Experiment No:

Experiment Name: Consolidation Test

Purpose: This test is performed to determine the magnitude and rate of volume decrease that a laterally confined soil specimen undergoes when subjected to different vertical pressures. From the measured data, the consolidation curve (pressure-void ratio relationship) can be plotted. This data is useful in determining the compression index, the recompression index and the precon-sollidation. pressure (or maximum past pressure) of the soil. In addition, the data obtained can also be used to determine the coefficient of consolidation and the coefficient of secondary compression of the soil.

Standard reference:

ASTM D 2435 - Standard Test Method for One-Dimensional Consolidation Properties of soil.

Significance:

The consolidation properties determind from the consolidation test are used to estimate the magnitude and the rate of both primary and secondary consolidation settlement of a structure or an earthfill. Estimates of this type are of key importance in the design of engineered structures and the evaluation of their performance.

Equipment:

1. Consolidation device
2. Dial gauge
3. Sample trimming device.
4. Glass plate.
5. Metal straight edge
6. Clock
7. Moisture can
8. Filter paper

Procedure:

(i) Empty mass of the ring was determined

(ii) Diameter and height of the ring in the consolidometer was measured.

(iii) The ring was then entered into the soil specimen straightly

(iv) The exceed soil specimen in the ring was cut down with the help of triming device.

(v) Then the top surface of the specimen in the ring was levelled with the straight edge.

vi) Then the mass of ring with the soil was measured

vii) After that the ring with the specimen was placed into the consolidometer.

viii) The whole assembly was sinked into the water

ix) Then incremental load $\frac{1}{2}$, 1, 2, 4, 8 kg were applied each for 24 hours

x) After the loading action was completed, the unloading action was done in descending order

xi) Then the mass of the ring and dry soil was taken

xii) After that, the specific gravity of the soil was determined.

Data sheets:

Data tested:

Tested by: Civil-18 series, Sec-C (1st 30 group)

Project Name: CE-3234 lab

Sample Number: Left side test sample of the machine

Visual Classification: Gray silty clay.

Before test:

Consolidation type = Floating type

Mass of the ring + glass plate = 58.84 g

Inside diameter of the ring = 5.05 cm

Height of the specimen, H_i = 1.98 cm

Area of the specimen, A = 20.03 cm^2

Mass of specimen + ring = 134.45 g

Initial moisture content of specimen (w_i (%)) = 31.42%

specific gravity of solids, G_s = 2.67

After test:

Mass of wet sample + ring = 130g

Mass of wet sample + ring (after dry) = 118g

Mass of ring = 58.84

Mass of dry speimen, M_s = 59.16g

Final moisture content of specimen, W_f = 20.28%

Calculation:

Mass of solids in specimen, M_s = 59.16g

Mass of water in specimen before test, $M_{wi} = w_i \times M_s$

$= 0.3142 \times 59.16$

$= 18.59$ g

Mass of water in specimen after test, $M_{wf} = W_f \times M_s$

$= 0.2028 \times 59.16$

$= 12$g

Height of solids, $H_s = \frac{M_s}{A \times G_s \times \rho_w} = 1.11$cm

Height of water before test, $H_{wi} = \frac{M_{wi}}{A \times \rho_w} = 0.93$cm

Height of water after test, $H_{wf} = \frac{M_{wf}}{A \times \rho_w} = \frac{12}{20.03}$

$= 0.6$ cm

Change in height of specimen after test $\Sigma \Delta H = 0.33$ cm

($\Sigma \Delta H$ for all pressures - see t vs Dial reading plots)

Height of specimen after test, $H_f = H_i - \Sigma \Delta H$

$= 1.98 - 0.33 = 1.65$ cm

Void ratio before test, $e_0 = \frac{H_i - H_s}{H_s} = \frac{1.98 - 1.11}{1.11}$

$= 0.74$

Void ratio after test, $e_f = \frac{H_f - H_s}{H_s} = \frac{1.65 - 1.11}{1.11} = 0.45$

Degree of saturation before test $= \frac{H_{wi}}{H_i - H_s} = \frac{0.93}{1.98 - 1.11}$

$= 1.0689$

$= 106.89\%$

Degree of saturation after test, $S_f = \frac{H_{wf}}{H_f - H_s} = \frac{0.6}{1.65 - 1.11}$

