Lampiran 1

DATA HASIL PENGUJIAN *INDEX PROPERTIES* KAOLIN

Atterberg Limit
Specific Gravity (Gs)
Hydrometer Analysis

FAKULTAS TEKNIK UNIVERSITAS INDONESIA
LABORATORIUM MEKANIKATANAH
Kampus UI - Depok 16424 Telp. (021)7270029, 78849102 Fax. (021)7270028

ATTERBERG LIMITS DETERMINATION

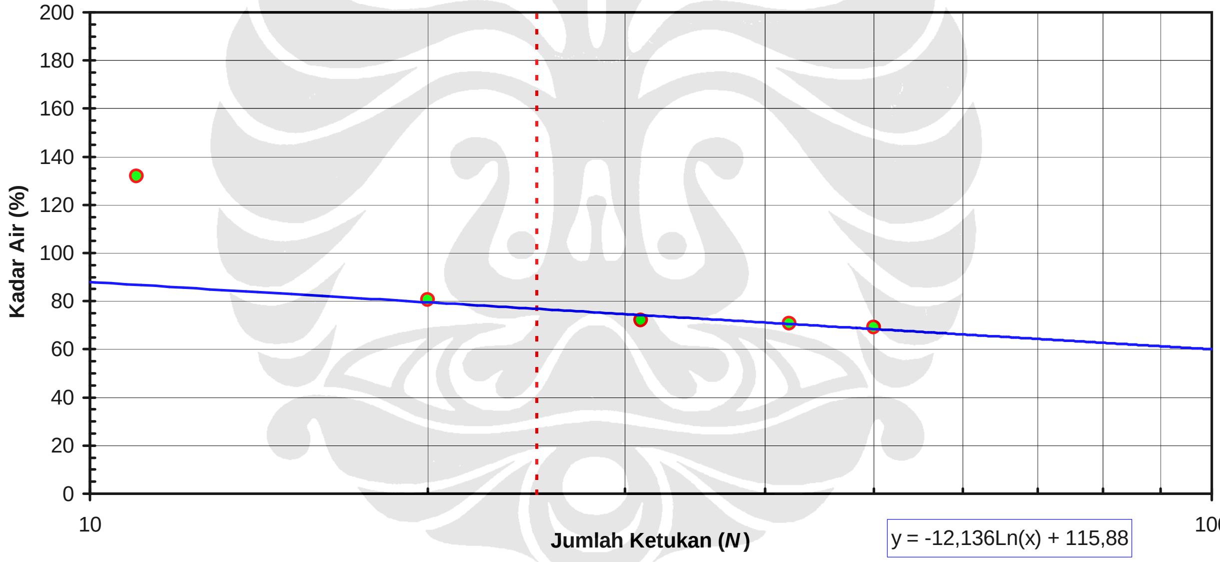
Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

No. Pekerjaan = ---
No. Boring = --- No. Sampel = #1
Kedalaman = ---
Tanggal Pengujian = 21 Juli 2008

Liquid Limit Determination

No. Can	Unit	1	2	3	4	5
Berat *can*	(*gr*)	6,34	8,13	7,87	7,94	8,15
Berat tanah basah + *can*	(*gr*)	26,13	27,74	27,22	25,11	36,57
Berat tanah kering + *can*	(*gr*)	14,87	18,99	19,11	18,00	24,94
Berat air	(*gr*)	11,26	8,75	8,11	7,11	11,63
Berat tanah kering	(*gr*)	8,53	10,86	11,24	10,06	16,79
Kadar air (*w*)	(%)	132,00	80,57	72,15	70,68	69,27
Jumlah ketukan (*N*)		11	20	31	42	50

Catatan : data no.1 pada LL diabaikan dalam grafik, karena menyimpang terlalu jauh.



Flow Index (FI) =	**-27,90**	(%)	-12,136	115,88
Liquid Limit (LL) =	**76,80**	(%)		
Plastic Limit (PL) =	**-**	(%)		
Plasticity Index (PI) =	**-**	(%)		

Plastic Limit Determination

No. Can	Unit					
Berat *can*	(*gr*)					
Berat tanah basah + *can*	(*gr*)					
Berat tanah kering + *can*	(*gr*)					
Berat air	(*gr*)					
Berat tanah kering	(*gr*)					
Kadar air (*w*)	(%)					

Catatan :

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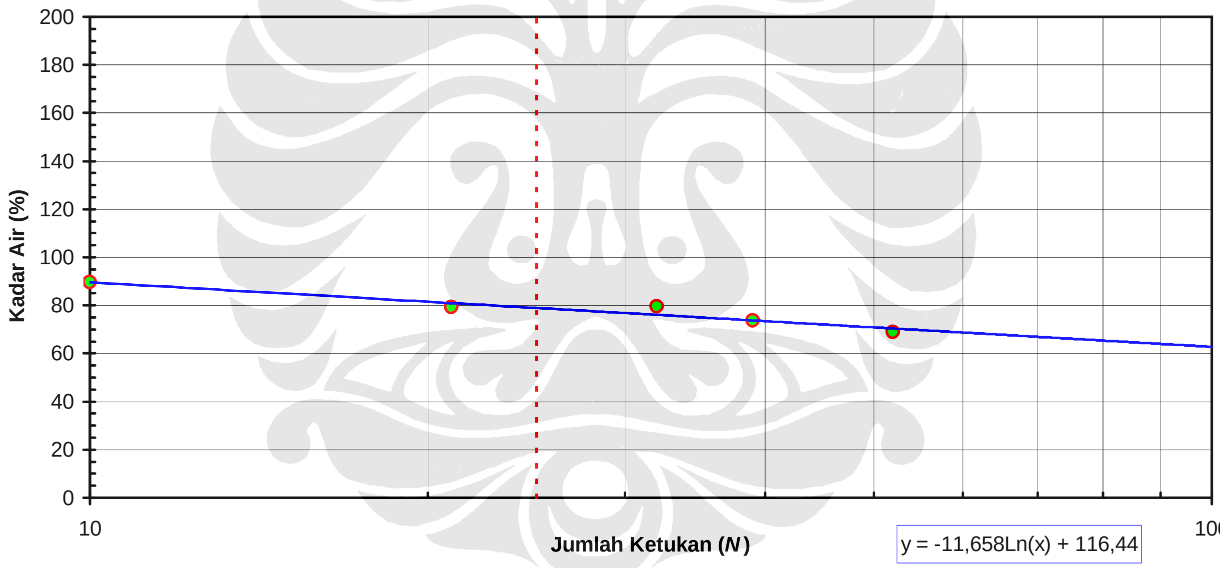
Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

No. Pekerjaan = ---
No. Boring = --- No. Sampel = #2
Kedalaman = ---
Tanggal Pengujian = 21 Juli 2008

Liquid Limit Determination

No. Can	Unit	1	2	3	4	5
Berat *can*	(*gr*)	8,80	8,63	9,33	8,73	9,11
Berat tanah basah + *can*	(*gr*)	19,93	16,53	20,13	22,02	20,81
Berat tanah kering + *can*	(*gr*)	14,67	13,04	15,35	16,38	16,04
Berat air	(*gr*)	5,26	3,49	4,78	5,64	4,77
Berat tanah kering	(*gr*)	5,87	4,41	6,02	7,65	6,93
Kadar air (*w*)	(%)	89,61	79,14	79,40	73,73	68,83
Jumlah ketukan (*N*)		10	21	32	39	52

Catatan :



Flow Index (FI) =	**-26,80**	(%)
Liquid Limit (LL) =	**78,90**	(%)
Plastic Limit (PL) =	**38,40**	(%)
Plasticity Index (PI) =	**40,50**	(%)

-11,658 116,44

Plastic Limit Determination

No. Can	Unit	1	2			
Berat *can*	(*gr*)	21,49	12,82			
Berat tanah basah + *can*	(*gr*)	39,65	29,76			
Berat tanah kering + *can*	(*gr*)	34,60	25,07			
Berat air	(*gr*)	5,05	4,69			
Berat tanah kering	(*gr*)	13,11	12,25			
Kadar air (*w*)	(%)	38,52	38,29			

Catatan :

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ATTERBERG LIMITS DETERMINATION

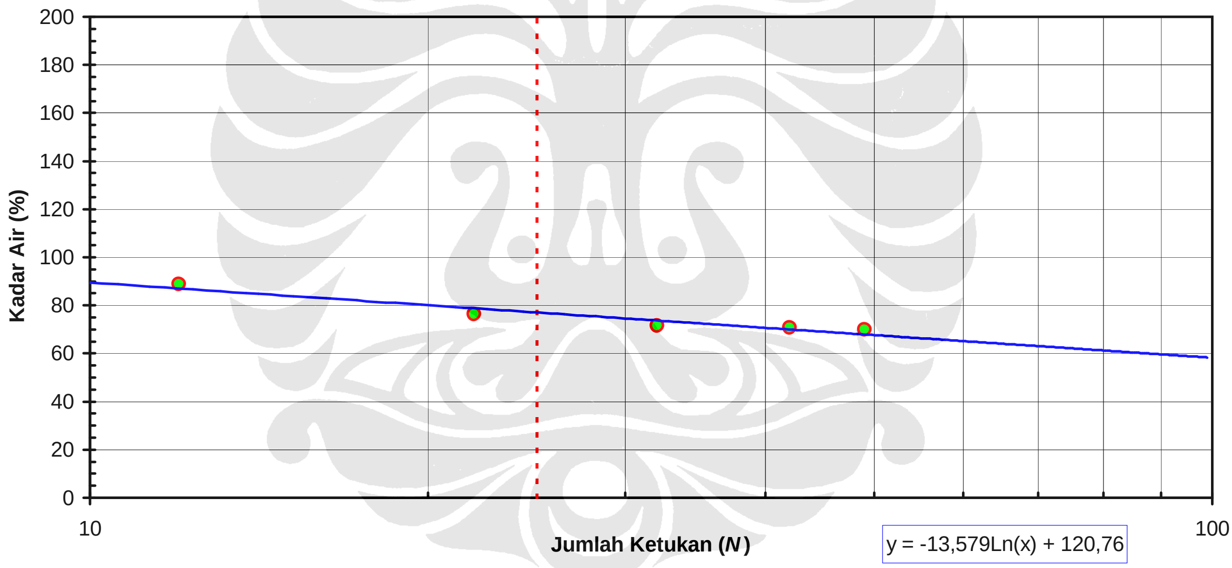
Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

No. Pekerjaan = ---
No. Boring = --- No. Sampel = #3
Kedalaman = ---
Tanggal Pengujian = 21 Juli 2008

Liquid Limit Determination

No. Can	Unit	1	2	3	4	5
Berat *can*	(*gr*)	9,14	8,00	8,00	8,47	8,04
Berat tanah basah + *can*	(*gr*)	26,43	18,39	19,73	23,53	26,55
Berat tanah kering + *can*	(*gr*)	18,29	13,89	14,84	17,29	18,94
Berat air	(*gr*)	8,14	4,50	4,89	6,24	7,61
Berat tanah kering	(*gr*)	9,15	5,89	6,84	8,82	10,90
Kadar air (*w*)	(%)	88,96	76,40	71,49	70,75	69,82
Jumlah ketukan (*N*)		12	22	32	42	49

Catatan :



***Flow Index (FI)* =** **-31,30** (%)
***Liquid Limit (LL)* =** **77,10** (%)
***Plastic Limit (PL)* =** **-** (%)
***Plasticity Index (PI)* =** **-** (%)

-13,579 120,76

Plastic Limit Determination

No. Can	Unit					
Berat *can*	(*gr*)					
Berat tanah basah + *can*	(*gr*)					
Berat tanah kering + *can*	(*gr*)					
Berat air	(*gr*)					
Berat tanah kering	(*gr*)					
Kadar air (*w*)	(%)					

Catatan :

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ATTERBERG LIMITS DETERMINATION

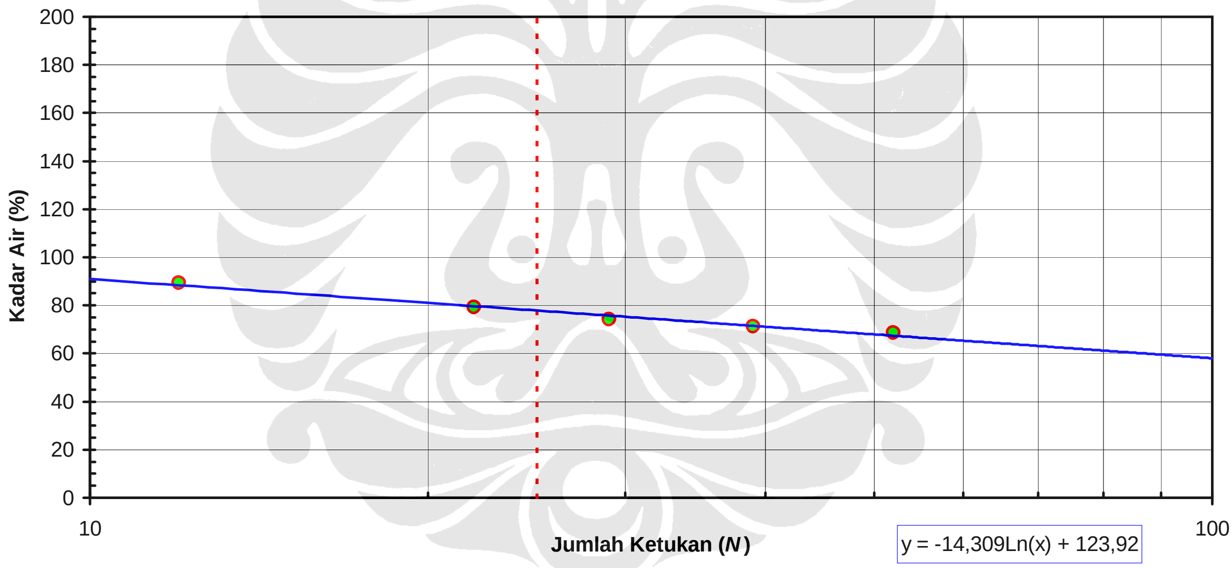
Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

No. Pekerjaan = ---
No. Boring = --- No. Sampel = #4
Kedalaman = ---
Tanggal Pengujian = 22 Juli 2008

Liquid Limit Determination

No. Can	Unit	1	2	3	4	5
Berat *can*	(*gr*)	9,11	8,72	8,48	8,76	9,31
Berat tanah basah + *can*	(*gr*)	17,97	19,56	23,79	23,53	23,73
Berat tanah kering + *can*	(*gr*)	13,79	14,77	17,27	17,38	17,86
Berat air	(*gr*)	4,18	4,79	6,52	6,15	5,87
Berat tanah kering	(*gr*)	4,68	6,05	8,79	8,62	8,55
Kadar air (*w*)	(%)	89,32	79,17	74,18	71,35	68,65
Jumlah ketukan (*N*)		12	22	29	39	52

Catatan :



Flow Index (FI) = **-32,90** (%)
Liquid Limit (LL) = **77,90** (%)
Plastic Limit (PL) = **40,17** (%)
Plasticity Index (PI) = **37,73** (%)

-14,309 123,92

Plastic Limit Determination

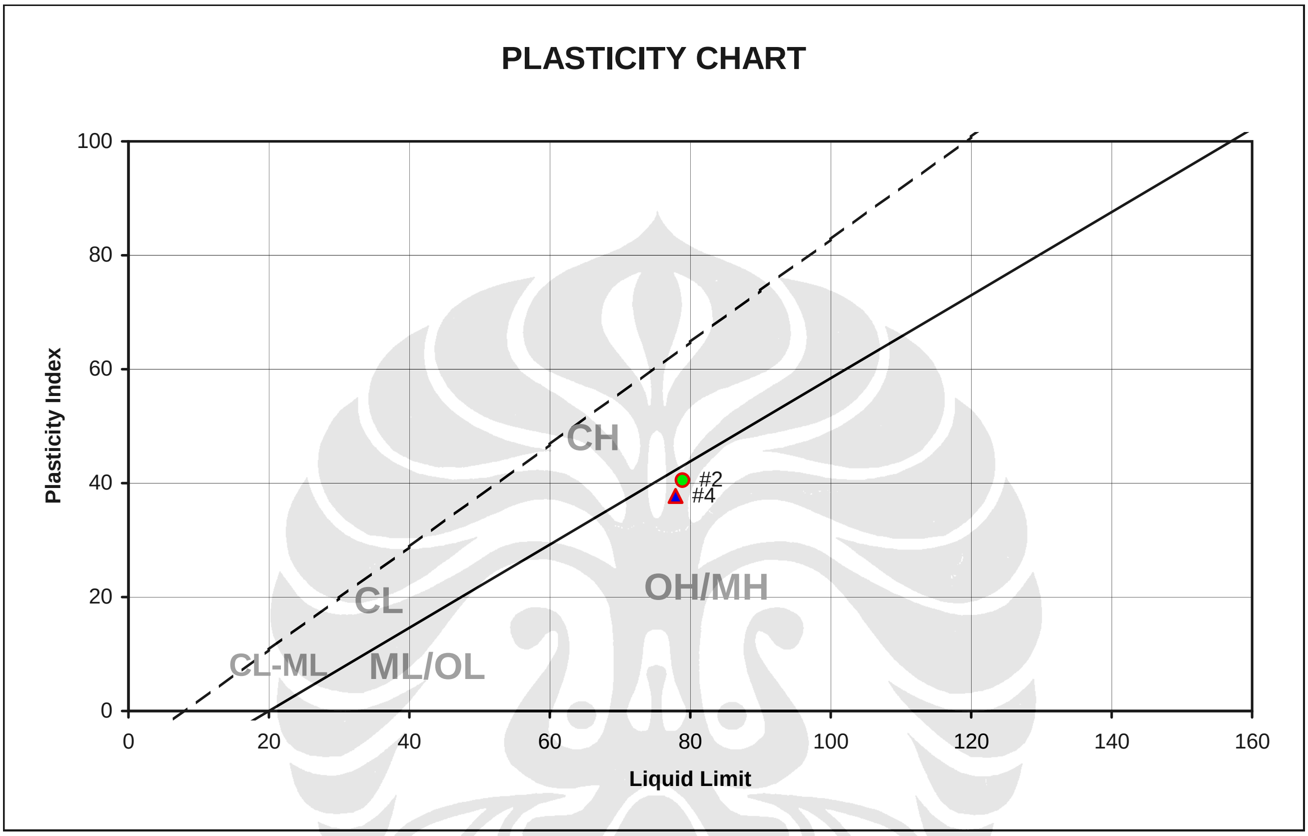
No. Can	Unit	1	2			
Berat *can*	(*gr*)	20,95	13,06			
Berat tanah basah + *can*	(*gr*)	38,65	30,12			
Berat tanah kering + *can*	(*gr*)	33,62	25,19			
Berat air	(*gr*)	5,03	4,93			
Berat tanah kering	(*gr*)	12,67	12,13			
Kadar air (*w*)	(%)	39,70	40,64			

Catatan :

Laboratorium Mekanika Tanah
Departemen Sipil, Fakultas Teknik Universitas Indonesia
Depok 16424 Telp. +62 21 788 49102, Fax. +62 21 788 49102

ATTERBERG LIMIT

PROYEK	TANGGAL
Skripsi Kaoline	21-22 Juli 2008
LOKASI	**DIUJI OLEH**
Lab. Mektan FT-UI	Tim Kaoline



No. Bor	Kedalaman (m)	Simbol	LL (%)	PL (%)	PI (%)	*Unified Classification*
		#1	76,80			-
		#2	78,90	38,40	40,50	OH/MH
		#3	77,10			-
		#4	77,90	40,17	37,73	OH/MH

SPECIFIC GRAVITY DARI TANAH SOLID ***(Gs)***

Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

No. Pekerjaan = ---
No. Boring = --- No. Sampel = ---
Kedalaman = ---
Tanggal Pengujian = 23 Juli 2008

NO. TES	Unit	1	2	3	4
Vol. piknometer pada 20^{o}C	(*mL*)	500	500	500	500
Metode *air removal* [1]		dididihkan	dididihkan	dididihkan	dididihkan
Berat piknometer + air + tanah = W_{bws}	(*gr*)	718,29	718,15	727,44	726,16
Temperatur pada saat pengujian, ^{o}C		29	29	29	29
Berat piknometer + air [2] = W_{bw}	(*gr*)	656,65	656,43	665,75	664,40
No. *evaporate dish*		1	2	7	8
Berat *evaporate dish* + tanah kering	(*gr*)	402,29	407,95	418,23	394,76
Berat *evaporate dish*	(*gr*)	302,27	307,92	318,08	294,71
Berat tanah kering = W_s	(*gr*)	100,02	100,03	100,15	100,05
$W_w = W_s + W_{bw} - W_{bws}$	(*gr*)	38,38	38,31	38,46	38,29
Nilai α pada temperatur pengujian		0,99598	0,99598	0,99598	0,99598
$Gs = \alpha W_s / W_w$		2,596	2,601	2,594	2,602
***Gs* Rata-rata**		**2,598**			

Keterangan :

[1] mengindikasikan pengeluaran udara dengan divakum atau dengan aspirator.

[2] W_{bw} adalah berat piknometer yang diisi air yang kuantitasnya sama dengan cairan pendispersi yang telah ditambahkan pada campuran air-tanah dan pada temperatur yang sama.

Catatan :

***Gs* rata-rata dari tanah solid = 2,598**

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GRAIN SIZE ANALYSIS - HIDROMETER METHOD

Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

Tanggal Pengujian = 24 - 25 Juli 2008
No. Pekerjaan = ---
No. Boring = --- No. Sampel = #1
Kedalaman = ---

Hidrometer analysis

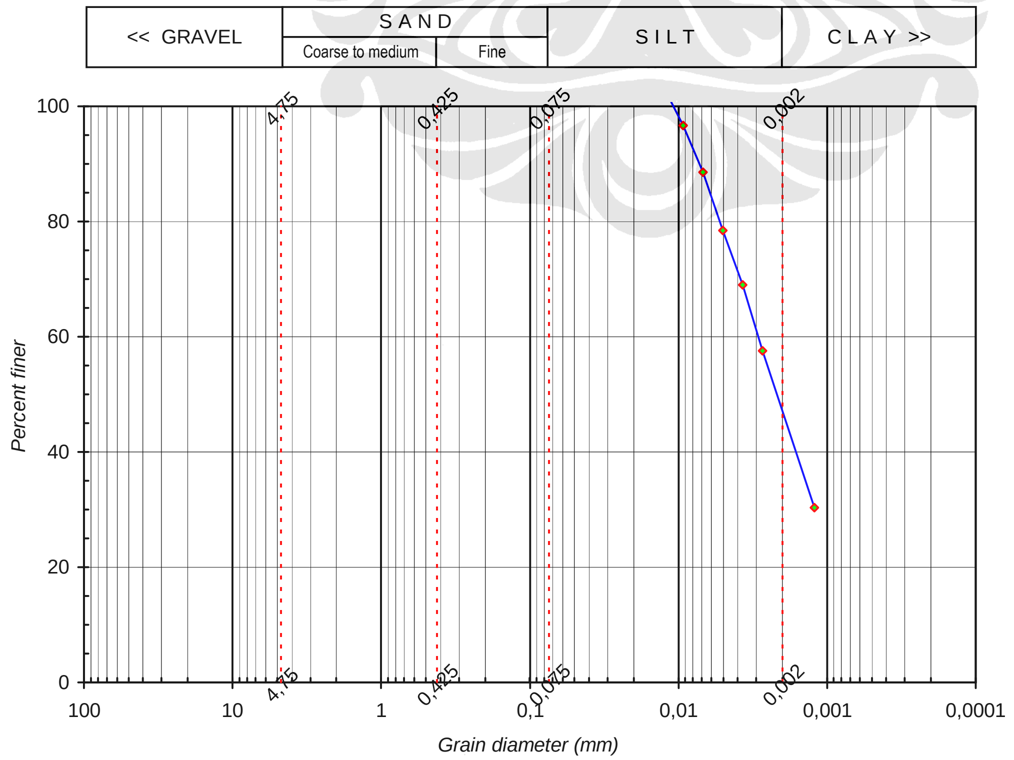
No. hidrometer = 1
Agen pendispersi = *Water glass*
Berat pendispersi = 40 *gr*

Gs tanah = 2,598
a = 1,012
Berat tanah (W_s) = 50 *gr*

Koreksi nol = 4
Koreksi meniskus = 1

Waktu pembacaan: Tanggal	Waktu pembacaan: Jam	Waktu berjalan (*menit*)	Temp. °C	C_T	Actual Hyd. reading R_a	Corr. Hyd. reading R_c	% Finer	Hyd. corr. only for meniskus R	L	L/t	K	D (*mm*)
24-Jul-08	10:05	1	28,5	2,76	53	51,76	104,8	54	7,4	7,400	0,0126	0,034
	10:06	2	28,5	2,76	53	51,76	104,8	54	7,4	3,700	0,0126	0,024
	10:07	3	28,5	2,76	52,7	51,46	104,2	53,7	7,5	2,500	0,0126	0,020
	10:08	4	28,5	2,76	52,2	50,96	103,2	53,2	7,6	1,900	0,0126	0,017
	10:12	8	28,5	2,76	52	50,76	102,8	53	7,6	0,950	0,0126	0,012
	10:19	15	28,5	2,76	49	47,76	96,7	50	8,1	0,540	0,0126	0,009
	10:34	30	28,5	2,76	45	43,76	88,6	46	8,8	0,293	0,0126	0,007
	11:04	60	28,5	2,76	40	38,76	78,5	41	9,6	0,160	0,0126	0,005
	12:04	120	29	3,08	35	34,08	69,0	36	10,4	0,087	0,0125	0,004
	14:04	240	29,5	3,42	29	28,42	57,5	30	11,4	0,048	0,0125	0,003
	18:04	480										
	2:04	960										
25-Jul-08	10:04	1440	28	2,48	16,5	14,98	30,3	17,5	13,4	0,009	0,0126	0,001

Catatan : $R_c = R_a$ - (koreksi nol) + C_T % finer = R_c.(a) / W_s D = K.√(L/t)



Komposisi	
Sand	0%
Silt	53%
Clay	47%

Deskripsi visual tanah :
Kaoline Clay

Klasifikasi tanah :
Silty Clay

Sistem klasifikasi :
Unified

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Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

Tanggal Pengujian = 24 - 25 Juli 2008
No. Pekerjaan = ---
No. Boring = --- No. Sampel = #2
Kedalaman = ---

Hidrometer analysis

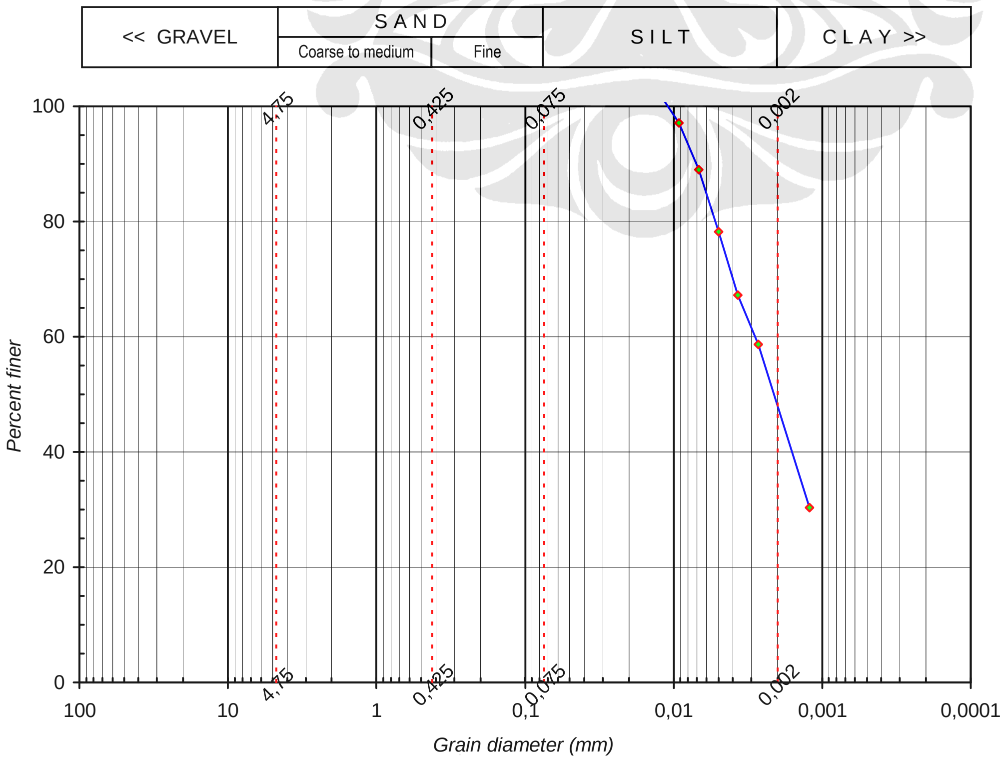
No. hidrometer = 1
Agen pendispersi = *Water glass*
Berat pendispersi = 40 *gr*

Gs tanah = 2,598
a = 1,012
Berat tanah (W_s) = 50 *gr*

Koreksi nol = 4
Koreksi meniskus = 1

Waktu pembacaan: Tanggal	Waktu pembacaan: Jam	Waktu berjalan (*menit*)	Temp. °C	C_T	Actual Hyd. reading R_a	Corr. Hyd. reading R_c	% Finer	Hyd. corr. only for meniskus *R*	L	L/t	K	D (*mm*)
24-Jul-08	10:20	1	28,5	2,76	54	52,76	106,8	55	7,3	7,300	0,0126	0,034
	10:21	2	28,5	2,76	53,3	52,06	105,4	54,3	7,4	3,700	0,0126	0,024
	10:22	3	28,5	2,76	52,9	51,66	104,6	53,9	7,5	2,500	0,0126	0,020
	10:23	4	28,5	2,76	52,5	51,26	103,8	53,5	7,5	1,875	0,0126	0,017
	10:27	8	28,5	2,76	51,7	50,46	102,2	52,7	7,7	0,963	0,0126	0,012
	10:34	15	28,8	2,95	49	47,95	97,1	50	8,1	0,540	0,0125	0,009
	10:49	30	28,8	2,95	45	43,95	89,0	46	8,8	0,293	0,0125	0,007
	11:19	60	28,8	2,95	39,7	38,65	78,2	40,7	9,6	0,160	0,0125	0,005
	12:19	120	29	3,08	34,1	33,18	67,2	35,1	10,5	0,088	0,0125	0,004
	14:19	240	30	3,80	29,2	29,00	58,7	30,2	11,3	0,047	0,0124	0,003
	18:19	480										
	2:19	960										
25-Jul-08	10:19	1440	28	2,48	16,5	14,98	30,3	17,5	13,4	0,009	0,0126	0,001

Catatan : $R_c = R_a$ - (koreksi nol) + C_T % finer = R_c.(a) / W_s D = K.√(L/t)



Komposisi	
Sand	0%
Silt	52%
Clay	48%

Deskripsi visual tanah :
Kaoline Clay

Klasifikasi tanah :
Silty Clay

Sistem klasifikasi :
Unified

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Proyek = Kaoline filler super 325 mesh
Lokasi proyek = Lab. Mektan FT-UI
Deskripsi tanah = kaoline, warna putih
Diuji oleh = Tim skripsi kaoline

Tanggal Pengujian = 24 - 25 Juli 2008
No. Pekerjaan = ---
No. Boring = --- No. Sampel = #3
Kedalaman = ---

Hidrometer analysis

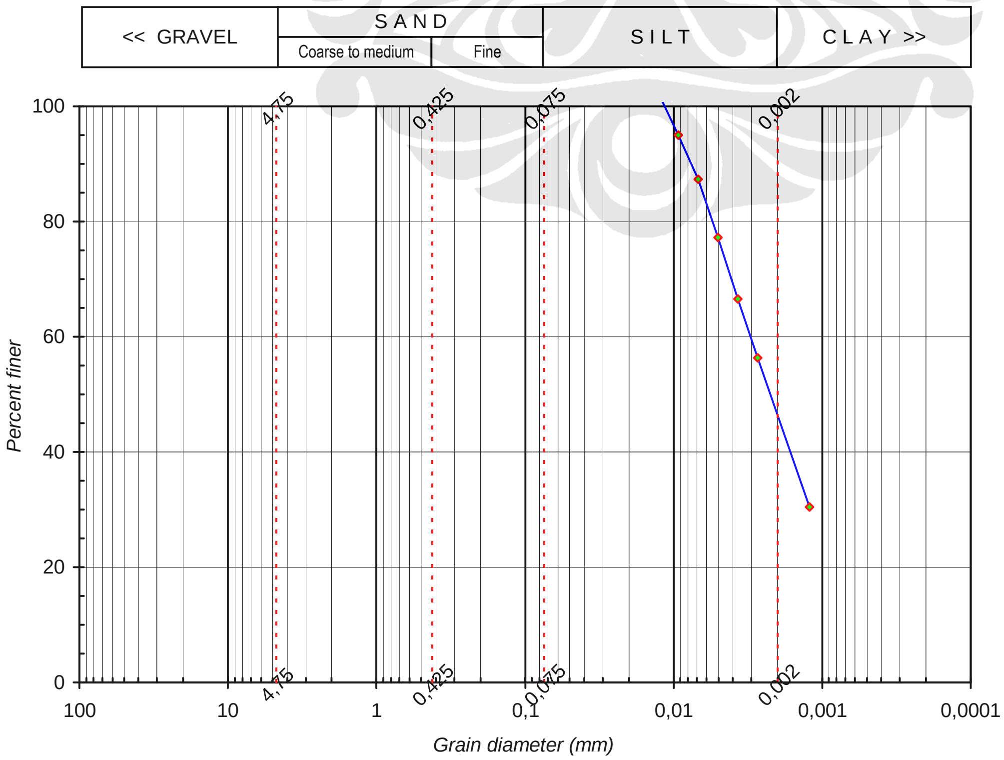
No. hidrometer = 1
Agen pendispersi = *Water glass*
Berat pendispersi = 40 *gr*

Gs tanah = 2,598
a = 1,012
Berat tanah (W_s) = 50 *gr*

Koreksi nol = 4
Koreksi meniskus = 1

Waktu pembacaan		Waktu berjalan (*menit*)	Temp. °C	C_T	Actual Hyd. reading R_a	Corr. Hyd. reading R_c	% Finer	Hyd. corr. only for meniskus *R*	L	L/t	K	D (*mm*)
Tanggal	Jam											
24-Jul-08	10:45	1	28,8	2,95	54	52,95	107,2	55	7,3	7,300	0,0125	0,034
	10:46	2	28,8	2,95	53	51,95	105,2	54	7,4	3,700	0,0125	0,024
	10:47	3	28,8	2,95	52,8	51,75	104,8	53,8	7,5	2,500	0,0125	0,020
	10:48	4	28,8	2,95	52	50,95	103,2	53	7,6	1,900	0,0125	0,017
	10:52	8	28,8	2,95	51,2	50,15	101,5	52,2	7,7	0,963	0,0125	0,012
	10:59	15	28,8	2,95	48	46,95	95,1	49	8,3	0,553	0,0125	0,009
	11:14	30	28,8	2,95	44,2	43,15	87,4	45,2	8,9	0,297	0,0125	0,007
	11:44	60	28,8	2,95	39,2	38,15	77,2	40,2	9,7	0,162	0,0125	0,005
	12:44	120	29	3,08	33,8	32,88	66,6	34,8	10,6	0,088	0,0125	0,004
	14:44	240	30	3,80	28	27,80	56,3	29	11,5	0,048	0,0124	0,003
	18:44	480										
	2:44	960										
25-Jul-08	10:44	1440	28,1	2,53	16,5	15,03	30,4	17,5	13,4	0,009	0,0126	0,001

Catatan : $R_c = R_a$ - (koreksi nol) + C_T % finer = R_c.(a) / W_s D = K.√(L/t)



Komposisi	
Sand	0%
Silt	53%
Clay	47%

Deskripsi visual tanah :
Kaoline Clay (white)

Klasifikasi tanah :
Silty Clay

Sistem klasifikasi :
Unified

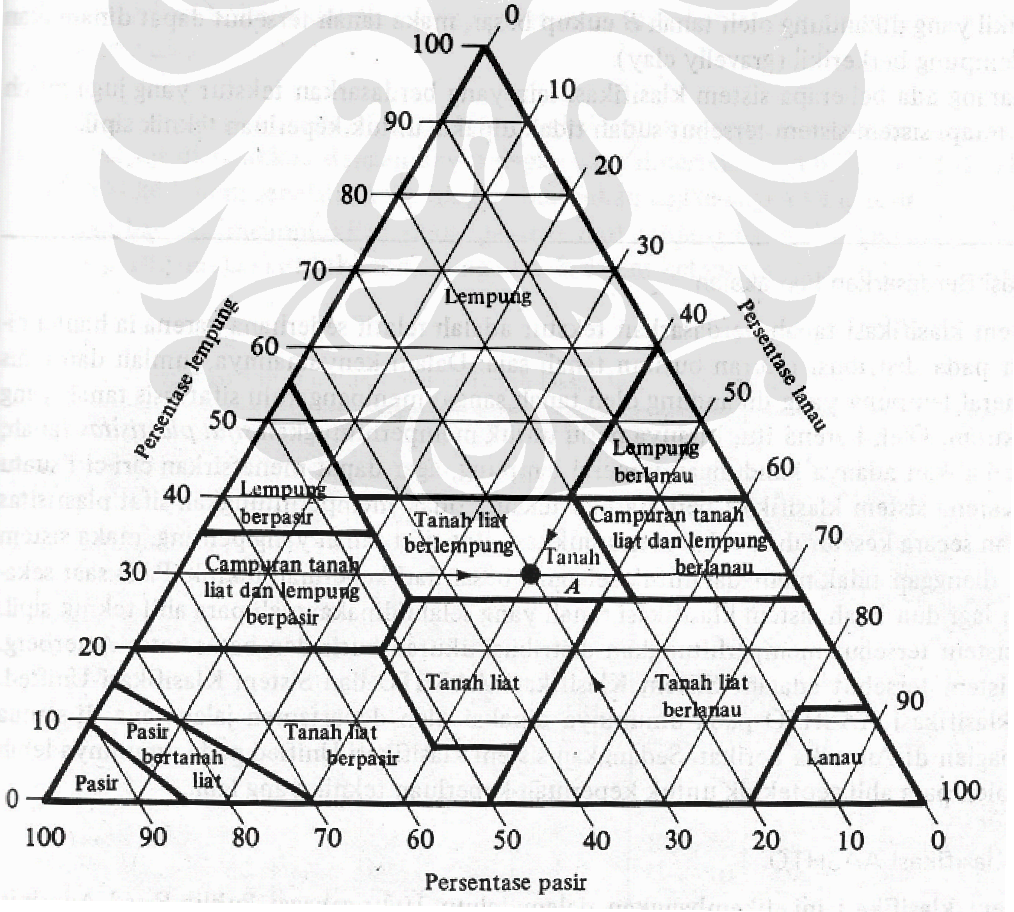
Tabel 2.4. Harga-harga Batas Atterberg untuk Mineral Lempung*.

