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CIVIL ENGINEERING

مختبر الهندسة الجيوتقنية

لجميع الشعب

11/2/2018

Sieve and Hydrometer Analysis

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Section: 1

Date: 18/2/2018

18.5/20

Objective:

- we use sieve analysis and Hydrometer analysis is for soil classifica
- seive analysis → to classify the soil to coarse and fine usin sieve #200 (0.075) and classify coarse soil into gravel and sand
- Hydrometer analysis → to classify the soil into silt and clay

Equipment:

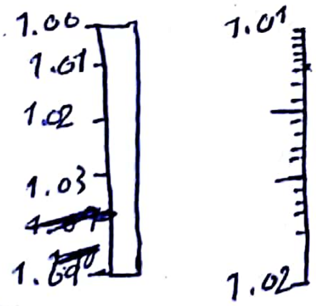
* Mechanical sieve analysis

① sieve chaker
② Balance
③ sieve with different sizes

* Hydrometer analysis

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

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



$$1\,Div = \frac{0.01}{20} = 0.0005 = 5 \times 10^{-4}$$

$$1.01 + 5\,(Div) = 1.01 + 6 \times (0.0005)$$

$$= 1.0225$$

Procedure:

Mecanical sieve analgsis (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 %
1	25	553	620	67	67	6.7	93.3
(3/4)	19	556	592	36	103	10.3	89.7
(1/2)	12.500	542	585	43	146	14.6	85.4
(3/8)	9.5000	542	569	27	173	17.3	82.7
# 4	4.7500	511	545	34	207	20.7	79.3
# 10	2.00	486	510	24	231	23.1	76.9
# 20	.85	420	434	14	245	24.5	75.5
# 40	.425	385	392	7	252	25.2	74.8
#60	.25	359	361	2	254	25.4	74.6
# 100	0.1500	354	358	4	258	25.8	74.2
# 200	0.0750	339	345	6	264	26.4	73.6
pan		366	366.5	0.5	264.5	26.45	73.55
				$\boxed{264.5}$			

$M_{tot} = 1000$ g

% finer = 100-%ret

Hydrometer analysis

Elapsed time (min)	Actual Hydrometer reading	Composite correction $R_1 - R_2$	R corrected $A_c - C_0$	Temperature (C°)	L (cm)	K	D	%of finer	Actual % of finer
.25 = 15 sec	1.02+16 Div = 1.028	0.0005	1.0215 ~~0.928~~	17°	8.9	0.01396	0.0833	91.1% ~~72.05~~%	67.05% ~~53.02~~%
.5 = 30 sec	1.02+15 Div = 1.0275	0.0005	1.027 ~~0.9275~~	17°	9.05	0.01396	0.0593	89.51 %	65.87 %
1	1.02+13 Div = 1.0265	0.0005	1.026 ~~0.9265~~	17°	9.3	0.01396	0.0425	86.33 %	63.53 %
2	1.02+12 Div = 1.026	0.0005	1.0233 0.926	17°	9.4	0.01396	0.0302	84.75 %	62.37 %
4	1.02+10 Div = 1.025	0.0005	1.0245 ~~0.925~~	17°	9.7	0.01396	0.0217	81.57 %	60.03 %
8	1.02+5 Div = 1.0225	0.0005	1.022 ~~0.9225~~	17°	10.35	0.01396	0.0158	73.64 %	54.19 %
15	1.02+3 Div = 1.0215	0.0005	1.021 ~~0.9215~~	17°	10.6	0.01396	0.1173	70.46 %	51.85 %
30	1.01+19 Div = 1.0195	0.0005	1.019 ~~0.9195~~	17°	11.15	0.01396	8.51×10^{-3}	64.11 %	47.18 %
19 (hrs)	1+11 div = 1.0055	0.0005	1.005 ~~0.9055~~	17°	14.85	0.01396	1.593×10^{-3}	19.68 %	14.48 %

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 +3 Div.

1.02 + 3 (0.0005)

= 1.0215

**Composite Correction @

c = (W of water + disp) – (Wof water)

*** Hydrometer reading with composite correction applied
= Actual hydraulic – Composite $R_1 - R_2$

$R_1 = 1$

$R_2 = 1 - 1\ Div$

$1 - (1 - 0.0005)$

$\boxed{= 0.0005}$

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

at @ 15min   L = ~~1.0215~~ at actual Reading 1.0215
10.6

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

k = 0.01396

Gs = 2.7

T = 17°

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

$D_{mm} = k\sqrt{\frac{L}{T}} = 0.01396\sqrt{\frac{10.6}{15}} = \cancel{0.0593}$ 0.1173

******* Soil in Suspension
Note W= 50 g   GS = 2.7 $G_w = 0.99880$

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

$= \left(\frac{\frac{100000 * 2.7}{50}}{2.7 -}\right)\left(\cancel{1.0215}\ 1.019 - 0.9988\right)$

= ~~70.85%~~
~~41.1%~~
~~51.85%~~
70.46%

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

= ~~71.05 * 0.736~~ = ~~52.02%~~

~~52.58% * 0.736~~   ~~67.05%~~

70.46% * 0.736 = 51.85%

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

@sieve # 100

Weight sieve empty = 354 g

Weight sieve full = 358 g

Weight retained = W full - W empty 358 - 354 = 4 g

% of Retained = $\frac{258}{1000} \times 100\% = 25.8\%$ $\frac{\text{commulative retained sieve \#4}}{\text{total weight of soil}}$ to 100%

Commutative of retained = 254 + 4 = 258 g commulative retained on sieve (3/8) + retained on sieve #4

% passing = 100% - 25.8% = 74.2

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Discussion and conclusion

*% Gravel 20.7 % retained on ~~sieve~~ sieve # 4

**%sand retained on sieve # 200 and passed on sieve # 4
26.4 % - 20.7 % = 5.7 %

***%silt ~~retained~~ ~~finer~~ finer than sieve # 200 and retained on ~~sieve~~ less ~~than~~ D = 0.002 mm
73.6 - 19 = 54.6 %

****%clay Finer than D = 0.002 = 19 %

*****D10= can't be determent , D60= 0.02 , D30= 0.0037 , D85= 13 , D50= 0.0088

******Cc= $\frac{\cancel{D60}}{\cancel{D10}}$ = can't be determine

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

*******Cu= $\cancel{\frac{(D_{30})^2}{(D_{10})(D_{60})}}$ = can't be determined

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

******** Soil classification fine grained soil because % coarse < 50% which that 26.4 %

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

Why using the hexameta phosphate (calgon)?
To neutralize the negative charge on the soil particles then the soil go down to the bottom of the bottle and To prevent the soil Lumps

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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	$\boxed{0.01396}$	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	0.01438	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	$\boxed{0.01312}$	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	$\boxed{0.01282}$	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	$\boxed{0.01221}$	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)*
$\frac{3}{8}$ 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 = 105.35 g

Weight of container = 59.57 g

For sieve analysis of fine aggregate:

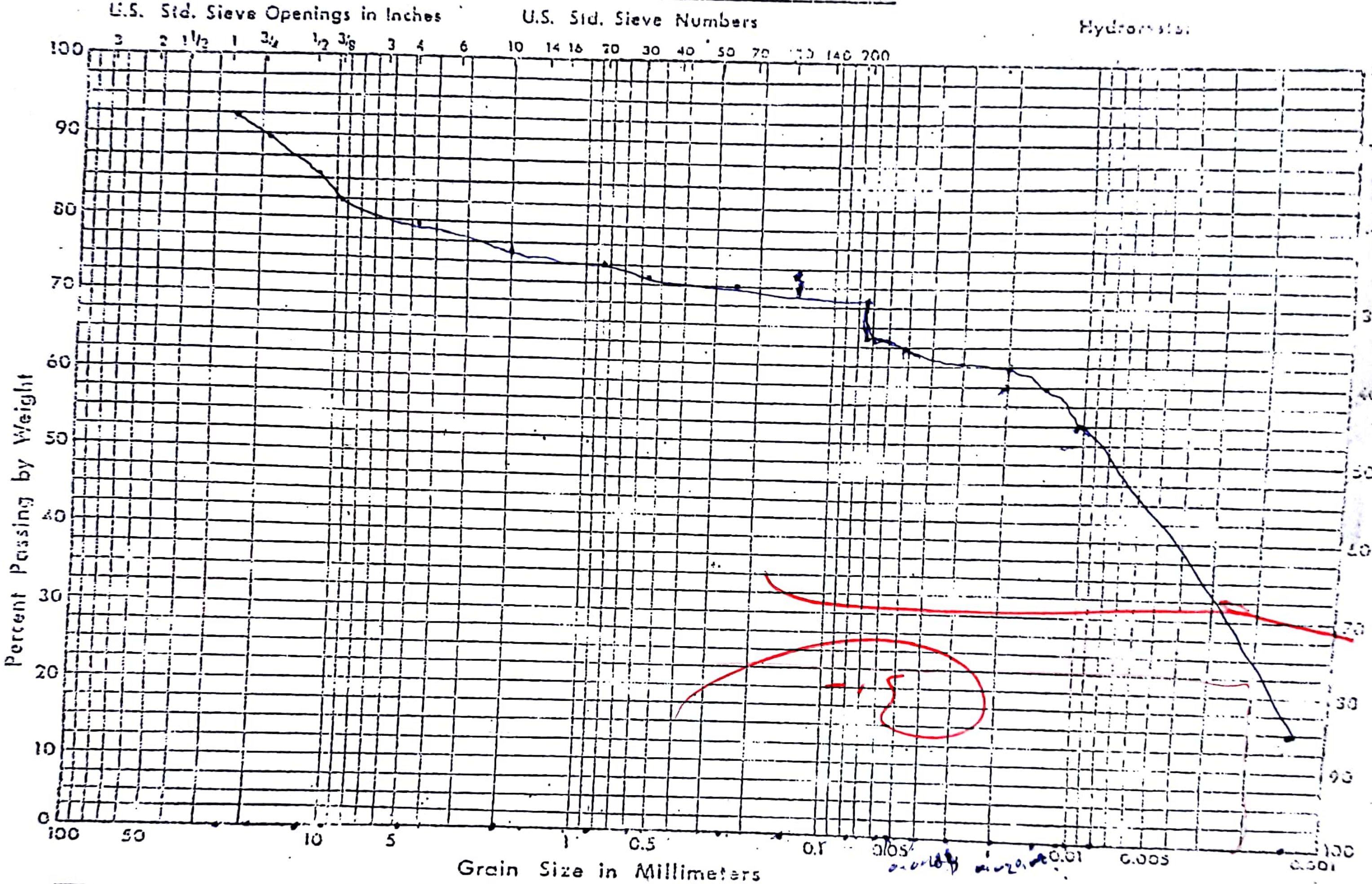
Weight of container = 110.21 g

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
1.0275 × 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	7.6				
1.033	7.3				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

MECHANICAL ANALYSIS GRAPH



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

D_{10} = cant be determine

D_{15} = 1.475×10^{-3} $5D_{15}$ = ______ $20D_{15}$ = ______

D_{30} = 0.0037

D_{60} = 0.0088

D_{85} = 13 $5D_{85}$ = ______

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

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

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تجربة (٢)

CIVIL ENGINEERING

الهندسة المدنية

مختبر الهندسة الجيوتقنية

18/12/2018

المجمع الشعب

الجامعة الهاشمية

Zarqa - Jordan

THE HASHEMITE UNIVERSITY

1995

ATTERBERG LIMIT
Liquid and Plastic Limits of a Soil

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ID#: 1632472

Section: 1

Date: 25/2/2018

9/10

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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 Liquidity index and plastic index.