$= 1.111$

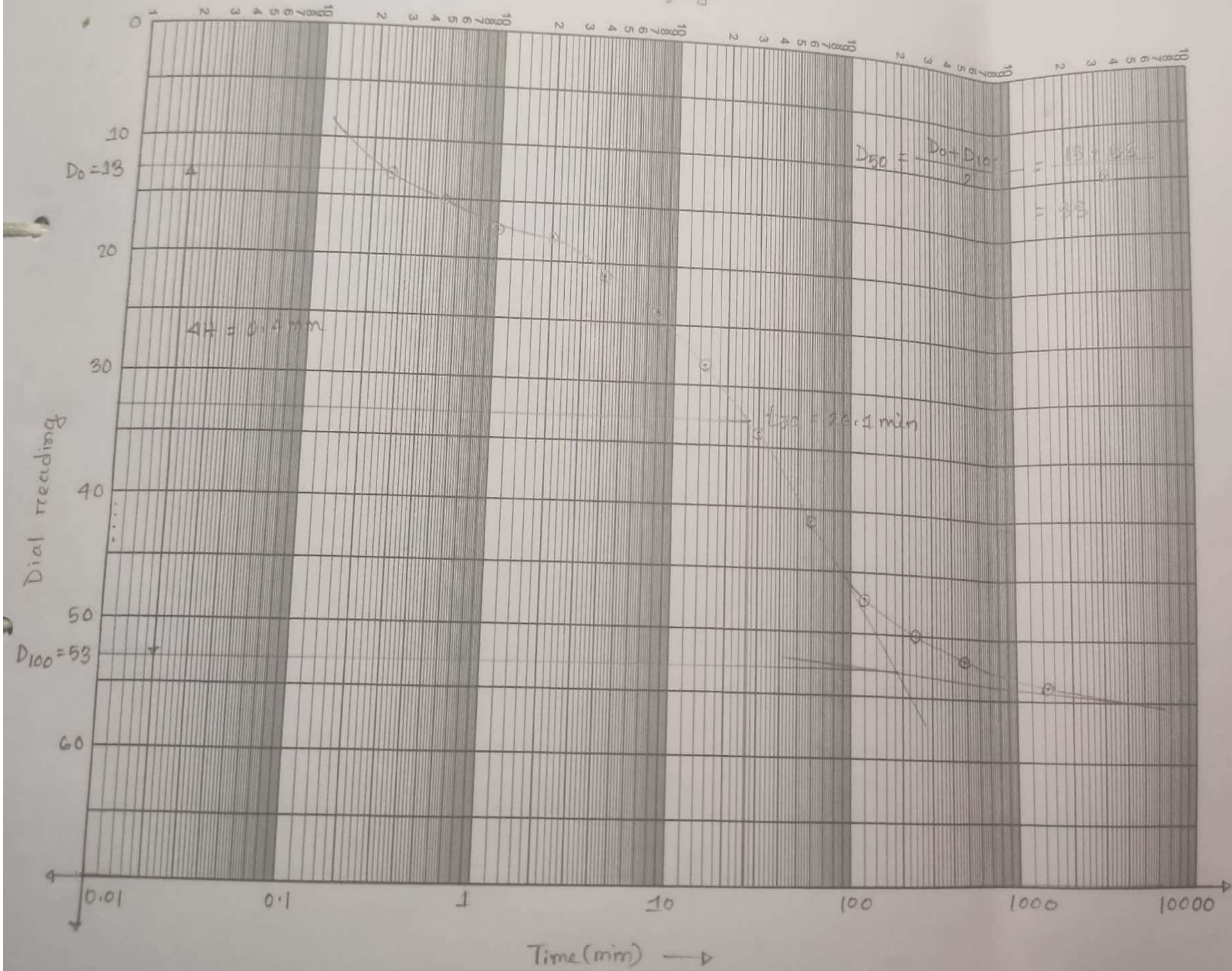
$= 111.11\%$

Dry density before test, $\rho_d = \frac{M_s}{H_i \times A} = \frac{59.16}{1.98 \times 20.03}$

$= 1.49$ g/cm3

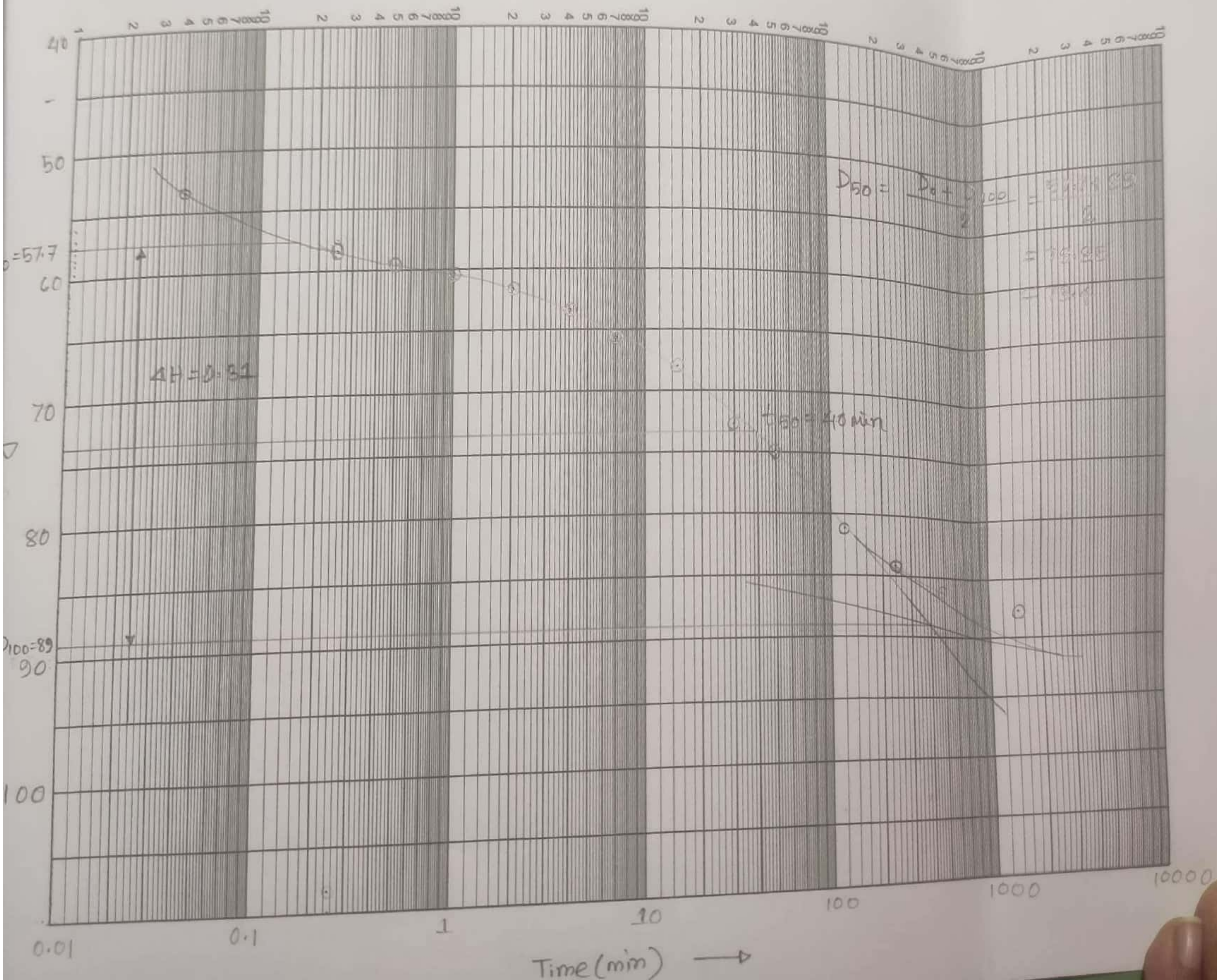
Time	Dial Gauge Reading								
Theoretical time	Load						Unload		
	½ kg	1kg	2kg	4kg	6kg	8g	6kg	4kg	2kg
0 min	0	53.5	87.5	135.5	198	241	285.8	284.9	280.0
1/4 min	13.5	58.5	98.5	148.5	202	244	285.7	284.5	279.8
1/2 min	15	59.5	100	150.5	203	245	285.6	284.2	279.6
1 min	16.5	60.3	101	153	203.5	246.5	285.6	283.8	278.5
2 min	18.5	61.6	103.5	156	204.5	249	285.5	283.8	278.2
4 min	21	63.1	105	159	206	252	285.5	283	277.9
8 min	24	65.5	108	163.5	207.5	257	285.1	282.4	277.3
15 min	28	68.3	112	169.5	210.1	263	285.1	282.1	277.1
30 min	34	72.5	117.5	177.3	214	272	285.1	282	276.7
1 hr	41	75.0	124.5	185.5	218.5	277.4	285	281.9	275.9
2 hr	47	81	128.5	191	222	282	284.9	281.8	275.4
4 hr	50	84.1	131	194	225	284.5	284.9	281.4	275.0
8 hr	52	86	133.5	195	226.5	285.5	284.9	281.3	
16 hr	–	–	–	–					
24 hr	53.5	87.5	135.5	198	241	287.8	284.9	281.0	274.2