Mineral	Batas cair	Batas plastis	Batas kerut
Montmorillonite	100–900	50–100	8,5–15
Nontronite	37–72	19–27	
Illite	60–120	35–60	15–17
Kaolinite	30–110	25–40	25–29
Halloysite terhidrasi	50–70	47–60	
Halloysite	35–55	30–45	
Attapulgite	160–230	100–120	
Chlorite	44–47	36–40	
Allophane	200–250	130–140	

*Menurut Mitchell (1976)

Tabel 1.4. **Berat Spesifik Mineral-mineral Penting.**

Mineral	Berat Spesifik G_s
Quartz (kwarsa)	**2,65**
Kaolinite	**2,6**
Illite	**2,8**
Montmorillonite	**2,65–2,80**
Halloysite	**2,0–2,55**
Potassium feldspar	**2,57**
Sodium and calcium feldspar	**2,62–2,76**
Chlorite	**2,6–2,9**
Biotite	**2,8–3,2**
Muscovite	**2,76–3,1**
Hornblende	**3,0–3,47**
Limonite	**3,6–4,0**
Olivine	**3,27–3,37**



Klasifikasi berdasarkan tekstur oleh Departemen Pertanian USA (USDA)

Lampiran 2

DATA HASIL MONITORING PEMBUATAN SAMPEL CONTOH TANAH KAOLIN

MONITORING PEMBUATAN BENDA UJI

Hari / Tanggal =		Selasa / 23-Sept-2008
Jenis tanah =		Kaoline murni
Tegangan preloading (Pc) =		200 kPa
Alat untuk preloading =		Rowe Cell
Kode sampel =		**# 2 - B**
Kadar air renc. Sblm. preloading (w_o) =		100 %
Ukuran cetakan :	ϕ =	15,2 cm
	H =	17,8 cm
Kondisi sebelum preloading :		
(a) Volume cetakan (can) =		79,20 cm3
(b) Berat cetakan =		9,40 gr
(c) Berat cetakan + wet soil =		122,95 gr
(d) Berat cetakan + dry soil =		67,42 gr

Kadar air aktual w_{act} --> (c-d)/(d-b) =	95,71 %
γ_{wet} --> (c-b)/a =	1,43 gr/cm3
γ_{dry} --> γ_{wet}/(1+w_{act}) =	0,73 gr/cm3
Specific Gravity (GS) =	2,60
Vw --> (γ_{wet}-γ_{dry})/γ_w =	0,70 cm3/cm3 sampel
Vs --> γ_{dry}/(GS x γ_w) =	0,28 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,72 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	0,98 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	2,55 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,72 *(estimasi)*

1 div = 0,01 mm (Bacaan Dial); 1 div = 0,01 mm (Penurunan Δh)

Waktu		Waktu Berjalan			Elevasi Sampel: Elev.(H)	Bacaan Dial		Penurunan (ΔH)	Kecepatan Penurunan: Penurunan (Δh)		Durasi (Δt)		Kec. Penurunan (v)	Catatan
(hari)	(jam)	(jam)	(hari)	(1/hari)	(mm)	(div)	(mm)	(mm)	(div)	(mm)	(detik)	(hari)	(mm/hari)	
23-Sep-08	11:00	0:00:00	0,000	~	94,00	43	0,43	**0**	-	-	-	-	-	
(Selasa)	11:15	0:15:00	0,010	96	70,33	2410	24,10	**-23,67**	50	0,50	44,10	0,0005	**979,592**	
	11:30	0:30:00	0,021	48	62,93	3150	31,50	**-31,07**	50	0,50	60,30	0,0007	**716,418**	
	12:00	1:00:00	0,042	24	52,73	4170	41,70	**-41,27**	10	0,10	45,10	0,0005	**191,574**	
	12:30	1:30:00	0,063	16	50,77	4366	43,66	**-43,23**	2	0,02	41,11	0,0005	**42,034**	
	13:00	2:00:00	0,083	12	50,53	4390	43,90	**-43,47**	1	0,01	56,86	0,0007	**15,195**	
	14:00	3:00:00	0,125	8	50,26	4417	44,17	**-43,74**	-	0,27	-	0,0417	**6,480**	
	15:00	4:00:00	0,167	6	50,15	4428	44,28	**-43,85**	-	0,11	-	0,0417	**2,640**	
	16:00	5:00:00	0,208	4,8	50,11	4432	44,32	**-43,89**	-	0,04	-	0,0417	**0,960**	
24-Sep-08	12:00	25:00:00	1,042	0,960	49,35	4508	45,08	**-44,65**	-	0,76	-	0,8333	**0,912**	
25-Sep-08	14:20	51:20:00	2,139	0,468	49,25	4518	45,18	**-44,75**	-	0,10	-	1,0972	**0,091**	
26-Sep-08	9:43	70:43:00	2,947	0,339	49,23	4520	45,20	**-44,77**	-	0,02	-	0,8076	**0,025**	
27-Sep-08														
28-Sep-08														
29-Sep-08														
30-Sep-08														

Kondisi setelah preloading : (*dari benda uji triaksial*)	
(a) Volume cetakan =	86,19 cm3
(b) Berat cetakan =	8,64 gr
(c) Berat cetakan + wet soil =	151,21 gr
(d) Berat cetakan + dry soil =	100,31 gr
Kadar air w_c --> (c-d)/(d-b) =	55,53 %
γ_{wet} --> (c-b)/a =	1,65 gr/cm3
γ_{dry} --> γ_{wet}/(1+w_c) =	1,06 gr/cm3

Specific Gravity (GS) =	2,60
Vw --> (γ_{wet}-γ_{dry})/γ_w =	0,59 cm3/cm3 sampel
Vs --> γ_{dry}/(GS x γ_w) =	0,41 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,59 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	1,00 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	1,44 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,59 *(estimasi)*

MONITORING PEMBUATAN BENDA UJI

Hari / Tanggal =		Kamis / 06-Nop-2008
Jenis tanah =		Kaoline murni
Tegangan preloading (Pc) =		200 kPa
Alat untuk preloading =		Rowe Cell
Kode sampel =		**# 3 - B**
Kadar air renc. Sblm. preloading (w_o) =		100 %
Ukuran cetakan :	ϕ =	15,2 cm
	H =	17,8 cm
Kondisi sebelum preloading :		
(a) Volume cetakan (can) =		76,69 cm3
(b) Berat cetakan =		9,41 gr
(c) Berat cetakan + wet soil =		121,69 gr
(d) Berat cetakan + dry soil =		65,71 gr

Kadar air aktual w_{act} --> (c-d)/(d-b) =	99,43 %
γ_{wet} --> (c-b)/a =	1,46 gr/cm3
γ_{dry} --> $\gamma_{wet}/(1+w_{act})$ =	0,73 gr/cm3
Specific Gravity (GS) =	2,60
Vw --> $(\gamma_{wet}-\gamma_{dry})/\gamma_w$ =	0,73 cm3/cm3 sampel
Vs --> $\gamma_{dry}/(GS \times \gamma_w)$ =	0,28 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,72 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	1,02 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	2,54 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,72 *(estimasi)*

Waktu		Waktu Berjalan			Elevasi Sampel			Penurunan	Kecepatan Penurunan				Kec. Penurunan (v)	Catatan
					Elev.(H)	Bacaan Dial (1 div = 0,01 mm)		(ΔH)	Penurunan (Δh) (1 div = 0,01 mm)		Durasi (Δt)			
(hari)	(jam)	(jam)	(hari)	(1/hari)	(mm)	(div)	(mm)	(mm)	(div)	(mm)	(detik)	(hari)	(mm/hari)	
6-Nov-08	13:30	0:00:00	0,000	~	83,90	-	-	**0**	-	-	-	-	-	
(Kamis)	13:45	0:15:00	0,010	96	63,25	100	1,00	**-20,65**	10	0,10	8,14	0,0001	**1061,425**	
	14:00	0:30:00	0,021	48	54,10	1015	10,15	**-29,80**	10	0,10	11,98	0,0001	**721,202**	
	14:15	0:45:00	0,031	32	47,25	1700	17,00	**-36,65**	5	0,05	8,33	0,0001	**518,607**	
	14:30	1:00:00	0,042	24	42,45	2180	21,80	**-41,45**	5	0,05	15,61	0,0002	**276,746**	
	15:00	1:30:00	0,063	16	39,15	2510	25,10	**-44,75**	2	0,02	25,59	0,0003	**67,526**	
	15:30	2:00:00	0,083	12	38,43	2582	25,82	**-45,47**	5	0,05	221,22	0,0026	**19,528**	
	16:00	2:30:00	0,104	9,6	38,16	2609	26,09	**-45,74**	-	0,27	-	0,0208	**12,960**	
7-Nov-08	8:54	19:24:00	0,808	1,237	37,29	2696	26,96	**-46,61**	-	0,87	-	0,7042	**1,236**	
8-Nov-08	11:05	45:35:00	1,899	0,527	37,23	2702	27,02	**-46,67**	-	0,06	-	1,0910	**0,055**	
9-Nov-08														
10-Nov-08	11:46	94:16:00	3,928	0,255	37,19	2706	27,06	**-46,71**	-	0,04	-	2,0285	**0,020**	
11-Nov-08														
12-Nov-08														
13-Nov-08														

Kondisi setelah preloading : (*dari benda uji triaksial*)	
(a) Volume cetakan =	85,63 cm3
(b) Berat cetakan =	8,11 gr
(c) Berat cetakan + wet soil =	150,90 gr
(d) Berat cetakan + dry soil =	99,42 gr
Kadar air w_c --> (c-d)/(d-b) =	56,38 %
γ_{wet} --> (c-b)/a =	1,67 gr/cm3
γ_{dry} --> $\gamma_{wet}/(1+w_c)$ =	1,07 gr/cm3

Specific Gravity (GS) =	2,60
Vw --> $(\gamma_{wet}-\gamma_{dry})/\gamma_w$ =	0,60 cm3/cm3 sampel
Vs --> $\gamma_{dry}/(GS \times \gamma_w)$ =	0,41 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,59 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	1,02 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	1,44 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,59 *(estimasi)*

MONITORING PEMBUATAN BENDA UJI

Hari / Tanggal =		Kamis / 13-Nop-2008
Jenis tanah =		Kaoline murni
Tegangan preloading (Pc) =		200 kPa
Alat untuk preloading =		Rowe Cell
Kode sampel =		**# 4 - B**
Kadar air renc. Sblm. preloading (w_o) =		100 %
Ukuran cetakan :	ϕ =	15,2 cm
	H =	17,8 cm
Kondisi sebelum preloading :		
(a) Volume cetakan (can) =		76,70 cm3
(b) Berat cetakan =		9,40 gr
(c) Berat cetakan + wet soil =		120,79 gr
(d) Berat cetakan + dry soil =		65,18 gr

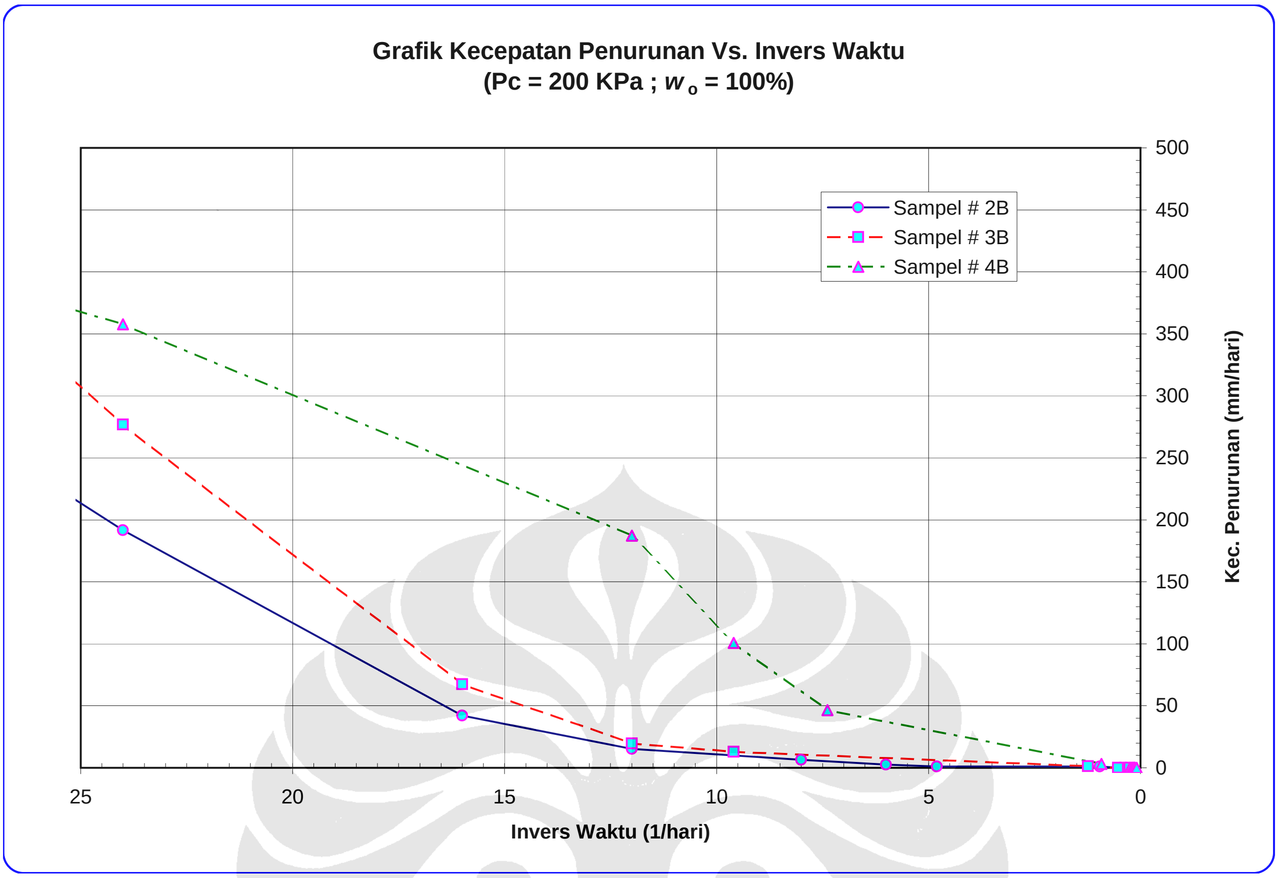
Kadar air aktual w_{act} --> (c-d)/(d-b) =	99,70 %
γ_{wet} --> (c-b)/a =	1,45 gr/cm3
γ_{dry} --> $\gamma_{wet}/(1+w_{act})$ =	0,73 gr/cm3
Specific Gravity (GS) =	2,60
Vw --> $(\gamma_{wet}-\gamma_{dry})/\gamma_w$ =	0,73 cm3/cm3 sampel
Vs --> $\gamma_{dry}/(GS \times \gamma_w)$ =	0,28 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,72 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	1,01 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	2,58 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,72 *(estimasi)*

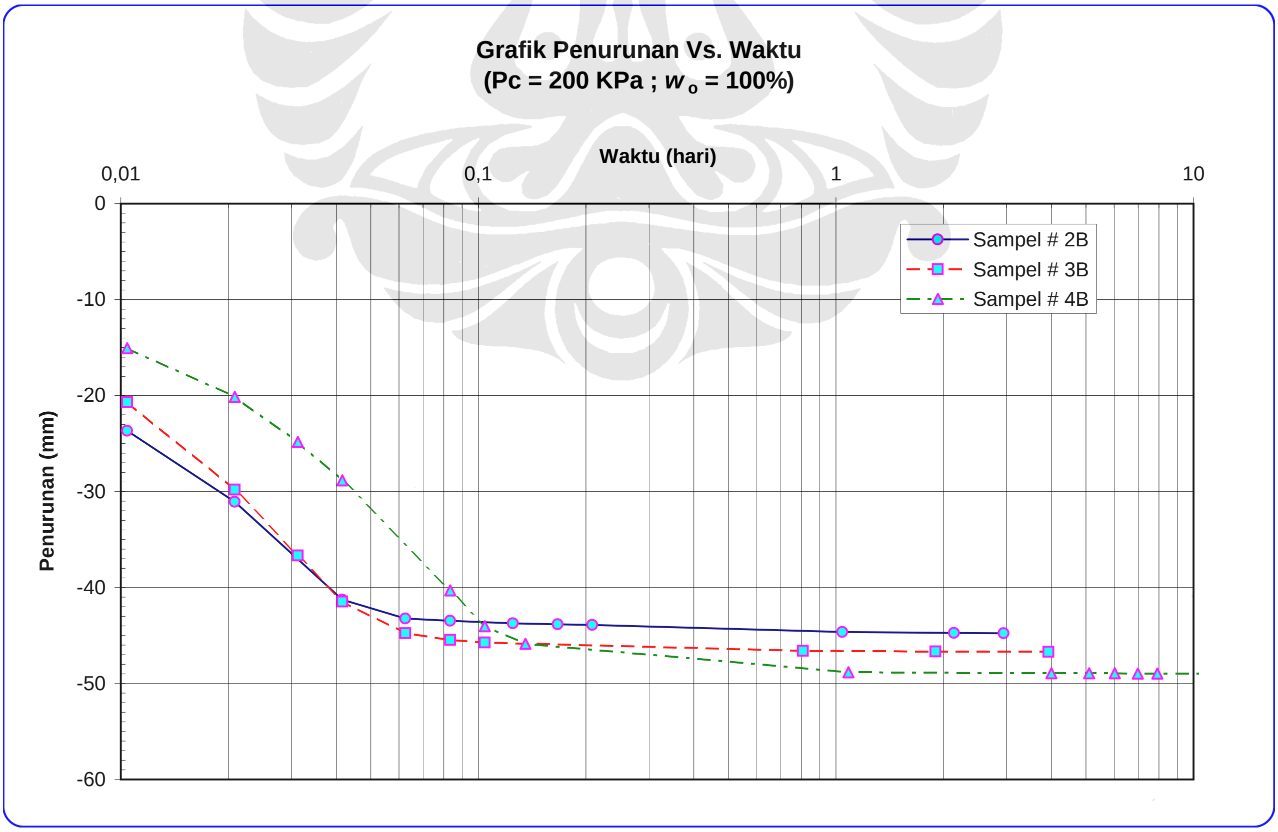
Waktu		Waktu Berjalan			Elevasi Sampel	Bacaan Dial (1 div = 0,01 mm)		Penurunan (ΔH)	Kecepatan Penurunan Penurunan (Δh) (1 div = 0,01 mm)		Durasi (Δt)		Kec. Penurunan (v)	Catatan
(hari)	(jam)	(jam)	(hari)	(1/hari)	Elev.(H) (mm)	(div)	(mm)	(mm)	(div)	(mm)	(detik)	(hari)	(mm/hari)	
13-Nov-08	12:00	0:00:00	0,000	~	85,00	65	0,65	0	-	-	-	-	-	
(Kamis)	12:15	0:15:00	0,010	96	69,95	1570	15,70	-15,05	10	0,10	12,63	0,0001	684,086	
	12:30	0:30:00	0,021	48	64,85	2080	20,80	-20,15	10	0,10	17,32	0,0002	498,845	
	12:45	0:45:00	0,031	32	60,15	2550	25,50	-24,85	10	0,10	19,79	0,0002	436,584	
	13:00	1:00:00	0,042	24	56,15	2950	29,50	-28,85	10	0,10	24,16	0,0003	357,616	
	14:00	2:00:00	0,083	12	44,70	4095	40,95	-40,30	10	0,10	46,14	0,0005	187,256	
	14:30	2:30:00	0,104	10	40,95	4470	44,70	-44,05	5	0,05	42,86	0,0005	100,793	
	15:15	3:15:00	0,135	7,4	39,13	4652	46,52	-45,87	1	0,01	18,6	0,0002	46,452	
14-Nov-08	14:00	26:00:00	1,083	0,923	36,16	4949	49,49	-48,84	-	2,97	-	0,9479	3,133	
15-Nov-08														
16-Nov-08														
17-Nov-08	12:00	96:00:00	4,000	0,250	36,08	4957	49,57	-48,92	-	0,08	-	2,9167	0,027	
18-Nov-08	14:30	122:30:00	5,104	0,196	36,06	4959	49,59	-48,94	-	0,02	-	1,1042	0,018	
19-Nov-08	12:30	144:30:00	6,021	0,166	36,05	4960	49,60	-48,95	-	0,01	-	0,9167	0,011	
20-Nov-08	11:30	167:30:00	6,979	0,143	36,04	4961	49,61	-48,96	-	0,01	-	0,9583	0,010	
21-Nov-08	10:00	190:00:00	7,917	0,126	36,04	4961	49,61	-48,96	-	0,00	-	0,9375	0,000	
22-Nov-08														
23-Nov-08														
24-Nov-08	8:30	260:30:00	10,854	0,092	36,03	4962	49,62	-48,97	-	0,01	-	2,9375	0,003	

Kondisi setelah preloading : (*dari benda uji triaksial*)	
(a) Volume cetakan =	72,68 cm3
(b) Berat cetakan =	0,00 gr
(c) Berat cetakan + wet soil =	119,40 gr
(d) Berat cetakan + dry soil =	77,97 gr
Kadar air w_c --> (c-d)/(d-b) =	53,14 %
γ_{wet} --> (c-b)/a =	1,64 gr/cm3
γ_{dry} --> $\gamma_{wet}/(1+w_c)$ =	1,07 gr/cm3

Specific Gravity (GS) =	2,60
Vw --> $(\gamma_{wet}-\gamma_{dry})/\gamma_w$ =	0,57 cm3/cm3 sampel
Vs --> $\gamma_{dry}/(GS \times \gamma_w)$ =	0,41 cm3/cm3 sampel
Vv --> 1-*Vs* =	0,59 cm3/cm3 sampel
Derajat kejenuhan (DS) --> *Vw*/*Vv* =	0,97 *(estimasi)*
Angka pori (e) --> *Vv*/*Vs* =	1,42 *(estimasi)*
Porositas (n) --> *Vv*/*V* =	0,59 *(estimasi)*

GRAFIK MONITORING PEMBUATAN BENDA UJI





Lampiran 3

DATA HASIL PENGUJIAN TRIAKSIAL TEKAN *UNCONSOLIDATED – UNDRAINED SINGLE STAGE* (*STX-UU*)

TRIAXIAL COMPRESSION TEST

Proyek = Skripsi grup kaoline
Lokasi = Lab. MekTan FTUI
Deskripsi tanah = Kaoline Pc=200 kPa, *w*o=100%
No. pengeboran = ---
No. sampel = ---
Kedalaman = ---

Hari / tanggal = Senin / 10 Nop 2008
Jenis pengujian triaksial = UU - test
Diuji oleh = Cipto Adi B.

Data sampel :
Kode sampel = # 3.B-(1)
Diameter (ϕ) = 3,80 cm
Tinggi awal (Ho) = 7,55 cm
Luas penampang (Ao) = 11,34 cm2
Volume (V) = 85,63 cm3

Data alat :
Load ring constant (LRC) = 0,196 kg/div
Strain rate = 1,00 mm/menit

#1

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	(ΔH/Ho)	(1-ε)	(Ao/[1-ε])	$(\sigma_1-\sigma_3)$		
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)
	0	0,000	0	0,000	40,0	0,000	1,000	11,341	0,0	0,0	40,0
	25	0,025	9,5	1,862		0,331	0,997	11,379	16,4	8,2	48,2
	50	0,050	13,5	2,646		0,662	0,993	11,417	23,2	11,6	51,6
	75	0,075	15	2,940		0,993	0,990	11,455	25,7	12,8	52,8
	100	0,100	19,5	3,822		1,325	0,987	11,493	33,3	16,6	56,6
	125	0,125	23,5	4,606		1,656	0,983	11,532	39,9	20,0	60,0
	150	0,150	25	4,900		1,987	0,980	11,571	42,3	21,2	61,2
	175	0,175	29	5,684		2,318	0,977	11,610	49,0	24,5	64,5
	200	0,200	32	6,272		2,649	0,974	11,650	53,8	26,9	66,9
	225	0,225	34,5	6,762		2,980	0,970	11,690	57,8	28,9	68,9
	250	0,250	37	7,252		3,311	0,967	11,730	61,8	30,9	70,9
	275	0,275	40	7,840		3,642	0,964	11,770	66,6	33,3	73,3
	300	0,300	41,5	8,134		3,974	0,960	11,810	68,9	34,4	74,4
	325	0,325	43,5	8,526		4,305	0,957	11,851	71,9	36,0	76,0
	350	0,350	44,5	8,722		4,636	0,954	11,892	73,3	36,7	76,7
	375	0,375	45,5	8,918		4,967	0,950	11,934	74,7	37,4	77,4
	400	0,400	47	9,212		5,298	0,947	11,976	76,9	38,5	78,5
	425	0,425	48,5	9,506		5,629	0,944	12,018	79,1	39,6	79,6
	450	0,450	49,7	9,741		5,960	0,940	12,060	80,8	40,4	80,4
	475	0,475	50,5	9,898		6,291	0,937	12,103	81,8	40,9	80,9
	500	0,500	51	9,996		6,623	0,934	12,145	82,3	41,2	81,2
	525	0,525	51,7	10,133		6,954	0,930	12,189	83,1	41,6	81,6
	550	0,550	52,1	10,212		7,285	0,927	12,232	83,5	41,7	81,7
	575	0,575	52,5	10,290		7,616	0,924	12,276	83,8	41,9	81,9
	600	0,600	53	10,388		7,947	0,921	12,320	84,3	42,2	82,2
	625	0,625	53	10,388		8,278	0,917	12,365	84,0	42,0	82,0
	650	0,650	53	10,388		8,609	0,914	12,410	83,7	41,9	81,9
	675	0,675	53	10,388		8,940	0,911	12,455	83,4	41,7	81,7
	700	0,700	53	10,388		9,272	0,907	12,500	83,1	41,6	81,6
	725	0,725	53	10,388		9,603	0,904	12,546	82,8	41,4	81,4
	750	0,750	52,5	10,290		9,934	0,901	12,592	81,7	40,9	80,9
	775	0,775	52,5	10,290		10,265	0,897	12,638	81,4	40,7	80,7
	800	0,800	52,5	10,290		10,596	0,894	12,685	81,1	40,6	80,6
	825	0,825	52,5	10,290		10,927	0,891	12,732	80,8	40,4	80,4
	850	0,850	52,5	10,290		11,258	0,887	12,780	80,5	40,3	80,3
	875	0,875	52,5	10,290		11,589	0,884	12,828	80,2	40,1	80,1
	900	0,900	52,5	10,290		11,921	0,881	12,876	79,9	40,0	80,0
	925	0,925	52,5	10,290		12,252	0,877	12,925	79,6	39,8	79,8
	950	0,950	52,5	10,290		12,583	0,874	12,974	79,3	39,7	79,7
	975	0,975	52,5	10,290		12,914	0,871	13,023	79,0	39,5	79,5
	1000	1,000	52,5	10,290		13,245	0,868	13,073	78,7	39,4	79,4
	1025	1,025	52,5	10,290		13,576	0,864	13,123	78,4	39,2	79,2
	1050	1,050	52,5	10,290		13,907	0,861	13,173	78,1	39,1	79,1
	1075	1,075	52,5	10,290		14,238	0,858	13,224	77,8	38,9	78,9
	1100	1,100	52,5	10,290		14,570	0,854	13,275	77,5	38,8	78,8
	1125	1,125	52,5	10,290		14,901	0,851	13,327	77,2	38,6	78,6
	1150	1,150	52,5	10,290		15,232	0,848	13,379	76,9	38,5	78,5
	1175	1,175	52,5	10,290		15,563	0,844	13,431	76,6	38,3	78,3
	1200	1,200	52,5	10,290		15,894	0,841	13,484	76,3	38,2	78,2

Perhitungan data :
Tegangan lateral (σ_3) = 40,0 kPa
Tegangan deviator maksimum $(\Delta\sigma = \sigma_1-\sigma_3)$ = 84,3 kPa
Tegangan vertikal maksimum $(\sigma_1 = \Delta\sigma+\sigma_3)$ = 124,3 kPa
Regangan saat tegangan vertikal maximum = 7,947 %

TRIAXIAL COMPRESSION TEST

Proyek = Skripsi grup kaoline
Lokasi = Lab. MekTan FTUI
Deskripsi tanah = Kaoline Pc=200 kPa, *w*o=100%
No. pengeboran = ---
No. sampel = ---
Kedalaman = ---

Data alat :
Load ring constant (LRC) = 0,196 kg/div
Strain rate = 1,00 mm/menit

Hari / tanggal = Selasa / 11 Nop 2008
Jenis pengujian triaksial = UU - test
Diuji oleh = Cipto Adi B.

Data sampel :
Kode sampel = # 3.B-(3)
Diameter (ϕ) = 3,78 cm
Tinggi awal (Ho) = 7,57 cm
Luas penampang (Ao) = 11,22 cm2
Volume (V) = 84,95 cm3

#2

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	(ΔH/Ho)	(1-ε)	(Ao/[1-ε])	($\sigma_1-\sigma_3$)		
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)
	0	0,000	0	0,000	80,0	0,000	1,000	11,222	0,0	0,0	80,0
	25	0,025	9	1,764		0,330	0,997	11,259	15,7	7,8	87,8
	50	0,050	13,5	2,646		0,661	0,993	11,297	23,4	11,7	91,7
	75	0,075	16,5	3,234		0,991	0,990	11,334	28,5	14,3	94,3
	100	0,100	18	3,528		1,321	0,987	11,372	31,0	15,5	95,5
	125	0,125	21	4,116		1,651	0,983	11,410	36,1	18,0	98,0
	150	0,150	24	4,704		1,982	0,980	11,449	41,1	20,5	100,5
	175	0,175	26,5	5,194		2,312	0,977	11,488	45,2	22,6	102,6
	200	0,200	27,5	5,390		2,642	0,974	11,527	46,8	23,4	103,4
	225	0,225	31	6,076		2,972	0,970	11,566	52,5	26,3	106,3
	250	0,250	33,5	6,566		3,303	0,967	11,605	56,6	28,3	108,3
	275	0,275	36	7,056		3,633	0,964	11,645	60,6	30,3	110,3
	300	0,300	37,5	7,350		3,963	0,960	11,685	62,9	31,5	111,5
	325	0,325	40	7,840		4,293	0,957	11,725	66,9	33,4	113,4
	350	0,350	42,5	8,330		4,624	0,954	11,766	70,8	35,4	115,4
	375	0,375	44,5	8,722		4,954	0,950	11,807	73,9	36,9	116,9
	400	0,400	46,5	9,114		5,284	0,947	11,848	76,9	38,5	118,5
	425	0,425	47,5	9,310		5,614	0,944	11,890	78,3	39,2	119,2
	450	0,450	49,5	9,702		5,945	0,941	11,931	81,3	40,7	120,7
	475	0,475	51,5	10,094		6,275	0,937	11,973	84,3	42,2	122,2
	500	0,500	53	10,388		6,605	0,934	12,016	86,5	43,2	123,2
	525	0,525	54,5	10,682		6,935	0,931	12,058	88,6	44,3	124,3
	550	0,550	55,5	10,878		7,266	0,927	12,101	89,9	44,9	124,9
	575	0,575	56,5	11,074		7,596	0,924	12,145	91,2	45,6	125,6
	600	0,600	57,5	11,270		7,926	0,921	12,188	92,5	46,2	126,2
	625	0,625	58,5	11,466		8,256	0,917	12,232	93,7	46,9	126,9
	650	0,650	59,7	11,701		8,587	0,914	12,276	95,3	47,7	127,7
	675	0,675	61	11,956		8,917	0,911	12,321	97,0	48,5	128,5
	700	0,700	62	12,152		9,247	0,908	12,366	98,3	49,1	129,1
	725	0,725	62,9	12,328		9,577	0,904	12,411	99,3	49,7	129,7
	750	0,750	63,5	12,446		9,908	0,901	12,456	99,9	50,0	130,0
	775	0,775	64,1	12,564		10,238	0,898	12,502	100,5	50,2	130,2
	800	0,800	64,9	12,720		10,568	0,894	12,548	101,4	50,7	130,7
	825	0,825	65,1	12,760		10,898	0,891	12,595	101,3	50,7	130,7
	850	0,850	65,6	12,858		11,229	0,888	12,642	101,7	50,9	130,9
	875	0,875	66,2	12,975		11,559	0,884	12,689	102,3	51,1	131,1
	900	0,900	66,9	13,112		11,889	0,881	12,736	103,0	51,5	131,5
	925	0,925	67,1	13,152		12,219	0,878	12,784	102,9	51,4	131,4
	950	0,950	67,1	13,152		12,550	0,875	12,833	102,5	51,2	131,2
	975	0,975	67,2	13,171		12,880	0,871	12,881	102,3	51,1	131,1
	1000	1,000	67,5	13,230		13,210	0,868	12,930	102,3	51,2	131,2
	1025	1,025	67,8	13,289		13,540	0,865	12,980	102,4	51,2	131,2
	1050	1,050	68,5	13,426		13,871	0,861	13,029	103,0	51,5	131,5
	1075	1,075	68,9	13,504		14,201	0,858	13,079	103,2	51,6	131,6
	1100	1,100	69,1	13,544		14,531	0,855	13,130	103,1	51,6	131,6
	1125	1,125	70	13,720		14,861	0,851	13,181	104,1	52,0	132,0
	1150	1,150	70,2	13,759		15,192	0,848	13,232	104,0	52,0	132,0
	1175	1,175	70,9	13,896		15,522	0,845	13,284	104,6	52,3	132,3
	1200	1,200	71,2	13,955		15,852	0,841	13,336	104,6	52,3	132,3
	1225	1,225	71,5	14,014		16,182	0,838	13,389	104,7	52,3	132,3
	1250	1,250	71,5	14,014		16,513	0,835	13,442	104,3	52,1	132,1
	1275	1,275	71,8	14,073		16,843	0,832	13,495	104,3	52,1	132,1
	1300	1,300	72	14,112		17,173	0,828	13,549	104,2	52,1	132,1
	1325	1,325	72,1	14,132		17,503	0,825	13,603	103,9	51,9	131,9
	1350	1,350	72,1	14,132		17,834	0,822	13,658	103,5	51,7	131,7
	1375	1,375	72,1	14,132		18,164	0,818	13,713	103,1	51,5	131,5
	1400	1,400	72,3	14,171		18,494	0,815	13,768	102,9	51,5	131,5
	1425	1,425	72,6	14,230		18,824	0,812	13,824	102,9	51,5	131,5
	1450	1,450	72,9	14,288		19,155	0,808	13,881	102,9	51,5	131,5
	1475	1,475	73,5	14,406		19,485	0,805	13,938	103,4	51,7	131,7
	1500	1,500	73,8	14,465		19,815	0,802	13,995	103,4	51,7	131,7

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	($\Delta H/Ho$)	($1-\varepsilon$)	($Ao/[1-\varepsilon]$)	($\sigma_1-\sigma_3$)		
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)
	1525	1,525	73,9	14,484		20,145	0,799	14,053	103,1	51,5	131,5
	1550	1,550	74,1	14,524		20,476	0,795	14,111	102,9	51,5	131,5
	1575	1,575	74,5	14,602		20,806	0,792	14,170	103,0	51,5	131,5
	1600	1,600	74,7	14,641		21,136	0,789	14,230	102,9	51,4	131,4
	1625	1,625	75	14,700		21,466	0,785	14,290	102,9	51,4	131,4
	1650	1,650	75	14,700		21,797	0,782	14,350	102,4	51,2	131,2
	1675	1,675	75,2	14,739		22,127	0,779	14,411	102,3	51,1	131,1
	1700	1,700	75,3	14,759		22,457	0,775	14,472	102,0	51,0	131,0
	1725	1,725	75,6	14,818		22,787	0,772	14,534	102,0	51,0	131,0
	1750	1,750	75,8	14,857		23,118	0,769	14,596	101,8	50,9	130,9
	1775	1,775	76,2	14,935		23,448	0,766	14,659	101,9	50,9	130,9
	1800	1,800	76,5	14,994		23,778	0,762	14,723	101,8	50,9	130,9
	1825	1,825	76,7	15,033		24,108	0,759	14,787	101,7	50,8	130,8
	1850	1,850	76,9	15,072		24,439	0,756	14,852	101,5	50,7	130,7
	1875	1,875	77,1	15,112		24,769	0,752	14,917	101,3	50,7	130,7
	1900	1,900	77,2	15,131		25,099	0,749	14,983	101,0	50,5	130,5
	1925	1,925	77,2	15,131		25,429	0,746	15,049	100,5	50,3	130,3
	1950	1,950	77,2	15,131		25,760	0,742	15,116	100,1	50,1	130,1
	1975	1,975	77,2	15,131		26,090	0,739	15,183	99,7	49,8	129,8
	2000	2,000	77,2	15,131		26,420	0,736	15,252	99,2	49,6	129,6
	2025	2,025	77,5	15,190		26,750	0,732	15,320	99,1	49,6	129,6
	2050	2,050	77,9	15,268		27,081	0,729	15,390	99,2	49,6	129,6
	2075	2,075	78,9	15,464		27,411	0,726	15,460	100,0	50,0	130,0
	2100	2,100	79,3	15,543		27,741	0,723	15,530	100,1	50,0	130,0
	2125	2,125	79,6	15,602		28,071	0,719	15,602	100,0	50,0	130,0
	2150	2,150	80	15,680		28,402	0,716	15,674	100,0	50,0	130,0
	2175	2,175	80	15,680		28,732	0,713	15,746	99,6	49,8	129,8
	2200	2,200	80	15,680		29,062	0,709	15,820	99,1	49,6	129,6

Perhitungan data :

Tegangan lateral (σ_3) = 80,0 kPa

Tegangan deviator maksimum ($\Delta\sigma = \sigma_1-\sigma_3$) = 104,7 kPa

Tegangan vertikal maksimum ($\sigma_1 = \Delta\sigma+\sigma_3$) = 184,7 kPa

Regangan saat tegangan vertikal maximum = 16,182 %

TRIAXIAL COMPRESSION TEST

Proyek = Skripsi grup kaoline
Lokasi = Lab. MekTan FTUI
Deskripsi tanah = Kaoline Pc=200 kPa, *w*o=100%
No. pengeboran = ---
No. sampel = ---
Kedalaman = ---

Data alat :
Load ring constant (LRC) = 0,196 kg/div
Strain rate = 1,00 mm/menit

Hari / tanggal = Selasa / 11 Nop 2008
Jenis pengujian triaksial = UU - test
Diuji oleh = Cipto Adi B.

Data sampel :
Kode sampel = # 3.B-(4)
Diameter (ϕ) = 3,78 cm
Tinggi awal (Ho) = 7,56 cm
Luas penampang (Ao) = 11,22 cm2
Volume (V) = 84,84 cm3

#3

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel (σ_3)	Regangan (ε) (ΔH/Ho)	Faktor Koreksi Luas (1-ε)	Luas Pen. Terkoreksi (Ao/[1-ε])	Tegangan Deviator (σ_1-σ_3)	(σ_1-σ_3)/2	(σ_1+σ_3)/2
	1 div =	0,001 cm	1 div =	0,196 kg							
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)
	0	0,000	0	0,000	120,0	0,000	1,000	11,222	0,0	0,0	120,0
	25	0,025	9	1,764		0,331	0,997	11,259	15,7	7,8	127,8
	50	0,050	19	3,724		0,661	0,993	11,297	33,0	16,5	136,5
	75	0,075	26	5,096		0,992	0,990	11,335	45,0	22,5	142,5
	100	0,100	29	5,684		1,323	0,987	11,373	50,0	25,0	145,0
	125	0,125	33,5	6,566		1,653	0,983	11,411	57,5	28,8	148,8
	150	0,150	37	7,252		1,984	0,980	11,449	63,3	31,7	151,7
	175	0,175	39	7,644		2,315	0,977	11,488	66,5	33,3	153,3
	200	0,200	43,5	8,526		2,646	0,974	11,527	74,0	37,0	157,0
	225	0,225	46,5	9,114		2,976	0,970	11,566	78,8	39,4	159,4
	250	0,250	48,5	9,506		3,307	0,967	11,606	81,9	41,0	161,0
	275	0,275	51	9,996		3,638	0,964	11,646	85,8	42,9	162,9
	300	0,300	53,5	10,486		3,968	0,960	11,686	89,7	44,9	164,9
	325	0,325	55,5	10,878		4,299	0,957	11,726	92,8	46,4	166,4
	350	0,350	57,5	11,270		4,630	0,954	11,767	95,8	47,9	167,9
	375	0,375	58,5	11,466		4,960	0,950	11,808	97,1	48,6	168,6
	400	0,400	60,5	11,858		5,291	0,947	11,849	100,1	50,0	170,0
	425	0,425	62,5	12,250		5,622	0,944	11,891	103,0	51,5	171,5
	450	0,450	64,1	12,564		5,952	0,940	11,932	105,3	52,6	172,6
	475	0,475	65,5	12,838		6,283	0,937	11,974	107,2	53,6	173,6
	500	0,500	67	13,132		6,614	0,934	12,017	109,3	54,6	174,6
	525	0,525	68	13,328		6,944	0,931	12,060	110,5	55,3	175,3
	550	0,550	68,5	13,426		7,275	0,927	12,103	110,9	55,5	175,5
	575	0,575	69,5	13,622		7,606	0,924	12,146	112,2	56,1	176,1
	600	0,600	70,6	13,838		7,937	0,921	12,190	113,5	56,8	176,8
	625	0,625	71,9	14,092		8,267	0,917	12,233	115,2	57,6	177,6
	650	0,650	73,2	14,347		8,598	0,914	12,278	116,9	58,4	178,4
	675	0,675	74,1	14,524		8,929	0,911	12,322	117,9	58,9	178,9
	700	0,700	75,1	14,720		9,259	0,907	12,367	119,0	59,5	179,5
	725	0,725	76,5	14,994		9,590	0,904	12,412	120,8	60,4	180,4
	750	0,750	77	15,092		9,921	0,901	12,458	121,1	60,6	180,6
	775	0,775	78	15,288		10,251	0,897	12,504	122,3	61,1	181,1
	800	0,800	78,5	15,386		10,582	0,894	12,550	122,6	61,3	181,3
	825	0,825	78,6	15,406		10,913	0,891	12,597	122,3	61,1	181,1
	850	0,850	78,9	15,464		11,243	0,888	12,644	122,3	61,2	181,2
	875	0,875	79,1	15,504		11,574	0,884	12,691	122,2	61,1	181,1
	900	0,900	80,3	15,739		11,905	0,881	12,739	123,6	61,8	181,8
	925	0,925	81	15,876		12,235	0,878	12,787	124,2	62,1	182,1
	950	0,950	81,5	15,974		12,566	0,874	12,835	124,5	62,2	182,2
	975	0,975	82,4	16,150		12,897	0,871	12,884	125,4	62,7	182,7
	1000	1,000	83	16,268		13,228	0,868	12,933	125,8	62,9	182,9
	1025	1,025	83,5	16,366		13,558	0,864	12,982	126,1	63,0	183,0
	1050	1,050	83,9	16,444		13,889	0,861	13,032	126,2	63,1	183,1
	1075	1,075	84,2	16,503		14,220	0,858	13,082	126,1	63,1	183,1
	1100	1,100	84,9	16,640		14,550	0,854	13,133	126,7	63,4	183,4
	1125	1,125	85	16,660		14,881	0,851	13,184	126,4	63,2	183,2
	1150	1,150	85,2	16,699		15,212	0,848	13,235	126,2	63,1	183,1
	1175	1,175	85,7	16,797		15,542	0,845	13,287	126,4	63,2	183,2
	1200	1,200	86	16,856		15,873	0,841	13,339	126,4	63,2	183,2
	1225	1,225	86,3	16,915		16,204	0,838	13,392	126,3	63,2	183,2
	1250	1,250	86,5	16,954		16,534	0,835	13,445	126,1	63,0	183,0
	1275	1,275	86,9	17,032		16,865	0,831	13,499	126,2	63,1	183,1
	1300	1,300	87,1	17,072		17,196	0,828	13,553	126,0	63,0	183,0
	1325	1,325	87,3	17,111		17,526	0,825	13,607	125,8	62,9	182,9
	1350	1,350	87,6	17,170		17,857	0,821	13,662	125,7	62,8	182,8
	1375	1,375	87,8	17,209		18,188	0,818	13,717	125,5	62,7	182,7
	1400	1,400	88	17,248		18,519	0,815	13,773	125,2	62,6	182,6
	1425	1,425	88,1	17,268		18,849	0,812	13,829	124,9	62,4	182,4
	1450	1,450	88,2	17,287		19,180	0,808	13,885	124,5	62,3	182,3
	1475	1,475	88,5	17,346		19,511	0,805	13,942	124,4	62,2	182,2
	1500	1,500	88,7	17,385		19,841	0,802	14,000	124,2	62,1	182,1

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	(ΔH/Ho)	(1-ε)	(Ao/[1-ε])	$(\sigma_1-\sigma_3)$		
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)
	1525	1,525	88,8	17,405		20,172	0,798	14,058	123,8	61,9	181,9
	1550	1,550	88,9	17,424		20,503	0,795	14,116	123,4	61,7	181,7
	1575	1,575	89,1	17,464		20,833	0,792	14,175	123,2	61,6	181,6
	1600	1,600	89,5	17,542		21,164	0,788	14,235	123,2	61,6	181,6
	1625	1,625	90	17,640		21,495	0,785	14,295	123,4	61,7	181,7
	1650	1,650	90,5	17,738		21,825	0,782	14,355	123,6	61,8	181,8
	1675	1,675	90,8	17,797		22,156	0,778	14,416	123,5	61,7	181,7
	1700	1,700	91,2	17,875		22,487	0,775	14,478	123,5	61,7	181,7
	1725	1,725	91,5	17,934		22,817	0,772	14,540	123,3	61,7	181,7
	1750	1,750	91,8	17,993		23,148	0,769	14,602	123,2	61,6	181,6
	1775	1,775	92	18,032		23,479	0,765	14,665	123,0	61,5	181,5
	1800	1,800	92,2	18,071		23,810	0,762	14,729	122,7	61,3	181,3
	1825	1,825	92,5	18,130		24,140	0,759	14,793	122,6	61,3	181,3
	1850	1,850	92,8	18,189		24,471	0,755	14,858	122,4	61,2	181,2
	1875	1,875	93	18,228		24,802	0,752	14,923	122,1	61,1	181,1
	1900	1,900	93,5	18,326		25,132	0,749	14,989	122,3	61,1	181,1
	1925	1,925	93,8	18,385		25,463	0,745	15,056	122,1	61,1	181,1
	1950	1,950	94,1	18,444		25,794	0,742	15,123	122,0	61,0	181,0
	1975	1,975	94,4	18,502		26,124	0,739	15,191	121,8	60,9	180,9
	2000	2,000	94,6	18,542		26,455	0,735	15,259	121,5	60,8	180,8
	2025	2,025	94,9	18,600		26,786	0,732	15,328	121,4	60,7	180,7
	2050	2,050	95,1	18,640		27,116	0,729	15,397	121,1	60,5	180,5
	2075	2,075	95,2	18,659		27,447	0,726	15,467	120,6	60,3	180,3
	2100	2,100	95,5	18,718		27,778	0,722	15,538	120,5	60,2	180,2
	2125	2,125	95,7	18,757		28,108	0,719	15,610	120,2	60,1	180,1
	2150	2,150	95,9	18,796		28,439	0,716	15,682	119,9	59,9	179,9
	2175	2,175	96	18,816		28,770	0,712	15,755	119,4	59,7	179,7
	2200	2,200	96,2	18,855		29,101	0,709	15,828	119,1	59,6	179,6
	2225	2,225	96,7	18,953		29,431	0,706	15,902	119,2	59,6	179,6
	2250	2,250	96,9	18,992		29,762	0,702	15,977	118,9	59,4	179,4
	2275	2,275	97	19,012		30,093	0,699	16,053	118,4	59,2	179,2
	2300	2,300	97,1	19,032		30,423	0,696	16,129	118,0	59,0	179,0
	2325	2,325	97,5	19,110		30,754	0,692	16,206	117,9	59,0	179,0
	2350	2,350	97,6	19,130		31,085	0,689	16,284	117,5	58,7	178,7
	2375	2,375	97,8	19,169		31,415	0,686	16,362	117,2	58,6	178,6
	2400	2,400	98	19,208		31,746	0,683	16,442	116,8	58,4	178,4
	2425	2,425	98,1	19,228		32,077	0,679	16,522	116,4	58,2	178,2
	2450	2,450	98,5	19,306		32,407	0,676	16,603	116,3	58,1	178,1
	2475	2,475	98,7	19,345		32,738	0,673	16,684	115,9	58,0	178,0
	2500	2,500	98,9	19,384		33,069	0,669	16,767	115,6	57,8	177,8
	2525	2,525	98,9	19,384		33,399	0,666	16,850	115,0	57,5	177,5
	2550	2,550	99	19,404		33,730	0,663	16,934	114,6	57,3	177,3
	2575	2,575	99,1	19,424		34,061	0,659	17,019	114,1	57,1	177,1
	2600	2,600	99,1	19,424		34,392	0,656	17,105	113,6	56,8	176,8

Perhitungan data :

Tegangan lateral (σ_3) = 120,0 kPa

Tegangan deviator maksimum $(\Delta\sigma = \sigma_1-\sigma_3)$ = 126,7 kPa

Tegangan vertikal maksimum $(\sigma_1 = \Delta\sigma+\sigma_3)$ = 246,7 kPa

Regangan saat tegangan vertikal maximum = 14,550 %

TRIAXIAL COMPRESSION TEST

Proyek =	Skripsi grup kaoline	Tanggal =	10-11 Nopember 2008
Lokasi =	Lab. MekTan FTUI		
Deskripsi tanah =	Kaoline Pc=200 kPa, *w* o=100%	Jenis pengujian triaksial =	UU - test
No. pengeboran =	---		
No. sampel =	---	Diuji oleh =	Cipto Adi B.
Kedalaman =	---		

		Unit	Data sampel			Catatan
	No. Sampel		1	2	3	
	Kode Sampel		# 3.B-(1)	# 3.B-(3)	# 3.B-(4)	
(a)	Berat can	(gr)	8,11	8,00	7,95	
(b)	Berat can + tanah basah	(gr)	150,90	148,68	148,63	
(c)	Berat can + tanah kering	(gr)	99,42	99,07	99,27	
(b-c)	Berat air	(gr)	51,48	49,61	49,36	
(c-a)	Berat tanah kering	(gr)	91,31	91,07	91,32	
(b-c)/(c-a)	Kadar air (w)	(%)	56,38	54,47	54,05	
	Kadar air rata-rata (w)	(%)		54,97		
(d)	Tinggi sampel (H_o)	(cm)	7,55	7,57	7,56	
(e)	Diameter sampel (ϕ)	(cm)	3,80	3,78	3,78	
(f)	Luas (A_o)	(cm2)	11,34	11,22	11,22	
(g)	Volume (V_o)	(cm3)	85,63	84,95	84,84	
(b-a)/(g)	Berat jenis tanah basah (γ_{wet})	(gr/cm3)	1,668	1,656	1,658	
(c-a)/(g)	Berat jenis tanah kering (γ_{dry})	(gr/cm3)	1,066	1,072	1,076	
	Rata-rata (γ_{wet})	(gr/cm3)		1,661		
	Rata-rata (γ_{dry})	(gr/cm3)		1,072		
	Tegangan lateral / sel pada sampel (σ_3)	(kPa)	40,0	80,0	120,0	
	Tipe keruntuhan					

TRIAXIAL COMPRESSION TEST

Proyek =	Skripsi grup kaoline	Tanggal =	10-11 Nopember 2008
Lokasi =	Lab. MekTan FTUI		
Deskripsi tanah =	Kaoline Pc=200 kPa, *w* o=100%	Jenis pengujian	
No. pengeboran =	# 3B	triaksial =	UU - test
No. sampel =	---		
Kedalaman =	---	Diuji oleh =	Cipto Adi. B

No. sampel		1	2	3	Catatan
Kode sampel		# 3.B-(1)	# 3.B-(3)	# 3.B-(4)	
Teg. normal saat runtuh ($\Delta\sigma$)	(kPa)	84,3	104,7	126,7	
Tegangan lateral (σ_3)	(kPa)	40,0	80,0	120,0	
Tegangan normal total (σ_1)	(kPa)	124,3	184,7	246,7	
Regangan saat runtuh	(%)	7,95	16,18	14,55	

Berat jenis tanah basah (γ_{wet}) = 1,661 gr/cm3

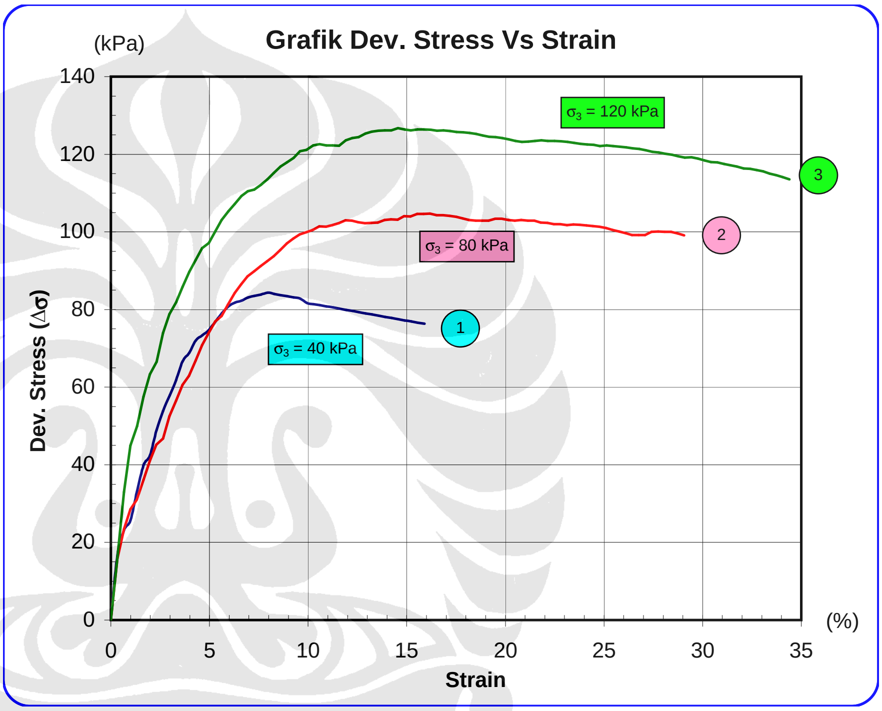
Berat jenis tanah kering (γ_{dry}) = 1,072 gr/cm3

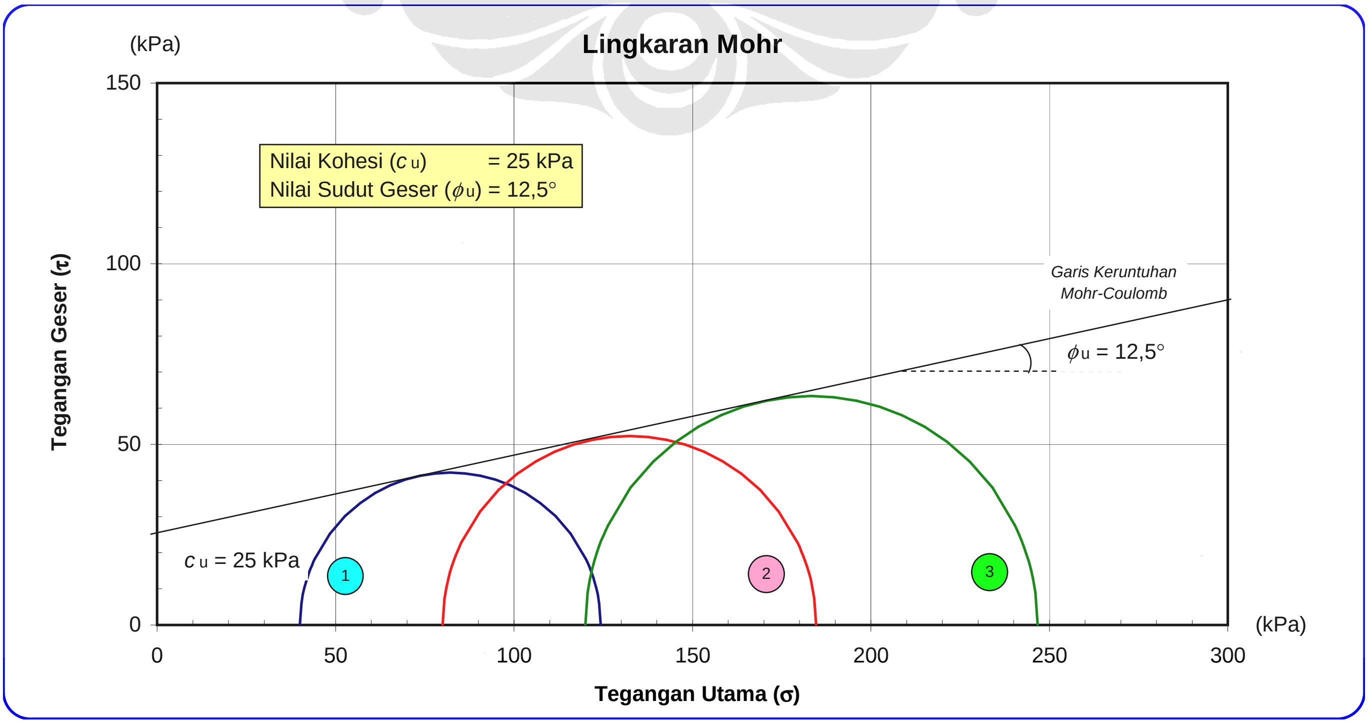
Kadar air (*w*) = 54,97 %

Nilai tahanan kohesi (c_u) = 25 (kPa)

Nilai tahanan sudut geser (ϕ_u) = 12,5 °

Strain rate = 1,00 mm/min





Lampiran 4

DATA HASIL PENGUJIAN TRIAKSIAL TEKAN *UNCONSOLIDATED – UNDRAINED MULTISTAGE* (*MTX-UU*)

TRIAXIAL COMPRESSION TEST

Proyek =	Skripsi grup kaoline	Hari / tanggal =	Rabu / 12 Nop 2008
Lokasi =	Lab. MekTan FTUI	Jenis pengujian triaksial =	Multistage TX-UU - test
Deskripsi tanah =	Kaoline Pc=200 kPa, *w* o=100%	Diuji oleh =	Cipto Adi B.
No. pengeboran =	---		
No. sampel =	---		
Kedalaman =	---		

Data alat :

Load ring constant (LRC) = 0,196 kg/div

Strain rate = 1,00 mm/menit

Data sampel :

Kode sampel = # 3.B-(5)

Diameter (ϕ) = 3,58 cm

Tinggi awal (Ho) = 7,10 cm

Luas penampang (Ao) = 10,07 cm2

Volume (V) = 71,47 cm3

#1

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$	(σ_1/σ_3)
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	(ΔH/Ho)	(1-ε)	(Ao/[1-ε])	($\sigma_1-\sigma_3$)			
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)	(kPa)
Stage 1	0	0,000	0	0,000	40,0	0,000	1,000	10,066	0,0	0,0	40,0	1,00
	25	0,025	8	1,568		0,352	0,996	10,102	15,5	7,8	47,8	1,39
	50	0,050	11	2,156		0,704	0,993	10,137	21,3	10,6	50,6	1,53
	75	0,075	13,5	2,646		1,056	0,989	10,173	26,0	13,0	53,0	1,65
	100	0,100	15	2,940		1,408	0,986	10,210	28,8	14,4	54,4	1,72
	125	0,125	16,5	3,234		1,761	0,982	10,246	31,6	15,8	55,8	1,79
	150	0,150	18	3,528		2,113	0,979	10,283	34,3	17,2	57,2	1,86
	175	0,175	18,5	3,626		2,465	0,975	10,320	35,1	17,6	57,6	1,88
	200	0,200	21,5	4,214		2,817	0,972	10,358	40,7	20,3	60,3	2,02
	225	0,225	23,5	4,606		3,169	0,968	10,395	44,3	22,2	62,2	2,11
	250	0,250	26	5,096		3,521	0,965	10,433	48,8	24,4	64,4	2,22
	275	0,275	27,5	5,390		3,873	0,961	10,472	51,5	25,7	65,7	2,29
	300	0,300	28	5,488		4,225	0,958	10,510	52,2	26,1	66,1	2,31
	325	0,325	30	5,880		4,577	0,954	10,549	55,7	27,9	67,9	2,39
	350	0,350	32,5	6,370		4,930	0,951	10,588	60,2	30,1	70,1	2,50
	375	0,375	34,5	6,762		5,282	0,947	10,627	63,6	31,8	71,8	2,59
	400	0,400	36	7,056		5,634	0,944	10,667	66,1	33,1	73,1	2,65
	425	0,425	37,5	7,350		5,986	0,940	10,707	68,6	34,3	74,3	2,72
	450	0,450	37,8	7,409		6,338	0,937	10,747	68,9	34,5	74,5	2,72
	475	0,475	40,5	7,938		6,690	0,933	10,788	73,6	36,8	76,8	2,84
	500	0,500	42,5	8,330		7,042	0,930	10,829	76,9	38,5	78,5	2,92
	525	0,525	44	8,624		7,394	0,926	10,870	79,3	39,7	79,7	2,98
	550	0,550	45,2	8,859		7,746	0,923	10,911	81,2	40,6	80,6	3,03
	575	0,575	46,5	9,114		8,099	0,919	10,953	83,2	41,6	81,6	3,08
	600	0,600	47,5	9,310		8,451	0,915	10,995	84,7	42,3	82,3	3,12
	625	0,625	48	9,408		8,803	0,912	11,038	85,2	42,6	82,6	3,13
	650	0,650	49,5	9,702		9,155	0,908	11,080	87,6	43,8	83,8	3,19
	675	0,675	50,7	9,937		9,507	0,905	11,123	89,3	44,7	84,7	3,23
	700	0,700	51,7	10,133		9,859	0,901	11,167	90,7	45,4	85,4	3,27
	725	0,725	52,7	10,329		10,211	0,898	11,211	92,1	46,1	86,1	3,30
	750	0,750	53,8	10,545		10,563	0,894	11,255	93,7	46,8	86,8	3,34
	775	0,775	54,7	10,721		10,915	0,891	11,299	94,9	47,4	87,4	3,37
	800	0,800	55,5	10,878		11,268	0,887	11,344	95,9	47,9	87,9	3,40
	825	0,825	56,1	10,996		11,620	0,884	11,389	96,5	48,3	88,3	3,41
	850	0,850	56,6	11,094		11,972	0,880	11,435	97,0	48,5	88,5	3,43
	875	0,875	57,1	11,192		12,324	0,877	11,481	97,5	48,7	88,7	3,44
	900	0,900	57,6	11,290		12,676	0,873	11,527	97,9	49,0	89,0	3,45
	925	0,925	57,9	11,348		13,028	0,870	11,574	98,1	49,0	89,0	3,45
	950	0,950	58	11,368		13,380	0,866	11,621	97,8	48,9	88,9	3,45
	925	0,925	20	3,920		13,028	0,870	11,574	33,9	16,9	56,9	1,85
	900	0,900	11	2,156		12,676	0,873	11,527	18,7	9,4	49,4	1,47
	875	0,875	5	0,980		12,324	0,877	11,481	8,5	4,3	44,3	1,21
	850	0,850	1	0,196		11,972	0,880	11,435	1,7	0,9	40,9	1,04
end stage 1	820	0,820	0	0,000		11,549	0,885	11,380	0,0	0,0	40,0	1,00
Stage 2	0	0,000	0	0,000	80,0	11,549	0,885	11,380	0,0	0,0	80,0	1,00
	25	0,025	18	3,528		11,901	0,881	11,426	30,9	15,4	95,4	1,39
	50	0,050	25	4,900		12,254	0,877	11,472	42,7	21,4	101,4	1,53
	75	0,075	31	6,076		12,606	0,874	11,518	52,8	26,4	106,4	1,66
	100	0,100	39	7,644		12,958	0,870	11,564	66,1	33,0	113,0	1,83
	125	0,125	45,5	8,918		13,310	0,867	11,611	76,8	38,4	118,4	1,96
	150	0,150	49,5	9,702		13,662	0,863	11,659	83,2	41,6	121,6	2,04
	175	0,175	53,5	10,486		14,014	0,860	11,707	89,6	44,8	124,8	2,12
	200	0,200	55,5	10,878		14,366	0,856	11,755	92,5	46,3	126,3	2,16
	225	0,225	57,5	11,270		14,718	0,853	11,803	95,5	47,7	127,7	2,19
	250	0,250	58,5	11,466		15,070	0,849	11,852	96,7	48,4	128,4	2,21
	275	0,275	59,5	11,662		15,423	0,846	11,901	98,0	49,0	129,0	2,22
	300	0,300	59,9	11,740		15,775	0,842	11,951	98,2	49,1	129,1	2,23
	325	0,325	60,5	11,858		16,127	0,839	12,001	98,8	49,4	129,4	2,24
	350	0,350	61,1	11,976		16,479	0,835	12,052	99,4	49,7	129,7	2,24
	375	0,375	62,5	12,250		16,831	0,832	12,103	101,2	50,6	130,6	2,27
	400	0,400	63	12,348		17,183	0,828	12,154	101,6	50,8	130,8	2,27

Waktu Berjalan	Deformasi (ΔH) Dial Reading		Beban (P) Dial Reading		Tegangan Sel	Regangan (ε)	Faktor Koreksi Luas	Luas Pen. Terkoreksi	Tegangan Deviator	$(\sigma_1-\sigma_3)/2$	$(\sigma_1+\sigma_3)/2$	(σ_1/σ_3)
	1 div =	0,001 cm	1 div =	0,196 kg	(σ_3)	(ΔH/Ho)	(1-ε)	(Ao/[1-ε])	$(\sigma_1-\sigma_3)$			
(menit)	(div)	(cm)	(div)	(kg)	(kPa)	(%)		(cm2)	(kPa)	(kPa)	(kPa)	(kPa)
	425	0,425	64,5	12,642		17,535	0,825	12,206	103,6	51,8	131,8	2,29
	450	0,450	65	12,740		17,887	0,821	12,259	103,9	52,0	132,0	2,30
	475	0,475	65,3	12,799		18,239	0,818	12,312	104,0	52,0	132,0	2,30
	500	0,500	65,5	12,838		18,592	0,814	12,365	103,8	51,9	131,9	2,30
	475	0,475	28	5,488		18,239	0,818	12,312	44,6	22,3	102,3	1,56
	450	0,450	15,5	3,038		17,887	0,821	12,259	24,8	12,4	92,4	1,31
	425	0,425	8	1,568		17,535	0,825	12,206	12,8	6,4	86,4	1,16
	400	0,400	3,5	0,686		17,183	0,828	12,154	5,6	2,8	82,8	1,07
end stage 2	395	0,395	0	0,000		17,113	0,829	12,144	0,0	0,0	80,0	1,00
Stage 3	0	0,000	0	0,000	120,0	17,113	0,829	12,144	0,0	0,0	120,0	1,00
	25	0,025	22	4,312		17,465	0,825	12,196	35,4	17,7	137,7	1,29
	50	0,050	32	6,272		17,817	0,822	12,248	51,2	25,6	145,6	1,43
	75	0,075	44	8,624		18,169	0,818	12,301	70,1	35,1	155,1	1,58
	100	0,100	50	9,800		18,521	0,815	12,354	79,3	39,7	159,7	1,66
	125	0,125	57,5	11,270		18,873	0,811	12,408	90,8	45,4	165,4	1,76
	150	0,150	63	12,348		19,225	0,808	12,462	99,1	49,5	169,5	1,83
	175	0,175	65,6	12,858		19,577	0,804	12,516	102,7	51,4	171,4	1,86
	200	0,200	66,7	13,073		19,930	0,801	12,571	104,0	52,0	172,0	1,87
	225	0,225	67	13,132		20,282	0,797	12,627	104,0	52,0	172,0	1,87
	250	0,250	68,5	13,426		20,634	0,794	12,683	105,9	52,9	172,9	1,88
	275	0,275	70	13,720		20,986	0,790	12,739	107,7	53,8	173,8	1,90
	300	0,300	70,6	13,838		21,338	0,787	12,796	108,1	54,1	174,1	1,90
	325	0,325	71,5	14,014		21,690	0,783	12,854	109,0	54,5	174,5	1,91
	350	0,350	72,1	14,132		22,042	0,780	12,912	109,4	54,7	174,7	1,91
	375	0,375	73	14,308		22,394	0,776	12,971	110,3	55,2	175,2	1,92
	400	0,400	74	14,504		22,746	0,773	13,030	111,3	55,7	175,7	1,93
	425	0,425	74,6	14,622		23,099	0,769	13,089	111,7	55,9	175,9	1,93
	450	0,450	75,1	14,720		23,451	0,765	13,150	111,9	56,0	176,0	1,93
	475	0,475	75,6	14,818		23,803	0,762	13,210	112,2	56,1	176,1	1,93
	500	0,500	76	14,896		24,155	0,758	13,272	112,2	56,1	176,1	1,94
	525	0,525	76,3	14,955		24,507	0,755	13,334	112,2	56,1	176,1	1,93
	550	0,550	76,4	14,974		24,859	0,751	13,396	111,8	55,9	175,9	1,93
	575	0,575	76,6	15,014		25,211	0,748	13,459	111,5	55,8	175,8	1,93
	600	0,600	76,8	15,053		25,563	0,744	13,523	111,3	55,7	175,7	1,93
	625	0,625	76,9	15,072		25,915	0,741	13,587	110,9	55,5	175,5	1,92
	650	0,650	77	15,092		26,268	0,737	13,652	110,5	55,3	175,3	1,92
	675	0,675	77,2	15,131		26,620	0,734	13,718	110,3	55,2	175,2	1,92
	700	0,700	77,2	15,131		26,972	0,730	13,784	109,8	54,9	174,9	1,91
	725	0,725	77,2	15,131		27,324	0,727	13,850	109,2	54,6	174,6	1,91
	750	0,750	77,2	15,131		27,676	0,723	13,918	108,7	54,4	174,4	1,91
	775	0,775	77,2	15,131		28,028	0,720	13,986	108,2	54,1	174,1	1,90
end stage 3	800	0,800	76,8	15,053		28,380	0,716	14,055	107,1	53,6	173,6	1,89

Perhitungan data :

	Stage 1	*Stage 2*	*Stage 3*	
Tegangan lateral (σ_3) =	40,0	80,0	120,0	kPa
Tegangan deviator maksimum $(\Delta\sigma = \sigma_1-\sigma_3)$ =	98,1	104,0	112,2	kPa
Tegangan vertikal maksimum $(\sigma_1 = \Delta\sigma+\sigma_3)$ =	138,1	184,0	232,2	kPa
Regangan saat tegangan vertikal maximum =	13,028	18,239	24,507	%

TRIAXIAL COMPRESSION TEST

Proyek = Skripsi grup kaoline

Lokasi = Lab. MekTan FTUI

Deskripsi tanah = Kaoline Pc=200 kPa, *w* o=100%

No. pengeboran = ---

No. sampel = ---

Kedalaman = ---

Tanggal = 12 Nopember 2008

Jenis pengujian triaksial = Multistage TX-UU - test

Diuji oleh = Cipto Adi B.

		Unit	Data sampel			Catatan
	No. stage		1	2	3	
	Kode Sampel		# 3.B-(5)			
(a)	Berat can	(gr)	8,12			
(b)	Berat can + tanah basah	(gr)	124,93			
(c)	Berat can + tanah kering	(gr)	84,28			
(b-c)	Berat air	(gr)	40,65			
(c-a)	Berat tanah kering	(gr)	76,16			
(b-c)/(c-a)	Kadar air (*w*)	(%)	53,37			
	Kadar air rata-rata (*w*)	(%)				
(d)	Tinggi sampel (H_o)	(cm)	7,10			
(e)	Diameter sampel (ϕ)	(cm)	3,58			
(f)	Luas (A_o)	(cm2)	10,07			
(g)	Volume (V_o)	(cm3)	71,47			
(b-a)/(g)	Berat jenis tanah basah (γ_{wet})	(gr/cm3)	1,634			
(c-a)/(g)	Berat jenis tanah kering (γ_{dry})	(gr/cm3)	1,066			
	Rata-rata (γ_{wet})	(gr/cm3)				
	Rata-rata (γ_{dry})	(gr/cm3)				
	Tegangan lateral / sel pada sampel (σ_3)	(kPa)	40,0	80,0	120,0	
	Tipe keruntuhan		Stage 1	Stage 2	Stage 3	

TRIAXIAL COMPRESSION TEST

Proyek =	Skripsi grup kaoline	Tanggal =	12 Nopember 2008
Lokasi =	Lab. MekTan FTUI		
Deskripsi tanah =	Kaoline Pc=200 kPa, *w*o=100%	Jenis pengujian	
No. pengeboran =	# 3B	triaksial =	Multistage TX-UU - test
No. sampel =	---		
Kedalaman =	---	Diuji oleh =	Cipto Adi. B

No. stage		1	2	3	Catatan
Kode sampel		# 3.B-(5)			
Teg. normal saat runtuh ($\Delta\sigma$)	(kPa)	98,1	104,0	112,2	
Tegangan lateral (σ_3)	(kPa)	40,0	80,0	120,0	
Tegangan normal total (σ_1)	(kPa)	138,1	184,0	232,2	
Regangan saat runtuh	(%)	13,03	18,24	24,51	

Berat jenis tanah basah (γ_{wet})
= 1,634 gr/cm3

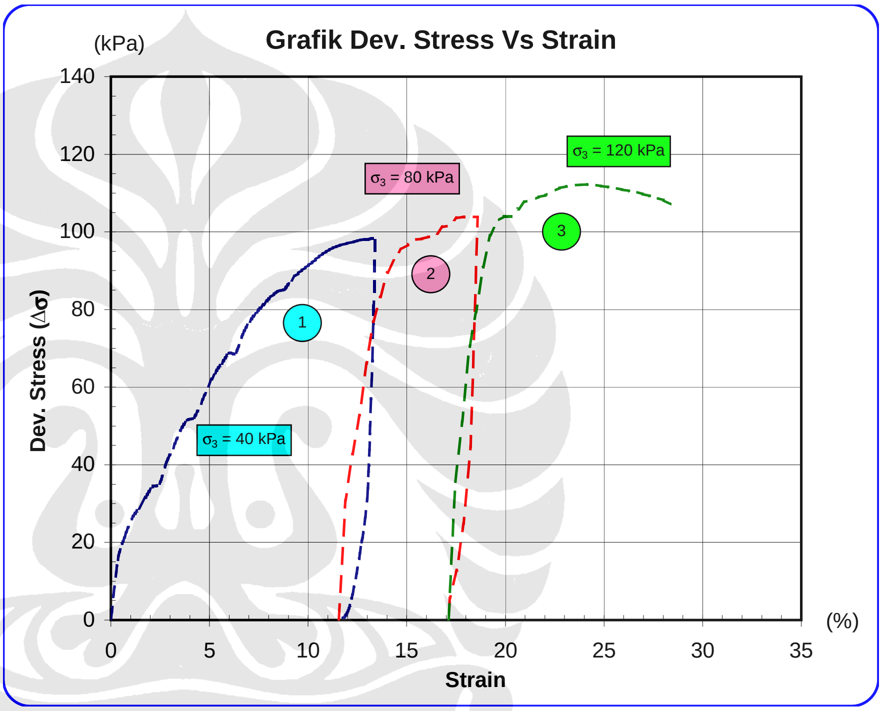
Berat jenis tanah kering (γ_{dry})
= 1,066 gr/cm3

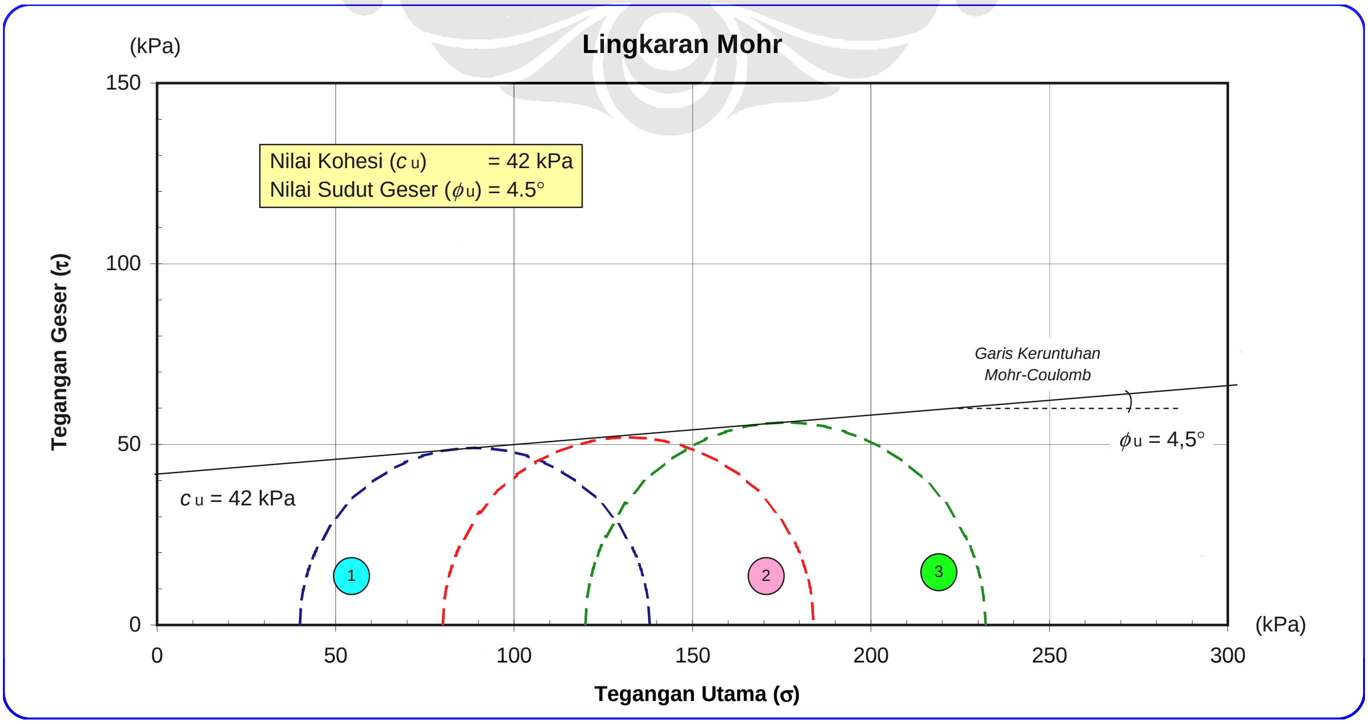
Kadar air (w) = 53,37 %

Nilai tahanan kohesi (c_u)
= 42 (kPa)

Nilai tahanan sudut geser (ϕ_u)
4,5 °

Strain rate = 1,00 mm/min





DATA HASIL PENGUJIAN TRIAKSIAL TEKAN *CONSOLIDATED – UNDRAINED SINGLE STAGE* (*STX-CU*)

Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	1
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(1)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,14 (cm)
Remarks	*Sampel no.1*				

Cell Pressure (kPa)	Back Pressure (kPa)	Pore Pressure (kPa)	PWP diff. (kPa)	B value	Back Pressure Volume Change			Cell Volume Change LHS/RHS				
					before	after	diff.	before	after	diff.	(+) consol (cm3)	(-) exp. (cm3)
0	0	0	-	-	-	-	-	-	-	-		
50	-	22	22	0,44	-	-	-	11,7	13,4	1,7		
50	40	32	-	-	24,7	25,3	0,6	-	-	-		
100	-	65	33	0,66	-	-	-	14,5	15,9	1,4		
100	90	82	-	-	25,6	26,9	1,3	-	-	-		
200	-	161	79	0,79	-	-	-	17,4	19,2	1,8		
200	190	187	-	-	27,1	27,9	0,8	-	-	-		
300	-	274	87	0,87	-	-	-	19,7	20,9	1,2		
300	290	288	-	-	28,1	28,6	0,5	-	-	-		
350	-	336	48	0,96	-	-	-	20,9	21,4	0,5		
									T O T A L =		0	0

Water content determination	Initial	Final	Net volume change	
Weight of can (gr)	-	20,15	Filter correction	- (cm3)
Weight of wet sample + can (gr)	119,40	141,63	Cell correction	- (cm3)
Weight of dry sample + can (gr)	-	98,12	Corrected volume change (ΔVs)	0 (cm3)
Water content (%)	53,14	55,80	Concolidation vol. change (ΔVc)	1,9 (cm3)
Weight of wet sample (gr)	119,4	γ_n (ton/m3) = 1,643	ΔVs + ΔVc = ΔVt	1,9 (cm3)

Ao	10,18 (cm2)	ε_v = (ΔVt/Vo) x 100%	⅓ ε_v	⅔ ε_v
Vo	72,68 (cm3)	2,614 %	0,871 %	1,743 %

Hc = Ho (1 - ⅓ ε_v / 100)	Ac = Ao (1 - ⅔ ε_v / 100)	Vc = Vo - ΔVt
7,08 (cm)	10,00 (cm2)	70,78 (cm3)

Note :

TRIAXIAL CONSOLIDATION

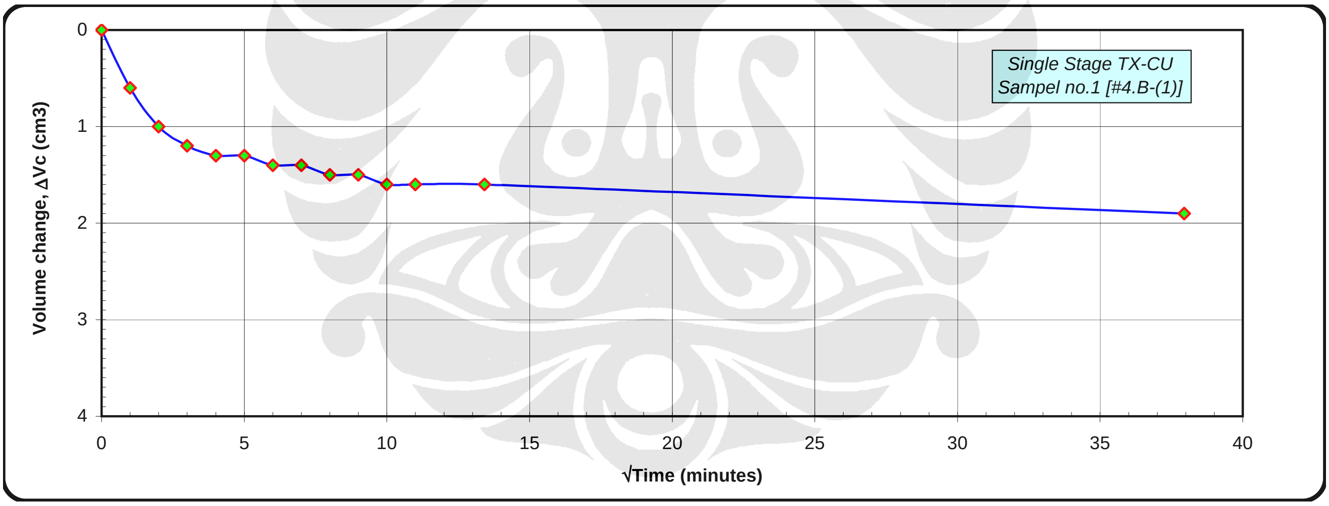
Date of test : 25 Nop. 2008 # 1

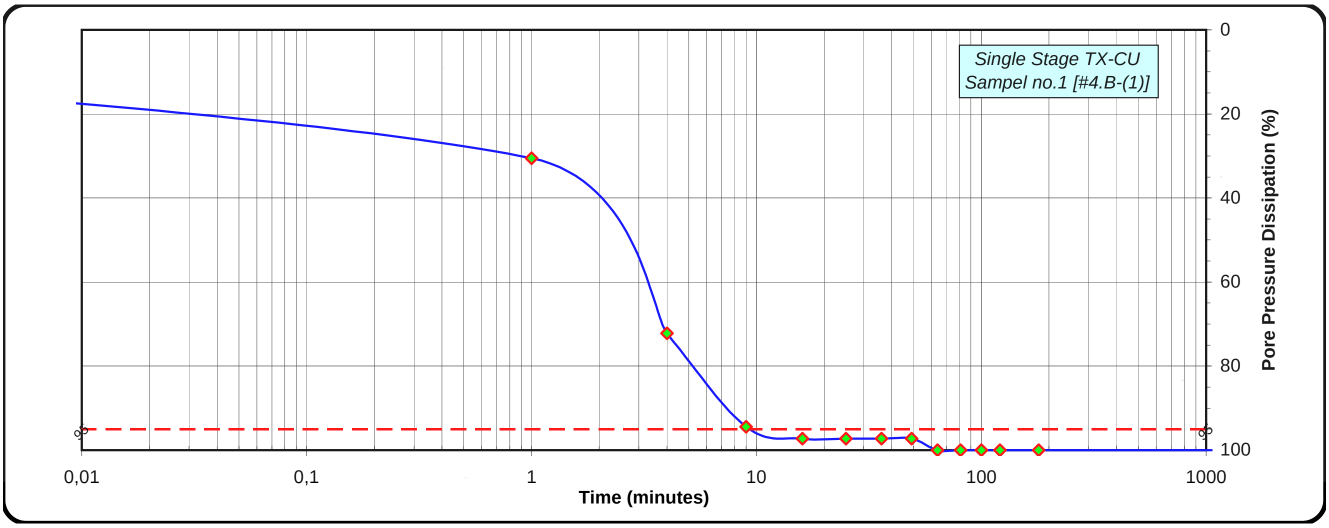
Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	1
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(1)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,14 (cm)
Remarks	*Sampel no.1*				

Effective pressure (kPa)	50
Cell pressure (kPa)	350
Back pressure (kPa)	300
PWP after build-up (kPa)	336
Diffrence (kPa)	36

Note :

Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
25-Nov-08	10:00	0	0	28,6	0	336	0	0
	10:01	1	1	28	0,6	325	11	30,6
	10:04	4	2	27,6	1	310	26	72,2
	10:09	9	3	27,4	1,2	302	34	94,4
	10:16	16	4	27,3	1,3	301	35	97,2
	10:25	25	5	27,3	1,3	301	35	97,2
	10:36	36	6	27,2	1,4	301	35	97,2
	10:49	49	7	27,2	1,4	301	35	97,2
	11:04	64	8	27,1	1,5	300	36	100,0
	11:21	81	9	27,1	1,5	300	36	100,0
	11:40	100	10	27	1,6	300	36	100,0
	12:01	121	11	27	1,6	300	36	100,0
	13:00	180	13,42	27	1,6	300	36	100,0
26-Nov-08	10:00	1440	37,95	26,7	1,9	300	36	100,0
Total consolidation volume change, ΔVc (cm3)					1,9			





TRIAXIAL SHEARING

Project =	Kaoline, Pc=200 kPa	Date of testing =	26 Nop. 2008	Effective cell pressure =	50 (kPa)
Location =	Lab. Mektan FT-UI	Test type =	Single stage TX-CU	Cell pressure =	350 (kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.	Back pressure =	300 (kPa)
Depth =	---	~~with~~ / without side drain		Consolidated length =	7,08 (cm)
Sample no. =	1			Consolidated area =	10,00 (cm2)
Sample code =	# 4.B-(1)	Rate of strain =	0,064 (mm/min)	Consolidated volume =	70,78 (cm3)

1

Date / Time	Strain			Axial load		Pore pressure		Corrected	Deviator	Principal stress & Stress ratio				Stress path				Remarks
	Dial		(ε)	Dial	Load			area	stress	Major tot.	Major eff.	Minor eff.	Eff. ratio	(p)	(q)	(p')	(q')	
	1 div =	0,001 cm		1 div =	0,14 kg	(u)	(Δu)		(σ_1-σ_3)	(σ_1)	(σ_1')	(σ_3')	(σ_1'/σ_3')	½(σ_1+σ_3)	½(σ_1-σ_3)	½(σ_1'+σ_3')	½(σ_1'-σ_3')	
	(div)	(cm)	(%)	(div)	(kg)	(kPa)	(kPa)	(cm2)	(kPa)	(kPa)	(kPa)	(kPa)		(kPa)	(kPa)	(kPa)	(kPa)	
00:00:00	0	0	0	0	0	300	0	10,00	0,0	350,0	50,0	50	1,00	350,0	0,0	50,0	0,0	
	25	0,025	0,353	28,5	3,990	305	5	10,04	39,8	389,8	84,8	45	1,88	369,9	19,9	64,9	19,9	
	50	0,05	0,706	33	4,620	309	9	10,07	45,9	395,9	86,9	41	2,12	372,9	22,9	63,9	22,9	
	75	0,075	1,060	36	5,040	311	11	10,11	49,9	399,9	88,9	39	2,28	374,9	24,9	63,9	24,9	
	100	0,1	1,413	39	5,460	312	12	10,14	53,8	403,8	91,8	38	2,42	376,9	26,9	64,9	26,9	
	125	0,125	1,766	41,6	5,824	312	12	10,18	57,2	407,2	95,2	38	2,51	378,6	28,6	66,6	28,6	
	150	0,15	2,119	44,6	6,244	312	12	10,22	61,1	411,1	99,1	38	2,61	380,6	30,6	68,6	30,6	
	175	0,175	2,473	47,5	6,650	312	12	10,25	64,8	414,8	102,8	38	2,71	382,4	32,4	70,4	32,4	
	200	0,2	2,826	50	7,000	312	12	10,29	68,0	418,0	106,0	38	2,79	384,0	34,0	72,0	34,0	
	225	0,225	3,179	53	7,420	312	12	10,33	71,8	421,8	109,8	38	2,89	385,9	35,9	73,9	35,9	
	250	0,25	3,532	55,1	7,714	312	12	10,37	74,4	424,4	112,4	38	2,96	387,2	37,2	75,2	37,2	
	275	0,275	3,885	57,5	8,050	312	12	10,41	77,4	427,4	115,4	38	3,04	388,7	38,7	76,7	38,7	
	300	0,3	4,239	60	8,400	312	12	10,44	80,4	430,4	118,4	38	3,12	390,2	40,2	78,2	40,2	
	325	0,325	4,592	62,4	8,736	312	12	10,48	83,3	433,3	121,3	38	3,19	391,7	41,7	79,7	41,7	
	350	0,35	4,945	64,9	9,086	312	12	10,52	86,4	436,4	124,4	38	3,27	393,2	43,2	81,2	43,2	
	375	0,375	5,298	67,3	9,422	312	12	10,56	89,2	439,2	127,2	38	3,35	394,6	44,6	82,6	44,6	
	400	0,4	5,651	70	9,800	311	11	10,60	92,4	442,4	131,4	39	3,37	396,2	46,2	85,2	46,2	
	425	0,425	6,005	73	10,220	310	10	10,64	96,1	446,1	136,1	40	3,40	398,0	48,0	88,0	48,0	
	450	0,45	6,358	75	10,500	309	9	10,68	98,3	448,3	139,3	41	3,40	399,2	49,2	90,2	49,2	
	475	0,475	6,711	77,5	10,850	309	9	10,72	101,2	451,2	142,2	41	3,47	400,6	50,6	91,6	50,6	
	500	0,5	7,064	79,5	11,130	308	8	10,76	103,4	453,4	145,4	42	3,46	401,7	51,7	93,7	51,7	
	525	0,525	7,418	81,5	11,410	308	8	10,80	105,6	455,6	147,6	42	3,51	402,8	52,8	94,8	52,8	
	550	0,55	7,771	83,7	11,718	307	7	10,84	108,1	458,1	151,1	43	3,51	404,0	54,0	97,0	54,0	
	575	0,575	8,124	85,8	12,012	307	7	10,89	110,3	460,3	153,3	43	3,57	405,2	55,2	98,2	55,2	
	600	0,6	8,477	88	12,320	306	6	10,93	112,7	462,7	156,7	44	3,56	406,4	56,4	100,4	56,4	
	625	0,625	8,830	90,4	12,656	306	6	10,97	115,4	465,4	159,4	44	3,62	407,7	57,7	101,7	57,7	
	650	0,65	9,184	92,5	12,950	305	5	11,01	117,6	467,6	162,6	45	3,61	408,8	58,8	103,8	58,8	
	675	0,675	9,537	94,5	13,230	305	5	11,06	119,7	469,7	164,7	45	3,66	409,8	59,8	104,8	59,8	
	700	0,7	9,890	95,8	13,412	304	4	11,10	120,8	470,8	166,8	46	3,63	410,4	60,4	106,4	60,4	
	725	0,725	10,243	97,5	13,650	303	3	11,14	122,5	472,5	169,5	47	3,61	411,3	61,3	108,3	61,3	
	750	0,75	10,597	99	13,860	303	3	11,19	123,9	473,9	170,9	47	3,64	411,9	61,9	108,9	61,9	
	775	0,775	10,950	100,8	14,112	302	2	11,23	125,7	475,7	173,7	48	3,62	412,8	62,8	110,8	62,8	
	800	0,8	11,303	102,5	14,350	302	2	11,28	127,3	477,3	175,3	48	3,65	413,6	63,6	111,6	63,6	
	825	0,825	11,656	103,6	14,504	301	1	11,32	128,1	478,1	177,1	49	3,61	414,1	64,1	113,1	64,1	
	850	0,85	12,009	105	14,700	301	1	11,37	129,3	479,3	178,3	49	3,64	414,7	64,7	113,7	64,7	
	875	0,875	12,363	105,9	14,826	300	0	11,41	129,9	479,9	179,9	50	3,60	415,0	65,0	115,0	65,0	
	900	0,9	12,716	107,1	14,994	300	0	11,46	130,9	480,9	180,9	50	3,62	415,4	65,4	115,4	65,4	*peak*
	925	0,925	13,069	107,2	15,008	300	0	11,50	130,4	480,4	180,4	50	3,61	415,2	65,2	115,2	65,2	
	950	0,95	13,422	107,2	15,008	300	0	11,55	129,9	479,9	179,9	50	3,60	415,0	65,0	115,0	65,0	
	975	0,975	13,776	105,1	14,714	300	0	11,60	126,9	476,9	176,9	50	3,54	413,4	63,4	113,4	63,4	
	1000	1	14,129	103,8	14,532	300	0	11,65	124,8	474,8	174,8	50	3,50	412,4	62,4	112,4	62,4	
	1025	1,025	14,482	102,4	14,336	300	0	11,70	122,6	472,6	172,6	50	3,45	411,3	61,3	111,3	61,3	
	1050	1,05	14,835	101,9	14,266	300	0	11,74	121,5	471,5	171,5	50	3,43	410,7	60,7	110,7	60,7	
	1075	1,075	15,188	101,6	14,224	300	0	11,79	120,6	470,6	170,6	50	3,41	410,3	60,3	110,3	60,3	
	1100	1,1	15,542	101	14,140	300	0	11,84	119,4	469,4	169,4	50	3,39	409,7	59,7	109,7	59,7	*)
	1125	1,125	15,895	100	14,000	300	0	11,89	117,7	467,7	167,7	50	3,35	408,9	58,9	108,9	58,9	
2:59:30	1150	1,15	16,248	99,4	13,916	300	0	11,94	116,5	466,5	166,5	50	3,33	408,3	58,3	108,3	58,3	

*Note : *) bidang keruntuhan geser mulai jelas terlihat.*

Calculation :

Maximum deviator stress (Δσ = σ_1-σ_3)	=	130,9	(kPa)
Pore pressure at max. dev. stress (*u*)	=	300,0	(kPa)
Strain at max. deviator stress (ε)	=	12,716	(%)

Principal stresses at maximum deviator stress :

Total major principal stress (σ_1)	=	480,9	(kPa)
Total minor principal stress (σ_3)	=	350,0	(kPa)
Effective major principal stress (σ_1')	=	180,9	(kPa)
Effective minor principal stress (σ_3')	=	50,0	(kPa)
Effective principal stress ratio (σ_1'/σ_3')	=	3,62	

TRIAXIAL SATURATION

Date of test : 24 Nop. 2008 # 2

Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(2)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,16 (cm)
Remarks	*Sampel no.2*				

Cell Pressure (kPa)	Back Pressure (kPa)	Pore Pressure (kPa)	PWP diff. (kPa)	B value	Back Pressure Volume Change before	after	diff.	Cell Volume Change LHS/RHS before	after	diff.	(+) consol (cm3)	(-) exp. (cm3)
0	0	0	-	-	-	-	-	-	-	-		
50	-	14	14	0,28	-	-	-	6	7,7	1,7		
50	40	28	-	-	10,5	11,9	1,4	-	-	-		
100	-	52	24	0,48	-	-	-	9,5	12	2,5		
100	90	78	-	-	12,2	14,4	2,2	-	-	-		
200	-	151	73	0,73	-	-	-	14,8	18,3	3,5		
200	190	182	-	-	14,7	15,6	0,9	-	-	-		
300	-	268	86	0,86	-	-	-	19,8	22	2,2		
300	290	285	-	-	15,8	16,3	0,5	-	-	-		
350	-	330	45	0,9	-	-	-	22,6	24	1,4		
350	340	338	-	-	16,3	16,7	0,4	-	-	-		
400	-	386	48	0,96	-	-	-	24,8	25,8	1		
									TOTAL =		0	0

Water content determination	Initial	Final	Net volume change	
Weight of can (gr)	-	19,48	Filter correction	- (cm3)
Weight of wet sample + can (gr)	119,70	140,59	Cell correction	- (cm3)
Weight of dry sample + can (gr)	-	97,52	Corrected volume change (ΔVs)	0 (cm3)
Water content (%)	53,38	55,19	Concolidation vol. change (ΔVc)	3,9 (cm3)
Weight of wet sample (gr)	119,7	γ_n (ton/m3) = 1,642	ΔVs + ΔVc = ΔVt	3,9 (cm3)

Ao	10,18 (cm2)	ε_v = (ΔVt/Vo) x 100%	⅓ ε_v	⅔ ε_v
Vo	72,88 (cm3)	5,351 %	1,784 %	3,568 %

Hc = Ho (1 - ⅓ ε_v / 100)	Ac = Ao (1 - ⅔ ε_v / 100)	Vc = Vo - ΔVt
7,03 (cm)	9,82 (cm2)	68,98 (cm3)

Note :

TRIAXIAL CONSOLIDATION

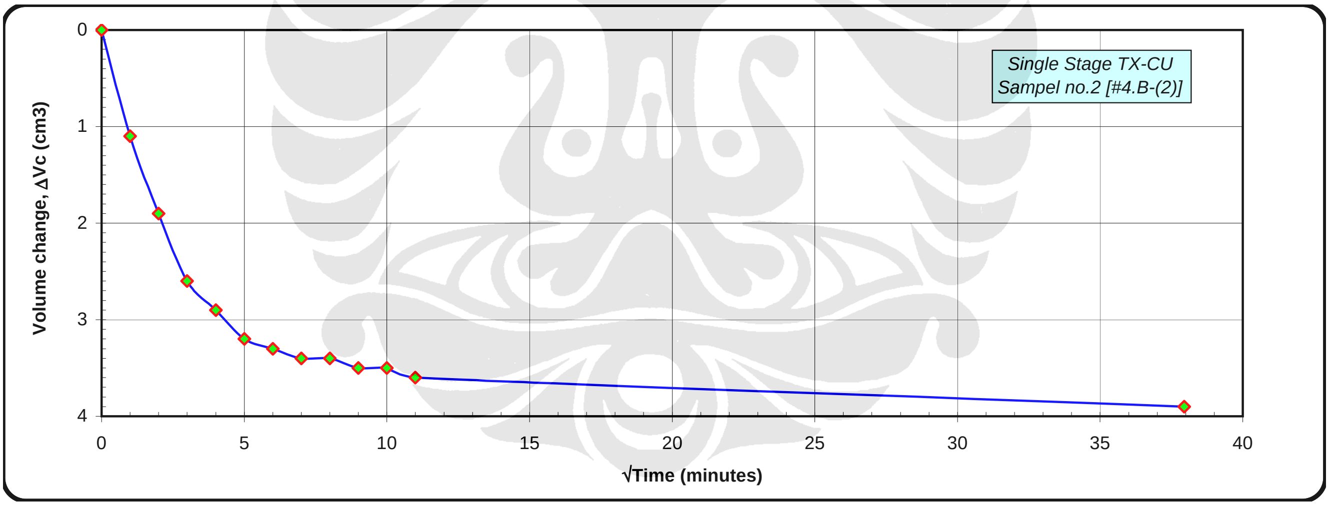
Date of test : 25 Nop. 2008 # 2

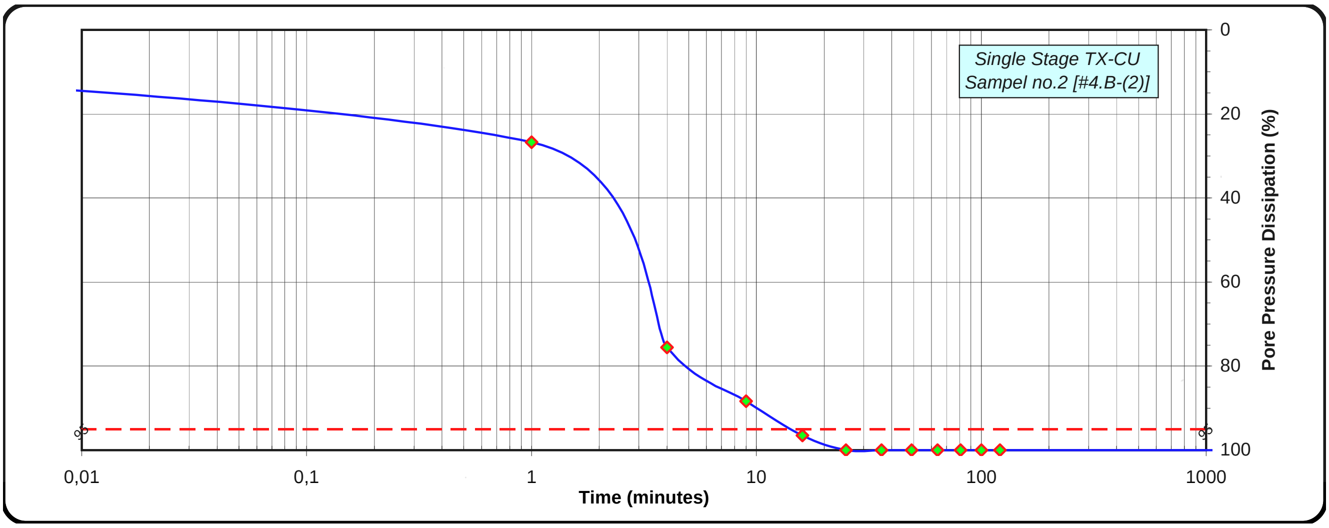
Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(2)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,16 (cm)
Remarks	*Sampel no.2*				

Effective pressure (kPa)	100
Cell pressure (kPa)	400
Back pressure (kPa)	300
PWP after build-up (kPa)	386
Diffrence (kPa)	86

Note :

Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
25-Nov-08	11:00	0	0	16,7	0	386	0	0
	11:01	1	1	15,6	1,1	363	23	26,7
	11:04	4	2	14,8	1,9	321	65	75,6
	11:09	9	3	14,1	2,6	310	76	88,4
	11:16	16	4	13,8	2,9	303	83	96,5
	11:25	25	5	13,5	3,2	300	86	100,0
	11:36	36	6	13,4	3,3	300	86	100,0
	11:49	49	7	13,3	3,4	300	86	100,0
	12:04	64	8	13,3	3,4	300	86	100,0
	12:21	81	9	13,2	3,5	300	86	100,0
	12:40	100	10	13,2	3,5	300	86	100,0
	13:01	121	11	13,1	3,6	300	86	100,0
26-Nov-08	11:00	1440	37,95	12,8	3,9	300	86	100,0
Total consolidation volume change, ΔVc (cm3)					3,9			





TRIAXIAL SHEARING

Project =	Kaoline, Pc=200 kPa	Date of testing =	26 Nop. 2008	Effective cell pressure =	100 (kPa)
Location =	Lab. Mektan FT-UI	Test type =	Single stage TX-CU	Cell pressure =	400 (kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.	Back pressure =	300 (kPa)
Depth =	---	~~with~~ / without side drain		Consolidated length =	7,03 (cm)
Sample no. =	2			Consolidated area =	9,82 (cm2)
Sample code =	# 4.B-(2)	Rate of strain =	0,062 (mm/min)	Consolidated volume =	68,98 (cm3)

2

Date / Time	Strain: Dial (1 div =)	Strain: Dial (0,001 cm)	Strain (ε)	Axial load: Dial (1 div =)	Axial load: Load (0,14 kg)	Pore pressure (u)	Pore pressure (Δu)	Corrected area	Deviator stress (σ_1-σ_3)	Major tot. (σ_1)	Major eff. (σ_1')	Minor eff. (σ_3')	Eff. ratio (σ_1'/σ_3')	(p) ½(σ_1+σ_3)	(q) ½(σ_1-σ_3)	(p') ½(σ_1'+σ_3')	(q') ½(σ_1'-σ_3')	Remarks
	(div)	(cm)	(%)	(div)	(kg)	(kPa)	(kPa)	(cm2)	(kPa)	(kPa)	(kPa)	(kPa)		(kPa)	(kPa)	(kPa)	(kPa)	
00:00:00	0	0	0	0	0	300	0	9,82	0,0	400,0	100,0	100	1,00	400,0	0,0	100,0	0,0	
	25	0,025	0,356	42	5,880	316	16	9,85	59,7	459,7	143,7	84	1,71	429,8	29,8	113,8	29,8	
	50	0,05	0,711	52,5	7,350	326	26	9,89	74,3	474,3	148,3	74	2,00	437,2	37,2	111,2	37,2	
	75	0,075	1,067	60	8,400	332	32	9,92	84,7	484,7	152,7	68	2,25	442,3	42,3	110,3	42,3	
	100	0,1	1,422	64,7	9,058	337	37	9,96	91,0	491,0	154,0	63	2,44	445,5	45,5	108,5	45,5	
	125	0,125	1,778	68,5	9,590	339	39	9,99	96,0	496,0	157,0	61	2,57	448,0	48,0	109,0	48,0	
	150	0,15	2,133	72,3	10,122	341	41	10,03	100,9	500,9	159,9	59	2,71	450,5	50,5	109,5	50,5	
	175	0,175	2,489	75,5	10,570	342	42	10,07	105,0	505,0	163,0	58	2,81	452,5	52,5	110,5	52,5	
	200	0,2	2,844	79,4	11,116	343	43	10,10	110,0	510,0	167,0	57	2,93	455,0	55,0	112,0	55,0	
	225	0,225	3,200	82,9	11,606	343	43	10,14	114,5	514,5	171,5	57	3,01	457,2	57,2	114,2	57,2	
	250	0,25	3,555	85,4	11,956	343	43	10,18	117,5	517,5	174,5	57	3,06	458,7	58,7	115,7	58,7	
	275	0,275	3,911	88,4	12,376	343	43	10,22	121,2	521,2	178,2	57	3,13	460,6	60,6	117,6	60,6	
	300	0,3	4,266	91,1	12,754	343	43	10,25	124,4	524,4	181,4	57	3,18	462,2	62,2	119,2	62,2	
	325	0,325	4,622	93,8	13,132	343	43	10,29	127,6	527,6	184,6	57	3,24	463,8	63,8	120,8	63,8	
	350	0,35	4,977	95,9	13,426	343	43	10,33	130,0	530,0	187,0	57	3,28	465,0	65,0	122,0	65,0	
	375	0,375	5,333	98	13,720	343	43	10,37	132,3	532,3	189,3	57	3,32	466,2	66,2	123,2	66,2	
	400	0,4	5,688	100,3	14,042	343	43	10,41	134,9	534,9	191,9	57	3,37	467,5	67,5	124,5	67,5	
	425	0,425	6,044	101,8	14,252	343	43	10,45	136,4	536,4	193,4	57	3,39	468,2	68,2	125,2	68,2	
	450	0,45	6,399	103,8	14,532	343	43	10,49	138,6	538,6	195,6	57	3,43	469,3	69,3	126,3	69,3	
	475	0,475	6,755	105,4	14,756	342	42	10,53	140,2	540,2	198,2	58	3,42	470,1	70,1	128,1	70,1	
	500	0,5	7,110	106,5	14,910	341	41	10,57	141,1	541,1	200,1	59	3,39	470,6	70,6	129,6	70,6	
	525	0,525	7,466	108	15,120	341	41	10,61	142,5	542,5	201,5	59	3,42	471,3	71,3	130,3	71,3	
	550	0,55	7,821	109,3	15,302	340	40	10,65	143,7	543,7	203,7	60	3,40	471,9	71,9	131,9	71,9	
	575	0,575	8,177	110,4	15,456	339	39	10,69	144,6	544,6	205,6	61	3,37	472,3	72,3	133,3	72,3	
	600	0,6	8,532	111	15,540	338	38	10,73	144,8	544,8	206,8	62	3,34	472,4	72,4	134,4	72,4	*peak*
	625	0,625	8,888	111,2	15,568	338	38	10,77	144,5	544,5	206,5	62	3,33	472,3	72,3	134,3	72,3	
	650	0,65	9,243	111,2	15,568	338	38	10,82	143,9	543,9	205,9	62	3,32	472,0	72,0	134,0	72,0	
	675	0,675	9,599	111,2	15,568	338	38	10,86	143,4	543,4	205,4	62	3,31	471,7	71,7	133,7	71,7	
	700	0,7	9,954	110	15,400	337	37	10,90	141,3	541,3	204,3	63	3,24	470,6	70,6	133,6	70,6	
	725	0,725	10,310	108,7	15,218	337	37	10,94	139,1	539,1	202,1	63	3,21	469,5	69,5	132,5	69,5	
	750	0,75	10,665	107,3	15,022	337	37	10,99	136,7	536,7	199,7	63	3,17	468,4	68,4	131,4	68,4	*)
	775	0,775	11,021	105,5	14,770	337	37	11,03	133,9	533,9	196,9	63	3,13	466,9	66,9	129,9	66,9	
2:09:07	800	0,8	11,376	104,5	14,630	337	37	11,08	132,1	532,1	195,1	63	3,10	466,0	66,0	129,0	66,0	

*Note : *) bidang keruntuhan geser mulai jelas terlihat.*

Calculation :

Maximum deviator stress ($\Delta\sigma = \sigma_1$-σ_3)	=	144,8	(kPa)
Pore pressure at max. dev. stress (*u*)	=	338,0	(kPa)
Strain at max. deviator stress (ε)	=	8,532	(%)

Principal stresses at maximum deviator stress :

Total major principal stress (σ_1)	=	544,8	(kPa)
Total minor principal stress (σ_3)	=	400,0	(kPa)
Effective major principal stress (σ_1')	=	206,8	(kPa)
Effective minor principal stress (σ_3')	=	62,0	(kPa)
Effective principal stress ratio (σ_1'/σ_3')	=	3,34	

TRIAXIAL SATURATION

Date of test : 27 Nop. 2008 # 3

Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	1
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(3)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.3*				

Cell Pressure (kPa)	Back Pressure (kPa)	Pore Pressure (kPa)	PWP diff. (kPa)	B value	Back Pressure Volume Change before	Back Pressure Volume Change after	Back Pressure Volume Change diff.	Cell Volume Change LHS/RHS before	after	diff.	(+) consol (cm3)	(-) exp. (cm3)
0	0	0	-	-	-	-	-	-	-	-		
50	-	35	35	0,7	-	-	-	12,6	14,5	1,9		
50	40	39	-	-	22,4	23,8	1,4	-	-	-		
100	-	84	45	0,9	-	-	-	16	17,7	1,7		
100	90	89	-	-	24,2	25	0,8	-	-	-		
200	-	185	96	0,96	-	-	-	18,3	19,2	0,9		
										T O T A L =	0	0

Water content determination	Initial	Final	Net volume change	
Weight of can (gr)	-	19,47	Filter correction	- (cm3)
Weight of wet sample + can (gr)	142,22	160,19	Cell correction	- (cm3)
Weight of dry sample + can (gr)	-	111,83	Corrected volume change (ΔVs)	0 (cm3)
Water content (%)	53,98	52,36	Concolidation vol. change (ΔVc)	7,3 (cm3)
Weight of wet sample (gr)	142,22	γ_n (ton/m3) = 1,650	ΔVs + ΔVc = ΔVt	7,3 (cm3)

Ao	11,34 (cm2)	$\varepsilon_v = (\Delta Vt/Vo) \times 100\%$	⅓ ε_v	⅔ ε_v
Vo	86,19 (cm3)	8,469 %	2,823 %	5,646 %

Hc = Ho (1 - ⅓ ε_v / 100)	Ac = Ao (1 - ⅔ ε_v / 100)	Vc = Vo - ΔVt
7,39 (cm)	10,70 (cm2)	78,89 (cm3)

Note :

TRIAXIAL CONSOLIDATION

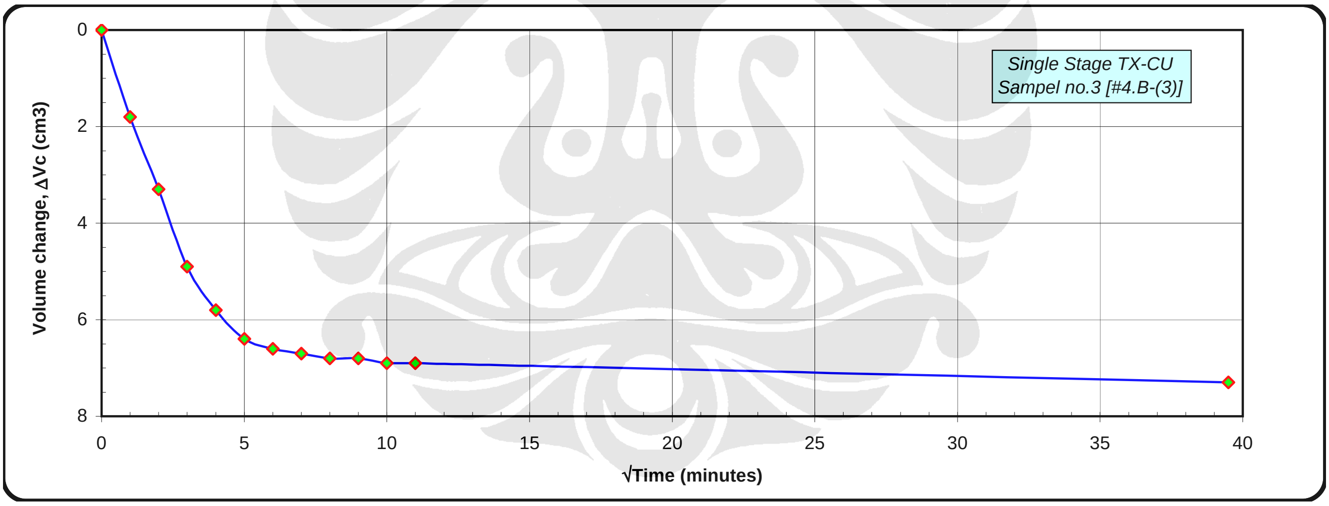
Date of test : 27 Nop. 2008 # 3

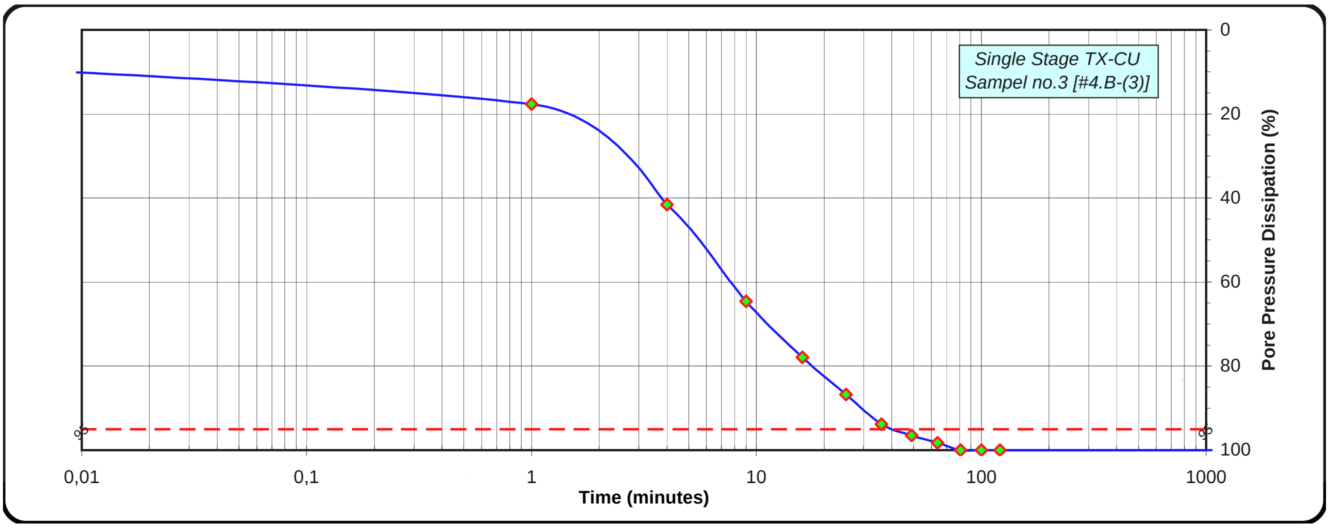
Project	Kaoline, Pc=200 kPa	Type of test	CU, single stage	Cell no.	1
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(3)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.3*				

Effective pressure (kPa)	150
Cell pressure (kPa)	450
Back pressure (kPa)	300
PWP after build-up (kPa)	413
Diffrence (kPa)	113

Note :

Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
27-Nov-08	11:00	0	0	25	0	413	0	0
	11:01	1	1	23,2	1,8	393	20	17,7
	11:04	4	2	21,7	3,3	366	47	41,6
	11:09	9	3	20,1	4,9	340	73	64,6
	11:16	16	4	19,2	5,8	325	88	77,9
	11:25	25	5	18,6	6,4	315	98	86,7
	11:36	36	6	18,4	6,6	307	106	93,8
	11:49	49	7	18,3	6,7	304	109	96,5
	12:04	64	8	18,2	6,8	302	111	98,2
	12:21	81	9	18,2	6,8	300	113	100,0
	12:40	100	10	18,1	6,9	300	113	100,0
	13:01	121	11	18,1	6,9	300	113	100,0
28-Nov-08	13:00	1560	39,50	17,7	7,3	300	113	100,0
Total consolidation volume change, ΔVc (cm3)					7,3			





TRIAXIAL SHEARING

Project =	Kaoline, Pc=200 kPa	Date of testing =	28 Nop. 2008	Effective cell pressure =	150 (kPa)
Location =	Lab. Mektan FT-UI	Test type =	Single stage TX-CU	Cell pressure =	450 (kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.	Back pressure =	300 (kPa)
Depth =	---	~~with~~ / without side drain		Consolidated length =	7,39 (cm)
Sample no. =	3			Consolidated area =	10,70 (cm2)
Sample code =	# 4.B-(3)	Rate of strain =	0,064 (mm/min)	Consolidated volume =	78,89 (cm3)

3

Date / Time	Strain: Dial 1 div = (div)	Strain: Dial 0,001 cm (cm)	Strain (ε) (%)	Axial load: Dial 1 div = (div)	Axial load: Load 0,14 kg (kg)	Pore pressure (u) (kPa)	Pore pressure (Δu) (kPa)	Corrected area (cm2)	Deviator stress (σ_1-σ_3) (kPa)	Major tot. (σ_1) (kPa)	Major eff. (σ_1') (kPa)	Minor eff. (σ_3') (kPa)	Eff. ratio (σ_1'/σ_3')	(p) ½(σ_1+σ_3) (kPa)	(q) ½(σ_1-σ_3) (kPa)	(p') ½(σ_1'+σ_3') (kPa)	(q') ½(σ_1'-σ_3') (kPa)	Remarks
00:00:00	0	0	0	0	0	300	0	10,70	0,0	450,0	150,0	150	1,00	450,0	0,0	150,0	0,0	
	25	0,025	0,339	60	8,400	350	50	10,74	78,2	528,2	178,2	100	1,78	489,1	39,1	139,1	39,1	
	50	0,05	0,677	70,5	9,870	363	63	10,77	91,6	541,6	178,6	87	2,05	495,8	45,8	132,8	45,8	
	75	0,075	1,016	77,5	10,850	369	69	10,81	100,4	550,4	181,4	81	2,24	500,2	50,2	131,2	50,2	
	100	0,1	1,354	83,2	11,648	374	74	10,85	107,4	557,4	183,4	76	2,41	503,7	53,7	129,7	53,7	
	125	0,125	1,693	87,5	12,250	378	78	10,89	112,5	562,5	184,5	72	2,56	506,3	56,3	128,3	56,3	
	150	0,15	2,031	91	12,740	381	81	10,92	116,6	566,6	185,6	69	2,69	508,3	58,3	127,3	58,3	
	175	0,175	2,370	93,5	13,090	382	82	10,96	119,4	569,4	187,4	68	2,76	509,7	59,7	127,7	59,7	
	200	0,2	2,708	97	13,580	383	83	11,00	123,5	573,5	190,5	67	2,84	511,7	61,7	128,7	61,7	
	225	0,225	3,047	101	14,140	384	84	11,04	128,1	578,1	194,1	66	2,94	514,1	64,1	130,1	64,1	
	250	0,25	3,385	103,5	14,490	384	84	11,08	130,8	580,8	196,8	66	2,98	515,4	65,4	131,4	65,4	
	275	0,275	3,724	105,5	14,770	385	85	11,11	132,9	582,9	197,9	65	3,04	516,4	66,4	131,4	66,4	
	300	0,3	4,062	106,3	14,882	385	85	11,15	133,4	583,4	198,4	65	3,05	516,7	66,7	131,7	66,7	
	325	0,325	4,401	108,3	15,162	386	86	11,19	135,5	585,5	199,5	64	3,12	517,7	67,7	131,7	67,7	
	350	0,35	4,739	109,5	15,330	386	86	11,23	136,5	586,5	200,5	64	3,13	518,2	68,2	132,2	68,2	
	375	0,375	5,078	111	15,540	386	86	11,27	137,8	587,8	201,8	64	3,15	518,9	68,9	132,9	68,9	
	400	0,4	5,416	112	15,680	386	86	11,31	138,6	588,6	202,6	64	3,17	519,3	69,3	133,3	69,3	
	425	0,425	5,755	114	15,960	386	86	11,35	140,6	590,6	204,6	64	3,20	520,3	70,3	134,3	70,3	
	450	0,45	6,093	116	16,240	386	86	11,40	142,5	592,5	206,5	64	3,23	521,3	71,3	135,3	71,3	
	475	0,475	6,432	117	16,380	386	86	11,44	143,2	593,2	207,2	64	3,24	521,6	71,6	135,6	71,6	
	500	0,5	6,770	118,3	16,562	386	86	11,48	144,3	594,3	208,3	64	3,25	522,1	72,1	136,1	72,1	
	525	0,525	7,109	119	16,660	386	86	11,52	144,6	594,6	208,6	64	3,26	522,3	72,3	136,3	72,3	
	550	0,55	7,447	119,6	16,744	386	86	11,56	144,8	594,8	208,8	64	3,26	522,4	72,4	136,4	72,4	
	575	0,575	7,786	120,8	16,912	386	86	11,60	145,7	595,7	209,7	64	3,28	522,9	72,9	136,9	72,9	
	600	0,6	8,124	122	17,080	386	86	11,65	146,6	596,6	210,6	64	3,29	523,3	73,3	137,3	73,3	
	625	0,625	8,463	123	17,220	385	85	11,69	147,3	597,3	212,3	65	3,27	523,7	73,7	138,7	73,7	
	650	0,65	8,801	124	17,360	385	85	11,73	148,0	598,0	213,0	65	3,28	524,0	74,0	139,0	74,0	
	675	0,675	9,140	125,5	17,570	385	85	11,78	149,2	599,2	214,2	65	3,30	524,6	74,6	139,6	74,6	
	700	0,7	9,478	126,3	17,682	384	84	11,82	149,6	599,6	215,6	66	3,27	524,8	74,8	140,8	74,8	
	725	0,725	9,817	127	17,780	384	84	11,87	149,8	599,8	215,8	66	3,27	524,9	74,9	140,9	74,9	*peak*
	750	0,75	10,155	127,3	17,822	384	84	11,91	149,6	599,6	215,6	66	3,27	524,8	74,8	140,8	74,8	
	775	0,775	10,494	126,8	17,752	384	84	11,96	148,5	598,5	214,5	66	3,25	524,2	74,2	140,2	74,2	
	800	0,8	10,832	126,6	17,724	384	84	12,00	147,7	597,7	213,7	66	3,24	523,8	73,8	139,8	73,8	
	825	0,825	11,171	126,2	17,668	384	84	12,05	146,7	596,7	212,7	66	3,22	523,3	73,3	139,3	73,3	
	850	0,85	11,509	125,9	17,626	384	84	12,09	145,8	595,8	211,8	66	3,21	522,9	72,9	138,9	72,9	
	875	0,875	11,848	125,8	17,612	384	84	12,14	145,1	595,1	211,1	66	3,20	522,5	72,5	138,5	72,5	*)
	900	0,9	12,186	125,6	17,584	384	84	12,19	144,3	594,3	210,3	66	3,19	522,1	72,1	138,1	72,1	
	925	0,925	12,525	125	17,500	384	84	12,23	143,1	593,1	209,1	66	3,17	521,5	71,5	137,5	71,5	
2:29:05	950	0,95	12,863	124	17,360	384	84	12,28	141,4	591,4	207,4	66	3,14	520,7	70,7	136,7	70,7	

*Note : *) bidang keruntuhan geser mulai jelas terlihat.*

<u>*Calculation :*</u>

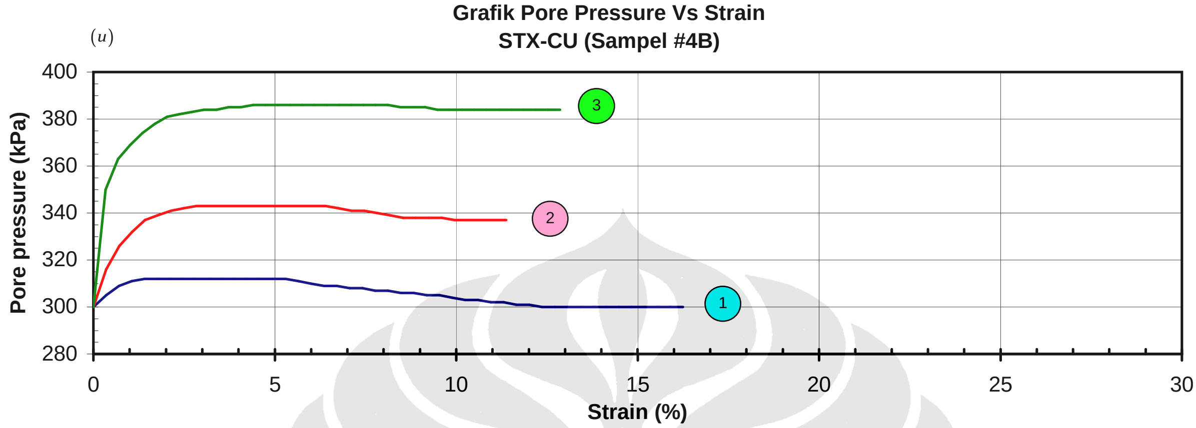
Maximum deviator stress ($\Delta\sigma = \sigma_1$-σ_3)	=	149,8	(kPa)
Pore pressure at max. dev. stress (*u*)	=	384,0	(kPa)
Strain at max. deviator stress (ε)	=	9,817	(%)

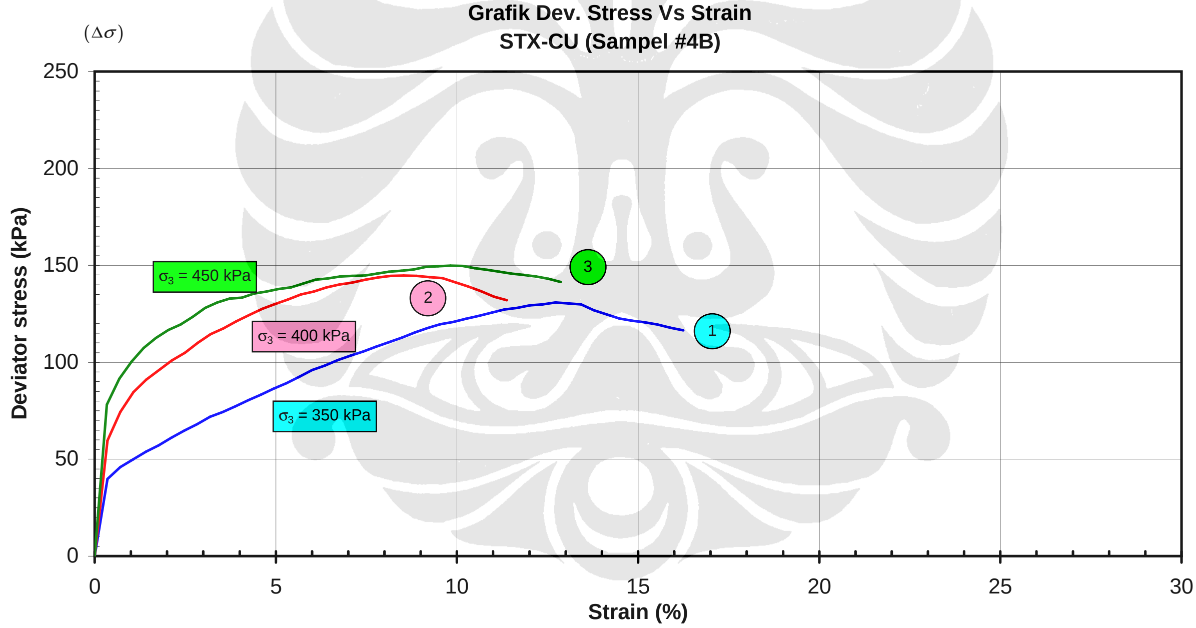
<u>*Principal stresses at maximum deviator stress :*</u>

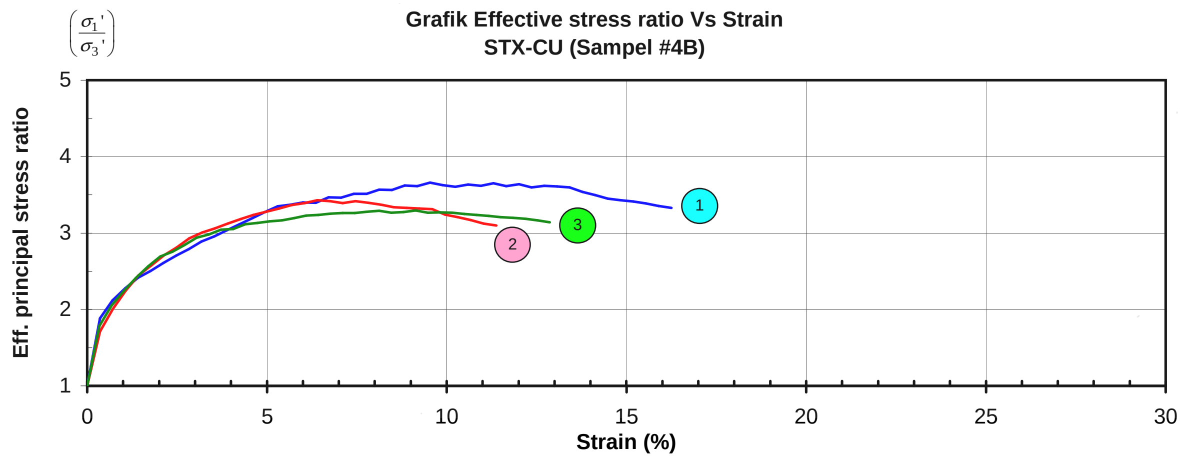
Total major principal stress (σ_1)	=	599,8	(kPa)
Total minor principal stress (σ_3)	=	450,0	(kPa)
Effective major principal stress (σ_1')	=	215,8	(kPa)
Effective minor principal stress (σ_3')	=	66,0	(kPa)
Effective principal stress ratio (σ_1'/σ_3')	=	3,27	

TRIAXIAL COMPRESSION TEST - CU TEST (SINGLE STAGE)

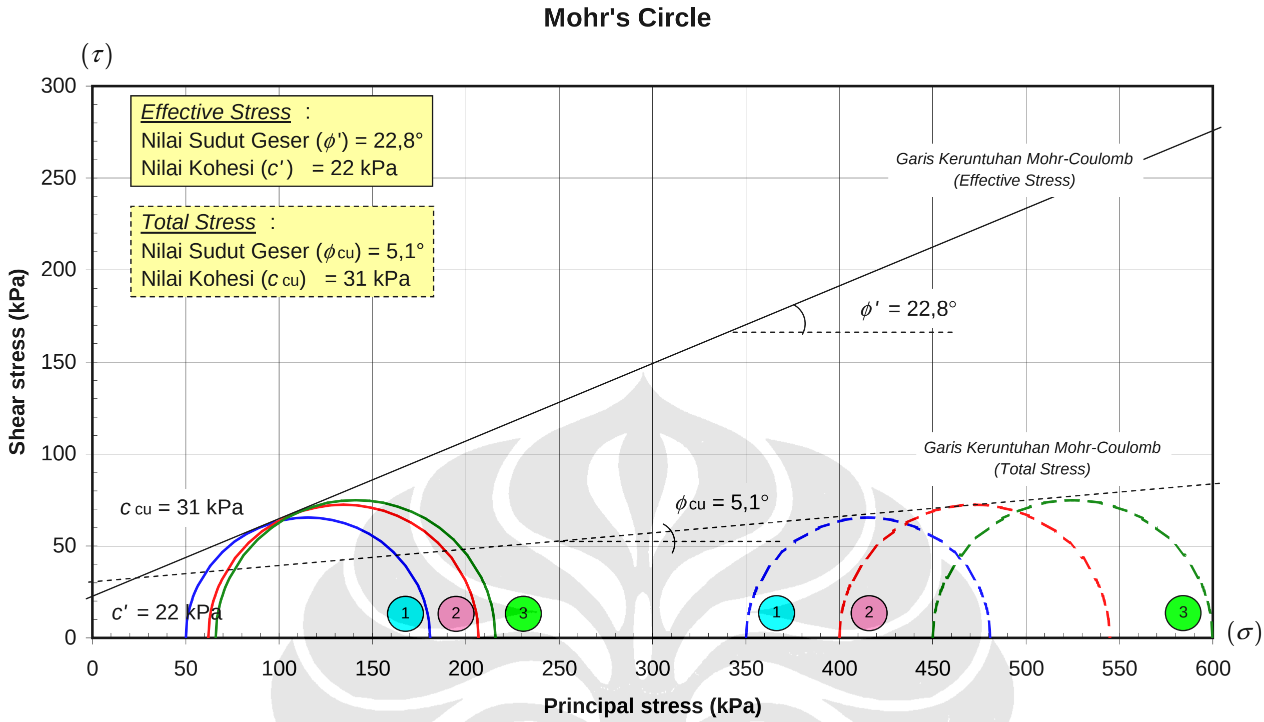
No. Sampel		1	2	3		Keterangan
Kode Sampel		# 4.B-(1)	# 4.B-(2)	# 4.B-(3)		
Maximum deviator stress ($\Delta\sigma = \sigma_1$-σ_3)	(kPa)	130,9	144,8	149,8		
Pore pressure at max. dev. stress (u)	(kPa)	300,0	338,0	384,0		
Total major principal stress (σ_1)	(kPa)	480,9	544,8	599,8		
Total minor principal stress (σ_3)	(kPa)	350,0	400,0	450,0		
Effective major principal stress (σ_1')	(kPa)	180,9	206,8	215,8		
Effective minor principal stress (σ_3')	(kPa)	50,0	62,0	66,0		
Strain at max. deviator stress (ε)	(%)	12,716	8,532	9,817		

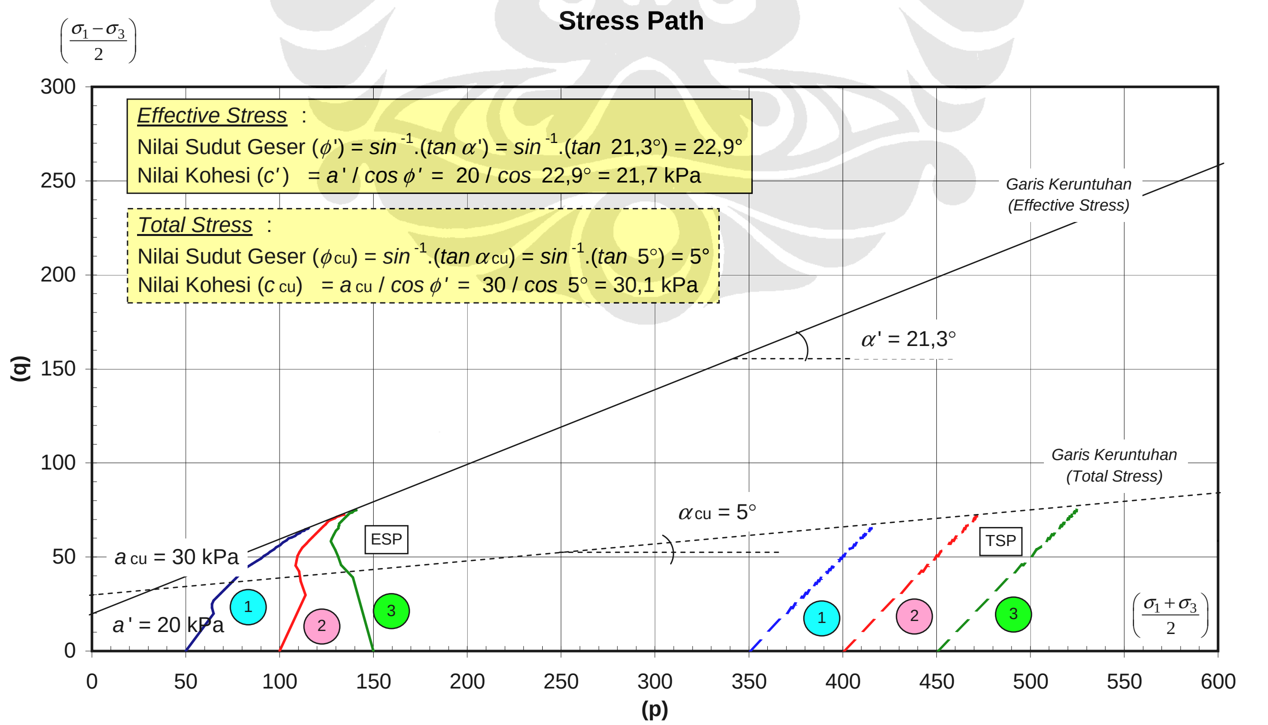






TRIAXIAL COMPRESSION TEST - CONSOLIDATED UNDRAINED
SINGLE STAGE TX-CU
SAMPEL NO. #4B-(1)-(2)-(3)





DATA HASIL PENGUJIAN TRIAKSIAL TEKAN *CONSOLIDATED – UNDRAINED MULTISTAGE* (*MTX-CU*)

Sampel No.#4B-(4)
Sampel No.#4B-(5)

TRIAXIAL SATURATION Date of test : 27 Nop. 2008 # 4

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(4)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,18 (cm)
Remarks	*Sampel no.4*				

Cell Pressure (kPa)	Back Pressure (kPa)	Pore Pressure (kPa)	PWP diff. (kPa)	B value	Back Pressure Volume Change			Cell Volume Change LHS/RHS				
					before	after	diff.	before	after	diff.	(+) consol (cm3)	(-) exp. (cm3)
0	0	0	-	-	-	-	-	-	-	-		
50	-	25	25	0,5	-	-	-	13	15,1	2,1		
50	40	28	-	-	21,8	22,2	0,4	-	-	-		
100	-	65	37	0,74	-	-	-	17,8	19,7	1,9		
100	90	80	-	-	22,5	24,4	1,9	-	-	-		
150	-	122	42	0,84	-	-	-	22	23,4	1,4		
150	140	135	-	-	24,7	27	2,3	-	-	-		
200	-	181	46	0,92	-	-	-	25,1	26,5	1,4		
200	190	187	-	-	27,2	27,4	0,2	-	-	-		
250	-	235	48	0,96	-	-	-	27,8	30,5	2,7		
										T O T A L =	0	0

Water content determination	Initial	Final	Net volume change		
Weight of can (gr)	-	16,56	Filter correction	-	(cm3)
Weight of wet sample + can (gr)	120,04	134,13	Cell correction	-	(cm3)
Weight of dry sample + can (gr)	-	94,89	Corrected volume change (ΔVs)	0	(cm3)
Water content (%)	53,25	50,10	Concolidation vol. change (ΔVc)	1,6	(cm3)
Weight of wet sample (gr)	120,04	γ_n (ton/m3) = 1,643	ΔVs + ΔVc = ΔVt	1,6	(cm3)

Ao	10,18 (cm2)	$\varepsilon_v = (\Delta Vt/Vo) \times 100\%$	⅓ ε_v	⅔ ε_v
Vo	73,08 (cm3)	2,189 %	0,730 %	1,460 %

$Hc = Ho (1 - ⅓ \varepsilon_v / 100)$	$Ac = Ao (1 - ⅔ \varepsilon_v / 100)$	$Vc = Vo - \Delta Vt$
7,13 (cm)	10,03 (cm2)	71,48 (cm3)

	Initial	*STAGE 1*	*STAGE 2*	*STAGE 3*	
Consolidation					
ΔVs	-	0	0	0	(cm3)
ΔVc	-	1,6	2,5	1,5	(cm3)
ΔVt	-	1,6	2,5	1,5	(cm3)
ε_v	-	2,189	3,497	2,174	(%)
dia. (ϕ)	3,60	3,57	3,53	3,51	(cm)
Height (H)	7,18	7,13	7,04	6,99	(cm)
Area (A)	10,18	10,03	9,80	9,65	(cm2)
Vol. (V)	73,08	71,48	68,98	67,48	(cm3)

Note :

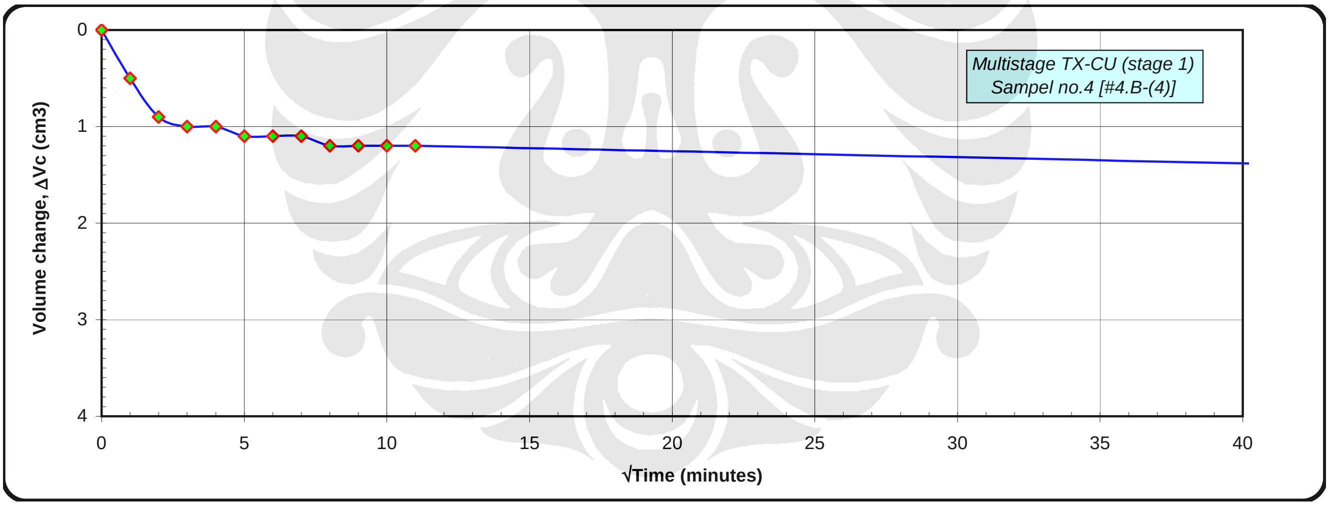
Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(4)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,18 (cm)
Remarks	*Sampel no.4 (Stage 1)*				

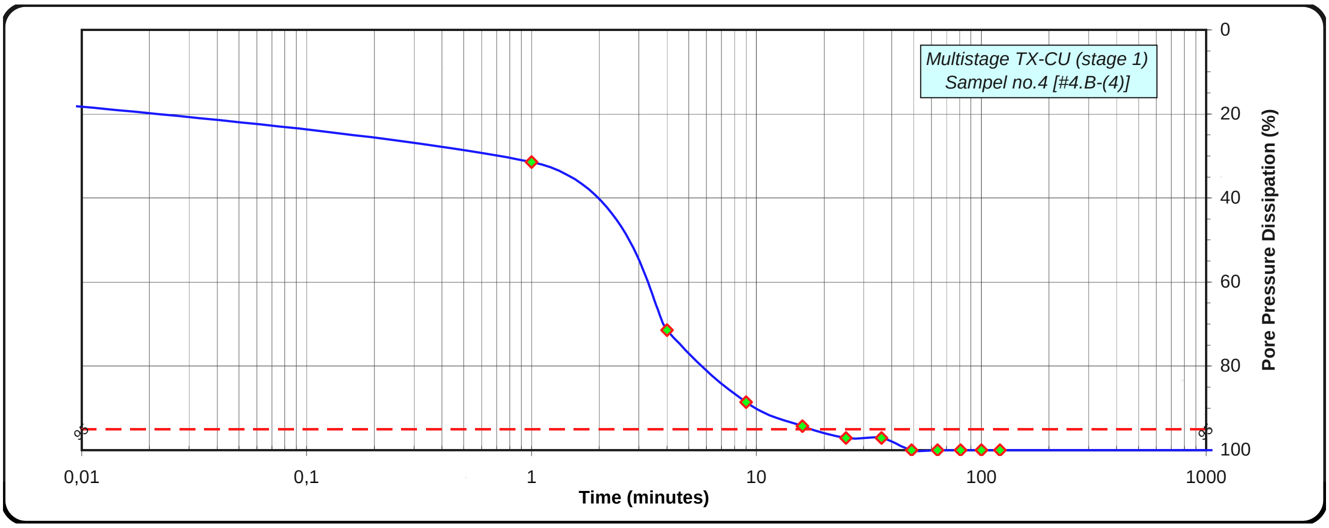
Effective pressure (kPa)	50
Cell pressure (kPa)	250
Back pressure (kPa)	200
PWP after build-up (kPa)	235
Diffrence (kPa)	35

Note :

Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
28-Nov-08	13:00	0	0	27,3	0	235	0	0
	13:01	1	1	26,8	0,5	224	11	31,4
	13:04	4	2	26,4	0,9	210	25	71,4
	13:09	9	3	26,3	1	204	31	88,6
	13:16	16	4	26,3	1	202	33	94,3
	13:25	25	5	26,2	1,1	201	34	97,1
	13:36	36	6	26,2	1,1	201	34	97,1
	13:49	49	7	26,2	1,1	200	35	100,0
	14:04	64	8	26,1	1,2	200	35	100,0
	14:21	81	9	26,1	1,2	200	35	100,0
	14:40	100	10	26,1	1,2	200	35	100,0
	15:01	121	11	26,1	1,2	200	35	100,0
2-Dec-08	10:00	5580	74,70	25,7	1,6	200	35	100,0

Total consolidation volume change, ΔVc (cm3) 1,6

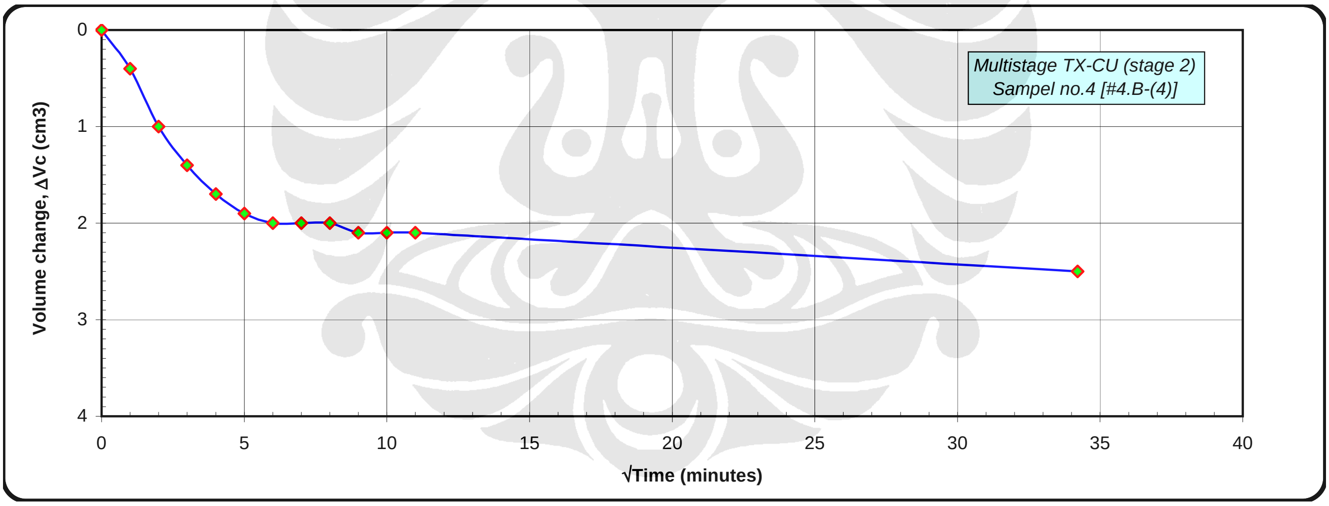


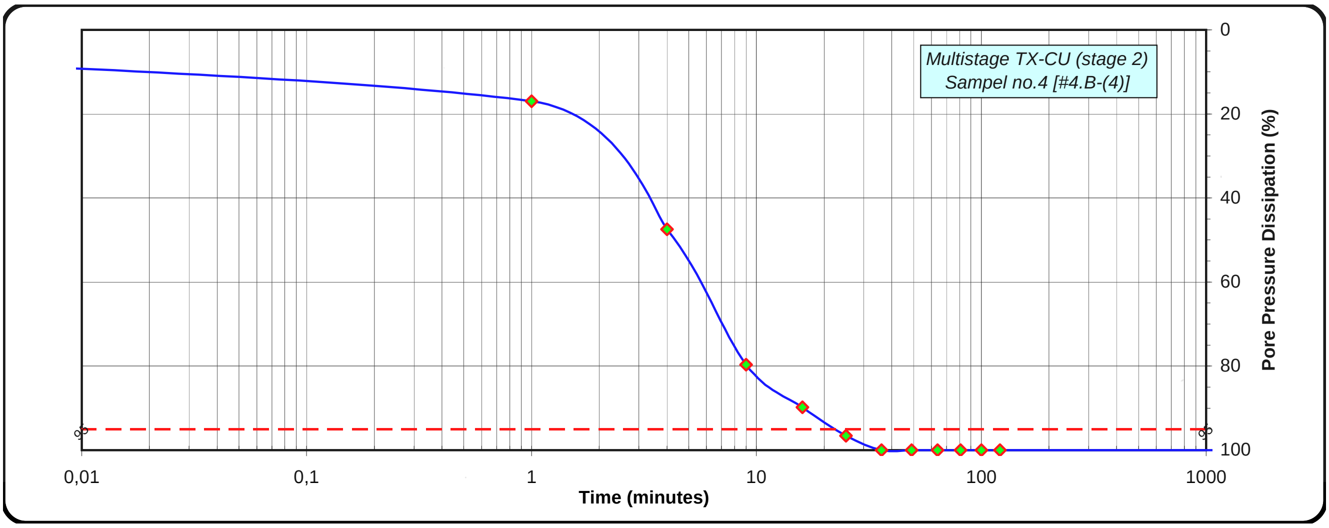


TRIAXIAL CONSOLIDATION Date of test : 2 Dec. 2008 # 4

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(4)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,18 (cm)
Remarks	*Sampel no.4 (Stage 2)*				

		Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
Effective pressure (kPa)	100									
Cell pressure (kPa)	300									
Back pressure (kPa)	200									
PWP after build-up (kPa)	259	2-Dec-08	13:30	0	0	25,6	0	259	0	0
Diffrence (kPa)	59		13:31	1	1	25,2	0,4	249	10	16,9
			13:34	4	2	24,6	1	231	28	47,5
			13:39	9	3	24,2	1,4	212	47	79,7
			13:46	16	4	23,9	1,7	206	53	89,8
			13:55	25	5	23,7	1,9	202	57	96,6
			14:06	36	6	23,6	2	200	59	100,0
			14:19	49	7	23,6	2	200	59	100,0
			14:34	64	8	23,6	2	200	59	100,0
			14:51	81	9	23,5	2,1	200	59	100,0
			15:10	100	10	23,5	2,1	200	59	100,0
			15:31	121	11	23,5	2,1	200	59	100,0
Note :		3-Dec-08	9:00	1170	34,21	23,1	2,5	200	59	100,0
		Total consolidation volume change, ΔVc (cm3)					2,5			





TRIAXIAL CONSOLIDATION

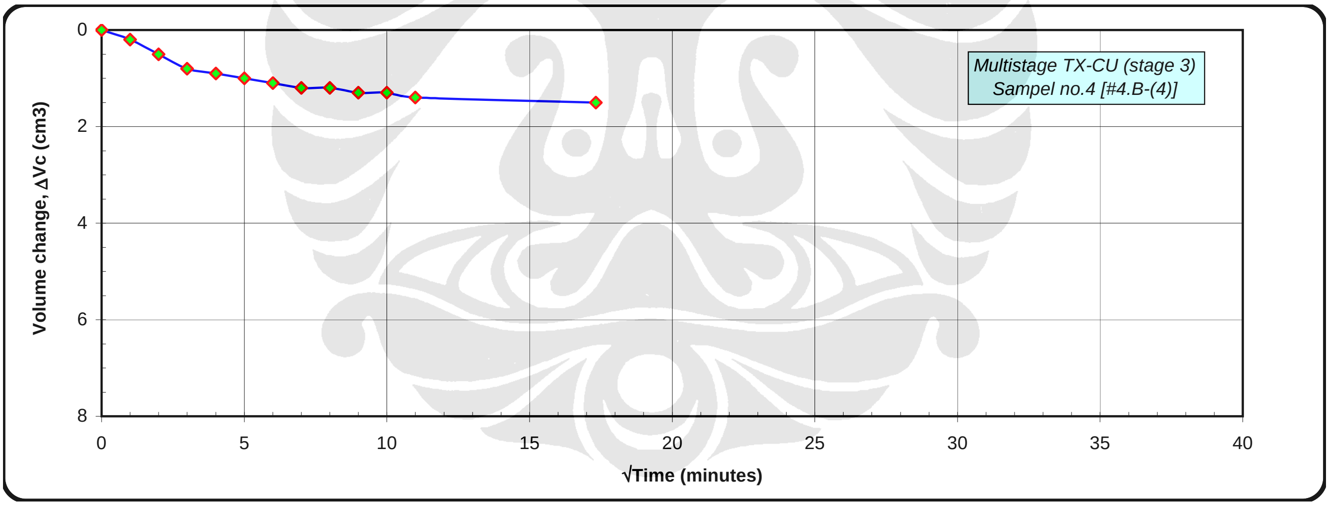
Date of test : 3 Des. 2008 # 4

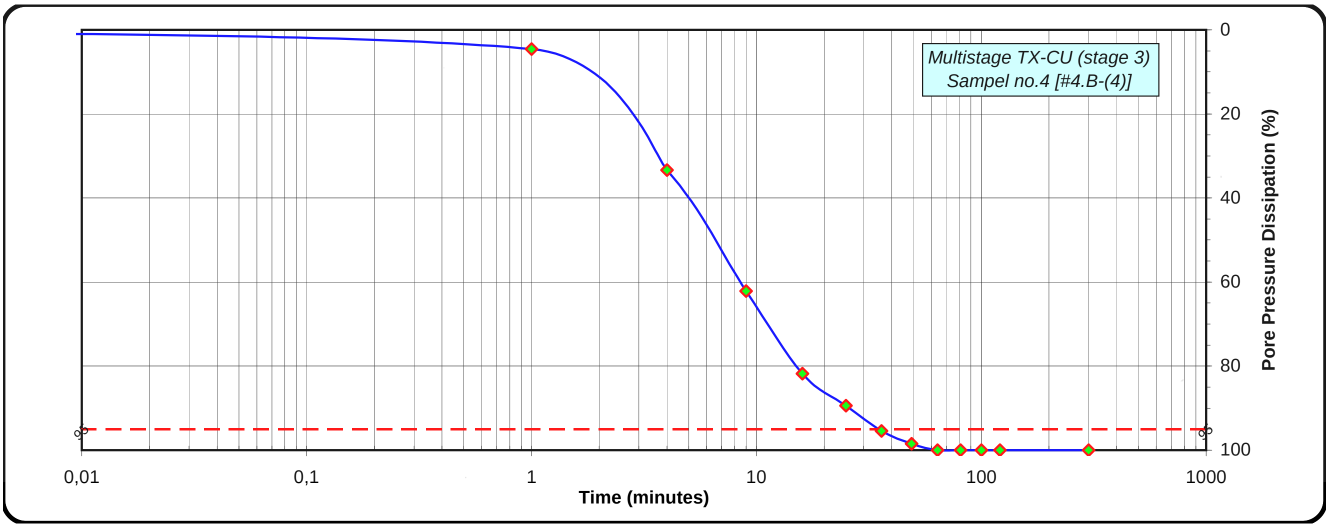
Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	2
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(4)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,60 (cm)
Depth	-	Without		Specimen height (Ho)	7,18 (cm)
Remarks	*Sampel no.4 (Stage 3)*				

Effective pressure (kPa)	150
Cell pressure (kPa)	350
Back pressure (kPa)	200
PWP after build-up (kPa)	266
Diffrence (kPa)	66

Note :

Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
3-Dec-08	10:30	0	0	23	0	266	0	0
	10:31	1	1	22,8	0,2	263	3	4,5
	10:34	4	2	22,5	0,5	244	22	33,3
	10:39	9	3	22,2	0,8	225	41	62,1
	10:46	16	4	22,1	0,9	212	54	81,8
	10:55	25	5	22	1	207	59	89,4
	11:06	36	6	21,9	1,1	203	63	95,5
	11:19	49	7	21,8	1,2	201	65	98,5
	11:34	64	8	21,8	1,2	200	66	100,0
	11:51	81	9	21,7	1,3	200	66	100,0
	12:10	100	10	21,7	1,3	200	66	100,0
	12:31	121	11	21,6	1,4	200	66	100,0
	15:30	300	17,32	21,5	1,5	200	66	100,0
Total consolidation volume change, ΔVc (cm3)					1,5			





TRIAXIAL SHEARING

Project =	Kaoline, Pc=200 kPa	Date of testing = 2 - 3 Des. 2008					
					STAGE 1	*STAGE 2*	*STAGE 3*	
Location =	Lab. Mektan FT-UI	Test type =	Multistage TX-CU	Effective cell pressure =	50	100	150	(kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.	Cell pressure =	250	300	350	(kPa)
Depth =	---	~~with~~ side drain		Back pressure =	200	200	200	(kPa)
Sample no. =	4	without	*Stage 1* / *Stage 2* / *Stage 3*	Consolidated length =	7,13	7,04	6,99	(cm)
Sample code =	# 4.B-(4)	Rate of strain =	0,063 / 0,063 / 0,063 (mm/min)	Consolidated area =	10,03	9,80	9,65	(cm2)
				Consolidated volume =	71,48	68,98	67,48	(cm3)

\# 4

Date / Time / Stage	Strain: Dial 1 div = (div)	Strain: Dial 0,001 cm (cm)	Strain (ε) (%)	Axial load: Dial 1 div = (div)	Axial load: Load 0,14 kg (kg)	Pore pressure (u) (kPa)	Pore pressure (Δu) (kPa)	Corrected area (cm2)	Deviator stress (σ_1-σ_3) (kPa)	Principal stress & Stress ratio: Major tot. (σ_1) (kPa)	Major eff. (σ_1') (kPa)	Minor eff. (σ_3') (kPa)	Eff. ratio (σ_1'/σ_3')	Stress path: (p) ½(σ_1+σ_3) (kPa)	(q) ½(σ_1-σ_3) (kPa)	(p') ½(σ_1'+σ_3') (kPa)	(q') ½(σ_1'-σ_3') (kPa)	Remarks
Stage 1																		
00:00:00	0	0	0	0	0	200	0	10,03	0,0	250,0	50,0	50	1,00	250,0	0,0	50,0	0,0	
(2 des 08)	25	0,025	0,351	19,5	2,730	208	8	10,07	27,1	277,1	69,1	42	1,65	263,6	13,6	55,6	13,6	
	50	0,05	0,701	26	3,640	210	10	10,10	36,0	286,0	76,0	40	1,90	268,0	18,0	58,0	18,0	
	75	0,075	1,052	31	4,340	211	11	10,14	42,8	292,8	81,8	39	2,10	271,4	21,4	60,4	21,4	
	100	0,1	1,403	35,5	4,970	212	12	10,17	48,9	298,9	86,9	38	2,29	274,4	24,4	62,4	24,4	
	125	0,125	1,754	39,5	5,530	212	12	10,21	54,2	304,2	92,2	38	2,43	277,1	27,1	65,1	27,1	
	150	0,15	2,104	43,5	6,090	212	12	10,25	59,4	309,4	97,4	38	2,56	279,7	29,7	67,7	29,7	
	175	0,175	2,455	46,5	6,510	212	12	10,28	63,3	313,3	101,3	38	2,67	281,7	31,7	69,7	31,7	
	200	0,2	2,806	49	6,860	212	12	10,32	66,5	316,5	104,5	38	2,75	283,2	33,2	71,2	33,2	
	225	0,225	3,157	51,5	7,210	212	12	10,36	69,6	319,6	107,6	38	2,83	284,8	34,8	72,8	34,8	
	250	0,25	3,507	54	7,560	212	12	10,39	72,7	322,7	110,7	38	2,91	286,4	36,4	74,4	36,4	
	275	0,275	3,858	56	7,840	211	11	10,43	75,1	325,1	114,1	39	2,93	287,6	37,6	76,6	37,6	
	300	0,3	4,209	58	8,120	211	11	10,47	77,5	327,5	116,5	39	2,99	288,8	38,8	77,8	38,8	
	325	0,325	4,560	60	8,400	210	10	10,51	79,9	329,9	119,9	40	3,00	290,0	40,0	80,0	40,0	
	350	0,35	4,910	62	8,680	210	10	10,55	82,3	332,3	122,3	40	3,06	291,1	41,1	81,1	41,1	
	375	0,375	5,261	63,5	8,890	209	9	10,59	84,0	334,0	125,0	41	3,05	292,0	42,0	83,0	42,0	
	400	0,4	5,612	64,8	9,072	209	9	10,63	85,4	335,4	126,4	41	3,08	292,7	42,7	83,7	42,7	
	425	0,425	5,963	66	9,240	208	8	10,67	86,6	336,6	128,6	42	3,06	293,3	43,3	85,3	43,3	
	450	0,45	6,313	67,1	9,394	208	8	10,71	87,7	337,7	129,7	42	3,09	293,9	43,9	85,9	43,9	
	475	0,475	6,664	67,9	9,506	207	7	10,75	88,5	338,5	131,5	43	3,06	294,2	44,2	87,2	44,2	
	500	0,5	7,015	68,7	9,618	206	6	10,79	89,2	339,2	133,2	44	3,03	294,6	44,6	88,6	44,6	
	525	0,525	7,366	69,2	9,688	205	5	10,83	89,5	339,5	134,5	45	2,99	294,7	44,7	89,7	44,7	
	550	0,55	7,716	69,7	9,758	204	4	10,87	89,8	339,8	135,8	46	2,95	294,9	44,9	90,9	44,9	
	575	0,575	8,067	70	9,800	204	4	10,91	89,8	339,8	135,8	46	2,95	294,9	44,9	90,9	44,9	*peak*
1:35:08	600	0,6	8,418	70,2	9,828	204	4	10,95	89,7	339,7	135,7	46	2,95	294,9	44,9	90,9	44,9	
End Stage 1	575	0,575	8,067	0	0,000	204	4	10,91	0,0	250,0	46,0	46	1,00	250,0	0,0	46,0	0,0	*(reverse)*
Stage 2																		
00:00:00	0	0	8,067	0	0,000	200	0	9,80	0,0	300,0	100,0	100	1,00	300,0	0,0	100,0	0,0	
(3 des 08)	25	0,025	8,422	46	6,440	210	10	9,83	65,5	365,5	155,5	90	1,73	332,8	32,8	122,8	32,8	
	50	0,05	8,777	65	9,100	217	17	9,87	92,2	392,2	175,2	83	2,11	346,1	46,1	129,1	46,1	
	75	0,075	9,132	80,5	11,270	221	21	9,90	113,8	413,8	192,8	79	2,44	356,9	56,9	135,9	56,9	
	100	0,1	9,487	91,5	12,810	226	26	9,94	128,9	428,9	202,9	74	2,74	364,5	64,5	138,5	64,5	
	125	0,125	9,842	100	14,000	229	29	9,97	140,4	440,4	211,4	71	2,98	370,2	70,2	141,2	70,2	
	150	0,15	10,197	107	14,980	230	30	10,01	149,7	449,7	219,7	70	3,14	374,8	74,8	144,8	74,8	
	175	0,175	10,551	113,5	15,890	231	31	10,05	158,2	458,2	227,2	69	3,29	379,1	79,1	148,1	79,1	
	200	0,2	10,906	117	16,380	231	31	10,08	162,5	462,5	231,5	69	3,35	381,2	81,2	150,2	81,2	
	225	0,225	11,261	120	16,800	232	32	10,12	166,0	466,0	234,0	68	3,44	383,0	83,0	151,0	83,0	
	250	0,25	11,616	123	17,220	232	32	10,16	169,5	469,5	237,5	68	3,49	384,8	84,8	152,8	84,8	
	275	0,275	11,971	125	17,500	232	32	10,19	171,7	471,7	239,7	68	3,52	385,8	85,8	153,8	85,8	
	300	0,3	12,326	128	17,920	232	32	10,23	175,1	475,1	243,1	68	3,58	387,6	87,6	155,6	87,6	
	325	0,325	12,681	130	18,200	232	32	10,27	177,2	477,2	245,2	68	3,61	388,6	88,6	156,6	88,6	*peak*
0:55:38	350	0,35	13,036	130,4	18,256	232	32	10,31	177,1	477,1	245,1	68	3,60	388,5	88,5	156,5	88,5	
End Stage 2	315	0,315	12,539	0	0,000	232	32	10,25	0,0	300,0	68,0	68	1,00	300,0	0,0	68,0	0,0	*(reverse)*
Stage 3																		
00:00:00	0	0	12,539	0	0,000	200	0	9,65	0,0	350,0	150,0	150	1,00	350,0	0,0	150,0	0,0	
(3 des 08)	25	0,025	12,896	51	7,140	211	11	9,69	73,7	423,7	212,7	139	1,53	386,8	36,8	175,8	36,8	
	50	0,05	13,254	78	10,920	221	21	9,72	112,3	462,3	241,3	129	1,87	406,2	56,2	185,2	56,2	
	75	0,075	13,611	98	13,720	231	31	9,76	140,6	490,6	259,6	119	2,18	420,3	70,3	189,3	70,3	
	100	0,1	13,969	117	16,380	237	37	9,79	167,2	517,2	280,2	113	2,48	433,6	83,6	196,6	83,6	
	125	0,125	14,326	131	18,340	241	41	9,83	186,6	536,6	295,6	109	2,71	443,3	93,3	202,3	93,3	
	150	0,15	14,684	145	20,300	244	44	9,87	205,8	555,8	311,8	106	2,94	452,9	102,9	208,9	102,9	
	175	0,175	15,041	154	21,560	246	46	9,90	217,7	567,7	321,7	104	3,09	458,9	108,9	212,9	108,9	
	200	0,2	15,399	161	22,540	248	48	9,94	226,8	576,8	328,8	102	3,22	463,4	113,4	215,4	113,4	
	225	0,225	15,756	165,5	23,170	249	49	9,98	232,3	582,3	333,3	101	3,30	466,1	116,1	217,1	116,1	
	250	0,25	16,114	168	23,520	249	49	10,01	234,9	584,9	335,9	101	3,33	467,5	117,5	218,5	117,5	*peak*
	275	0,275	16,471	167	23,380	249	49	10,05	232,6	582,6	333,6	101	3,30	466,3	116,3	217,3	116,3	
	300	0,3	16,829	167	23,380	249	49	10,09	231,8	581,8	332,8	101	3,29	465,9	115,9	216,9	115,9	
	325	0,325	17,186	160	22,400	249	49	10,12	221,2	571,2	322,2	101	3,19	460,6	110,6	211,6	110,6	
	350	0,35	17,543	156	21,840	249	49	10,16	214,9	564,9	315,9	101	3,13	457,4	107,4	208,4	107,4	*)
0:59:47	375	0,375	17,901	153	21,420	247	47	10,20	210,0	560,0	313,0	103	3,04	455,0	105,0	208,0	105,0	
End Stage 3																		

*Note : *) bidang keruntuhan geser mulai jelas terlihat.*

Calculation :

		STAGE 1	*STAGE 2*	*STAGE 3*	
Maximum deviator stress ($\Delta\sigma = \sigma_1$-σ_3)	=	89,8	177,2	234,9	(kPa)
Pore pressure at max. dev. stress (*u*)	=	204,0	232,0	249,0	(kPa)
Strain at max. deviator stress (ε)	=	8,067	12,681	16,114	(%)

Principal stresses at maximum deviator stress :

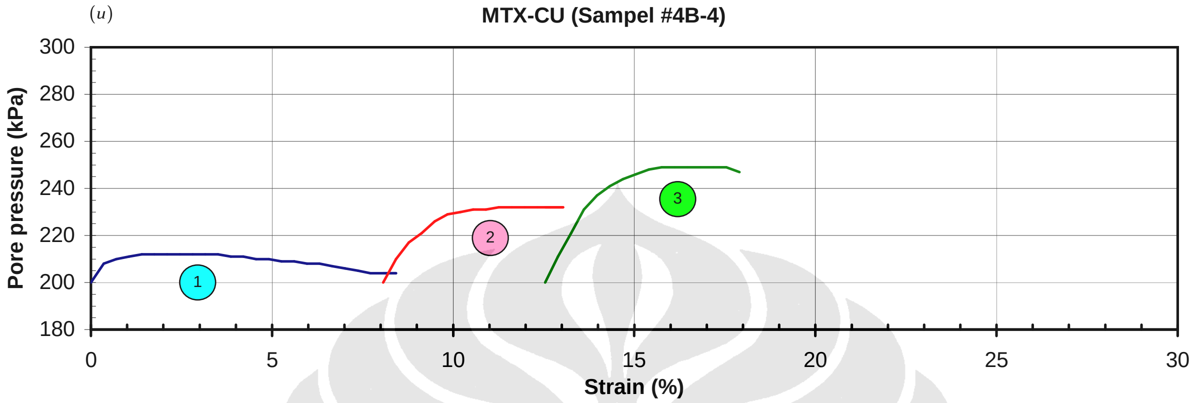
Total major principal stress (σ_1)	=	339,8	477,2	584,9	(kPa)
Total minor principal stress (σ_3)	=	250,0	300,0	350,0	(kPa)
Effective major principal stress (σ_1')	=	135,8	245,2	335,9	(kPa)
Effective minor principal stress (σ_3')	=	46,0	68,0	101,0	(kPa)
Effective principal stress ratio (σ_1'/σ_3')	=	2,95	3,61	3,33	

TRIAXIAL COMPRESSION TEST - CU TEST (MULTISTAGE)

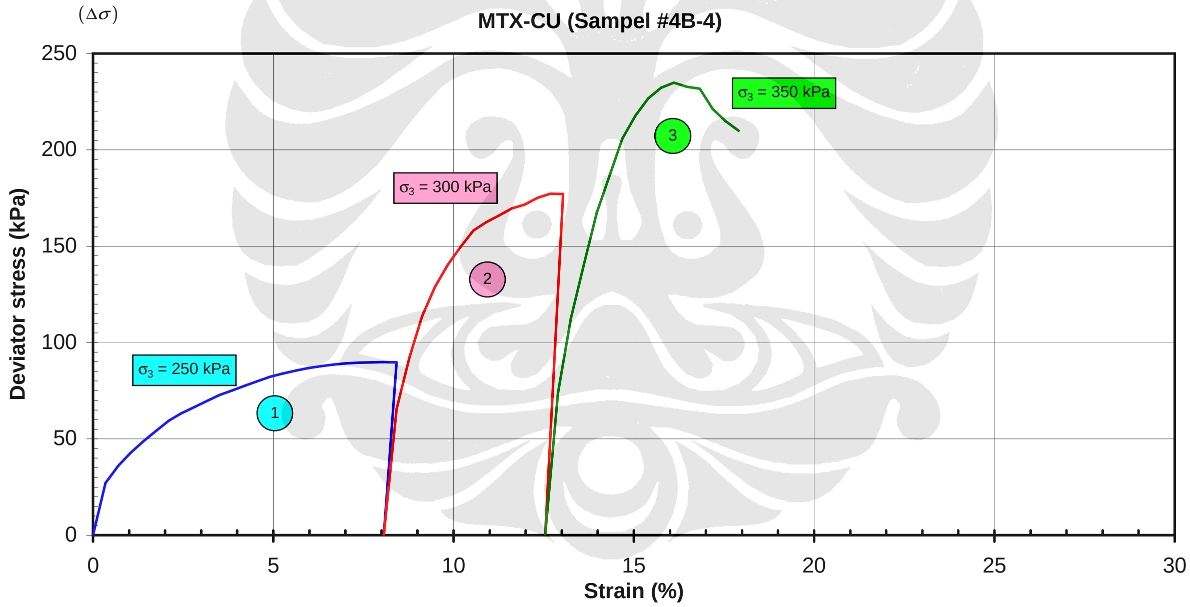
 # 4.B-(4)

Kode Sampel		# 4.B-(4)	# 4.B-(4)	# 4.B-(4)		Keterangan
Stage		Stage 1	Stage 2	Stage 3		
Maximum deviator stress ($\Delta\sigma = \sigma_1 - \sigma_3$)	(kPa)	89,8	177,2	234,9		
Pore pressure at max. dev. stress (u)	(kPa)	204,0	232,0	249,0		
Total major principal stress (σ_1)	(kPa)	339,8	477,2	584,9		
Total minor principal stress (σ_3)	(kPa)	250,0	300,0	350,0		
Effective major principal stress (σ_1')	(kPa)	135,8	245,2	335,9		
Effective minor principal stress (σ_3')	(kPa)	46,0	68,0	101,0		
Strain at max. deviator stress (ε)	(%)	8,067	12,681	16,114		

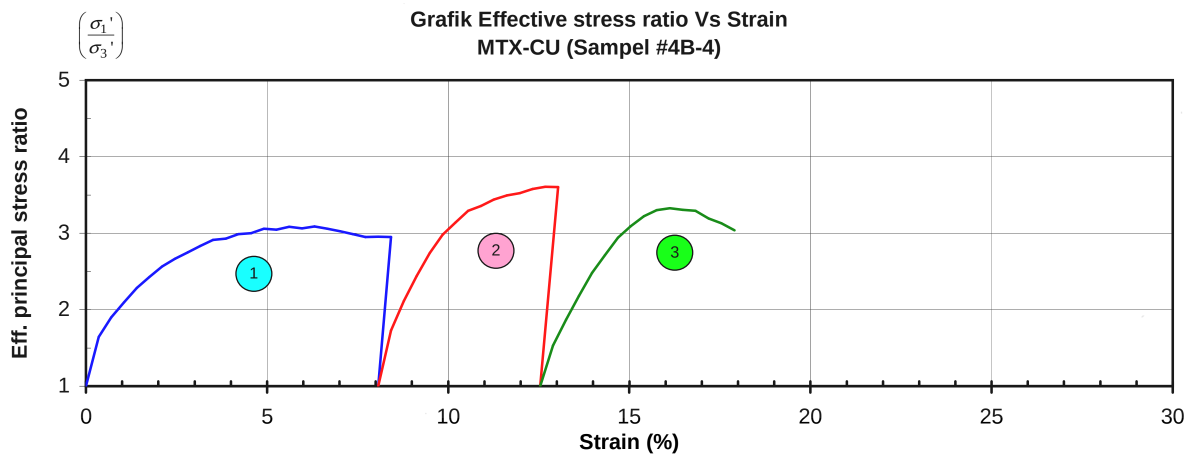
Grafik Pore Pressure Vs Strain
MTX-CU (Sampel #4B-4)



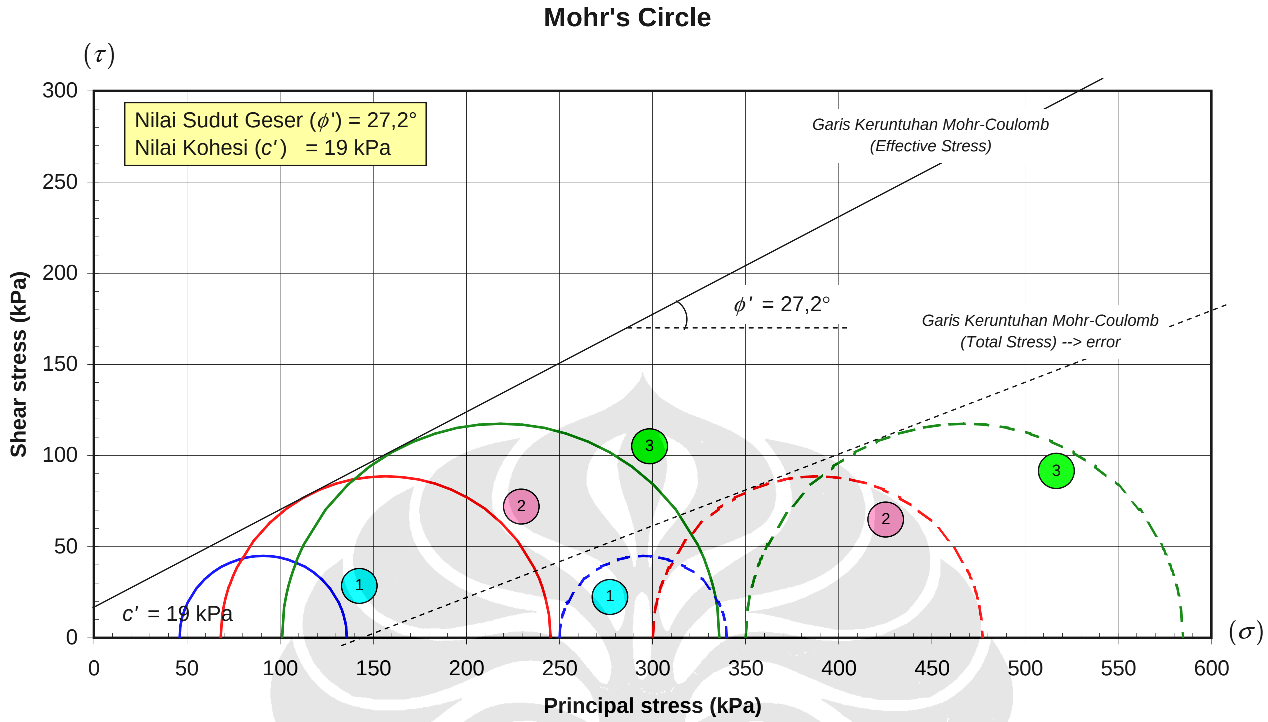
Grafik Dev. Stress Vs Strain
MTX-CU (Sampel #4B-4)

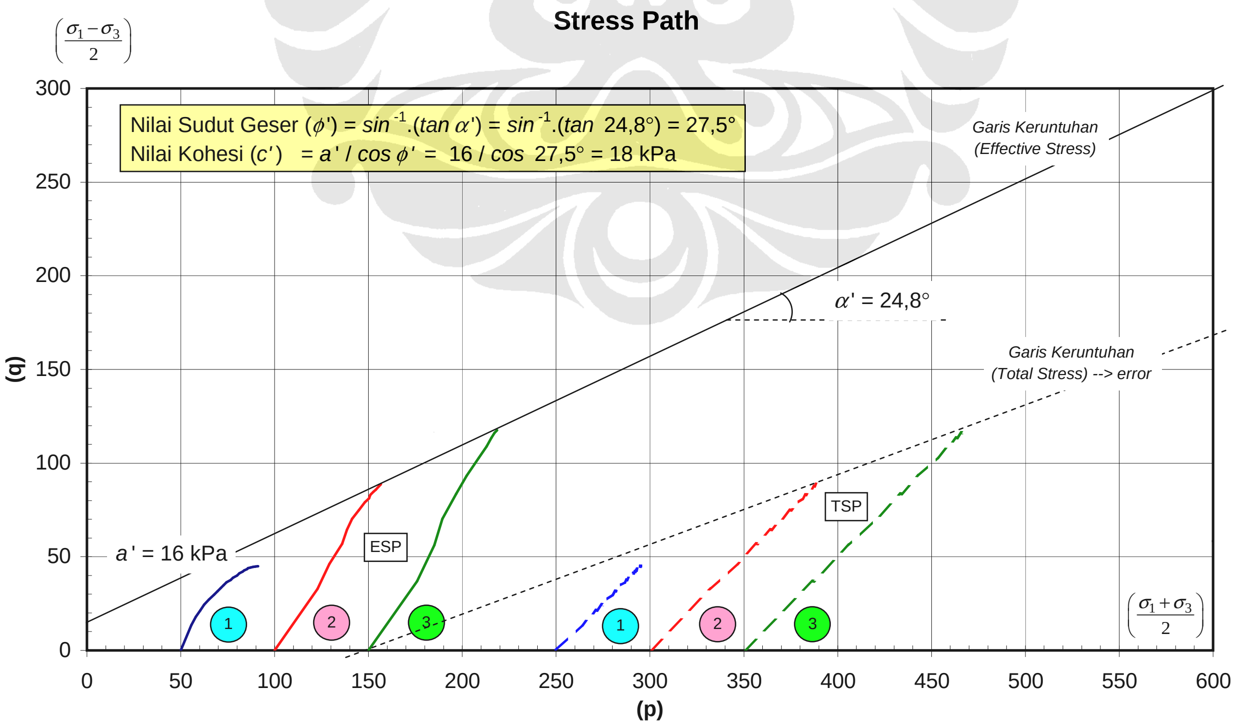


Grafik Effective stress ratio Vs Strain
MTX-CU (Sampel #4B-4)



TRIAXIAL COMPRESSION TEST - CONSOLIDATED UNDRAINED
MULTISTAGE TX-CU
SAMPEL NO. #4B-(4)





TRIAXIAL SATURATION Date of test : 28 Nop. 2008 # 5

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	3
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(5)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.5*				

Cell Pressure (kPa)	Back Pressure (kPa)	Pore Pressure (kPa)	PWP diff. (kPa)	B value	Back Pressure Volume Change before	after	diff.	Cell Volume Change LHS/RHS before	after	diff.	(+) consol (cm3)	(-) exp. (cm3)
0	0	0	-	-	-	-	-	-	-	-		
50	-	35	35	0,7	-	-	-					
50	40	39	-	-	31,2	32,6	1,4	-	-	-		
100	-	86	47	0,94	-	-	-					
100	90	90	-	-	32,8	33,3	0,5	-	-	-		
200	-	188	98	0,98	-	-	-					
									T O T A L =		0	0

Water content determination	Initial	Final	Net volume change	
Weight of can (gr)	-	8,64	Filter correction	- (cm3)
Weight of wet sample + can (gr)	142,27	146,50	Cell correction	- (cm3)
Weight of dry sample + can (gr)	-	100,31	Corrected volume change (ΔVs)	0 (cm3)
Water content (%)	55,20	50,39	Concolidation vol. change (ΔVc)	1,9 (cm3)
Weight of wet sample (gr)	142,27	γ_n (ton/m3) = 1,651	ΔVs + ΔVc = ΔVt	1,9 (cm3)

Ao	11,34 (cm2)	ε_v = (ΔVt/Vo) x 100%	⅓ ε_v	⅔ ε_v
Vo	86,19 (cm3)	2,204 %	0,735 %	1,470 %

Hc = Ho (1 - ⅓ ε_v / 100)	Ac = Ao (1 - ⅔ ε_v / 100)	Vc = Vo - ΔVt
7,54 (cm)	11,17 (cm2)	84,29 (cm3)

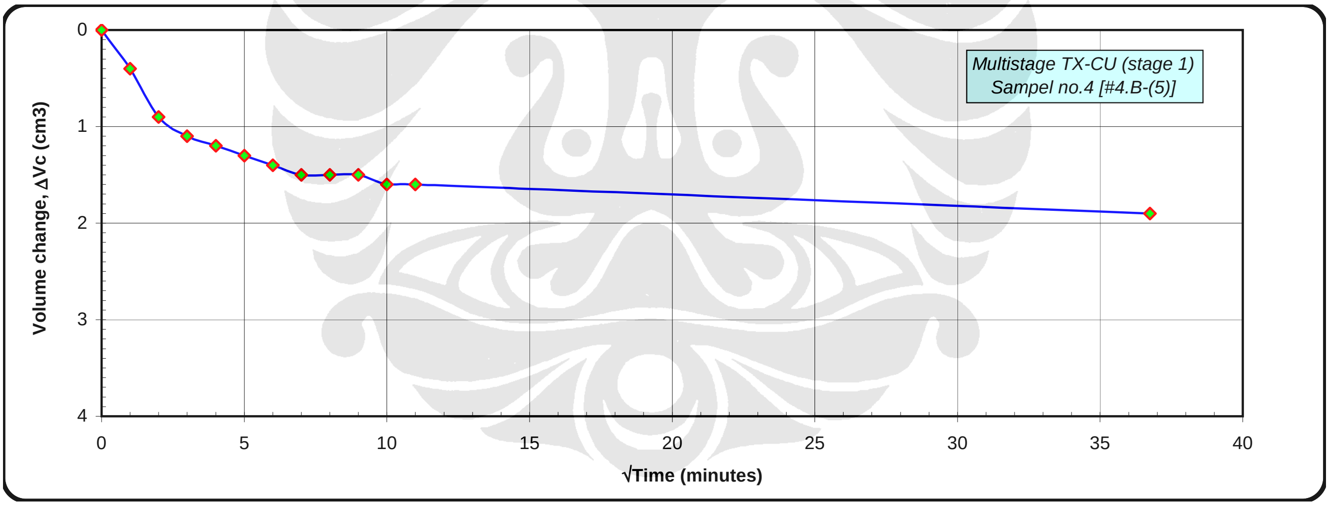
	Initial	*STAGE 1*	*STAGE 2*	*STAGE 3*	
<u>*Consolidation*</u>					
ΔVs	-	0	0	0	(cm3)
ΔVc	-	1,9	1,3	1,3	(cm3)
ΔVt	-	1,9	1,3	1,3	(cm3)
ε_v	-	2,204	1,542	1,566	(%)
dia. (ϕ)	3,80	3,77	3,75	3,73	(cm)
Height (H)	7,6	7,54	7,51	7,47	(cm)
Area (A)	11,34	11,17	11,06	10,94	(cm2)
Vol. (V)	86,19	84,29	82,99	81,69	(cm3)

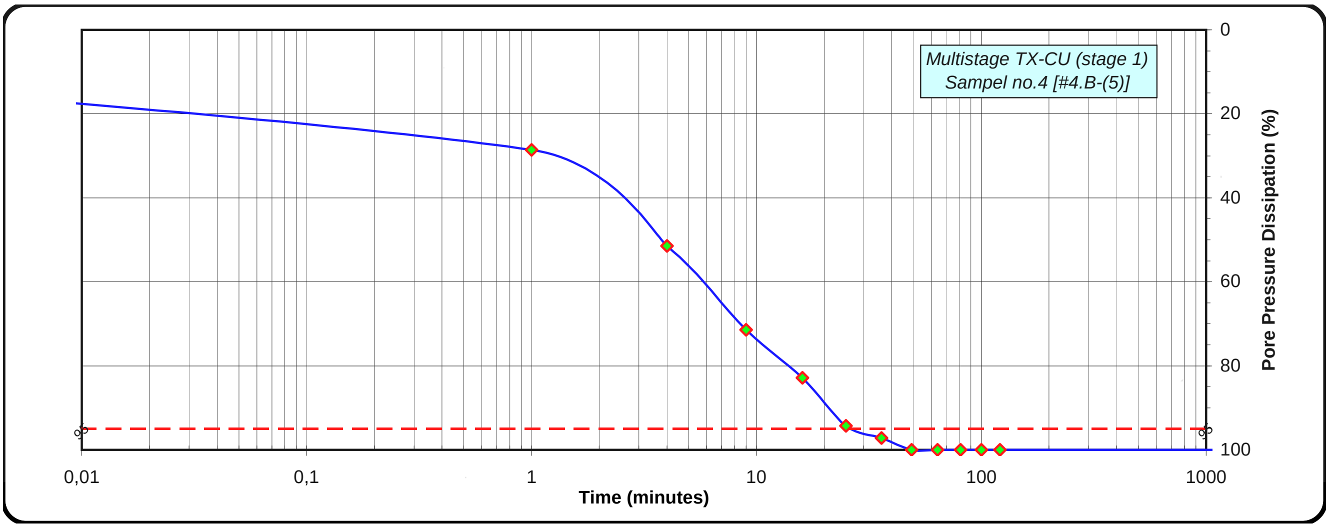
Note : cell volume gauge bocor sehingga tidak bisa dimonitor dengan baik.

TRIAXIAL CONSOLIDATION Date of test : 2 Dec. 2008 # 5

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	3
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(5)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.5 (Stage 1)*				

		Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
Effective pressure (kPa)	50									
Cell pressure (kPa)	350									
Back pressure (kPa)	300									
PWP after build-up (kPa)	335	2-Dec-08	12:00	0	0	33,4	0	335	0	0
Diffrence (kPa)	35		12:01	1	1	33	0,4	325	10	28,6
			12:04	4	2	32,5	0,9	317	18	51,4
			12:09	9	3	32,3	1,1	310	25	71,4
			12:16	16	4	32,2	1,2	306	29	82,9
			12:25	25	5	32,1	1,3	302	33	94,3
			12:36	36	6	32	1,4	301	34	97,1
			12:49	49	7	31,9	1,5	300	35	100,0
			13:04	64	8	31,9	1,5	300	35	100,0
			13:21	81	9	31,9	1,5	300	35	100,0
			13:40	100	10	31,8	1,6	300	35	100,0
			14:01	121	11	31,8	1,6	300	35	100,0
Note :		3-Dec-08	10:30	1350	36,74	31,5	1,9	300	35	100,0
		Total consolidation volume change, ΔVc (cm3)					1,9			



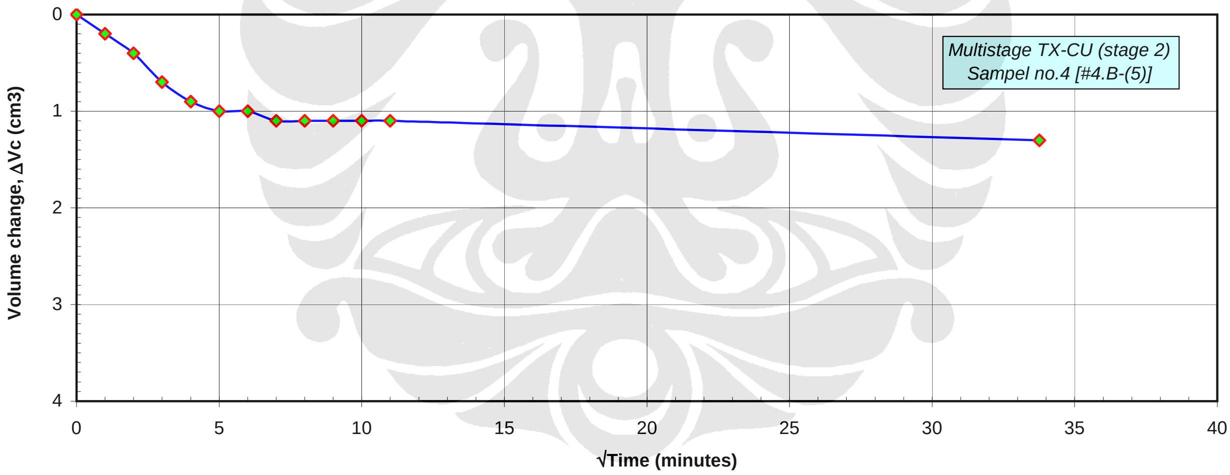


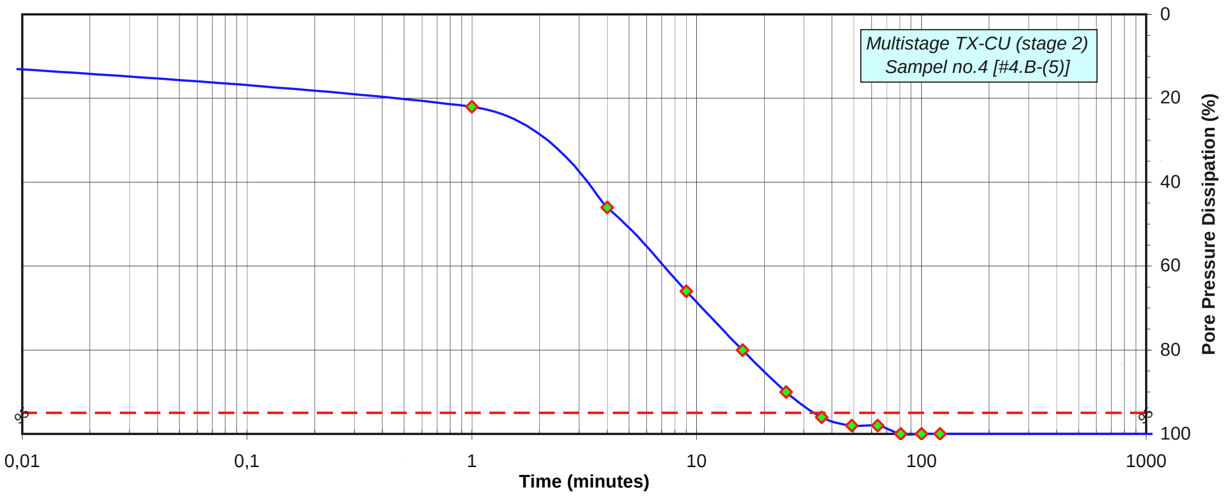
TRIAXIAL CONSOLIDATION

Date of test : 3 Dec. 2008 # 5

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	3
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(5)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.5 (Stage 2)*				

		Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
Effective pressure (kPa)	100									
Cell pressure (kPa)	400									
Back pressure (kPa)	300									
PWP after build-up (kPa)	350	3-Dec-08	14:00	0	0	31,4	0	350	0	0
Diffrence (kPa)	50		14:01	1	1	31,2	0,2	339	11	22,0
			14:04	4	2	31	0,4	327	23	46,0
			14:09	9	3	30,7	0,7	317	33	66,0
			14:16	16	4	30,5	0,9	310	40	80,0
			14:25	25	5	30,4	1	305	45	90,0
			14:36	36	6	30,4	1	302	48	96,0
			14:49	49	7	30,3	1,1	301	49	98,0
			15:04	64	8	30,3	1,1	301	49	98,0
			15:21	81	9	30,3	1,1	300	50	100,0
			15:40	100	10	30,3	1,1	300	50	100,0
			16:01	121	11	30,3	1,1	300	50	100,0
Note :		4-Dec-08	9:00	1140	33,76	30,1	1,3	300	50	100,0
		Total consolidation volume change, ΔVc (cm3)					1,3			

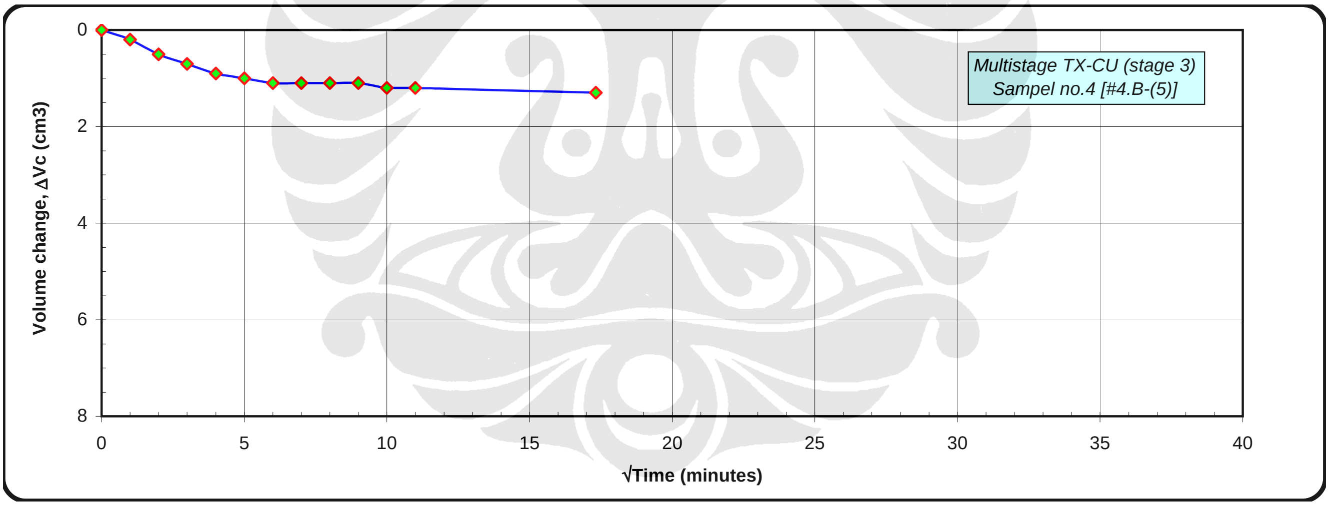


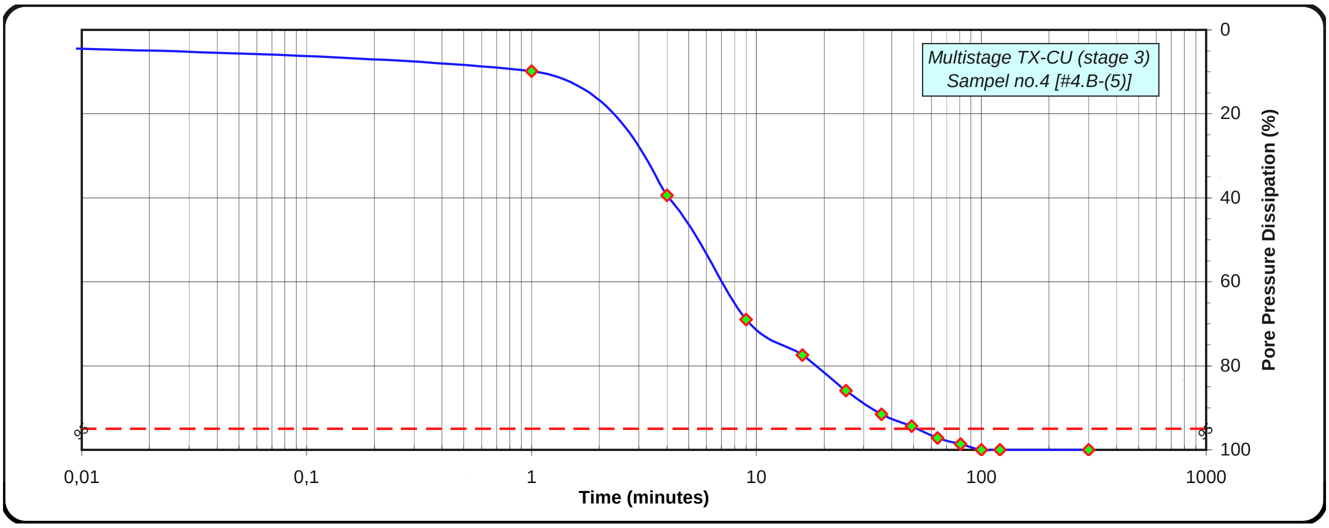


TRIAXIAL CONSOLIDATION Date of test : 4 Des. 2008 # 5

Project	Kaoline, Pc=200 kPa	Type of test	CU, multistage	Cell no.	3
Location	Lab. Mektan FT-UI	Tested by	Cipto Adi B.	Specimen no.	# 4.B-(5)
Hole no.	# 4.B Pc=200 kPa	~~With~~	side drains	Specimen dia (ϕ)	3,80 (cm)
Depth	-	Without		Specimen height (Ho)	7,60 (cm)
Remarks	*Sampel no.5 (Stage 3)*				

		Date	Clock time	Time elapsed (min)	√t	Volume change Gauge	Volume change diff. (cm3)	Pore pressure Reading (kPa)	Pore pressure diff. (kPa)	Pore pressure diss. (%)
Effective pressure (kPa)	150									
Cell pressure (kPa)	450									
Back pressure (kPa)	300									
PWP after build-up (kPa)	371	4-Dec-08	10:30	0	0	30	0	371	0	0
Diffrence (kPa)	71		10:31	1	1	29,8	0,2	364	7	9,9
			10:34	4	2	29,5	0,5	343	28	39,4
			10:39	9	3	29,3	0,7	322	49	69,0
			10:46	16	4	29,1	0,9	316	55	77,5
			10:55	25	5	29	1	310	61	85,9
			11:06	36	6	28,9	1,1	306	65	91,5
			11:19	49	7	28,9	1,1	304	67	94,4
			11:34	64	8	28,9	1,1	302	69	97,2
			11:51	81	9	28,9	1,1	301	70	98,6
			12:10	100	10	28,8	1,2	300	71	100,0
			12:31	121	11	28,8	1,2	300	71	100,0
Note :			15:30	300	17,32	28,7	1,3	300	71	100,0
		Total consolidation volume change, ΔVc (cm3)					1,3			





TRIAXIAL SHEARING

						STAGE 1	STAGE 2	STAGE 3	
Project =	Kaoline, Pc=200 kPa	Date of testing = 3 - 4 Des. 2008			Effective cell pressure =	50	100	150	(kPa)
Location =	Lab. Mektan FT-UI	Test type =	Multistage TX-CU		Cell pressure =	350	400	450	(kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.		Back pressure =	300	300	300	(kPa)
Depth =	---	~~with~~ side drain			Consolidated length =	7,54	7,51	7,47	(cm)
Sample no. =	5	without	Stage 1 / Stage 2 / Stage 3		Consolidated area =	11,17	11,06	10,94	(cm2)
Sample code =	# 4.B-(5)	Rate of strain =	0,064 / 0,064 / 0,063	(mm/min)	Consolidated volume =	84,29	82,99	81,69	(cm3)

5

Date / Time / Stage	Strain Dial 1 div =	Strain Dial 0,001 cm	Strain (ε)	Axial load Dial 1 div =	Axial load Load 0,14 kg	Pore pressure (u)	Pore pressure (Δu)	Corrected area	Deviator stress (σ_1-σ_3)	Principal stress Major tot. (σ_1)	Major eff. (σ_1')	Minor eff. (σ_3')	Eff. ratio (σ_1'/σ_3')	Stress path (p) ½(σ_1+σ_3)	(q) ½(σ_1-σ_3)	(p') ½(σ_1'+σ_3')	(q') ½(σ_1'-σ_3')	Remarks
	(div)	(cm)	(%)	(div)	(kg)	(kPa)	(kPa)	(cm2)	(kPa)	(kPa)	(kPa)	(kPa)		(kPa)	(kPa)	(kPa)	(kPa)	
Stage 1																		
00:00:00	0	0	0	0	0	300	0	11,17	0,0	350,0	50,0	50	1,00	350,0	0,0	50,0	0,0	
(3 des 08)	25	0,025	0,331	34	4,760	310	10	11,21	42,5	392,5	82,5	40	2,06	371,2	21,2	61,2	21,2	
	50	0,05	0,663	45	6,300	314	14	11,25	56,0	406,0	92,0	36	2,56	378,0	28,0	64,0	28,0	
	75	0,075	0,994	53	7,420	316	16	11,29	65,7	415,7	99,7	34	2,93	382,9	32,9	66,9	32,9	
	100	0,1	1,326	60	8,400	317	17	11,32	74,2	424,2	107,2	33	3,25	387,1	37,1	70,1	37,1	
	125	0,125	1,657	66	9,240	317	17	11,36	81,3	431,3	114,3	33	3,46	390,7	40,7	73,7	40,7	
	150	0,15	1,988	72	10,080	317	17	11,40	88,4	438,4	121,4	33	3,68	394,2	44,2	77,2	44,2	
	175	0,175	2,320	76,5	10,710	317	17	11,44	93,6	443,6	126,6	33	3,84	396,8	46,8	79,8	46,8	
	200	0,2	2,651	81	11,340	317	17	11,48	98,8	448,8	131,8	33	3,99	399,4	49,4	82,4	49,4	
	225	0,225	2,982	86	12,040	316	16	11,52	104,5	454,5	138,5	34	4,07	402,3	52,3	86,3	52,3	
	250	0,25	3,314	90	12,600	315	15	11,56	109,0	459,0	144,0	35	4,11	404,5	54,5	89,5	54,5	
	275	0,275	3,645	94,5	13,230	314	14	11,60	114,1	464,1	150,1	36	4,17	407,0	57,0	93,0	57,0	
	300	0,3	3,977	98,5	13,790	313	13	11,64	118,5	468,5	155,5	37	4,20	409,2	59,2	96,2	59,2	
	325	0,325	4,308	102,5	14,350	312	12	11,68	122,9	472,9	160,9	38	4,23	411,4	61,4	99,4	61,4	
	350	0,35	4,639	106	14,840	311	11	11,72	126,6	476,6	165,6	39	4,25	413,3	63,3	102,3	63,3	
	375	0,375	4,971	109	15,260	310	10	11,76	129,8	479,8	169,8	40	4,24	414,9	64,9	104,9	64,9	
	400	0,4	5,302	111,5	15,610	309	9	11,80	132,3	482,3	173,3	41	4,23	416,1	66,1	107,1	66,1	
	425	0,425	5,633	113,5	15,890	308	8	11,84	134,2	484,2	176,2	42	4,19	417,1	67,1	109,1	67,1	
	450	0,45	5,965	116,5	16,310	307	7	11,88	137,3	487,3	180,3	43	4,19	418,6	68,6	111,6	68,6	
	475	0,475	6,296	118	16,520	306	6	11,93	138,5	488,5	182,5	44	4,15	419,3	69,3	113,3	69,3	
	500	0,5	6,628	120,5	16,870	305	5	11,97	141,0	491,0	186,0	45	4,13	420,5	70,5	115,5	70,5	
	525	0,525	6,959	122	17,080	304	4	12,01	142,2	492,2	188,2	46	4,09	421,1	71,1	117,1	71,1	
	550	0,55	7,290	124	17,360	303	3	12,05	144,0	494,0	191,0	47	4,06	422,0	72,0	119,0	72,0	
	575	0,575	7,622	126,5	17,710	302	2	12,10	146,4	496,4	194,4	48	4,05	423,2	73,2	121,2	73,2	
	600	0,6	7,953	128,5	17,990	301	1	12,14	148,2	498,2	197,2	49	4,02	424,1	74,1	123,1	74,1	
	625	0,625	8,285	130	18,200	300	0	12,18	149,4	499,4	199,4	50	3,99	424,7	74,7	124,7	74,7	
	650	0,65	8,616	131,5	18,410	300	0	12,23	150,6	500,6	200,6	50	4,01	425,3	75,3	125,3	75,3	
	675	0,675	8,947	133	18,620	299	-1	12,27	151,7	501,7	202,7	51	3,97	425,9	75,9	126,9	75,9	
	700	0,7	9,279	134,5	18,830	299	-1	12,32	152,9	502,9	203,9	51	4,00	426,4	76,4	127,4	76,4	
	725	0,725	9,610	136	19,040	298	-2	12,36	154,0	504,0	206,0	52	3,96	427,0	77,0	129,0	77,0	
	750	0,75	9,941	137	19,180	297	-3	12,41	154,6	504,6	207,6	53	3,92	427,3	77,3	130,3	77,3	
	775	0,775	10,273	139,5	19,530	296	-4	12,45	156,8	506,8	210,8	54	3,90	428,4	78,4	132,4	78,4	
	800	0,8	10,604	142	19,880	296	-4	12,50	159,0	509,0	213,0	54	3,95	429,5	79,5	133,5	79,5	
	825	0,825	10,936	143	20,020	295	-5	12,55	159,6	509,6	214,6	55	3,90	429,8	79,8	134,8	79,8	
	850	0,85	11,267	143,8	20,132	294	-6	12,59	159,9	509,9	215,9	56	3,85	429,9	79,9	135,9	79,9	*peak*
2:17:04	875	0,875	11,598	144,3	20,202	293	-7	12,64	159,8	509,8	216,8	57	3,80	429,9	79,9	136,9	79,9	
End Stage 1	810	0,81	10,737	0	0,000	293	-7	12,52	0,0	350,0	57,0	57	1,00	350,0	0,0	57,0	0,0	*(reverse)*
Stage 2																		
00:00:00	0	0	10,737	0	0,000	300	0	11,06	0,0	400,0	100,0	100	1,00	400,0	0,0	100,0	0,0	
(3 des 08)	25	0,025	11,070	46	6,440	315	15	11,10	58,0	458,0	143,0	85	1,68	429,0	29,0	114,0	29,0	
	50	0,05	11,403	62	8,680	325	25	11,13	78,0	478,0	153,0	75	2,04	439,0	39,0	114,0	39,0	
	75	0,075	11,736	78	10,920	333	33	11,17	97,8	497,8	164,8	67	2,46	448,9	48,9	115,9	48,9	
	100	0,1	12,069	89	12,460	337	37	11,21	111,2	511,2	174,2	63	2,76	455,6	55,6	118,6	55,6	
	125	0,125	12,402	98	13,720	338	38	11,25	122,0	522,0	184,0	62	2,97	461,0	61,0	123,0	61,0	
	150	0,15	12,735	109	15,260	339	39	11,29	135,2	535,2	196,2	61	3,22	467,6	67,6	128,6	67,6	
	175	0,175	13,068	119	16,660	339	39	11,32	147,1	547,1	208,1	61	3,41	473,6	73,6	134,6	73,6	
	200	0,2	13,402	129,5	18,130	339	39	11,36	159,6	559,6	220,6	61	3,62	479,8	79,8	140,8	79,8	
	225	0,225	13,735	138	19,320	338	38	11,40	169,5	569,5	231,5	62	3,73	484,7	84,7	146,7	84,7	
	250	0,25	14,068	146	20,440	338	38	11,44	178,7	578,7	240,7	62	3,88	489,3	89,3	151,3	89,3	
	275	0,275	14,401	152	21,280	337	37	11,48	185,4	585,4	248,4	63	3,94	492,7	92,7	155,7	92,7	
	300	0,3	14,734	157	21,980	336	36	11,52	190,8	590,8	254,8	64	3,98	495,4	95,4	159,4	95,4	
	325	0,325	15,067	160	22,400	335	35	11,56	193,8	593,8	258,8	65	3,98	496,9	96,9	161,9	96,9	
	350	0,35	15,400	162,5	22,750	334	34	11,60	196,1	596,1	262,1	66	3,97	498,1	98,1	164,1	98,1	
	375	0,375	15,733	165	23,100	333	33	11,64	198,4	598,4	265,4	67	3,96	499,2	99,2	166,2	99,2	
	400	0,4	16,066	166,2	23,268	332	32	11,68	199,2	599,2	267,2	68	3,93	499,6	99,6	167,6	99,6	
	425	0,425	16,399	167,7	23,478	331	31	11,72	200,3	600,3	269,3	69	3,90	500,1	100,1	169,1	100,1	*peak*
1:08:27	440	0,44	16,599	168	23,520	330	30	11,75	200,2	600,2	270,2	70	3,86	500,1	100,1	170,1	100,1	
End Stage 2	360	0,36	15,533	0	0,000	330	30	11,62	0,0	400,0	70,0	70	1,00	400,0	0,0	70,0	0,0	*(reverse)*

TRIAXIAL SHEARING

							STAGE 1	*STAGE 2*	*STAGE 3*	
Project =	Kaoline, Pc=200 kPa	Date of testing = 3 - 4 Des. 2008				Effective cell pressure =	50	100	150	(kPa)
Location =	Lab. Mektan FT-UI	Test type =	Multistage TX-CU			Cell pressure =	350	400	450	(kPa)
Hole no. =	# 4.B Pc=200 kPa	Tested by =	Cipto Adi B.			Back pressure =	300	300	300	(kPa)
Depth =	---	~~with~~ side drain				Consolidated length =	7,54	7,51	7,47	(cm)
Sample no. =	5	without	*Stage 1*	*Stage 2*	*Stage 3*	Consolidated area =	11,17	11,06	10,94	(cm2)
Sample code =	# 4.B-(5)	Rate of strain =	0,064	0,064	0,063 (mm/min)	Consolidated volume =	84,29	82,99	81,69	(cm3)

5

Date / Time / Stage	Strain Dial			Axial load		Pore pressure		Corrected area	Deviator stress	Principal stress & Stress ratio				Stress path				Remarks
	1 div =	0,001 cm	(ε)	Dial 1 div =	Load 0,14 kg	(u)	(Δu)		(σ_1-σ_3)	Major tot. (σ_1)	Major eff. (σ_1')	Minor eff. (σ_3')	Eff. ratio (σ_1'/σ_3')	(p) ½(σ_1+σ_3)	(q) ½(σ_1-σ_3)	(p') ½(σ_1'+σ_3')	(q') ½(σ_1'-σ_3')	
	(div)	(cm)	(%)	(div)	(kg)	(kPa)	(kPa)	(cm2)	(kPa)	(kPa)	(kPa)	(kPa)		(kPa)	(kPa)	(kPa)	(kPa)	
Stage 3																		
00:00:00	0	0	15,533	0	0,000	300	0	10,94	0,0	450,0	150,0	150	1,00	450,0	0,0	150,0	0,0	
(3 des 08)	25	0,025	15,868	65	9,100	332	32	10,98	82,9	532,9	200,9	118	1,70	491,4	41,4	159,4	41,4	
	50	0,05	16,203	93	13,020	345	45	11,02	118,2	568,2	223,2	105	2,13	509,1	59,1	164,1	59,1	
	75	0,075	16,538	113	15,820	352	52	11,06	143,1	593,1	241,1	98	2,46	521,6	71,6	169,6	71,6	
	100	0,1	16,873	130	18,200	354	54	11,09	164,1	614,1	260,1	96	2,71	532,0	82,0	178,0	82,0	
	125	0,125	17,208	145	20,300	356	56	11,13	182,4	632,4	276,4	94	2,94	541,2	91,2	185,2	91,2	
	150	0,15	17,542	158	22,120	356	56	11,17	198,1	648,1	292,1	94	3,11	549,0	99,0	193,0	99,0	
	175	0,175	17,877	172	24,080	356	56	11,21	214,9	664,9	308,9	94	3,29	557,4	107,4	201,4	107,4	
	200	0,2	18,212	182	25,480	356	56	11,25	226,6	676,6	320,6	94	3,41	563,3	113,3	207,3	113,3	
	225	0,225	18,547	190	26,600	355	55	11,28	235,7	685,7	330,7	95	3,48	567,9	117,9	212,9	117,9	
	250	0,25	18,882	193,5	27,090	354	54	11,32	239,2	689,2	335,2	96	3,49	569,6	119,6	215,6	119,6	
	275	0,275	19,217	195,5	27,370	353	53	11,36	240,9	690,9	337,9	97	3,48	570,4	120,4	217,4	120,4	*peak*
	300	0,3	19,551	195,5	27,370	352	52	11,40	240,0	690,0	338,0	98	3,45	570,0	120,0	218,0	120,0	
	325	0,325	19,886	192,5	26,950	352	52	11,44	235,5	685,5	333,5	98	3,40	567,8	117,8	215,8	117,8	*)
	350	0,35	20,221	190	26,600	352	52	11,48	231,7	681,7	329,7	98	3,36	565,8	115,8	213,8	115,8	
0:59:53	375	0,375	20,556	186,5	26,110	352	52	11,52	226,6	676,6	324,6	98	3,31	563,3	113,3	211,3	113,3	
End Stage 3																		