Equipment

Liquid limit and plastic limit

1- casagrande bool
2- Balance
3- Bowl
4- groove
5- plate [glass]
6- seven cups [~~11B~~, 6B, ~~3A~~ 10B, 5B], [3B, 11D, A2]
LL PL

Procedure

According to ASTMD-4318

Data and Results

Table 1

Liquid Limit Determination				
can no.	6B	10B	11B	5B
Mass of wet soil + can	86.5	81.2	72.66	63.27
Mass of dry soil + can	66.2	63.7	59.5	53.6
Mass of can	30.56	36.68	30.94	30.95
Mass of dry soil	35.64	33.62	28.56	22.65
Mass of moisture	20.3	17.5	13.76	9.67
Water content ,w%	56.959	52.9	46.08	42.7
No. of blows, N	18	21	30	33

Table 2

Plastic limit Determination			
can no.	3B	11D	A2
Mass of wet soil + can	37.42	36.61	39.98
Mass of dry soil + can	35.6	34.8	37.8
Mass of can	31.27	30.18	30.87
Mass of dry soil	4.33	4.62	6.931
Mass of moisture	1.82	1.81	2.18
Water content ,w%	42.03%	39.18%	31.46%

% clay = 20%   (From the previous Experiment)

W_n (natural water content)= 25

Sample of calculations

Required

Liquid limit 51%
Plastic Limit 37.55%
Plasticity Index 13.45
Liquidity index -0.933
One Point liquid Limit 51.9%
Activity 0.6725

* one point method $\Rightarrow$ $LL = w_o \left(\frac{N}{25}\right)^{0.121}$ $LL = 53 \left(\frac{21}{25}\right)^{0.121} = 51.9\%$

↳ water content $= \frac{M_w}{M_s} * 100\% = \frac{17.5}{33.02} * 100\% = 53\%$

↳ mass of moisture = (Mass (can + wet soil) - mass (can + dry soil)

$\boxed{\text{at } 30B}$ $= 81.2 - 63.7 = 17.5$ (g)

↳ mass of dry soil = mass of (can + dry soil) - mass (can)

$= 63.7 - 30.68 = 33.02$

* multi point method from graph at 25 blow = 51%

* plastic Limit $= \frac{3B + 11D + A2}{3} = \frac{42.03 + 39.18 + 31.46}{3} = 37.55\%$

* plastic index (PI) = LL - PL

$= 51 - 37.55 = 13.45$

LI (Liquidity index) $= \frac{w_n - PL}{LL - PL} = \frac{25 - 37.55}{51 - 37.55} = -0.933$

Activity (A) $= \frac{PI}{\%\,clay} = ~~12.4633~~ = \frac{13.45}{20\%} = 0.6725$

Conclusion and Discussion

Soil classification

$A = 0.6725 < 0.75 \longrightarrow$ inactive clay

$LL = 51\% > 50\% \Longrightarrow$ high Liquid

$PI = 13.45$

PI Line $= 0.73(51 - 20) = 22.63$

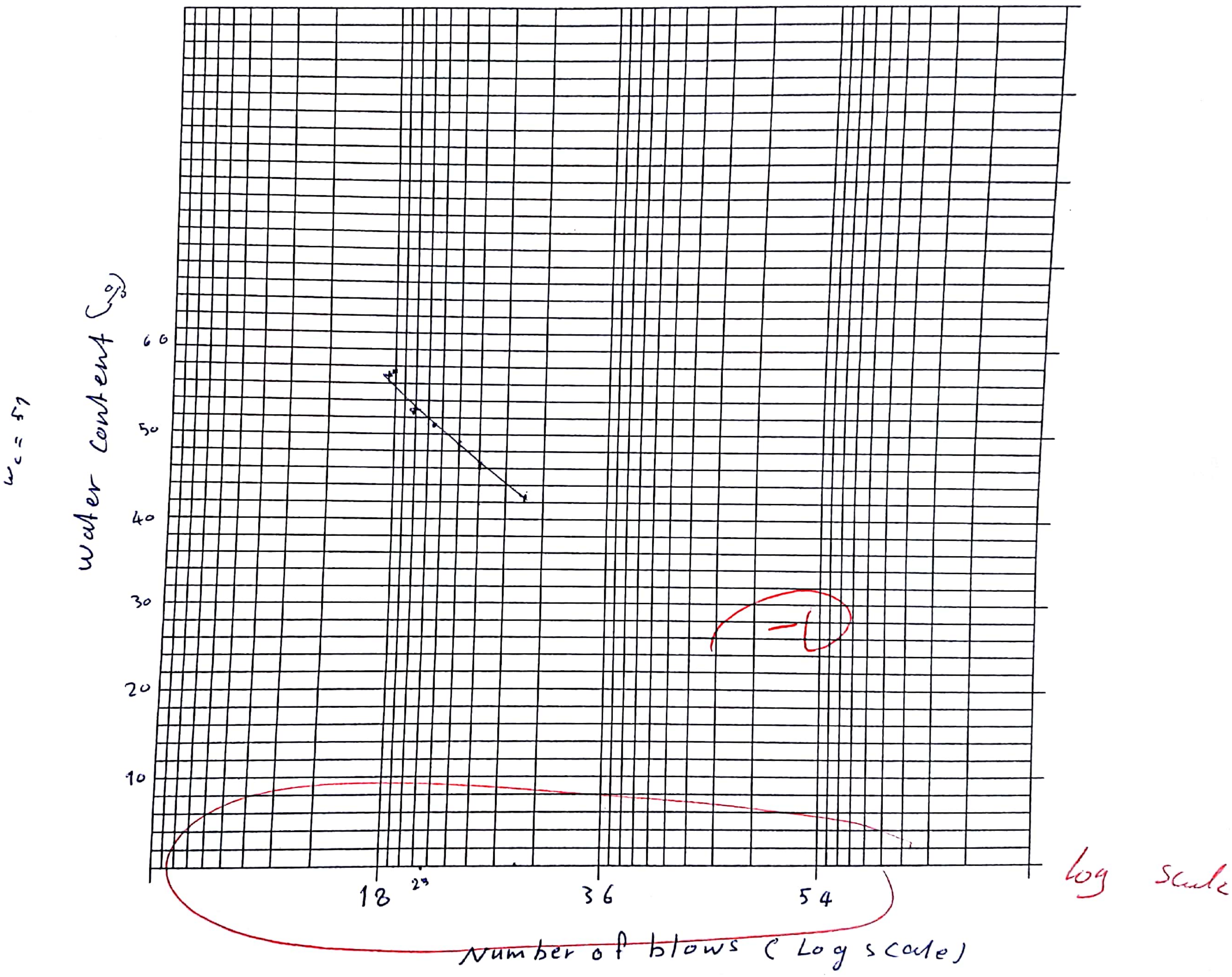
PI Line $> PI$ soil $22.63 > 13.45$ so $\Longrightarrow MH$

$LI = -0.933 < 0 \Longrightarrow$ Brittle (solid)

Why using soil pass sieve #40?

If we use sieve #200 then wash the soils, the soil will all became Lumps, but, if we use #40, that will avoid Lumps after washing and Fine graine soil wouldn't be loss

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



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مختبر الهندسة الجيوتقنية

لجميع الشعب

25-2-2018

التجربة الثالثة

Compaction

Student Name: علي محمد محمود علي عودة

ID#: 1632472

Section: 1

Date: 4/3/2018

10/10

Objective

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

Equipment

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

Procedure

According to ASTM D_1557

Data and Results

Table 1

Group #	M_m (g) ①	M_{m+s} (g) ②	Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+Oven Dry Soil (g)
1	3279	4885	1A	30.9	55.78	52.35
2	3300	4970	3B	31.32	77.84	70.39
3	3300	5000	11D	30.23	69.24	62.3
4	3305	5094	11B	31	53.19	48.24
5						

Table 2

Group #	W %	ρ_{wet} (g/cm^3)	ρ_{Dry} (g/cm^3)
1	16	1.78	~~1.79~~ 1.47
2	19.06	1.769	1.486
3	21.64	1.8	1.48
4	20.71	1.84	~~2.06~~ 1.472
5			

Table3: Zero-air voids curve Determination

Group #	W % <u>Assume</u> □omc	ρ_{Dry} (g/cm^3)
1	28 ~~[illegible]~~	~~1.29~~ 1.54
2	29 ~~[illegible]~~	~~1.28~~ 1.57
3	30 ~~[illegible]~~	~~1.263~~ 1.49
4	31 ~~[illegible]~~	~~2.41~~ ~~1.249~~ 1.46

Sample of calculations

Hint: volume =944cm^3
GS=2.7

Group ~~#~~ 4

$$wc\% = \frac{M_w}{M_s \text{ oven dry}} \times 100\% = \frac{53.19 - 48.24}{48.24 - 31} \times 100\% = 28.71$$

$$\rho_{wet} = \frac{w_2 - w_1}{V} = \frac{5094 - 3305}{944} = 1.895 \ g/cm^3$$

$$\rho_d = \frac{\rho_{wet}}{1 + wc\%} = \frac{1.895}{1 + 28.71} = 1.472$$

assume $w_c = 28\%$

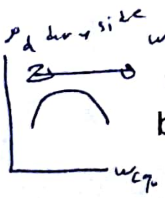
$$\rho_d = \frac{\rho_w G_s}{G_s w + 1} = \frac{1 \times 2.7}{2.7 \times \frac{28}{100} + 1} = \cancel{2.41} \ 1.54 \ g/cm^3$$

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

Conclusion and Discussion

Owc = 21.3%

ρ_{Dry}maximum 1.49%



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 (Lubricate the particles) and reoriented into a tenser configuration
above water opt :- water starts to replace soil particles in the mold and since $\rho_w << \rho_s$ the dry denesity starts to decrease.
at w opt :- the density become to its maximum value and it doesn't increase other than

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Data sheet

Group #	M_{mold} (g)	$M_{mold+soil}$ (g)	Can #	Can Wt. (g)	Can+Wet Soil (g)	Can+oven Dry Soil (g)
1	3279	4885	1A	30.9	55.78	52.35
2	3300	4970	3B	31.32	77.84	70.39
3	3300	5000	11D	30.23	69.24	62.3
4	3305	5094	11B	31	53.19	48.24
5						

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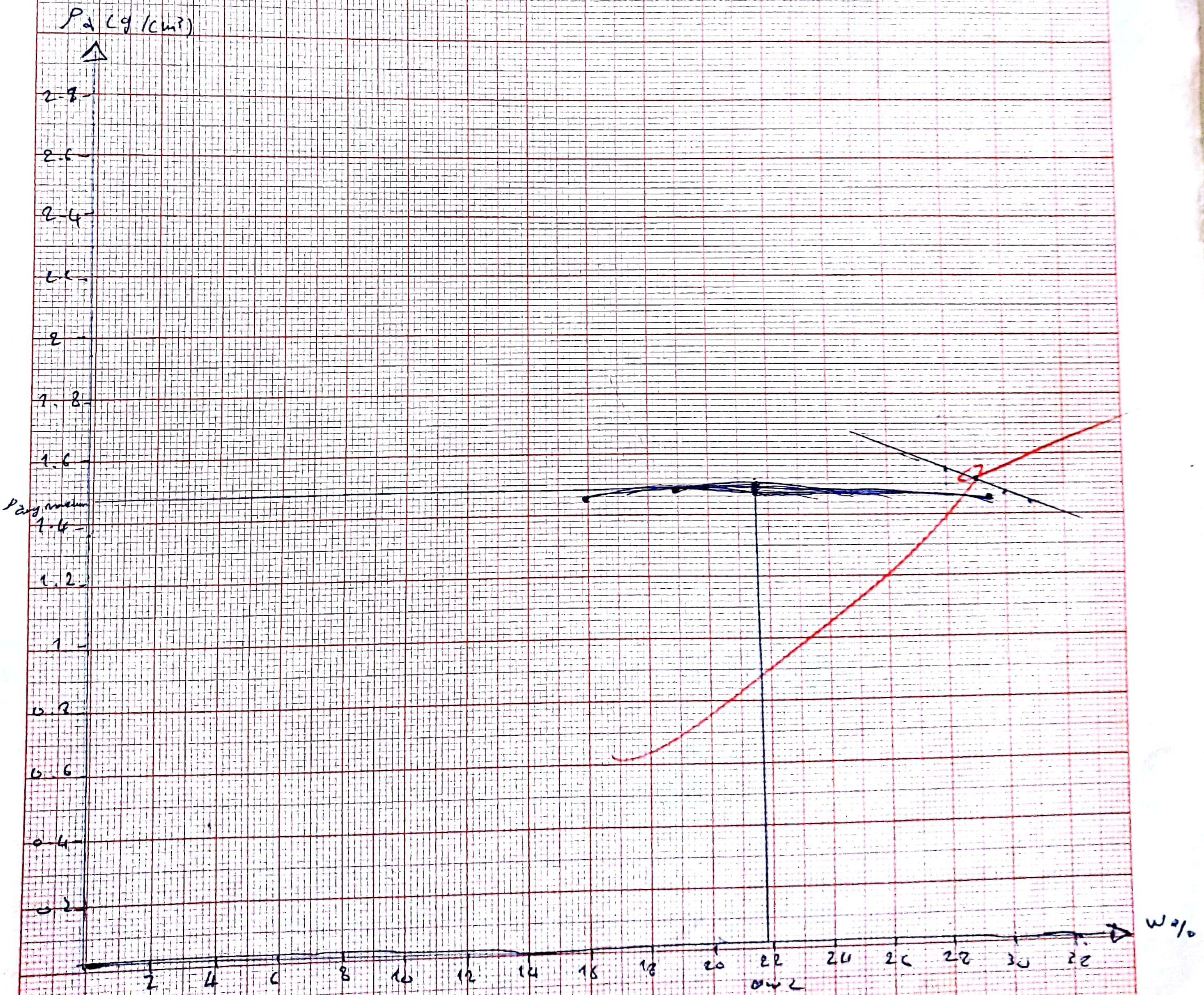
كل محمد دة

figure 1.1
relation between(ρ_d, wc)



