



Allan Brantley
Brantley Engineering, LLC.
13933 Tree Loft Road
Milton, GA 30004

Dear Mr. Brantley:

Thank you for consulting TRI California for your material testing needs.

Enclosed is the **final** laboratory report for the **Interface Shear** testing of the materials in accordance to the test configurations listed below.

PROJECT NAME: JED LANDFILL CELL 10

REFERENCE TRI JOB NO.: G140196

DATE REPORTED: March 31, 2014

SAMPLED BY: TRI at AGRU SC, CETCO WY & SKAPS GA

MATERIAL DESCRIPTION & IDENTIFICATIONS:

| Material | Type | Manufacturer | Roll No. | TRI Control No. | Date Received |
|--------------|-----------------------|--------------|-------------|-----------------|----------------------|
| Geomembrane | 60mil HDPE Microspike | AGRU | G14A097093 | 96759 | 3/10/2014 |
| Geocomposite | TN270-2-8 | SKAPS | 57871010001 | 96798 | 3/11/2014 |
| Geocomposite | TN330-2-8 | SKAPS | 57871020001 | 96901 | 3/17/2014 |
| GCL | Berntomat ST | CETCO | 761 | 96797 | 3/11/2014 |
| Soil | General Fill | N/A | N/A | 96718 | 3/7/2014 & 3/20/2014 |
| Soil | Protective Cover | N/A | N/A | 96719 | 3/7/2014 & 3/20/2014 |

TESTS REQUIRED/PERFORMED:

TEST METHOD

ASTM D5321

ASTM D56243

DESCRIPTION

Interface Shear Testing

Interface Shear/Internal Shear Testing

TEST CONFIGURATIONS:

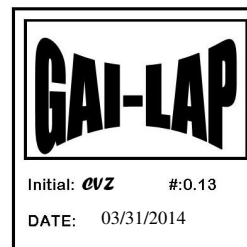
- GCL Internal Shear
- Cover Soil/330mil Geocomposite/60mil HDPE/270mil Geocomposite
- Fill Soil/Berntomat ST/60mil HDPE/270mil Geocomposite/60mil HDPE

TEST CONDITIONS: The samples were conditioned for a minimum of one hour in the laboratory at 21 to 23°C (71.6 ± 3.6°F) and at 60 ± 10% relative humidity prior to test.

TEST RESULTS: The test results are summarized in Table 1 to 3.

TRI Environmental, Inc. - California

Carmelo V. Zantua
Technical/Laboratory Director




It shall be noted that the samples tested are believed to be true representatives of the material produced under the designation herein stated. In addition, the attached laboratory tests results are considered indicative only of the quality of samples/specimens that were actually tested. The appropriate test methods hereby employed are based on the current and accepted industry practices. TRI neither accepts responsibility for nor makes claims to the intended final use and purpose of the material. The test data and all associated project information shall be held confidential and not to be reproduced and/or disclosed to other parties except in full and with prior written approval from pertinent entity duly authorized by the respective client or from the client itself. It is a policy of the company to keep physical records of each job for two (2) years commencing from the date of receipt of the samples and keep its corresponding electronic file for seven (7) years. ***Tested specimens and retained samples are kept for one (1) month.*** On the other hand, should you need us to keep them at longer time, please advise us in writing.

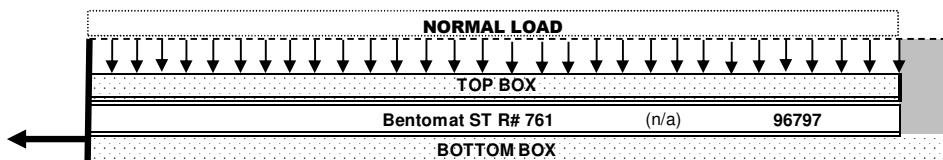
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TABLE 1
CLIENT: Brantley Engineering
PROJECT: JED Cell 10

INTERNAL SHEAR TEST RESULT (ASTM D6243)
TRI Job No. G140196

Reviewed By: 
 Date: **31-Mar-2014**

TEST CONFIGURATION 1



TEST CONDITIONS:

SAMPLE PREPARATION:

- Specimens were cut along machine direction with an effective test area of 12" x 12".
- Each face of the GCL specimen were fastened to a 1" thick PVC board coupled with a truss plate to secure the textiles in place.