*Note : *) bidang keruntuhan geser mulai jelas terlihat.*

Calculation :

		STAGE 1	*STAGE 2*	*STAGE 3*	
Maximum deviator stress ($\Delta\sigma = \sigma_1$-σ_3)	=	159,9	200,3	240,9	(kPa)
Pore pressure at max. dev. stress (*u*)	=	294,0	331,0	353,0	(kPa)
Strain at max. deviator stress (ε)	=	11,267	16,399	19,217	(%)

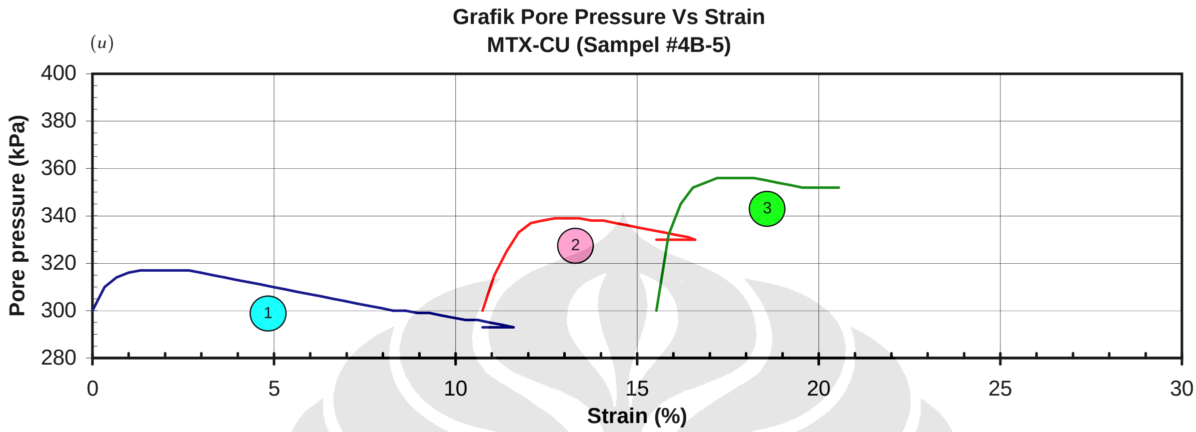
Principal stresses at maximum deviator stress :

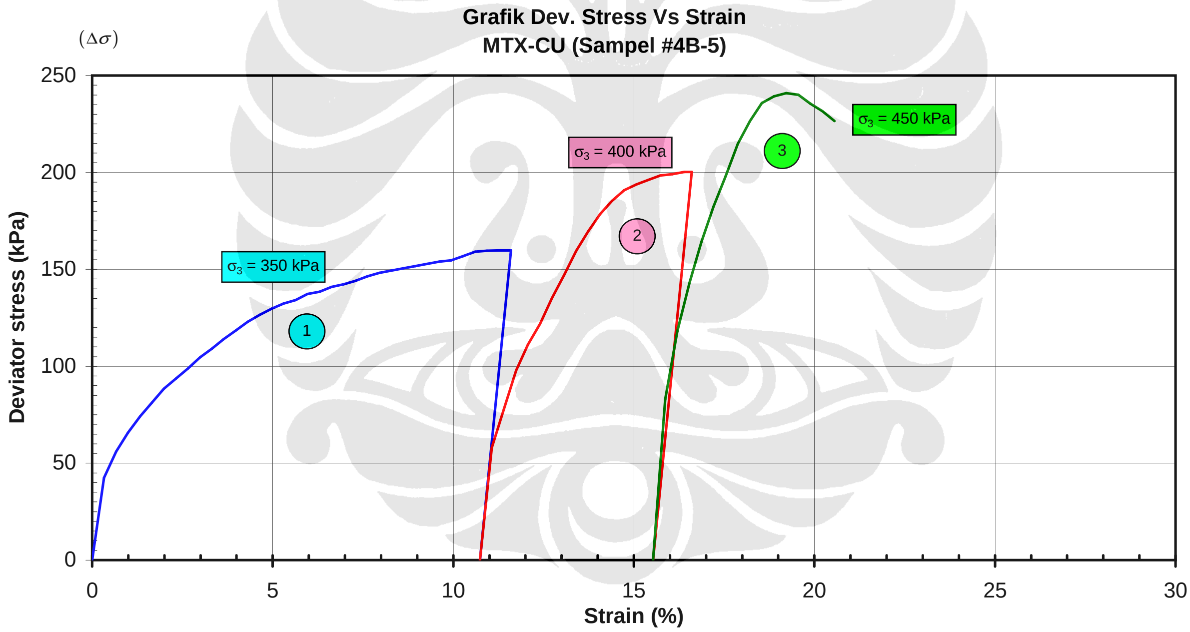
Total major principal stress (σ_1)	=	509,9	600,3	690,9	(kPa)
Total minor principal stress (σ_3)	=	350,0	400,0	450,0	(kPa)
Effective major principal stress (σ_1')	=	215,9	269,3	337,9	(kPa)
Effective minor principal stress (σ_3')	=	56,0	69,0	97,0	(kPa)
Effective principal stress ratio (σ_1'/σ_3')	=	3,85	3,90	3,48	

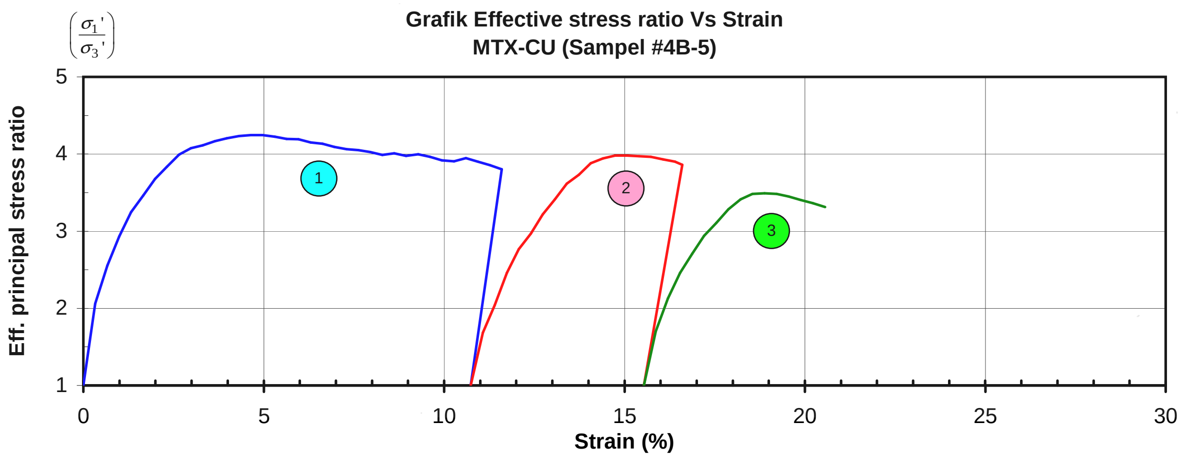
TRIAXIAL COMPRESSION TEST - CU TEST (MULTI STAGE)

 # 4.B-(5)

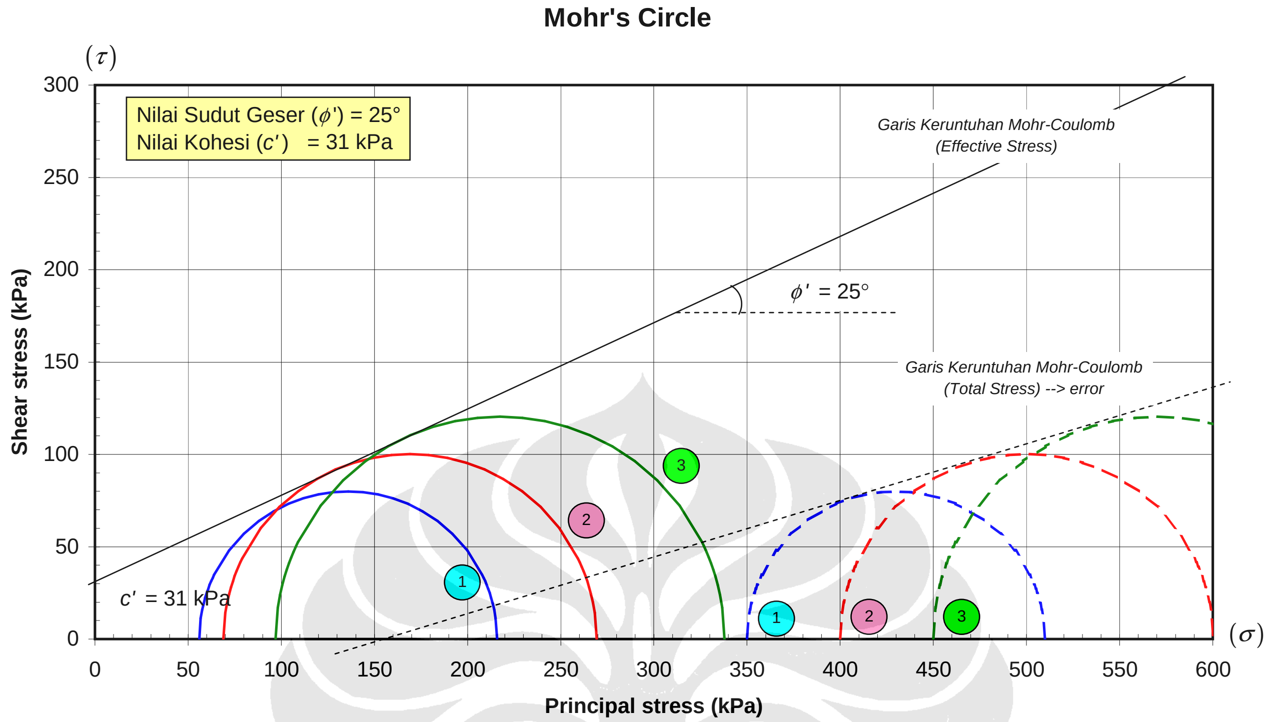
Kode Sampel		# 4.B-(5)	# 4.B-(5)	# 4.B-(5)		Keterangan
Stage		Stage 1	Stage 2	Stage 3		
Maximum deviator stress ($\Delta\sigma = \sigma_1 - \sigma_3$)	(kPa)	159,9	200,3	240,9		
Pore pressure at max. dev. stress (u)	(kPa)	294,0	331,0	353,0		
Total major principal stress (σ_1)	(kPa)	509,9	600,3	690,9		
Total minor principal stress (σ_3)	(kPa)	350,0	400,0	450,0		
Effective major principal stress (σ_1')	(kPa)	215,9	269,3	337,9		
Effective minor principal stress (σ_3')	(kPa)	56,0	69,0	97,0		
Strain at max. deviator stress (ε)	(%)	11,267	16,399	19,217		

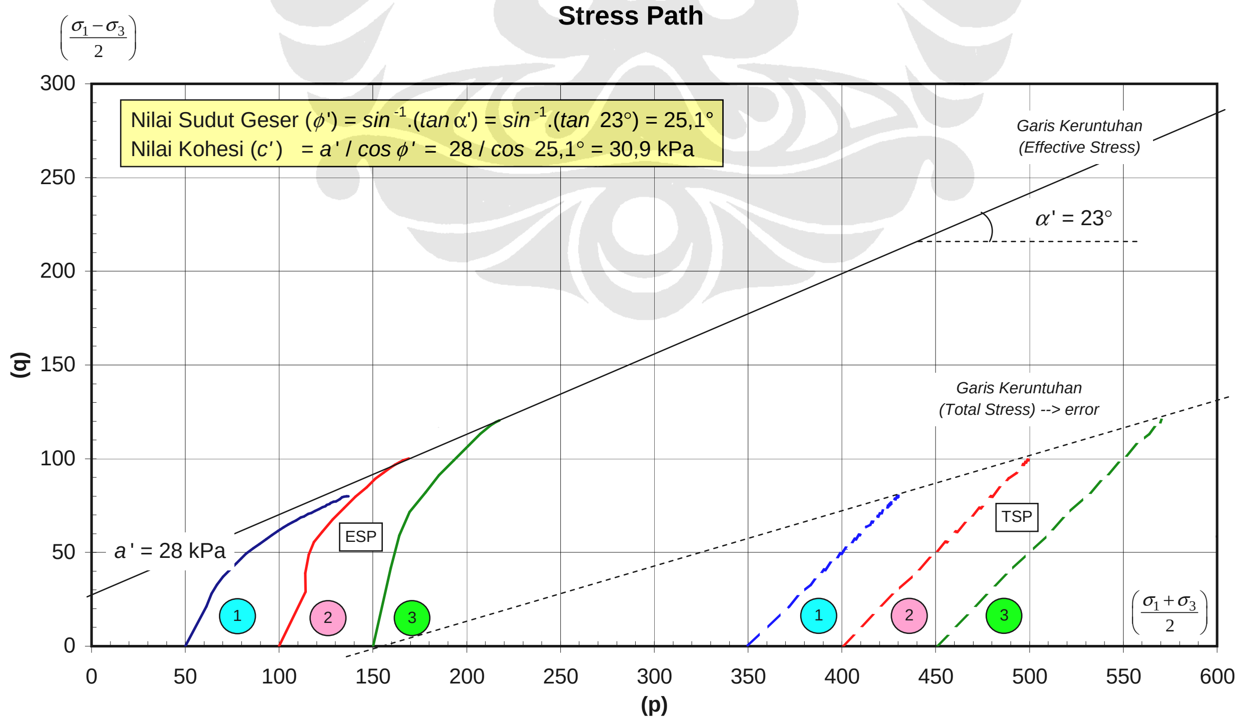






TRIAXIAL COMPRESSION TEST - CONSOLIDATED UNDRAINED
MULTISTAGE TX-CU
SAMPEL NO. #4B-(5)

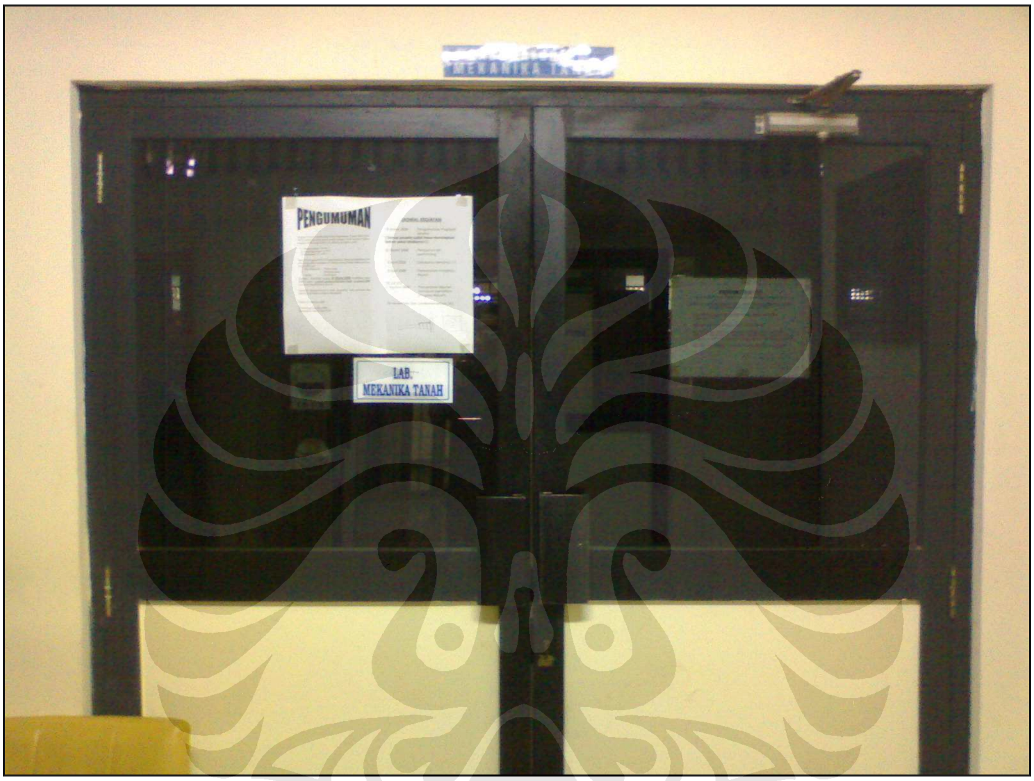




Lampiran 7

FOTO – FOTO DOKUMENTASI

LOKASI PENELITIAN
LABORATORIUM MEKANIKA TANAH FT-UI



MATERIAL KAOLIN

Material kaolin ex. PT. Asia Kaolin Raya


Material kaolin yang masih berbentuk bubuk berwarna putih

PROSES PENGUJIAN *PROPERTY INDEX* KAOLIN

Pengujian *Liquid Limit* (Batas Cair) kaolin dengan alat *Casagrande*.

Pengujian *Plastic Limit* (Batas Plastis) kaolin.

Pengujian *Spesific Gravity* (*Gs*) kaolin.

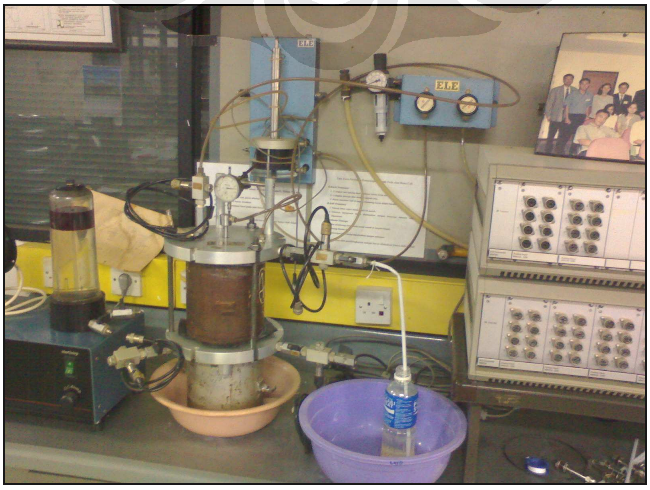
Pengujian distribusi ukuran butiran kaolin dengan *Hydrometer*.

PROSES PEMBUATAN SAMPEL CONTOH TANAH KAOLIN
UNTUK BENDA UJI TRIAKSIAL

Proses pencampuran dan pengadukan bubuk kaolin dengan air secara manual.

Proses pencetakan contoh tanah kaolin dengan memasukkan "*slurry*" kaolin ke dalam cetakan "CBR".

Cetakan sampel contoh tanah yang telah siap untuk dilakukan proses pemadatan dengan alat *rowe cell*.



Sampel contoh tanah yang sedang dalam proses pemadatan dengan menggunakan alat *rowe cell* yang telah dimodifikasi.

PROSES PENCETAKAN BENDA UJI TRIAKSIAL DARI CETAKAN CONTOH TANAH KAOLIN SETELAH SELESAI PROSES PEMADATAN

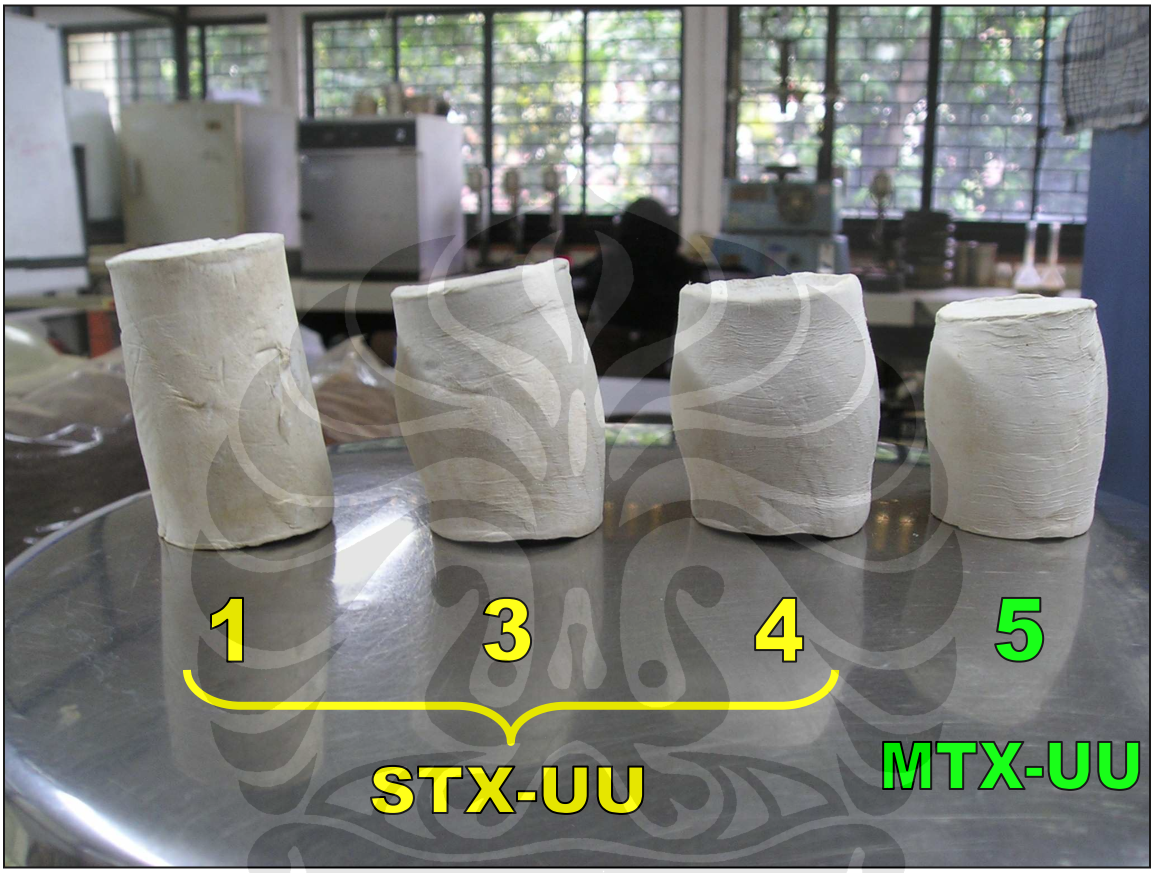
Proses pencetakan benda uji triaksial dengan cara memasukan cetakan triaksial secara manual ke dalam cetakan contoh tanah kaolin.

Cetakan benda uji triaksial yang telah dimasukkan ke dalam contoh tanah.

Sampel contoh tanah kaolin yang telah dikeluarkan dari cetakannya setelah proses pemasukan cetakan benda uji triaksial.

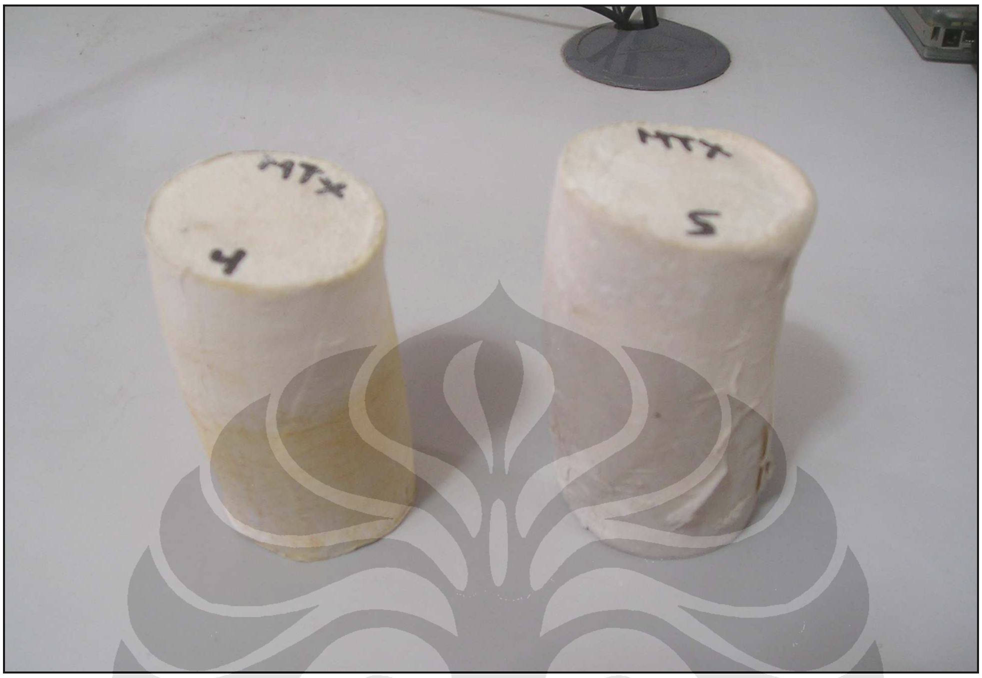
PROSES PENGUJIAN TRIAKSIAL TEKAN TERKONSOLIDASI – TAK TERDRAINASI (*TX-CU*)

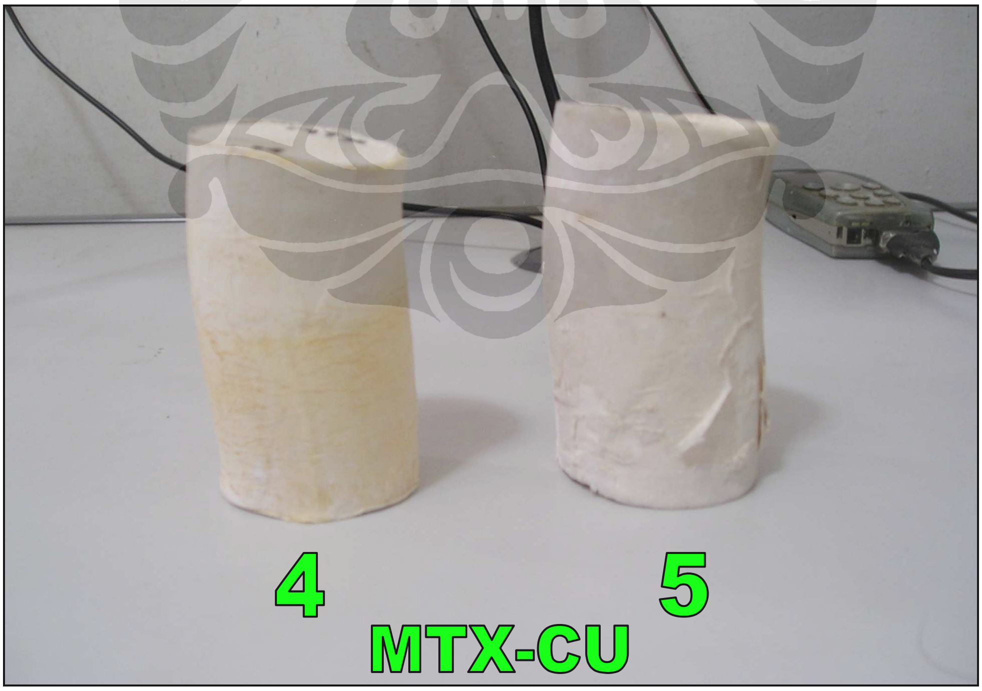
BENDA UJI SETELAH PROSES PENGUJIAN TRIAKSIAL TEKAN
TAK TERKONSOLIDASI – TAK TERDRAINASI
SINGLE STAGE (*STX-UU*) DAN *MULTISTAGE* (*MTX-UU*)



BENDA UJI SETELAH PROSES PENGUJIAN TRIAKSIAL TEKAN TERKONSOLIDASI – TAK TERDRAINASI *SINGLE STAGE* (*STX-CU*)

BENDA UJI SETELAH PROSES PENGUJIAN TRIAKSIAL TEKAN TERKONSOLIDASI – TAK TERDRAINASI *MULTISTAGE* (*MTX-CU*)





Lampiran 8

JURNAL – JURNAL

Maurizio Soranzo[1]

Results and Interpretation of Multistage Triaxial Compression Tests

REFERENCE: Soranzo, M., **"Results and Interpretation of Multistage Triaxial Compression Tests,"** *Advanced Triaxial Testing of Soil and Rock, ASTM STP 977,* Robert T. Donaghe, Ronald C. Chaney, and Marshall L. Silver, Eds., American Society for Testing and Materials, Philadelphia, 1988, pp. 353–362.

ABSTRACT: The procedure for performing and interpreting multistage triaxial compression tests is described. The results obtained from unconsolidated undrained and isotropically consolidated undrained tests on normally consolidated alluvial clay and overconsolidated colluvial gravelly clay are presented.

A direct comparison of the results of single stage and multistage compression tests, performed on homogeneous samples, indicates that the latter procedure may be applied to soil specimens that reach failure with vertical strain greater than 8 to 10%.

To demonstrate the similarity between the two procedures and to interpret the tests when only a limited percentage of strain is available for each compression stage, stress versus strain, normalized stress versus strain, normalized tangent modulus versus stress, and Kondner's hyperbolic criterion were used in the analysis.

KEY WORDS: soil mechanics, triaxial test, compression, shear strength, stress–strain behavior, cohesive soils

Triaxial testing of cylindrical soil specimens is common because they allow a wide range of mechanical parameters to be examined during consolidation and shear phases. When the aim of analysis of a defined natural soil is to determine the shear strength (that is, c, ϕ), the most common type of test, for cohesive soil, is undoubtedly consolidated triaxial compression, in which the specimen is tested in undrained conditions. Undrained testing is usually accompanied by the measurement of the pore water pressure to obtain shear strength parameters in terms of effective stresses.

In traditional tests, each specimen undergoes a phase of consolidation and shearing and thus supplies a single stress versus strain trend and of course only one state of stress at failure. A series of three or four specimens, consolidated at various stress levels, supplies an ensemble of stress data allowing identification of a failure envelope and thus shear strength parameters. Sometimes it is impossible to have a set of homogeneous specimens, for economic reasons or because some soil formations may be difficult to sample (for example, gravelly or boulder clay, laminated soil).

This study refers in particular to the shear strength measurements of a normally consolidated alluvial and an overconsolidated colluvial soil formation. Referring to the latter soil type, various authors have shown that the measured strength of plastic and fissured clays depends on the size of the tested specimen [*1–3*]. For this reason the diameter of the specimen is often equal to the diameter of the bored sample (which depends on the sampler—usual range is 7 to 10 cm). This is also the case of clays containing gravelly elements.

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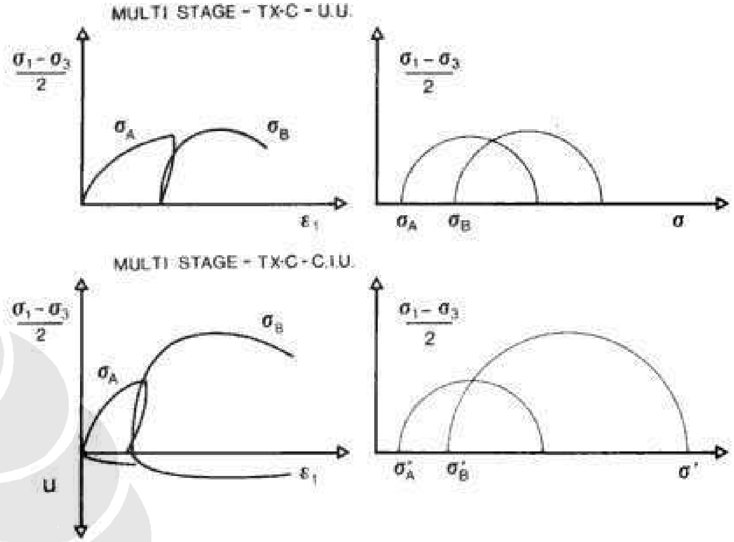


FIG. 1—*Shear stresses versus vertical strains and Mohr's circles at failure for unconsolidated (UU) and consolidated ($\overline{CIU}$) multistage triaxial compression tests (TX-C).*

If this procedure is adopted, it is highly improbable that two identical specimens from the same level can be obtained, unless several borings are made at the same site, which is very expensive. In these circumstances, it is important and sometimes necessary to have a large quantity of information from each single specimen.

The above reasons justify the development of triaxial tests which give more than one stress state at failure for each specimen. This is possible by using a technique of multiple consolidations and shearings within traditional triaxial apparatus and appropriate interpretation of test results. The method enables substantial homogeneity of results and appreciable cost savings.

Various authors have already shown the possibility of carrying out such tests to define undrained shear strength [*4*] or effective shear strength both in unsaturated [*5*] and saturated soils [*6*].

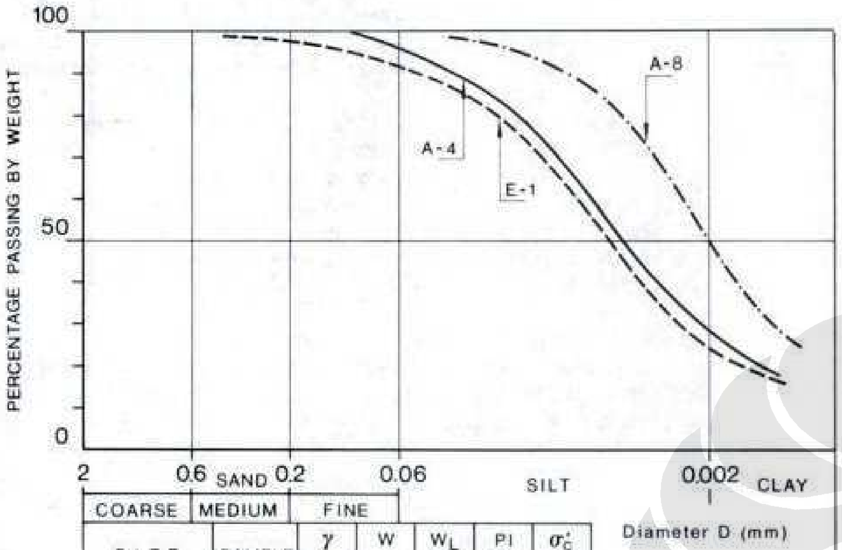
This paper presents the results of multistage unconsolidated undrained (UU) and isotropically consolidated undrained ($\overline{CIU}$) triaxial compression tests on natural complex clayey soils, with special emphasis on analysis and interpretation of test results.

Multistage Procedures

A multistage triaxial compression test induces more than one consolidation and shearing on the same soil specimen loaded inside a triaxial cell.

Specimen preparation and initial test stages of saturation (if required, by means of appropriate back pressure) or imbibition (soaking) are identical to those of traditional triaxial compression tests of various types (UU or consolidated undrained [$\overline{CU}$]).

During the shearing stage the specimen is strained to produce a significant amount of shear stress. Then the specimen is released from deviatoric stress and subjected to a higher confining (or consolidating) pressure before the following shearing stage takes place. A double confining and compression stage is suggested for triaxial compression (TX-C)



SITE	SAMPLE	γ (kN/m³)	W (%)	W_L (%)	PI (%)	σ'_c (kPa)
CERVIA	A - 4	18.6	30	51	25	130
CERVIA	A - 8	19.0	38	79	46	190
EUGANEI	E - 1	19-21	22	51	26	250

FIG. 2—*Particle-size distribution curves of examined soils. Table shows unit weight, water content, liquid limit, plasticity index, and consolidation pressures for each soil sample.*

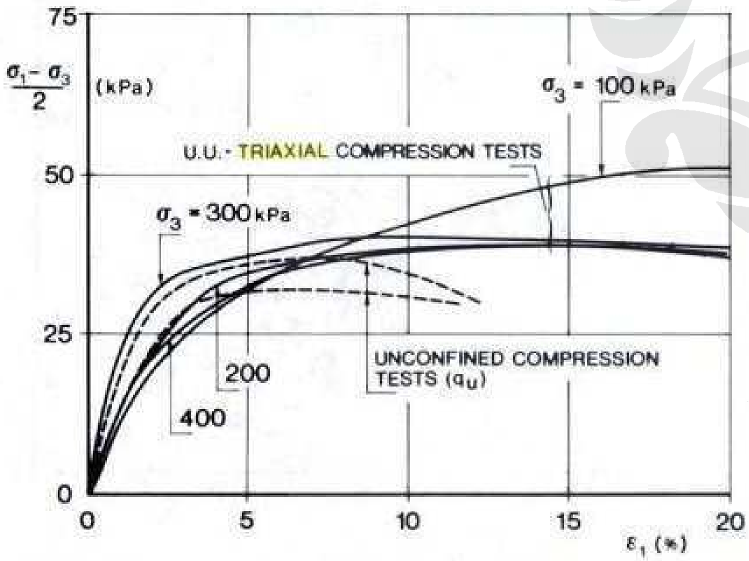


FIG. 3—*Shear stresses versus axial strains of a set of undrained compr*[illegible]

UU tests and a double or triple set of consolidation-shearing is allowed for TX-C $\overline{CIU}$ tests, if peak shear stress is not expected for axial strains of at least 8%. In $\overline{CIU}$ tests, after each consolidation phase, the new volume and height of the specimen are computed and assigned to it for the next compression stage.

Figure 1 shows the main results of multistage UU and $\overline{CIU}$ triaxial compression tests on isotropically confined specimens. For each test, stress–strain curves and the state of stress at failure for the first and second compression stages are plotted. Isotropic stresses σ_A and σ_B are the confining (UU) or consolidation ($\overline{CIU}$) stresses for each stage. The strain is of the order of 5% for each compression stage in the unconsolidated test and 3% for the consolidated one. In both cases, peak values of shear strength are expected for strain values greater than 8%, as is the case of many clayey and silty-clayey soils of medium to low plasticity.

Although we suggest that at least 5% of compression strain should be reached in the first compression stage, we will show here that, with appropriate interpretation of test results, this limitation may be reduced. However, the proposed method is not generally applicable for soil formations which reach "failure" at very small axial strain values (sometimes less than 3%), as is the case for sensitive clays [*7–9*] or stiff fissured clays [*10*].

Soil Specimens Examined

The soil specimens used were taken from high-quality borings, using an Osterberg piston sampler.

Two types of soil were tested: an alluvial silty clay from Cervia (central Italy) in the Po Plain and a colluvial gravelly-silty clay from the volcanic Euganean Hills (northeastern Italy). The main characteristics and grain-size distribution curves of these soils are given in Fig. 2.

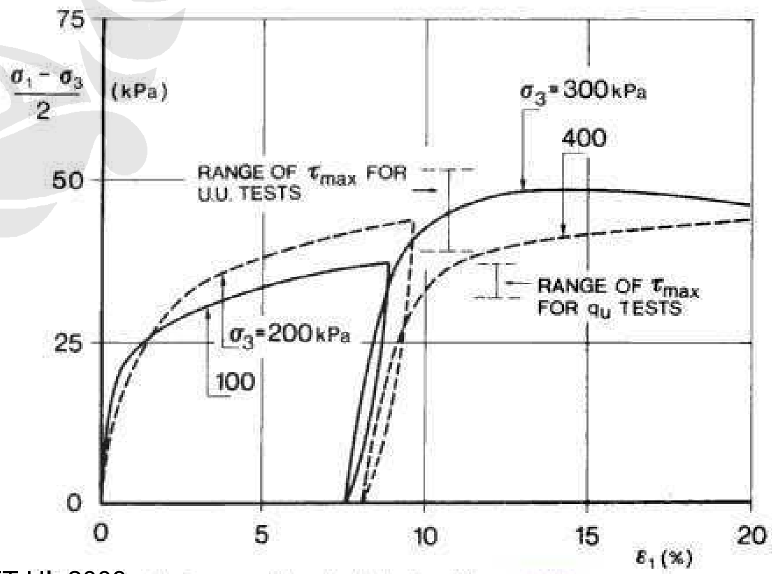


FIG. 4—*Results of unconsolidated undrained multistage triaxial compression tests.*

At each elevation, the Cervia alluvial clay gave very uniform samples and was used for comparing the results of the various triaxial techniques. On the other hand, each sample from the Euganei site was bored at different elevations and, because of the complex nature of the gravelly clay, only one specimen with the same diameter as the sampler per sample was prepared. In this case, no attempt was made to compare the results of the various test techniques.

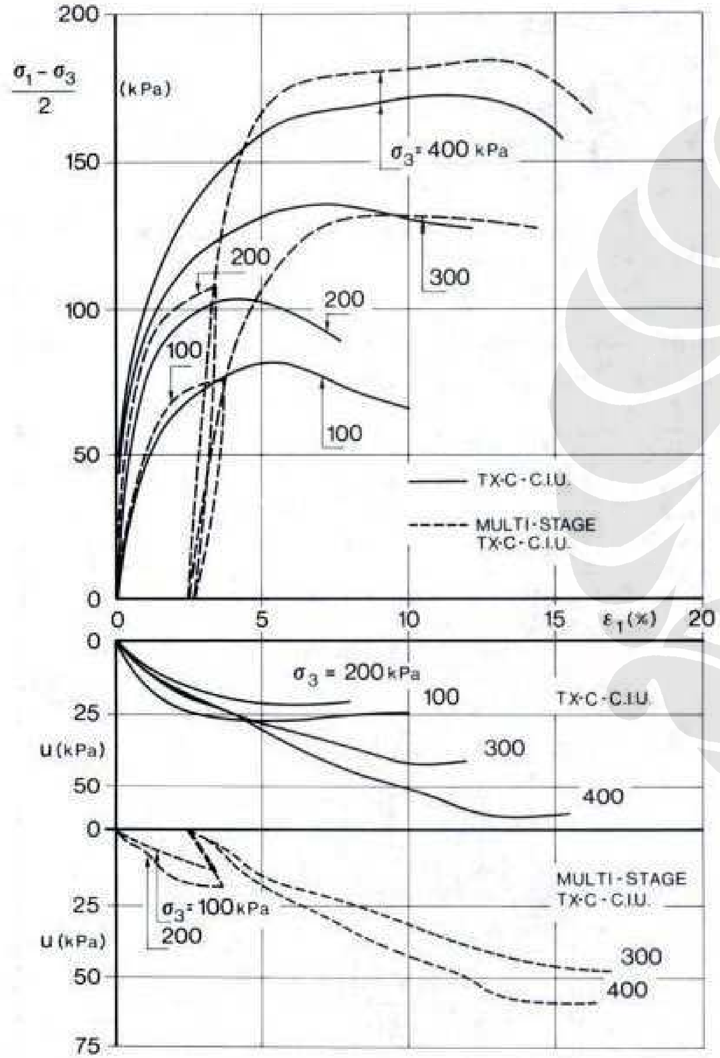


FIG. 5—*Comparison of stress versus strain curves of traditional and multistage TX-C-CIU tests.*

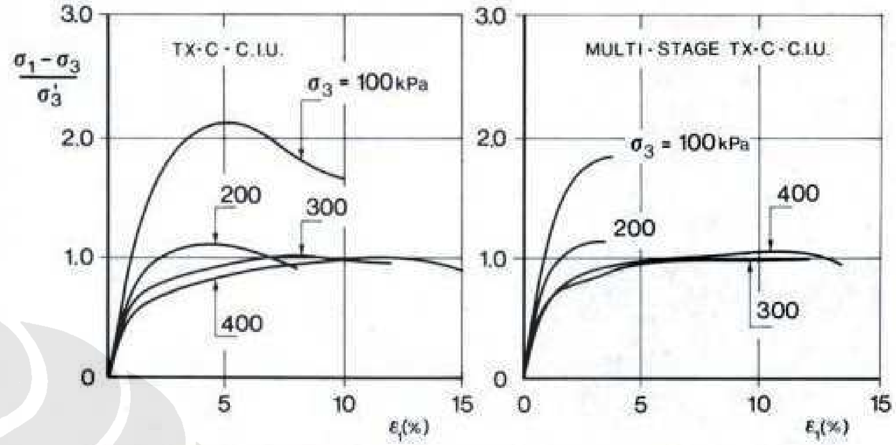


FIG. 6—*Normalized deviatoric stress versus strain curves for traditional and multistage TX-C-CIU tests.*

Test Results

Unconsolidated Undrained Triaxial Compression Test (TX-C-UU)

The multistage UU triaxial test may be run according to two techniques:

1. The initial confining pressure (σ_3) is kept constant to a very high compressive strain (15 to 20%) and then two or three successive increases of σ_3 are made to allow the multistage test to be performed.
   In these last phases, each increase in σ_3 is kept for a few units of strain (that is, 1 to 2%). This technique does not allow analysis of stress–strain behavior within this small range of strains, and thus the shear stresses given must be considered as "failure" values, no other interpretation being possible. This technique was proposed by Anderson [4] and will not be treated here.
2. Alternatively, the test may be run by increasing σ_3 when a sufficient degree of available shear stress has been mobilized. This usually corresponds to strains of 5 to 10%. Thus, the method is not applicable to brittle soils that reach failure with strains of less than 5%.

