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16. Abstract

As part of Research Project 0-4829, a new testing device was developed and a field monitoring program was initiated to evaluate the performance of geosynthetics used as reinforcement for unbound base courses. This implementation includes the use of the new testing device and procedures developed by the 0-4829 research project, which involves characterization of the confined stiffness in geosynthetic reinforcements. The project also provides continued monitoring of 32 experimental test sections constructed in FM2 and 6 test sections constructed in FM1644 for the purpose of correlating field performance with material characterization. The experimental component of this implementation project was accomplished by testing 11 different geosynthetic reinforcement products in the small pullout test. The field component of this implementation project involved conducting continued condition surveys, subsurface exploration, and weather data gathering in order to establish the threshold of the proposed confined stiffness parameter in the new specification based on the field performance.

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Geosynthetic-Reinforced Unbound Base Courses: Quantification of the Reinforcement Benefits

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Chapter 1. Objectives and Scope of the Report

An important objective of this project is to implement the new testing device and procedures proposed by the 0-4829 research project. The testing involves a modified small pullout device for characterization of the confined stiffness in geosynthetic reinforcements. The project also provided continued monitoring of 32 experimental test sections constructed in Farm-to-Market Road (FM) 2 and 6 experimental sections constructed in FM1644 for the purpose of comparing field performance with material characterization. The experimental component of this implementation project was accomplished by testing 11 different geosynthetic reinforcement products in the small pullout test. The field component of this implementation project involved conducting continued condition surveys, subsurface exploration, and weather-data gathering in order to establish the threshold of the proposed parameter in the new specification based on the field performance.

The contents of this report build on the previous report 5-4829-01-1 (Zornberg et al. 2012a), which included the theoretical background as well as the validation of the new laboratory testing procedures, equipment construction, and training TxDOT personnel. Accordingly, the focus of this report is on the presentation of experimental test results using the validated testing approach (Chapter 2) and the comparative evaluation of the field performance at the experimental sites in FM2 and FM1644 (Chapter 3). The comprehensive results of the small pullout tests are presented in Appendix A (found on the accompanying CD).

The research team generated experimental data to assess the important relationships that define the performance of geosynthetic-reinforced pavements—namely, confined tensile modulus under low strains and soil-geosynthetic interface shear behavior under low strains. The proposed, validated testing device, testing procedures, and corresponding specifications include generation of data using the geosynthetic products adopted in the two experimental sites undergoing field monitoring.

In addition, to validate the experimental results against field performance, the research team continued to monitor the structural condition of TxDOT-constructed pavement sections in FM2 and FM1644. Field monitoring includes continued condition surveying to document and quantify the field performance of the sections, continued gathering and evaluation of relevant weather data, and quantification and assessment of cracks and deterioration that may develop in the monitored sections. Also conducted was a comprehensive subsurface subgrade and pavement characterization to confirm the layout of the multiple sections at the FM2 experimental field site.

Chapter 2. Experimental Testing Program for Characterization of the Soil-Geosynthetic Interaction Stiffness

2.1 Introduction

This report contains all the results of the small pullout testing program conducted for this project, including the tests conducted for the development and evolvement of the test procedure until the final configuration. The main parameter obtained from these tests is the coefficient of soil-geosynthetic interaction, K_{SGI}. The K_{SGI} is a quantification of the stiffness of the soil-reinforcement interface under low strains, and is thus suitable as an index property for evaluating the confined performance of geosynthetic products in base-reinforced pavements.

Geosynthetic products used in the small pullout testing program included those used in FM2 and FM1644, as well as other products. These products were tested under confinement of a sieved aggregate that was selected as the standard soil. This chapter presents a detailed description of the geosynthetic products and analyses of the test results in the final recommended configuration of the test. These analyses include an evaluation of the repeatability of the results and a comparative evaluation of the results obtained for the various geosynthetic products.

Until the final configuration of the small pullout test was established, several other configurations were evaluated. Four different soils were tested with the geosynthetic products in addition to the sieved aggregate. A summary of these soils is presented in Table 2.1. The soil recommended for use with the small pullout test is Sieved Aggregate 2. Detailed descriptions of the soils along with the particle size distribution curves are also presented in this chapter.

This chapter comprises six sections. The first section describes the small pullout test equipment. Then, the scope of the testing program is presented, followed by the history of the development of the small pullout test. Next, the final procedure of the test is explained, including the data smoothing process and the calculation of the parameter K_{SGI}. Additionally, the analysis of the results of the testing matrix is provided. The final section presents a comparative evaluation of the K_{SGI} values for the 11 geosynthetic products obtained using Sieved Aggregate 2.

Table 2.1 Soils used in the testing program

Soil Description	Name used in this report	Comment
Sieved aggregate	Sieved Aggregate 2	Soil chosen for the final configuration of the small pullout test. Particles pass Sieve #1/4 and are retained on Sieve #4
Uniform sand	Monterey Sand	Commercial name: Monterey #30 Sand. First soil used in the testing program
Blend of sieved aggregate and uniform sand	Soil Blend	Soil blend composed of 75% of Sieved Aggregate 2 and 25% of Monterey Sand
Sieved aggregate	Sieved Aggregate 1	Particles passing Sieve #3/8 and retained on Sieve #1/4
Uniform aggregate	Aggregate	Gravel classified as uniform by the USCS

Note: USCS = Unified Soil Classification System

2.2 Test Equipment and Testing Procedure

The small pullout test equipment has the same basic components of the traditional pullout equipment described in the ASTM D 6706. However, there are two main differences. First, the volume of soil used in the small pullout test device is only 13.1% of the volume of soil used in a pullout box with the minimum dimensions suggested in ASTM D 6706. Second, the small pullout test device is used in a vertical position since it is designed to be employed with load frames dedicated to wide-width tensile strength tests of geosynthetics, as specified by the ASTM D 4595 and D 6337.

The cross section of the small pullout test setup is shown in Figure 2.1. Figure 2.2 shows the plan view of the test setup and illustrates the points of the geosynthetic specimen where displacements are monitored during the test. The small pullout box is composed of reinforced steel plates with internal dimensions of 11.8 in. (30 cm) x 9.8 in. (25 cm) x 5.9 in. (15 cm) (width x length x height). The internal side of the front wall of the box is flat, with an aperture of 0.59 in. (15 mm) through which the geosynthetic specimen is attached to the grip (Figure 2.1). The confining pressure is applied using compressed air in a bag attached to the lid of the box. The box is attached to a support frame that accommodates the displacement sensors and replaces the bottom grip of a wide-width tensile strength test (Figure 2.1 and Figure 2.2). The displacement sensors are linear variable differential transformers (LVDTs).

The width of the confined portion of the geosynthetic specimen is 11.0 in. ± 0.2 in. (28.0 cm ± 0.5 cm). The adjustment of ± 0.2 in. (0.5 cm) is to accommodate different aperture sizes of geogrid products. Bendalloy™ wires (cobalt-based alloy) of 0.016 in. in diameter are attached at five different junctions along the embedded length of the geogrid (at five locations along the geotextile). These wires are then attached to the displacement sensors to obtain the displacement along the geosynthetic specimen mobilized during the test.

The internal walls are covered with two layers of 0.007-in.-thick Mylar® sheet, a clear polyester sheet. White lithium grease is used between the walls of the box and the first layer of polyester sheet, and between the two layers of polyester sheet. The polyester sheet and grease are used to minimize friction between the compacted soil and the walls of the small pullout box.

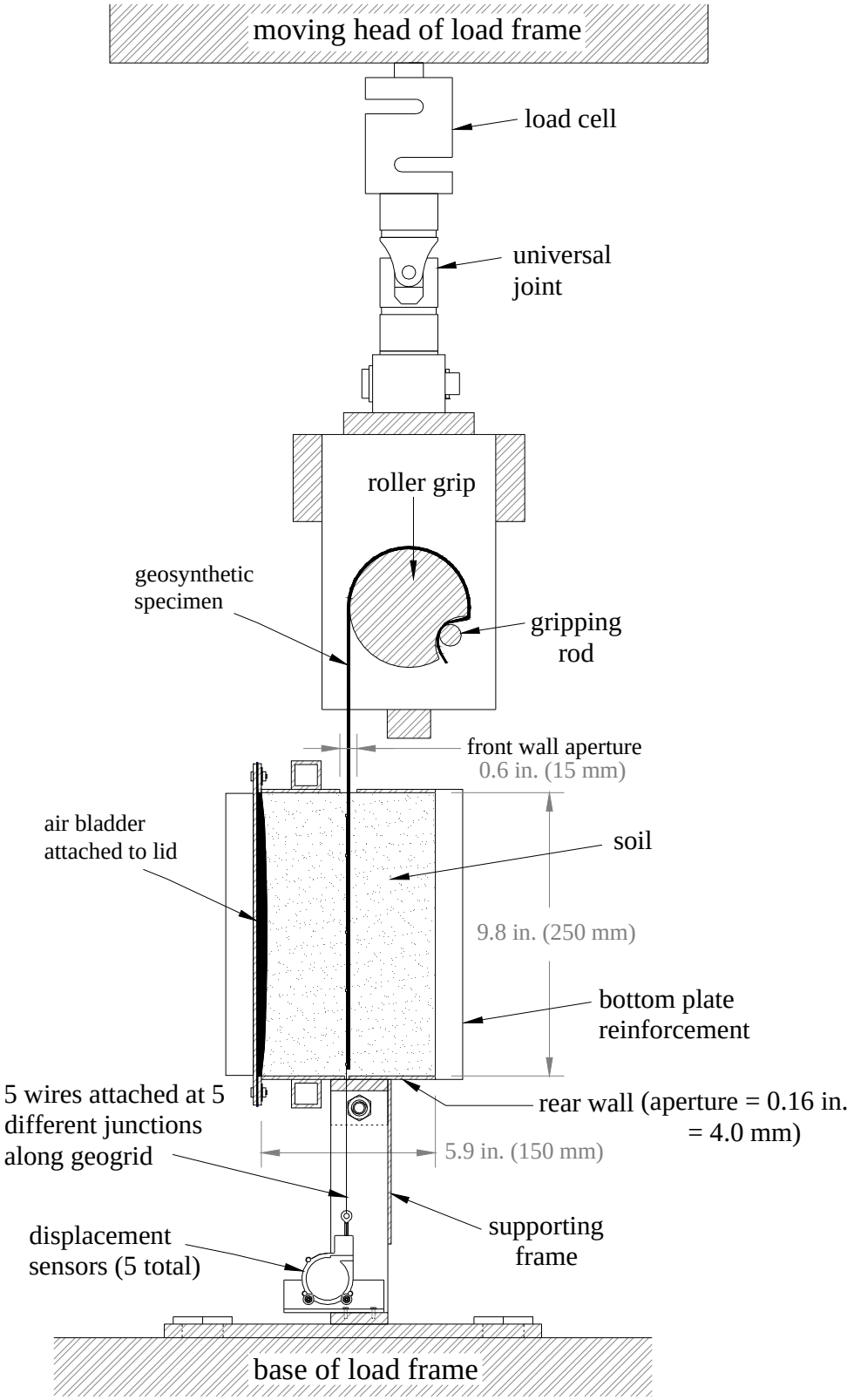
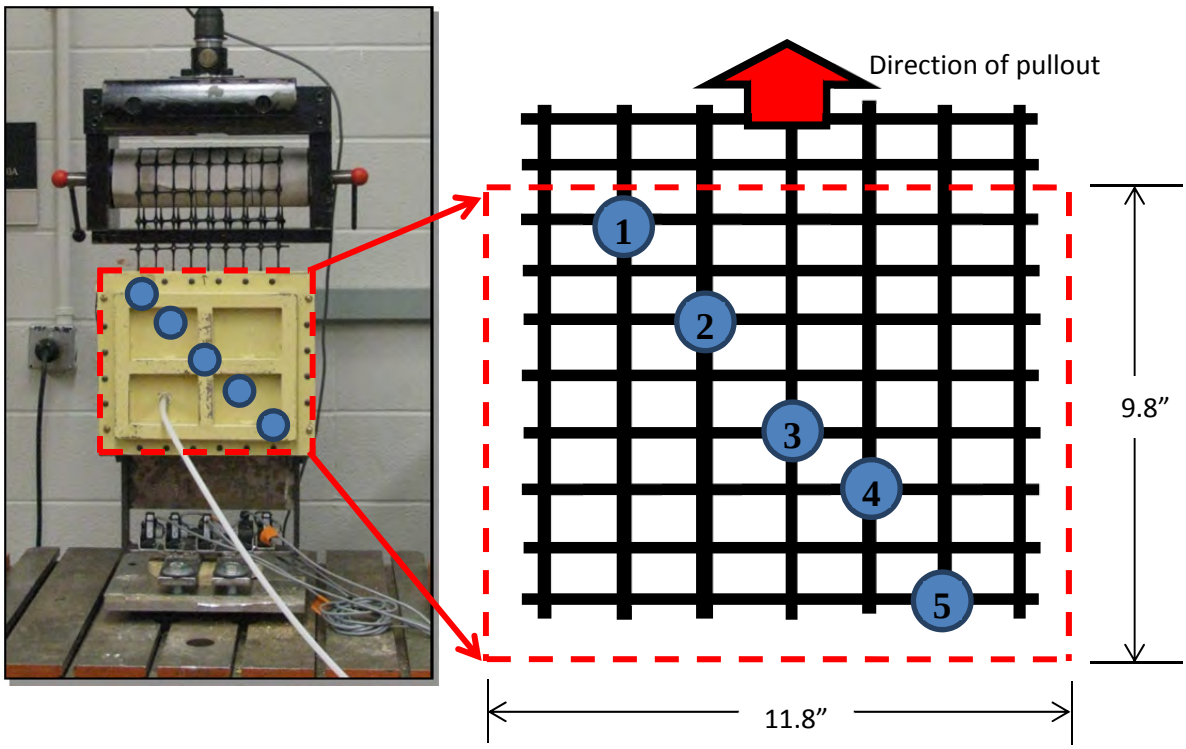


Figure 2.1 Cross section of the small pullout test setup.



(a) (b)

Figure 2.2 Small pullout testing: (a) Plan view of the small pullout test setup at UT Austin; (b) Location of points of monitored displacements along the geosynthetic specimen.

Soil compaction is conducted using a Bosch pneumatic hammer model GSH 11E with the coupling of a 6 x 6 in. squared head to the hammer. The degree of compaction is controlled by measuring the mass and the height of the compacted soil lifts in the box. The target dry density of Sieved Aggregate 2 specified for the small pullout test in this project is 96 ± 2 pcf (1.54 ±0.04 g/cm^3). The soil mass in the box is compacted in four lifts: two lifts for the bottom layer, which is below the level of the geosynthetic specimen, and two lifts for the top soil layer. Each lift is first compacted by placing a wooden board with dimensions of 11.5 in. x 9.5 in. on top of the soil, then using the pneumatic hammer on the wooden board for pre-compaction of the lift and leveling of the soil surface. Next, the wooden board is removed and the soil is compacted with the pneumatic hammer directly on the soil—initially with one blow in the center of the box and then four blows on each corner, starting with the corners near the front wall. This sequence is repeated until the desired height of the lift is reached.

After compaction of the last layer of soil, a piece of non-woven geotextile is placed to cover the soil and the lid of the box is attached. The geotextile is used to prevent damage to the air bladder used to apply the confining pressure. Next, the entire box is placed on a scale and the mass recorded for confirmation of the target dry density of the soil.

The next step involves applying the confining pressure. A pressure of 3.0 psi (21 kPa) was specified for the final configuration of the test. Initially, during the development of the small pullout test, a confining pressure of 1 psi (7 kPa) was used since it would be representative of the confinement on the geosynthetic reinforcement utilized at the field experiment at the FM2 road. In this field experiment, the geosynthetic was placed at a depth of 8 in., covered by 7 in. of

flexible base course and 1 in. of asphalt chip seal. However, a confining pressure of 1.0 psi (7 kPa) was found to be difficult to apply with adequate precision and to maintain constant throughout the test. After additional testing, the confining pressure of 3.0 psi (21 kPa) was chosen as the standard pressure for the small pullout test to evaluate geosynthetic products for base course reinforcement for mitigating environmental longitudinal cracking. This evaluation is performed with the index parameter K_{SGI}, a coefficient of soil-reinforcement interaction stiffness (Zornberg et al. 2012a).

The confining pressure is regulated with a digital gauge manufactured by Ashcroft with nominal precision of 0.01 psi (0.07 kPa) and accuracy of 0.08 psi (0.55 kPa). After applying the desired confining pressure, the box is secured on the support frame on the universal testing machine, and the wires are attached to the respective displacement sensors (Figure 2.1). Then the geosynthetic specimen is attached to the grip with a torque of 12.5 lbf/ft applied to the screws that secure the rod to the roller grip. To prevent slippage of the specimen in the grip, the surfaces of the rod and of the roller grip between the screws are covered on each side with three pieces of sanding belt glued with Duro® super glue. The sanding belt is a resin bond aluminum oxide with cotton cloth and medium (#80) grit manufactured by 3M™.

Before starting the test, a pre-load of about 30 lbf (0.15 kN) is applied. Then the pullout test is started with a constant rate of displacement of 0.04 in./min. (1 mm/min). Typical test results are shown in Figure 2.3, which presents the data for a test with geogrid Tensar BX1200 (referred to in this report as GG PP2) on the cross-machine direction in Sieved Aggregate 2 and a confining pressure of 3 psi (21 kPa). This curve is consistent with tests under low confining pressure reported in the literature (Lopes and Ladeira, 1996; Farrag et al., 1993; Moraci and Recalcati, 2006). As illustrated in Figure 2.3:a, a typical plot of pullout force vs. displacement along the geosynthetic reaches a maximum constant pullout load, which is defined as the pullout failure. The tests in this program were carried out up to pullout failure unless otherwise indicated.

(a)

(b)

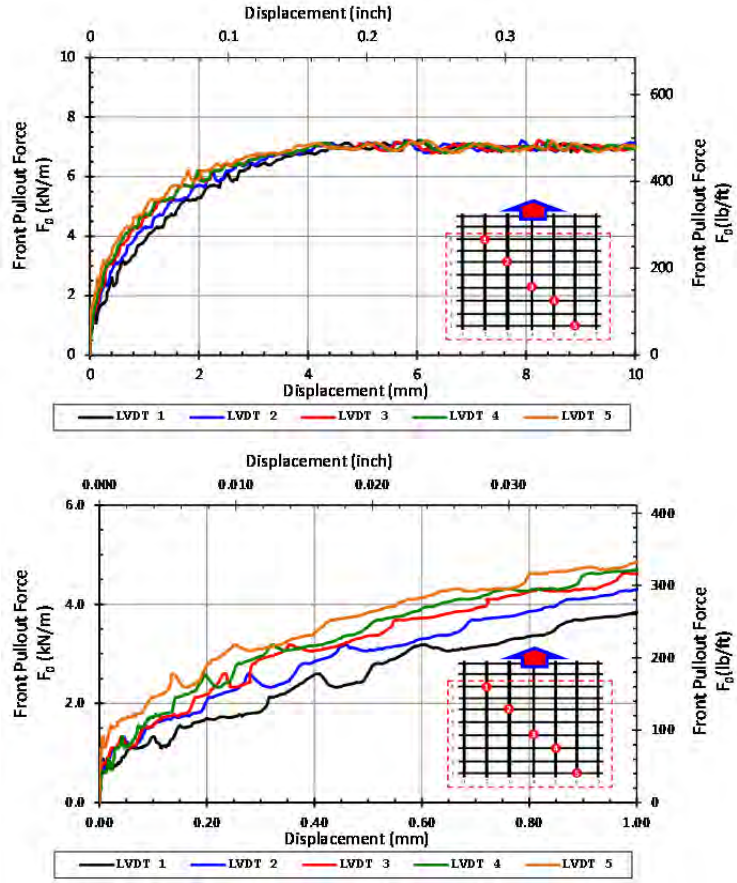


Figure 2.3 Typical pullout test results obtained with geogrid GG PP2 in the cross-machine direction, confining pressure of 3 psi (21 kPa) in Sieved Aggregate 2: (a) Entire test data showing pullout failure; (b) Data until 1 mm (0.04 in.) of displacement (the range used for calculation of the K_{SGI}).

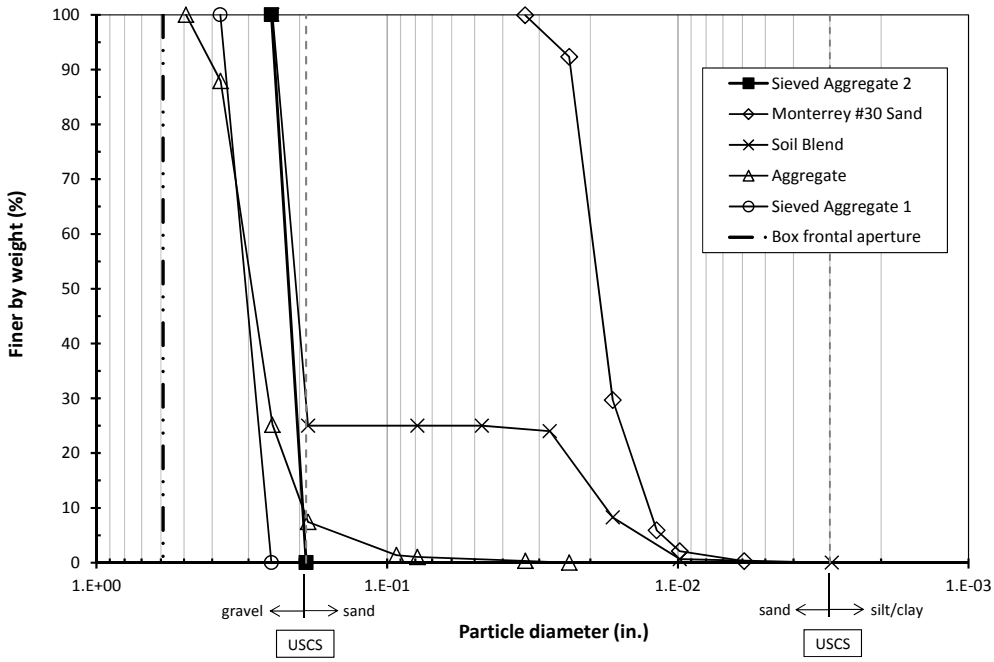
2.3 Scope of the Testing Program

Five different soils were used in this study (Table 2.1). These soils were used at different stages of the testing program for development of the final test procedure. The particle size distribution curves of the soils are presented in Figure 2.4.

Sieved Aggregate 2 contains particles of sizes between 0.19 in. (sieve #4) and 0.25 in (6.4 mm), and thus on the lower limit to be considered gravel. This soil is classified as GP in the United Soil Classification System (USCS) and A-1 in the American Association of State Highway and Transportation Officials (AASHTO) system. This soil was chosen for the final configuration of the small pullout test.

The Monterey #30 Sand is a uniformly graded standard sand classified as SP in the USCS with most particles near the diameter of the #30 sieve (0.024 in.). In the beginning of the testing program, the sand was compacted at a water content of 2.0 ±0.3%, which was later changed to a water content of 1.5 ±0.3%. The water was added to prevent the sand from falling out of the box through small spots between the box and the lid and through the aperture at the rear wall through which the wires attached to the geosynthetic are connected to the displacement sensors. This was the first soil used in the testing program because it is a granular standard soil compatible with the

dimensions of the small pullout box. However, the interaction mechanism of a uniform sand is not necessarily representative of those of coarser aggregates used in field projects. Specifically, base course layers used in pavement construction usually involve larger particles, i.e., gravelly materials. In this case, interlocking may be the main interaction component between soil and geogrid reinforcement. Accordingly, the testing matrix was changed to incorporate a gravel-sized material. The test results with sand are briefly discussed in Section 2.4.



Note: USCS = Unified Soil Classification System.

Figure 2.4 Particle size distribution curves of the soils used in the testing program.

The first gravel-size material tested is identified as Aggregate in Table 2.1. This soil is crushed dolomitic limestone, uniformly graded gravel formed with less than 10% of sand (Figure 2.4), classified as GP by the USCS. The maximum particle size is 0.5 in. The Aggregate was rinsed with water and used as received from the quarry[1]. The small pullout test results obtained with this soil showed poor repeatability. In 5 out of the 23 tests with this soil, particle jamming was visually detected at the front wall aperture when soil was exiting the box as the geogrid specimens were being pulled out. This problem is discussed in more details in Section 2.4. Moreover, it was concluded that the particle size distribution of this soil is difficult to reproduce for future laboratory testing. Accordingly, this soil was sieved to a uniform size and named Sieved Aggregate 1.

Sieved Aggregate 1 was sieved to particle sizes between 0.25 in. and 0.375 in. (6.4 to 9.5 mm)—thus with a maximum diameter smaller than that of the Aggregate—in an attempt to solve the particle jamming problem. Sieved Aggregate 1 is also categorized as GP according to the USCS and A-1 according to the AASHTO classification system. Particle jamming problems still occurred with this soil. The repeatability of the test results, including the ones with no apparent

[1] Capitol Aggregates Inc., Marble Falls Quarry. 8147 US Highway 281, Marble Falls, TX. Phone: (830) 693-2933.

particle jamming, was also inadequate. Discussion of these results and examples of data showing the occurrence of particle jamming are addressed in Section 2.4.

Accordingly, Sieved Aggregate 1 was replaced by a finer gravel, sieved to particle sizes between 0.19 in. and 0.25 in. (4.75 and 6.4 mm) and referred as Sieved Aggregate 2 in this report. This gravel is supplied by the same company as the Aggregate but it is a different material, since it was sieved from a well-graded 5/8" Washed River Gravel originally destined for concrete mixtures. Although Sieved Aggregate 2 is on the small range of gravel sizes, it is also classified as GP in the USCS method of classification and into group A-1 of the AASHTO system.

In the testing program 11 different geosynthetic products were used. The nominal specifications of these products are presented in Table 2.2. Among the products listed in Table 2.2, only GG PP4 is not commercially available. The geosynthetic GG PP4 is one layer of the double-layer product GG PP4x2.

Table 2.2 Nominal specifications of the geosynthetic products used in the testing program

Characteristics			Product	GG PP	GG PET	GT	GG PP3	GG PP4x2	GG PP4
Mechanical Properties	Tensile Strength @ (lbf/ft) ASTM 6637 (Geogrids) ASTM 4595 (Geotextiles)	ε = 0.5%	MD	---	---	---	---	---	---
			CD	---	---	---	---	---	---
		ε = 1%	MD	---	300	---	---	---	---
			CD	---	300	---	---	---	---
		ε = 2%	MD	280	500	960	343	301	151
			CD	450	500	1,320	480	450	225
		ε = 5%	MD	580	920	2,400	620	616	308
			CD	920	920	2,604	960	920	460
		Ultimate (lbf/ft)	MD	850	2,000	4,800	900	925	463
			CD	1,300	2,000	4,800	1,600	1,400	700
	Junction Efficiency (%) GRI-GG2		MD	93	---	N/A	---	93	93
			CD	93	---	N/A	---	93	93
	Junction Strength (lbf/ft)		MD	791	---	N/A	---	860	430
			CD	1,209	---	N/A	---	1,315	651
	Flexural Stiffness (mg-cm) ASTM D5732-95 & D1388		MD x CD	250,000	---	N/A	---	250,000	---
Geometric Properties	Aperture Dimensions (in.)		MD	1.0	1.0	N/A	0.6	variable	1.65
			CD	1.3	1.0	N/A	0.6	variable	1.96
	Minimum Rib Thickness (in.) ASTM D 1777 for GG PP4		MD	0.03	---	---	---	---	0.05
			CD	0.03	---	---	---	---	0.05
	Rib Width (in.)		MD	---	---	---	---	---	---
			CD	---	---	---	---	---	---
	Percent Open Area (%) CW 02215			---	70	---	---	75	---
Polymer & Geosynthetic Type				Polypropylene Geogrid	Polyester Geogrid	Polypropylene Woven Geotextile	Polypropylene Geogrid	2 layers of Polypropylene Geogrid	Polypropylene Geogrid (1 layer of GG PP4x2)
Manufacturing process				Integrally formed	Woven yarns	Woven yarns	Woven yarns	Integrally formed	Integrally formed

Table 2.2 (cont.): Nominal specifications of the geosynthetic products used in the testing program

Characteristics			Product	GG PP2	GG PPTG	GG PPTG3	GG PP5	GG PET2
Mechanical Properties	Tensile Strength @ (lbf/ft) ASTM 6637 (Geogrids) ASTM 4595 (Geotextiles)	ε = 0.5 %	MD	---	102.9	75.4	---	---
			CD	---	102.9	75.4	---	---
		ε = 1 %	MD	---	---	---	453	---
			CD	---	---	---	453	---
		ε = 2%	MD	410	---	---	686	526
			CD	620	---	---	686	578
		ε = 5%	MD	810	---	---	1,475	792
			CD	1340	---	---	1,475	1,042
		Ultimate (lbf/ft)	MD	1310	---	---	2,055	2,388
			CD	1,970	---	---	2,055	3,870
	Junction Efficiency (%) GRI-GG2		MD	93	93	93	30	201
			CD	93	93	93	30	100
	Junction Strength (lbf/ft)		MD	1218	---	---	617	4,800
			CD	1,832	---	---	617	3,870
	Flexural Stiffness (mg-cm) ASTM D5732-95 & D1388		MD x CD	750,000	---	---	500,000	---
Geometric Properties	Aperture Dimensions (in.)		MD	1.0	1.6	1.30	1.26	1.0
			CD	1.3	1.6	1.30	1.26	1.0
	Minimum Rib Thickness (in.)		MD	0.05	0.06	0.06	---	---
			CD	0.05	0.06	0.05	---	---
	Rib Width (in.)		MD	---	0.04	0.02	---	---
			CD	---	0.05	0.03	---	---
	Percent Open Area (%) CW 02215			---	---	---	---	---
Polymer & Geosynthetic Type				Polypropylene Geogrid	Polypropylene Triangular Geogrid	Polypropylene Triangular Geogrid	Polypropylene Geogrid	Polyester Geogrid
Manufacturing process				Integrally formed	Integrally formed	Integrally formed	Vibratory welded straps	Woven yarns

Note 1: The abbreviations used for the geosynthetic products are as follows: GG PP for Tensar BX1100, GG PET for Mirafi BasXgrid11, GT for Mirafi Geolon HP570, GG PP3 for Huesker Fornit 20, GG PP4x2 for Tenax MS220, GG PP4 for Tenax (1 layer) MS110, GG PP2 for Tensar BX1200, GG PPTG for TriAx TX160, GG PPTG3 for TriAx TX130s, GG PP5 for NAUE Secugrid 30/30 Q1, and GG PET2 for Synteen SF11.
Note 2: CD corresponds to the Cross-Machine Direction, and MD corresponds to Machine Direction.
Note 3: Properties reported for the triangular geogrid products (GG PPTG and GG PPTG3) as MD are on the diagonal direction (DD).

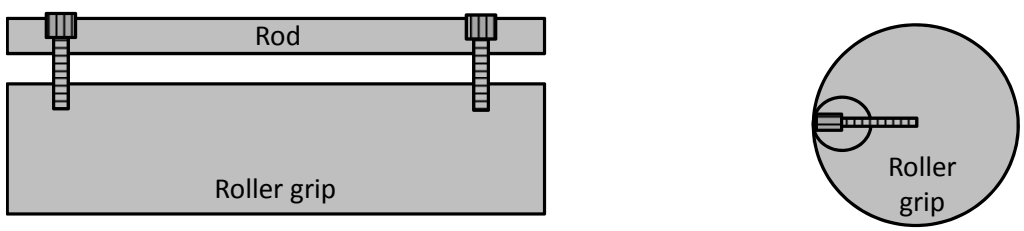
2.4 Development of the Test Procedure

The development of the small pullout testing procedure for geosynthetic products in base course reinforcement involves two main phases. The initial phase consisted of evaluating potential sources of variability on the test results. The following possible sources of variability were identified: clamping of the geosynthetic specimen on the grip, displacements at different locations of the geosynthetic, operator inconsistency when tying wires to the geosynthetic for displacement recordings, variability on the dry density of the compacted soil, material variability of the geosynthetic product, and imprecision of the air pressure gauge responsible for controlling the confining pressure. In this phase, only the Monterey Sand was used since it is a uniform granular soil that has been extensively tested at The University of Texas at Austin (UT Austin). The second phase consisted of testing with different soils before establishing the best standard soil for use in this project.

2.4.1 Initial Evaluation on Sources of Variability on the Test Results

The Monterey Sand was the first soil to be used in the testing program because it is an easily compacted, standard granular soil. Moreover, the particle size of this sand is compatible with the dimensions of the small pullout box. Tests were conducted to assess the influence on the results of the roller grip's clamping rod, and of the boundary effects on displacement readings on different locations across the geosynthetic specimen.

The potential issue associated with clamping the rod attached to the roller grip is related to the design of the clamping system, which is composed of a cylindrical roller grip and a clamping rod (Figure 2.5). The geosynthetic specimen is rolled around the cylindrical grip with its end clamped by a rod that, in turn, is tightened by two screws near the ends of the rod.



(a) (b)

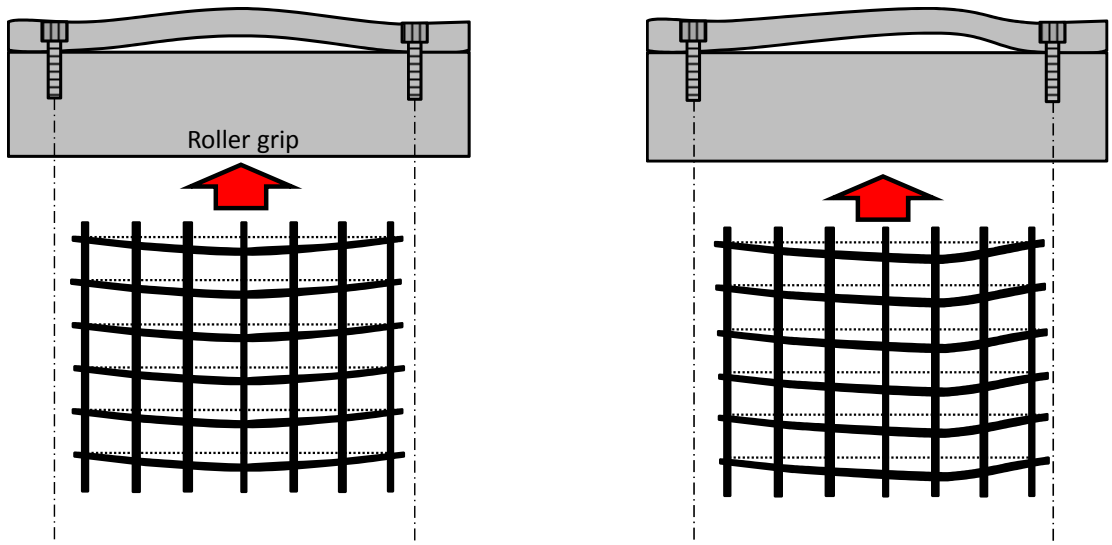
Figure 2.5 Geosynthetic specimen clamping system of the small pullout test setup composed by the roller grip and the gripping rod: (a) Front view; (b) Cross section.

This design can lead to uneven pullout of the geosynthetic specimen if appropriate care is not taken. The operator may tend to excessively tighten the screws of the rod in an attempt to prevent slippage of the specimen in the grip during the test. If both screws are tightened with excessive but even torque, the rod tends to bend in the center, leading to a looser grip of the geosynthetic at the center in relation to the edges (Figure 2.6:a). Consequently, uneven pullout of the specimen may occur, leading to erroneous displacement readings at the center of the specimen. The same problem may occur if excessive uneven torque is applied to the screws of the rod. In this case, the location of the looser grip of the geosynthetic would change, moving

closer to the screw with higher applied torque (Figure 2.6:b). This would also lead to uneven pullout of the specimen. Both situations could compromise the repeatability of the test results.

The solution found for these problems is the use of a torque wrench to apply a constant torque on both screws of the rod. The torque adopted for the tests is 12.5 lbf/ft. This amount of torque was sufficient to secure the geogrid specimen in the grip, preventing the slippage of the specimen that leads to uneven pullout.

Figure 2.7 depicts the potential issue of edge effects on the location of displacement monitoring along the geosynthetic specimen closer to the side walls. Even with adequate torque, the displacement readings on locations away from the center of the specimen can be affected by the interaction of the specimen's edges with the side wall. To minimize this problem, the internal walls of the box are covered with two layers of Mylar® sheet and white lithium grease. Also, the width of the geosynthetic specimen is controlled to keep a minimal distance of 0.39 in. (10 mm) between the edges of the specimen and the side walls of the box.



(a) (b)

Figure 2.6 Potential issues with geosynthetic clamping system (exaggerated illustrations): (a) Excessive equal torque on the screws of the rod leading to looser grip at the center of geosynthetic specimen and uneven pullout of the specimen; (b) Excessive uneven torque on the screws of the rod leading to looser grip closer to the side with higher torque and uneven pullout of the specimen.

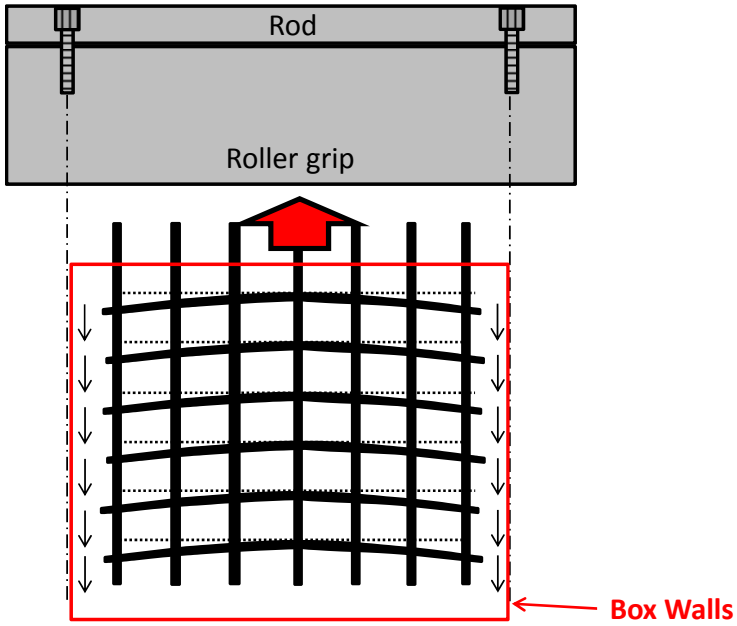


Figure 2.7 Adequate even torque on the screws of the rod and potential edge effect on the geosynthetic specimen inside the box interacting with side walls and interference of the displacement readings away from the center of the specimen.

To verify the effectiveness of the torque wrench and the potential edge effects on displacement readings, a series of small pullout tests were performed in Monterey Sand. To evaluate the use of controlled torque on the screws of the gripping rod, a series of repeat tests in Monterey Sand were performed with the product GG PP testing in cross-machine direction (CD) and subjected to 3.0 psi of confining pressure. At the time of this initial test evaluation, the confining pressure was controlled with an analog pressure gauge with resolution marks of 1.0 psi. The wires correspondent to the LVDTs 2, 3, and 4 were attached along the same transverse rib to which the wire for the LVDT 3 is located in regular tests. Testing was conducted in sand because the variability of the test results with this soil is expected to be smaller than that of tests in Sieved Aggregate 2.

Two tests were performed without controlled torque on the screws of the clamping rod, and two repeat tests were performed using a torque wrench. At the time these tests were conducted, test data were analyzed without a smoothing technique. However, the data were re-evaluated in this report using the smoothing approach described in Section 2.5.

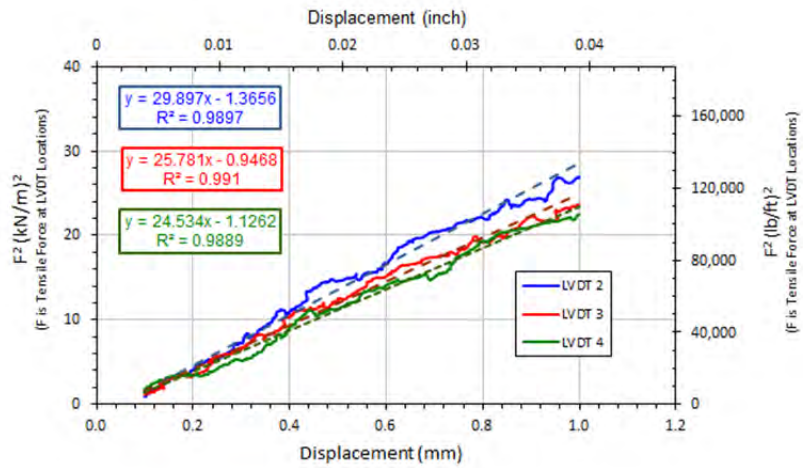
In this series of tests, the repeatability of the K_{SGI} values were analyzed by obtaining regression lines for the data of each LVDT separately, using the calculations according to the K_{SGI} model. In this model, the tensile forces along the embedded length of the geosynthetic specimen are derived from the readings of the load cell and the readings of the LVDTs (Zornberg et al. 2012a). Specifically, the forces developed throughout the test are calculated at the locations where the wires connected to the LVDTs are attached on the geosynthetic. Then, the square of the forces at each location are plotted against the displacement of the respective LVDT. A linear regression line for the data correspondent to each LVDT is obtained. The slope of the regression line is the K_{SGI} value.

The plots in which separate regression lines were obtained for each LVDT are presented throughout this chapter. The pullout curves (load readings from the load cell vs. displacement readings from each LVDT) are shown in the test reports in Appendix A along with the K_{SGI} plots presented in the final format of analysis, in which one regression line is obtained with the combined data from LVDTs 2, 3, and 4.

The results of the tests without the use of torque wrench are shown in Figure 2.8. The data from the first test provided similar K_{SGI} values for LVDTs 3 and 4 and a slightly higher value for LVDT 2 (Figure 2.8:a). The data from the second test provided similar K_{SGI} values for each LVDT (Figure 2.8:b).

The average K_{SGI} value from the six regression lines shown in Figure 2.8 is 26.4 $(kN/m)^2/mm$ with a coefficient of variation of only 7.2%. Treating the data from LVDTs 2, 3, and 4 together to obtain one regression line (Figures A.1 and A.2 in Appendix A) leads to a K_{SGI} value for Tests 1 and 2 equal to 26.1 and 26.7 $(kN/m)^2/mm$, respectively.

(a)



(b)

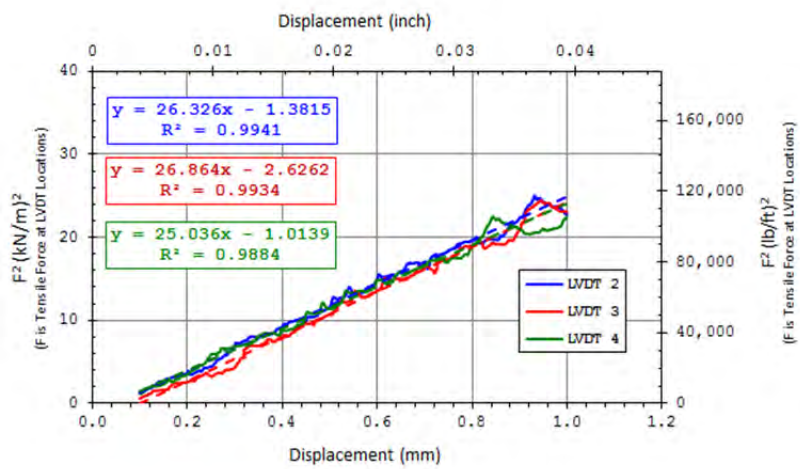


Figure 2.8 K_{SGI} plots for repeat tests of GG PP CD in Monterey Sand, confining pressure of 3.0 psi controlled by an analog pressure gauge and no use of torque wrench. Wires for LVDTs 2, 3, and 4 attached along the same transverse rib: (a) Test 1; (b) Test 2.

The results of the tests in which a torque wrench was used to apply 12.5 lbf/ft of torque on the screws of the clamping rod are shown in Figure 2.9. Similar to the results in Figure 2.8, the data from Test 3 provided similar K_{SGI} values for each LVDT (Figure 2.9:a). The data from Test 4 provided similar K_{SGI} values for LVDTs 3 and 4 and a slightly smaller value for LVDT 2 (Figure 2.9:b).

The average K_{SGI} value from the six regression lines shown in Figure 2.9 is 20.9 $(kN/m)^2/mm$ and the coefficient of variation is only 2.2%. Treating the data from LVDTs 2, 3, and 4 together to obtain one regression line leads to K_{SGI} values for Tests 3 and 4 of 20.9 and 20.6 $(kN/m)^2/mm$, respectively.

(a)

(b)

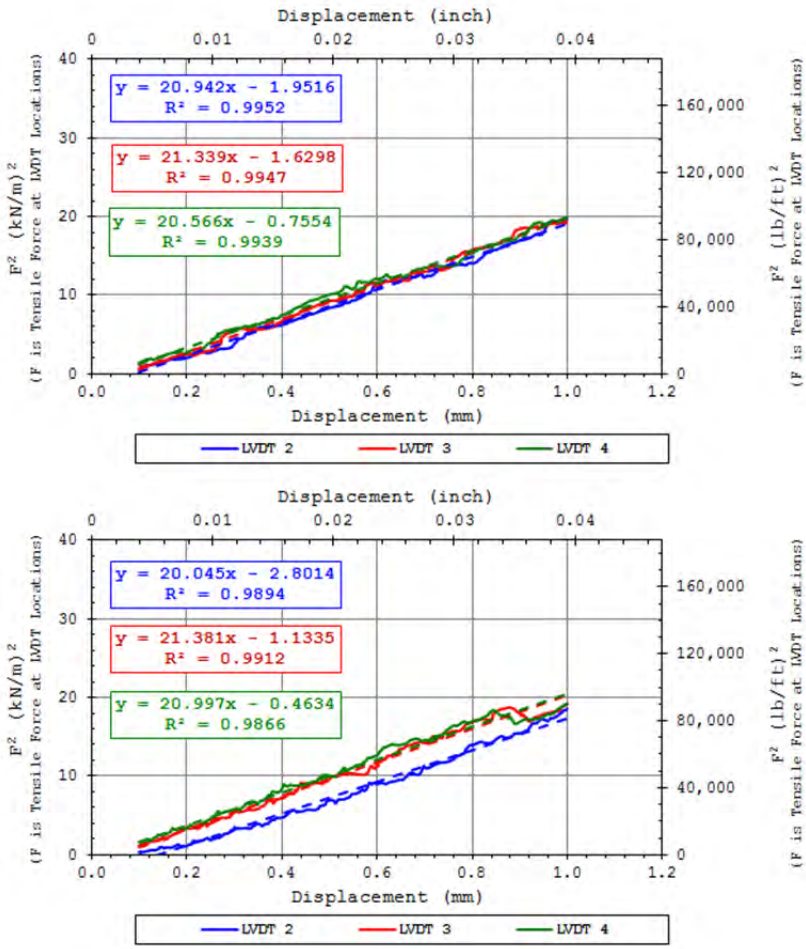


Figure 2.9 K_{SGI} plots for repeat tests of GG PP CD in Monterey Sand, confining pressure of 3.0 psi controlled by an analog pressure gauge and use of torque equal to 12.5 lbf/ft. Wires for LVDTs 2, 3, and 4 attached along the same transverse rib: (a) Test 3; (b) Test 4.

A comparison of the results shown in Figure 2.8 and Figure 2.9 indicates that the use of a torque wrench improved the repeatability of the test results, with the coefficient of variation of the individual K_{SGI} dropping from 7.2% to only 2.2%. The use of torque wrench also seems to have affected the average K_{SGI} value, although the differences might be due to sampling or to variation on the confining pressure due to the precision of the analog pressure gauge.

Nevertheless, it was concluded from these results that the use of torque wrench mitigates the potential problems illustrated in Figure 2.6.

The next step in the analysis was to evaluate the potential edge effect problem illustrated in Figure 2.7. For this evaluation two repeat tests were performed with Monterey Sand and use of a torque wrench with all the wires connected to LVDTs 1 to 5, attached along the same transverse rib of the GG PP CD specimen. The LVDTs 1 and 5 were attached near to the extremes of the side-edges of the specimens. If the edge effects were significant, the sides of the specimen would interact with the side walls of the box, and the friction between specimen side-edge and box side wall would lead to smaller displacements for LVDTs 1 and 5. As a result, higher K_{SGI} values would be derived from the data of LVDTs 1 and 5 since smaller displacements results steeper regression lines for the K_{SGI} plots. The results of this series of tests are presented in Figure 2.10.

(a)

(b)

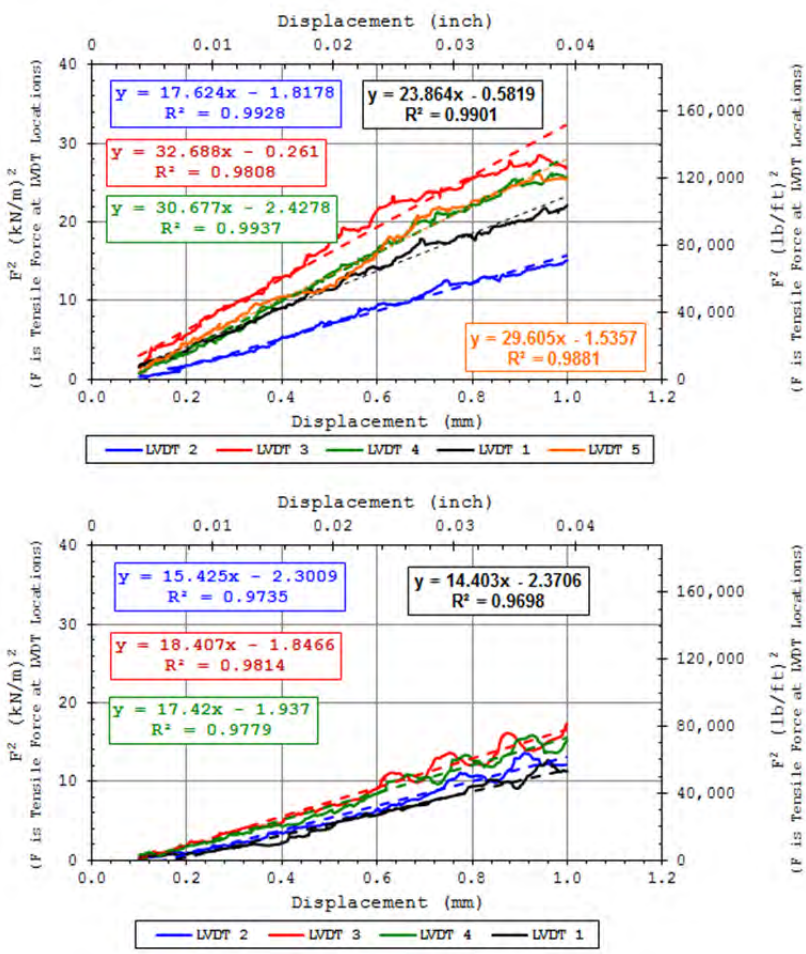


Figure 2.10 K_{SGI} plots for repeat tests of GG PP CD in Monterey Sand, confining pressure of 3.0 psi controlled by an analog pressure gauge and use of torque equal to 12.5 lbf/ft. Tell-tales for LVDTs 1 to 5 attached along the same transverse rib: (a) Test 5; (b) Test 6.

In Test 6, LVDT 5 did not record any data but the edge effect could still be evaluated with the results from LVDT 1 (Figure 2.10:b). The tests in Figure 2.10 did not produce results with the same consistency as the tests in Figure 2.9. The average K_{SGI} value from the five

regression lines obtained from Test 5 (Figure 2.10:a) is 26.9 $(kN/m)^2/mm$ and the coefficient of variation is relatively high, equal to 22.8%. The average K_{SGI} value from the four regression lines obtained from Test 6 (Figure 2.10:b) is 16.4 $(kN/m)^2/mm$ and the coefficient of variation is 11.1%. Although higher variability was observed in these tests with the use of torque wrench, the K_{SGI} values from LVDT 1 in Test 5 (Figure 2.10:a) and LVDT 1 in Test 6 (Figure 2.10:b) were smaller than the K_{SGI} values of the other LVDTs. These results are the opposite of what was expected for the edge effects. Accordingly, it can still be concluded that the potential issue illustrated in Figure 2.7 is not important in the small pullout test and may not represent a significant source of variability.

As shown in Figure 2.10, the difference in the K_{SGI} values from one test to the other repeat test can be significant. On the other hand, consistent values of the K_{SGI} were obtained with the duplicate tests in Figure 2.9. Accordingly, sources of variability on the results of small pullout tests were identified from these series of tests. The identified sources are as follows: uneven torque on the screws of the grip's clamping rod, variations intrinsic to the consistency of the operator in tying the wires to the geosynthetic specimen for displacement recordings, variations in the dry density of the compacted soil, material variations of the geosynthetic product, and inconsistency of the analog air pressure gauge.

The uneven torque on the screws of the clamping rod is mitigated with the use of a torque wrench and the application of a torque of 12.5 lbf/ft. This torque value was found to be adequate to prevent slippage of the geosynthetic specimen in the grip without damaging the specimen.

Variability intrinsic to the consistency of the operator in attaching the wires to the geosynthetic specimen for displacement recordings can also be minimized. In order to minimize inconsistencies in attaching the wires to the geosynthetic, the operator must practice this procedure before preparing a small pullout test until completely familiar with it, and can achieve satisfactory consistency in the quality of the attachment.

Variations on the dry density of the compacted soil are minimized by controlling the mass of soil used for each compaction lift and the respective height of the lift. The mass of the small pullout box with the final assembly before testing (i.e., target mass of compacted soil with geosynthetic specimen and lid attached to the box) is also measured as an additional verification of the degree of compaction of the soil. This procedure was adopted in the series of tests above and the variation between tests of the dry density of the soil was insignificant.

Material variability of the geosynthetic product itself occurs within a roll or among different rolls. The variability of geosynthetic products confined in soil was evaluated only with the final standard soil chosen for the small pullout test. However, the contribution of the variability of the soil stiffness and shear strength to the test results cannot be decoupled from the variability of confined geosynthetic products in small pullout testing. Thus, the repeatability analysis is an evaluation of the variability of the soil-geosynthetic system formed by the materials utilized in the testing program.

Inconsistency of the analog air pressure gauge was perceived during testing only with Sieved Aggregate 2. No significant variation of test results for a given geosynthetic product was observed for the series of tests with Monterey Sand. This may have been caused by the analog pressure gauge reaching the end of its service life during the period of testing with Sieved Aggregate 2. Before testing with this soil, series of tests were conducted initially with Monterey Sand, then with Aggregate and Sieved Aggregate 1. The analog pressure gauge had been used in other tests for years before it was installed as part of small pullout test. This problem was solved

by replacing the analog pressure gauge with a digital gauge manufactured by Ashcroft of nominal precision equal to 0.01 psi (0.07 kPa) and accuracy of 0.08 psi (0.55 kPa).

2.4.2 Selection of Standard Soil for Testing

In total, five different soils were used in this project. The description of the soils was presented in Section 2.3 along with the respective particle size distribution curves (Figure 2.4). Testing with Monterey Sand was described in Section 2.4.1. The test results with the other soils, which are all gravel-size materials, are discussed in this section.

The first gravel-size material used in the small pullout testing was named Aggregate. This soil has a uniform particle size distribution curve (Figure 2.4). The maximum particle size is 0.5 in. (12.7 mm), only 0.1 in. (2.54 mm) smaller than the aperture on the front wall of the box. The results of the small pullout tests with this soil are reported in Appendix A10. In the series of tests with this material, 5 out of 23 tests had particle jamming visually detected at the exit of the box's front wall during the tests. As the geosynthetic specimen is pulled out, particles got jammed at the front opening of the box. This resulted in significant increase of the pullout force and extremely small displacement of the geosynthetic specimen. In fact, geogrid breakage in the unconfined portion between the box and the grip was observed in 50% of the tests in Aggregate. Because of the low displacement readings, the resulting K_{SGI} was significantly higher than in identical tests when no particle jamming was observed.

Figure 2.11 shows the test result of GG PET CD with no particle jamming observed. The K_{SGI} value for this test was 29.3 $(kN/m)^2/mm$. Figure 2.12 shows the result of a test with GG PET CD when particle jamming occurred. The test was interrupted when particle jamming was visually detected. The K_{SGI} value for this test was 52.0 $(kN/m)^2/mm$. It should be noted that these tests were conducted without the use of torque wrench and with the analog gauge controlling the confining pressure. Consequently, it was concluded that this aggregate is not suitable for the small pullout box. Additionally, in coordination with TxDOT personnel, it was decided that a curve of particle size distribution of the shape of the Aggregate (Figure 2.4) is difficult to reproduce for future laboratory testing. Accordingly, the Aggregate was sieved to a uniform, smaller particle size and named Sieved Aggregate 1.

(a)

(b)

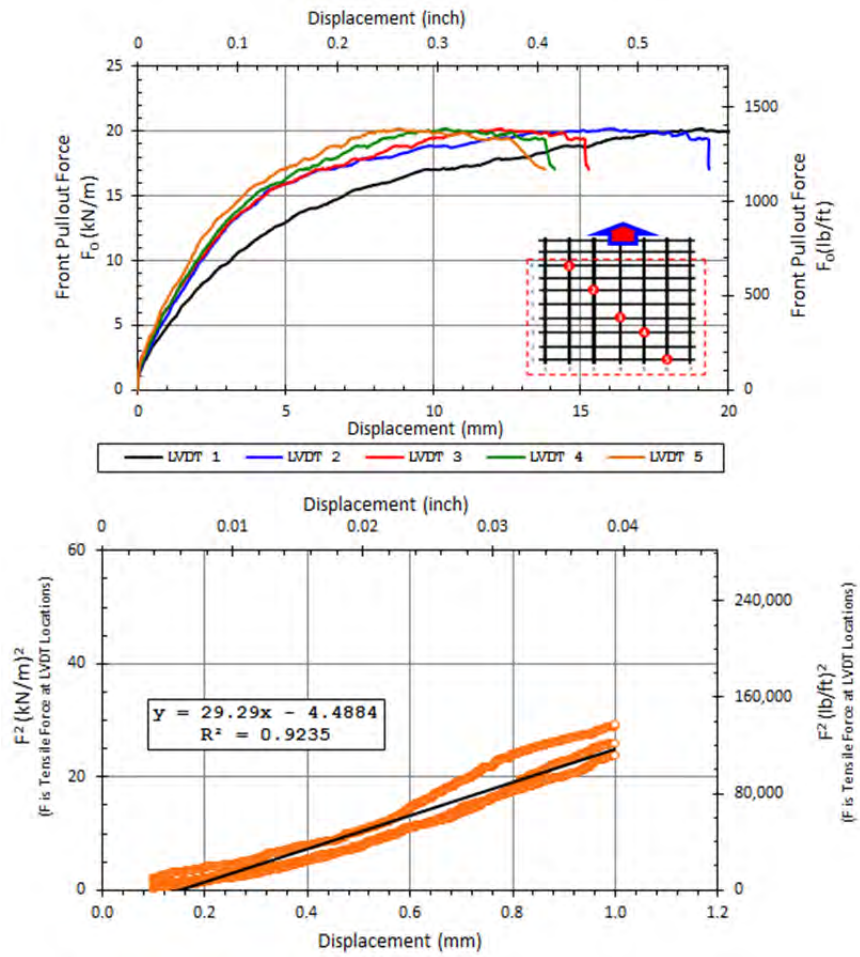


Figure 2.11 Pullout test with Aggregate and GG PET CD without particle jamming at the front wall aperture of the box: (a) Pullout curve; (b) K_{SGI} plot: K_{SGI} = 29.3 (kN/m)^2/mm.

Sieved Aggregate 1 is the Aggregate passing the 3/8 in. sieve and retained on the 1/4 in. sieve. Thus, the maximum particle size is 0.375 in. (9.525 mm), less than two-thirds the size of the front wall aperture. The smallest particle size is 0.250 in. (6.35 mm). Sieved Aggregate 1 is also categorized as GP according to the USCS and A-1 according to the AASHTO classification system. The results of the small pullout tests with this soil are reported in Appendix A9. Problems with particle jamming at the front wall aperture were also frequent with Sieved Aggregate 1. An example of the data obtained from small pullout tests with this soil is presented in Figure 2.13:a. The data shown in this figure is from a test with GG PP2 CD. The sudden drop of the pullout load occurred when the unconfined portion of the geogrid ruptured in tension.

(a)

(b)

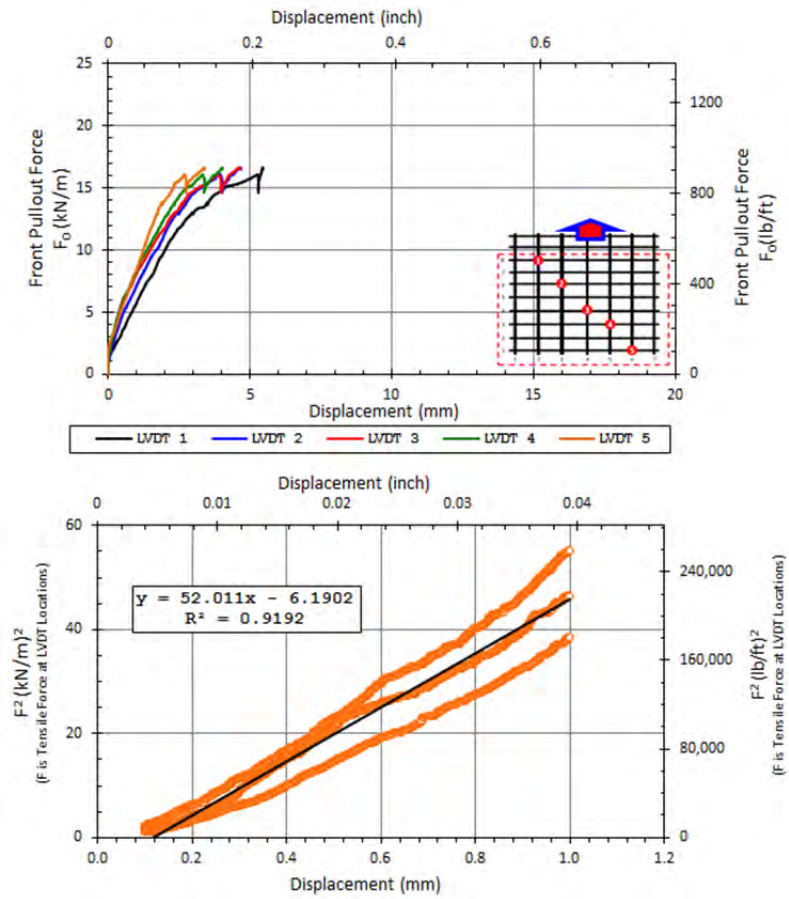


Figure 2.12 Pullout test with Aggregate and GG PET CD with occurrence of particle jamming at the front wall aperture of the box: (a) Pullout curve; (b) K_{SGI} plot: K_{SGI} = 52.0 (kN/m)^2/mm.

Accordingly, a uniform gravel with particle size smaller than Sieved Aggregate 1 was subsequently considered. The new soil, namely Sieved Aggregate 2, has particles finer than the 1/4 in. sieve and retained on the #4 sieve (Figure 2.4). Thus, the maximum particle size of Sieved Aggregate 2 is 0.250 in. and the smallest particle size is 0.187 in. A typical pullout test curve with Sieved Aggregate 2 is shown in Figure 2.13. No particle jamming was observed with this soil. The shape of the pullout curves is consistent with that reported in the literature for this type of test, with the pullout load reaching a maximum value and then staying constant. Sieved Aggregate 2 was the soil chosen as the standard soil in the final configuration of the small pullout test for geosynthetic products to be used to mitigate environmental cracking. Accordingly, a comprehensive testing matrix was compiled considering this soil and the 11 geosynthetic products listed in Table 2.2. A detailed analysis of the results is presented in Section 2.6. The results of the individual small pullout tests with this soil are reported in Appendices A1 and A2.

(a)

(b)

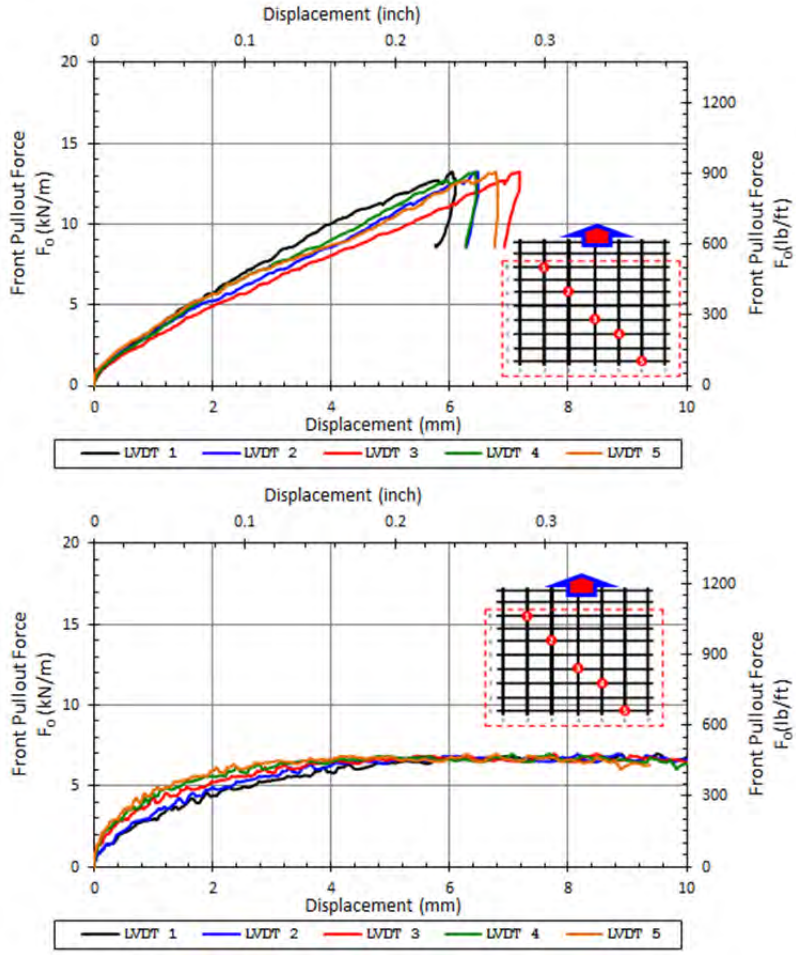


Figure 2.13 Results of small pullout tests with GG PP2 CD in (a) Sieved Aggregate 1 (particles jammed at box frontal opening) and (b) Sieved Aggregate 2 (no particle jamming).

Although Sieved Aggregate 2 is on the lower limit of a gravel size material, its D_{50} is compatible with the range of D_{50} of the materials specified by TxDOT to be used in flexible base course of pavements constructed in Texas (Special Provision 247-039 of item 247 of the 2004 Standard Specifications book). Moreover, this specification allows 55% of the soil particles to be finer than the #4 sieve (0.19 in.). Accordingly, additional testing was performed with the Soil Blend (composed of a mix of 75% of Sieved Aggregate 2 and 25% of Monterey Sand by weight); this blend's particle size was depicted in Figure 2.4. This proportion of soils was calculated to provide a primary soil skeleton of Sieved Aggregate 2 with the voids filled with Monterey Sand. The individual results of the small pullout tests with the Soil Blend are reported in Appendix A8.

The K_{SGI} values and coefficient of variations obtained in this series of tests were comparable with the values obtained with the tests in Sieved Aggregate 2. However, compaction of the Soil Blend proved significantly more difficult than Sieve Aggregate 2. Also, homogeneity of this blend was difficult to maintain since the particles tended to segregate when placing the soil mass into the pullout box for compaction and also during storage. This is caused by the significant difference of particle sizes between the soils.

2.5 Data Reduction and Calculation of the K_{SGI} Coefficient

The final small pullout setup involves the use of Sieved Aggregate 2, a normal pressure of 3.0 psi and the application of a torque of 12.5 lbf/ft on the screws of the gripping rod that secures the geosynthetic specimen. A detailed description of the test procedure and specifications of the test equipment were presented in Section 2.2. In this section, the procedures to smooth the raw data and to obtain the coefficient of interface stiffness, K_{SGI}, from the pullout test data are explained.

2.5.1 Data Smoothing

The raw data of the test are smoothed by calculating the moving average of 10 consecutive readings. In this smoothing technique, the reading "i" is averaged over from points "X_{i-4}" to "X_{i+5}", as follows in Equation 2.1:

$$X'_i = \frac{\sum_{i-4}^{i+5} X_i}{10} \tag{2.1}$$

Therefore, since readings are collected every 0.2 seconds, each smoothed data point is the result of averaging raw data over 1.8 seconds. Figure 2.14 shows the data from the readings of all LVDTs and of the load cell against time of a typical small pullout test. The horizontal axis is time in seconds and the primary vertical axis, on the left hand side of the graph, is the displacement readings of all LVDTs. The secondary vertical axis, on the right hand side of the graph, is the pullout force readings from the load cell. Specifically, the data shown in Figure 2.14 are from a test with GG PP2 CD using the final test setup. In this figure, the raw data (Figure 2.14:a) can be compared to the data treated using the moving average smoothing technique (Figure 2.14:b). It can be noted that the lines of the data from the LVDTs are slightly finer when the data is smoothed. Also, the noise of the data from the load cell decreases after applying the data smoothing technique described earlier.

Initially in project 0-4829, the calculations for the K_{SGI} model and the report of the test results had been done with the raw data only (Zornberg et al. 2012a). Moreover, the data from the points that have displacement monitored at the central portion of the geosynthetic specimen, i.e., LVDTs 2, 3, and 4, were used separated. Thus, three K_{SGI} values were obtained, one for each of LVDTs 2, 3, and 4. The reported value for the test result was the K_{SGI} correspondent to LVDT 3 only. The K_{SGI} values from the data of LVDTs 2 and 4 were used just as a checkup to validate the results. If the values of LVDTs 2 and 4 were significantly different than the one from LVDT 3, then the test was repeated.

(a)

(b)

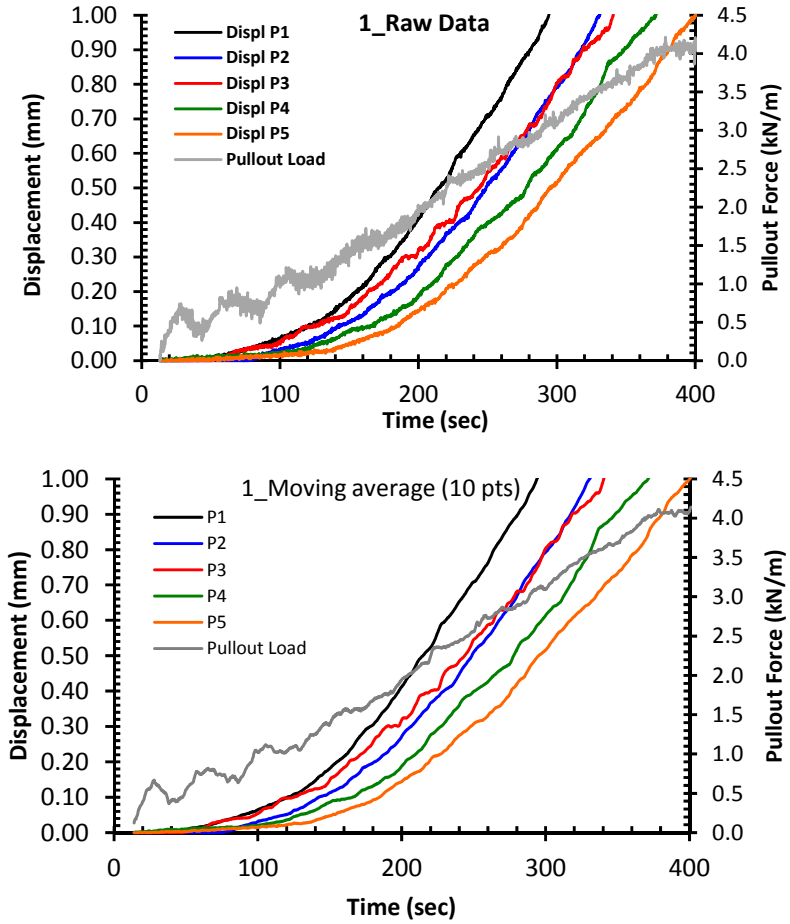


Figure 2.14 Load and displacement data vs. time from a small pullout test with GG PP2 CD: (a) Raw data; (b) Smoothed data.
Note: P1, P2, P3, P4, and P5 correspond to LVDTs 1, 2, 3, 4, and 5, respectively.

These calculation procedures were subsequently refined and the raw data is currently treated before the calculations for the K_{SGI} model. Another refinement in the data analysis is that the data from LVDTs 2, 3, and 4 are currently used together to obtain one regression line for the K_{SGI} value. Consequently, K_{SGI} reflects the interface stiffness over the central portion of the geosynthetic specimen.

Previously, individual regression lines were obtained for the data of each of LVDTs 2, 3, and 4 but only the K_{SGI} value obtained from the data of LVDT 3 was reported. The K_{SGI} values obtained with the data of LVDTs 2 and 4 were used only to check against inconsistencies in the data. Thus, the K_{SGI} reflected the interface stiffness only in the central point of the geosynthetic specimen.

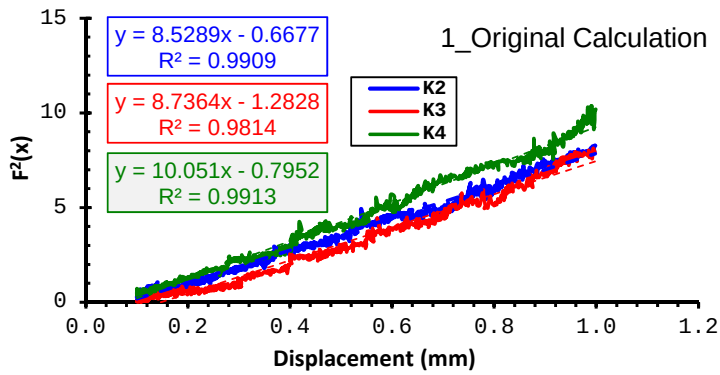
A disadvantage in reporting only the K_{SGI} of LVDT 3 is that if the data from LVDT 3 was inconsistent with the data from LVDTs 2 and 4, no criterion was defined to use the data from these two LVDTs and the test would need to be repeated. Moreover, in the event of the wire for LVDT 3 being poorly attached to the geosynthetic specimen, the impact of these low

quality data on the variability of the K_{SGI} value is more significant than when the data of three LVDTs are used together.

Figure 2.15 presents the K_{SGI} plots for the pullout test data shown in Figure 2.14. The K_{SGI} plot from the raw data is shown in Figure 2.15:a as adopted initially in project 0-4829. Three regression lines were obtained, one for each of LVDTs 2, 3, and 4. Only the K_{SGI} correspondent to LVDT 3 was reported. In the case shown in Figure 2.15:a, K_{SGI} equals to 8.74 $(kN/m)^2/mm$.

The K_{SGI} plot from the smoothed data is shown in Figure 2.15:b. Also, K_{SGI} is obtained from a single regression line derived from the data of LVDTs 2, 3, and 4 together. This procedure leads to smaller coefficients of variation for K_{SGI} values of replicate tests.

(a)



(b)

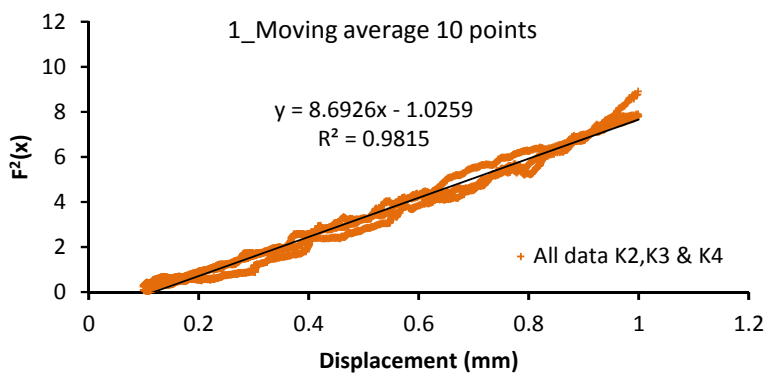


Figure 2.15 K_{SGI} plot for a small pullout test with GG PP2 CD: (a) Derived from raw data and 3 regression lines, one for each LVDT; (b) Derived from smoothed data and one regression line obtained.

Due to the adoption of the data smoothing technique shown in Equation 2.1 ($X'_i = \frac{\sum_{i-4}^{i+5} X_i}{10}$) and the new procedure to obtain the K_{SGI} (Figure 2.15), the small pullout test data generated were re-evaluated accordingly. This includes reassessment of small pullout test results from the previous testing programs, including those presented in report TxDOT 5-4829-01-3 (Zornberg et al. 2012b): tests with Monterey Sand and 5 psi of confining pressure (Appendix A4); tests with Sieved Aggregate 2 without the use of torque wrench (Appendix A6), and tests with GG PP3 CD with LVDTs 2, 3, and 4 attached to the geogrid with epoxy on longitudinal ribs instead of tighten around junction (Appendix A7). This re-evaluation led to the same trends and

conclusions obtained at the time by Zornberg et al. 2012b. Thus, the analyses are not repeated in this report but the smoothed data and new K_{SGI} plots are presented in the appendix.

2.6 Analysis of Test Results

This section presents analysis of the results for each geosynthetic product tested using the final configuration of the small pullout test. A comparative evaluation of the products is discussed at the end of this section. The results are evaluated with a statistical approach in terms of the repeatability and the estimated error of the K_{SGI} value obtained for each product.

The population constituted by the results of small pullout tests with a given geosynthetic product can be assumed to be normally distributed with unknown population mean μ and standard deviation σ. The number of repeats of a certain test is the sample size *n*. The sample with *n* repeat tests has a sample mean $\bar{X}$ and standard deviation *S*. Given a sample size *n* larger than 30, the Central Limit Theorem (CLT) can be applied and the population mean μ and standard deviation σ can be calculated (Devore, 2008). However, performing 30 replicate tests for a geosynthetic product is unreasonable due to limited resources, cost, and availability of time, material, and laboratory personnel. Thus, in practice, the number of replicate tests is limited to a small sample size if compared to the minimum requirement for application of the CLT. Accordingly, due to the small size of the sample, the occurrences (i.e., each K_{SGI} value obtained) in this sample will tend to follow a distribution that is more spread out than the normal distribution of the population. These conditions are the base of the family of t distribution curves (Devore, 2008).

A random sample of size *n* and mean $\bar{X}$ from a population with a normal distribution of mean μ can be described by the random variable *T*, which follows a *t* distribution with *n*-1 degrees of freedom, as shown in Equation 2.2:

$$T = \frac{\bar{X} - \mu}{S/\sqrt{n}} \tag{2.2}$$

Where:

T = random variable
$\bar{X}$ = sample mean
μ = population (or true) mean
S = sample standard deviation
n = sample size

The number of degrees of freedom, ν, is the only governing parameter of the t distribution curves. A specific value of ν corresponds to a specific *t* distribution. Naming t_ν as the density function curve for ν degrees of freedom, the properties of *t* distributions shown in Figure 2.16 are as follows (Devore 2008):

1. Each t_ν curve is bell-shaped and centered at zero;
2. Each t_ν curve is more spread out than the standard normal (z) curve;
3. As ν increases, the spread of the corresponding t_ν curve decreases;
4. As $\nu \rightarrow \infty$, the sequence of t_ν curves approaches the standard normal curve.

The random variable T in Equation 2.2 is used to compute the confidence interval (CI) when estimating the true K_{SGI} value of a given geosynthetic product from the sample of replicate tests. Due to the limited size of the sample (n repeat tests), there is uncertainty associated with the estimation of the K_{SGI} of the product as being the sample mean $\overline{X}$. The true value of the K_{SGI} is the population mean μ, which corresponds to an infinite number of repeat tests. Any CI is associated with a confidence level, which is the probability the interval will contain μ.

A CI is calculated using the random variable T with the t distribution curves using the t critical value, $t_{\alpha/2,\nu}$, correspondent to the desired confidence level, similar to the z critical values, $z_{\alpha/2}$, utilized with the standard normal variable Z. Thus, the t critical value depends not only on the desired confidence level but also on the number of degrees of freedom, ν. Given a confidence level, $t_{\alpha/2,\nu}$ decreases as ν increases. When ν approaches infinity, $t_{\alpha/2,\nu}$ equals $z_{\alpha/2}$. For instance, for a 95% confidence level, $t_{0.025,\infty}$ equals 1.96, which is the same value for $z_{0.025}$.

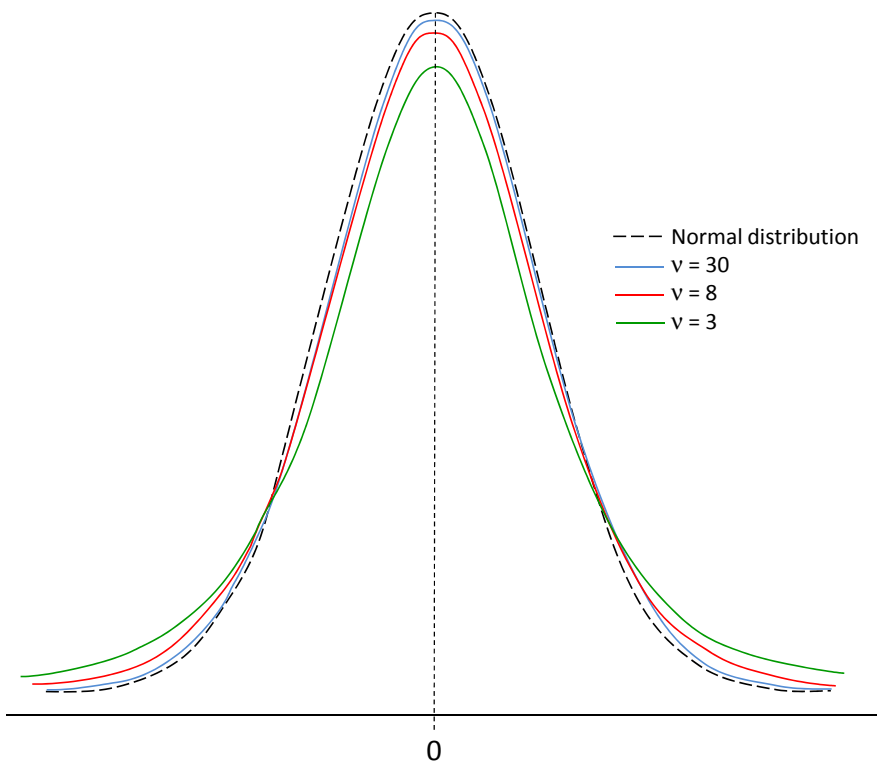


Figure 2.16 Comparison of t-distribution curves with different degrees of freedom ν and the standard normal distribution curve.
Note: ν = n-1, in which n = sample size.

Additionally, the width of the CI can be specified as its precision or accuracy. Moreover, the half-width of the CI is also the bound of the error estimation associated with the chosen confidence level (Devore, 2008). Therefore, the confidence level or the reliability of the interval is proportional to its error. An interval with an extremely high confidence level may lead to a high error and be imprecise since the limits of the interval may become far apart. On the other hand, an interval with an extremely low error may lead to a low confidence level. Accordingly, the determination of a desired CI should be a compromise with the error associated with it.

However, the number of tests (i.e., the sample size) and the coefficient of variation for the K_{SGI} results of a given geosynthetic also play a significant role in the estimation of the error associated to a CI.

Figure 2.17 presents a general t_ν distribution curve associated to ν degrees of freedom related to the number of repeat of small pullout tests, *n*, with any geosynthetic product. This sample size *n* has an average K_{SGI}, which is the sample mean $\overline{X}$ and a sample standard deviation *S*. As depicted in Figure 2.17, the width of the interval, ω, is directly related to the confidence level 1-α.

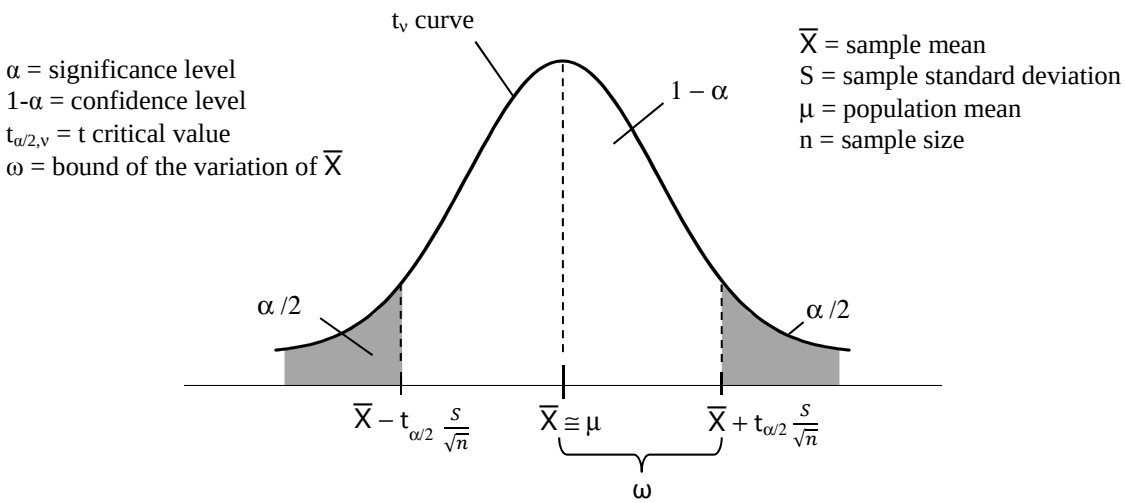


Figure 2.17 General t-distribution curve for repeat small pullout tests with any geosynthetic product.

In order to properly compare the repeatability of the K_{SGI} results of different geosynthetic products, it is necessary to assess the estimated error and the variability on the results as a percentage of the mean for each product (Equations 2.3 through 2.9). As shown in Figure 2.17, the width of the interval, ω, corresponds to

$$\omega = t_{\alpha/2,\nu}\frac{s}{\sqrt{n}} \tag{2.2}$$

By definition, the coefficient of variation, *cv*:

$$cv = \frac{s}{\bar{X}} \tag{2.3}$$

Thus

$$S = (cv)\overline{X} \tag{2.4}$$

Defining the bound of the variation of $\overline{X}$, ω, as a percentage of $\overline{X}$:

$$\omega = \varepsilon\,\overline{X} \tag{2.5}$$

Where:

ε = the bound on the error of estimation, in percent

Substituting Equations 2.6 and 2.5 into Equation 2.3:

$$\varepsilon \cdot \bar{X} = t_{\alpha/2,\nu} \frac{(cv)\bar{X}}{\sqrt{n}} \tag{2.6}$$

Therefore, the error in reporting the average K_{SGI} value for a given product can be estimated as follows:

$$\varepsilon = t_{\alpha/2,\nu} \frac{(cv)}{\sqrt{n}} \tag{2.7}$$

Alternatively, the number of test repeats for a given geosynthetic product that is needed to achieve a given error can be estimated as follows:

$$n = \left(t_{\alpha/2,\nu} \frac{cv}{\varepsilon}\right)^2 \tag{2.8}$$

It should be noted that values obtained using Equations 2.8 and 2.9 are estimations, and the final result may be different as more data are obtained along the process of performing more tests to achieve a desired error. This is because depending on the initial sample size *n*, the coefficient of variation *cv* may or may not change significantly as more data are obtained. In general, as *n* increases *cv* tends to decrease.

2.6.1 Results of Small Pullout Tests with Reinforcement on the CD

An important objective of this project is to identify a property that quantifies the ability of geosynthetic reinforcements in base course to mitigate environmental longitudinal cracking. Accordingly, a testing program involving small pullout tests was conducted. Longitudinal cracks are cracks developed in the pavement on the direction parallel to traffic. Thus, the soil-geosynthetic interaction on the CD of the geosynthetic rolls is evaluated in this project, as this is the direction of the mobilized loads due to the field installation arrangement of the geosynthetic products. This is because the reinforcement contribution to minimize or mitigate environmental longitudinal cracking is through the interaction with the soil on the direction perpendicular to the cracks.

In this series of tests, the number of tests performed with each product on the CD was equal or higher than the number of tests that correspondents to an estimated error of ± 20% on the K_{SGI} value. A summary of test results, including the number of test repeats and the results of the individual tests is presented next in this section for each product along with the correspondent average value of K_{SGI} (i.e., mean $\bar{X}$), the standard deviation *S*, the coefficient of variation *cv*, and the estimated error ε of the mean $\bar{X}$ for each product.

Geosynthetic GG PP CD

Twelve tests were performed with the product GG PP CD. The results are shown in Table 2.3. The average K_{SGI} for this product is 12.3 $(kN/m)^2/mm$ with a coefficient of variation of 35.8%. Accordingly, for a 95% CI the t-critical value is 2.306. From Equation 2.8 the estimated error is ± 23%.

This product has been extensively tested in other research projects at UT Austin. Testing was conducted with samples from a roll of the same lot of rolls installed in the field experiment at the FM2 road. However, not enough material was available to perform all the necessary tests to achieve an estimated error of ± 20% of the K_{SGI} value of this product. Thus, samples from rolls of different lots were used to complete this series of tests. This is the only product with samples taken from rolls of different lots, which may have added to any variability of test results. As shown in Table 2.3, comparatively lower values of K_{SGI} were obtained for Tests 6 to 9 as compared to the values of Tests 2 to 5 and 10 to 12. The use of samples from three different rolls led to the relatively high *cv* of this geogrid. With exception of the GG PP, the samples of all other products were obtained from a single roll.

Table 2.3 Results of small pullout tests with GG PP CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	8.9	
2	12.4	
3	10.6	
4	15.5	Tests conducted until 1 mm of displacement of LVDT 3
5	11.9	
6	8.1	
7	7.8	
8	7.8	
9	8.9	
10	17.3	
11	18.4	
12	19.7	
Mean, $\overline{X}$	12.27	
Standard deviation, S	4.39	
Coefficient of variation, cv	35.8%	
Estimated error, ε	± 23%	For a CI = 95%

Note: This was the only product with samples taken from different rolls.

The number of tests *n* needed to achieve an error of ± 20% on the K_{SGI} value can be estimated with Equation 2.9. The correspondent estimated *n* is 16 tests. This was the only product in the CD that the estimated error of the K_{SGI} exceeds 20%.

Geosynthetic GG PET CD

Six tests were performed with the product GG PET CD. The results are shown in Table 2.4. The average K_{SGI} for this product is 12.4 $(kN/m)^2/mm$ with a coefficient of variation of 13.2%. Accordingly, for a 95% CI the t-critical value is 2.571. From Equation 2.8 the estimated error is ± 14%.

Table 2.4 Results of small pullout tests with GG PET CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	13.8	
2	11.1	
3	12.2	
4	12.3	Tests conducted until 1 mm of displacement in LVDT 3
5	14.6	
6	10.2	
Mean, $\overline{X}$	12.36	
Standard deviation, S	1.64	
Coefficient of variation, cv	13.2%	
Estimated error, ε	± 14%	For a CI = 95%

Geosynthetic GT CD

Nine tests were performed with the product GT CD and the results are shown in Table 2.5. The average K_{SGI} for this product is 11.7 $(kN/m)^2/mm$ with a coefficient of variation of 23.0%. Accordingly, for a 95% CI the t-critical value is 2.306. From Equation 2.8 the estimated error is ± 18%.

Table 2.5 Results of small pullout tests with GT CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	11.0	
2	17.1	
3	13.4	
4	14.1	
5	11.1	Tests conducted until 1 mm of displacement of LVDT 3
6	9.6	
7	8.9	
8	9.1	
9	11.1	
Mean, $\overline{X}$	11.70	
Standard deviation, S	2.69	
Coefficient of variation, cv	23.0%	
Estimated error, ε	± 18%	For a CI = 95%

Geosynthetic GG PP2 CD

Eleven tests were performed with the product GG PP2 CD and the results are shown in Table 2.6. The average K_{SGI} for this product is 12.5 $(kN/m)^2/mm$ with a coefficient of variation of 15.1%. Accordingly, for a 95% CI the t-critical value is 2.228. From Equation 2.8 the estimated error is ± 10%.

Table 2.6 Results of small pullout tests with GG PP2 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	11.6	
2	10.1	
3	12.9	
4	10.6	
5	16.3	Tests conducted until 1 mm of displacement in LVDT 3
6	12.3	
7	12.5	
8	14.3	
9	10.6	
10	12.2	
11	14.4	
Mean, $\overline{X}$	12.52	
Standard deviation, S	1.90	
Coefficient of variation, cv	15.1%	
Estimated error, ε	± 10%	For a CI = 95%

Geosynthetic GG PP3 CD

Five tests were performed with the product GG PP3 CD and the results are shown in Table 2.7. The average K_{SGI} for this product is 34.9 $(kN/m)^2/mm$ with a coefficient of variation of 14.3%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 18%.

Table 2.7 Results of small pullout tests with GG PP3 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	38.7	
2	36.5	Tests conducted until 1 mm of displacement in LVDT 3
3	39.3	
4	27.1	
5	33.2	
Mean, $\overline{X}$	34.94	
Standard deviation, S	4.99	
Coefficient of variation, cv	14.3%	
Estimated error, ε	± 18%	For a CI = 95%

Geosynthetic GG PP4 CD

Eleven tests were performed with the product GG PP4 CD and the results are shown in Table 2.8. The average K_{SGI} for this product is 6.5 $(kN/m)^2/mm$ with a coefficient of variation of 27.6%. Accordingly, for a 95% CI the t-critical value is 2.228. From Equation 2.8 the estimated error is ± 19%.

Table 2.8 Results of small pullout tests with GG PP4 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	4.6	
2	6.5	
3	6.1	
4	4.3	Tests conducted until 1 mm of displacement of LVDT 3
5	10.3	
6	5.9	
7	6.5	
8	7.0	
9	4.6	
10	8.6	
11	7.0	
Mean, $\overline{X}$	6.49	
Standard deviation, S	1.79	
Coefficient of variation, cv	27.6%	
Estimated error, ε	± 19%	For a CI = 95%

Geosynthetic GG PP4x2 CD

Six tests were performed with the product GG PP4x2 CD and the results are shown in Table 2.9. The average K_{SGI} for this product is 11.5 $(kN/m)^2/mm$ with a coefficient of variation of 14.9%. Accordingly, for a 95% CI the t-critical value is 2.571. From Equation 2.8 the estimated error is ± 16%.

Table 2.9 Results of small pullout tests with GG PP4x2 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	11.1	
2	11.5	
3	10.6	
4	10.2	Tests conducted until 1 mm of displacement of LVDT 3
5	10.8	
6	14.9	
Mean, $\overline{X}$	11.51	
Standard deviation, S	1.72	
Coefficient of variation, cv	14.9%	
Estimated error, ε	± 16%	For a CI = 95%

Geosynthetic GG PP5 CD

Eight tests were performed with the product GG PP5 CD and the results are shown in Table 2.10. The average K_{SGI} for this product is 8.6 $(kN/m)^2/mm$ with a coefficient of variation of 16.1%. Accordingly, for a 95% CI the t-critical value is 2.365. From Equation 2.8 the estimated error is ± 13%.

Table 2.10 Results of small pullout tests with GG PP5 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	6.0	
2	9.0	
3	7.3	
4	10.0	
5	8.2	
6	10.1	
7	9.3	
8	8.9	
Mean, $\overline{X}$	8.60	
Standard deviation, S	1.39	
Coefficient of variation, cv	16.1%	
Estimated error, ε	± 13%	For a CI = 95%

Geosynthetic GG PET2 CD

Five tests were performed with the product GG PET2 CD and the results are shown in Table 2.11. The average K_{SGI} for this product is 8.5 $(kN/m)^2/mm$ with a coefficient of variation of 15.4%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 19%.

Table 2.11 Results of small pullout tests with GG PET2 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	9.0	
2	7.2	
3	8.9	
4	7.1	
5	10.1	
Mean, $\overline{X}$	8.45	
Standard deviation, S	1.30	
Coefficient of variation, cv	15.4%	
Estimated error, ε	± 19%	For a CI = 95%

Geosynthetic GG PPTG CD

Six tests were performed with the product GG PPTG CD and the results are shown in Table 2.12. The average K_{SGI} for this product is 15.0 $(kN/m)^2/mm$ with a coefficient of variation of 11.3%. Accordingly, for a 95% CI the t-critical value is 2.571. From Equation 2.8 the estimated error is ± 12%.

Table 2.12 Results of small pullout tests with GG PPTG CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	14.3	
2	13.5	
3	16.2	
4	17.3	
5	16.0	
6	13.0	
Mean, $\overline{X}$	15.04	
Standard deviation, S	1.70	
Coefficient of variation, cv	11.3%	
Estimated error, ε	± 12%	For a CI = 95%

Geosynthetic GG PPTG3 CD

Six tests were performed with the product GG PPTG3 CD and the results are shown in Table 2.13. The average K_{SGI} for this product is 14.9 $(kN/m)^2/mm$ with a coefficient of variation of 10.2%. Accordingly, for a 95% CI the t-critical value is 2.571. From Equation 2.8 the estimated error is ± 11%.

Table 2.13 Results of small pullout tests with GG PPTG3 CD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	16.3	
2	15.9	
3	15.8	
4	15.1	
5	12.3	
6	13.8	
Mean, $\overline{X}$	14.9	
Standard deviation, S	1.51	
Coefficient of variation, cv	10.2%	
Estimated error, ε	± 11%	For a CI = 95%

2.6.2 Comparative Evaluation of Tests on the CD

A summary of the results presented in the previous section is shown in Table 2.14. The average coefficient of variation, *cv*, of the results was around 14%—excluding the products GG PP, GT, and GG PP4, which presented a *cv* of around 29% on average. The average *cv* considering all tests is 18%. This *cv* on the K_{SGI} values is comparable with the *cv* on the resilient modulus, M_R, values reported by Kancherla (2004) for seven replicate tests with crushed granite, D_{50} of 0.47 in. (12 mm), used as base course for Interstate Highway 30 in Oklahoma.