Load = ½ kg

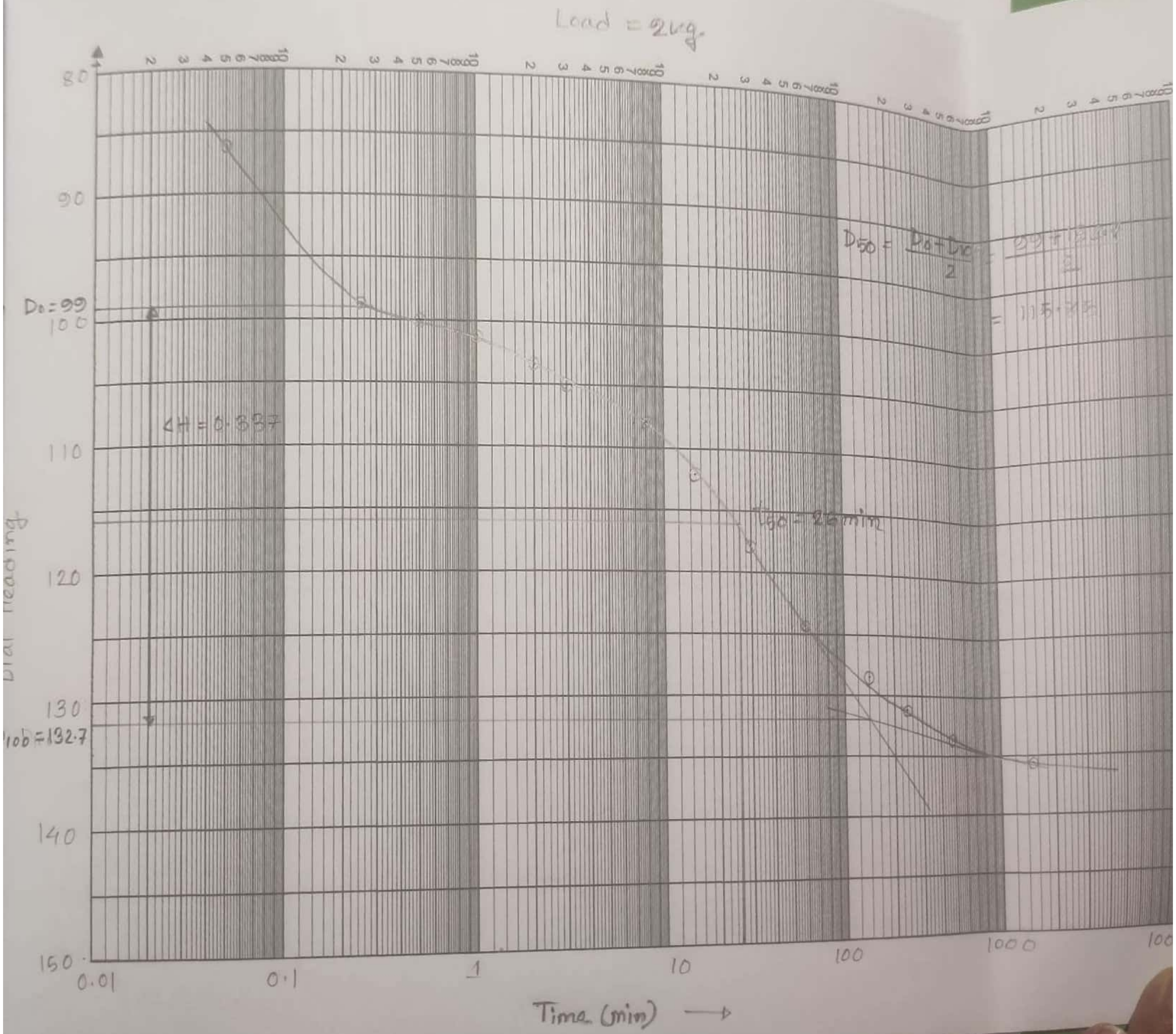


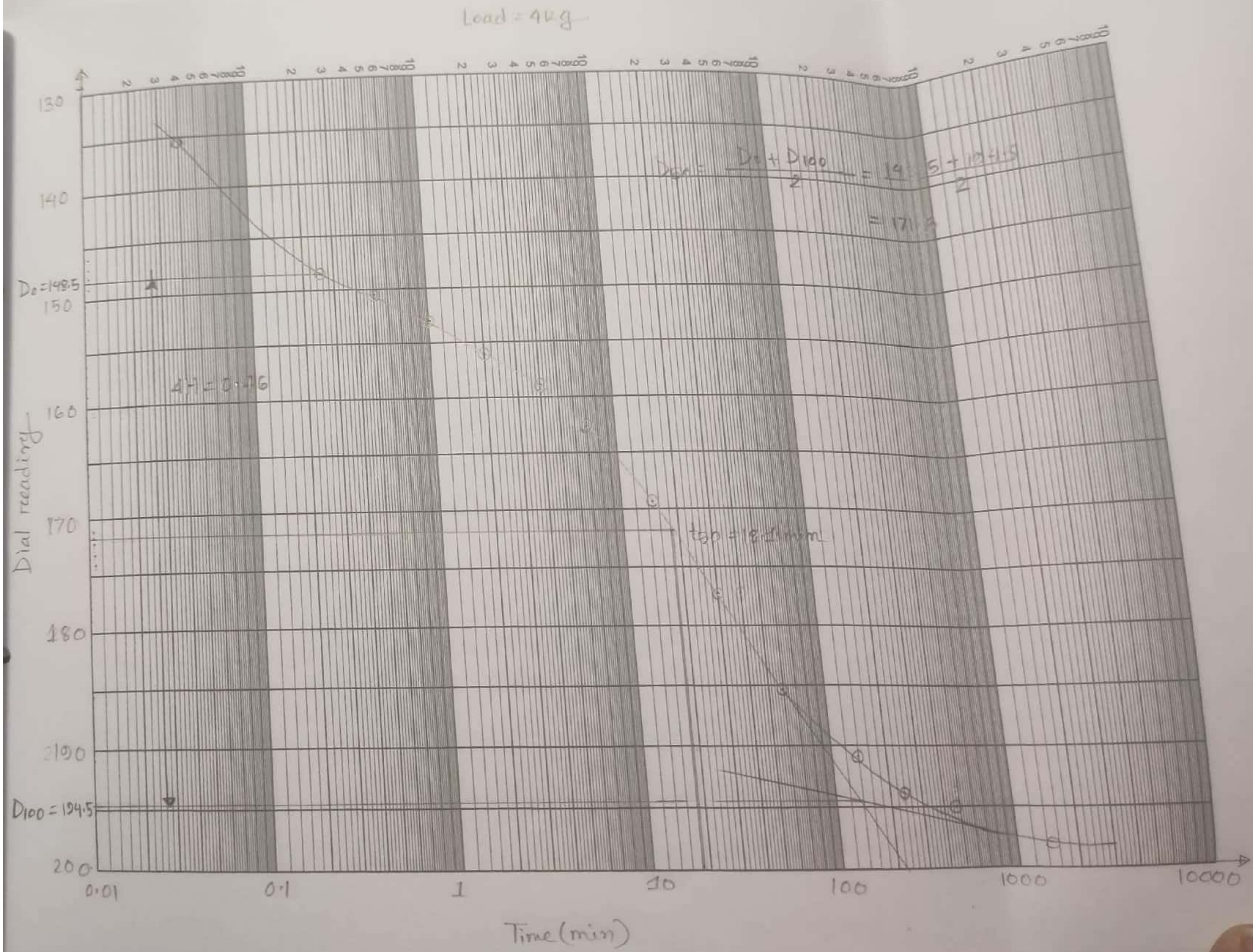
D₀ = 13
D₁₀₀ = 53
ΔH = 0.4 mm
t₅₀ = 26.1 min
D₅₀ = (D₀ + D₁₀₀) / 2
0
10
20
30
40
50
60
Dial reading
0.01
0.1
1
10
100