Objective

* Determine the coefficient of permeability :-

① voids ratio (e) compression index (cc), Recompression index (cr) preconsolidation pressure (σ'_c), coefficient of permeability (k) M_v, T_v

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

③ Determine Cv by two methods (casagrande, taylor)

Equipment

① Loads (kg)

② stop watch

③ can

④ consolidation test apparatus (oedometer tester)

⑤ balance

Procedure

consolidation test, ASTM D-2435

Sample of calculation

$Hs=Ms/(Gs*A*\rho_w)$	$e_0=(H_t-H_s)/H_s$	$Stress_{(MPa)}=P/A$
$\frac{140}{(2.7*38.465*1)}$ $=13.5$ mm	$\frac{20-13.5}{13.5}=0.481$	$\frac{50*9.81}{0.003847}$ $=0.128$ Mpa

$Hf=H_t.deformation$	$Hv=H_f-H_s$	$e=H_v/H_s$
$20-[0.01*30]$ $=19.2$	$19.2-13.5$ $=5.72$	0.422 $\frac{5.7}{13.5}=0.422$

Ms= 140 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	Time min	Time sec	Dial Reading Div	Time (min)	$Time^{0.5}$ ($min^{0.5}$)	Deformation (mm)	Hf	Hv	e
0	0	8	80	0.13	0.37	0.8	19.2	5.7	0.422
0	0	15	86	0.25	0.50	0.86	19.14	5.64	0.418
0	0	30	91	0.5	0.71	0.91	19.09	5.59	0.414
0	1	0	97.5	1	1.00	0.975	19.03	5.53	0.409
0	2	0	102	2	1.41	1.02	18.98	5.48	0.406
0	4	0	107.5	4	2.00	1.075	18.93	5.43	0.402
0	8	0	112.75	8	2.83	1.1275	18.87	5.37	0.398
0	16	0	117	16	4.00	1.17	18.83	5.33	0.395
0	30	0	121	30	5.48	1.21	18.79	5.29	0.392
1	0	0	124	60	7.75	1.24	18.76	5.26	0.390
2	0	0	126	120	10.95	1.26	18.74	5.24	0.389
4	0	0	128	240	15.49	1.28	18.72	5.22	0.387
8	0	0	129	480	21.91	1.29	18.71	5.21	0.386
24	0	0	130	1440	37.95	1.3	18.7	5.2	0.385

Load= 100kg

Time hr	Time min	Time sec	Dial Reading Div	Time (min)	$Time^{0.5}$ ($min^{0.5}$)	Deformation (mm)	Hf	Hv	e
0	0	8	132	0.13	0.365148	1.32	18.68	5.18	0.384
0	0	15	134	0.25	0.5	1.34	18.66	5.16	0.382
0	0	30	137	0.5	0.707107	1.37	18.63	5.13	0.38
0	1	0	140	1	1	1.4	18.6	5.1	0.378
0	2	0	144	2	1.414214	1.44	18.56	5.06	0.375
0	4	0	148	4	2	1.48	18.52	5.02	0.372
0	8	0	152.5	8	2.828427	1.525	18.48	4.98	0.369
0	16	0	157	16	4	1.57	18.43	4.93	0.365
0	30	0	161	30	5.477226	1.61	18.39	4.89	0.362
1	0	0	165.5	60	7.745967	1.655	18.35	4.85	0.359
2	0	0	169	120	10.95445	1.69	18.31	4.81	0.356
4	0	0	172	240	15.49193	1.72	18.28	4.78	0.354
8	0	0	175	480	21.9089	1.75	18.25	4.75	0.352
24	0	0	178	1440	37.94733	~~[illegible]~~	18.22	4.72	0.35

1.78

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	4.46	0.33
0	0	15	209	0.25	0.5	2.09	17.91	4.41	0.327
0	0	30	213	0.5	0.707107	2.13	17.87	4.37	0.324
0	1	0	217	1	1	2.17	17.83	4.33	0.321
0	2	0	221.5	2	1.414214	2.215	17.79	4.29	0.317
0	4	0	226.5	4	2	2.265	17.74	4.24	0.314
0	8	0	233	8	2.828427	2.33	17.67	4.17	0.309
0	16	0	240.5	16	4	2.405	17.6	4.1	0.303
0	30	0	249	30	5.477226	2.49	17.51	4.01	0.297
1	0	0	259	60	7.745967	2.59	17.41	3.91	0.29
2	0	0	267.5	120	10.95445	2.675	17.33	3.83	0.283
4	0	0	273	240	15.49193	2.73	17.27	3.77	0.279
8	0	0	275.5	480	21.9089	2.755	17.25	3.75	0.277
22	14	0	277	1334	36.52396	2.77	17.23	3.73	0.276

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	326	0.13	0.365148	3.26	16.74	3.24	0.24
0	0	15	329	0.25	0.5	3.29	16.71	3.21	0.238
0	0	30	331	0.5	0.707107	3.31	16.69	3.19	0.236
0	1	0	334	1	1	3.34	16.66	3.16	0.234
0	2	0	337.5	2	1.414214	3.375	16.63	3.13	0.231
0	4	0	341.5	4	2	3.415	16.59	3.09	0.229
0	8	0	346.5	8	2.828427	3.465	16.54	3.04	0.225
0	16	0	352.5	16	4	3.525	16.48	2.98	0.22
0	30	0	361	30	5.477226	3.61	16.39	2.89	0.214
1	0	0	372	60	7.745967	3.72	16.28	2.78	0.206
2	0	0	386	120	10.95445	3.86	16.14	2.64	0.196
4	0	0	395	240	15.49193	3.95	16.05	2.55	0.189
8	0	0	403	480	21.9089	4.03	15.97	2.44	0.183
23	30	0	407	1410	37.54997	4.07	15.93	2.43	0.18

Load= 1000kg

Time			Dial Reading	Time	$Time^{0.5}$	Deformation	Hf	Hv	e	Hf
hr	min	sec	Div	(min)	$(min^{0.5})$	(mm)				
0	0	8	414	0.13	0.365148	4.14	~~4.14~~	2.63	0.175	15.86
0	0	15	417	0.25	0.5	4.17	~~4.17~~	2.33	0.173	15.83
0	0	30	420	0.5	0.707107	4.2	~~4.2~~	2.3	0.17	15.80
0	1	0	424	1	1	4.24	~~4.24~~	2.26	0.167	15.76
0	2	0	430	2	1.414214	4.3	~~4.3~~	2.2	0.163	15.7
0	4	0	436	4	2	4.36	~~4.36~~	2.14	0.159	15.64
0	8	0	443	8	2.828427	4.43	~~4.43~~	2.07	0.153	15.57
0	16	0	453	16	4	4.53	~~4.53~~	1.97	0.146	15.47
0	30	0	463	30	5.477226	4.63	~~4.63~~	1.87	0.139	15.37
1	0	0	476	60	7.745967	4.76	~~4.76~~	1.74	0.129	15.24
2	0	0	485	120	10.95445	4.85	~~4.85~~	1.65	0.122	15.15
4	0	0	491	240	15.49193	4.91	~~4.91~~	1.59	0.142	15.09
8	0	0	493	480	21.9089	4.93	~~4.93~~	1.57	0.116	15.07
24	0	0	495	1440	37.94733	4.95	~~4.95~~	1.55	0.115	15.65

$\frac{H_f - H_s}{H_s}$

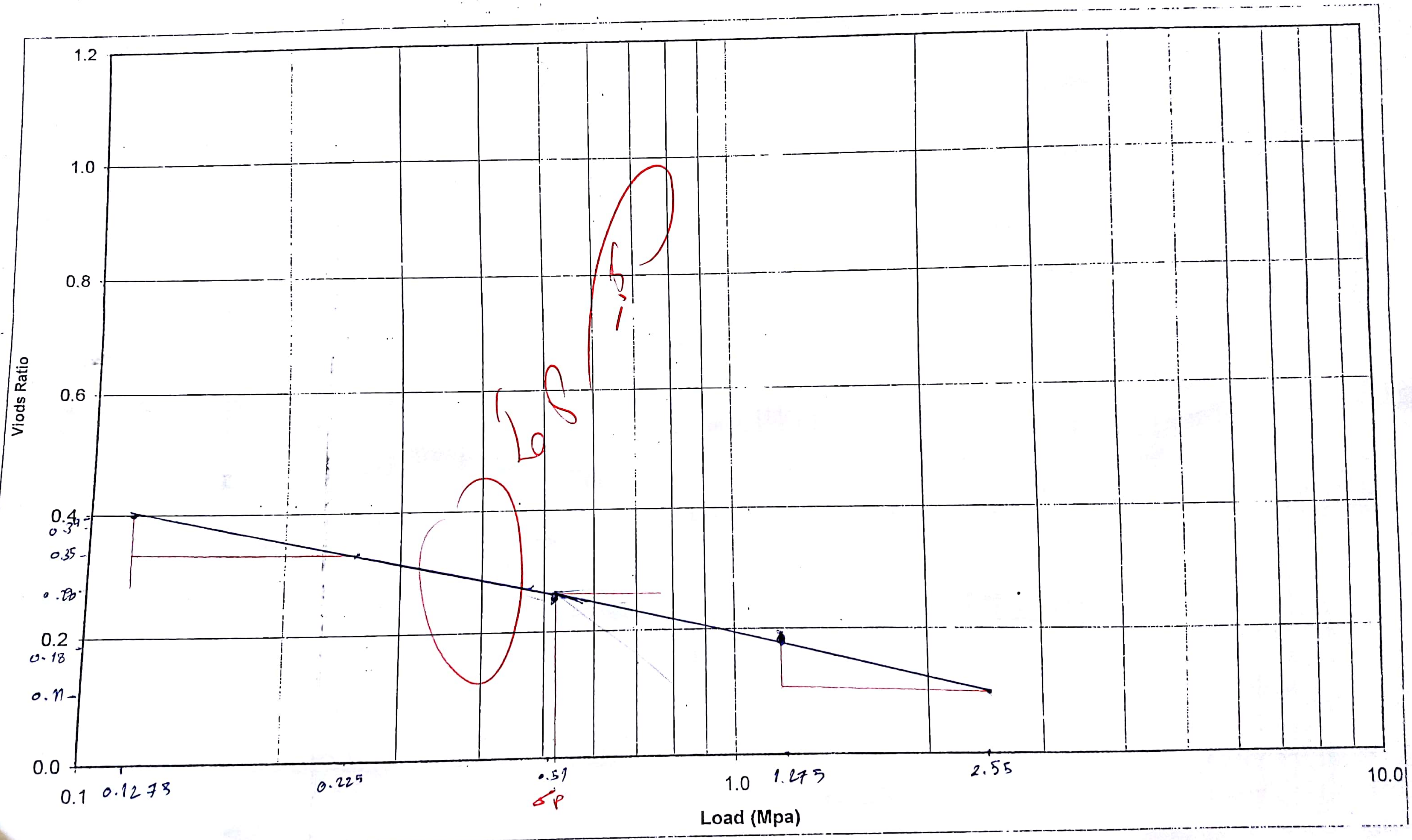
	P/A	Cum.	$H_{F(n-1)} - \Delta H$	$H_F - H_S$	$(H_F - H_S)/H_S$	$(H_{F(n-1)} + H_{F(n)})/2$	Figures		$0.848*H^2_{avg}/(4*t_{90})$	$0.197*H^2_{avg}/(4*t_{50})$
Load kg	Load MPa	Final Def. ΔH_{cum} (mm)	Final Height H_F (mm)	Height of voids (mm)	Final voids ratio	Avg. Height (mm)	Fitting Time (Min) t_{90}	Fitting Time (Min) t_{50}	Cv (mm^2/min) from t_{90}	Cv (mm^2/min) from t_{50}
50	0.1275	1.3	18.7	5.2	0.39	19.35	2	2.4	45.2	7.01
100	0.255	1.78	18.22	4.72	0.35	18.46	2	2	46.26	8.99
200	0.51	2.77	17.23	3.73	0.28	17.73	1.4	8	69.25	2.13
500	1.275	4.07	15.93	2.43	0.18	16.58	1.4	18	73.32	0.89
1000	2.55	4.95	15.05	1.55	0.11	15.49	7.8	10.5	13.73	1.5