CONSOLIDATION:

- Each set of specimen was consolidated under **wet** condition for **24 hours** at normal load before shearing.
- Normal loads were applied using **hydraulic** for the highest load and **bladder** for the other 2 loads.

SHEAR TEST:

- Shear test was conducted at **0.040** in/ min.
- Sheared at a maximum of **3.3 inch** horizontal displacement
- The test specimens were sheared at **wet** condition .
- Test were performed in general accordance with ASTM D6243 using Brainard-Kilman LG-112 Direct Shear machine with effective test area of 12 in X 12

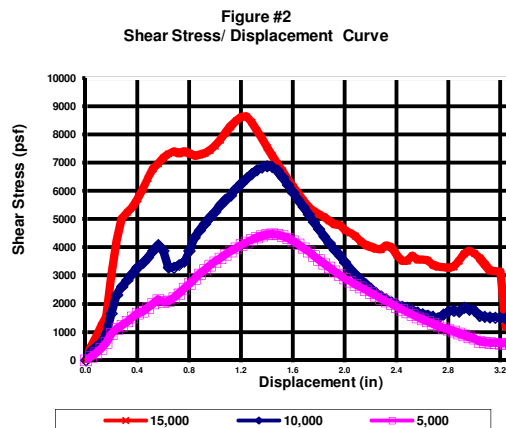
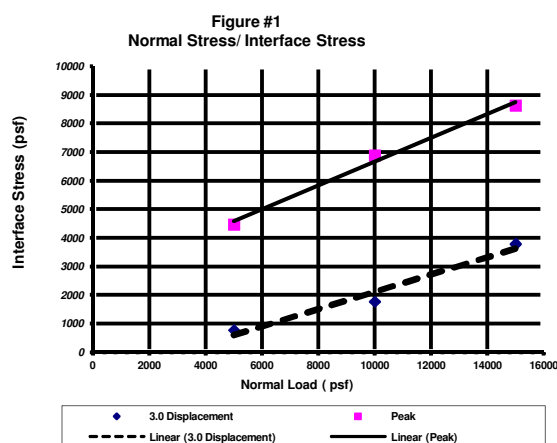
TEST RESULTS:

| Normal Stresses Applied | | GCL Moisture Content | | PEAK STRENGTH | | POST- PEAK STRENGTH AT 3.0 INCHES | |
|--------------------------------------|--------|-----------------------------------|---------|---------------|--------------|-----------------------------------|--------------|
| | | | | Shear Stress | Secant Angle | Shear Stress | Secant Angle |
| (psi) | (psf) | (Before) | (After) | (psf) | (degrees) | (psf) | (degrees) |
| 34.72 | 5,000 | 15.3 | 73.4 | 4,477 | 42 | 773 | 9 |
| 69.44 | 10,000 | 15.3 | 66.2 | 6,880 | 35 | 1,764 | 10 |
| 104.17 | 15,000 | 15.3 | 57.0 | 8,634 | 30 | 3,793 | 14 |
| Note: N/A - Not Applicable | | COHESION (psf) : | | 2507 | | 0 | |
| | | COEFFICIENT OF FRICTION : | | 0.42 | | 0.30 | |
| | | FRICTION ANGLE (degrees) : | | 22.6 | | 16.8 | |

NOTE: The friction angles and cohesion results given here are based on mathematically determined best fit line.

OBSERVATIONS:

- No tilting of the system or any abnormalities observed during and after the test.
- No visible tearing, stretching and wrinkling.

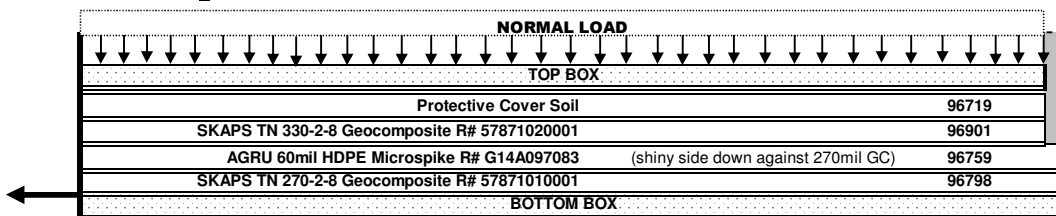


By accepting the data and results presented on this report, the Client agrees to limit the liability of Precision Geosynthetic Laboratories from Client and all other parties for claims on issues, due to the use of this data, to the cost for the respective tests presented in this report; and the Client agrees to indemnify and hold harmless Precision Geosynthetic Laboratories from and against all liabilities in excess of the aforementioned limit.

TABLE 2
CLIENT: Brantley Engineering
PROJECT: JED Cell 10 Landfill
INTERFACE SHEAR TEST RESULT (ASTM D5321)
TRI Job No. G140196

Reviewed By: _____
 Date: **31-Mar-2014**

TEST CONFIGURATION 2



TEST CONDITIONS:

SAMPLE PREPARATION:

- Geosynthetic specimens were cut along machine direction to 14" x 19" for the lower box, with an effective test area of 12" x 12".
- The soil was compacted to **93.8 pcf**; at **90% of MDD** at **12.5%** moisture content, forming 2 inch layer in the TOP box.
- The TN 270-2-8 secondary geocomposite specimens were secured in the bottom shear box via flat bar sampling mechanisms complete with bolt and nuts (7-pairs).
 The TN 330-2-8 primary geocomposite and 60mil HDPE microspike specimens were unclamped to the shear box during shear run.

CONSOLIDATION:

- Each set of specimen or system was consolidated under **wet** condition for **24 hours** at normal load before shearing.
- Normal loads were applied using **hydraulic** for the 15k psf load and **bladder** for the 10k and 5k psf loads.

SHEAR TEST:

- Shear test was conducted at **0.040** in/ min.
- Sheared at a maximum of **3.0 inch** horizontal displacement.
- The test specimens were sheared in **wet** condition.
- Test were performed in general accordance with ASTM D5321 using Geotac Direct Shear machine with effective test area of 12 in X 12 in.

TEST RESULTS:

| Normal Stresses Applied | | Soil Moisture Content | | Asperity Heights (Shiny side) | | PEAK STRENGTH | | | POST-PEAK AT 3.0 INCHES | |
|--------------------------------------|--------|-----------------------------------|------|-------------------------------|--------|---------------|--------------|--------------|-------------------------|--------------|
| | | | | | | Shear Stress | Secant Angle | Secant Angle | Shear Stress | Secant Angle |
| (psi) | (psf) | (%) | (%) | (mils) | (mils) | (psf) | (degrees) | (degrees) | (psf) | (degrees) |
| 34.72 | 5,000 | 12.5 | 22.7 | 31 | 29 | 1951 | 21 | | 1,161 | 13 |
| 69.44 | 10,000 | 12.5 | 21.3 | 31 | 27 | 3579 | 20 | | 2,168 | 12 |
| 104.17 | 15,000 | 12.5 | 21.0 | 31 | 27 | 5753 | 21 | | 3,209 | 12 |
| Note: N/A - Not Applicable | | COHESION (psf) : | | | | 0 | | | 131 | |
| | | COEFFICIENT OF FRICTION : | | | | 0.38 | | | 0.20 | |
| | | FRICTION ANGLE (degrees) : | | | | 20.8 | | | 11.6 | |

NOTE: The friction angles and cohesion results given here are based on mathematically determined best fit line.

OBSERVATIONS:

- No tilting of the system or any abnormalities observed during and after the test.
- Superficial abrasion on the geosynthetics interfacing sides (typical to all loads).
- No tearing, stretching and wrinkling observed on the specimens.
- Sliding occurred between the TN 270-2-8 secondary geocomposite and HDPE microspike interface.

Figure #1
Normal Stress/ Interface Stress

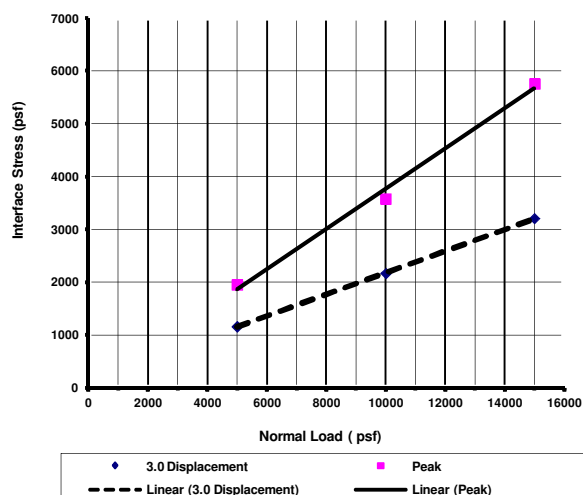
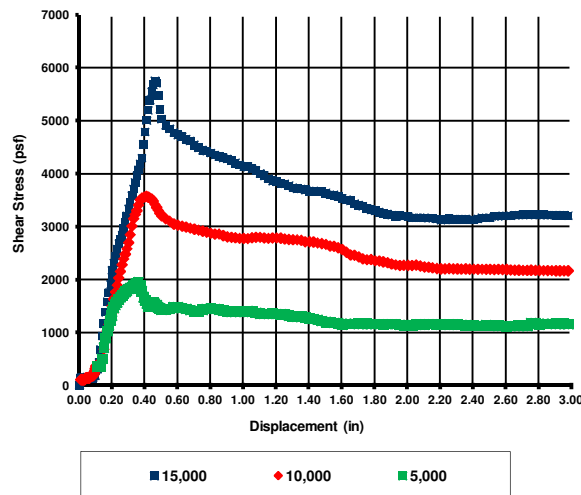


Figure #2
Shear Stress/ Displacement Curve




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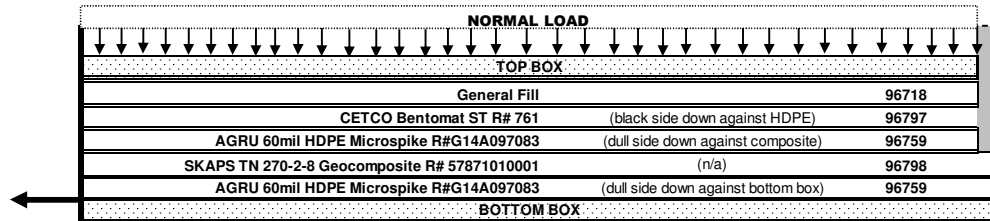
TESTING, RESEARCH, CONSULTING AND FIELD SERVICES

AUSTIN, TX - USA | ANAHEIM, CA - USA | ANDERSON, SC - USA | GOLD COAST - AUSTRALIA | SUZHOU - CHINA

TABLE 3
CLIENT: Brantley Engineering
PROJECT: JED Cell 10
INTERFACE SHEAR TEST RESULT (ASTM D6243)
TRI Job No. G140196

Reviewed By: 
Date: 31-Mar-2014

TEST CONFIGURATION 3



TEST CONDITIONS:

SAMPLE PREPARATION:

- Geosynthetic specimens were cut along machine direction to 14" x 19" for the lower box, with an effective test area of 12" x 12".
- Maximum Dry Density (MDD) of the select fill soil is 102.7 pcf at Optimum Moisture Content (OMC) of 15.40%.
- Soil was compacted to 97.6 pcf; at 95.0% of MDD at 15.4% moisture content, forming 2 inch layer in the TOP box.
- The lower 60mil HDPE were secured in the bottom shear box via flat bar sampling mechanisms complete with bolt and nuts (7-pairs).
The TN 270-2-8 secondary geocomposite, upper 60mil HDPE and Bentomat ST specimens were unclamped to the shear box during shear run.

CONSOLIDATION:

- Each set of specimen or system was consolidated under wet condition for 24 hours at normal load before shearing.
- Normal loads were applied using hydraulic for the 15k psf load and bladder for the 10k and 5k psf loads.

SHEAR TEST:

- Shear test was conducted at 0.040 in/min.
- Sheared at a maximum of 3.0 inch horizontal displacement.
- The test specimens were sheared in wet condition.
- Test were performed in general accordance with ASTM D6243 using Geotac Direct Shear machine with effective test area of 12 in X 12 in.

TEST RESULTS:

| Normal Stresses Applied | | Soil Moisture Content | | Lower HDPE Asperity Heights (Shiny side) | | PEAK STRENGTH | | POST-PEAK AT 3.0 INCHES | |
|-------------------------------|--------|----------------------------|-------|--|--------|---------------|--------------|-------------------------|--------------|
| | | Before | After | Before | After | Shear Stress | Secant Angle | Shear Stress | Secant Angle |
| (psi) | (psf) | (%) | (%) | (mils) | (mils) | (psf) | (degrees) | (psf) | (degrees) |
| 34.72 | 5,000 | 15.4 | 24.0 | 31 | 29 | 1875 | 21 | 1,281 | 14 |
| 69.44 | 10,000 | 15.4 | 23.6 | 31 | 28 | 3301 | 18 | 2,209 | 12 |
| 104.17 | 15,000 | 15.4 | 21.6 | 31 | 27 | 5189 | 19 | 2,807 | 11 |
| Note: N/A - Not Applicable | | COHESION (psf) : | | | | 142 | | 573 | |
| | | COEFFICIENT OF FRICTION : | | | | 0.33 | | 0.15 | |
| | | FRICTION ANGLE (degrees) : | | | | 18.3 | | 8.7 | |

NOTE: The friction angles and cohesion results given here are based on mathematically determined best fit line.

OBSERVATIONS:

- No tilting of the system or any abnormalities observed during and after the test.
- Superficial abrasion on the geosynthetics interfacing sides (typical to all loads).
- No tearing, stretching and wrinkling observed on the specimens.
- Sliding occurred between the 60mil HDPE microspike and TN 270-2-8 secondary geocomposite interface.

Figure #1
Normal Stress/ Interface Stress

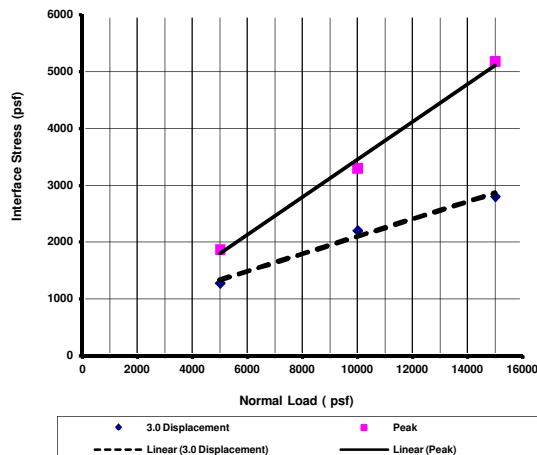
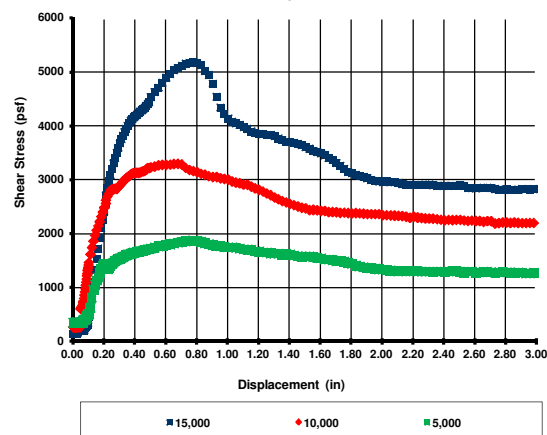


Figure #2
Shear Stress/ Displacement Curve



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