1000
10000
Time (min)

Load = 1 kg



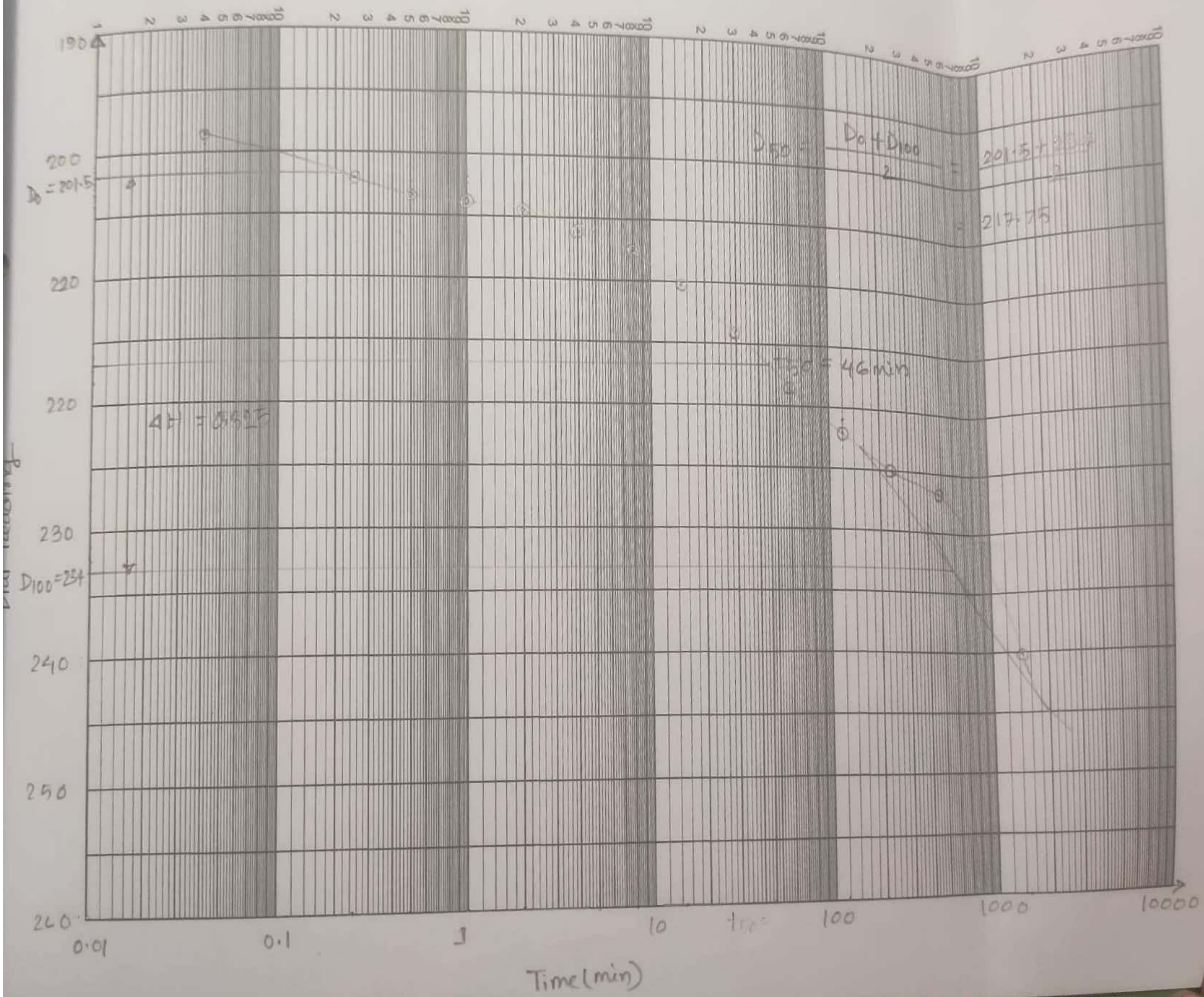
D50 = (D0 + D100)/2
t50 = 40 min
ΔH = 0.31
=57.7
D100=89
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000
10000
Time (min)