$(Cv)_{avg} = \frac{\Sigma Cv}{10}$

$\boxed{= 26.9}$

$$C_r = \left| \frac{\Delta e}{\log\left(\frac{\sigma_1}{\sigma_1}\right)} \right| = \left| \frac{0.39 - 0.35}{\log\left(\frac{0.1275}{0.255}\right)} \right| = 0.134$$

$$C_c = \left| \frac{\Delta e}{\log\left(\frac{\sigma_1}{\sigma_1}\right)} \right| = \left| \frac{0.18 - 0.10}{\log\left(\frac{0.1275}{2.55}\right)} \right| = 0.234$$



$\Delta = d_2 - d_1$

$0.91 - 0.8 = 0.11$

$2\Delta = 0.22$

$d_0 = d_2 - 2\Delta = 0.9 - 0.22 = 0.68$

$d_{50} = \frac{d_0 + d_{100}}{2}$

$= \frac{0.68 + 1.28}{2}$

$= 0.975$

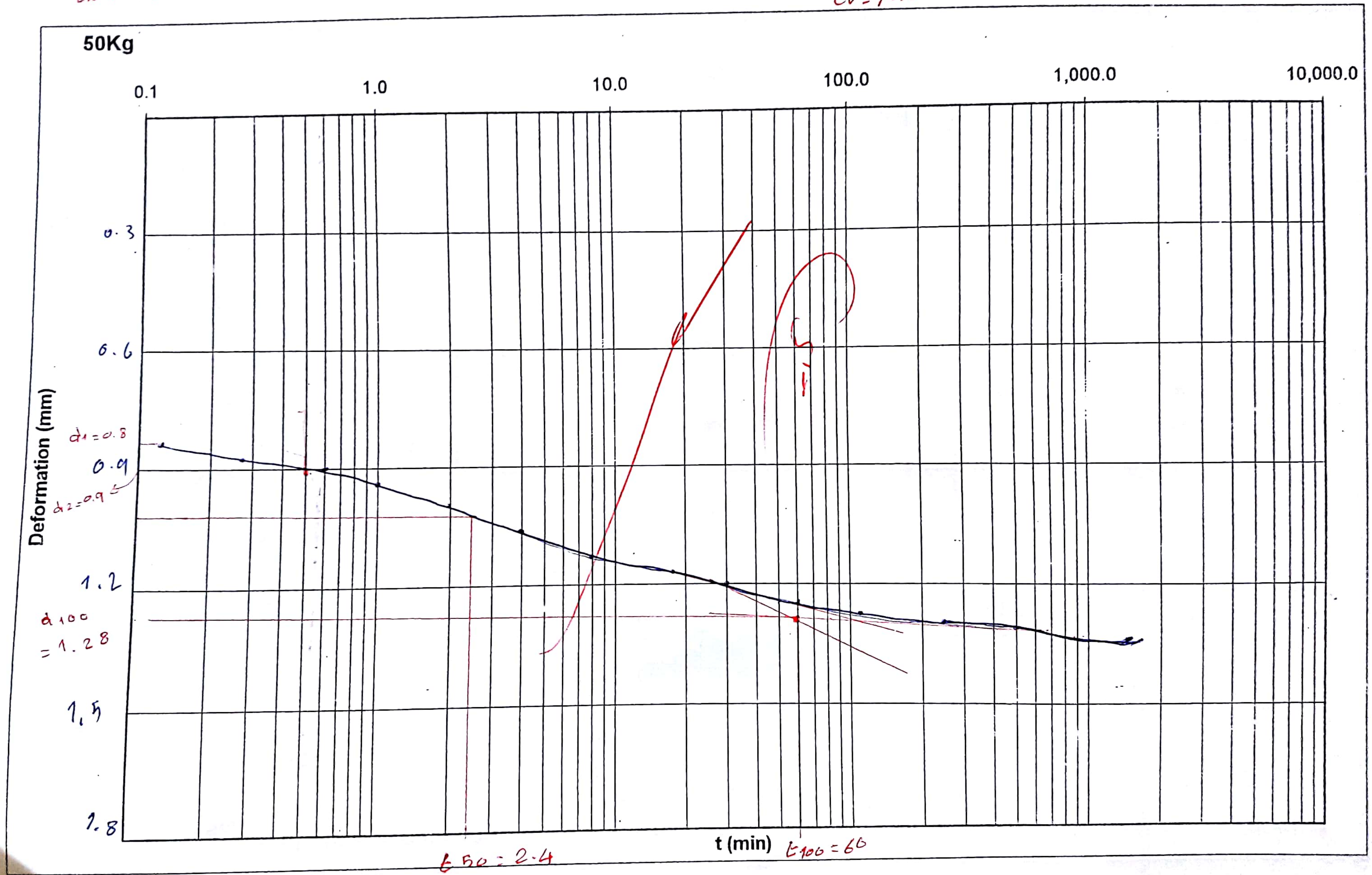
$T_v = \frac{C_v t_{50}}{d^2}$

$0.197 = \frac{C_v(2.4)}{(9.7)^2}$

$C_v = 7.12$

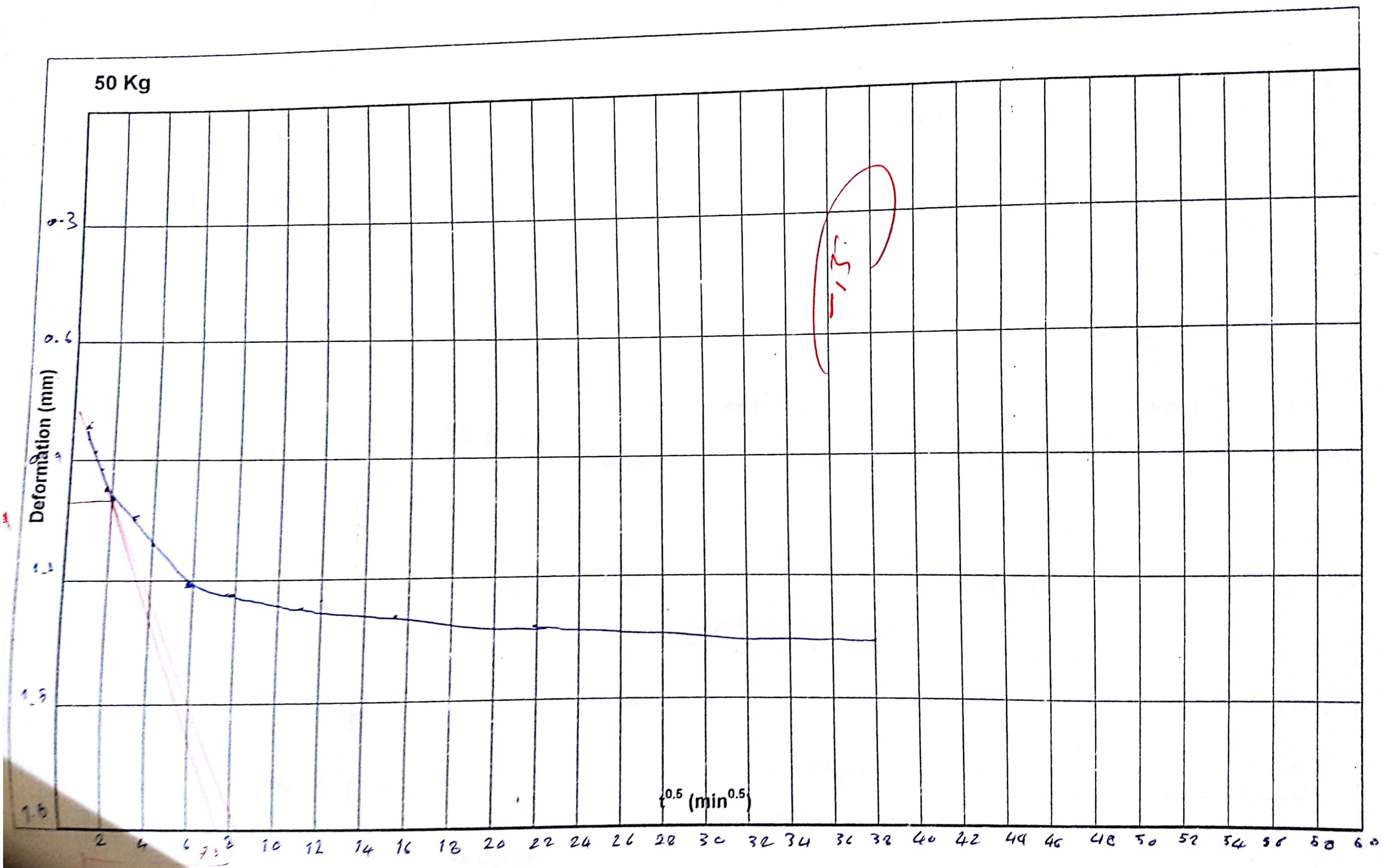
$d = \frac{H_{avg}}{2}$

$= 20 + \frac{[20 - 1.3]}{4} = 9.7$



$d_{90} = 1.09$

$t_{90} = 2\,min$



$7.5 \times 1.15 = 8.625$

$\Delta d = 0.05$
$2\Delta d = 0.1$

$d_0 = 1.36 - 0.1$
$= 1.26$

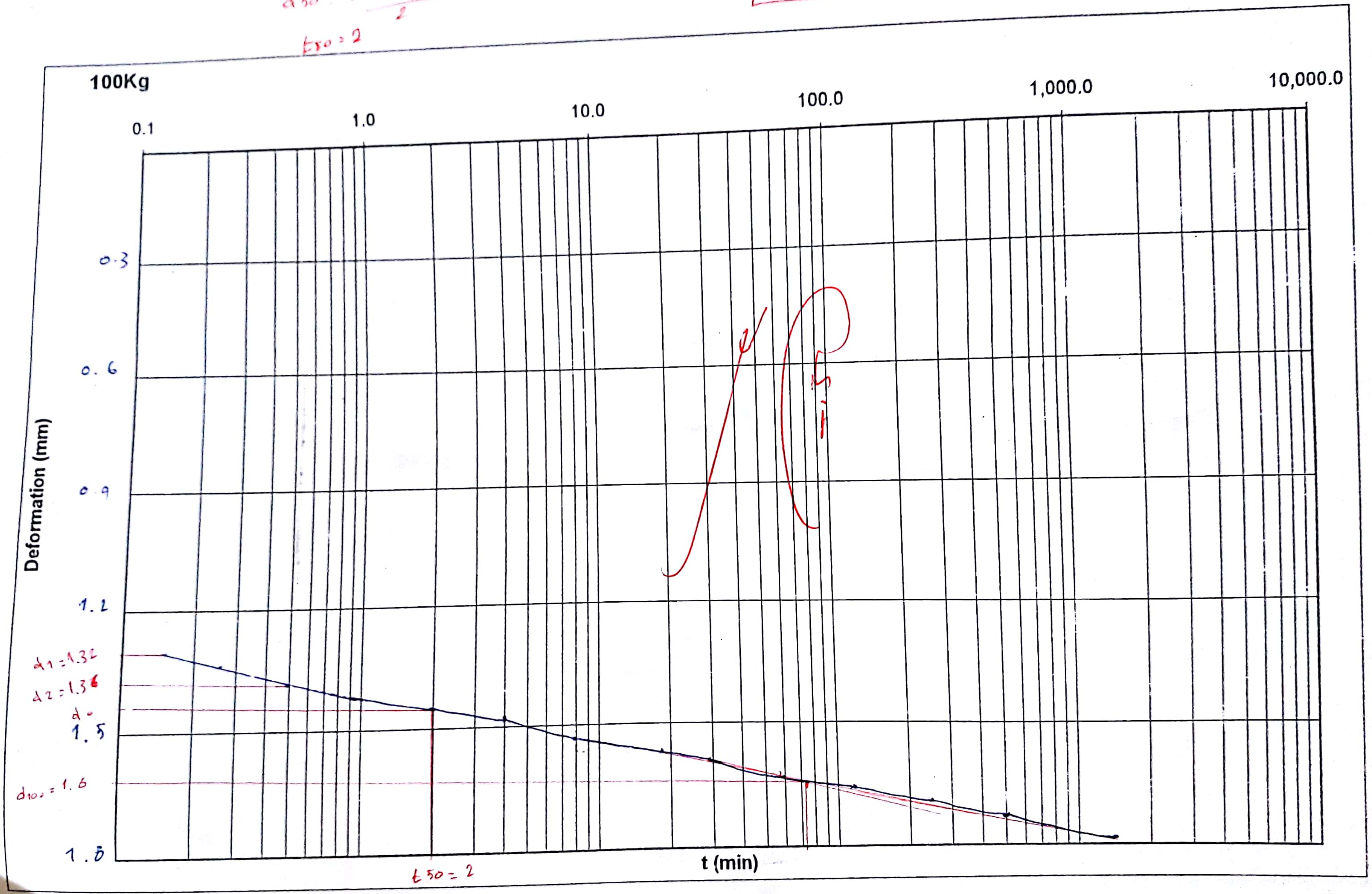
$d_{50} = \frac{1.26 + 1.6}{2} = 1.43$

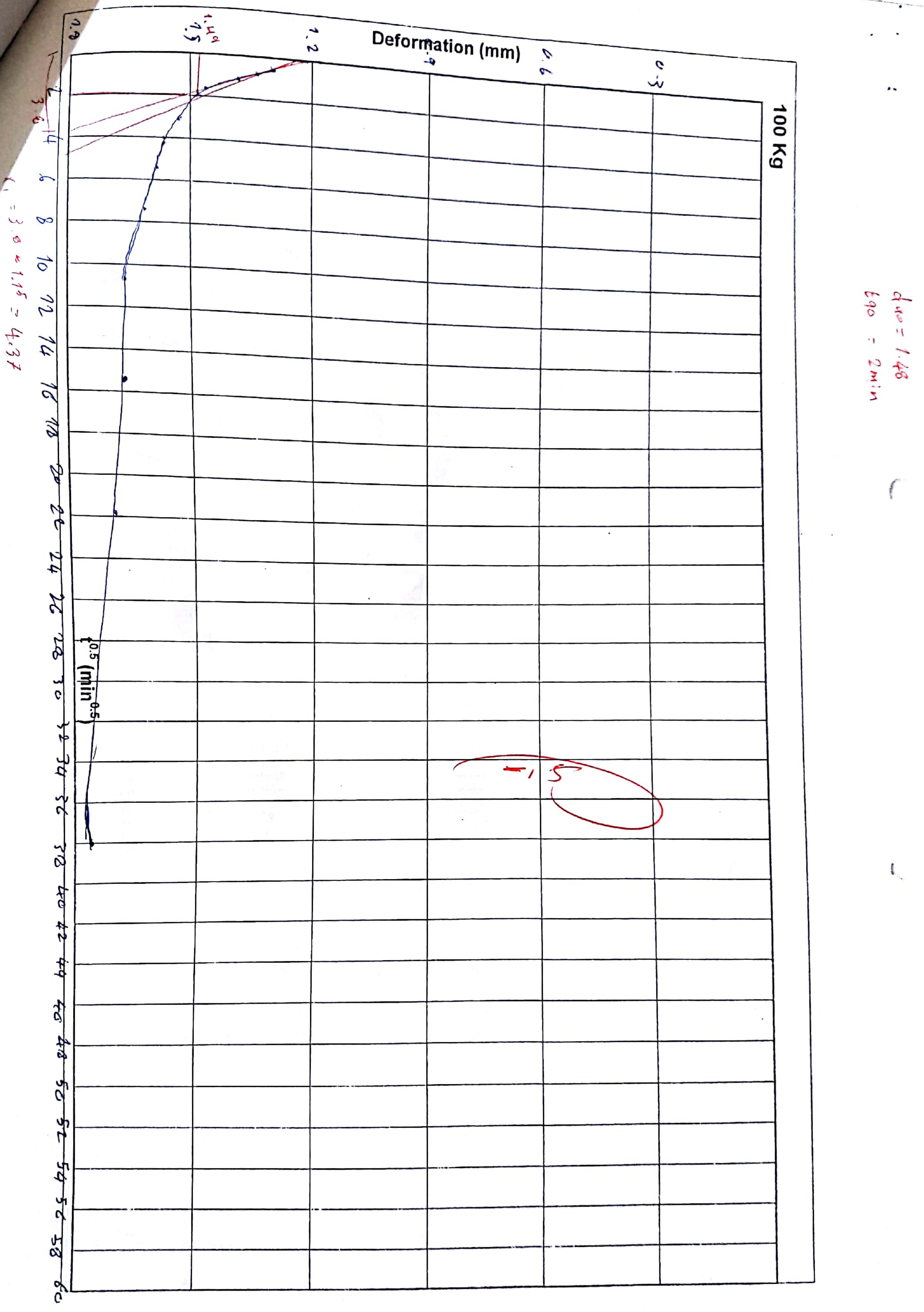
$t_{50} = 2$

$T_v = \frac{C_v \times t_{50}}{d^2}$

