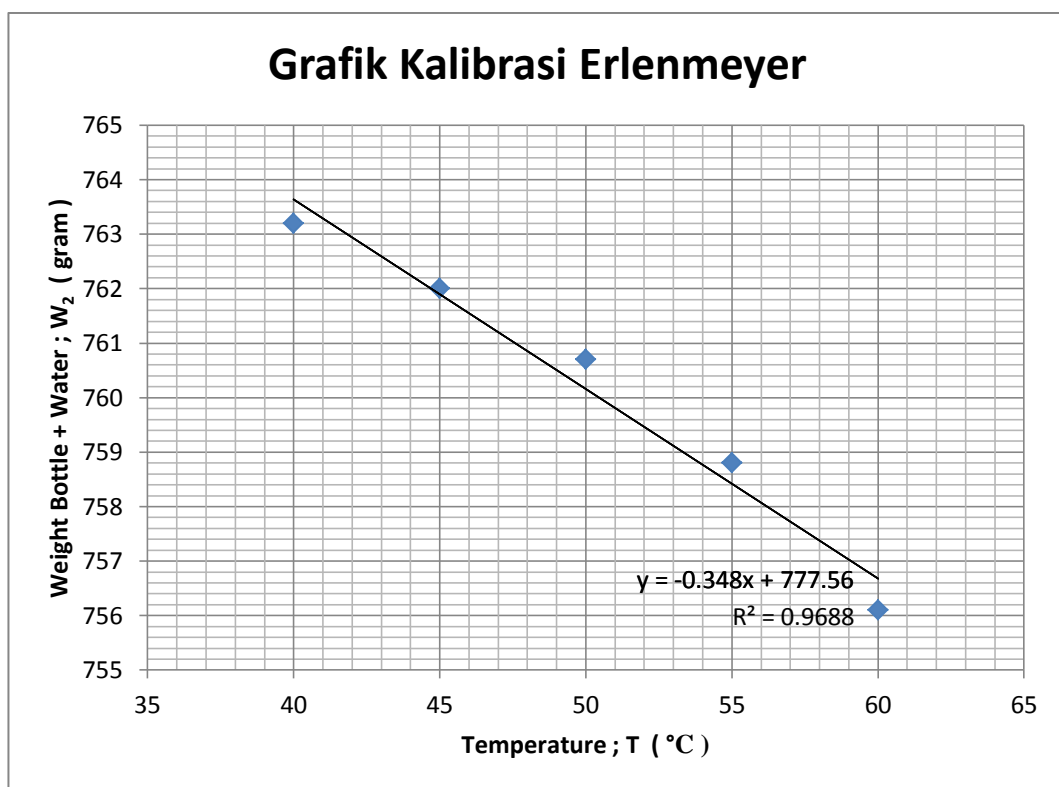


LAMPIRAN

Lampiran 1 Pengujian *Specific Gravity*

Tabel L1.1 Data kalibrasi erlenmeyer

Determination No.	1	2	3	4	5
Wt. Bottle + Water ; W_2 (gr)	756.10	758.80	760.70	762.00	763.20
Temperatur ; T (°C)	60	55	50	45	40



Gambar L1.1 Grafik kalibrasi erlenmeyer

Tabel L1.2 Data pengujian *specific gravity*

Determination No.	1	2	3	4	5
Wt. Bottle + Water + Soil ; W_1 (gr)	797.70	800.20	801.70	802.80	805.00
Temperatur ; T (°C)	60	55	50	45	40
Wt. Bottle + Water ; W_2 (gr)	756.10	758.80	760.70	762.00	763.20
Spec. Grav. of Water at T °C ; G_T	0.9832	0.9857	0.9881	0.9902	0.9922
Spec. Grav. of Soil at T °C ; G_S	2.72	2.71	2.67	2.65	2.77

Berat cawan (W₃) = 214.70 gr

Berat cawan + tanah kering (W₄) = 279.80 gr

Berat tanah kering (W₅) = 65.10 gr

$$\text{Average Value of } G_s = \frac{2.72 + 2.71 + 2.67 + 2.65 + 2.77}{5} = 2.71$$

Tabel L1.3 Specific gravity of water

°C	0	1	2	3	4	5	6	7	8	9
0	0.9999	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9999	0.9999
10	0.9997	0.9996	0.9995	0.9994	0.9993	0.9991	0.9990	0.9988	0.9986	0.9984
20	0.9982	0.9980	0.9978	0.9976	0.9973	0.9971	0.9968	0.9965	0.9963	0.9960
30	0.9957	0.9954	0.9951	0.9947	0.9944	0.9941	0.9937	0.9934	0.9930	0.9926
40	0.9922	0.9919	0.9915	0.9911	0.9907	0.9902	0.9898	0.9894	0.9890	0.9885
50	0.9881	0.9876	0.9872	0.9867	0.9862	0.9857	0.9852	0.9848	0.9842	0.9838
60	0.9832	0.9827	0.9822	0.9817	0.9811	0.9806	0.9800	0.9795	0.9789	0.9784
70	0.9778	0.9772	0.9767	0.9761	0.9755	0.9749	0.9743	0.9737	0.9731	0.9724
80	0.9718	0.9712	0.9606	0.9699	0.9693	0.9686	0.9680	0.9673	0.9667	0.9660
90	0.9653	0.9647	0.9640	0.9633	0.9626	0.9619	0.9612	0.9605	0.9598	0.9591

Tabel L1.4 G_s value of some soil

Type of Soil	G _s
Quartz sand	2.64 – 2.66
Silt	2.67 – 2.73
Clay	2.7 – 2.9
Chalk	2.6 – 2.75
Loses	2.65 – 2.73
Peat	1.3 – 1.9

Sumber: Das, M. Braja, 1985

Foto-foto alat dan proses pengujian



Gambar L1.2 Erlenmeyer



Gambar L1.3 Timbangan



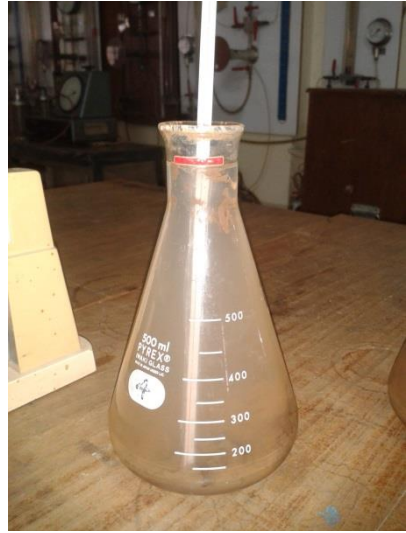
Gambar L1.4 Piringan pengaduk



Gambar L1.5 Oven



Gambar L1.6 Thermometer



**Gambar L1.7 Pengujian
*Specific Gravity***

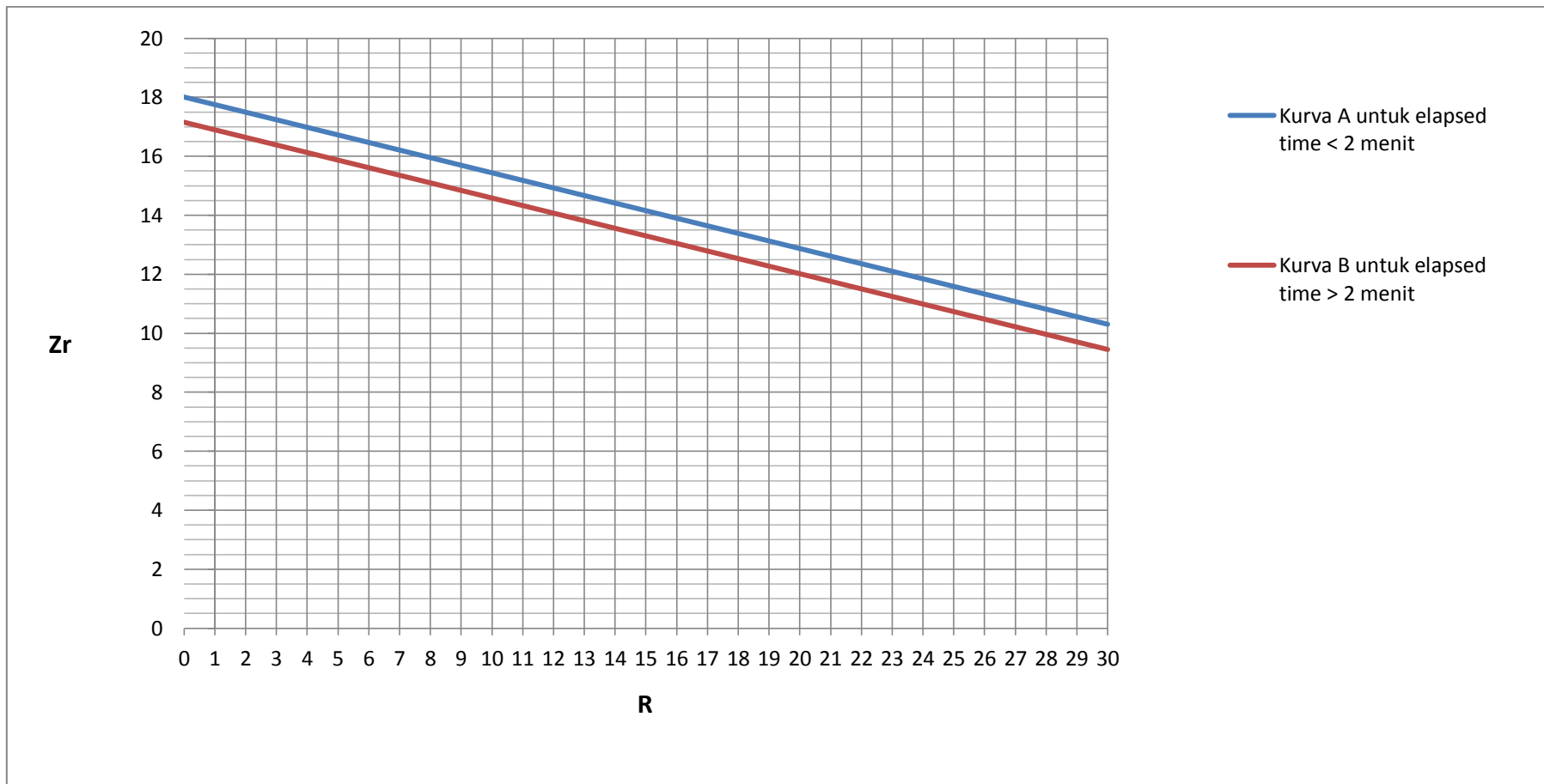
Lampiran 2 Pengujian *Hydrometer Analysis*

Data

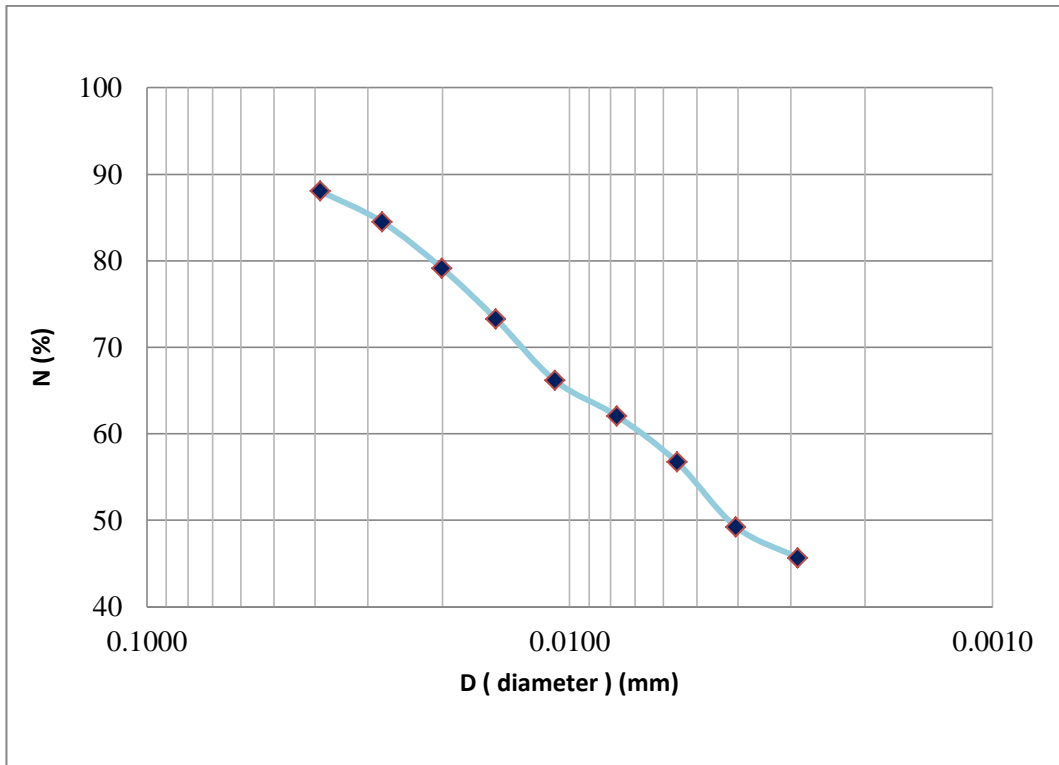
<i>Type of hydrometer used</i>	= 151H-3	<i>Correction menicus</i>	= 0.025
<i>Weight of soil</i>	= 44.5 gr	γ_c	= 1 gr/cm ³
<i>Specific gravity of soil</i> (G_s)	= 2.71	Volume	= 1000 ml
<i>Specific gravity of water</i> (G_t)	= 0.9976	Koreksi dispersen	= 2

Tabel L2.1 Data pengujian analisis hidrometer

Elapsed time ; t (detik)	R _h '	R _w	T (°C)	R _h	C _t (°C)	Coor. R	N (%)	Z _r (cm)	k	D (mm)
120	23.0	3.0	23.0	23.025	0.70	24.725	88.054	10.800	0.01297	0.0389
240	22.0	3.0	23.0	22.025	0.70	23.725	84.493	11.000	0.01297	0.0278
480	21.5	2.0	23.0	21.525	0.70	22.225	79.151	11.500	0.01297	0.0201
900	20.0	2.0	22.5	20.025	0.55	20.575	73.275	11.800	0.01305	0.0149
1800	18.0	2.0	22.5	18.025	0.55	18.575	66.152	12.400	0.01305	0.0108
3600	17.0	2.0	22.0	17.025	0.40	17.425	62.056	12.500	0.01312	0.0077
7200	15.5	2.0	22.0	15.525	0.40	15.925	56.714	13.000	0.01312	0.0056
14400	14.5	1.0	21.5	14.525	0.30	13.825	49.235	13.500	0.01320	0.0040
28800	13.5	1.0	21.5	13.525	0.30	12.825	45.674	13.750	0.01320	0.0029



Gambar L2.1 Grafik hubungan antara R vs Z_r



Gambar L2.2 Grafik hubungan antara diameter (D) dan N

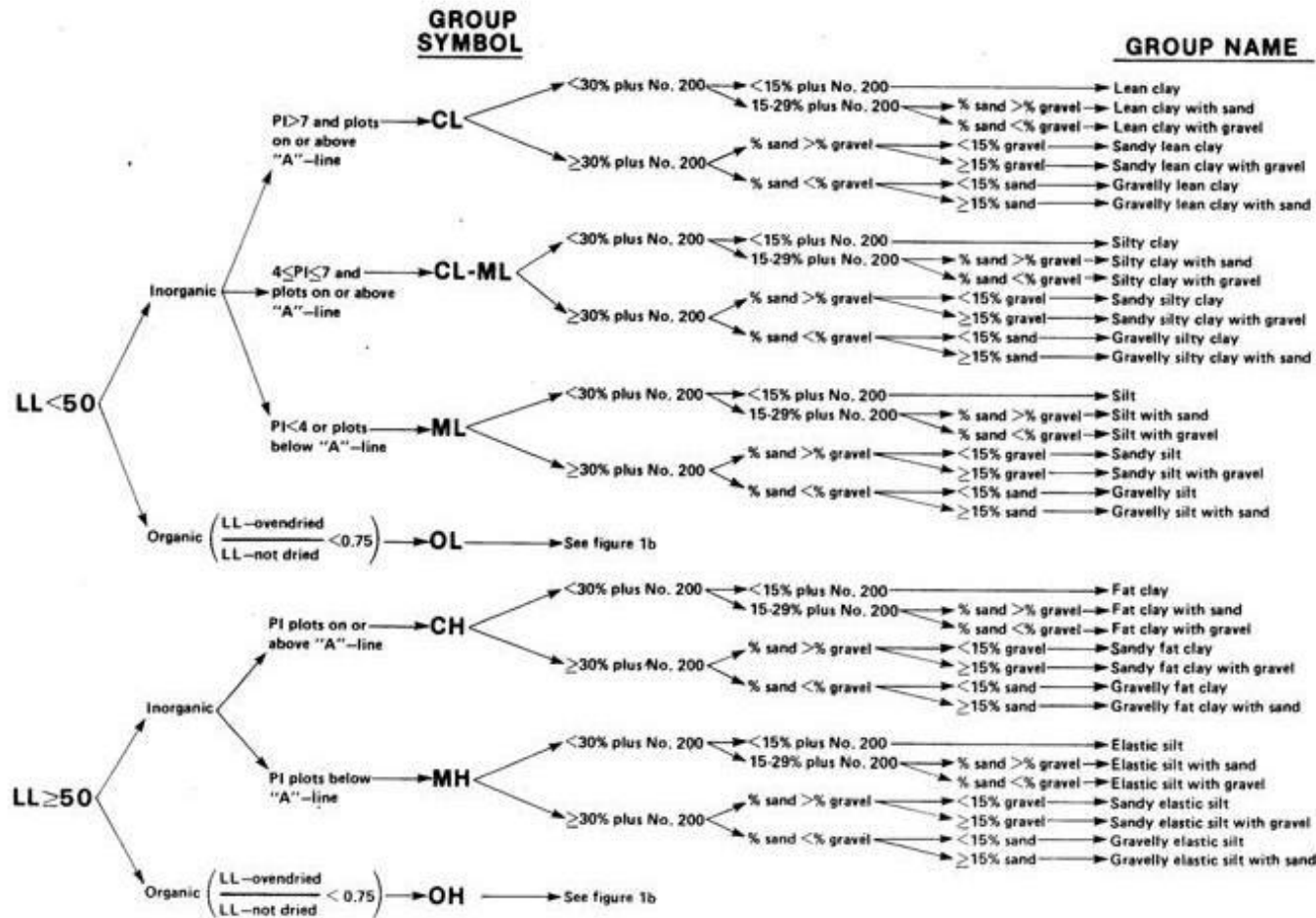
Tabel L2.2 Harga-harga faktor koreksi suhu

