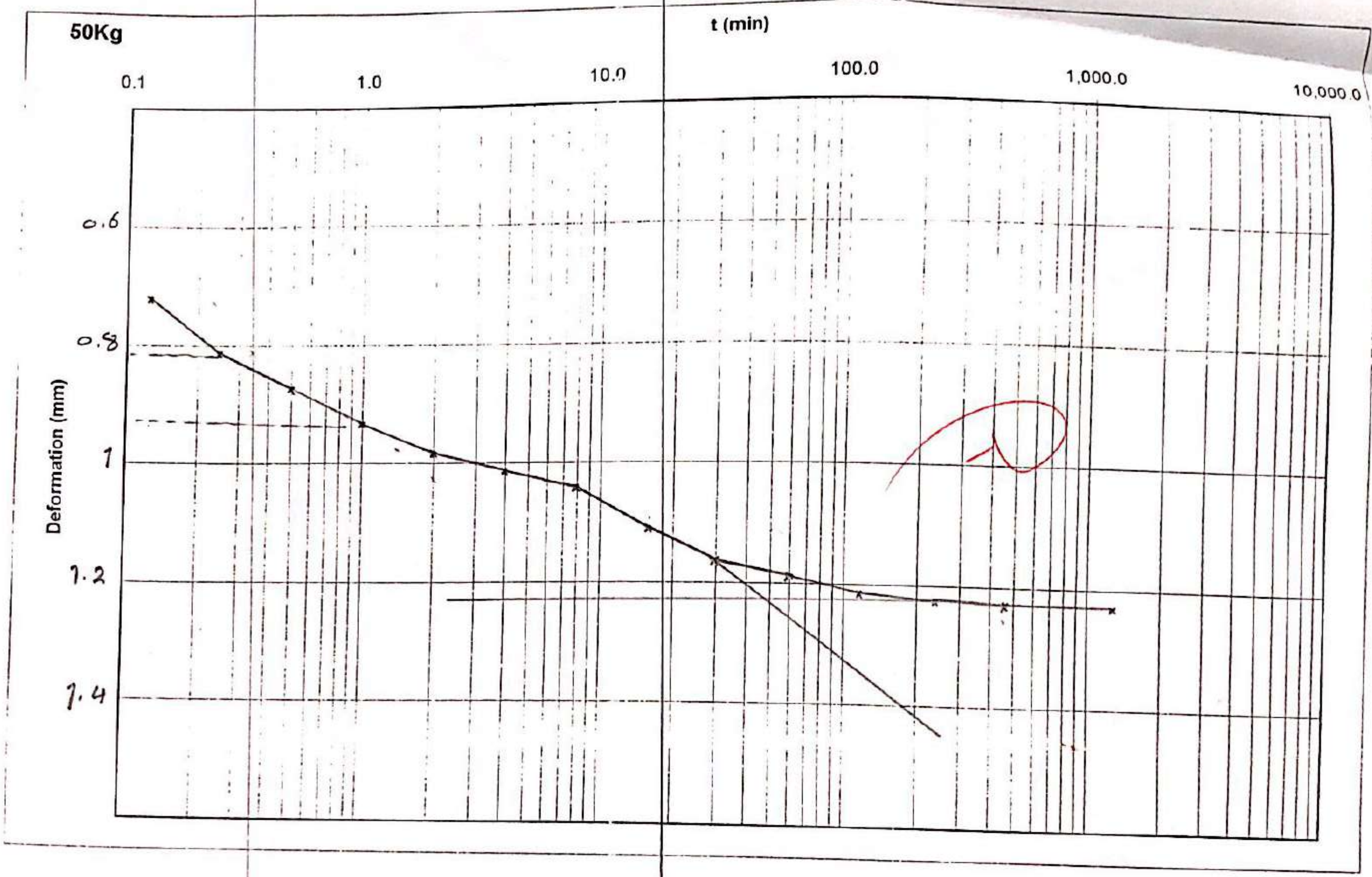
5.08	0.371	19.375	
4.57	0.334	18.495	
3.56	0.260	[illegible]	17.735
2.48	0.181	18[illegible]	16.69
1.36	0.099	15.59	[illegible]

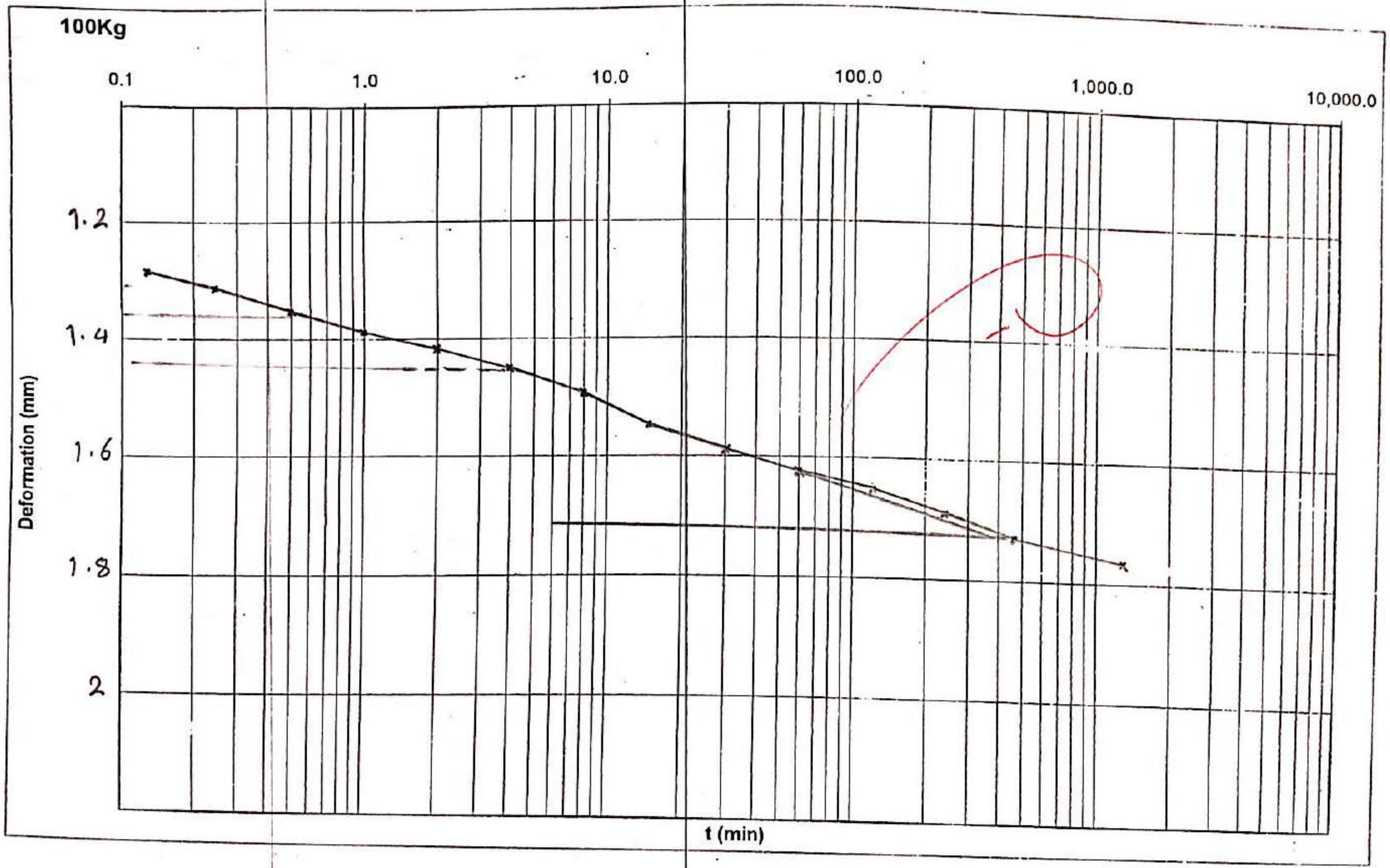
$$C_r = \left| \frac{\Delta e}{\log\left(\frac{\sigma_1}{\sigma_2}\right)} \right| = \left| \frac{0.371 - 0.334}{\log\left(\frac{0.128}{0.255}\right)} \right| = 0.1236$$