Load = 2kg.
D₀ = 99
D_{100} = 132.7
ΔH = 0.337
t_{50} = 28 min
$D_{50} = \frac{D_0 + D_{100}}{2}$
Dial Reading
Time (min)
80
90
100
110
120
130
140
150
0.01
0.1
1
10
100
1000



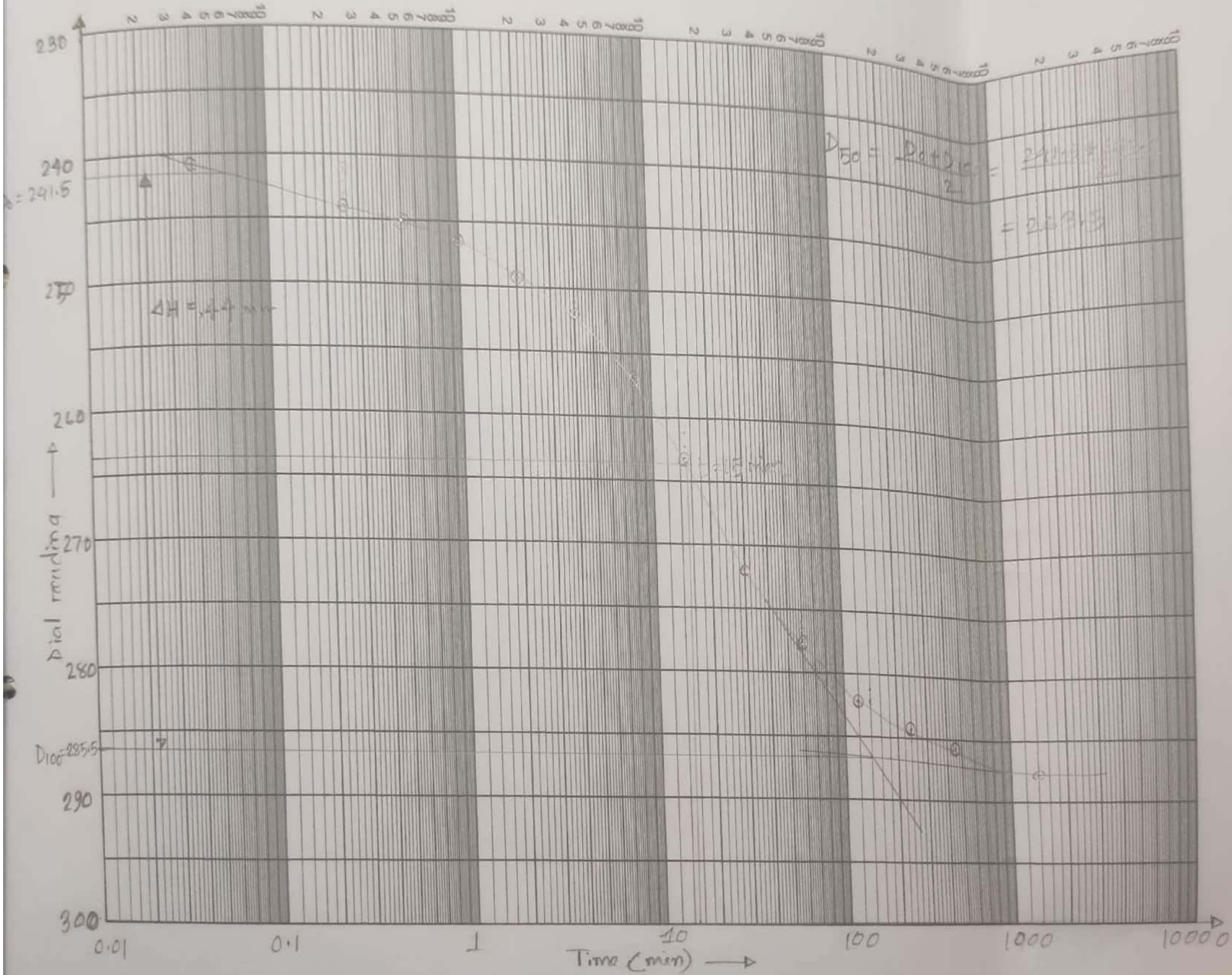
Load = 4kg
Dial reading
Time (min)
$D_0 = 148.5$
$D_{100} = 194.5$
$D_{50} = \frac{D_0 + D_{100}}{2}$
= 171.5
$t_{50} = 18$ min
0.01
0.1
1
10
100
1000
10000
130
140
150
160
170
180
190
200