Suhu (°C)	C_t	Suhu (°C)	C_t
15	-1.10	24	+1.00
17	-0.90	25	+1.30
18	-0.70	26	+1.66
19	-0.50	27	+2.00
20	0.00	28	+2.50
21	+0.20	29	+3.50
22	+0.40	30	+3.80
23	+0,70		

Sumber: G. Djatmiko Soedarmo dkk, 1977:79

Tabel L2.3 Koreksi K

<i>Temperature</i> (°C)	<i>Specific Gravity of Soil Particles</i>								
	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	0.01427	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	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



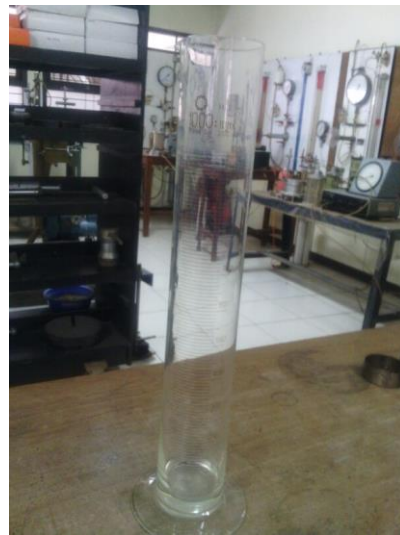
D 2487

Gambar L2.3 Flow chart for classifying fine-grained soil (50% or more passes no. 200 sieve)

Foto-foto alat dan proses pengujian



Gambar L2.4 Hidrometer



Gambar L2.5 Gelas pengukur volume 1000 cc



Gambar L2.6 Mixer



Gambar L2.7 Sodium Hexametafosfat



Gambar L2.8 Tapis no. 200



Gambar L2.9 Stopwatch



Gambar L2.10 Pembacaan hidrometer dan temperatur pada kondisi suspensi dispersi total



Gambar L2.11 Pembacaan hidrometer dan temperatur pada suspensi dan bak ukur

Lampiran 3 Pengujian *Index Properties* untuk analisis lama pemeraman

Tabel L3.1 Data pengujian *index properties* kondisi $w_i + 20\%w_i$

Lama Pemeraman		1 Hari	2 Hari	3 Hari
Ring No.		A		
Diameter of Ring	; d (cm)	6.35		
Height of Ring	; t (cm)	2.55		
Area of Ring	; A (cm ²)	31.67		
Volume of Ring	; V (cm ³)	80.76		
Wt. of Ring	; W ₁ (gr)	82.00	82.00	82.00
Wt. of Dish + Ring + Wet Soil	; W ₂ (gr)	277.40	279.70	281.80
Wt. of Dish	; W ₃ (gr)	63.00	64.30	66.00
Wt. of Dish + Ring + Dry Soil	; W ₄ (gr)	229.00	230.60	232.00
Wt. of Ring + Dry Soil	; W ₅ (gr)	166.00	166.30	166.00
Wt. of Wet Soil	; W (gr)	132.40	133.40	133.80
Wt. of Water	; W _w (gr)	48.40	49.10	49.80
Wt. of Dry Soil	; W _s (gr)	84.00	84.30	84.00
Specific Gravity of Soil at T °C	; G _s	2.71	2.71	2.71
Water Content	; w (%)	57.62	58.24	59.29
Volume of Soil	; V (cm ³)	80.76	80.76	80.76
Unit Wt. of Soil	; γ (gr/cm ³)	1.64	1.65	1.66
Void Ratio	; e	1.61	1.60	1.61
Porositas	; n	0.62	0.61	0.62
Degree of Saturation	; S _r (%)	97.27	98.89	100.08

Tabel L3.2 Data pengujian *index properties* kondisi $w_i + 40\%w_i$

Lama Pemeraman		1 Hari	2 Hari	3 Hari
Ring No.		A		
Diameter of Ring	; d (cm)	6.50		
Height of Ring	; t (cm)	2.56		
Area of Ring	; A (cm ²)	33.18		
Volume of Ring	; V (cm ³)	84.85		
Wt. of Ring	; W ₁ (gr)	98.00	98.00	98.00
Wt. of Dish + Ring + Wet Soil	; W ₂ (gr)	301.90	306.50	310.30
Wt. of Dish	; W ₃ (gr)	63.00	64.30	66.00
Wt. of Dish + Ring + Dry Soil	; W ₄ (gr)	247.70	250.10	252.40
Wt. of Ring + Dry Soil	; W ₅ (gr)	184.70	185.80	186.40
Wt. of Wet Soil	; W (gr)	140.90	144.20	146.30
Wt. of Water	; W _w (gr)	54.20	56.40	57.90
Wt. of Dry Soil	; W _s (gr)	86.70	87.80	88.40
Specific Gravity of Soil at T °C	; G _s	2.71	2.71	2.71
Water Content	; w (%)	62.51	64.24	65.50
Volume of Soil	; V (cm ³)	84.85	84.85	84.85
Unit Wt. of Soil	; γ (gr/cm ³)	1.66	1.70	1.72
Void Ratio	; e	1.65	1.62	1.60
Porositas	; n	0.62	0.62	0.62
Degree of Saturation	; S _r (%)	102.54	107.53	110.86

Tabel L3.3 Data pengujian *index properties* kondisi $w_i + 60\%w_i$

Lama Pemeraman		1 Hari	2 Hari	3 Hari
Ring No.		A		
Diameter of Ring	; d (cm)	6.35		
Height of Ring	; t (cm)	2.55		
Area of Ring	; A (cm ²)	31.67		
Volume of Ring	; V (cm ³)	80.76		
Wt. of Ring	; W ₁ (gr)	82.00	82.00	82.00
Wt. of Dish + Ring + Wet Soil	; W ₂ (gr)	290.60	294.80	300.30
Wt. of Dish	; W ₃ (gr)	63.00	64.30	66.00
Wt. of Dish + Ring + Dry Soil	; W ₄ (gr)	229.80	231.10	233.70
Wt. of Ring + Dry Soil	; W ₅ (gr)	166.80	166.80	167.70
Wt. of Wet Soil	; W (gr)	145.60	148.50	152.30
Wt. of Water	; W _w (gr)	60.80	63.70	66.60
Wt. of Dry Soil	; W _s (gr)	84.80	84.80	85.70
Specific Gravity of Soil at T °C	; G _s	2.71	2.71	2.71
Water Content	; w (%)	71.70	75.12	77.71
Volume of Soil	; V (cm ³)	80.76	80.76	80.76
Unit Wt. of Soil	; γ (gr/cm ³)	1.80	1.84	1.89
Void Ratio	; e	1.58	1.58	1.55
Porositas	; n	0.61	0.61	0.61
Degree of Saturation	; S _r (%)	122.92	128.78	135.55

Lampiran 4 Pengujian *Index Properties*

Tabel L4.1 Data pengujian *index properties* kondisi initial (w_i)

Determination No.		1	2
Ring No.		A	B
Wt. of Ring	; W_1 (gr)	82.00	98.00
Diameter of Ring	; d (cm)	6.35	6.50
Height of Ring	; t (cm)	2.55	2.56
Area of Ring	; A (cm^2)	31.67	33.18
Volume of Ring	; V (cm^3)	80.76	84.85
Wt. of Dish + Ring + Wet Soil	; W_2 (gr)	266.40	286.70
Wt. of Dish	; W_3 (gr)	58.00	63.80
Wt. of Dish + Ring + Dry Soil	; W_4 (gr)	225.10	244.60
Wt. of Ring + Dry Soil	; W_5 (gr)	167.10	180.80
Wt. of Wet Soil	; W (gr)	126.40	124.90
Wt. of Water	; W_w (gr)	41.30	42.10
Wt. of Dry Soil	; W_s (gr)	85.10	82.80
Specific Gravity of Soil at T °C	; G_s	2.71	2.71
Water Content	; w (%)	48.53	50.85
Volume of Soil	; V (cm^3)	80.76	84.85
Unit Wt. of Soil	; γ (gr/cm^3)	1.57	1.47
Void Ratio	; e	1.57	1.78
Porositas	; n	0.61	0.64
Degree of Saturation	; S_r (%)	83.68	77.54

Average Value w = 49.69 %

γ = 1.52 gr/cm^3

e = 1.67

n = 0.63

S_r = 80.61 %

$$\gamma_d = \frac{\gamma}{(1+w)} = \frac{1.52}{(1+0.4969)} = 1.015 \text{ gr}/\text{cm}^3$$

$$\begin{aligned} \gamma' &= \gamma - \gamma_w \\ &= 1.52 - 1.00 \\ &= 0.52 \text{ gr}/\text{cm}^3 = 0.52 \text{ t}/\text{m}^3 \end{aligned}$$

Tabel L4.2 Data pengujian *index properties* kondisi $w_i + 10\%w_i$

Determination No.	1	2
Ring No.	A	B
Diameter of Ring ; d (cm)	6.35	6.50
Height of Ring ; t (cm)	2.55	2.56
Area of Ring ; A (cm ²)	31.67	33.18
Volume of Ring ; V (cm ³)	80.76	84.85
Wt. of Ring ; W ₁ (gr)	82.00	98.00
Wt. of Dish + Ring + Wet Soil ; W ₂ (gr)	271.50	289.50
Wt. of Dish ; W ₃ (gr)	64.30	63.00
Wt. of Dish + Ring + Dry Soil ; W ₄ (gr)	226.30	244.90
Wt. of Ring + Dry Soil ; W ₅ (gr)	162.00	181.90
Wt. of Wet Soil ; W (gr)	125.20	128.50
Wt. of Water ; W _w (gr)	45.20	44.60
Wt. of Dry Soil ; W _s (gr)	80.00	83.90
Specific Gravity of Soil at T °C ; G _s	2.71	2.71
Water Content ; w (%)	56.50	53.16
Volume of Soil ; V (cm ³)	80.76	84.85
Unit Wt. of Soil ; γ (gr/cm ³)	1.55	1.51
Void Ratio ; e	1.74	1.74
Porositas ; n	0.63	0.64
Degree of Saturation ; S _r (%)	88.22	82.76

Average Value w = 54.83 %

γ = 1.53 gr/cm³

e = 1.74

n = 0.63

S_r = 85.49 %

$$\gamma_d = \frac{\gamma}{(1+w)} = \frac{1.53}{(1+0.5483)} = 0.988 \text{ gr/cm}^3$$

$$\begin{aligned} \gamma' &= \gamma - \gamma_w \\ &= 1.53 - 1.00 \\ &= 0.53 \text{ gr/cm}^3 = 0.53 \text{ t/m}^3 \end{aligned}$$

Tabel L4.3 Data pengujian *index properties* kondisi $w_i + 12\%w_i$

Determination No.	1	2
Ring No.	A	B
Diameter of Ring ; d (cm)	6.35	6.50
Height of Ring ; t (cm)	2.55	2.56
Area of Ring ; A (cm ²)	31.67	33.18
Volume of Ring ; V (cm ³)	80.76	84.85
Wt. of Ring ; W ₁ (gr)	82.00	98.00
Wt. of Dish + Ring + Wet Soil ; W ₂ (gr)	272.80	291.90
Wt. of Dish ; W ₃ (gr)	64.30	63.00
Wt. of Dish + Ring + Dry Soil ; W ₄ (gr)	227.40	245.10
Wt. of Ring + Dry Soil ; W ₅ (gr)	163.10	182.10
Wt. of Wet Soil ; W (gr)	126.50	130.90
Wt. of Water ; W _w (gr)	45.40	46.80
Wt. of Dry Soil ; W _s (gr)	81.10	84.10
Specific Gravity of Soil at T °C ; G _s	2.71	2.71
Water Content ; w (%)	55.98	55.65
Volume of Soil ; V (cm ³)	80.76	84.85
Unit Wt. of Soil ; γ (gr/cm ³)	1.57	1.54
Void Ratio ; e	1.70	1.73
Porositas ; n	0.63	0.63
Degree of Saturation ; S _r (%)	89.32	86.96

Average Value $w = 55.81 \%$

$\gamma = 1.55 \text{ gr/cm}^3$

$e = 1.72$

$n = 0.63$

$S_r = 88.14 \%$

$$\gamma_d = \frac{\gamma}{(1+w)} = \frac{1.55}{(1+0.5581)} = 0.995 \text{ gr/cm}^3$$

$$\gamma' = \gamma - \gamma_w$$

$$= 1.55 - 1.00$$

$$= 0.55 \text{ gr/cm}^3 = 0.55 \text{ t/m}^3$$

Tabel L4.4 Data pengujian *index properties* kondisi $w_i + 15\%w_i$

Determination No.	1	2
Ring No.	A	B
Diameter of Ring ; d (cm)	6.35	6.50
Height of Ring ; t (cm)	2.55	2.56
Area of Ring ; A (cm ²)	31.67	33.18
Volume of Ring ; V (cm ³)	80.76	84.85
Wt. of Ring ; W ₁ (gr)	82.00	98.00
Wt. of Dish + Ring + Wet Soil ; W ₂ (gr)	274.30	294.30
Wt. of Dish ; W ₃ (gr)	64.30	63.00
Wt. of Dish + Ring + Dry Soil ; W ₄ (gr)	228.40	245.30
Wt. of Ring + Dry Soil ; W ₅ (gr)	164.10	182.30
Wt. of Wet Soil ; W (gr)	128.00	133.30
Wt. of Water ; W _w (gr)	45.90	49.00
Wt. of Dry Soil ; W _s (gr)	82.10	84.30
Specific Gravity of Soil at T °C ; G _s	2.71	2.71
Water Content ; w (%)	55.91	58.13
Volume of Soil ; V (cm ³)	80.76	84.85
Unit Wt. of Soil ; γ (gr/cm ³)	1.59	1.57
Void Ratio ; e	1.67	1.73
Porositas ; n	0.62	0.63
Degree of Saturation ; S _r (%)	90.96	91.18

Average Value $w = 57.02 \%$

$\gamma = 1.58 \text{ gr/cm}^3$

$e = 1.70$

$n = 0.63$

$S_r = 91.07 \%$

$$\gamma_d = \frac{\gamma}{(1+w)} = \frac{1.58}{(1+0.5702)} = 1.006 \text{ gr/cm}^3$$

$$\gamma' = \gamma - \gamma_w$$

$$= 1.58 - 1.00$$

$$= 0.58 \text{ gr/cm}^3 = 0.58 \text{ t/m}^3$$

Tabel L4.5 Data pengujian *index properties* kondisi jenuh

Determination No.		1
Ring No.		B
Diameter of Ring	; d (cm)	6.50
Height of Ring	; t (cm)	2.56
Area of Ring	; A (cm ²)	33.18
Volume of Ring	; V (cm ³)	84.85
Wt. of Ring	; W ₁ (gr)	98.00
Wt. of Dish + Ring + Wet Soil	; W ₂ (gr)	299.30
Wt. of Dish	; W ₃ (gr)	63.00
Wt. of Dish + Ring + Dry Soil	; W ₄ (gr)	244.70
Wt. of Ring + Dry Soil	; W ₅ (gr)	181.70
Wt. of Wet Soil	; W (gr)	138.30
Wt. of Water	; W _w (gr)	54.60
Wt. of Dry Soil	; W _s (gr)	83.70
Specific Gravity of Soil at T °C	; G _s	2.71
Water Content	; w (%)	65.23
Volume of Soil	; V (cm ³)	84.85
Unit Wt. of Soil	; γ (gr/cm ³)	1.63
Void Ratio	; e	1.75
Porositas	; n	0.64
Degree of Saturation	; S _r (%)	101.18