$\boxed{C_v = 8.41}$

$d = \frac{[20 - 1.3] + [20 - 1.78]}{4}$
$= 9.23$




Deformation (mm)
100 Kg
$t^{0.5}$ ($min^{0.5}$)
d_{90} = 1.48
t_{90} = 2min
1.5

$\Delta d = 2.2 - 2.15 = 0.05$

$\Sigma \Delta d = 0.1$

$d_0 = d_1 - 0.1$

$d_0 = 1.9$

$d_{50} = \frac{1.9 + 2.6}{2}$

$= 2.33$

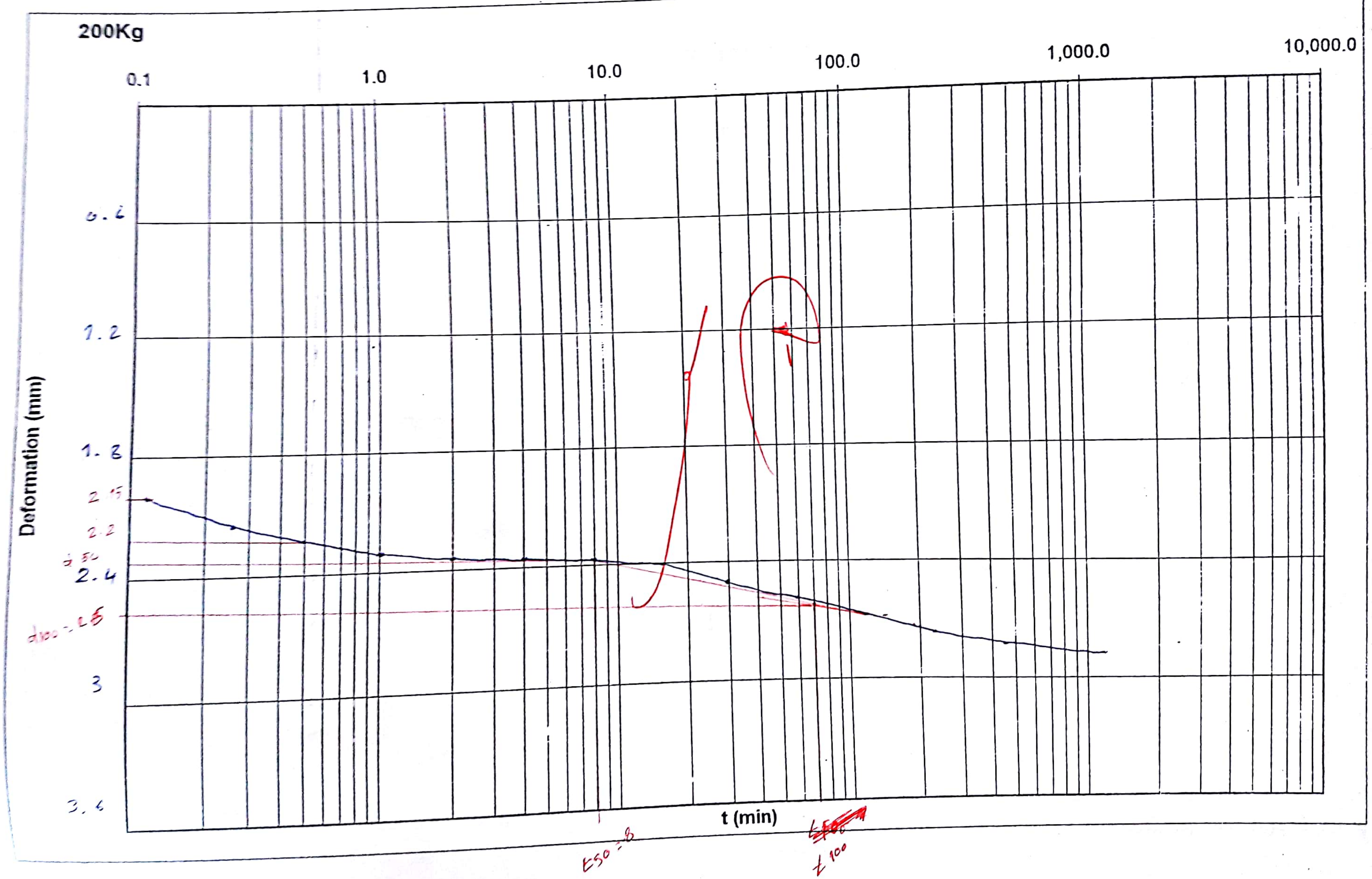
$t_{50} = 8$

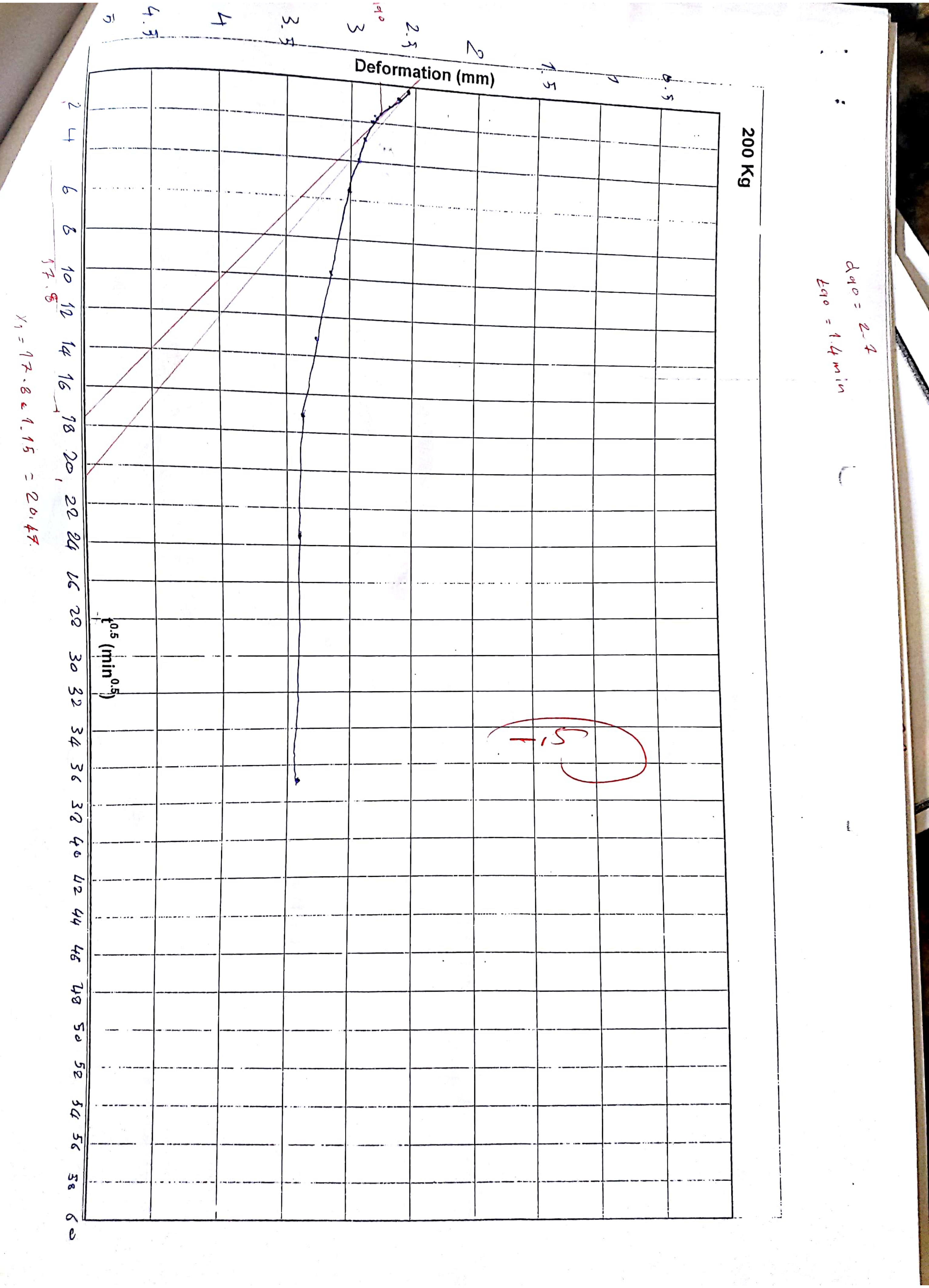
$T_v = \frac{C_v t_{50}}{d^2}$

$0.197 = \frac{C_v \cdot 8}{\cancel{(8.8)} (8.85)^2} = \boxed{1.92}$

$d = \frac{[20 - 1.78] + [20 - 2.6]}{4}$

$= 8.85$





Deformation (mm)
200 Kg
$t^{0.5}$ (min$^{0.5}$)
$d_{90} = 2.7$
$t_{90} = 1.4$ min
$x_1 = 17.8 \times 1.15 = 20.47$
17.8
15

$\Delta d = 3.4 - 3.3 = 0.1$

$2\Delta d = 0.2$

$d_0 = 3.4 - 0.2 = 3.2$

$d_{50} = \frac{3.2 + 3.9}{2}$

$= 3.56$

$T_v = \frac{C_v t_{50}}{d^2}$

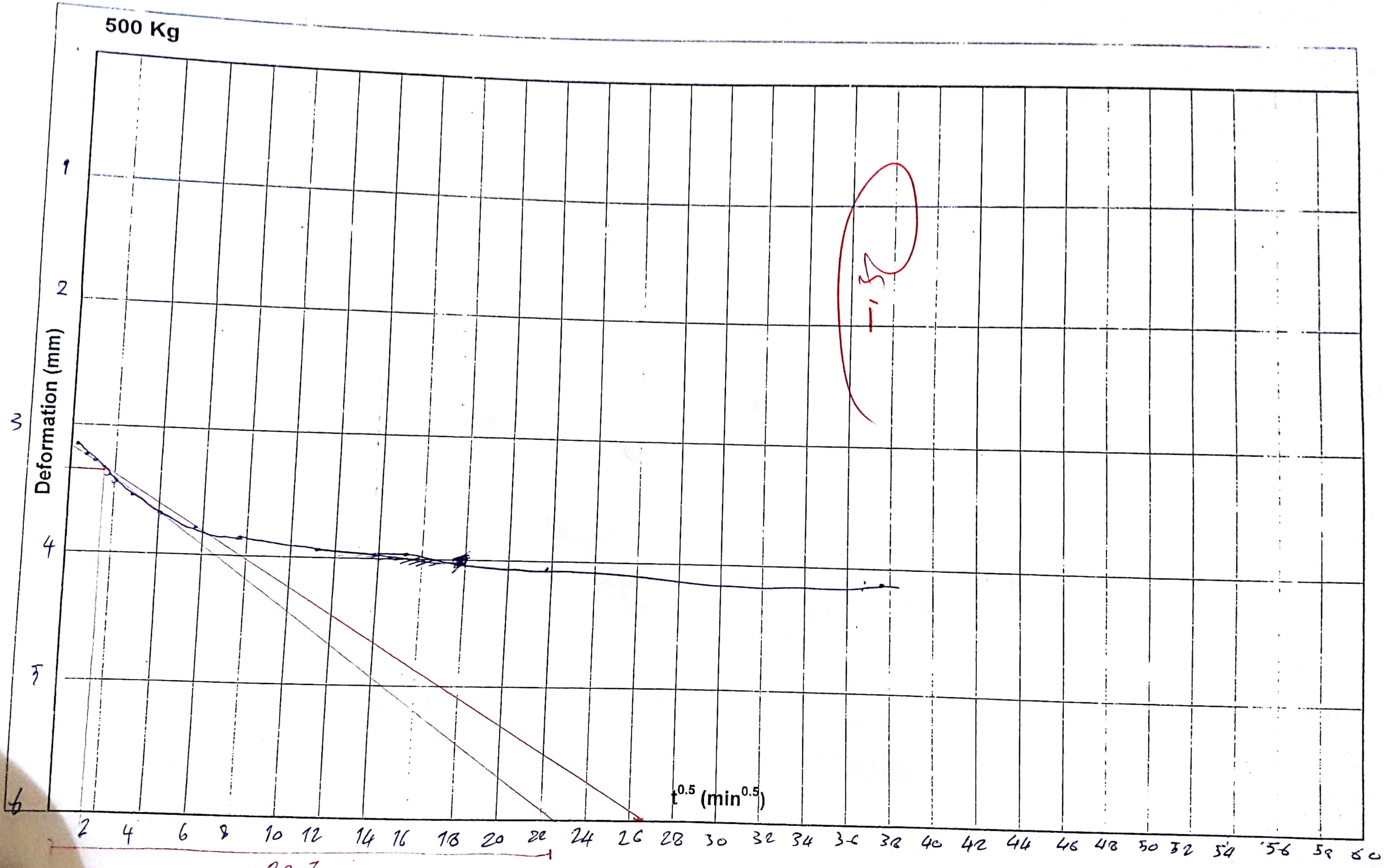
$0.197 = \frac{C_v (18)}{(8.28)^2} = 0.76$

$d = \frac{[20 - 2.77] + [20 - 4.07]}{4}$

$= 8.28$

$d_{90} = 3.4$ mm

$t_{90} = 1.4$ min



$X_1 = 22.7 \times 1.15 = 26.12$

$\Delta d = 4.2 - 4.16 = 0.04$

$2\Delta d = 0.08$

$d_0 = 4.2 - 0.08 = 4.12$

$d_{50} = \frac{4.12 + 4.92}{2}$

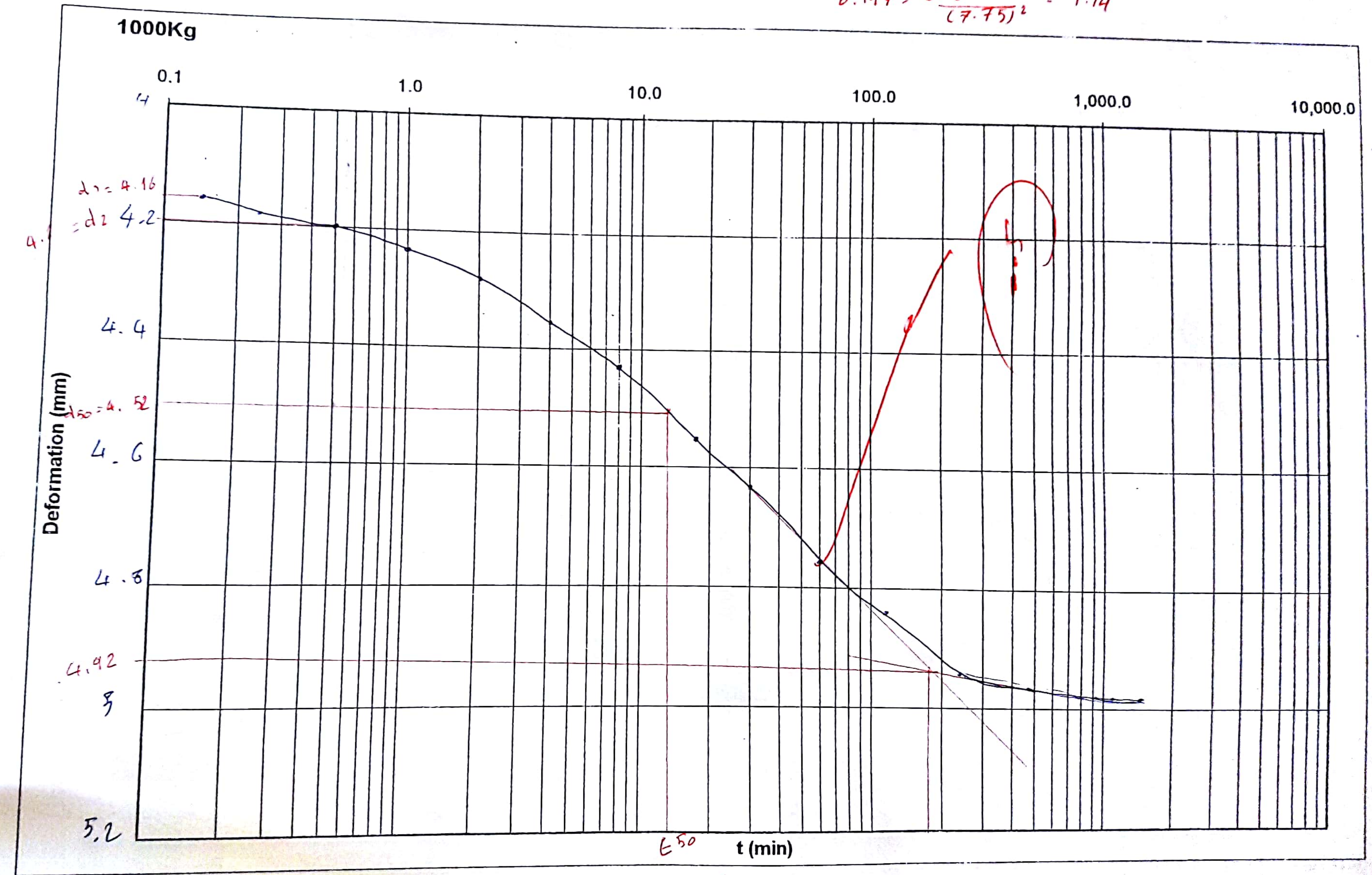
$= 4.52$

$T_v = \frac{C_v\, t_{50}}{d^2}$

$0.197 = \frac{C_v (10.4)}{(7.75)^2} = 1.14$

$d = \frac{[20 - 4.07] + [20 - 4.95]}{4}$

$= 7.75$



$= 10.4$

CIVIL ENGINEERING

قرش

مختبر الهندسة الجيوتقنية

قسم الهندسة المدنية

شعبة الأحد

1/4/2018

م. آيات الخادم

THE HASHEMITE UNIVERSITY
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Direct Shear

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Section: 1

Date: 8/4/2017

15/15

Objective

① Determine the shear strength parameters (ϕ, C)

② Determine Ip, I residual

Equipment

① Direct shear Device
② Loads
③ trowel
④ mold
⑤ dialgage
⑥ callibers
⑦ Balance
⑧ panfilled with soil

Procedure

According to ASTM D-3080

Sample of calculations

σn	τ(Kpa)	τ(Kpa)resid
27.25	59.89	55
54.5	142.4	132
109	177.22	168.65

A (mm)	σn $= \frac{P}{A}$	T(N)	τ(Kpa) $= \frac{T}{A}$
$6 \times 6 = 36\ cm^2$ $3.6 \times 10^{-3}\ m^2$	$= \frac{10 \times 9.81}{3.6}$ $= 27.25$	$= 0.007 \times 2200$ $= 15.41$	$= \frac{15.41}{3.6}$ $= 4.28$

-Plot τ(Kpa) versus H(mm) for each load in the same figure .

-Plot τ(Kpa) versus σn &. τ(Kpa)res versus σn in the same figure .

Discussion and Conclusion

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

dense sand

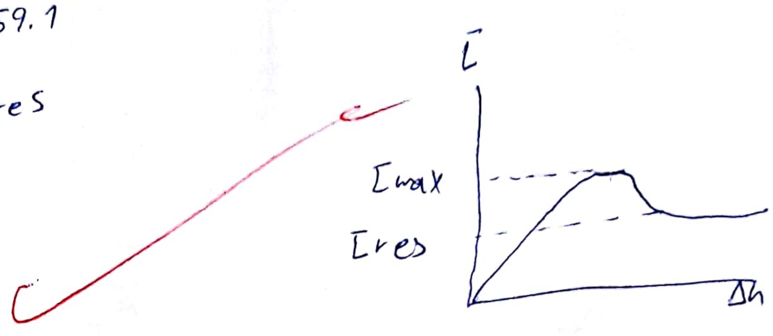
$c = 0$

$\phi = 63.43^\circ$

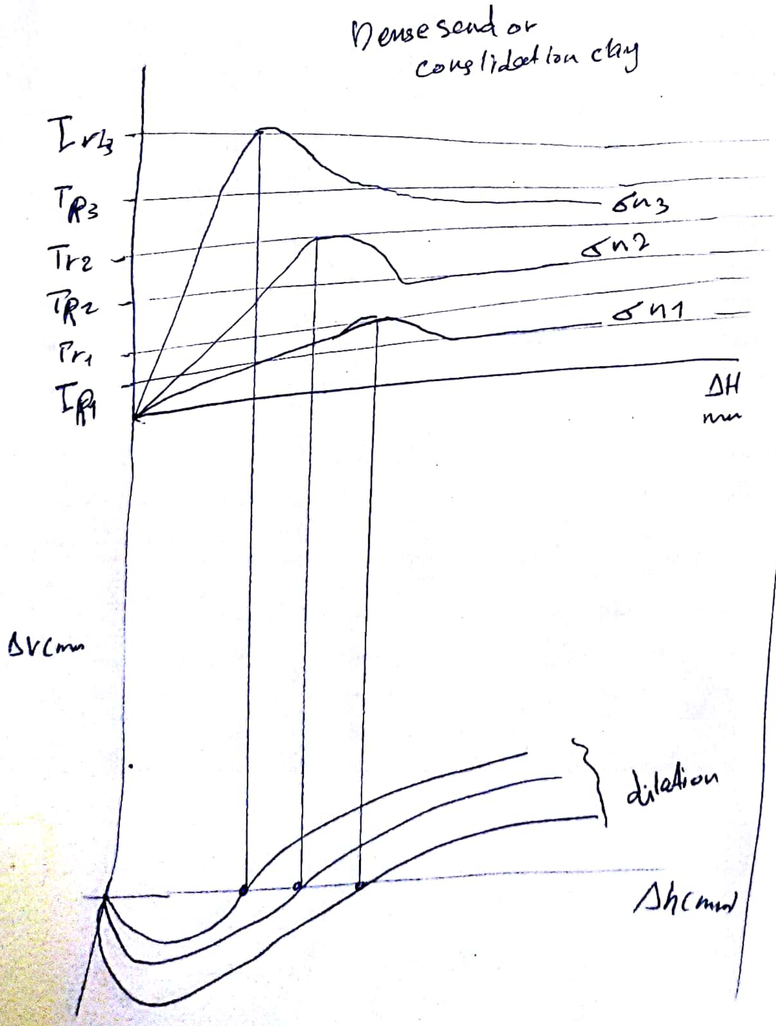
$c_{res} = 0$

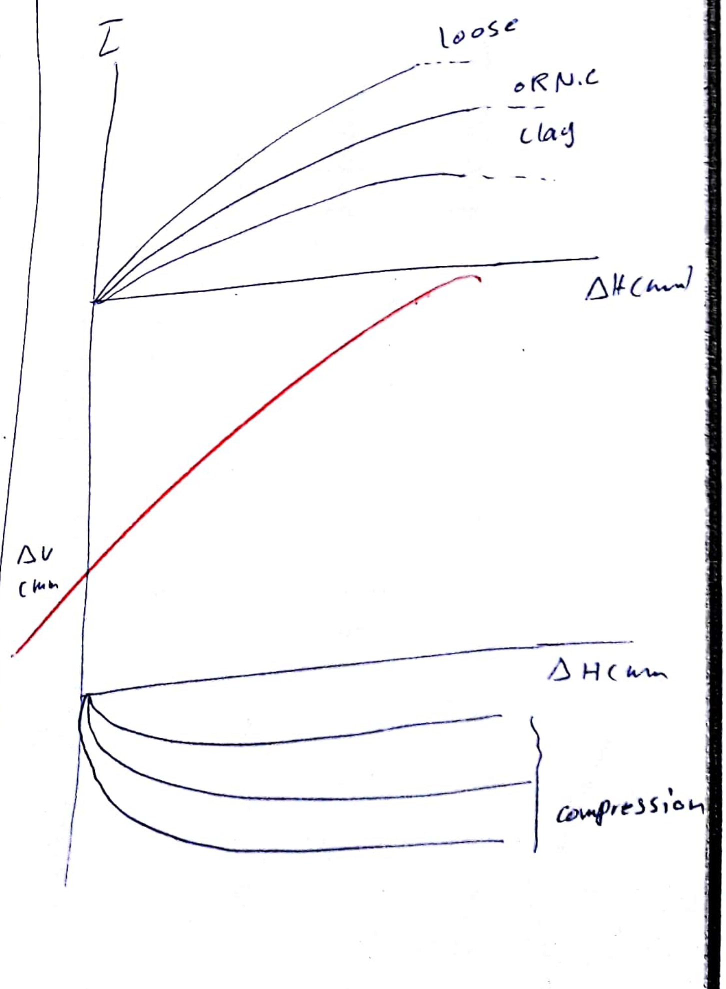
$\phi_{res} = 59.1^\circ$

$\phi > \phi_{res}$



2-draw the free sketch between shear stress versus horizontal displacement curve, and vertical displacement versus horizontal displacement for both (loss sand, normal consolidation clay) & (dense sand, over consolidation clay).





m

=6cm load=10 Kg $\sigma n=$ 27.25 Kpa

Hint : 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	-9	7	0.1	-0.09	0.007	15.41	3600	4.28
20	-10	16	0.2	-0.1	0.016	35.2	3600	9.78
30	-11	25	0.3	-0.11	0.025	55	3600	15.28
40	-11	32	0.4	-0.11	0.032	70.4	3600	19.56
50	-10	40	0.5	-0.1	0.04	88	3600	24.44
60	-10	45	0.6	-0.1	0.045	99	3600	27.5
70	-9	51	0.7	-0.09	0.051	112	3600	31.17
80	-9	55	0.8	-0.09	0.055	121	3600	33.61
90	-8	60	0.9	-0.08	0.06	132	3600	36.6
100	-7	65	1	-0.07	0.065	143	3600	39.72
120	-5	71	1.2	-0.05	0.071	156	3600	43.39
140	-2	76	1.4	-0.02	0.076	167	3600	46.44
160	2	81	1.6	0.02	0.081	178	3600	49.5
180	7	85	1.8	0.07	0.085	187	3600	51.94
200	12	87	2	0.12	0.087	191	3600	53.17
220	17	91	2.2	0.17	0.091	200	3600	55.61
240	21	92	2.4	0.21	0.092	202	3600	56.22
260	26	94	2.6	0.26	0.094	207	3600	57.44
270	29	96	2.7	0.29	0.096	211	3600	58.67
300	34	97	3	0.34	0.097	213	3600	59.28
320	37	98	3.2	0.37	0.098	216	3600	59.89
340	41	95	3.4	0.41	0.095	209	3600	58.06
360	44	94	3.6	0.44	0.094	207	3600	57.44
380	47	93	3.8	0.47	0.093	205	3600	56.83
400	50	92	4	0.5	0.092	202	3600	56.22
450	57	91	4.5	0.57	0.091	200	3600	55.61
500	63	90	5	0.63	0.09	198	3600	55
550	67	90	5.5	0.67	0.09	198	3600	55
600	72	90	6	0.72	0.09	198	3600	55
650	74	90	6.5	0.74	0.09	198	3600	55
700	75	90	7	0.75	0.09	198	3600	55
750	77	90	7.5	0.77	0.09	198	3600	55
800	80	90	8	0.8	0.09	198	3600	55
850	81	90	8.5	0.81	0.09	198	3600	55
900	83	90	9	0.83	0.09	198	3600	55
950	83	90	9.5	0.83	0.09	198	3600	55
1000	83	90	10	0.83	0.09	198	3600	55
1050	83	90	10.5	0.83	0.09	198	3600	55
1100	83	90	11	0.83	0.09	198	3600	55
1150	83	90	11.5	0.83	0.09	198	3600	55
1200	83	90	12	0.83	0.09	198	3600	55
1250	83	90	12.5	0.83	0.09	198	3600	55

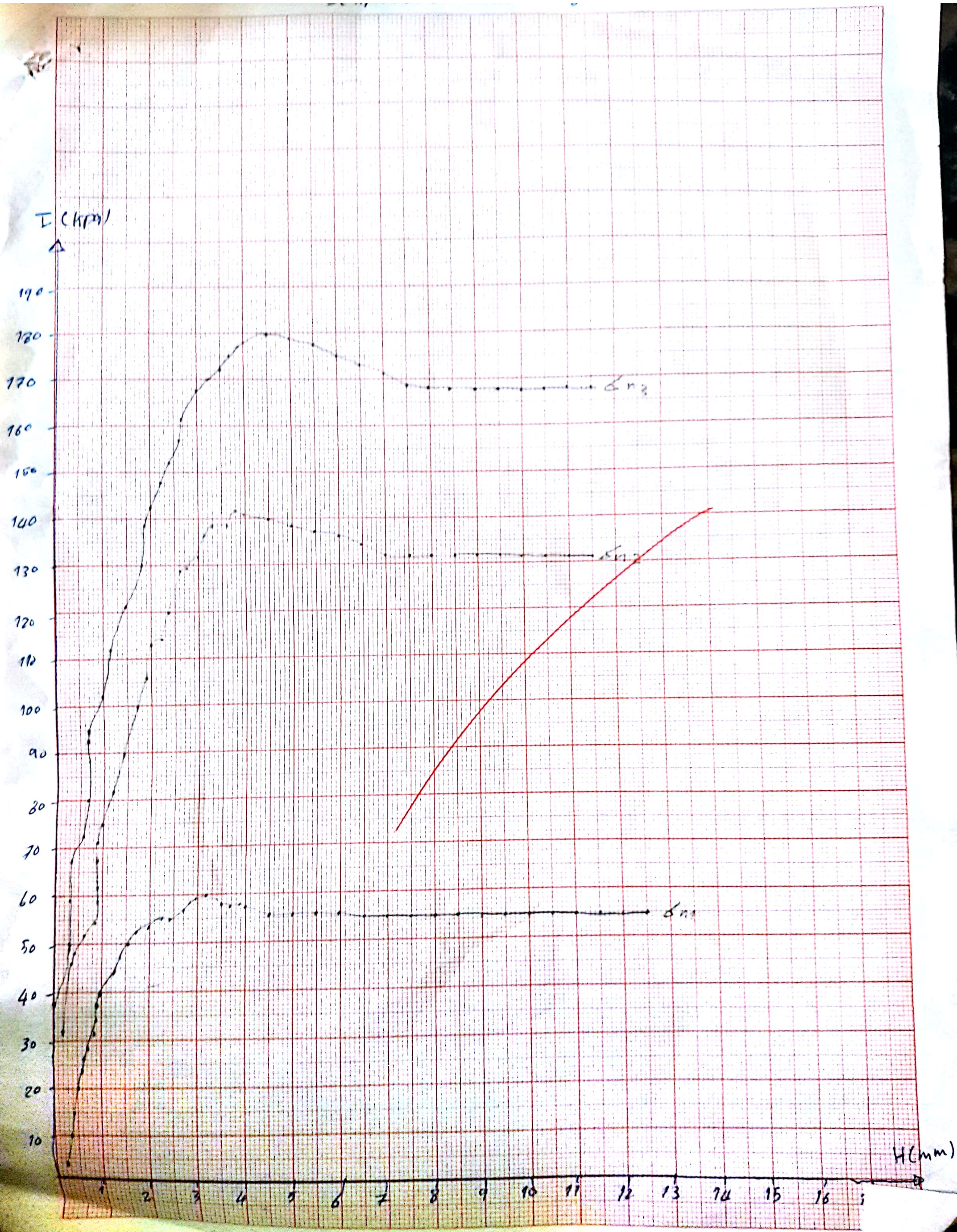
load=20 kg σn= 54.5 Kpa

H	V	T	H(.01)mm	V.01mm	T.001mm	T(N)	AC(mm)	τ(Kpa)
10	-9.5	53	0.1	-0.095	0.053	117	3600	32.39
20	-11.5	77	0.2	-0.115	0.077	169	3600	47.06
30	-11.5	78	0.3	-0.115	0.078	172	3600	47.67
40	-12.5	85	0.4	-0.125	0.085	187	3600	51.94
50	-11.5	89	0.5	-0.115	0.089	196	3600	54.39
60	-11.5	95	0.6	-0.115	0.095	209	3600	58.66
70	-10.5	101	0.7	-0.105	0.101	222	3600	61.72
80	-9.5	108	0.8	-0.095	0.108	238	3600	66
90	-7.5	115	0.9	-0.075	0.115	253	3600	70.28
100	-6.5	122	1	-0.065	0.122	262	3600	72.56
120	-2.5	135	1.2	-0.025	0.135	297	3600	82.5
140	1.5	147	1.4	0.015	0.147	323	3600	89.83
160	4.5	163	1.6	0.045	0.163	359	3600	99.01
180	10.5	172	1.8	0.105	0.172	378	3600	105.1
200	14.5	182	2	0.145	0.182	400	3600	111.2
220	18.5	185	2.2	0.185	0.185	407	3600	113.05
240	23.5	196	2.4	0.235	0.196	431	3600	119.78
260	29.5	210	2.6	0.295	0.21	462	3600	128.33
270	32.5	210	2.7	0.325	0.21	462	3600	128.33
300	35.5	216	3	0.355	0.216	475	3600	132
320	39.5	222	3.2	0.395	0.222	488	3600	135.67
340	42.5	224	3.4	0.425	0.224	493	3600	136.89
360	46.5	226	3.6	0.465	0.226	497	3600	138.12
380	49.5	233	3.8	0.495	0.233	513	3600	142.4
400	52.5	230	4	0.525	0.23	506	3600	140.56
450	59.5	228	4.5	0.595	0.228	502	3600	139.33
500	64.5	225	5	0.645	0.225	495	3600	137.5
550	69.5	222	5.5	0.695	0.222	488	3600	135.67
600	75.5	220	6	0.755	0.22	484	3600	134.44
650	78.5	218	6.5	0.785	0.218	480	3600	133.27
700	81.5	216	7	0.815	0.216	475	3600	132
750	82.5	216	7.5	0.825	0.216	475	3600	132
800	84.5	216	8	0.845	0.216	475	3600	132
850	86.5	216	8.5	0.865	0.216	475	3600	132
900	86.5	216	9	0.865	0.216	475	3600	132
950	86.5	216	9.5	0.865	0.216	475	3600	132
1000	86.5	216	10	0.865	0.216	475	3600	132
1050	86.5	216	10.5	0.865	0.216	475	3600	132
1100	86.5	216	11	0.865	0.216	475	3600	132
1150	85.5	216	11.5	0.855	0.216	475	3600	132

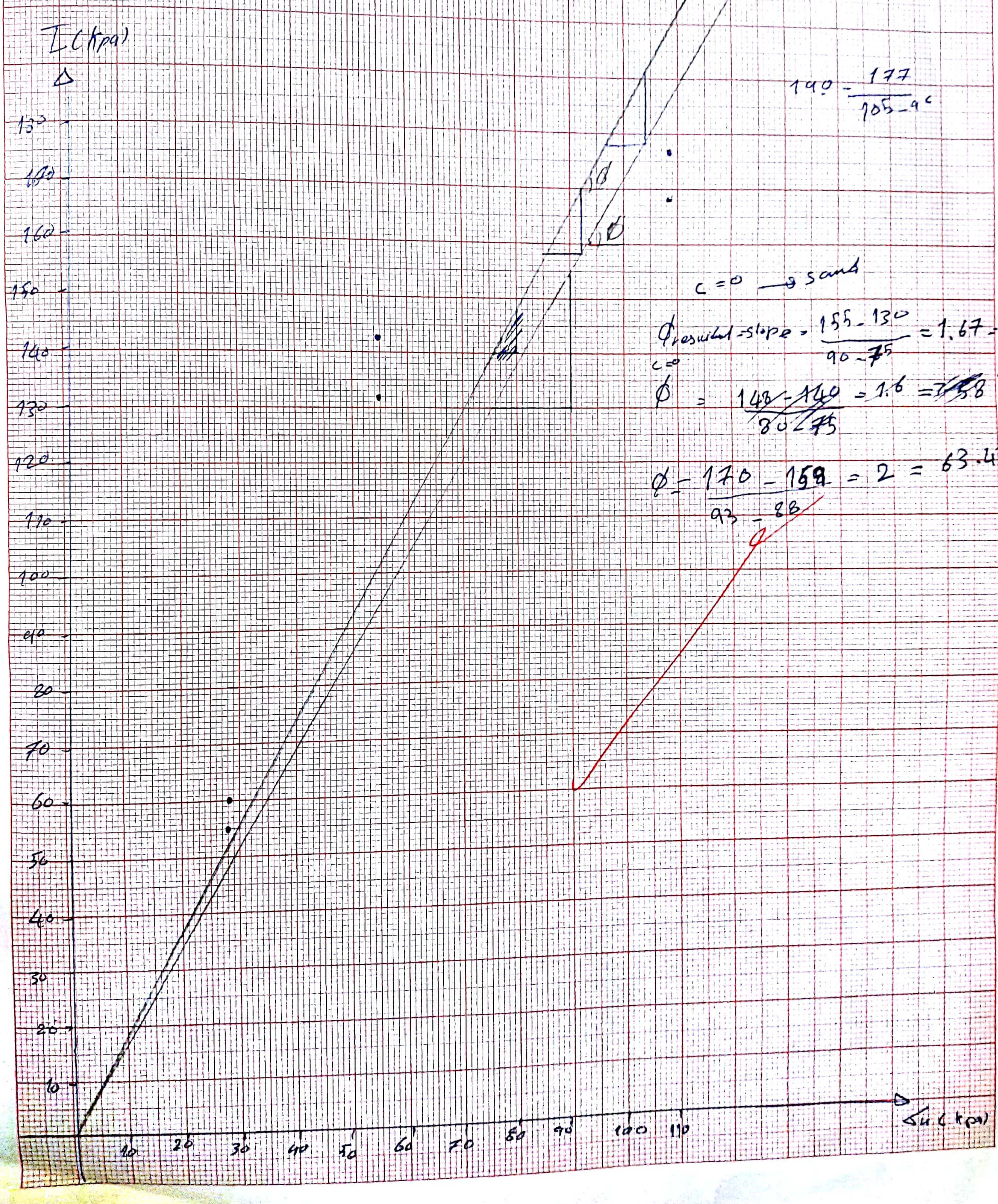
load=40 kg

σn= 109 Kpa

H	V	T	H(.01)mm	V.01mm	T.001mm	T(N)	AC(mm)	τ(Kpa)
10	-7	60	0.1	-0.07	0.06	132	3600	36.67
20	-8	77	0.2	-0.08	0.077	169	3600	47.06
30	-9	94	0.3	-0.09	0.094	207	3600	57.43
40	-9	108	0.4	-0.09	0.108	238	3600	66
50	-9	119	0.5	-0.09	0.119	262	3600	72.73
60	-9	132	0.6	-0.09	0.132	290	3600	80.66
70	-9	143	0.7	-0.09	0.143	315	3600	87.38
80	-9	151	0.8	-0.09	0.151	332	3600	92.28
90	-8	158	0.9	-0.08	0.158	348	3600	96.55
100	-7	167	1	-0.07	0.167	367	3600	102.06
120	-5	182	1.2	-0.05	0.182	406	3600	111.23
140	-2	199	1.4	-0.02	0.199	438	3600	121.6
160	2	212	1.6	0.02	0.212	466	3600	129.56
180	6	224	1.8	0.06	0.224	493	3600	136.89
200	11	234	2	0.11	0.234	515	3600	143
220	15	243	2.2	0.15	0.243	535	3600	148.5
240	-5	248	2.4	-0.05	0.248	546	3600	151.55
260	23	257	2.6	0.23	0.257	565	3600	157.06
270	27	264	2.7	0.27	0.264	581	3600	161.33
300	30	272	3	0.3	0.272	598	3600	166.21
320	34	277	3.2	0.34	0.277	609	3600	169.28
340	39	281	3.4	0.39	0.281	618	3600	171.72
360	42	285	3.6	0.42	0.285	627	3600	174.17
380	45	286	3.8	0.45	0.286	629	3600	174.78
400	49	288	4	0.49	0.288	634	3600	176
450	54	290	4.5	0.54	0.29	638	3600	177.22
500	58	288	5	0.58	0.288	634	3600	176
550	68	285	5.5	0.68	0.285	627	3600	174.17
600	66	283	6	0.66	0.283	623	3600	172.93
650	65	280	6.5	0.65	0.28	616	3600	171.1
700	65	277	7	0.65	0.277	609	3600	169.25
750	66	275	7.5	0.66	0.275	605	3600	168.06
800	66	275	8	0.66	0.275	605	3600	168.06
850	66	275	8.5	0.66	0.275	605	3600	168.06
900	68	275	9	0.68	0.275	605	3600	168.06
950	68	275	9.5	0.68	0.275	605	3600	168.06
1000	68	275	10	0.68	0.275	605	3600	168.06
1050	60	275	10.5	0.6	0.275	605	3600	168.06
1100	58	275	11	0.58	0.275	605	3600	168.06
1150	57	275	11.5	0.57	0.275	605	3600	168.06



I (kPM)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
H(mm)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16



$\frac{190 - 177}{105 - 90}$

$c = 0 \longrightarrow$ sand

$\phi_{residual} = \text{slope} = \frac{155 - 130}{90 - 75} = 1.67 = 59.1^\circ$

$c = 0$

$\phi = \frac{148 - 140}{80 - 75} = 1.6 = 57.8^\circ$

$\phi = \frac{170 - 159}{93 - 88} = 2 = 63.43$