Load = 6kg

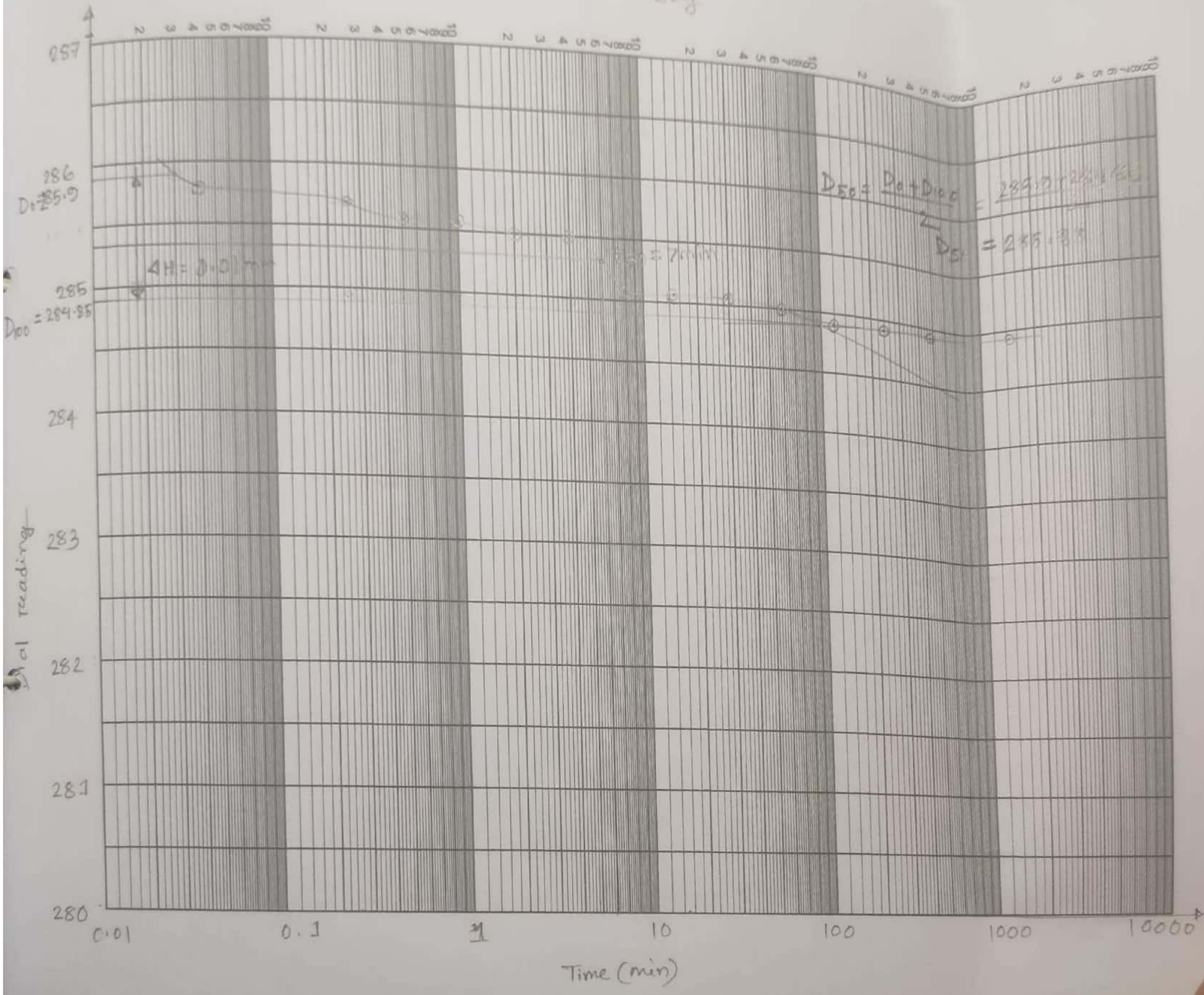


190
200
D_0 = 201.5
220
230
D_{100} = 234
240
250
260
D_{50} = $\frac{D_0 + D_{100}}{2}$ = 201.5 +
217.75
T_{50} = 46min
ΔH =
0.01
0.1
1
10
100
1000
10000
Time(min)