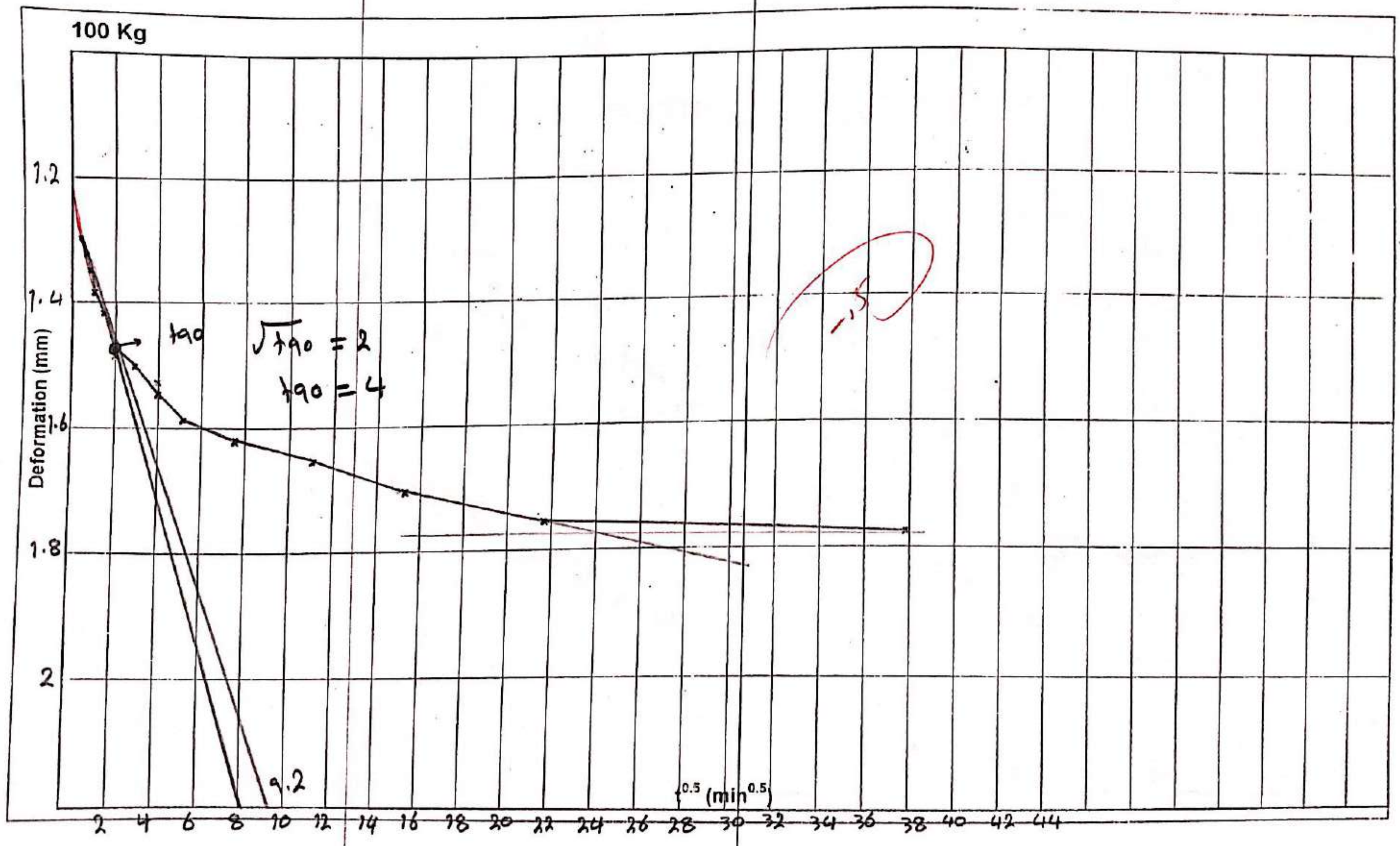


$$C_c = \left| \frac{\Delta e}{\log\left(\frac{\sigma_1}{\sigma_2}\right)} \right| = \left| \frac{0.181 - 0.099}{\log\left(\frac{1.275}{2.55}\right)} \right| = 0.2724$$

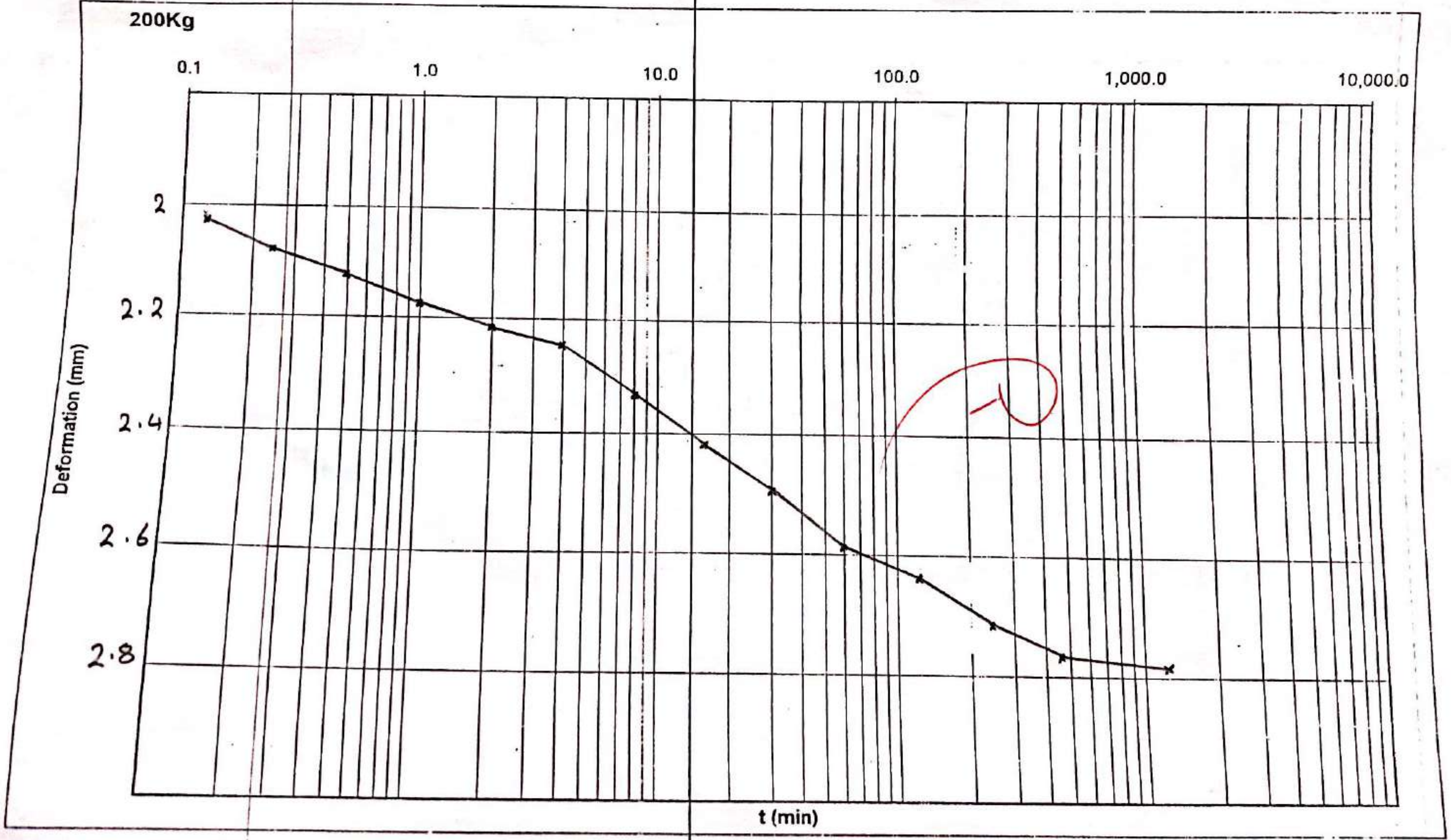

50 Kg
$t^{0.5}$ (min$^{0.5}$)
Deformation (mm)
0.6
0.8
1
1.2
1.4
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46
5.8
6.67
t90
$\sqrt{t90}$ = 2.3
t90 = 5.29
-.5
How to determine Cv value ??

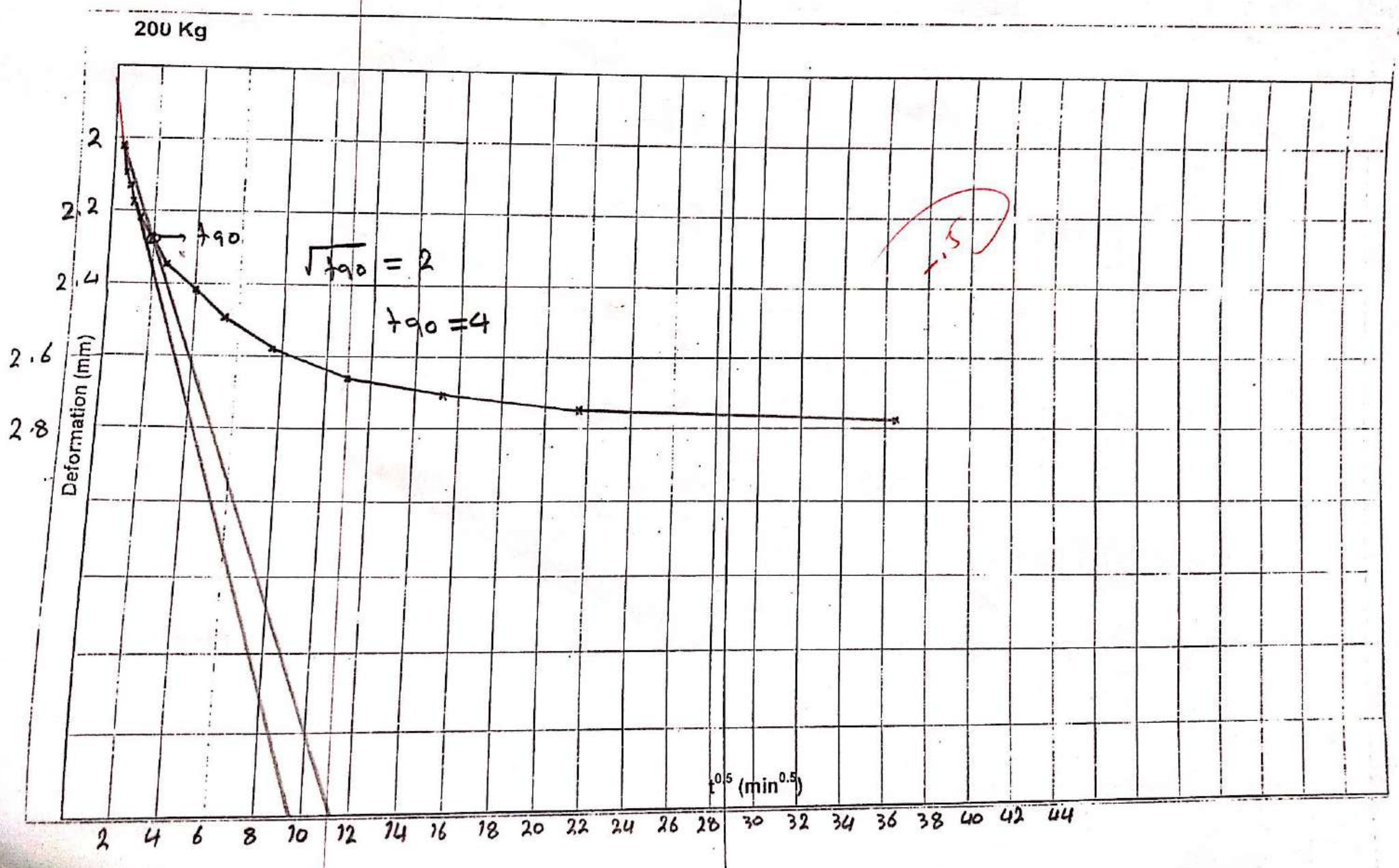

50Kg
t (min)
0.1
1.0
10.0
100.0
1,000.0
10,000.0
Deformation (mm)
0.6
0.8
1
1.2
1.4

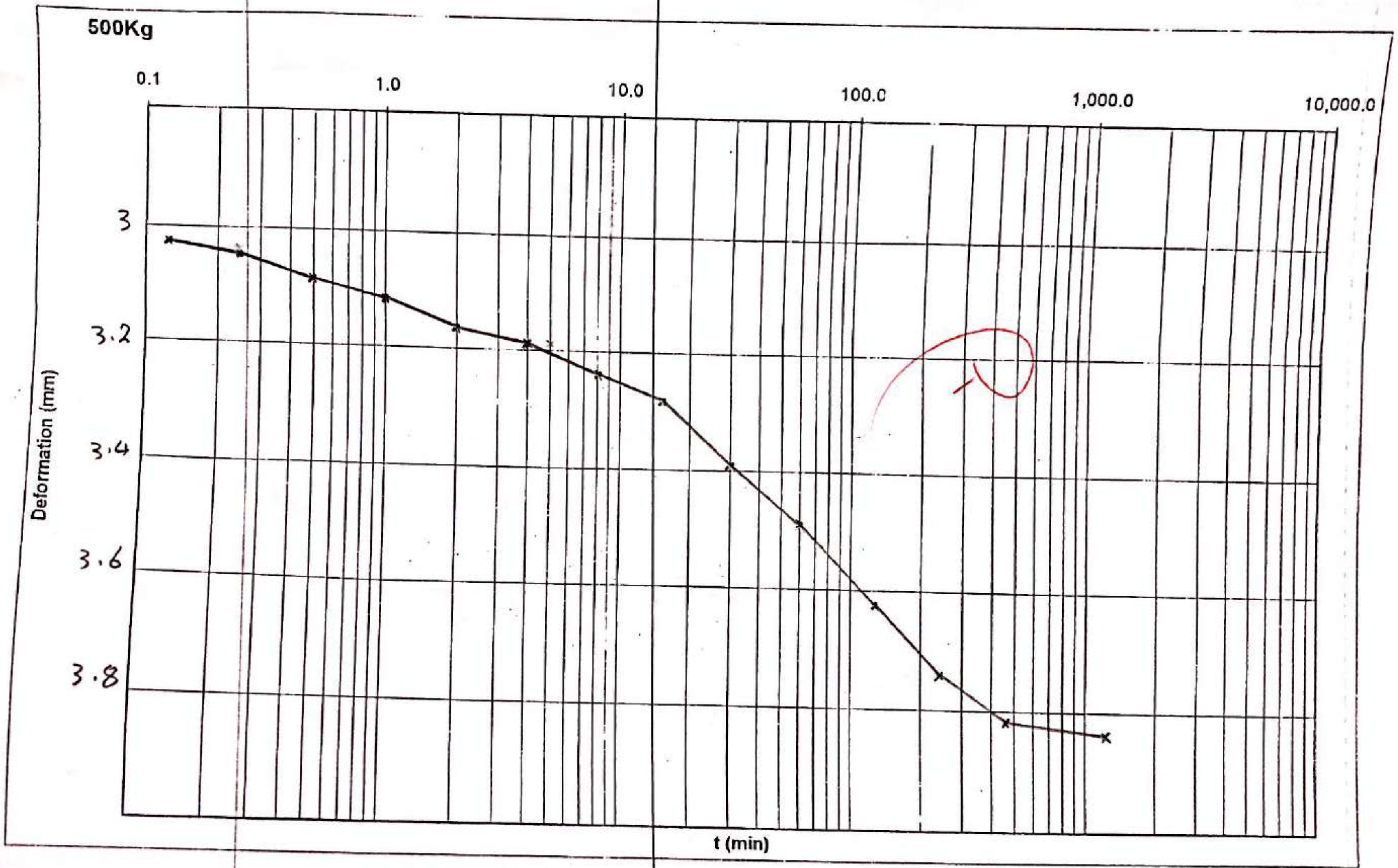

100Kg
Deformation (mm)
1.2
1.4
1.6
1.8
2
0.1
1.0
10.0
100.0
1,000.0
10,000.0
t (min)

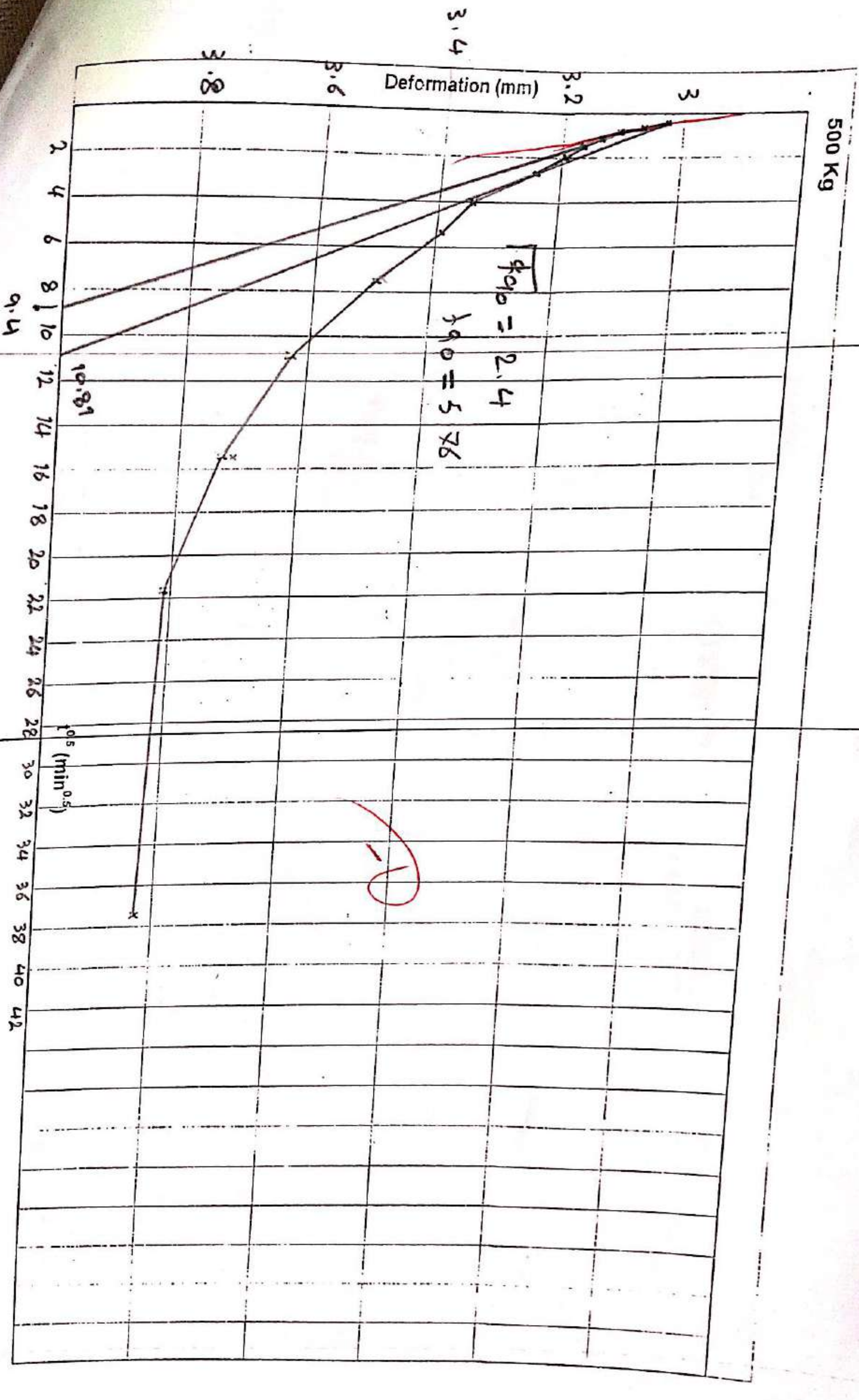


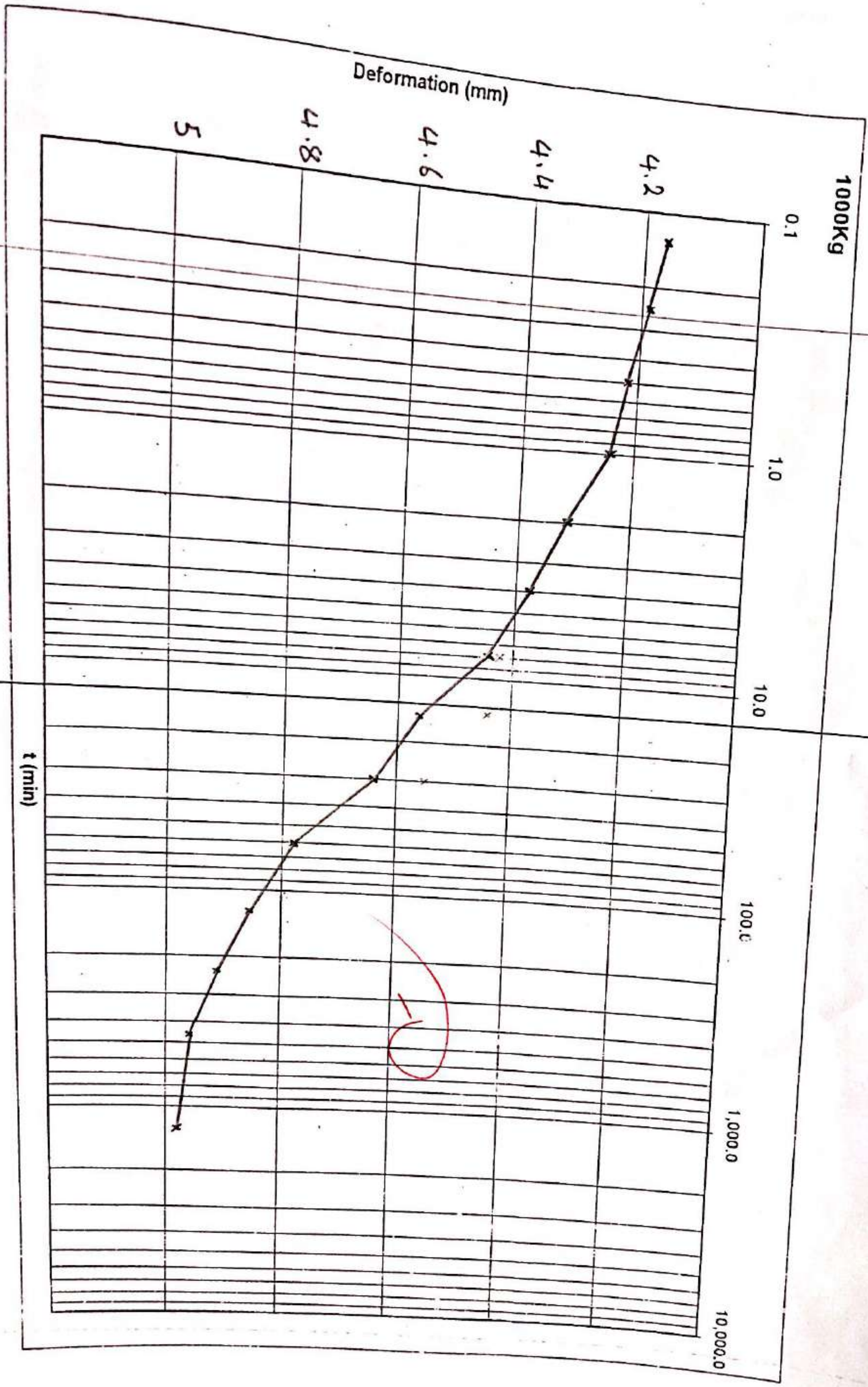
100 Kg
Deformation (mm)
1.2
1.4
1.6
1.8
2
t90
√t90 = 2
t90 = 4
9.2
-1.5
t0.5 (min0.5)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44

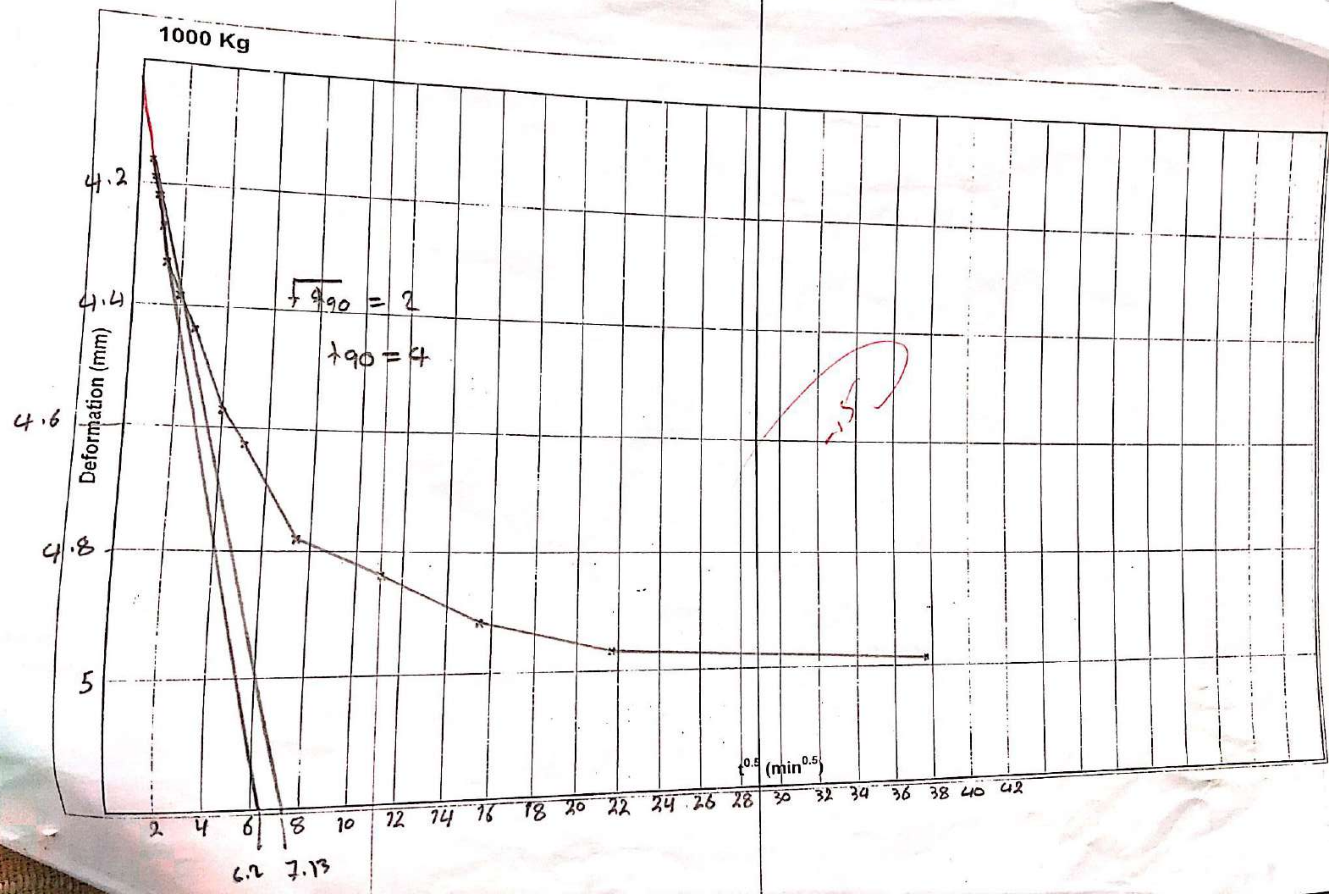

200Kg
0.1
1.0
10.0
100.0
1,000.0
10,000.0
Deformation (mm)
2
2.2
2.4
2.6
2.8
t (min)


200 Kg
Deformation (mm)
2
2.2
2.4
2.6
2.8
t90
√t90 = 2
t90 = 4
t^0.5 (min^0.5)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44


500Kg
0.1
1.0
10.0
100.0
1,000.0
10,000.0
Deformation (mm)
3
3.2
3.4
3.6
3.8
t (min)


500 Kg
Deformation (mm)
3
3.2
3.4
3.6
3.8
$t^{0.5}$ (min$^{0.5}$)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
9.4
10.89
√t90 = 2.4
t90 = 5.76


1000Kg
Deformation (mm)
t (min)
0.1
1.0
10.0
100.0
1,000.0
10,000.0
4.2
4.4
4.6
4.8
5



1000 Kg
Deformation (mm)
4.2
4.4
4.6
4.8
5
$\sqrt{t_{90}} = 2$
$t_{90} = 4$
-1.5
$t^{0.5}$ (min$^{0.5}$)
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
6.2 7.13

CIVIL ENGINEERING

مختبر الهندسة الجيوتقنية

قسم الهندسة المدنية

15.7-2018

Direct Shear

Student Name: عبدالله خالد المصري

ID#: 1639799

Section: 1

Date: 23/7/2018

18.5/20

Objective

① Determine the shear strength parameters (ϕ, C).

② Determine I.f , Iresidual

Equipment

① loads.
② pan filled with soil.
③ Mold.
④ dialgage.
⑤ trowel
⑥ callibers.
⑦ Direct shear device.
⑧ Balance.

Procedure

According to ASTMD – 3080

Sample of calculations

	σn (Kpa)	τ(Kpa) max	τ(Kpa)resid
(20)	54.5	62.94	62.94
(40)	109	88.61	88.61
(60)	163.5	165	165

* normal stress σ_n :-

$$\sigma_{n_1} = \frac{P}{A} = \frac{20*9.81}{36*10^{-4}} = 54.5 \text{ Kpa}$$

$$\sigma_{n_2} = \frac{P}{A} = \frac{40*9.81}{36*10^{-4}} = 109 \text{ Kpa}$$

$$\sigma_{n_3} = \frac{P}{A} = \frac{60*9.81}{36*10^{-4}} = 163.5 \text{ Kpa}$$

* shear stress τ :-

$$T = 0.01*2200 = 22 \text{ N}$$

$$\tau_1 = \frac{T}{A} = \frac{22*10^{-3}}{36*10^{-4}} = 6.11 \text{ Kpa}$$

$$T = 0.015*2200 = 33 \text{ N}$$

$$\tau_2 = \frac{T}{A} = \frac{33*10^{-3}}{36*10^{-4}} = 9.17 \text{ Kpa}$$

$$T = 0.024*2200 = 52.8 \text{ N}$$

$$\tau_3 = \frac{T}{A} = \frac{52.8*10^{-3}}{36*10^{-4}} = 14.67 \text{ Kpa}$$

$$A = 6*6*10^{-4} = 36*10^{-4} \text{ m}^2$$

$$H(mm) = 20*0.01 = 0.2 \text{ mm}$$

$$V(mm) = -2*0.01 = -0.02 \text{ mm}$$

$$T(mm) = 43*0.001 = 0.043 \text{ mm}$$

$$\tau_{1max} = 62.94 \text{ Kpa}$$

$$\tau_{2max} = 88.61 \text{ Kpa}$$

$$\tau_{3max} = 165 \text{ Kpa}$$

$$\tau_{r1} = \frac{T}{A} = \frac{226.6*10^{-3}}{36*10^{-4}} = 62.94 \text{ Kpa}$$

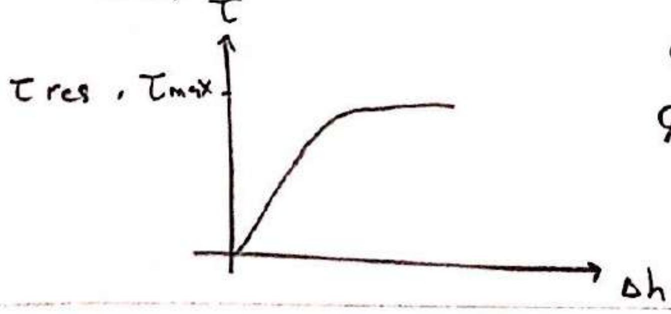
$$\tau_{r2} = \frac{T}{A} = \frac{319*10^{-3}}{36*10^{-4}} = 88.61 \text{ Kpa}$$

$$\tau_{r3} = \frac{T}{A} = \frac{594*10^{-3}}{36*10^{-4}} = 165 \text{ Kpa}$$

-Plot τ(Kpa) versus σn .