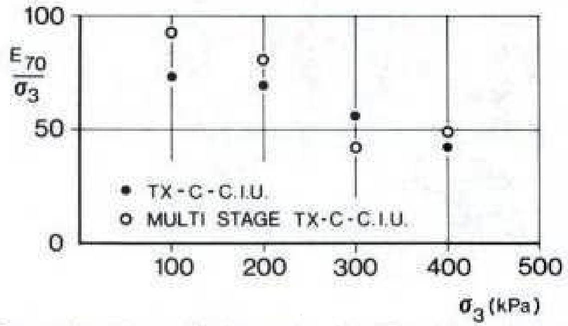


FIG. 7—*Comparison of normalized tangent undrained moduli for single and multistage TX-C-CIU tests.*

The results of eight undrained compression tests carried out on specimens trimmed from the same A-4 Cervia sample are reported in Figs. 3 and 4. Figure 3 shows the results of four TX-C-UU tests and two unconfined compression tests (q_u) on the Cervia silty clay, plotted in the shear stress versus strain plane. Figure 4 shows the results of two multistage TX-C-UU tests on the same soil and at the same depth. The range of the peak shear stresses of the previous six compressions are also shown in this figure. An increase in confining pressure took place at strains of 8.9 and 9.6%, after complete unloading of the shear stress acting on the specimen. The new σ_3 was given time to act before the subsequent compression stage took place. A complete double-stage TX-C-UU test took 10% longer than one conventional UU compression test.

In alluvial and colluvial soils without fissures or particular structures, it is sometimes possible to perform triple-stage UU tests. In this case, some judgment is required to define the limit strain for each stage.

It is advisable to plot the test results throughout the test and to use some simple analytical tool to define the approach of a failure condition (see next section).

Isotropically Consolidated Undrained Triaxial Compression Test ($TX\text{-}C\text{-}\overline{CIU}$)

The multistage technique applied to $\overline{CIU}$ tests requires a number of consolidation phases which occur by raising the value of the hydrostatic confining pressure in the triaxial cell.

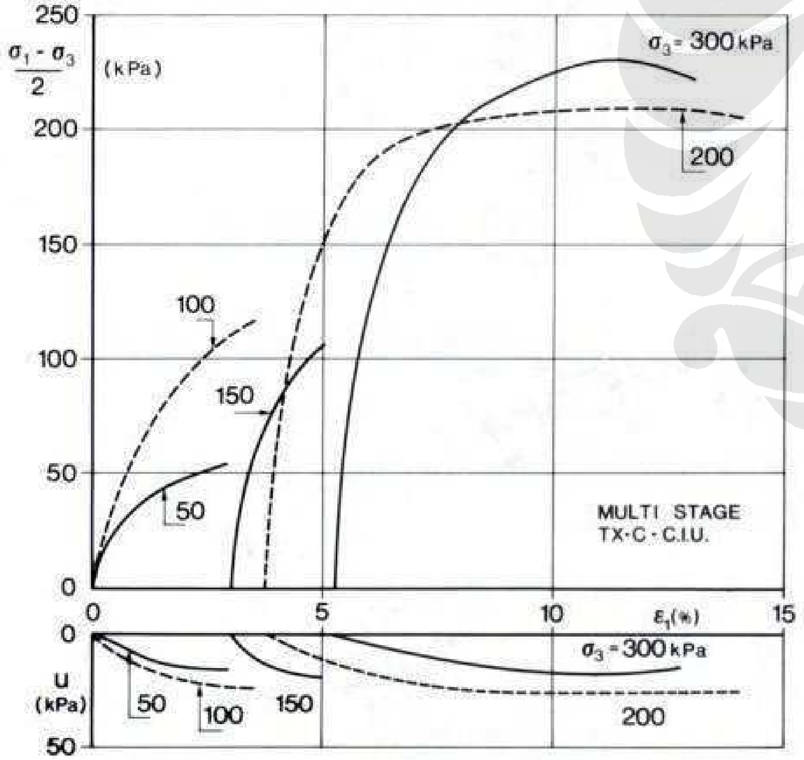


FIG. 8—*Shear stress versus strain curves for two multistage ($\overline{CIU}$) triaxial compression tests.*

Each consolidation stage does not seem to affect the stress–strain curve for stress levels higher than those previously reached (Fig. 5). The shear stresses $(\sigma_1 - \sigma_3)/2$ versus strain for traditional and multistage CIU tests carried out on the Cervia specimens are plotted in the same diagram. The six specimens were trimmed from the central part of a very uniform sample taken with a 102-mm Osterberg sampler.

Tests were performed on specimens taken at a depth of about 24 m, where the consolidation pressure, determined with an oedometer, was estimated to be 190 kPa. Consolidation pressure in the triaxial cell was selected at 100, 200, 300, and 400 kPa, so that one specimen (and one stage of the multistage test) would show overconsolidated behavior, while the other ones would follow normally consolidated behavior.

The plots of Fig. 5 give comparable results: the first phase of each multistage test almost covers the corresponding traditional tests.

More convincing evidence may be achieved by plotting the results in a normalized plane such as $(\sigma_1 - \sigma_3)/\sigma_3'$ versus ϵ_1, as done in Fig. 6. In this way the effective stress behavior and the overconsolidation effect are shown. The curve of each stage of the multistage test is represented in the above figure starting with a strain equal to zero. In both sets of results, the specimens consolidated to 100 kPa, due to their overconsolidation with respect to cell pressure, show normalized resistance almost double that of the other specimens, whose normalized strength falls in a very narrow range. The shape of the curves was also analyzed by plotting a normalized tangent modulus E_{70}/σ_3 (that is, tangent moduli calculated at 70% of soil strength) versus consolidation pressure (Fig. 7). This direct comparison shows that the scatter among the results, which turned out to be 20 to 25% at various consolidation pressures, must be considered within usual experimental practice on natural soils. These moduli (E_{70}) were chosen at a high shear strength level in order to exceed stress levels encountered in the first stage of the test, so they must be considered loading moduli.

If a strong softening effect is feared after reaching peak strength, each compression stage

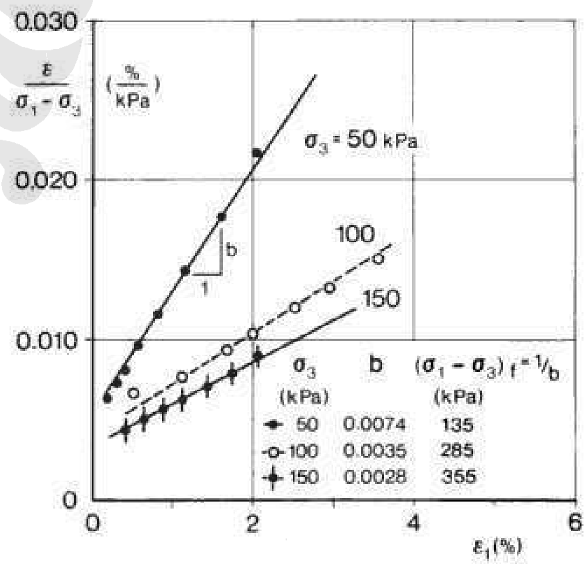


FIG. 9—*Kondner's hyperbolic interpretation for first stages of multiple compression tests.*

may be stopped at low strain values (2 to 3%). In this case, doubts may exist as to whether peak shear has been reached, and the limited stress–strain curve may have to be interpreted.

It was found that Kondner's [*11,12*] "hyperbole" criterion defining a failure condition was useful for the soils tested. Stress–strain data, plotted on a plane $\epsilon/(\sigma_1 - \sigma_3)$ versus ϵ, approximate a hyperbola which has a linear trend in such a plane. The inverse of slope b of the line gives the "at failure" value $(\sigma_1 - \sigma_3)_f$ of the soil. This procedure of data interpretation was used to define the strength of the first stages of the TX-C-CIU tests performed on the complex colluvial clay of the Euganei site (Fig. 8). In this case, these are one triple-stage compression and one double-stage compression at consolidation stresses ranging from 50 to 300 kPa. Only the loading stages are shown.

Kondner's criterion on the stages with confining pressure of 50, 100, and 150 kPa was used, as shown in Fig. 9.

Lastly, the five stress conditions at failure, evaluated from the compression of two specimens, are shown in the Terzaghi-Mohr space in terms of effective stresses (Fig. 10). Again, the test technique and its interpretation gave a homogeneous view of soil strength. In this case, no comparison with the one-stage test was possible because only two samples of complex natural soil were available.

Discussion and Conclusions

Test results demonstrate that it is possible and convenient to perform multistage triaxial compression tests on natural soil to measure shear strength.

Both UU and $\overline{\text{CIU}}$ tests were carried out using the multistage technique and , as shown, the results are highly comparable to those of traditional triaxial tests.

No particular interpretation is needed if it is possible to reach strain levels so that failure stresses are definitely indicated for each stage of consolidation or loading. This is the case of soils that reach peak strength at compression strains higher than 8 to 10% and that do not tend to exhibit brittle behavior after having reached peak strength. In this case, two or possibly three different confining (UU tests) or consolidation ($\overline{\text{CIU}}$ tests) pressures may be used.

As pointed out, when brittle behavior occurs at low strain values (less than 4%), as happens for heavily overconsolidated fissured soil formations and cemented or sensitive clays, the described procedure is not recommended. On the other hand, if for some reason brittle behavior is feared at intermediate strains (that is, 5 to 6%), failure should not be approached too closely. In this case, previous experiences on similar soils help in program-

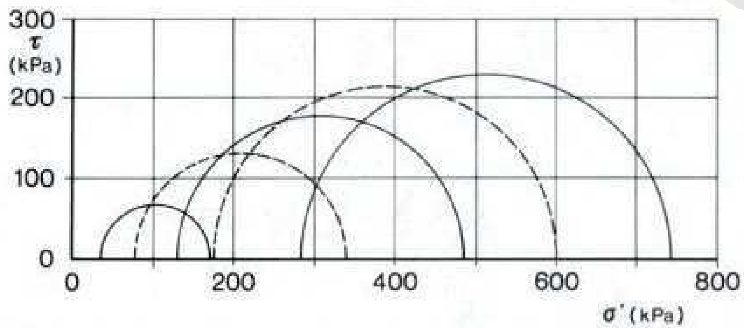


FIG. 10—*Complete set of Mohr's circles at failure of multistage tests shown in Fig. 8.*

ming tests, and some interpretation is needed to define the shear stress at failure of the initial stage(s).

The simple Kondner model is proposed to overcome this difficulty.

Because of successive consolidations, multistage $\overline{\text{CIU}}$ tests also allow the stress–strain curves to be used to evaluate some of the deformation characteristics of the examined soil, if these curves are evaluated at stress levels higher than those reached in the previous stage.

Lastly, the described procedure was found to be economically feasible, because test time is shortened due to reduced manual intervention during specimen preparation in the laboratory.

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Application of Multistage Triaxial Test to Kuwaiti Soils

REFERENCE: Saeedy, H. S. and Mollah, M. A., **"Application of Multistage Triaxial Test to Kuwaiti Soils,"** *Advanced Triaxial Testing of Soil and Rock, ASTM STP 977*, Robert T. Donaghe, Ronald C. Chaney, and Marshall L. Silver, Eds., American Society for Testing and Materials, Philadelphia, 1988, pp. 363–375.

ABSTRACT: Forty-eight soil samples taken from twelve different locations in Kuwait City and the Jahra area were used in four series of drained and undrained triaxial compression tests using multistage and conventional test techniques on undisturbed and remolded specimens. Classification tests indicated that the Kuwaiti soil is predominantly sandy with various content of fines. The fines content includes silt and clay, and also clay-size particles of calcareous and gypsiferous matter. Strength test results indicated that the cohesion and angle of friction determined from both techniques are in agreement and hence the multistage principle can be applied to determine the shear strength parameters of Kuwaiti soils. Specific recommendations on applying the multistage technique on cemented soils, occasionally encountered in Kuwait, are also included.

KEY WORDS: triaxial test, multistage test, conventional triaxial test, calcareous soil, drained triaxial test, undrained triaxial test, shear strength, cohesion, angle of friction, cemented soil

A comprehensive investigation for the evaluation of geotechnical properties of soil from various areas of Kuwait was made between 1984 and 1986 in the Building Department of the Kuwait Institute for Scientific Research [*1*]. An intensive field and laboratory testing program was implemented. This included tests which have not yet been standardized by international institutions. Among these, the most prominent was the multistage triaxial compression test being used to determine the shear strength parameters.

The subsoil of Kuwait is characterized as being predominantly sandy but occasionally calcareous. During the investigation, considerable variations of soil properties were noticed even within small zones. The evaluation of the drainage characteristics of soil, which was one of the primary objectives of the 30-month project, indicated that the subsoil ranged from fair draining to impervious material. The ranges of various geotechnical properties of these soils have been reported elsewhere [*2*]. While dealing with these soils, various problems were faced. Certainly, the foremost problem encountered was the selection of truly representative specimens during testing.

In Kuwaiti soils, variation of strength from specimen to specimen was noticed. This occasionally led to multiple choice of failure envelopes wherein cohesion (c) and angle of

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friction (ϕ) values varied by 0 to 100 kPa and 2 to 14°, respectively.[3] Such variation was, to a large extent, attributed to the presence of calcareous and gypsiferous matter (resulting in local cementation), cemented conglomerates, and pockets of silt and clay particles in various contents. Sampling and preparation of specimens posed a very serious challenge in testing, particularly in triaxial compression. Sampling of Kuwaiti soils was generally difficult. A pitcher sampler, 73 mm in diameter and 900 mm in length, was used to extract soil samples from the boreholes. In some instances, the recovery of samples was discouraging. Usually, recovery ranged between 20 and 40 cm (rarely exceeding 60 cm), which was not sufficient to conduct a normal triaxial test. Specimens of smaller diameter were tried but were not found feasible, as a result of the granular nature of particles which did not permit obtaining good specimens. Moreover, specimens were found to crumble even with utmost care. These factors (poor recovery and nonavailability of sufficient homogeneous specimens) compelled the use of the multistage principle. However, before the final decision was made, several trials were conducted using conventional and multistage techniques on specimens of fairly homogeneous soils having satisfactory recovery.

This paper reports the application of the multistage principle to Kuwaiti soils. The program of testing included shearing a total of 48 samples from areas in Kuwait City and Jahra, at a constant rate of strain under undrained and drained conditions.

Shear Strength of Soil

The shear strength of soil is generally determined using the Mohr-Coulomb's equation, given by

$$\tau_f = c + \sigma_f \tan \phi \qquad (1)$$

where

τ_f = shearing resistance of soil,
c = the intercept on the axis representing shear stress,
σ_f = normal stress on the failure plane, and
ϕ = angle of shearing resistance.

In a saturated soil, the normal stress acting across the plane of failure is not necessarily equal to the effective stress. In terms of effective stress, a concept introduced by Terzaghi [*3*], the above equation can be rewritten as

$$\tau_f = c' + \sigma_{f'} \tan \phi' \qquad (2a)$$

and

$$\tau_f = c' + (\sigma_f - u_f) \tan \phi' \qquad (2b)$$

where

u_f = pore water pressure developed and
c' and ϕ' are same as in Eq 1 but in terms of effective condition.

The above equations specifically apply to direct shear test. In a triaxial test, the failure envelope in terms of effective stress is generally drawn on (q', p') plot to be represented

[3] Government Laboratories and Testing Station, "Laboratory Soil Testing for Sub-Surface Water Rise in Kuwait and Suburbs Project," Second Bimonthly Report, Kuwait (Unpublished), 1985.

by the following equation [*4*]:

$$q_f' = a' + p_f' \tan \alpha' \quad (3)$$

where

$$q' = \frac{\sigma_1' - \sigma_3'}{2} = \frac{\sigma_1 - \sigma_3}{2} \quad (4a)$$

$$p' = \frac{\sigma_1' + \sigma_3'}{2} \quad (4b)$$

σ_1', σ_3' are major and minor principal effective stresses, respectively, and

q_f', p_f' represent the values of (q', p') corresponding to peak points of the stress–strain curves.

a', α' are the modified strength parameters defined by

$$a' = c' \cos \phi' \quad (5a)$$

and

$$\alpha' = \tan^{-1} (\sin \phi') \quad (5b)$$

Multistage Test

A conventional triaxial test using three or more specimens is normally used to determine the shear strength parameters of soil. A multistage test is a modified version of the conventional test and is becoming increasingly popular. The test technique comprises shearing a single specimen to near failures at several elevated lateral pressures, while measuring the corresponding deviator stresses at which the failures occur. The multistage test is mainly used when the soil available for testing is scarce or they are nonhomogeneous.

The relative advantages and disadvantages of the multistage principle over the conventional have been discussed in detail by Lumb [*5*]. The principal advantages include the reduction of the laborious and often delicate job of specimen preparation and test set-up. This is, in particular, important for brittle or cemented soils as well as saturated sands, where sampling is not only difficult but costly too. Moreover, a drained triaxial test is generally time-consuming. As such, a multistage test would be economical provided it can be used properly for the particular type of soil. On the other hand, compliance to a predefined failure criterion during shear is the most difficult task when applying the multistage principle. This requires immediate data reduction in addition to a standard procedure to define failure. The other shortfalls include (1) the selection of representative specimens for testing and (2) the straining limit of ordinary commercial cells.

Early research work on the multistage test was very limited. A brief review of literature has been offered by Kenney and Watson [*6*]. Since its first application in 1950, the technique drew attention of few researchers who were reported to have successfully utilized the principle on different soils for the determination of shear strength parameters [*5–10*].

Physiographic Condition of Kuwait

Kuwait is a small country located at the northwestern part of the Arabian Peninsula. It is bordered by Iraq on the north, by Saudi Arabia on the south and west, and by the Arabian Gulf on the east. The topography of the state of Kuwait is generally flat. The land surface slopes northeastward at an average gradient of 1:500 with elevations ranging from sea level in the east to about 300 m in the southwestern corner of the country.

The area in the state of Kuwait is covered by various types of sedimentary deposits ranging in age from Eocene to Recent [*11*]. The surficial deposit consists of wind-blown sand and sediments comprising silicious sands and gravels with varying content of silt and clay, and gypsum band, wherein the original sand belongs to Dibbibba formation. The climate of Kuwait is characterized by an extreme hot and dry summer lasting several months. Evaporation is high throughout the year with very little runoff into the sea. The evaporation in excess of the rainfall leads to a general upward movement of groundwater with increased concentration of soluble salts at or near surface, enriching the top layers with gypsum and carbonates, and ultimately leading to cementation. Such soils are locally known as "Gatch" [*12*].[4]

The study areas were two relatively recent developed urban zones, namely, Kuwait City and its suburbs, and Jahra. The city of Kuwait, at 29° 25′ N latitude and 48° E longitude, is located on Kuwait Bay whereas Jahra is an oasis on the main road to Basra City in Iraq about 40 km southwest of Kuwait City.

Sampling and Testing Program

Soils used for this investigation were collected at depths of 1.5 to 8.0 m from a total of twelve boreholes. Seven of these boreholes were located in Kuwait City and its suburbs, and the remainder were located in the Jahra area (Fig. 1). All boreholes, 100 mm in nominal diameter, were advanced by rotary wash technique using bentonite slurry except above water table where casing was used to protect side walls. The samples were extracted using 73-mm inside diameter (ID) and 900-mm length pitcher samplers.

The testing program included first determining the physical and index properties of all samples. To obtain parameters that could be used in comparing the multistage with the conventional triaxial test, four series of tests were performed under drained and undrained conditions. A total of twelve sets, each comprising three conventional tests and one multistage test were conducted using both undisturbed and remolded specimens. The remolded specimens were prepared to have the same moisture content and density as the natural soil.

The testing program, detailed in Table 1, was implemented using a cell and machine manufactured by Wykeham Farrance. The soil samples exhibiting limited variation in properties and having ample recovery were used. The specimens, with nominal dimension of 73-mm diameter (ID) and 150-mm length, were tested employing a back pressure of 345 kPa. The sequences of isotropically applied consolidation pressures were 69, 207, 414 kPa and 207, 414, 621 kPa. To prepare a test specimen, the sample from the pitcher sampler was pushed hydraulically to standard laboratory tubes of the same ID and 150 mm in length. This practice ensured obtaining good specimens with the least disturbance. (Earlier attempts at taking specimens of smaller dimension ended in failure because of the type of soil, which is characterized by its loose structure and bulky shaped grains.) The true dimension of each individual specimen was recorded after its extraction from the standard tube. End and radial drainage was allowed by using porous stones and filter strips, respectively. In the beginning of the first stage, the specimens were left for 24 h under full back pressure and slightly elevated cell pressure to ensure saturation, followed by application of the consolidation pressure. Each specimen was checked for a degree of saturation ranging from 90 to 100%. After allowing for full consolidation, the specimens were sheared at a constant rate of strain of 0.5 and 1% per hour in drained and undrained tests, respectively. During the shearing stage, a continuous record of load and volume change for drained/pore water pressure for undrained tests were taken at a deformation interval of 0.1 mm.

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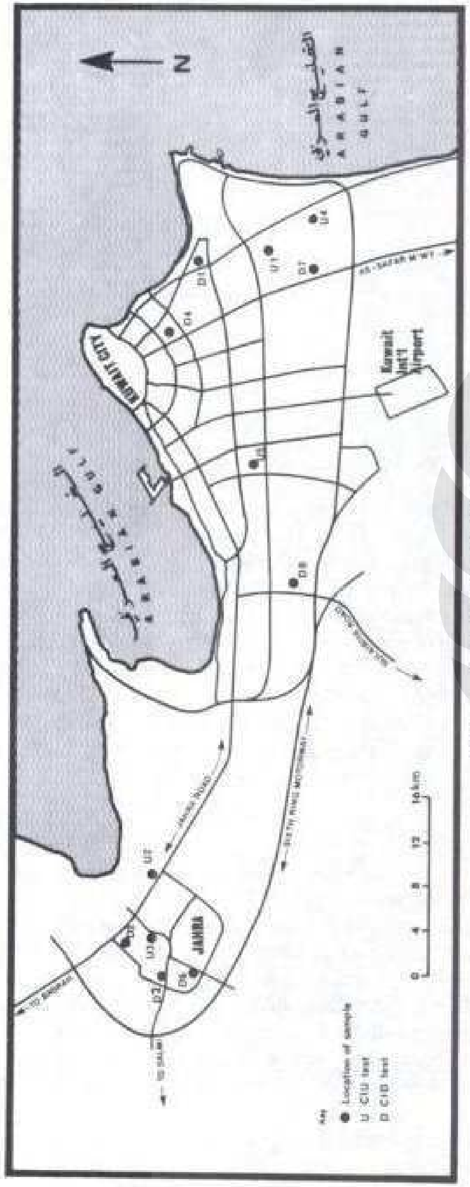

FIG. 1—*Location of sampling sites.*

TABLE 1—*Details of test program.*

Test Set	Test Series	Sample Identification	Sample Depth, m	Sampling Area	Confining Pressure Range, kPa	Type of Samples
1		D1	2.0	East Hawalli	207, 414, 621	disturbed
2	CID-I[a]	D2	1.5	Jahra		(remolded
3		D3	6.5			at in situ
4		D4	4.0	Qadisiya		moisture content and density)
5		D5	1.5	Firdous	69, 207, 414	undisturbed
6	CID-II	D6	1.5	Jahra		
7		D7	1.8	Mushrif		
8		U1	1.5	Bayan	69, 207, 414	undisturbed
9	CIU-I[b]	U2	6.5	Jahra		
10		U3	6.5			
11	CIU-II	U4	6.5	Mushrif	207, 414, 621	undisturbed
12		U5	1.5	Rai		

[a] CID = isotropically consolidated drained.
[b] CIU = isotropically consolidated undrained.

For the purpose of this study, a specimen in multistage test was considered to have reached the failure during Stages 1 and 2 at the point where two consecutive observations showed negligible increase (<0.05%) in the deviator stress. During these stages, the shearing was stopped immediately after failure and was followed successively by closing the drainage valve (in drained test) and unloading the specimen. The confining pressure was then increased to the level required for the next stage. After waiting for sufficient time to allow pore water pressure (PWP) in the specimen to stabilize, the drainage valve was let open to achieve complete dissipation of the PWP. The specimens were sheared as usual, but the test data were analyzed immediately to determine the deviator stress ($\sigma_1 - \sigma_3$). In the third and final stage, however, the shearing was continued beyond failure point to at least 20% axial strain.

Basic Properties

The physical and index properties determined, including natural moisture content, in situ density, Atterberg limits, and specific gravity of soil solids, are given in Table 2. The grain size distribution of all samples was determined using both the sieve and hydrometer methods. The limiting boundaries of all grain size distribution curves are given in Fig. 2. The results indicated that the soil was predominantly sandy and the contents of fines ranged between 12 and 40%. Further, the grain size distribution of coarse fraction was noticed to be similar, unless the sample contained cemented fragments. The natural moisture contents, which ranged between 9 and 17%, were all below their corresponding values of shrinkage limit. This has indicated a general moisture deficiency and possible sensitivity to saturation. Seven out of twelve samples were found to be nonplastic (NP), while the remaining samples were only slightly plastic with a range of plasticity index values less than 12%. According to Unified Soil Classification System (USCS), these soils can be grouped as silty sand to clayey sand (SM-SC), the majority of them belonging to SM. The samples were generally dense to very dense, as indicated by the Standard Penetration Test (SPT) values ($N > 50$), with the degree of saturation varying from 47 to 91%.

TABLE 2—*Physical and index properties of test samples.*

Test Set	Sample Identification	Natural Moisture Content, %	Bulk Density, kg/m³	Passing U.S. No. 200 Sieve, %	Average Grain Size D_{50}, mm	Liquid Limit, %	Plastic Limit, %	Shrinkage Limit, %	Specific Gravity of Soil Solids	Degree of Saturation, %	Unified Soil Classification[a]
1	D1	9.0	1935	21.4	0.30	33.6	24.8	21.9	2.69	47.0	SM
2	D2	14.8	2060	17.4	0.25	NP[b]	NP	NA[c]	2.68	80.3	SM
3	D3	16.8	2077	12.7	0.55	NP	NP	NA[c]	2.65	90.9	SM
4	D4	16.2	1991	20.2	0.27	NP	NP	NA[c]	2.68	77.0	SM
5	D5	16.8	2014	25.9	0.30	25.4	21.2	14.8	ND[d]	81.3	SM-SC
6	D6	16.6	2074	18.7	0.23	NP	NP	NA[c]	2.66	89.2	SM
7	D7	13.2	2063	19.2	0.42	NP	NP	NA[c]	2.67	75.8	SM
8	U1	12.4	2040	20.4	0.24	23.4	18.4	16.0	2.67	70.3	SM-SC
9	U2	12.7	2065	28.1	0.20	28.2	17.2	14.4	2.71	71.9	SC
10	U3	13.3	2117	40.4	0.15	27.5	16.3	14.1	2.71	80.1	SC
11	U4	12.8	2075	24.6	0.60	NP	NP	NA[c]	2.67	75.8	SM
12	U5	9.5	2010	11.6	0.42	NP	NP	NA[c]	2.69	55.0	SM

[a] SM = silty sand, and SC = clayey sand.
[b] NP = nonplastic.
[c] NA = not applicable.
[d] ND = not determined.

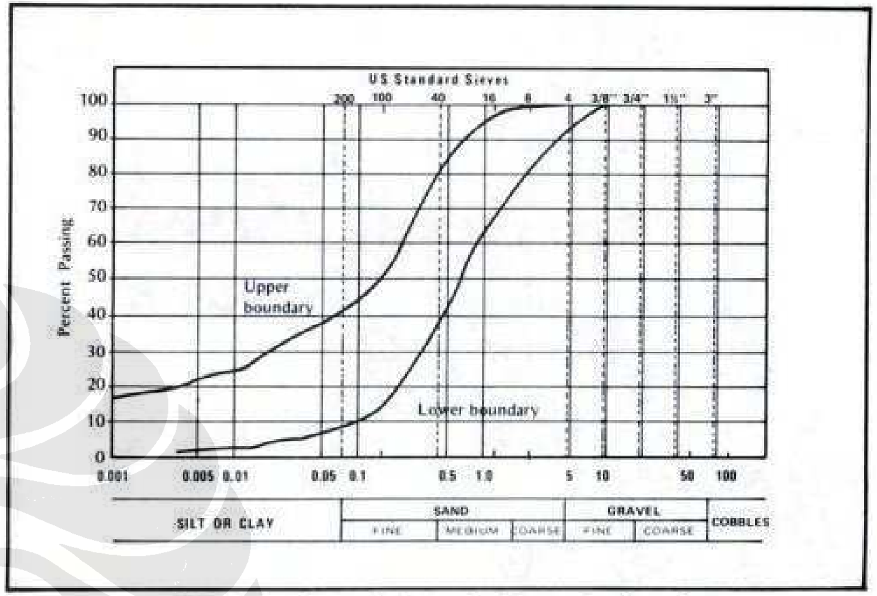

FIG. 2—*Particle size distribution band for tested soil samples.*

Results and Discussion

Two series of drained tests were performed on seven sets of samples taken from different sites. Of these samples, four sets were disturbed and the remainder were undisturbed samples. The disturbed specimens were remolded to the in situ density at the natural moisture content of the sample. The remolded specimens served two purposes, namely, compensation of the lack of undisturbed specimens and comparison of results with those of undisturbed samples.

A typical set of stress–deformation relationships, obtained from both multistage and conventional triaxial tests, is given in Fig. 3. The data were obtained from drained compression tests performed using the confining pressure sequence of 207, 414, 621 kPa. The data presented in Fig. 3 show that the stiffness and peak strength of all specimens increase with confining pressures. Volume changes during shear were measured, and the observations were also plotted in Fig. 3. The volume changes as well as failure strains were generally small. All samples, irrespective of the type of testing, were noticed to fail by slight bulging with the development of failure planes indicating transitional response, a behavior usually displayed by brittle-to-ductile material. The reason for the transition from brittle-to-ductile failure modes appears to be related to the relative contributions to the soil strength response by the cementation and frictional components of the deformation resistance mechanism. Similar observations were noted in the undrained test series performed on five sets of undisturbed samples taken from different sites in which the sequence of lateral pressures were varied from 69, 207, 414 kPa to 207, 414, 621 kPa and records of load, deformation, and changes of pore water pressure during shear were recorded (Fig. 4).

Stress–deformation relationships for multistage versus conventional triaxial test can be compared in Figs. 3 and 4. From these figures, it is clear that during the first stage shearing, the stress–strain curve in the multistage test fairly matches the conventional test. But de-

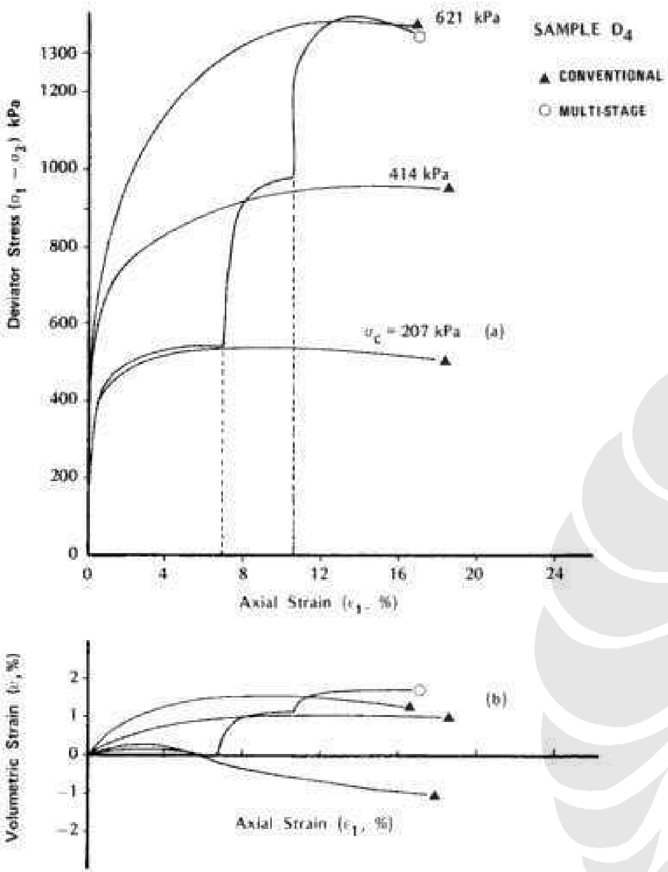

FIG. 3—*Typical stress–strain and volumetric strain relationship for drained test.*

viations are noticed between the two techniques at subsequent stages of shearing with regard to the values of axial strain and corresponding pore water pressure in undrained series and volumetric strain in drained test series. The lack of agreement in Stages 2 and 3 is possibly attributed to the difference in the physical state of specimens before shearing at the relevant stage. Generally, in stages other than Stage 1, the stiffening of soils as a result of further consolidation resulted in smaller failure strains. Figure 4 indicated that multistage tests have provided a much faster rate of excess pore pressure dissipation. This could be attributed to the formation of internal failure planes within the soil sample. These observations confirm the findings of Lumb [*5*] that true reproduction of stress–strain behavior is not possible in multistage tests.

To compare the shear strength for multistage versus conventional test, the values of deviator stress at failure condition $(\sigma_1 - \sigma_3)_f$ for both the drained and undrained series are plotted in Fig. 5*a* and *b*. In these figures $(\sigma_1 - \sigma_3)_f$ values refer to specimens tested at the same confining pressure. These figures are self explanatory because almost all data lie on the 45° line.

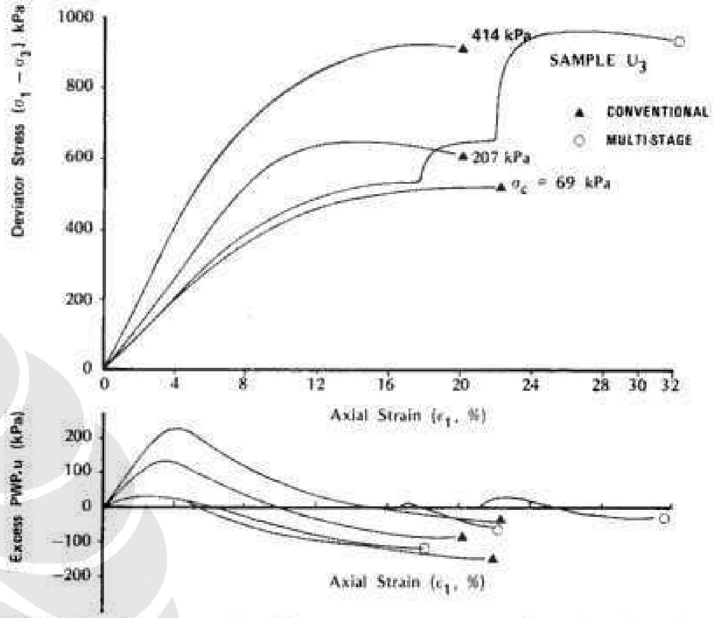

FIG. 4—*Typical stress–strain and excess pore water pressure relationship for undrained test.*

The strength parameters, c' and ϕ', are given in Table 3. To obtain these parameters, the test results, in terms of effective stress, were plotted on (q', p') plots. The criterion for failure envelope was based on the peak values (q_f', p_f'). These have produced reasonably consistent test results which is often unusual with Kuwaiti soils. The reason of such consistency possibly may be explained by the fairly homogeneous samples selected for testing.

It was further observed in Table 3 that for both undrained and drained series there was a reasonable agreement between the multistage and conventional triaxial tests so far as the strength parameters were concerned. This observation was in agreement to those reported on other soils (decomposed granite and rhyolite [*3*] and glacial till and estuarine soils [*4*]). On the other hand, axial strain and volumetric strain/excess pore water pressure did not show a satisfactory agreement.

Conclusions

The subsoil of Kuwait is predominantly sandy but calcareous. The percentage passing through a No. 200 U.S. sieve (<75 μm) ranged between 12 and 40%. The subsoil is generally heterogeneous, often turning plastic because of calcareous or clay content. There is a general moisture deficiency in the soil which makes it vulnerable to saturation, causing swelling.

Undrained and drained tests conducted on various specimens indicated that the shear strength parameters determined from the multistage and conventional tests are in good agreement while other test parameters (such as axial and volumetric strain/PWP) varied widely because they are functions of the soil's physical conditions before shearing. Hence, as far as the strength parameters are concerned, the multistage technique can be applied. These remarks hold true irrespective of the test conditions such as applied pressure range, degree of saturation of soils, and the type of test (drained or undrained).

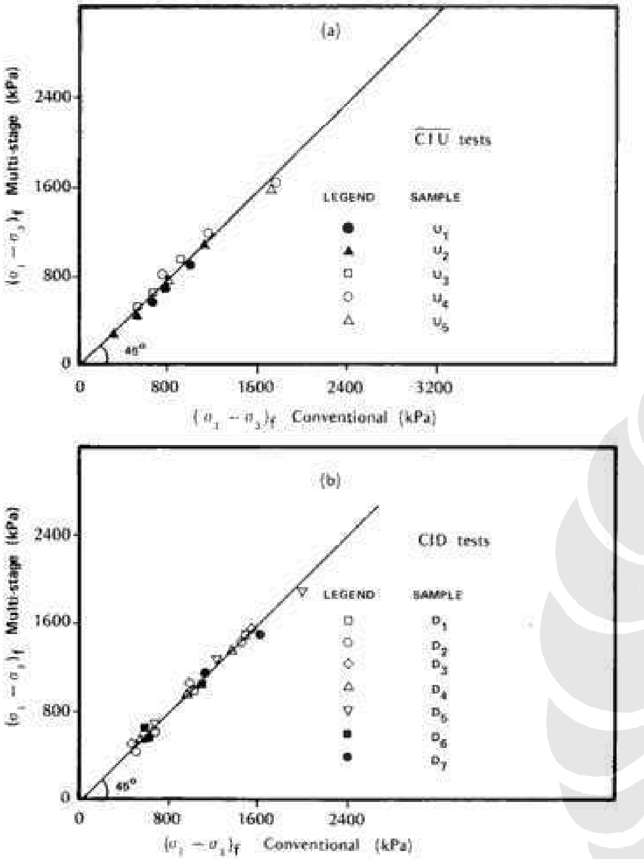

FIG. 5—*Comparison of deviator stress for multistage versus conventional test.*

However, multistage principle should be applied cautiously to strongly cemented (brittle) soil which was not dealt with in depth during this study. This was due to difficulty encountered in obtaining satisfactory recovery, as the soil formation was of a very hard type. These soils are occasionally encountered in Kuwait. Continuation of test beyond failure in either of the first two stages in these soils may induce severe distortion or total collapse of the soil structure. In such soils, it is recommended that the tests at the end of Stages 1 and 2 should be stopped just before the failure, and then proceed to the next stage of confining pressure. To spot failure manually is extremely difficult, but with the aid of computerized testing devices, such difficulty may be overcome. An alternative procedure may be to shear specimens during the first two stages, to a very small strain (say 0.2%). In the last stage, shearing may be continued beyond failure. An initial line connecting the (q', p') values corresponding to the selected small strains should be drawn. The final strength envelope shall be drawn parallel to this line but passing through (q_f', p_f').

Very loose samples usually have large axial failure strains, consequently attainment of failure in multistage tests using ordinary commercial cells may not be possible.

TABLE 3—*Comparison of strength parameters at failure condition.*

			Strength Parameters			
			Cohesion, kPa		Angle of Friction, deg	
Test Set	Test Series	Sample Identification	Conventional Test	Multistage Test	Conventional Test	Multistage Test
1		D1	69	59	30.8	31.2
2	CID-I[a]	D2	12	0	31.6	32.2
3		D3	0	12	33.7	33.4
4		D4	35	23	30.6	30.0
5		D5	13	13	36.9	36.0
6	CID-II	D6	69	58	30.0	30.0
7		D7	36	47	32.7	32.2
8		U1	23	35	31.5	31.2
9	CIU-I[b]	U2	0	13	33.7	34.0
10		U3	34	57	28.6	28.3
11	CIU-II	U4	24	24	33.0	33.0
12		U5	24	24	32.9	32.9

[a] CID = isotropically consolidated drained.
[b] CIU = isotropically consolidated undrained.

Acknowledgments

The testing program was carried out at the soil laboratory of Government Laboratories and Testing Station, Ministry of Public Works, Kuwait. The authors express their deep gratitude to Dr. Abdulmajid Jeragh of the Ministry of Public Works and Ms. Sarah Al-Omar of the Ministry of Electricity and Water.

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