Table 2.14 Summary of the small pullout test results with the geosynthetic on the CD

Product		Average K_{SGI} [(kN/m)^2/mm]	Coefficient of variation, c.v.	Tests performed, *n*	Confidence level = 95%
Type	**UT Product Name**				**Estimated Error, ε**
Geogrid	GG PP	12.3	35.8%	12	23%
Geogrid	GG PET	12.4	13.2%	6	14%
Woven Geotextile	GT	11.7	23.0%	9	18%
Geogrid	GG PP2	12.5	15.1%	11	10%
Geogrid	GG PP3	34.9	14.3%	5	18%
Geogrid	GG PP4	6.5	27.6%	11	19%
Geogrid	GG PP4x2	11.5	14.9%	6	16%
Geogrid	GG PP5	8.6	16.1%	8	13%
Geogrid	GG PPTG	15.0	11.3%	6	12%
Geogrid	GG PPTG3	14.9	10.2%	6	11%
Geogrid	GG PET2	8.5	15.4%	5	19%

The average K_{SGI} of all the products used in this testing program are shown in Figure 2.18 together with the estimated error bound bars. The results in Figure 2.18 also show the ranking of the products with the highest to the lowest K_{SGI} values.

In the small pullout test setup adopted in this project with Sieved Aggregate 2 and 3 psi (21 kPa) of confining pressure, the geogrid GG PP3 showed the highest average K_{SGI}. The product with the second highest average K_{SGI} is GG PPTG. However, the interval on the error estimation of the K_{SGI} of GG PPTG with 95% of confidence overlaps the interval on the error estimation of the K_{SGI} of GG PPTG3, GG PP2, GG PET, GG PP, GT, and GG PP4x2. An overlap of intervals on the error estimation of the K_{SGI} of different products means that the K_{SGI} of the entire population of these products might be the same. Only the product GG PP3 is isolated from the other products since its interval on the error estimation of K_{SGI} does not overlap with the interval of any other product.

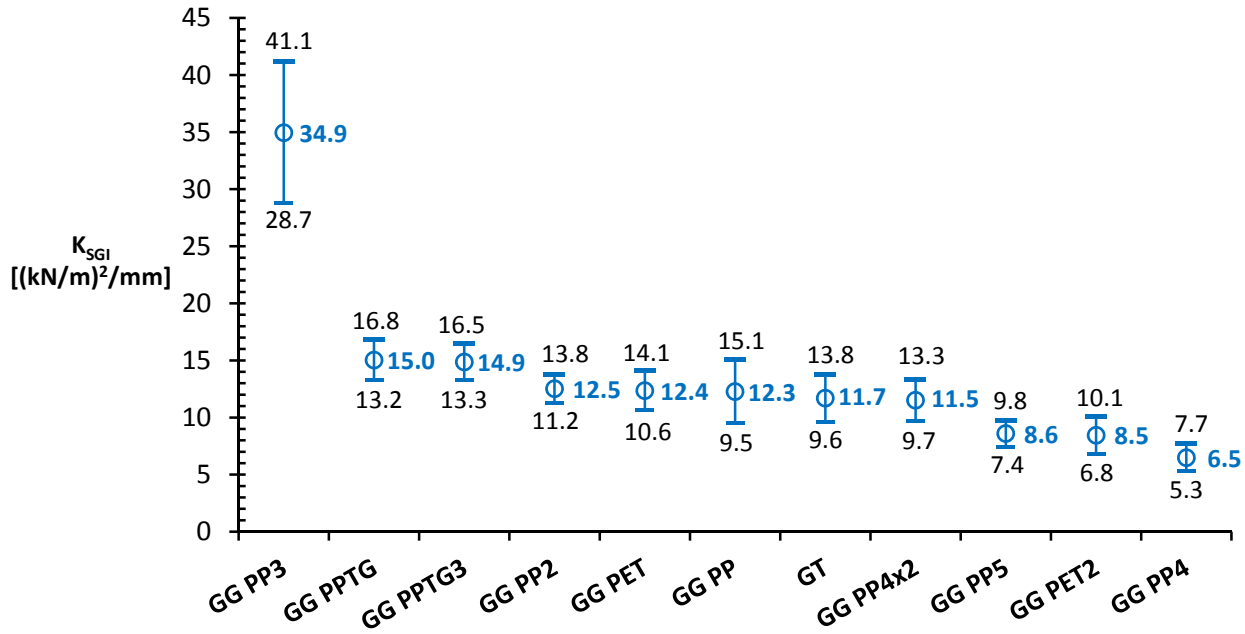


Figure 2.18 Ranking of geosynthetics on the CD, 95% confidence level, average K_{SGI} with error bound bars.

Considering only the average K_{SGI} values, five groups of product could be qualitatively considered. The first group includes the products with the highest K_{SGI} value, where only GG PP3 is included. A second group with GG PPTG and GG PPTG3 could be identified. A third group could be considered as formed by GG PP2, GG PET, GG PP, GT, and GG PP4x2. A fourth group includes GG PP5 and GG PET2. Finally, the group composed of products with the lowest K_{SGI} corresponds to only GG PP4.

Based on this qualitative evaluation, a minimum value for the K_{SGI} coefficient to be recommended for acceptance of products to be used in the mitigation of environmental cracking needs to be higher than the estimation of the K_{SGI} of the products within the group with the lowest K_{SGI} coefficient. A recommendation based on preliminary field evaluation and experience in TxDOT is to consider a minimum K_{SGI} of 8.0 $(kN/m)^2/mm$.

It should be noted that the recommended minimum K_{SGI} of 8.0 $(kN/m)^2/mm$ for acceptance of products is based on an index parameter obtained from the specific test setup of the small pullout testing used in this project: Sieved Aggregate 2 and confining pressure of 3.0 psi (21 kPa). While field data has been generated in this project with the experimental sections reinforced with some of these products in FM2 and FM1644 roads, additional information is needed to establish a correlation of field performance of all tested products in mitigating environmental cracking. A comprehensive database with the geosynthetic products available in the market would allow refinement of the recommended minimum K_{SGI} value.

2.6.3 Additional Observation on CD Test Results

The product GG PP3 provided a K_{SGI} value significantly higher than that of the other products on the CD tested under the same conditions. In a comparison of the nominal specifications of the products shown in Table 2.2, the only characteristic of the GG PP3 that is significantly different than the other products is its smaller aperture size. Table 2.15 presents a

summary with the aperture sizes, the tensile strength at 2% strain, and ultimate tensile strength of the geosynthetic products. The products in this table are listed in order from the highest to the lowest K_{SGI} value obtained on the small pullout tests on the CD. Additionally, the ratio (W/D_{50}) of the nominal aperture size on each direction to the D_{50} of Sieved Aggregate 2 is also shown in Table 2.15.

It can be noted in Table 2.15 that the aperture size of GG PP4x2 on both directions was the only one measured. The manufacturer of this product does not specify the aperture size of this product, probably because of the variability and the different sizes of apertures created by the utilization of two layers of geogrid. However, the nominal aperture for one layer of the geogrid is specified and reported in Table 2.15 for GG PP4. Figure 2.19 illustrates the variable aperture size of GG PP4x2. The aperture size reported in Table 2.15 for GG PP4x2 is the average value of the aperture designated with the white rectangle number 1 in Figure 2.19.

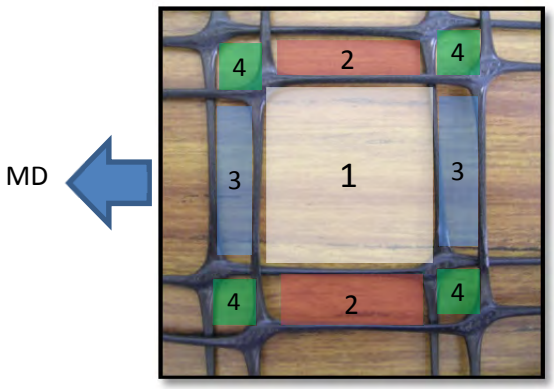


Figure 2.19 Variable aperture size of GG PP4x2 due to the use of two layers of geogrid.

The probable reason why GG PP3 provided a high K_{SGI} value is a combination of the mechanical and geometric characteristics of the geogrid. The influence of each of many characteristics of a geogrid on the soil-reinforcement interaction includes the stiffness of the geogrid, the junction strength, and the ability to interact with the surrounding soil.

A factor that affects the ability of a geogrid to interact with the surrounding soil and influence the interface stiffness is the aperture size. As observed in Table 2.15, the aperture size of GG PP3 on both directions has the lowest W/D_{50} ratio of all products (equal to 2.7). This was the product with the W/D_{50} ratio closest to the optimal ratio of 1.4 suggested by Brown et al. (2008). Brown et al. (2008) performed a series of cyclic loading beam tests on large aggregates used in railway ballast reinforced with integrally formed geogrids. The magnitude of the cyclic loads was 4,500 lbf (20 kN) applied at a rate of 2 Hz. Reinforcement performance was measured in terms of settlement of the beam at 30,000 loading cycles. The aggregate used by Brown et al. (2008) has a D_{50} equal to 2 in. (50 mm), significantly larger than the Sieved Aggregate 2 used in this project. Accordingly, the biaxial geogrids used by Brown et al. (2008) have aperture sizes ranging from 1.25 to 4 in. (32 to 100 mm), also significantly larger than the apertures of the geogrids used in this project. An optimal aperture size of 2.75 in. (70 mm), 1.4 larger than the D_{50} of the aggregate, was found by Brown et al. (2008) from a curve fitted to the data.

Table 2.15 Selected nominal specifications of geosynthetic products on the CD and relation between aperture sizes and D_{50} of Sieved Aggregate 2

Roll Direction	CD	Nominal specification						
Product	Average K_{SGI} [(kN/m)^2/mm]	Tensile Strength @ (lbf/ft)			Aperture, W (in.)		W/D_{50}	
UT Product Name		ε = 0.5%	ε = 2.0%	Ultimate	CD	MD	CD	MD
GG PP3	34.9	---	480	1,600	0.6	0.6	2.8	2.8
GG PPTG	15.0	102.9	---	---	0.9(1)	0.9(1)	4.3(1)	4.3(1)
GG PPTG3	14.9	75.4	---	---	0.8(1)	0.8(1)	3.5(1)	3.5(1)
GG PP2	12.5	---	620	1,970	1.3	1.0	6.0	4.6
GG PET	12.4	---	500	2,000	1.0	1.0	4.6	4.6
GG PP	12.3	---	450	1,300	1.3	1.0	6.0	4.5
GT	11.7	---	1,320	4,800	N/A	N/A	N/A	N/A
GG PP4x2	11.5	---	450	1,400	1.5(2)	1.1(2)	7.1	5.1
GG PP5	8.6	---	686	2,055	1.3	1.3	5.8	5.8
GG PET2	8.5	---	578	3,870	1.0	1.0	4.6	4.6
GG PP4	6.5	---	225	700	2.0	1.7	9.1	7.6

Note: (1) Distance along the roll direction correspondent to the diameter of a circle inscribed in the triangular aperture. (2) Average value measured by the authors.

The aperture size is only one of the factors that contribute to the high K_{SGI} value of GG PP3. The product GG PET2 is among the products with the second lowest W/D_{50} ratio of 4.6 but still presented the second lowest K_{SGI} value among all products tested. If the aperture size were the driving factor, then similar to the tests in the CD, the K_{SGI} value of GG PP3 tested on the MD should be significantly higher than the K_{SGI} value for the other products on the MD. However, the K_{SGI} value of GG PP3 on the MD is only the eighth highest value among the 11 products tested. The results of the series of tests on the MD are presented in Section 2.7.

Another important observation that can be inferred from the data in Table 2.15 is that the tensile stiffness (or tensile strength) of the geosynthetic at 2% strain does not correlate with interface stiffness at the low confining level of 3.0 psi (21 kPa). This is clear with the extreme comparison of the results between geotextiles and geogrids. For example, the nominal tensile strength of GT at 2% strain on the CD is 175% higher than the one of GG PP3, but the average K_{SGI} for GT on the CD is only 34% of the average K_{SGI} for GG PP3. When comparing only geogrid products, the nominal tensile strength of GG PP5 at 2% strain is 43% higher than the one of GG PP3, but the average K_{SGI} for GG PP5 is only 25% of the average K_{SGI} for GG PP3.

Stiffness of the geosynthetic may have a more significant role at higher confinement as reported by Brown et al. (2007). Tests with geogrids of same aperture size but different stiffness values showed improved performance of stiffer geogrids at higher confining pressures.

These results illustrate that material properties obtained by testing geosynthetic products in isolation do not correlate well with the characterization of confined interface stiffness. Specifications based on unconfined tests of geosynthetics may be misleading as shown by the results on Table 2.15. Moreover, the small pullout test setup with Sieved Aggregate 2 has the potential to be used as a standard test. This test fulfills the need to test geosynthetics in the confined situation and provides satisfactory repeatability of the results with coefficients of variation of the results on the order of 15%. The K_{SGI} coefficient can be used as an index

parameter for testing geosynthetics to be used in base course reinforcement for mitigating longitudinal environmental cracking in roads.

2.7 Additional Tests

Two additional series of tests were conducted, including small pullout tests with the geosynthetic products oriented in the machine direction (MD). A fixed number of five replicate tests were performed for each product. The only exception was with GG PP for which six replicate tests were conducted. The GG PP was the only product with specimens taken from different rolls. A summary of the results with each product is presented in this section. The reports of the individual results of these tests are presented in Appendix A2. A comparative evaluation of the results on the MD is also presented in this section.

Additional tests were also performed in an attempt to further decrease the *cv* of the tests on the CD. Two tests in the series of replicate tests of seven products were conducted only up to 1 mm of displacement recorded by the LVDT 3. Once this displacement was reached, the tests were stopped and the geosynthetic unloaded to 30 lbf (0.15 kN). Next, a new data acquisition file was started and the test was re-started similarly to a regular test. Thus, the variability due to the use of different geosynthetic specimens would be reduced since the same specimen was used for both tests. This attempt was unsuccessful as the tests with the reloaded specimens provided significantly different pullout curves and, consequently, K_{SGI} values from the regular tests. An example of the results obtained in this series of tests is discussed in this section. The results with the reports of the individual tests are presented in Appendix A5.

2.7.1 Results of Small Pullout Tests with Reinforcement on the MD

Although the focus of this project is on the results with the geosynthetic products on the CD, testing on the MD was deemed important in order to provide a more detailed analysis of the characteristics of the geosynthetics that influence the soil-geosynthetic interaction of the initial stiffness of the interface. In case of projects where base reinforcement focuses on traffic loading (rather than environmental loading), the reinforcement is mobilized on both roll directions since traffic loading is multidirectional. Also, construction of the base course is performed with the machines moving along the traffic direction, thus mobilizing the reinforcement on the MD as the soil is placed and compacted on top of the reinforcement.

Geosynthetic GG PP MD

Six tests were performed with the product GG PP MD and the results are shown in 0. The average K_{SGI} for this product is 13.4 $(kN/m)^2/mm$ with a coefficient of variation of 28.5%. Accordingly, for a 95% CI the t-critical value is 2.571. From Equation 2.8 the estimated error is ± 30%.

Table 2.16 Results of small pullout tests with GG PP MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	8.4	
2	11.3	
3	15.0	
4	19.3	
5	11.5	
6	14.7	
Mean, $\overline{X}$	13.37	
Standard deviation, S	3.81	
Coefficient of variation, cv	28.5	
Estimated error, ε	± 30%	For a CI = 95%

Geosynthetic GG PET MD

Five tests were performed with the product GG PET MD and the results are shown in Table 2.17. The average K_{SGI} for this product is 14.1 $(kN/m)^2/mm$ with a coefficient of variation of 32.8%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 41%.

Table 2.17 Results of small pullout tests with GG PET MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	16.5	
2	14.9	
3	19.9	
4	11.4	
5	7.9	
Mean, $\overline{X}$	14.11	
Standard deviation, S	4.63	
Coefficient of variation, cv	32.8	
Estimated error, ε	± 41%	For a CI = 95%

Geosynthetic GT MD

Five tests were performed with the product GT MD and the results are shown in Table 2.18. The average K_{SGI} for this product is 4.7 $(kN/m)^2/mm$ with a coefficient of variation of 62.3%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 77%.

Table 2.18 Results of small pullout tests with GT MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	4.1	
2	4.1	
3	9.8	
4	3.2	
5	2.4	
Mean, $\overline{X}$	4.73	
Standard deviation, S	2.95	
Coefficient of variation, cv	62.3	
Estimated error, ε	± 77%	For a CI = 95%

Geosynthetic GG PP2 MD

Five tests were performed with the product GG PP2 MD and the results are shown in Table 2.19. The average K_{SGI} for this product is 8.8 $(kN/m)^2/mm$ with a coefficient of variation of 9.2%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 11%.

Table 2.19 Results of small pullout tests with GG PP2 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	9.7	
2	7.9	
3	9.0	
4	8.0	
5	9.2	
Mean, $\overline{X}$	8.76	
Standard deviation, S	0.81	
Coefficient of variation, cv	9.2	
Estimated error, ε	± 11%	For a CI = 95%

Geosynthetic GG PP3 MD

Five tests were performed with the product GG PP3 MD and the results are shown in Table 2.20. The average K_{SGI} for this product is 8.3 $(kN/m)^2/mm$ with a coefficient of variation of 13.8%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 17%.

Table 2.20 Results of small pullout tests with GG PP3 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	6.9	
2	10.1	
3	8.5	
4	8.2	
5	8.1	
Mean, $\overline{X}$	8.33	
Standard deviation, S	1.15	
Coefficient of variation, cv	13.8%	
Estimated error, ε	± 17%	For a CI = 95%

Geosynthetic GG PP4 MD

Five tests were performed with the product GG PP4 MD and the results are shown in Table 2.21. The average K_{SGI} for this product is 6.6 $(kN/m)^2/mm$ with a coefficient of variation of 11.9%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 15%.

Table 2.21 Results of small pullout tests with GG PP4 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	7.7	
2	5.8	
3	5.9	
4	6.7	
5	6.9	
Mean, $\overline{X}$	6.59	
Standard deviation, S	0.78	
Coefficient of variation, cv	11.9	
Estimated error, ε	± 15%	For a CI = 95%

Geosynthetic GG PP4x2 MD

Five tests were performed with the product GG PP4x2 MD and the results are shown in Table 2.22. The average K_{SGI} for this product is 7.6 $(kN/m)^2/mm$ with a coefficient of variation of 12.0%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 15%.

Table 2.22 Results of small pullout tests with GG PP4x2 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	6.7	
2	7.8	
3	7.9	
4	8.8	
5	6.7	
Mean, $\overline{X}$	7.58	
Standard deviation, S	0.91	
Coefficient of variation, cv	12.0%	
Estimated error, ε	± 15%	For a CI = 95%

Geosynthetic GG PP5 MD

Five tests were performed with the product GG PP5 MD and the results are shown in Table 2.23. The average K_{SGI} for this product is 9.7 $(kN/m)^2/mm$ with a coefficient of variation of 21.8%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 27%.

Table 2.23 Results of small pullout tests with GG PP5 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	8.0	
2	11.3	
3	12.5	
4	7.8	
5	8.9	
Mean, $\overline{X}$	9.68	
Standard deviation, S	2.11	
Coefficient of variation, cv	21.8%	
Estimated error, ε	± 27%	For a CI = 95%

Geosynthetic GG PET2 MD

Five tests were performed with the product GG PET2 MD and the results are shown in Table 2.24. The average K_{SGI} for this product is 11.2 $(kN/m)^2/mm$ with a coefficient of variation of 12.1%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 15%.

Table 2.24 Results of small pullout tests with GG PET2 MD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	13.3	
2	11.7	
3	10.0	
4	10.3	
5	10.6	
Mean, $\overline{X}$	11.17	
Standard deviation, S	1.35	
Coefficient of variation, cv	12.1%	
Estimated error, ε	± 15%	For a CI = 95%

Geosynthetic GG PPTG DD

Small pullout tests with triangular geogrids on the MD could not to be performed, at least with the roller clamp used in this study. With this grip, there is a large unconfined portion of the geogrid specimen. This type of product does not have a rib aligned along the MD. As a result, the unconfined portion of the geogrid experiences significant necking as the triangular apertures tend to narrow when tension is applied. Consequently, the ribs aligned along the CD, which in this case are positioned perpendicular to the pullout direction, collapse out of plane and the geogrid specimen becomes increasingly narrower at the unconfined portion. This significant deformation under necking of the unconfined portion of the geogrid does not allow proper engagement of the confined portion of the geogrid in the pullout box, thus making the test difficult to perform. The use of a sanders clamp would leave a small unconfined portion of the geogrid and might allow small pullout testing of triangular geogrids. Accordingly, this type of geogrids was tested in the diagonal direction (DD) instead of MD since there are ribs aligned to the DD.

Five tests were performed with the product GG PPTG DD and the results are shown in Table 2.25. The average K_{SGI} for this product is 13.8 $(kN/m)^2/mm$ with a coefficient of variation of 6.4%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 8%.

Table 2.25 Results of small pullout tests with GG PPTG DD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	15.3	
2	13.5	
3	13.6	
4	12.9	
5	13.8	
Mean, $\overline{X}$	13.80	
Standard deviation, S	0.88	
Coefficient of variation, cv	6.4%	
Estimated error, ε	± 8%	For a CI = 95%

Geosynthetic GG PPTG3 DD

Five tests were performed with the product GG PPTG3 DD and the results are shown in Table 2.26. The average K_{SGI} for this product is 16.0 $(kN/m)^2/mm$ with a coefficient of variation of 6.8%. Accordingly, for a 95% CI the t-critical value is 2.776. From Equation 2.8 the estimated error is ± 8%.

Table 2.26 Results of small pullout tests with GG PPTG3 DD

Test number	K_{SGI} $(kN/m)^2/mm$	Comments
1	15.9	
2	15.6	
3	15.7	
4	14.9	
5	17.8	
Mean, $\overline{X}$	15.97	
Standard deviation, S	1.09	
Coefficient of variation, cv	6.8%	
Estimated error, ε	± 8%	For a CI = 95%

2.7.2 Comparative Evaluation of Tests on the MD

A summary of the results presented in the previous section is shown in Table 2.27. Since a fixed number of five tests were performed with each product on the MD, the resultant estimation of the error of K_{SGI} is higher than the estimated errors of the results on the CD.

Table 2.27 Summary of the small pullout test results with the geosynthetic on the MD

Product		Average K_{SGI} $[(kN/m)^2/mm]$	Coefficient of variation, c.v.	Tests performed, *n*
Type	**UT Product Name**			
Geogrid	GG PP	13.4	28.5%	6
Geogrid	GG PET	14.1	32.8%	5
Woven Geotextile	GT	4.7	62.3%	5
Geogrid	GG PP2	8.8	9.2%	5
Geogrid	GG PP3	8.3	13.8%	5
Geogrid	GG PP4	6.6	11.9%	5
Geogrid	GG PP4x2	7.6	12.0%	5
Geogrid	GG PP5	9.7	21.8%	5
Geogrid	GG PPTG(1)	13.8	6.4%	5
Geogrid	GG PPTG3(1)	16.0	6.8%	5
Geogrid	GG PET2	11.2	12.1%	5

Note: (1) Results on the diagonal direction (DD).

The average K_{SGI} results on the MD of all the products used in the small pullout testing matrix are plotted in Figure 2.20. The results in Figure 2.20 show the ranking of the products with the highest K_{SGI} value on the left side of the horizontal axis and the lowest K_{SGI} value on the right side of the horizontal axis. As observed in this figure, the ranking of the geosynthetic products on the MD is significantly different than the ranking on the CD. For example, The K_{SGI} for GG PP3 MD is only the eighth highest value among the 11 products as opposed to the highest value obtained in the CD. The K_{SGI} of GG PP3 on the MD is only 24% of the K_{SGI} on the CD. An important difference is also shown for GT whose K_{SGI} on the MD is 60% smaller than the K_{SGI} on the CD. These differences between K_{SGI} values of the same products in different directions highlight the complexity of the mechanisms involving the soil-geosynthetic interaction in the initial stiffness of the interface.

Similarly to the results presented for the CD, a summary with only the aperture sizes, the tensile strength at 2% strain, and the ultimate tensile strength of the geosynthetic products is presented in Table 2.28. The products in this table are listed in order from the highest to the lowest K_{SGI} value obtained on the small pullout tests on the MD. Additionally, the ratio (W/D_{50}) of the nominal aperture size on each direction to the D_{50} of Sieved Aggregate 2 is calculated and also shown on Table 2.28. As shown in this table, the smallest W/D_{50} ratio for the GG PP3 does not lead this product to the highest K_{SGI}.

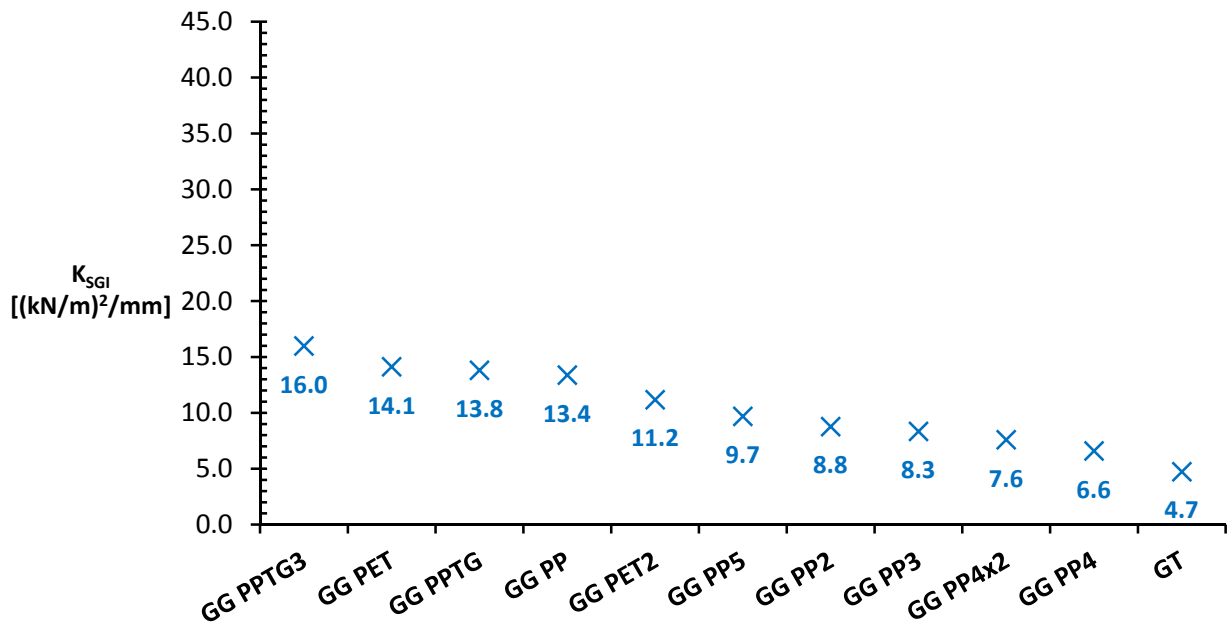


Figure 2.20 Ranking geosynthetics on the MD with average K_{SGI}.

Table 2.28 Selected nominal specifications of geosynthetic products on the MD and relation between aperture sizes and D_{50} of Sieved Aggregate 2

Roll Direction	MD	Nominal specification						
Product	Average K_{SGI} [(kN/m)^2/mm]	Tensile Strength @ (lbf/ft)			Aperture, W (in.)		W/D_{50}	
UT Product Name		ε = 0.5%	ε = 2.0%	Ultimate	CD	MD	CD	MD
GG PPTG3	16.0	75.4	---	---	1.3	1.3(1)	6.0	6.0(1)
GG PET	14.1	---	500	2,000	1.0	1.0	4.6	4.6
GG PPTG	13.8	102.9	---	---	1.6	1.6(1)	7.4	7.4(1)
GG PP	13.4	---	280	850	1.3	1.0	6.0	4.5
GG PET2	11.2	---	526	2,388	1.0	1.0	4.6	4.6
GG PP5	9.7	---	686	2,055	1.3	1.3	5.8	5.8
GG PP2	8.8	---	410	1,310	1.3	1.0	6.0	4.6
GG PP3	8.3	---	343	900	0.6	0.6	2.8	2.8
GG PP4x2	7.6	---	301	925	1.5	1.1(2)	7.1	5.1(2)
GG PP4	6.6	---	151	463	2.0	1.7	9.1	7.6
GT	4.7	---	960	4,800	N/A	N/A	N/A	N/A

Notes: (1) Aperture dimension in the diagonal direction. (2) Average value measured by the authors.

2.7.3 Tests with Re-Loaded Specimens

As previously mentioned, tests with re-loaded specimens were performed in an attempt to further decrease the *cv* of the tests on the CD. The variability is expected to decrease since the same specimen is used in replicate tests, thus eliminating material variability. Two tests with re-loading were conducted with the following products: GG PP, GG PET, GT, GG PP2, GG PP3, GG PP4, and GG PP4x2. In this section the results with only GG PP are presented. The results with the other products followed the same trend as the results for GG PP and are not showed in this section. However, the reports of the individual tests are presented in Appendix A5.

The results of the test with GG PP CD conducted until 1 mm of displacement was registered by LVDTs 2, 3 and 4 are shown in Figure 2.21. The results of the re-loaded specimen are shown in Figure 2.22. Comparing these two figures, it can be visually noted that the K_{SGI} plot for the re-loaded test (Figure 2.22) is not as linear as the plot for the regular test (Figure 2.21), what is shown in the lower R^2 value of the re-loaded test. Also, the K_{SGI} of the re-loaded specimen is higher than the K_{SGI} of the specimen loaded until 1 mm of displacement of LVDT 3. This same behavior was observed in the results of all re-loading tests. Therefore, re-loading the specimen is not appropriate to minimize the *cv* of the results of small pullout tests.

(a)

(b)

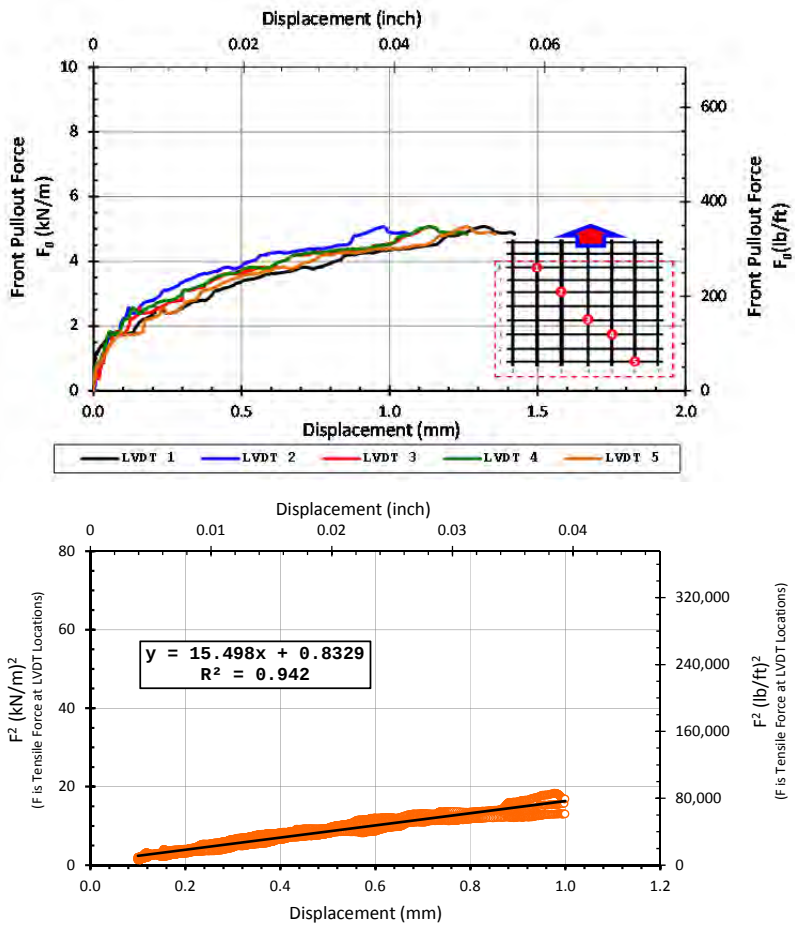


Figure 2.21 Results of the small pullout test with GG PP CD conducted until 1 mm of displacement was recorded for LVDT 3: (a) Pullout curve; (b) K_{SGI} plot.

(a)

(b)

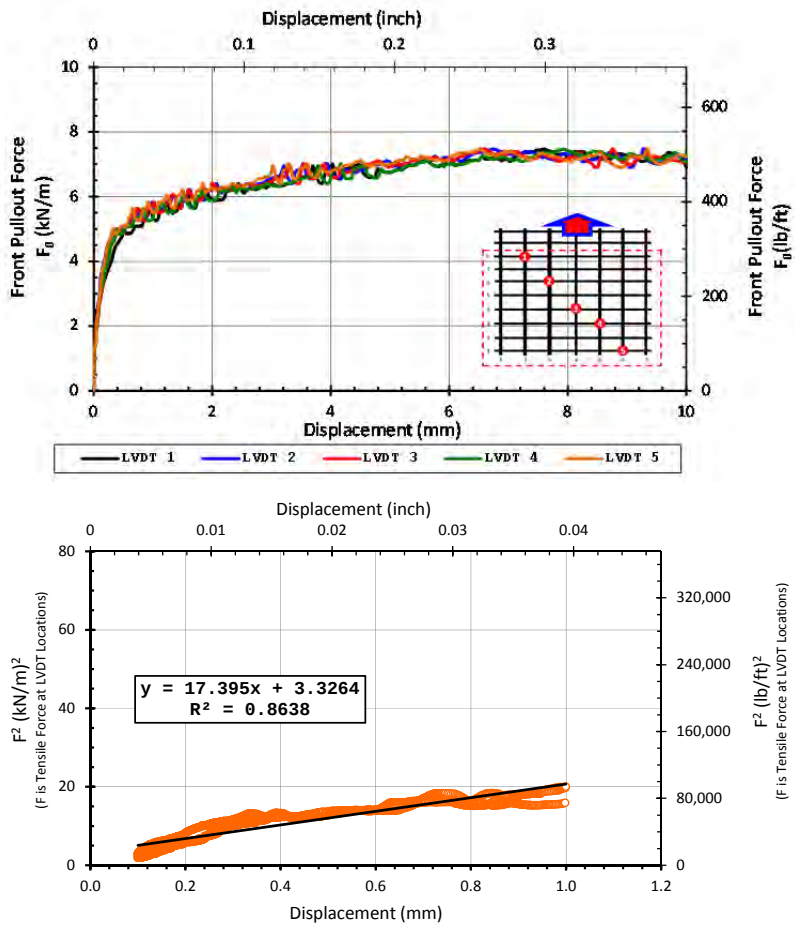


Figure 2.22 Results of the re-loaded small pullout test with GG PP CD: (a) Pullout curve; (b) K_{SGI} plot.

2.8 Summary of Findings from the Experimental Component

An evaluation was presented of the stiffness of the soil-geosynthetic interface for 11 geosynthetic products embedded in a uniform aggregate (namely Sieved Aggregate 2). The products were characterized using the parameter K_{SGI}, proposed in project report 5-4829-01 (Zornberg et al. 2012a). The testing matrix was focused on evaluating the interface with the geosynthetics oriented on the CD. Additional tests were also performed with the geosynthetics oriented on the MD.

A ranking of the performance of the geosynthetics in the CD was compiled based on the mean K_{SGI} values obtained from the small pullout tests. The product that yielded the highest mean K_{SGI} on the CD was GG PP3, followed by GG PPTG, GG PPTG3, GG PP2, GG PET, GG PP, GT, GG PP4x2, GG PP5, GG PET2, and GG PP4. Additionally, these results allowed classifying the geosynthetic products in five different groups based on a qualitative evaluation of their performance.

The results from the tests to characterize K_{SGI} in the MD led to a different ranking of geosynthetics products than that obtained in the CD. For example, in the MD, GG PP3 yielded the eighth highest K_{SGI} value, whereas in the CD, GG PP3 yielded the highest one.

Trends and rankings of geosynthetic products obtained from unconfined tensile tests are significantly different than those obtained using stiffness results from the proposed confined pullout tests, highlighting the relevance of characterizing the stiffness under confined applications in pavement projects involving geosynthetic reinforcements.

Chapter 3. Field Monitoring Program

3.1 Introduction

Roads founded on problematic subgrades reportedly show enhanced performance when reinforced with geosynthetic products. These products proved to be most effective when used in roads designed for low to moderate traffic volumes. However, little work has been done on the performance of these products to enhance the performance of paved roads subjected to environmental loading. As a part of Projects 0-4829 and 5-4829-01, a comprehensive field performance evaluation program was conducted. This program involved construction and instrumentation of experimental test sections over expansive subgrade clays followed by continuous monitoring of their performance. Different geosynthetic products were used for reinforcement of the sections. The main purposes of the monitoring program were to evaluate performances of the different geosynthetic reinforcements used in the roads and to correlate their performance with the material characteristics. The experimental test sections were constructed in two sites in Texas: FM2 and FM1644. The preliminary results of the monitoring program were presented in previous reports of this project (Zornberg et al. 2012a). This chapter presents updated information on the performance of the experimental test sections in FM2 and FM1644.

3.2 Identification of the Test Sections in FM2

The FM2 experimental test sections are located in Grimes County, where the subgrade soil included expansive clays. As shown in Figures 3.1 and 3.2, FM2 is a 6.4-mile road located approximately 10 miles south of Navasota and 122 miles east of Austin. This road starts from the west of State Highway 6 (SH6) and extends eastward to FM362. The test sections lie in two sections of the road. The first section starts from FM362 and extends westward for 1.02 miles. After a 1.3-mile gap, the second section starts and continues to the west for 0.34 mile.

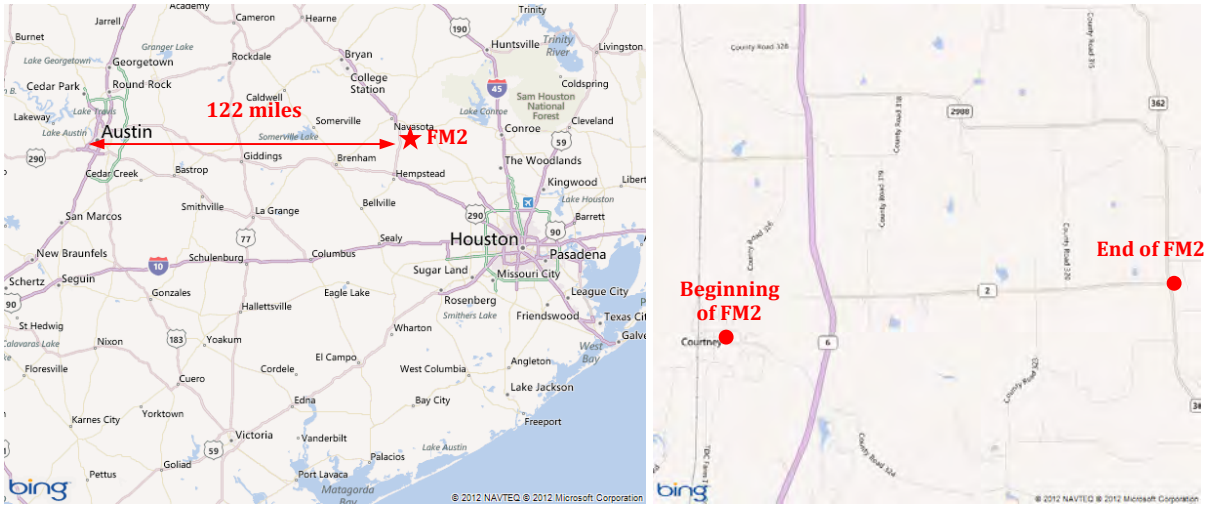


Figure 3.1 Location of FM2.

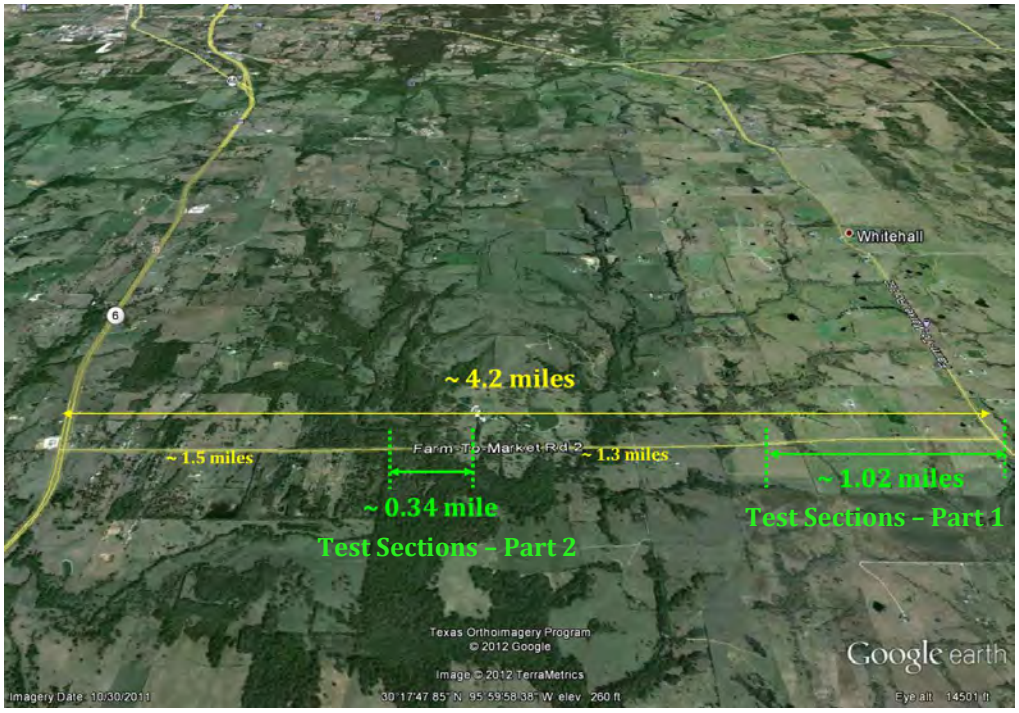


Figure 3.2 Location of test sections in FM2.

3.2.1 Original Layout

In the original plan, 32 test sections, each 450 ft long, were planned for construction in FM2. This corresponds to 16 sections on each lane. Part 1 has 24 sections (12 sections in each lane) and Part 2 has 8 (4 sections in each lane). As described in previous reports (Zornberg et al. 2012a, Zornberg et al. 2008), the test sections were categorized into eight different reinforcement schemes:

Schemes 1 to 3: Reinforcement of the base layer with three geosynthetic products (Figure 3.3).

The geosynthetic products used in the field were the Tensar Geogrid BX1100 (referred to as GGPP), the Mirafi Geogrid BasXgrid 11 (referred to as GGPET), and the Mirafi Geotextile HP570 (referred to as GT). The geosynthetic products were installed to reinforce the base course layer. The top 10 in. of the old base course was scarified. Then the geosynthetic layer was laid on top of the scarified layer, and a new 7-in. base course was constructed on top of the geosynthetic reinforcement, followed by a 1-in. asphalt layer. In this scheme, the old scarified base course performed as the subbase layer for the new road.

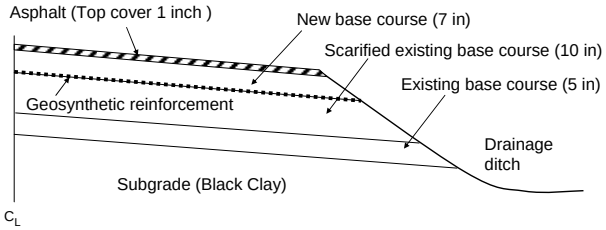


Figure 3.3 Schemes 1 to 3: Geosynthetic reinforcement of base layer.

Schemes 4 to 6: Reinforcement with the same geosynthetic product combined with lime stabilization of subbase (Figure 3.4).
These schemes were constructed with the same procedure and same product described in Schemes 1 to 3 except for the subbase layer. In Schemes 4 to 6, the scarified subbase layer was stabilized with lime.

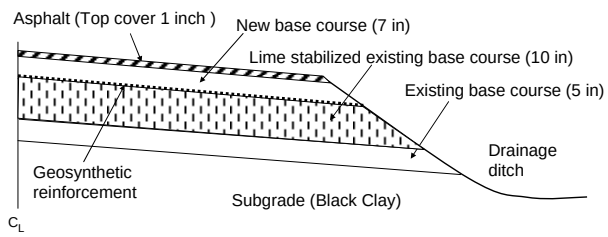


Figure 3.4 Schemes 4 to 6: Geosynthetic reinforcement of base layer combined with lime stabilization of subbase layer.

Scheme 7: Lime-stabilized subbase sections (Figure 3.5).
Geosynthetic reinforcement layer was not used in this scheme, but the subbase layer was stabilized with lime. Therefore, the road section was composed of a 10-in. scarified lime-stabilized subbase layer overlain by a 7-in. newly constructed base layer.

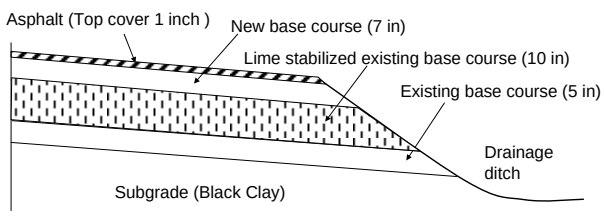


Figure 3.5 Scheme 7: Lime stabilization of subbase layer.

Scheme 8: Unreinforced and non-stabilized sections (Control Sections) (Figure 3.6).
Neither geosynthetic reinforcement nor lime stabilization was used in Scheme 8. In this scheme, the top 10 in. of the current base course was scarified and overlain by a new 7-in. base course layer. Scheme 8 provides a baseline for the study. Comparative evaluation of Schemes 1 to 7 to this scheme is expected to reveal benefits of each scheme.

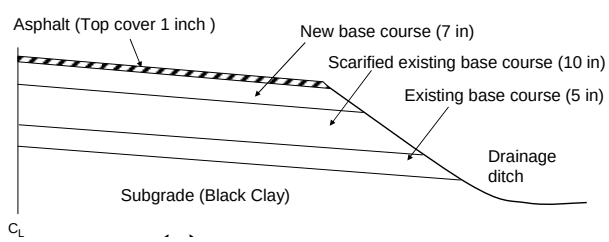


Figure 3.6 Scheme 8: Control sections.

To account for variation in field due to environmental, construction, and site factors, four repeats of each test section were originally planned at the site. Therefore, a total of 32 test

sections (4 reinforcement types x 2 stabilization approaches x 4 repeats) were planned for construction on FM2. Table 3.1 shows these sections along with the geotextile abbreviations.

Table 3.1 Original plan for 32 test sections in FM2

Scheme	Geosynthetic Product for Base Reinforcement	Stabilization of Subbase	Number of Repeats	Abbreviation
Scheme 1 to 3 (Geosynthetic-Reinforced Base Sections)	Tensar Geogrid BX1100	No Stabilization	4	GGPP
	Mirafi Geogrid BasXgrid 11		4	GGPET
	Mirafi Geotextile HP570		4	GT
Scheme 4 to 6 (Geosynthetic-Reinforced Base Sections) + (Lime-Stabilized Subbase)	Tensar Geogrid BX1100	Lime Stabilization	4	GGPP+LM
	Mirafi Geogrid BasXgrid 11		4	GGPET+LM
	Mirafi Geotextile HP570		4	GT+LM
Scheme 7 (Lime-Stabilized Subbase)	No Geosynthetic	Lime Stabilization	4	LM
Scheme 8 (Control Sections) (unreinforced and non-stabilized)	No Geosynthetic	No Stabilization	4	Control
Total number of sections			32	

The original layout proposed for the construction is presented in Figure 3.7. In this layout, all test sections were 450 ft long, organized as follows:

- The testing sections were divided into four areas: Areas "A," "A + Lime," "B," and "B + Lime" (Figure 3.7).
- **Area "A":** Starting from FM362, this area includes the first four sections in the K6 lane and K1 lane. The K6 lane sections were Control, GGPP, GGPET, and GT. In the K1 lane, the same schemes were used but with a different order: GGPP, GGPET, GT, and Control.
- **Area "A + Lime":** This area included the next four sections in both lanes, and was composed of the same schemes as Area "A" with the addition of the lime stabilization.
- **Area "B":** This area included the next four sections in both lanes. In the K6 lane, the same scheme as Area A was used with the same order: Control, GGPP, GGPET, and GT. However, in the K1 lane, the order of the sections was changed compared to Area "A." In this lane, the order of schemes was GGPET, GT, Control, and GGPP. This could provide a different combination of the schemes when comparing them side by side.
- **Area "B + Lime":** This area included the next four sections in both lanes, and was composed of the same schemes as Area "B" with the addition of the lime stabilization. Note that this area lies in Part 2 of the testing sections identified in Figure 3.7.

However, future investigations revealed that this layout was not followed rigorously during construction. As will be discussed next, a field investigation program was conducted to determine the as-built layout (Figure 3.8).

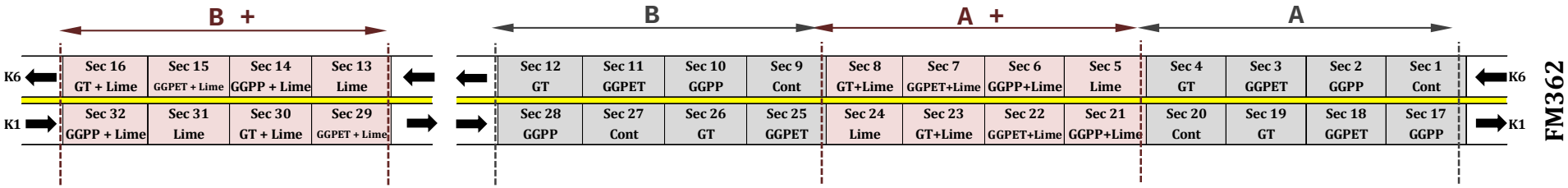


Figure 3.7 Original layout of test sections in FM2 road.

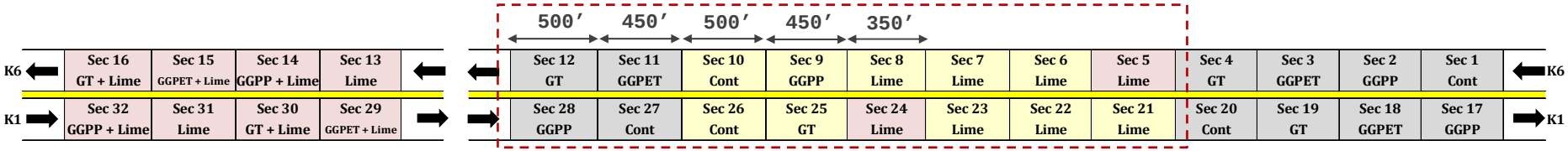


Figure 3.8 Modified layout after March 2010 investigation.

3.2.2 Discrepancies in Section Layout

Preliminary Investigation of Layout in 2010

During the course of the condition surveys performed for FM2, it was realized that some sections may have not been reinforced in accordance with the original plans. A preliminary investigation was performed in March 2010 to explore the observed discrepancies. In this investigation, a number of small holes were manually excavated along the shoulder of the road in Part 1 of the test sections.

The March 2010 investigation revealed some discrepancies in Areas "A + Lime" and "B" of the test sections. The major discrepancies were reported as follows:

- In some of the sections, the constructed geosynthetic layer was not consistent with the original plans.
- The length of some of the sections was not consistent with the original plans.
- No geosynthetic reinforcement found in some of the locations that were supposed to have geosynthetics.

A modified layout of the test sections was prepared and proposed after the March 2010 investigation. As shown in Figure 3.8, in the modified layout the length and the section type were changed for a number of sections in Areas "A + Lime" and "B." In the new layout, instead of four repeats of the Geosynthetic + Lime sections, there were two repeats, because two from each lane were ruled out. Accordingly, the number of lime sections increased from four to ten.

Although the 2010 investigation confirmed existence of discrepancies in the sections, this investigation could not capture all discrepancies. This might be partly due to the locations of small holes that were just on the shoulder of the road where the geosynthetic might not exist. Therefore, a more comprehensive investigation was conducted in August 2012 through collaboration between UT Austin and TxDOT.

Comprehensive Investigation of Layout in 2012

A comprehensive investigation of layout accompanied with a subsurface exploration was conducted in August 2012 thorough collaboration between UT Austin and TxDOT. The main objectives of this complementary section and subsurface investigation were as follows:

1. Confirmation of the section layouts (i.e., presence or not of geosynthetic reinforcement and of subbase lime treatment)
2. Confirmation of the cross section of the pavement system (i.e., thickness and materials of the various pavement layers, including asphalt layer, base layer, and subbase layer)
3. Characterization of the subgrade soils
4. Confirmation of the "length of the test sections," particularly in areas where discrepancies have been found between the as-built and originally planned sections.

To achieve these objectives, borings were planned for drilling within the paved area. The borings were conducted through the road layers and into the subgrade soil. A tentative plan of

investigation with three sets of borings was designed. These sets are presented in order of priority, ranging from imperative (Set I), to desirable (Set II), to additional (Set III).

Borings Set I (Imperative)

The 10 borings needed to achieve Objectives 1 to 3 in the most critical sections of this investigation are identified in this set. While some insight may be obtained regarding the actual length of the sections (Objective 4), a full characterization of such extent was not conducted. Borings Set I includes the following:

a) The most controversial areas in FM2 where the actual section layout has not been fully verified during the previous investigations. This includes Areas (A+Lime) and (B), illustrated in Figure 3.7, where the length and the layout of the sections were reassessed in 2010. The location of the proposed borings in his region (eastern portion of FM2) is shown in Figure 3.9. The borings are proposed to be drilled in the middle of the originally proposed 500 ft-long sections.

b) One boring in one of the remaining test sections (central portion of FM2), as also shown in Figure 3.9. The main objective of these borings is to investigate the pavement layer and subgrade soil properties.

Additional information on the borings in Set I is provided in Table 3.2.

Table 3.2 Borings in proposed Set I

Boring Location	Lane	Station	Distance from site reference (ft)	Site reference line
7	K6	191+50	2,950	Line on the pavement at Station 221+00
8	K6	187+00	3,400	Line on the pavement at Station 221+00
10	K6	177+00	4,400	Line on the pavement at Station 221+00
14	K6	92+50	550	Line on the pavement at Station 98+00
5	K1	201+00	3,350	Line on the pavement at Station 167+00
6	K1	196+00	2,950	Line on the pavement at Station 167+00
7	K1	191+50	2,500	Line on the pavement at Station 167+00
8	K1	189+00	1,950	Line on the pavement at Station 167+00
9	K1	186+00	1,450	Line on the pavement at Station 167+00
10	K1	178+50	1,250	Line on the pavement at Station 167+00

Borings Set II (Desirable)

Boring Set II includes a total of 35 borings in order to fully achieve Objectives 1 to 3. This plan was designed not only to confirm the original test sections, but also to provide a thorough understanding of the subsurface conditions. Borings Set II includes:

a) The various areas in FM2 where the actual section layout has not been fully verified during the previous investigations. As mentioned, this includes Areas (A) and (B), illustrated in Figure 3.7, where the length and the layout of the sections were reassessed in 2009. The location of the proposed borings in his region (eastern portion of FM2) is shown in Figure 3.10.

b) In order to confirm the section type and the length of each section, conducting two borings for each section in these areas is recommended. The first boring of each section should be taken at 50 ft from the beginning of the section and the second boring at 50 ft to the end of the section. These locations are preferred in relation to a single boring in the center of the test section as proposed in Set I.

c) One boring in the middle of the rest of the sections in K6 Lane, i.e., Sections 1 to 4, 11, 12, 13, 14, and 16. The main objective of these borings is to investigate the pavement layer and subgrade soil properties. These borings also help verify the section type, i.e., help verify the existence of geosynthetic layer. This is especially important because although the majority of these sections are expected to be reinforced with geosynthetic layer, no geosynthetic layer has been observed during condition surveys.

d) One boring in Category (I) is in Section 30 on K1 Lane. Although Section 30 is expected to be reinforced with a geotextile layer, in a number of the visual surveys a geogrid layer was observed in this section. This boring helps verify the actual geosynthetic layer in this section.

e) The last boring in Category (I) is proposed to be conducted in Section 31 on Lane K1, as this is the only area without boring in Set II.

Table 3.3 summarizes the location of the proposed borings in Set II.

Table 3.3 Location of Borings Set II

Lane K6				
Boring #		Distance from the reference point	Station	Depth
K6 Part 1	Core #1	5175	218+75	12ft
	Core #2	4725	214+25	12ft
	Core #3	4275	209+75	12ft
	Core #4	3825	205+25	12ft
	Core #5-2	3550	202+50	12ft
	Core #5-1	3200	199+00	12ft
	Core #6-2	3100	198+00	12ft
	Core #6-1	2750	194+50	12ft
	Core #7-2	2650	193+50	12ft
	Core #7-1	2300	190+00	12ft
	Core #8-2	2200	189+00	12ft
	Core #8-1	1950	186+50	12ft
	Core #9-2	1850	185+50	12ft
	Core #9-1	1500	182+00	12ft
	Core #10-2	1400	181+00	12ft
	Core #10-1	1000	177+00	12ft
	Core #11	725	174+25	12ft
	Core #12	250	169+50	12ft
K6 Part 2	Core #13	1575	95+75	12ft
	Core #14	1125	91+25	12ft
	Core #16	225	82+25	12ft

Lane K1				
Boring #		Distance from the reference point	Station	Depth
K1 Part 1	Core #26-2	4400	177+00	12ft
	Core #26-1	4000	181+00	12ft
	Core #25-2	3900	182+00	12ft
	Core #25-1	3550	185+50	12ft
	Core #24-2	3450	1950	12ft
	Core #24-1	3200	2200	12ft
	Core #23-2	3100	2300	12ft
	Core #23-1	2750	2650	12ft
	Core #22-2	2650	2750	12ft
	Core #22-1	2300	3100	12ft
	Core #21-2	2200	199+00	12ft
	Core #21-1	1850	202+50	12ft
K1 Part 2	Core #31	1125	86+75	12ft
	Core #30	675	91+25	12ft

Set III (Additional Borings)

The borings proposed for Set III are shown in Figure 3.11. This category includes borings in the sections not investigated in the previous sets. This includes one boring in the middle of Sections 17 to 20, 29, and 32. Boring in these sections help verify section types and complement subsurface investigation for the entire FM2 test sections. Table 3.4 summarizes the location of the proposed borings in Set III.

Table 3.4 Location of borings in Set III

Lane K1				
Boring #		Distance from the reference point	Station	Depth
K1 Part 1	Core #17	225	218+75	12ft
	Core #18	675	214+25	12ft
	Core #19	1125	209+75	12ft
	Core #20	1575	205+25	12ft
	Core #27	4675	174+25	12ft
	Core #28	5150	169+50	12ft
K1 Part 2	Core #29	225	95+75	12ft
	Core #32	1575	82+25	12ft

This tentative plan was discussed with TxDOT personnel and final plan was approved as shown in Figure 3.12. The final plan was composed of the following:

- 13 boring locations on the shoulder of the road to investigate the subgrade soil
- 38 coring locations on the white line of the road to investigate the pavement sections

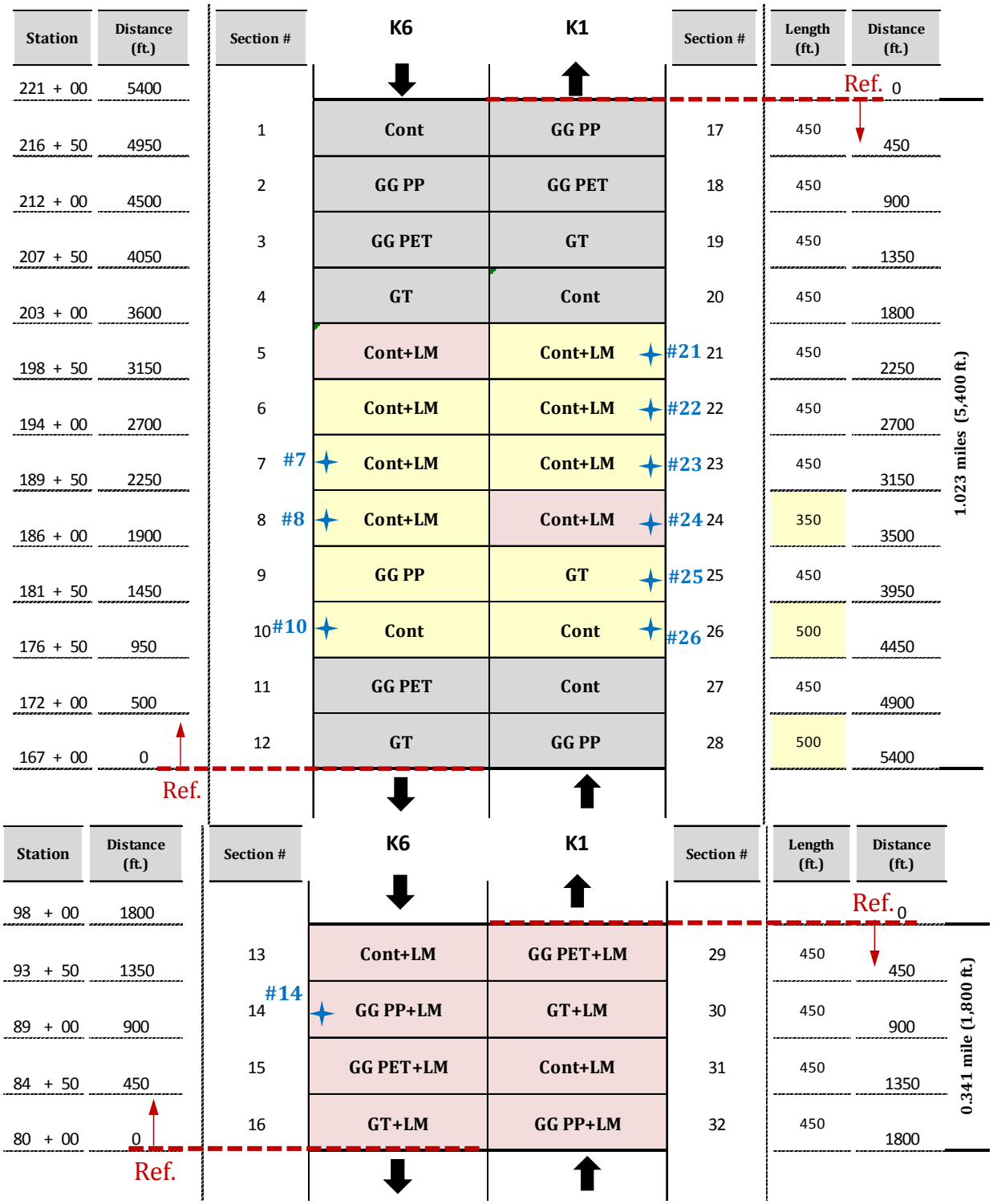


Figure 3.9 Set I of proposed borings

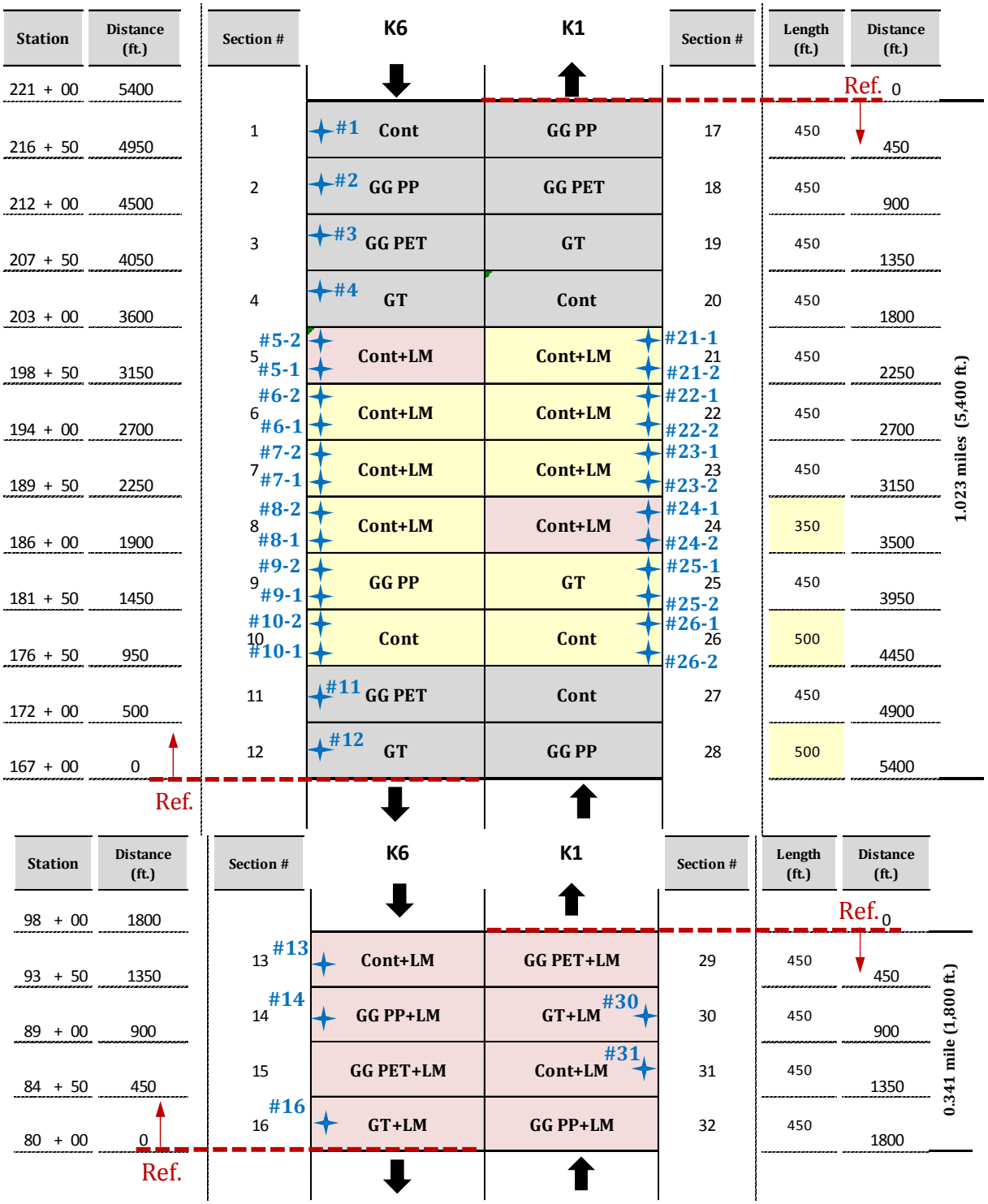


Figure 3.10 Set II of proposed borings.

Station	Distance (ft.)	Section #	K6	K1	Section #	Length (ft.)	Distance (ft.)
221 + 00	5400						Ref. 0
216 + 50	4950	1	Cont	GG PP #17	17	450	450
212 + 00	4500	2	GG PP	GG PET #18	18	450	900
207 + 50	4050	3	GG PET	GT #19	19	450	1350
203 + 00	3600	4	GT	Cont #20	20	450	1800
198 + 50	3150	5	Cont+LM	Cont+LM	21	450	2250
194 + 00	2700	6	Cont+LM	Cont+LM	22	450	2700
189 + 50	2250	7	Cont+LM	Cont+LM	23	450	3150
186 + 00	1900	8	Cont+LM	Cont+LM	24	350	3500
181 + 50	1450	9	GG PP	GT	25	450	3950
176 + 50	950	10	Cont	Cont	26	500	4450
172 + 00	500	11	GG PET	Cont #27	27	450	4900
167 + 00	0	12	GT	GG PP #28	28	500	5400
	Ref.						

1.023 miles (5,400 ft.)

Station	Distance (ft.)	Section #	K6	K1	Section #	Length (ft.)	Distance (ft.)
98 + 00	1800						Ref. 0
93 + 50	1350	13	Cont+LM	GG PET+LM #29	29	450	450
89 + 00	900	14	GG PP+LM	GT+LM	30	450	900
84 + 50	450	15	GG PET+LM	Cont+LM	31	450	1350
80 + 00	0	16	GT+LM	GG PP+LM #32	32	450	1800
	Ref.						

0.341 mile (1,800 ft.)

Set III Borings (Proposed for complementary investigation)

Figure 3.11 Set III of proposed borings.

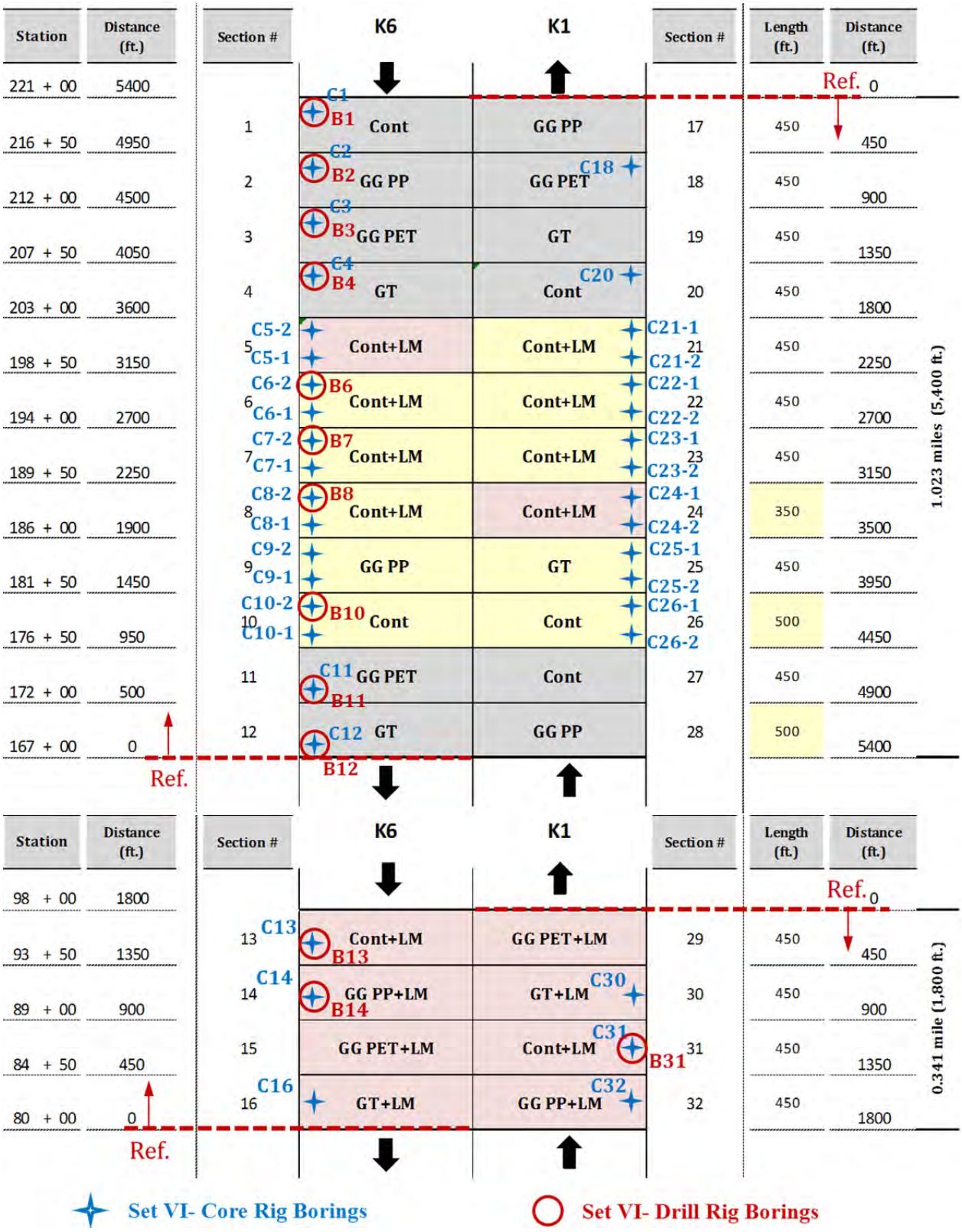


Figure 3.12 Final plan for August 2012 investigation approved by TxDOT.

Details and results of the 13 boring locations are discussed in the subsequent section of the report.

Coring of the pavement sections was performed with a trailer-mounted core drill equipped with a pavement core bit with a capacity of 20” coring. At each location, the coring operation was continued to the bottom of the base course. Sample pictures from coring locations C5-1, C9-1, and C9-2 are shown in Figure 3.14, which presents both the GG PET product found in Core C5-1 and the GG PP product found in Core C9-1. At each location the depth of the geosynthetic layer, if found, was measured with a measuring tape. In addition, the presence of lime in the subbase layer was examined using phenolphthalein solution. Table 3.5 and Figure 3.15 summarize findings of the August 2012 coring operation. Comparison of these findings with the original and modified layout in Figure 3.7 and Figure 3.8 reveals the following:

- The original sections are confirmed to be built in Areas “A” and “B + Lime” (except for Section #16 in which the geotextile was not found)
- The actual as-built sections in Areas “A + Lime” and “B” were found to be inconsistent with the original layout and modified layout
- The lengths of the sections in Areas “A + Lime” and “B” were found to be inconsistent with the original layout and the modified layout

Since findings of this investigation resulted in a layout significantly different from the one expected based on the original layout, a complementary investigation was performed in November 2012 to confirm and finalize findings of the August 2012 investigation. Specifically, findings of the August 2012 investigation raised doubts about the extension of geosynthetic reinforcement in areas I to VII as specified in Figure 3.15. Therefore, in November 2012 11 additional holes were excavated at the white line of the road to confirm the extent of the geosynthetic reinforcements in the aforementioned areas. Figure 3.16 and Figure 3.17 demonstrate the location of the additional holes. These holes were excavated manually up to the bottom of the base layer.

Figure 3.13 illustrates some of the holes excavated as part of this investigation. As shown in this figure, the depth of the geosynthetic layer, if found, was measured using measuring tape. This figure also displays the GT and GGPP reinforcements found in locations P8 and P12.

Figure 3.13 Equipment used for coring of the pavement sections.

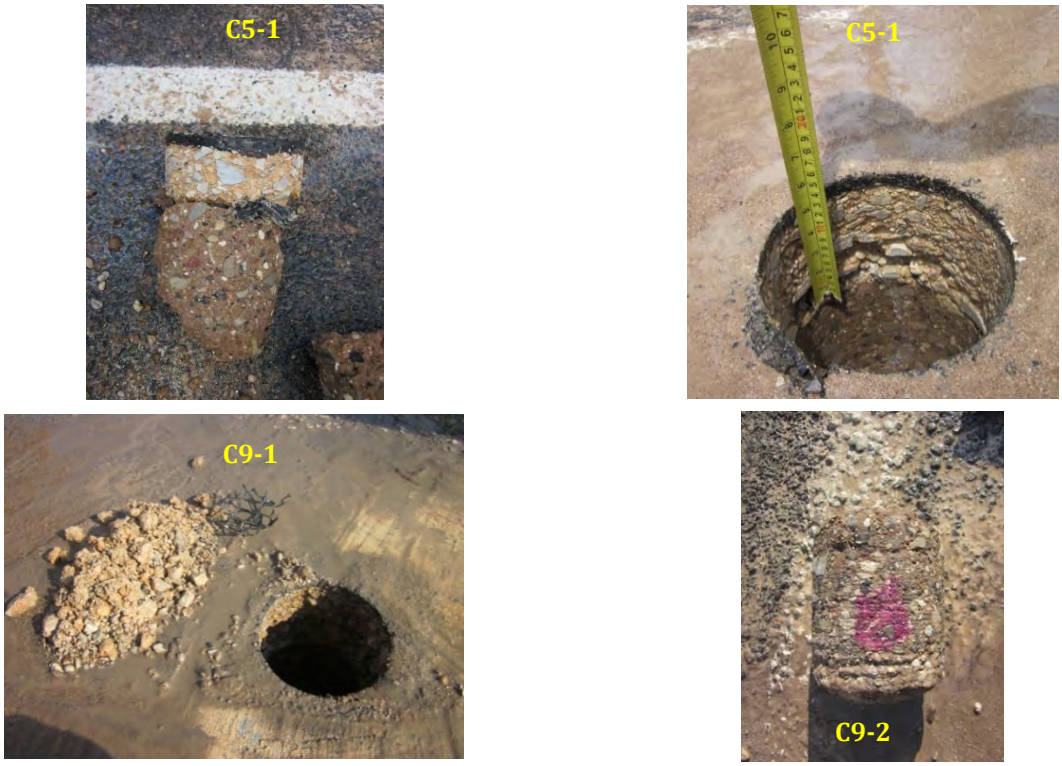


Figure 3.14 Sample pictures from coring operation in August 2012.

Table 3.5 Summary of the findings in the August 2012 coring operation

Coring in West Bound (K6) - Aug 2012						
Coring	Distance from East End	Distance from West End	Geosynthetic Type	Lime in Subbase	Asphalt Thicknes	Base Thickness
	ft	ft			in	in
C1	10	5390	--	No		
C2	460	4940	GGPP	No	0.25	6.5
C3	910	4490	GGPET	No	0.25	5
C4	1360	4040	GT	No	0.25	6.5
C5-2	1810	3590	--	Yes		
C5-1	2240	3160	GGPET	Yes	0.25	5
C6-2	2260	3140	GGPET	Yes		
C6-1	2690	2710	GGPP	Yes	0.25	4.5
C7-2	2710	2690	GGPP	Yes		
C7-1	3140	2260	GGPP	Yes	0.25	5
C8-2	3160	2240	GGPP	Yes	0.25	6
C8-1	3490	1910	GGPP	Yes	0.25	7
C9-2	3510	1890	GGPP	Yes	0.25	7.5
C9-1	3940	1460	GGPP	No	0.25	6.5
C10-2	3960	1440	GGPP	No		
C10-1	4440	960	GGPET	No	0.25	6.5
C11-70'	4820	580	--	No		
C11	4890	510	GT	No	0.25	5.5
C12	5370	30	GT	No		
C13	225	1575	--	Yes	0.25	6
C14	675	1125	GGPP	Yes		
C16	1575	225	--	Yes	0.25	6.5

Coring in East Bound (K1) - Aug 2012						
Coring	Distance from East End	Distance from West End	Geosynthetic Type	Lime in Subbase	Asphalt Thickness	new Base Thickness
	ft	ft			in	in
C18	460	4940	GGPET	No		
C19	910	4490	GT	No	0.25	6.5
C20	1360	4040	--	No	0.25	6.5
C20-2	1780	3620	--	Yes	0.25	8.5
C21-2	2240	3160	--	Yes	0.25	7
C22-1	2260	3140	--	Yes	0.25	7.5
C22-1+95'	2355	3045	GT	Yes	0.25	6.5
C22-2	2690	2710	GT	Yes	0.25	7
C23-1						
C23-2	3140	2260	GT	Yes	4	7
C24-1	3160	2240	GT	Yes	0.25	7.5
C24-2	3490	1910	GT	Yes	0.25	8
C25-1	3510	1890	GT	Yes	0.25	7
C25-2	3940	1460	GT	No	0.25	4.5
C26-1	3960	1440	GT	No	0.25	5
C26-2	4440	960	--	No	0.25	7
C30	675	1125	GT	Yes	0.25	6.5
C31	1125	675	--	Yes		
C32	1575	225	GGPP	Yes	0.25	4.5

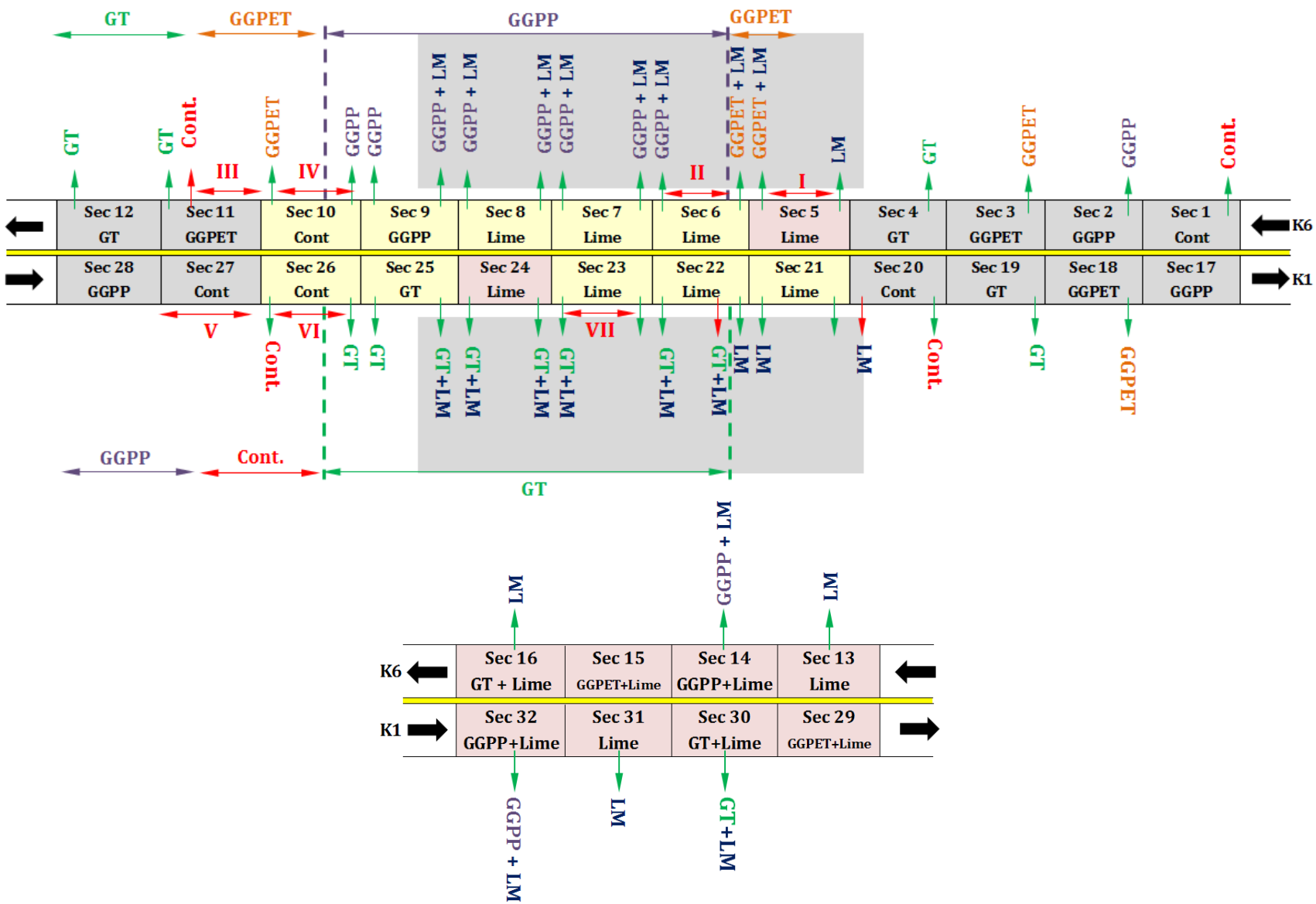
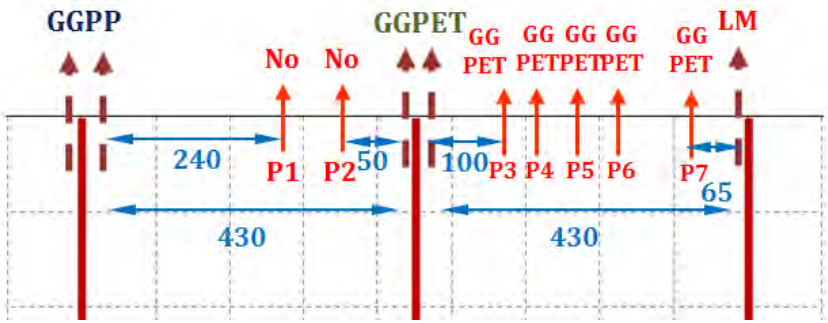
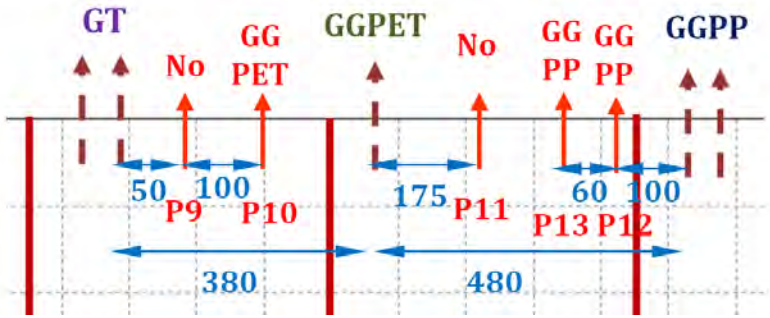


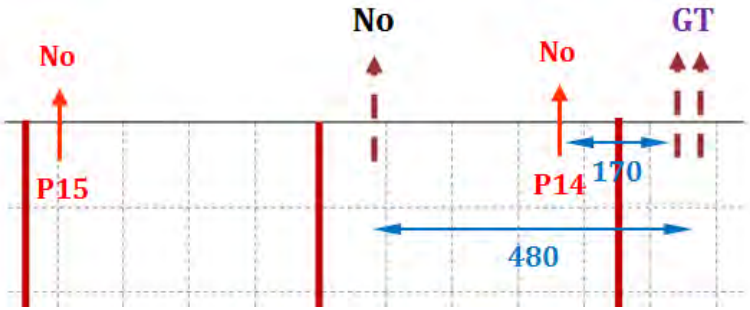
Figure 3.15 Summary of the findings in the August 2012 coring operation.



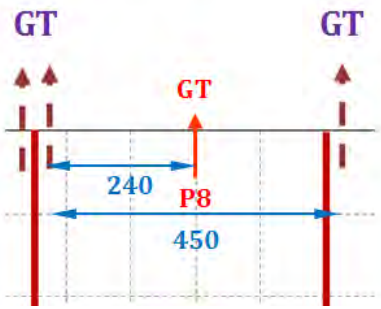
a) Areas I and II



b) Areas III and IV



c) Areas V and VI



d) Area VII

Figure 3.16 Additional holes excavated in November 2012 in Areas I to V.

Table 3.6 Additional holes excavated in November 2012

Digging in West Bound (K6) - Nov 2012				Digging in East Bound (K1) - Nov 2012			
Digging	Distance from East End	Distance from West End	Geosynthetic Type	Digging	Distance from East End	Distance from West End	Geosynthetic Type
	ft	ft			ft	ft	
P1	2450	2950	No	P8	2900	2500	GT
P2	2310	3090	No	P14	4130	1270	--
P3	2140	3260	GGPET	P15	4900	500	--
P4	2090	3310	GGPET				
P5	2040	3360	GGPET				
P6	1990	3410	GGPET				
P7	1875	3525	GGPET				
P9	4770	630	No				
P10	4670	730	GGPET				
P11	4265	1135	No				
P12	4060	1340	GGPP				
P13	4120	1280	GGPP				

Figure 3.17 Sample pictures of the additional holes excavated in November 2012.

3.2.3 Final Layout of FM2

Information collected through the described investigations was analyzed and final layout of the test sections in FM2 was identified as demonstrated in Figure 3.18. Highlights of the final layout are summarized as follows:

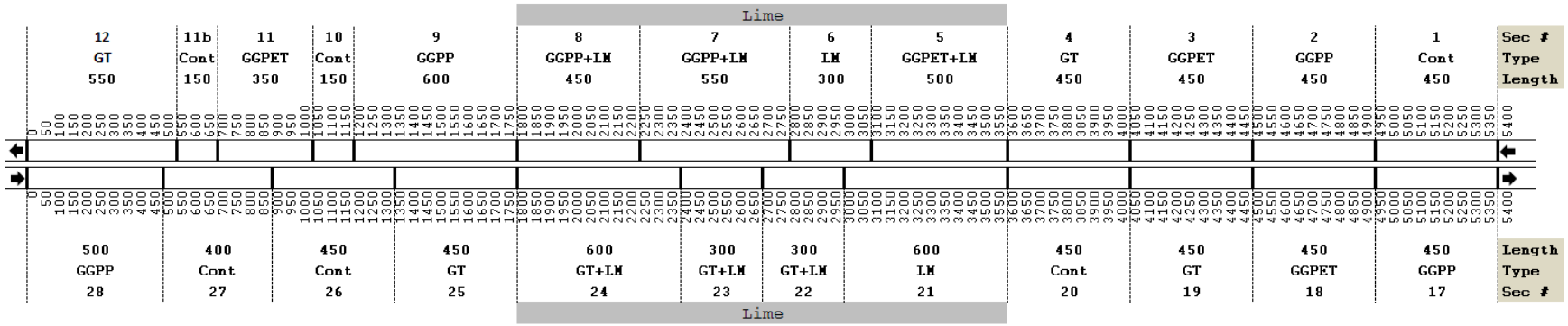
- Areas “A” and “B + Lime” are consistent with the originally planned layout.
- In Area “B,” findings of the March 2010 investigation were almost confirmed but the length of the sections was modified. In addition, a 150 ft long gap area between reinforced sections 11 and 12 was identified. This gap area was named Section 11b and considered as a control section.
- In Area “A + Lime” it was found that the actual lengths and the sections are different from those in original layout and the modified layout. A great portion of Area “A + Lime” in K1 lane, i.e., from 2400 ft to 3600 ft, was built with GT. The rest of Area “A + Lime” in lane K1 was made without any reinforcement. On the other hand, most of K6 lane, i.e., from 1800 ft to 2750 ft, was built with GGPP. The

rest of Area “A + Lime” in K6 lane was composed of a 300 ft solely Lime section and a 500 ft GGPET + Lime section.

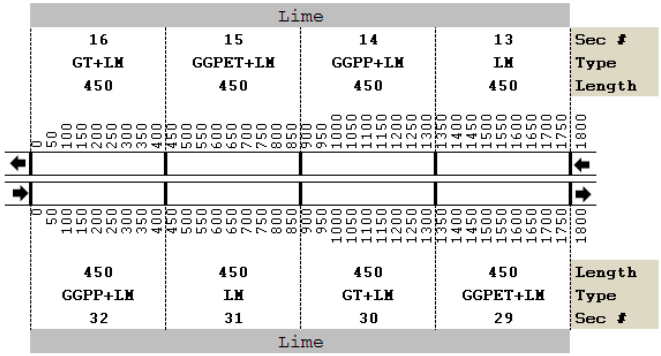
In summary, the final layout of the FM2 testing sections is composed of the following:

- “Control” Sections: 6 Sections (total length of 2050 ft)
  - Sections #1 (450’), #10 (150’), #11b (150’), #20 (450’), #26 (450’), and #27 (400’)
- “Lime” Sections (LM): 4 Sections (total length of 1800 ft)
  - Sections #6 (300’), #13 (450’), #21 (600’), and #31(450’)
- “Tensar Geogrid” Sections (GGPP):4 Sections (total length of 2000 ft)
  - Sections #2 (450’), #9 (600’), #17 (450’), and #28 (500’)
- “Mirafi Geogrid” Sections (GGPET): 3 Sections (total length of 1250 ft)
  - Sections #3 (450’), #11 (350’), and #18 (450’)
- “Mirafi Geotextile” Sections (GT): 4 Sections (total length of 1900 ft)
  - Sections #4 (450’), #12 (550’), #19 (450’), and #25 (450’)
- “Tensar Geogrid + Lime” Sections (GGPP+LM): 4 Sections (total length of 1900 ft)
  - Sections #7 (550’), #8 (450’), #14 (450’), and #32 (450’)
- “Mirafi Geogrid + Lime” Sections (GGPET+LM): 3 Sections (total length of 1400 ft)
  - Sections #5 (500’), #15 (450’), and #29 (450’)
- “Mirafi Geotextile + Lime” Sections (GT+LM): 5 Sections (total length of 2100 ft)
  - Sections #16 (450’), #22 (300’), #23 (300’), #24 (600’), and #30 (450’)

This final layout is used as the basis for the analysis of the performance of the road.



Part 1



Part 2

Figure 3.18 The final layout of FM2 test sections.

3.3 Subsurface Soil Investigation in FM2

3.3.1 2002 Soil Investigation by TxDOT

TxDOT drilled four 10-ft-deep borings in FM2 road in 2002. The locations of these borings are shown in Figure 3.19. The cores were drilled within the paved area and provided information about the thickness and materials in both existing pavement layers and the subgrade soil layers. Atterberg limits and in-situ moisture content were determined from the collected soil samples.

Only two of the four cores were located in the area of the test sections constructed in FM2: Core #2 (located 1.5 miles from SH6) and Core #4 (located 3.5 miles from SH6). As these cores were bored before rehabilitation of FM2 in 2006, they provided information on the previous pavement system layers.

3.3.2 2006 UT and TxDOT Soil Investigation

In a subsequent investigation (now part of the 5-4829 TxDOT project), two borings were conducted outside of the paved area with the main objective of determining the water content profile of in-situ soils. The data collected from these cores provided information on the subgrade soil layers but no information was collected on the pavement sections. The depth of the borings was 10 ft. Moisture content and Atterberg limits were determined for the collected soil samples.

Figure 3.19 illustrates the location and the results of this investigation.

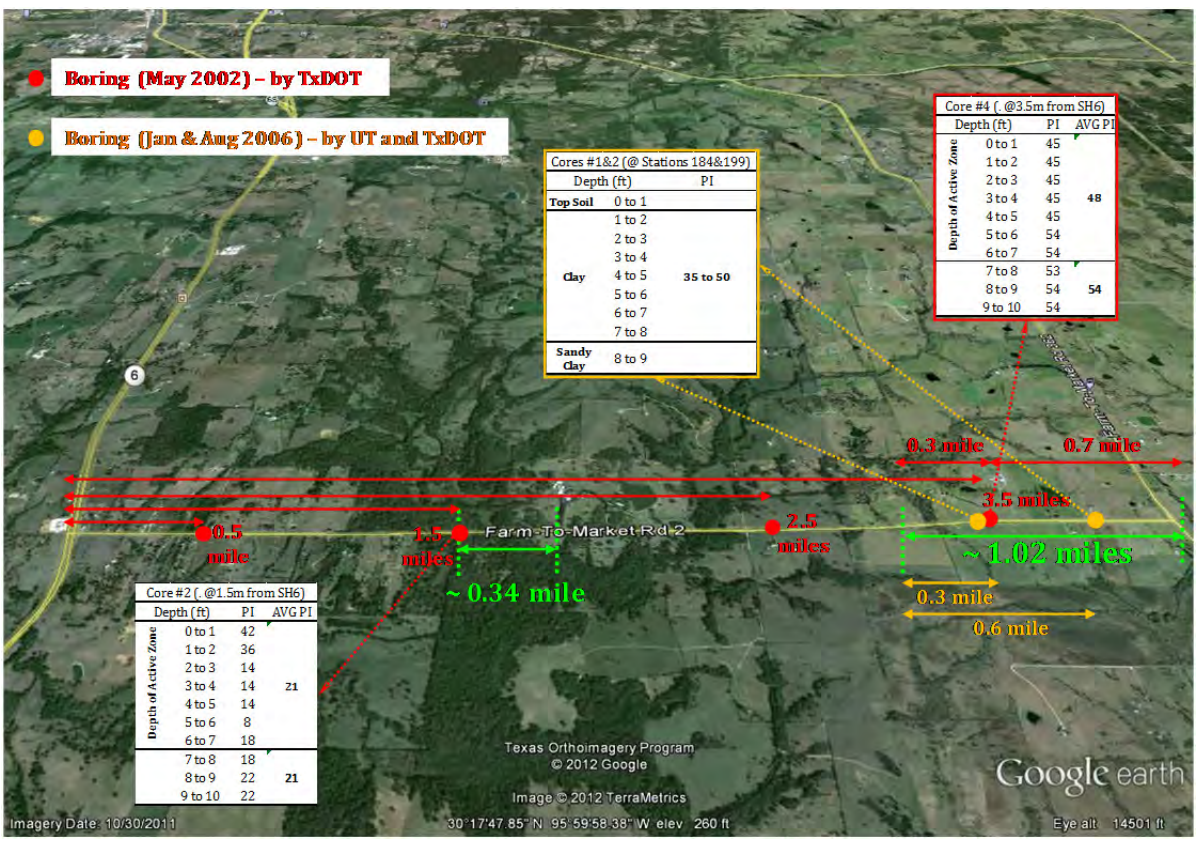


Figure 3.19 Borings conducted in 2002 and 2006 in various locations of FM2.

3.3.3 2011 Soil Sampling by UT

As part of the Condition Survey #17 conducted for Project 5-4829 in 2011, an additional effort was undertaken, which involved collection of 16 soil samples of the subgrade soil on the northern side of FM2. Samples were obtained from comparatively surficial locations with the depths ranging from 1 to 2 ft below the subgrade level. Moisture content, plasticity, and liquid limits were determined for the soil samples. These samples did not provide information on the constructed pavement sections.

Figure 3.20 provides a consolidated view of the sections as defined in 2009, the locations of the observed geosynthetic layers, and the locations of the various subsurface investigations conducted in FM2.

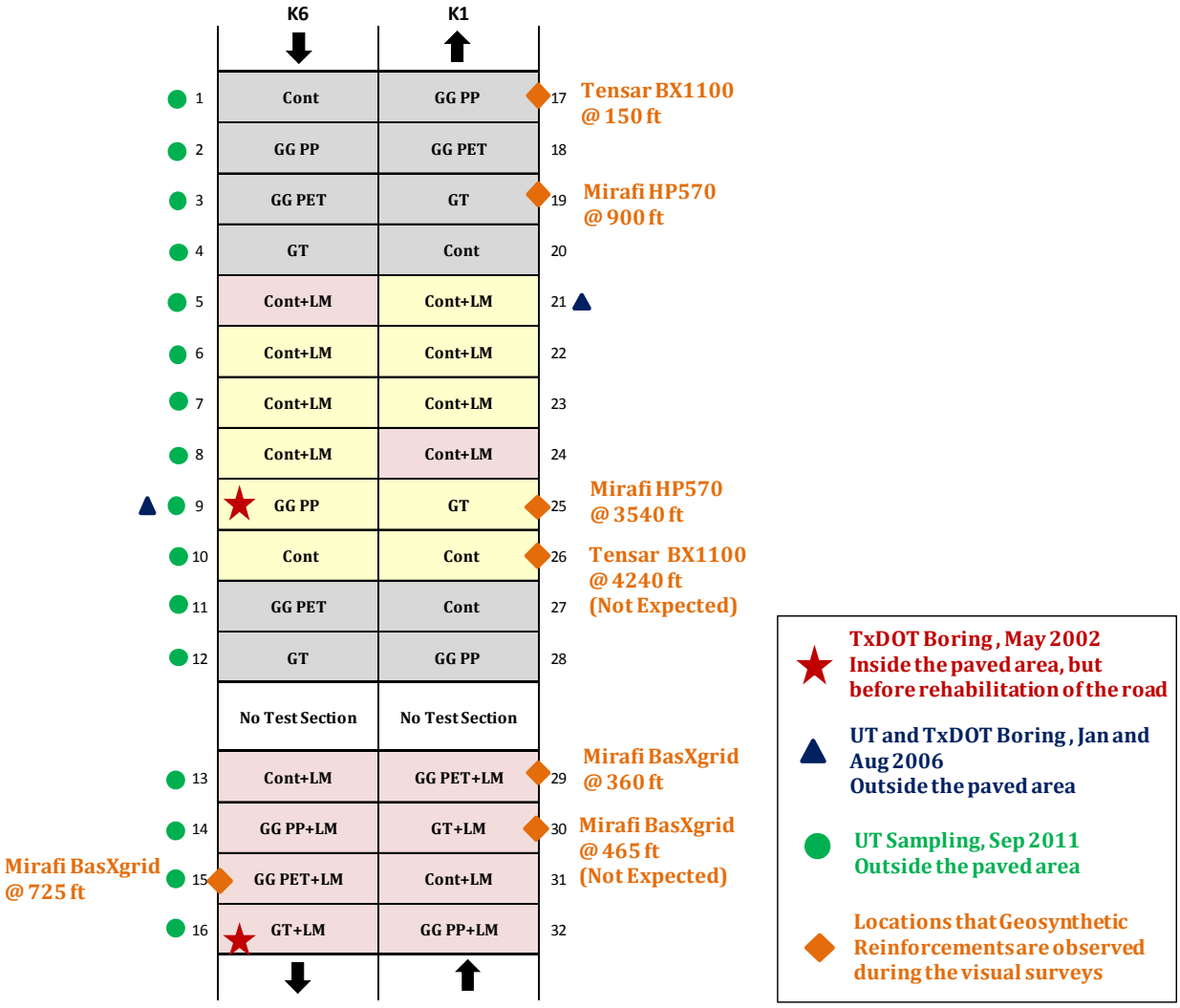


Figure 3.20 Summary of previous sections and subsurface investigations of FM2.

3.3.4 2012 Comprehensive Soil Investigation by UT and TxDOT

As described earlier, in August 2012 a comprehensive section and subsurface investigation was carried out through collaboration between UT Austin and TxDOT. This investigation was composed of two sets of borings: 38 coring locations on the white line of the

road to investigate the pavement sections and 13 boring locations on the shoulder of the road to investigate the subgrade soil. Findings from the coring operation are discussed in the last section of this report. In this section, results of the 13 boring locations are discussed.

The boring operation was performed with a hollow-stem auger and a 5-ft split spoon sampler shown in Figure 3.21. Core samples were divided into 0.5-ft soil specimens, wrapped in aluminum foil, and taken to the lab for classification testing. Boring locations were shown in Figure 3.12. These locations complemented the previous subsurface investigations to allow a proper understanding of the subsoil profile along the road.

Figure 3.21 Boring operation in August 2012.

Soil samples were transferred to the UT Austin geosynthetic and geoenvironmental laboratory, where a preliminary classification of the samples was carried out. This classification was on the basis of the color and general appearance of the soil samples (Figure 3.22). From this preliminary classification, it was found that the subgrade soil is composed of a wide variety of soil types (preliminary soil layers were identified by cooperation of UT and TxDOT personnel. As shown in Figure 3.23, from visual inspection of soil samples in Part 1 of the road, i.e., Borings B1 to B12, five different clayey soils and one sandy soil were recognized. On the basis of their colors, the clayey soils were classified as Black, Dark Green, Tan, Grey, and Light Tan. However, these clayey soils were mixed with sand in varying degrees at different depths. In order to accurately classify the soil samples and their index properties, specimens from the top 3 ft of all cores were sent to TxDOT laboratory to perform particle size analysis and Atterberg limits tests. Furthermore, additional specimens were collected from each boring from depths that soil type changes. These results, along with the results obtained from previous borings, are summarized and discussed in the next section of this report.

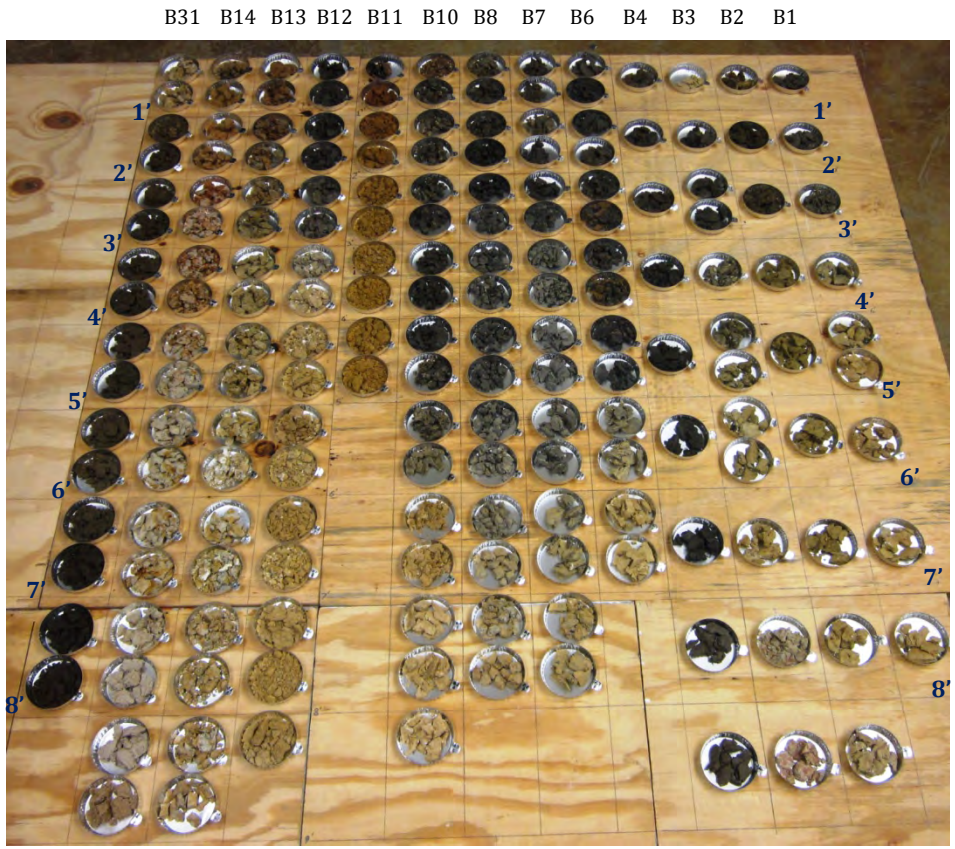


Figure 3.22 Diversity of subsurface soil types in Borings B1 to B31 from the ground surface to the maximum depth of 9 ft.

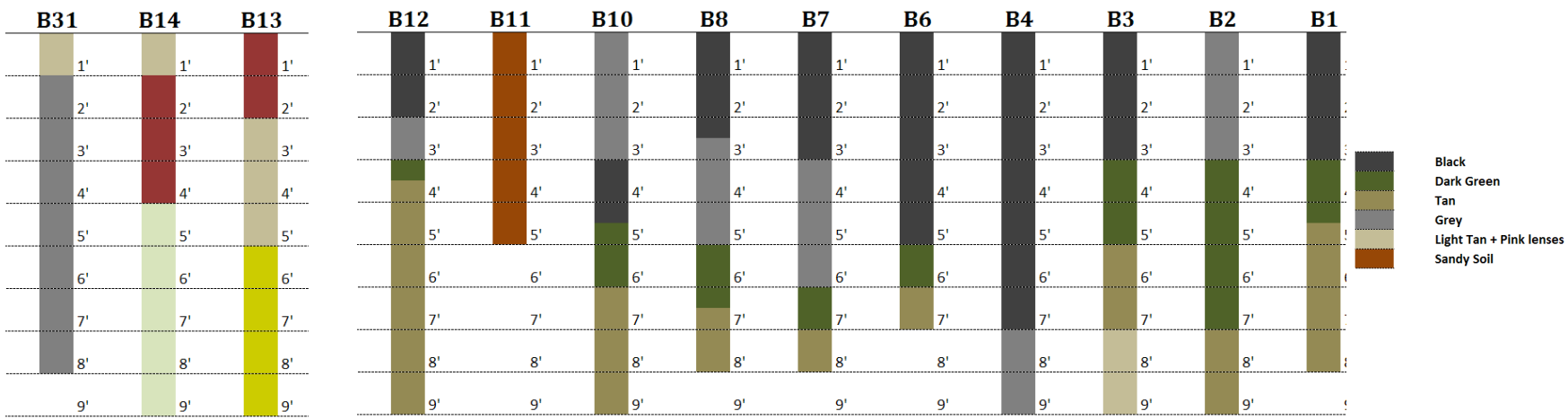


Figure 3.23 Preliminary soil classification on the basis of the color and general appearance.

3.3.5 Summary of the Subsurface Soil Investigation

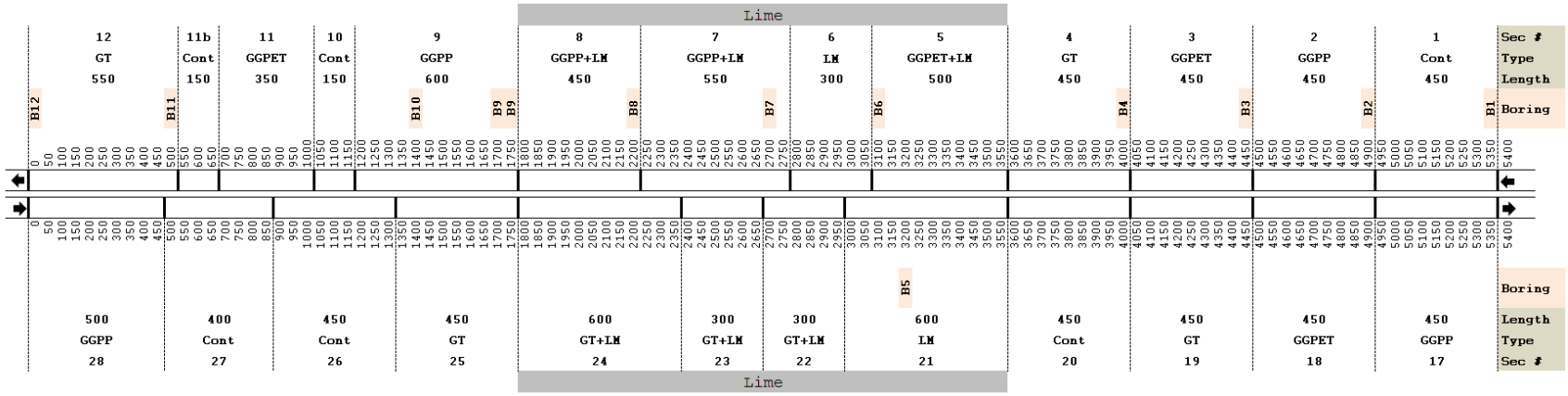
Figure 3.24 shows the location of the 18 borings drilled in FM2 in 2002, 2006, and 2012. Comparing the location of these borings to the test sections, it is clear that these borings reasonably cover the entire road length in Part 1 and Part 2. The maximum distance between borings is 900 ft, which occurs between B10 and B11. Except for B5 and B31, the rest of the borings were drilled on the north shoulder of the road.

Table 3.7 summarizes the location, depth, and plasticity index (PI) values for the 18 borings displayed in Figure 3.24. The PI values in this table indicate large variations in soil properties at different locations and different depths. Even in soil samples with the same color and appearance, the PI values vary significantly. Figures 3.25 to 3.27 summarize the results of the classification and Atterberg limits testing for all borings. The information provided in these figures include soil color, liquid limit (LL), plastic limit (PL), PI, percentage of fine particles (passing 75µm [No. 200] Sieve), percentage of soil binder (passing the 425 µm [No. 40] Sieve), and soil classification according to the USCS. It should be noted that the borings drilled in 2002 and 2006 yielded less information than did the 2012 drilled borings.

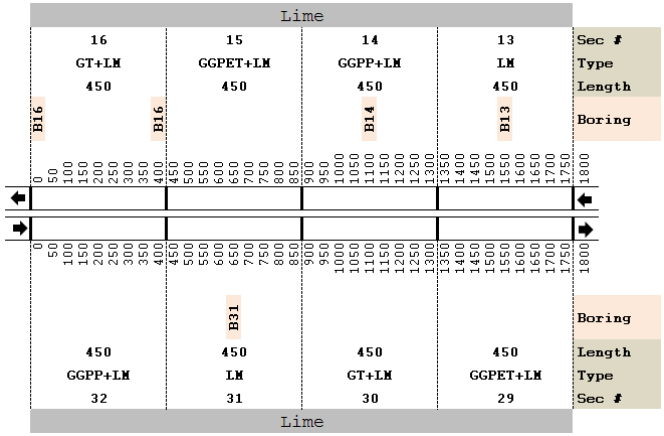
The data presented in these figures emphasize the variability in the soil properties along the subgrade soil. This variability can be observed not only in the PI values, but also in percentage of fine particles and percentage of soil binder. At some locations, such as borings B2 and B7, the percentage of fine particles are as low as 17%. Consequently, the soil types at those locations are classified as SC (Clayey Sand) or SM (Silty Sand) with PI values as low as 11, which is classified as a non-expansive soil. It appears that the response of this type of soil to environmental loadings is fundamentally different from the response of expansive clays, which are the focus of this study. Therefore, it is necessary to take into account the influence that the soil variability may have on the performance of the test sections.

Table 3.7 Location, depth, and PI values for all borings in FM2

Boring	Year	Distance from East End	Distance from West End	Depth of Boring	PI									
					1'	2'	3'	4'	5'	6'	7'	8'	9'	AVG 1'-3'
		ft	ft	ft										
B1	2012	10	5390	8	39	31	33	44			71			34
B2	2012	460	4940	9	14	21	24	25				28		20
B3	2012	910	4490	9	--	27	39	43		60		50		33
B4	2012	1360	4040	9	27	37	34	34				51		33
B5	2006	2200	3200	9			50					35		50
B6	2012	2260	3140	7	24	55	34	--	55	39	47			38
B7	2012	2710	2690	8	11	18	40	47			41	52		23
B8	2012	3160	2240	8	34	40	49	49		58		60		41
B9	2002	3646	1754	10			45					54		45
B9	2006	3700	1700	9			50					35		50
B10	2012	3960	1440	9	23	92	49	52		43	33	25		55
B11	2012	4890	510	5	--	--	--	--	--					0
B12	2012	5370	30	9	27	32	36	29	16					32
B13	2012	225	1575	9	18	20	29	27		37			42	22
B14	2012	675	1125	9	26	32	26	19		20		18		28
B31	2012	1125	675	8	37	22	17	--		16		13		25
B16	2006	1400	400	9			35							35
B16	2002	1800	0	10	42	36	14	14	14	8	18	18	22	31



Part 1



Part 2

Figure 3.24 Location of the borings as compared to the test sections.

B5	Boring
2200	Distance from East End (ft)
3200	Distance from West End (ft)

from 2006

B5	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'						
3'	CH					50
4'						
5'						
6'						
7'						
8'	CL					35
9'	SM					5

B4	Boring
1360	Distance from East End (ft)
4040	Distance from West End (ft)

B4	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	23	66	10	37	27
2'	SC	42	92	19	56	37
3'	CH	54	95	18	52	34
4'	CH	56	97	23	57	34
5'						
6'						
7'						
8'	CH	64	96	17	68	51
9'						

B3	Boring
910	Distance from East End (ft)
4490	Distance from West End (ft)

B3	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'	SC	20	57	12	39	27
3'	CH	55	96	19	58	39
4'	SC	40	78	14	57	43
5'						
6'	CH	97	99	24	84	60
7'						
8'	CH	96	100	20	70	50
9'						

B2	Boring
460	Distance from East End (ft)
4940	Distance from West End (ft)

B2	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	20	84	10	24	14
2'	SC	40	98	14	35	21
3'	SC	29	98	15	39	24
4'	SC	18	91	11	36	25
5'						
6'						
7'						
8'	CL	50	91	10	38	28
9'						

B1	Boring
10	Distance from East End (ft)
5390	Distance from West End (ft)

B1	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	CH	58	90	14	53	39
2'	CL	56	82	14	45	31
3'	CH	61	97	17	50	33
4'	CH	77	91	18	62	44
5'						
6'						
7'	CH	100	100	23	94	71
8'						
9'						

B9	Boring
3700	Distance from East End (ft)
1700	Distance from West End (ft)

from 2002

B9	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'						
3'						
4'						
5'	CH				72	45
6'						
7'	CH				78	54
8'	CH				78	53
9'	CH				79	54

B9	Boring
3700	Distance from East End (ft)
1700	Distance from West End (ft)

from 2006

B9	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'						
3'	CH					50
4'	CL					35
5'	CL					35
6'						
7'						
8'						
9'	SM					5

B8	Boring
3160	Distance from East End (ft)
2240	Distance from West End (ft)

B8	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	CH	70	92	16	50	34
2'	CH	77	95	23	63	40
3'	CH	84	97	25	74	49
4'	CH	84	98	28	77	49
5'						
6'	CH	88	97	32	90	58
7'						
8'	CH	94	96	27	87	60
9'						

B7	Boring
2710	Distance from East End (ft)
2690	Distance from West End (ft)

B7	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	23	60	12	23	11
2'	SC	17	44	19	37	18
3'	CH	54	85	22	62	40
4'	CH	69	94	22	69	47
5'						
6'						
7'	CH	68	86	16	57	41
8'	CH	81	92	16	68	52
9'						

B6	Boring
2260	Distance from East End (ft)
3140	Distance from West End (ft)

B6	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	33	69	19	43	24
2'	CH	74	86	21	76	55
3'	CH	55	94	21	55	34
4'						
5'	CH	80	97	24	79	55
6'	CH	79	95	19	58	39
7'	SC	34	74	17	64	47
8'						
9'						

Figure 3.25 Results of the Atterberg limits and classification testing for all borings in Part 1 of FM2.

B12	Boring
5370	Distance from East End (ft)
30	Distance from West End (ft)

B12	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	CL	60	87	17	44	27
2'	CH	71	95	25	57	32
3'	CH	80	98	21	57	36
4'	CL	66	94	16	45	29
5'				12	28	16
6'						
7'						
8'						
9'						

B11	Boring
4890	Distance from East End (ft)
510	Distance from West End (ft)

B11	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'	SM	19	84	10		
3'	SM	15	76	13		
4'	SM	11	67	10		
5'	SM	12	83	8		
6'						
7'						
8'						
9'						

B10	Boring
3960	Distance from East End (ft)
1440	Distance from West End (ft)

B10	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'				16	39	23
2'	CH	82	97	22	114	92
3'	CH	84	98	29	78	49
4'	CH	86	97	28	80	52
5'						
6'	CH	87	97	29	72	43
7'	CH	75	94	17	50	33
8'	CL	71	97	15	40	25
9'						

Figure 3.26 (Continued) Results of the Atterberg limits and classification testing for all borings in Part 1 of FM2.

B16	Boring
1800	Distance from East End (ft)
0	Distance from West End (ft)
from 2002	

B16	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	CH				57	42
2'	CH				51	36
3'						
4'						
5'	CL				34	14
6'	SC				19	8
7'						
8'	CL				33	18
9'	CL				35	22

B16	Boring
1400	Distance from East End (ft)
400	Distance from West End (ft)
from 2006	

B16	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'						
2'						
3'	CL					35
4'						
5'						
6'						
7'						
8'						
9'	SC					

B31	Boring
1125	Distance from East End (ft)
675	Distance from West End (ft)

B31	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	37	61	20	57	37
2'	CL	61	99	14	36	22
3'	CL	60	96	12	29	17
4'						
5'						
6'	SC	48	100	11	27	16
7'						
8'	SC	46	98	14	27	13
9'						

B14	Boring
675	Distance from East End (ft)
1125	Distance from West End (ft)

B14	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'	SC	43	82	17	43	26
2'	CL	60	84	15	47	32
3'	CL	58	86	15	41	26
4'	CL	53	94	13	32	19
5'						
6'	CL	56	97	15	35	20
7'						
8'	SC	40	96	14	32	18
9'						

B13	Boring
225	Distance from East End (ft)
1575	Distance from West End (ft)

B13	Soil Class	Fine %	Soil Binder %	PL	LL	PI
1'				15	33	18
2'	CL	51	87	16	36	20
3'	CL	52	89	15	44	29
4'	CL	52	78	16	43	27
5'						
6'	CH	77	96	20	57	37
7'						
8'						
9'	CH	80	93	17	59	42

Figure 3.27 Results of the Atterberg limits and classification testing for all borings in Part 2 of FM2.

3.4 Condition Surveys in FM2

The main purpose of this field study is to investigate the performance of the geosynthetic reinforcement in mitigation of the longitudinal cracks induced by seasonal expansion and shrinkage of the expansive subgrade soil. As illustrated in Figure 3.28, seasonal changes in the moisture content of an expansive subgrade may lead to cycles of expansion and shrinkage of the subgrade. The amount of expansion and shrinkage is expected to be the maximum in the shoulder areas, where the soil is freely exposed to the open-air environment, and to be the minimum beneath the paved area, where the access to the environment is limited. This non-uniform displacement pattern causes flexural moments in the pavement structure, which results in the development of tensile strains and longitudinal cracks in the pavement layers. Use of geosynthetic reinforcements can redistribute the stresses beneath the pavement structure and result in a more uniform displacement pattern with reduced tensile strains within the pavement layers.

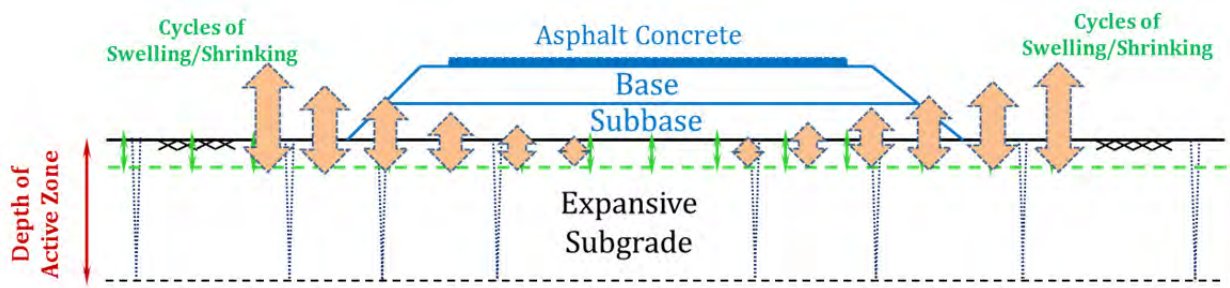


Figure 3.28 Non-uniform displacement of pavements over expansive subgrades.

In this study, the performance of the geosynthetic-reinforced sections in mitigation of longitudinal cracks has been compared to the performance of non-reinforced and lime-treated sections. The basis for this comparison has been a series of visual conditions surveys conducted through the life of the road. The surveys have been conducted based on the instructions recommended in the TxDOT Pavement Management Information System (PMIS) Rater's Manual. According to this manual, flexible pavement distress types may be categorized in following groups:

- Shallow Rutting and Deep Rutting
- Alligator Cracking and Block Cracking
- Longitudinal and Transverse Cracking
- Patching
- Raveling and Flushing
- Failures

However, since the main function of the geosynthetic reinforcements is expected to be mitigation of the longitudinal cracks, documentation of the longitudinal cracks has been the principal focus of the surveys. Although the TxDOT PMIS Rater's Manual ignores longitudinal

and transverse cracks with width less than 3 mm, all cracks have been documented during the conditions surveys, even those cracks smaller than 3 mm wide. A total of 20 conditions surveys were performed during the service life of the project. Table 3.8 lists the date of the conditions surveys, from the first one in August 2006 to the last one in November 2012. The last column of this table shows the life of the project in terms of days.

Table 3.8 List of conditions surveys conducted during the life of FM2

No.	Date	Life of the Project (Days)	No.	Date	Life of the Project (Days)
SURVEY 1	Aug-06	0	SURVEY 11	Dec-09	1227
SURVEY 2	Nov-06	92	SURVEY 12	Mar-10	1312
SURVEY 3	Feb-07	184	SURVEY 13	Jun-10	1403
SURVEY 4	May-07	273	SURVEY 14	Nov-10	1556
SURVEY 5	Nov-07	459	SURVEY 15	Feb-11	1669
SURVEY 6	Apr-08	624	SURVEY 16	Apr-11	1732
SURVEY 7	Aug-08	750	SURVEY 17	Sep-11	1877
SURVEY 8	May-09	1008	SURVEY 18	Dec-11	1966
SURVEY 9	Jun-09	1059	SURVEY 19	May-12	2102
SURVEY 10	Aug-09	1119	SURVEY 20	Nov-12	2306

3.5 Environmental Data in FM2

Environmental conditions determine seasonal changes in the moisture conditioning of the soil. In a humid climate the moisture content of soil remains reasonably constant. In contrast, in arid or semi-arid climates, where distinguished wet seasons and dry seasons occur, the moisture content in the active zone of the expansive soils could change dramatically. In these climates, dry summer months with minimum precipitation are often accompanied by high temperatures, which maximize evaporation/transpiration from soil. This combination could maximize the shrinkage of the soil, thus increasing the rate of cracking in the pavement. Therefore, cycles of wet and dry seasons as well as fluctuation in the temperature should be taken into account in the evaluation of the performance of the field sections.

Environmental data were collected at FM2 site in the form of a precipitation record and temperature record. Precipitation data were collected from two nearby stations shown in Figure 3.29 and Figure 3.30. In both stations, the precipitation data are estimated by a quality-controlled, multi-sensor (radar, satellite, and rain gauge) approach from National Weather Service (NWS) West Gulf River Forecast Center. In this approach, precipitation estimates from WSR-88D (**W**eather **S**urveillance **R**adar, 19**88**, **D**oppler) NEXRAD (**Nex**t-Generation **Rad**ar) are compared to ground rainfall gauge reports, and a correction factor is calculated and applied to the radar field. If the radar coverage is limited, satellite precipitation estimates (SPE) are incorporated into this multisensory field. In this case, the correction factor will be calculated by comparing the SPE values against the rainfall gauge reports.

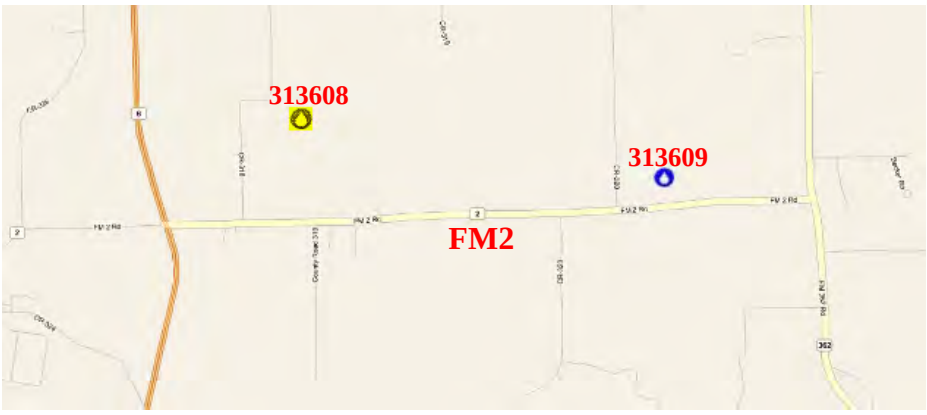


Figure 3.29 Stations used for precipitation data in FM2.

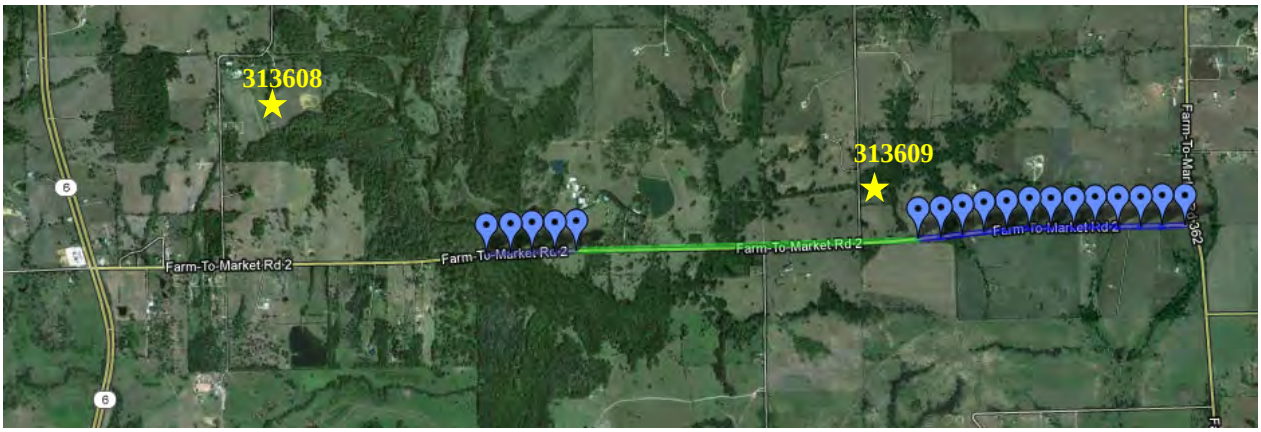


Figure 3.30 Location of precipitation record stations.

In this study, precipitation data from Station 313609 are used as the basis but compared and verified with the data from Station 313608. Daily precipitation data were collected in each station and then summed to obtain monthly precipitation data.

Figure 3.31 shows the results for monthly precipitation data at Station 313609 from 2006 (the beginning of the project) to the end of 2012. The horizontal axis of this graph shows month numbers in each year and bars demonstrate the total amount of rainfall in corresponding month in inches.

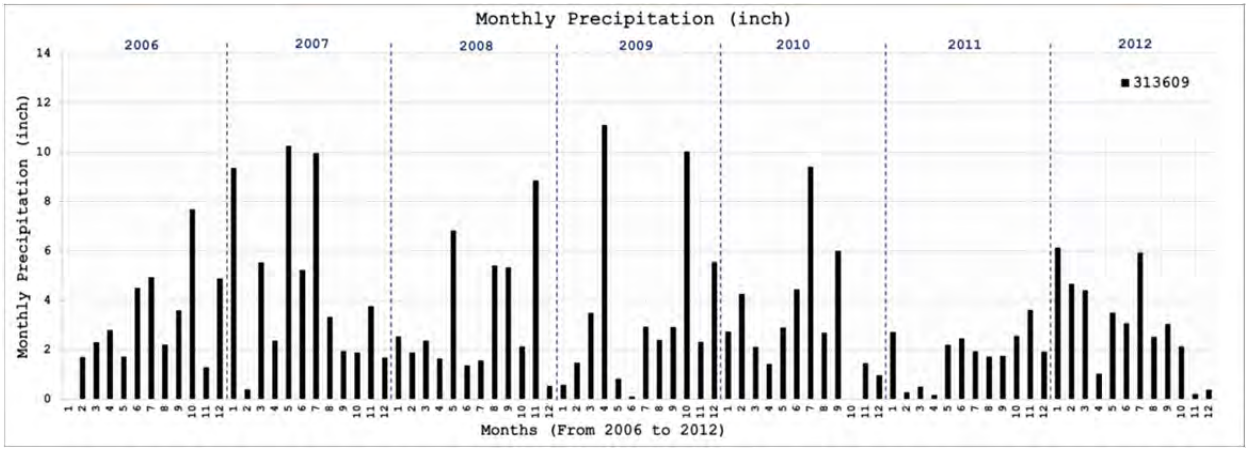


Figure 3.31 Monthly average precipitation data from Station 313609 from 2006 to 2012.

Temperature records were collected from NWS data provided for College Station. These data were compared and verified against three local weather stations: 1) Bluebonnet Ranch, 2) Rocky Creek Ranch, and 3) Whitehall. Figure 3.32 shows the location of the three local stations.

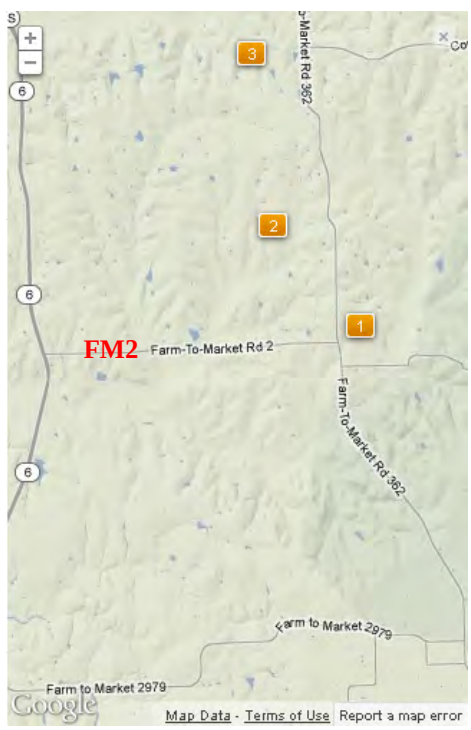


Figure 3.32 Location of the local weather stations used to verify temperature records.

Figure 3.33 presents the results for temperature data from 2006 (the beginning of the project) to the end of 2012. In this figure, the data are presented in the form of weekly average. The horizontal axis is week number changing from 1 (the first week of year 2006) to 366 (the last week of year 2012), assuming 52 weeks per year. The vertical axis of the plot is the weekly average temperate in Fahrenheit. This graph shows a cyclic pattern for temperature in FM2.

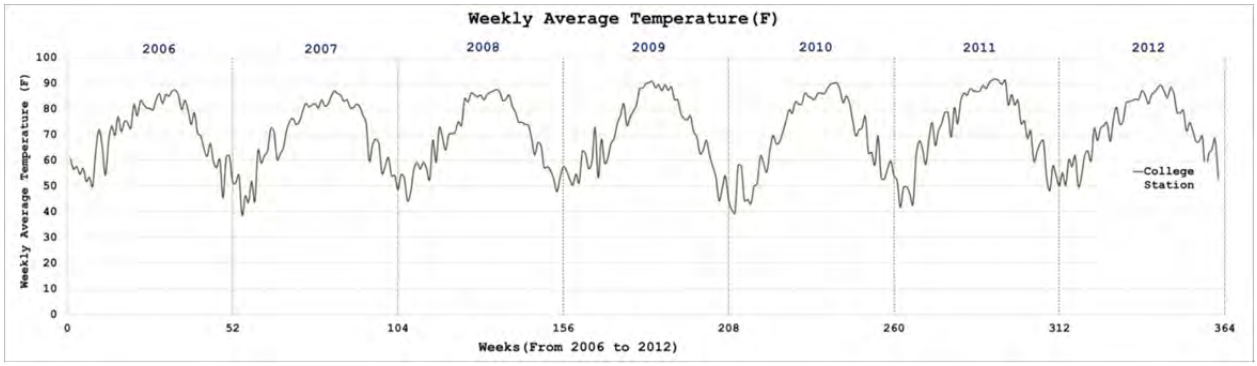


Figure 3.33 Weekly average temperature record from college station from 2006 to 2012.

Figure 3.34 displays the date of the conditions surveys conducted in FM2 as compared with the precipitation data, depicting several cycles of wetting and drying. While the total amount of rain in the first 4 months of the project—Months 2 to 5 of 2006—was 8.53 in. (2.13 in. per month on average), in the next 14 months—from Month 6, 2006 to Month 7, 2007—the total amount of rain increased to 72.21 in. (5.16 in. per month on average). From Month 8, 2007 to Month 9, 2009 the road experienced 12 relatively dry months followed by short cycles of wet and dry periods. Then, a relatively intensive wet season started in Month 10, 2009, and continued for 1 year with total rain of 53.87 in. (4.49 in. per month on average). This wet season was followed by a record-long dry season from Month 10, 2010, to the end of 2011. The total amount of rain in this period was 24.23 in. (1.62 in. per month on average). This history of wet and dry seasons, which is summarized in Table 3.9, could cause cycles of swelling and shrinkage in the expansive subgrade soil, which would lead to accumulation of tensile strains in the pavement structure. The accumulated tensile strains could cause development of longitudinal cracks in the pavement. The development of the longitudinal cracks is expected to be mitigated by the application of geosynthetic reinforcements. Therefore, a contrast between performances of different test sections could be expected at the end of 2011.

Table 3.9 Cycles of wetting and drying seasons in FM2 from 2006 to 2012

Year	Month	Dry/Wet	Month	Total Rain	Rain Per Month
				in	in
2006	2 to 5	Dry	4	8.53	2.13
	6 to 12	Wet	14	72.21	5.16
2007	1 to 7				
	8 to 12	Dry	12	30.8	2.57
2008	1 to 7				
	8 to 11	Wet	4	21.73	5.43
	12	Dry	3	2.58	0.86
2009	1 to 2				
	3 to 4	Wet	2	14.59	7.30
	5 to 9	Dry	5	9.17	1.83
	10 to 12	Wet	12	53.87	4.49
2010	1 to 9				
	10 to 12	Dry	15	24.23	1.62
2011	1 to 12				
2012	1 to 10	Wet	10	36.45	3.65

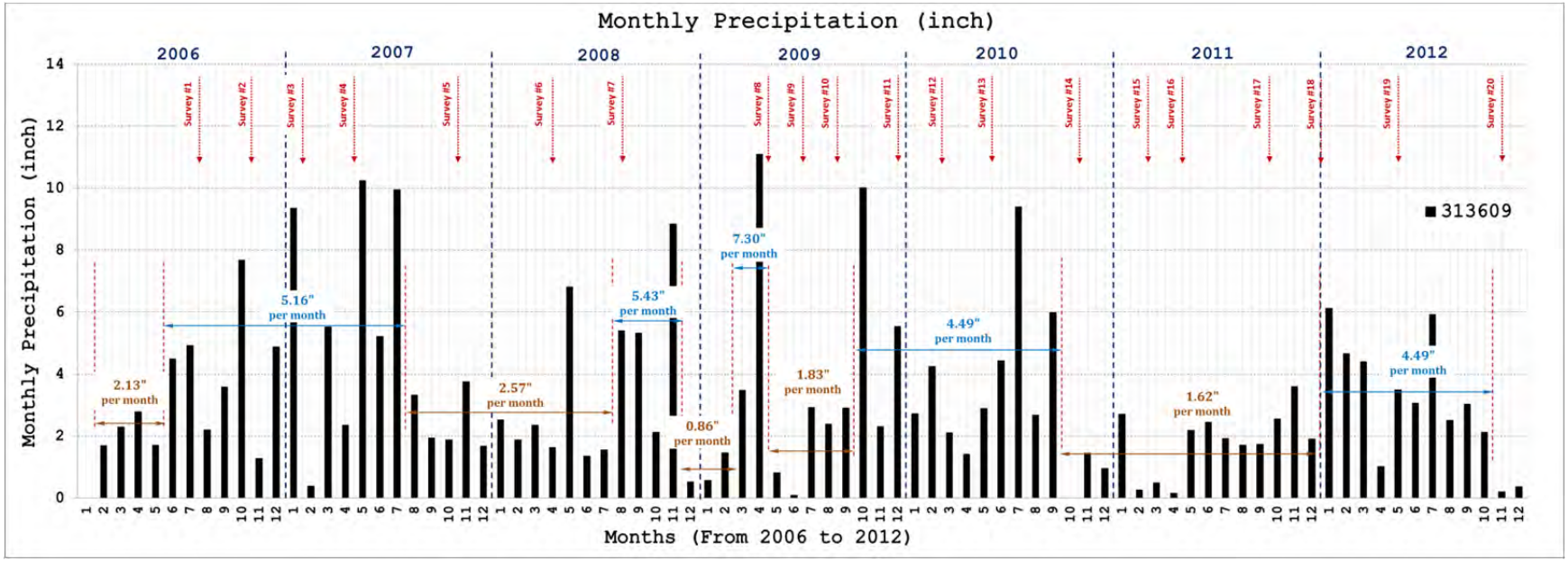


Figure 3.34 Cycles of wetting and drying in FM2 Road from 2006 to 2012 along with the conditions surveys dates.

3.6 Evaluation of the Performance of the Test Sections in FM2

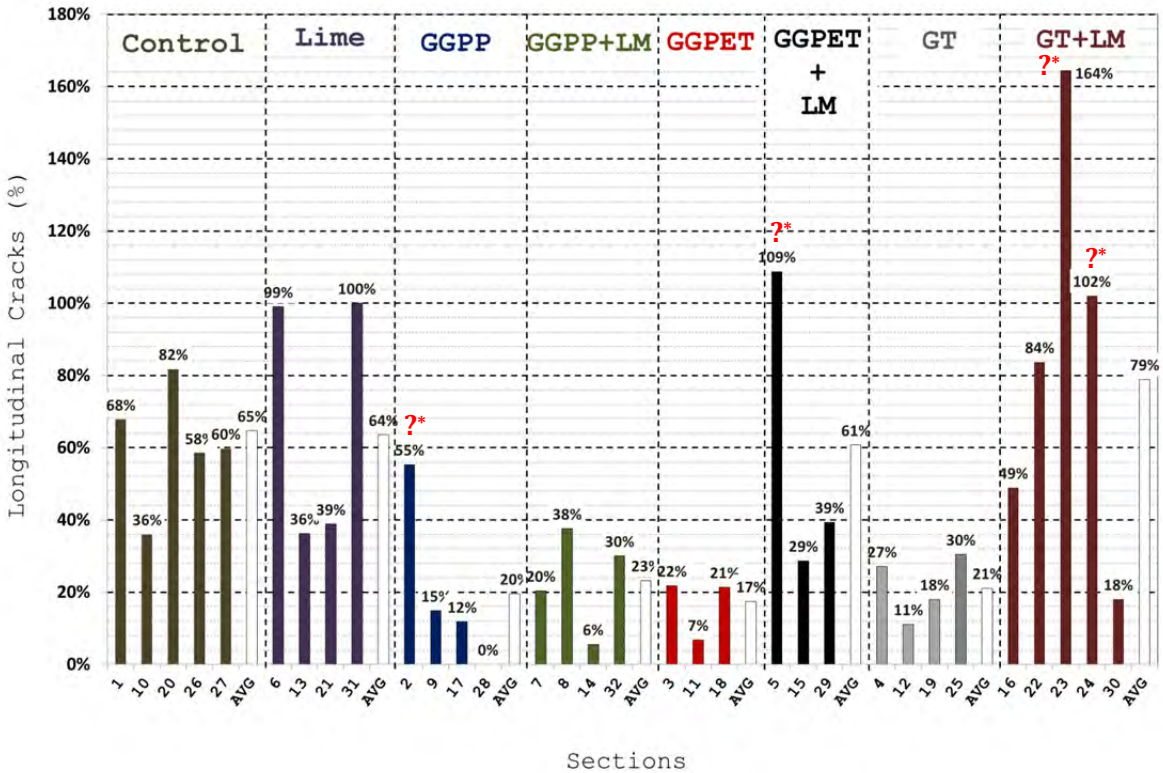
As described in Section 3.4, the performance of the test sections was evaluated using the results of the visual conditions surveys. Specifically, the percentages of longitudinal cracks recorded in the surveys are used to compare the performance of the sections. Results of Survey #18 are reported herein as the final performance of the sections at the end of the project. In addition, the performance of the sections is presented over time. For this purpose, results of Survey #14 (before the dry season), Surveys #16 and #17 (during the dry season), and Survey #18 (at the end of the dry season) are discussed in a single plot. Subsurface soil data are also used to interpret and explain the results.

3.6.1 Performance of the Sections at the End of the Project

Final performance of the test sections is presented in Figure 3.35 and Table 3.10. The horizontal axis of this graph corresponds to the section numbers, and the vertical axis is the percentage of longitudinal cracking. The longitudinal cracks are measured in terms of the linear foot of cracking per 100-ft stations and are presented in percentage. Note that this number can exceed 100% if the accumulated length of cracks per 100-ft stations is higher than 100 ft. As shown in this figure, sections are classified in eight groups described in Section 3.2.1. The last bar in each group, which is filled white, is the weighted average for the group.

Table 3.10 Final performance of the test sections at the end of the project

Layout	Section	Layout	Length	Lane	Longitudinal Cracks >3mm
Control	1	Cont	450	K6 -1	68%
	10	Cont	150	K6 -1	36%
	20	Cont	450	K1 -1	82%
	26	Cont	450	K1 -1	58%
	27	Cont	400	K1 -1	60%
	AVG	Cont			65%
Lime	6	Cont+LM	300	K6 -1	99%
	13	Cont+LM	450	K6 -2	36%
	21	Cont+LM	600	K1 -1	39%
	31	Cont+LM	450	K1 -2	100%
	AVG	Cont+LM			64%
GG PP	2	GG PP	450	K6 -1	55%
	9	GG PP	600	K6 -1	15%
	17	GG PP	450	K1 -1	12%
	28	GG PP	500	K1 -1	0%
	AVG	GG PP			20%
GG PP + Lime	7	GG PP+LM	550	K6 -1	20%
	8	GG PP+LM	450	K6 -1	38%
	14	GG PP+LM	450	K6 -2	6%
	32	GG PP+LM	450	K1 -2	30%
	AVG	GG PP+LM			23%
GG PET	3	GG PET	450	K6 -1	22%
	11	GG PET	350	K6 -1	7%
	18	GG PET	450	K1 -1	21%
	AVG	GG PET			17%
GG PET + Lime	5	GG PET+LM	500	K6 -1	109%
	15	GG PET+LM	450	K6 -2	29%
	29	GG PET+LM	450	K1 -2	39%
	AVG	GG PET+LM			61%
GT	4	GT	450	K6 -1	27%
	12	GT	550	K6 -1	11%
	19	GT	450	K1 -1	18%
	25	GT	450	K1 -1	30%
	AVG	GT			21%
GT + Lime	16	GT+LM	450	K6 -2	49%
	22	GT+LM	300	K1 -1	84%
	23	GT+LM	300	K1 -1	164%
	24	GT+LM	600	K1 -1	102%
	30	GT+LM	450	K1 -2	18%
	AVG	GT+LM			79%



*Borings show sandy subgrade in these sections. The performance may not be attributed to the expansive clay.

Figure 3.35 Final performance of the test sections at the end of the project.

The main findings obtained from inspection of the results presented in Figure 3.35 and Table 3.10 are as follows:

1. On average, all three different geosynthetic-reinforced section groups were found to perform significantly better than the control sections.
2. The three geosynthetic-reinforced section groups demonstrate approximately the same level of performance. The average percentages of cracking for these groups are 20% for GGPP sections, 17% for GGPET sections, and 21% for GT sections.
3. The addition of lime does not show improvement in the performance of the test sections. Indeed the lime-treated section group performs similarly to the control sections. In one of the geosynthetic-reinforced section groups, i.e., GGPP sections, addition of lime results in a small increase in the percentage of cracking (23% for GGPP+Lime versus 20% for GGPP). However, in the other geosynthetic-reinforced section groups, the average cracking percentage increases significantly when lime is added.
4. Out of the 23 sections reinforced with geosynthetics, with or without adding lime, 5 sections performed questionably poor: Sections #2, #5, #22, #23, and #24. Subsurface soil data was studied to investigate the reason for this poor performance. As shown in Figure 3.24, the closest boring to Section #2 is B2, and the closest borings to Sections #5, #22, #23, and #24 are B6, B7, and B8. Results of the soil classification tests at these boring are presented in Figure 3.36. As seen in this figure, the presence of sandy layers is

recognized in B2, B6, and B7 to varying extents. In B2, sand layers were found to extend from the surface of the ground to the depth of 4 ft, at least. The PI values for these layers ranged from 25 to as low as 14, categorizing them as low to non-expansive soils. Similar sand layers are also observed in the first layer of B6 and the first and the second layer of B7. Presence of sandy soils might have influential effects on the performance of pavements over expansive clays. These potential effects are listed as follows:

- If the sand layers are deep enough to pass the moisture fluctuation depth, the subgrade would not behave expansively. In other words, this kind of subgrade would not expand in wet season and would not shrink in dry season. Therefore, evaluation of the performance of a section founded on deep sand layers to seasonal change of moisture might not be relevant.
- A shallow non-plastic sand layer underlain by highly plastic deeper layers could change the flow regime in the subgrade soil. While saturated, the high permeability of a sand layer could facilitate transportation of surface waters to deeper expansive soils.
- Sporadic occurrences of sandy lenses along and across a pavement section could notably influence differential heave and settlement in the road. As explained in the previous item, existence of sand layers at one spot can change the response of the spot to the seasonal change in the moisture. Therefore, random appearances of sandy layers along and across a pavement section might influence the response of the section to an unknown extent. In this condition, non-uniform deformation of the pavement, thus cracking, are more likely to be observed.

B8	Soil Class	Fine %	PI
1'	CH	70	34
2'	CH	77	40
3'	CH	84	49
4'	CH	84	49
5'			
6'	CH	88	58
7'			
8'	CH	94	60
9'			

B7	Soil Class	Fine %	PI
1'	SC	23	11
2'	SC	17	18
3'	CH	54	40
4'	CH	69	47
5'			
6'			
7'	CH	68	41
8'	CH	81	52
9'			

B6	Soil Class	Fine %	PI
1'	SC	33	24
2'	CH	74	55
3'	CH	55	34
4'			
5'	CH	80	55
6'	CH	79	39
7'	SC	34	47
8'			
9'			

B2	Soil Class	Fine %	PI
1'	SC	20	14
2'	SC	40	21
3'	SC	29	24
4'	SC	18	25
5'			
6'			
7'			
8'	CL	50	28
9'			

Figure 3.36 Soil classification data at the locations of the questionable sections.

The average performance of the sections in each group is summarized and reorganized in Figure 3.37.

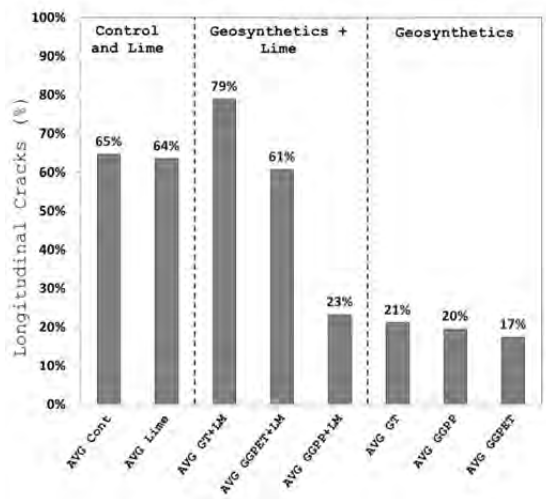


Figure 3.37 Ranking of the performances of the sections.

3.6.2 Effect of the Subsurface Soil Data on the Performance Results

An evaluation of the potential influence of the soil data on the final performance data presented in Section 3.6.1. The expansive potential of soil at a given site can vary significantly from one location to another due to variability of subsurface soil characteristics. Index parameters commonly used to evaluate the expansive potential of clays are PI and LL. These parameters are obtained for the representative portion of soil samples, also known as *soil binder*, which is the portion of soil passing the 425 μm (No. 40) sieve. The U.S. Army Corp of Engineers (USACE) (1983) adopted an empirical method for identification of expansive clays (Table 3.11). This method classifies the potential swell in expansive clays as low, marginal, and high. Under this classification, a highly expansive clay is considered to have a PI value of 35 or higher and an LL value of 60 or higher. On the other hand, a clay with PI values of 25 or lower and LL values of 50 or lower is classified as having low potential swell.

Table 3.11 Classification of potential swell by USACE Waterways Experiment Station

Classification of potential swell	Potential swell S_p percent	Liquid limit LL percent	Plasticity index PI percent	Natural soil suction τ^{o}_{nat} tsf
Low	<0.5	<50	<25	<1.5
Marginal	0.5-1.5	50-60	25-35	1.5-4.0
High	>1.5	>60	>35	>4.0

Atterberg limits are obtained for the representative portion of soil samples, i.e., soil binder. Therefore, classification of expansive clays based on these limits might neglect the effectiveness of this portion in the actual behavior of the soil. Other classification methods, such as the correlation developed by the U.S. Bureau of Reclamation (2004) and the correlation recommended by Chen (1988), incorporate the percentage of colloids (particles passing 0.001mm sieve) or the percentage of fines (particles passing #200 sieve) into the classification. Table 3.12 and Table 3.13 illustrate the latter classifications.

Table 3.12 Classification of expansion potential of soils by the U.S. Bureau of Reclamation

Data from index tests [1]			Probable expansion [2], percent total volume change, dry to saturated condition	Degree of expansion
Colloid content, percent minus 0.001 mm	Plasticity index, PI, %	Shrinkage limit, SL, %		
>28	>35	<11	>30	Very high
20 to 31	25 to 41	7 to 12	20 to 30	High
13 to 23	15 to 28	10 to 16	10 to 20	Medium
<15	<18	>15	<10	Low

[1] All three index tests should be considered in estimating expansive properties.
[2] Based on a vertical loading of 7 kPa (1.0 lbf/in^2)

Table 3.13 Correlation of expansion potential of soils with common soil tests (Chen 1988)

Laboratory and Field Data			Degree of Expansiveness			
Percent Passing #200 Sieve	Liquid Limit	SPT N Value	Probable Expansion (%)[a]	Swelling Pressure (k/ft^2)	Swelling Pressure (kPa)	Swelling Potential
<30	<30	<10	<1	1	50	Low
30–60	30–40	10–20	1–5	3–5	150–250	Medium
60–95	40–60	20–30	3–10	5–20	250–1000	High
>95	>60	>30	>10	>20	>1000	Very High

[a]Percent volume change when subjected to a total stress of 1000 lb/ft^2 (50 kPa).

The Potential Vertical Rise (PVR) method has been widely used by TxDOT for estimation of surface movement due to expansive soil (Tex-124-E). This method takes into account various aspects influencing expansion in the soil. The PVR method incorporates LL and the moisture content of soil to identify the moisture conditioning in each soil layer; next, using the PI, the percent volumetric change of the soil is calculated for 1psi surcharge. This value is modified to find the percent free swell under no surcharge. Then, the PVR value for the soil layer is obtained by taking into account the surcharge on the top and at the bottom of the layer. Finally, the PVR value is modified with two correction factors that take into account the percentage of soil binder and the density of the soil layer. The PVR value is then added up from the ground surface to the required depth to obtain the total PVR.

In this section, the expansive potential of the subsurface soil is evaluated using two approaches: (1) the PI value of soil in the top layers and (2) the PVR value of soil calculated from the surface to the bottom of the borings. Results from these approaches were compared with each other, and then incorporated in the performance results of the field sections.

In the first approach, the PI value was averaged for the top 3 ft of soil in each boring. The surface layers have the largest contribution in the expansive potential of the soil; because these

layers are the most susceptible layers to the seasonal change in the moisture. Furthermore, since the surcharge is the minimum, the volume of expansion and shrinkage could be maximized in the surface layers.

Figure 3.38 shows the average PI values for the 13 borings drilled in 2012. In this figure, the surface layers of the subgrade soil are classified into three groups on the basis of the PI values recommended by USACE. Layers with the PI values lower than 25 are classified as *Low Expansive*; layers with the PI values higher than 35 are classified as *High Expansive*; and layers with PI values between 25 and 35 are classified as *Medium Expansive*. This classification was also examined with the LL correlation recommended by the USACE (1983) and Chen (1988). According to the USACE (1983), in low expansive clays LL shall be lower than 50; according to Chen (1988) this value shall be lower than 30. According to both references, the LL of a high expansive clay shall not be lower than 60. Figure 3.39 evaluates and confirms these criteria for the classification presented in Figure 3.38.

In the second approach, the PVR value was calculated for the 13 borings drilled in 2012. The calculation was conducted based on the procedure established by the TxDOT standard Tex-124-E. The subsurface soil was divided into 1 ft sub-layers with approximate wet density of 125 lb/ft^3 (2002.5 kg/m^3). Since the road has undergone several cycles of wetting and drying, the extreme moisture conditioning was assumed for the calculation. It was assumed that the moisture content has changed from the "dry" condition with (wdry=0.2LL+9) to the "wet" condition with (wwet=0.47LL+2). Results of the sieving analysis, discussed in Section 3.3, were used to modify the PVR values for the percentage of soil binder. The total PVR values were calculated from the ground surface to the bottom of the borings. Figure 3.40 presents the final results of this calculation. Figure 3.40 presents the final results of this calculation. The PVR values were used to confirm the classification performed based on the PI and LL values. According to TxDOT Pavement Design Guide 2011 (TxDOT 2011), the PVR value should be calculated for a 15-ft soil column. This guide also recommends 1.5 in. as the limit value of PVR for design of main lanes. As shown in Figure 3.40, the minimum PVR value obtained for the FM2 borings is 0.2 in and the maximum value is 4.6 in. Since the maximum depth of the borings was 9 ft, higher values of PVR had been expected if the calculation would have continued to 15 ft. Taking into account the soil classification presented in Figure 3.38, it appears that the range of PVR values are consistent with the soil classes. The PVR values for soil classified as Low Expansive vary between 0.2 and 1.7 in., whereas for Medium Expansive and High Expansive classes the PVR changes from 1.1 to 3.1 in. (except for B1) , and from 3.1 to 44, respectively.

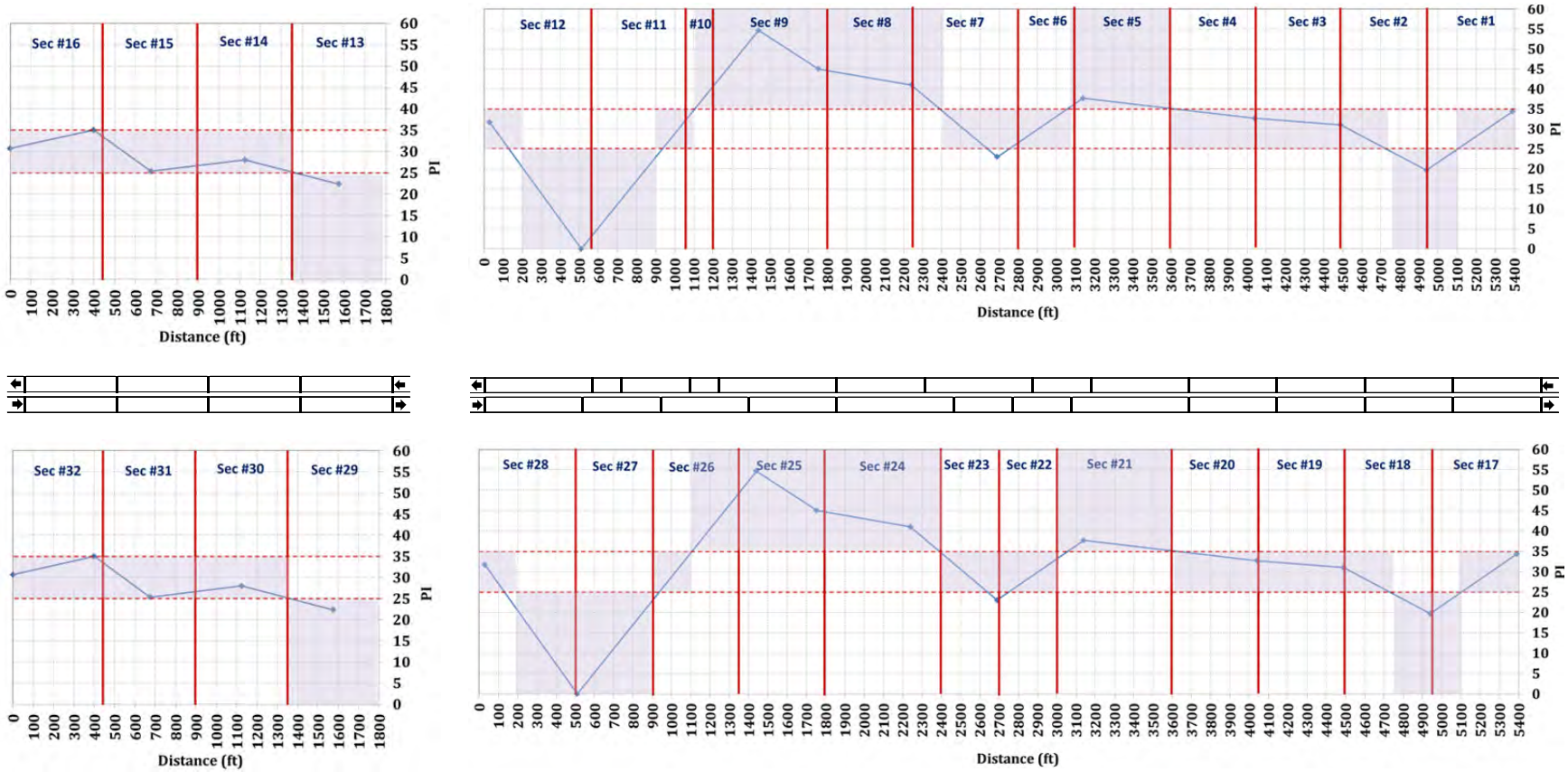


Figure 3.38 PI value for the surface layers of soil.

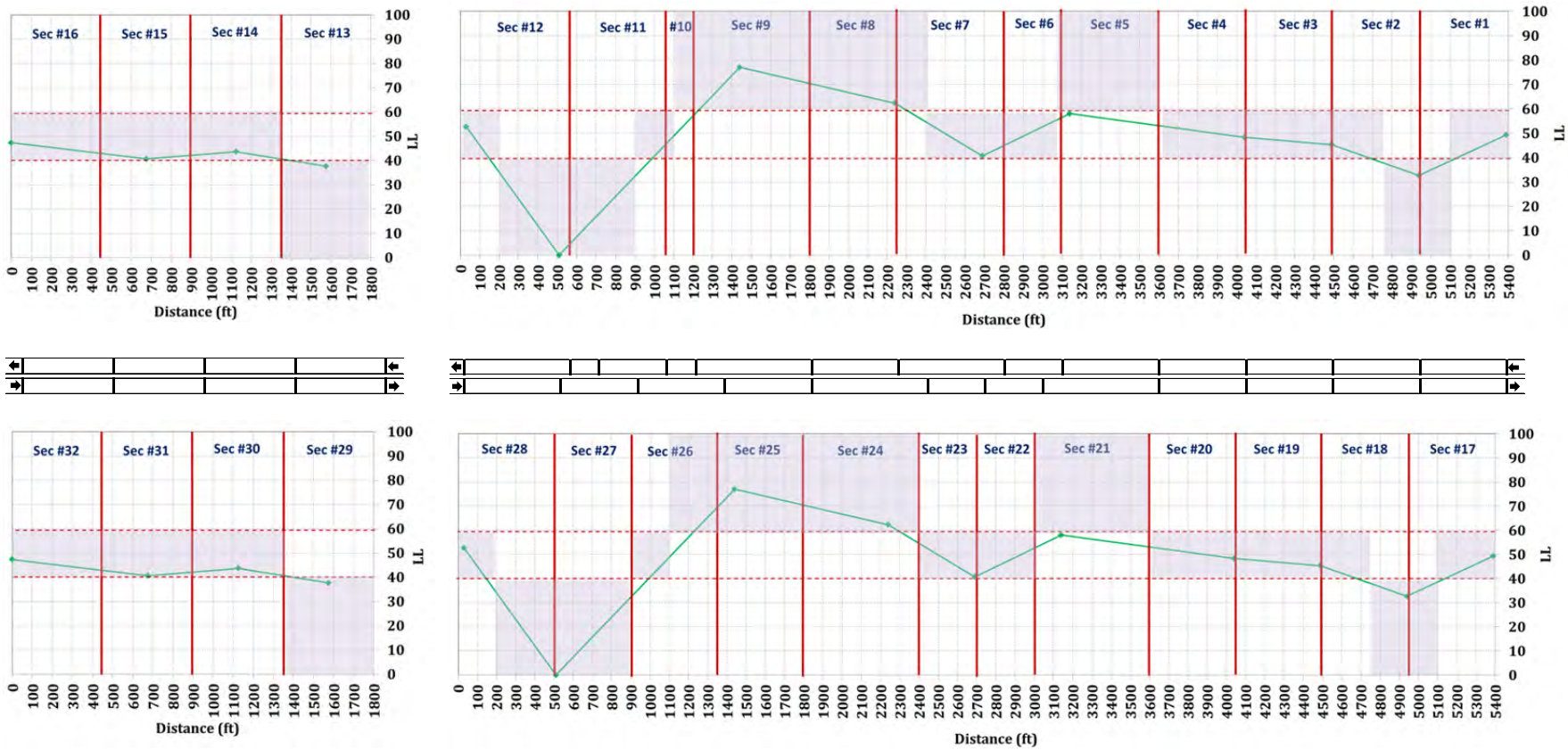


Figure 3.39 LL value for the surface layers of soil.

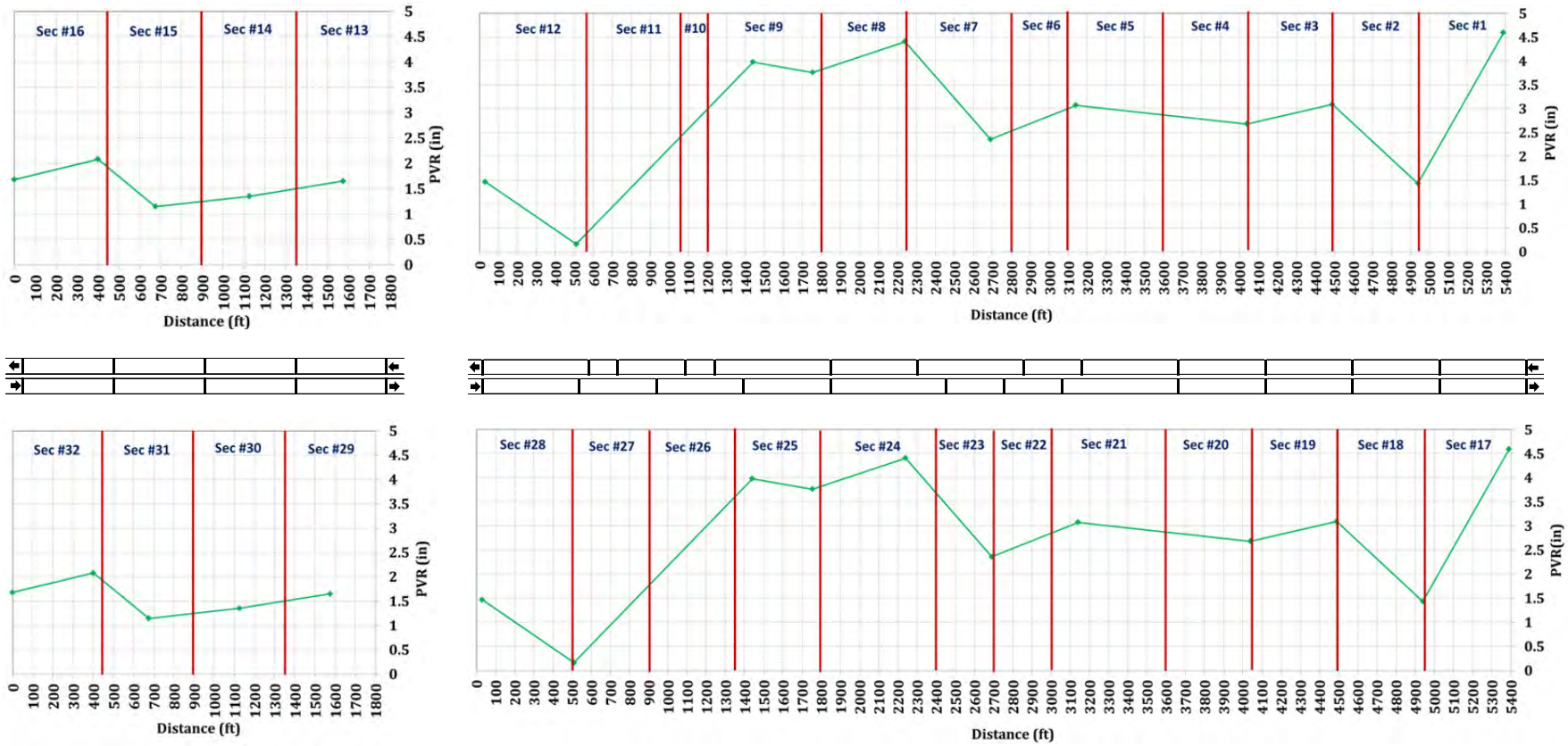


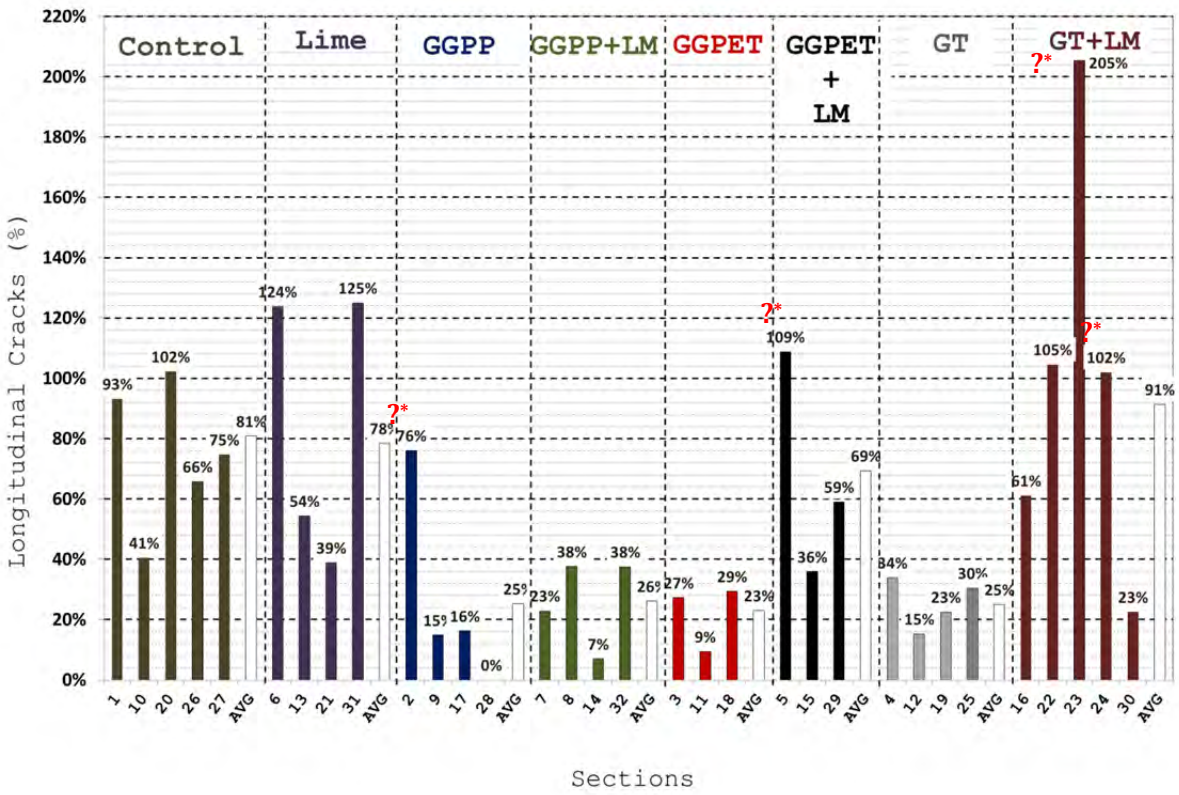
Figure 3.40 PVR value calculated from the surface to the bottom of the borings.

The aforementioned soil classification criteria are summarized in Table 3.14 along with the field sections that correspond to each class. This table also recommends provisional expansive potential correction factors to be applied to the performance results of the test sections. As shown in this table, the correction factor for High Expansive sections is 1, whereas the correction factors for Medium Expansive and Low Expansive sections were adopted as 1.25 and 1.5, respectively. In other words, the percentage crack of a field section is increased when the section was not highly expansive. For example, 15% cracking in a highly expansive section is assumed to be equivalent to 10% cracking in a low expansive section which is not expected to crack significantly. A correction factor of 1.125 is assumed for sections founded on partly highly expansive and partly medium expansive soil. Accordingly, a factor of 1.375 was used for sections with partly medium expansive and partly low expansive subgrade. It should be noted that these provisional numbers are used only for comparison purposes. The actual corrections needed to adjust the performance of a highly expansive section with the performance of a medium or low expansive section appears impossible to identify with the current knowledge of expansive clays.

Table 3.14 Summary of expansive classification criteria and correction factors recommended for each class

	PI	LL	PVR (in)	Test Sections in Each Group	Correction Factor
Low Expansive	< 25	< 40	0.2 to 1.7	#13, #27, #29	1.5
Medium to Low				#1, #2, #11, #12, #17, #18, #28	1.375
Medium Expansive	25 < < 35	40 < < 60	1.1 to 3.1 (except for one location)	#3, #4, #6, #14, #15, #16, #19, #20, #30, #31, #32	1.25
High to Medium				#7, #10, #22, #23, #26	1.125
High Expansive	> 35	> 60	3.1 to 4.4	#5, #8, #9, #21, #24, #25	1.0

Figure 3.41 demonstrates the performance results of the test sections after modifying them with the expansive potential correction factors. Figure 3.42 compares the average values of percent cracking before and after applying the correction factors. These figures indicate that the described incorporation of the soil data into performance results does not change the major conclusions made in the last section, Section 3.6.1. Indeed, the modified performance results show a clearer contrast between the performance of the control and lime-treated groups and the performance of the geosynthetic-reinforced groups. While the percentage cracking of the control and the lime groups was on the order of 65% before modification, this number rises to almost 80% after modification (15% increase). However, the percentage of cracking in the geosynthetic-reinforced groups change from almost 20% before modification to almost 25% after modification (only 5% increase).



* Borings show sandy subgrade in these sections. The performance may not be attributed to the expansive clay.

Figure 3.41 Performance of the test sections modified with the provisional Expansive Potential Correction Factors

Before correction factors ***After correction factors***

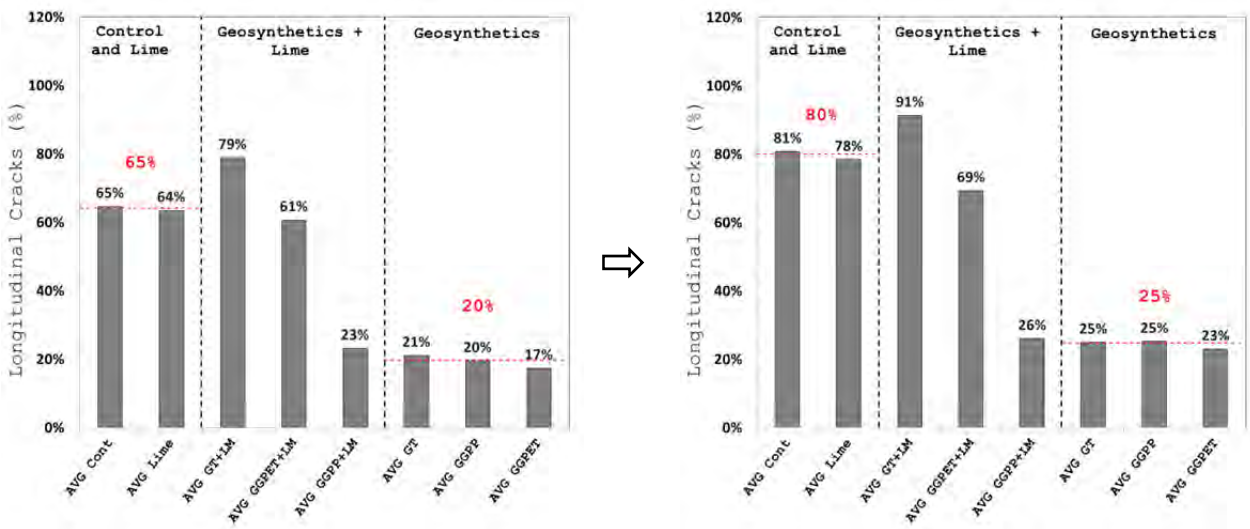


Figure 3.42 Comparison of the average performance of the test sections before and after applying the correction factors.

3.6.3 Performance of the Test Sections over Time

As described in Section 3.5, the field sections have experienced cycles of wetting and drying from the first survey in 2006 to Survey #14 in November 2010. The road underwent a historic dry period from Survey #14 to Survey #18, which was performed at the end of the year 2011. The drought lasted for 15 months. In Section 3.6.1 the performance of the test sections was discussed at the end of the drought. In this part, we discuss the performance results over time from the opening of the road in 2006 to Survey #14, the beginning of the drought, and through the drought from Survey #14 to Survey #18.

Performance of the sections from 2006 to Survey #14

Environmental cracks in expansive clays widen during a major dry season when tensile strains are maximized through soil shrinkage. Conversely, in a wet season cracks tend to close up with expansion of soil. The history of environmental data reviewed in Figure 3.34 shows cycles of relatively short wet and dry seasons from the opening of the road in 2006 to the time of Survey #14. The major drought occurs only after Survey #14. Therefore, it is expected that the field sections experienced medium to small magnitude of tensile strains in the period before Survey #14, and, consequently, only a small amount of major longitudinal cracks was observed. Figure 3.45 presents the performance of the sections in Survey #14 in terms of longitudinal cracking wider than 3 mm. This figure indicates that in most of the sections the percentage of longitudinal cracks was zero. The maximum percentage cracking recorded in this survey was 21% in Section #5, followed by 19% in Section #24. It should be noted that both sections are two of the controversial sections underlain by sandy subgrade, as discussed in Section 3.6.1. Studying Figure 3.43, the average percentage cracking in the control section group was 8%, whereas the maximum percentage cracking in the geosynthetic-reinforced section groups was 3%.

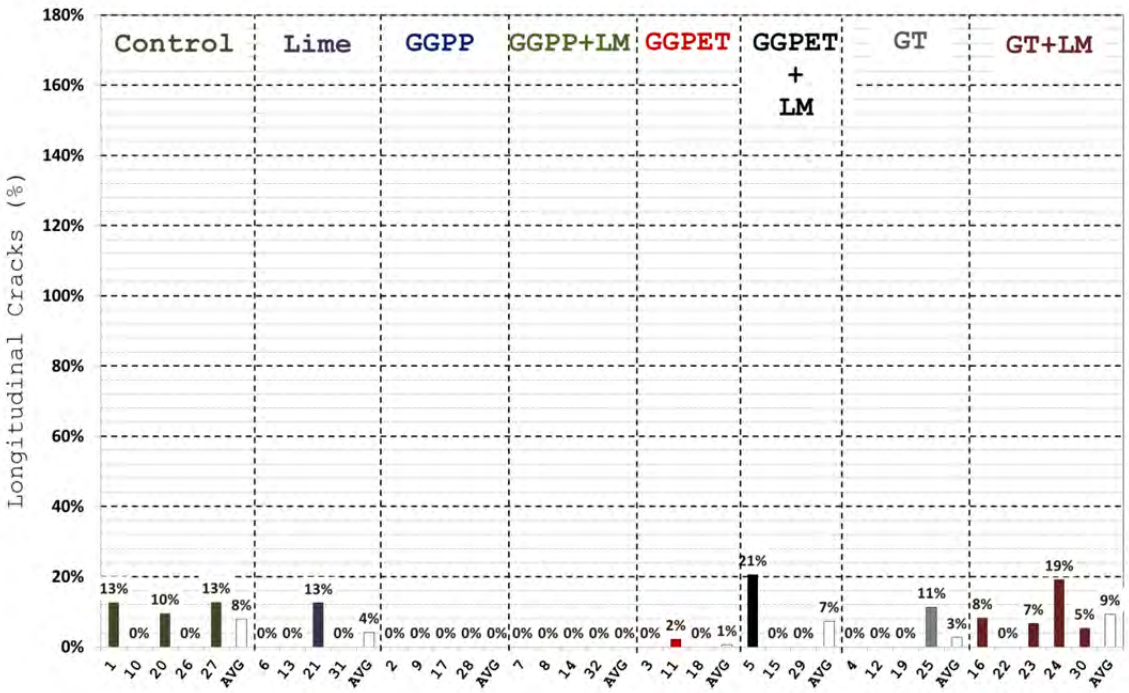


Figure 3.43 Performance of the test sections in Survey #14.

Performance of the sections during the drought

A major drought in FM2's location occurred from October 2010 to the end of 2011. Analysis of the performance of the sections during the drought could highlight the benefits expected from the application of geosynthetic reinforcements. As displayed in Figure 3.34, Survey #14 was conducted almost in the beginning of the drought and Survey #18 was conducted at the end of the drought, and Surveys #15, #16, and #17 were performed during the drought. In this section, the percentage cracking of each group is plotted over time to recognize the contrast between their performances.

Figure 3.44 presents the performance of the non-lime-treated sections for this period. The horizontal axis of this graph is the life of the project from the first survey in days, and the vertical axis is the percentage cracking. This graph indicates that with the start of the drought the control section group presents a clear difference in the performance. In the first few months, cracking accelerates in the control sections whereas all three geosynthetic-reinforced sections show a comparatively small rate of cracking. The large rate of cracking in the control section group continues to Survey #16, which is the end of the most severe period of the drought. During this period, the contrast between the performance of the control sections and the performance of the geosynthetic-reinforced sections rises from 5% in Survey #14 to 37% in Survey #16. After Survey #16 precipitation slightly increases in the road which results in a notable drop in the cracking rate of the control sections. At the end of the drought the contrast between the performance of the control sections and the geosynthetic-reinforced sections is 45%.

It should be emphasized that cracking is ultimately expected to occur in roads susceptible to repeated differential movements. That is, geosynthetic reinforcements are not expected to eliminate cracking in these roads because these reinforcements do not eliminate the tensile strains developed in the layers. Instead, the role of geosynthetics is to alleviate the tensile strains

and mitigate the cracking. Thus, a major benefit of using geosynthetic is to delay the development of the cracks. Investigation of the results presented in Figure 3.44 helps identify and quantify this benefit. Looking at the same level cracking in this figure, it is clear that occurrence of the longitudinal cracking can be delayed by using geosynthetic reinforcements. For example, while control sections show 8% of cracking after 1,556 days (52 months) of project life, geosynthetic-reinforced sections show the same level of cracking only after 1,736 to 1,856 days (58 to 62 months). This difference will be even larger if comparison made for higher percentage of cracking. This highlights the benefit of geosynthetic reinforcement in extending the service life of pavements under environmental loads, and consequently, reducing the maintenance costs associated with these roads.

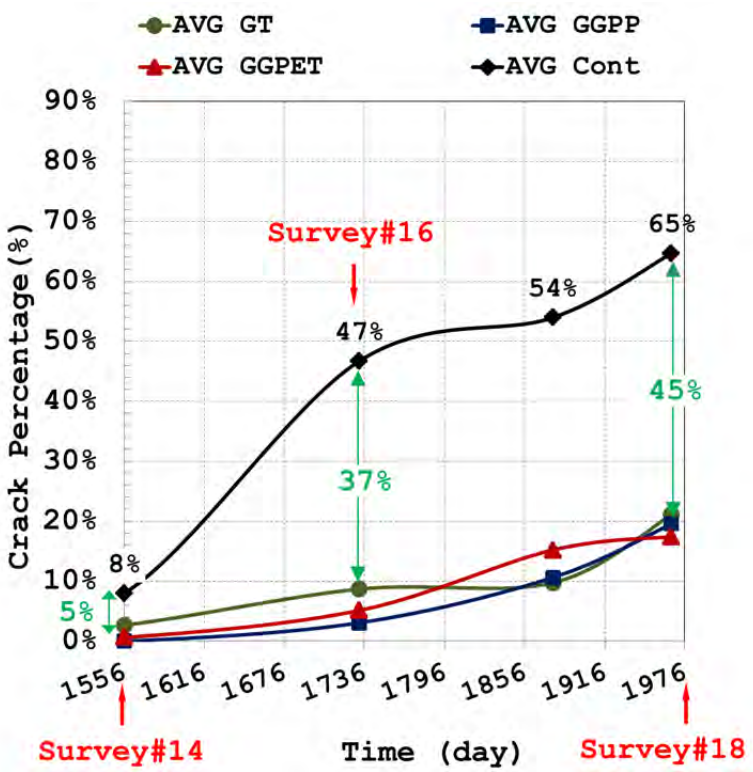


Figure 3.44 Performance of the non-lime-treated test sections during the drought.

Performance of all groups of field sections, including non-lime-treated and lime-treated sections, are described with the eight graphs presented in Figure 3.45. As the figure legend indicates, the control and lime sections are represented by black lines, the GGPP and GGPP+LM sections are represented by blue lines, GGPET and GGPET+LM sections are represented by red lines, and GT and GT+LM sections are represented by green lines. Solid lines represent non-lime-treated sections and dashed lines represent the lime-treated sections. Percentage cracking numbers are shown on the control and lime-treated curves, i.e., the solid black curve and dashed black curve. These black curves make evident that the lime-treated sections continuously perform slightly better than the control sections.

Except for GGPP groups (blue curves), in which the performance of the lime-treated section is similar to the performance of the non-lime-treated sections, for the other geosynthetic sections (i.e., GGPET and GT), lime treating does not show improvement in the performances.

The poor performance of the GGPET+LM and GT+LM sections can be partly described by the poor performance of the questionable sections founded on sand, as discussed in Section 3.6.1. However, inspection of the results in Figure 3.45 indicates that the performance of these lime-treated geosynthetic sections., is more similar to the performance of the control and the lime-treated sections. It can be concluded that the response of these sections is dominated by the performance of lime rather than geosynthetic reinforcements. Addition of lime builds up a strong and rigid (and potentially brittle) layer in the pavement system. The rigidity of this layer, which in this study underlies the geosynthetic reinforcement layer, could prevent mobilization of the displacements needed to activate reinforcement mechanisms of geosynthetics. On the other hand, this potentially brittle layer does not provide the level of flexibility realized by geosynthetics. Once a lime-treated layer cracks it loses its functionality and the separated parts of the layer cannot help prevent or mitigate further cracking. Conversely, the location of a crack in a lime-treated layer might serve as a weak point for additional cracking or faulting in the structure of the pavement.

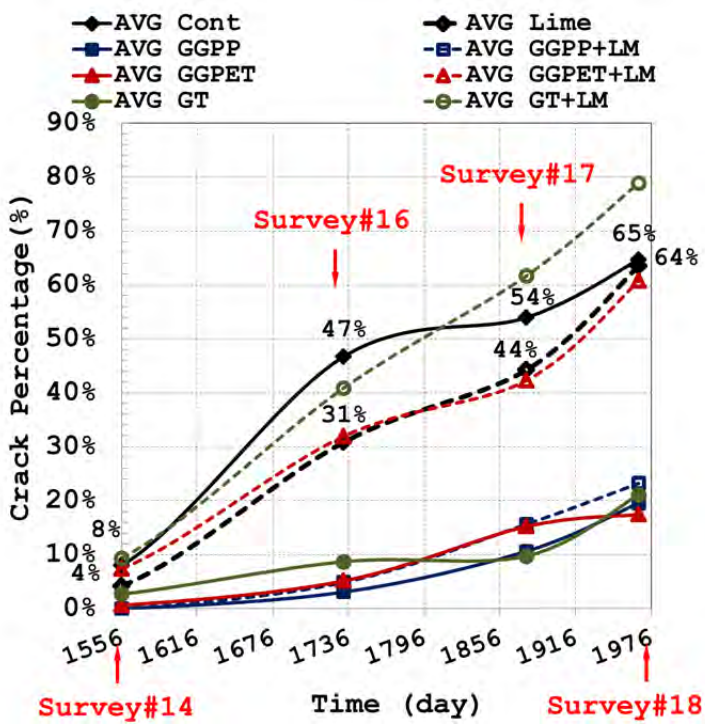


Figure 3.45 Performance of all test sections during the drought.

3.7 Performance of FM1644

As part of this project, additional field test sections were identified and reconstructed in 2010 in Robertson County's FM1644. As shown in Figure 3.46, this site is located approximately 100 miles northeast of Austin and 70 miles northwest of FM2.

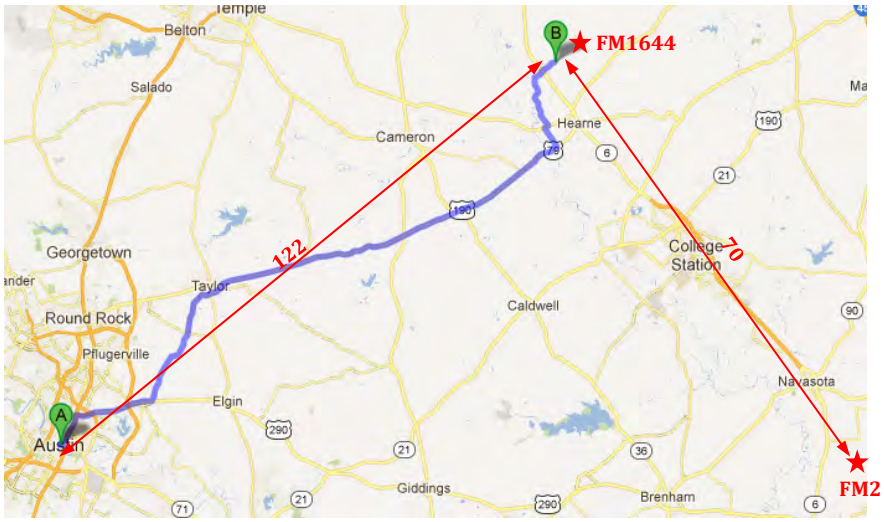


Figure 3.46 Location of the FM1644 road.

3.7.1 Test Sections in FM1644

As shown in Figure 3.47, six 500-ft-long test sections were defined in FM1644. A typical section of the reconstructed road in FM1644 is shown in Figure 3.48. As indicated in this figure, the existing base layer was scarified and reshaped over the subgrade. The top 8 in. of this material was treated with cement in all sections. The middle sections in both lanes, i.e., Sections #2 and #4, were reinforced with Huesker Fornit20 Geogrid, which is noted as GGPP3 in this study. The geosynthetic reinforcements were placed on top of the cement-treated materials. Then, a new 6-in. flexible base layer was constructed, followed by a thin asphalt layer.

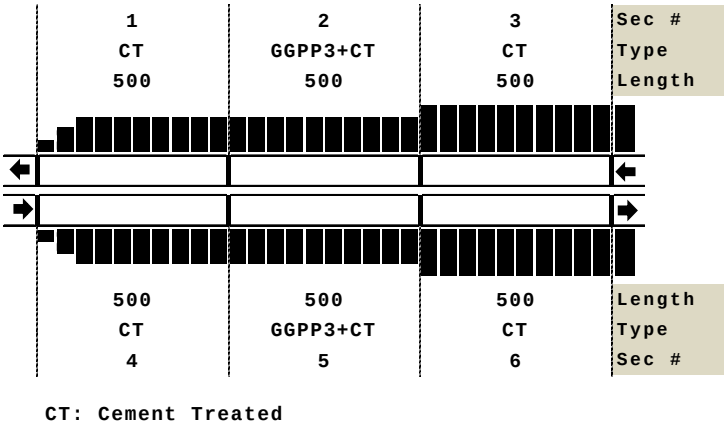


Figure 3.47 Test sections in FM1644.

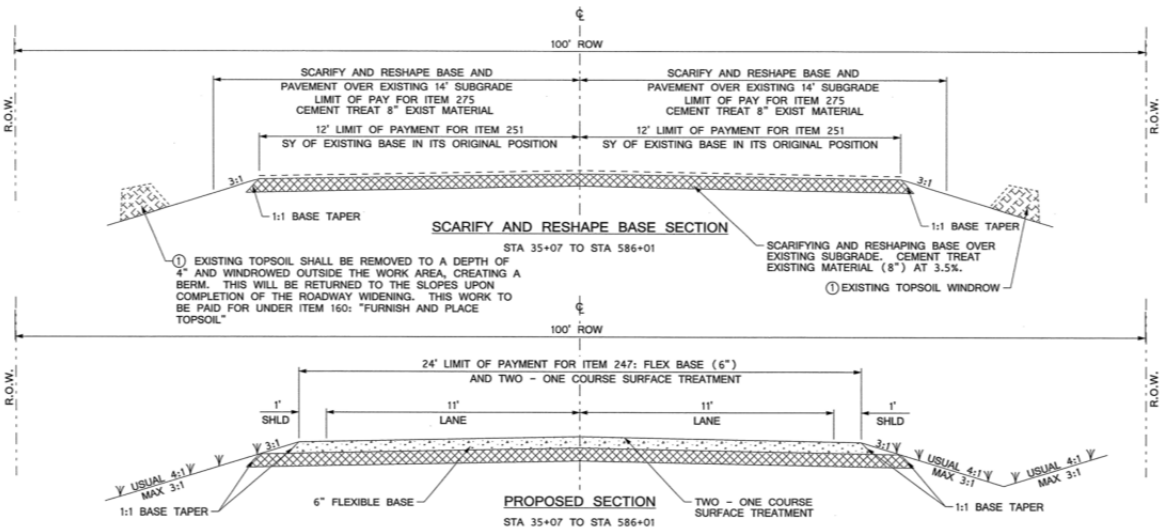


Figure 3.48 Typical section of the reconstructed road in FM1644.

3.7.2 Subsurface Soil Investigation in FM1644

TxDOT conducted a comprehensive soil characterization for FM1644 in 2008. This investigation included 11 borings from the top of the then-existing pavement to the depth of 9 ft. As shown in Figure 3.49, the investigation started from Hickory Street in Calvert to Hearne Street in Franklin and the distance between borings was 1 mile. Boring No. 4 lies approximately in the east side of the test sections, i.e., in the area of Sections #3 and #6. Results of the laboratory tests for all boring are presented in Table 3.15 and Table 3.16. As indicated in these tables, ignoring the first half-foot, the PI value for the top 3 ft of Boring No. 4 was between 37 and 39. The PI value drops to 23 and 25 in deeper layers. Also, the PVR value for this boring was reported as 1.6 in. According to the classification discussed in Chapter 3, soil in this area is classified as high to medium expansive clay. However, this classification might be valid only at the neighborhood of Boring No. 4, i.e., the east side of the test sections, and cannot be extended to other areas. Results presented in Tables 3.15 and 3.16 suggest large variability in subsurface soil properties in FM1644. For example, at Borings No. 2 and 6, the PI value of surface layers was reported as low as 2 and 6, which are referred to non-expansive soils.

Figure 3.49 Subsurface soil investigation in FM1644 in 2008.

Table 3.15 Results of the 2008 soil investigation in FM1644 (Part 1)

Texas Department of Transportation

Highway:	FM 1644	CSJ:	2337-01-018
County	Robertson	Limits:	Hickory St. in Calvert to Hearne St. in Franklin

Existing Pavement and Soil Summary

Existing Pavement											
Location	1	2	3	4	5	6	7	8	9	10	11
Description	0.5 Mi. from Hickory St.	1.5 Mi. from Hickory St.	2.5 Mi. from Hickory St.	3.5 Mi. from Hickory St.	4.5 Mi. from Hickory St.	5.5 Mi. from Hickory St.	6.5 Mi. from Hickory St.	7.5 Mi. from Hickory St.	8.5 Mi. from Hickory St.	9.5 Mi. from Hickory St.	10.5 Mi. from Hickory St.
Surface (thickness-in.)	½"	½"	¾"	¾"	½"	¾"		2"	1 ¼"	½"	3"
Base (thickness-in.)	7 ½"	9 ½"	11 ¼"	7 ¼"	16 ½"	13 ¼"		4 ½"	9 ¼"	13 ½"	0"
Existing Subgrade											
PI											
Loc/Depth	1	2	3	4	5	6	7	8	9	10	11
0 - 0.5'	15	2	28	2	22	14	25	2	15	2	23
0.5 - 1.0'	15	2	28	39	22	5	25	1	2	2	23
1.0 - 1.5'	2	2	24	39	22	5	25	1	2	2	3
1.5 - 2.0'	27	21	24	37	32	5	25	1	17	2	3
2.0 - 2.5'	27	21	24	37	8	5	25	1	17	2	3
2.5 - 3.0'	27	21	24	37	8	5	25	1	22	2	2
3.0 - 3.2'	27	21	24	23	8	5	28	15	2	2	2
3.2 - 3.5	27	21	24	23	8	5	28	2	2	2	2
3.5 - 4.0	27	27	24	23	8	5	28	2	2	2	2
4.0 - 4.5'	18	27	24	23	8	5	28	2	2	21	2
4.5 - 5.0'	18	27	24	23	8	5	28	2	2	21	2
5.0 - 5.5'	18	27	26	23	8	2	28	19	2	21	2
5.5 - 6.0'	18	27	26	23	13	2	28	19	2	21	3
6.0 - 6.5'	18	37	26	25	13	2	16	19	2	21	3
6.5 - 7.0'	18	37	26	25	13	2	16	19	2	21	3
7.0 - 7.5'	22	37	26	25	13	2	16	2	2	21	3
7.5 - 8.0'	22	24	26	25	13	2	16	2	2	21	3
8.0 - 8.5'	22	24	26	25	13	2	3	2	2	21	3
8.5 - 9.0'	22	24	26	25	13	2	3	2	2	21	14

Table 3.16 Results of the 2008 soil investigation in FM1644 (Part 2)

Highway:	FM 1644	CSJ:	2337-01-018
County	Robertson	Limits:	Hickory St. in Calvert to Hearne St. in Franklin

Existing Subgrade											
Location	1	2	3	4	5	6	7	8	9	10	11
Description	0.5 Mi. from Hickory St.	1.5 Mi. from Hickory St.	2.5 Mi. from Hickory St.	3.5 Mi. from Hickory St.	4.5 Mi. from Hickory St.	5.5 Mi. from Hickory St.	6.5 Mi. from Hickory St.	7.5 Mi. from Hickory St.	8.5 Mi. from Hickory St.	9.5 Mi. from Hickory St.	10.5 Mi. from Hickory St.
Sulfates (ppm)/ Organics (%)											
Loc/Depth	1	2	3	4	5	6	7	8	9	10	11
0 - 0.5'	0/3.4	0/1.5	0/2.7	0/3.6	0/5.3	0/5.3	160/.6	140	0/0.7	0/0.4	0/0.3
0.5 - 1.0'	0/3.4	0/1.5	0/2.7	0/12.2	0/5.3	0/3.8	160/.6	0/0.6	120	0/0.4	0/0.3
1.0 - 1.5'	0/1.9	0/1.5	0/5.3	0/12.2	0/5.3	0/3.8	160/.6	0/0.6	0/0.5	0/0.4	0/3.0
1.5 - 2.0'	0/5.2	0/4	0/5.3	0/6.5	0/7.2	0/3.8	160/.6	0/0.6	0/0.4	0/0.4	0/3.0
2.0 - 2.5'	0/5.2	0/4	0/5.3	0/6.5	0/2.8	0/3.8	160/.6	0/0.6	0/0.4	0/0.4	0/3.0
2.5 - 3.0'	0/5.2	0/4	0/5.3	0/6.5	0/2.8	0/3.8	160/.6	0/0.6	0/0.6	0/0.4	0/0.4
3.0 - 3.2'	0/5.2	0/4	0/5.3	0	0/2.8	0/3.8	120	240	0	0	0/0.4
3.2 - 3.5	0/5.2	0/4	0/5.3	0	0/2.8	0/3.8	120	0	0	0	0/0.4
3.5 - 4.0	0/5.2	27	0/5.3	0	0/2.8	0/3.8	120	0	0	0	0/0.4
4.0 - 4.5'	0	27	0/5.3	0	0/2.8	0/3.8	120	0	0	220	0/0.4
4.5 - 5.0'	0	27	0/5.3	0	0/2.8	0/3.8	120	0	0	220	0/0.4
5.0 - 5.5'	0	27	260	0	0/2.8	120	120	0	0	220	0/0.4
5.5 - 6.0'	0	27	260	0	0	120	120	0	0	220	100
6.0 - 6.5'	0	0	260	0	0	0	0	0	0	220	100
6.5 - 7.0'	0	0	260	0	0	0	0	0	0	220	100
7.0 - 7.5'	220	0	260	0	0	0	0	0	0	220	100
7.5 - 8.0'	220	0	260	0	0	0	0	0	0	220	100
8.0 - 8.5'	220	0	260	0	0	0	0	0	0	220	100
8.5 - 9.0'	220	0	260	0	0	0	0	0	0	220	0
Notes: If only one value if shown, it refers to the sulfate content											
Combined PVR	0.7	0.8	1.5	1.6	<1"	<1"	1.6	<1"	<1"	<1"	<1"
Geogrid	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Subgrade Stabilizer Type & %	C 4%	C 4%	C 4%	C L 4%	C 4%	C 4%	C 4%	C 4%	C 4%	C 4%	C 4%
Est. Triaxial Class	4	3.8	5.5	5.7	4.9	3.6	5.3	3.9	3.9	3.8	5
Notes: C = Cement, L = Lime; Percent stabilizer is for estimating purposes and further testing should be performed to determine actual rates and types of stabilizer to uses.											

3.7.3 Condition Surveys in FM1644

Visual condition surveys have been performed from the opening of the road to traffic in January 2010. The condition surveys were conducted with the same procedures described in Section 3.4. A total of 11 conditions surveys were performed during the service life of the project. Table 3.17 lists the date of the conditions surveys, from the first one in January 2010 to the last one in December 2012. The last column of this table shows the life of the project in terms of days.

Table 3.17 List of conditions surveys conducted during the life of FM2

No.	Date	Life of the Preject (Days)
SURVEY 1	Jan-10	0
SURVEY 2	Mar-10	61
SURVEY 3	Sep-10	231
SURVEY 4	Dec-10	322
SURVEY 5	Feb-11	393
SURVEY 6	Apr-11	447
SURVEY 7	Jun-11	509
SURVEY 8	Sep-11	613
SURVEY 9	Dec-11	698
SURVEY 10	May-12	834
SURVEY 11	Dec-12	1065

3.7.4 Environmental Data in FM1644

Precipitation and temperature data were collected from nearby stations depicted in Figure 3.50. Station 344208 was used for the precipitation data provided by NWS West Gulf River Forecast Center. Temperature records were collected from NWS data provided for Hearne Municipal Airport station.

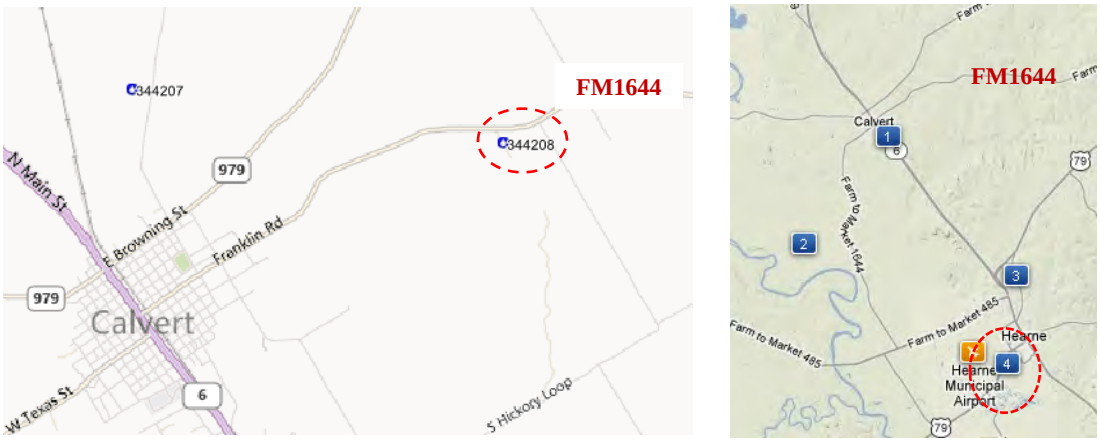


Figure 3.50 Weather stations used for collecting environmental data in FM1644.

Figure 3.51 and Figure 3.52 present the results for precipitation and temperature data from 2010 to the end of 2012. The precipitation data is presented in the form of monthly average and the temperature data is presented in the form of weekly average. Dates of the condition surveys are also depicted in Figure 3.51. Unlike FM2, in which a clear drought could be recognized, FM1644 has experienced several short cycles of dry and wet seasons without a significant drought period. However, comparison between Figure 3.51 and Figure 3.34 reveals that FM1644 test sections are located in a comparatively drier area than the FM2 sections. While the average precipitation during the rainiest seasons in FM1644— November 2011 through March 2012—was less than 4 in. per month, this average for all wet seasons in FM2 was greater than or equal to 4.49 in. per month. On the other hand, during the driest season in FM1644—July

2011 to October 2011—the average precipitation was 0.5 in. per month, whereas this average was never less than 0.86 in. in FM2.

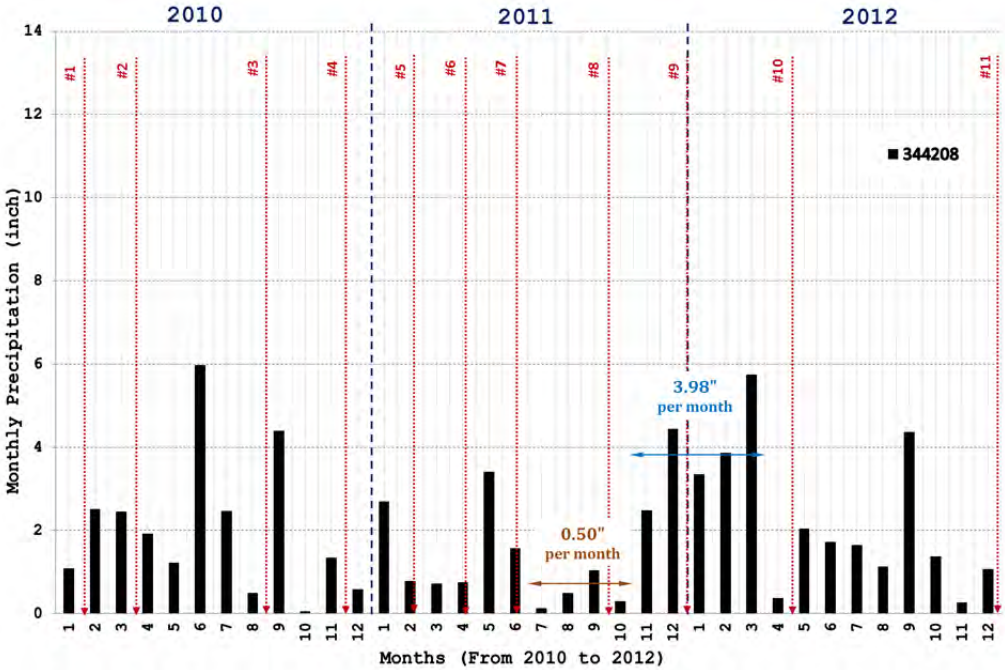


Figure 3.51 Monthly average precipitation data from Station 344208 from 2006 to 2012.

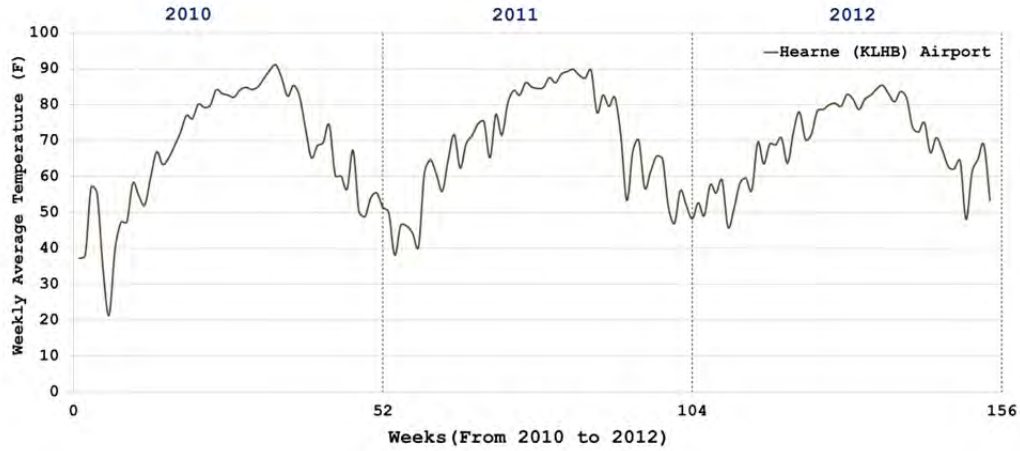


Figure 3.52 Weekly average temperature record from Hearne Municipal Airport station from 2010 to 2012.

3.7.5 Evaluation of the Performance of the Test Sections in FM1644

Since a well-defined drought season was not identified in environmental data collected at the FM1644 site, the performance of the test sections was evaluated for the last three surveys, i.e., Surveys #9, #10, and #11, which were performed in the last year of the service life of the road. As explained in Section 3.6, the performance of the road sections are evaluated in terms of the percentage of longitudinal cracks wider than 3 mm recorded in each section.

Performance of the test sections in Survey #11, which was performed in December 2012, is displayed in Figure 3.53. The horizontal axis in this graph is the section numbers and the vertical axis is the percentage of longitudinal cracking. The last bar in each group is the average of the percentage cracking in that group. Test sections are classified in three groups:

- CT (East) sections are cement-treated sections located on the east side (Sections #3 and #6 in Figure 3.47)
- GGPP3+CT sections are Geosynthetic-Reinforced Cement Treated sections located in the middle (Sections #2 and #5 in Figure 3.47)
- CT (West) sections are cement-treated sections located on the West side (Sections #1 and #4 in Figure 3.47)

The results presented in Figure 3.53 indicate that the geogrid reinforced sections are performing better than both east side and west side sections. This figure also shows a clear difference between the performances of the cement-treated east side sections and the cement-treated west side sections. This difference might be due to different subsurface soil properties or non-adequate construction practices for one of these sides.

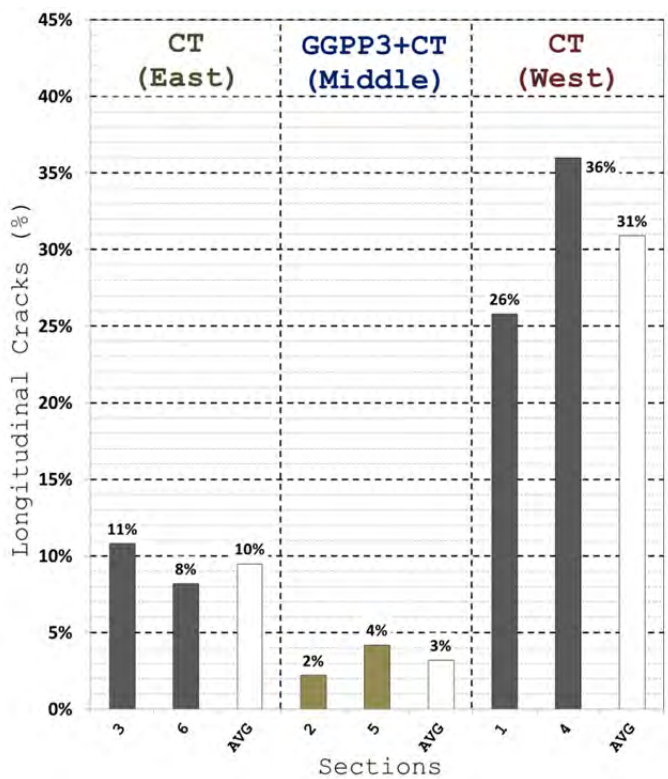
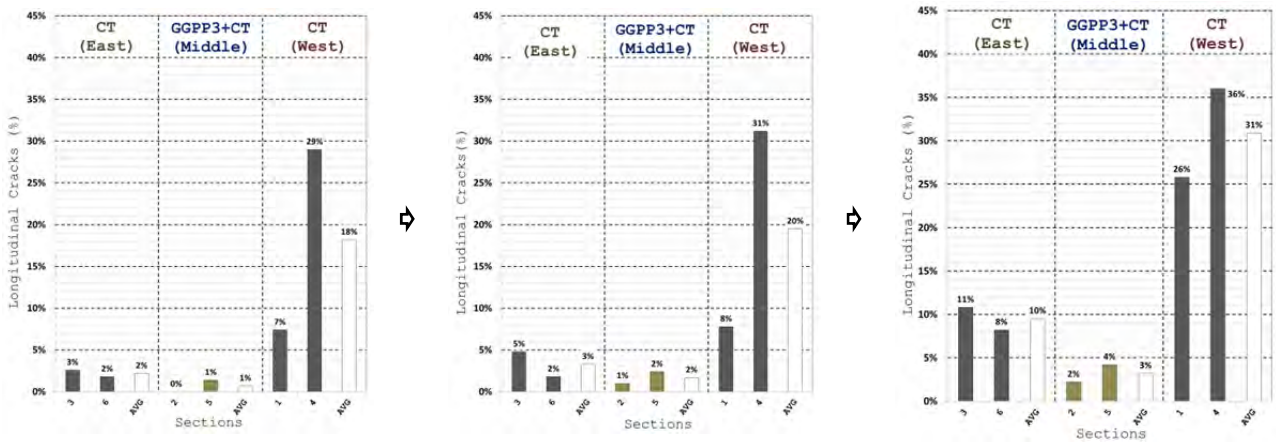


Figure 3.53 Performance of the FM1644 test sections in Survey #11.

Figure 3.54 and Figure 3.55 compare the performance of the sections over time between Surveys #09 and #11. As seen in these figures, GGPP3+CT sections continuously perform better than both east side and west side CT sections. In Figure 3.55, the rate of cracking can be compared between different sections. Evaluation of the data presented in this figure indicates that

the rate of cracking between Survey #9 and Survey #10 was very slow in all sections. However, between Survey #10 and Survey #11, both CT east and CT west sections show a higher rate of cracking than GGPP3+CT sections. This can be explained by referring to the environmental data collected between these surveys in Figure 3.51. The test sections experienced a relatively wet season between Survey #9 and Survey #10, but a relatively dry season between Survey #10 and Survey #11. Therefore, it is expected that the rate of cracking is accelerated after Survey #10. It can be concluded that the geosynthetic-reinforced sections show benefits in mitigation of cracking percentage even before and especially during this relatively dry season.



Survey #9 ***Survey #10*** ***Survey#11***

Figure 3.54 Comparison of the performance of the FM1644 test sections over time.

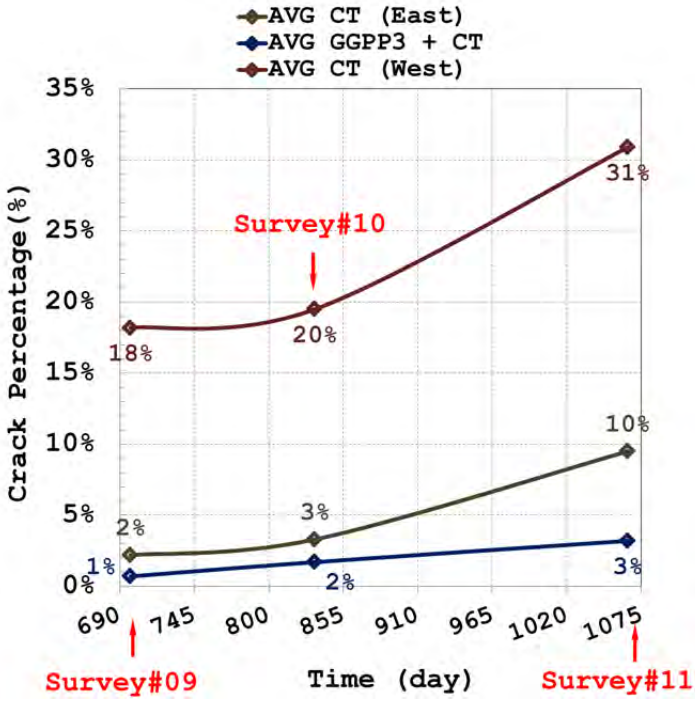


Figure 3.55 Average performance of the FM1644 test sections over time.

3.8 Summary of Findings from the Field Monitoring Component

In this chapter the performance of the experimental test sections constructed in FM2 and FM1644 were monitored at different time intervals during their service life. The performance of the test sections was evaluated using the results of the visual conditions surveys. Specifically, the percentages of longitudinal cracks recorded in the surveys are used to compare the performance of the sections.

Inspection of environmental data collected from the opening of the test sections to traffic showed that FM2 has experienced a major drought between October 2010 and December 2011. The performance of the experimental test sections in FM2 was evaluated based on the accumulated results collected from condition Surveys #14 to #18, which were conducted at the beginning and the end of the drought season, respectively. These results show that on average all geosynthetic-reinforced section groups perform significantly better than the control sections and the subbase lime-treated sections. Addition of lime to the subbase of the test sections did not show an enhancement in the performance of the sections. In one of the geosynthetic-reinforced section groups, the addition of lime results in a slight increase in the percentage of cracking, whereas in the other geosynthetic-reinforced section groups the average cracking percentage increases significantly when lime is added.

Weather data collected for FM1644 does not identify a well-defined drought season. This data suggests that the FM1644 test sections have experienced comparatively drier weather than the FM2 test sections. The performance of the FM1644 experimental sections was evaluated during the last year of their life. This evaluation shows that the geosynthetic-reinforced sections in this road perform continuously better than the non-reinforced sections.

Chapter 4. Conclusions

The laboratory component of this project included the refinement of a testing procedure involving modified small pullout tests, including adopting a standard soil. This approach resulted in a consistent basis for characterization and comparison of the soil-geosynthetic interface stiffness using the stiffness parameter K_{SGI}. Eleven different geosynthetic products were tested, oriented in both roll directions: cross-machine direction (CD) and machine direction (MD).

After evaluation of five different types of soils, a uniform sieved aggregate (Sieved Aggregate 2), with particle sizes finer than the 1/4 in. sieve and retained on the #4 sieve, was selected as the standard soil for testing in the small pullout test. Procedures were developed for smoothing the data and analyzing the results. An extensive testing program was conducted, with special focus on geosynthetics oriented on the CD. Replicate tests on the CD were conducted until achieving an estimated error equal to or less than ± 20% of the mean K_{SGI} value of the corresponding geosynthetic.

The results of the small pullout tests evaluated with the K_{SGI} parameter in the CD allowed classifying the geosynthetic products in 5 different groups based on a qualitative evaluation of their performance. The results of the tests with the geosynthetic oriented on the MD were significantly different from the results obtained with the geosynthetic oriented on the CD. No correlations were found between K_{SGI} values and unconfined tensile stiffness of the geosynthetic products, or between K_{SGI} and the ratio of geogrid aperture sizes with D_{50} of the soil.

The field monitoring component of this implementation project involved continued monitoring of experimental sections constructed in FM2 and FM1644. In FM2, 32 sections were constructed with combinations of base reinforcement with 3 different geosynthetic reinforcements and subbase lime treatment. For comparison purposes, six of the sections were constructed without any geosynthetic reinforcement or lime treatment. In FM1644, six experimental test sections were defined: two sections reinforced with a geosynthetic product different from those used in FM2, and four sections without geosynthetic reinforcements. The subbase layers of all experimental sections in FM1644 were treated with cement. The geosynthetic products used in FM2 and FM1644 were chosen from the products tested in the experimental testing program in the small pullout test.

The performance of these experimental test sections was evaluated using the results of continued condition surveys, subsurface exploration, and weather data collection. It was found that, on average, all three different geosynthetic-reinforced section groups in FM2 perform significantly better than the control sections and the subbase lime-treated sections. The average percentage crack for these three geosynthetic-reinforced groups was between 17 to 21%, whereas the average percentage crack for the control sections and the subbase lime-treated sections was almost 65%. Stabilization of the subbase with lime did not show an enhancement in the performance of the geosynthetic-reinforced test sections. In one of the geosynthetic-reinforced section groups, the addition of lime to the subbase did not significantly change the average percentage of cracking. In the other two groups, the use of lime treatment in the sub-base considerably increased the average percentage cracking. It should also be noted that some of the test sections that showed poor performance involved at least partly sandy subgrades.

The geosynthetic-reinforced sections in FM1644 were found to perform significantly better than the control sections. The control sections in FM1644 involved sub-base cement-treated sections, and were found to perform somewhat differently on the east-bound and west-bound sides of the road. While the average percentage crack for the geosynthetic-reinforced

sections was 3%, the average percentage crack for the west side and the east side sections were 31% and 10%, respectively.

The results of the field performance were found to be reasonably consistent with the experimental testing program using the small pullout device. While the small pullout tests suggested very similar K_{SGI} values for GGPP, GGPET, and GT, field evaluation results in FM2 also showed a very comparable performance for the test sections reinforced with these geosynthetic products. The average K_{SGI} value for GGPP, GGPET, and GT products was found to be 12.3, 12.4, and 11.7 $(kN/m)^2/mm$, respectively, and the average percentage crack for the test sections constructed with these products was quantified as 20%, 17%, and 21%, respectively. On the other hand, the average K_{SGI} value for the geosynthetic product used in FM1644, i.e., GGPP3, was found to be 34.9 $(kN/m)^2/mm$ and the average percentage cracking for the test sections reinforced with this product was 3%. It should be noted, however, that there is a significant difference between the service life, environmental conditions, and subsurface soil properties of the test sections in FM1644 and the test sections in FM2. Consequently, the main basis for the field comparisons should be between the reinforced sections and the control sections of the same road. Overall, the performance of the various geosynthetic products used to reinforce the unbound base in these two pavement projects was significantly better than that of control, unreinforced sections.

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Appendix A: Results of the Small Pullout Tests

The results of the testing matrix with small pullout tests are presented in this appendix in the format of laboratory reports (found on the accompanying CD-ROM).

1. The results with the final configuration of the small pullout tests (Sieved Aggregate 2 and geosynthetic products on the CD) are presented in Appendix A1.
2. The results with the final configuration of the small pullout tests with geosynthetics on the MD are presented in Appendix A2.
3. Appendix A3 reports the results of the tests with Sieved Aggregate 2 and Monterey Sand used to evaluate the influence on the results of the grip's clamping rod and the torque wrench.
4. The results of different products tested with Monterey Sand with confining pressures of 3 and 5 psi (21 and 35 kPa) are presented in Appendix A4.
5. Appendix A5 shows the results of the tests with reloaded specimens with Sieved Aggregate 2.
6. The results of the tests with Sieved Aggregate 2 without the use of a torque wrench are reported in Appendix A6.
7. Appendix A7 presents the results of the tests with GG PP3 CD in which LVDTs 2, 3, and 4 were attached to the geogrid specimen with epoxy on longitudinal ribs (instead of tightened around junctions).
8. The results of the tests with Soil Blend are reported in Appendix A8.
9. The results of the tests with Sieved Aggregate 1 are presented in Appendix A9.
10. Finally, the results of the tests with Aggregate (the first gravel-size material used) are shown in Appendix A10.

The laboratory report for each small pullout test is summarized in two pages. The first page presents general test specifications. These specifications include geosynthetic type, dimensions of geosynthetic specimen and box, soil specifications, and position of the wires for the LVDTs along the geosynthetic in relation to the distance from the front wall of the box.

The second page of the laboratory report presents two graphs. The first graph shows the pullout curves of the test, i.e., front pullout force versus displacement of the five LVDTs. The data in this graph are the input for the calculation of the K_{SGI} of the test. The second graph demonstrates the relationship between *the square of the calculated unit tension from the K_{SGI} model at the location of LVDTs 2, 3, and 4* (F^2) versus *displacements recorded at these locations (w)* in the range of 0.004 to 0.04 in (0.1 to 1 mm).

Appendix A1

This appendix presents the results of the small pullout tests for geosynthetic specimens tested on the Cross Machine Direction (CD) with the final configuration of the test: confining pressure of 3 psi (21 kPa), Sieved Aggregate 2, use of torque wrench and digital air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	3/6/2012 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	33.3	1.311
2	72.6	2.858
3	112.6	4.433
4	153.0	6.024
5	234.7	9.240

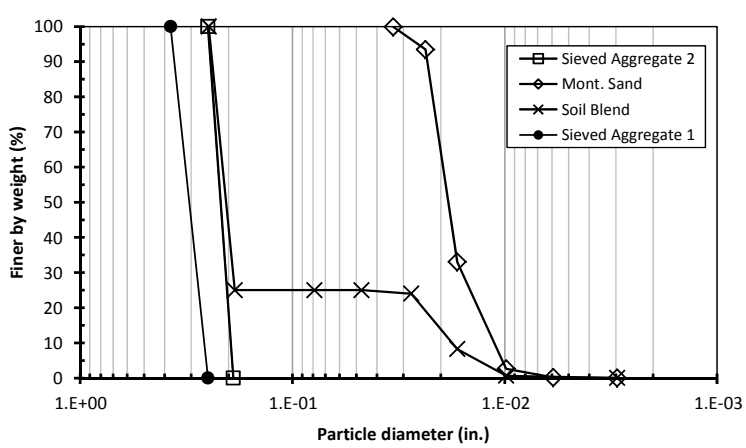
Pullout Rate	
1.0 mm/min.	0.04 in/min

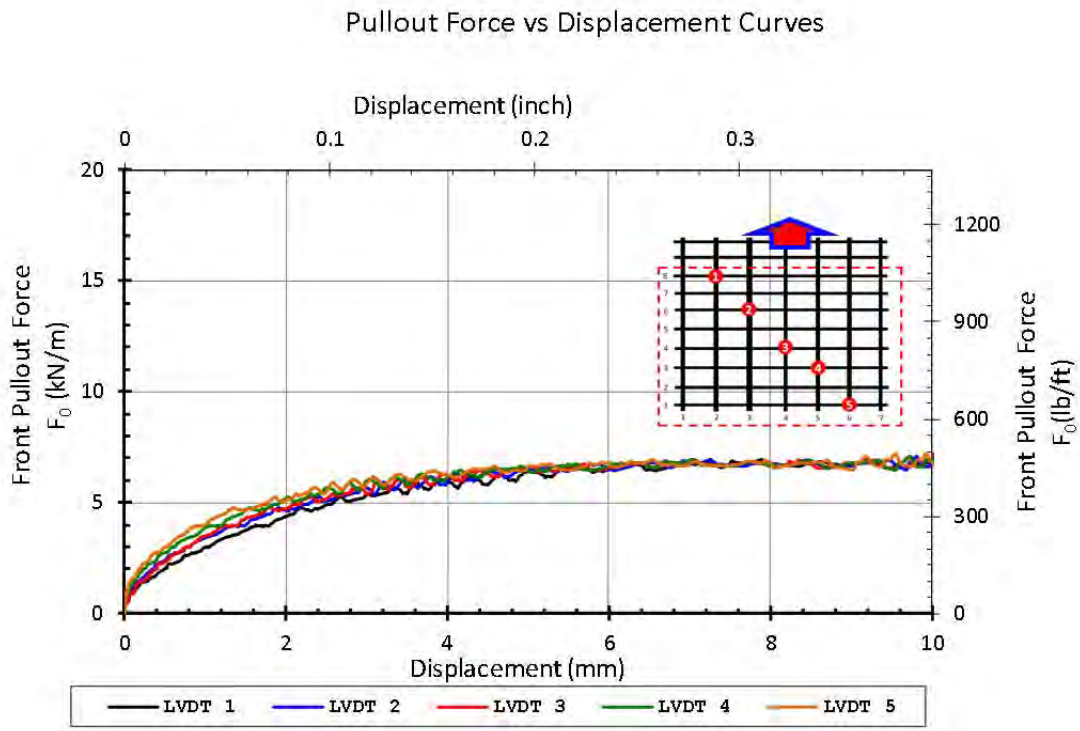
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

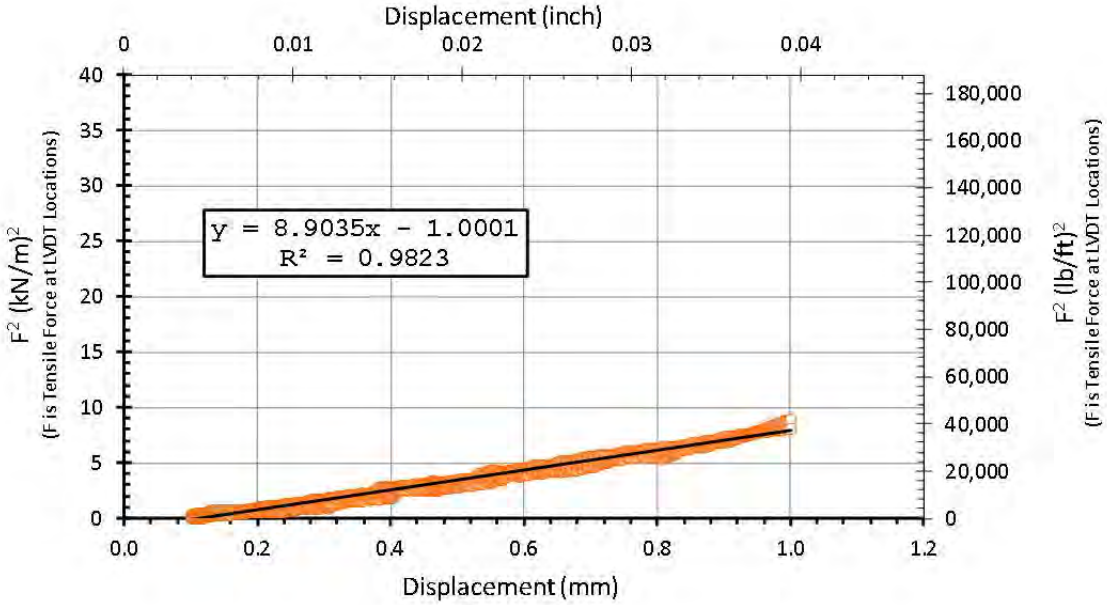
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.3	kN/m	498	lb/ft
Max Pullout Load	P_{max}	2.00	kN	480	lb
Max Shear Stress	τ_{max}	26.9	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
8.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:
slight tilt to the left.

SMALL PULLOUT TEST

Date test conducted	3/6/2012 PM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.275	m	0.245	m
	10	0.902	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	29.8	1.175
2	70.4	2.770
3	110.7	4.357
4	150.9	5.942
5	231.8	9.124

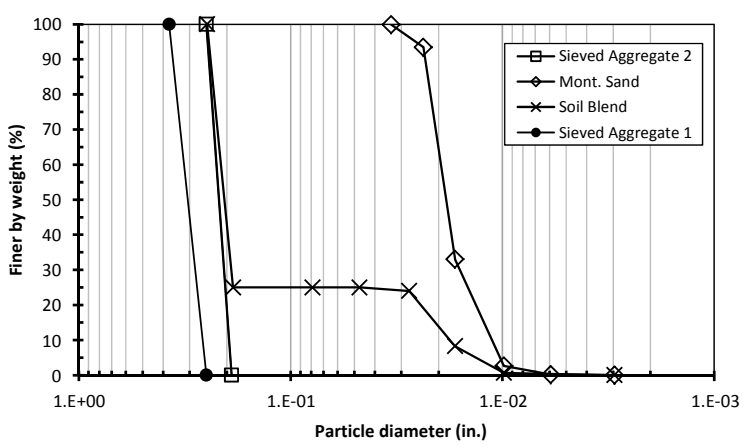
Pullout Rate	
1.0 mm/min.	0.04 in/min

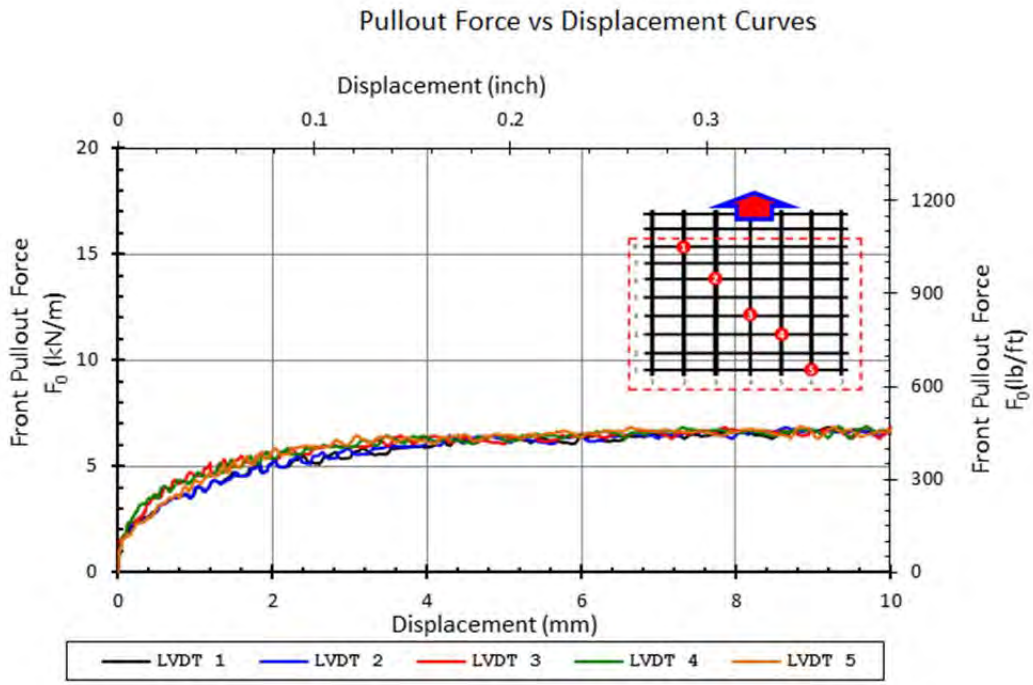
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.538 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

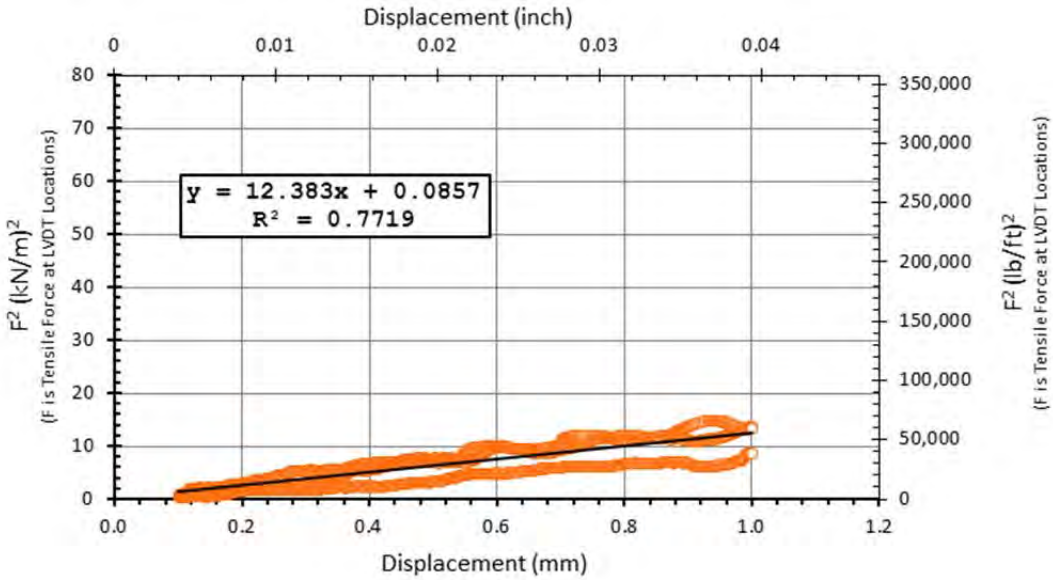
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	471	lb/ft
Max Pullout Load	P_{max}	1.89	kN	456	lb
Max Shear Stress	τ_{max}	25.4	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
12.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/7/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	31.1	1.226
2	71.0	2.795
3	110.9	4.367
4	151.7	5.971
5	231.2	9.103

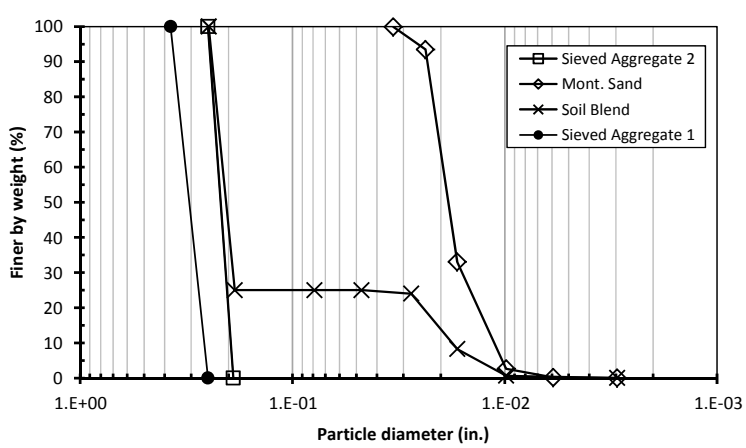
Pullout Rate	
1.0 mm/min.	0.04 in/min

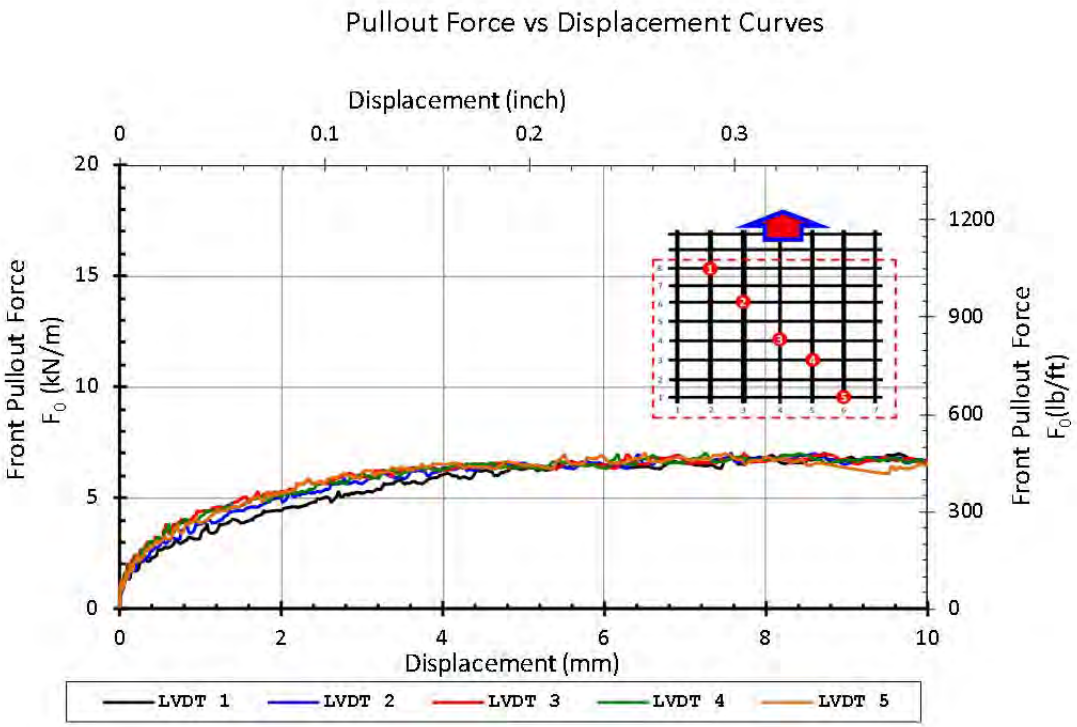
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

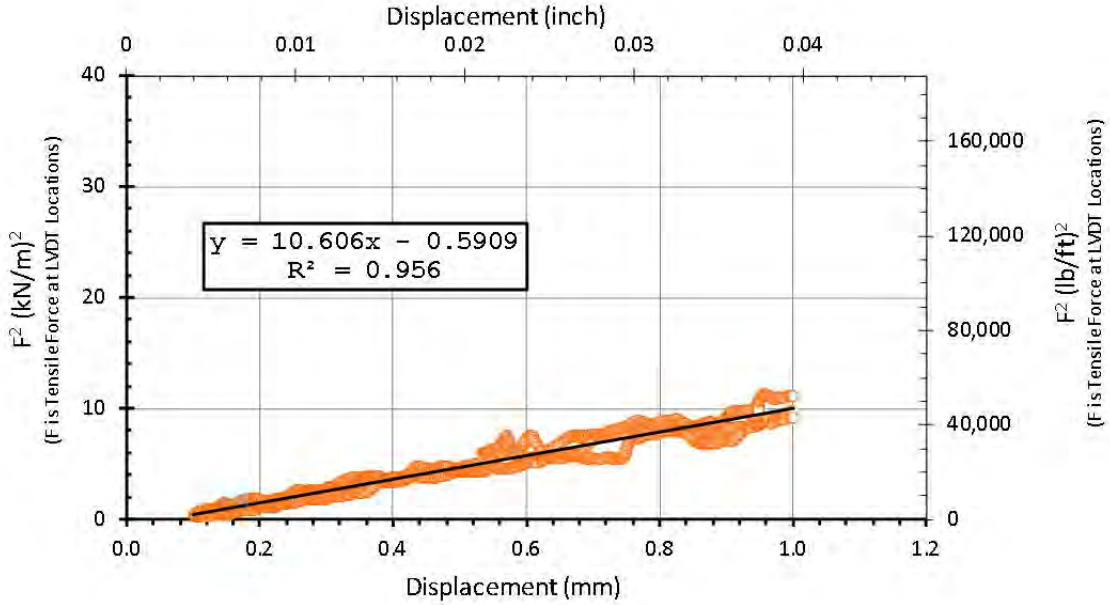
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	481	lb/ft
Max Pullout Load	P_{max}	1.93	kN	458	lb
Max Shear Stress	τ_{max}	25.9	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 1 slightly to the left.

SMALL PULLOUT TEST

Date test conducted	4/10/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	10	0.915	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	36.0	1.419
2	76.3	3.003
3	116.5	4.587
4	156.3	6.154
5	236.8	9.322

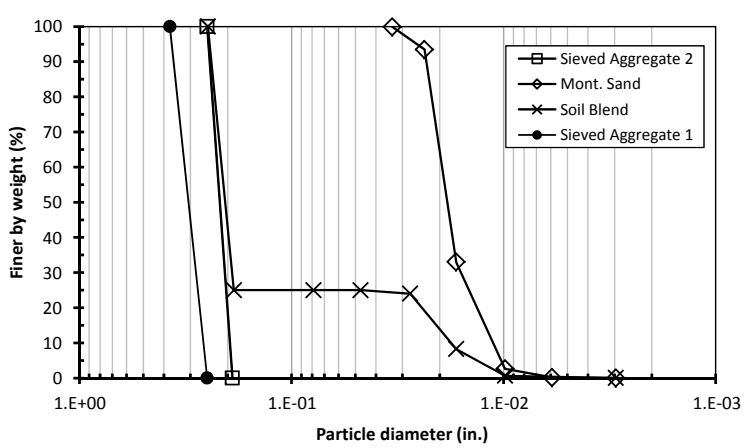
Pullout Rate	
1.0 mm/min.	0.04 in/min

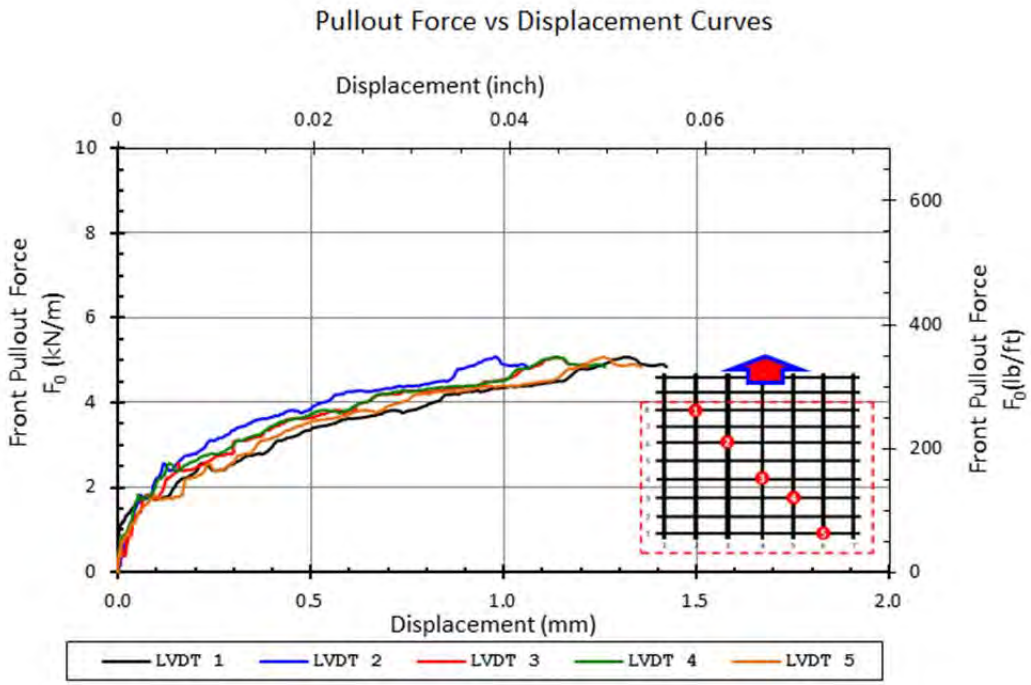
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

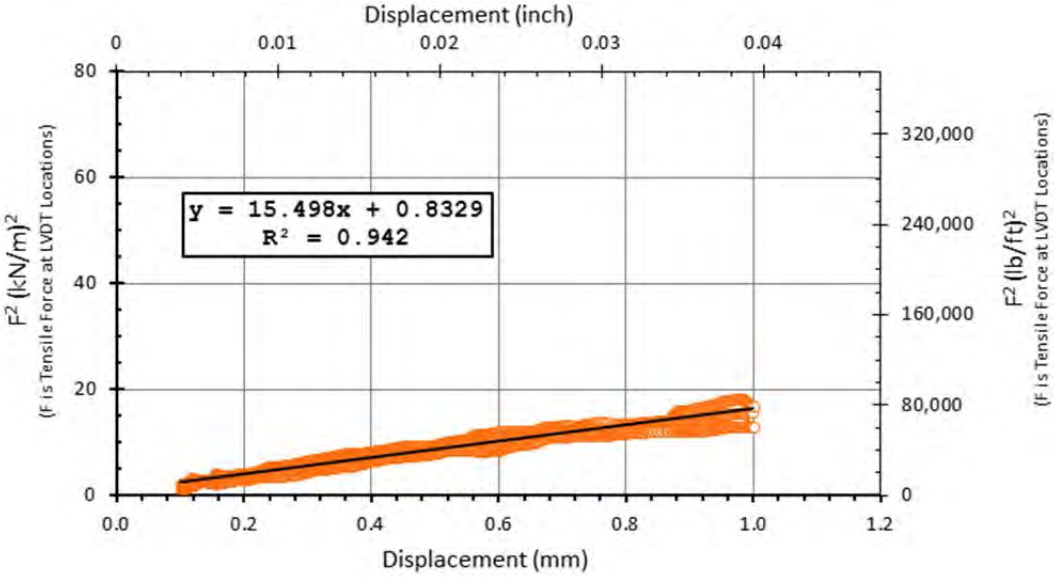
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
15.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/11/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.7	0.894
2	62.1	2.446
3	102.6	4.041
4	142.5	5.610
5	223.0	8.778

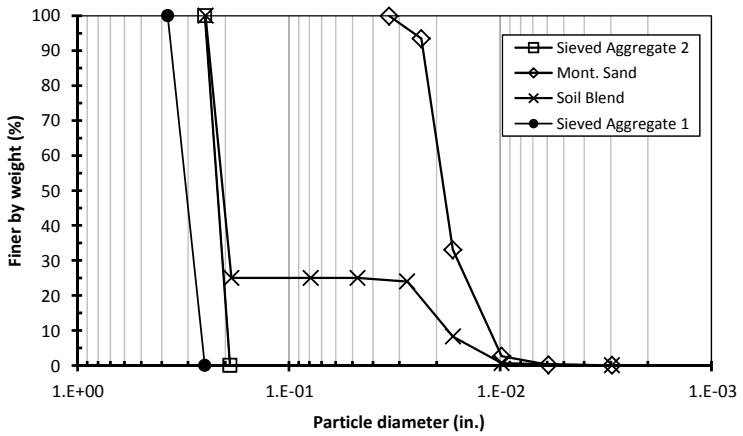
Pullout Rate	
1.0 mm/min.	0.04 in/min

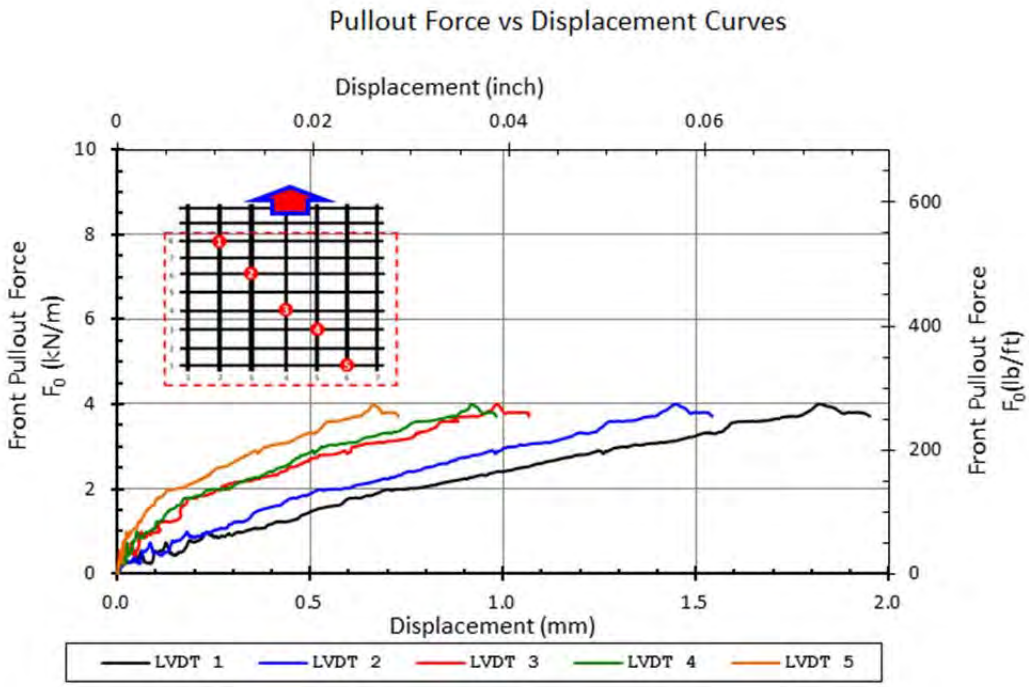
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.524 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

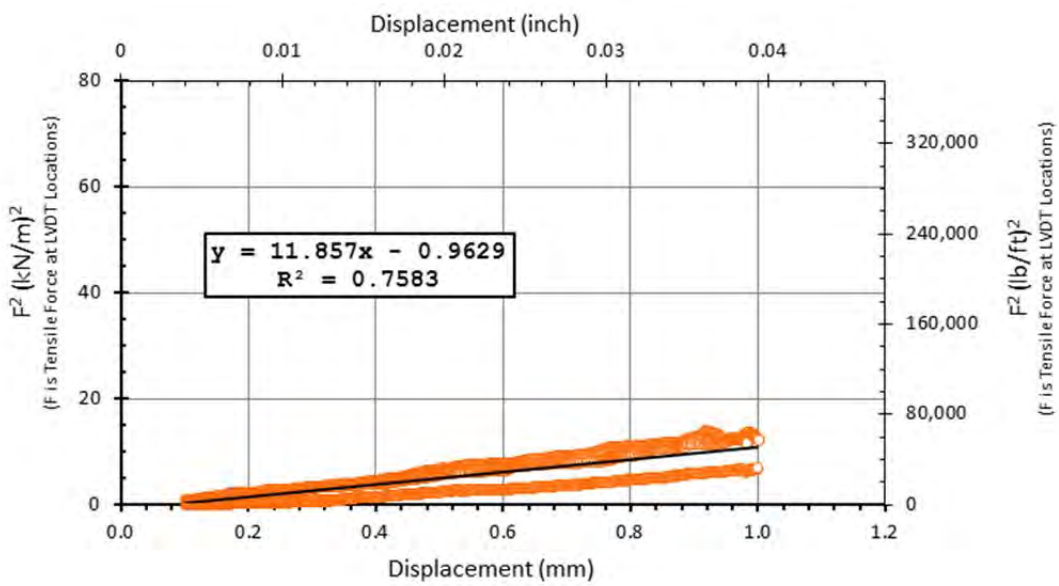
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
11.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test conducted up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	8/7/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.4	0.880
2	63.0	2.479
3	103.2	4.062
4	144.2	5.678
5	225.6	8.881

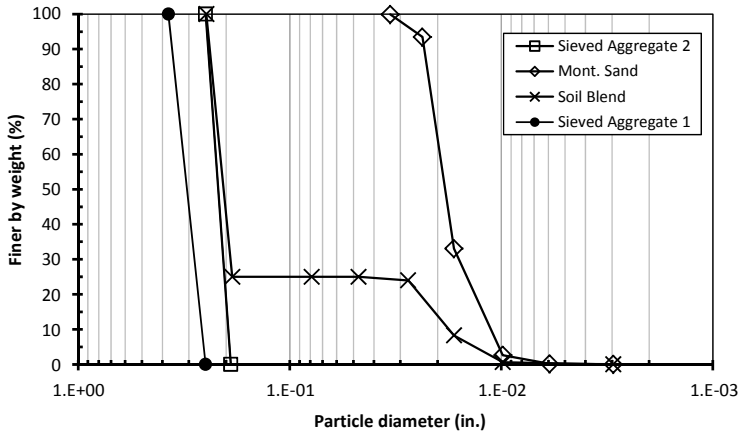
Pullout Rate	
1.0 mm/min.	0.04 in/min

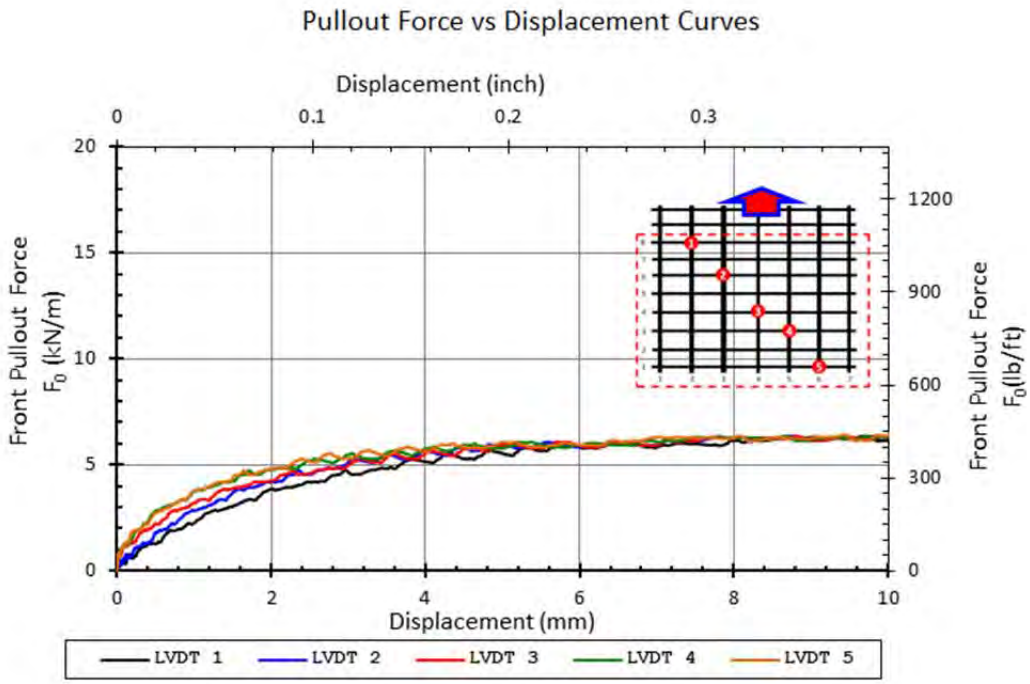
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

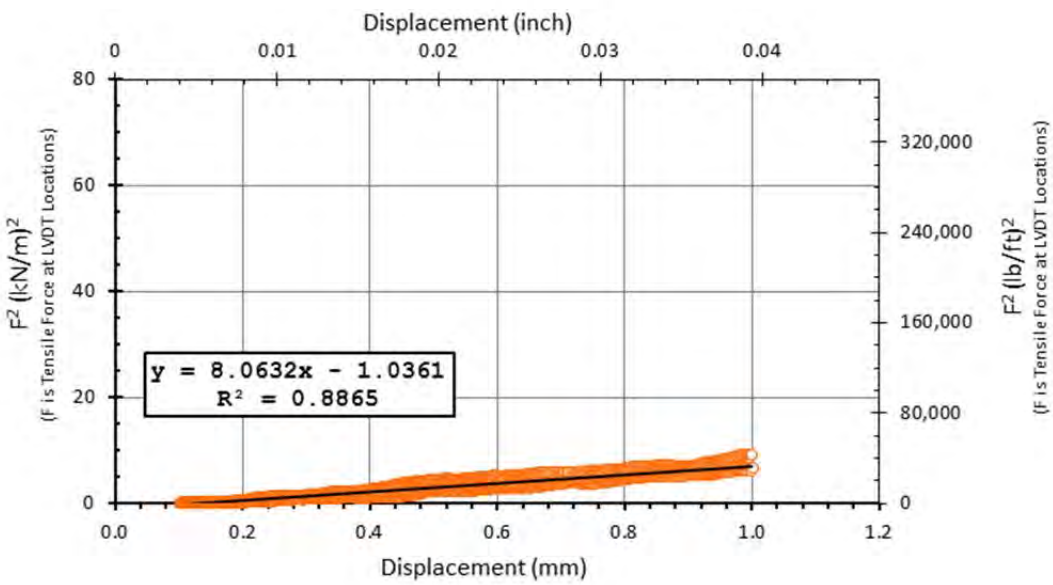
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.5	kN/m	447	lb/ft
Max Pullout Load	P_{max}	1.79	kN	426	lb
Max Shear Stress	τ_{max}	24.1	kPa	3.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
8.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/9/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.275	m	0.245	m
	10	0.925	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.6	0.850
2	62.7	2.468
3	103.3	4.067
4	143.6	5.652
5	225.3	8.870

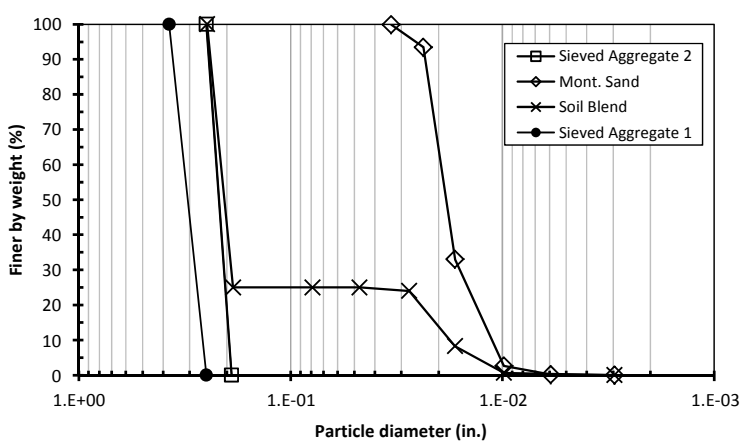
Pullout Rate	
1.0 mm/min.	0.04 in/min

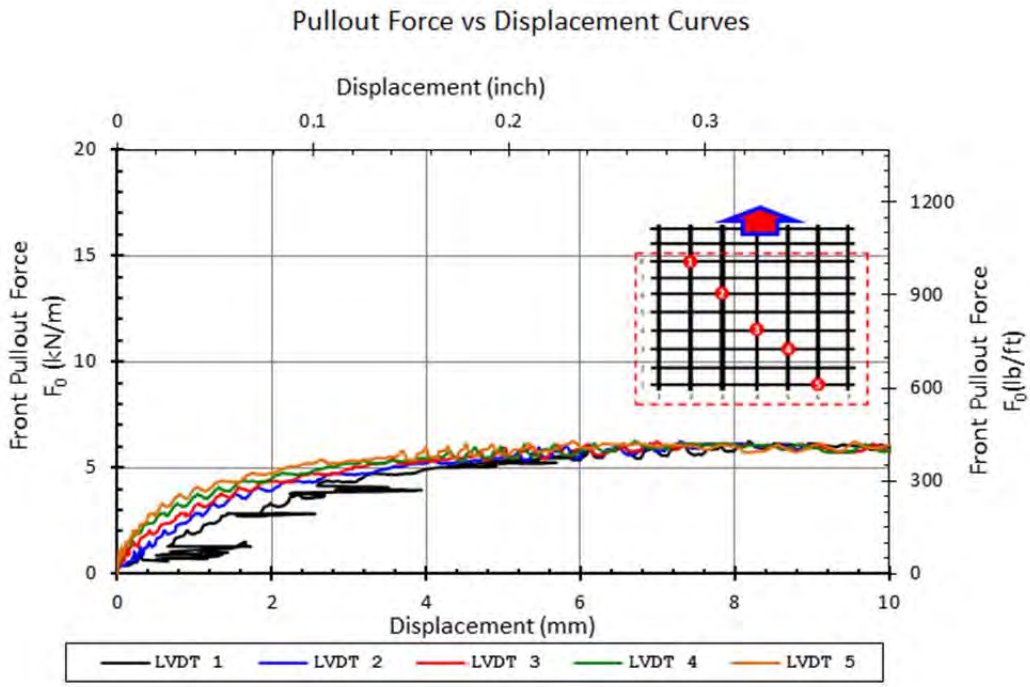
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

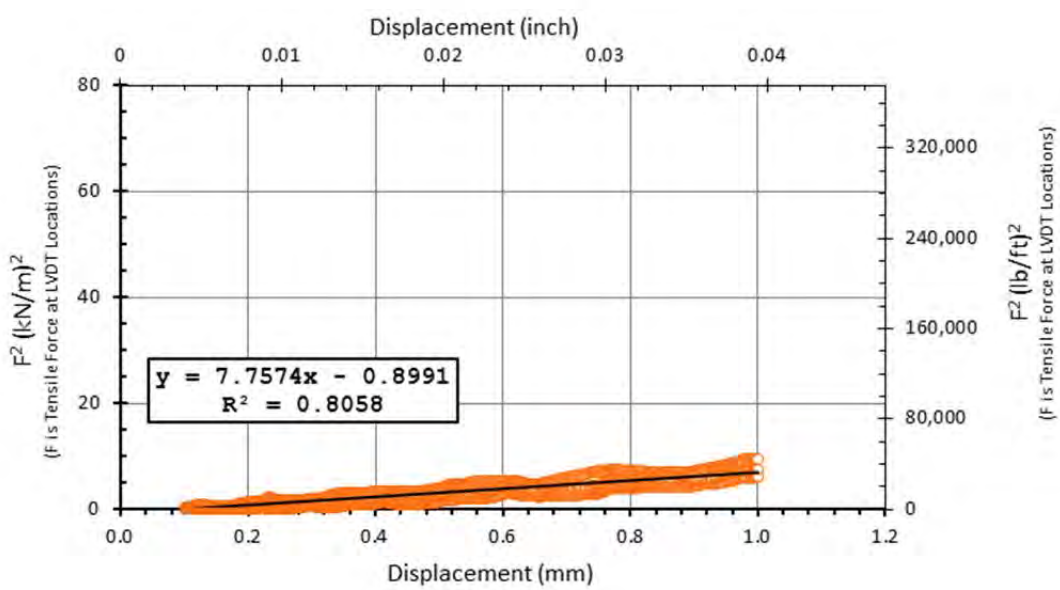
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	428	lb/ft
Max Pullout Load	P_{max}	1.72	kN	418	lb
Max Shear Stress	τ_{max}	23.1	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
7.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Problems with LVDT 1

SMALL PULLOUT TEST

Date test conducted	8/11/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.3	0.877
2	62.8	2.473
3	103.6	4.077
4	144.7	5.697
5	225.4	8.873

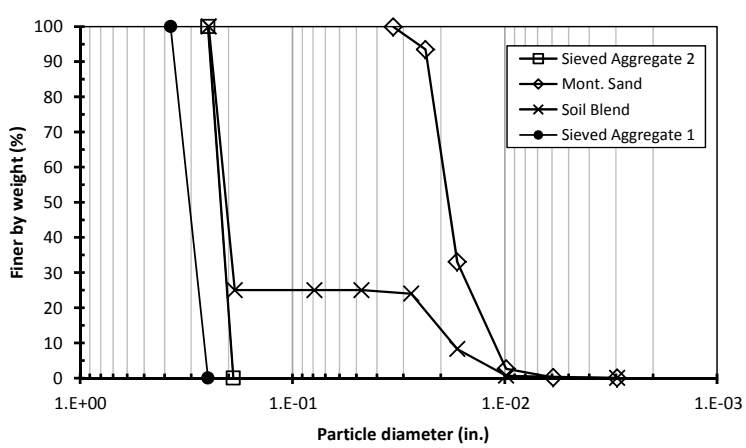
Pullout Rate	
1.0 mm/min.	0.04 in/min

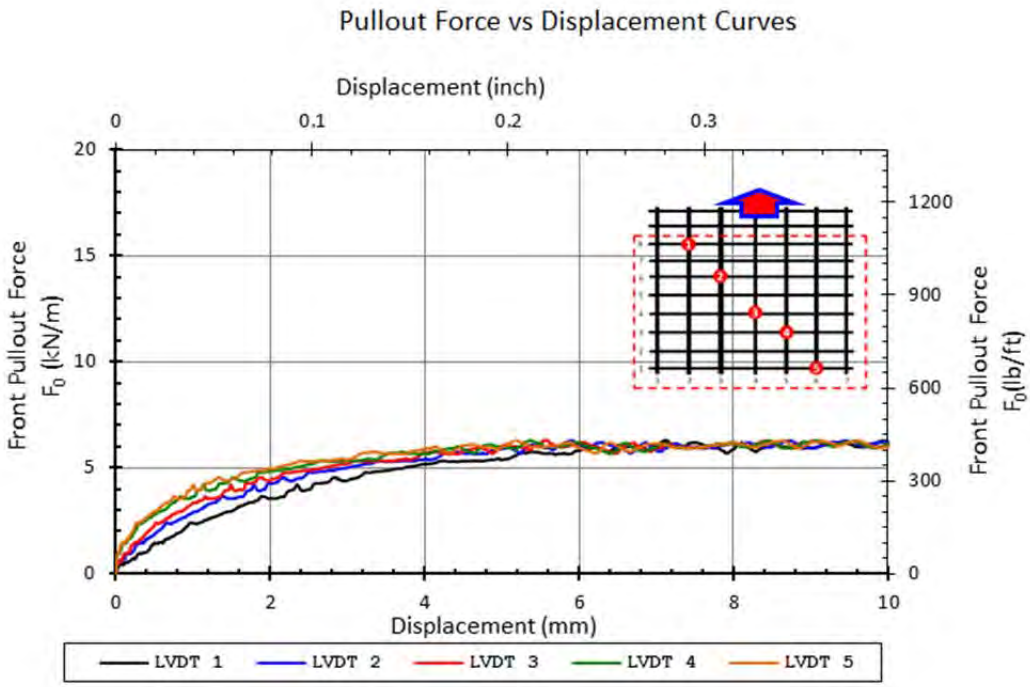
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

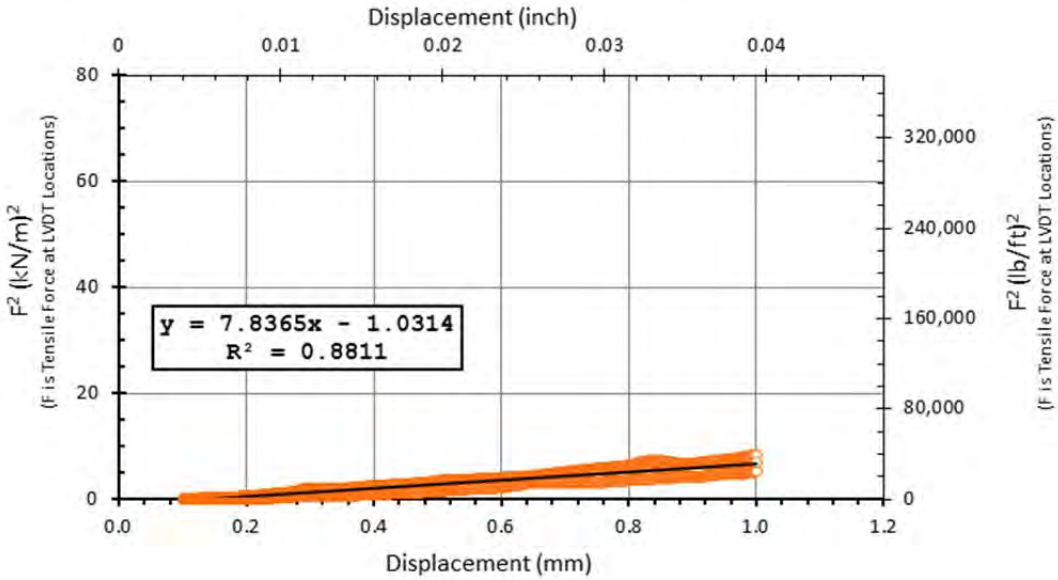
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	432	lb/ft
Max Pullout Load	P_{max}	1.73	kN	415	lb
Max Shear Stress	τ_{max}	23.3	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
7.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/13/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.8	0.896
2	63.5	2.500
3	104.5	4.114
4	145.0	5.710
5	225.2	8.867

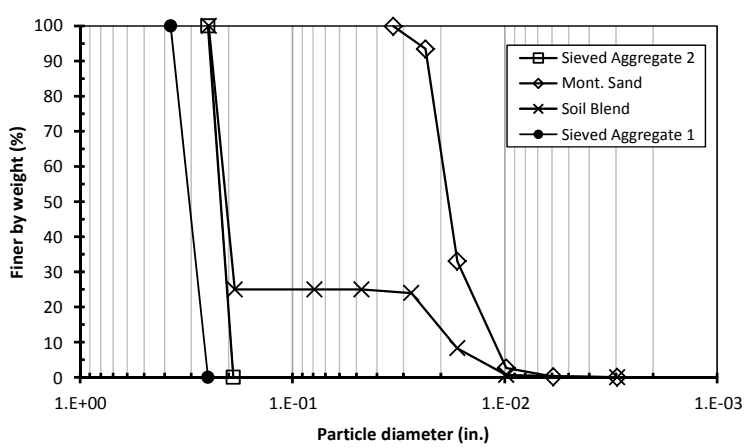
Pullout Rate	
1.0 mm/min.	0.04 in/min

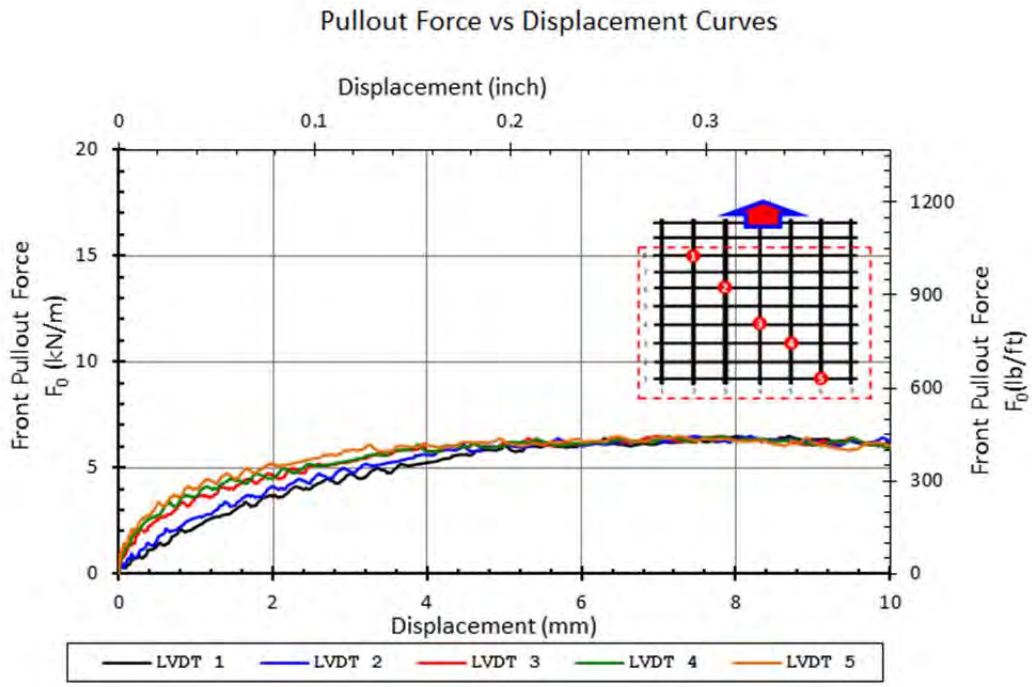
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

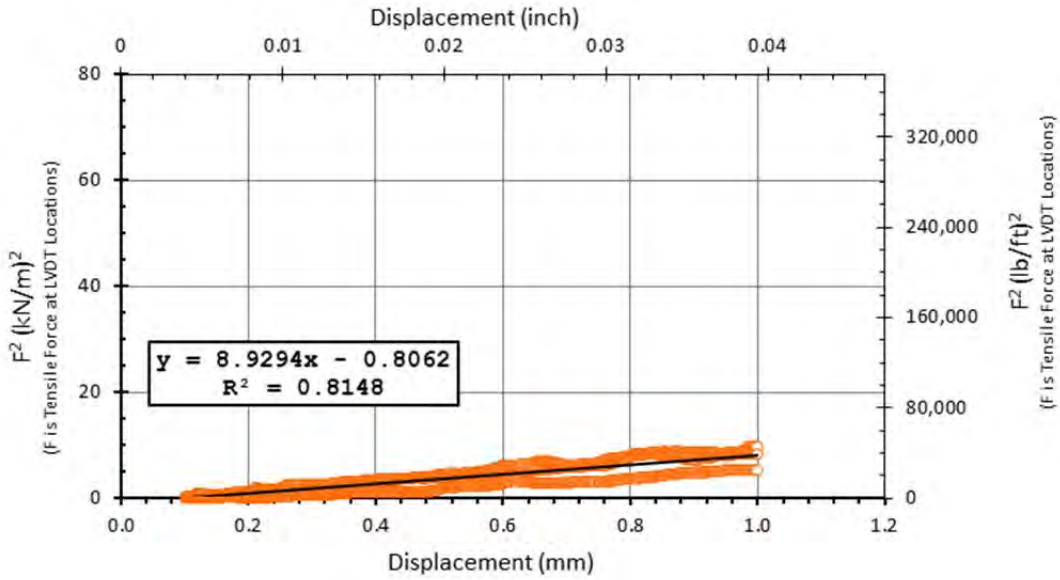
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.5	kN/m	445	lb/ft
Max Pullout Load	P_{max}	1.79	kN	430	lb
Max Shear Stress	τ_{max}	24.0	kPa	3.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
8.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 1 slightly off to the left

SMALL PULLOUT TEST

Date test conducted	12/6/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.291	m	0.275	m	0.245	m
	10	0.955	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	25.2	0.993
2	67.3	2.650
3	108.4	4.269
4	150.1	5.910
5	231.5	9.115

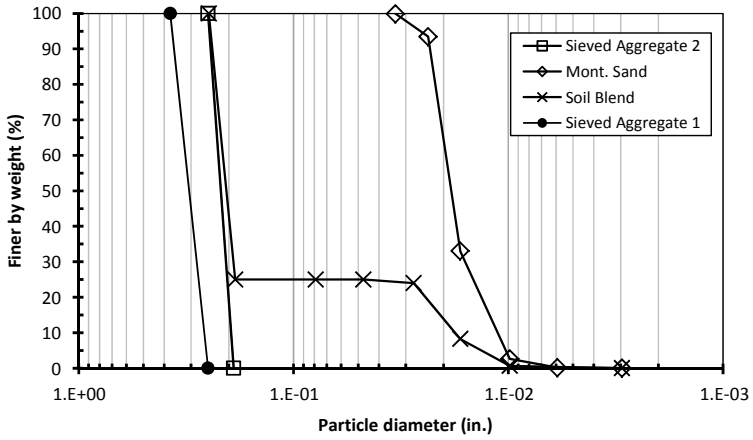
Pullout Rate	
1.0 mm/min.	0.04 in/min

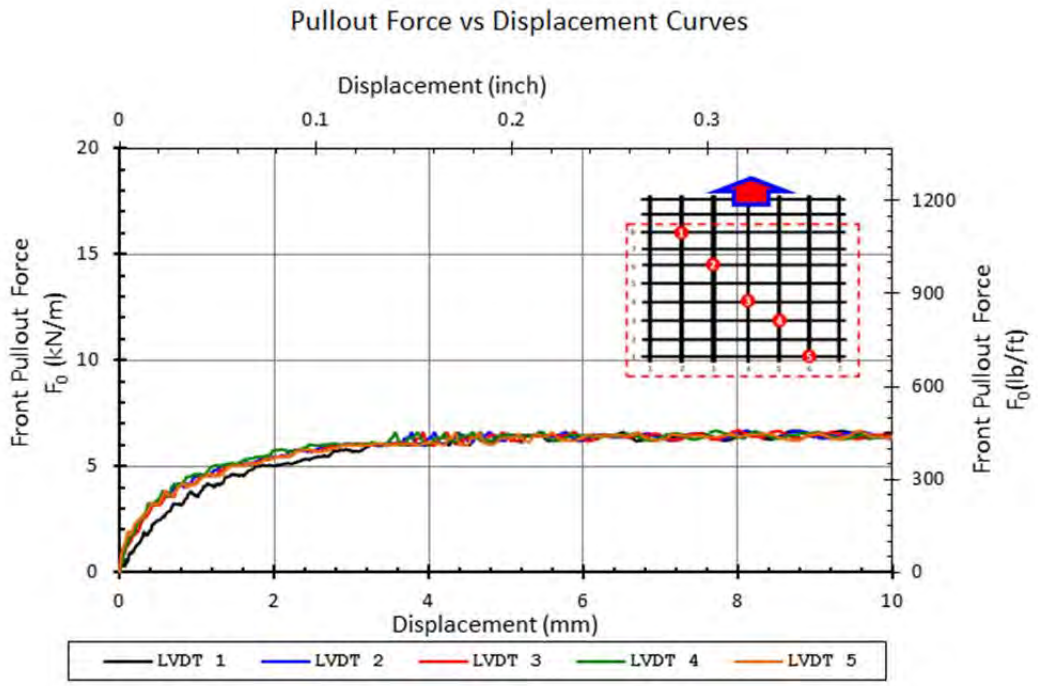
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

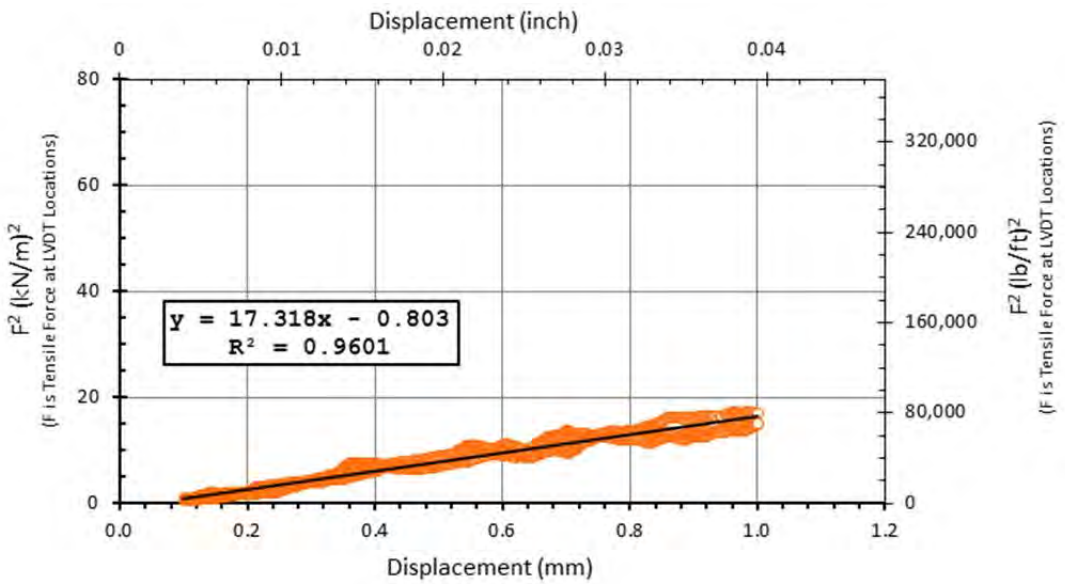
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.7	kN/m	461	lb/ft
Max Pullout Load	P_{max}	1.85	kN	448	lb
Max Shear Stress	τ_{max}	24.9	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
17.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/10/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.248	m	0.245	m
	9	0.919	ft	0.812	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	25.8	1.017
2	67.0	2.637
3	108.7	4.280
4	150.2	5.913
5	231.9	9.131

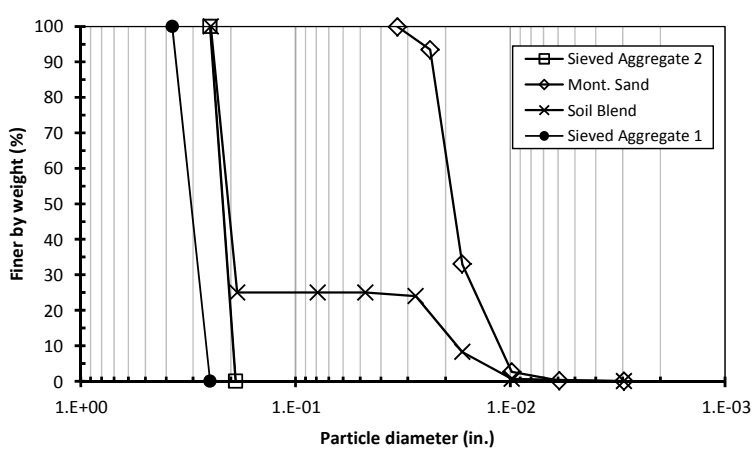
Pullout Rate	
1.0 mm/min.	0.04 in/min

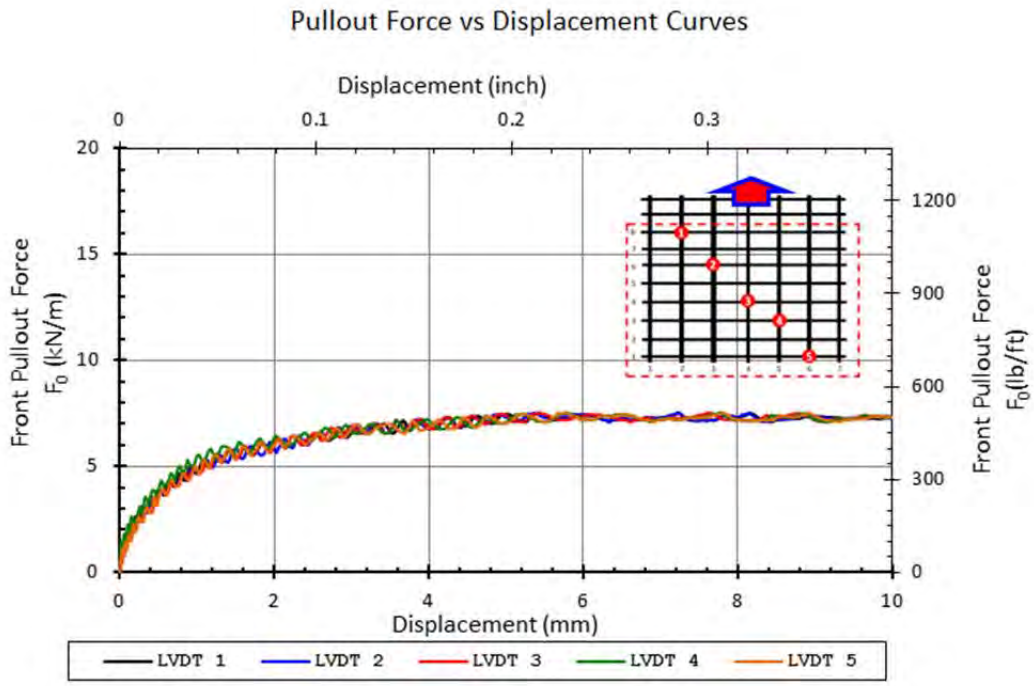
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

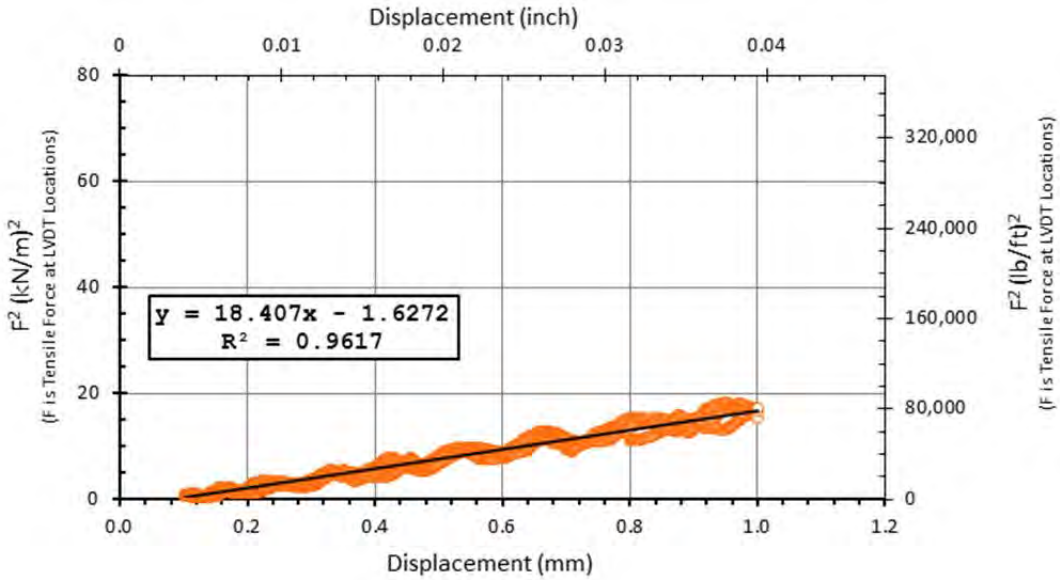
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	516	lb/ft
Max Pullout Load	P_{max}	1.86	kN	443	lb
Max Shear Stress	τ_{max}	25.1	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
18.4	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/11/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.248	m	0.245	m
	9	0.919	ft	0.812	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	25.2	0.993
2	66.7	2.627
3	108.5	4.270
4	149.9	5.903
5	231.8	9.125

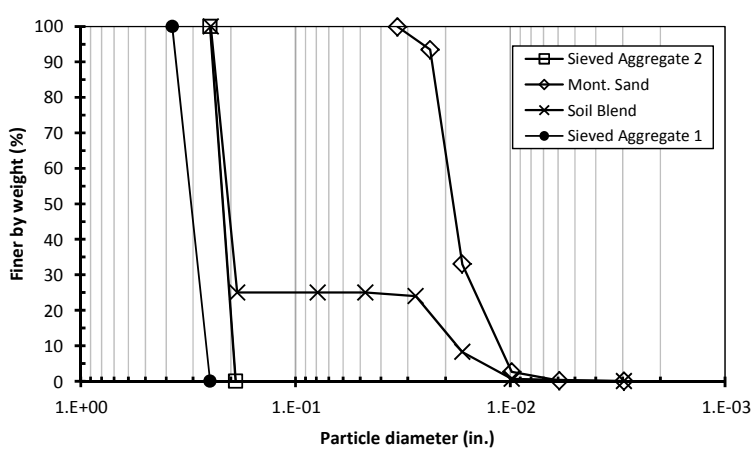
Pullout Rate	
1.0 mm/min.	0.04 in/min

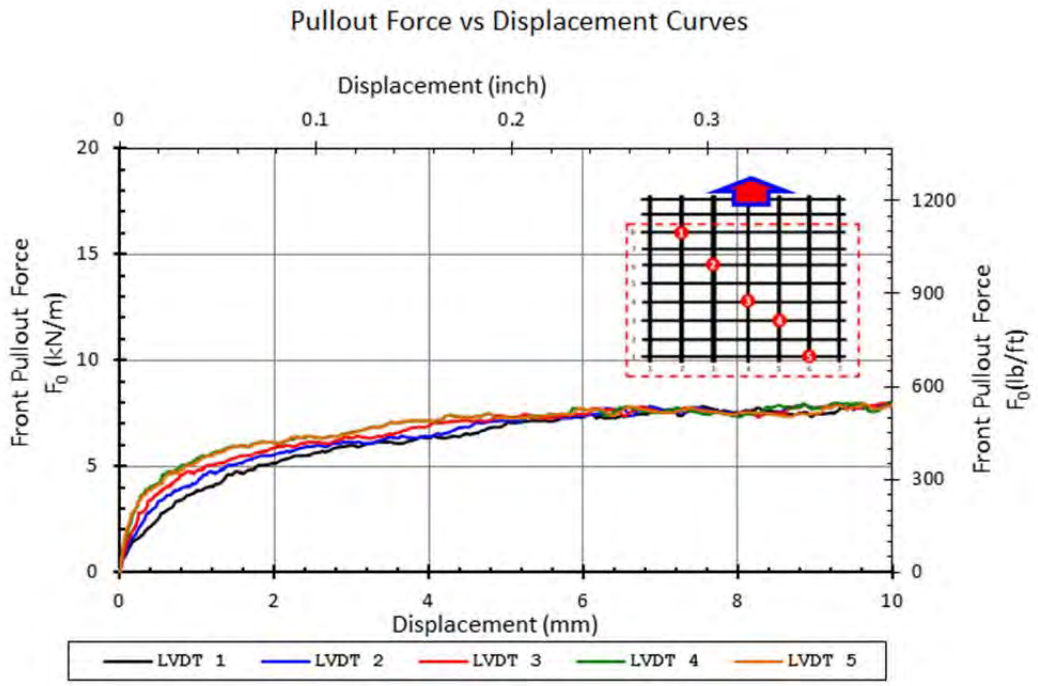
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

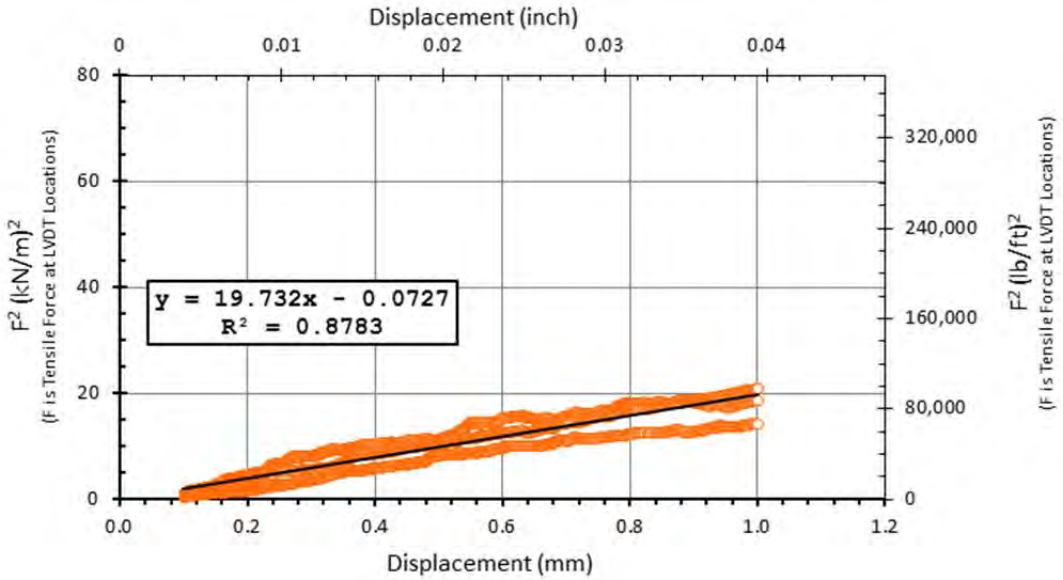
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.2	kN/m	564	lb/ft
Max Pullout Load	P_{max}	2.04	kN	499	lb
Max Shear Stress	τ_{max}	27.4	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
19.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/4/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.261	m	0.245	m
	8	0.925	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.2	1.346
2	90.0	3.543
3	117.8	4.638
4	172.5	6.791
5	229.9	9.051

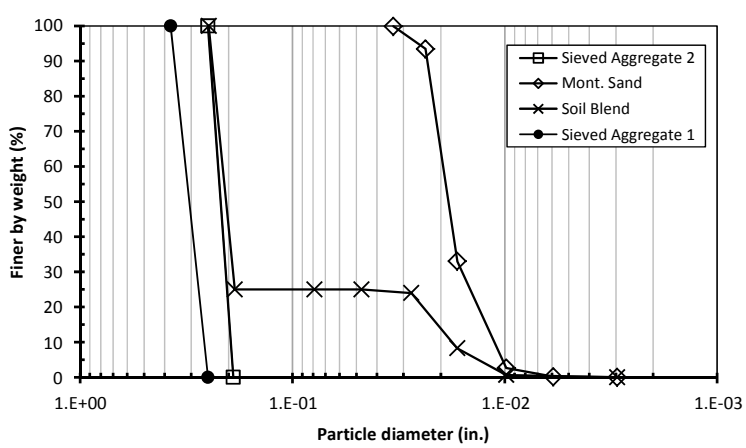
Pullout Rate	
1.0 mm/min.	0.04 in/min

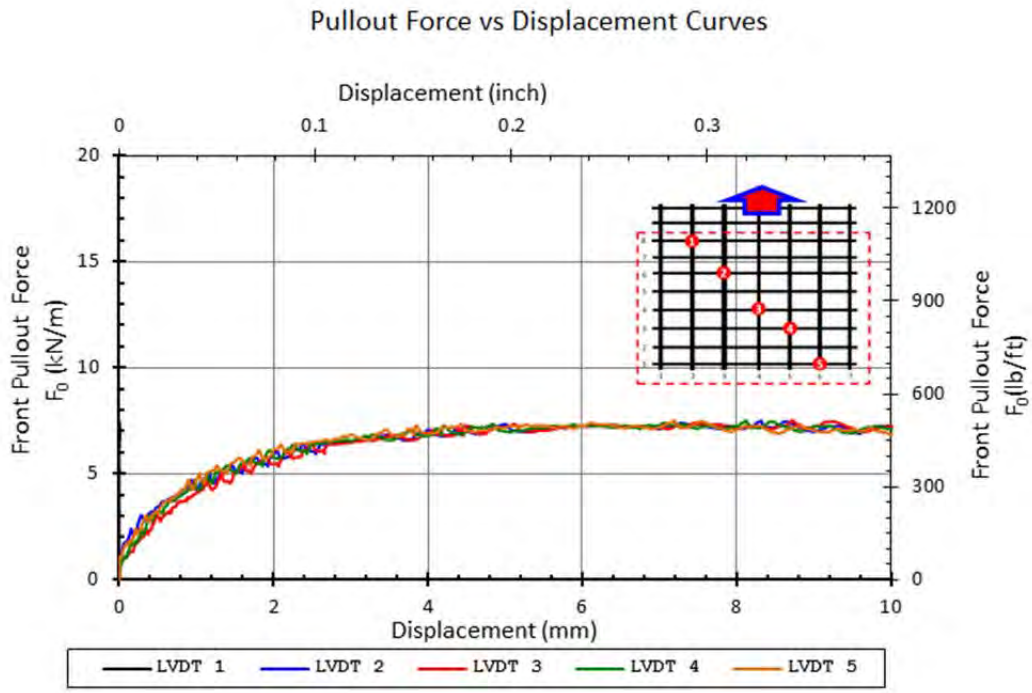
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

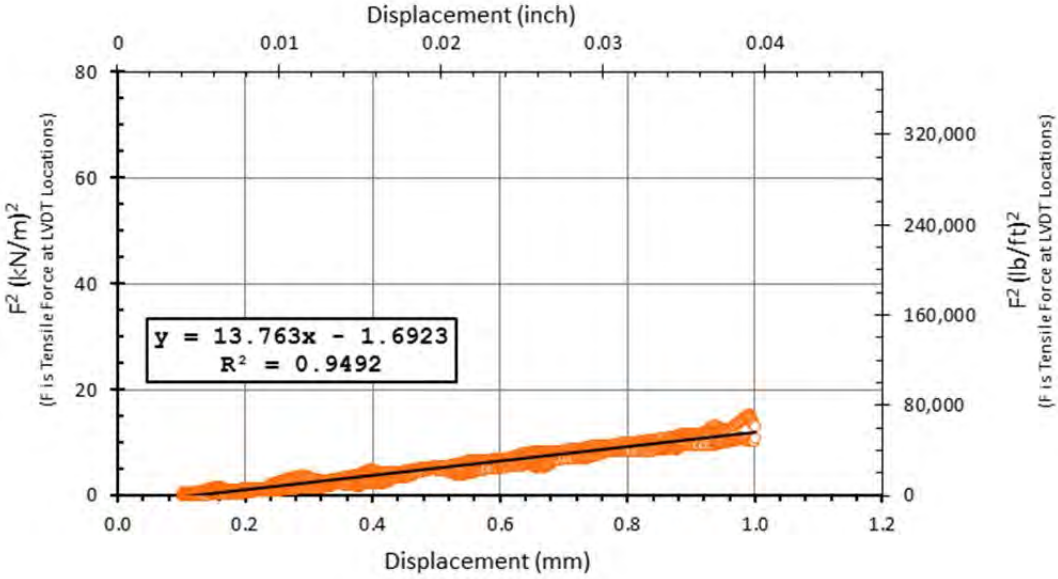
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	515	lb/ft
Max Pullout Load	P_{max}	1.96	kN	469	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
13.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 5 far off to the right. LVDT 1 is broken.

SMALL PULLOUT TEST

Date test conducted	3/5/2012 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.261	m	0.245	m
	8	0.935	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	33.2	1.306
2	89.0	3.504
3	116.9	4.602
4	173.3	6.823
5	230.4	9.071

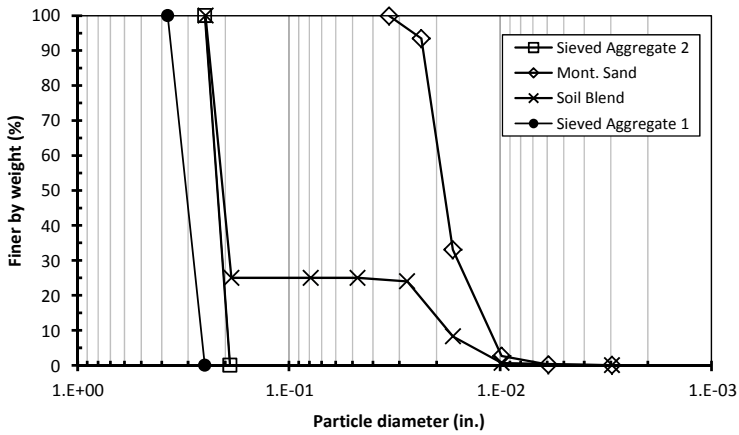
Pullout Rate	
1.0 mm/min.	0.04 in/min

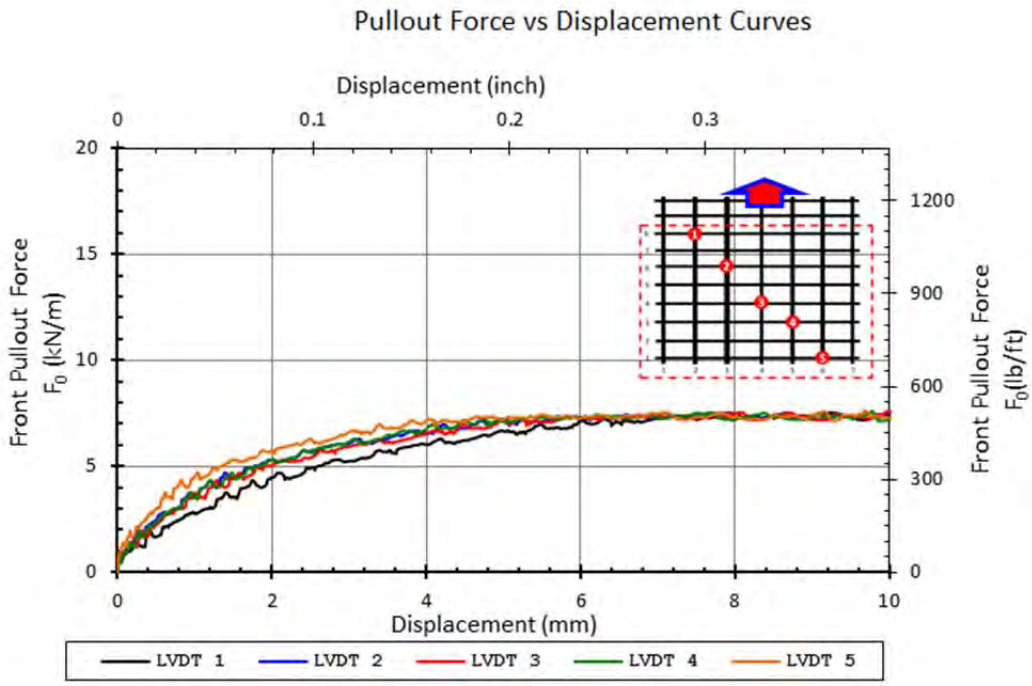
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

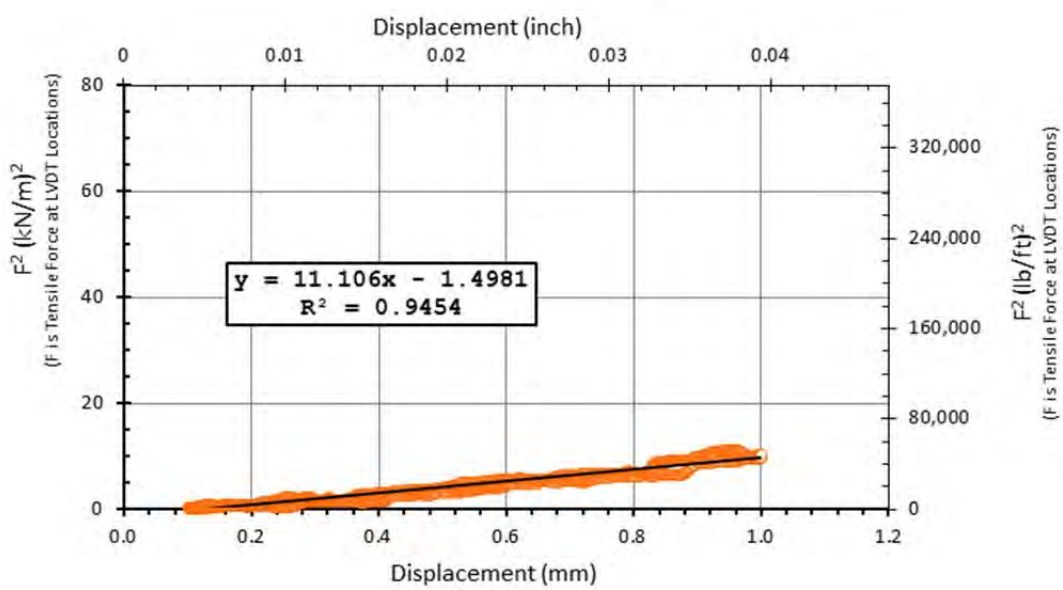
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.7	kN/m	530	lb/ft
Max Pullout Load	P_{max}	2.02	kN	499	lb
Max Shear Stress	τ_{max}	27.2	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
11.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 slightly skewed.

SMALL PULLOUT TEST

Date test conducted	3/28/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	8	0.915	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.6	1.360
2	90.6	3.568
3	118.5	4.664
4	174.4	6.865
5	230.3	9.069

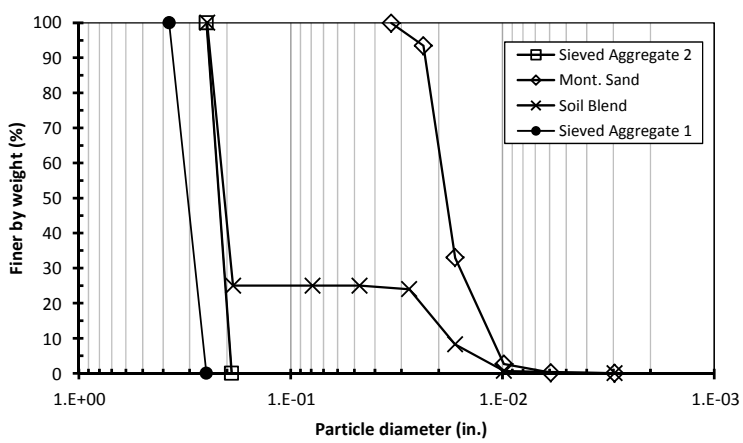
Pullout Rate	
1.0 mm/min.	0.04 in/min

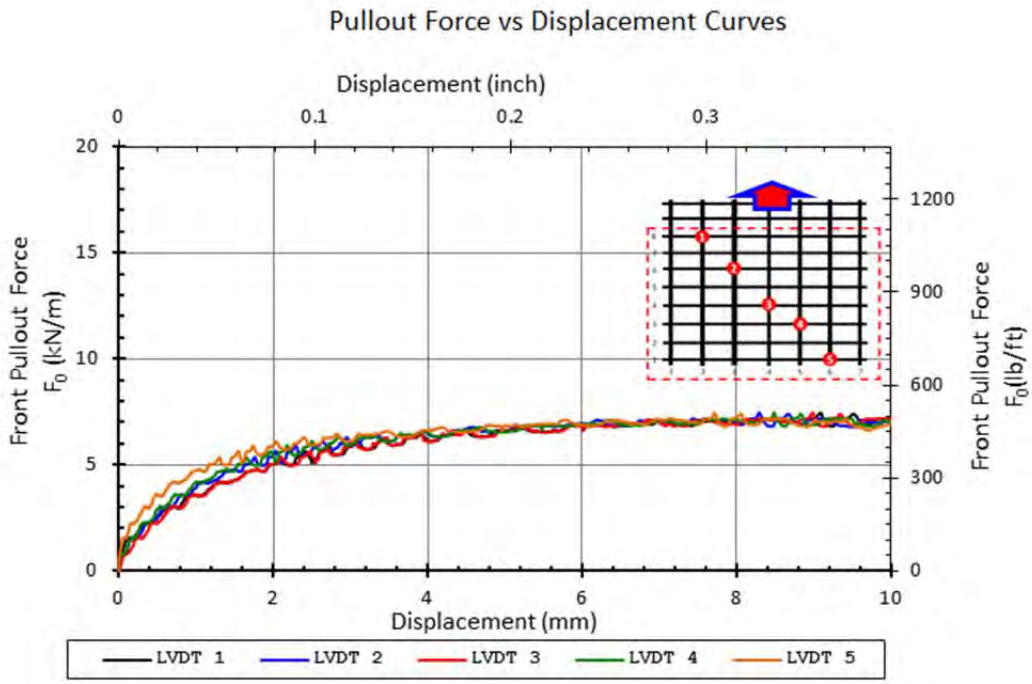
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

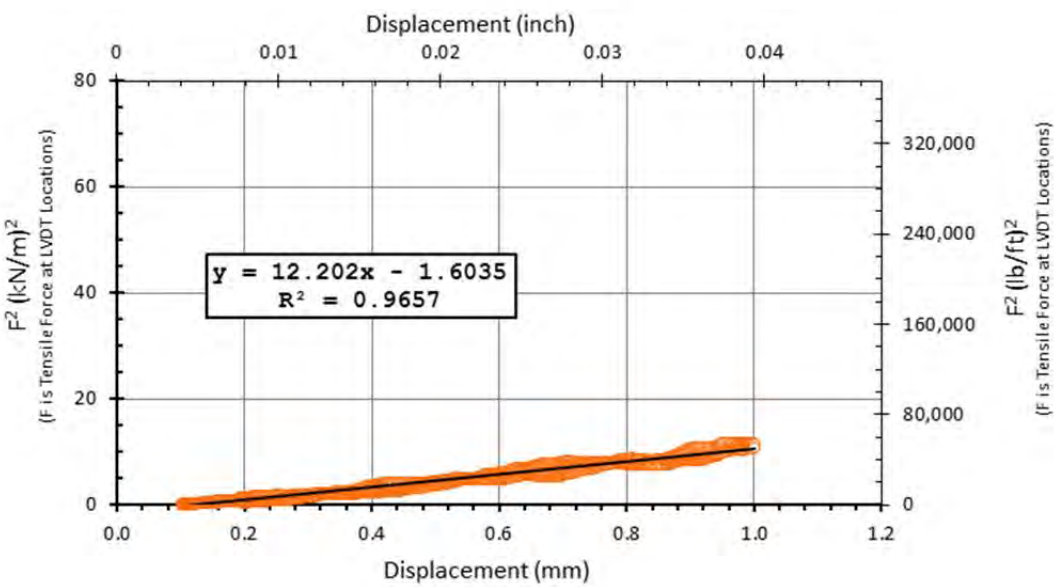
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	511	lb/ft
Max Pullout Load	P_{max}	1.95	kN	488	lb
Max Shear Stress	τ_{max}	26.2	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
12.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 off to the right

SMALL PULLOUT TEST

Date test conducted	4/13/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	8	0.915	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.2	1.269
2	88.0	3.466
3	115.0	4.529
4	170.9	6.729
5	227.1	8.943

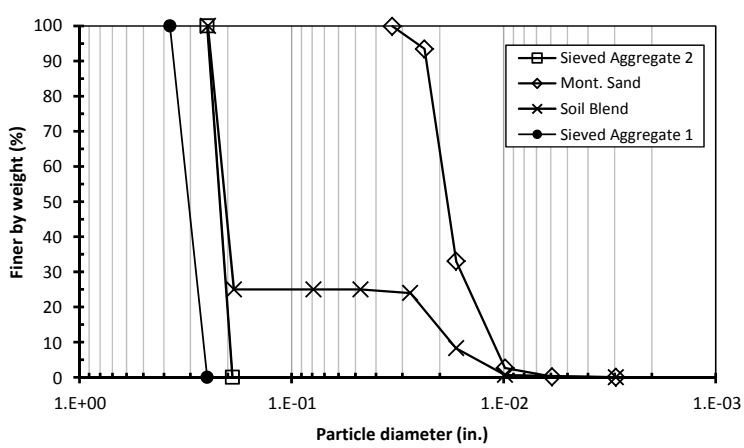
Pullout Rate	
1.0 mm/min.	0.04 in/min

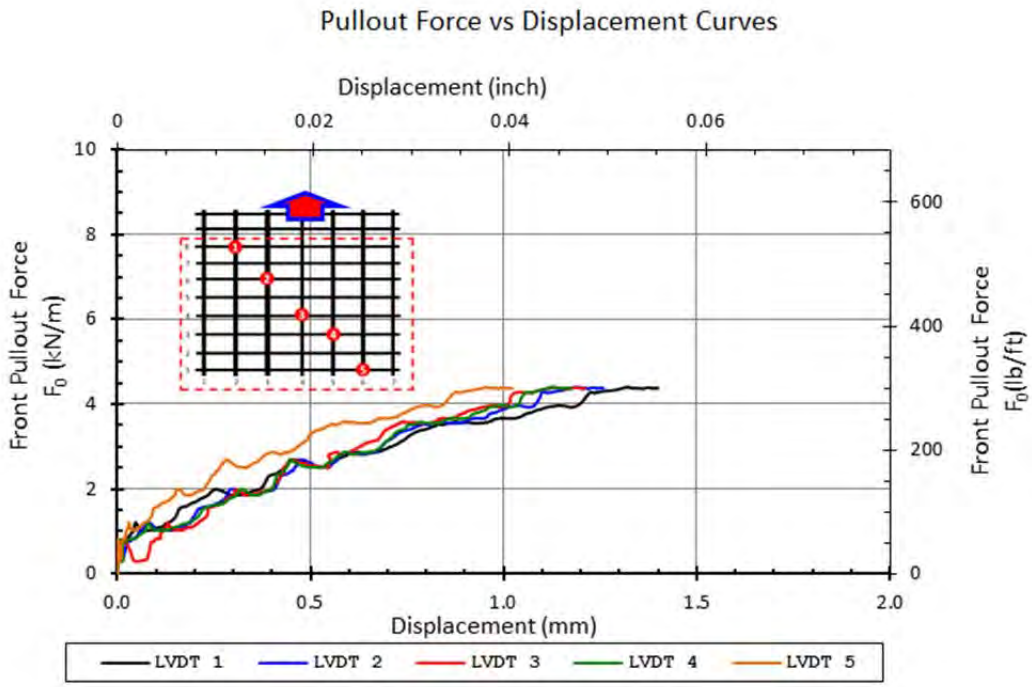
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

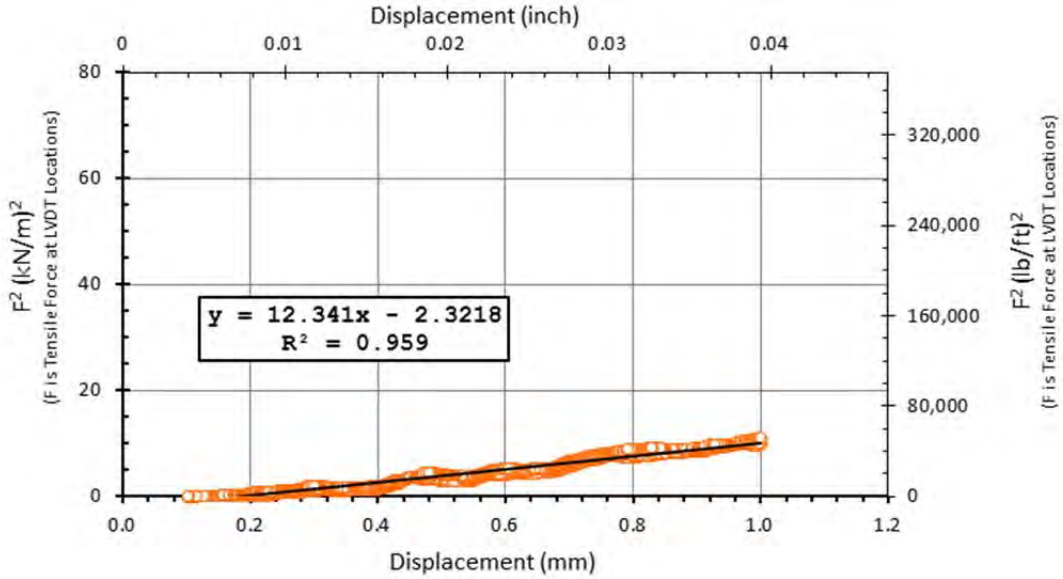
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.4	kN/m	302	lb/ft
Max Pullout Load	P_{max}	1.15	kN	282	lb
Max Shear Stress	τ_{max}	15.5	kPa	2.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.5			

Reported K_{SGI}
12.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test ran up to 1 mm of displacement of LVDTs. LVDT 5 off to the right.

SMALL PULLOUT TEST

Date test conducted	4/14/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.9	1.136
2	84.8	3.338
3	111.9	4.406
4	168.8	6.645
5	225.4	8.872

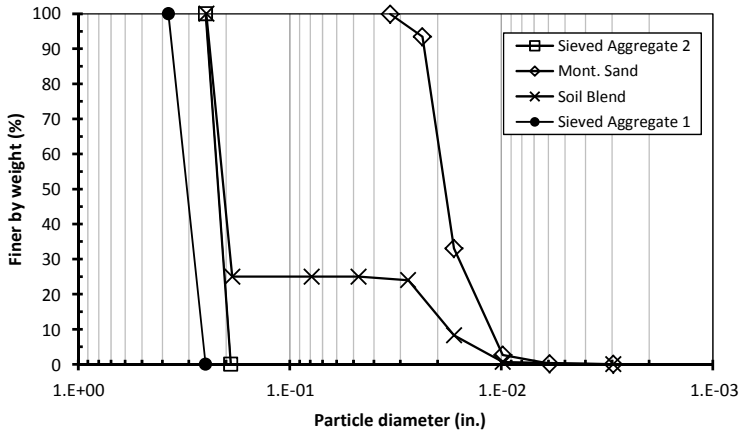
Pullout Rate	
1.0 mm/min.	0.04 in/min

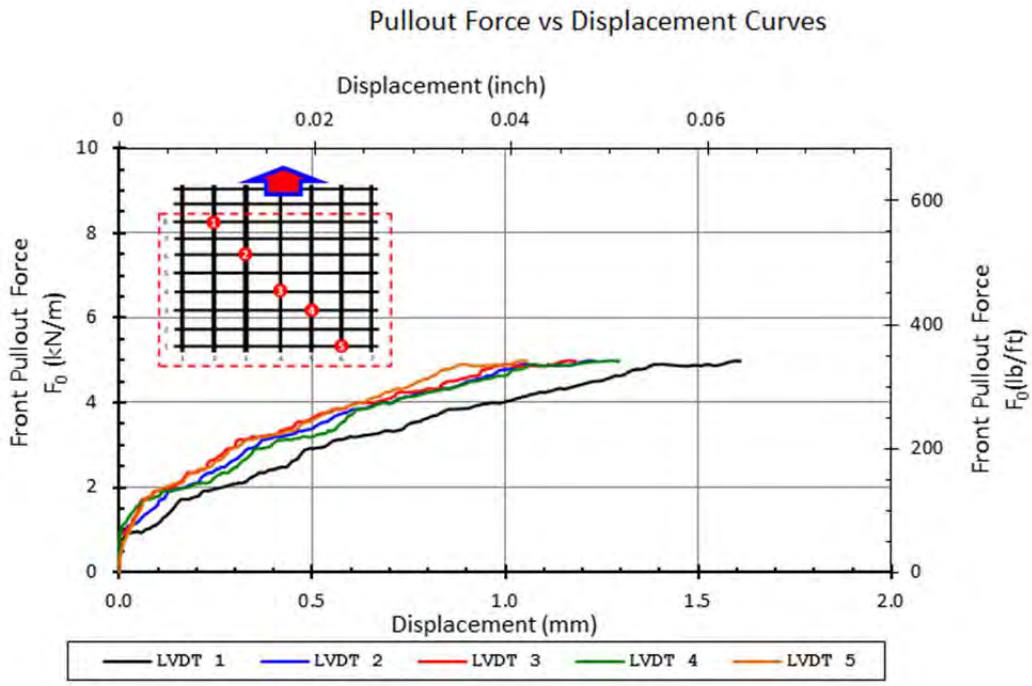
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

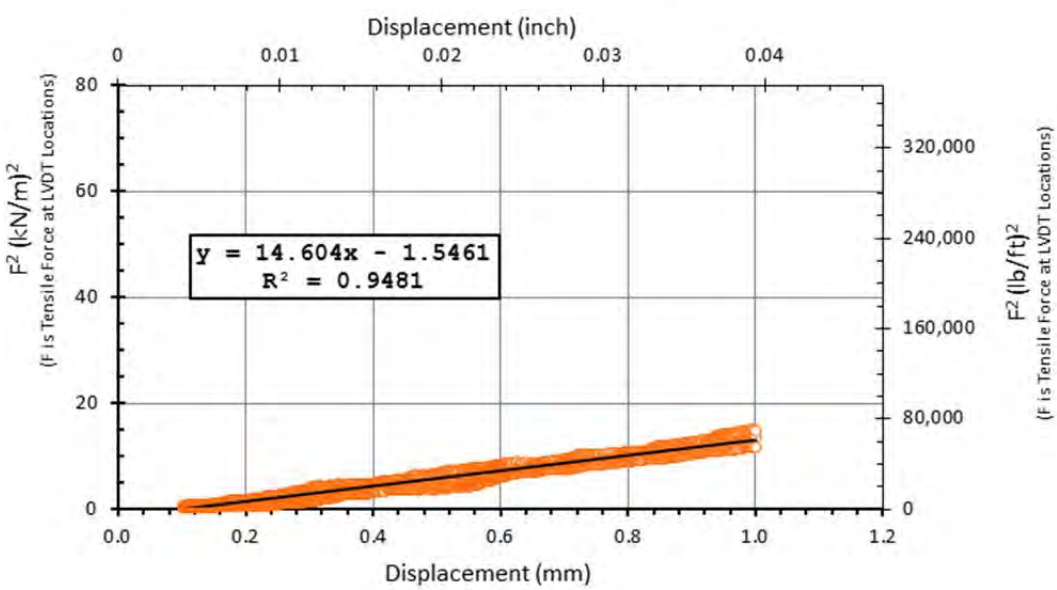
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.0	kN/m	342	lb/ft
Max Pullout Load	P_{max}	1.30	kN	326	lb
Max Shear Stress	τ_{max}	17.5	kPa	2.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
14.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test conducted up to 1 mm of displacement of LVDT 3. LVDT 5 off to the right.

SMALL PULLOUT TEST

Date test conducted	8/19/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.9	1.215
2	85.7	3.375
3	114.4	4.504
4	170.0	6.694
5	225.0	8.856

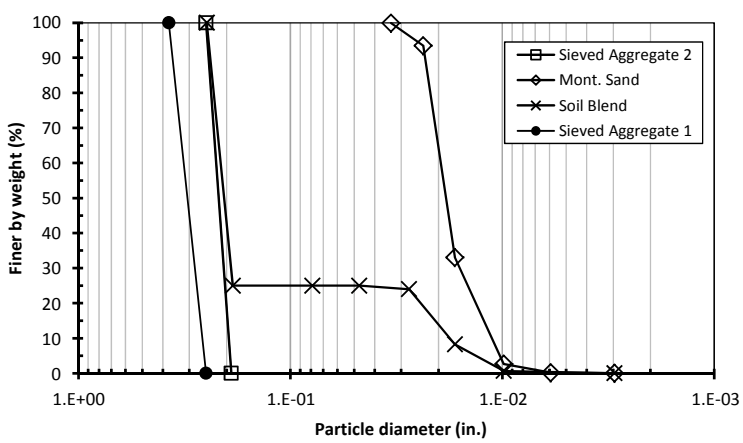
Pullout Rate	
1.0 mm/min.	0.04 in/min

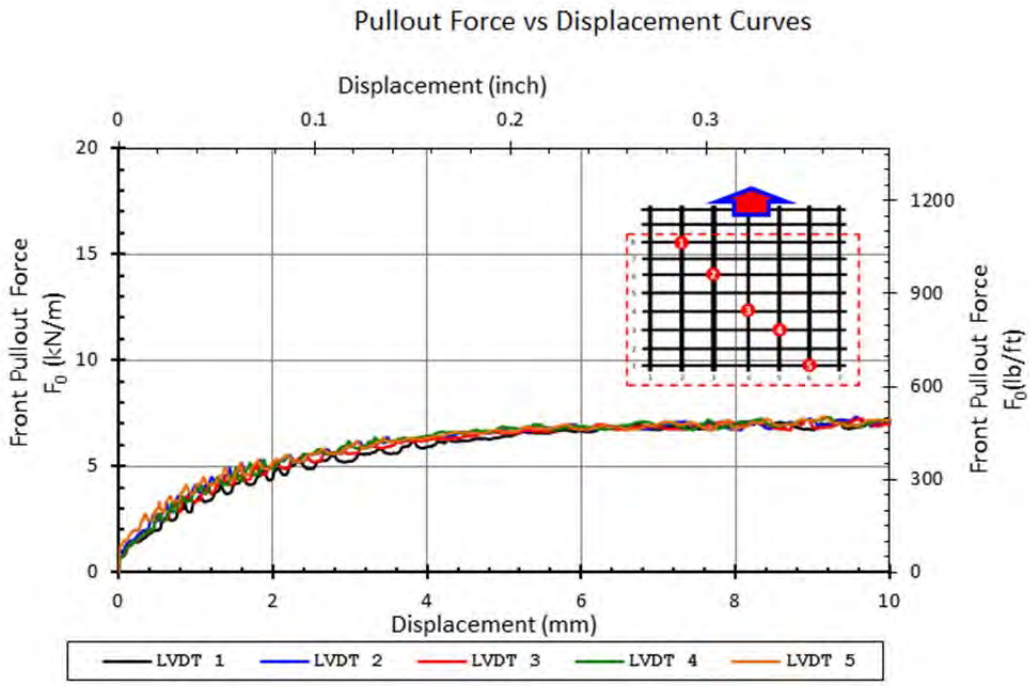
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

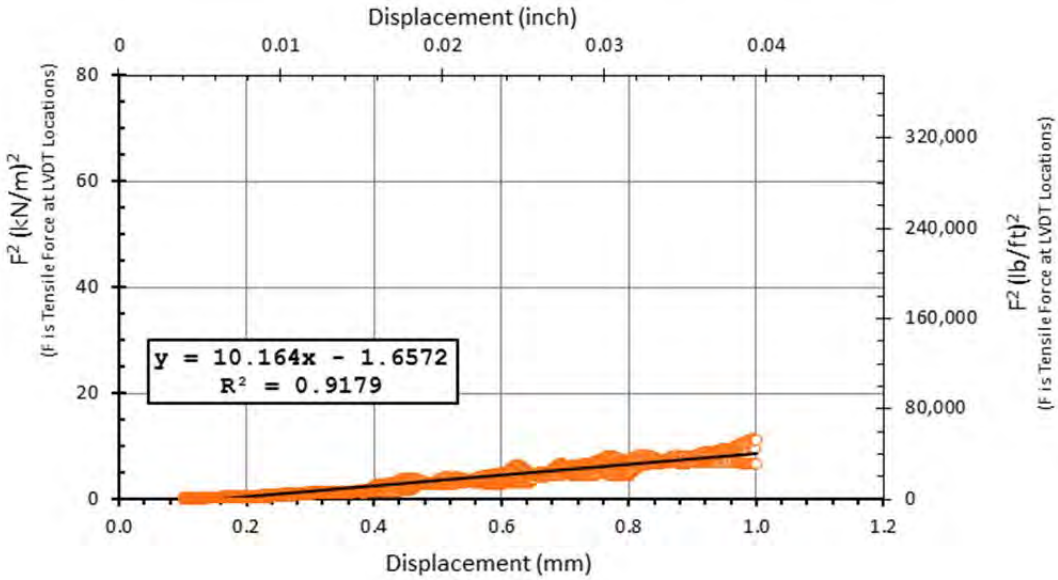
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	519	lb/ft
Max Pullout Load	P_{max}	1.98	kN	462	lb
Max Shear Stress	τ_{max}	26.6	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
10.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT #5 off to the right

SMALL PULLOUT TEST

Date test conducted	1/24/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	-	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	26.6	1.048
2	113.3	4.459
3	123.2	4.850
4	134.9	5.309
5	235.5	9.273

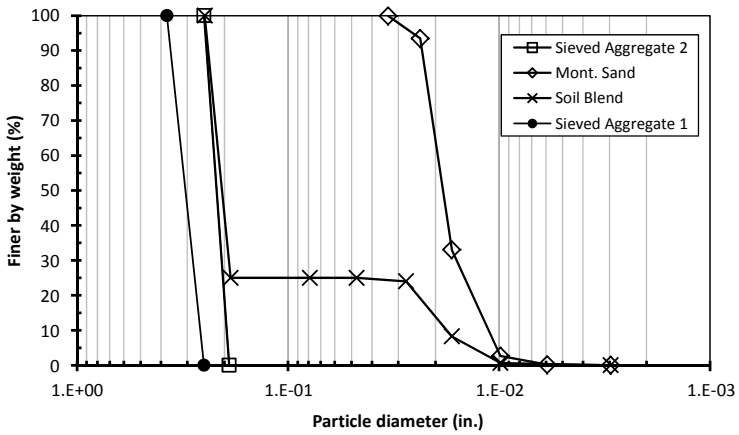
Pullout Rate	
1.0 mm/min.	0.04 in/min

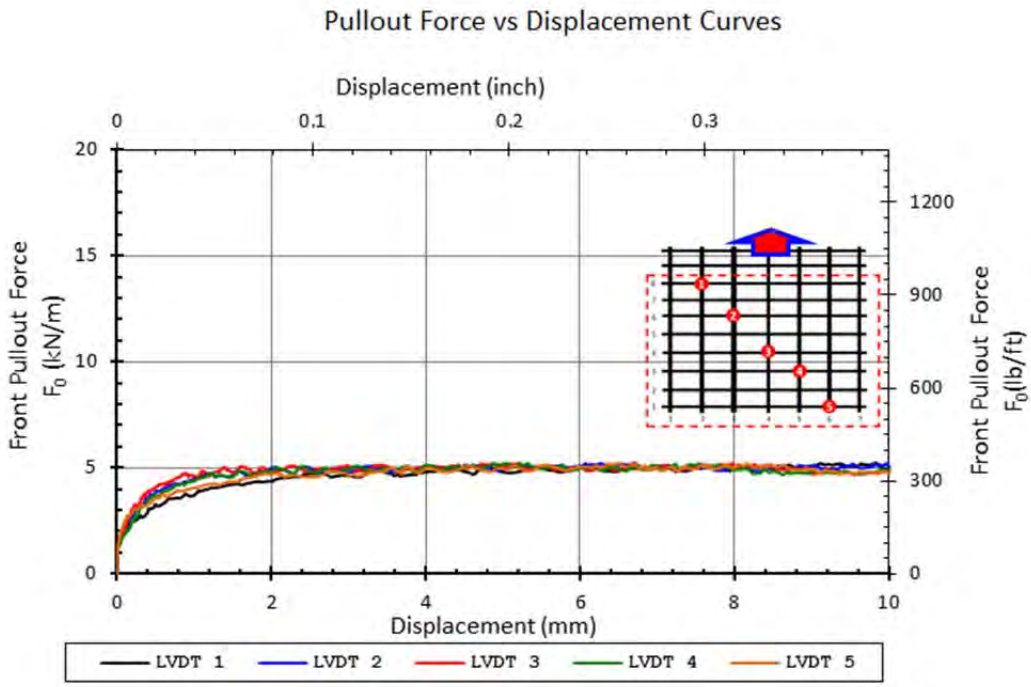
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

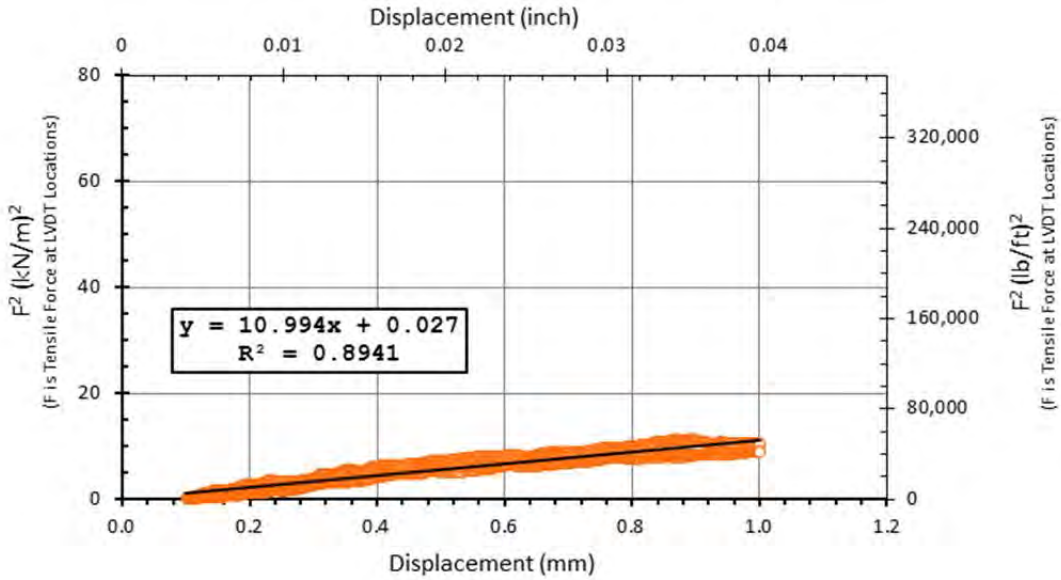
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.2	kN/m	357	lb/ft
Max Pullout Load	P_{max}	1.46	kN	364	lb
Max Shear Stress	τ_{max}	19.6	kPa	2.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
11.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/25/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.271	m	0.271	m	0.245	m
	-	0.889	ft	0.889	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.1	0.711
2	107.0	4.211
3	120.6	4.746
4	132.8	5.227
5	231.1	9.098

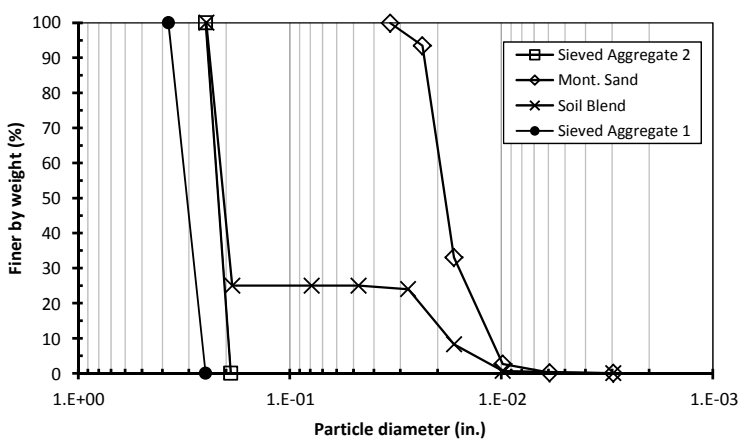
Pullout Rate	
1.0 mm/min.	0.04 in/min

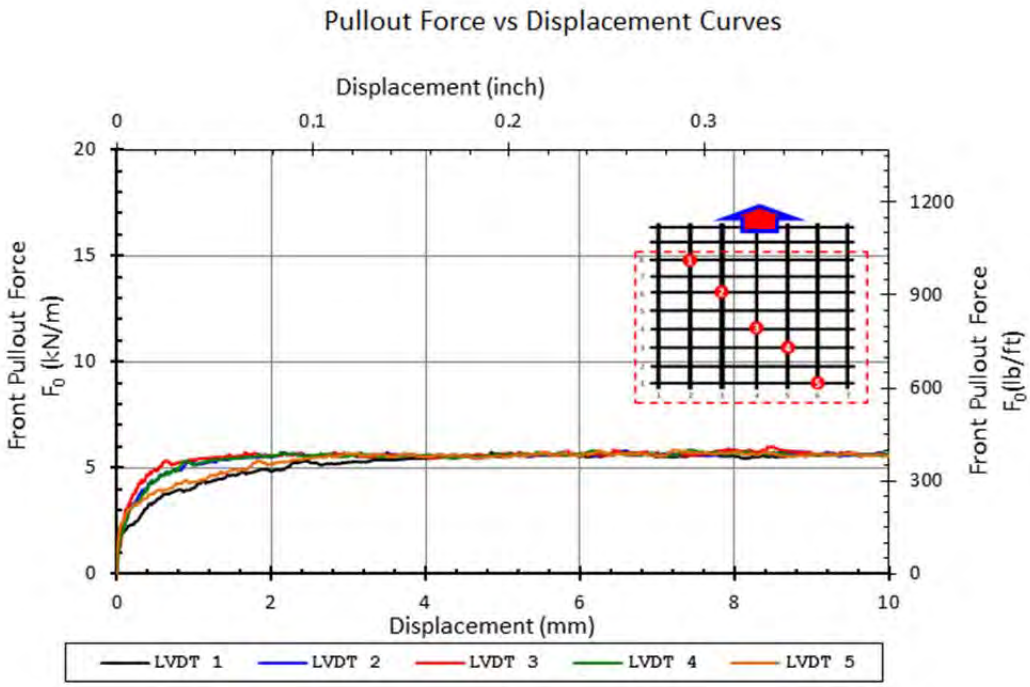
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

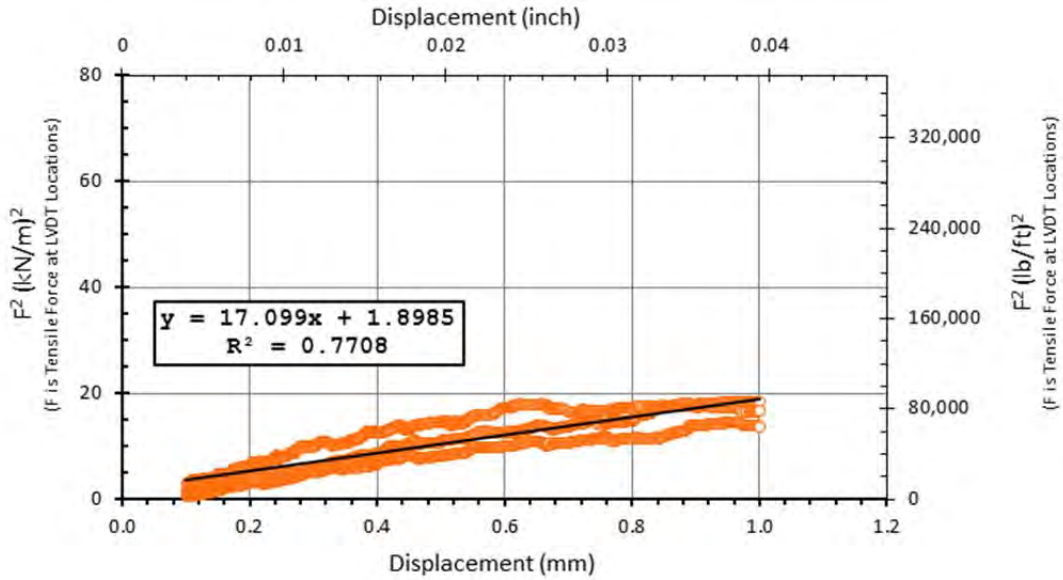
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.0	kN/m	410	lb/ft
Max Pullout Load	P_{max}	1.62	kN	392	lb
Max Shear Stress	τ_{max}	21.8	kPa	3.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
17.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/26/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.266	m	0.266	m	0.245	m
	-	0.873	ft	0.873	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.7	0.698
2	99.9	3.933
3	114.8	4.518
4	129.1	5.084
5	236.0	9.293

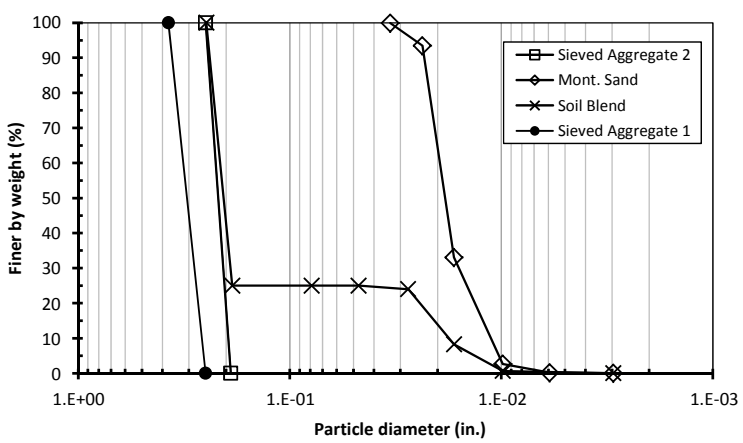
Pullout Rate	
1.0 mm/min.	0.04 in/min

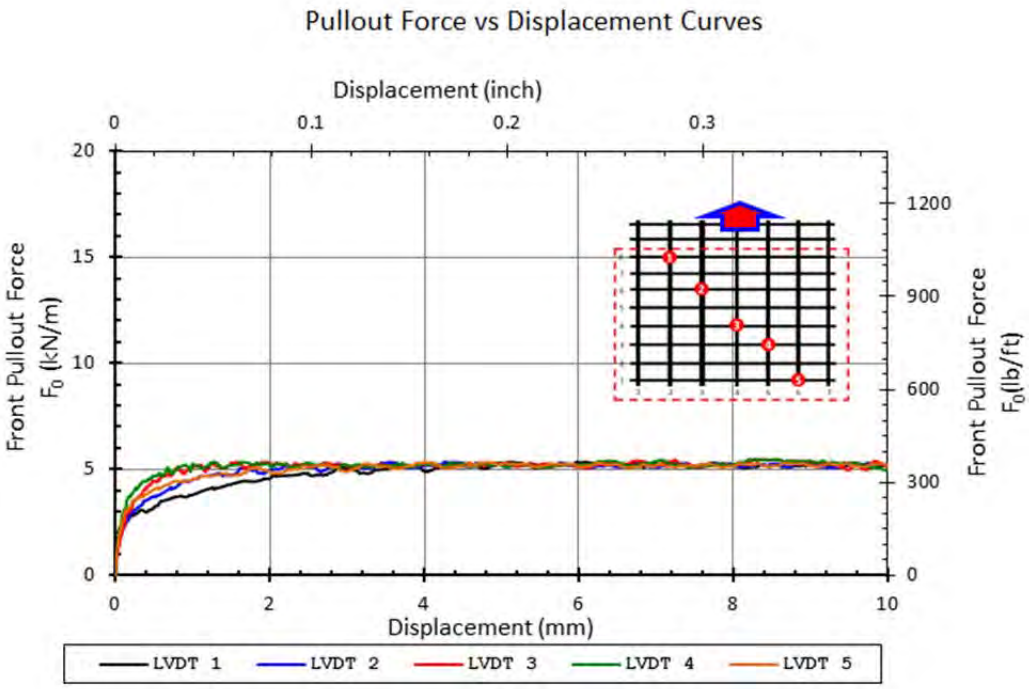
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

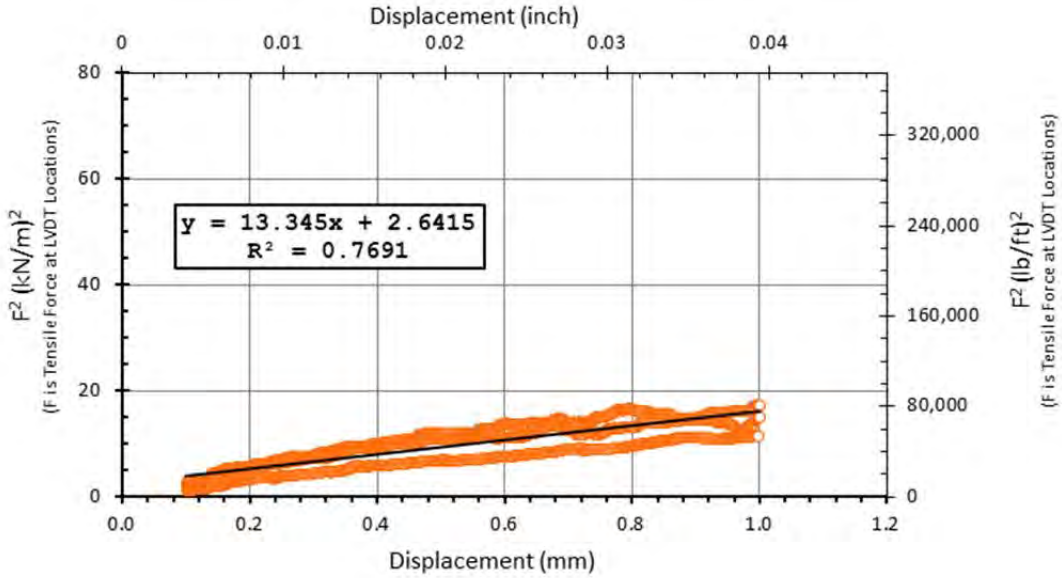
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.5	kN/m	375	lb/ft
Max Pullout Load	P_{max}	1.46	kN	357	lb
Max Shear Stress	τ_{max}	19.6	kPa	2.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
13.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/27/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.284	m	0.284	m	0.245	m
	-	0.932	ft	0.932	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-0.5	-0.020
2	96.4	3.793
3	118.9	4.681
4	139.4	5.489
5	238.7	9.396

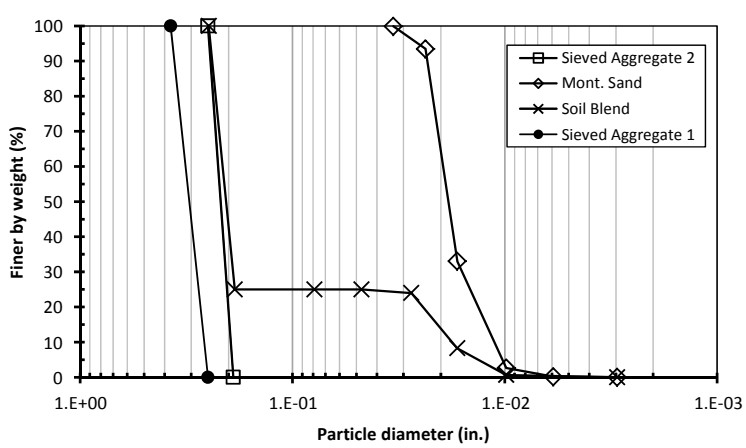
Pullout Rate	
1.0 mm/min.	0.04 in/min

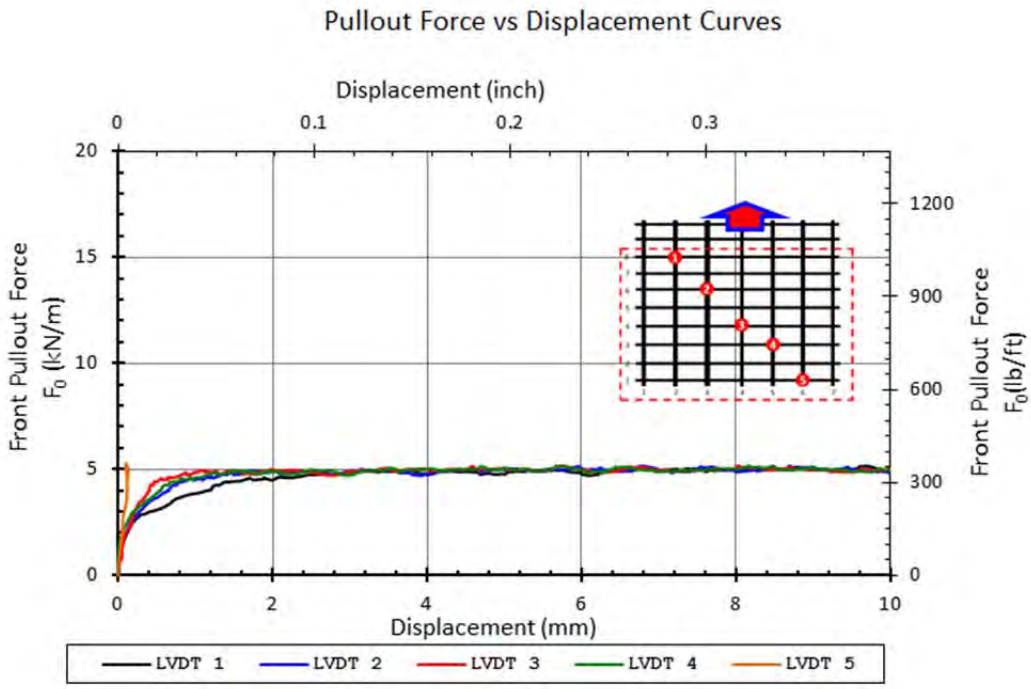
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

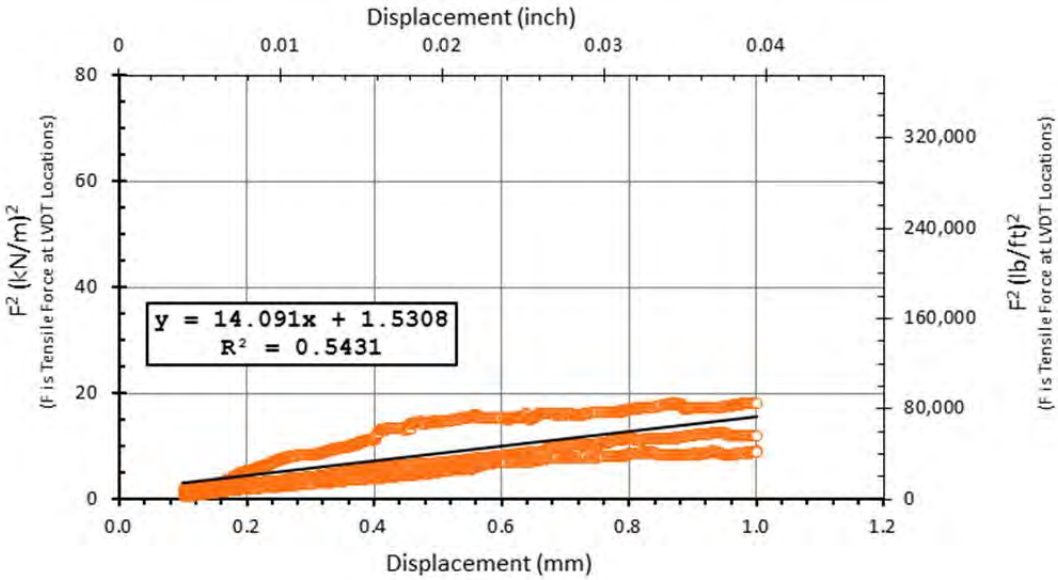
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.3	kN/m	361	lb/ft
Max Pullout Load	P_{max}	1.50	kN	369	lb
Max Shear Stress	τ_{max}	20.1	kPa	2.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
14.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

weight of box from the previous test.

SMALL PULLOUT TEST

Date test conducted	4/7/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	N/A	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-2.9	-0.116
2	96.8	3.810
3	112.3	4.420
4	126.9	4.994
5	225.2	8.866

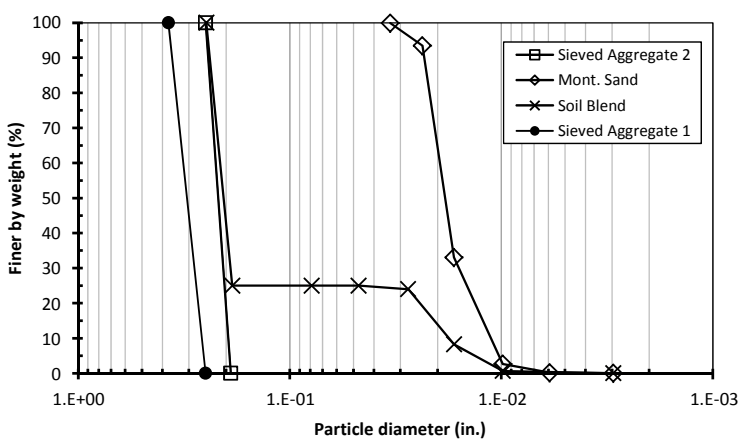
Pullout Rate	
1.0 mm/min.	0.04 in/min

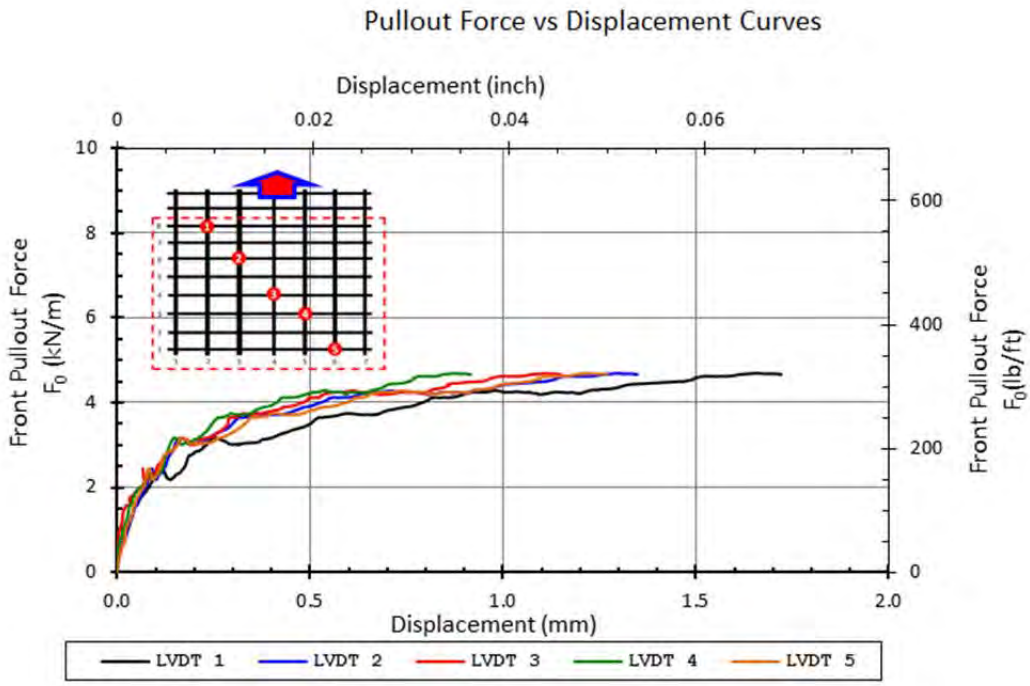
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

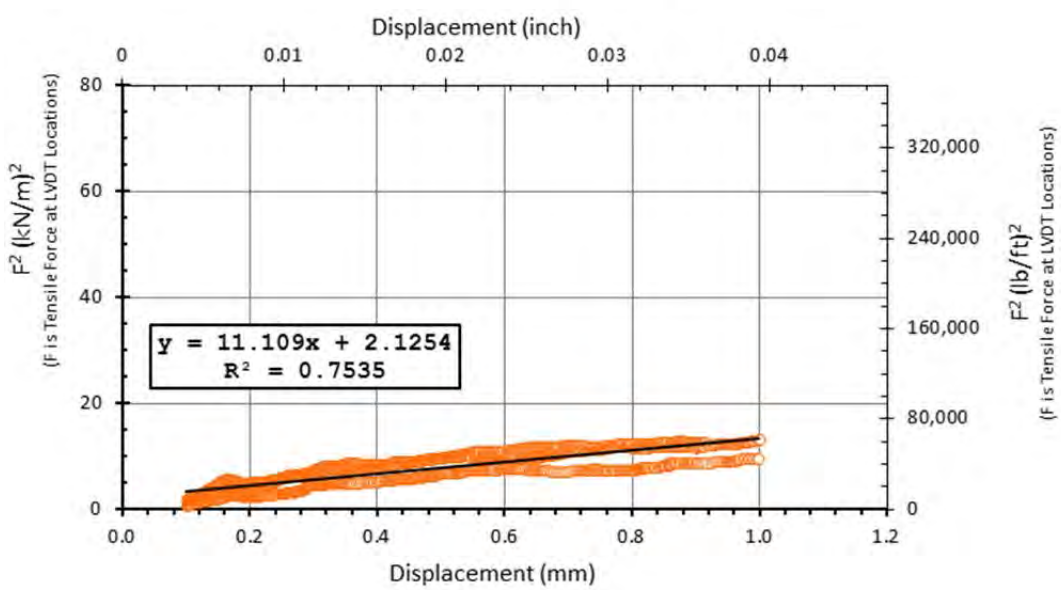
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
11.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run only up to 1 mm of displacement of LVDTs 2, 3 and 4.

SMALL PULLOUT TEST

Date test conducted	4/9/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	N/A	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.2	0.559
2	107.8	4.244
3	123.6	4.867
4	138.8	5.463
5	239.9	9.445

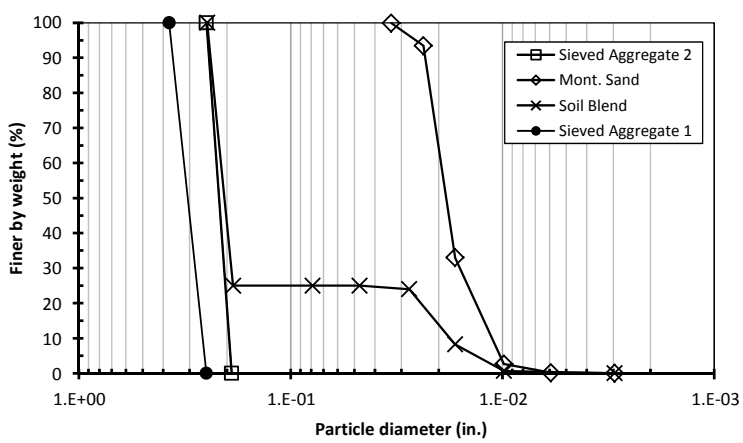
Pullout Rate	
1.0 mm/min.	0.04 in/min

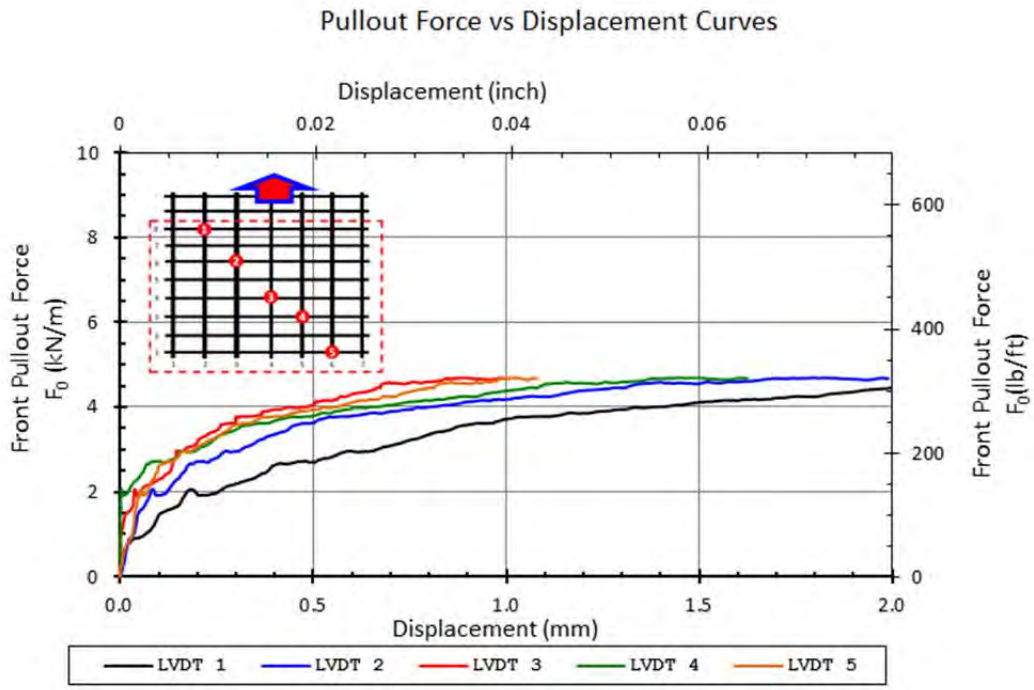
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

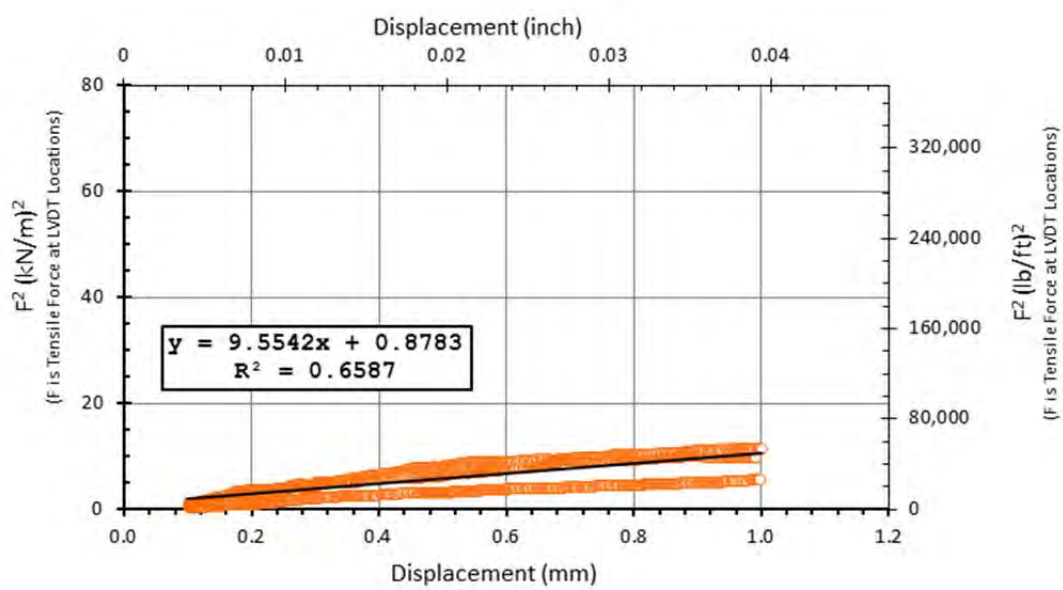
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
9.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run only up to 1 mm of displacement of LVDTs 2, 3 and 4.

SMALL PULLOUT TEST

Date test conducted	8/20/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.283	m	0.283	m	0.245	m
	---	0.929	ft	0.929	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.3	0.915
2	115.0	4.529
3	128.3	5.050
4	143.4	5.644
5	231.8	9.126

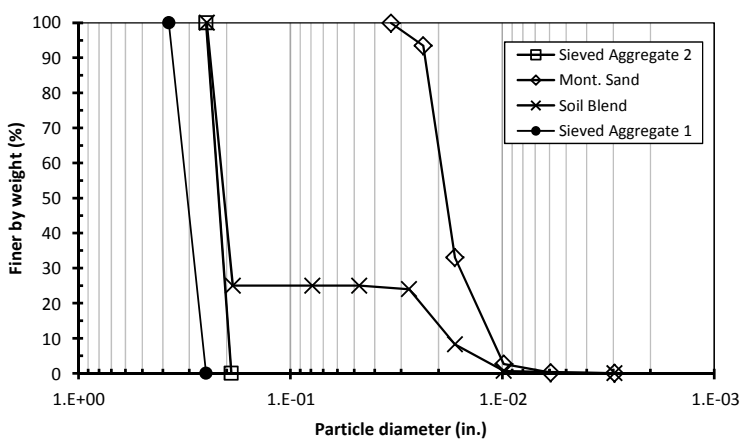
Pullout Rate	
1.0 mm/min.	0.04 in/min

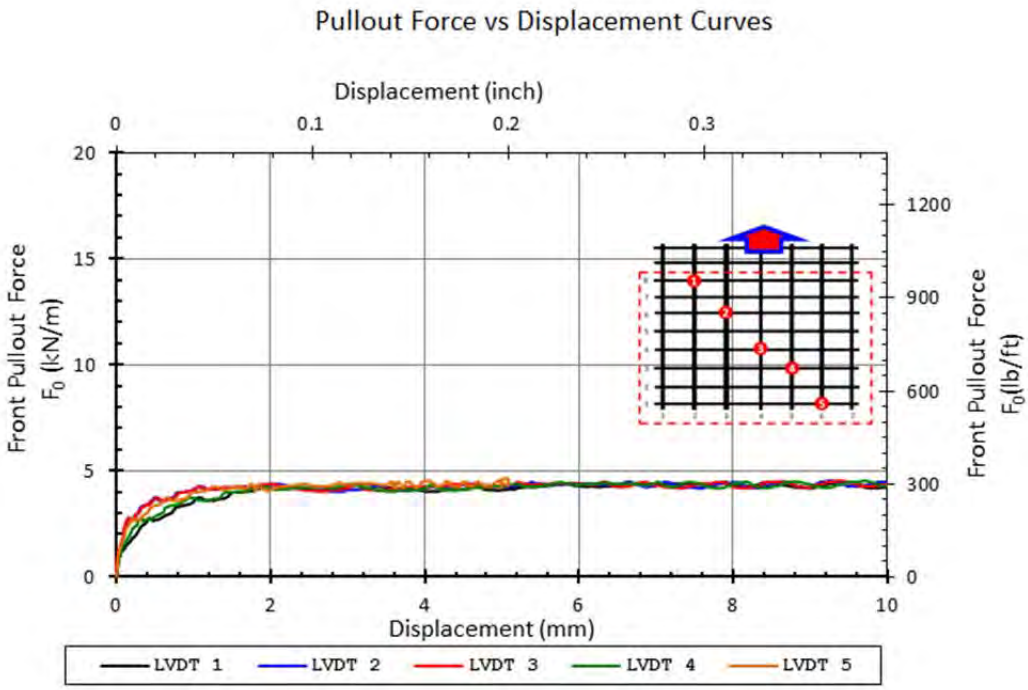
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

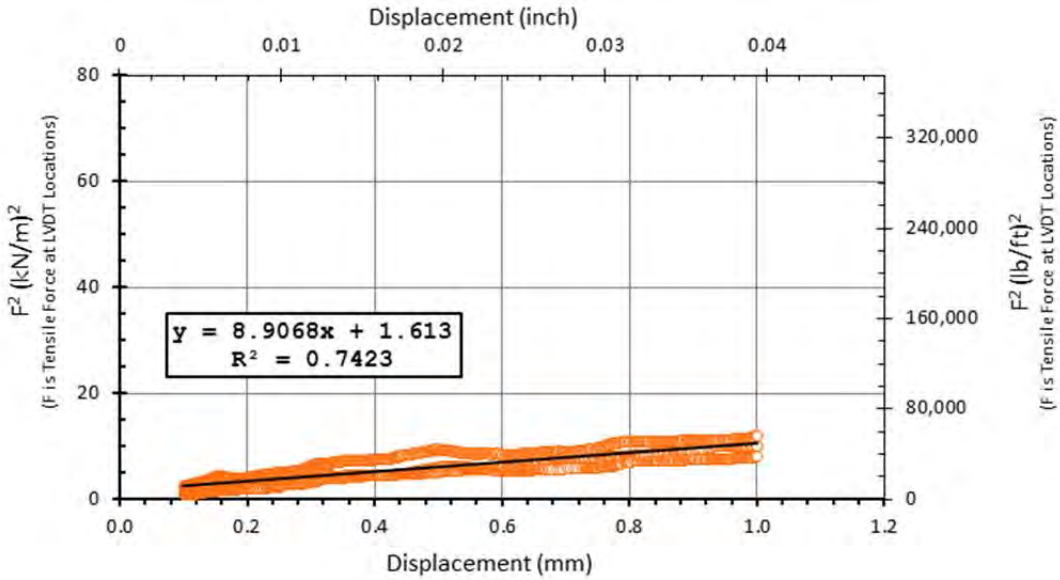
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.6	kN/m	318	lb/ft
Max Pullout Load	P_{max}	1.31	kN	337	lb
Max Shear Stress	τ_{max}	17.7	kPa	2.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.5			

Reported K_{SGI}
8.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/20/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.283	m	0.283	m	0.245	m
	---	0.929	ft	0.929	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	20.9	0.824
2	111.2	4.376
3	127.0	5.000
4	141.5	5.570
5	225.5	8.878

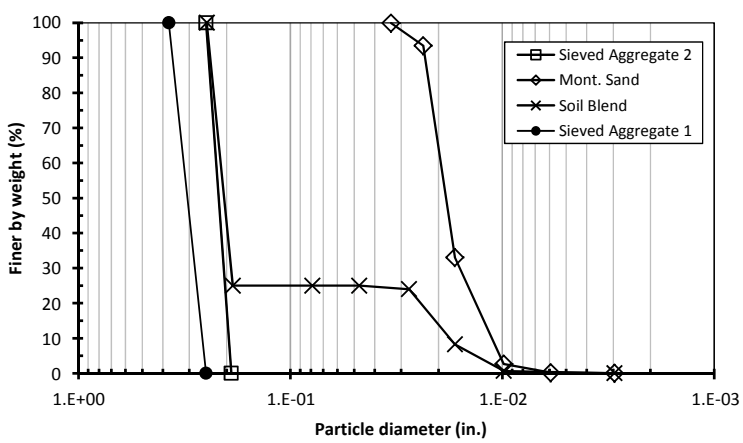
Pullout Rate	
1.0 mm/min.	0.04 in/min

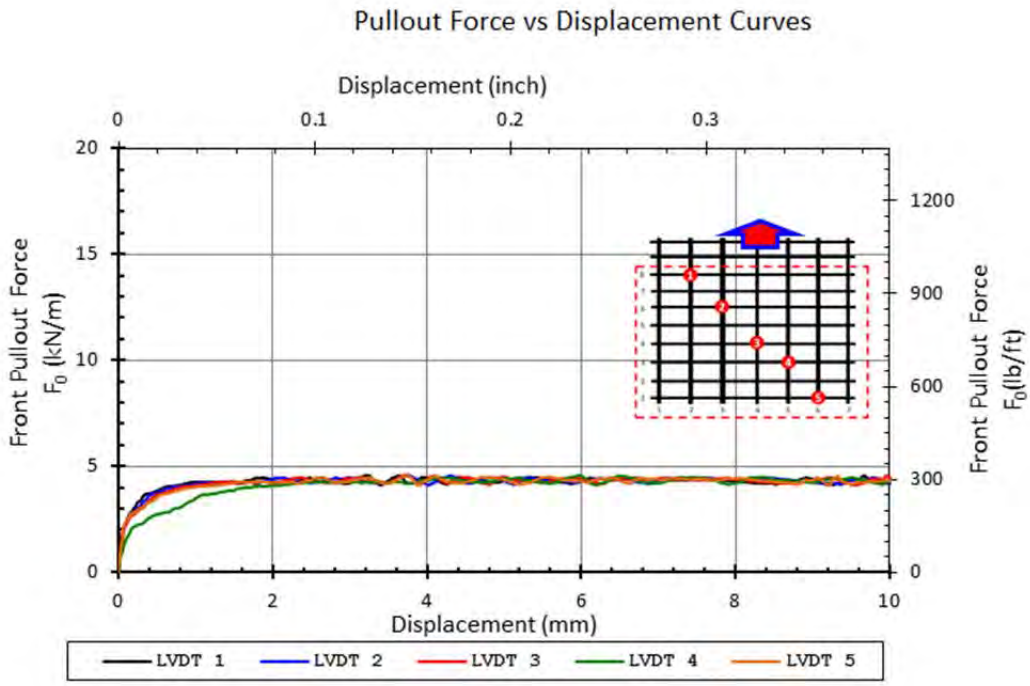
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

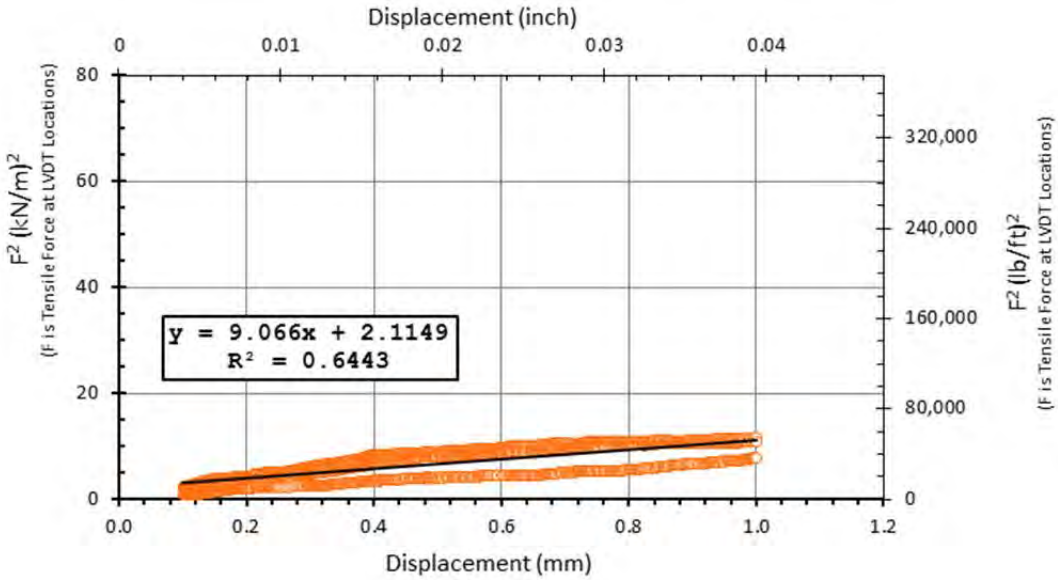
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.6	kN/m	313	lb/ft
Max Pullout Load	P_{max}	1.29	kN	321	lb
Max Shear Stress	τ_{max}	17.4	kPa	2.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.5			

Reported K_{SGI}
9.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/21/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	---	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.8	0.898
2	109.3	4.303
3	125.1	4.924
4	140.4	5.526
5	224.1	8.822

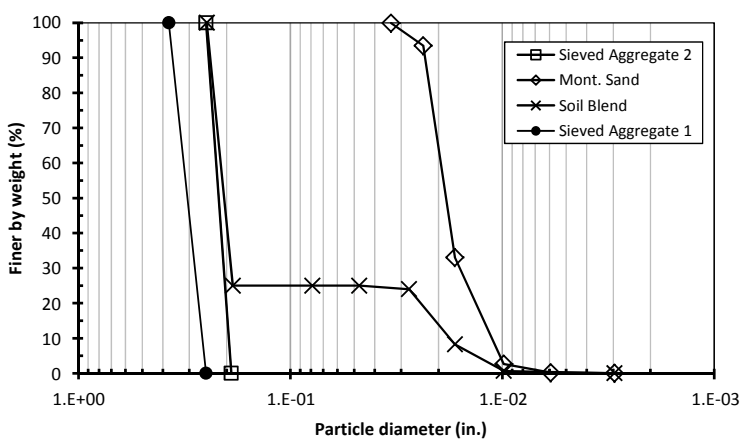
Pullout Rate	
1.0 mm/min.	0.04 in/min

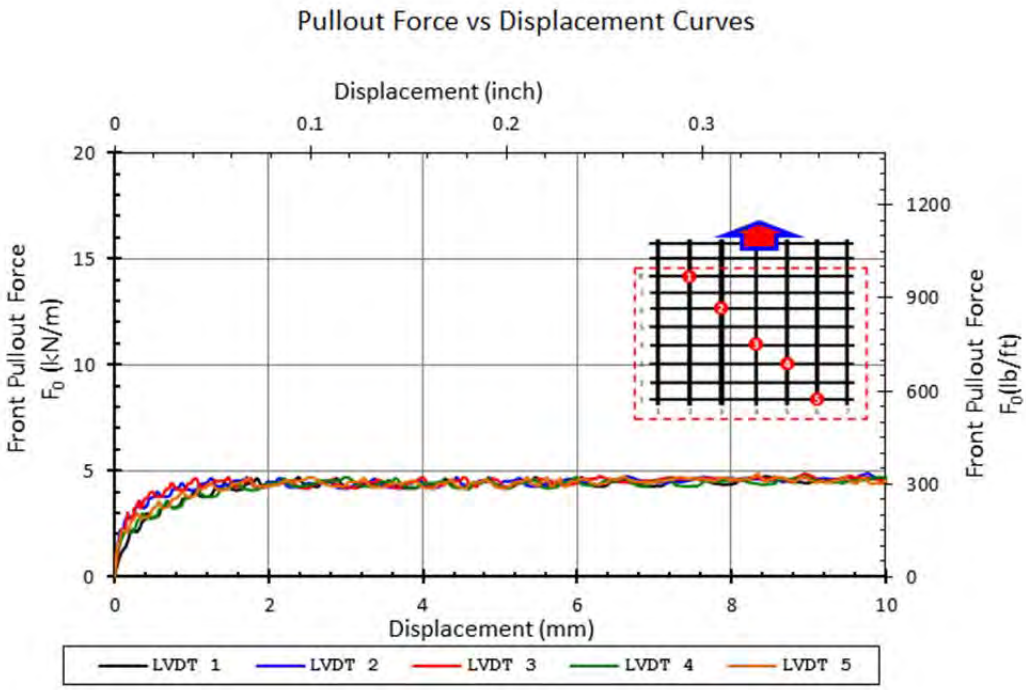
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

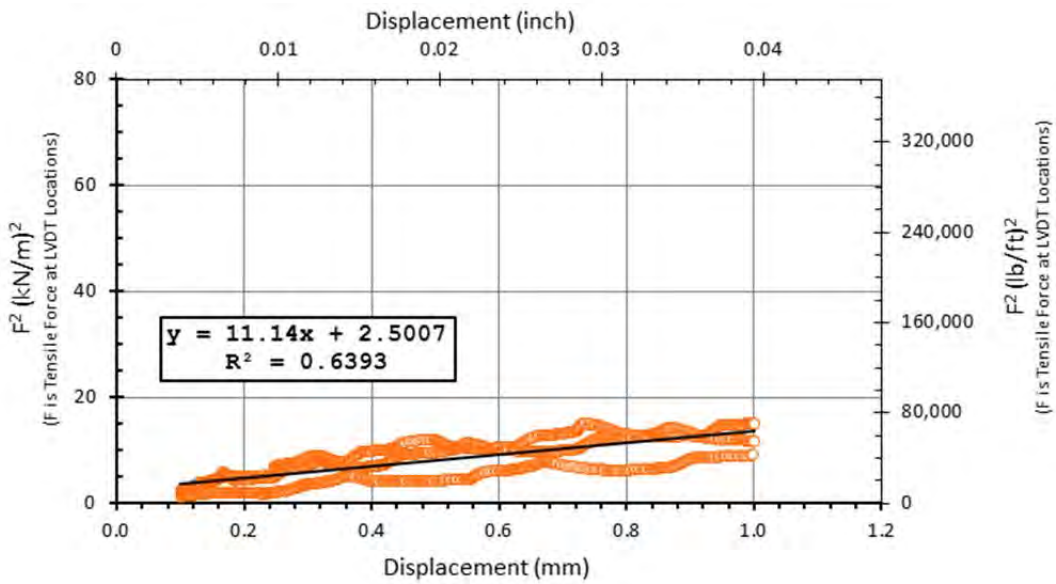
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.9	kN/m	334	lb/ft
Max Pullout Load	P_{max}	1.36	kN	341	lb
Max Shear Stress	τ_{max}	18.3	kPa	2.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
11.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/9/2012 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.265	m	0.245	m
	9	0.909	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	1.9	0.073
2	47.0	1.848
3	91.9	3.619
4	136.9	5.391
5	224.8	8.850

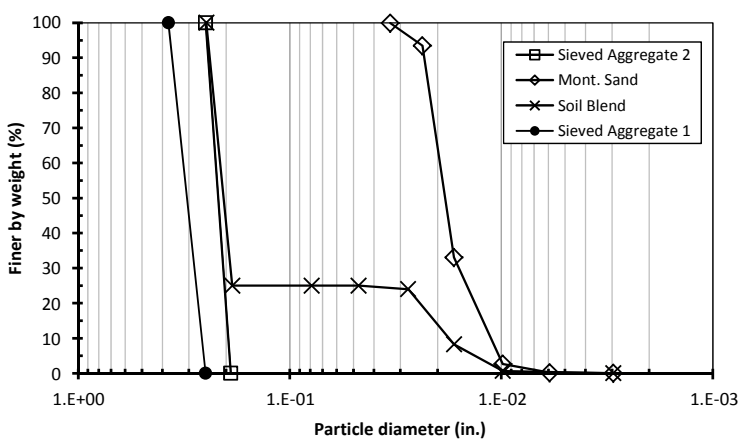
Pullout Rate	
1.0 mm/min.	0.04 in/min

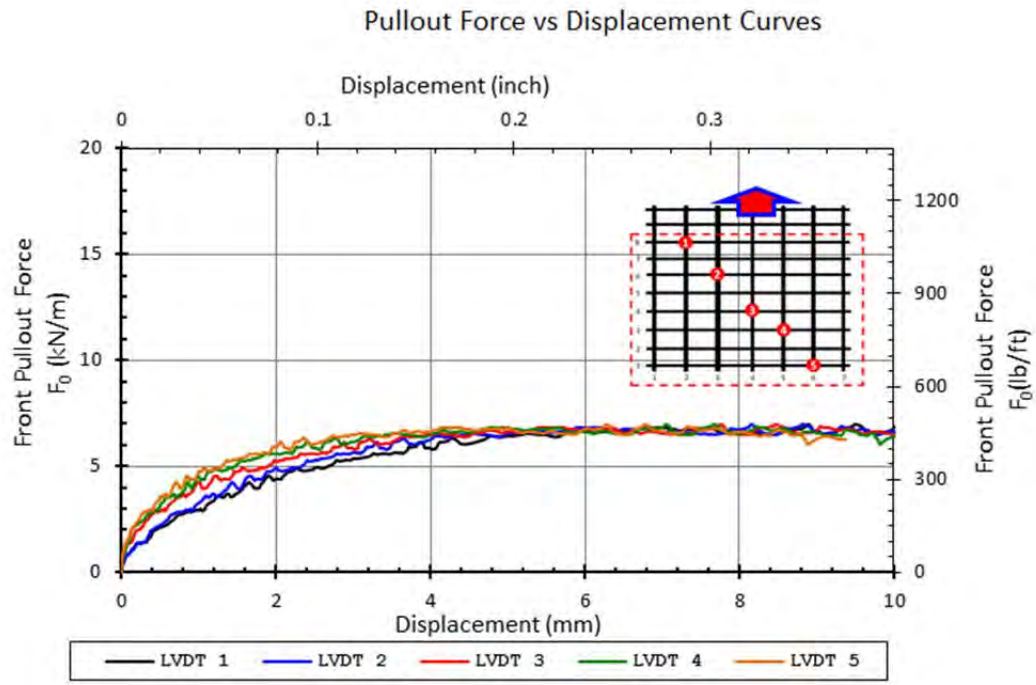
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

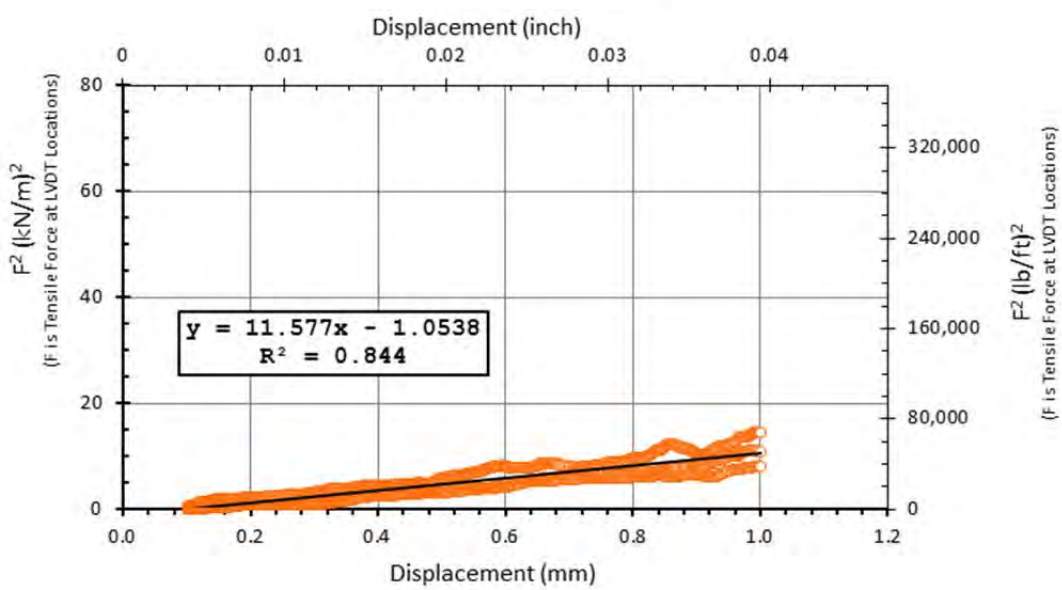
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	479	lb/ft
Max Pullout Load	P_{max}	1.85	kN	467	lb
Max Shear Stress	τ_{max}	24.9	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
11.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 1 Started outside of box

SMALL PULLOUT TEST

Date test conducted	3/9/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	16.1	0.633
2	55.9	2.202
3	95.8	3.771
4	136.8	5.387
5	221.3	8.712

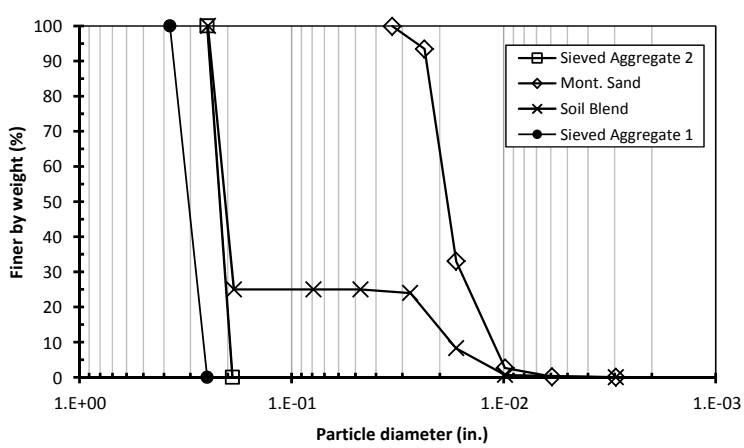
Pullout Rate	
1.0 mm/min.	0.04 in/min

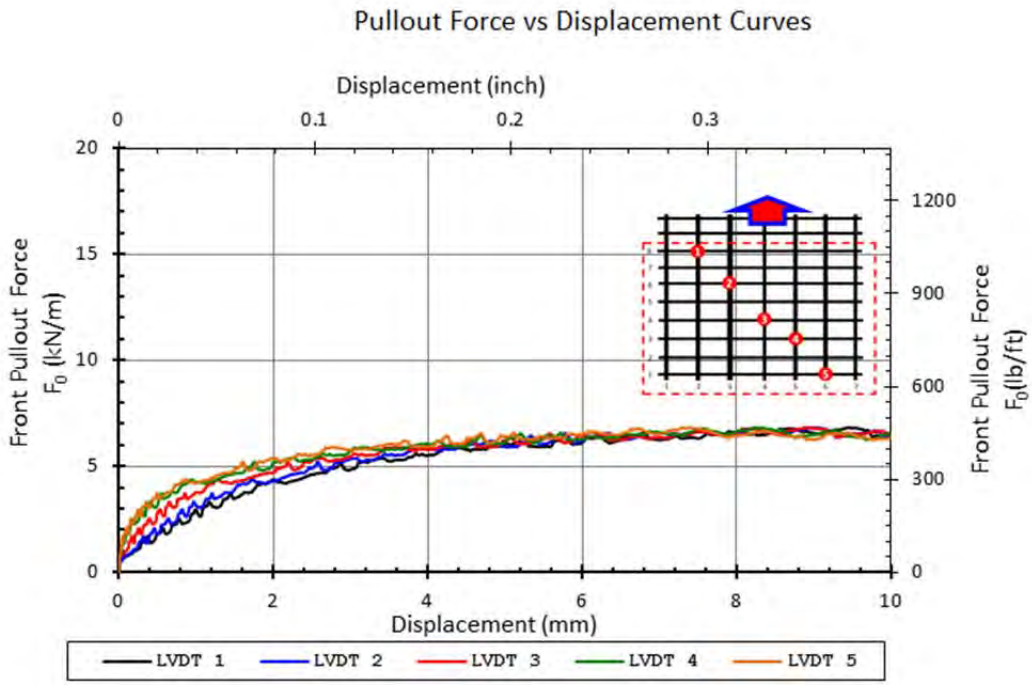
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.524 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

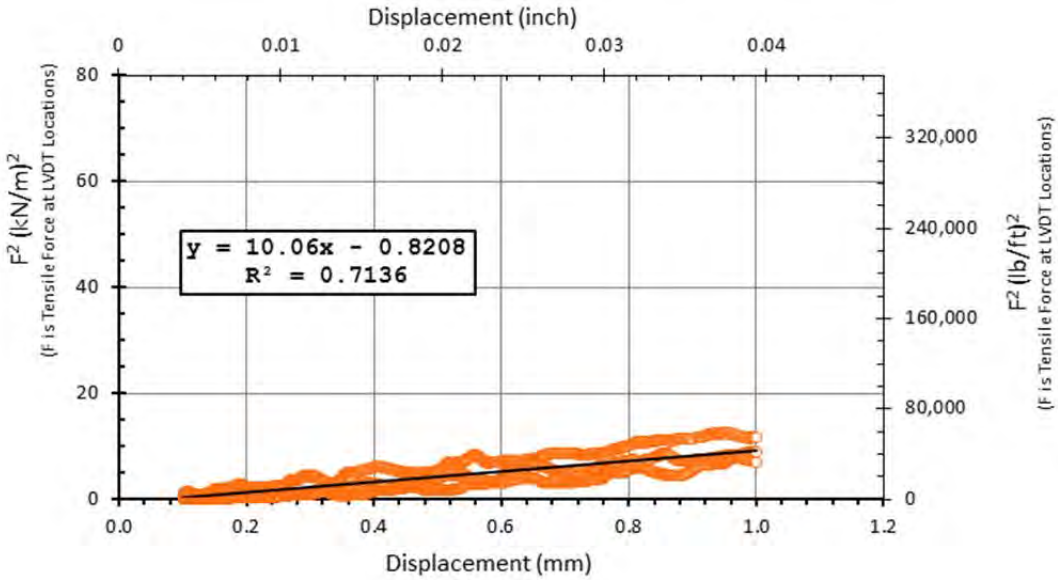
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.8	kN/m	467	lb/ft
Max Pullout Load	P_{max}	1.81	kN	451	lb
Max Shear Stress	τ_{max}	24.3	kPa	3.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/12/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	0.7	0.028
2	45.8	1.804
3	90.3	3.556
4	134.9	5.310
5	222.6	8.765

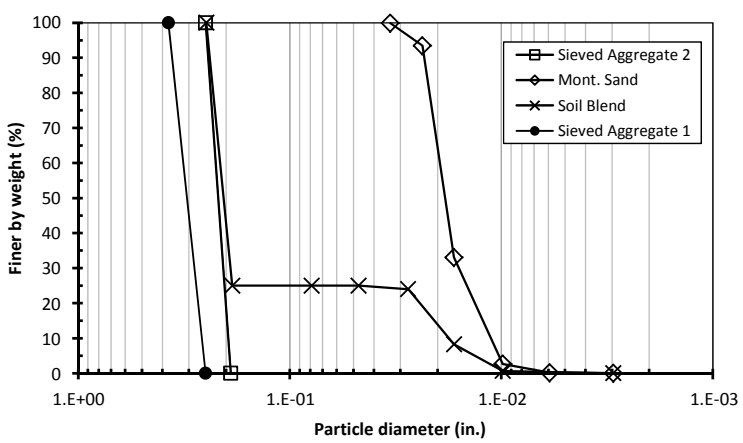
Pullout Rate	
1.0 mm/min.	0.04 in/min

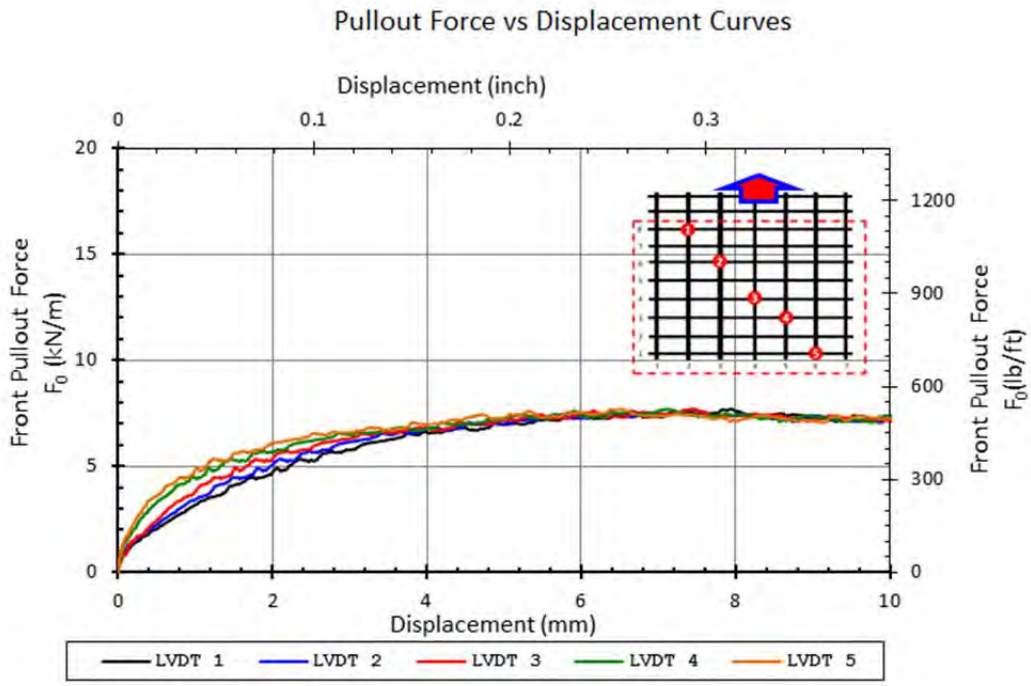
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

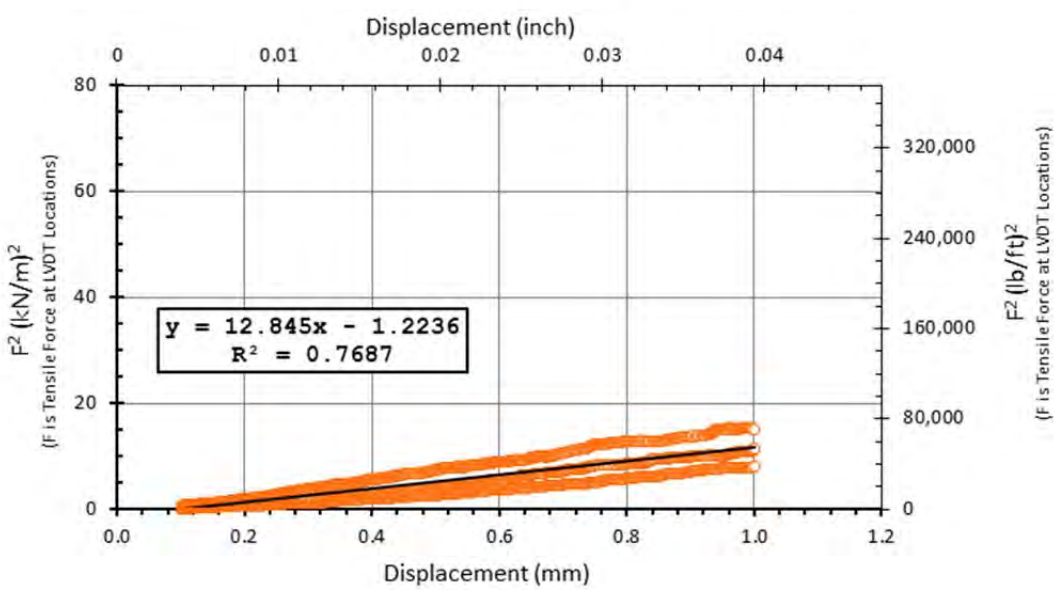
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.7	kN/m	528	lb/ft
Max Pullout Load	P_{max}	2.04	kN	490	lb
Max Shear Stress	τ_{max}	27.4	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
12.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/14/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.265	m	0.245	m
	9	0.915	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.4	0.726
2	58.3	2.295
3	99.1	3.901
4	139.4	5.488
5	222.3	8.752

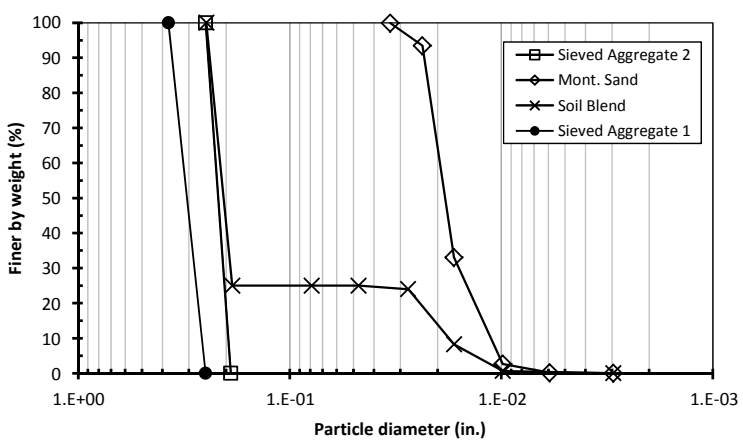
Pullout Rate	
1.0 mm/min.	0.04 in/min

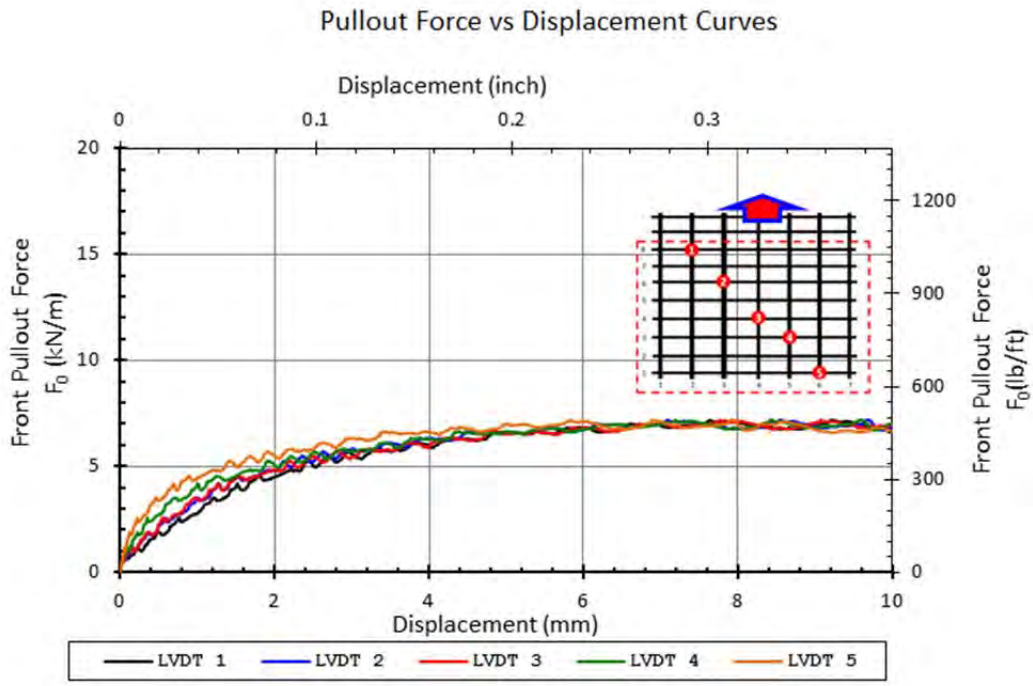
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

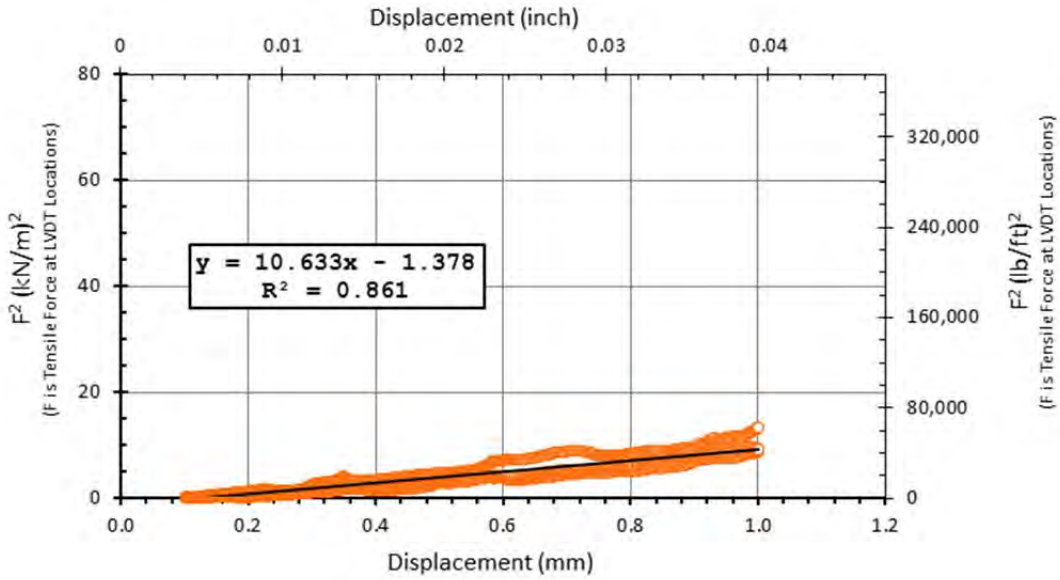
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	493	lb/ft
Max Pullout Load	P_{max}	1.90	kN	470	lb
Max Shear Stress	τ_{max}	25.6	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/17/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.265	m	0.245	m
	9	0.915	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	3.0	0.118
2	47.9	1.885
3	92.5	3.641
4	137.0	5.394
5	223.5	8.799

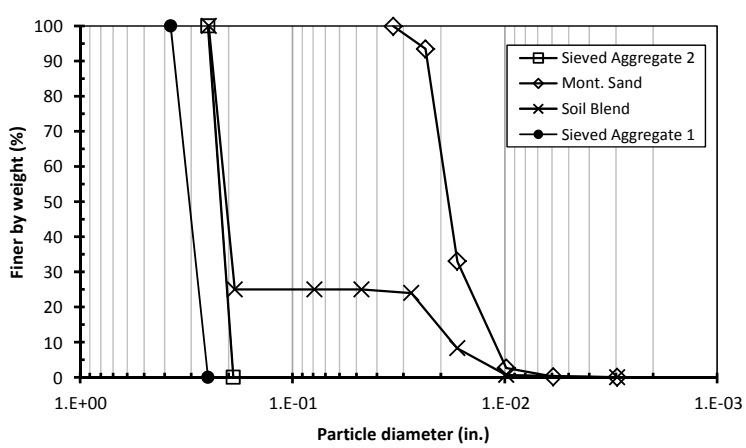
Pullout Rate	
1.0 mm/min.	0.04 in/min

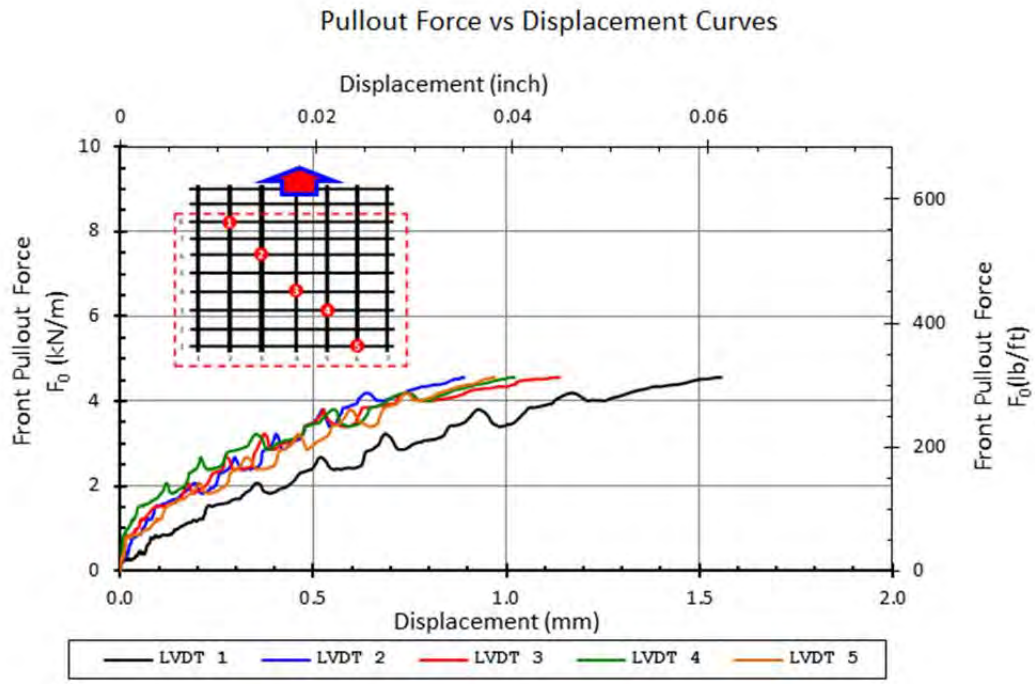
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

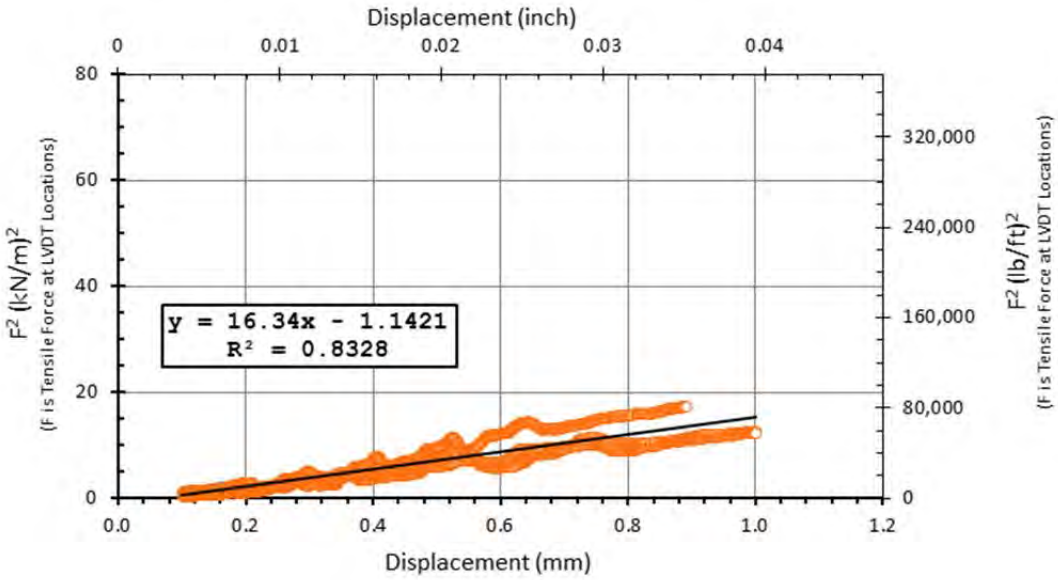
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
16.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/18/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.9	0.470
2	53.7	2.113
3	94.6	3.725
4	136.5	5.374
5	222.0	8.739

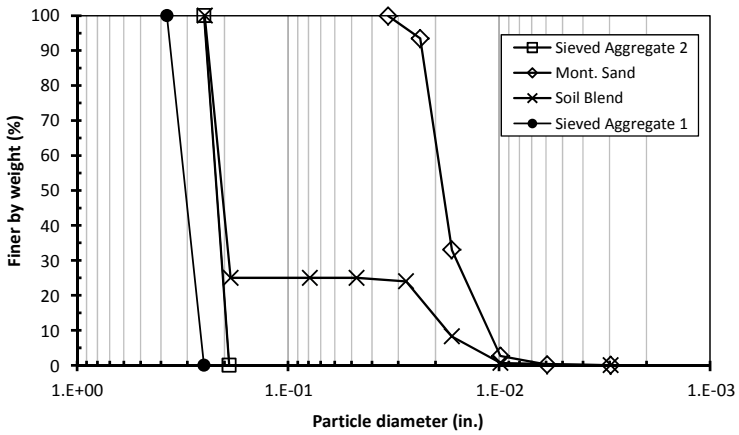
Pullout Rate	
1.0 mm/min.	0.04 in/min

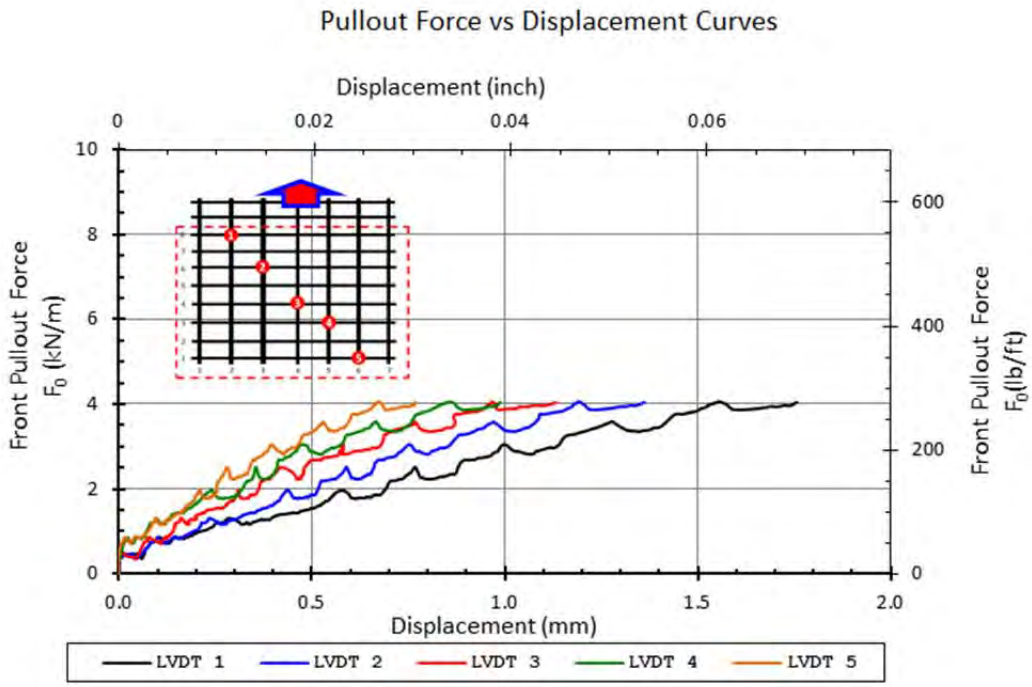
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

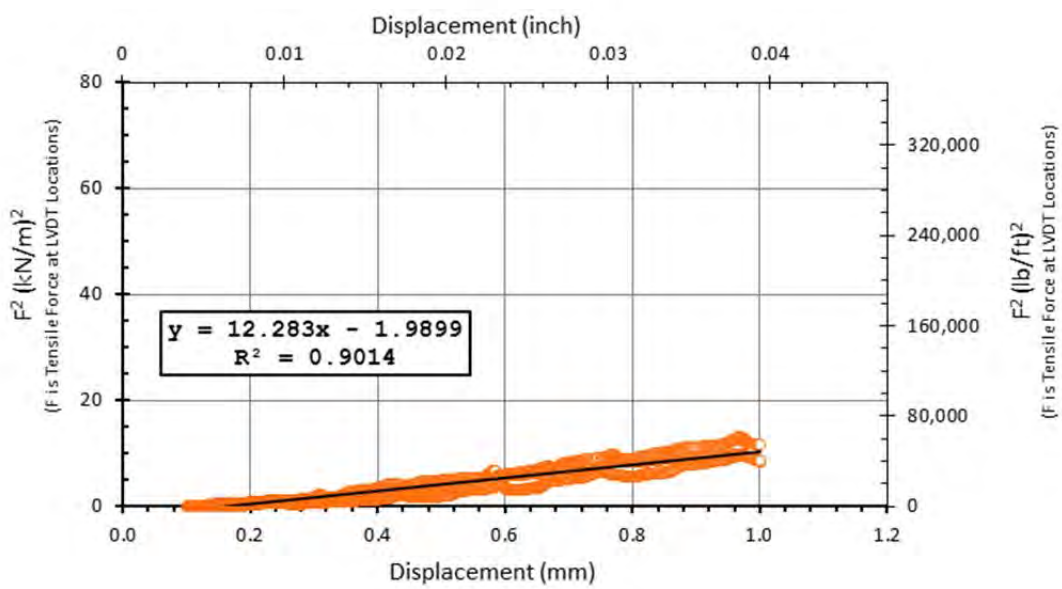
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
12.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	6/11/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.3	0.405
2	51.8	2.038
3	94.0	3.699
4	136.5	5.372
5	221.9	8.735

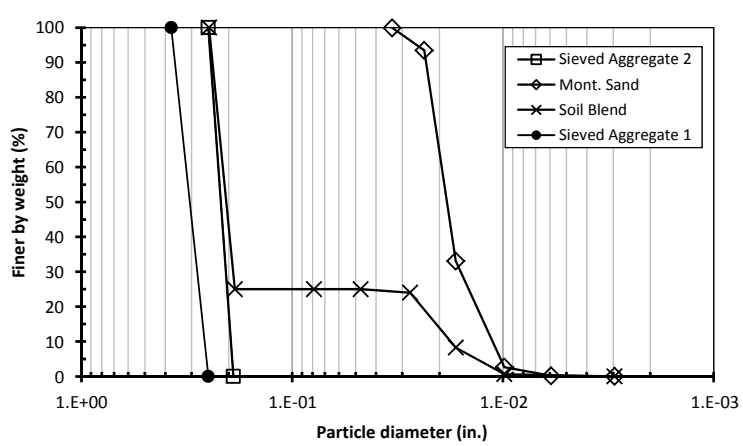
Pullout Rate	
1.0 mm/min.	0.04 in/min

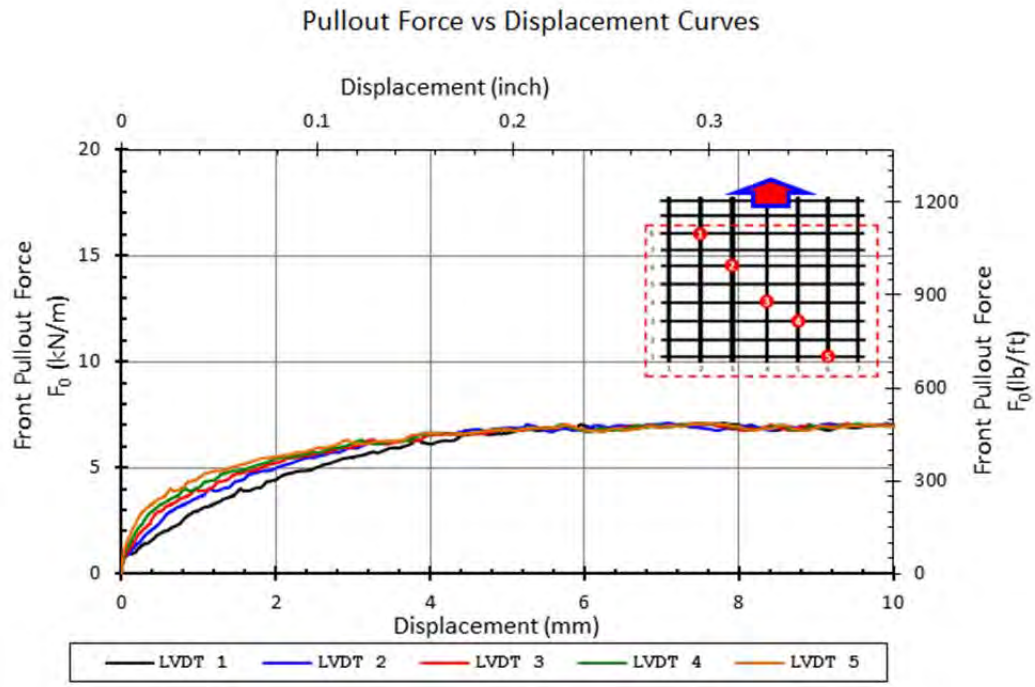
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

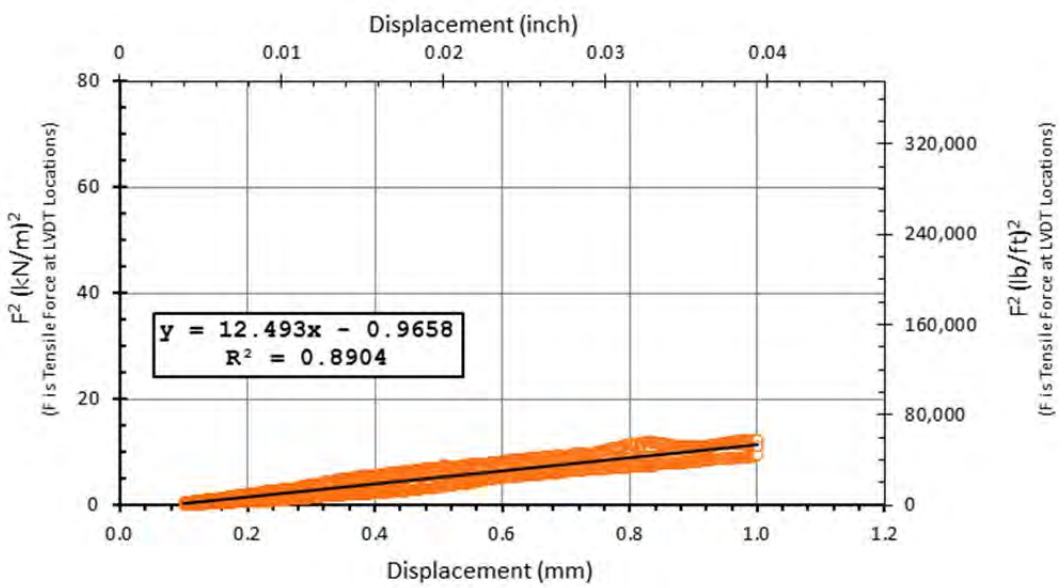
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	487	lb/ft
Max Pullout Load	P_{max}	1.88	kN	459	lb
Max Shear Stress	τ_{max}	25.3	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
12.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	6/12/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.265	m	0.245	m
	9	0.922	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-1.9	-0.077
2	43.0	1.694
3	88.1	3.469
4	131.6	5.181
5	221.3	8.713

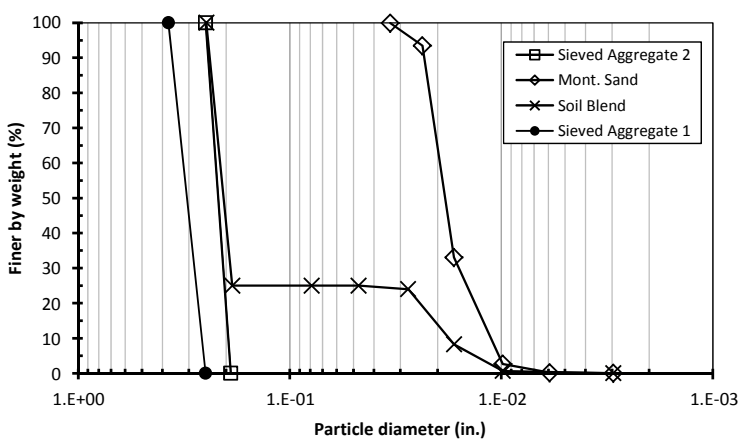
Pullout Rate	
1.0 mm/min.	0.04 in/min

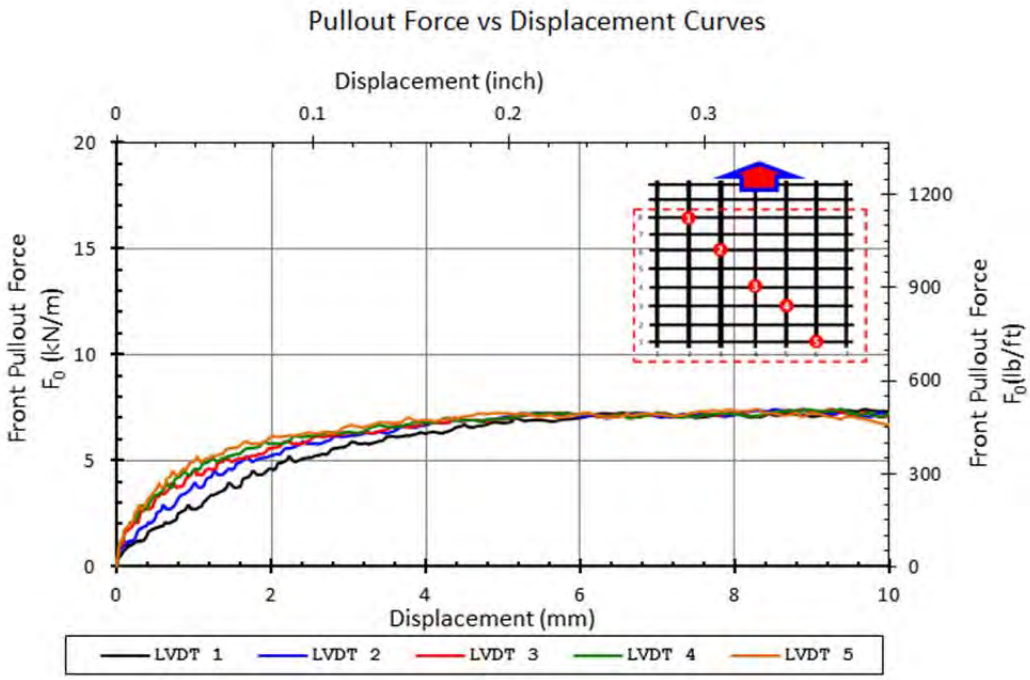
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

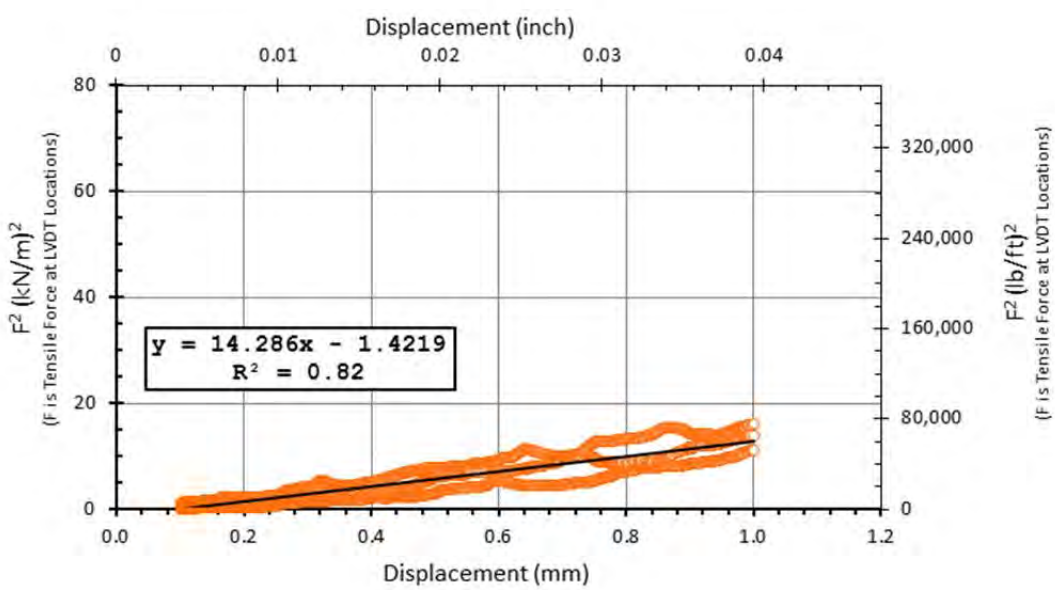
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	509	lb/ft
Max Pullout Load	P_{max}	1.97	kN	464	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
14.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 5 a small distance off to the right.

SMALL PULLOUT TEST

Date test conducted	6/13/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.265	m	0.245	m
	9	0.922	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.9	0.585
2	54.3	2.137
3	95.8	3.770
4	136.7	5.381
5	220.6	8.685

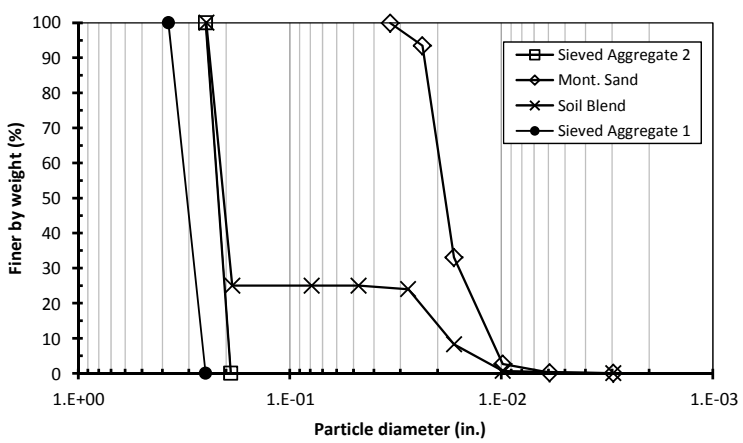
Pullout Rate	
1.0 mm/min.	0.04 in/min

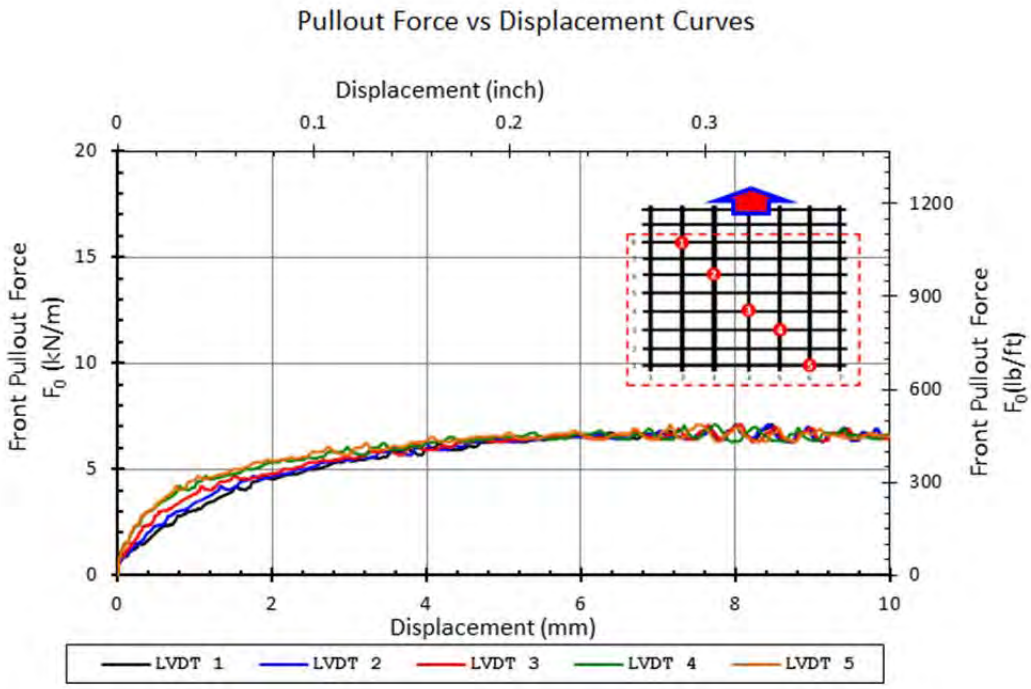
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.538 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

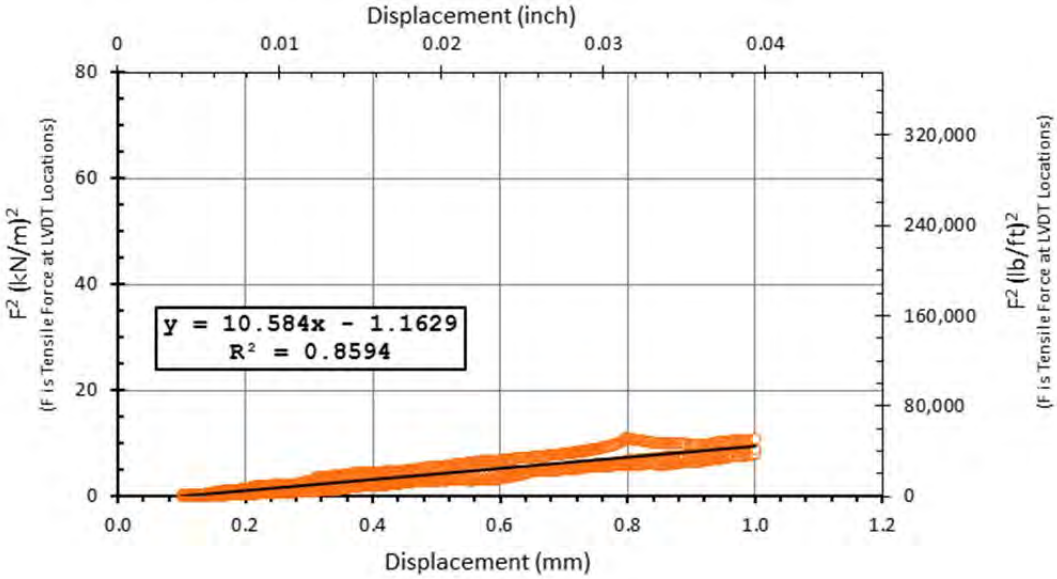
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	487	lb/ft
Max Pullout Load	P_{max}	1.88	kN	456	lb
Max Shear Stress	τ_{max}	25.3	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	6/15/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.6	0.574
2	55.3	2.177
3	96.5	3.800
4	138.2	5.441
5	222.2	8.748

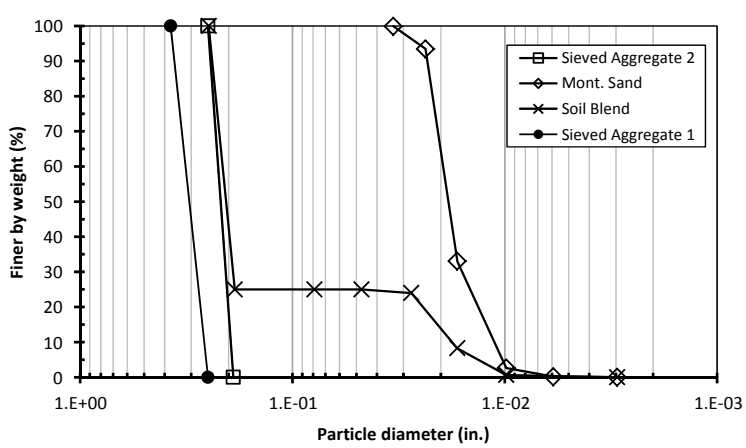
Pullout Rate	
1.0 mm/min.	0.04 in/min

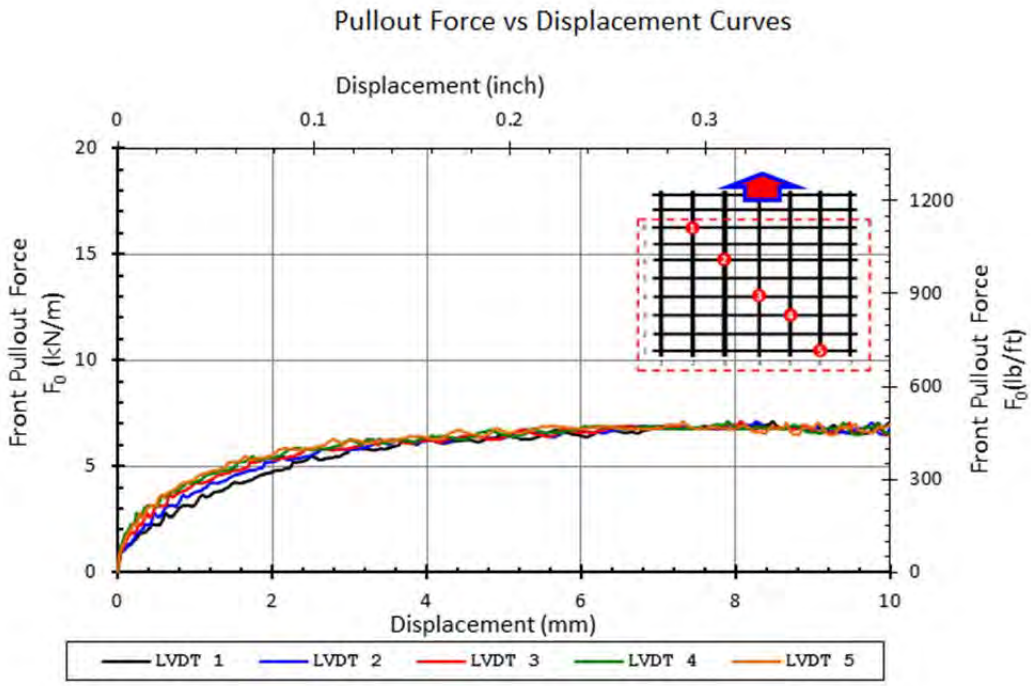
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

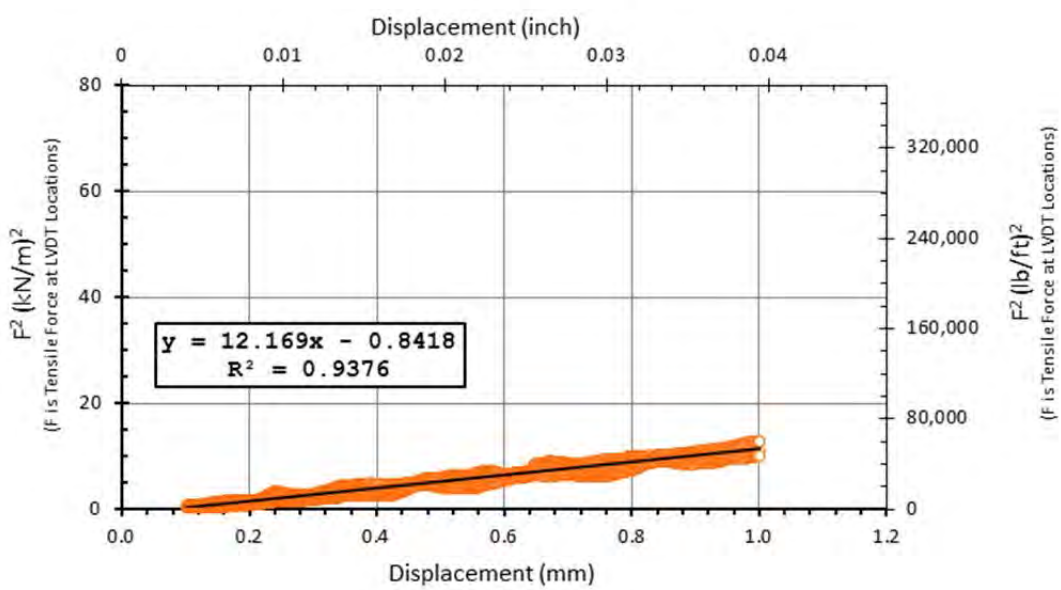
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	491	lb/ft
Max Pullout Load	P_{max}	1.90	kN	449	lb
Max Shear Stress	τ_{max}	25.5	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
12.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	6/18/2012
Done by	Daniel

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.265	m	0.245	m
	9	0.922	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	4.7	0.186
2	49.6	1.952
3	92.7	3.650
4	136.0	5.355
5	221.5	8.720

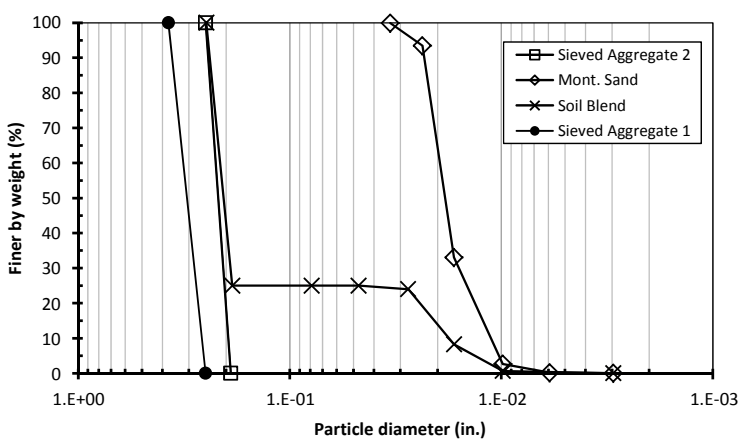
Pullout Rate	
1.0 mm/min.	0.04 in/min

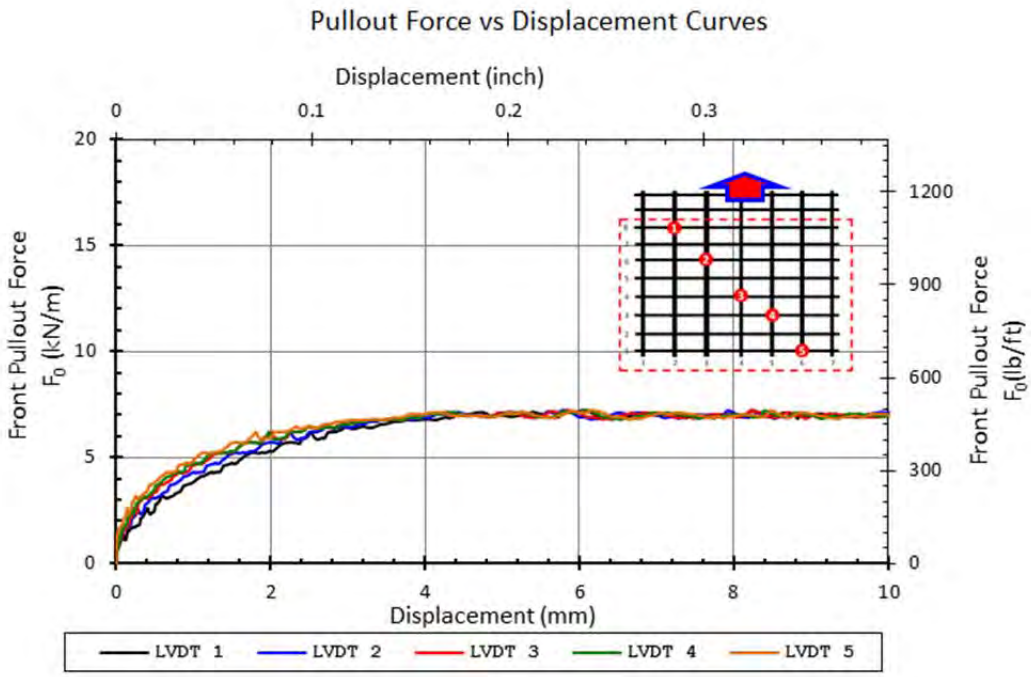
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

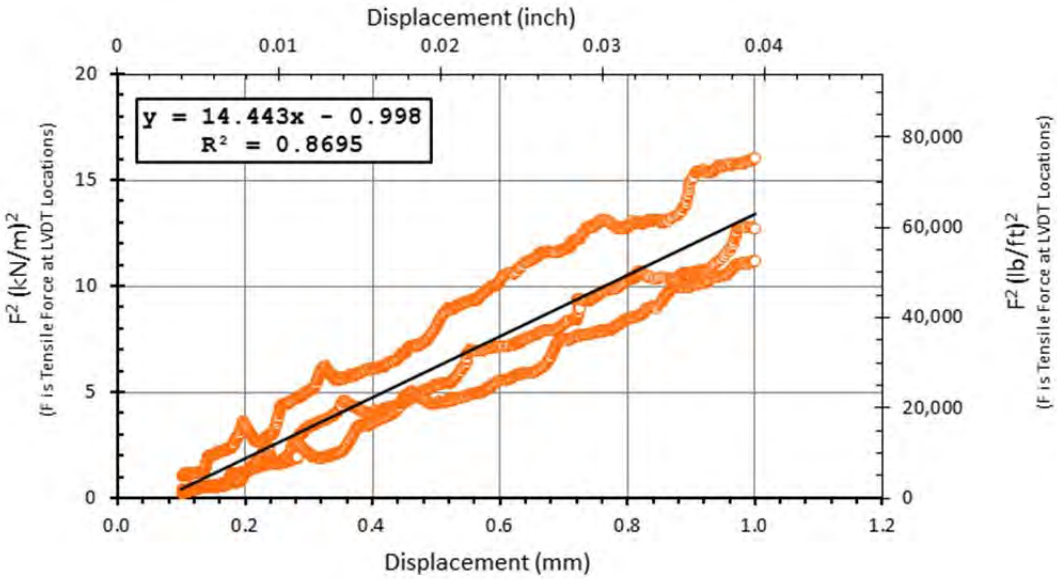
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.7	kN/m	528	lb/ft
Max Pullout Load	P_{max}	2.04	kN	477	lb
Max Shear Stress	τ_{max}	27.4	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
14.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

First test performed by Daniel. LVDT 1 off to the left

SMALL PULLOUT TEST

Date test conducted	3/19/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.8	0.700
2	69.3	2.728
3	104.1	4.099
4	137.7	5.420
5	221.6	8.726

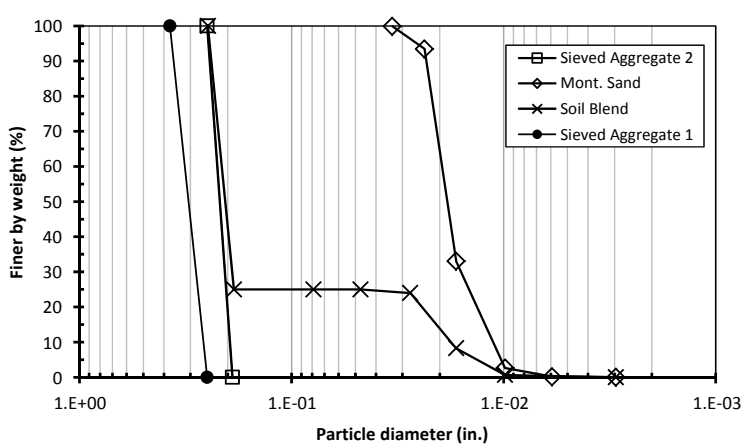
Pullout Rate	
1.0 mm/min.	0.04 in/min

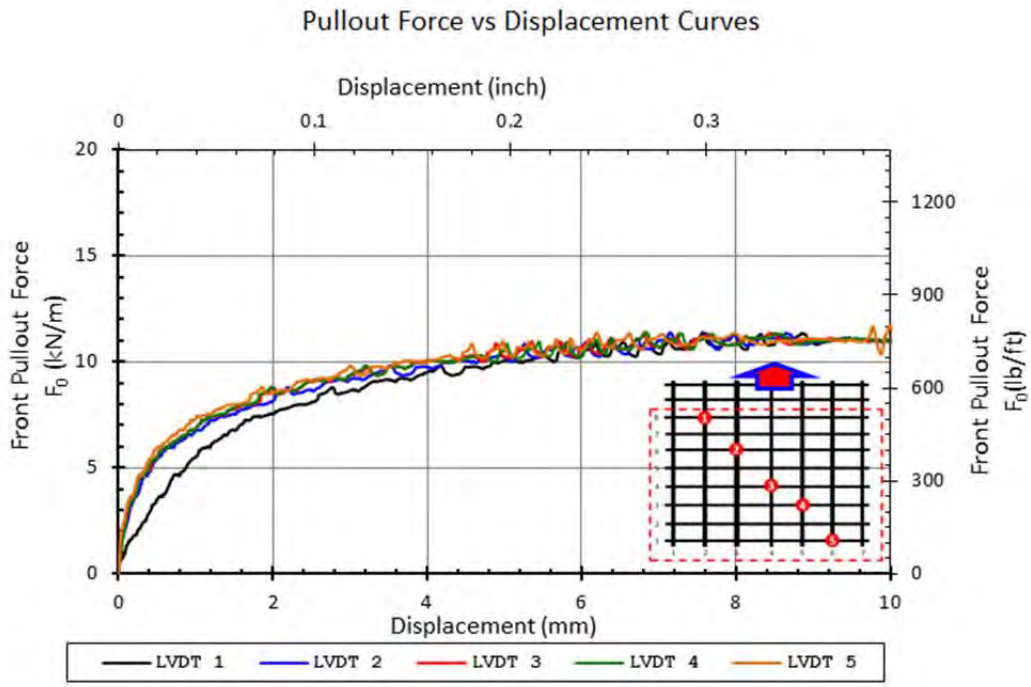
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

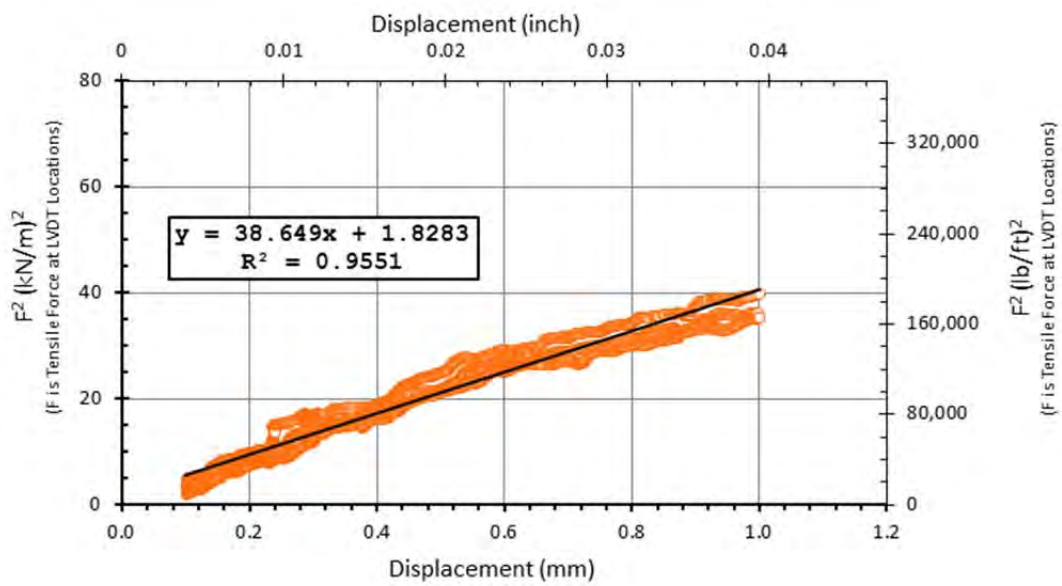
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.0	kN/m	823	lb/ft
Max Pullout Load	P_{max}	2.53	kN	600	lb
Max Shear Stress	τ_{max}	34.1	kPa	4.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
38.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/19/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.1	0.516
2	65.2	2.566
3	100.1	3.940
4	134.1	5.281
5	218.7	8.611

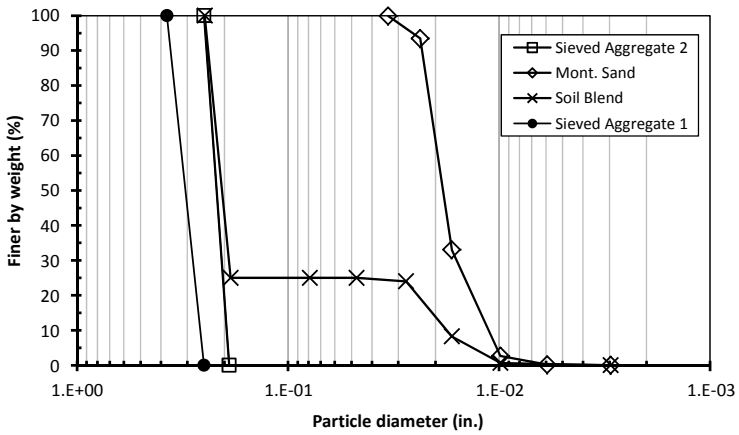
Pullout Rate	
1.0 mm/min.	0.04 in/min

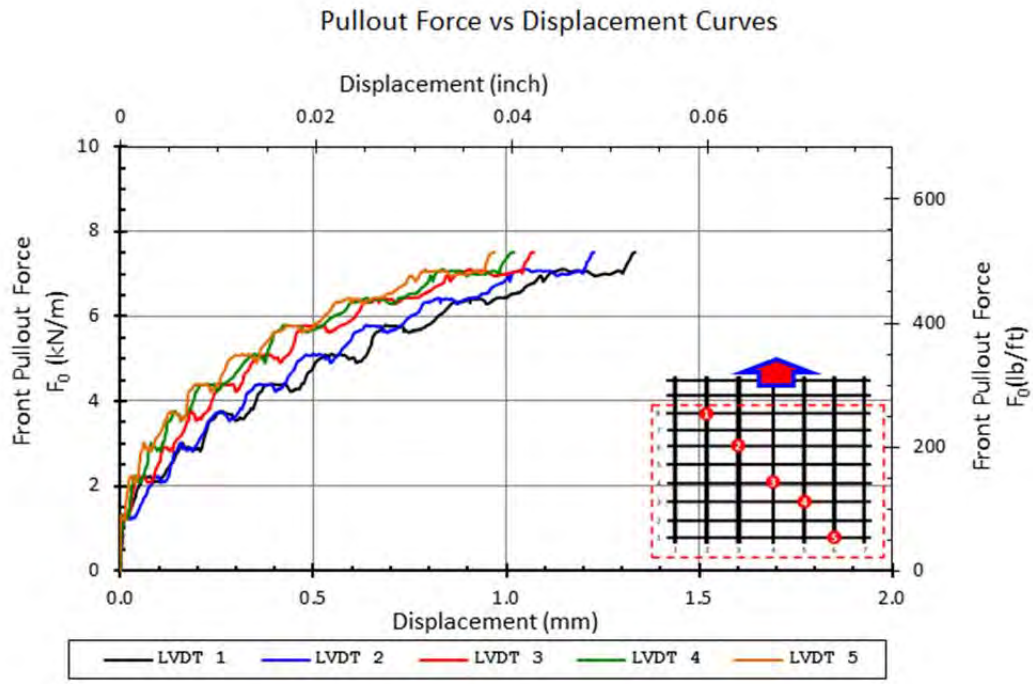
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

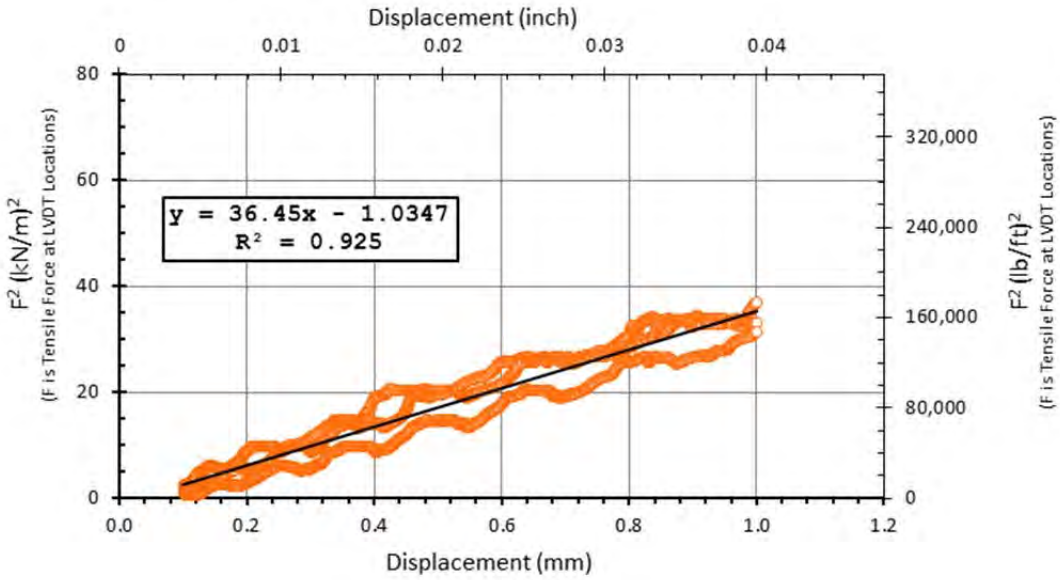
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
36.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Grip slightly slanted right.

SMALL PULLOUT TEST

Date test conducted	4/20/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.4	0.528
2	65.1	2.563
3	99.4	3.914
4	132.9	5.233
5	218.0	8.583

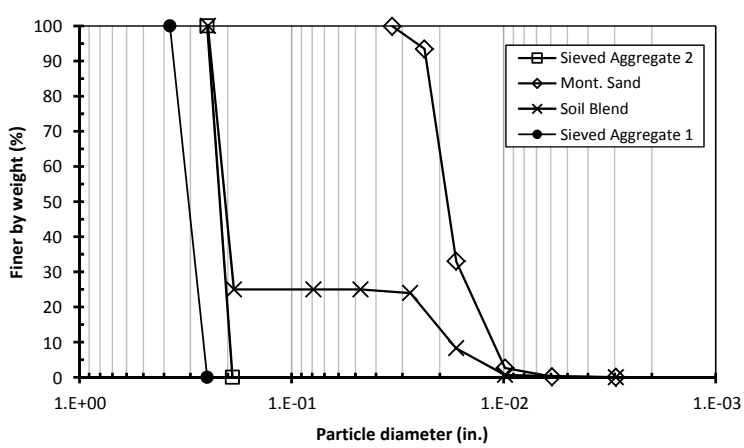
Pullout Rate	
1.0 mm/min.	0.04 in/min

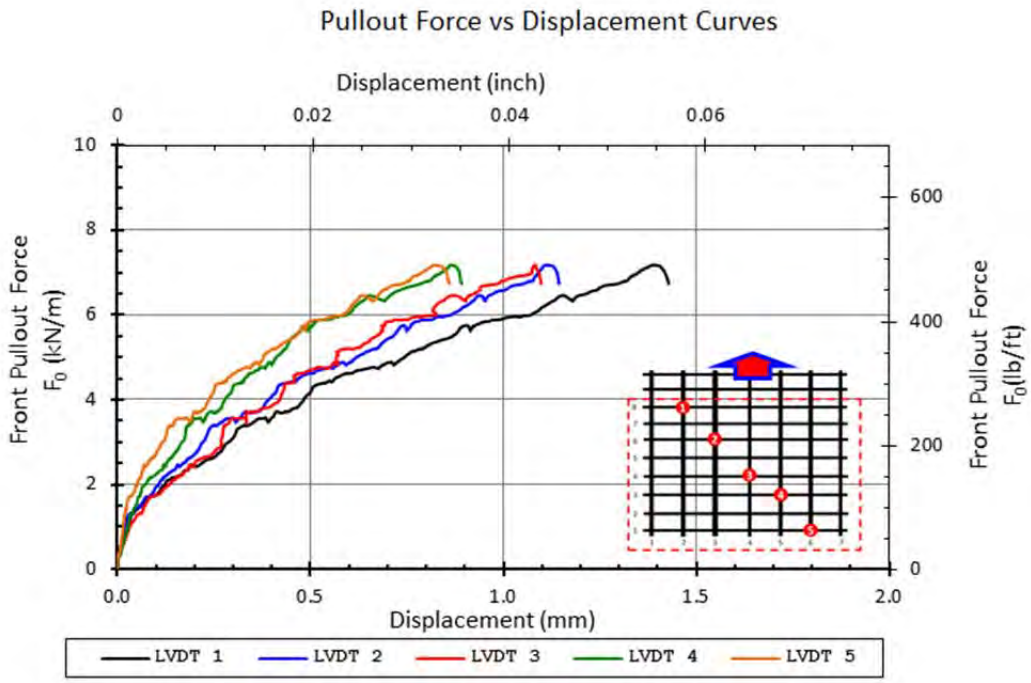
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

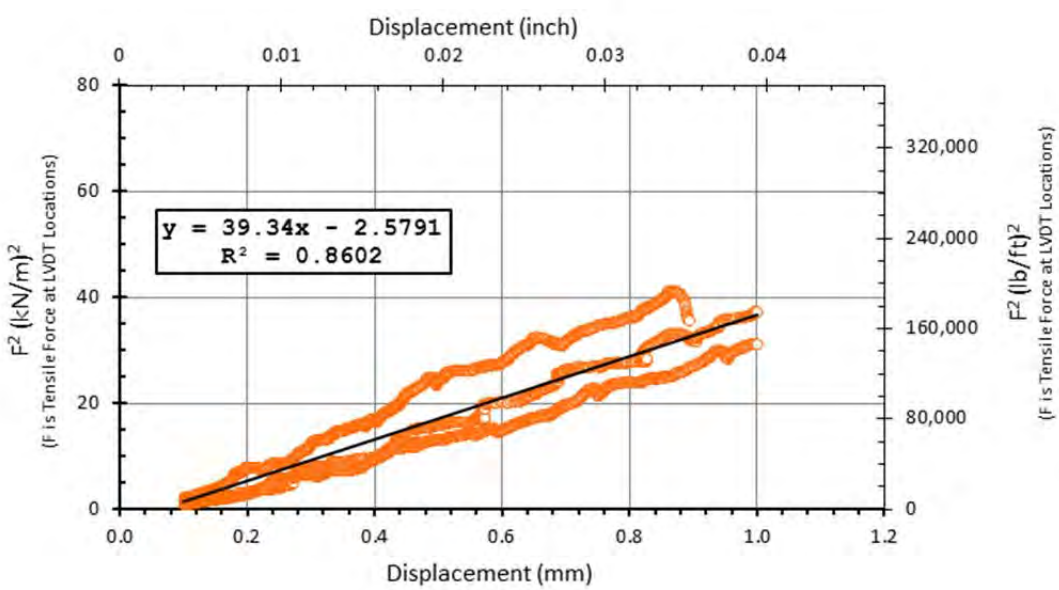
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
39.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	5/3/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.9	0.467
2	63.1	2.486
3	97.7	3.846
4	132.7	5.223
5	217.6	8.567

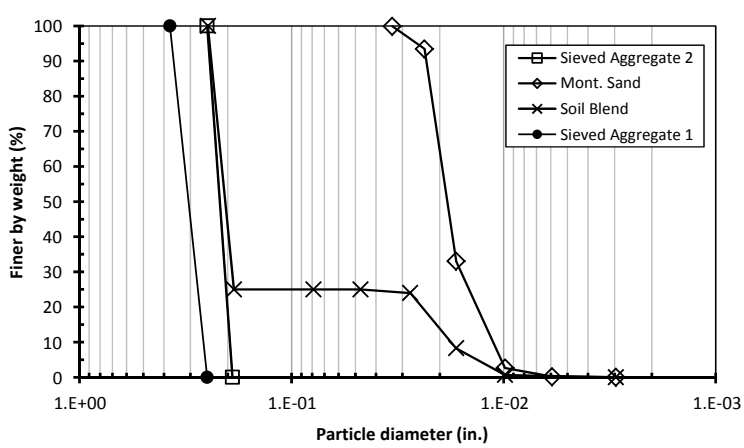
Pullout Rate	
1.0 mm/min.	0.04 in/min

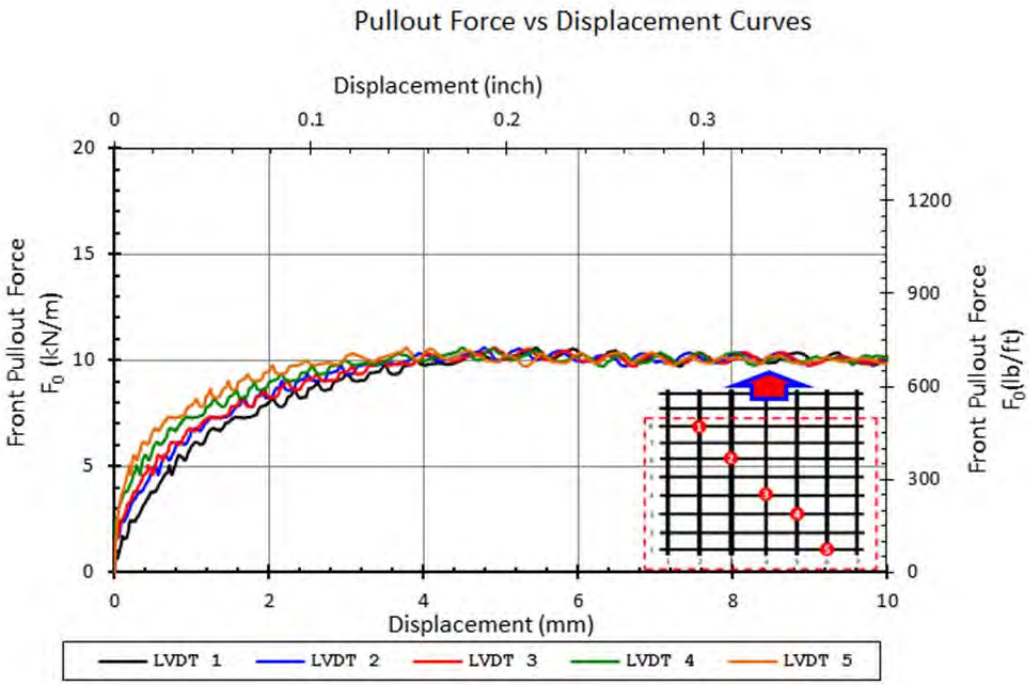
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

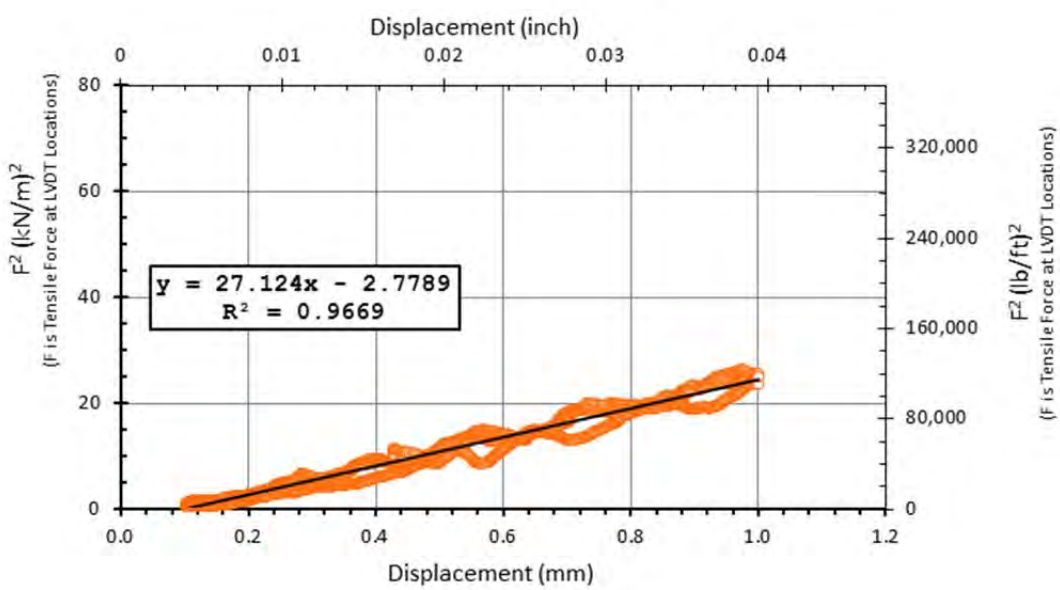
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.2	kN/m	767	lb/ft
Max Pullout Load	P_{max}	2.36	kN	561	lb
Max Shear Stress	τ_{max}	31.7	kPa	4.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
27.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	5/6/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.1	0.438
2	63.3	2.494
3	96.9	3.816
4	131.0	5.156
5	215.4	8.480

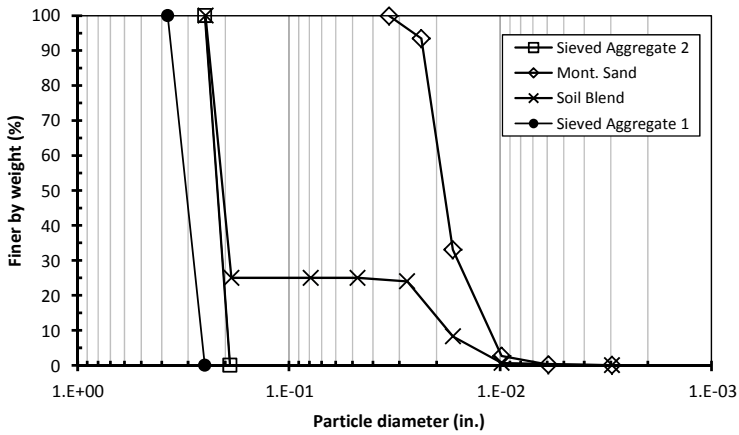
Pullout Rate			
1.0	mm/min.	0.04	in/min

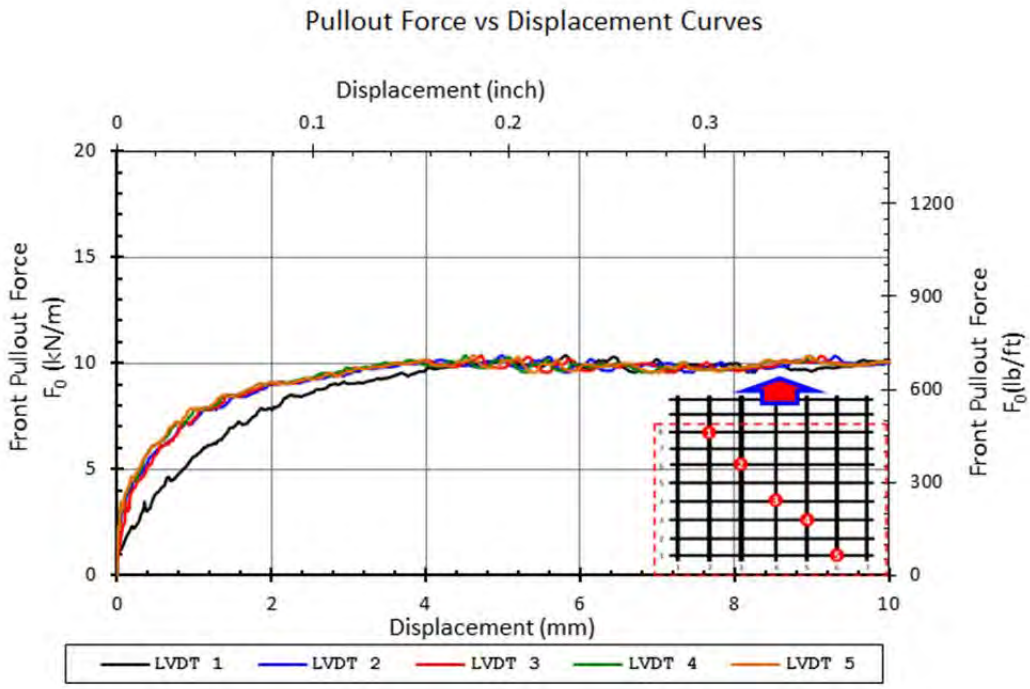
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.551 **g/cm^3**	**97**	**pcf**

Note: particle size distribution curve shown below

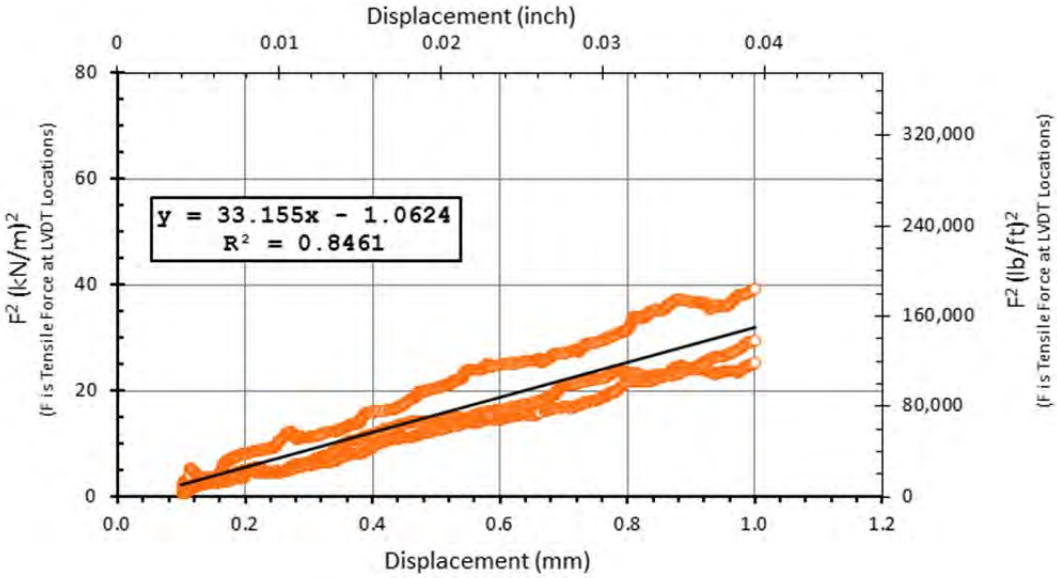
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.5	kN/m	720	lb/ft
Max Pullout Load	P_{max}	2.22	kN	538	lb
Max Shear Stress	τ_{max}	29.8	kPa	4.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
33.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	02/27/12 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.286	m	0.304	m	0.245	m
	7	0.938	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	2.6	0.102
2	55.5	2.183
3	108.8	4.285
4	161.6	6.361
5	217.4	8.558

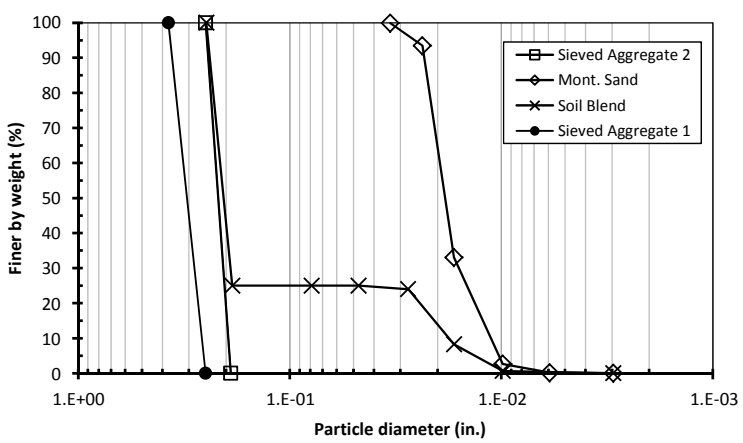
Pullout Rate	
1.0 mm/min.	0.04 in/min

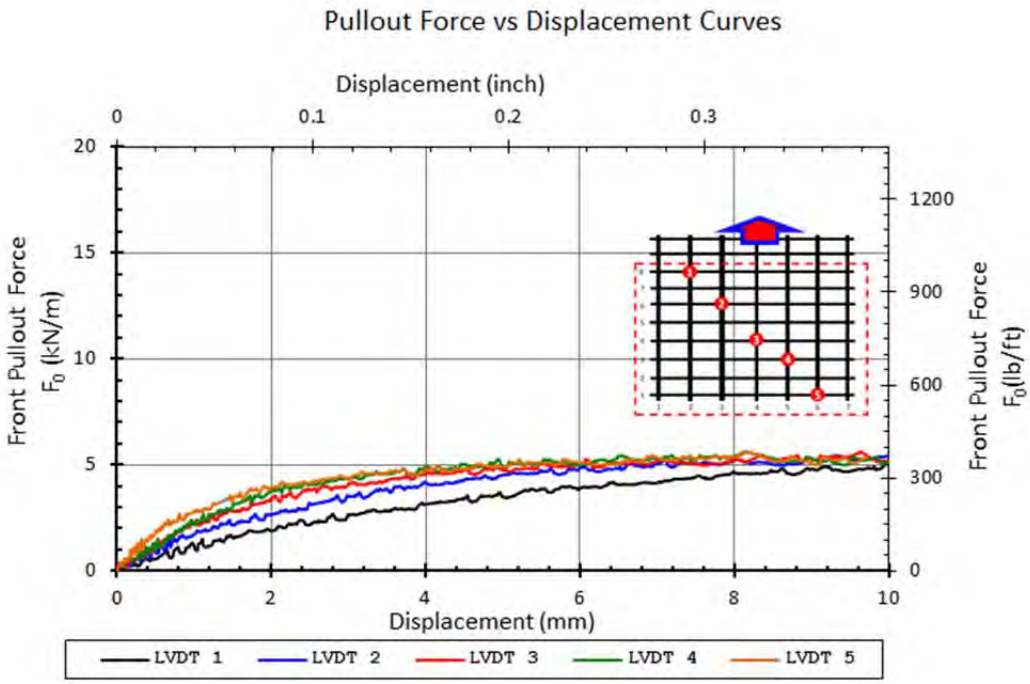
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

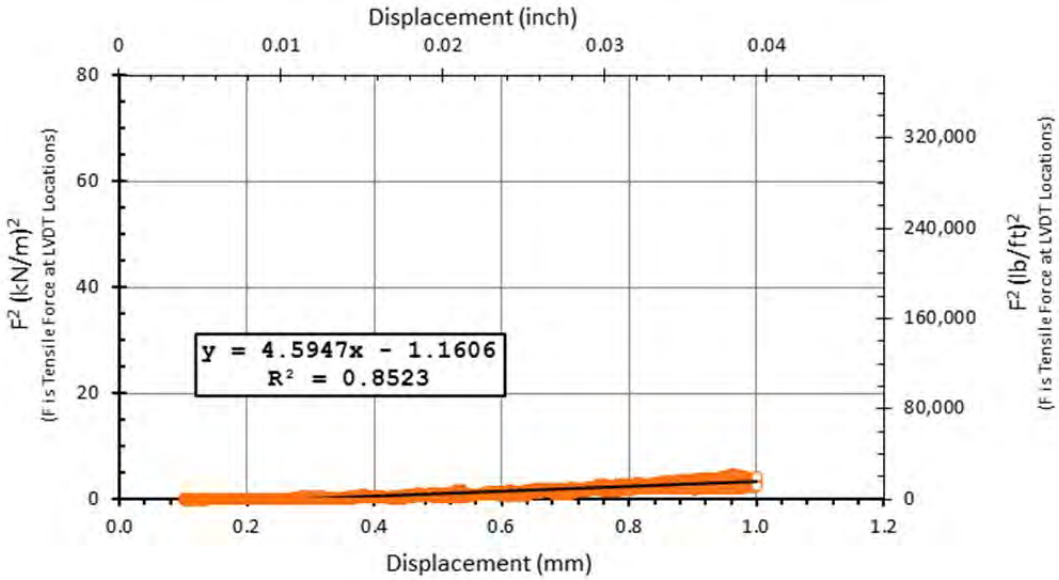
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.6	kN/m	385	lb/ft
Max Pullout Load	P_{max}	1.71	kN	428	lb
Max Shear Stress	τ_{max}	23.0	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
4.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	02/27/12 PM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.304	m	0.245	m
	7	0.935	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.7	0.777
2	73.6	2.899
3	127.4	5.017
4	181.2	7.135
5	234.9	9.249

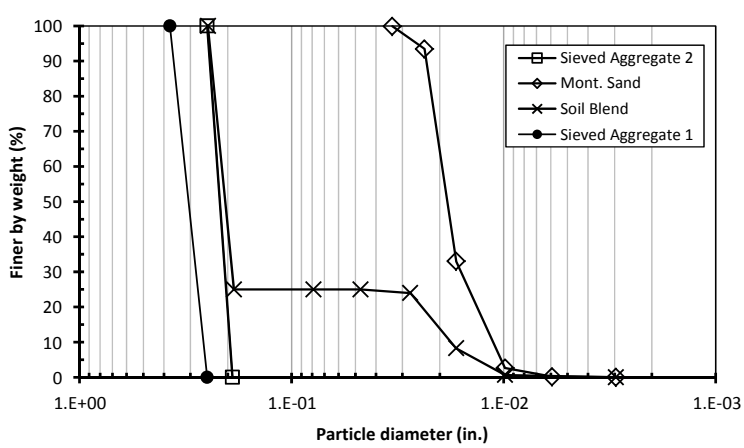
Pullout Rate	
1.0 mm/min.	0.04 in/min

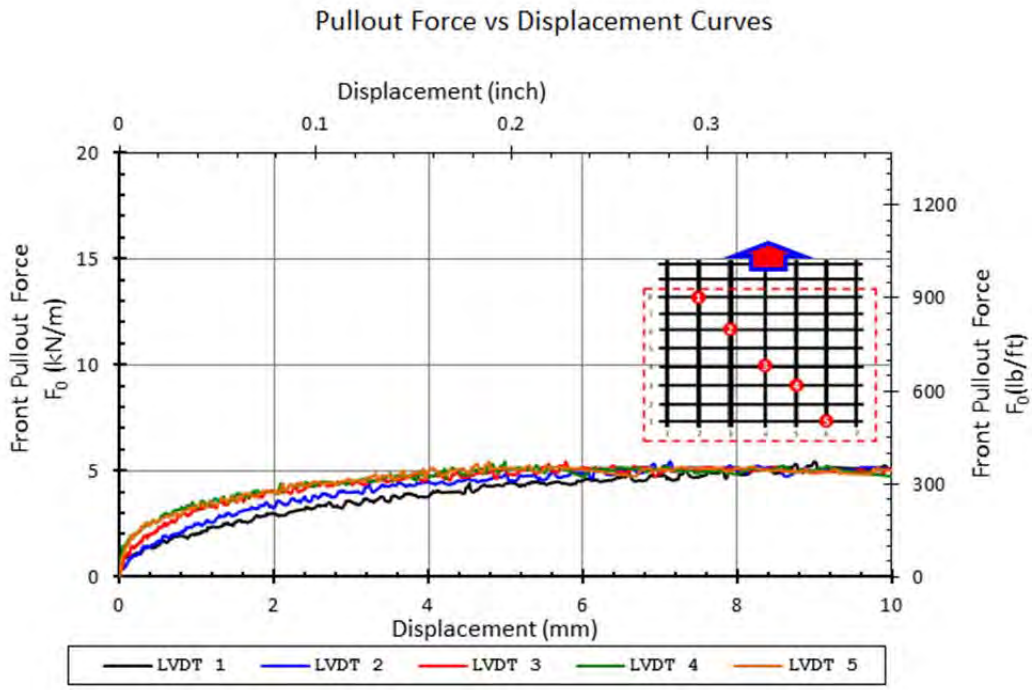
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

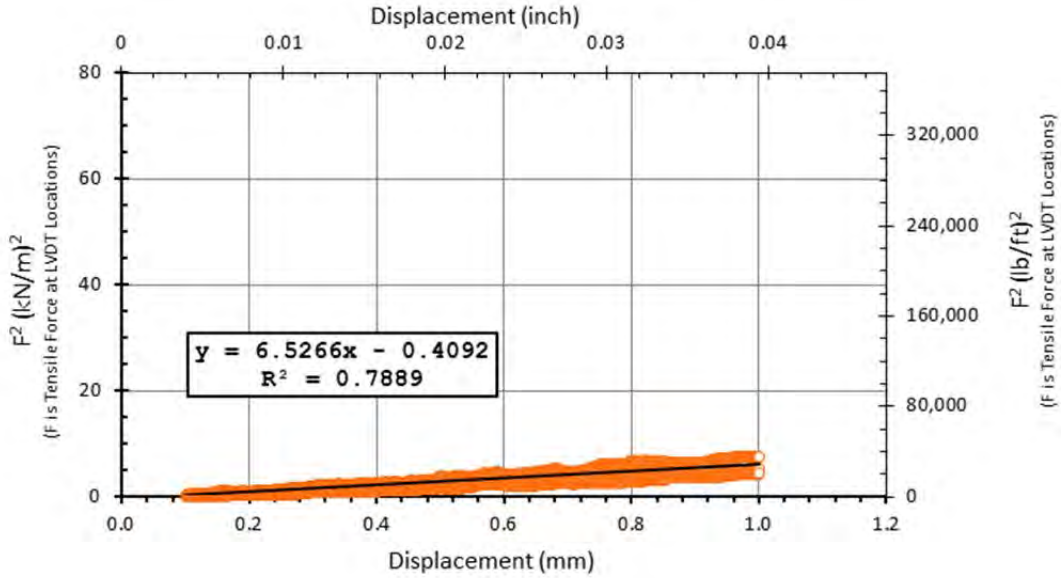
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.4	kN/m	372	lb/ft
Max Pullout Load	P_{max}	1.65	kN	409	lb
Max Shear Stress	τ_{max}	22.2	kPa	3.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
6.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 5 off to the right

SMALL PULLOUT TEST

Date test conducted	2/28/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.289	m	0.304	m	0.245	m
	7	0.948	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	2.4	0.096
2	56.2	2.212
3	110.1	4.334
4	165.2	6.506
5	218.4	8.598

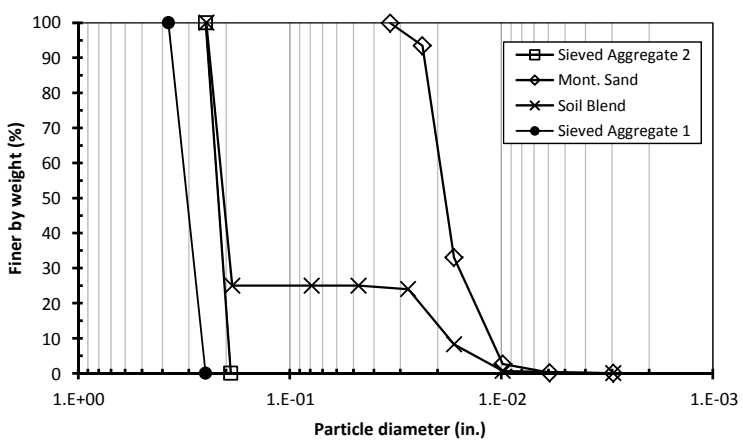
Pullout Rate	
1.0 mm/min.	0.04 in/min

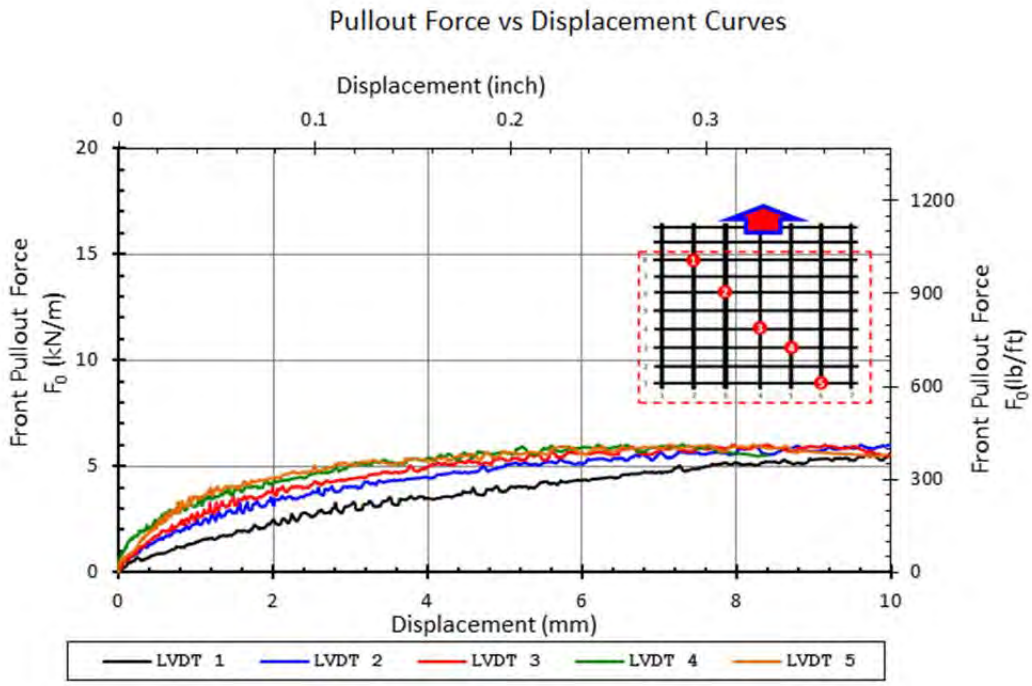
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

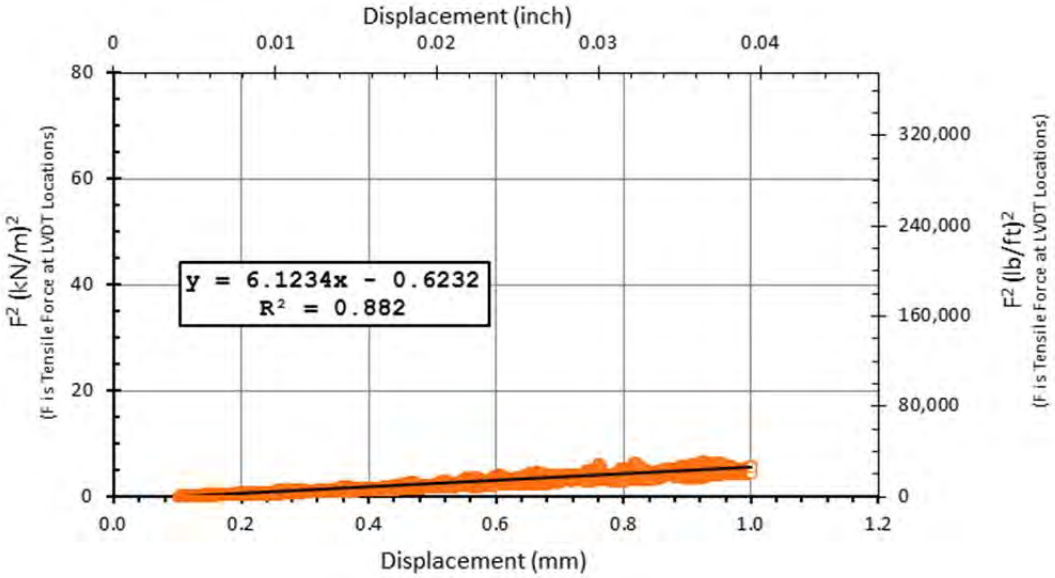
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.0	kN/m	413	lb/ft
Max Pullout Load	P_{max}	1.84	kN	438	lb
Max Shear Stress	τ_{max}	24.7	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
6.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

Sample slightly curved

SMALL PULLOUT TEST

Date test conducted	4/21/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.1	0.870
2	71.4	2.812
3	121.3	4.775
4	172.3	6.782
5	224.1	8.821

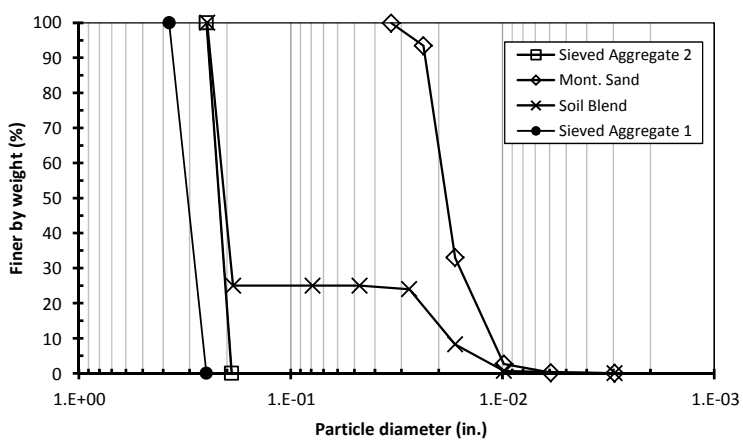
Pullout Rate	
1.0 mm/min.	0.04 in/min

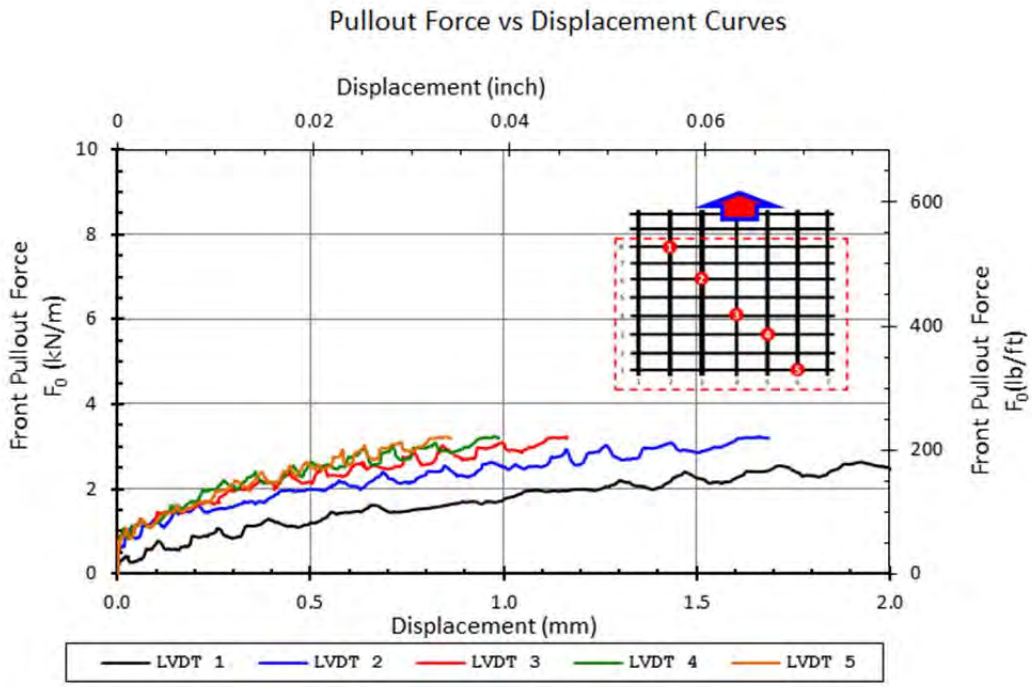
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

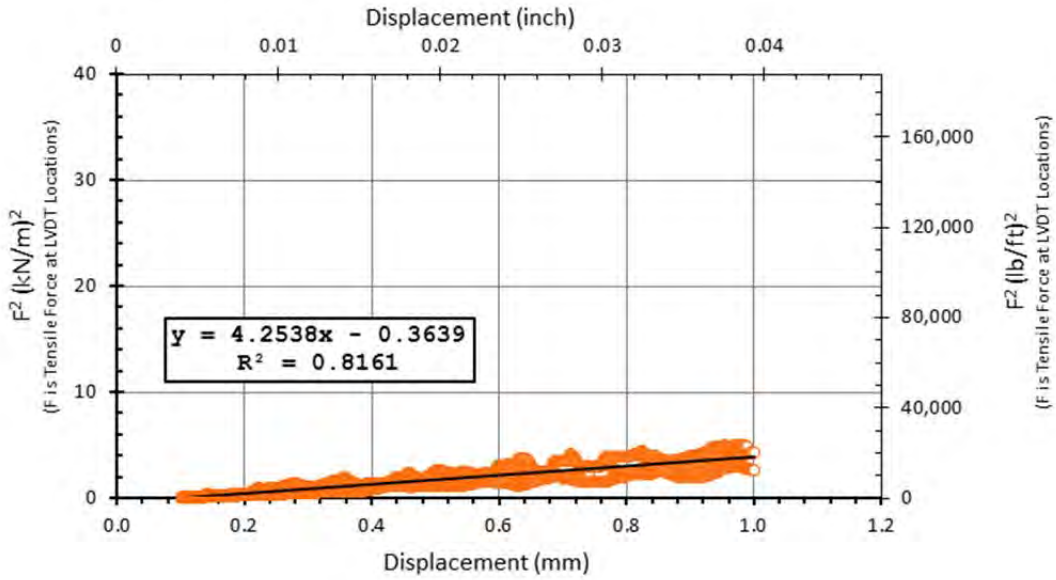
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
4.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test taken to only 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/24/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.304	m	0.245	m
	7	0.935	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.1	0.948
2	74.5	2.935
3	126.3	4.971
4	176.2	6.937
5	228.9	9.012

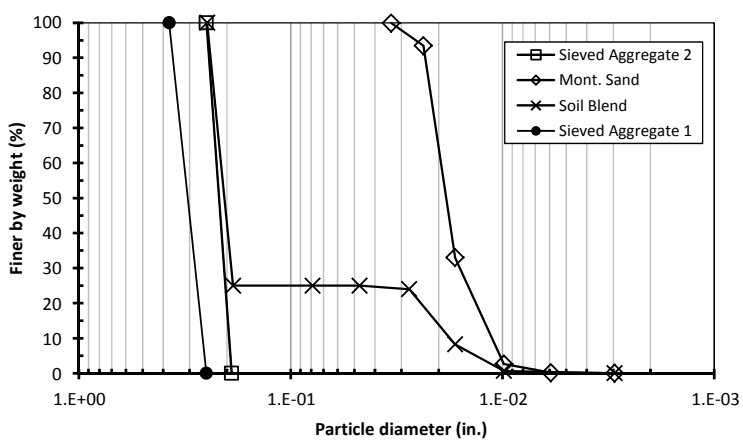
Pullout Rate	
1.0 mm/min.	0.04 in/min

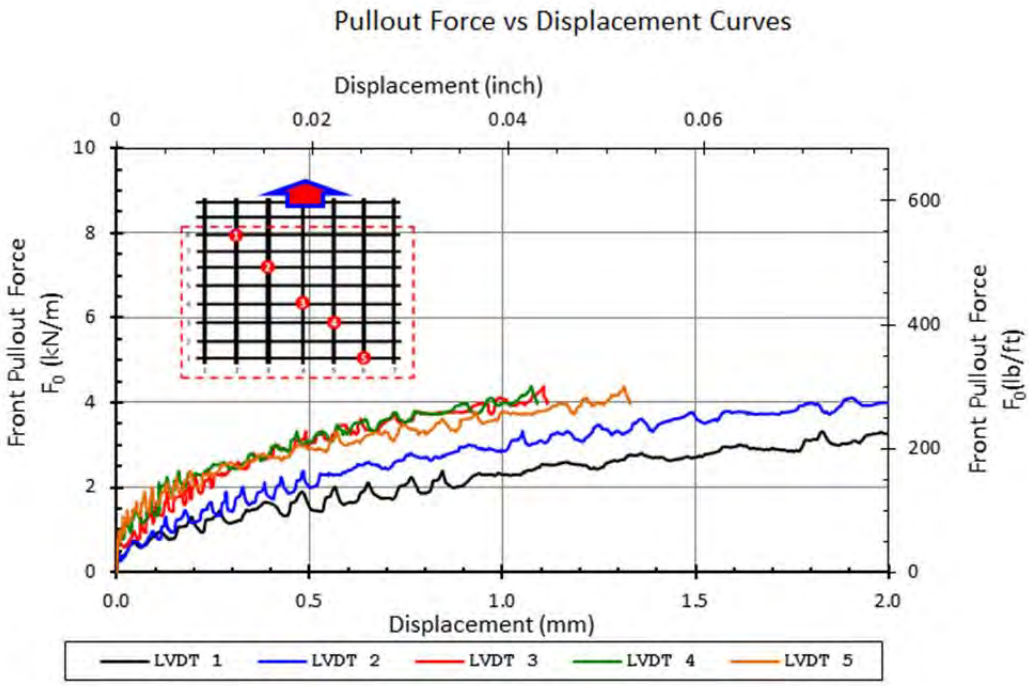
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

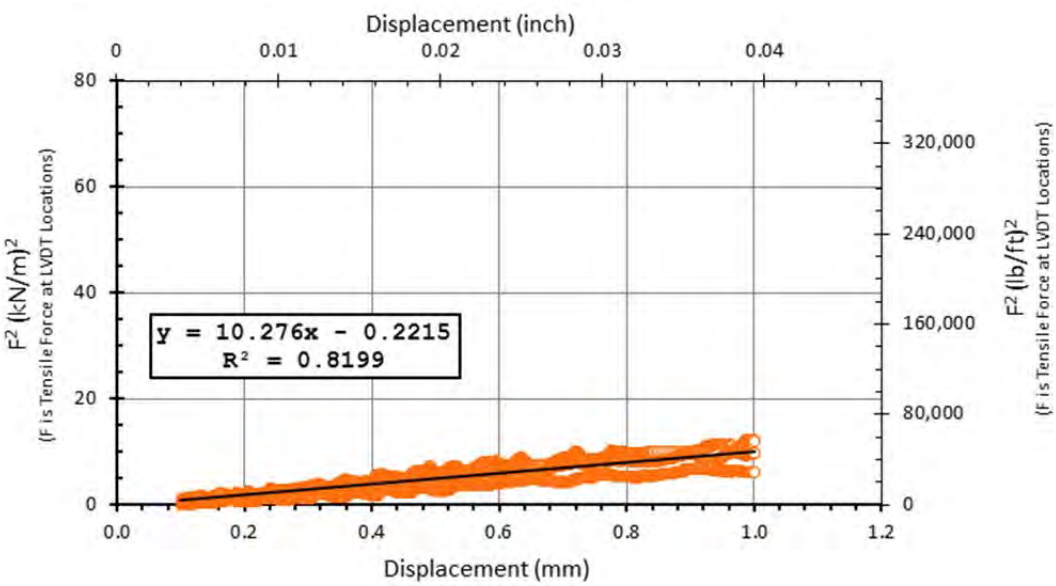
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 off slightly to the right. Grid slightly tilted right. Test conducted up to 1.1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	8/14/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.304	m	0.245	m
	7	0.922	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.3	0.760
2	69.7	2.743
3	121.7	4.789
4	172.0	6.770
5	223.3	8.793

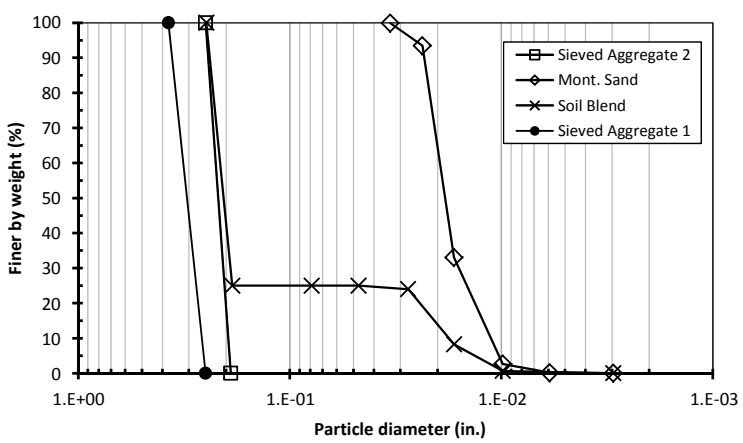
Pullout Rate	
1.0 mm/min.	0.04 in/min

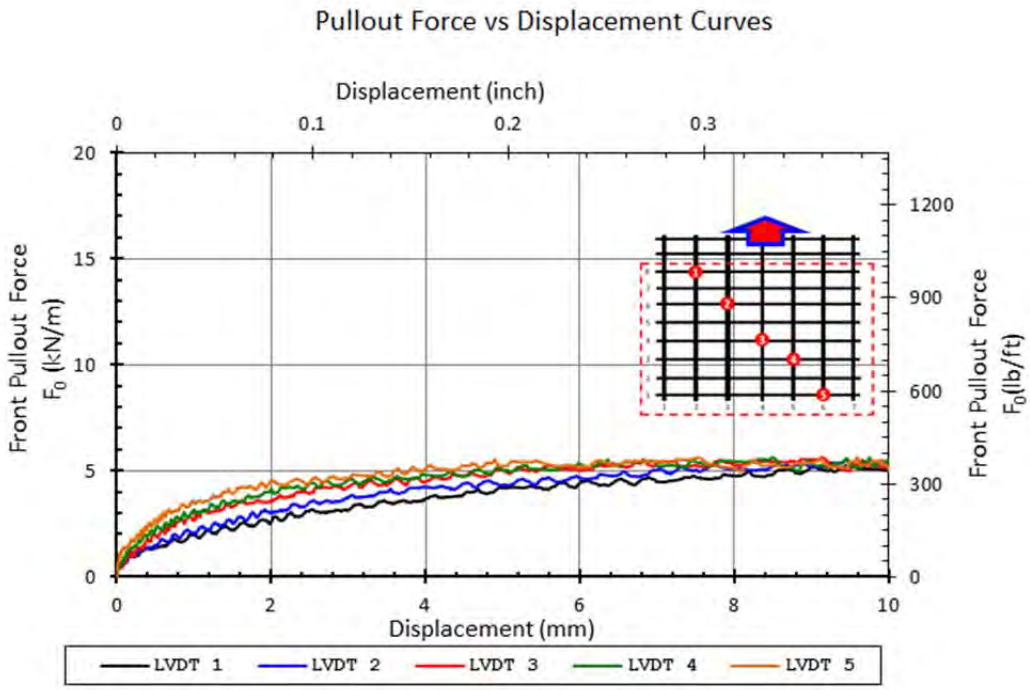
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

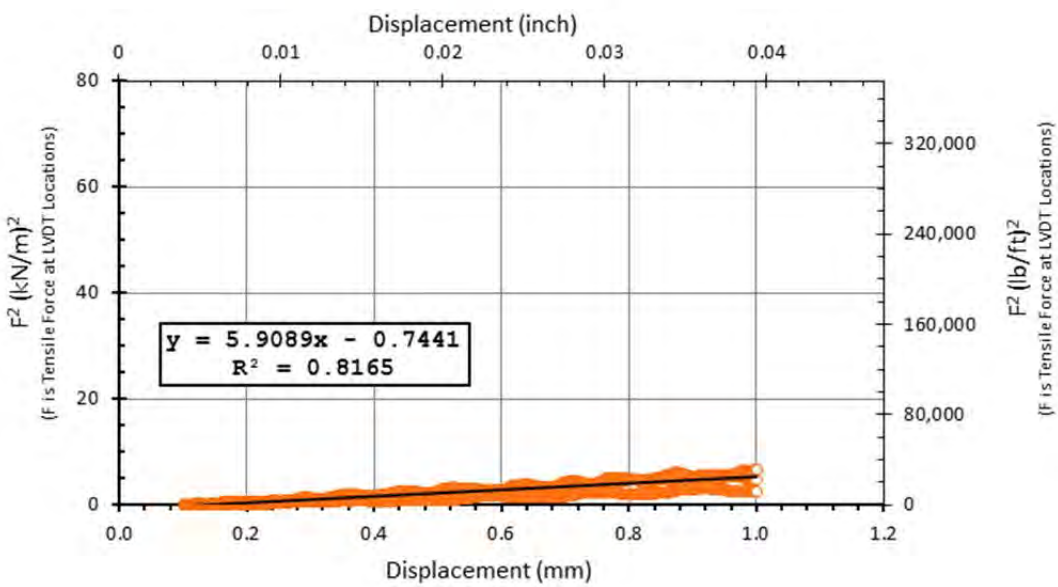
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.6	kN/m	385	lb/ft
Max Pullout Load	P_{max}	1.71	kN	399	lb
Max Shear Stress	τ_{max}	23.0	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
5.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/15/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.7	0.856
2	73.6	2.896
3	123.2	4.851
4	174.0	6.850
5	224.9	8.855

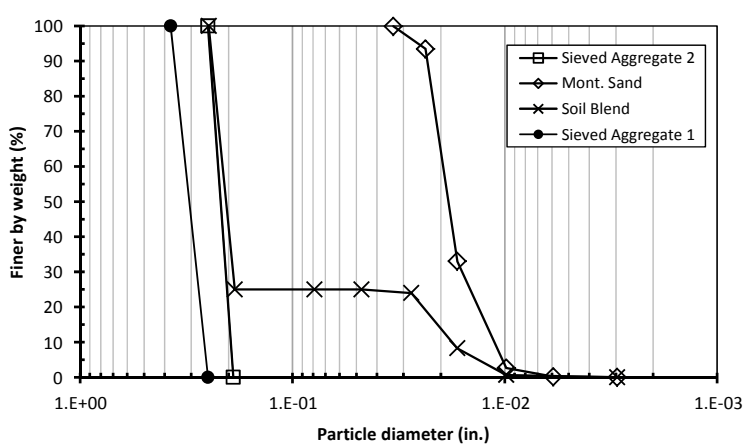
Pullout Rate	
1.0 mm/min.	0.04 in/min

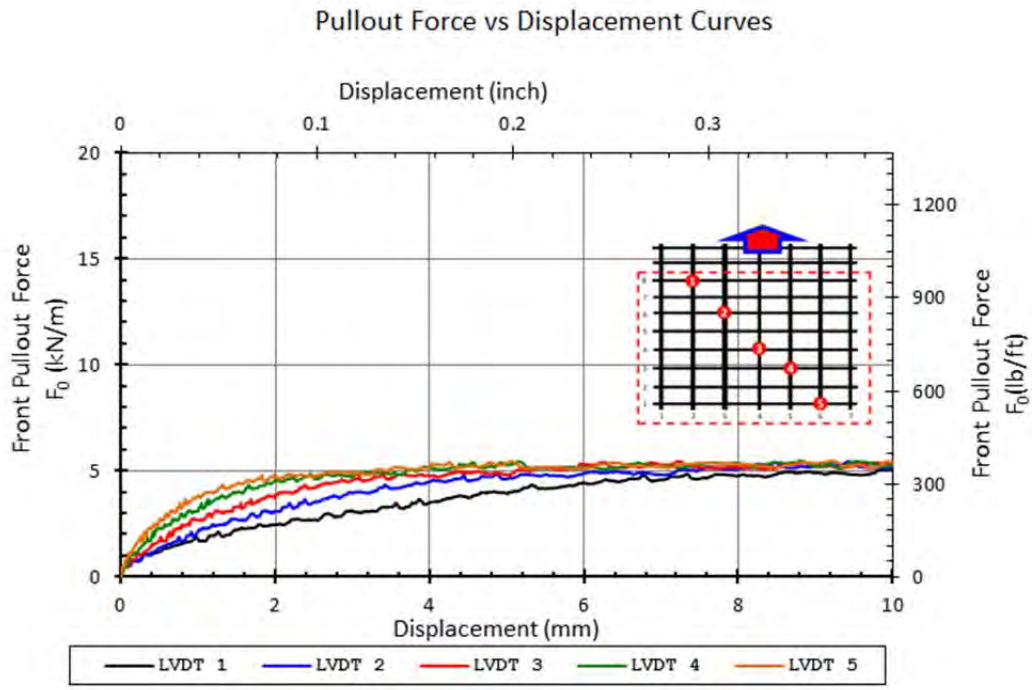
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

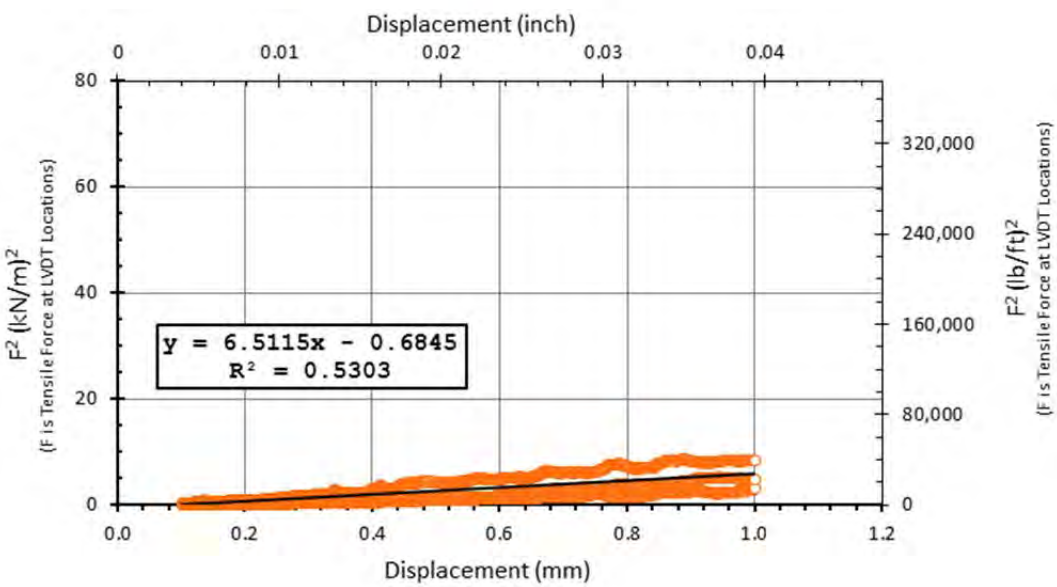
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.5	kN/m	375	lb/ft
Max Pullout Load	P_{max}	1.66	kN	402	lb
Max Shear Stress	τ_{max}	22.4	kPa	3.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
6.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/15/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.6	0.575
2	66.3	2.610
3	117.9	4.642
4	170.1	6.696
5	222.9	8.774

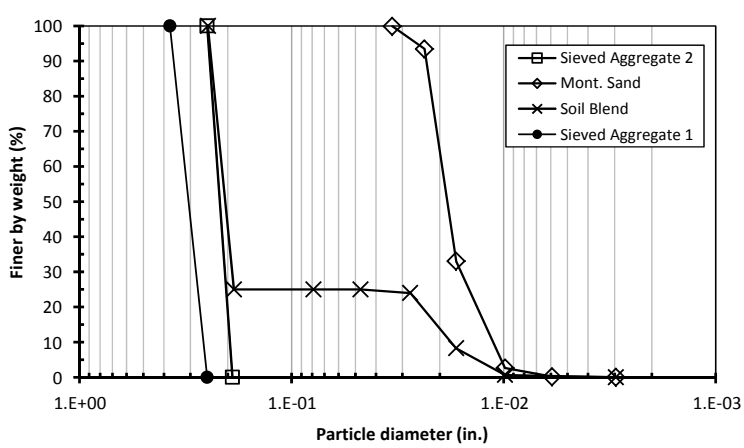
Pullout Rate	
1.0 mm/min.	0.04 in/min

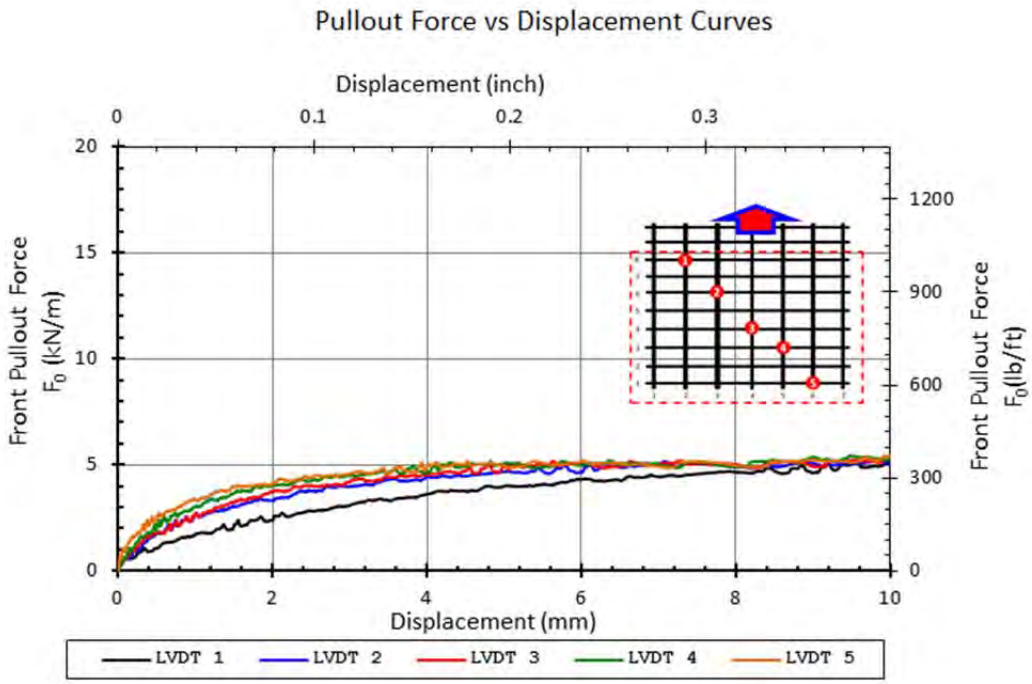
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

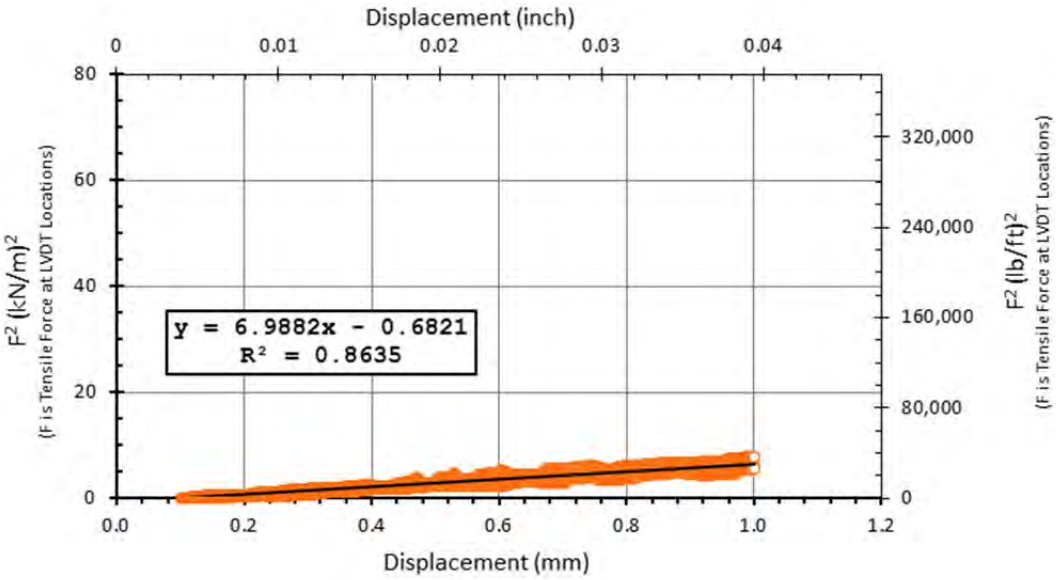
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.5	kN/m	378	lb/ft
Max Pullout Load	P_{max}	1.68	kN	403	lb
Max Shear Stress	τ_{max}	22.6	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
7.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/16/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.0	0.513
2	65.5	2.580
3	118.2	4.653
4	170.1	6.697
5	223.3	8.791

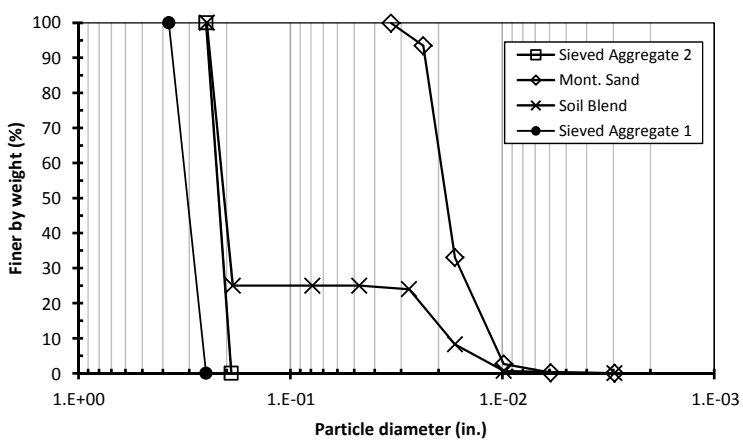
Pullout Rate	
1.0 mm/min.	0.04 in/min

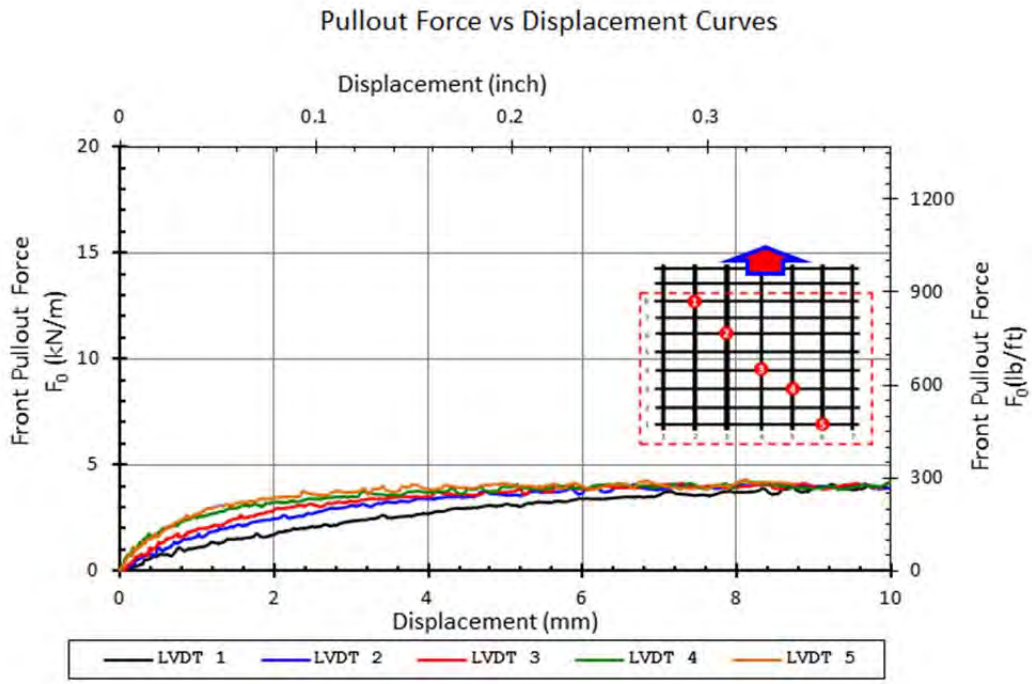
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

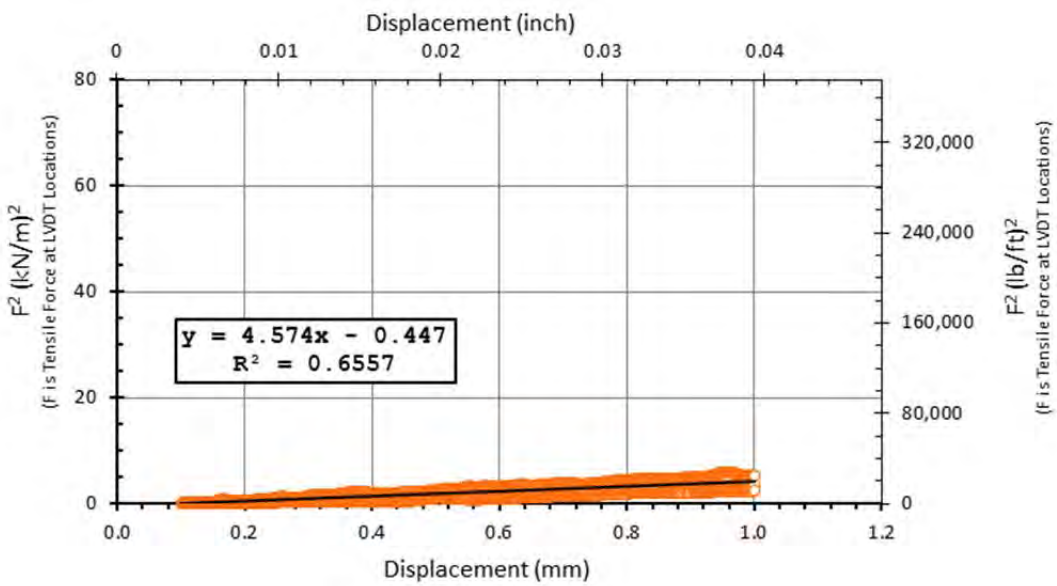
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.3	kN/m	295	lb/ft
Max Pullout Load	P_{max}	1.31	kN	332	lb
Max Shear Stress	τ_{max}	17.6	kPa	2.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.5			

Reported K_{SGI}
4.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/16/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.304	m	0.245	m
	7	0.922	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.7	0.619
2	68.3	2.690
3	120.1	4.726
4	172.1	6.775
5	224.1	8.823

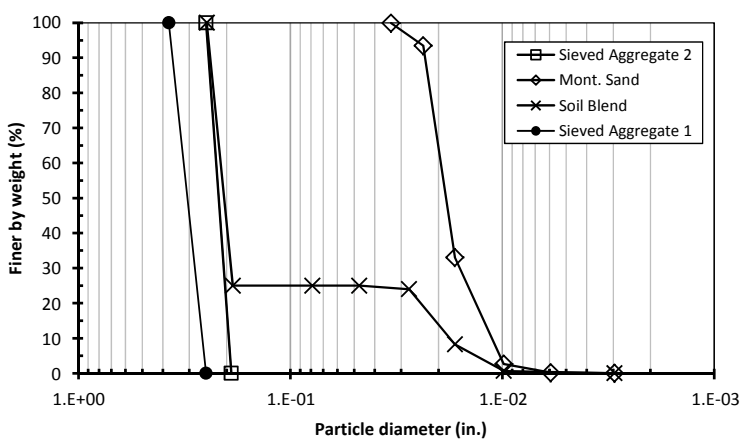
Pullout Rate	
1.0 mm/min.	0.04 in/min

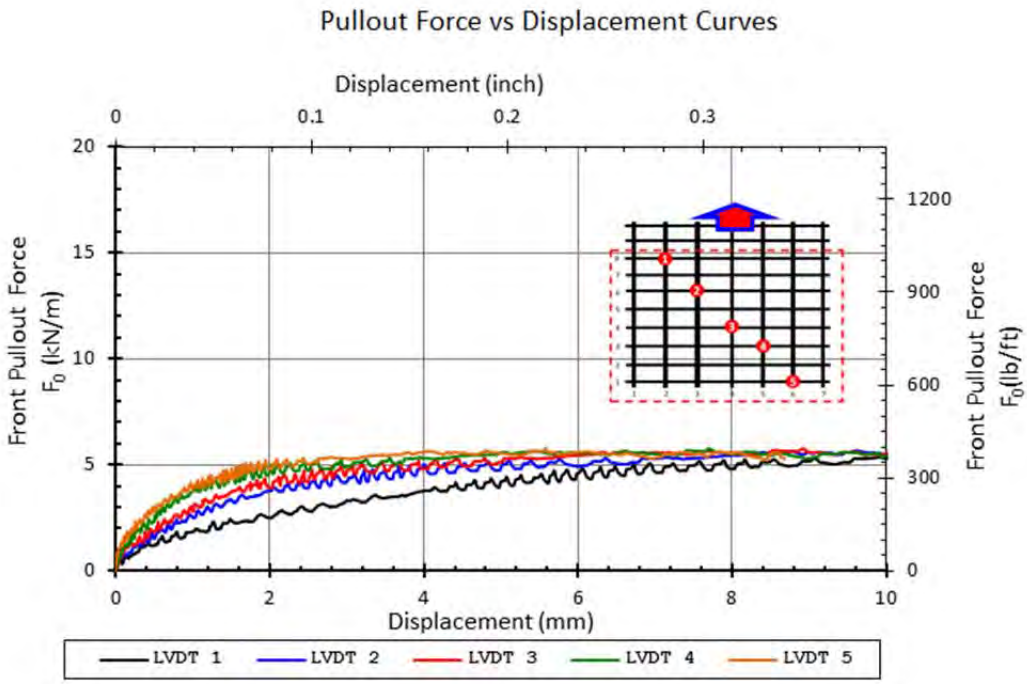
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

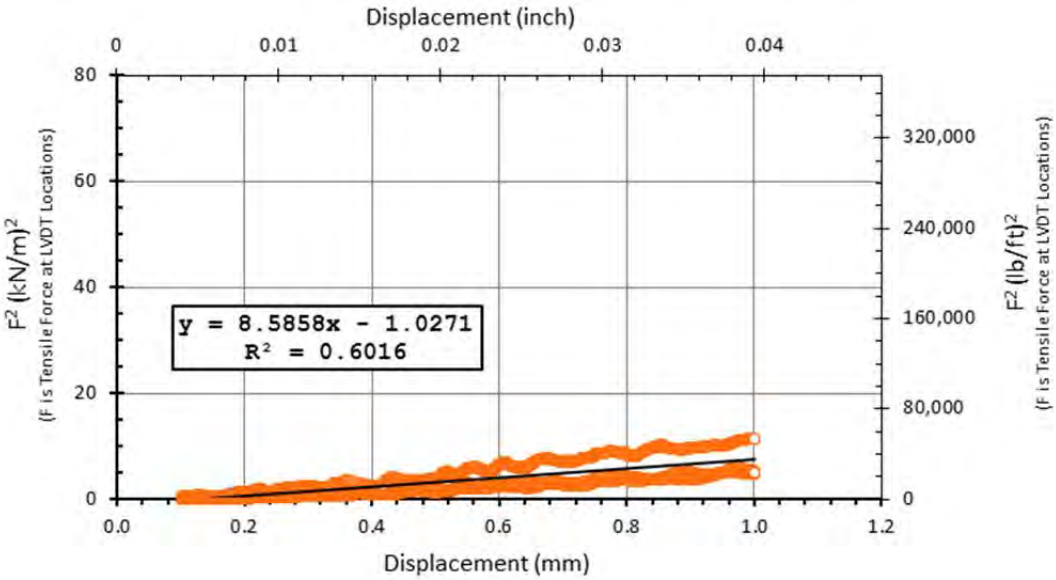
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.8	kN/m	396	lb/ft
Max Pullout Load	P_{max}	1.76	kN	419	lb
Max Shear Stress	τ_{max}	23.6	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
8.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/17/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.304	m	0.245	m
	7	0.922	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.0	0.513
2	66.5	2.618
3	119.1	4.688
4	170.3	6.706
5	223.1	8.782

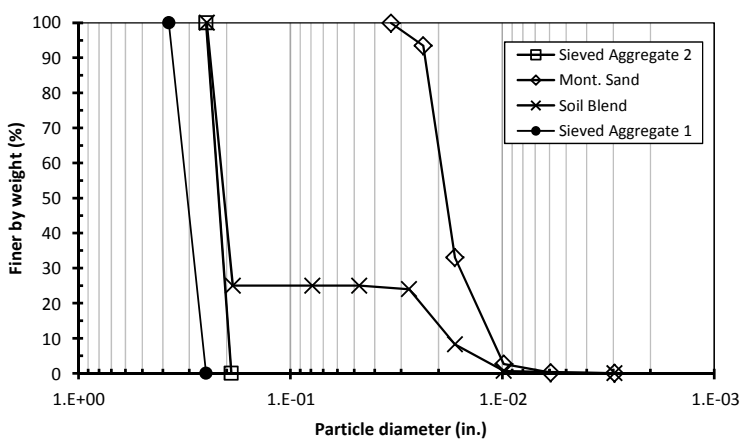
Pullout Rate	
1.0 mm/min.	0.04 in/min

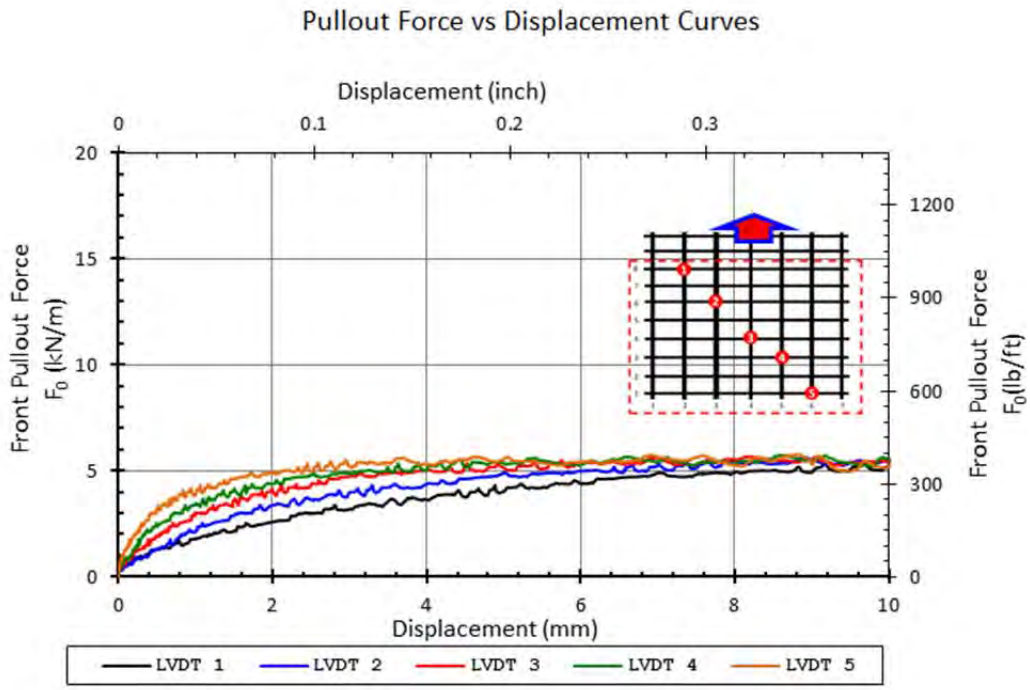
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

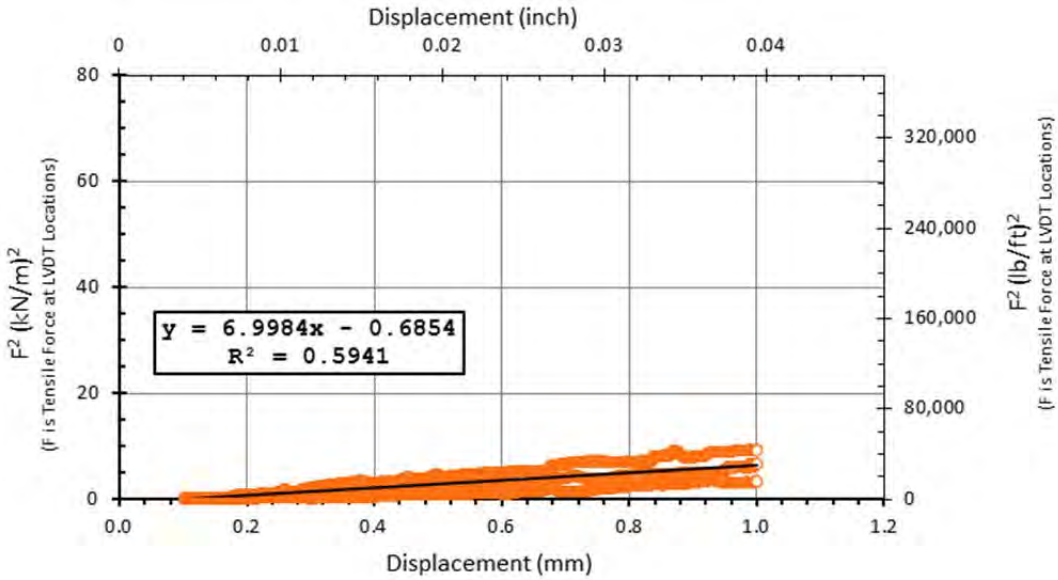
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.8	kN/m	395	lb/ft
Max Pullout Load	P_{max}	1.76	kN	413	lb
Max Shear Stress	τ_{max}	23.6	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
7.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/22/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.287	m	0.304	m	0.245	m
	14	0.942	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	29.4	1.159
2	81.1	3.193
3	131.9	5.194
4	183.1	7.207
5	234.7	9.241

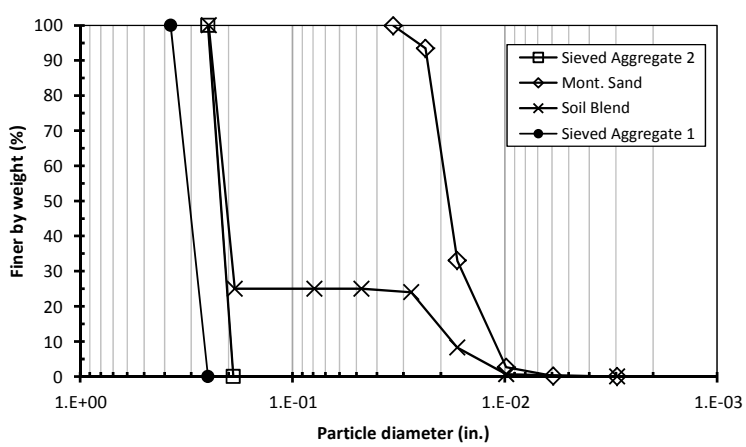
Pullout Rate	
1.0 mm/min.	0.04 in/min

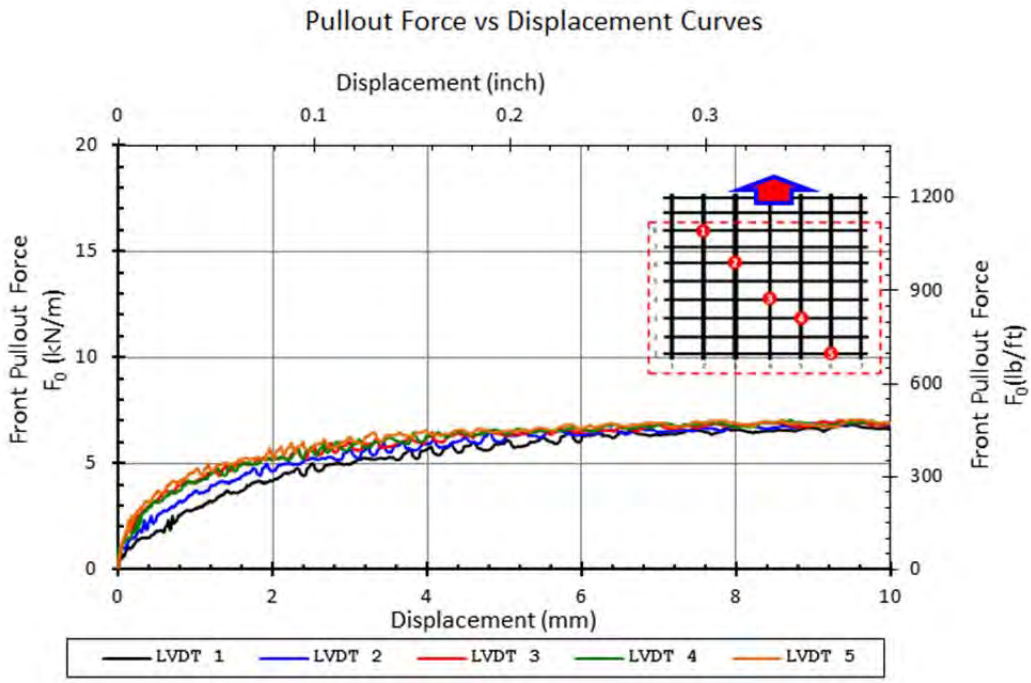
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

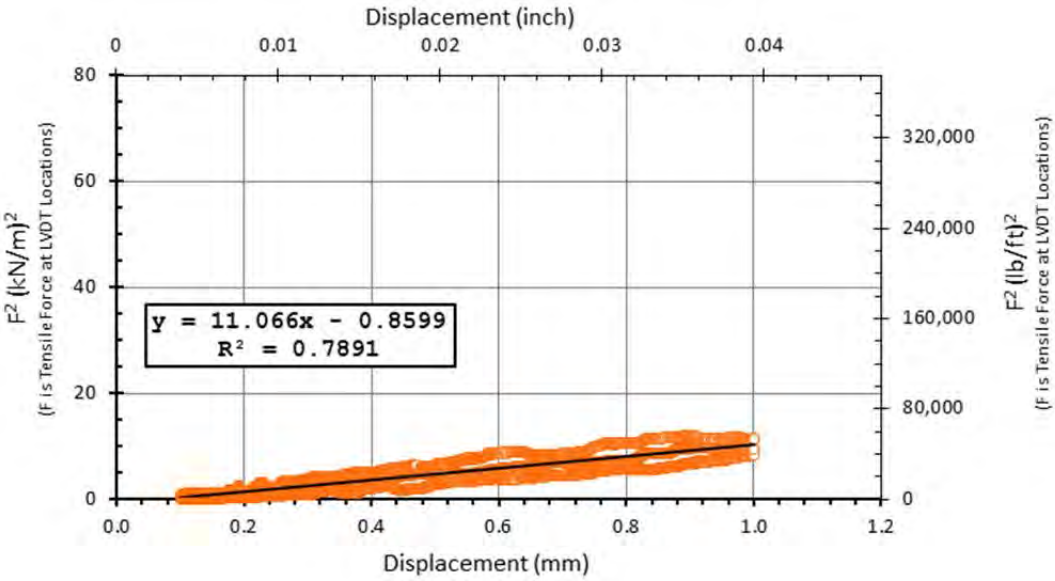
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	484	lb/ft
Max Pullout Load	P_{max}	2.15	kN	505	lb
Max Shear Stress	τ_{max}	28.9	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
11.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/23/12 AM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.304	m	0.245	m
	14	0.951	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	20.7	0.815
2	72.3	2.846
3	123.2	4.851
4	174.4	6.867
5	225.1	8.862

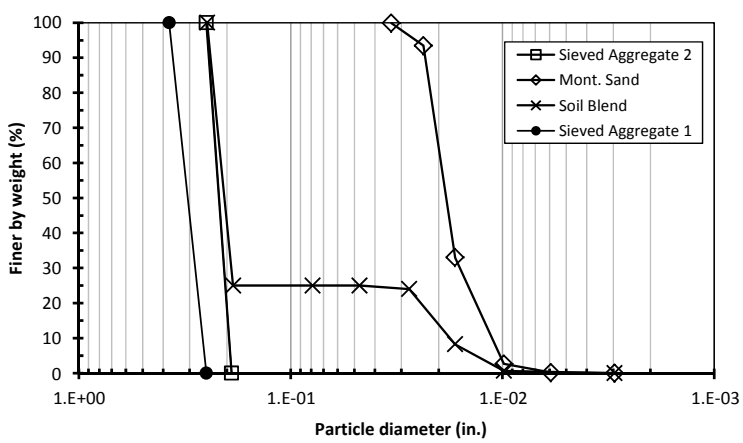
Pullout Rate	
1.0 mm/min.	0.04 in/min

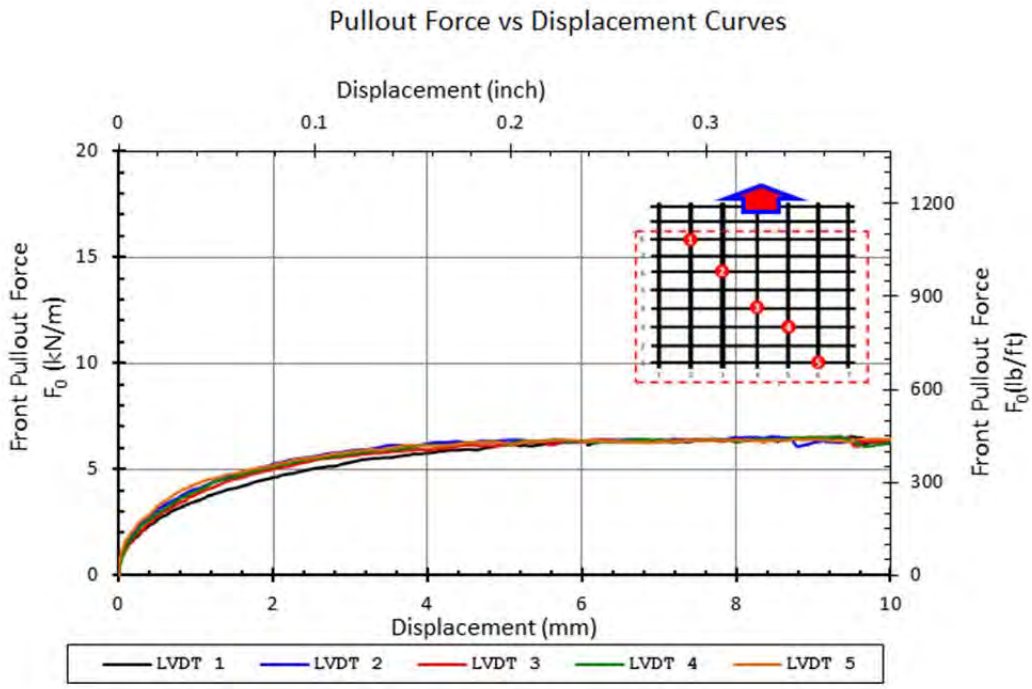
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

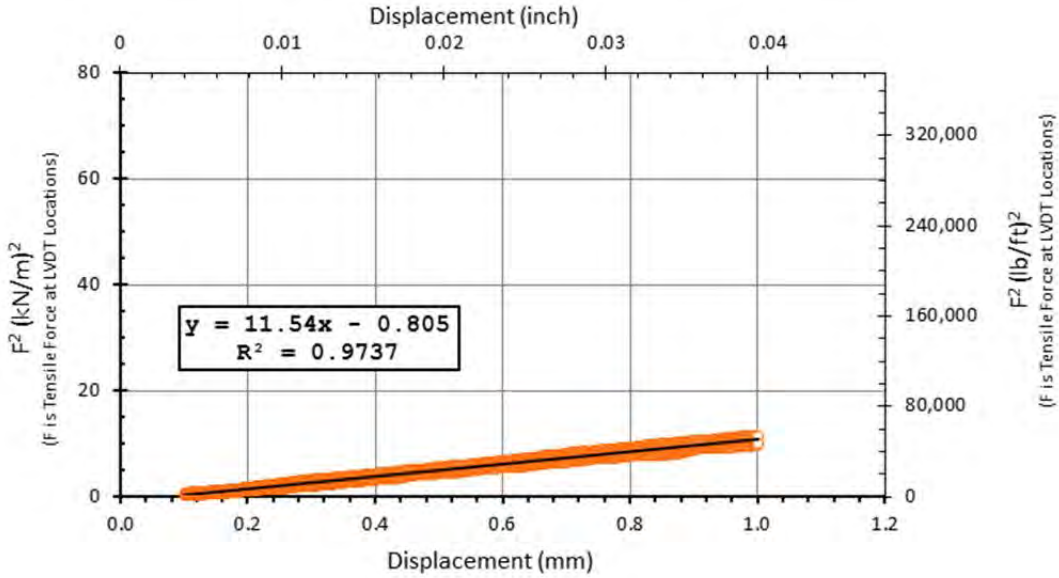
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.6	kN/m	451	lb/ft
Max Pullout Load	P_{max}	2.00	kN	484	lb
Max Shear Stress	τ_{max}	26.9	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
11.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

Specimen slightly slanted right at start of test

SMALL PULLOUT TEST

Date test conducted	2/23/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.296	m	0.304	m	0.245	m
	14	0.971	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	40.1	1.579
2	89.1	3.509
3	138.3	5.446
4	187.3	7.372
5	237.2	9.337

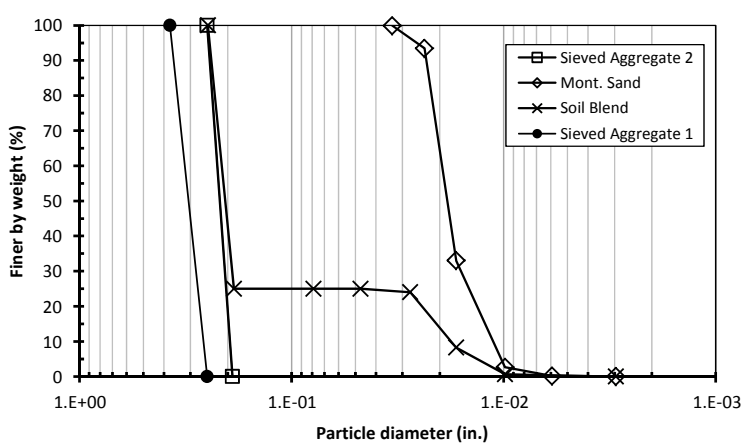
Pullout Rate	
1.0 mm/min.	0.04 in/min

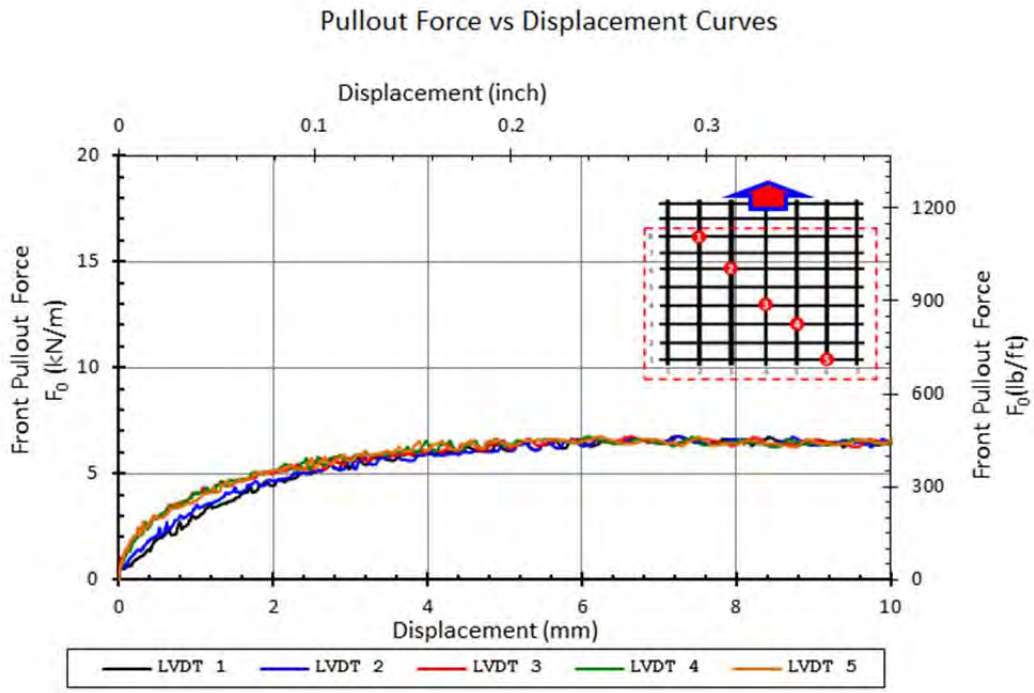
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.520 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

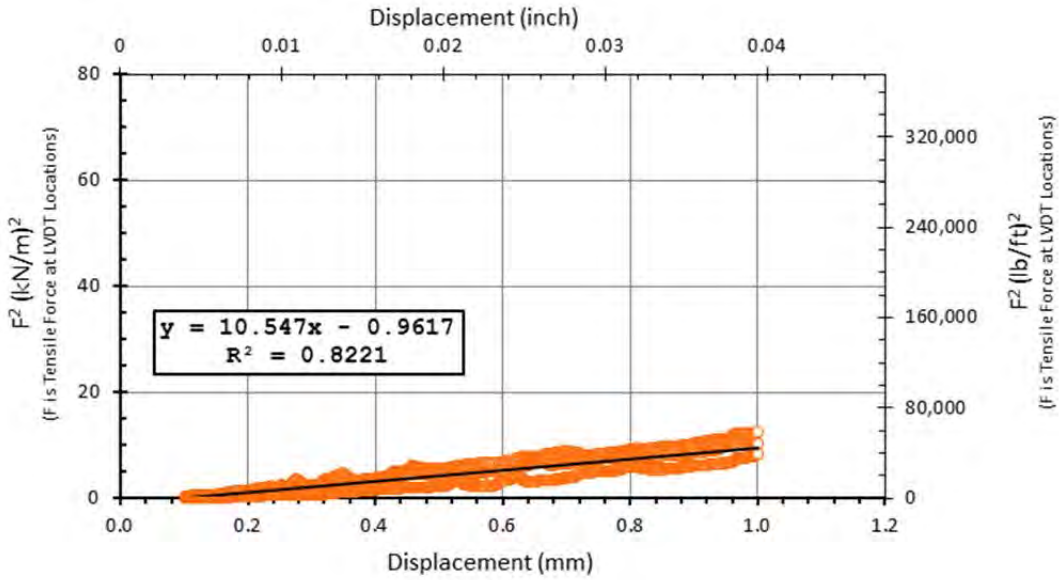
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	478	lb/ft
Max Pullout Load	P_{max}	2.12	kN	516	lb
Max Shear Stress	τ_{max}	28.5	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/25/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.304	m	0.245	m
	14	0.951	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.8	0.700
2	69.8	2.749
3	121.7	4.791
4	174.3	6.860
5	224.4	8.835

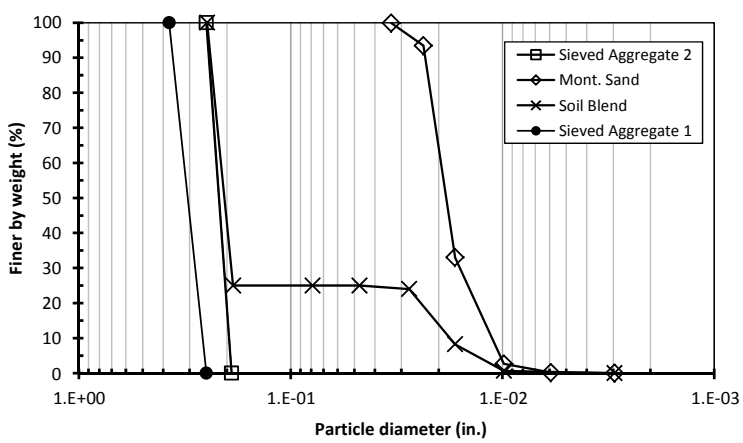
Pullout Rate	
1.0 mm/min.	0.04 in/min

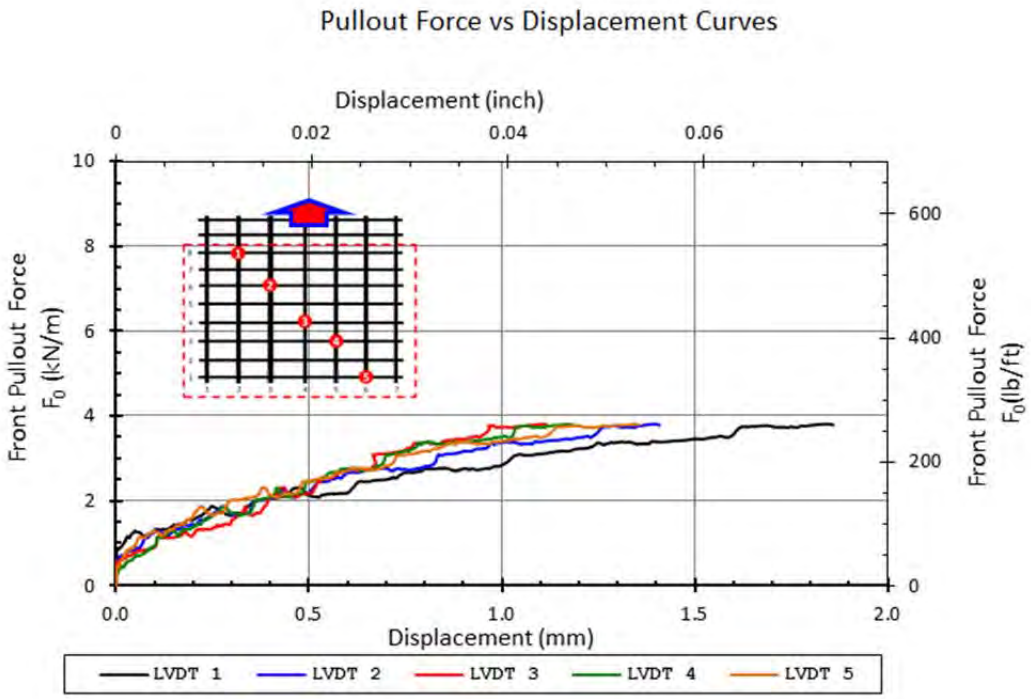
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

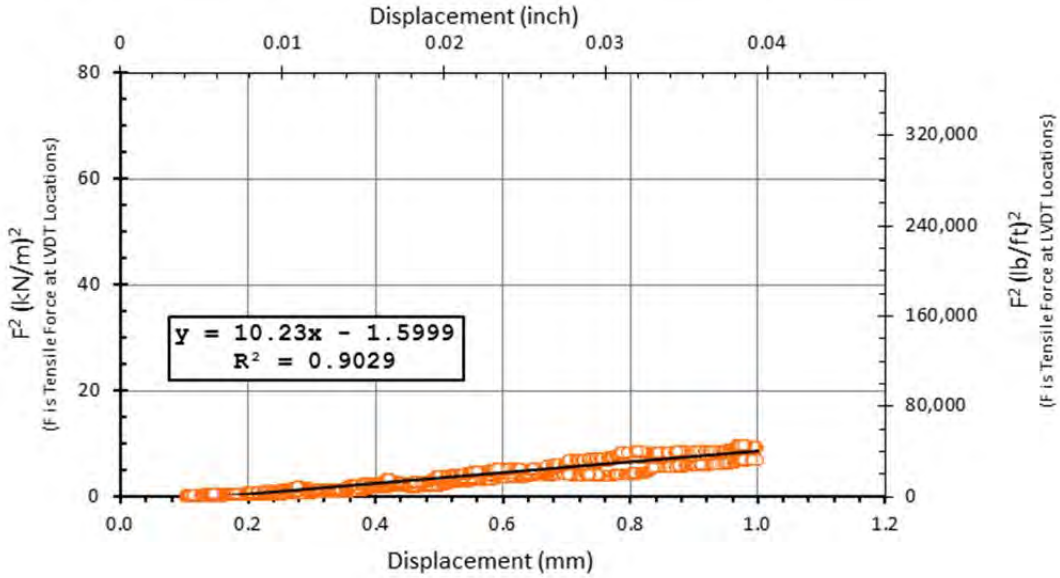
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	5/1/12 AM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.261	m	0.245	m
	12	0.912	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.0	0.707
2	69.2	2.726
3	121.8	4.795
4	172.8	6.804
5	224.9	8.854

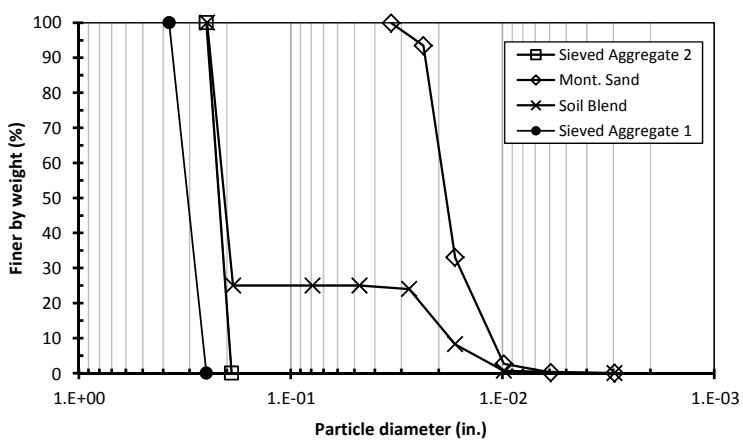
Pullout Rate	
1.0 mm/min.	0.04 in/min

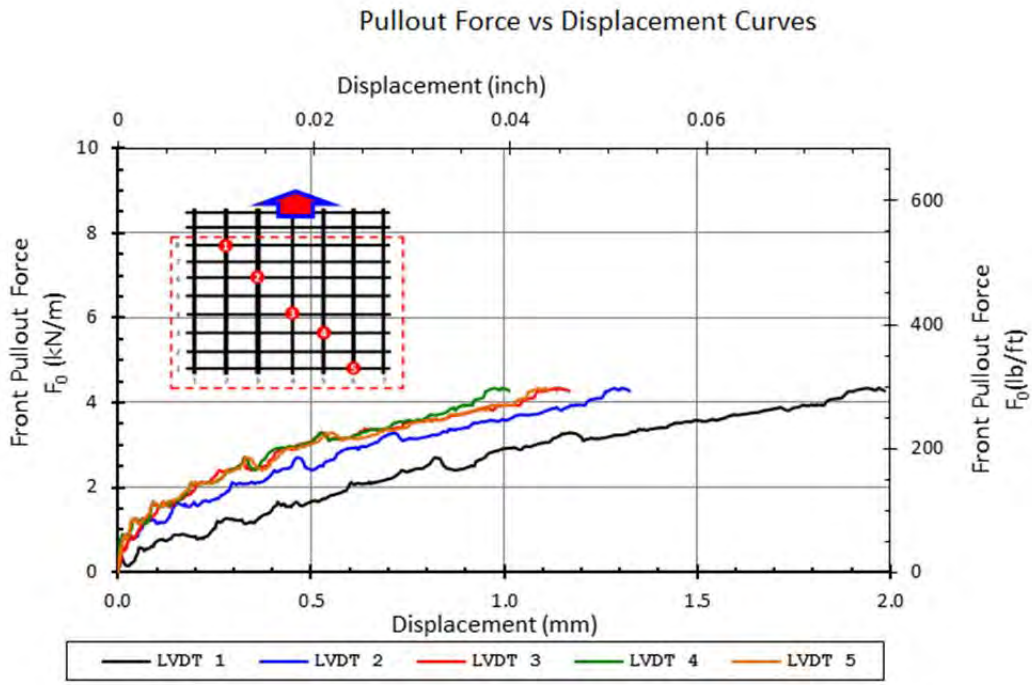
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

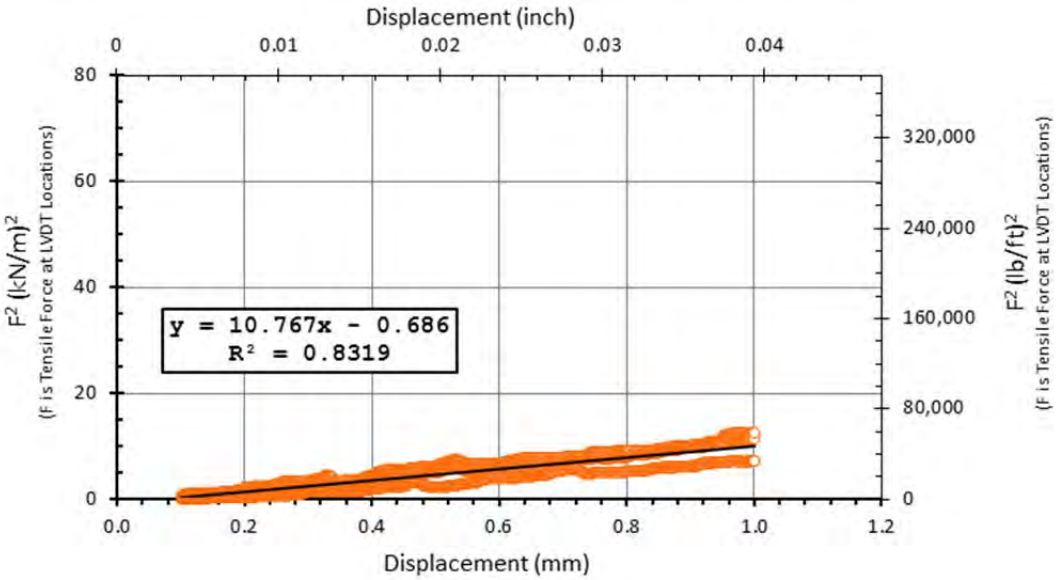
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Specimen with 12 ribs instead of 14 due to variation of aperture sizes of the product. PSI slightly increased as test begins and decreased as test ends. Adjusted constantly back to 3 psi throughout the test.

SMALL PULLOUT TEST

Date test conducted	5/1/12 PM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	12	0.915	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.5	0.610
2	67.4	2.654
3	120.2	4.733
4	170.5	6.711
5	222.7	8.768

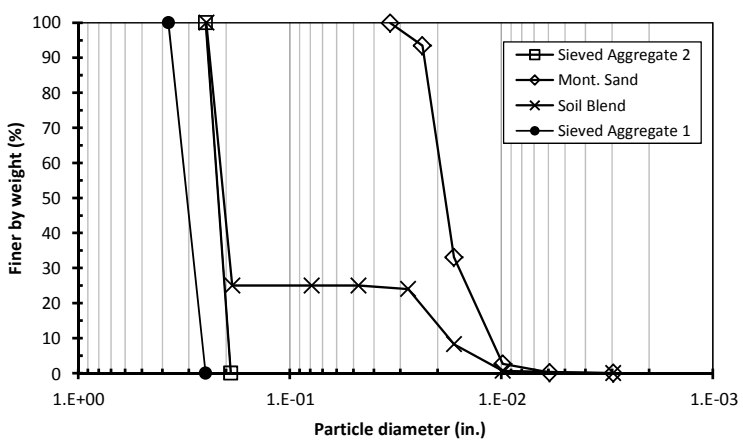
Pullout Rate	
1.0 mm/min.	0.04 in/min

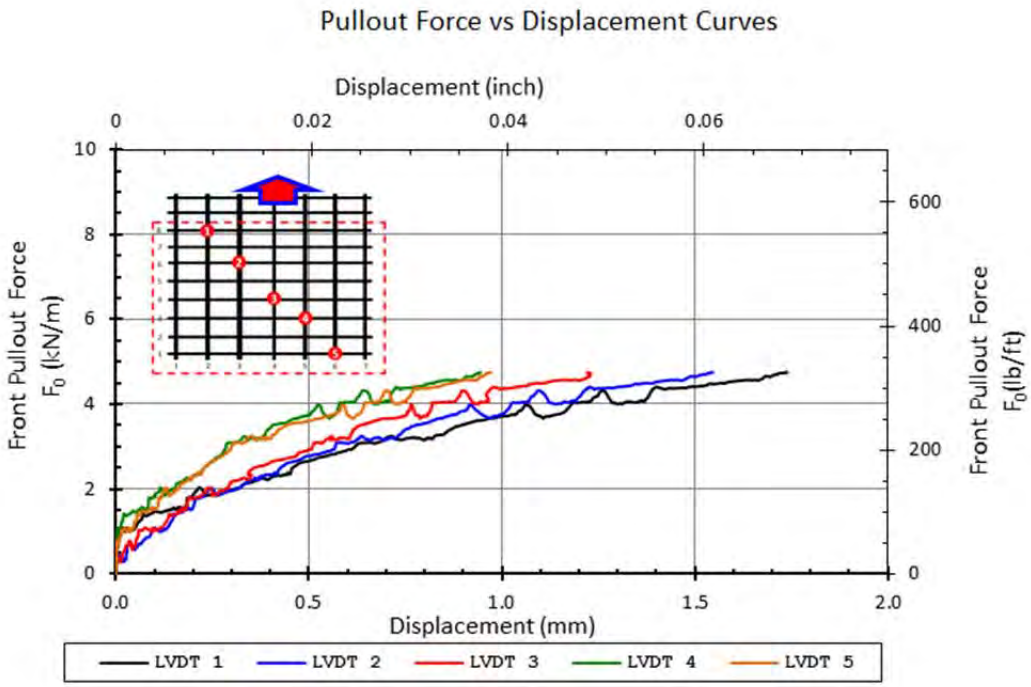
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

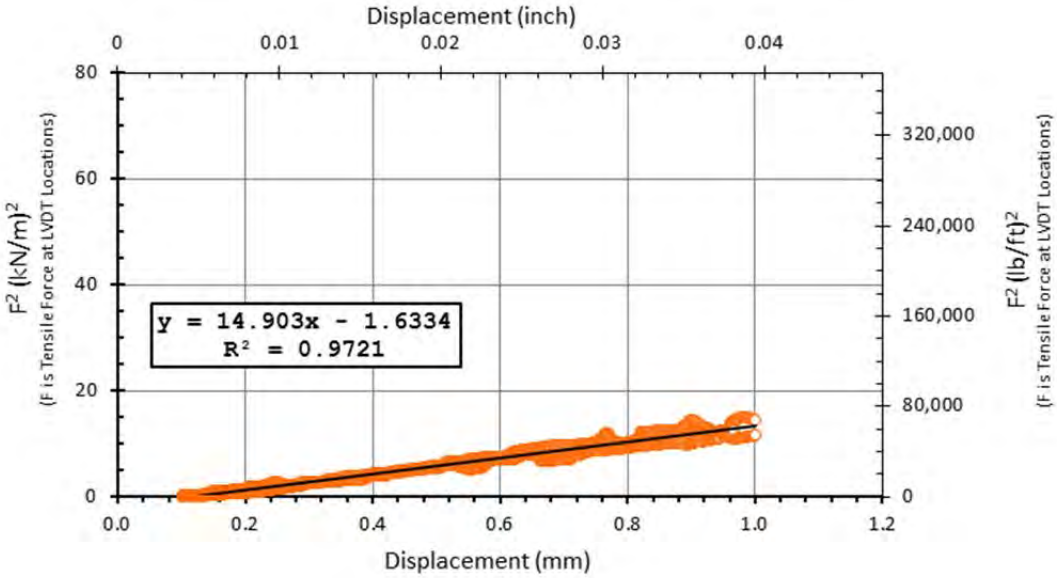
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
14.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Specimen with 12 ribs instead of 14 due to variation of aperture sizes of the product. PSI slightly increased as test began and decreased as test ended. No adjusting of overburden pressure throughout the test.

SMALL PULLOUT TEST

Date test conducted	9/13/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	7	0.915	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	27.0	1.064
2	66.5	2.619
3	105.5	4.154
4	144.0	5.670
5	222.2	8.746

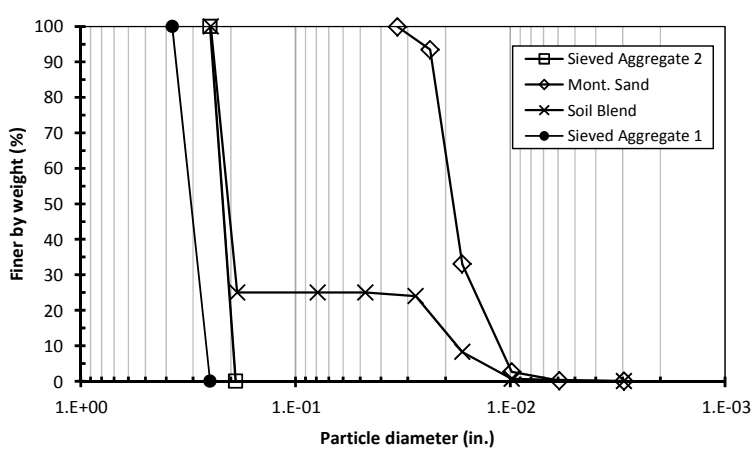
Pullout Rate	
1.0 mm/min.	0.04 in/min

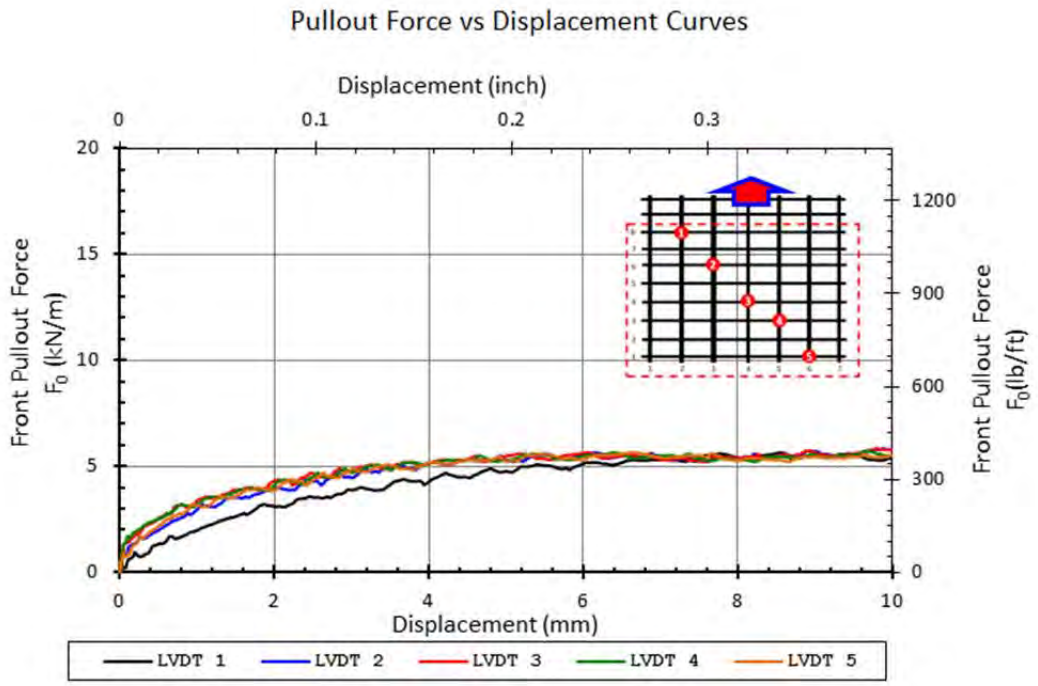
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

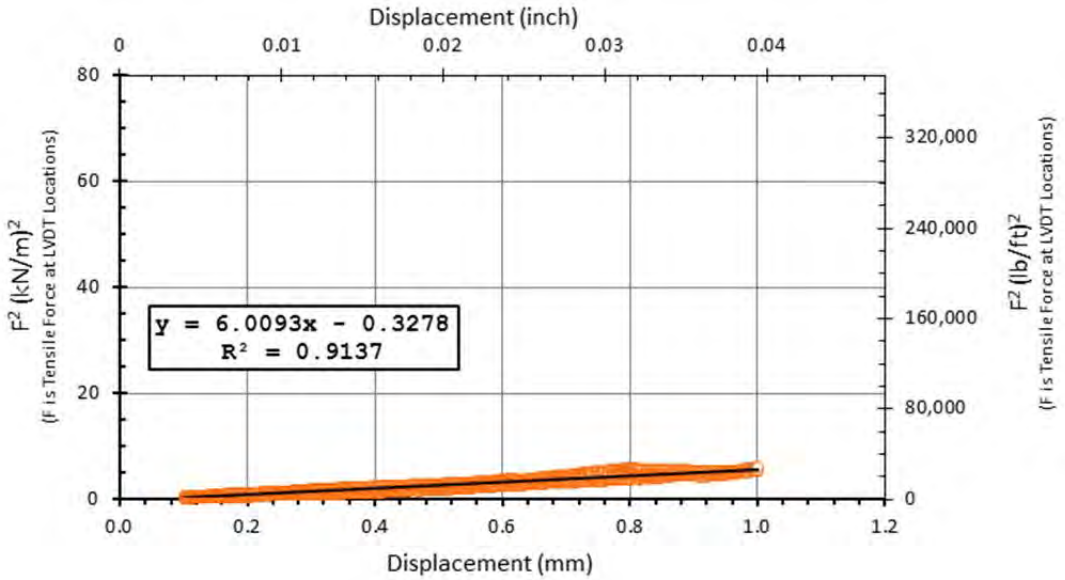
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.9	kN/m	401	lb/ft
Max Pullout Load	P_{max}	1.61	kN	389	lb
Max Shear Stress	τ_{max}	21.6	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
6.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT #1 off to the right and LVDT #2 slightly off to the left

SMALL PULLOUT TEST

Date test conducted	9/17/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	7	0.919	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	32.6	1.285
2	71.0	2.796
3	110.2	4.339
4	145.9	5.744
5	227.6	8.959

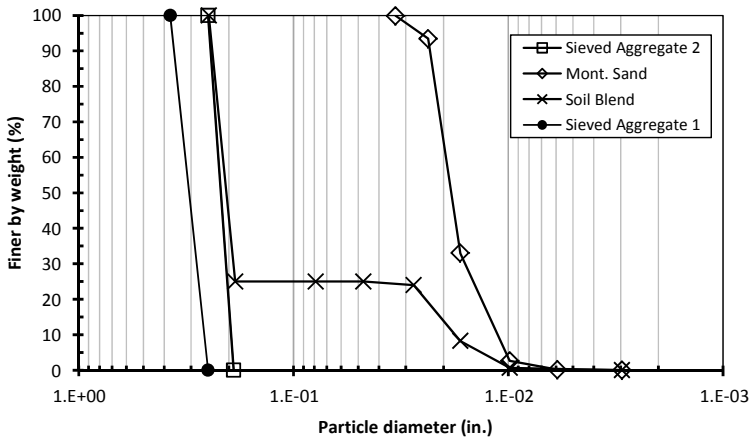
Pullout Rate	
1.0 mm/min.	0.04 in/min

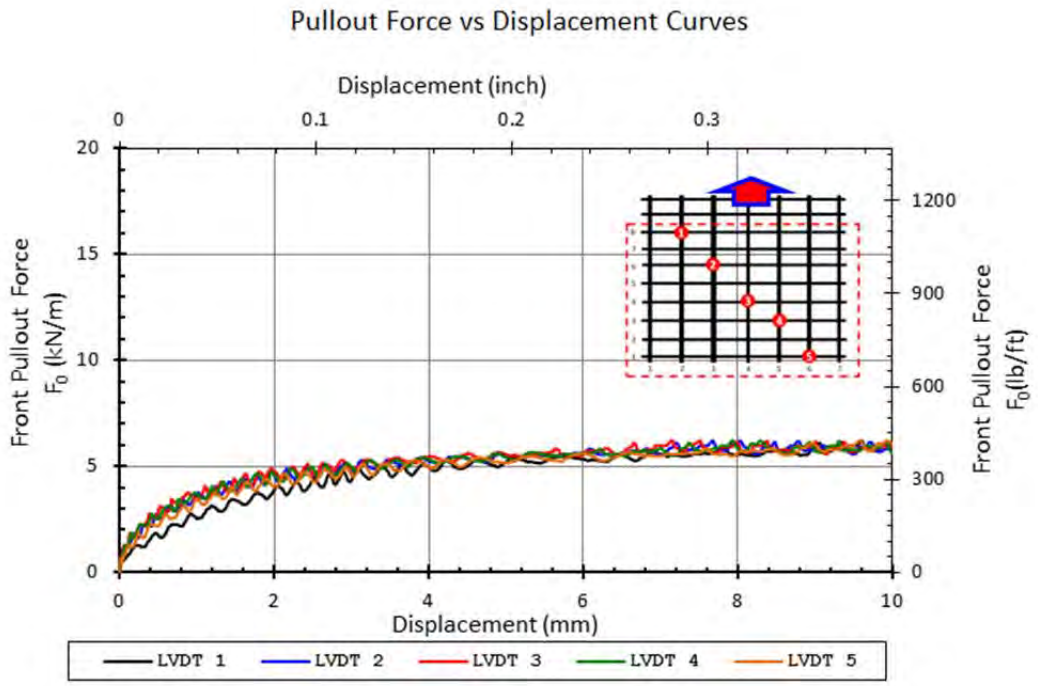
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

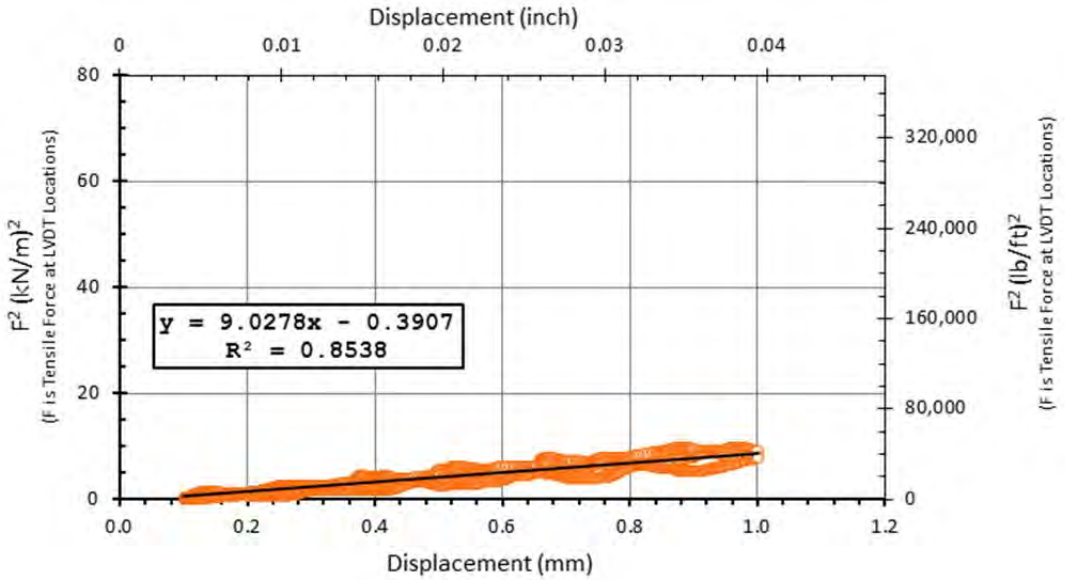
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	429	lb/ft
Max Pullout Load	P_{max}	1.72	kN	410	lb
Max Shear Stress	τ_{max}	23.1	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
9.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT #1 off to the right. LVDT #5 off to the left.

SMALL PULLOUT TEST

Date test conducted	9/18/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	7	0.919	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	109.0	4.291
2	109.0	4.291
3	109.0	4.291
4	109.0	4.291
5	109.0	4.291

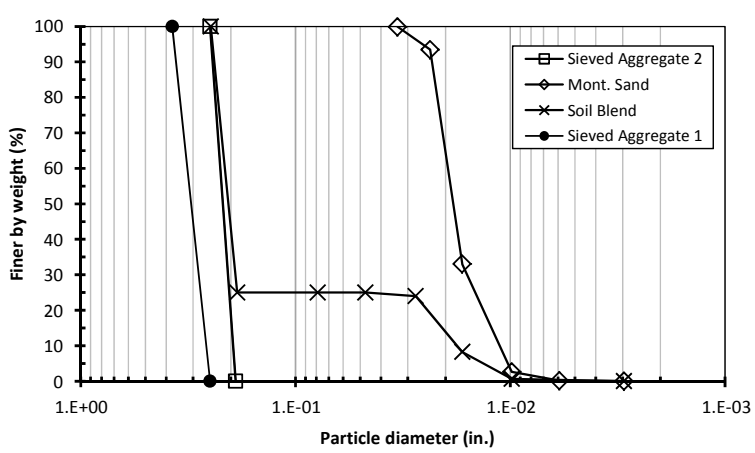
Pullout Rate	
1.0 mm/min.	0.04 in/min

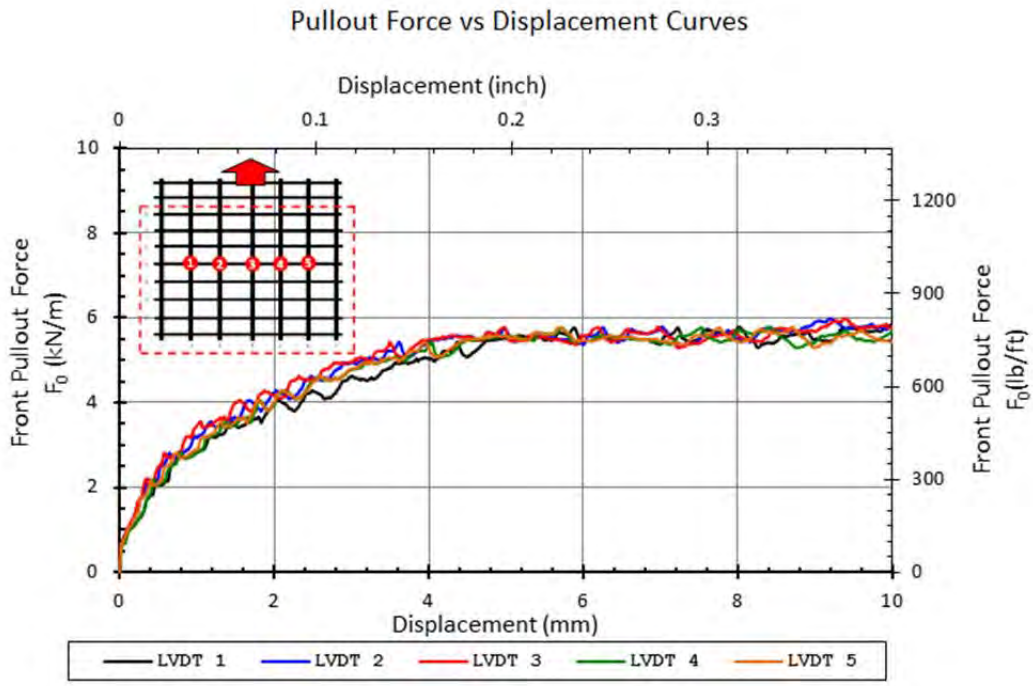
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

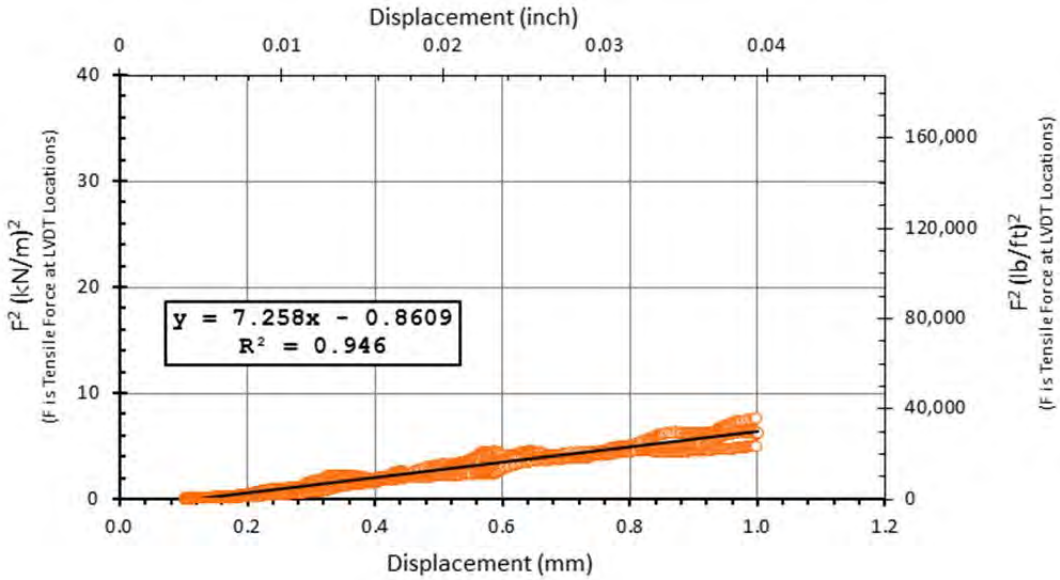
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.1	kN/m	418	lb/ft
Max Pullout Load	P_{max}	1.67	kN	415	lb
Max Shear Stress	τ_{max}	22.5	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
7.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

All wires were tied on the same longitudinal rib as #3.
LVDT #1 off to the right. LVDT #5 off to the left.

SMALL PULLOUT TEST

Date test conducted	9/20/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	7	0.915	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	108.9	4.287
2	108.9	4.287
3	108.9	4.287
4	108.9	4.287
5	108.9	4.287

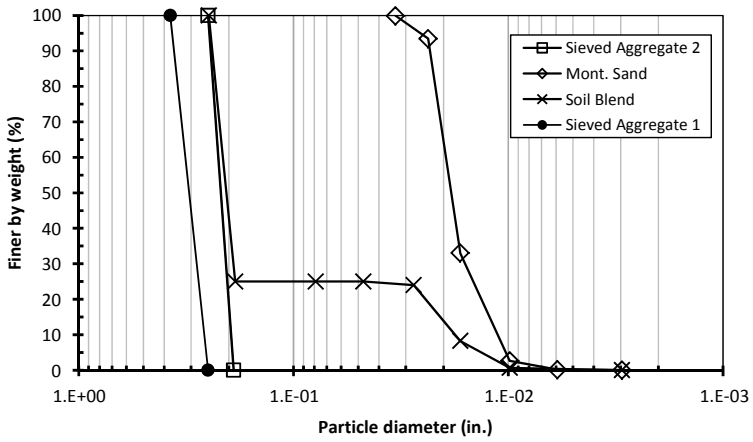
Pullout Rate	
1.0 mm/min.	0.04 in/min

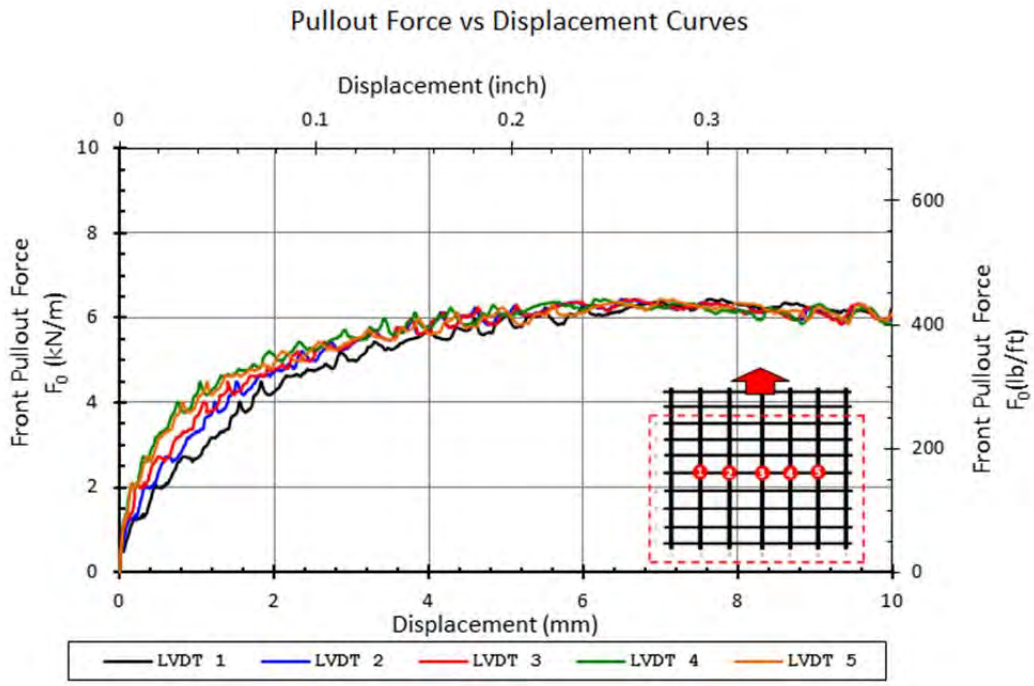
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

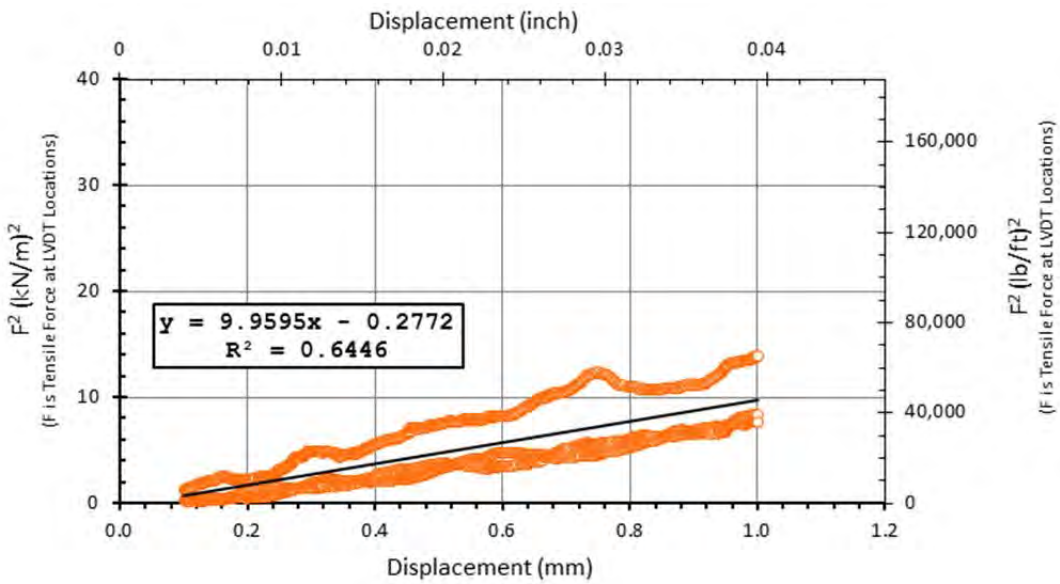
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.4	kN/m	441	lb/ft
Max Pullout Load	P_{max}	1.77	kN	424	lb
Max Shear Stress	τ_{max}	23.8	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
10.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

All wires were tied on the same transverse rib as LVDT 3.
LVDT 1 off to the right. LVDT 5 off to the left.