Discussion and Conclusion

1-the value of(c & Ø) discuss these value (the type of soil depend on these value).



dense sand:.

$C = 0$

$\phi = 47.98$

-15

load=20 Kg σn= 54.5 Kpa

: lood in (mm)*2200=load in (N)

H	V	T	H(.01)mm	V(.01)mm	T(.001)mm	T(N)	AC(mm)	τ(Kpa)
10	-0.5	10	0.1	-0.005	0.010	22	3600	6.11
20	-1	19	0.2	-0.01	0.019	41.8	3600	11.61
30	-2	28	0.3	-0.02	0.028	61.6	3600	17.11
40	-4	35	0.4	-0.04	0.035	77	3600	21.39
50	-5.5	43	0.5	-0.055	0.043	94.6	3600	26.28
60	-6.5	48	0.6	-0.065	0.048	105.6	3600	29.33
70	-7	54	0.7	-0.07	0.054	118.8	3600	33
80	-8	58	0.8	-0.08	0.058	127.6	3600	35.44
90	-3	63	0.9	-0.03	0.063	138.6	3600	38.5
100	-2	68	1	-0.02	0.068	149.6	3600	41.56
120	0	74	1.2	0.00	0.074	162.8	3600	45.22
140	4	79	1.4	0.04	0.079	173.8	3600	48.28
160	8	84	1.6	0.08	0.084	184.8	3600	51.33
180	13	88	1.8	0.13	0.088	193.6	3600	53.78
200	18	90	2	0.18	0.090	198	3600	55
220	23	94	2.2	0.23	0.094	206.8	3600	57.44
240	27	95	2.4	0.27	0.095	209	3600	58.06
260	32	97	2.6	0.32	0.097	213.4	3600	59.28
270	35	99	2.7	0.35	0.099	217.8	3600	60.5
300	40	100	3	0.40	0.100	220	3600	61.11
320	43	101	3.2	0.43	0.101	222.2	3600	61.72
340	47	102	3.4	0.47	0.102	224.4	3600	62.33
360	50	103	3.6	0.50	0.103	226.6	3600	62.94
380	53	102	3.8	0.53	0.102	224.4	3600	62.33
400	56	102	4	0.56	0.102	224.4	3600	62.33
450	63	103	4.5	0.63	0.103	226.6	3600	62.94
500	69	103	5	0.69	0.103	226.6	3600	62.94
550	73	103	5.5	0.73	0.103	226.6	3600	62.94
600	78	103	6	0.78	0.103	226.6	3600	62.94
650	80	103	6.5	0.80	0.103	226.6	3600	62.94
700	81	103	7	0.81	0.103	226.6	3600	62.94
750	83	103	7.5	0.83	0.103	226.6	3500	62.94
800	86	103	8	0.86	0.103	226.6	3600	62.94
850	87	103	8.5	0.87	0.103	226.6	3600	62.94
900	89	103	9	0.89	0.103	226.6	3600	62.94
950	89	103	9.5	0.89	0.103	226.6	3600	62.94
1000	89	103	10	0.89	0.103	226.6	3600	62.94
1050	89	103	10.5	0.89	0.103	226.6	3600	62.94
1100	89	103	11	0.89	0.103	226.6	3600	62.94
1150	89	103	11.5	0.89	0.103	226.6	3600	62.94
1200	89	103	12	0.89	0.103	226.6	3600	62.94
1250	89	103	12.5	0.89	0.103	226.6	3600	62.94