load = 8g

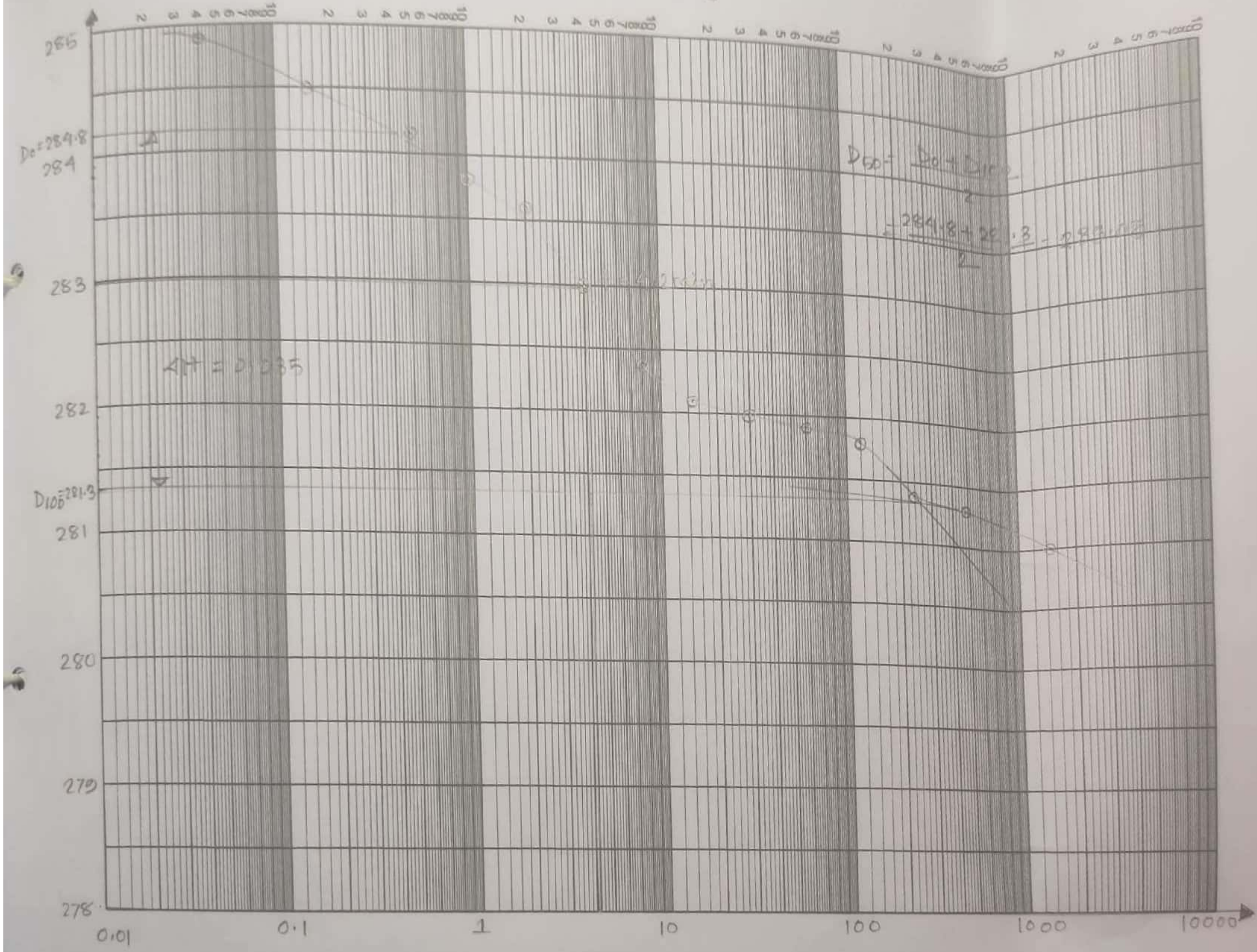

230
240
260
270
280
290
300
Dial reading
D_0 = 241.5
D_{100} = 285.5
ΔH = .44 mm
$D_{50} = \frac{D_0 + D_{100}}{2}$
0.01
0.1
1
10
100
1000
10000
Time (min)

Unload = 6kg

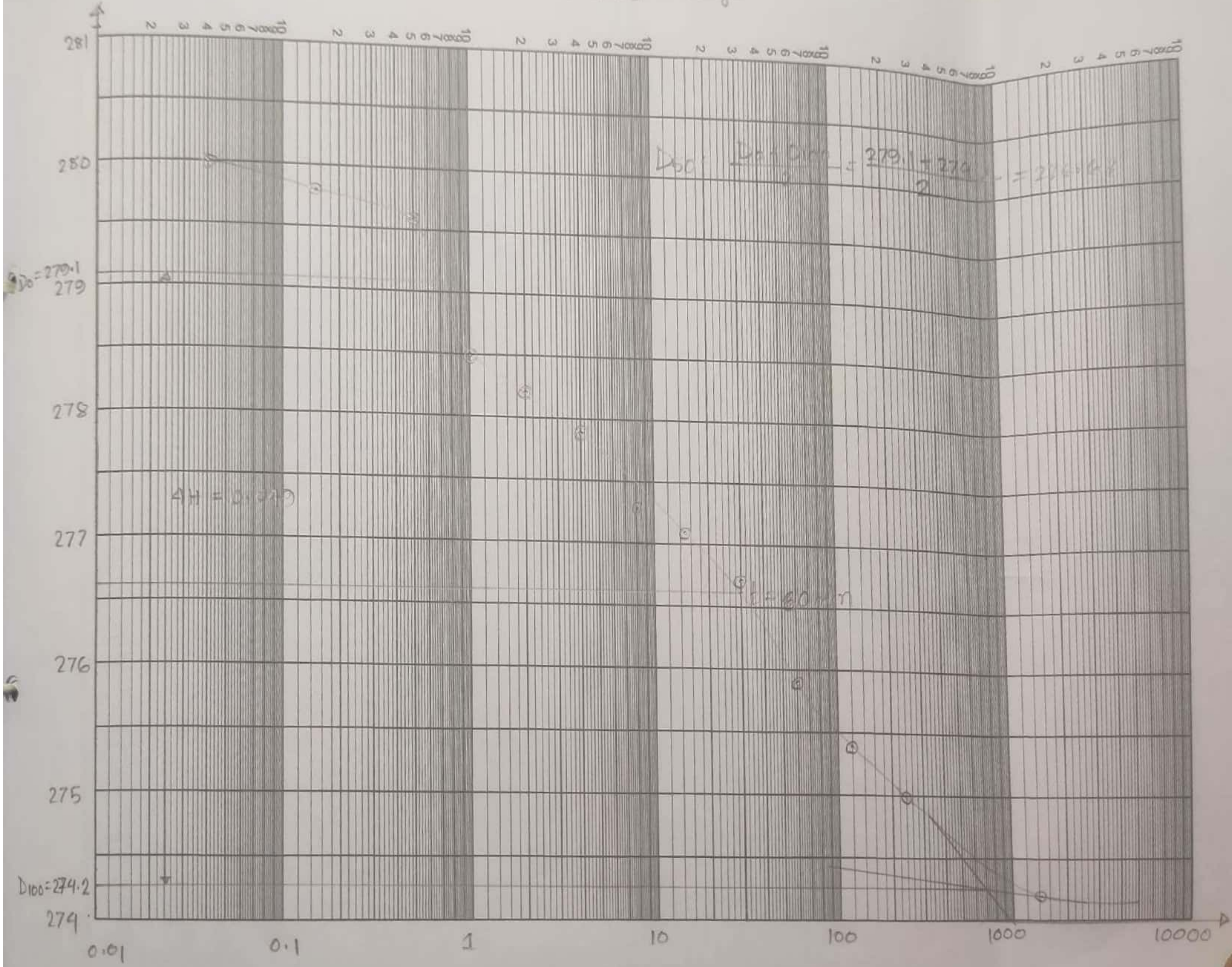


D0 = 285.9
D100 = 284.85
ΔH = 0.01
D50 = (D0 + D100) / 2
286
285
284
283
282
281
280
0.01
0.1
1
10
100
1000
10000
Dial reading
Time (min)

unload - 4kg


285
D_0=284.8
284
283
282
D_{100}=281.3
281
280
279
278
0.01
0.1
1
10
100
1000
10000

Unload = 2kg



281
280
279
278
277
276
275
274
D_0 = 279.1
D_{100} = 274.2
D_{50} = $\frac{D_0 + D_{100}}{2}$ = $\frac{279.1 + 274.2}{2}$
0.01
0.1
1
10
100
1000
10000

Analysis of Consolidation Test data :