Value

$$w = 65.32 \%$$

$$\gamma = 1.63 \text{ gr/cm}^3$$

$$e = 1.75$$

$$n = 0.64$$

$$S_r = 101.18 \%$$

$$\gamma_d = \frac{\gamma}{(1+w)} = \frac{1.63}{(1+0.6532)} = 0.986 \text{ gr/cm}^3$$

$$\begin{aligned} \gamma' &= \gamma - \gamma_w \\ &= 1.63 - 1.00 \\ &= 0.63 \text{ gr/cm}^3 = 0.63 \text{ t/m}^3 \end{aligned}$$

Foto-foto alat dan proses pengujian



Gambar L4.1 Silinder ring pencetak tanah



Gambar L4.2 Extruder



Gambar L4.3 Jangka sorong



Gambar L4.4 Desikator



Gambar L4.5 Gergaji kawat



Gambar L4.6 Contoh tanah setelah dicetak pada ring

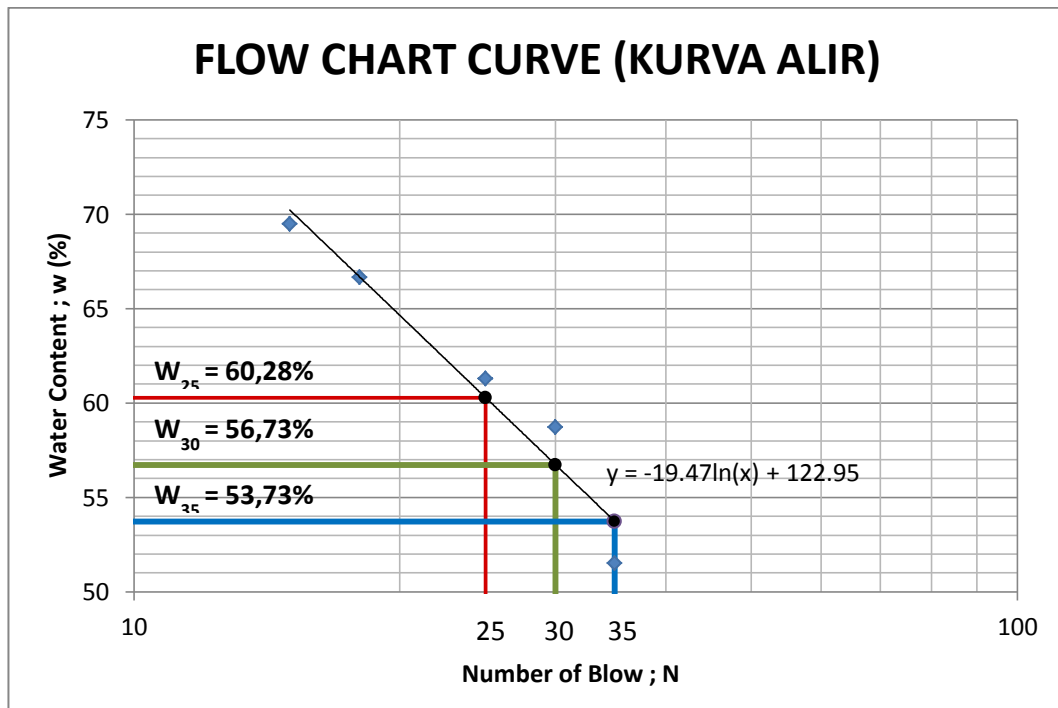
Lampiran 5 Pengujian Atterberg Limits

Tabel L5.1 Data pengujian kadar air alami

Container No.	C-11
Wt. of Container ; W_1 (gr)	21.50
Wt. Cont + Wet Soil ; W_2 (gr)	31.50
Wt. Cont + Dry Soil ; W_3 (gr)	28.20
Wt. of Water ; W_w (gr)	3.30
Wt. of Dry Soil ; W_s (gr)	6.70
WATER CONTENT ; w (%)	49.25

Tabel L5.2 Data pengujian batas cair (*liquid limit*)

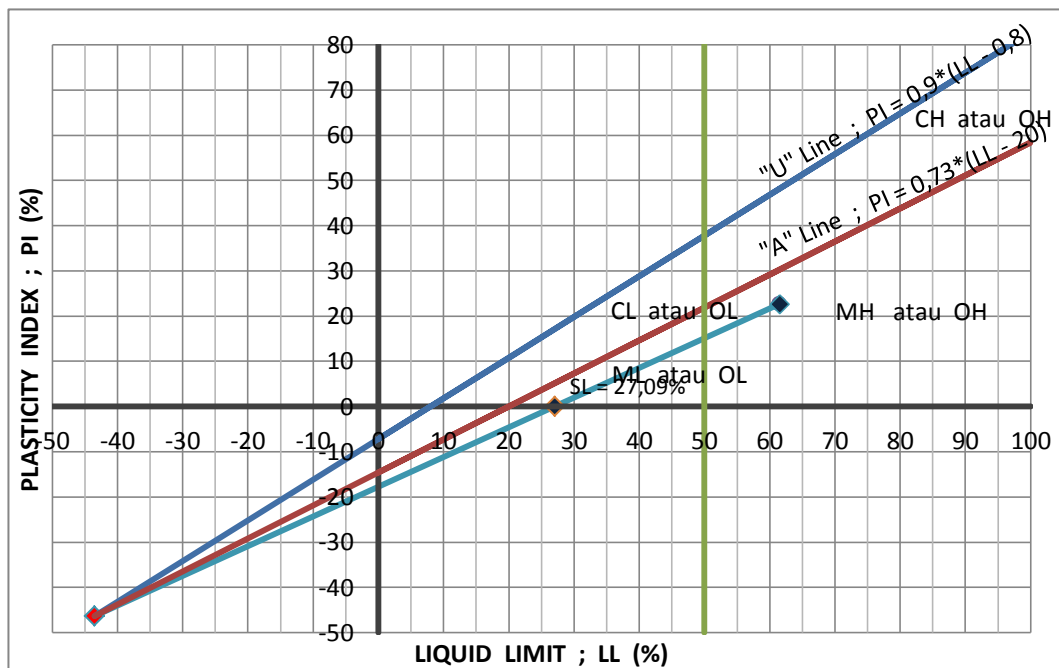
Container No.	T-2	T-5	T-6	T-8	T-9
Wt. of Container ; W_1 (gr)	10.00	9.20	10.00	10.00	10.00
Wt. Cont + Wet Soil ; W_2 (gr)	20.00	19.20	20.00	20.00	20.00
Wt. Cont + Dry Soil ; W_3 (gr)	15.90	15.20	16.20	16.30	16.60
Wt. of Water ; W_w (gr)	4.10	4.00	3.80	3.70	3.40
Wt. of Dry Soil ; W_s (gr)	5.90	6.00	6.20	6.30	6.60
WATER CONTENT ; w (%)	69.49	66.67	61.29	58.73	51.52
NUMBER OF BLOWS ; N	15	18	25	30	35



Gambar L5.1 Grafik hubungan antara jumlah pukulan vs kadar air

Tabel L5.3 Data pengujian batas plastis (*plastic limit*)

Container No.	D-21	D-22
Wt. of Container ; W_1 (gr)	14.50	14.70
Wt. Cont + Wet Soil ; W_2 (gr)	24.50	24.70
Wt. Cont + Dry Soil ; W_3 (gr)	21.60	22.00
Wt. of Water ; W_w (gr)	2.90	2.70
Wt. of Dry Soil ; W_s (gr)	7.10	7.30
WATER CONTENT ; w (%)	40.85	36.99



Gambar L5.2 Bagan plastisitas

Keterangan :

CH = Lempung Anorganik dengan Plastisitas Tinggi

MH = Lanau Elastis atau Tanah Pasiran/Lanauan

OH = Lempung Organik dengan Plastisitas Sedang sampai Tinggi

CL = Lempung Anorganik dengan Plastisitas Rendah sampai Sedang;
Lempung Berkerikil; Lempung Berpasir; Lempung Lanauan

ML = Lanau Anorganik dan Pasir Sangat Halus; Pasir Halus Berlanau atau
Berlempung dengan Plastisitas Rendah

OL = Lanau Anorganik dan Lanau-Lempung Organik dengan Plastisitas
Rendah

Tabel L5.4 Harga PI, LI, I_f, I_t dan I_c

SUMMARY	
LL ; (%)	61.54
PL ; (%)	38.92
SL ; (%)	27.09
PI ; (%)	22.62
W _n ; (%)	49.25
LI	0.46
I _f	44.83
I _t	0.50
I _c	0.54

Foto-foto alat dan proses pengujian



Gambar L5.3 Alat Cassagrande



Gambar L5.4 Grooving tool



Gambar L5.5 Container

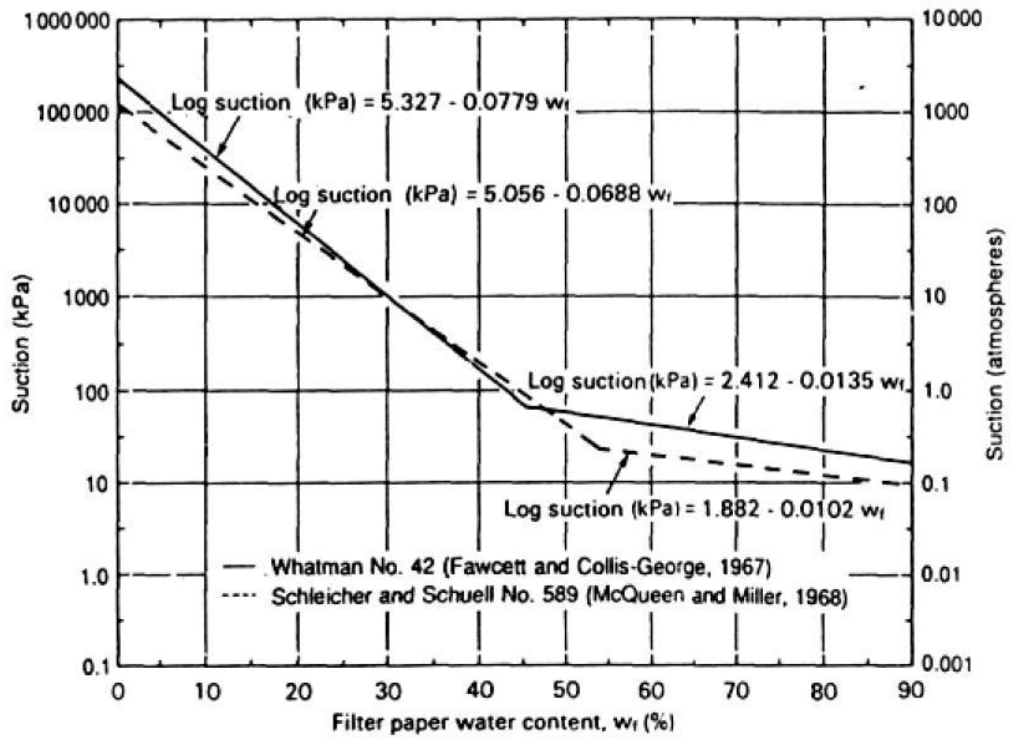


Gambar L5.6 Scraper

Lampiran 6 Soil Suction Measurement Using Filter Paper Method

Tabel L6.1 Data pengujian *matric suction*

Condition		Initial (w_i)	$w_i+10\%w_i$	$w_i+12\%w_i$	$w_i+15\%w_i$
Moisture Tin No.		1	2	3	4
Cold Tare Mass (g)	T_c	20.1856	19.3542	18.4929	19.0308
Mass of Wet Filter Paper + Cold Tare Mass (g)	M_1	20.6502	19.6919	18.8328	19.5824
Mass of Dry Filter Paper + Cold Tare Mass (g)	M_2	20.4675	19.5492	18.6732	19.3141
Hot Tare Mass (g)	T_h	20.1856	19.3542	18.4929	19.0308
Mass of Dry Filter Paper (g)	M_f	0.2819	0.195	0.1803	0.2833
Mass of Water in Filter Paper (g)	M_w	0.1827	0.1427	0.1596	0.2683
Filter Paper Water Content (%)	w	64.8102	73.1795	88.5191	94.7053
Suction (kPa)	h	34.4399	26.5507	16.4813	13.5981
Suction (Kg/cm ²)	h	0.3512	0.2707	0.1681	0.1387



Gambar L6.1 Grafik hubungan kadar air vs nilai *suction* pada jenis kertas filter tertentu

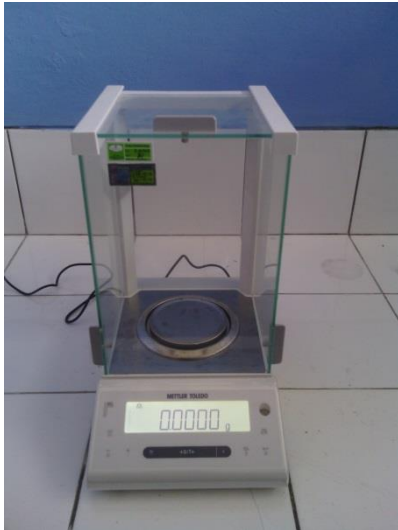
Foto-foto alat dan proses pengujian



Gambar L6.2 Kertas filter



Gambar L6.3 Tabung kaca



Gambar L6.4 Timbangan dengan ketelitian 0.0001 gr



Gambar L6.5 Wadah aluminium



Gambar L6.6 Penyiapan benda uji untuk metode *contact*



Gambar L6.7 Bahan uji yang sedang didiamkan sampai kondisi keseimbangan dicapai

Lampiran 7 Pengujian *Direct Shear*

Lampiran 7.1 *Direct Shear* kondisi initial

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.1	Kg/cm ²
Ring constant		= 0.2956	Kg/div

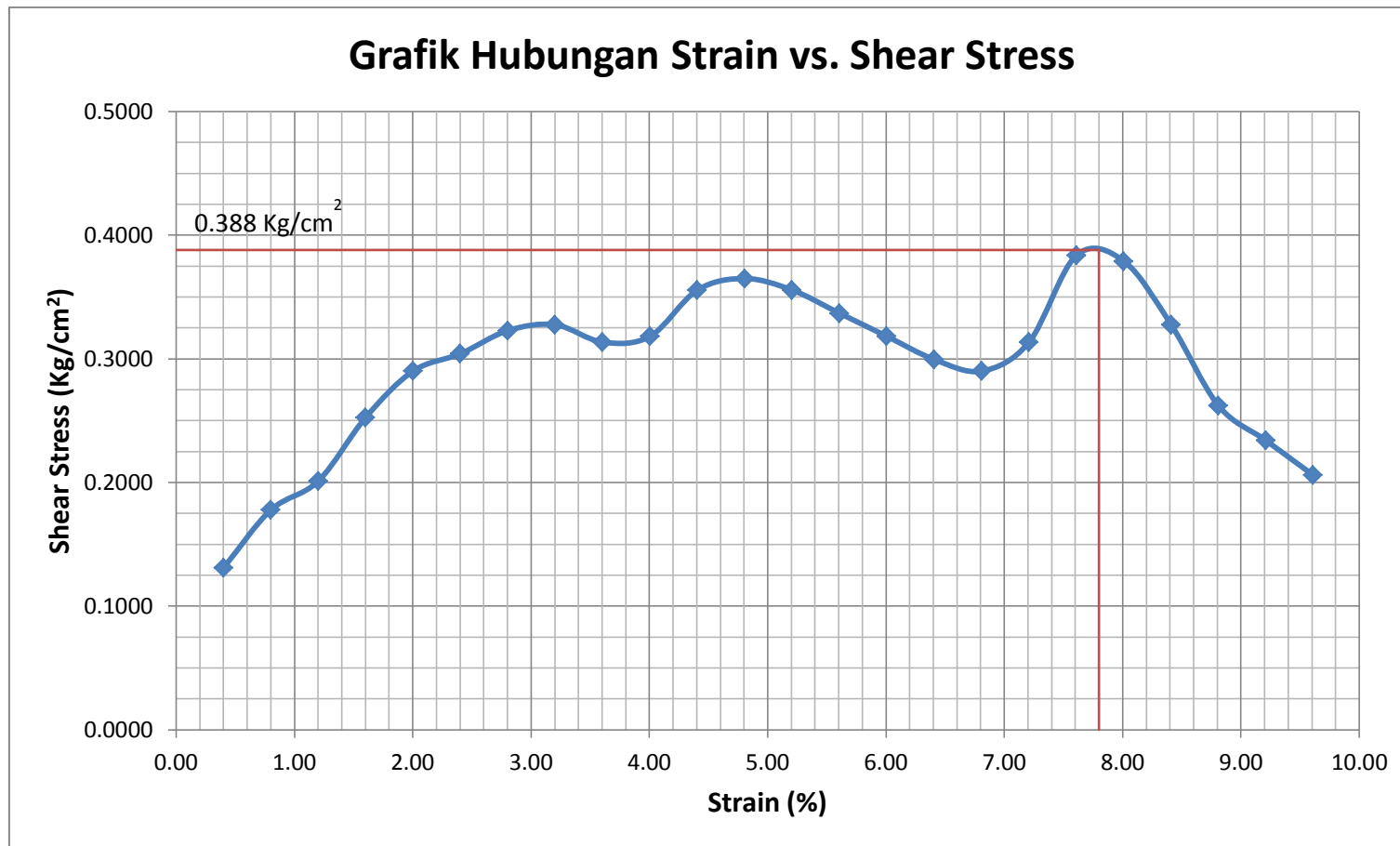
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 66.7	gr
Wt. cont + wet soil	(W_2)	= 184	gr
Wt. cont + dry soil	(W_3)	= 145.2	gr
Wt. of water	(W_w)	= 38.8	gr
Wt. of dry soil	(W_s)	= 78.5	gr
Water content	(w)	= 49.43	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.699	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 83.931	%

Tabel L7.1 Data pengujian *direct shear* kondisi initial dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	6	0.0024	14	4.138	0.131
	20	0.80	11	0.0043	19	5.616	0.178
	30	1.20	19	0.0075	21.5	6.355	0.201
	40	1.60	26	0.0102	27	7.981	0.253
	50	2.00	34	0.0134	31	9.164	0.290
	60	2.40	41	0.0161	32.5	9.607	0.304
	70	2.80	49	0.0193	34.5	10.198	0.323
	80	3.20	59	0.0232	35	10.346	0.328
	90	3.60	68	0.0268	33.5	9.903	0.313
	100	4.01	76	0.0299	34	10.050	0.318
	110	4.41	86	0.0339	38	11.233	0.356
	120	4.81	92	0.0362	39	11.528	0.365
	130	5.21	100	0.0394	38	11.233	0.356
	140	5.61	105	0.0413	36	10.642	0.337
	150	6.01	110	0.0433	34	10.050	0.318
	160	6.41	114	0.0449	32	9.459	0.299
	170	6.81	116	0.0457	31	9.164	0.290
	180	7.21	120	0.0472	33.5	9.903	0.313
	190	7.61	122	0.0480	41	12.120	0.384
	200	8.01	123	0.0484	40.5	11.972	0.379
	210	8.41	124	0.0488	35	10.346	0.328
	220	8.81	124	0.0488	28	8.277	0.262
	230	9.21	124	0.0488	25	7.390	0.234
2.7573	240	9.61	124	0.0488	22	6.503	0.206

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{9.61}{2.7573} = 3.486 \text{ \%/min}$$



Gambar L7.1 Grafik hubungan *strain vs shear stress* kondisi initial dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.2	Kg/cm ²
Ring constant		= 0.2956	Kg/div

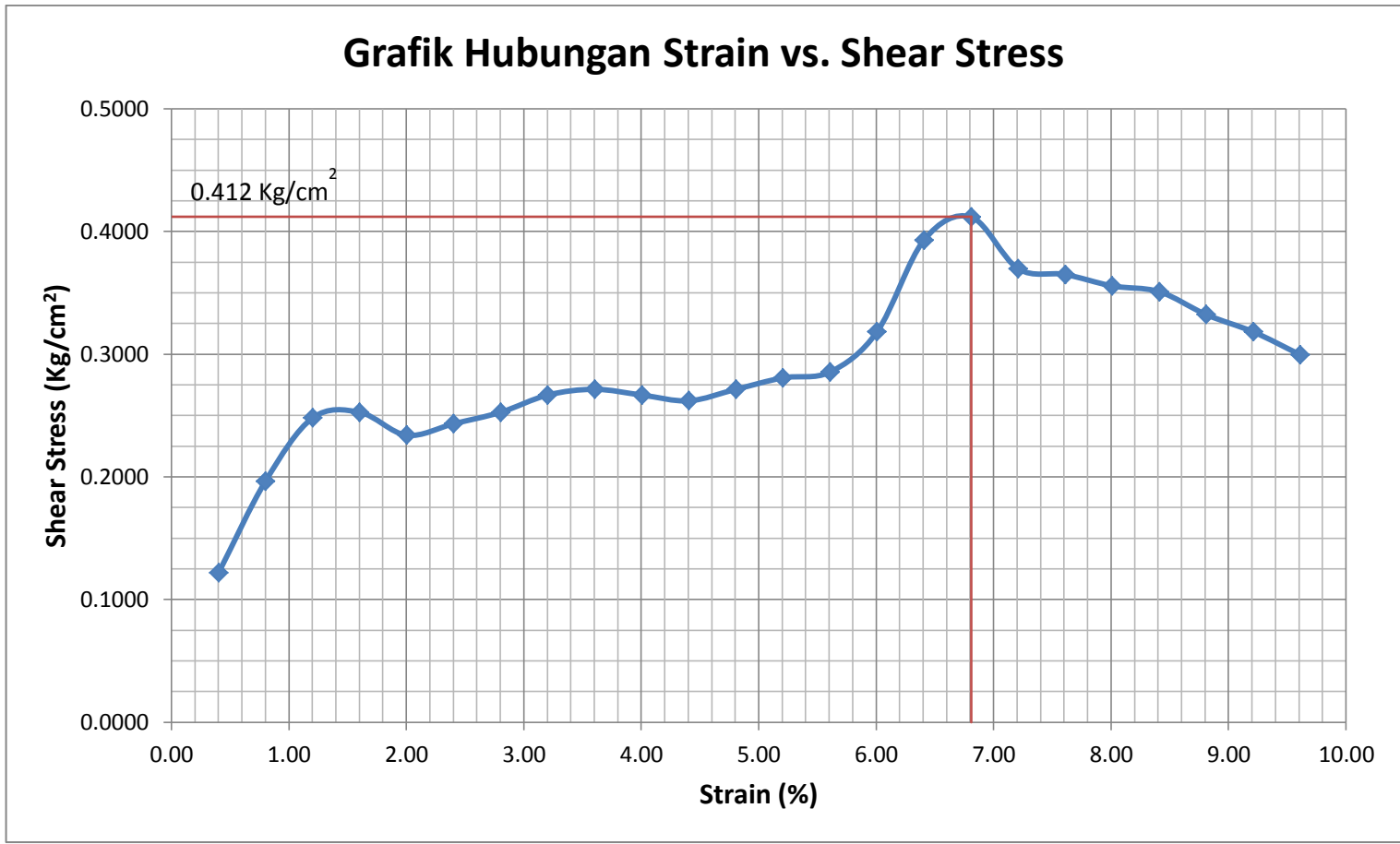
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 62.7	gr
Wt. cont + wet soil	(W_2)	= 182	gr
Wt. cont + dry soil	(W_3)	= 142.65	gr
Wt. of water	(W_w)	= 39.35	gr
Wt. of dry soil	(W_s)	= 79.95	gr
Water content	(w)	= 49.22	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.700	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 83.577	%

Tabel L7.2 Data pengujian *direct shear* kondisi initial dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	1	0.0004	13	3.843	0.122
	20	0.80	1	0.0004	21	6.208	0.197
	30	1.20	0.5	0.0002	26.5	7.833	0.248
	40	1.60	1	0.0004	27	7.981	0.253
	50	2.00	2	0.0008	25	7.390	0.234
	60	2.40	3.5	0.0014	26	7.686	0.243
	70	2.80	5	0.0020	27	7.981	0.253
	80	3.20	7	0.0028	28.5	8.425	0.267
	90	3.60	9.5	0.0037	29	8.572	0.271
	100	4.01	12	0.0047	28.5	8.425	0.267
	110	4.41	19	0.0075	28	8.277	0.262
	120	4.81	21	0.0083	29	8.572	0.271
	130	5.21	29	0.0114	30	8.868	0.281
	140	5.61	22	0.0087	30.5	9.016	0.285
	150	6.01	25	0.0098	34	10.050	0.318
	160	6.41	26	0.0102	42	12.415	0.393
	170	6.81	27	0.0106	44	13.006	0.412
	180	7.21	28	0.0110	39.5	11.676	0.370
	190	7.61	39.5	0.0156	39	11.528	0.365
	200	8.01	44.5	0.0175	38	11.233	0.356
	210	8.41	50	0.0197	37.5	11.085	0.351
	220	8.81	54.5	0.0215	35.5	10.494	0.332
	230	9.21	60	0.0236	34	10.050	0.318
2.9053	240	9.61	65.5	0.0258	32	9.459	0.299

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{9.61}{2.9053} = 3.308\%/\text{min}$$



Gambar L7.2 Grafik hubungan *strain vs shear stress* kondisi initial dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.3	Kg/cm ²
Ring constant		= 0.2956	Kg/div

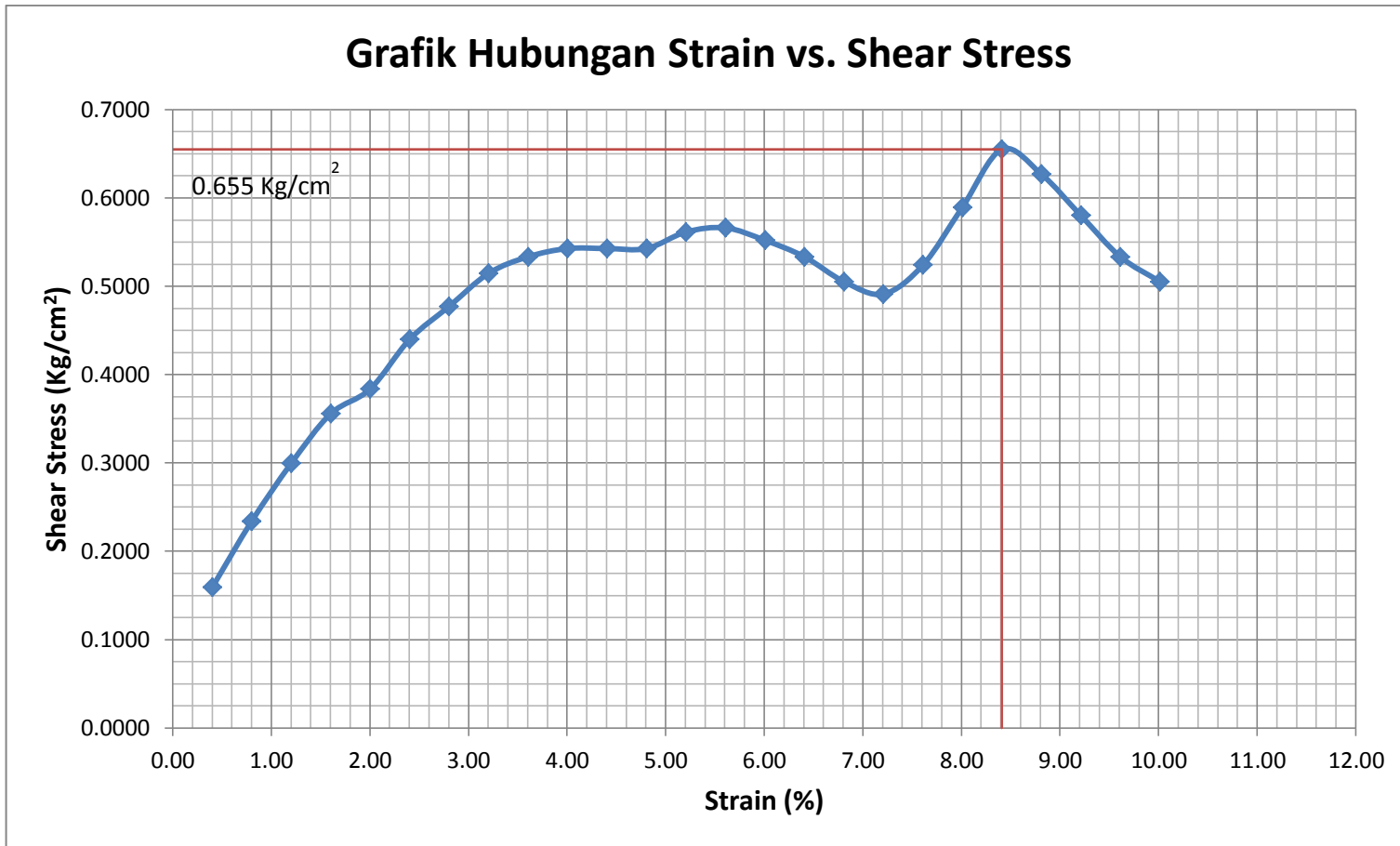
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 63.5	gr
Wt. cont + wet soil	(W_2)	= 195	gr
Wt. cont + dry soil	(W_3)	= 150.9	gr
Wt. of water	(W_w)	= 44.1	gr
Wt. of dry soil	(W_s)	= 87.4	gr
Water content	(w)	= 50.46	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.694	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 85.682	%

Tabel L7.3 Data pengujian *direct shear* kondisi initial dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	5	0.0020	17	5.025	0.159
	20	0.80	9	0.0035	25	7.390	0.234
	30	1.20	15	0.0059	32	9.459	0.299
	40	1.60	14	0.0055	38	11.233	0.356
	50	2.00	14	0.0055	41	12.120	0.384
	60	2.40	14	0.0055	47	13.893	0.440
	70	2.80	12	0.0047	51	15.076	0.477
	80	3.20	10	0.0039	55	16.258	0.515
	90	3.60	8	0.0031	57	16.849	0.533
	100	4.01	7	0.0028	58	17.145	0.543
	110	4.41	6	0.0024	58	17.145	0.543
	120	4.81	4	0.0016	58	17.145	0.543
	130	5.21	4	0.0016	60	17.736	0.561
	140	5.61	2	0.0008	60.5	17.884	0.566
	150	6.01	2	0.0008	59	17.440	0.552
	160	6.41	2	0.0008	57	16.849	0.533
	170	6.81	2	0.0008	54	15.962	0.505
	180	7.21	2	0.0008	52.5	15.519	0.491
	190	7.61	2	0.0008	56	16.554	0.524
	200	8.01	2	0.0008	63	18.623	0.590
	210	8.41	1	0.0004	70	20.692	0.655
	220	8.81	1	0.0004	67	19.805	0.627
	230	9.21	1	0.0004	62	18.327	0.580
	240	9.61	1	0.0004	57	16.849	0.533
	250	10.01	1	0.0004	54	15.962	0.505
3.0343	250	10.01	1	0.0004	51	15.076	0.477

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{10.01}{3.0343} = 3.300\%/\text{min}$$



Gambar L7.3 Grafik hubungan *strain vs shear stress* kondisi initial dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Lampiran 7.2 Direct Shear kondisi $w_i + 10\%w_i$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.1	Kg/cm ²
Ring constant		= 0.2956	Kg/div

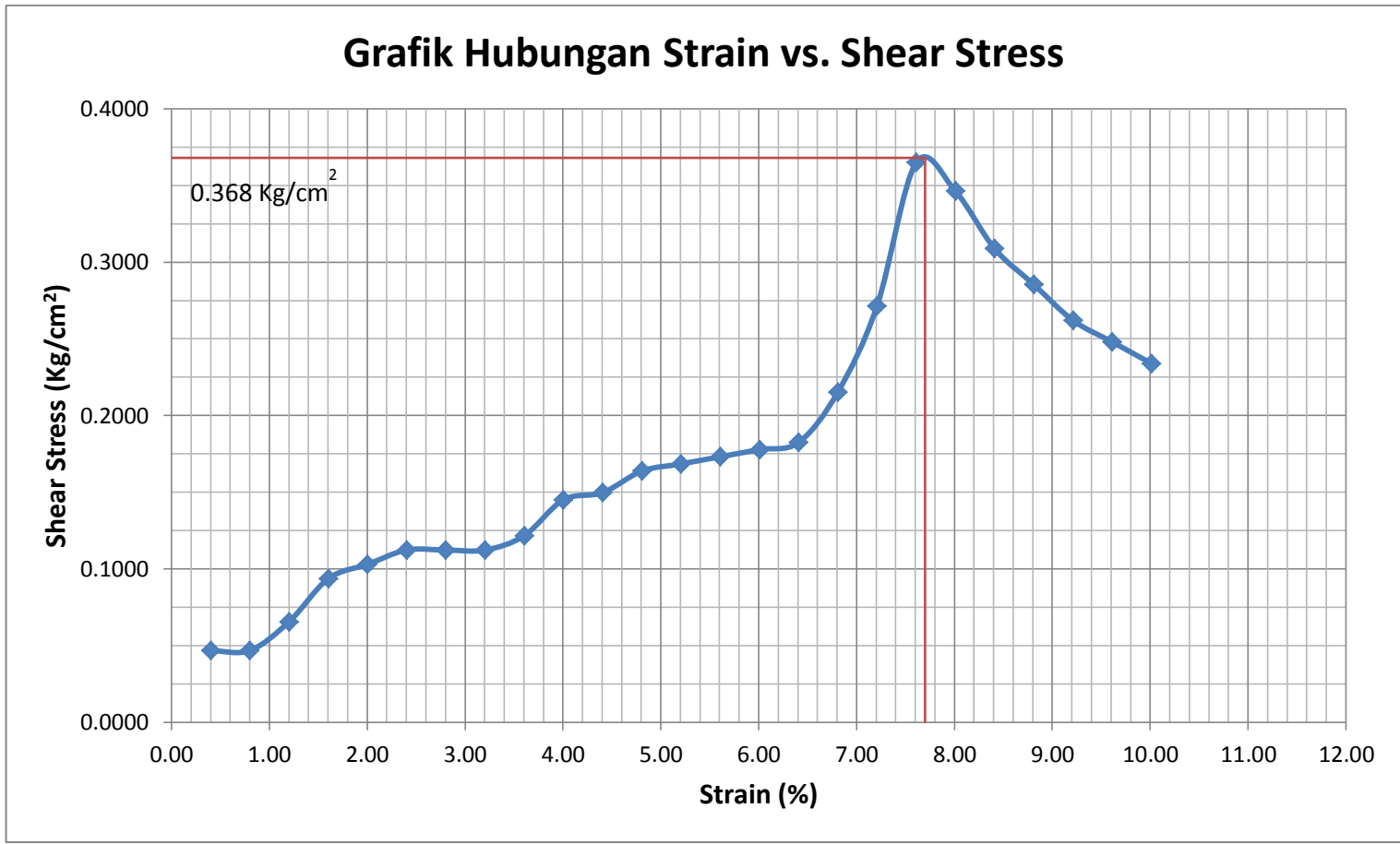
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 66	gr
Wt. cont + wet soil	(W_2)	= 178.5	gr
Wt. cont + dry soil	(W_3)	= 138.8	gr
Wt. of water	(W_w)	= 39.7	gr
Wt. of dry soil	(W_s)	= 72.8	gr
Water content	(w)	= 54.53	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.676	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 92.6025	%

Tabel L7.4 Data pengujian *direct shear* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.1$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	8	0.0031	5	1.478	0.047
	20	0.80	11	0.0043	5	1.478	0.047
	30	1.20	13	0.0051	7	2.069	0.066
	40	1.60	16	0.0063	10	2.956	0.094
	50	2.00	17	0.0067	11	3.252	0.103
	60	2.40	19	0.0075	12	3.547	0.112
	70	2.80	19	0.0075	12	3.547	0.112
	80	3.20	18	0.0071	12	3.547	0.112
	90	3.60	18	0.0071	13	3.843	0.122
	100	4.01	17	0.0067	15.5	4.582	0.145
	110	4.41	17	0.0067	16	4.730	0.150
	120	4.81	15	0.0059	17.5	5.173	0.164
	130	5.21	11	0.0043	18	5.321	0.168
	140	5.61	10	0.0039	18.5	5.469	0.173
	150	6.01	6	0.0024	19	5.616	0.178
	160	6.41	4	0.0016	19.5	5.764	0.182
	170	6.81	3	0.0012	23	6.799	0.215
	180	7.21	1	0.0004	29	8.572	0.271
	190	7.61	4	0.0016	39	11.528	0.365
	200	8.01	10	0.0039	37	10.937	0.346
	210	8.41	15	0.0059	33	9.755	0.309
	220	8.81	20	0.0079	30.5	9.016	0.285
	230	9.21	25	0.0098	28	8.277	0.262
	240	9.61	30	0.0118	26.5	7.833	0.248
2.823	250	10.01	36	0.0142	25	7.390	0.234

$$\text{Strain rate} = \frac{\text{Strain}}{\text{Elapsed Time}} = \frac{10.01}{2.823} = 3.547 \text{ \%/min}$$



Gambar L7.4 Grafik hubungan *strain vs shear stress* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.2	Kg/cm ²
Ring constant		= 0.2956	Kg/div

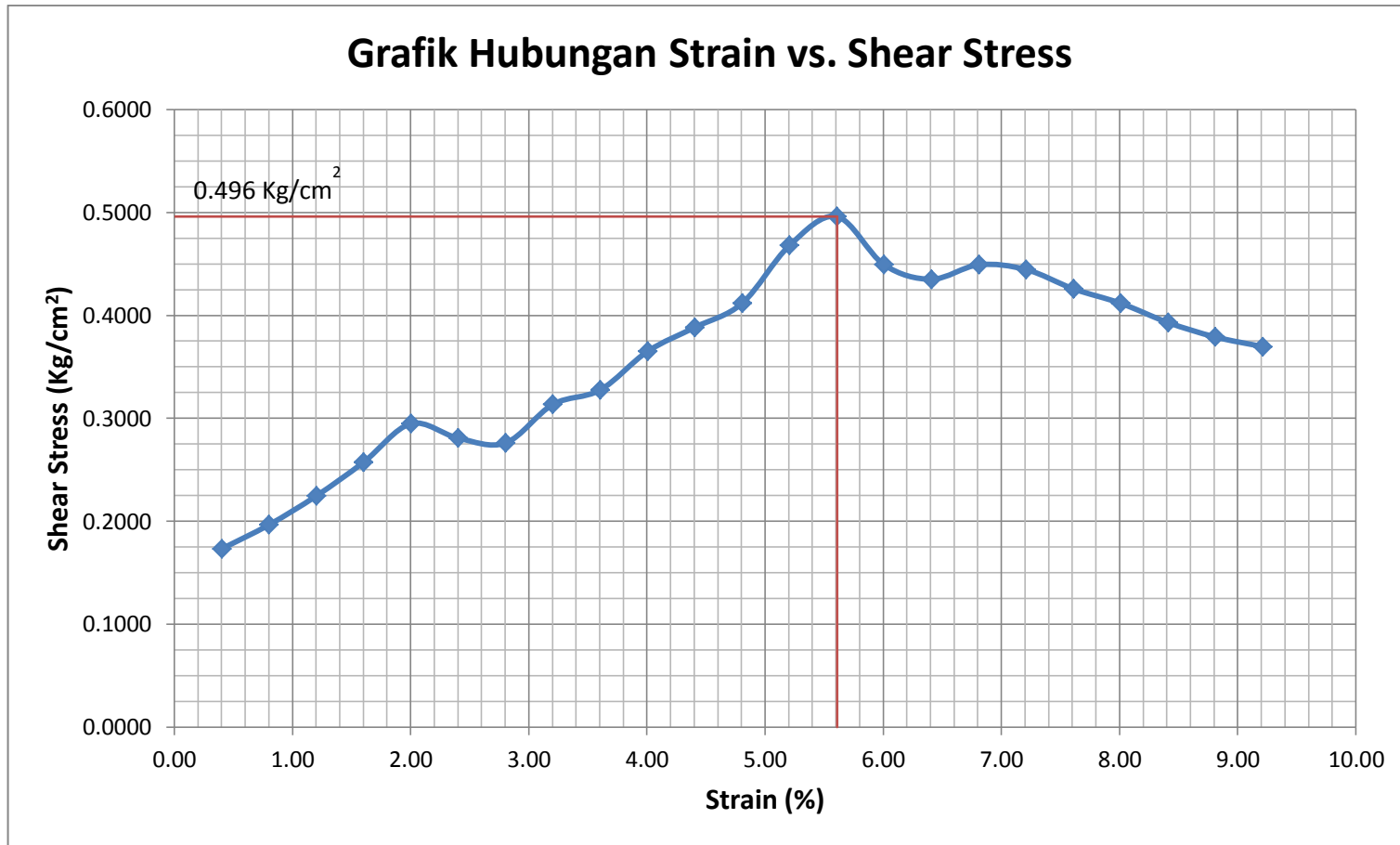
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 66	gr
Wt. cont + wet soil	(W_2)	= 194.6	gr
Wt. cont + dry soil	(W_3)	= 149	gr
Wt. of water	(W_w)	= 45.6	gr
Wt. of dry soil	(W_s)	= 83	gr
Water content	(w)	= 54.94	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.674	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 93.293	%

Tabel L7.5 Data pengujian *direct shear* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.2$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	5	0.0020	18.5	5.469	0.173
	20	0.80	10	0.0039	21	6.208	0.197
	30	1.20	18	0.0071	24	7.094	0.225
	40	1.60	25	0.0098	27.5	8.129	0.257
	50	2.00	29	0.0114	31.5	9.311	0.295
	60	2.40	31.5	0.0124	30	8.868	0.281
	70	2.80	34	0.0134	29.5	8.720	0.276
	80	3.20	36	0.0142	33.5	9.903	0.313
	90	3.60	38	0.0150	35	10.346	0.328
	100	4.01	39	0.0154	39	11.528	0.365
	110	4.41	40	0.0157	41.5	12.267	0.388
	120	4.81	39.5	0.0156	44	13.006	0.412
	130	5.21	39.5	0.0156	50	14.780	0.468
	140	5.61	39	0.0154	53	15.667	0.496
	150	6.01	37	0.0146	48	14.189	0.449
	160	6.41	35	0.0138	46.5	13.745	0.435
	170	6.81	35	0.0138	48	14.189	0.449
	180	7.21	34	0.0134	47.5	14.041	0.444
	190	7.61	32	0.0126	45.5	13.450	0.426
	200	8.01	31	0.0122	44	13.006	0.412
	210	8.41	29.5	0.0116	42	12.415	0.393
	220	8.81	28	0.0110	40.5	11.972	0.379
2.646	230	9.21	25.5	0.0100	39.5	11.676	0.370

$$\text{Strain rate} = \frac{\text{Strain}}{\text{Elapsed Time}} = \frac{9.21}{2.646} = 3.481\%/\text{min}$$



Gambar L7.5 Grafik hubungan *strain vs shear stress* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.3	Kg/cm ²
Ring constant		= 0.2956	Kg/div

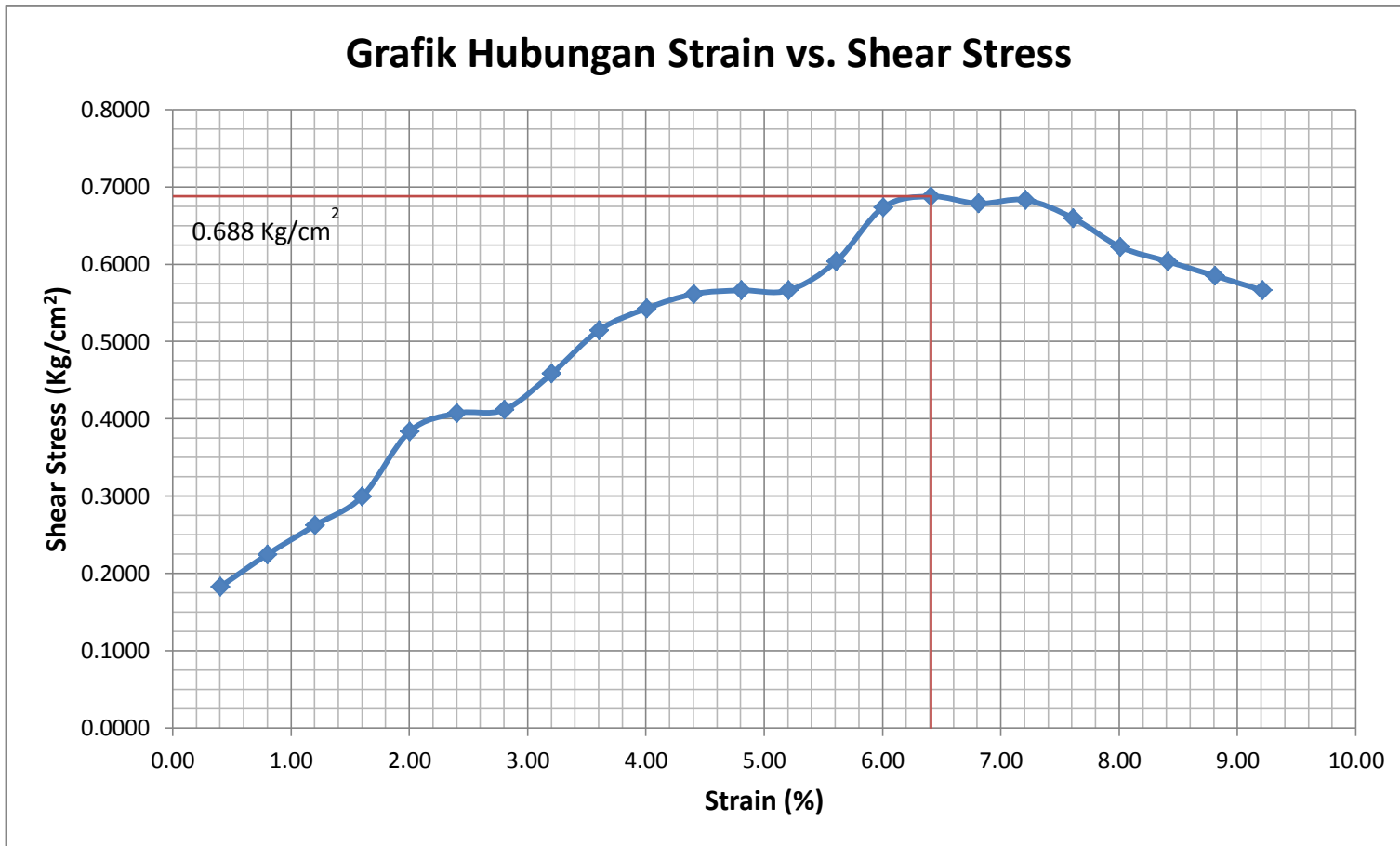
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 68	gr
Wt. cont + wet soil	(W_2)	= 194.8	gr
Wt. cont + dry soil	(W_3)	= 150.4	gr
Wt. of water	(W_w)	= 44.4	gr
Wt. of dry soil	(W_s)	= 82.4	gr
Water content	(w)	= 53.88	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.678	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 91.499	%

Tabel L7.6 Data pengujian *direct shear* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.3$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	2	0.0008	19.5	5.764	0.182
	20	0.80	6.5	0.0026	24	7.094	0.225
	30	1.20	9	0.0035	28	8.277	0.262
	40	1.60	13	0.0051	32	9.459	0.299
	50	2.00	16	0.0063	41	12.120	0.384
	60	2.40	18	0.0071	43.5	12.859	0.407
	70	2.80	18	0.0071	44	13.006	0.412
	80	3.20	17.5	0.0069	49	14.484	0.459
	90	3.60	17	0.0067	55	16.258	0.515
	100	4.01	16	0.0063	58	17.145	0.543
	110	4.41	15	0.0059	60	17.736	0.561
	120	4.81	13	0.0051	60.5	17.884	0.566
	130	5.21	12	0.0047	60.5	17.884	0.566
	140	5.61	8.5	0.0033	64.5	19.066	0.604
	150	6.01	7	0.0028	72	21.283	0.674
	160	6.41	5	0.0020	73.5	21.727	0.688
	170	6.81	3	0.0012	72.5	21.431	0.678
	180	7.21	1.5	0.0006	73	21.579	0.683
	190	7.61	0	0.0000	70.5	20.840	0.660
	200	8.01	5	0.0020	66.5	19.657	0.622
	210	8.41	9	0.0035	64.5	19.066	0.604
	220	8.81	14	0.0055	62.5	18.475	0.585
2.642	230	9.21	17	0.0067	60.5	17.884	0.566

$$\text{Strain rate} = \frac{\text{Strain}}{\text{Elapsed Time}} = \frac{9.21}{2.642} = 3.487 \text{ \%/min}$$



Gambar L7.6 Grafik hubungan *strain vs shear stress* kondisi $w_i + 10\%w_i$ dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Lampiran 7.3 Direct Shear kondisi $w_i + 12\%w_i$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.1	Kg/cm ²
Ring constant		= 0.2956	Kg/div

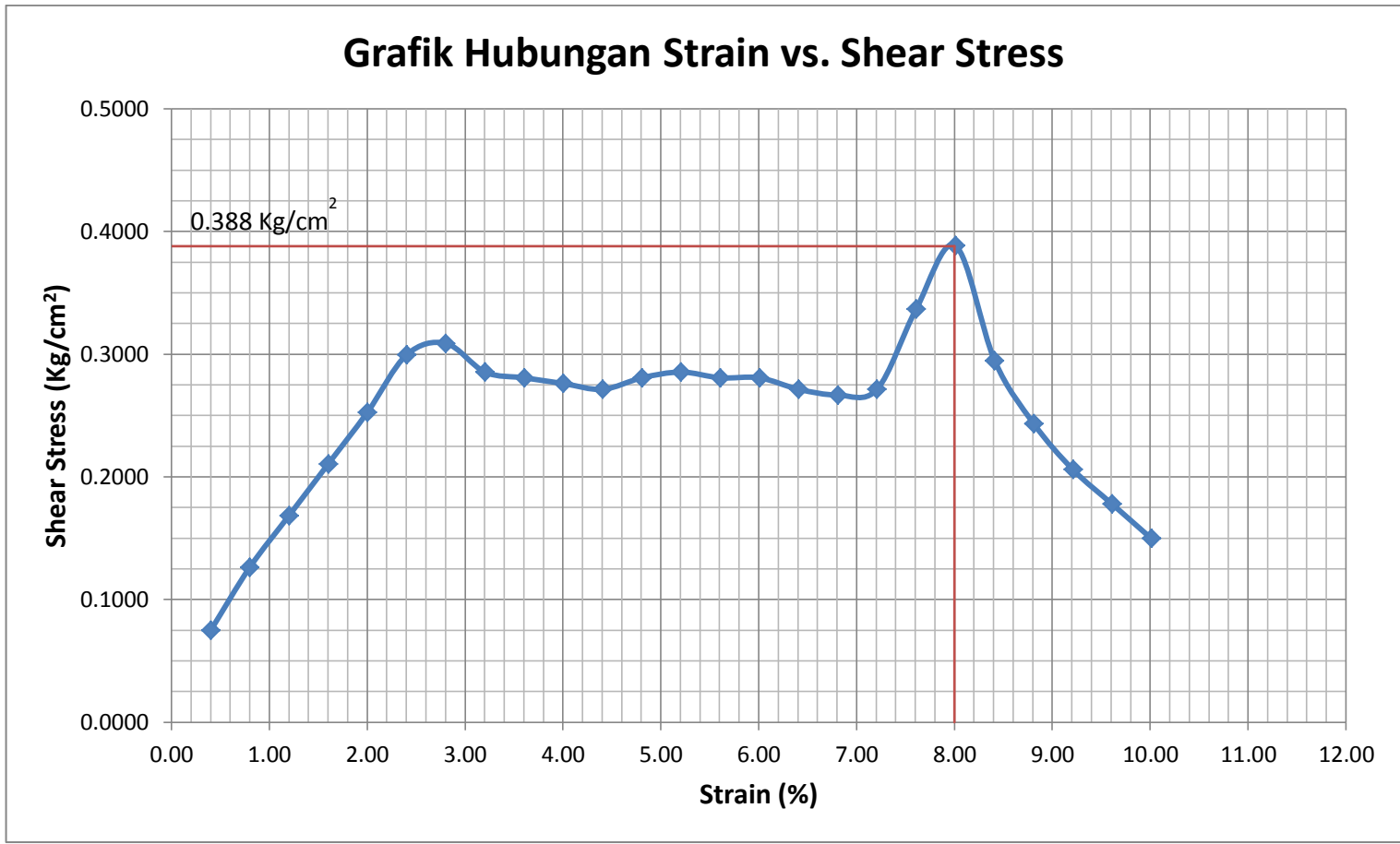
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 78.6	gr
Wt. cont + wet soil	(W_2)	= 189.5	gr
Wt. cont + dry soil	(W_3)	= 149.6	gr
Wt. of water	(W_w)	= 39.9	gr
Wt. of dry soil	(W_s)	= 71	gr
Water content	(w)	= 56.20	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.668	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 95.428	%

**Tabel L7.7 Data pengujian *direct shear* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.1$
Kg/cm²**

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	2	0.0008	8	2.365	0.075
	20	0.80	2	0.0008	13.5	3.991	0.126
	30	1.20	1	0.0004	18	5.321	0.168
	40	1.60	3	0.0012	22.5	6.651	0.211
	50	2.00	7	0.0028	27	7.981	0.253
	60	2.40	10	0.0039	32	9.459	0.299
	70	2.80	15	0.0059	33	9.755	0.309
	80	3.20	18	0.0071	30.5	9.016	0.285
	90	3.60	22	0.0087	30	8.868	0.281
	100	4.01	25	0.0098	29.5	8.720	0.276
	110	4.41	26	0.0102	29	8.572	0.271
	120	4.81	29	0.0114	30	8.868	0.281
	130	5.21	31	0.0122	30.5	9.016	0.285
	140	5.61	33	0.0130	30	8.868	0.281
	150	6.01	35	0.0138	30	8.868	0.281
	160	6.41	40	0.0157	29	8.572	0.271
	170	6.81	43	0.0169	28.5	8.425	0.267
	180	7.21	47	0.0185	29	8.572	0.271
	190	7.61	50	0.0197	36	10.642	0.337
	200	8.01	54	0.0213	41.5	12.267	0.388
	210	8.41	49	0.0193	31.5	9.311	0.295
	220	8.81	62	0.0244	26	7.686	0.243
	230	9.21	77	0.0303	22	6.503	0.206
	240	9.61	70	0.0276	19	5.616	0.178
2.8287	250	10.01	74	0.0291	16	4.730	0.150

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{10.01}{2.8287} = 3.540\%/\text{min}$$



Gambar L7.7 Grafik hubungan *strain vs shear stress* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.2	Kg/cm ²
Ring constant		= 0.2956	Kg/div

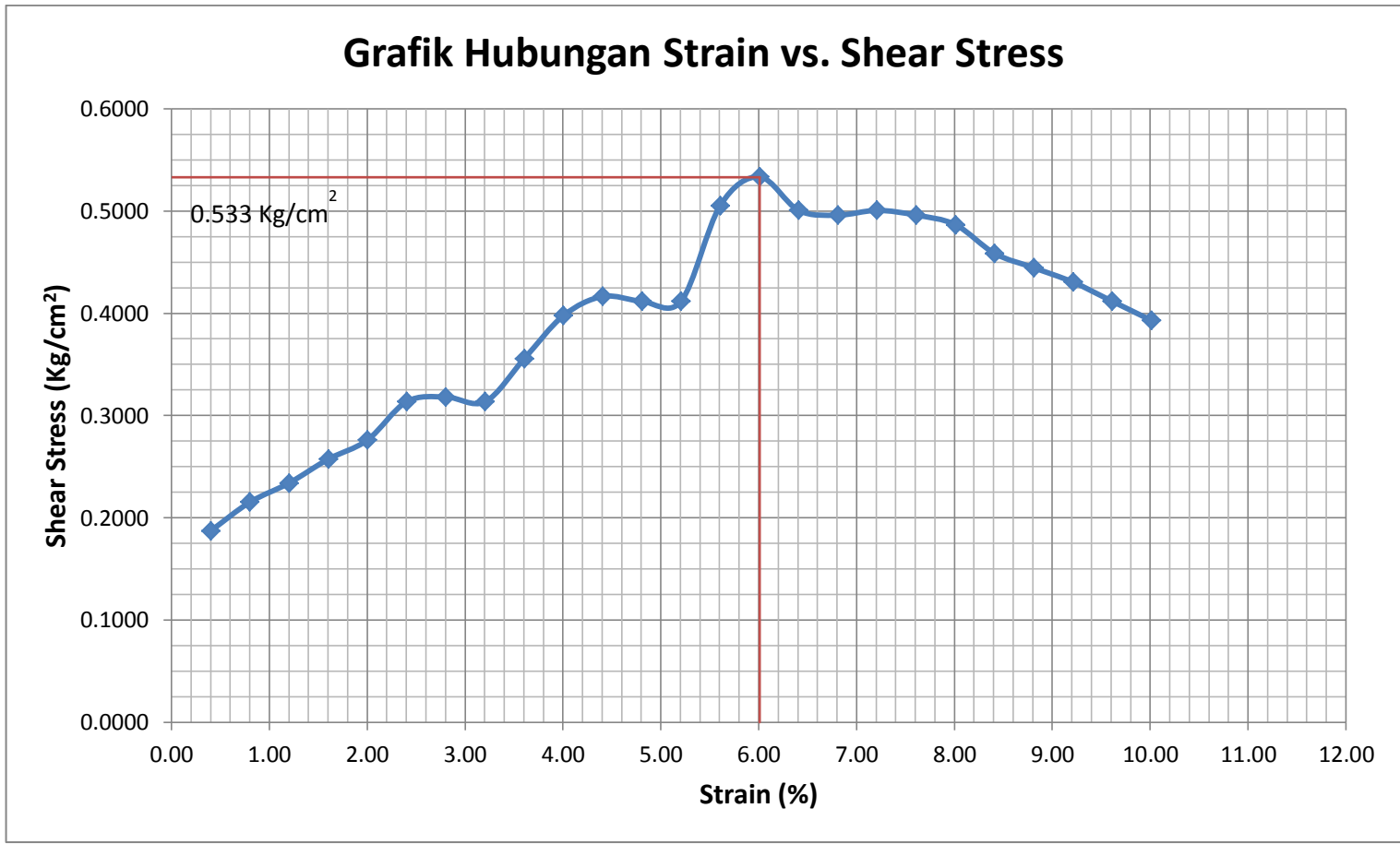
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 73.3	gr
Wt. cont + wet soil	(W_2)	= 186	gr
Wt. cont + dry soil	(W_3)	= 145.5	gr
Wt. of water	(W_w)	= 40.5	gr
Wt. of dry soil	(W_s)	= 72.2	gr
Water content	(w)	= 56.09	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.669	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 95.253	%

Tabel L7.8 Data pengujian *direct shear* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.2$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	6	0.0024	20	5.912	0.187
	20	0.80	13	0.0051	23	6.799	0.215
	30	1.20	14	0.0055	25	7.390	0.234
	40	1.60	15	0.0059	27.5	8.129	0.257
	50	2.00	14	0.0055	29.5	8.720	0.276
	60	2.40	14	0.0055	33.5	9.903	0.313
	70	2.80	14	0.0055	34	10.050	0.318
	80	3.20	13.5	0.0053	33.5	9.903	0.313
	90	3.60	14.5	0.0057	38	11.233	0.356
	100	4.01	13	0.0051	42.5	12.563	0.398
	110	4.41	11	0.0043	44.5	13.154	0.416
	120	4.81	7	0.0028	44	13.006	0.412
	130	5.21	5	0.0020	44	13.006	0.412
	140	5.61	3	0.0012	54	15.962	0.505
	150	6.01	1	0.0004	57	16.849	0.533
	160	6.41	3	0.0012	53.5	15.815	0.501
	170	6.81	8	0.0031	53	15.667	0.496
	180	7.21	11	0.0043	53.5	15.815	0.501
	190	7.61	14	0.0055	53	15.667	0.496
	200	8.01	16	0.0063	52	15.371	0.487
	210	8.41	20	0.0079	49	14.484	0.459
	220	8.81	25	0.0098	47.5	14.041	0.444
	230	9.21	27.5	0.0108	46	13.598	0.430
	240	9.61	30	0.0118	44	13.006	0.412
2.9297	250	10.01	31	0.0122	42	12.415	0.393

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{10.01}{2.9297} = 3.418 \%/min$$



Gambar L7.8 Grafik hubungan *strain vs shear stress* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.3	Kg/cm ²
Ring constant		= 0.2956	Kg/div

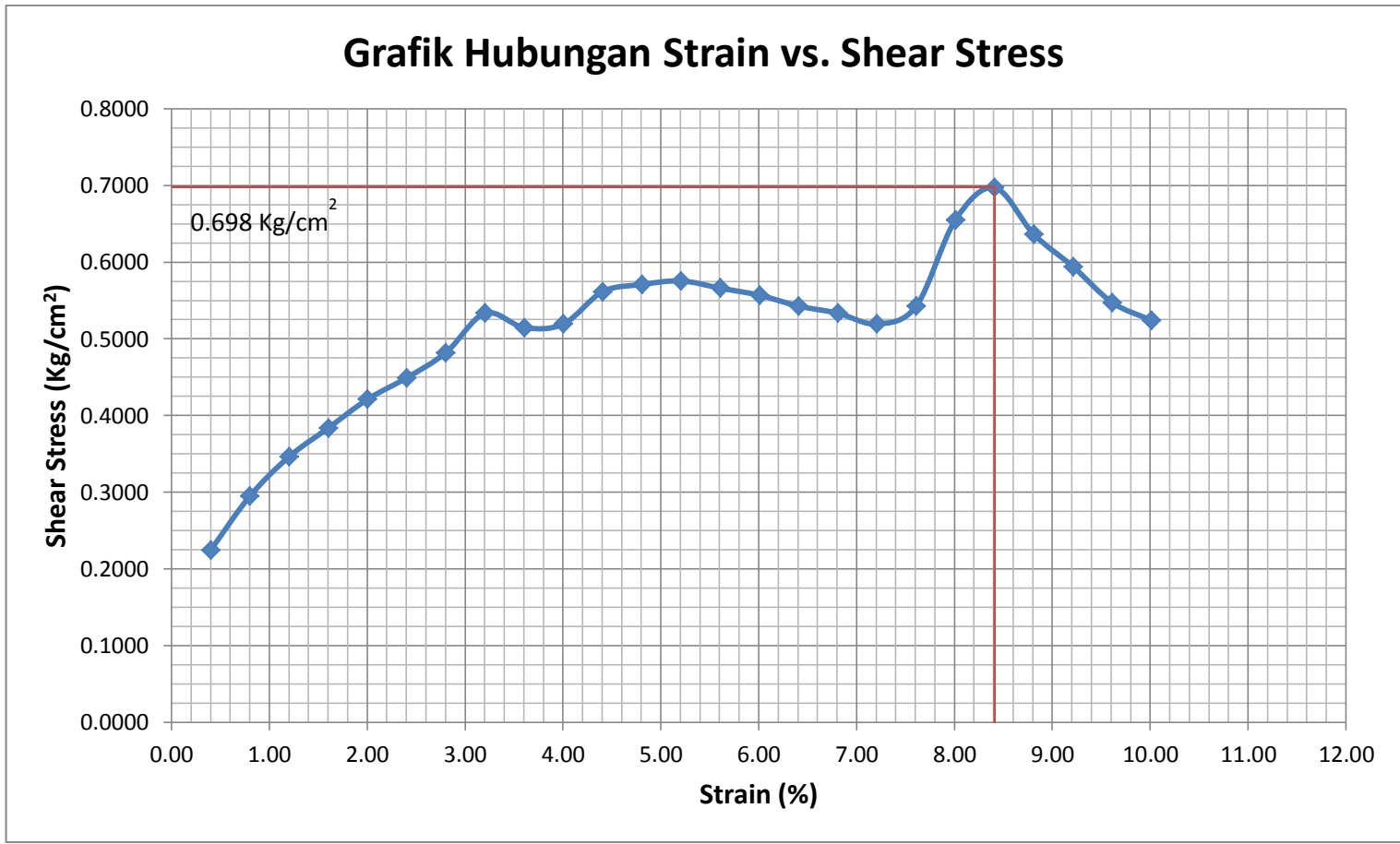
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 67.6	gr
Wt. cont + wet soil	(W_2)	= 183.2	gr
Wt. cont + dry soil	(W_3)	= 141.8	gr
Wt. of water	(W_w)	= 41.4	gr
Wt. of dry soil	(W_s)	= 74.2	gr
Water content	(w)	= 55.80	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.670	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 94.745	%

Tabel L7.9 Data pengujian *direct shear* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.3$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	3.5	0.0014	24	7.094	0.225
	20	0.80	6	0.0024	31.5	9.311	0.295
	30	1.20	5.5	0.0022	37	10.937	0.346
	40	1.60	4	0.0016	41	12.120	0.384
	50	2.00	3.5	0.0014	45	13.302	0.421
	60	2.40	4	0.0016	48	14.189	0.449
	70	2.80	3	0.0012	51.5	15.223	0.482
	80	3.20	1	0.0004	57	16.849	0.533
	90	3.60	4	0.0016	55	16.258	0.515
	100	4.01	9	0.0035	55.5	16.406	0.519
	110	4.41	13	0.0051	60	17.736	0.561
	120	4.81	17	0.0067	61	18.032	0.571
	130	5.21	23.5	0.0093	61.5	18.179	0.575
	140	5.61	27	0.0106	60.5	17.884	0.566
	150	6.01	31	0.0122	59.5	17.588	0.557
	160	6.41	35	0.0138	58	17.145	0.543
	170	6.81	39	0.0154	57	16.849	0.533
	180	7.21	42	0.0165	55.5	16.406	0.519
	190	7.61	45	0.0177	58	17.145	0.543
	200	8.01	47.5	0.0187	70	20.692	0.655
	210	8.41	49.5	0.0195	74.5	22.022	0.697
	220	8.81	52	0.0205	68	20.101	0.636
	230	9.21	54	0.0213	63.5	18.771	0.594
	240	9.61	55	0.0217	58.5	17.293	0.547
2.944	250	10.01	57	0.0224	56	16.554	0.524

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{10.01}{2.944} = 3.401\%/min$$



Gambar L7.9 Grafik hubungan *strain vs shear stress* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Lampiran 7.4 Direct Shear kondisi $w_i + 15\%w_i$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.1	Kg/cm ²
Ring constant		= 0.2956	Kg/div

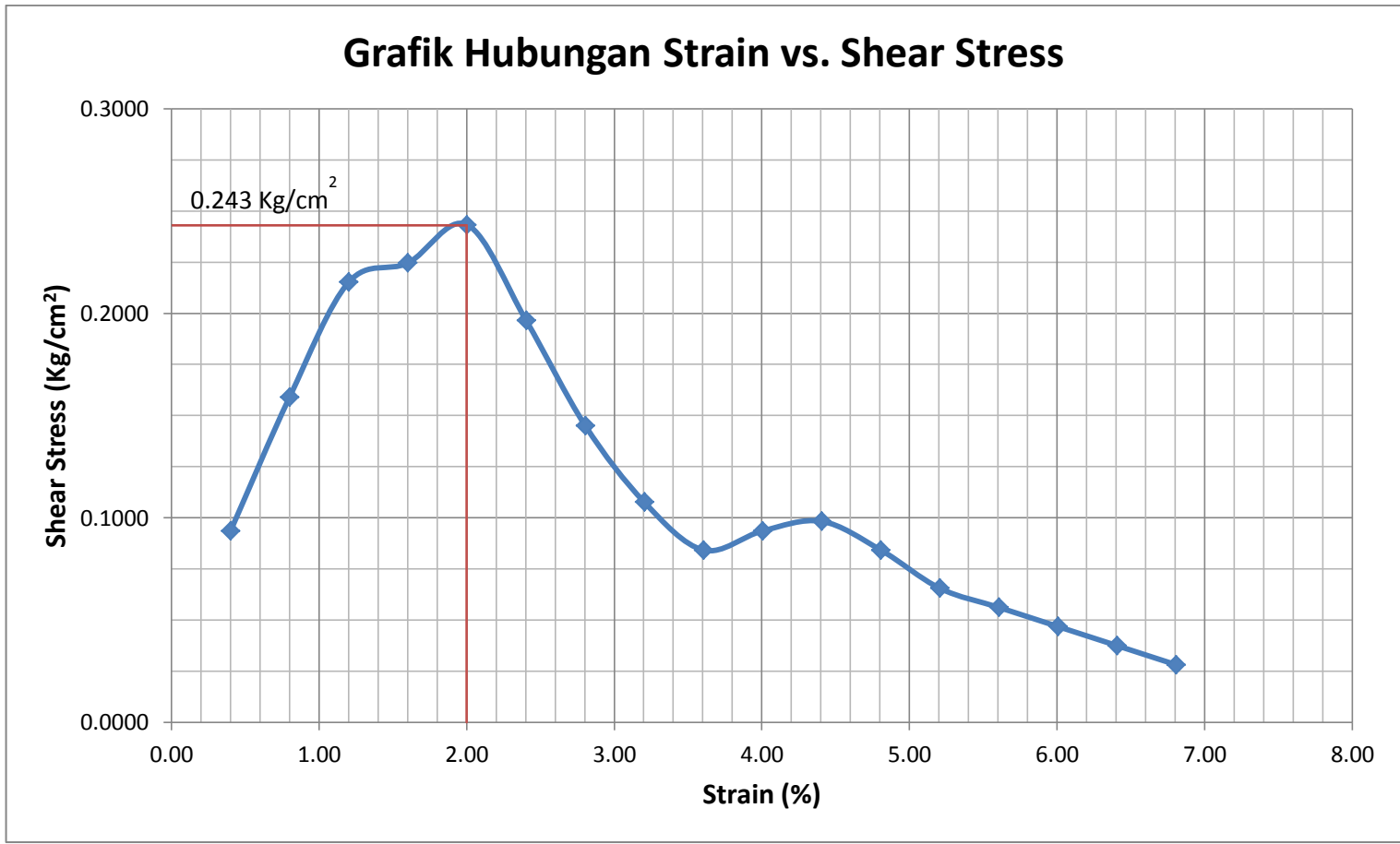
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 66.2	gr
Wt. cont + wet soil	(W_2)	= 182.4	gr
Wt. cont + dry soil	(W_3)	= 140.3	gr
Wt. of water	(W_w)	= 42.1	gr
Wt. of dry soil	(W_s)	= 74.1	gr
Water content	(w)	= 56.82	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.666	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 96.477	%

**Tabel L7.10 Data pengujian *direct shear* kondisi $w_i + 12\%w_i$ dengan $\sigma_n = 0.1$
Kg/cm²**

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	6	0.0024	10	2.956	0.094
	20	0.80	12	0.0047	17	5.025	0.159
	30	1.20	22	0.0087	23	6.799	0.215
	40	1.60	31	0.0122	24	7.094	0.225
	50	2.00	40	0.0157	26	7.686	0.243
	60	2.40	50	0.0197	21	6.208	0.197
	70	2.80	60	0.0236	15.5	4.582	0.145
	80	3.20	68	0.0268	11.5	3.399	0.108
	90	3.60	71	0.0280	9	2.660	0.084
	100	4.01	75	0.0295	10	2.956	0.094
	110	4.41	80	0.0315	10.5	3.104	0.098
	120	4.81	85	0.0335	9	2.660	0.084
	130	5.21	89	0.0350	7	2.069	0.066
	140	5.61	91	0.0358	6	1.774	0.056
	150	6.01	92	0.0362	5	1.478	0.047
	160	6.41	95	0.0374	4	1.182	0.037
1.917	170	6.81	96	0.0378	3	0.887	0.028

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{6.81}{1.917} = 3.552 \text{ \%/min}$$



Gambar L7.10 Grafik hubungan *strain vs shear stress* kondisi $w_i + 15\%w_i$ dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.2	Kg/cm ²
Ring constant		= 0.2956	Kg/div

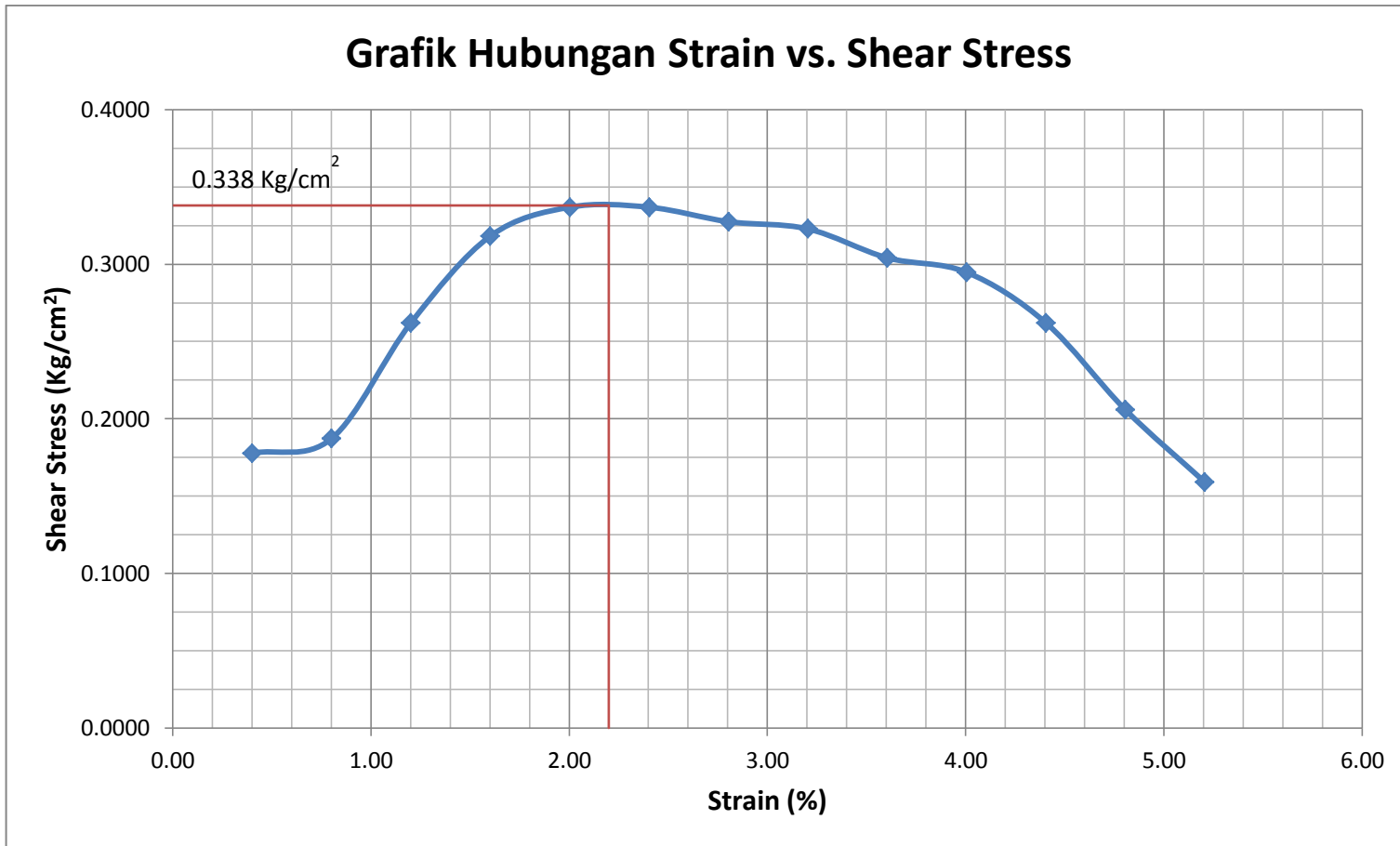
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 61.7	gr
Wt. cont + wet soil	(W_2)	= 199.8	gr
Wt. cont + dry soil	(W_3)	= 149.7	gr
Wt. of water	(W_w)	= 50.1	gr
Wt. of dry soil	(W_s)	= 88	gr
Water content	(w)	= 56.93	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.665	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 96.676	%

Tabel L7.11 Data pengujian *direct shear* kondisi $w_i + 15\%w_i$ dengan $\sigma_n = 0.2$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	1	0.0004	19	5.616	0.178
	20	0.80	0	0.0000	20	5.912	0.187
	30	1.20	1	0.0004	28	8.277	0.262
	40	1.60	4	0.0016	34	10.050	0.318
	50	2.00	5	0.0020	36	10.642	0.337
	60	2.40	8	0.0031	36	10.642	0.337
	70	2.80	9	0.0035	35	10.346	0.328
	80	3.20	14	0.0055	34.5	10.198	0.323
	90	3.60	18	0.0071	32.5	9.607	0.304
	100	4.01	25	0.0098	31.5	9.311	0.295
	110	4.41	29	0.0114	28	8.277	0.262
	120	4.81	32	0.0126	22	6.503	0.206
1.487	130	5.21	33	0.0130	17	5.025	0.159

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{5.21}{1.487} = 3.501 \text{ \% / min}$$



Gambar L7.11 Grafik hubungan *strain vs shear stress* kondisi $w_i + 15\%w_i$ dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.3	Kg/cm ²
Ring constant		= 0.2956	Kg/div

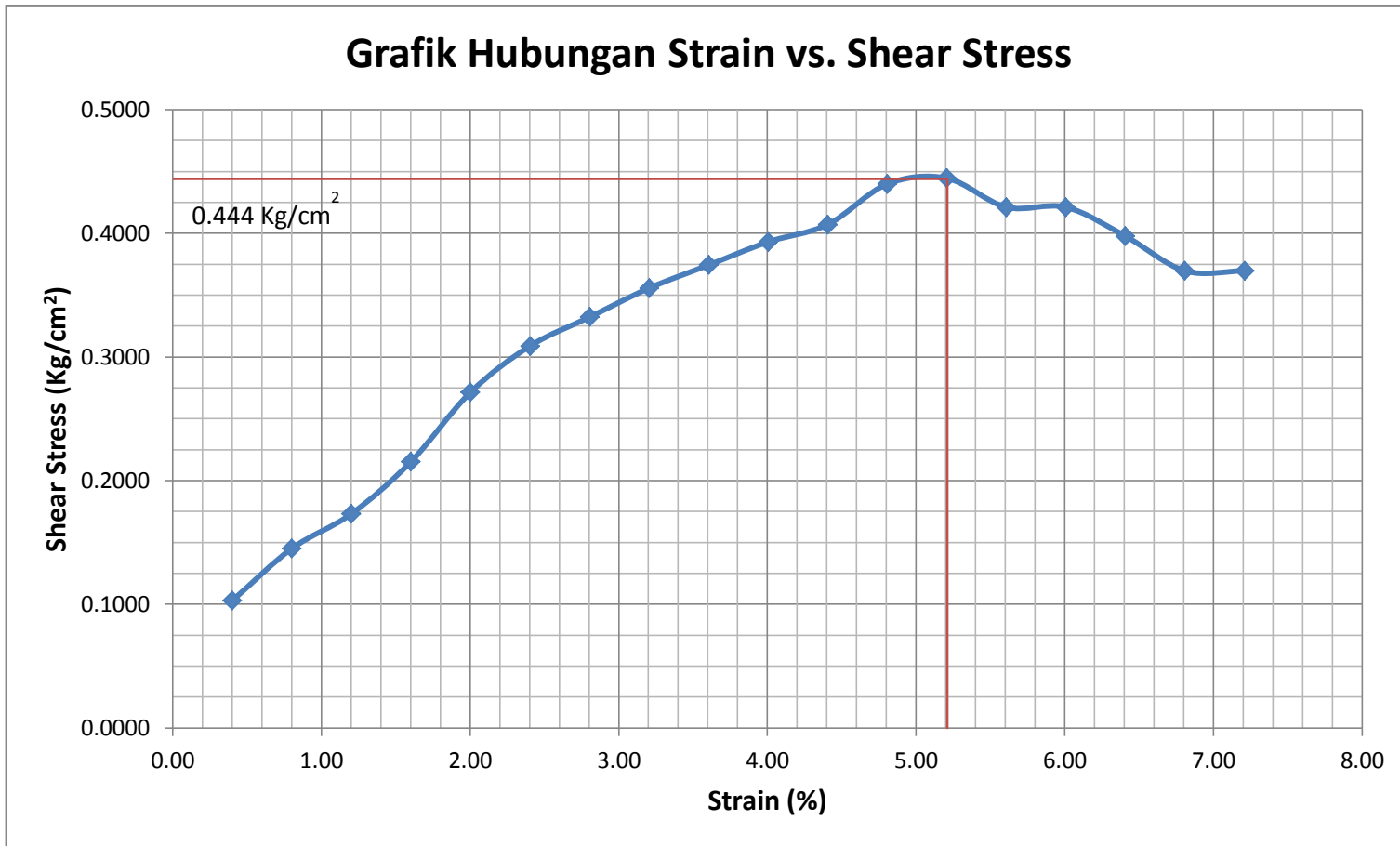
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 68.5	gr
Wt. cont + wet soil	(W_2)	= 209.8	gr
Wt. cont + dry soil	(W_3)	= 158.4	gr
Wt. of water	(W_w)	= 51.4	gr
Wt. of dry soil	(W_s)	= 89.9	gr
Water content	(w)	= 57.17	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.664	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 97.088	%

Tabel L7.12 Data pengujian *direct shear* kondisi $w_i + 15\%w_i$ dengan $\sigma_n = 0.3$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	5	0.0020	11	3.252	0.103
	20	0.80	10	0.0039	15.5	4.582	0.145
	30	1.20	13	0.0051	18.5	5.469	0.173
	40	1.60	15	0.0059	23	6.799	0.215
	50	2.00	15	0.0059	29	8.572	0.271
	60	2.40	18	0.0071	33	9.755	0.309
	70	2.80	18.5	0.0073	35.5	10.494	0.332
	80	3.20	17.5	0.0069	38	11.233	0.356
	90	3.60	16	0.0063	40	11.824	0.374
	100	4.01	14	0.0055	42	12.415	0.393
	110	4.41	13	0.0051	43.5	12.859	0.407
	120	4.81	10	0.0039	47	13.893	0.440
	130	5.21	9	0.0035	47.5	14.041	0.444
	140	5.61	8	0.0031	45	13.302	0.421
	150	6.01	7	0.0028	45	13.302	0.421
	160	6.41	7	0.0028	42.5	12.563	0.398
	170	6.81	6.5	0.0026	39.5	11.676	0.370
2.004	180	7.21	6	0.0024	39.5	11.676	0.370

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{7.21}{2.004} = 3.597 \text{ \%/min}$$



Gambar L7.12 Grafik hubungan *strain vs shear stress* kondisi $w_i + 15\%w_i$ dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Lampiran 7.5 Direct Shear kondisi jenuh

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.1	Kg/cm ²
Ring constant		= 0.2956	Kg/div

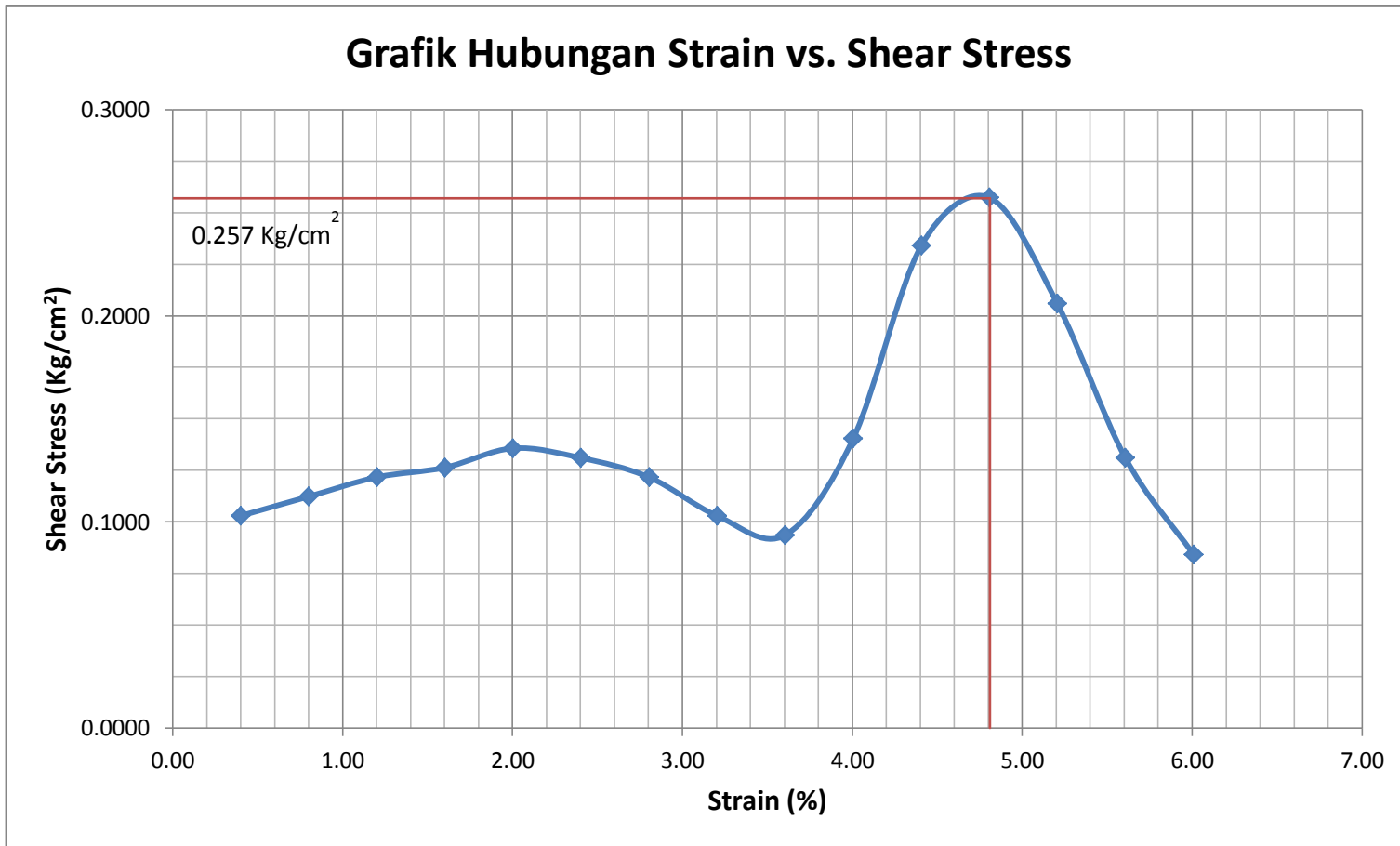
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 83	gr
Wt. cont + wet soil	(W_2)	= 207.1	gr
Wt. cont + dry soil	(W_3)	= 149.4	gr
Wt. of water	(W_w)	= 57.7	gr
Wt. of dry soil	(W_s)	= 66.4	gr
Water content	(w)	= 86.90	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.559	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 147.560	%

**Tabel L7.13 Data pengujian *direct shear* kondisi jenuh dengan $\sigma_n = 0.1$
Kg/cm²**

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	0	0.0000	11	3.252	0.103
	20	0.80	1	0.0004	12	3.547	0.112
	30	1.20	1.8	0.0007	13	3.843	0.122
	40	1.60	4	0.0016	13.5	3.991	0.126
	50	2.00	10	0.0039	14.5	4.286	0.136
	60	2.40	15	0.0059	14	4.138	0.131
	70	2.80	18.8	0.0074	13	3.843	0.122
	80	3.20	21.5	0.0085	11	3.252	0.103
	90	3.60	22	0.0087	10	2.956	0.094
	100	4.01	22.5	0.0089	15	4.434	0.140
	110	4.41	22.3	0.0088	25	7.390	0.234
	120	4.81	22.5	0.0089	27.5	8.129	0.257
	130	5.21	22.5	0.0089	22	6.503	0.206
	140	5.61	22	0.0087	14	4.138	0.131
1.747	150	6.01	22	0.0087	9	2.660	0.084

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{6.01}{1.747} = 3.439 \text{ \%/min}$$



Gambar L7.13 Grafik hubungan *strain vs shear stress* kondisi jenuh dengan $\sigma_n = 0.1 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.2	Kg/cm ²
Ring constant		= 0.2956	Kg/div

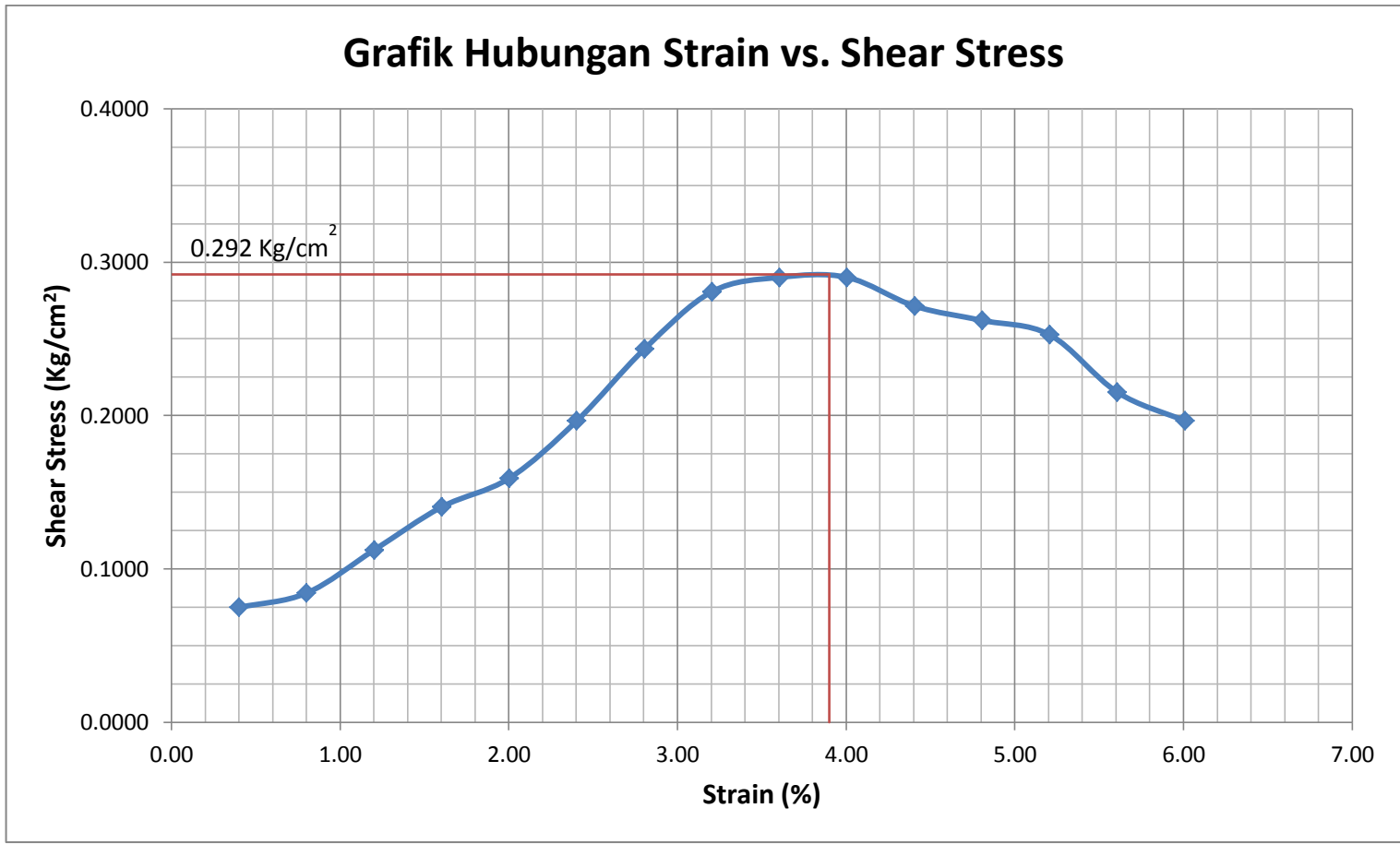
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 83	gr
Wt. cont + wet soil	(W_2)	= 205.2	gr
Wt. cont + dry soil	(W_3)	= 150.6	gr
Wt. of water	(W_w)	= 54.6	gr
Wt. of dry soil	(W_s)	= 67.6	gr
Water content	(w)	= 80.77	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.578	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 137.154	%

Tabel L7.14 Data pengujian *direct shear* kondisi jenuh dengan $\sigma_n = 0.2$
Kg/cm²

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm ²)
	10	0.40	3	0.0012	8	2.365	0.075
	20	0.80	11	0.0043	9	2.660	0.084
	30	1.20	18	0.0071	12	3.547	0.112
	40	1.60	24	0.0094	15	4.434	0.140
	50	2.00	31	0.0122	17	5.025	0.159
	60	2.40	35	0.0138	21	6.208	0.197
	70	2.80	39	0.0154	26	7.686	0.243
	80	3.20	41	0.0161	30	8.868	0.281
	90	3.60	43.5	0.0171	31	9.164	0.290
	100	4.01	46	0.0181	31	9.164	0.290
	110	4.41	47	0.0185	29	8.572	0.271
	120	4.81	46	0.0181	28	8.277	0.262
	130	5.21	47.5	0.0187	27	7.981	0.253
	140	5.61	47.8	0.0188	23	6.799	0.215
1.814	150	6.01	47.5	0.0187	21	6.208	0.197

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{6.01}{1.814} = 3.312 \text{ \%/min}$$



Gambar L7.14 Grafik hubungan *strain vs shear stress* kondisi jenuh dengan $\sigma_n = 0.2 \text{ Kg/cm}^2$

Data pengujian

Diameter	(D)	= 6.342	cm
Height	(t)	= 2.540	cm
Area	(A)	= 31.589	cm ²
Volume	(V)	= 80.237	cm ³
Normal stress	(σ_n)	= 0.3	Kg/cm ²
Ring constant		= 0.2956	Kg/div

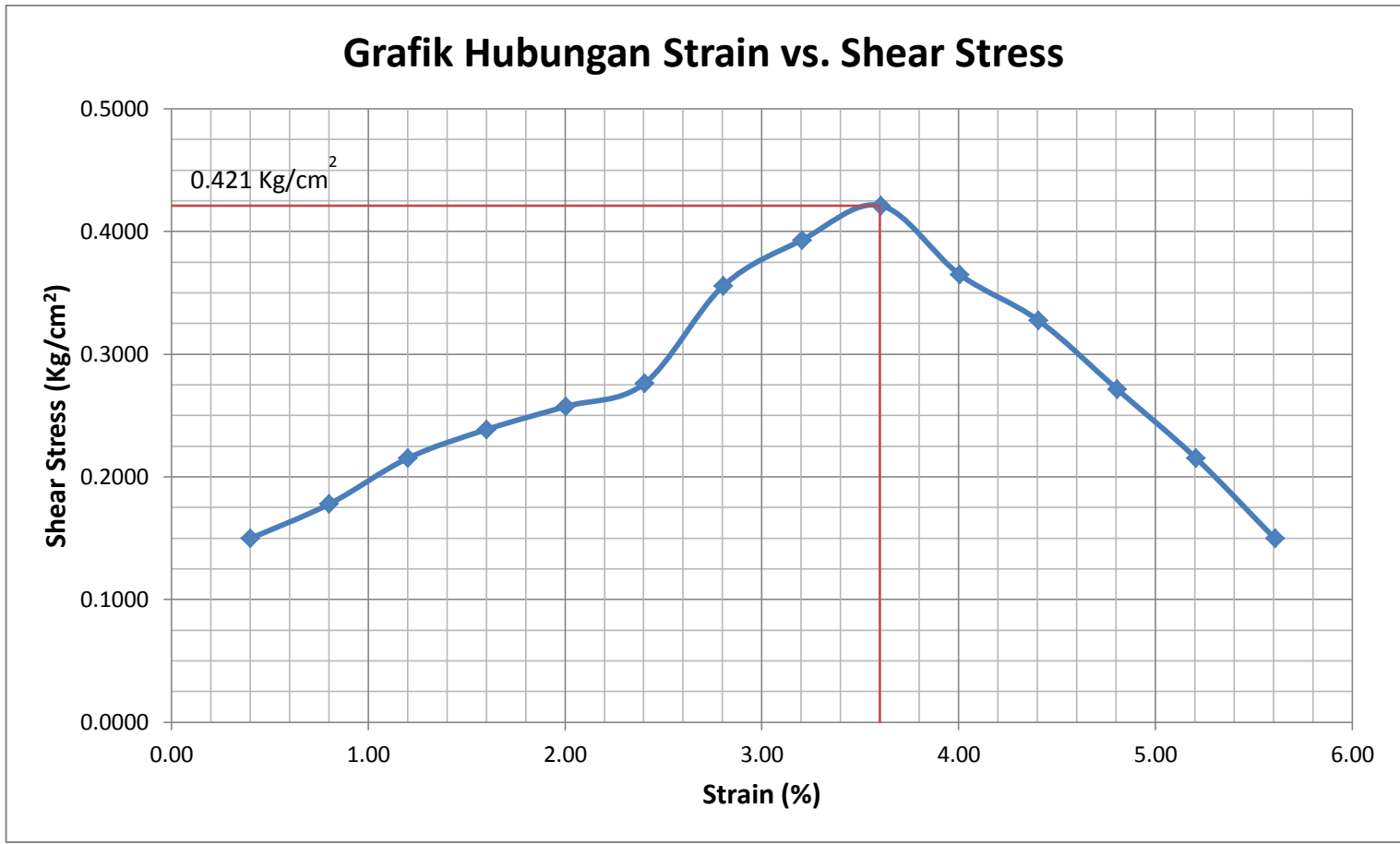
Soil specimen properties

Container no		= 1	
Wt. of container	(W_1)	= 83	gr
Wt. cont + wet soil	(W_2)	= 219	gr
Wt. cont + dry soil	(W_3)	= 161	gr
Wt. of water	(W_w)	= 58	gr
Wt. of dry soil	(W_s)	= 78	gr
Water content	(w)	= 74.36	%
Wet density	(γ_{wet})	= 1.044	gr/cm ³
Dry density	(γ_{dry})	= 0.599	gr/cm ³
Angka pori	(e)	= 1.596	
Porositas	(n)	= 0.615	
Derajat kejenuhan	(S_r)	= 126.269	%

**Tabel L7.15 Data pengujian *direct shear* kondisi jenuh dengan $\sigma_n = 0.3$
Kg/cm²**

Elapsed Time (minute)	Horizontal Dial (0,0254 mm)	Strain (%)	Vertical Dial (0,01 mm)	Vertical Displacement	Proving Ring Dial (div)	Shear Force (Kg)	Shear Stress (Kg/cm²)
	10	0.40	4.7	0.0019	16	4.730	0.150
	20	0.80	8	0.0031	19	5.616	0.178
	30	1.20	11	0.0043	23	6.799	0.215
	40	1.60	15	0.0059	25.5	7.538	0.239
	50	2.00	17.8	0.0070	27.5	8.129	0.257
	60	2.40	20	0.0079	29.5	8.720	0.276
	70	2.80	23	0.0091	38	11.233	0.356
	80	3.20	24.5	0.0096	42	12.415	0.393
	90	3.60	25.2	0.0099	45	13.302	0.421
	100	4.01	25.2	0.0099	39	11.528	0.365
	110	4.41	25	0.0098	35	10.346	0.328
	120	4.81	24.9	0.0098	29	8.572	0.271
	130	5.21	24	0.0094	23	6.799	0.215
1.864	140	5.61	21	0.0083	16	4.730	0.150

$$\text{Strain rate} = \frac{\text{Strain}}{\text{ElapsedTime}} = \frac{5.61}{1.864} = 3.008 \text{ \%/min}$$



Gambar L7.15 Grafik hubungan *strain vs shear stress* kondisi jenuh dengan $\sigma_n = 0.3 \text{ Kg/cm}^2$

Foto-foto alat dan proses pengujian



Gambar L7.16 *Shear box* bagian bawah dan blok pengaku



Gambar L7.17 *Shear box* bagian atas



Gambar L7.18 *Proving ring* dan alat pengukur



Gambar L7.19 Ring pencetak tanah untuk *direct shear*