

**APPENDIX D**

**DIRECT SHEAR INTERFACE TEST RESULTS**



# SGI TESTING SERVICES

A Georgia Limited Liability Company

5 April 2009

Mr. David Steele  
Parsons  
290 Elwood Davis Road, Suite 312  
Liverpool, NY 13088

Subject: Laboratory Test Results Transmittal  
Interface Direct Shear Testing

Dear Mr. Barker,

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

SGI appreciates the opportunity to provide laboratory testing services to Parsons. 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. Archived specimens will be discarded 30 days after the completion of the testing program, unless long-term storage arrangements are specifically made with SGI.
- (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.

SGI9002.REPORT.09.01

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

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Liverpool, Georgia 30048-2427

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

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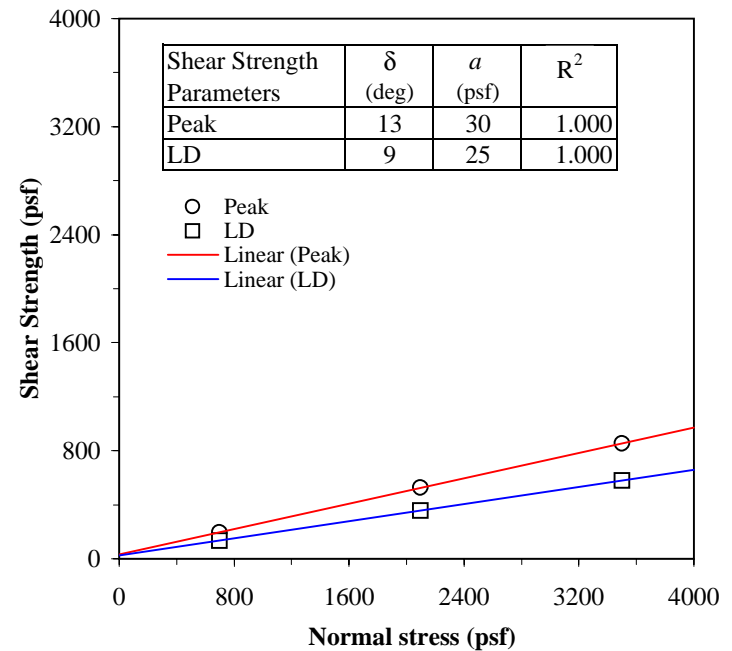
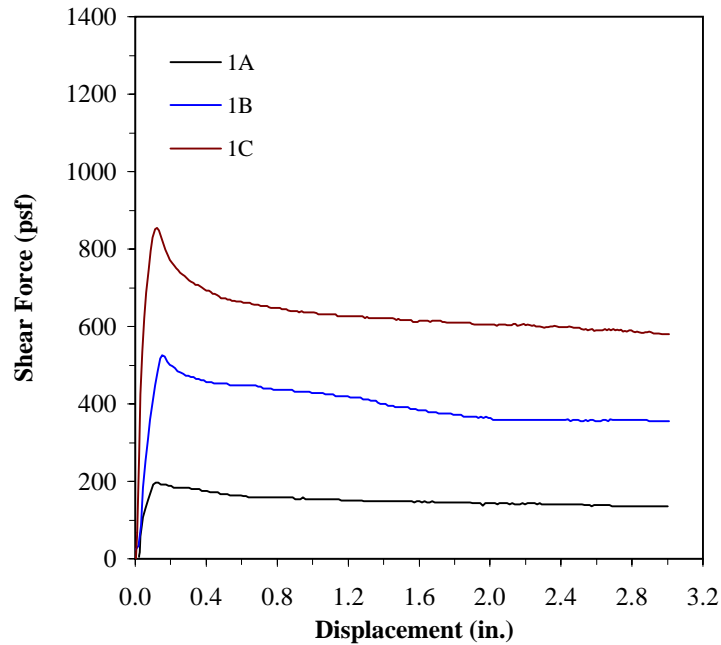
**PARSONS**  
**INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)**

**Upper Shear Box:** Concrete sand

TenCate S1600 (16 oz) nonwoven geotextile #000167745 with non heat-treated side down/

GSE 40-mil double smooth HDPE geomembrane # 101130132/

**Lower Shear Box:** Clay soil compacted to approximately 95% of max modified Proctor density at 3% wet of optimum moisture content



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking		Consolidation		Clay Soil			Upper Soil			GCL		Shear Stress		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_P$ (psf)	$\tau_{LD}$ (psf)	
1A	12 x 12	700	0.04	-	-	-	-	118.6	13.9	13.1	-	-	-	-	-	196	135	(1)
1B	12 x 12	2100	0.04	-	-	-	-	118.9	13.6	12.5	-	-	-	-	-	526	355	(1)
1C	12 x 12	3500	0.04	-	-	-	-	119.3	13.2	12.7	-	-	-	-	-	855	580	(1)

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the non heat-treated side of 16 oz nonwoven geotextile and geomembrane.
- (2) Each geosynthetic specimen was tested in the machine direction (i.e., direction of shearing parallel to MD)

DATE OF REPORT: 2/2/2009

FIGURE NO.	C-1
PROJECT NO.	SGI9002
DOCUMENT NO.	
FILE NO.	



**SGI TESTING SERVICES, LLC**

**ATTACHMENT A**

**INTERFACE DIRECT SHEAR  
TEST RESULTS**

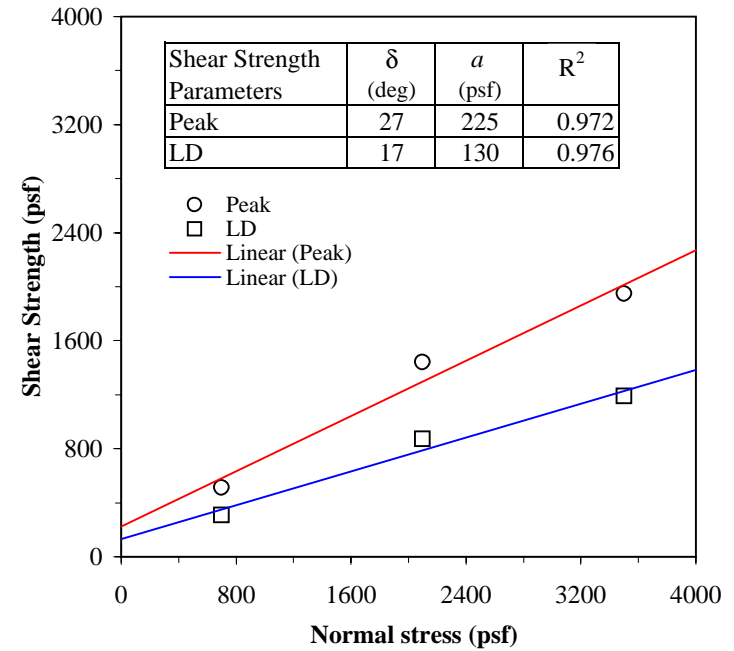
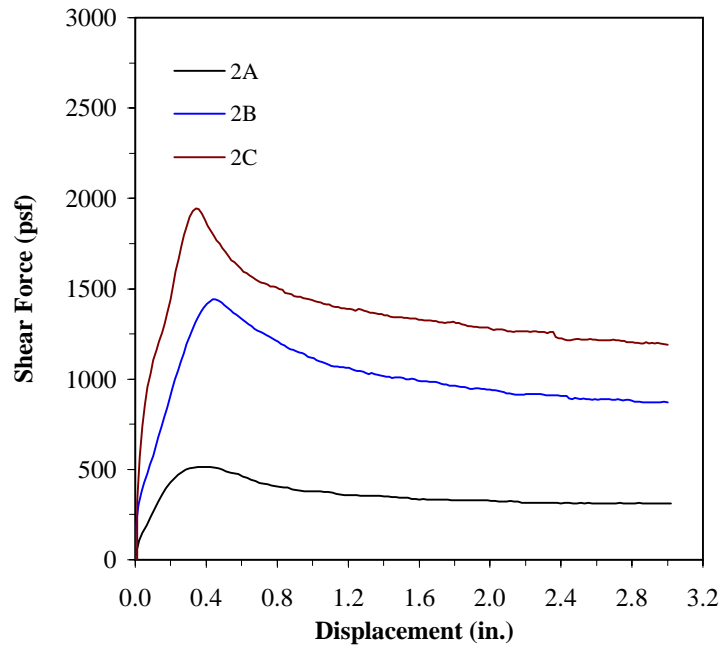
**PARSONS**  
**INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)**

**Upper Shear Box:** Concrete sand

TenCate S1600 (16 oz) nonwoven geotextile #000167745 with non heat-treated side down/

GSE 40-mil double textured HDPE geomembrane # 105140273/

**Lower Shear Box:** Clay soil compacted to approximately 95% of max modified Proctor density at 3% wet of optimum moisture content



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking		Consolidation		Clay Soil			Upper Soil			GCL		Shear Stress		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_P$ (psf)	$\tau_{LD}$ (psf)	
2A	12 x 12	700	0.04	-	-	-	-	119.6	12.9	12.2	-	-	-	-	-	514	310	(1)
2B	12 x 12	2100	0.04	-	-	-	-	119.9	12.6	12.0	-	-	-	-	-	1441	870	(1)
2C	12 x 12	3500	0.04	-	-	-	-	118.9	13.6	12.9	-	-	-	-	-	1946	1189	(1)

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the non heat-treated side of 16 oz nonwoven geotextile and geomembrane.
- (2) Each geosynthetic specimen was tested in the machine direction (i.e., direction of shearing parallel to MD)

DATE OF REPORT: 2/2/2009

FIGURE NO.	C-2
PROJECT NO.	SGI9002
DOCUMENT NO.	
FILE NO.	



**SGI TESTING SERVICES, LLC**

PARSONS

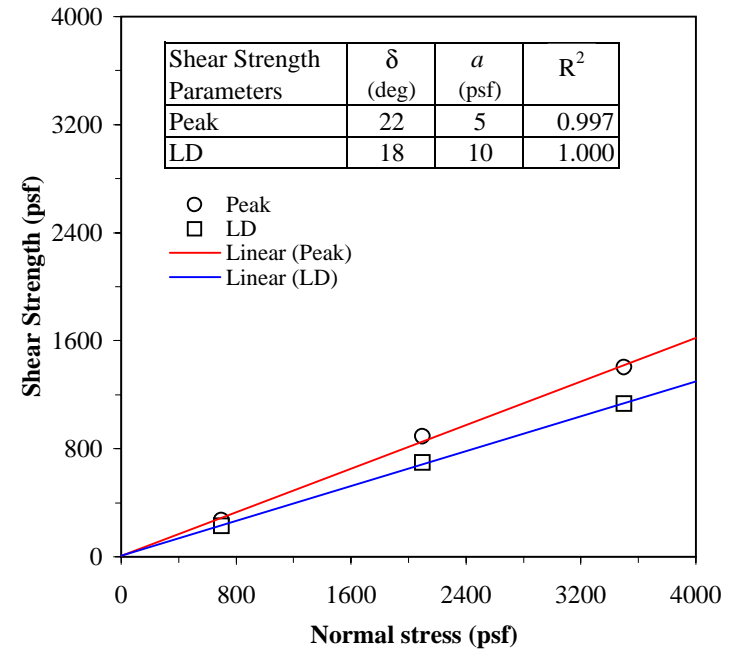
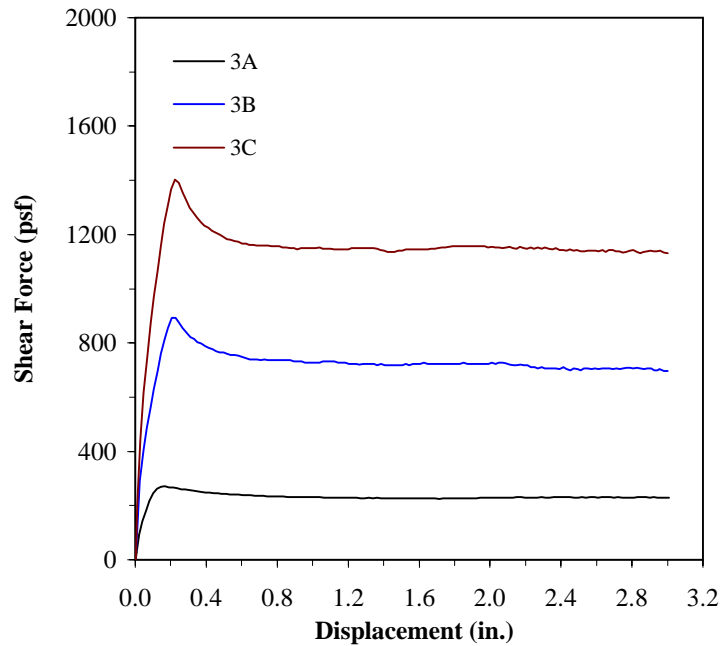
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

**Upper Shear Box:** Concrete sand

TenCate S1600 (16 oz) nonwoven geotextile #000167745 with non heat-treated side down/

40-mil EPDM geomembrane # AZ 12343/

**Lower Shear Box:** Clay soil compacted to approximately 95% of max modified Proctor density at 3% wet of optimum moisture content



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking		Consolidation		Clay Soil			Upper Soil			GCL		Shear Stress		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_P$ (psf)	$\tau_{LD}$ (psf)	
3A	12 x 12	700	0.04	-	-	-	-	119.8	12.7	12.3	-	-	-	-	-	271	228	(1)
3B	12 x 12	2100	0.04	-	-	-	-	119.4	13.1	12.5	-	-	-	-	-	892	697	(1)
3C	12 x 12	3500	0.04	-	-	-	-	119.1	13.4	12.8	-	-	-	-	-	1402	1132	(1)

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the non heat-treated side of 16 oz nonwoven geotextile and geomembrane.
- (2) Each geosynthetic specimen was tested in the machine direction (i.e., direction of shearing parallel to MD)

DATE OF REPORT: 2/4/2009

FIGURE NO. C-3  
 PROJECT NO. SG19002  
 DOCUMENT NO.  
 FILE NO.



**SGI TESTING SERVICES, LLC**

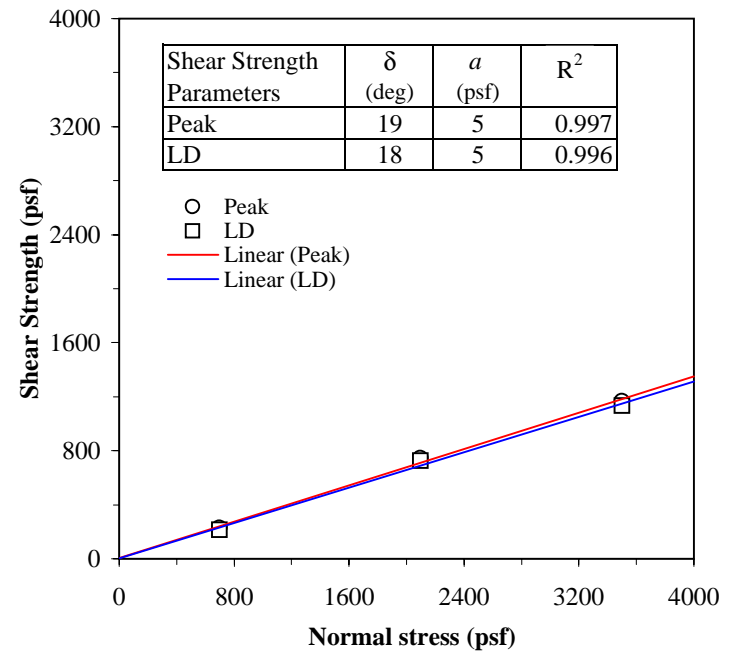
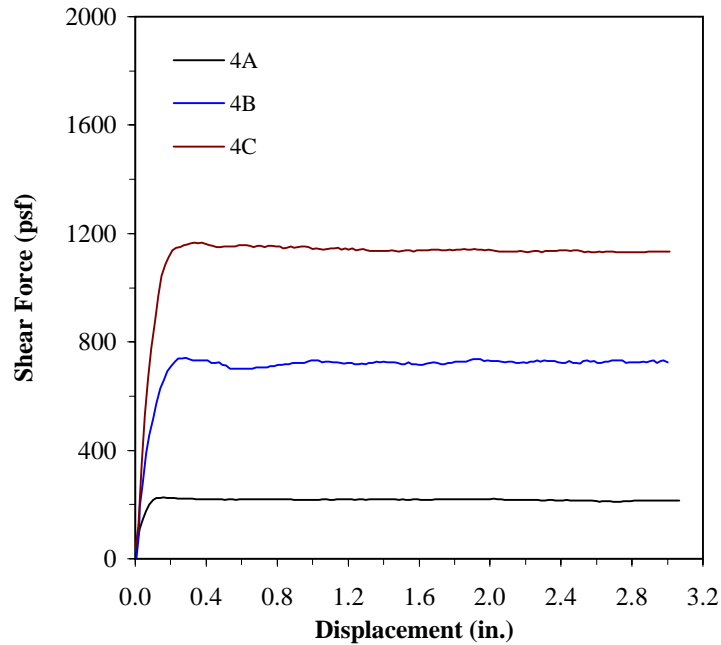
PARSONS

INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

**Upper Shear Box:** Concrete sand

TenCate S1600 (16 oz) nonwoven geotextile #000167745 with non heat-treated side down/  
40-mil PP geomembrane with rough side up to geotextile and smooth side down to clay soil/

**Lower Shear Box:** Clay soil compacted to approximately 95% of max modified Proctor density at 3% wet of optimum moisture content



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking		Consolidation		Clay Soil			Upper Soil			GCL		Shear Stress		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_P$ (psf)	$\tau_{LD}$ (psf)	
4A	12 x 12	700	0.04	-	-	-	-	118.6	13.9	13.3	-	-	-	-	-	226	215	(1)
4B	12 x 12	2100	0.04	-	-	-	-	119.0	13.5	12.9	-	-	-	-	-	742	726	(1)
4C	12 x 12	3500	0.04	-	-	-	-	118.8	13.7	12.5	-	-	-	-	-	1166	1133	(1)

**NOTES:**

- (1) Sliding (i.e., shear failure) occurred at the interface between the non heat-treated side of 16 oz nonwoven geotextile and rough side of geomembrane.
- (2) Each geosynthetic specimen was tested in the machine direction (i.e., direction of shearing parallel to MD)

DATE OF REPORT: 2/4/2009

FIGURE NO. C-4

PROJECT NO. SGI9002

DOCUMENT NO.

FILE NO.



**SGI TESTING SERVICES, LLC**

PARSONS

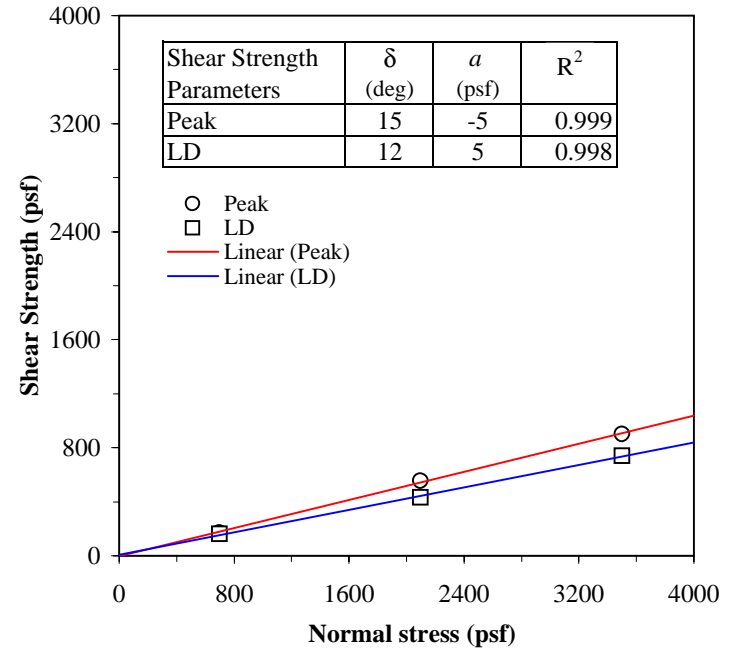
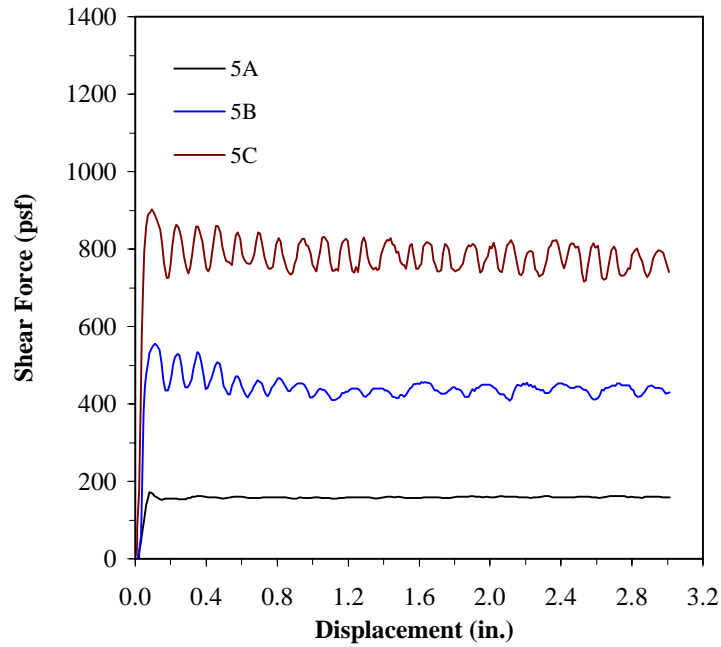
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: Rigid substrate

TenCate GT500 geotextile #021812318 in the machine direction/

TenCate GT500 geotextile #021812318 in the machine direction

Lower Shear Box: Concrete sand



Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking		Consolidation		Clay Soil			Upper Soil			GCL		Shear Stress		Failure Mode
				Stress (psf)	Time (hour)	Stress (psf)	Time (hour)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\gamma_d$ (pcf)	$\omega_i$ (%)	$\omega_f$ (%)	$\omega_i$ (%)	$\omega_f$ (%)	$\tau_P$ (psf)	$\tau_{LD}$ (psf)	
5A	12 x 12	700	0.04	-	-	-	-	-	-	-	-	-	-	-	-	172	159	(1)
5B	12 x 12	2100	0.04	-	-	-	-	-	-	-	-	-	-	-	-	555	429	(1)
5C	12 x 12	3500	0.04	-	-	-	-	-	-	-	-	-	-	-	-	902	741	(1)

NOTES:

- (1) Sliding (i.e., shear failure) occurred at the interface between the GT500 geotextile and GT500 geotextile.
- (2) Each geosynthetic specimen was tested in the machine direction (i.e., direction of shearing parallel to MD)

DATE OF REPORT: 2/2/2009

FIGURE NO. C-5  
 PROJECT NO. SGI9002  
 DOCUMENT NO.  
 FILE NO.



SGI TESTING SERVICES, LLC