oad=40 kg

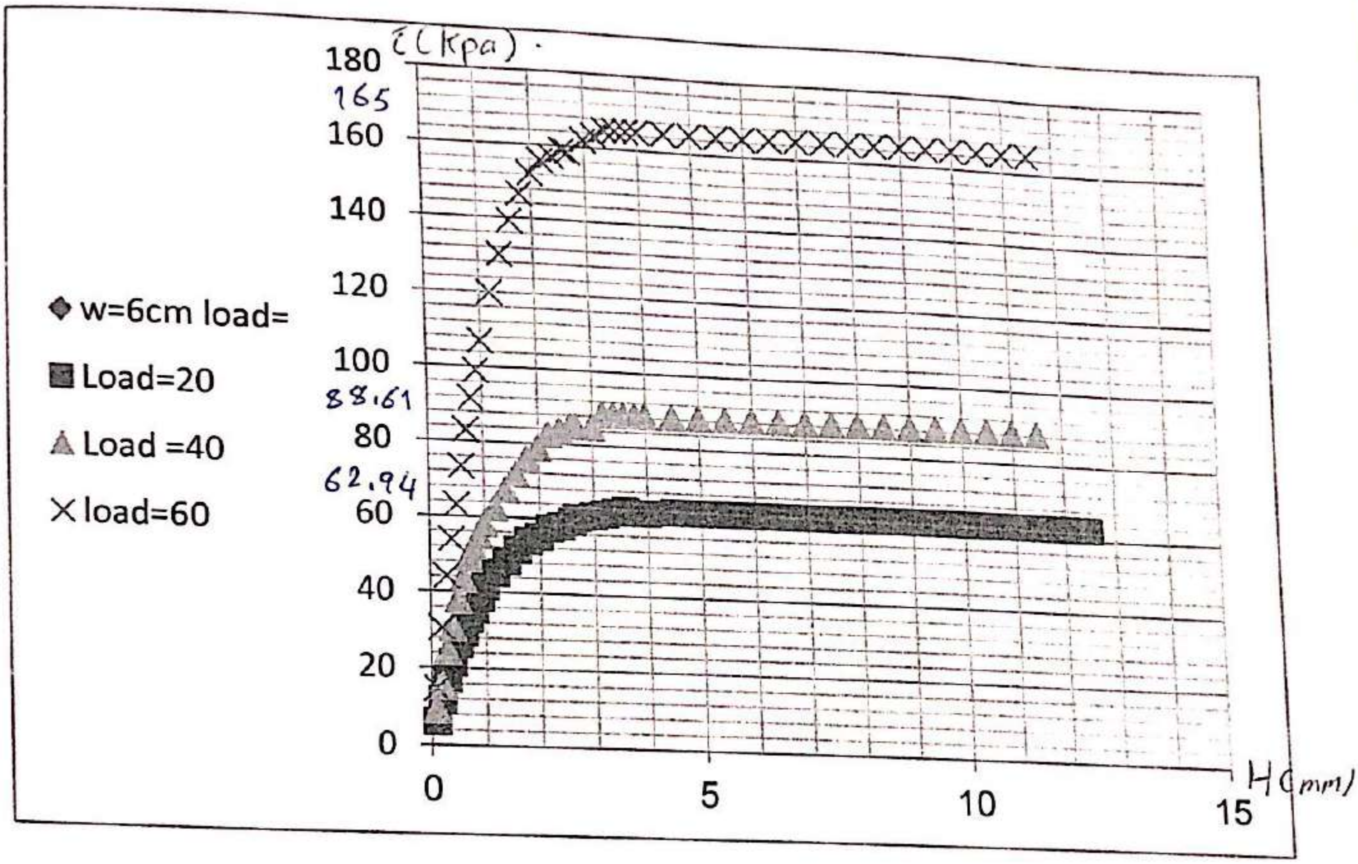
σn= 109 Kpa

H	V	T	H(.01)mm	V.01mm	T.001mm	T(N)	AC(mm)	τ(Kpa)
10	-3	15	0.1	-0.03	0.015	33	3600	9.17
20	-5	25	0.2	-0.05	0.025	55	3600	15.28
30	-5	40	0.3	-0.05	0.040	88	3600	24.44
40	-6	50	0.4	-0.06	0.050	110	3600	30.56
50	-5	62	0.5	-0.05	0.062	136.4	3600	37.89
60	-5	71	0.6	-0.05	0.071	156.2	3600	43.39
70	-4	80	0.7	-0.04	0.080	176	3600	48.89
80	-3	85	0.8	-0.03	0.085	187	3600	51.94
90	-1	90	0.9	-0.01	0.090	198	3600	55
100	0	95	1	0.00	0.095	209	3600	58.06
120	4	102	1.2	0.04	0.102	224.4	3600	62.33
140	8	110	1.4	0.08	0.110	242	3600	67.22
160	11	117	1.6	0.11	0.117	257.4	3600	71.5
180	17	124	1.8	0.17	0.124	272.8	3600	75.78
200	21	129	2	0.21	0.129	283.8	3600	78.83
220	25	135	2.2	0.25	0.135	297	3600	82.5
240	30	137	2.4	0.30	0.137	301.4	3600	83.72
260	36	139	2.6	0.36	0.139	305.8	3600	84.94
270	39	139	2.7	0.39	0.139	305.8	3600	84.94
300	42	139	3	0.42	0.139	305.8	3600	84.94
320	46	145	3.2	0.46	0.145	319	3600	88.61
340	49	145	3.4	0.49	0.145	319	3600	88.61
360	53	145	3.6	0.53	0.145	319	3600	88.61
380	56	145	3.8	0.56	0.145	319	3600	88.61
400	59	145	4	0.59	0.145	319	3600	88.61
450	66	145	4.5	0.66	0.145	319	3600	88.61
500	71	145	5	0.71	0.145	319	3600	88.61
550	76	145	5.5	0.76	0.145	319	3600	88.61
600	82	145	6	0.82	0.145	319	3600	88.61
650	85	145	6.5	0.85	0.145	319	3600	88.61
700	88	145	7	0.88	0.145	319	3600	88.61
750	89	145	7.5	0.89	0.145	319	3600	88.61
800	91	145	8	0.91	0.145	319	3600	88.61
850	93	145	8.5	0.93	0.145	319	3600	88.61
900	93	145	9	0.93	0.145	319	3600	88.61
950	93	145	9.5	0.93	0.145	319	3600	88.61
1000	93	145	10	0.93	0.145	319	3600	88.61
1050	93	145	10.5	0.93	0.145	319	3600	88.61
1100	93	145	11	0.93	0.145	319	3600	88.61
1150	92	145	11.5	0.92	0.145	319	3600	88.61

load=60 kg

σn= 163.5 Kpa

H	V	T	H(.01)mm	V.01mm	T.001mm	T(N)	AC(mm)	τ(Kpa)
10	-4	24	0.1	-0.04	0.024	52.8	3600	14.67
20	-5	50	0.2	-0.05	0.050	110	3600	30.56
30	-6	72	0.3	-0.06	0.072	158.4	3600	44
40	-6	88	0.4	-0.06	0.088	193.6	3600	53.78
50	-6	103	0.5	-0.06	0.103	226.6	3600	62.94
60	-6	120	0.6	-0.06	0.120	264	3600	~~83.11~~ 73.33
70	-6	136	0.7	-0.06	0.136	299.2	3600	83.11
80	-6	150	0.8	-0.06	0.150	330	3600	91.67
90	-5	162	0.9	-0.05	0.162	356.4	3600	99
100	-4	175	1	-0.04	0.175	385	3600	106.94
120	-2	196	1.2	-0.02	0.196	413.2	3600	114.78
140	1	213	1.4	0.01	0.213	468.6	3600	130.17
160	5	228	1.6	0.05	0.228	501.6	3600	139.33
180	9	240	1.8	0.09	0.240	528	3600	146.67
200	14	249	2	0.14	0.249	547.8	3600	152.17
220	18	255	2.2	0.18	0.255	561	3600	155.83
240	-2	257	2.4	-0.02	0.257	565.4	3600	157.06
260	26	260	2.6	0.26	0.260	572	3600	158.89
270	30	259	2.7	0.30	0.259	569.8	3600	158.28
300	33	265	3	0.33	0.265	583	3600	161.94
320	37	267	3.2	0.37	0.267	587.4	3600	163.17
340	42	270	3.4	0.42	0.270	594	3600	165
360	45	270	3.6	0.45	0.270	594	3600	165
380	48	270	3.8	0.48	0.270	594	3600	165
400	52	270	4	0.52	0.270	594	3600	165
450	57	270	4.5	0.57	0.270	594	3600	165
500	61	270	5	0.61	0.270	594	3600	165
550	71	270	5.5	0.71	0.270	594	3600	165
600	69	270	6	0.69	0.270	594	3600	165
650	68	270	6.5	0.68	0.270	594	3600	165
700	68	270	7	0.68	0.270	594	3600	165
750	69	270	7.5	0.69	0.270	594	3600	165
800	69	270	8	0.69	0.270	594	3600	165
850	69	270	8.5	0.69	0.270	594	3600	165
900	71	270	9	0.71	0.270	594	3600	165
950	71	270	9.5	0.71	0.270	594	3600	165
1000	71	270	10	0.71	0.270	594	3600	165
1050	63	270	10.5	0.63	0.270	594	3600	165
1100	61	270	11	0.61	0.270	594	3600	165
1150	60	270	11.5	0.60	0.270	594	3600	165


τ (Kpa)
180
165
160
140
120
100
88.61
80
62.94
60
40
20
0
0
5
10
15
H (mm)
w=6cm load=
Load=20
Load =40
load=60