

VI. CONCLUSION AND SUGGESTION

6.1. Conclusion

Based on the experimental investigations and data analysis from previous chapter, research found several conclusion as follows:

1. Addition of lime content can decrease the plasticity index of soil. Optimum lime content is 6%, with 44.27% maximum decrement of liquid limit, 28.50% maximum increment of plastic limit and 15.77% maximum decrement of plasticity index.
2. Soil specimens with 2%, 4%, 6%, and 8% of lime content have increasing cohesion value (c) in 7 and 14 days curing time but in 28 days it shows the decrement of cohesion (c), and friction angle (ϕ) are varied in 7 days curing time, but in 14 and 28 days curing time it starts to increase.
3. Soil specimen that mixed with 6% lime content and 10%, 15%, and 20% press mud have decreasing cohesion value (c), and increasing friction angle (ϕ) compare to original soil along the time curing periods. Specimen with 6% lime and 20% press mud show maximum decrement of cohesion about 0.
4. The result of direct shear test shows not only specimen with lime but also specimen with lime and press mud specimen indicates the improvement of shear strength (τ). The shear strength of clay which is added by lime mixed with press mud is provides better result than lime only additive.
5. In summary, clay with 6% lime and 20% press mud content in 28 days curing time reaches value of shear strength (τ) about 59.32%. This lime-press mud

content provides a good result in increasing the shear strength. Whether, the addition of press mud content is from 0% up to 20%.

6.2. Suggestion

Based on experiments on the laboratory, several suggestions made for the next researchers are:

1. It is better to check chemical content of the soil, to check the percentage of silica in the soil.
2. Minimize human error when doing experimental investigations and operating the apparatus.
3. For the next researcher, it is better to check whether the press mud content increase ($>20\%$), the shear strength still increases or not.
4. It needs to conduct other test to determine shear strength of soil such as; Triaxial test and unconfined compressive strength test to get the better result.

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APPENDICES



APPENDICES

APPENDIX 1

Original Soil

I. Water Content Test

Sample Number		A	B
Weight of tin-box	W ₁ gram	10.10	8.72
Weight of tin-box + wet soil	W ₂ gram	44.75	43.22
Weight of tin-box + dry soil	W ₃ gram	31.32	29.80
Weight of water	(W ₂ -W ₃) gram	13.43	13.42
Weight of dry soil	(W ₃ -W ₁) gram	21.22	21.08
Water content (ω)	$\frac{(W_2-W_3)}{(W_3-W_1)} \times 100\%$	63.29	63.66
Average water content (%)		63.48	

II. Specific Gravity Test

No. Picnometer		A	B
Weight of Picnometer	W ₁ gram	30.56	28.30
Weight of Picnometer + Dry Soil	W ₂ gram	44.51	44.61
Weight of Picnometer + Dry Soil +Water	W ₃ gram	88.89	87.64
Weight of Picnometer + Water	W ₄ gram	80.72	78.05
Temperature	t	29	29
W ₂ - W ₁	A gram	13.95	16.31
W ₃ - W ₄	B gram	8.17	9.59
A-B	C gram	5.78	6.72
Specific Gravity	$G = \frac{A}{C}$	2.4135	2.4271
Average Specific Gravity	$G_{avg} = \frac{G_A + G_B}{2}$	2.4203	



III. Sieve Analysis

Sieve No.	Grain Size (mm)	Weight of Sieve	Weight of Sieve + Soil	Retained Weight	Passing Weight	Percent Passing
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	$e = (d - c)$	$f = J - e$	$g = \frac{f}{J} \times 100\%$
#4	4.750	585.24	597.83	12.6	87.4	87.41
#10	2.000	530.89	533.89	3.0	84.4	84.41
#20	0.850	487.27	491.51	4.2	80.17	80.17
#40	0.425	435.97	440.25	4.3	75.89	75.89
#60	0.250	435.42	439.34	3.9	71.97	71.97
#140	0.106	427.22	433.16	5.9	66.03	66.03
#200	0.075	415.03	416.15	1.1	64.9	64.91
Pan				64.91		
Jumlah (<i>J</i>)				100		



HYDROMETER ANALYSIS

Hydrometer type	152 H	Dry weight of the soil	W = 100 gr
Meniscus Correction	m = 1		
Soil Unit Weight	G = 2.4203	For Hydrometer 151 H, $K_1 = \left(\frac{100000}{w} \times \frac{G}{G-1} \right)$	-
Correction for Hydrometer 152 (List 2)	a = 1.0590		
Reagent	Na ₂ SiO ₃ / NaPO ₃	For Hydrometer 152 H, $K_2 = \left(\frac{a}{W} \right) \times 100$	1.0590
Amount of Reagent	3 ml/gr		

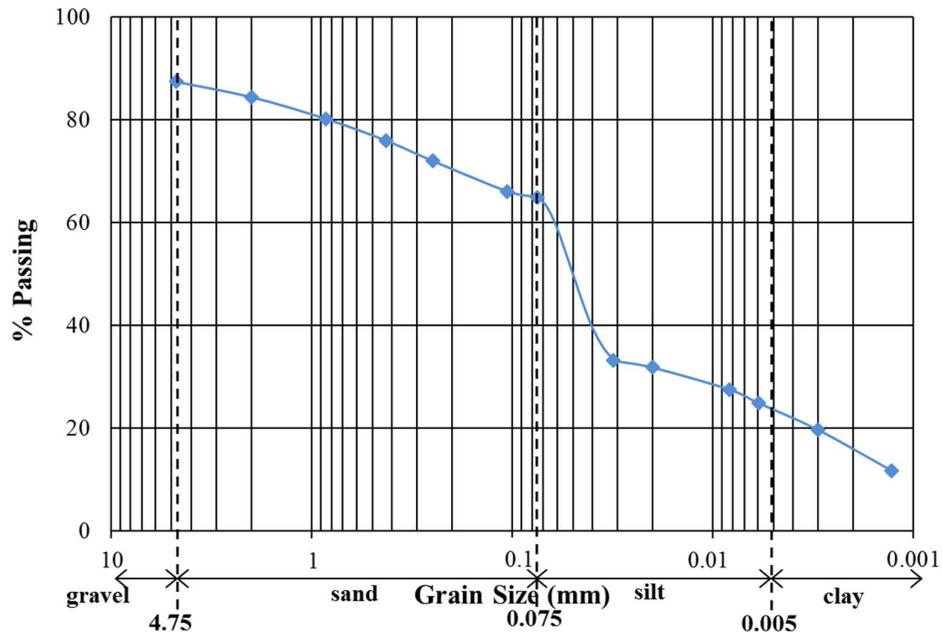
Date	Time	Period T (min)	R ₁	R ₂	Temperature °C	R' = R ₁ + m	L* (cm)	K**	Grain Diameter $D = K \sqrt{\frac{L}{T}}$ (mm)	R = R ₁ - R ₂ (mm)	Smaller Weight Percentage P*** (%)
17 Oct 2016	16.10	2	30	5	29	31	11.2	0.01325	0.03136	25	33.1268
17 Oct 2016	16.12	5	29	5	29	30	11.4	0.01325	0.02001	24	31.8017
17 Oct 2016	16.15	30	25	4	30	26	12.0	0.01311	0.00829	21	27.5325
17 Oct 2016	16.40	60	23	4	30	24	12.3	0.01311	0.00594	19	24.9104
17 Oct 2016	20.20	250	19	4	30	20	13.0	0.01311	0.00299	15	19.6661
18 Oct 2016	16.10	1440	13	4	30	14	14.0	0.01311	0.00129	9	11.7997

*) From List 2, based on R'

***) From List 3, based on t and G

**) Calculated using formula:

-for hydrometer 151 H, $p = K_1(R-1)$



Grain Size Analysis Graph



APPENDIX 2

**PLASTIC LIMIT TEST
ORIGINAL SOIL (0%)**

Project : Final Project
Location : Godean

Depth : -1 m

Code of tin box		a	b
Weight of empty tin box	(gr) w_t	16.90	17.30
Weight of tin box + wet soil	(gr) w_1	27.82	31.26
Weight of tinbox + dry soil	(gr) w_2	25.71	28.40
Weight of water	(gr) $w_w = w_1 - w_2$	2.11	2.86
Weight of dry soil	(gr) $w_s = w_2 - w_t$	8.81	11.10
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	23.95	25.77
Plastic Limit	(%)	24.86	



**LIQUID LIMIT TEST
 ORIGINAL SOIL (0%)**

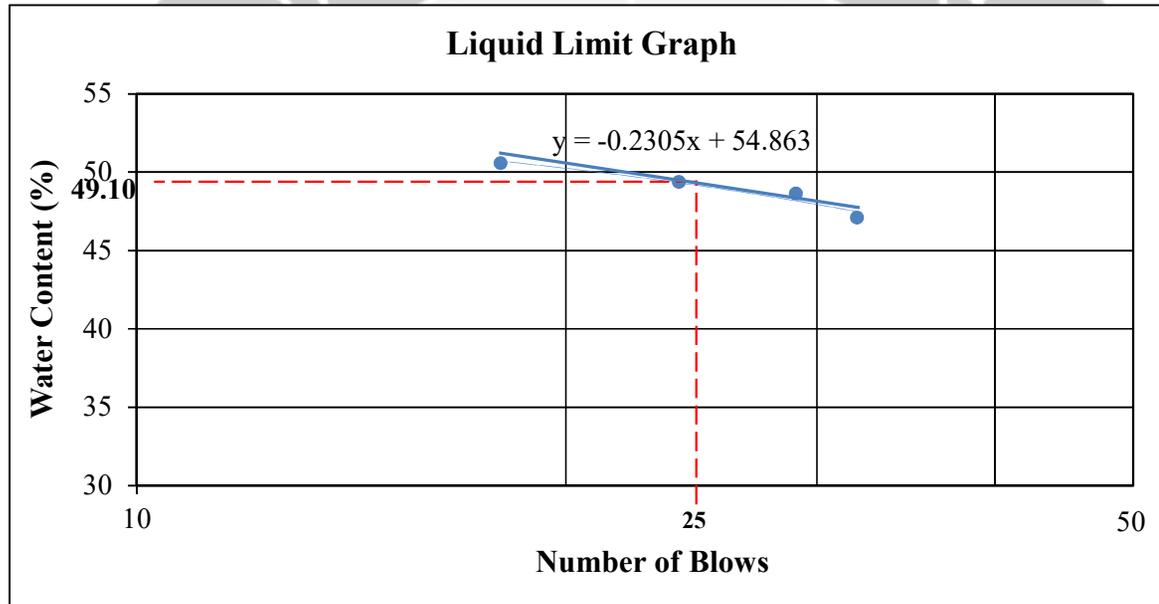
Project : Final Project

Depth : -1 m

Location : Godean

Number of test		15-20		21-24		26-30		31-40	
Number of blows		18		24		29		32	
Code of tin box		A1	A2	B1	B2	C1	C2	D1	D2
Weight of empty tin box	(gr) w_t	12.48	9.74	10.44	10.64	10.16	8.73	10.65	9.50
Weight of tin box + wet soil	(gr) w_1	32.03	27.84	29.12	28.07	35.31	35.72	41.43	33.40
Weight of tinbox + dry soil	(gr) w_2	25.43	21.79	22.89	22.36	27.04	26.93	31.52	25.79
Weight of water	(gr) $w_w = w_1 - w_2$	6.60	6.05	6.23	5.71	8.27	8.79	9.91	7.61
Weight of dry soil	(gr) $w_s = w_2 - w_t$	12.95	12.05	12.45	11.72	16.88	18.20	20.87	16.29
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	50.97	50.21	50.04	48.72	48.99	48.30	47.48	46.72
Average water content	(%)	50.59		49.38		48.64		47.10	

Liquid Limit (LL) = 49.10 %
 w_{10} = 52.56 %
 w_{100} = 31.81 %
 Flow Index (I_f) = $w_{10} - w_{100}$ = 20.75 %
 Plasticity index = LL-PL = 24.24 %





PLASTIC LIMIT TEST
Soil + 2% Lime

Project : Final Project
Location : Godean

Depth : -1 m

Code of tin box		a	b
Weight of empty tin box (gr)	w_t	10.23	10.46
Weight of tin box + wet soil (gr)	w_1	21.72	20.63
Weight of tinbox + dry soil (gr)	w_2	19.28	18.55
Weight of water (gr)	$w_w = w_1 - w_2$	2.44	2.08
Weight of dry soil (gr)	$w_s = w_2 - w_t$	9.05	8.09
Water content (%)	$w = \frac{w_w}{w_s} \times 100\%$	26.96	25.71
Plastic Limit (%)		26.34	



LIQUID LIMIT TEST

Soil + 2% Lime

Project : Final Project

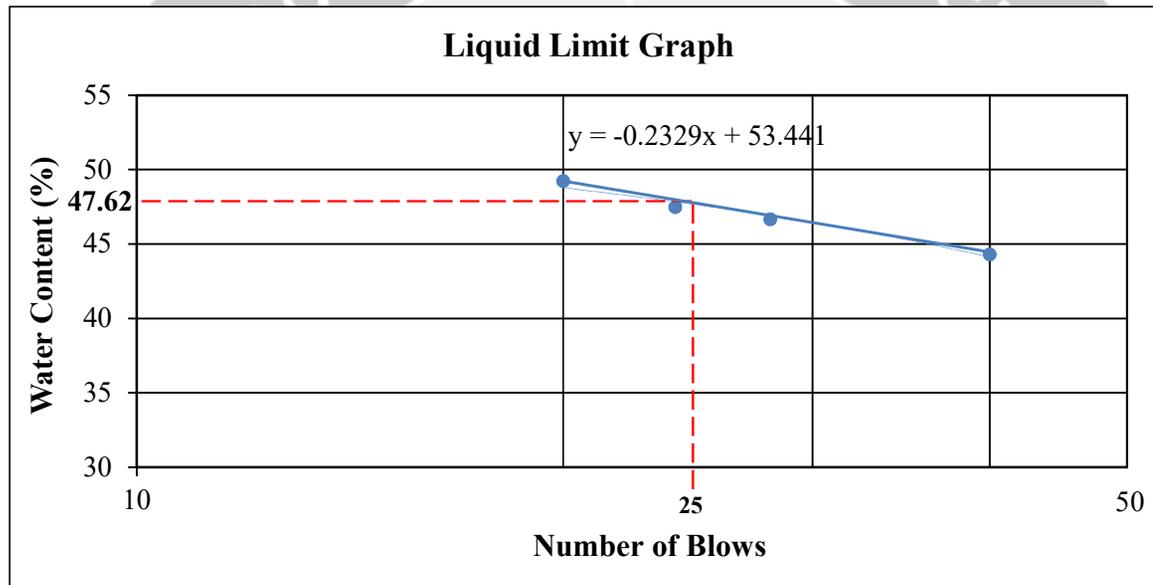
Depth : -1 m

Location : Godean

Number of test		15-20		21-24		26-30		31-40	
Number of blows		20		24		28		40	
Code of tin box		LL 1	LL 2	LL 3	LL 4	LL 5	LL 6	LL 7	LL 8
Weight of empty tin box	(gr) w_t	15.08	14.54	16.50	16.91	17.14	16.86	14.04	10.07
Weight of tin box + wet soil	(gr) w_1	40.80	35.18	39.61	42.62	53.98	52.19	42.12	39.42
Weight of tinbox + dry soil	(gr) w_2	32.34	28.35	32.20	34.31	42.26	40.95	33.47	30.44
Weight of water	(gr) $w_w = w_1 - w_2$	8.46	6.83	7.41	8.31	11.72	11.24	8.65	8.98
Weight of dry soil	(gr) $w_s = w_2 - w_t$	17.26	13.81	15.70	17.40	25.12	24.09	19.43	20.37
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	49.02	49.46	47.20	47.76	46.66	46.66	44.52	44.08
Average water content	(%)	49.24		47.48		46.66		44.30	

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Liquid Limit (LL) = 47.62 %
 w_{10} = 51.11 %
 w_{100} = 30.15 %
 Flow Index (I_f) = $w_{10} - w_{100}$ = 20.96 %
 Plasticity index = LL-PL = 21.28 %





PLASTIC LIMIT TEST
Soil + 4% Lime

Project : Final Project
Location : Godean

Depth : -1 m

Code of tin box		a	b
Weight of empty tin box (gr)	w_t	14.35	14.63
Weight of tin box + wet soil (gr)	w_1	30.23	27.42
Weight of tinbox + dry soil (gr)	w_2	26.78	24.73
Weight of water (gr)	$w_w = w_1 - w_2$	3.45	2.69
Weight of dry soil (gr)	$w_s = w_2 - w_t$	12.43	10.10
Water content (%)	$w = \frac{w_w}{w_s} \times 100\%$	27.71	26.63
Plastic Limit (%)		27.17	



LIQUID LIMIT TEST
 Soil + 4% Lime

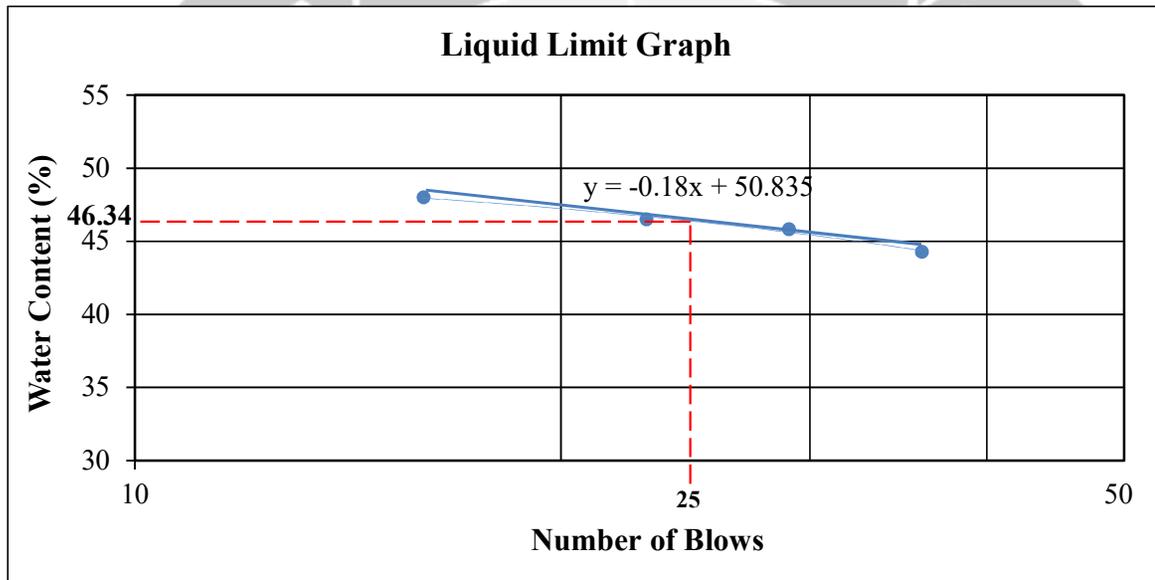
Project : Final Project

Depth : -1 m

Location : Godean

Number of test		15-20		21-24		26-30		31-40	
Number of blows		16		23		29		36	
Code of tin box		1A	1B	2A	2B	3A	3B	4A	4B
Weight of empty tin box	(gr) w_t	14.70	16.10	15.60	17.24	14.59	15.79	13.88	16.66
Weight of tin box + wet soil	(gr) w_1	33.46	35.85	38.02	38.40	37.17	41.92	39.58	41.85
Weight of tinbox + dry soil	(gr) w_2	27.35	29.47	30.94	31.65	30.04	33.75	31.71	34.10
Weight of water	(gr) $w_w = w_1 - w_2$	6.11	6.38	7.08	6.75	7.13	8.17	7.87	7.75
Weight of dry soil	(gr) $w_s = w_2 - w_t$	12.65	13.37	15.34	14.41	15.45	17.96	17.83	17.44
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	48.30	47.72	46.15	46.84	46.15	45.49	44.14	44.44
Average water content	(%)	48.01		46.50		45.82		44.29	

Liquid Limit (LL) = 46.34 %
 w_{10} = 49.04 %
 w_{100} = 32.84 %
 Flow Index (I_f) = $w_{10} - w_{100}$ = 16.20 %
 Plasticity index = LL-PL = 19.16 %





PLASTIC LIMIT TEST
Soil + 6% Lime

Project : Final Project
Location : Godean

Depth : -1 m

Code of tin box		a	b
Weight of empty tin box (gr)	w_t	15.15	16.73
Weight of tin box + wet soil (gr)	w_1	24.96	28.86
Weight of tinbox + dry soil (gr)	w_2	22.80	26.15
Weight of water (gr)	$w_w = w_1 - w_2$	2.16	2.71
Weight of dry soil (gr)	$w_s = w_2 - w_t$	7.65	9.42
Water content (%)	$w = \frac{w_w}{w_s} \times 100\%$	28.24	28.77
Plastic Limit (%)		28.50	



LIQUID LIMIT TEST

Soil + 6% Lime

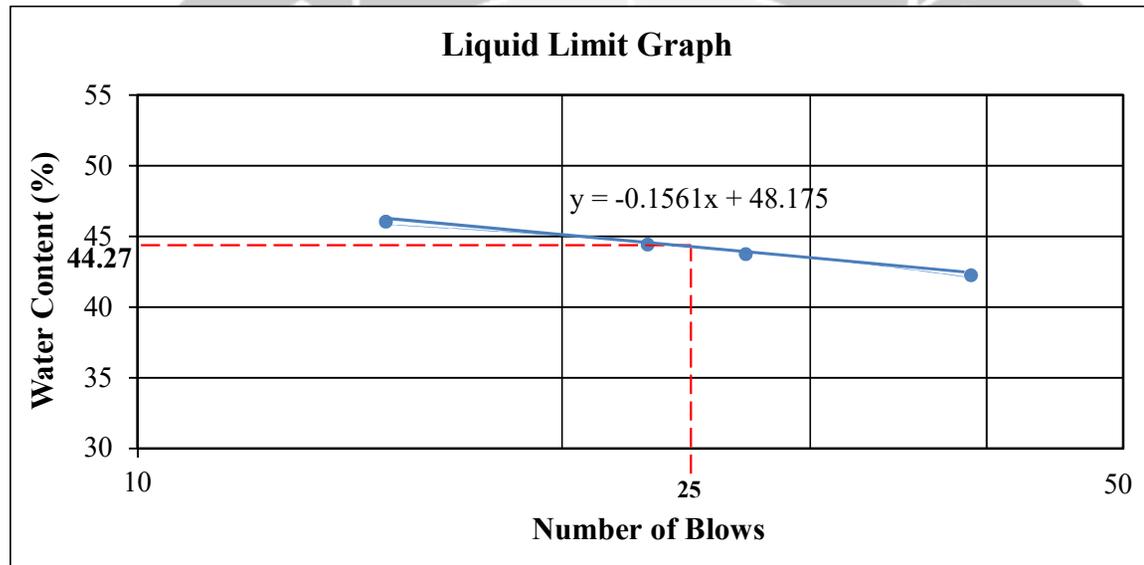
Project : Final Project

Depth : -1 m

Location : Godean

Number of test		15-20		21-24		26-30		31-40	
Number of blows		15		23		27		39	
Code of tin box		LL 1	LL 2	LL 3	LL 4	LL 5	LL 6	LL 7	LL 8
Weight of empty tin box	(gr) w_t	10.55	16.37	8.34	8.72	9.25	10.43	14.10	16.10
Weight of tin box + wet soil	(gr) w_1	34.68	52.47	41.27	38.69	45.21	41.48	44.79	46.18
Weight of tinbox + dry soil	(gr) w_2	27.05	41.12	31.11	29.50	34.20	32.09	35.64	37.28
Weight of water	(gr) $w_w = w_1 - w_2$	7.63	11.35	10.16	9.19	11.01	9.39	9.15	8.90
Weight of dry soil	(gr) $w_s = w_2 - w_t$	16.50	24.75	22.77	20.78	24.95	21.66	21.54	21.18
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	46.24	45.86	44.62	44.23	44.13	43.35	42.48	42.02
Average water content	(%)	46.05		44.42		43.74		42.25	

Liquid Limit (LL) = 44.27 %
 w_{10} = 46.61 %
 w_{100} = 32.57 %
 Flow Index (I_f) = $w_{10} - w_{100}$ = 16.20 %
 Plasticity index = LL-PL = 15.77 %





PLASTIC LIMIT TEST
Soil + 8% Lime

Project : Final Project
Location : Godean

Depth : -1 m

Code of tin box		PL1	PL2
Weight of empty tin box	(gr) w_t	14.61	17.05
Weight of tin box + wet soil	(gr) w_1	26.53	26.03
Weight of tinbox + dry soil	(gr) w_2	23.89	24.06
Weight of water	(gr) $w_w = w_1 - w_2$	2.64	1.97
Weight of dry soil	(gr) $w_s = w_2 - w_t$	9.28	7.01
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	28.45	28.10
Plastic Limit	(%)	28.28	



LIQUID LIMIT TEST
 Soil + 8% Lime

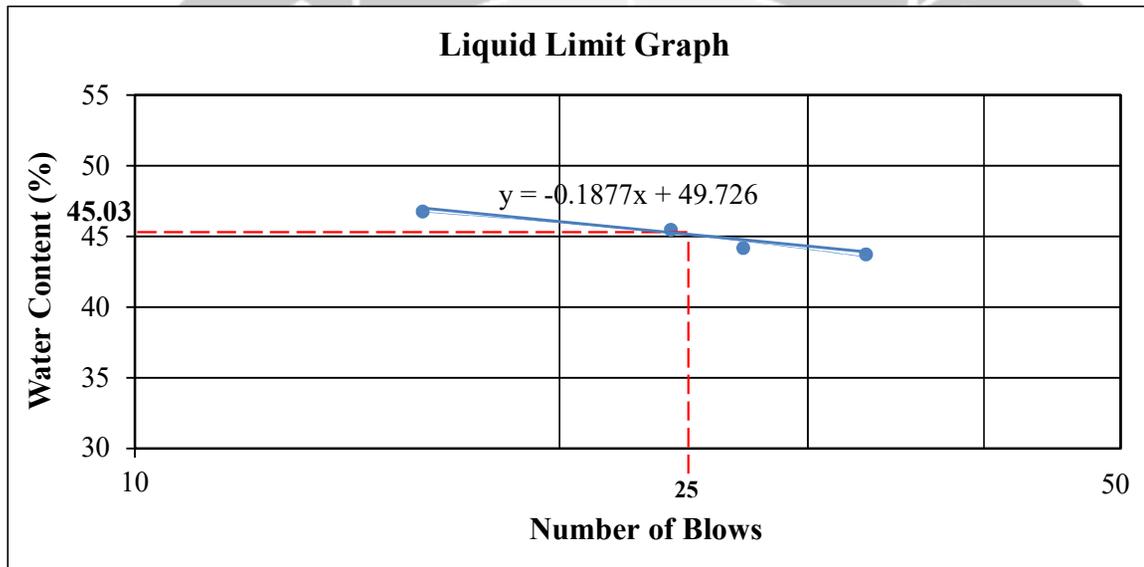
Project : Final Project

Depth : -1 m

Location : Godean

Number of test		15-20		21-24		26-30		31-40	
Number of blows		16		24		27		33	
Code of tin box		LL 1	LL 2	LL 3	LL 4	LL 5	LL 6	LL 7	LL 8
Weight of empty tin box	(gr) w_t	10.62	9.13	9.09	9.22	9.15	8.47	9.51	10.50
Weight of tin box + wet soil	(gr) w_1	46.66	46.63	33.36	33.58	32.23	33.74	51.43	45.44
Weight of tinbox + dry soil	(gr) w_2	35.18	34.68	25.75	25.99	25.19	25.96	38.62	34.86
Weight of water	(gr) $w_w = w_1 - w_2$	11.48	11.95	7.61	7.59	7.04	7.78	12.81	10.58
Weight of dry soil	(gr) $w_s = w_2 - w_t$	24.56	25.55	16.66	16.77	16.04	17.49	29.11	24.36
Water content	(%) $w = \frac{w_w}{w_s} \times 100\%$	46.74	46.77	45.68	45.26	43.89	44.48	44.01	43.43
Average water content	(%)	46.76		45.47		44.19		43.72	

Liquid Limit (LL) = 45.03 %
 w_{10} = 47.85 %
 w_{100} = 30.96 %
 Flow Index (I_f) = $w_{10} - w_{100}$ = 16.20 %
 Plasticity index = LL-PL = 16.76 %





APPENDIX 3

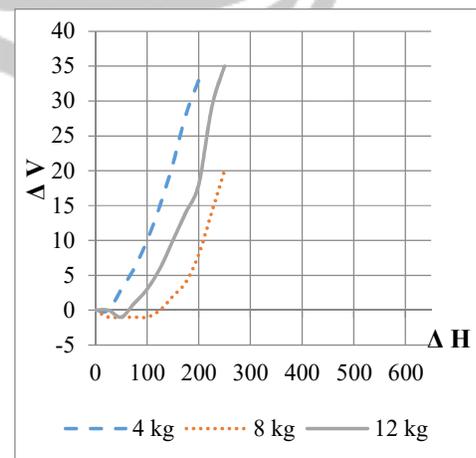
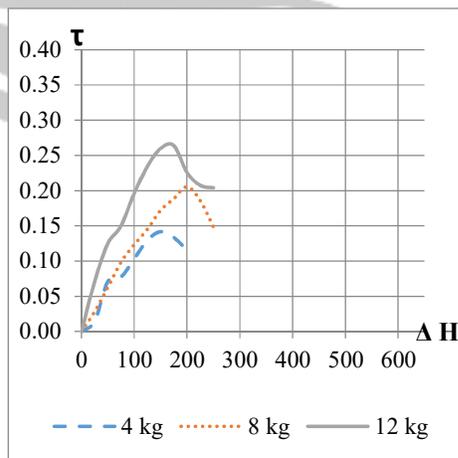
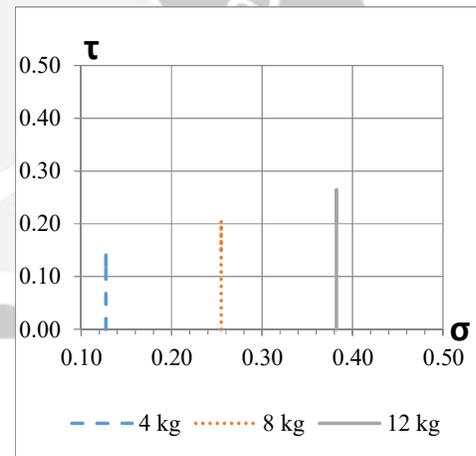
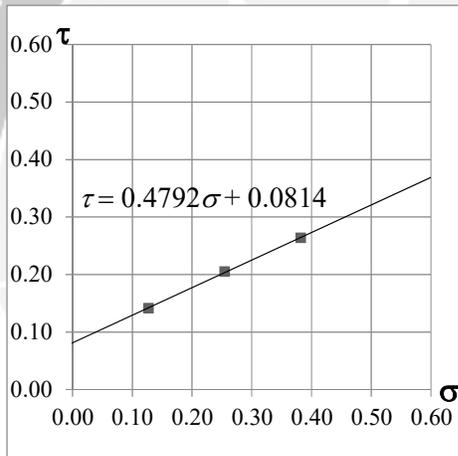
DIRECT SHEAR TEST
 Original Soil (0 day curing time)

Project : Final Project
Location : Godean
Date : 21 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1416	0.1274
8	0.2053	0.2549
12	0.2638	0.3823

$c = 0.0814 \text{ kg/cm}^2$
 $\tan \phi = 0.4792$
 $\phi = 25.60^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.370 gr
 γ_w : 1.569 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	10	0.44	0.0141	0.1274
50	3	0.0079	50	2.21	0.0710	0.1274
75	6	0.0119	55	2.39	0.0771	0.1274
100	10	0.0158	72	3.19	0.1033	0.1274
125	15	0.0198	90	3.98	0.1294	0.1274
150	21	0.0237	98	4.34	0.1416	0.1274
175	28	0.0277	92	4.07	0.1334	0.1274
200	33	0.0316	79	3.50	0.1152	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 104.480 gr
 γ_w : 1.541 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	20	0.88	0.0281	0.2549
50	-1	0.0079	44	1.95	0.0626	0.2549
75	-1	0.0119	69	3.05	0.0983	0.2549
100	-1	0.0158	86	3.81	0.1233	0.2549
125	0	0.0198	101	4.47	0.1453	0.2549
150	2	0.0237	119	5.27	0.1720	0.2549
175	4	0.0277	130	5.75	0.1884	0.2549
200	8	0.0316	141	6.24	0.2053	0.2549
225	14	0.0356	127	5.62	0.1857	0.2549
250	20	0.0395	101	4.47	0.1483	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.570 gr
 γ_w : 1.572 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	50	2.21	0.0707	0.3823
50	-1	0.0079	88	3.89	0.1249	0.3823
75	1	0.0119	105	4.65	0.1499	0.3823
100	3	0.0158	137	6.06	0.1962	0.3823
125	6	0.0198	163	7.21	0.2343	0.3823
150	10	0.0237	180	7.96	0.2598	0.3823
175	14	0.0277	182	8.05	0.2638	0.3823
200	18	0.0316	155	6.86	0.2257	0.3823
225	29	0.0356	142	6.28	0.2075	0.3823
250	35	0.0395	139	6.15	0.2040	0.3823



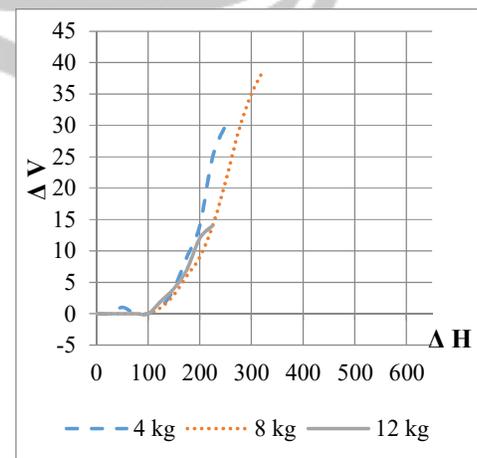
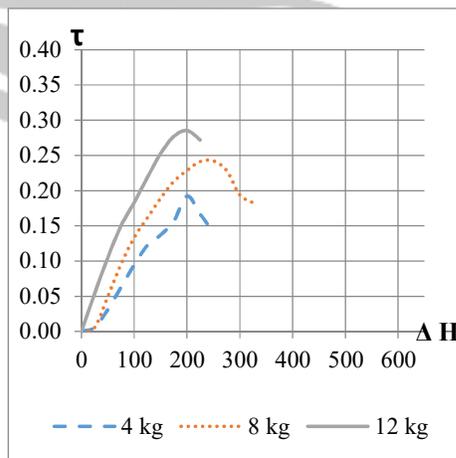
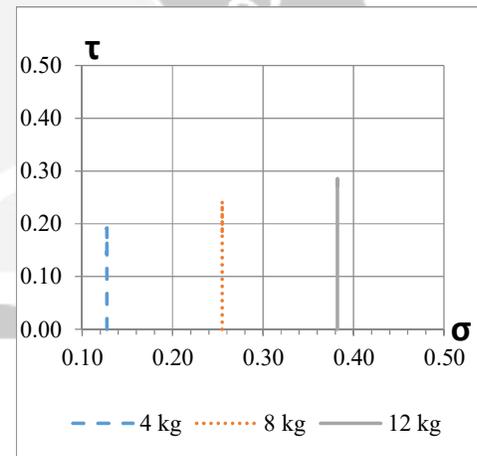
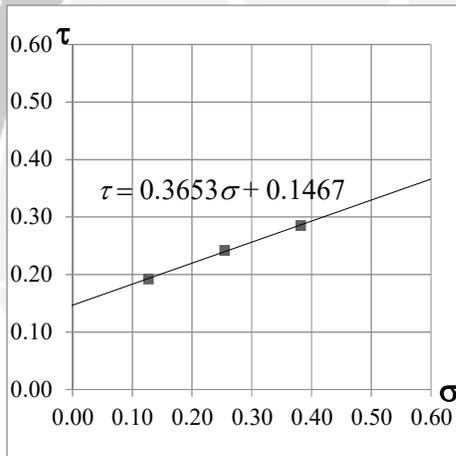
DIRECT SHEAR TEST
 Soil + 2% Lime (7 days curing time)

Project : Final Project
Location : Godean
Date : 24 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1921	0.1274
8	0.2422	0.2549
12	0.2853	0.3823

$c = 0.1467 \text{ kg/cm}^2$
 $\tan \phi = 0.3653$
 $\phi = 20.07^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.720 gr
 γ_w : 1.560 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	4	0.18	0.0058	0.1274
50	1	0.0079	22	0.97	0.0312	0.1274
75	0	0.0119	44	1.95	0.0629	0.1274
100	0	0.0158	66	2.92	0.0945	0.1274
125	1	0.0198	85	3.76	0.1222	0.1274
150	4	0.0237	95	4.20	0.1371	0.1274
175	9	0.0277	108	4.78	0.1566	0.1274
200	14	0.0316	132	5.84	0.1921	0.1274
225	25	0.0356	114	5.04	0.1665	0.1274
250	30	0.0395	96	4.25	0.1410	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.150 gr
 γ_w : 1.551 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	4	0.18	0.0058	0.2549
50	0	0.0079	35	1.55	0.0498	0.2549
75	0	0.0119	67	2.96	0.0954	0.2549
100	0	0.0158	93	4.12	0.1334	0.2549
125	1	0.0198	112	4.96	0.1612	0.2549
150	3	0.0237	131	5.80	0.1893	0.2549
175	6	0.0277	147	6.50	0.2130	0.2549
200	9	0.0316	157	6.95	0.2287	0.2549
225	14	0.0356	165	7.30	0.2412	0.2549
250	21	0.0395	165	7.30	0.2422	0.2549
275	29	0.0435	155	6.86	0.2285	0.2549
300	35	0.0475	131	5.80	0.1940	0.2549
325	39	0.0514	123	5.44	0.1827	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.740 gr
 γ_w : 1.560 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	38	1.68	0.0537	0.3823
50	0	0.0079	74	3.27	0.1050	0.3823
75	0	0.0119	105	4.65	0.1499	0.3823
100	0	0.0158	128	5.66	0.1832	0.3823
125	2	0.0198	152	6.73	0.2187	0.3823
150	4	0.0237	175	7.74	0.2526	0.3823
175	7	0.0277	191	8.45	0.2769	0.3823
200	12	0.0316	196	8.67	0.2853	0.3823
225	14	0.0356	186	8.23	0.2719	0.3823



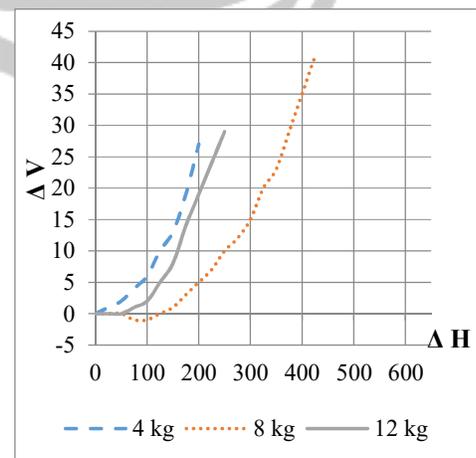
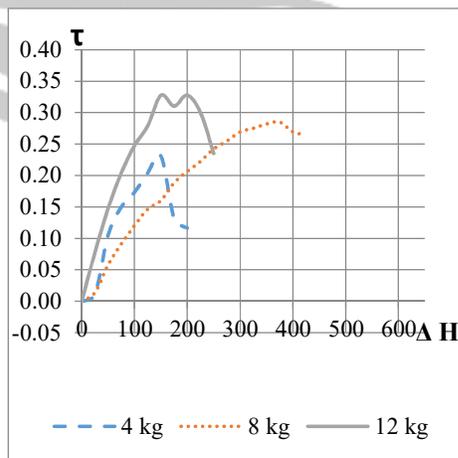
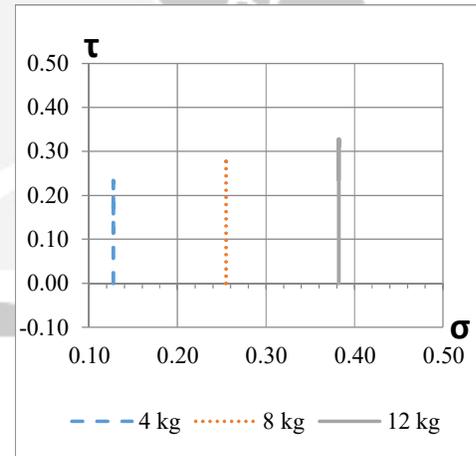
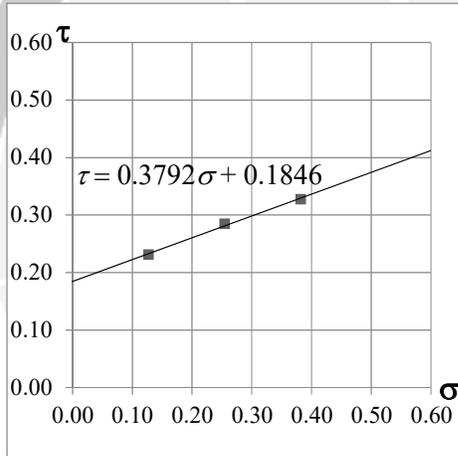
DIRECT SHEAR TEST
 Soil + 2% Lime (14 days curing time)

Project : Final Project
Location : Godean
Date : 29 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2311	0.1274
8	0.2848	0.2549
12	0.3277	0.3823

$c = 0.1846 \text{ kg/cm}^2$
 $\tan \phi = 0.3792$
 $\phi = 20.77^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.030 gr
 γ_w : 1.564 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	1	0.0040	8	0.35	0.0112	0.1274
50	2	0.0079	74	3.27	0.1050	0.1274
75	4	0.0119	105	4.65	0.1499	0.1274
100	6	0.0158	121	5.35	0.1732	0.1274
125	10	0.0198	142	6.28	0.2041	0.1274
150	13	0.0237	160	7.08	0.2311	0.1274
175	19	0.0277	91	4.03	0.1321	0.1274
200	27	0.0316	80	3.54	0.1165	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.470 gr
 γ_w : 1.571 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	10	0.44	0.0141	0.2549
50	0	0.0079	41	1.81	0.0581	0.2549
75	-1	0.0119	65	2.83	0.0912	0.2549
100	-1	0.0158	84	3.72	0.1204	0.2549
125	0	0.0198	102	4.51	0.1466	0.2549
150	1	0.0237	111	4.91	0.1602	0.2549
175	3	0.0277	130	5.75	0.1884	0.2549
200	5	0.0316	142	6.28	0.2066	0.2549
225	7	0.0356	152	6.73	0.2223	0.2549
250	10	0.0395	165	7.30	0.2422	0.2549
275	12	0.0435	173	7.65	0.2548	0.2549
300	15	0.0475	182	8.05	0.2693	0.2549
325	20	0.0514	185	8.19	0.2751	0.2549
350	23	0.0554	189	8.36	0.2820	0.2549
375	29	0.0593	190	8.41	0.2848	0.2549
400	35	0.0633	179	7.92	0.2694	0.2549
425	41	0.0672	175	7.74	0.2644	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 100.410 gr
 γ_w : 1.481 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	56	2.43	0.0777	0.3823
50	0	0.0079	104	4.60	0.1477	0.3823
75	1	0.0119	143	6.33	0.2041	0.3823
100	2	0.0158	173	7.65	0.2477	0.3823
125	5	0.0198	194	8.58	0.2789	0.3823
150	8	0.0237	227	10.04	0.3277	0.3823
175	14	0.0277	214	9.47	0.3103	0.3823
200	19	0.0316	225	9.96	0.3277	0.3823
225	24	0.0356	205	9.07	0.2996	0.3823
250	29	0.0395	160	7.08	0.2349	0.3823



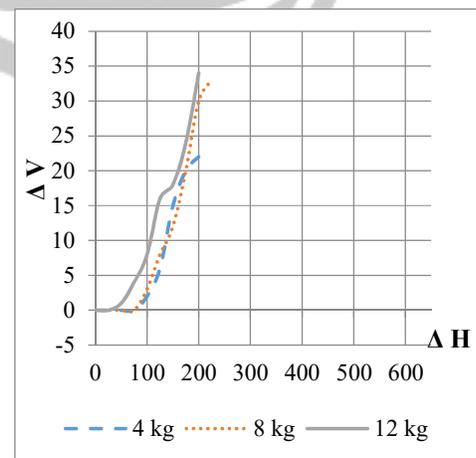
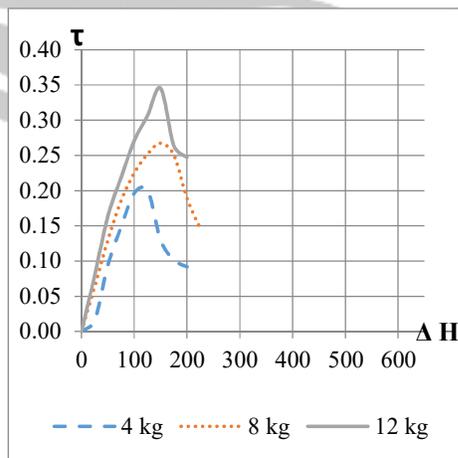
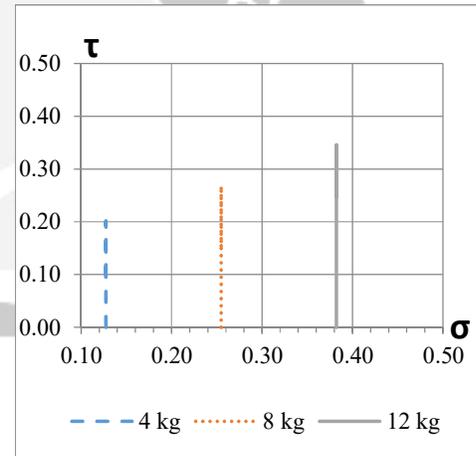
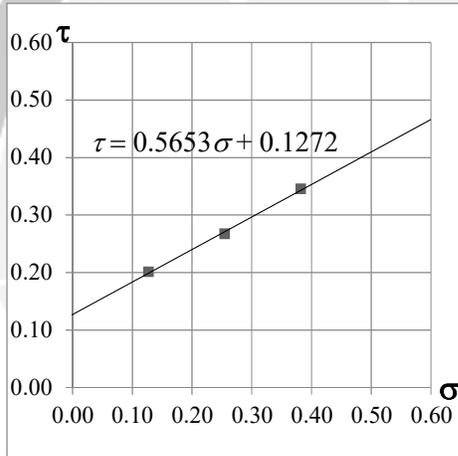
DIRECT SHEAR TEST
 Soil + 2% Lime (28 days curing time)

Project : Final Project
Location : Godean
Date : 5 Dec 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2012	0.1274
8	0.2673	0.2549
12	0.3453	0.3823

$c = 0.1272 \text{ kg/cm}^2$
 $\tan \phi = 0.5653$
 $\phi = 29.48^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.600 gr
 γ_w : 1.558 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	11	0.49	0.0157	0.1274
50	0	0.0079	66	2.92	0.0938	0.1274
75	0	0.0119	104	4.60	0.1483	0.1274
100	2	0.0158	137	6.06	0.1962	0.1274
125	6	0.0198	140	6.19	0.2012	0.1274
150	15	0.0237	90	3.98	0.1299	0.1274
175	20	0.0277	70	3.10	0.1016	0.1274
200	22	0.0316	64	2.79	0.0918	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.300 gr
 γ_w : 1.568 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	45	1.99	0.0637	0.2549
50	0	0.0079	91	4.03	0.1294	0.2549
75	0	0.0119	130	5.75	0.1854	0.2549
100	3	0.0158	157	6.95	0.2250	0.2549
125	8	0.0198	175	7.74	0.2516	0.2549
150	12	0.0237	185	8.19	0.2673	0.2549
175	20	0.0277	173	7.65	0.2507	0.2549
200	30	0.0316	130	5.75	0.1892	0.2549
225	33	0.0356	100	4.42	0.1460	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.420 gr
 γ_w : 1.585 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	57	2.48	0.0793	0.3823
50	1	0.0079	115	5.09	0.1635	0.3823
75	4	0.0119	153	6.77	0.2183	0.3823
100	8	0.0158	189	8.36	0.2706	0.3823
125	16	0.0198	213	9.42	0.3062	0.3823
150	18	0.0237	239	10.58	0.3453	0.3823
175	24	0.0277	182	8.05	0.2638	0.3823
200	34	0.0316	170	7.52	0.2474	0.3823



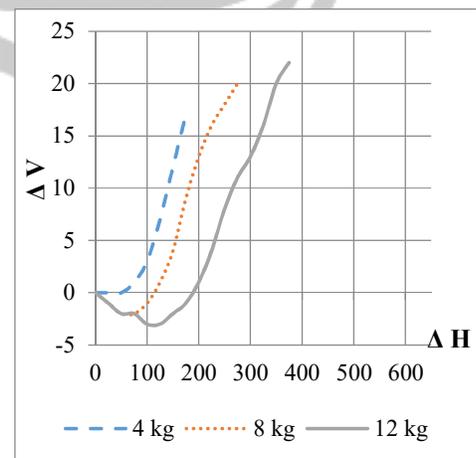
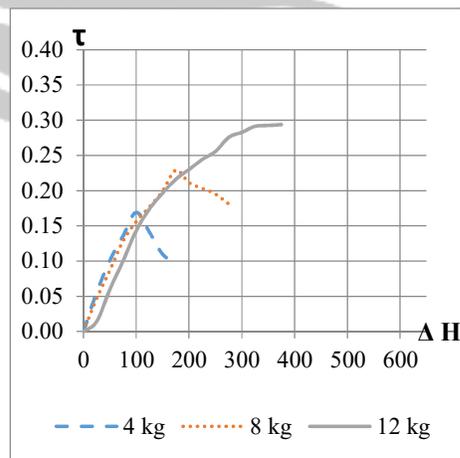
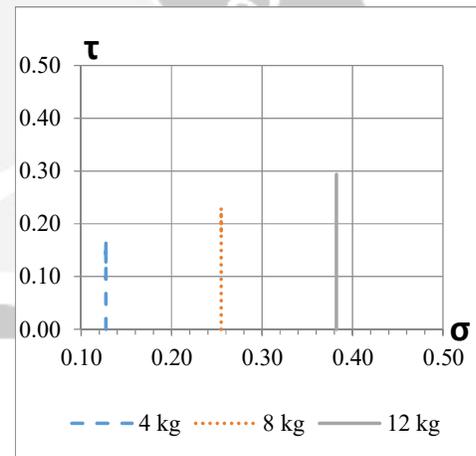
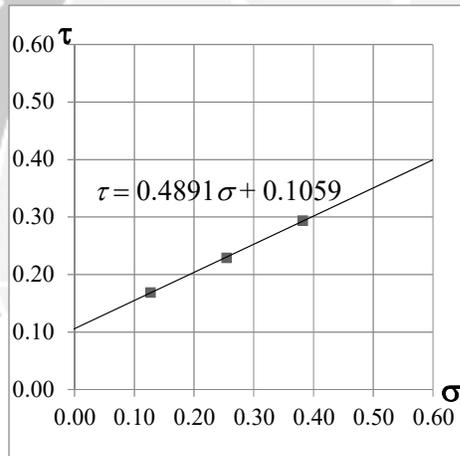
DIRECT SHEAR TEST
 Soil + 4% Lime (7 days curing time)

Project : Final Project
Location : Godean
Date : 24 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1690	0.1274
8	0.2290	0.2549
12	0.2937	0.3823

$c = 0.1059 \text{ kg/cm}^2$
 $\tan \phi = 0.4891$
 $\phi = 26.06^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.830 gr
 γ_w : 1.561 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	39	1.73	0.0553	0.1274
50	0	0.0079	71	3.14	0.1008	0.1274
75	1	0.0119	95	4.20	0.1354	0.1274
100	3	0.0158	118	5.22	0.1690	0.1274
125	7	0.0198	98	4.34	0.1411	0.1274
150	12	0.0237	76	3.36	0.1097	0.1274
175	17	0.0277	67	2.96	0.0970	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.690 gr
 γ_w : 1.574 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	33	1.46	0.0467	0.2549
50	-2	0.0079	62	2.70	0.0867	0.2549
75	-2	0.0119	90	3.98	0.1283	0.2549
100	-1	0.0158	109	4.82	0.1560	0.2549
125	1	0.0198	123	5.44	0.1768	0.2549
150	4	0.0237	138	6.11	0.1994	0.2549
175	9	0.0277	158	6.99	0.2290	0.2549
200	13	0.0316	145	6.42	0.2112	0.2549
225	16	0.0356	139	6.15	0.2032	0.2549
250	18	0.0395	133	5.88	0.1951	0.2549
275	20	0.0435	123	5.44	0.1812	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.840 gr
 γ_w : 1.576 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	-1	0.0040	10	0.44	0.0141	0.3823
50	-2	0.0079	42	1.86	0.0597	0.3823
75	-2	0.0119	70	3.10	0.1000	0.3823
100	-3	0.0158	100	4.42	0.1431	0.3823
125	-3	0.0198	121	5.35	0.1739	0.3823
150	-2	0.0237	136	6.02	0.1965	0.3823
175	-1	0.0277	149	6.59	0.2159	0.3823
200	1	0.0316	158	6.99	0.2300	0.3823
225	4	0.0356	167	7.39	0.2441	0.3823
250	8	0.0395	174	7.70	0.2554	0.3823
275	11	0.0435	187	8.27	0.2755	0.3823
300	13	0.0475	191	8.45	0.2826	0.3823
325	16	0.0514	196	8.67	0.2912	0.3823
350	20	0.0554	196	8.67	0.2924	0.3823
375	22	0.0593	196	8.67	0.2937	0.3823



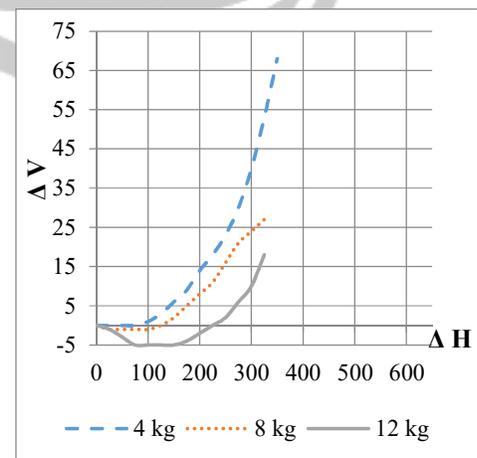
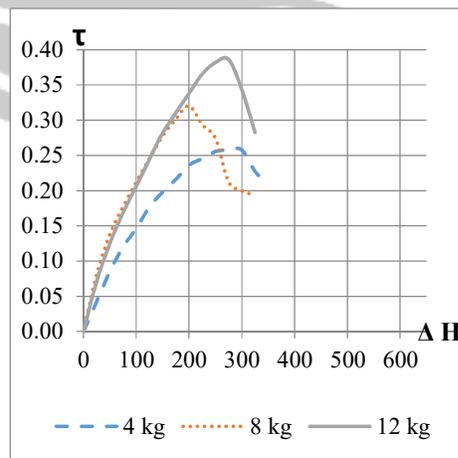
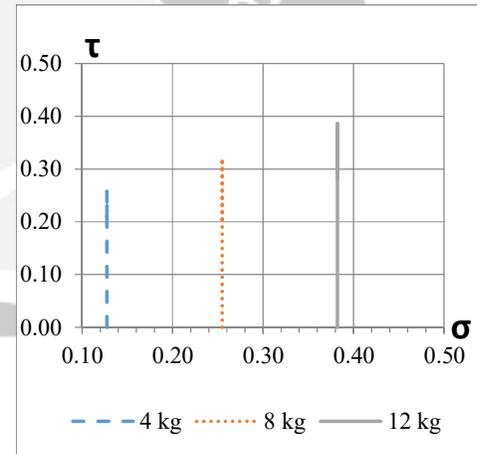
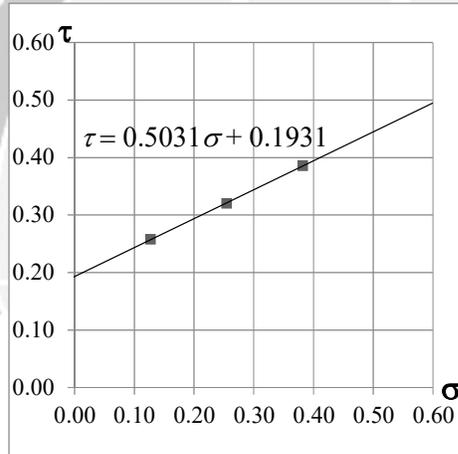
DIRECT SHEAR TEST
 Soil + 4% Lime (14 days curing time)

Project : Final Project
Location : Godean
Date : 29 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2578	0.1274
8	0.3201	0.2549
12	0.3861	0.3823

$c = 0.1931 \text{ kg/cm}^2$
 $\tan \phi = 0.5031$
 $\phi = 26.71^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.040 gr
 γ_w : 1.564 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	30	1.33	0.0425	0.1274
50	0	0.0079	61	2.65	0.0851	0.1274
75	0	0.0119	84	3.72	0.1199	0.1274
100	1	0.0158	102	4.51	0.1460	0.1274
125	3	0.0198	123	5.44	0.1768	0.1274
150	6	0.0237	137	6.06	0.1978	0.1274
175	9	0.0277	149	6.59	0.2159	0.1274
200	14	0.0316	162	7.17	0.2359	0.1274
225	18	0.0356	168	7.43	0.2455	0.1274
250	23	0.0395	174	7.70	0.2554	0.1274
275	30	0.0435	175	7.74	0.2578	0.1274
300	40	0.0475	174	7.70	0.2576	0.1274
325	53	0.0514	153	6.77	0.2274	0.1274
350	68	0.0554	139	6.15	0.2074	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.090 gr
 γ_w : 1.580 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	58	2.52	0.0806	0.2549
50	-1	0.0079	97	4.29	0.1378	0.2549
75	-1	0.0119	124	5.49	0.1770	0.2549
100	-1	0.0158	148	6.55	0.2120	0.2549
125	0	0.0198	171	7.57	0.2461	0.2549
150	2	0.0237	192	8.50	0.2774	0.2549
175	5	0.0277	208	9.20	0.3015	0.2549
200	8	0.0316	220	9.73	0.3201	0.2549
225	11	0.0356	201	8.89	0.2937	0.2549
250	16	0.0395	187	8.27	0.2743	0.2549
275	21	0.0435	144	6.37	0.2122	0.2549
300	24	0.0475	135	5.97	0.1997	0.2549
325	27	0.0514	130	5.75	0.1931	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.590 gr
 γ_w : 1.587 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	-1	0.0040	50	2.21	0.0707	0.3823
50	-3	0.0079	88	3.89	0.1249	0.3823
75	-5	0.0119	118	5.22	0.1683	0.3823
100	-5	0.0158	144	6.37	0.2062	0.3823
125	-5	0.0198	170	7.52	0.2444	0.3823
150	-5	0.0237	195	8.63	0.2816	0.3823
175	-4	0.0277	214	9.47	0.3103	0.3823
200	-2	0.0316	232	10.27	0.3379	0.3823
225	0	0.0356	250	11.06	0.3654	0.3823
250	2	0.0395	260	11.51	0.3818	0.3823
275	6	0.0435	262	11.59	0.3861	0.3823
300	10	0.0475	232	10.27	0.3435	0.3823
325	18	0.0514	190	8.41	0.2825	0.3823



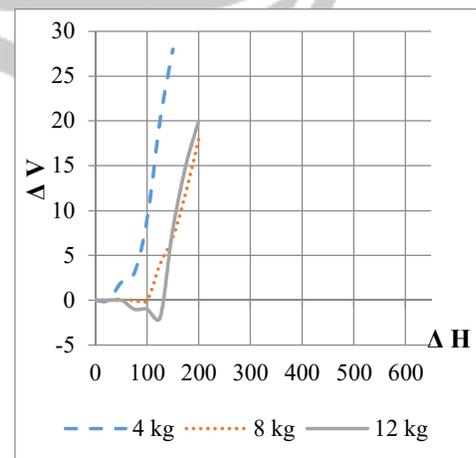
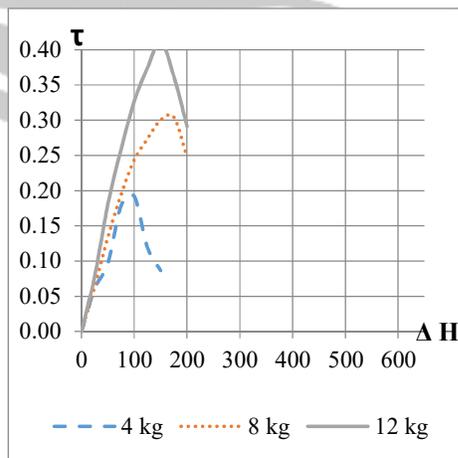
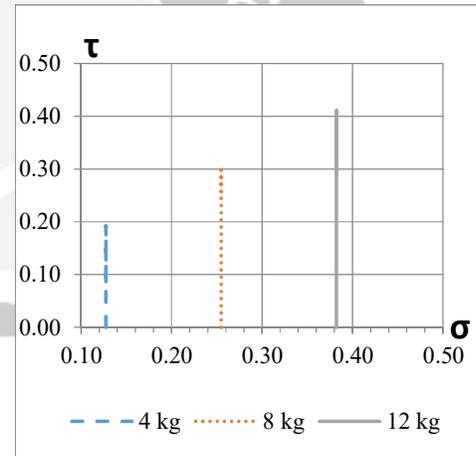
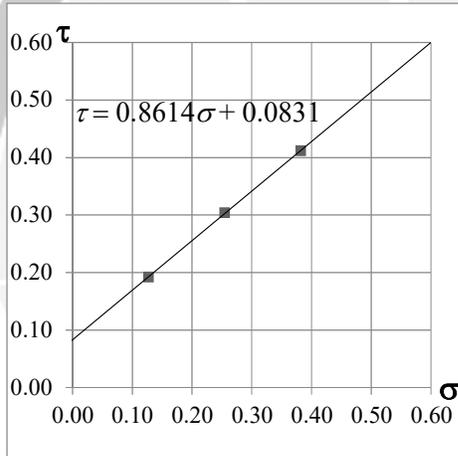
DIRECT SHEAR TEST
 Soil + 4% Lime (28 days curing time)

Project : Final Project
Location : Godean
Date : 5 Dec 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1920	0.1274
8	0.3044	0.2549
12	0.4115	0.3823

$c = 0.0831 \text{ kg/cm}^2$
 $\tan \phi = 0.8614$
 $\phi = 40.74^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.240 gr
 γ_w : 1.582 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	43	1.90	0.0608	0.1274
50	2	0.0079	68	3.01	0.0967	0.1274
75	3	0.0119	125	5.53	0.1783	0.1274
100	9	0.0158	134	5.93	0.1920	0.1274
125	20	0.0198	83	3.67	0.1193	0.1274
150	28	0.0237	61	2.65	0.0865	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 108.050 gr
 γ_w : 1.594 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	45	1.99	0.0637	0.2549
50	0	0.0079	94	4.16	0.1336	0.2549
75	0	0.0119	136	6.02	0.1941	0.2549
100	0	0.0158	170	7.52	0.2434	0.2549
125	4	0.0198	190	8.41	0.2734	0.2549
150	7	0.0237	208	9.20	0.3002	0.2549
175	12	0.0277	210	9.29	0.3044	0.2549
200	18	0.0316	170	7.52	0.2474	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 109.570 gr
 γ_w : 1.616 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	56	2.43	0.0777	0.3823
50	0	0.0079	127	5.62	0.1805	0.3823
75	-1	0.0119	181	8.01	0.2583	0.3823
100	-1	0.0158	228	10.09	0.3266	0.3823
125	-2	0.0198	260	11.51	0.3741	0.3823
150	8	0.0237	285	12.61	0.4115	0.3823
175	15	0.0277	250	11.06	0.3624	0.3823
200	20	0.0316	200	8.85	0.2912	0.3823



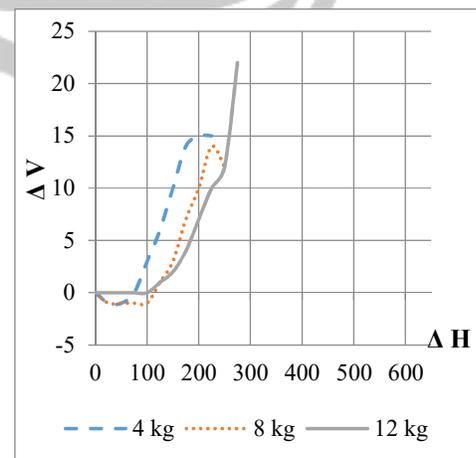
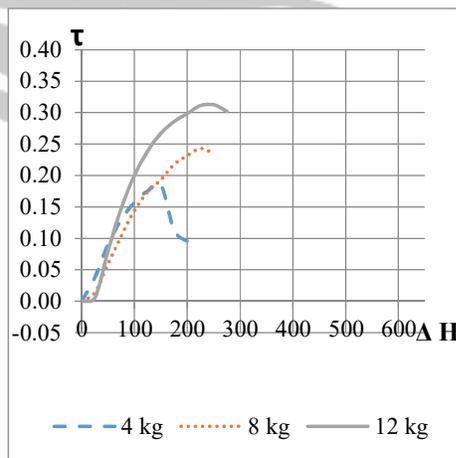
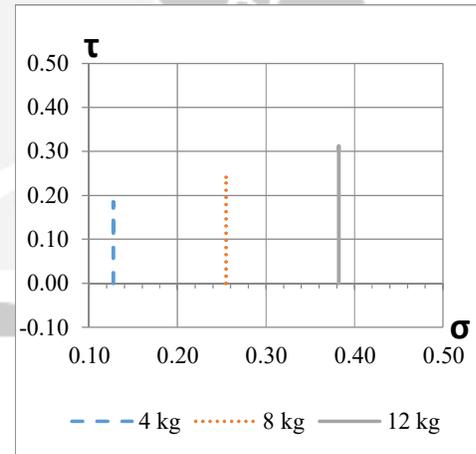
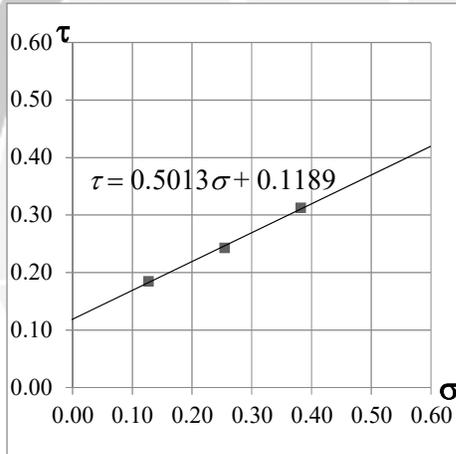
DIRECT SHEAR TEST
 Soil + 6% Lime (7 days curing time)

Project : Final Project
Location : Godean
Date : 24 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1847	0.1274
8	0.2428	0.2549
12	0.3125	0.3823

$c = 0.1189 \text{ kg/cm}^2$
 $\tan \phi = 0.5013$
 $\phi = 26.62^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 105.390 gr
 γ_w : 1.555 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	-1	0.0040	27	1.19	0.0381	0.1274
50	-1	0.0079	65	2.83	0.0909	0.1274
75	0	0.0119	91	4.03	0.1299	0.1274
100	3	0.0158	110	4.87	0.1577	0.1274
125	6	0.0198	122	5.40	0.1755	0.1274
150	10	0.0237	128	5.66	0.1847	0.1274
175	14	0.0277	78	3.45	0.1130	0.1274
200	15	0.0316	66	2.92	0.0961	0.1274
225	15	0.0356	66	2.92	0.0965	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.500 gr
 γ_w : 1.571 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	10	0.44	0.0141	0.2549
50	-1	0.0079	42	1.86	0.0597	0.2549
75	-1	0.0119	73	3.23	0.1041	0.2549
100	-1	0.0158	101	4.47	0.1447	0.2549
125	1	0.0198	121	5.35	0.1739	0.2549
150	3	0.0237	134	5.93	0.1935	0.2549
175	7	0.0277	150	6.64	0.2176	0.2549
200	10	0.0316	159	7.04	0.2316	0.2549
225	14	0.0356	166	7.35	0.2428	0.2549
250	12	0.0395	160	7.08	0.2349	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.910 gr
 γ_w : 1.577 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	4	0.18	0.0058	0.3823
50	0	0.0079	58	2.52	0.0809	0.3823
75	0	0.0119	104	4.60	0.1483	0.3823
100	0	0.0158	140	6.19	0.2004	0.3823
125	1	0.0198	166	7.35	0.2389	0.3823
150	2	0.0237	185	8.19	0.2673	0.3823
175	4	0.0277	197	8.72	0.2857	0.3823
200	7	0.0316	205	9.07	0.2984	0.3823
225	10	0.0356	213	9.42	0.3112	0.3823
250	12	0.0395	213	9.42	0.3125	0.3823
275	22	0.0435	205	9.07	0.3021	0.3823



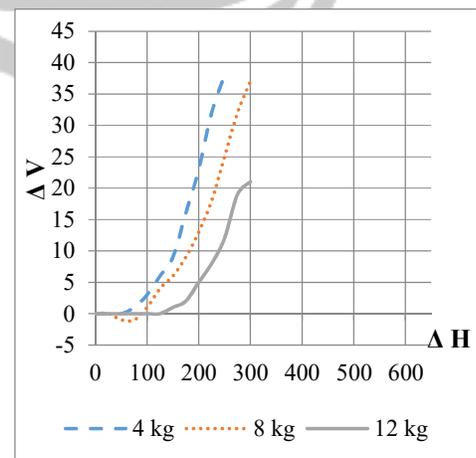
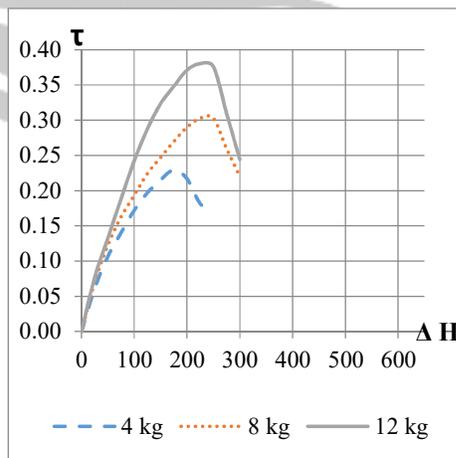
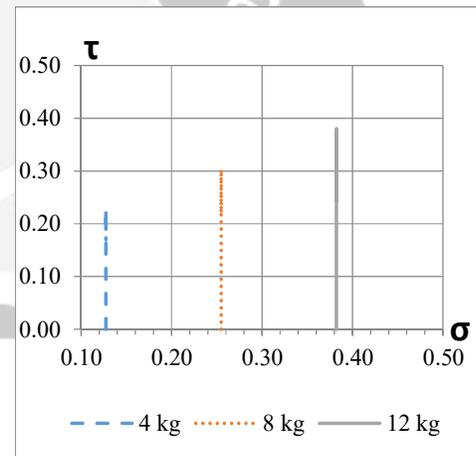
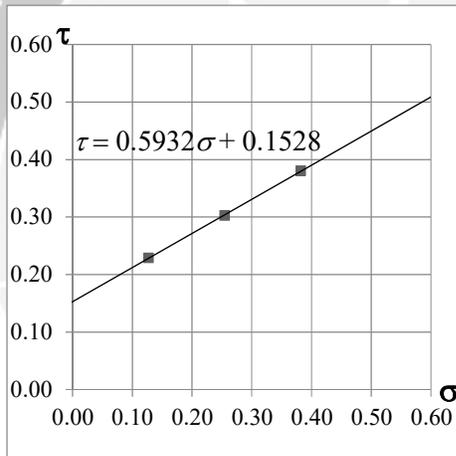
DIRECT SHEAR TEST
 Soil + 6% Lime (14 days curing time)

Project : Final Project
Location : Godean
Date : 29 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2290	0.1274
8	0.3026	0.2549
12	0.3803	0.3823

$c = 0.1528 \text{ kg/cm}^2$
 $\tan \phi = 0.5932$
 $\phi = 30.68^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.270 gr
 γ_w : 1.582 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	43	1.90	0.0608	0.1274
50	0	0.0079	75	3.32	0.1066	0.1274
75	1	0.0119	98	4.34	0.1399	0.1274
100	3	0.0158	120	5.31	0.1719	0.1274
125	6	0.0198	137	6.06	0.1970	0.1274
150	9	0.0237	149	6.59	0.2151	0.1274
175	16	0.0277	158	6.99	0.2290	0.1274
200	23	0.0316	149	6.59	0.2168	0.1274
225	32	0.0356	124	5.49	0.1814	0.1274
250	38	0.0395	116	5.13	0.1702	0.1274



Data of Sample

Load : 8 kg

Diameter : 6.3216 cm

Height : 2.1598 cm

Area : 31.387 cm²

Weight : 107.930 gr

γ_w : 1.592 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	49	2.17	0.0694	0.2549
50	-1	0.0079	86	3.81	0.1224	0.2549
75	-1	0.0119	114	5.04	0.1625	0.2549
100	1	0.0158	135	5.97	0.1933	0.2549
125	4	0.0198	156	6.90	0.2243	0.2549
150	6	0.0237	171	7.57	0.2470	0.2549
175	9	0.0277	186	8.23	0.2697	0.2549
200	13	0.0316	199	8.81	0.2899	0.2549
225	18	0.0356	207	9.16	0.3026	0.2549
250	25	0.0395	206	9.12	0.3025	0.2549
275	32	0.0435	176	7.79	0.2595	0.2549
300	37	0.0475	149	6.59	0.2204	0.2549

**Data of Sample**

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 108.030 gr
 γ_w : 1.594 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	55	2.39	0.0764	0.3823
50	0	0.0079	93	4.12	0.1323	0.3823
75	0	0.0119	132	5.84	0.1883	0.3823
100	0	0.0158	169	7.48	0.2421	0.3823
125	0	0.0198	200	8.85	0.2877	0.3823
150	1	0.0237	224	9.91	0.3234	0.3823
175	2	0.0277	240	10.62	0.3480	0.3823
200	5	0.0316	255	11.28	0.3711	0.3823
225	8	0.0356	260	11.51	0.3803	0.3823
250	12	0.0395	256	11.33	0.3758	0.3823
275	19	0.0435	210	9.29	0.3094	0.3823
300	21	0.0475	165	7.30	0.2442	0.3823



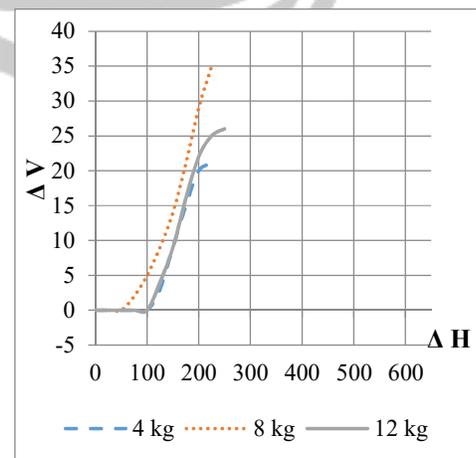
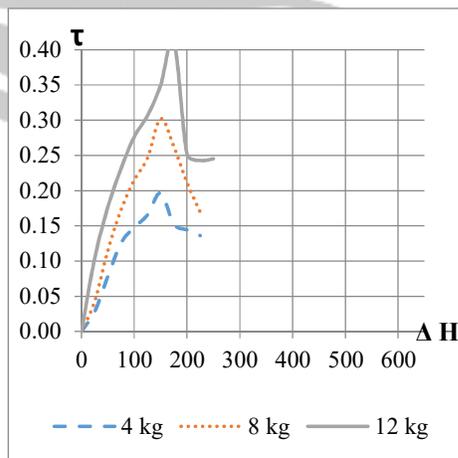
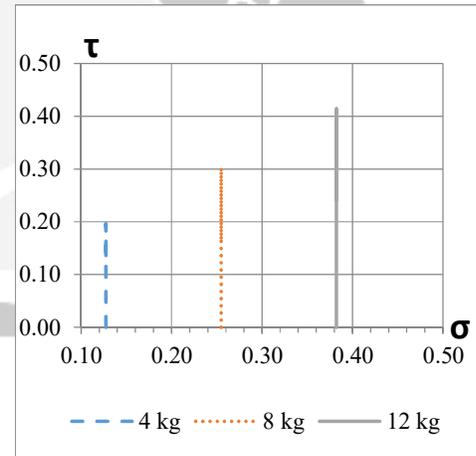
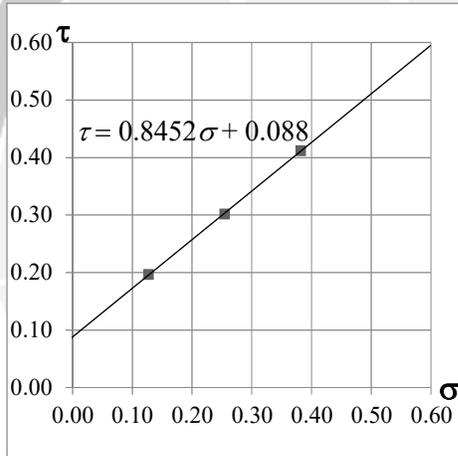
DIRECT SHEAR TEST
 Soil + 6% Lime (28 days curing time)

Project : Final Project
Location : Godean
Date : 5 Dec 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1965	0.1274
8	0.3019	0.2549
12	0.4119	0.3823

$c = 0.0880 \text{ kg/cm}^2$
 $\tan \phi = 0.8452$
 $\phi = 40.20^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.770 gr
 γ_w : 1.575 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	20	0.88	0.0281	0.1274
50	0	0.0079	56	2.43	0.0780	0.1274
75	0	0.0119	88	3.89	0.1254	0.1274
100	0	0.0158	103	4.56	0.1476	0.1274
125	3	0.0198	115	5.09	0.1654	0.1274
150	9	0.0237	136	6.02	0.1965	0.1274
175	15	0.0277	105	4.65	0.1524	0.1274
200	20	0.0316	99	4.38	0.1441	0.1274
225	21	0.0356	93	4.12	0.1361	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 108.440 gr
 γ_w : 1.600 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	30	1.33	0.0425	0.2549
50	0	0.0079	81	3.58	0.1150	0.2549
75	2	0.0119	121	5.35	0.1725	0.2549
100	5	0.0158	150	6.64	0.2150	0.2549
125	9	0.0198	171	7.57	0.2461	0.2549
150	14	0.0237	209	9.25	0.3019	0.2549
175	21	0.0277	181	8.01	0.2625	0.2549
200	29	0.0316	145	6.42	0.2112	0.2549
225	35	0.0356	116	5.13	0.1695	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 108.500 gr
 γ_w : 1.601 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	73	3.23	0.1033	0.3823
50	0	0.0079	124	5.49	0.1763	0.3823
75	0	0.0119	162	7.17	0.2312	0.3823
100	0	0.0158	193	8.54	0.2765	0.3823
125	4	0.0198	213	9.42	0.3062	0.3823
150	9	0.0237	242	10.71	0.3495	0.3823
175	16	0.0277	284	12.57	0.4119	0.3823
200	22	0.0316	173	7.65	0.2517	0.3823
225	25	0.0356	166	7.35	0.2428	0.3823
250	26	0.0395	167	7.39	0.2451	0.3823



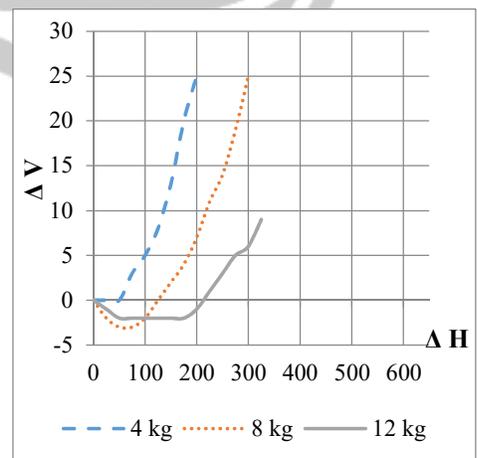
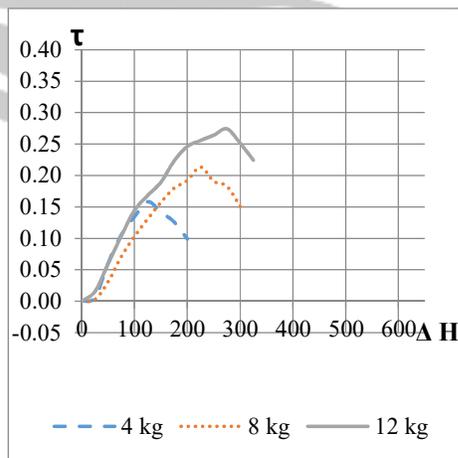
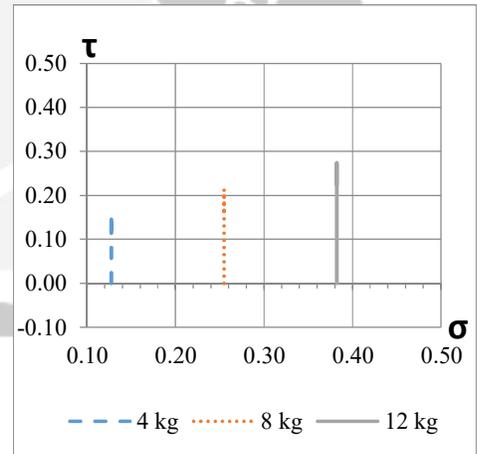
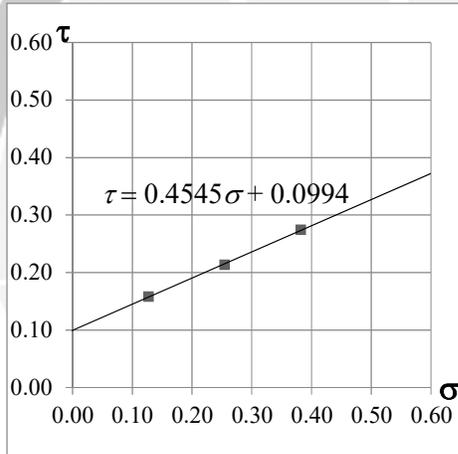
DIRECT SHEAR TEST
 Soil + 8% Lime (7 days curing time)

Project : Final Project
Location : Godean
Date : 24 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1583	0.1274
8	0.2134	0.2549
12	0.2741	0.3823

$c = 0.0994 \text{ kg/cm}^2$
 $\tan \phi = 0.4545$
 $\phi = 24.44^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.260 gr
 γ_w : 1.582 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	4	0.18	0.0058	0.1274
50	0	0.0079	43	1.90	0.0610	0.1274
75	3	0.0119	74	3.27	0.1054	0.1274
100	5	0.0158	94	4.16	0.1347	0.1274
125	8	0.0198	110	4.87	0.1583	0.1274
150	13	0.0237	98	4.34	0.1416	0.1274
175	20	0.0277	87	3.85	0.1262	0.1274
200	25	0.0316	68	3.01	0.0990	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 107.330 gr
 γ_w : 1.583 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-2	0.0040	2	0.09	0.0029	0.2549
50	-3	0.0079	22	0.97	0.0312	0.2549
75	-3	0.0119	50	2.21	0.0713	0.2549
100	-2	0.0158	72	3.19	0.1033	0.2549
125	0	0.0198	91	4.03	0.1310	0.2549
150	2	0.0237	109	4.82	0.1573	0.2549
175	4	0.0277	124	5.49	0.1799	0.2549
200	7	0.0316	132	5.84	0.1921	0.2549
225	11	0.0356	146	6.46	0.2134	0.2549
250	14	0.0395	130	5.75	0.1907	0.2549
275	19	0.0435	124	5.49	0.1829	0.2549
300	25	0.0475	102	4.51	0.1509	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.970 gr
 γ_w : 1.578 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	-1	0.0040	11	0.49	0.0157	0.3823
50	-2	0.0079	42	1.86	0.0597	0.3823
75	-2	0.0119	73	3.23	0.1041	0.3823
100	-2	0.0158	101	4.47	0.1447	0.3823
125	-2	0.0198	117	5.18	0.1684	0.3823
150	-2	0.0237	131	5.80	0.1893	0.3823
175	-2	0.0277	154	6.81	0.2231	0.3823
200	-1	0.0316	169	7.48	0.2461	0.3823
225	1	0.0356	175	7.74	0.2557	0.3823
250	3	0.0395	180	7.96	0.2641	0.3823
275	5	0.0435	186	8.23	0.2741	0.3823
300	6	0.0475	170	7.52	0.2515	0.3823
325	9	0.0514	151	6.68	0.2244	0.3823



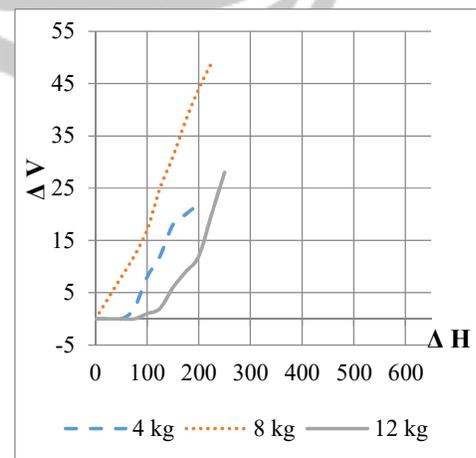
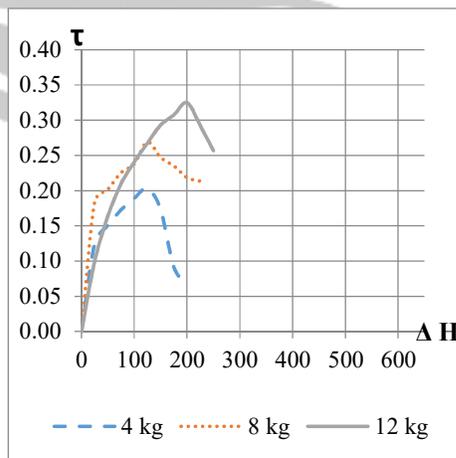
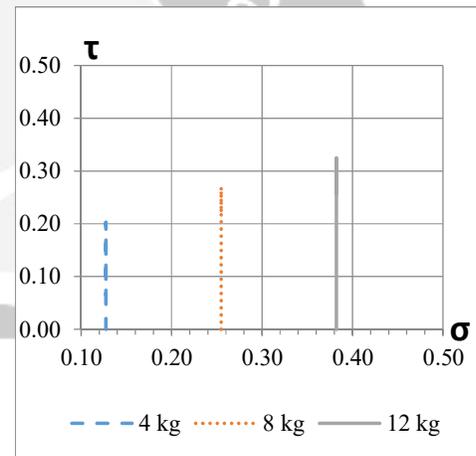
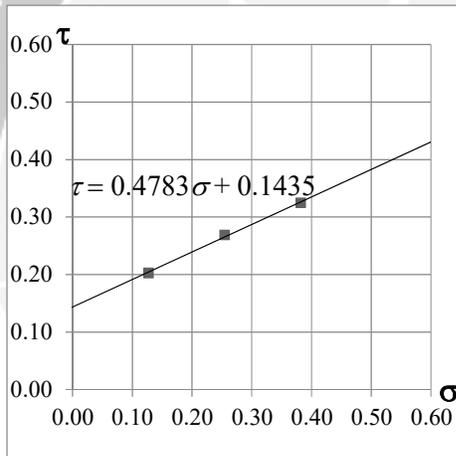
DIRECT SHEAR TEST
 Soil + 8% Lime (14 days curing time)

Project : Final Project
Location : Godean
Date : 29 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2028	0.1274
8	0.2688	0.2549
12	0.3247	0.3823

$c = 0.1435 \text{ kg/cm}^2$
 $\tan \phi = 0.4783$
 $\phi = 25.56^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.530 gr
 γ_w : 1.572 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	88	3.89	0.1244	0.1274
50	0	0.0079	106	4.69	0.1506	0.1274
75	2	0.0119	121	5.35	0.1725	0.1274
100	8	0.0158	132	5.84	0.1891	0.1274
125	12	0.0198	141	6.24	0.2028	0.1274
150	18	0.0237	120	5.31	0.1733	0.1274
175	20	0.0277	64	2.79	0.0914	0.1274
200	22	0.0316	45	1.99	0.0655	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.490 gr
 γ_w : 1.571 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	4	0.0040	130	5.75	0.1839	0.2549
50	8	0.0079	142	6.28	0.2017	0.2549
75	12	0.0119	158	6.99	0.2254	0.2549
100	17	0.0158	166	7.35	0.2379	0.2549
125	25	0.0198	187	8.27	0.2688	0.2549
150	31	0.0237	171	7.57	0.2470	0.2549
175	38	0.0277	162	7.17	0.2349	0.2549
200	44	0.0316	150	6.64	0.2185	0.2549
225	49	0.0356	146	6.46	0.2134	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.640 gr
 γ_w : 1.573 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	70	3.10	0.0992	0.3823
50	0	0.0079	115	5.09	0.1635	0.3823
75	0	0.0119	147	6.50	0.2096	0.3823
100	1	0.0158	168	7.43	0.2405	0.3823
125	2	0.0198	186	8.23	0.2675	0.3823
150	6	0.0237	203	8.98	0.2931	0.3823
175	9	0.0277	212	9.38	0.3074	0.3823
200	12	0.0316	223	9.87	0.3247	0.3823
225	20	0.0356	200	8.85	0.2924	0.3823
250	28	0.0395	175	7.74	0.2568	0.3823



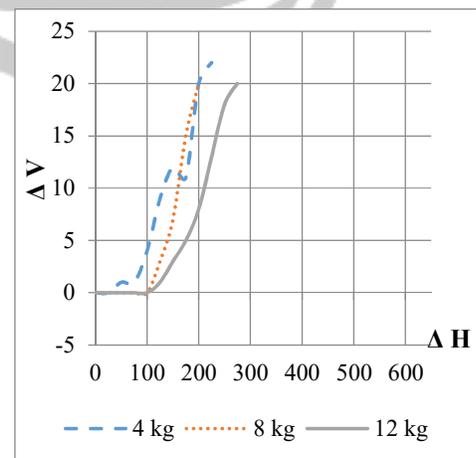
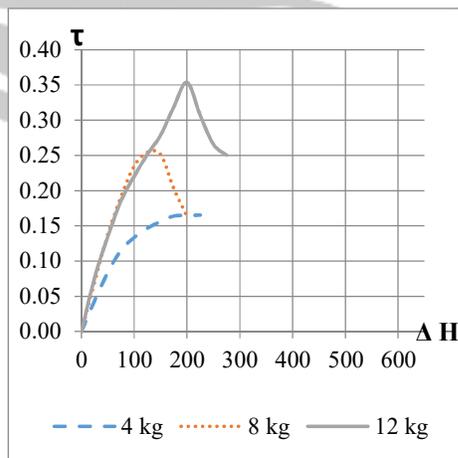
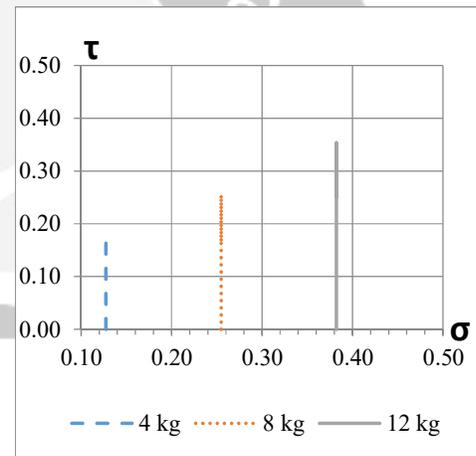
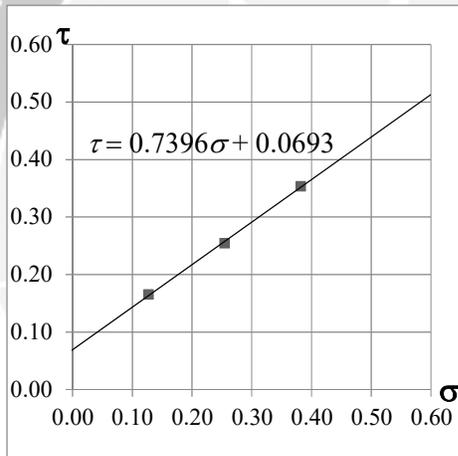
DIRECT SHEAR TEST
 Soil + 8% Lime (28 days curing time)

Project : Final Project
Location : Godean
Date : 5 Dec 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1652	0.1274
8	0.2545	0.2549
12	0.3537	0.3823

$c = 0.0693 \text{ kg/cm}^2$
 $\tan \phi = 0.7396$
 $\phi = 36.49^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.750 gr
 γ_w : 1.575 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	31	1.37	0.0438	0.1274
50	1	0.0079	60	2.61	0.0838	0.1274
75	1	0.0119	81	3.58	0.1154	0.1274
100	4	0.0158	93	4.12	0.1334	0.1274
125	9	0.0198	102	4.51	0.1466	0.1274
150	12	0.0237	108	4.78	0.1560	0.1274
175	11	0.0277	113	5.00	0.1638	0.1274
200	20	0.0316	113	5.00	0.1645	0.1274
225	22	0.0356	113	5.00	0.1652	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 106.980 gr
 γ_w : 1.578 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	50	2.21	0.0707	0.2549
50	0	0.0079	97	4.29	0.1378	0.2549
75	0	0.0119	134	5.93	0.1912	0.2549
100	0	0.0158	164	7.26	0.2350	0.2549
125	3	0.0198	177	7.83	0.2545	0.2549
150	7	0.0237	174	7.70	0.2513	0.2549
175	15	0.0277	140	6.19	0.2028	0.2549
200	20	0.0316	112	4.96	0.1632	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 108.910 gr
 γ_w : 1.607 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	55	2.39	0.0764	0.3823
50	0	0.0079	95	4.20	0.1349	0.3823
75	0	0.0119	130	5.75	0.1854	0.3823
100	0	0.0158	154	6.81	0.2205	0.3823
125	1	0.0198	175	7.74	0.2516	0.3823
150	3	0.0237	193	8.54	0.2787	0.3823
175	5	0.0277	220	9.73	0.3188	0.3823
200	8	0.0316	243	10.75	0.3537	0.3823
225	13	0.0356	210	9.29	0.3069	0.3823
250	18	0.0395	181	8.01	0.2657	0.3823
275	20	0.0435	170	7.52	0.2505	0.3823



DIRECT SHEAR TEST

Soil + Lime 6% + Press Mud 10% (7 days curing time)

Project : Final Project

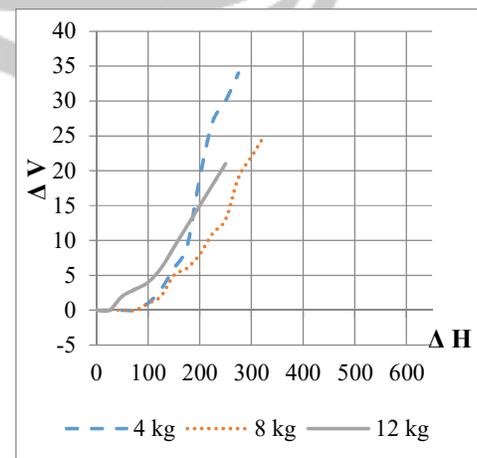
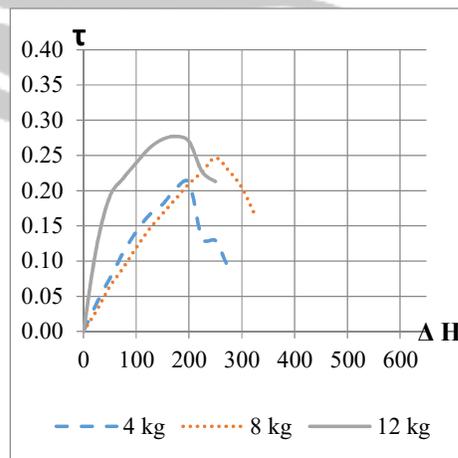
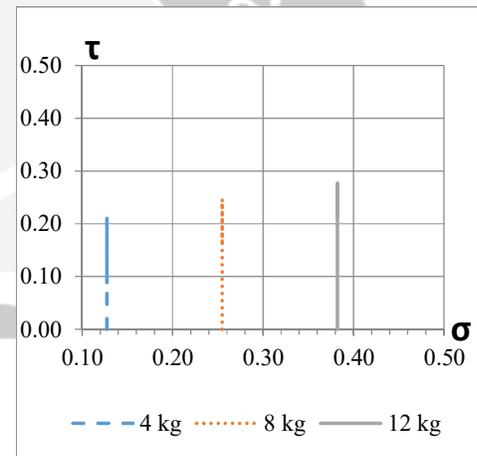
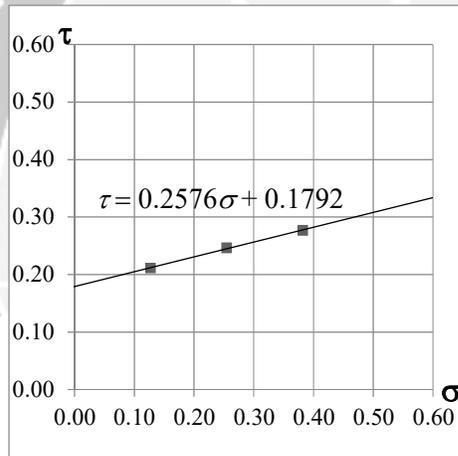
Depth : -1 m

Location : Godean

Date : 25 Nov 2016

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2112	0.1274
8	0.2465	0.2549
12	0.2769	0.3823

$c = 0.1792 \text{ kg/cm}^2$
 $\tan \phi = 0.2576$
 $\phi = 14.45^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.200 gr
 γ_w : 1.434 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	28	1.24	0.0397	0.1274
50	0	0.0079	54	2.35	0.0755	0.1274
75	0	0.0119	78	3.45	0.1112	0.1274
100	1	0.0158	99	4.38	0.1418	0.1274
125	3	0.0198	115	5.09	0.1654	0.1274
150	6	0.0237	125	5.53	0.1805	0.1274
175	9	0.0277	140	6.19	0.2028	0.1274
200	19	0.0316	145	6.42	0.2112	0.1274
225	27	0.0356	90	3.98	0.1315	0.1274
250	30	0.0395	88	3.89	0.1290	0.1274
275	34	0.0435	61	2.65	0.0883	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 98.430 gr
 γ_w : 1.452 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	21	0.93	0.0297	0.2549
50	0	0.0079	45	1.99	0.0639	0.2549
75	0	0.0119	64	2.79	0.0900	0.2549
100	1	0.0158	83	3.67	0.1188	0.2549
125	2	0.0198	101	4.47	0.1453	0.2549
150	5	0.0237	116	5.13	0.1674	0.2549
175	6	0.0277	130	5.75	0.1884	0.2549
200	8	0.0316	144	6.37	0.2096	0.2549
225	11	0.0356	155	6.86	0.2266	0.2549
250	13	0.0395	168	7.43	0.2465	0.2549
275	19	0.0435	155	6.86	0.2285	0.2549
300	22	0.0475	138	6.11	0.2044	0.2549
325	25	0.0514	111	4.91	0.1649	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 99.460 gr
 γ_w : 1.467 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	85	3.76	0.1203	0.3823
50	2	0.0079	135	5.97	0.1917	0.3823
75	3	0.0119	152	6.73	0.2170	0.3823
100	4	0.0158	167	7.39	0.2392	0.3823
125	6	0.0198	181	8.01	0.2604	0.3823
150	9	0.0237	189	8.36	0.2728	0.3823
175	12	0.0277	191	8.45	0.2769	0.3823
200	15	0.0316	185	8.19	0.2695	0.3823
225	18	0.0356	155	6.86	0.2266	0.3823
250	21	0.0395	145	6.42	0.2130	0.3823



DIRECT SHEAR TEST

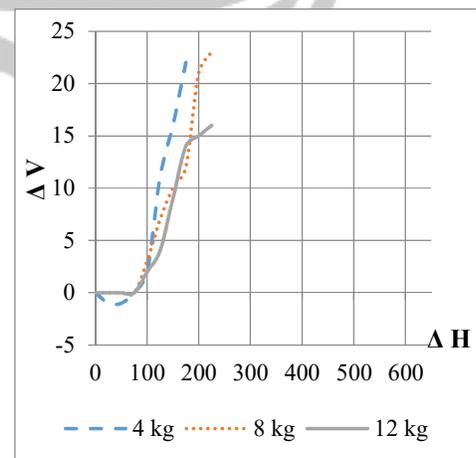
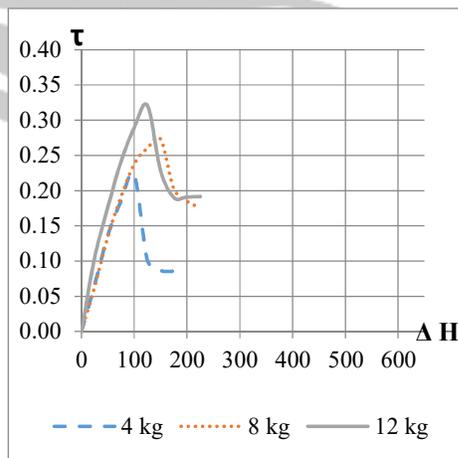
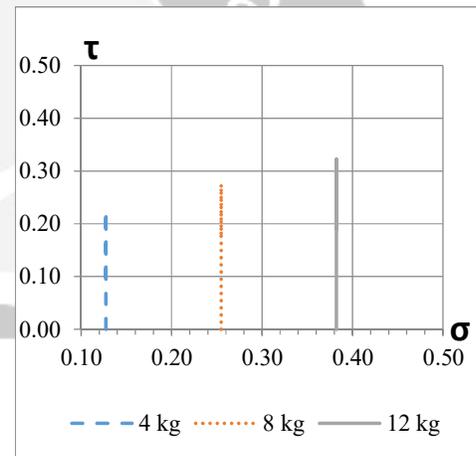
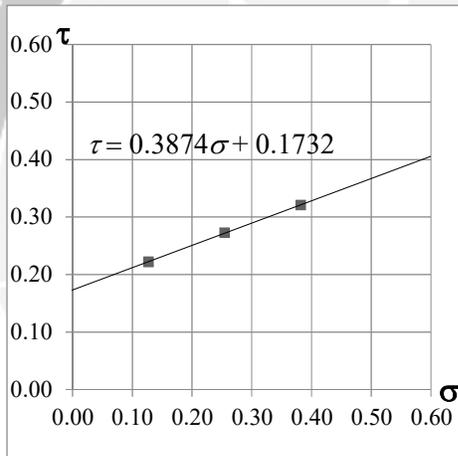
Soil + Lime 6% + Press Mud 10% (14 days curing time)

Project : Final Project
Location : Godean
Date : 30 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2221	0.1274
8	0.2728	0.2549
12	0.3208	0.3823

$c = 0.1732 \text{ kg/cm}^2$
 $\tan \phi = 0.3874$
 $\phi = 21.18^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.380 gr
 γ_w : 1.437 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	-1	0.0040	47	2.08	0.0665	0.1274
50	-1	0.0079	96	4.25	0.1365	0.1274
75	0	0.0119	130	5.75	0.1854	0.1274
100	2	0.0158	155	6.86	0.2221	0.1274
125	11	0.0198	70	3.10	0.1008	0.1274
150	16	0.0237	61	2.65	0.0865	0.1274
175	22	0.0277	60	2.61	0.0855	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.870 gr
 γ_w : 1.444 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	45	1.99	0.0637	0.2549
50	0	0.0079	95	4.20	0.1349	0.2549
75	0	0.0119	134	5.93	0.1912	0.2549
100	3	0.0158	166	7.35	0.2379	0.2549
125	7	0.0198	181	8.01	0.2604	0.2549
150	10	0.0237	189	8.36	0.2728	0.2549
175	12	0.0277	140	6.19	0.2028	0.2549
200	21	0.0316	127	5.62	0.1849	0.2549
225	23	0.0356	120	5.31	0.1754	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.680 gr
 γ_w : 1.441 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	74	3.27	0.1046	0.3823
50	0	0.0079	124	5.49	0.1763	0.3823
75	0	0.0119	169	7.48	0.2412	0.3823
100	2	0.0158	202	8.94	0.2894	0.3823
125	4	0.0198	223	9.87	0.3208	0.3823
150	9	0.0237	158	6.99	0.2281	0.3823
175	14	0.0277	131	5.80	0.1901	0.3823
200	15	0.0316	131	5.80	0.1908	0.3823
225	16	0.0356	131	5.80	0.1916	0.3823



DIRECT SHEAR TEST

Soil + Lime 6% + Press Mud 10% (28 days curing time)

Project : Final Project

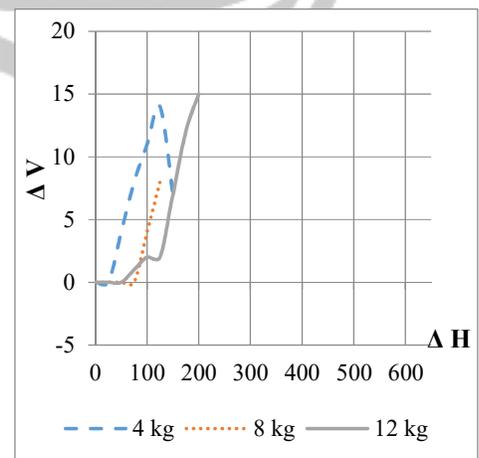
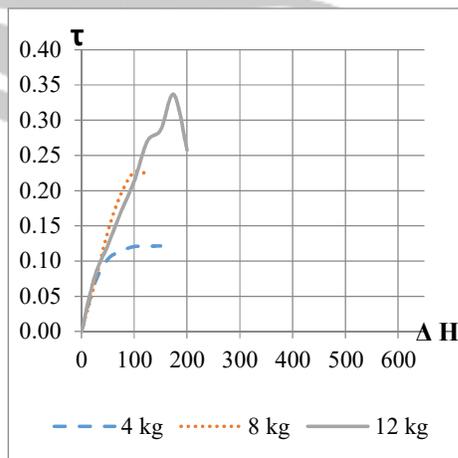
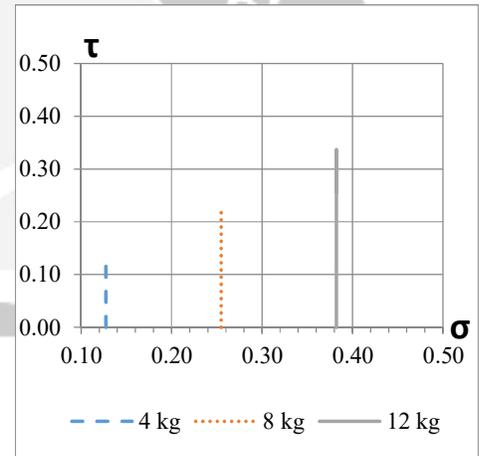
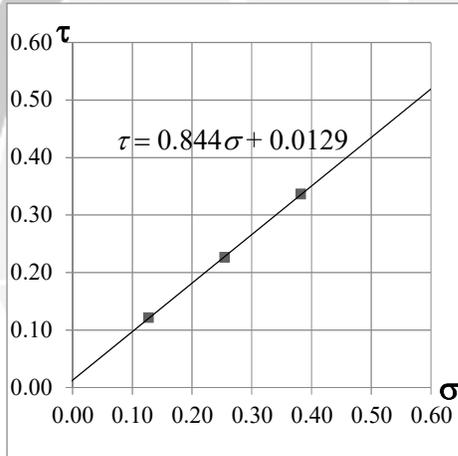
Depth : -1 m

Location : Godean

Date : 6 Dec 2016

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1214	0.1274
8	0.2263	0.2549
12	0.3365	0.3823

$c = 0.0129 \text{ kg/cm}^2$
 $\tan \phi = 0.8440$
 $\phi = 40.16^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 103.660 gr
 γ_w : 1.529 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	48	2.12	0.0678	0.1274
50	4	0.0079	72	3.19	0.1024	0.1274
75	8	0.0119	80	3.54	0.1141	0.1274
100	11	0.0158	84	3.72	0.1204	0.1274
125	14	0.0198	84	3.72	0.1209	0.1274
150	7	0.0237	84	3.72	0.1214	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 100.580 gr
 γ_w : 1.484 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	48	2.12	0.0678	0.2549
50	0	0.0079	100	4.42	0.1419	0.2549
75	0	0.0119	137	6.06	0.1954	0.2549
100	4	0.0158	158	6.99	0.2263	0.2549
125	8	0.0198	155	6.86	0.2230	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 100.330 gr
 γ_w : 1.480 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	56	2.43	0.0777	0.3823
50	0	0.0079	86	3.81	0.1224	0.3823
75	1	0.0119	119	5.27	0.1699	0.3823
100	2	0.0158	149	6.59	0.2133	0.3823
125	2	0.0198	188	8.32	0.2704	0.3823
150	7	0.0237	198	8.76	0.2859	0.3823
175	12	0.0277	232	10.27	0.3365	0.3823
200	15	0.0316	177	7.83	0.2576	0.3823



DIRECT SHEAR TEST

Soil + Lime 6% + Press Mud 15% (7 days curing time)

Project : Final Project

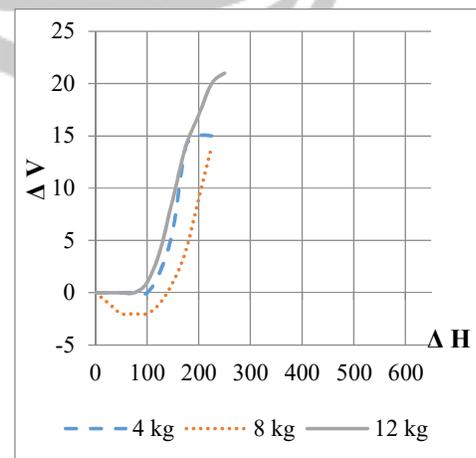
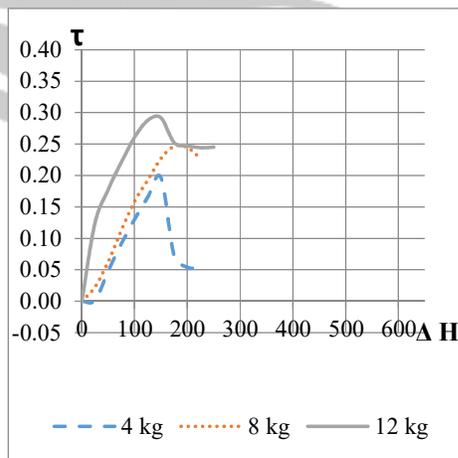
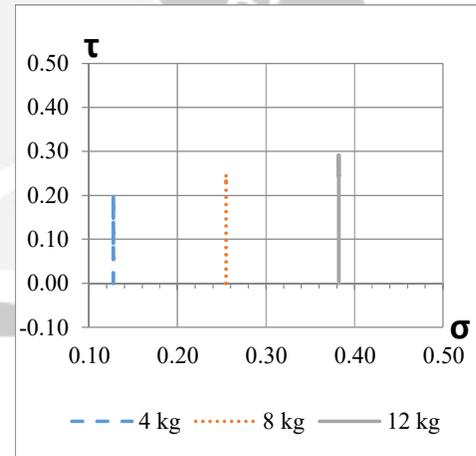
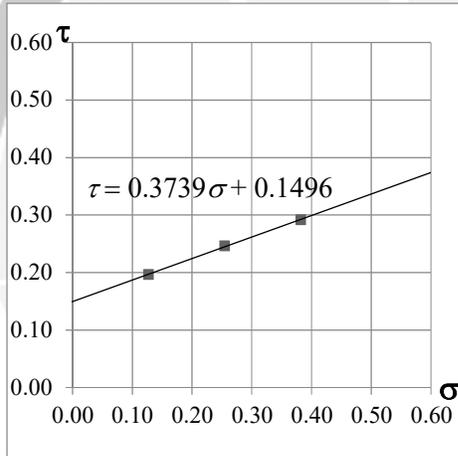
Depth : -1 m

Location : Godean

Date : 25 Nov 2016

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1965	0.1274
8	0.2464	0.2549
12	0.2918	0.3823

$c = 0.1496 \text{ kg/cm}^2$
 $\tan \phi = 0.3739$
 $\phi = 20.50^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.020 gr
 γ_w : 1.416 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	1	0.04	0.0013	0.1274
50	0	0.0079	34	1.50	0.0482	0.1274
75	0	0.0119	65	2.83	0.0912	0.1274
100	0	0.0158	91	4.03	0.1305	0.1274
125	2	0.0198	115	5.09	0.1654	0.1274
150	6	0.0237	136	6.02	0.1965	0.1274
175	14	0.0277	50	2.21	0.0724	0.1274
200	15	0.0316	37	1.64	0.0540	0.1274
225	15	0.0356	37	1.64	0.0542	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.020 gr
 γ_w : 1.431 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	16	0.71	0.0227	0.2549
50	-2	0.0079	44	1.95	0.0626	0.2549
75	-2	0.0119	79	3.50	0.1129	0.2549
100	-2	0.0158	111	4.91	0.1590	0.2549
125	-1	0.0198	134	5.93	0.1927	0.2549
150	1	0.0237	157	6.95	0.2268	0.2549
175	4	0.0277	170	7.52	0.2464	0.2549
200	9	0.0316	168	7.43	0.2445	0.2549
225	14	0.0356	155	6.86	0.2266	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.850 gr
 γ_w : 1.429 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	88	3.89	0.1244	0.3823
50	0	0.0079	125	5.53	0.1776	0.3823
75	0	0.0119	155	6.86	0.2212	0.3823
100	1	0.0158	182	8.05	0.2606	0.3823
125	4	0.0198	200	8.85	0.2877	0.3823
150	9	0.0237	202	8.94	0.2918	0.3823
175	14	0.0277	174	7.70	0.2523	0.3823
200	17	0.0316	170	7.52	0.2474	0.3823
225	20	0.0356	167	7.39	0.2441	0.3823
250	21	0.0395	167	7.39	0.2451	0.3823



DIRECT SHEAR TEST

Soil + Lime 6% + Press Mud 15% (14 days curing time)

Project : Final Project

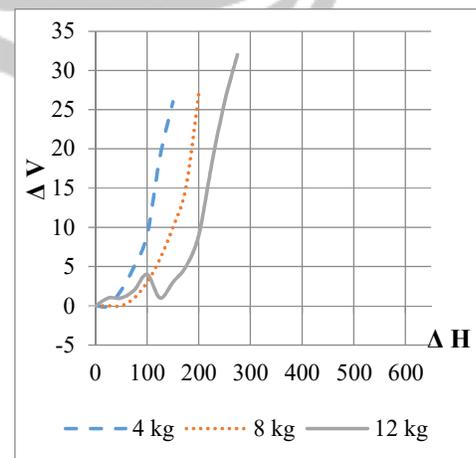
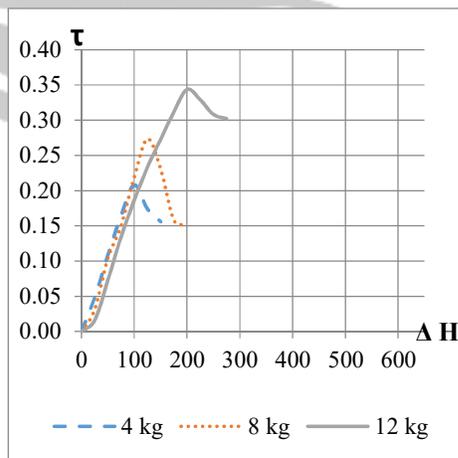
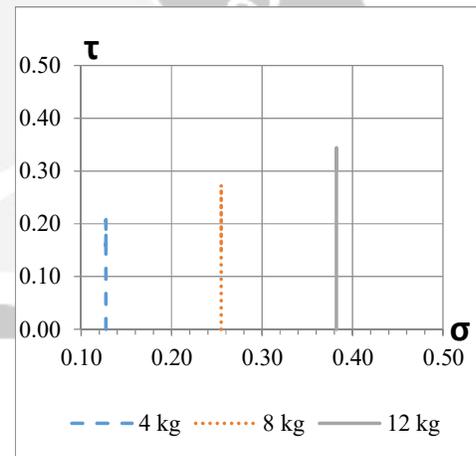
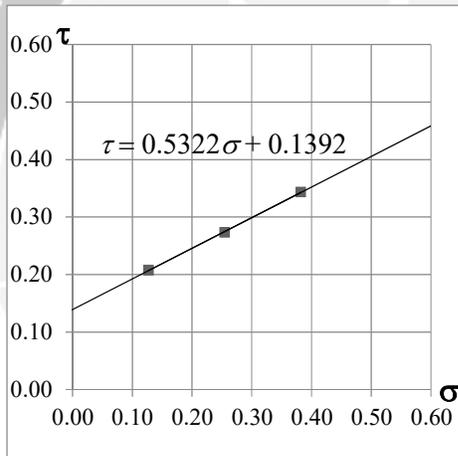
Depth : -1 m

Location : Godean

Date : 30 Nov 2016

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.2078	0.1274
8	0.2734	0.2549
12	0.3435	0.3823

$c = 0.1392 \text{ kg/cm}^2$
 $\tan \phi = 0.5322$
 $\phi = 28.02^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.840 gr
 γ_w : 1.443 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	34	1.50	0.0480	0.1274
50	2	0.0079	76	3.36	0.1079	0.1274
75	5	0.0119	115	5.09	0.1641	0.1274
100	9	0.0158	145	6.42	0.2078	0.1274
125	19	0.0198	121	5.35	0.1739	0.1274
150	26	0.0237	108	4.78	0.1560	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.410 gr
 γ_w : 1.437 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	22	0.97	0.0310	0.2549
50	0	0.0079	73	3.23	0.1037	0.2549
75	1	0.0119	105	4.65	0.1499	0.2549
100	3	0.0158	153	6.77	0.2192	0.2549
125	6	0.0198	190	8.41	0.2734	0.2549
150	10	0.0237	160	7.08	0.2311	0.2549
175	15	0.0277	109	4.82	0.1579	0.2549
200	27	0.0316	104	4.60	0.1513	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 98.790 gr
 γ_w : 1.457 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	1	0.0040	11	0.49	0.0157	0.3823
50	1	0.0079	52	2.26	0.0726	0.3823
75	2	0.0119	94	4.16	0.1341	0.3823
100	4	0.0158	130	5.75	0.1861	0.3823
125	1	0.0198	162	7.17	0.2330	0.3823
150	3	0.0237	189	8.36	0.2728	0.3823
175	5	0.0277	215	9.51	0.3116	0.3823
200	9	0.0316	236	10.44	0.3435	0.3823
225	18	0.0356	225	9.96	0.3290	0.3823
250	26	0.0395	210	9.29	0.3082	0.3823
275	32	0.0435	205	9.07	0.3021	0.3823



DIRECT SHEAR TEST

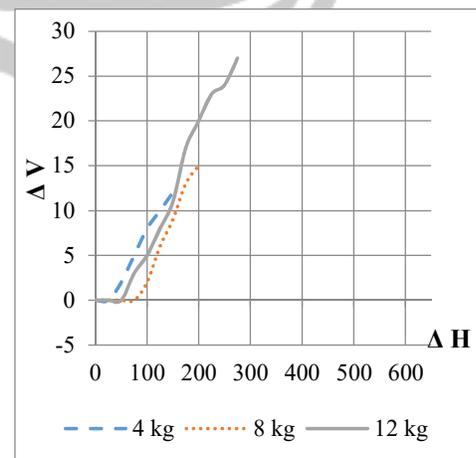
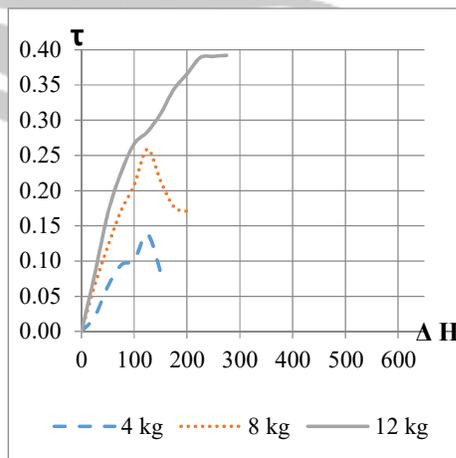
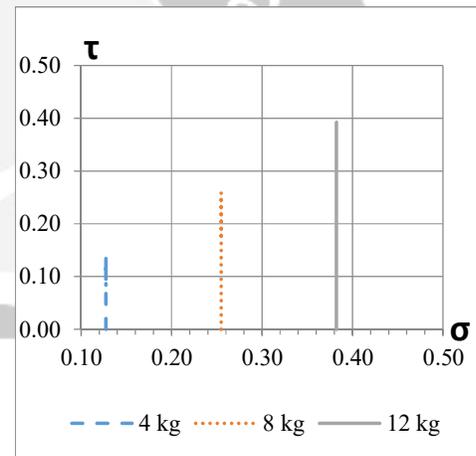
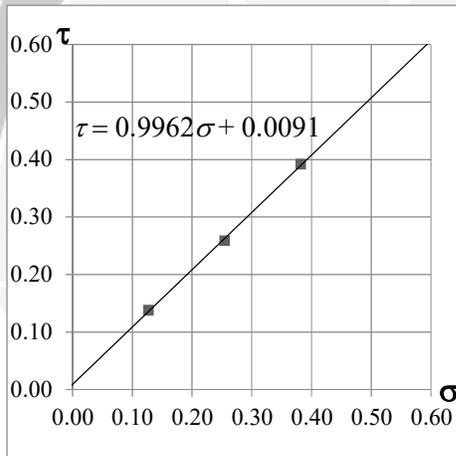
Soil + Lime 6% + Press Mud 15% (28 days curing time)

Project : Final Project
Location : Godean
Date : 6 Dec 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1381	0.1274
8	0.2587	0.2549
12	0.3921	0.3823

$c = 0.0091 \text{ kg/cm}^2$
 $\tan \phi = 0.9962$
 $\phi = 44.89^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.940 gr
 γ_w : 1.445 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ϵ (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	15	0.66	0.0211	0.1274
50	2	0.0079	45	1.99	0.0639	0.1274
75	5	0.0119	66	2.92	0.0942	0.1274
100	8	0.0158	71	3.14	0.1017	0.1274
125	10	0.0198	96	4.25	0.1381	0.1274
150	12	0.0237	59	2.57	0.0839	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 98.070 gr
 γ_w : 1.447 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	46	2.04	0.0653	0.2549
50	0	0.0079	85	3.76	0.1208	0.2549
75	0	0.0119	120	5.31	0.1712	0.2549
100	2	0.0158	145	6.42	0.2078	0.2549
125	6	0.0198	180	7.96	0.2587	0.2549
150	9	0.0237	148	6.55	0.2138	0.2549
175	13	0.0277	122	5.40	0.1769	0.2549
200	15	0.0316	117	5.18	0.1704	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 97.820 gr
 γ_w : 1.443 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	58	2.52	0.0806	0.3823
50	0	0.0079	118	5.22	0.1676	0.3823
75	3	0.0119	158	6.99	0.2254	0.3823
100	5	0.0158	186	8.23	0.2664	0.3823
125	8	0.0198	197	8.72	0.2834	0.3823
150	11	0.0237	214	9.47	0.3091	0.3823
175	17	0.0277	237	10.49	0.3437	0.3823
200	20	0.0316	251	11.11	0.3655	0.3823
225	23	0.0356	266	11.77	0.3888	0.3823
250	24	0.0395	266	11.77	0.3904	0.3823
275	27	0.0435	266	11.77	0.3921	0.3823



DIRECT SHEAR TEST

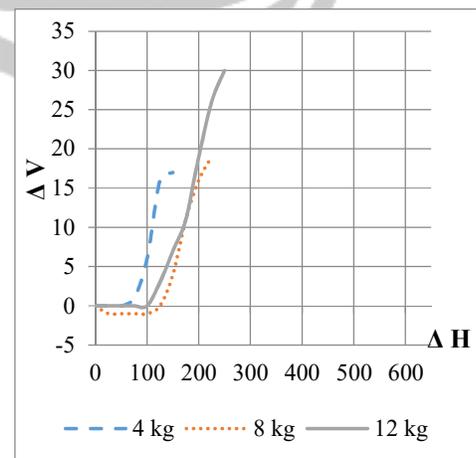
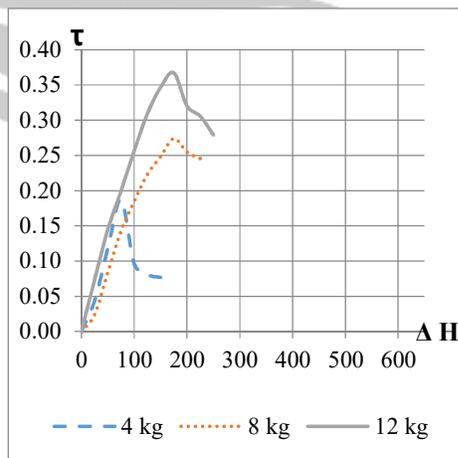
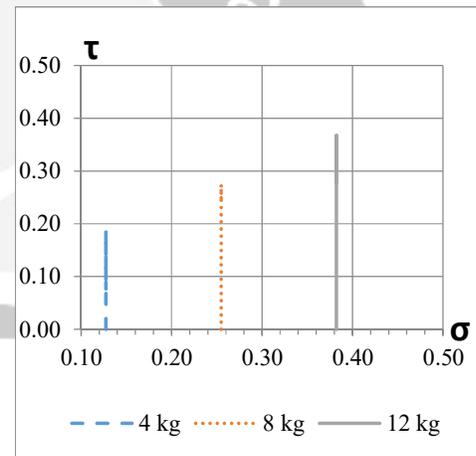
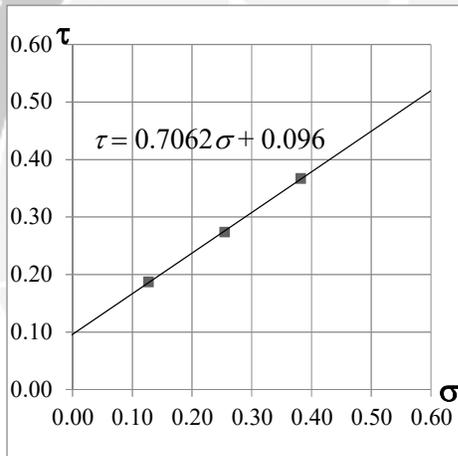
Soil + Lime 6% + Press Mud 20% (7 days curing time)

Project : Final Project
Location : Godean
Date : 25 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1870	0.1274
8	0.2739	0.2549
12	0.3670	0.3823

$c = 0.0960 \text{ kg/cm}^2$
 $\tan \phi = 0.7062$
 $\phi = 35.23^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.840 gr
 γ_w : 1.429 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	31	1.37	0.0438	0.1274
50	0	0.0079	83	3.67	0.1179	0.1274
75	1	0.0119	131	5.80	0.1870	0.1274
100	6	0.0158	67	2.96	0.0958	0.1274
125	16	0.0198	57	2.48	0.0806	0.1274
150	17	0.0237	54	2.35	0.0767	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 98.010 gr
 γ_w : 1.446 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	-1	0.0040	17	0.75	0.0240	0.2549
50	-1	0.0079	60	2.61	0.0838	0.2549
75	-1	0.0119	100	4.42	0.1425	0.2549
100	-1	0.0158	129	5.71	0.1848	0.2549
125	0	0.0198	155	6.86	0.2230	0.2549
150	4	0.0237	172	7.61	0.2484	0.2549
175	11	0.0277	189	8.36	0.2739	0.2549
200	16	0.0316	175	7.74	0.2547	0.2549
225	19	0.0356	168	7.43	0.2455	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 98.810 gr
 γ_w : 1.458 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	53	2.30	0.0736	0.3823
50	0	0.0079	102	4.51	0.1448	0.3823
75	0	0.0119	140	6.19	0.1996	0.3823
100	0	0.0158	179	7.92	0.2564	0.3823
125	3	0.0198	215	9.51	0.3091	0.3823
150	7	0.0237	240	10.62	0.3466	0.3823
175	11	0.0277	253	11.20	0.3670	0.3823
200	19	0.0316	220	9.73	0.3201	0.3823
225	26	0.0356	209	9.25	0.3056	0.3823
250	30	0.0395	190	8.41	0.2790	0.3823



DIRECT SHEAR TEST

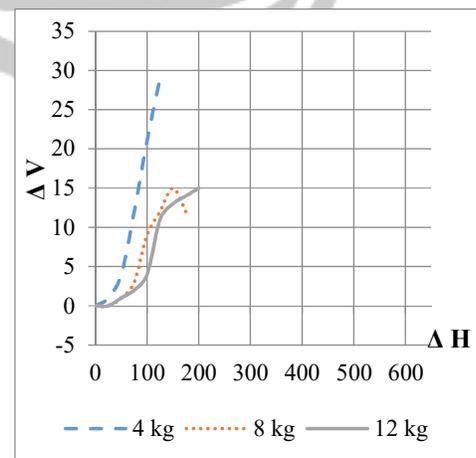
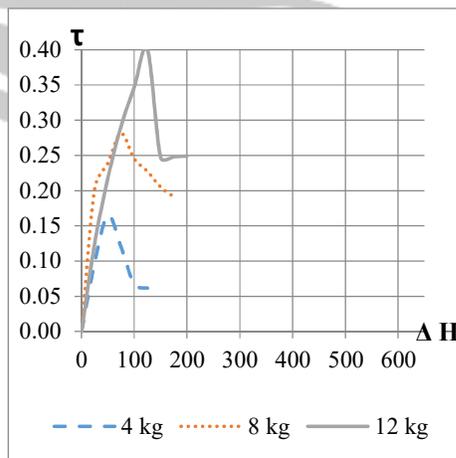
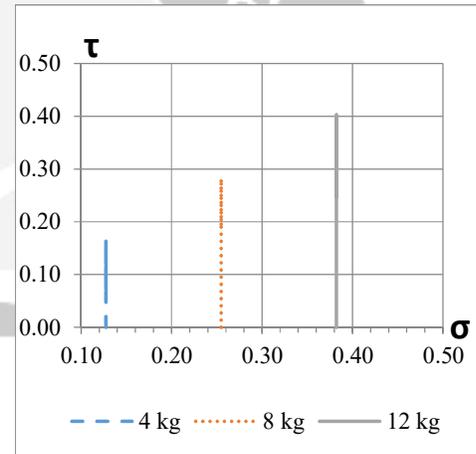
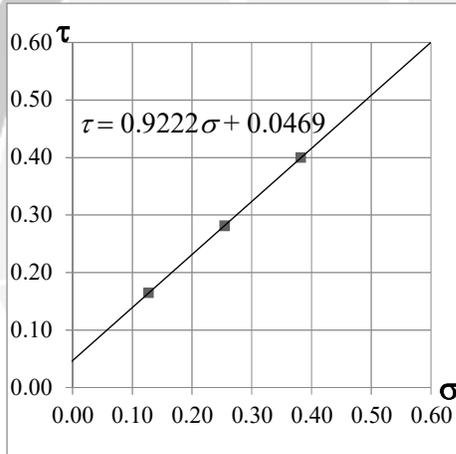
Soil + Lime 6% + Press Mud 20% (14 days curing time)

Project : Final Project
Location : Godean
Date : 30 Nov 2016

Depth : -1 m

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1647	0.1274
8	0.2812	0.2549
12	0.3998	0.3823

$c = 0.0469 \text{ kg/cm}^2$
 $\tan \phi = 0.9222$
 $\phi = 42.68^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.500 gr
 γ_w : 1.424 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	1	0.0040	69	3.05	0.0976	0.1274
50	4	0.0079	116	5.13	0.1647	0.1274
75	12	0.0119	84	3.72	0.1199	0.1274
100	21	0.0158	47	2.08	0.0673	0.1274
125	29	0.0198	43	1.90	0.0618	0.1274



Data of Sample

Load : 8 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 95.970 gr
 γ_w : 1.416 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	143	6.33	0.2025	0.2549
50	1	0.0079	168	7.43	0.2386	0.2549
75	3	0.0119	197	8.72	0.2812	0.2549
100	9	0.0158	171	7.57	0.2451	0.2549
125	12	0.0198	158	6.99	0.2272	0.2549
150	15	0.0237	142	6.28	0.2049	0.2549
175	12	0.0277	132	5.84	0.1914	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.500 gr
 γ_w : 1.424 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	88	3.89	0.1244	0.3823
50	1	0.0079	153	6.77	0.2174	0.3823
75	2	0.0119	204	9.03	0.2912	0.3823
100	4	0.0158	242	10.71	0.3467	0.3823
125	11	0.0198	278	12.30	0.3998	0.3823
150	13	0.0237	171	7.57	0.2470	0.3823
175	14	0.0277	171	7.57	0.2481	0.3823
200	15	0.0316	171	7.57	0.2491	0.3823



DIRECT SHEAR TEST

Soil + Lime 6% + Press Mud 20% (28 days curing time)

Project : Final Project

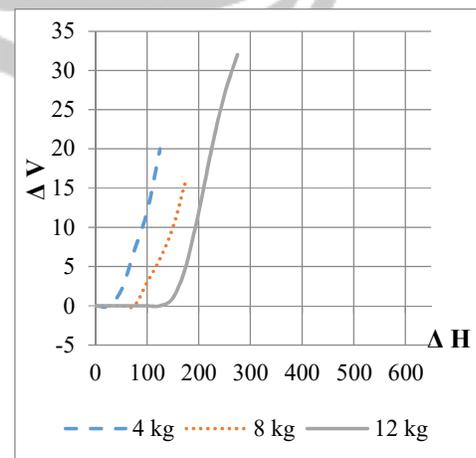
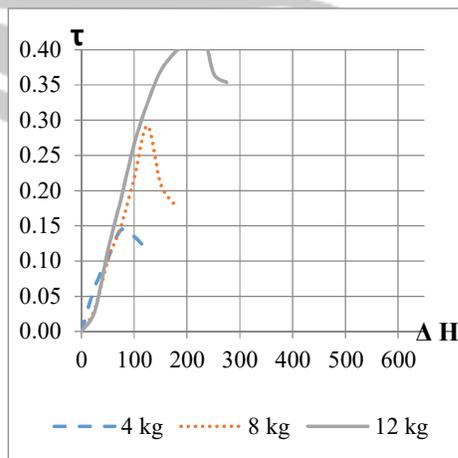
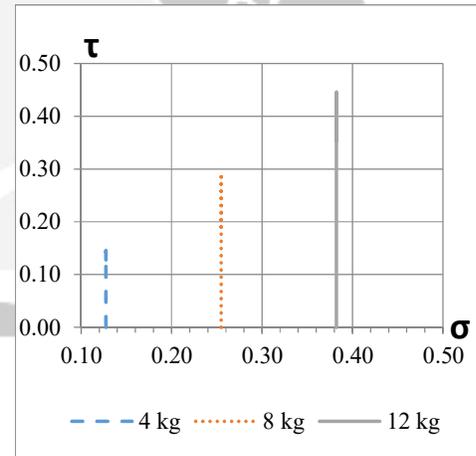
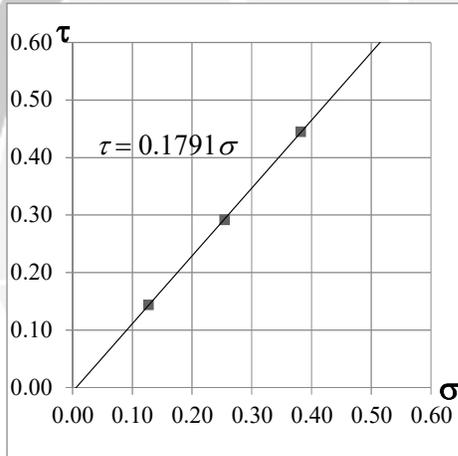
Depth : -1 m

Location : Godean

Date : 6 Dec 2016

Load (kg)	τ (kg/cm ²)	σ (kg/cm ²)
4	0.1441	0.1274
8	0.2919	0.2549
12	0.4447	0.3823

$c = 0.0000 \text{ kg/cm}^2$
 $\tan \phi = 1.1791$
 $\phi = 49.70^\circ$





Data of Sample

Load : 4 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 95.680 gr
 γ_w : 1.411 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.1274
25	0	0.0040	44	1.95	0.0624	0.1274
50	2	0.0079	73	3.23	0.1037	0.1274
75	7	0.0119	101	4.47	0.1441	0.1274
100	12	0.0158	94	4.16	0.1347	0.1274
125	20	0.0198	80	3.54	0.1151	0.1274



Data of Sample

Load : 8 kg

Diameter : 6.3216 cm

Height : 2.1598 cm

Area : 31.387 cm²

Weight : 96.800 gr

γ_w : 1.428 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.2549
25	0	0.0040	22	0.97	0.0310	0.2549
50	0	0.0079	71	3.14	0.1008	0.2549
75	0	0.0119	105	4.65	0.1499	0.2549
100	3	0.0158	152	6.73	0.2179	0.2549
125	6	0.0198	203	8.98	0.2919	0.2549
150	10	0.0237	145	6.42	0.2095	0.2549
175	16	0.0277	125	5.53	0.1812	0.2549



Data of Sample

Load : 12 kg
Diameter : 6.3216 cm
Height : 2.1598 cm
Area : 31.387 cm²
Weight : 96.640 gr
 γ_w : 1.426 gr/cm³

ΔH (x10 ⁻³ cm)	ΔV (x10 ⁻³ cm)	ε (%)	Load		τ (kg/cm ²)	σ (kg/cm ²)
			dial	kg		
0	0	0.0000	0	0.00	0.0000	0.3823
25	0	0.0040	20	0.88	0.0281	0.3823
50	0	0.0079	81	3.58	0.1150	0.3823
75	0	0.0119	132	5.84	0.1883	0.3823
100	0	0.0158	186	8.23	0.2664	0.3823
125	0	0.0198	225	9.96	0.3237	0.3823
150	1	0.0237	256	11.33	0.3698	0.3823
175	5	0.0277	272	12.04	0.3945	0.3823
200	12	0.0316	283	12.53	0.4123	0.3823
225	20	0.0356	304	13.46	0.4447	0.3823
250	27	0.0395	250	11.06	0.3669	0.3823
275	32	0.0435	240	10.62	0.3537	0.3823



DOCUMENTATIONS OF RESEARCH

APPENDIX 4



Standard Proctor Test Preparation



Preparation of Materials



Mixing Specimens



Making Specimens



Conducting Direct Shear Test and Taking Test Data



Specimens After Direct Shear Test