Pressure (tsf)	Time for 50% consolidation t_{50} (min)	D_0 (from graph)	D_{100} (from graph)	$D_{50} = (D_0+D_{100}) * 0.5$	$H_j = D_{50} * 0.01$	ΔH (from graph)	$\Sigma\Delta H$	H	H_d	Coefficient of Consolidation C_v (mm^2/min)	H_v	e
0	26.1							19.8				
0.5	26.1	13	53	33	0.33	0.4	0.4	19.4	9.7825	0.7223	8.3	0.75
1	40	57.7	89	73.4	0.73	0.31	0.71	19.09	9.7275	0.4660	7.99	0.72
2	26	99	132.7	115.85	1.1585	0.337	1.05	18.75	9.6646	0.7077	7.65	0.69
4	18.1	148.5	194.5	171.5	1.715	0.46	1.51	18.29	9.5737	0.9976	7.19	0.65
6	46	201.5	234	217.75	2.1775	0.325	1.83	17.97	9.5293	0.3888	6.87	0.62
8	15	241.5	285.5	263.5	2.635	0.44	2.27	17.53	9.4237	1.1663	6.43	0.58
6	7	285.9	284.85	285.38	2.8538	0.01	2.28	17.54	9.4834	2.53[illegible]	6.42	0.58
4	4.2	284.8	281.3	283.05	2.8305	0.035	2.32	17.575 ~~17.48~~	9.4951 ~~9.4476~~	4.2288 ~~4.4865~~	6.38	0.57
2	30	279.1	274.2	276.67	2.7667	0.049	2.37	17.624 ~~17.43~~	9.5096	0.5931 ~~0.5840~~	6.33	0.57

$H = H_i \pm \Delta H$ [(+) for unloading, (−) for loading] ; $H_d = H/2 + H_j/4$,

$C_v = 0.197 \times H_d^2 / t_{50}$, $H_v = (H_i - H_s) - \Sigma\Delta H$ & $e = \frac{H_v}{H_s}$

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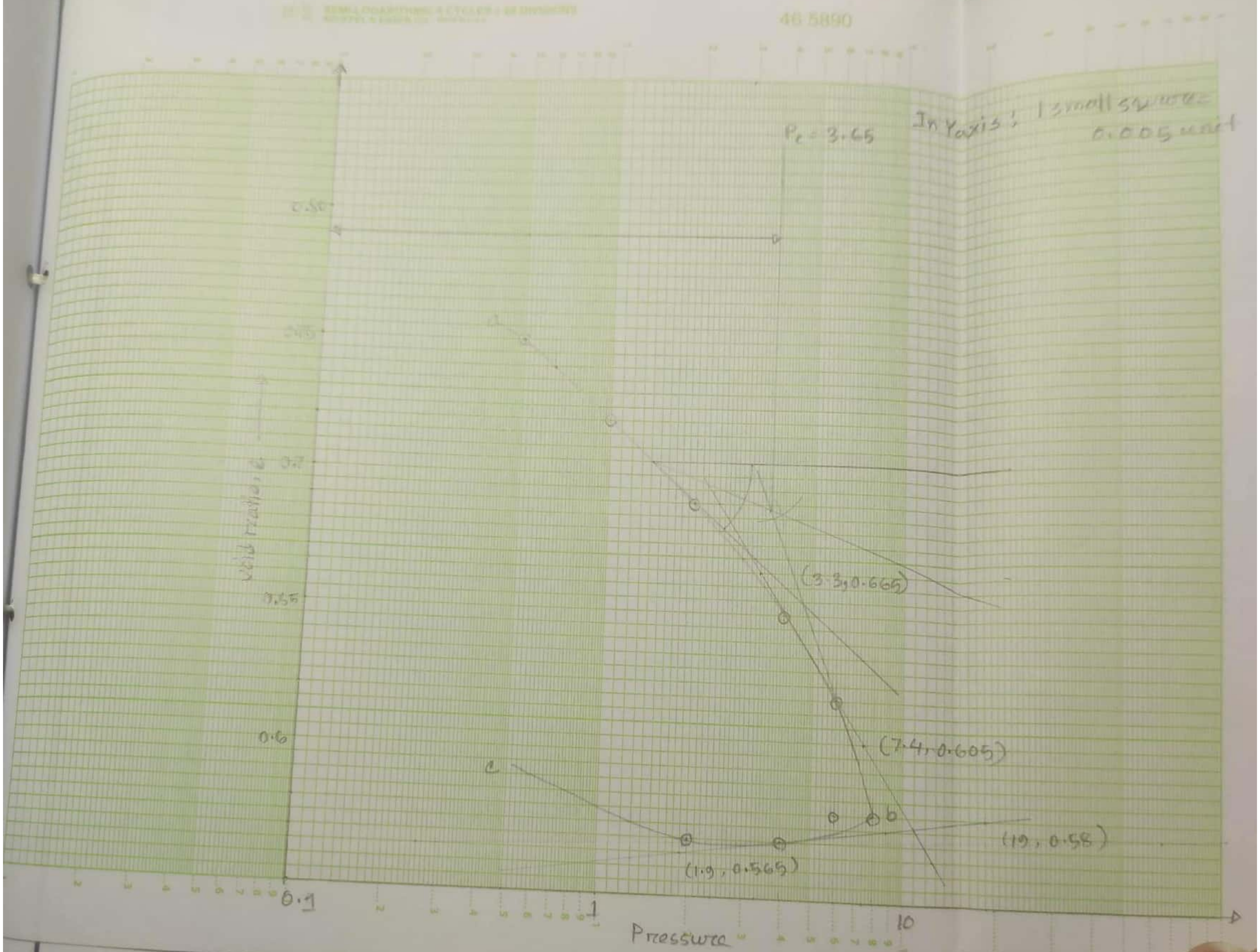

Calculation from graph:

Compression index, C_c = slope of ab curve

$$C_c = \frac{0.665 - 0.605}{\log_{10}\left(\frac{7.4}{3.3}\right)} = 0.17$$

Swelling index, C_s = slope of bc curve

$$C_s = \frac{0.58 - 0.565}{\log_{10}\left(\frac{19}{1.9}\right)} = 0.015$$

Result:

Compression index (C_c) = 0.17

Swelling index (C_s) = 0.015

Preconsolidation Pressure, P_c =

Discussion: