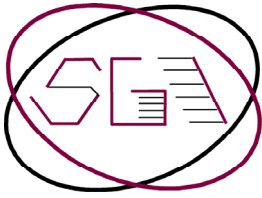


## RCM<sup>®</sup> DIRECT SHEAR TEST DATA

The following report summarizes direct shear testing on Reactive Core Mat (RCM) that has been performed by an independent laboratory. Testing was performed between organoclay RCM and silty-sandy soil (SM classification). This data will give the designer some general information about the shear strength of RCM-soil interfaces for cases where slope stability is a concern. The RCM was set in the shear box so that the shear failure could occur internally (at the needlepunch bonding) or along the interface, whichever was weaker. Since the shear failure occurred at the interface, the internal shear strength of the RCM is greater than the interface shear strength noted.

This data is for informational purposes only and is not intended to replace project-specific direct shear testing, which CETCO recommends. CETCO makes no warranty regarding the use of the data.



# SGI TESTING SERVICES

A Georgia Limited Liability Company

19 June 2008

Mr. James Olsta, P.E.  
CETCO Lining Technologies  
1500 West Shure Drive  
Arlington Heights, IL 60004-1440

Subject: Laboratory Test Results Transmittal  
Interface Direct Shear Strength Testing  
Silt Sand/Organoclay RCM

Dear Mr. Olsta,

SGI Testing Services, LLC (SGI) is pleased to present the attached test results for the above-mentioned project. The note section below addresses sample preparation, sample disposal and a disclosure statement.

SGI appreciates the opportunity to provide laboratory testing services to CETCO. Should you have any questions regarding the attached document(s), or if you require additional information, please do not hesitate to contact the undersigned.

Sincerely,

Zehong Yuan, Ph.D., P.E.  
Laboratory Manager

## Attachments

### Notes:

- (1) Unless otherwise noted in the test results the sample(s)/specimen(s) were prepared in accordance with the applicable test standards or generally accepted sampling procedures.
- (2) Contaminated/chemical samples and all related laboratory generated waste (i.e., test liquids, PPE, absorbents, etc.) will be returned to the client or designated representative(s), at the client's cost, within 60 days following the completion of the testing program, unless special arrangements for proper disposal are made with SGI.
- (3) Materials that are not contaminated will be discarded after test specimens and archived specimens are obtained. All of the tested and archived specimens will be discarded 30 days after the completion of testing, unless long-term storage arrangements are specifically made with the laboratory.
- (4) The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analysis unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. The reported results are submitted for the exclusive use of the client to whom they are addressed.

SGI8007

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**Mail To: SGI Testing Services, LLC**

P.O. Box 2427  
Lilburn, Georgia 30048-2427

Web Site: [www.interactionsspecialists.com](http://www.interactionsspecialists.com)

**Facility Location**

4405 International Boulevard  
Suite B-117  
Norcross, Georgia 30093

Phone : 770.931.8222 Fax: 770.931.8240

**ATTACHMENT A**

**SOIL INDEX, COMPACTION, AND DIRECT  
SHEAR TEST DATA**



# SGI Testing Services, LLC

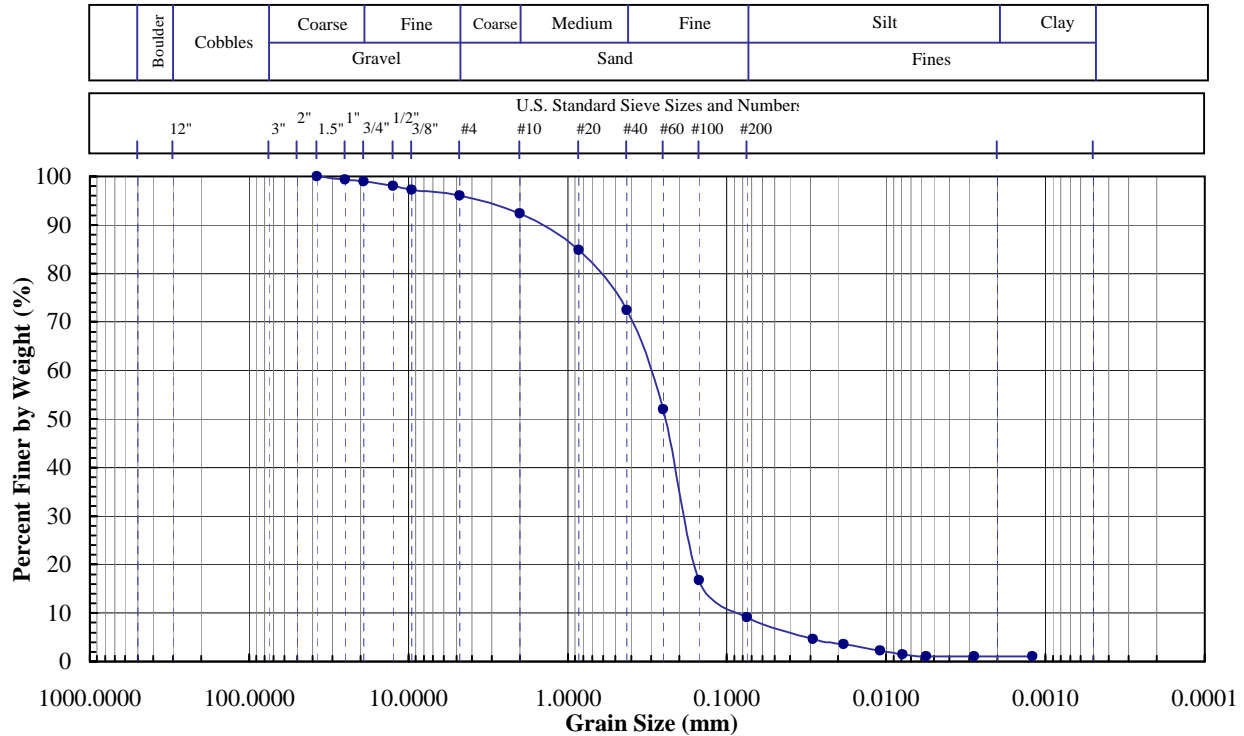
4405 International Blvd., Suite B-117, Norcross, GA 30093  
 Ph: (770) 931 8222 Fax: (770) 931 8240

Project Name: Interface Shear Strength  
 Project No: SGI6013  
 Client Sample ID: Silty Sand  
 Lab Sample No: S11649

ASTM D 2216, D 1140, D 422,  
 C 136, D 4318, D 2487

## SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg  
 Limits, Classification

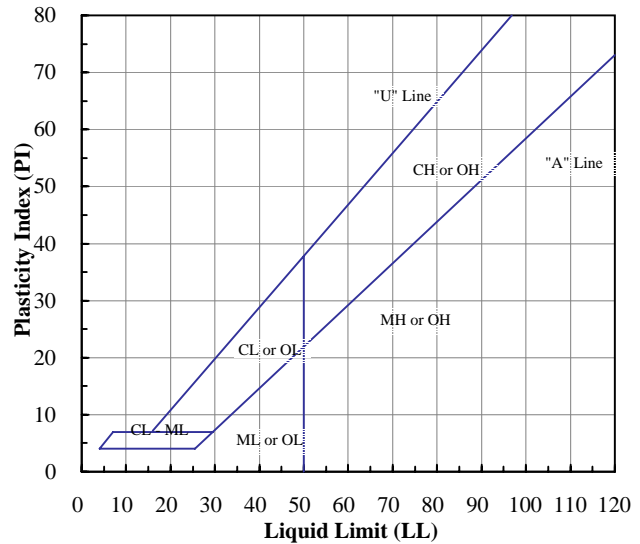


Sieve No.	Size (mm)	% Finer
3"	75	
2"	50	
1.5"	37.5	100.0
1"	25	99.3
3/4"	19	98.9
1/2"	12.5	98.0
3/8"	9.5	97.2
#4	4.75	96.0
#10	2.00	92.4
#20	0.850	84.8
#40	0.425	72.4
#60	0.250	52.0
#100	0.150	16.8
#200	0.075	9.1

Hydrometer Particle Diameter (mm)	% Finer
0.0288	4.6
0.0184	3.5
0.0109	2.2
0.0079	1.5
0.0012	1.0

Gravel (%):	0
Sand (%):	90.9
Fines (%):	9.1
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	-
Coeff. Curv. (Cc):	-



Client Sample ID	Lab Sample No	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits			Engineering Classification
				LL (%)	PL (%)	PI (-)	
Silty Sand	S11649	23.3	9.1	NP	NP	NP	SM (Silty Sand)

Note(s):



# SGI Testing Services, LLC

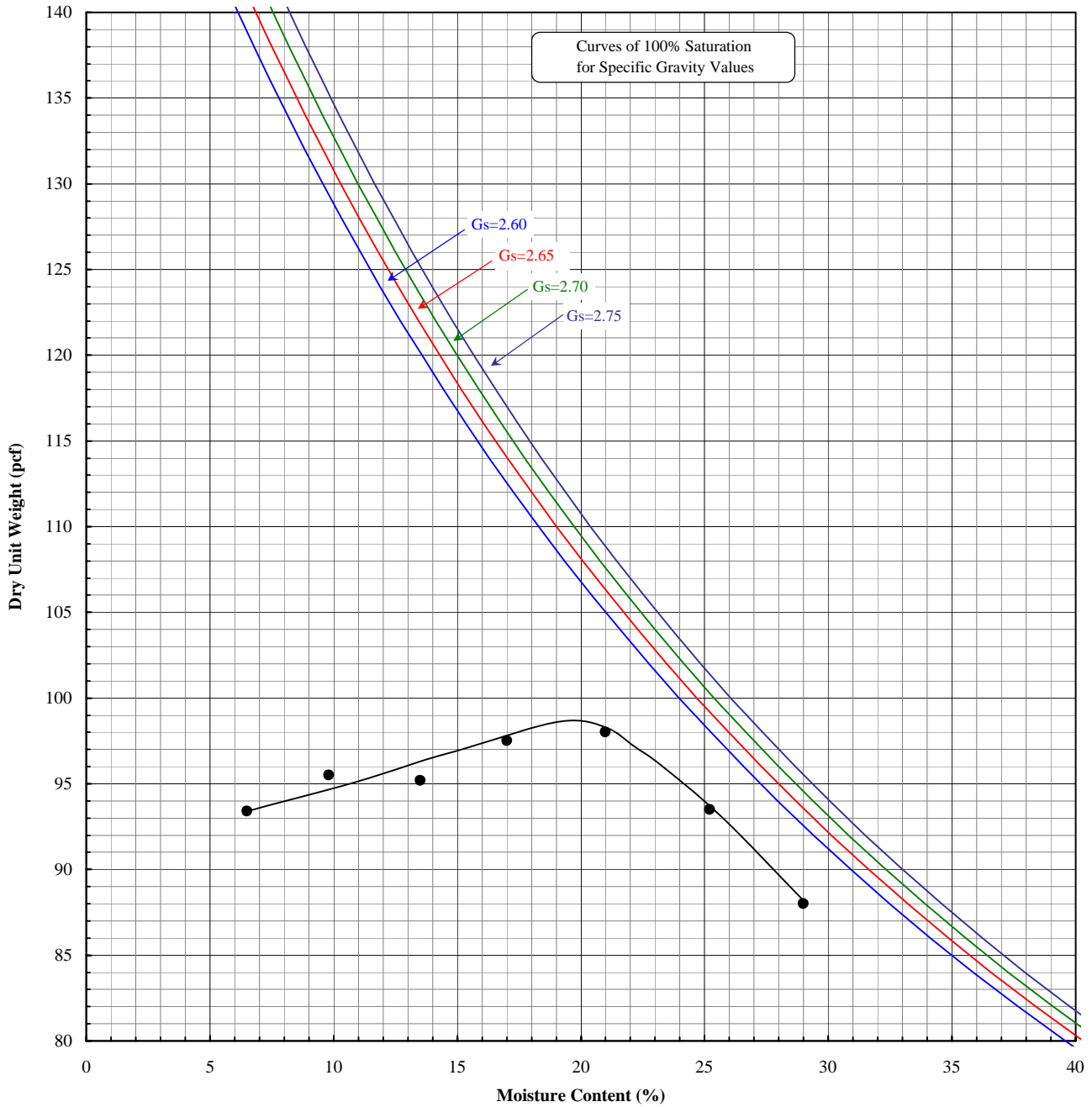
4405 International Blvd., Suite B-117, Norcross, GA 30093  
 Ph: (770) 931 8222 Fax: (770) 931 8240

**Project Name:** Interface Shear Strength  
**Project No:** SGI6013  
**Client Sample ID:** Silty Sand  
**Lab Sample No:** S11649

ASTM D698

## COMPACTION MOISTURE-DENSITY RELATIONSHIP

Standard - Method A

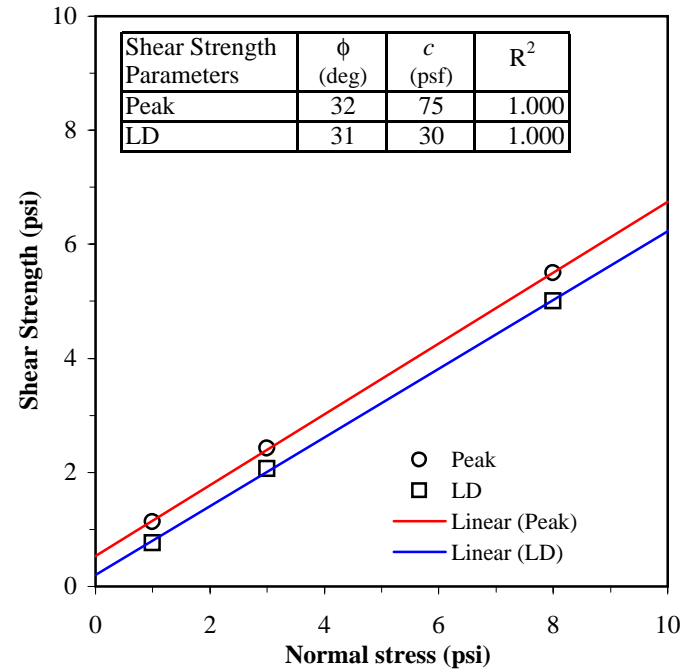
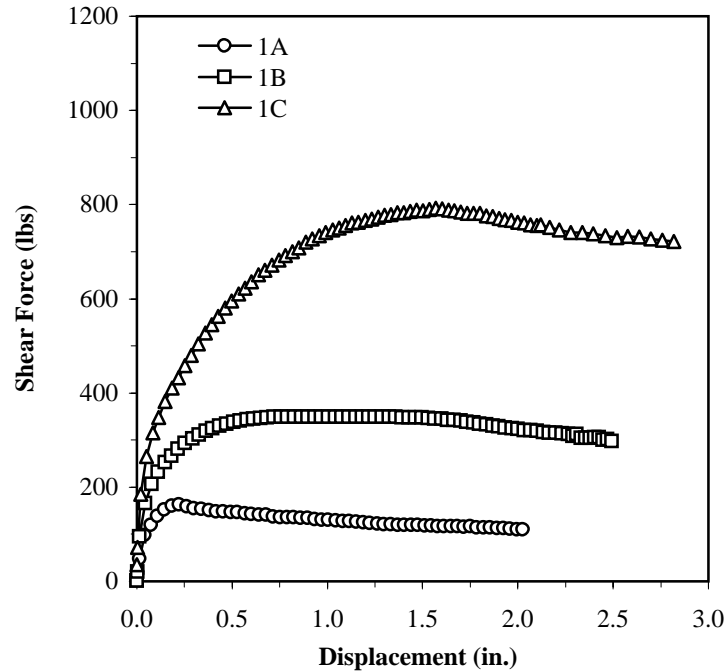


Client Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Silty Sand	S11649	98.5	19.0	

Note(s):

**SGI TESTING SERVICES**  
**DIRECT SHEAR TESTING (ASTM D 3080)**

Internal strength of silt sand compacted to approximately 95% of standard Proctor density at optimum moisture content



Test No.	Shear Box Size (in. x in.)	Normal Stress (psi)	Shear Rate (in./min)	Soaking		Consolidation		Lower Soil			Upper Soil			GCL		Shear Strength		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_p$ (psi)	$\tau_{LD}$ (psi)	
1A	12 x 12	1.0	0.040	-	-	-	-	94.1	19.5	19.0	94.1	19.5	19.0	-	-	1.14	0.77	(1)
1B	12 x 12	3.0	0.040	-	-	-	-	93.8	20.1	19.2	93.8	20.1	19.2	-	-	2.43	2.06	(1)
1C	12 x 12	8.0	0.040	-	-	-	-	93.6	18.2	18.3	93.6	18.2	18.3	-	-	5.50	5.01	(1)

**Notes:** (1) Sliding (i.e., shear failure) occurred internally through the silty sand at the predetermined plane between the upper and lower shear box during each test.  
(2) The reported total-stress parameters of friction angle and cohesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for application involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

DATE OF TEST: January 2003



**SGI TESTING SERVICES, LLC**

FIGURE NO.	
PROJECT NO.	SGI6013
DOCUMENT NO.	SGI06018
FILE NO.	

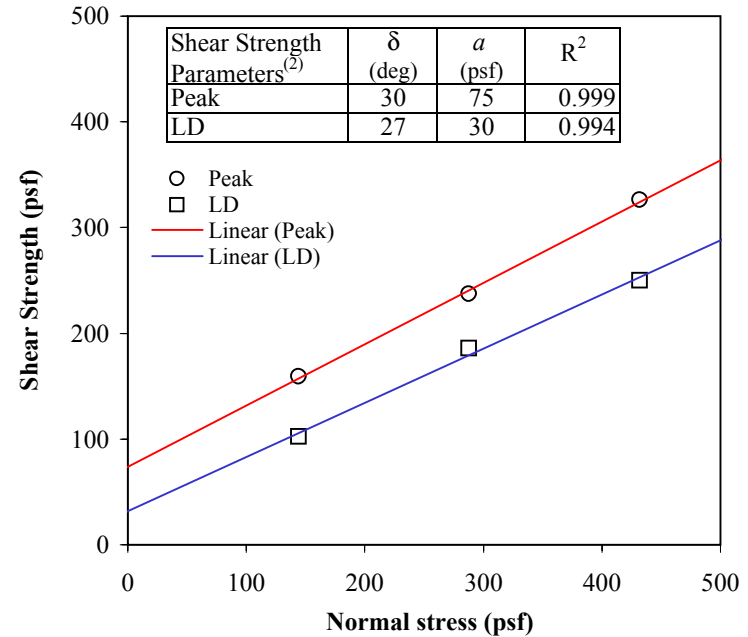
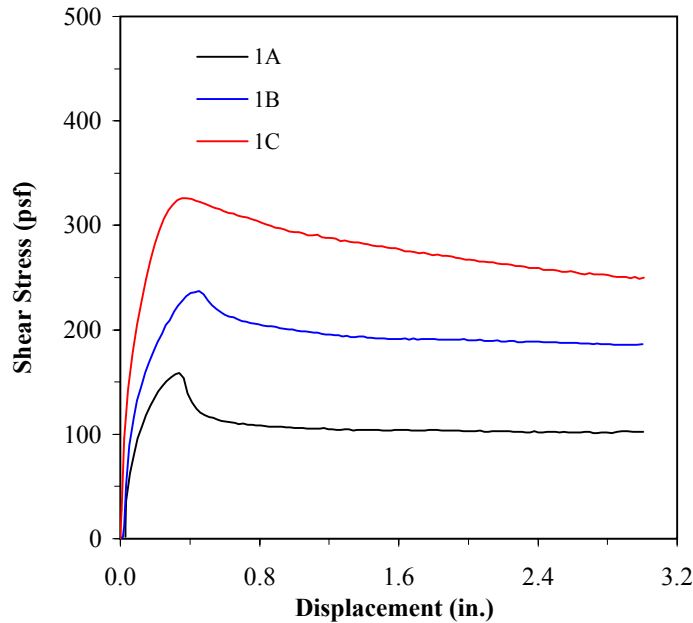
## **ATTACHMENT B**

### **INTERFACE DIRECT SHEAR TEST RESULTS**

**CETCO LINING TECHNOLOGIES - ANNUAL SHEARING  
GCL DIRECT SHEAR TESTING (ASTM D 6243)**

**Upper Shear Box:** Silty sand (SM) compacted to approximately 95% of max standard Proctor density at optimum moisture content/  
Organoclay RCM (Lot #200733LO/Roll # 1) with black side up against silty sand under soaked and consolidated conditions

**Lower Shear Box:** Steel grip



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking		Consolidation		Soil		RCM	Soil Shear Strength Parameters				Shear Strength		Coefficient of Direct Sliding		
				Stress (psf)	Time (hours)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)		$\omega_f$ (%)	$\phi_p$ (deg)	$c_p$ (psf)	$\phi_{LD}$ (deg)	$c_{LD}$ (psf)	$\tau_p$ (psf)	$\tau_{LD}$ (psf)	$C_{DS-P}$	$C_{DS-LD}$
1A	12 x 12	144	0.04	100	24	144	24	93.0	19.8	46.9	32	75	31	30	159	102	0.96	0.88	
1B	12 x 12	288	0.04	100	24	288	24	93.5	19.1	40.2	32	75	31	30	237	186	0.93	0.92	
1C	12 x 12	432	0.04	100	24	432	24	92.7	20.1	35.6	32	75	31	30	326	250	0.95	0.86	

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the silty sand-and back side of RCM in each test.
- (2) The reported total-stress parameters of friction angle and cohesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

DATE OF REPORT: 6/4/2008



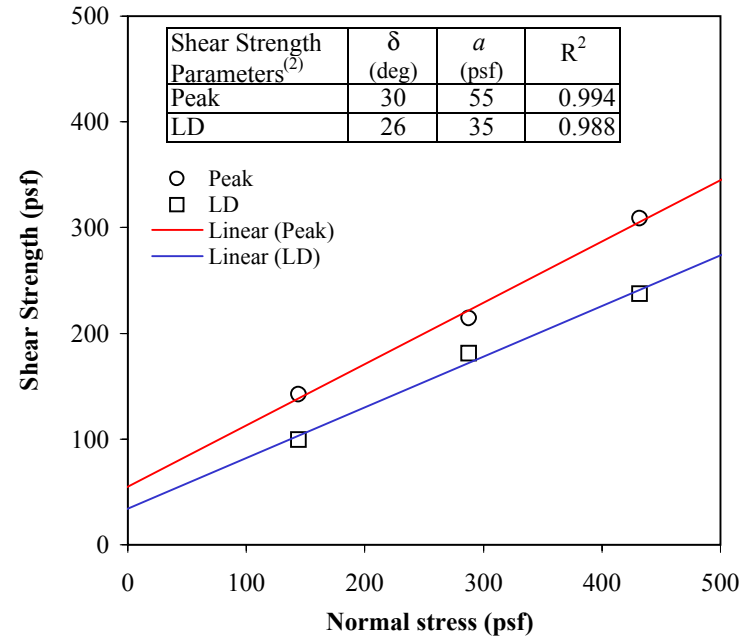
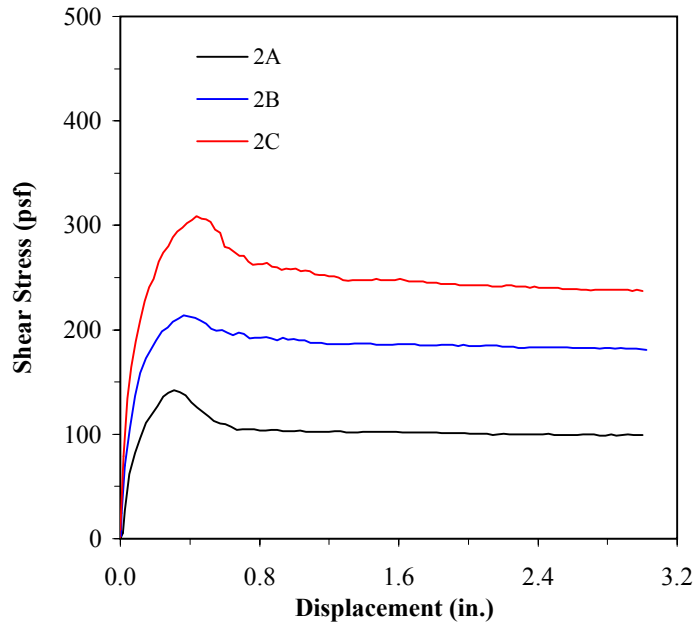
**SGI TESTING SERVICES, LLC**

FIGURE NO. C-1  
PROJECT NO. SG8007  
DOCUMENT NO.  
FILE NO.

**CETCO LINING TECHNOLOGIES - ANNUAL SHEARING  
GCL DIRECT SHEAR TESTING (ASTM D 6243)**

**Upper Shear Box:** Silty sand (SM) compacted to approximately 95% of max standard Proctor density at optimum moisture content/  
Organoclay RCM (Lot #200733LO/Roll # 1) with white side up against silty sand under soaked and consolidated conditions

**Lower Shear Box:** Steel grip



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking		Consolidation		Soil		RCM	Soil Shear Strength Parameters				Shear Strength		Coefficient of Direct Sliding		
				Stress (psf)	Time (hours)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)		$\omega_f$ (%)	$\phi_p$ (deg)	$c_p$ (psf)	$\phi_{LD}$ (deg)	$c_{LD}$ (psf)	$\tau_p$ (psf)	$\tau_{LD}$ (psf)	$C_{DS-P}$	$C_{DS-LD}$
2A	12 x 12	144	0.04	100	24	144	24	93.8	18.7	42.8	32	75	31	30	142	99	0.86	0.85	
2B	12 x 12	288	0.04	100	24	288	24	93.7	18.9	39.0	32	75	31	30	214	181	0.84	0.89	
2C	12 x 12	432	0.04	100	24	432	24	93.3	19.4	35.8	32	75	31	30	309	237	0.90	0.82	

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the silty sand-and back side of RCM in each test.
- (2) The reported total-stress parameters of friction angle and cohesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

DATE OF REPORT: 6/15/2008

FIGURE NO. C-2

PROJECT NO. SG8007

DOCUMENT NO.

FILE NO.



**SGI TESTING SERVICES, LLC**