SMALL PULLOUT TEST

Date test conducted	9/24/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	7	0.919	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	29.8	1.174
2	69.5	2.735
3	107.5	4.232
4	147.5	5.807
5	227.3	8.947

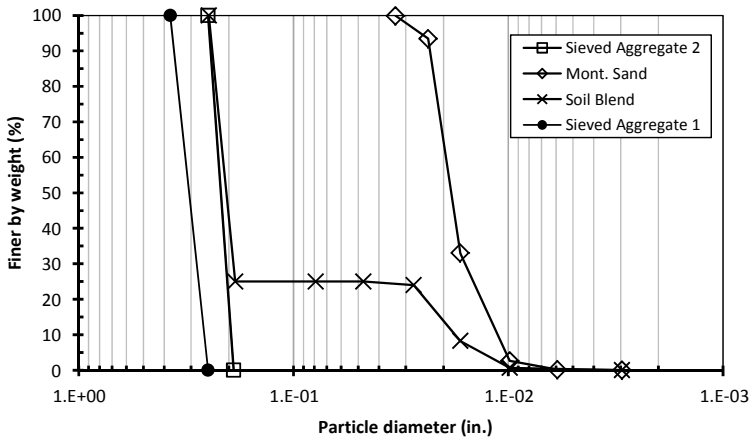
Pullout Rate	
1.0 mm/min.	0.04 in/min

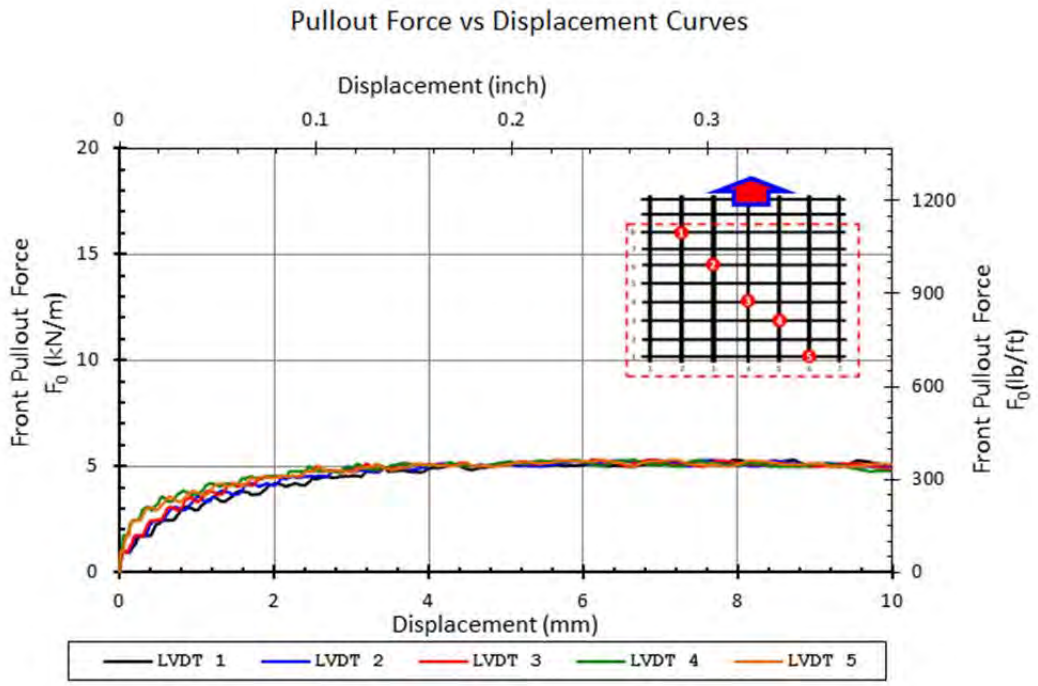
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

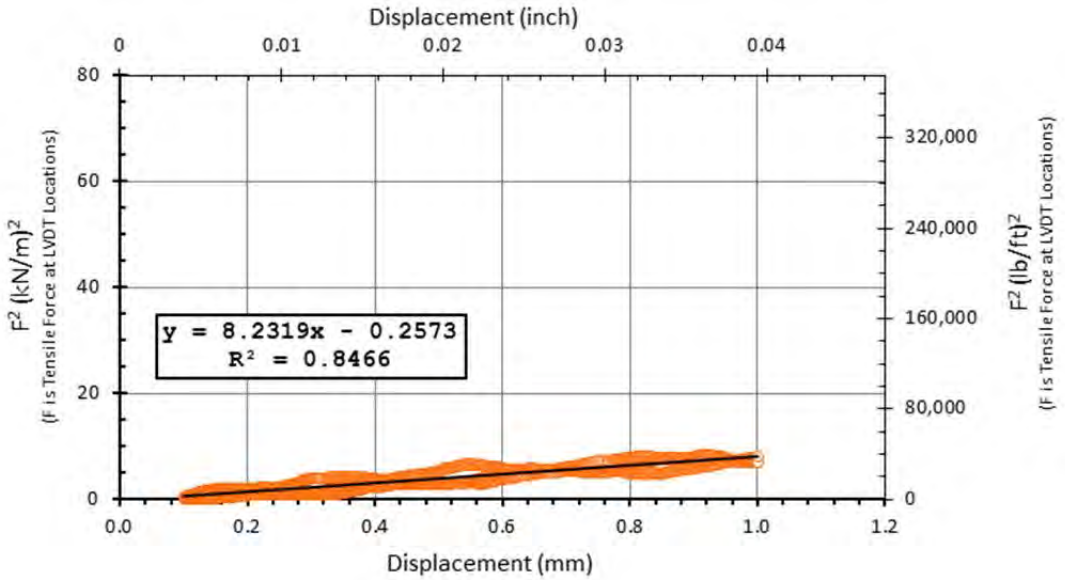
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.3	kN/m	364	lb/ft
Max Pullout Load	P_{max}	1.46	kN	369	lb
Max Shear Stress	τ_{max}	19.6	kPa	2.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}	
8.2	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	9/26/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	7	0.922	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	30.5	1.202
2	70.8	2.789
3	111.5	4.388
4	149.5	5.887
5	228.0	8.978

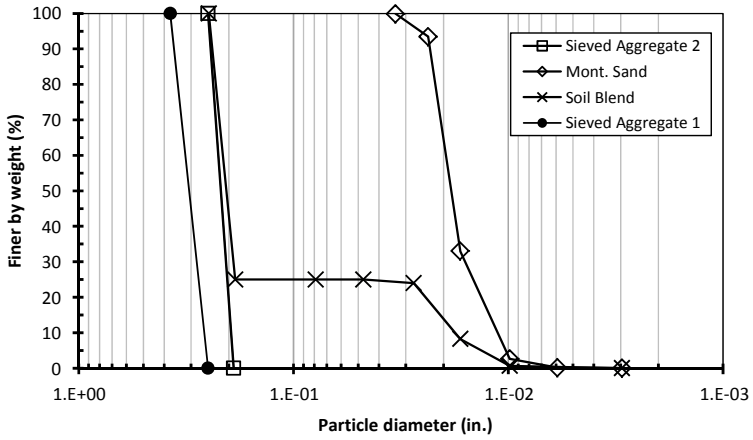
Pullout Rate	
1.0 mm/min.	0.04 in/min

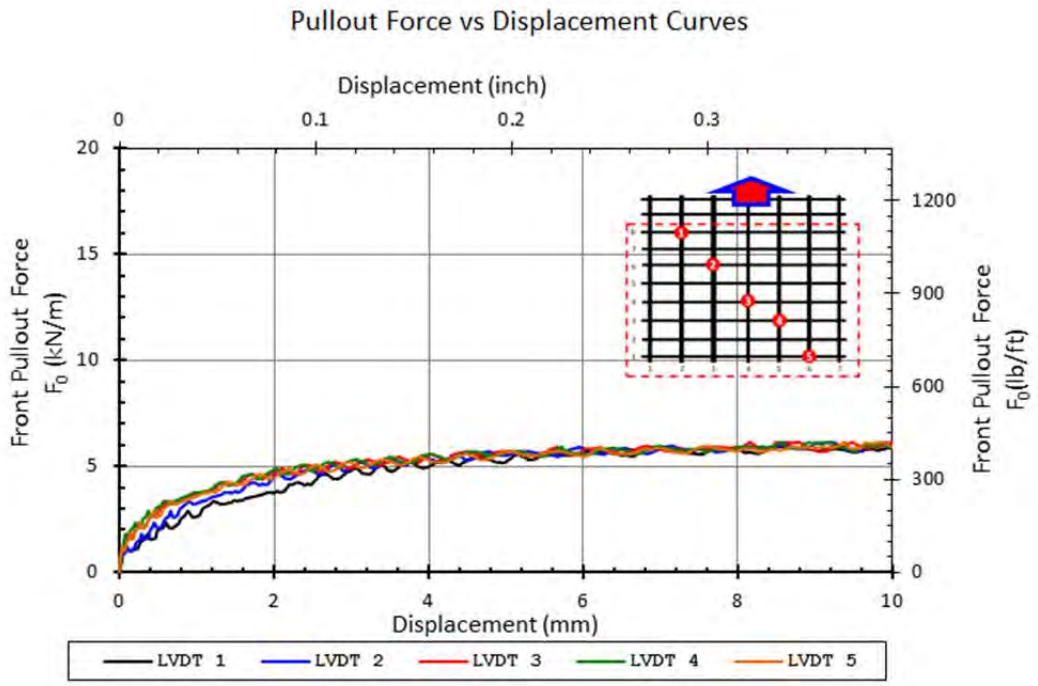
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

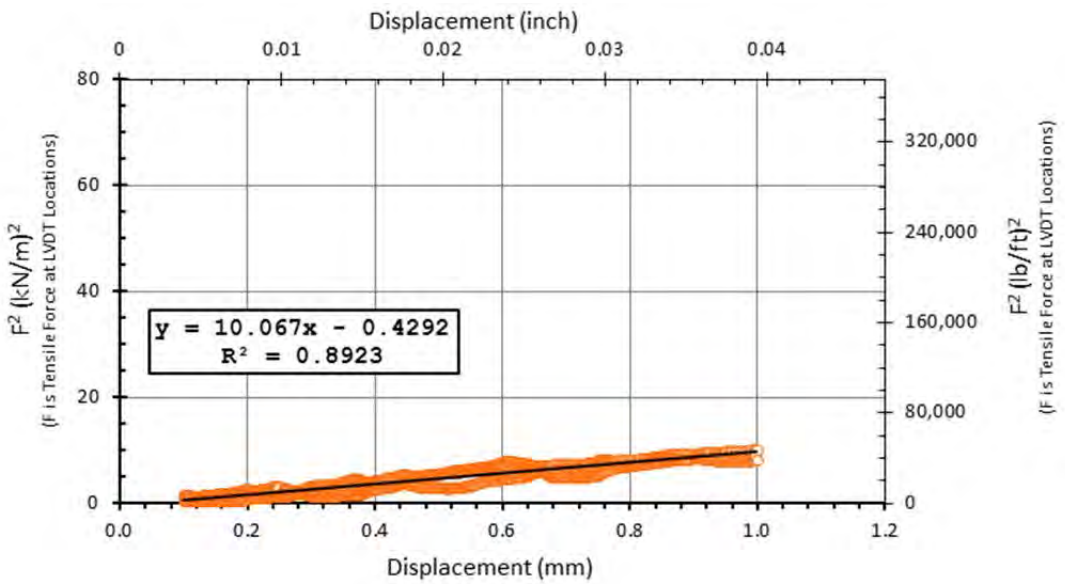
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.4	kN/m	435	lb/ft
Max Pullout Load	P_{max}	1.74	kN	403	lb
Max Shear Stress	τ_{max}	23.4	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
10.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	9/27/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	7	0.919	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	31.1	1.225
2	71.0	2.794
3	111.4	4.384
4	149.4	5.883
5	228.5	8.995

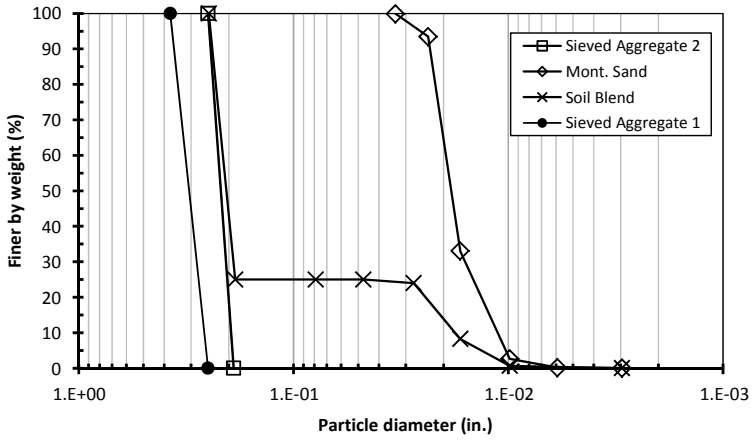
Pullout Rate	
1.0 mm/min.	0.04 in/min

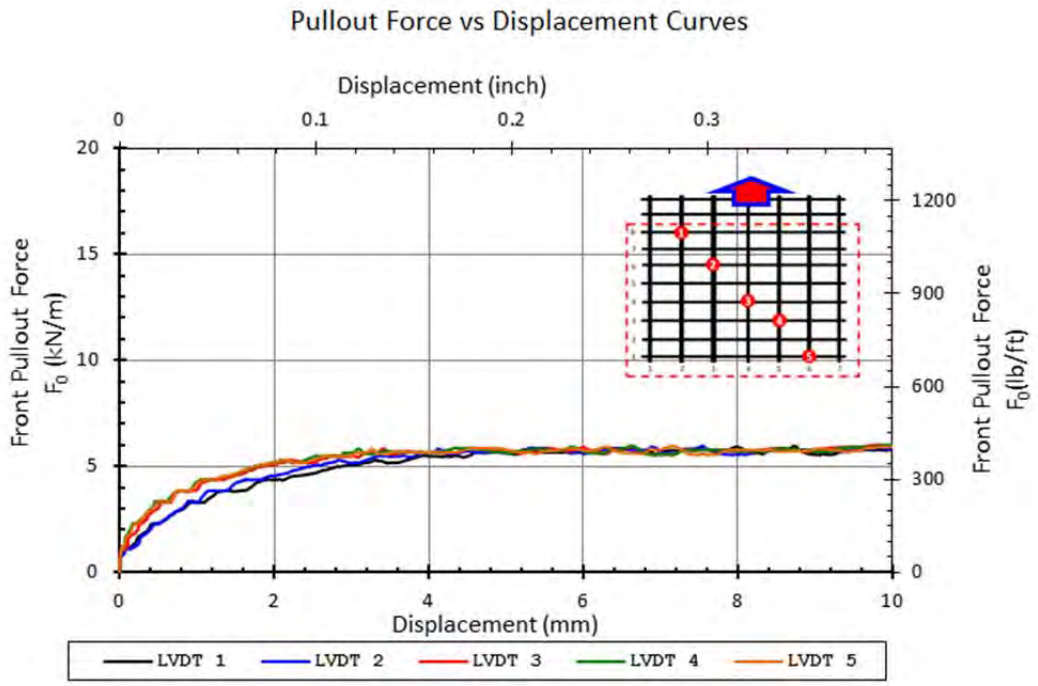
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

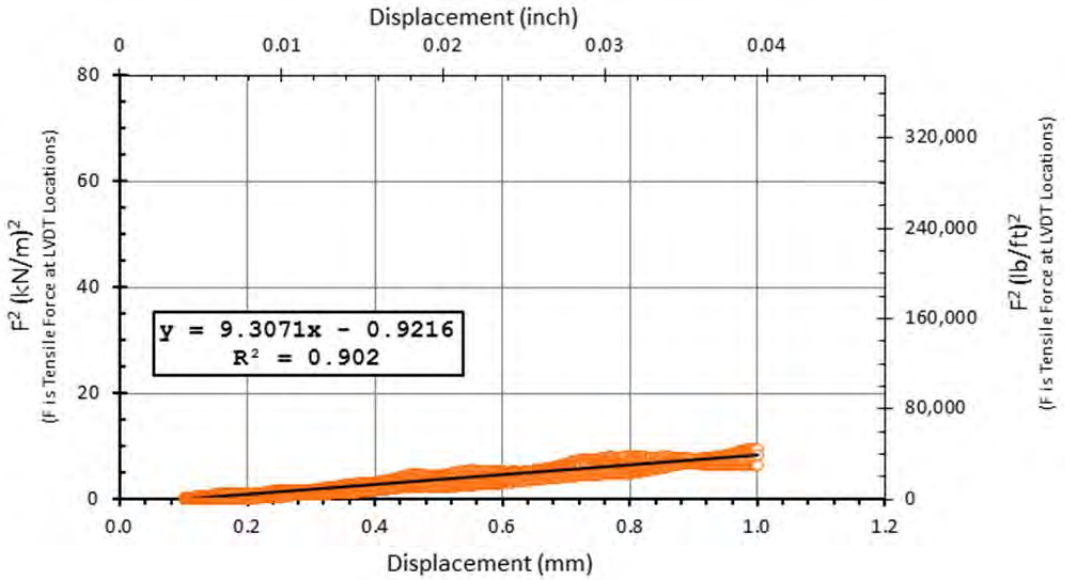
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.1	kN/m	417	lb/ft
Max Pullout Load	P_{max}	1.67	kN	401	lb
Max Shear Stress	τ_{max}	22.4	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
9.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT #1 off to the right

SMALL PULLOUT TEST

Date test conducted	10/2/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	7	0.919	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	56.4	2.219
2	97.7	3.848
3	138.1	5.436
4	149.0	5.867
5	228.7	9.005

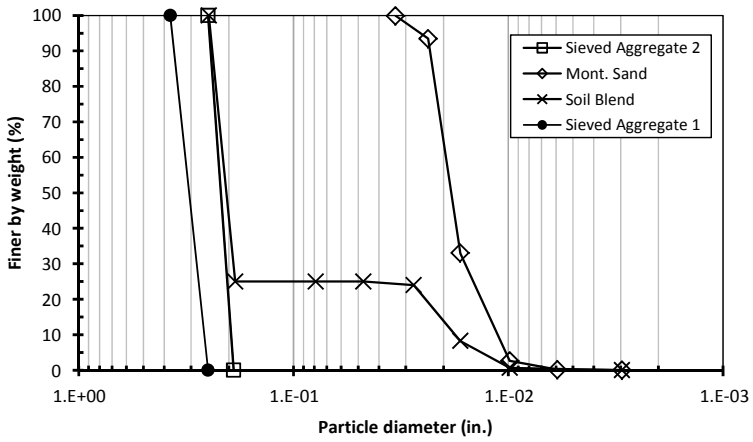
Pullout Rate	
1.0 mm/min.	0.04 in/min

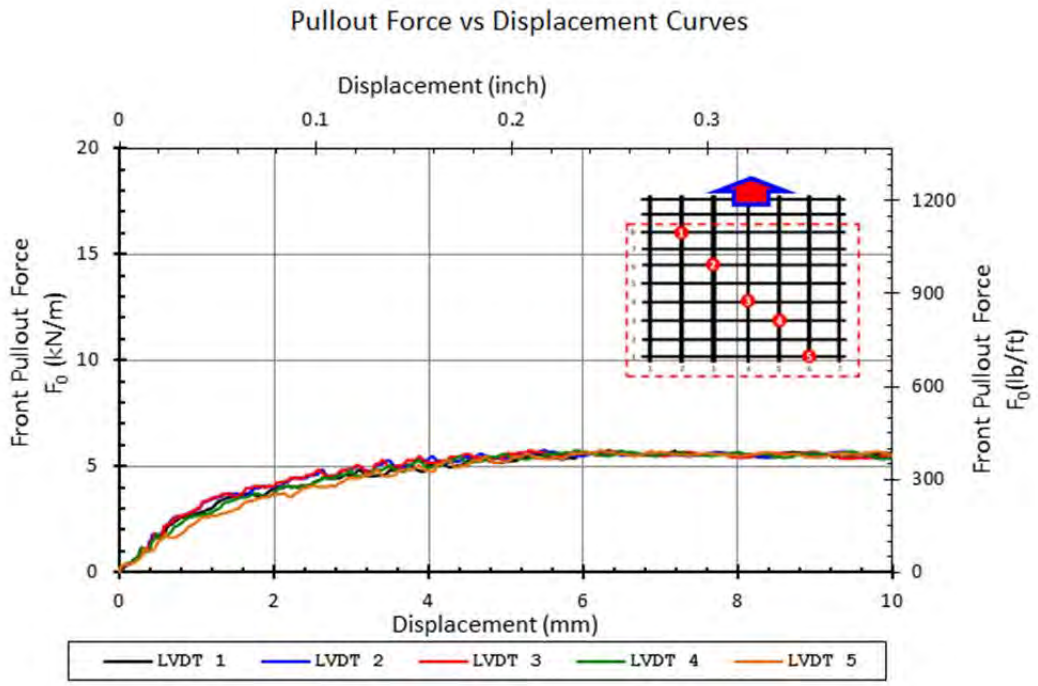
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

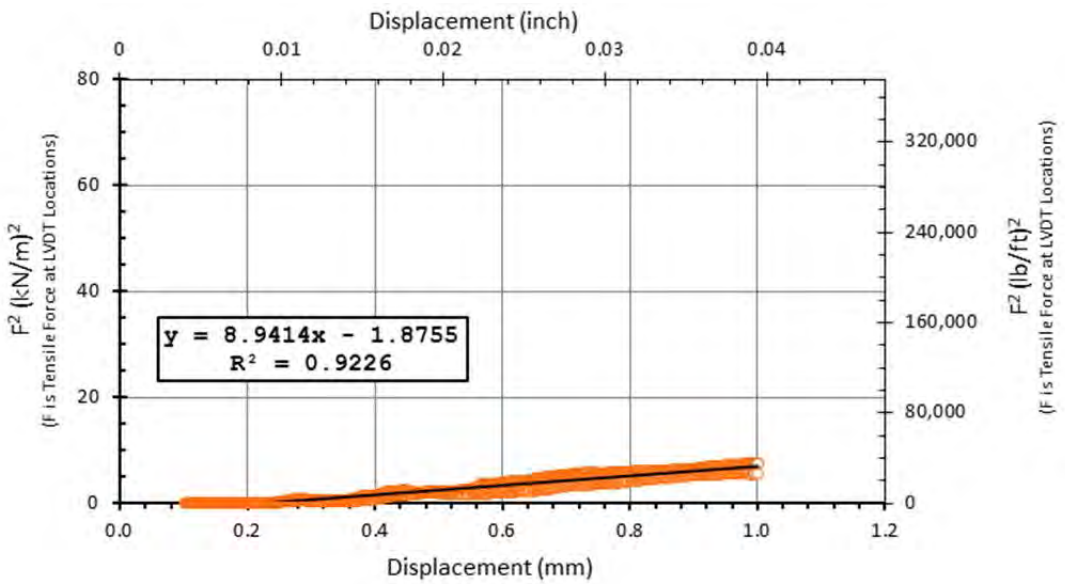
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.8	kN/m	395	lb/ft
Max Pullout Load	P_{max}	1.58	kN	389	lb
Max Shear Stress	τ_{max}	21.3	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/22/2012 AM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	9	0.919	ft	0.920	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	8.7	0.343
2	71.6	2.820
3	104.2	4.102
4	135.2	5.323
5	229.6	9.039

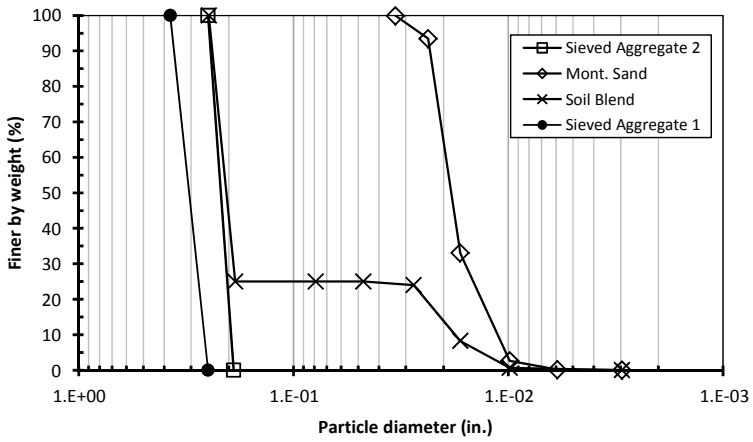
Pullout Rate	
1.0 mm/min.	0.04 in/min

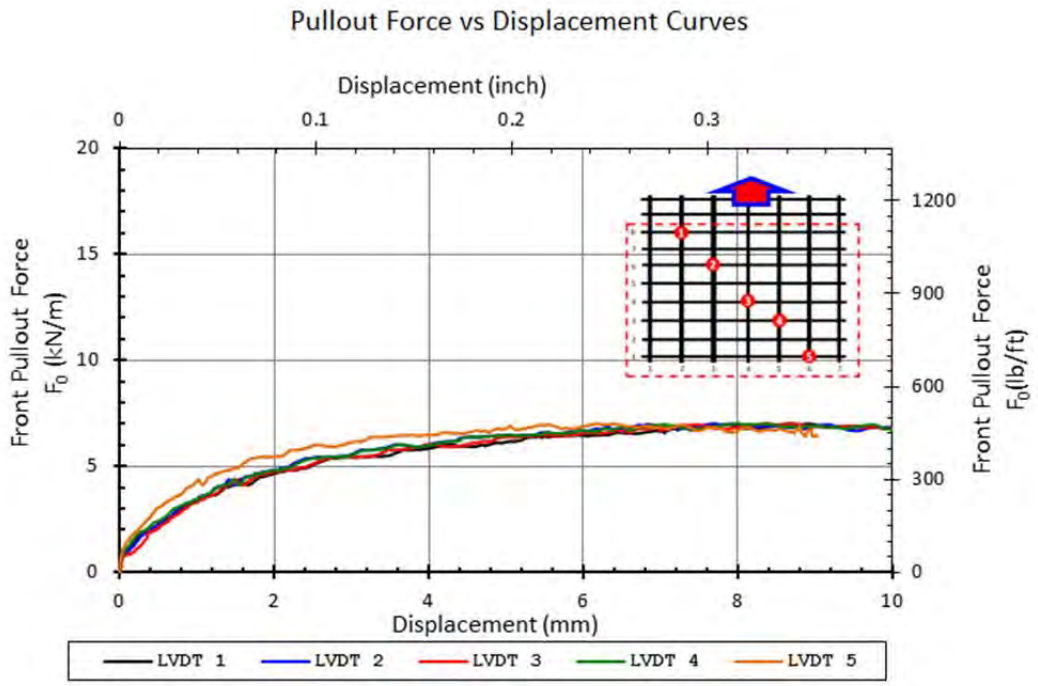
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.587 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

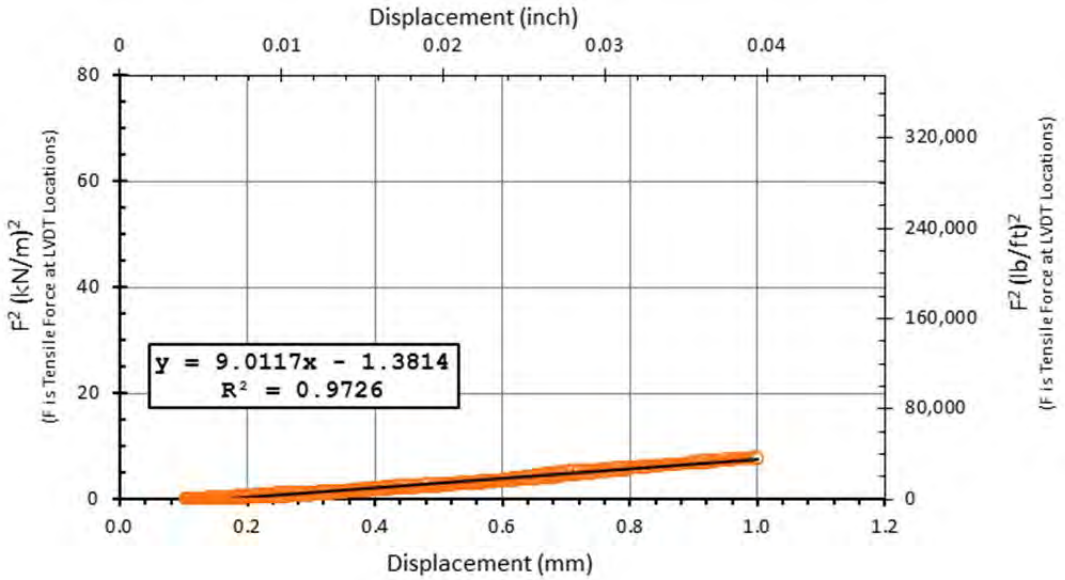
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	481	lb/ft
Max Pullout Load	P_{max}	1.97	kN	472	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
9.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT #1 off to the left, LVDT #5 off to the right.

SMALL PULLOUT TEST

Date test conducted	10/22/12 PM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	9	0.919	ft	0.920	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	8.3	0.328
2	71.8	2.826
3	103.6	4.080
4	136.5	5.373
5	231.6	9.119

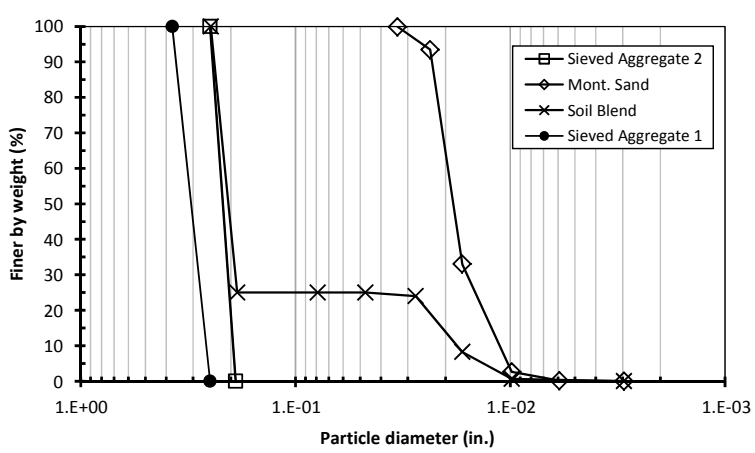
Pullout Rate	
1.0 mm/min.	0.04 in/min

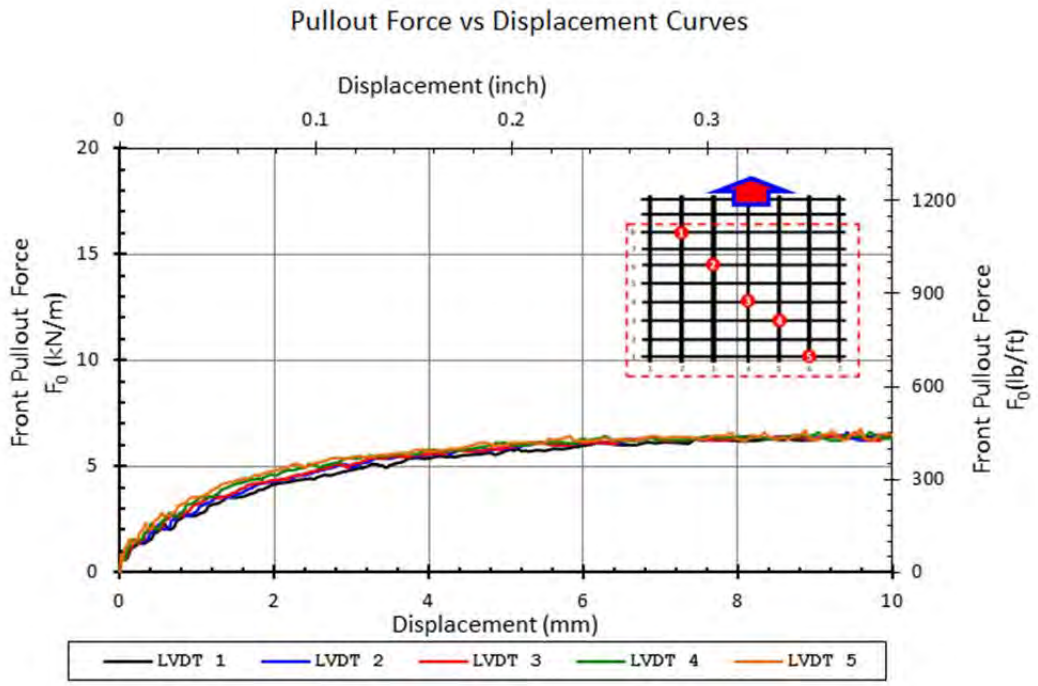
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

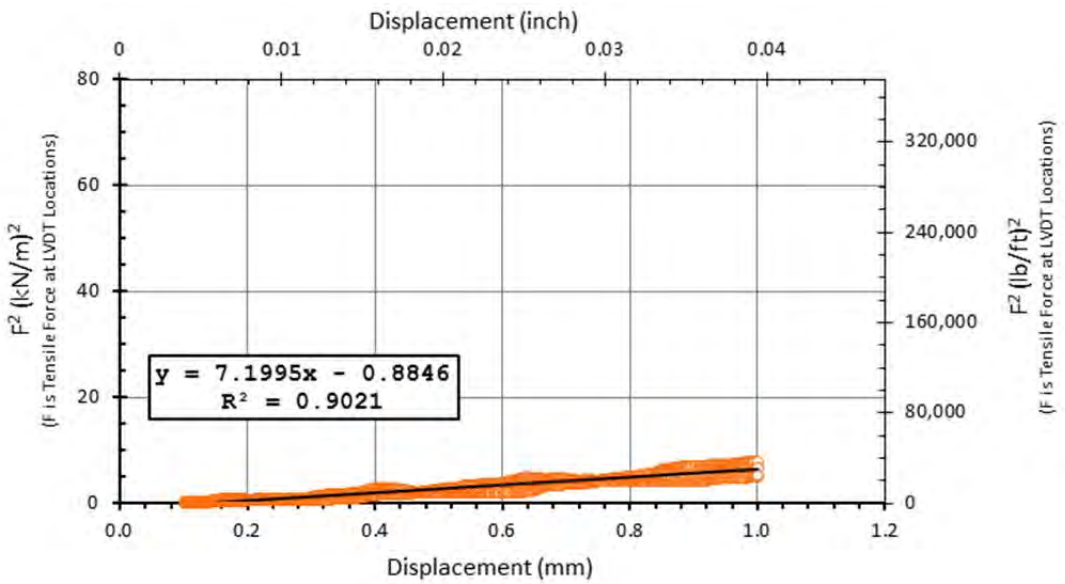
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.8	kN/m	463	lb/ft
Max Pullout Load	P_{max}	1.89	kN	456	lb
Max Shear Stress	τ_{max}	25.5	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
7.2	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/23/2012 AM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	9	0.919	ft	0.920	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	12.4	0.487
2	74.4	2.927
3	106.4	4.188
4	138.9	5.467
5	231.5	9.114

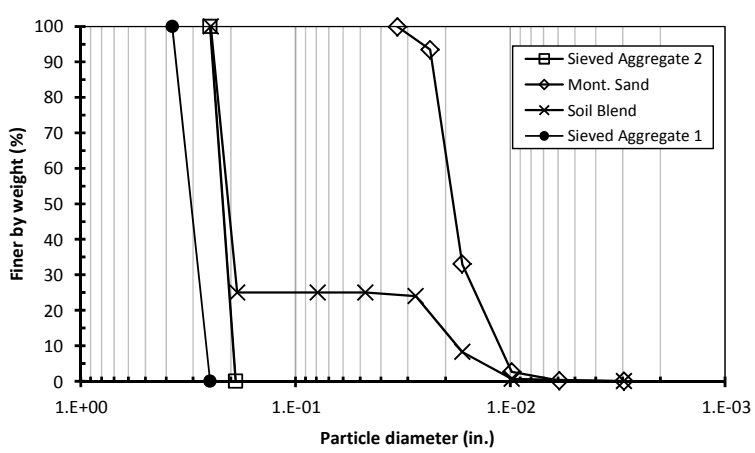
Pullout Rate	
1.0 mm/min.	0.04 in/min

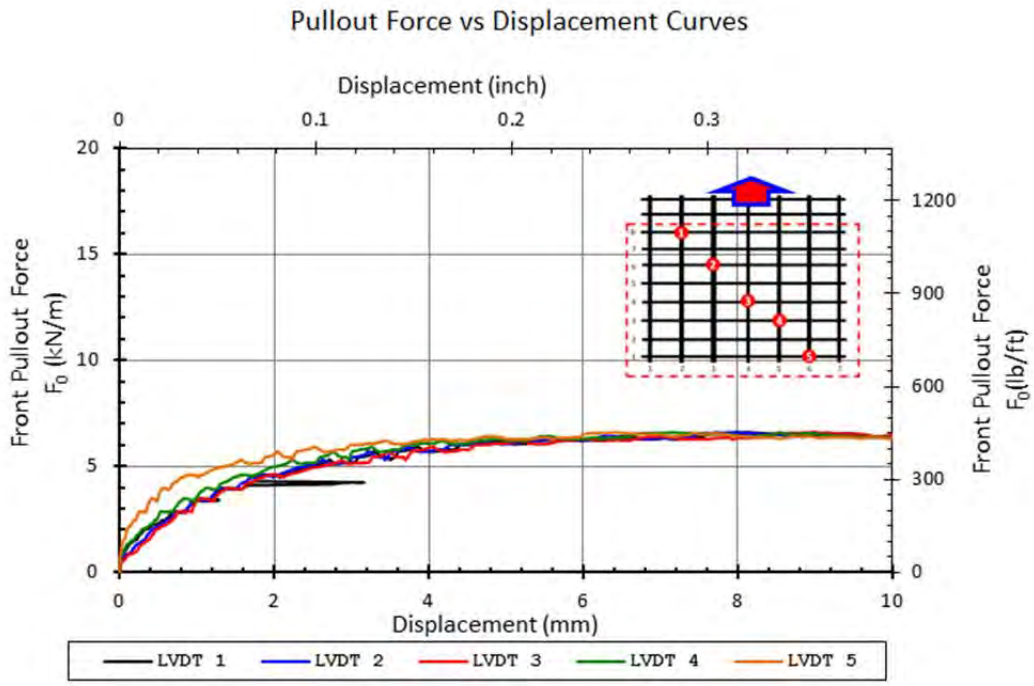
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

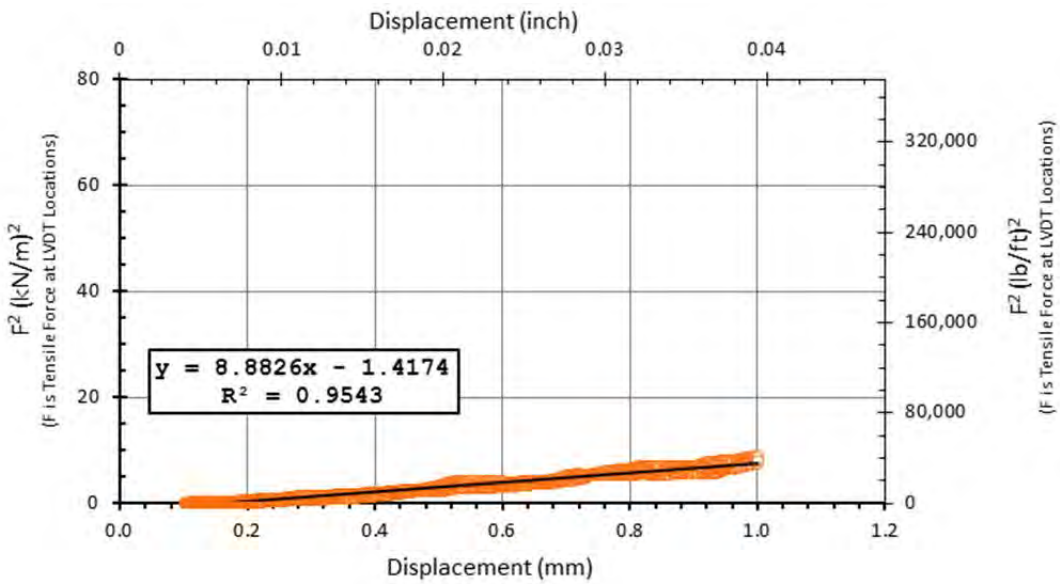
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.6	kN/m	453	lb/ft
Max Pullout Load	P_{max}	1.85	kN	456	lb
Max Shear Stress	τ_{max}	24.9	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
8.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Temporary problem with readings of LVDT 1 during the test.

SMALL PULLOUT TEST

Date test conducted	10/23/12 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.280	m	0.245	m
	9	0.925	ft	0.920	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	12.3	0.482
2	75.5	2.973
3	106.1	4.177
4	135.1	5.319
5	230.9	9.090

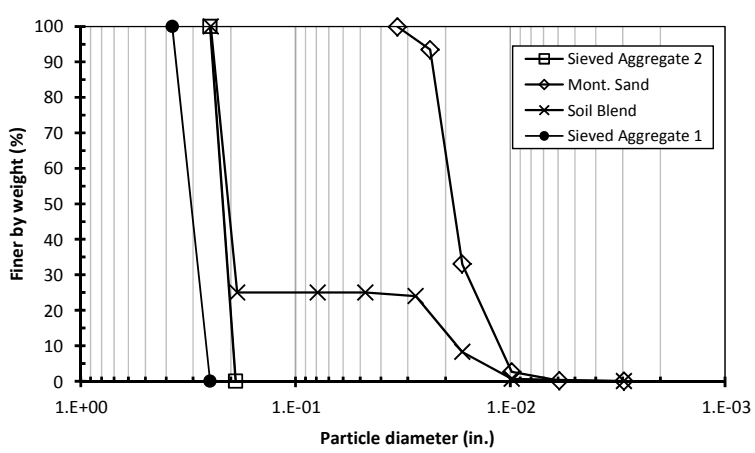
Pullout Rate	
1.0 mm/min.	0.04 in/min

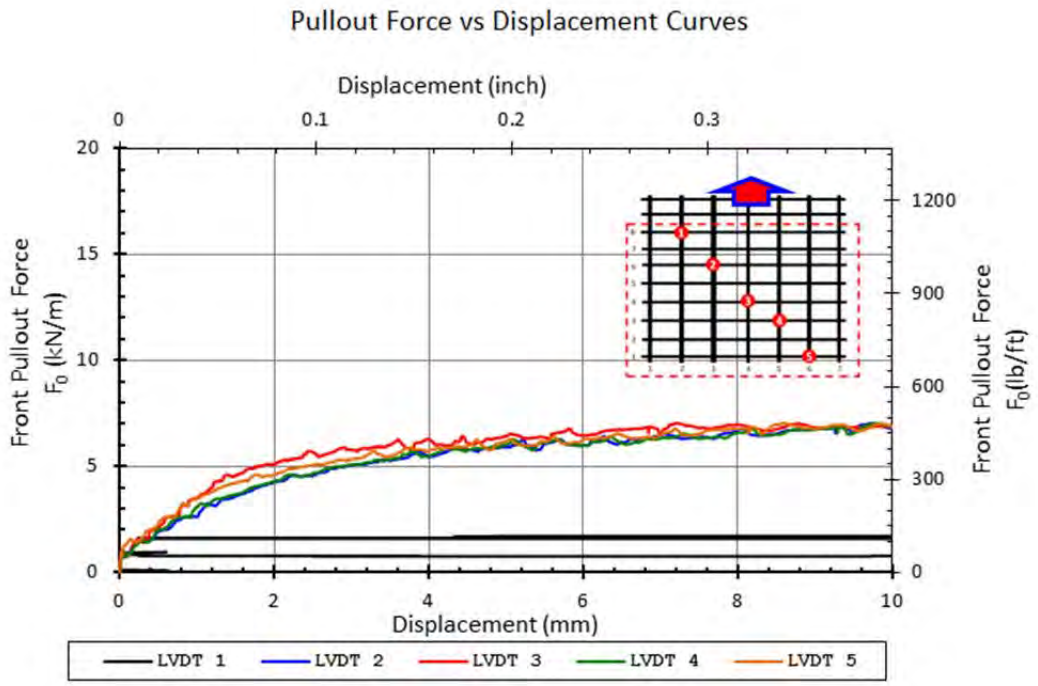
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

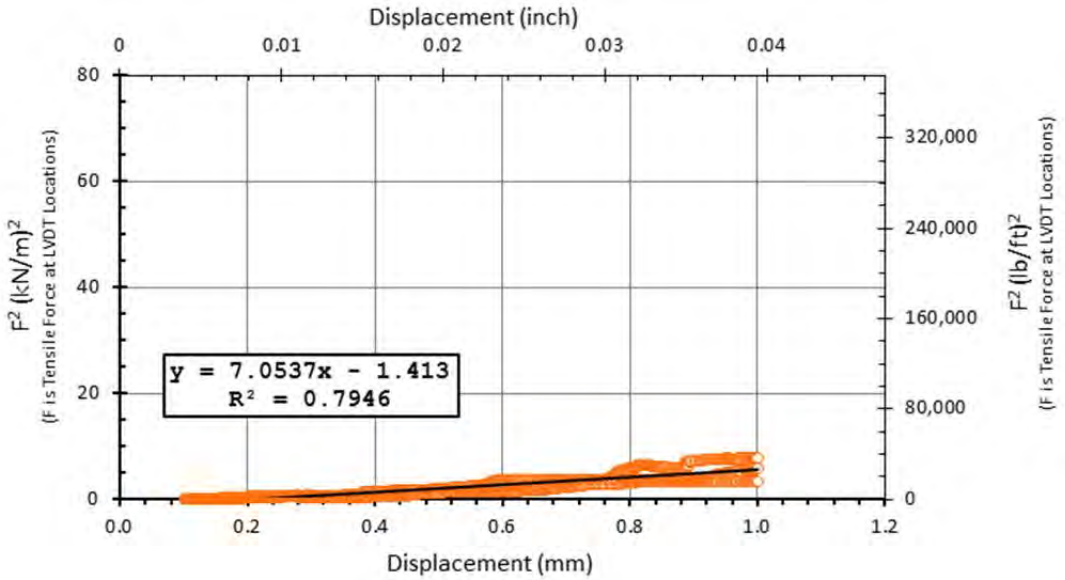
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	496	lb/ft
Max Pullout Load	P_{max}	2.03	kN	488	lb
Max Shear Stress	τ_{max}	27.3	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
7.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Problems with readings of LVDT 1 during the test. Soldering of the connections of the wires need to be fixed.

SMALL PULLOUT TEST

Date test conducted	10/25/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	9	0.919	ft	0.920	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	5.0	0.195
2	68.1	2.681
3	100.3	3.948
4	132.2	5.203
5	228.6	9.000

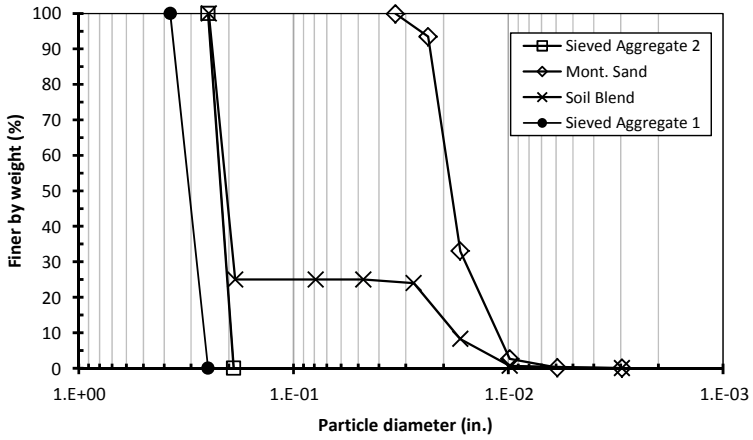
Pullout Rate	
1.0 mm/min.	0.04 in/min

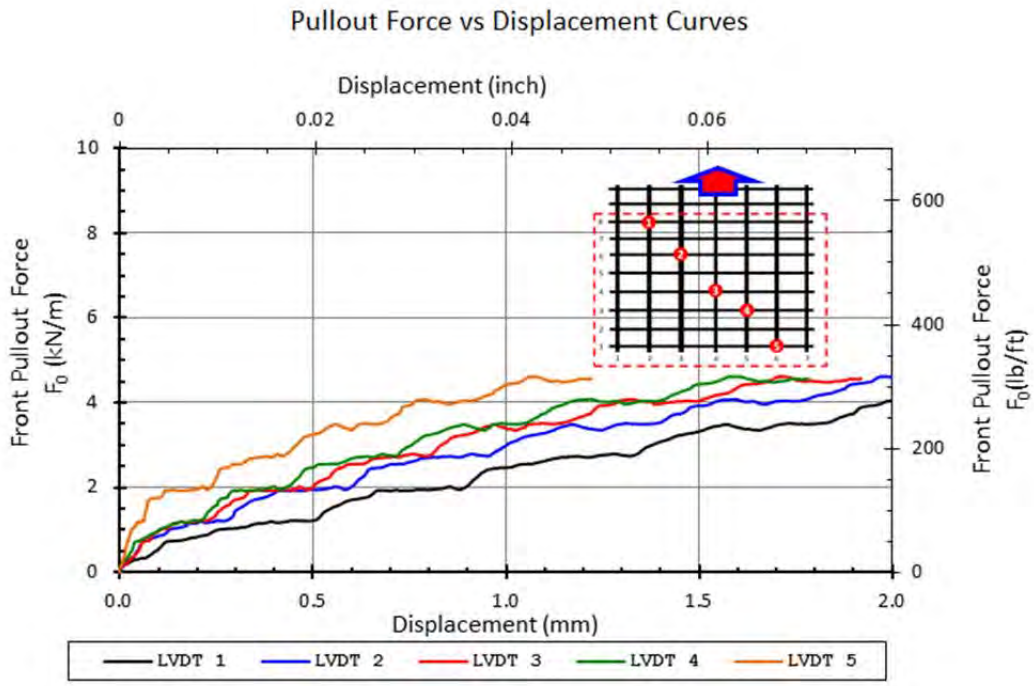
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

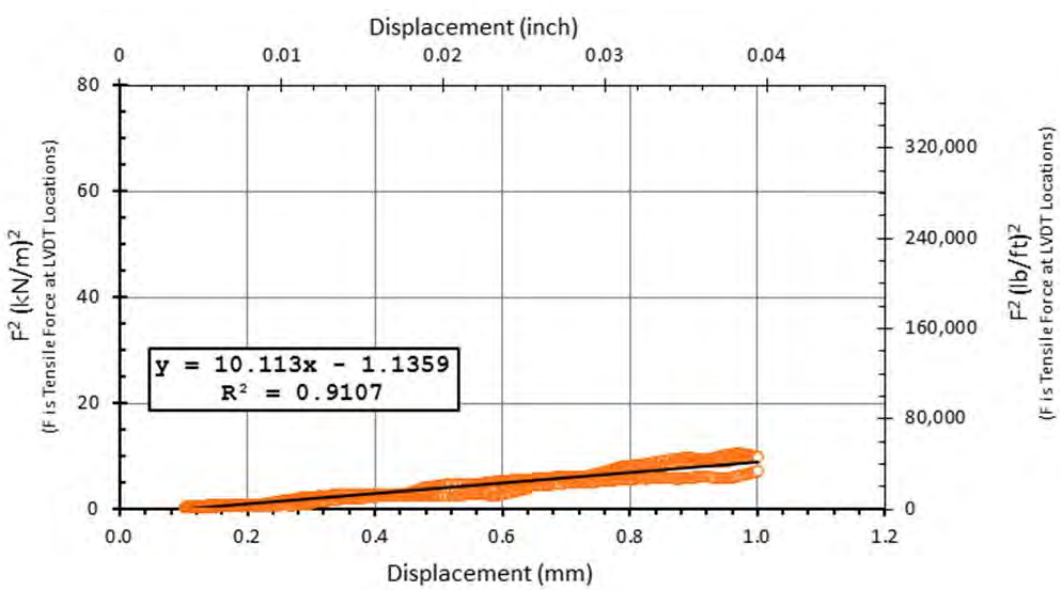
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}	
10.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Test conducted until 1.1 mm of displacement of LVDTs 2, 3 and 4.

SMALL PULLOUT TEST

Date test conducted	10/9/2012 AM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	7	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	44.6	1.755
2	89.7	3.533
3	114.6	4.511
4	142.2	5.599
5	234.2	9.222

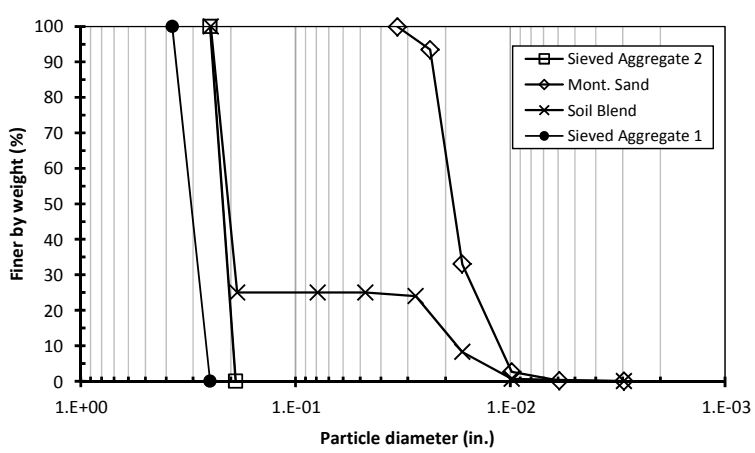
Pullout Rate	
1.0 mm/min.	0.04 in/min

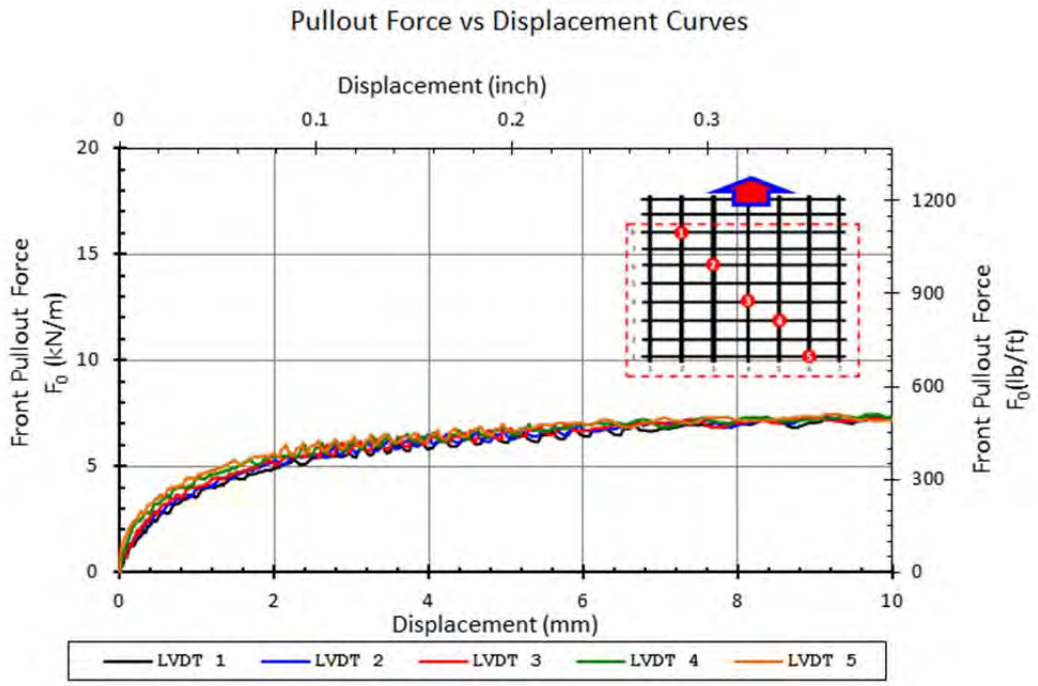
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

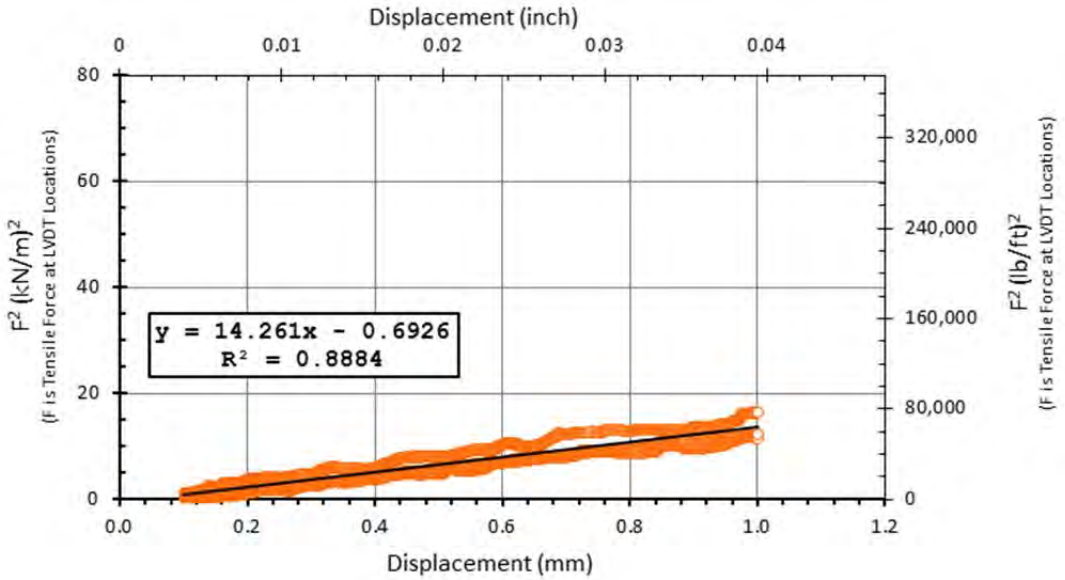
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	511	lb/ft
Max Pullout Load	P_{max}	2.09	kN	512	lb
Max Shear Stress	τ_{max}	28.1	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
14.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/9/2012 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	7	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	48.6	1.914
2	94.0	3.700
3	117.5	4.624
4	139.9	5.507
5	229.9	9.051

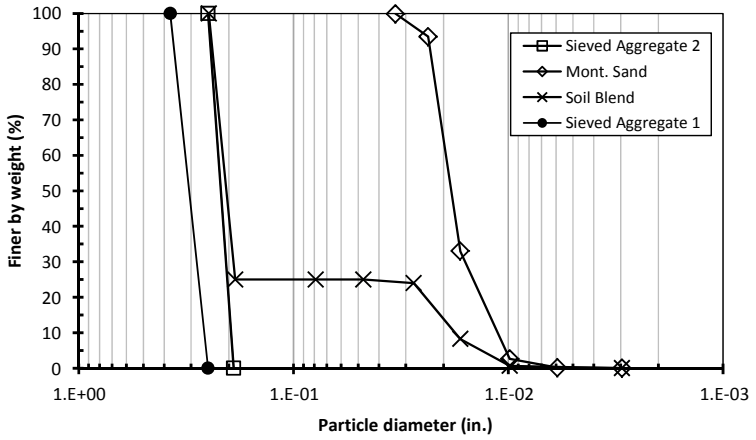
Pullout Rate	
1.0 mm/min.	0.04 in/min

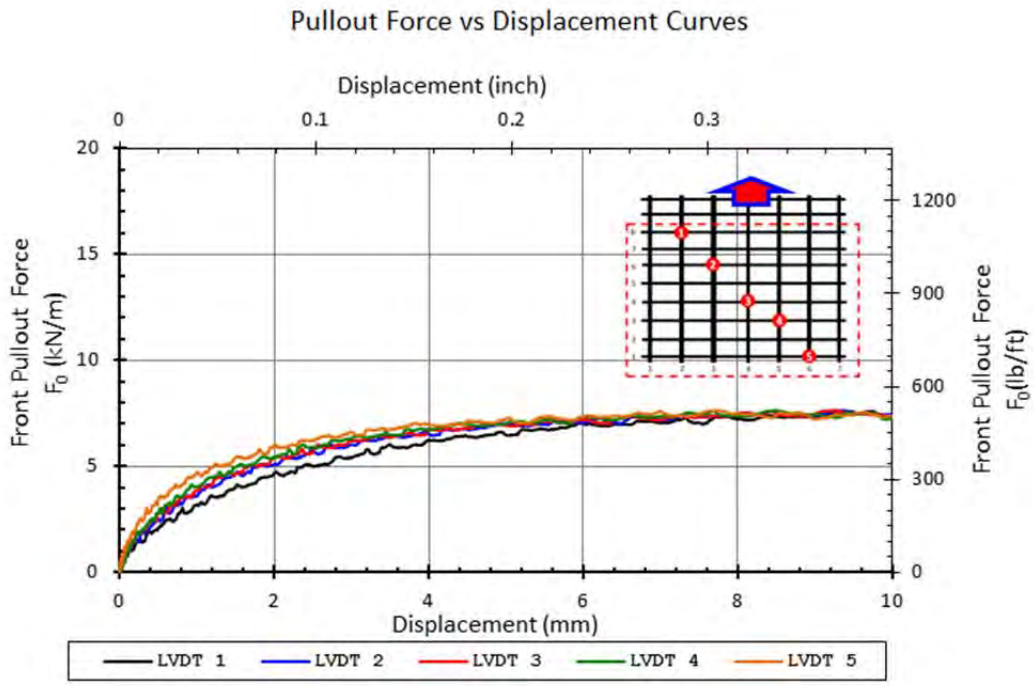
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

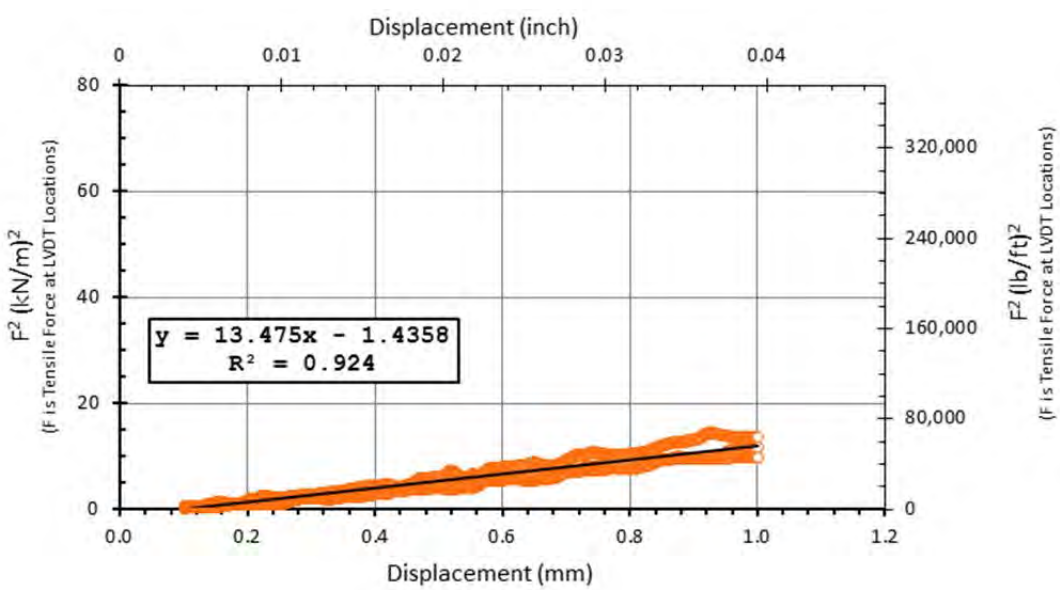
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.7	kN/m	530	lb/ft
Max Pullout Load	P_{max}	2.17	kN	514	lb
Max Shear Stress	τ_{max}	29.1	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
13.5	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 2 slightly to the left, LVDT 4 slightly to the right

SMALL PULLOUT TEST

Date test conducted	10/12/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	7	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	46.9	1.848
2	94.0	3.700
3	118.7	4.672
4	142.1	5.593
5	233.1	9.175

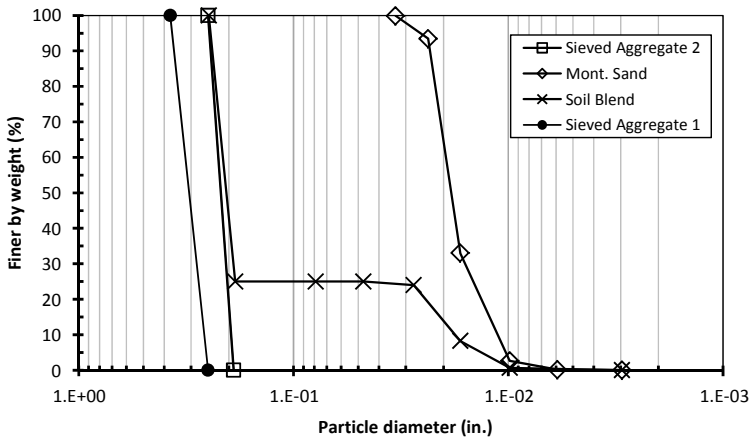
Pullout Rate	
1.0 mm/min.	0.04 in/min

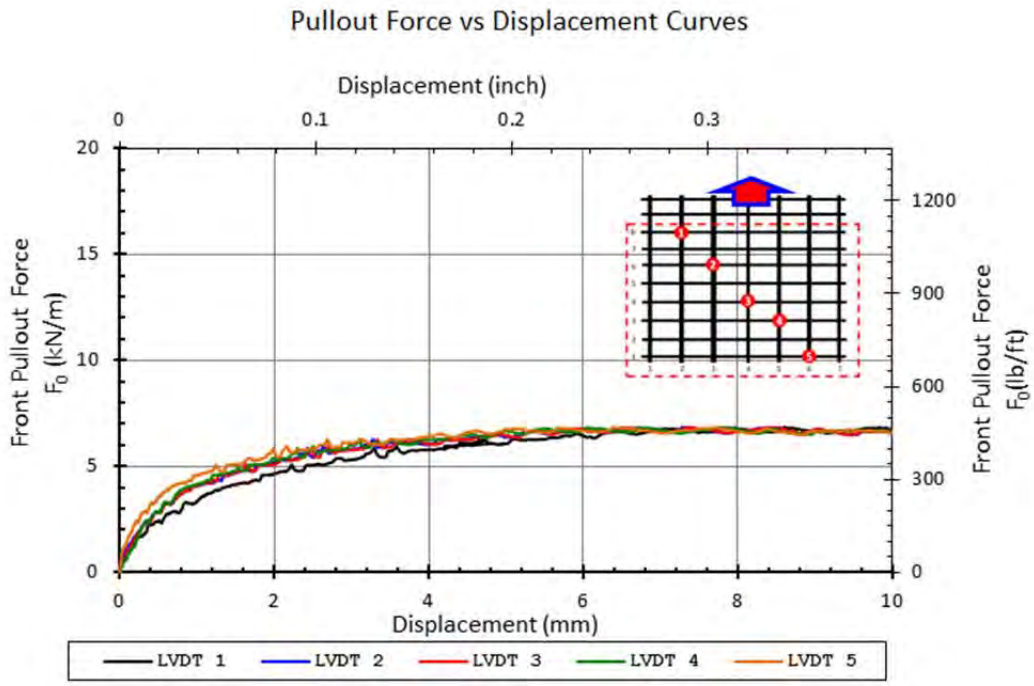
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

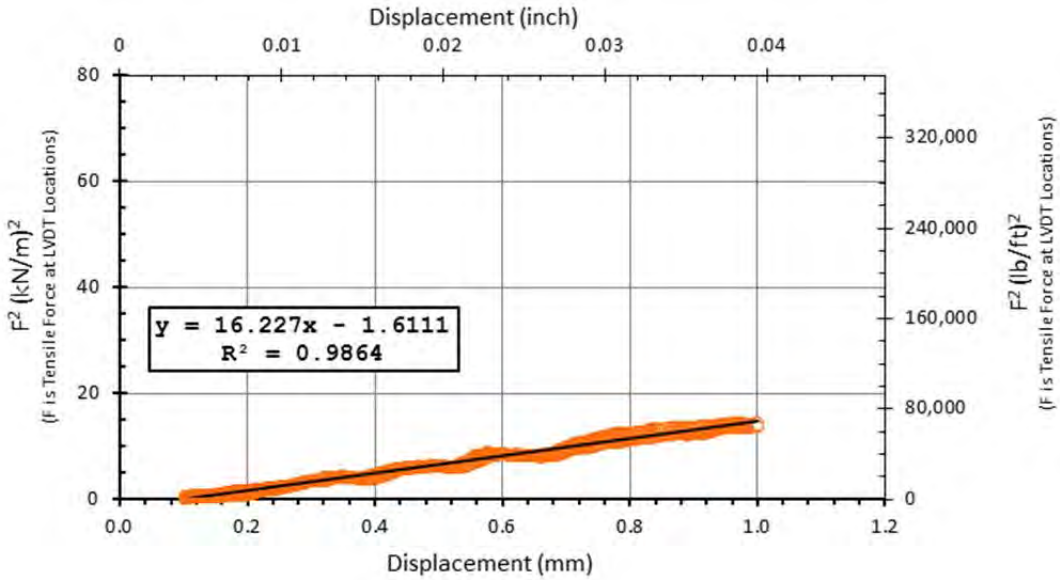
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.8	kN/m	469	lb/ft
Max Pullout Load	P_{max}	1.92	kN	470	lb
Max Shear Stress	τ_{max}	25.8	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
16.2	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT slightly to the right

SMALL PULLOUT TEST

Date test conducted	10/16/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.280	m	0.245	m
	7	0.922	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	47.6	1.874
2	93.4	3.677
3	118.8	4.676
4	142.0	5.589
5	232.0	9.134

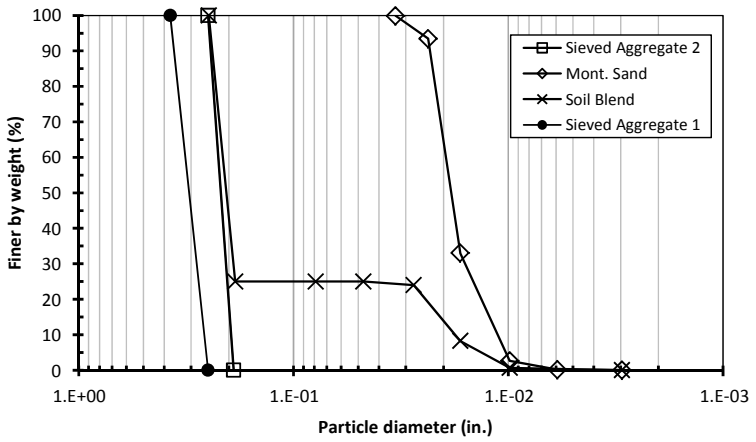
Pullout Rate	
1.0 mm/min.	0.04 in/min

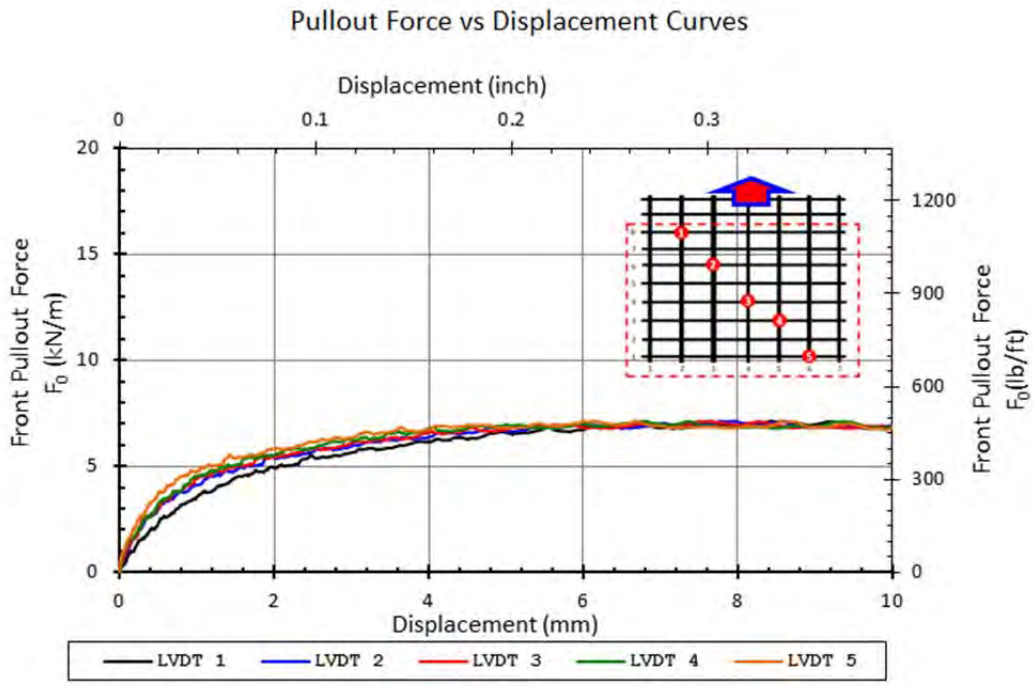
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

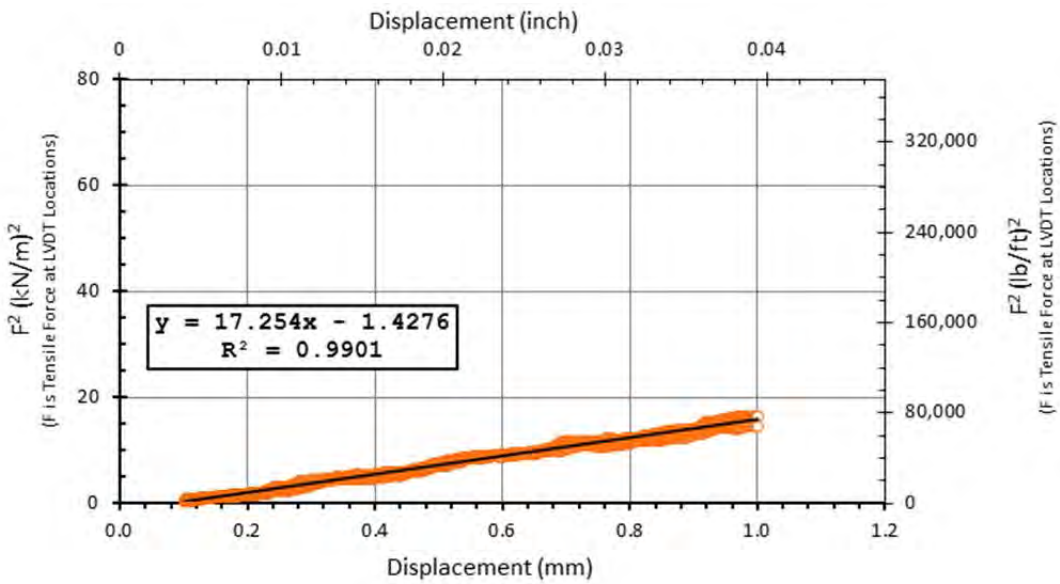
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	489	lb/ft
Max Pullout Load	P_{max}	2.00	kN	481	lb
Max Shear Stress	τ_{max}	26.9	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
17.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/17/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.280	m	0.245	m
	7	0.912	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	50.6	1.993
2	97.7	3.847
3	120.0	4.723
4	142.0	5.589
5	231.7	9.120

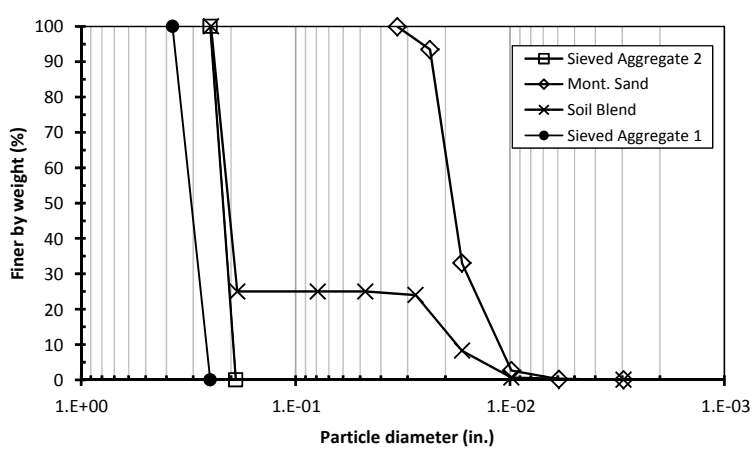
Pullout Rate	
1.0 mm/min.	0.04 in/min

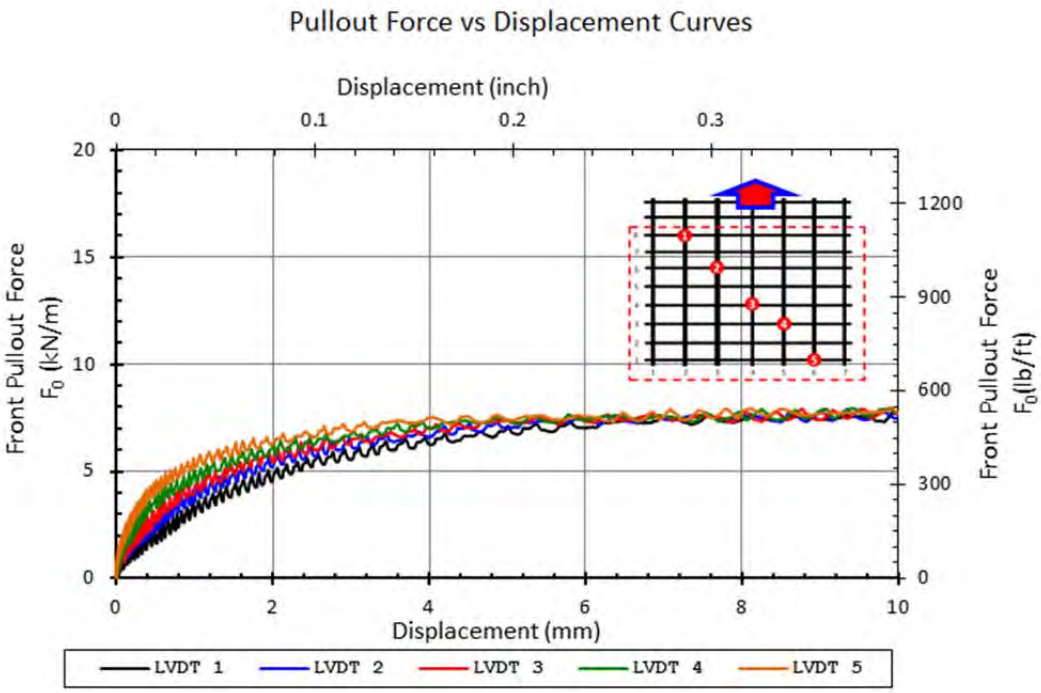
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

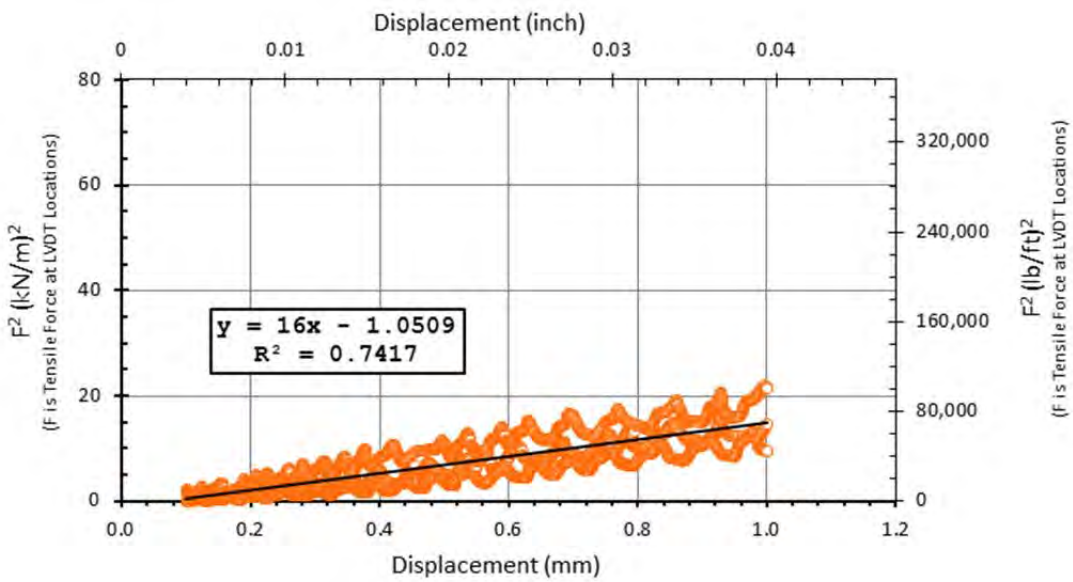
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.8	kN/m	604	lb/ft
Max Pullout Load	P_{max}	2.47	kN	532	lb
Max Shear Stress	τ_{max}	33.2	kPa	4.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
16.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT # 3 slightly off to the left. LVDT #4 off to the right.

SMALL PULLOUT TEST

Date test conducted	10/18/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	7	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	38.8	1.529
2	86.9	3.420
3	112.0	4.409
4	137.6	5.418
5	229.3	9.028

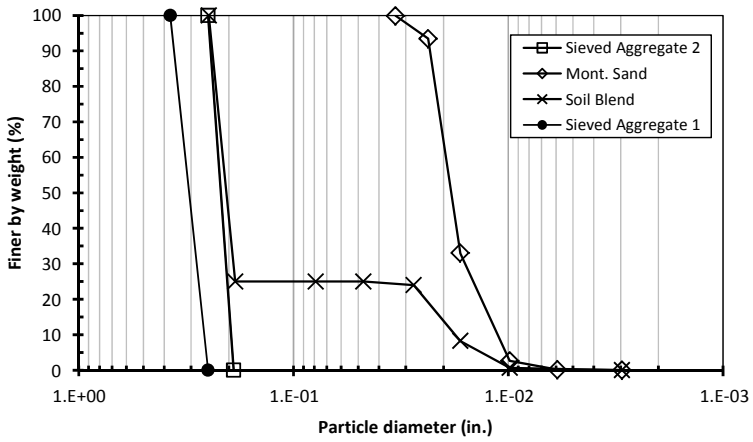
Pullout Rate	
1.0 mm/min.	0.04 in/min

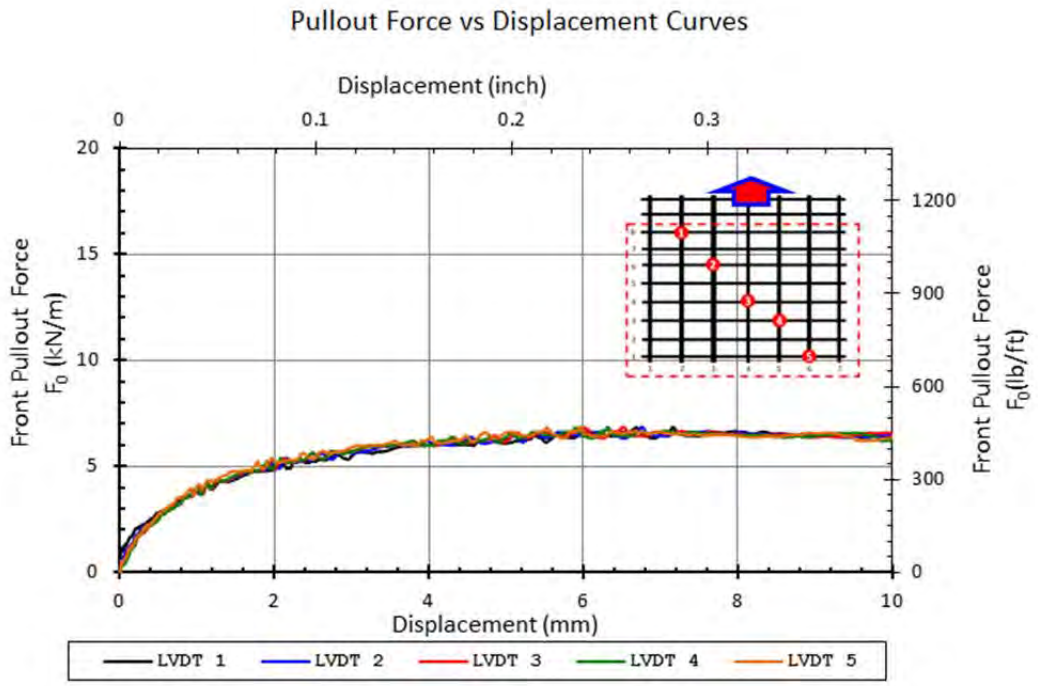
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

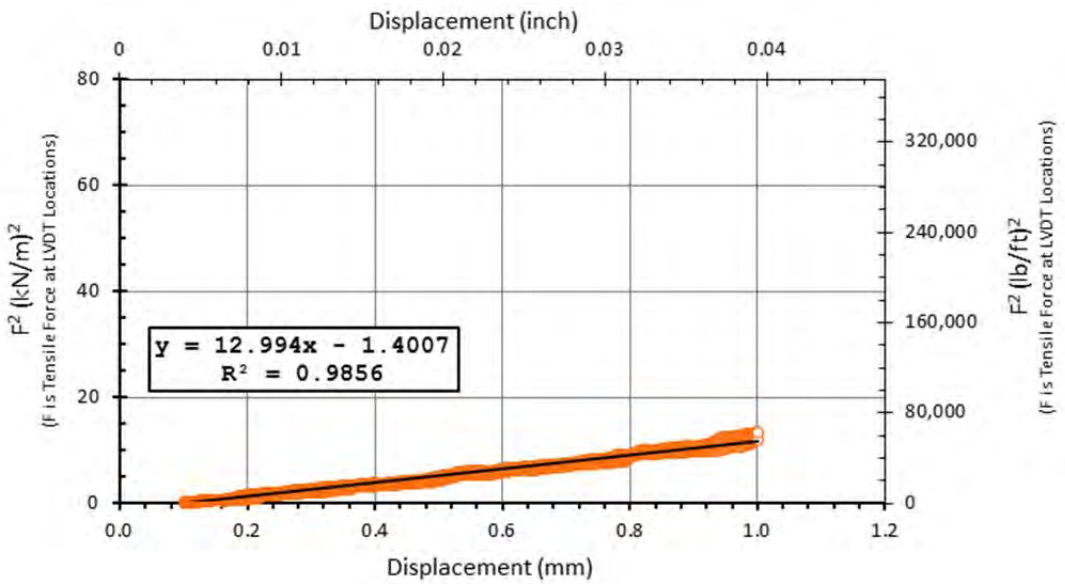
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	470	lb/ft
Max Pullout Load	P_{max}	1.92	kN	490	lb
Max Shear Stress	τ_{max}	25.8	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
13.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Test restarted, file did not record on first run.

SMALL PULLOUT TEST

Date test conducted	10/11/2012 AM
Conducted by	Pong/Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.267	m	0.245	m
	8	0.902	ft	0.875	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	4.9	0.193
2	98.6	3.881
3	137.1	5.399
4	175.0	6.889
5	232.8	9.164

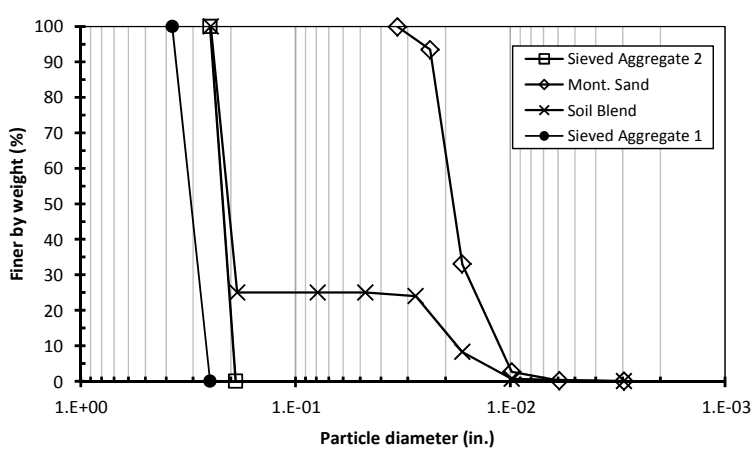
Pullout Rate	
1.0 mm/min.	0.04 in/min

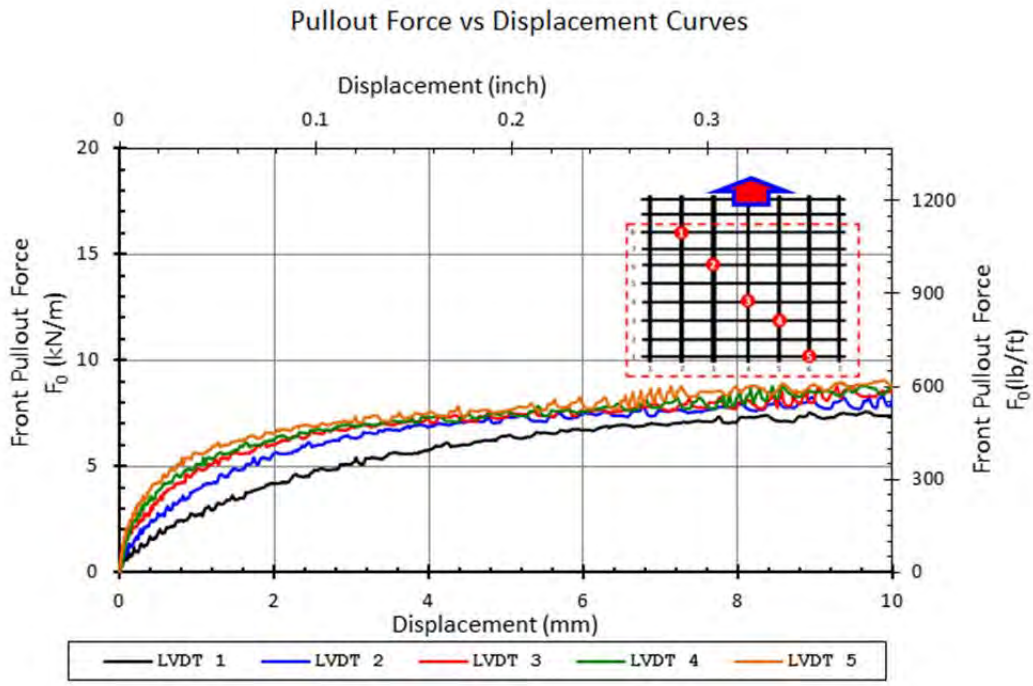
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

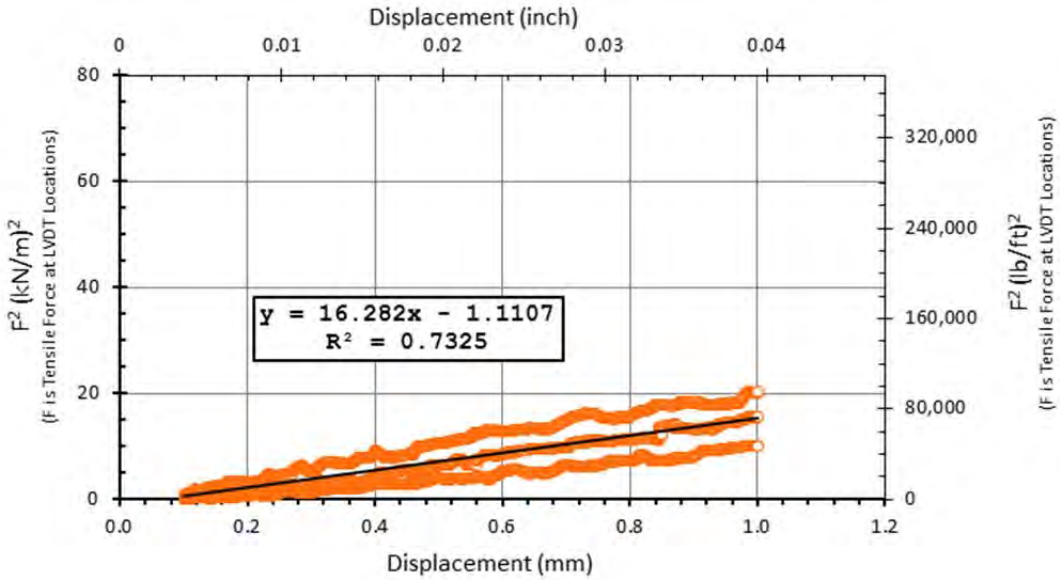
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.7	kN/m	663	lb/ft
Max Pullout Load	P_{max}	2.58	kN	503	lb
Max Shear Stress	τ_{max}	34.7	kPa	5.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
16.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/29/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.267	m	0.245	m
	8	0.915	ft	0.875	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	30.8	1.214
2	104.6	4.116
3	139.5	5.490
4	176.2	6.938
5	232.3	9.144

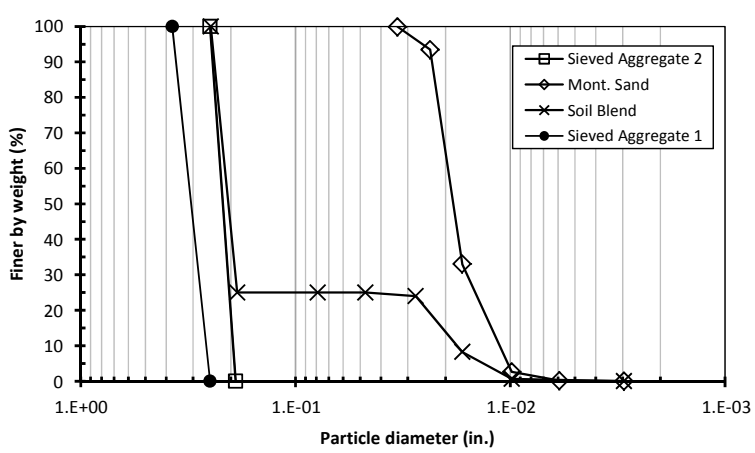
Pullout Rate	
1.0 mm/min.	0.04 in/min

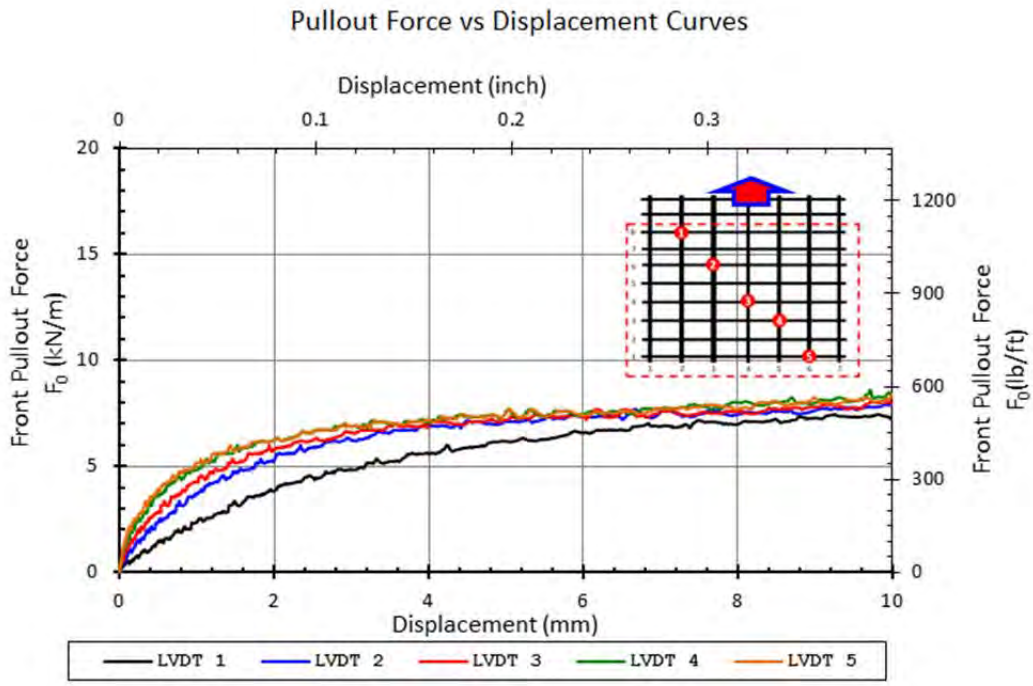
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.587 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

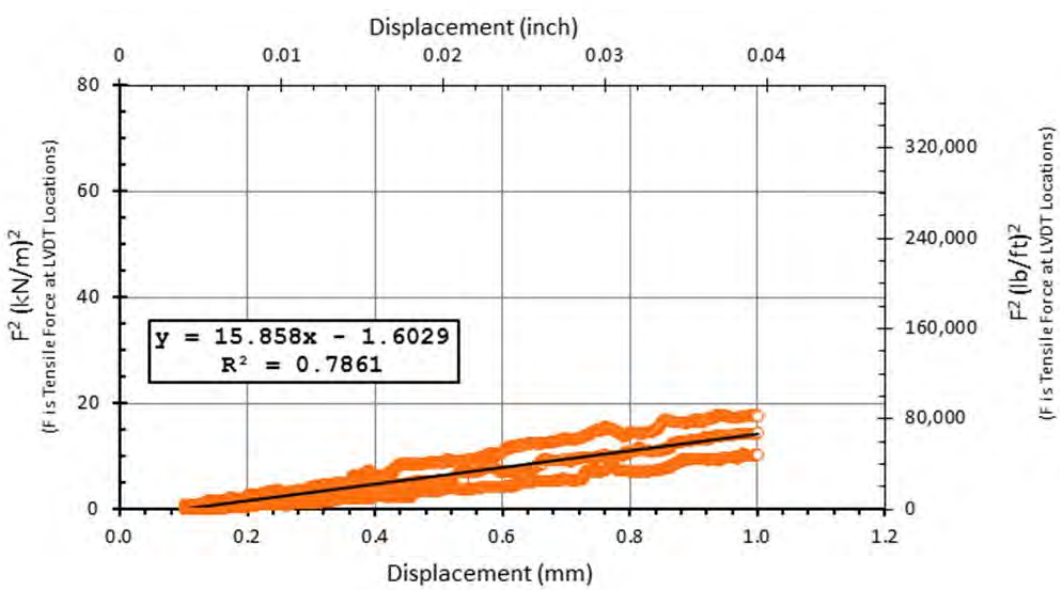
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.6	kN/m	589	lb/ft
Max Pullout Load	P_{max}	2.29	kN	498	lb
Max Shear Stress	τ_{max}	30.8	kPa	4.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
15.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/30/2012 AM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.267	m	0.245	m
	8	0.902	ft	0.875	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	-13.8	-0.542
2	90.5	3.563
3	131.8	5.189
4	172.7	6.800
5	237.4	9.346

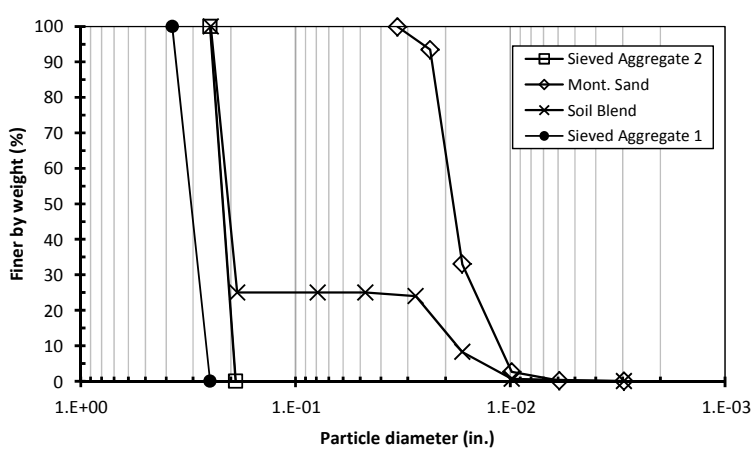
Pullout Rate	
1.0 mm/min.	0.04 in/min

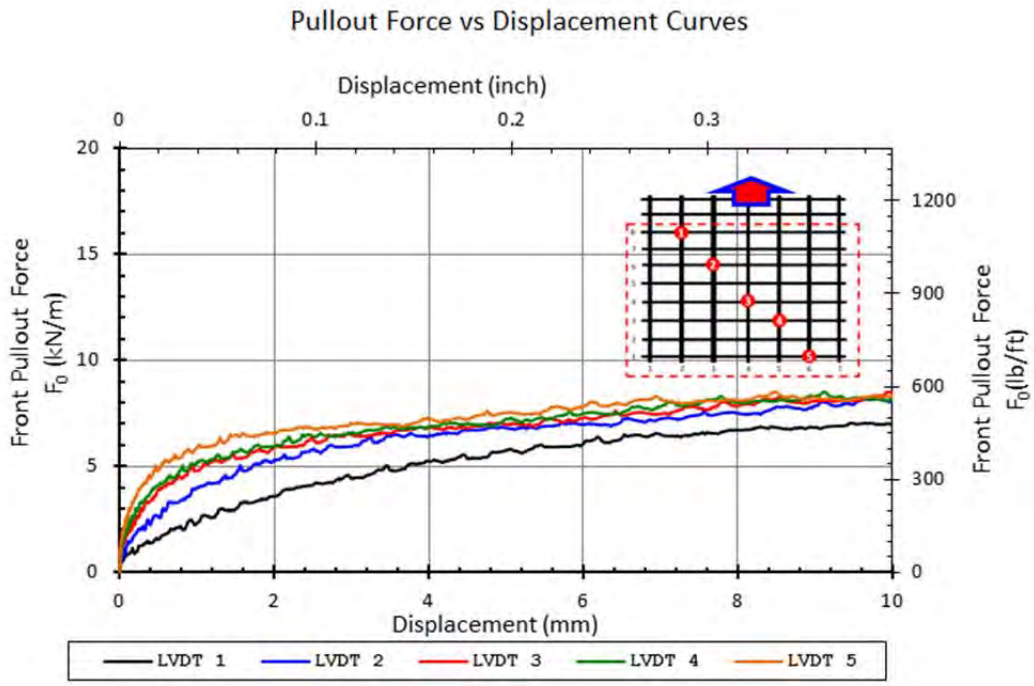
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

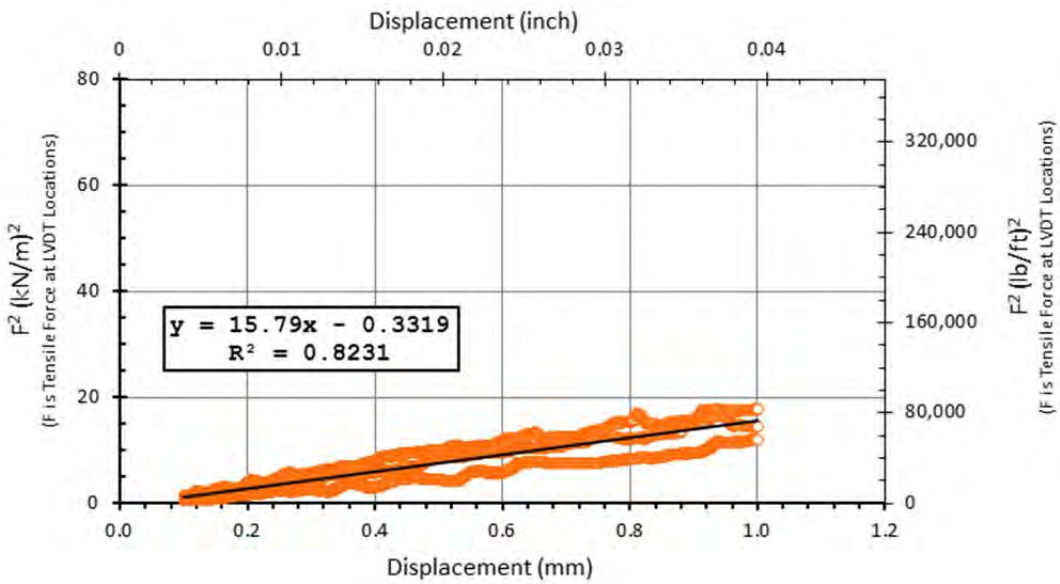
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.6	kN/m	588	lb/ft
Max Pullout Load	P_{max}	2.29	kN	551	lb
Max Shear Stress	τ_{max}	30.8	kPa	4.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
15.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/30/2012 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.267	m	0.245	m
	8	0.902	ft	0.875	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	10.3	0.404
2	104.2	4.104
3	140.7	5.539
4	176.9	6.965
5	232.3	9.147

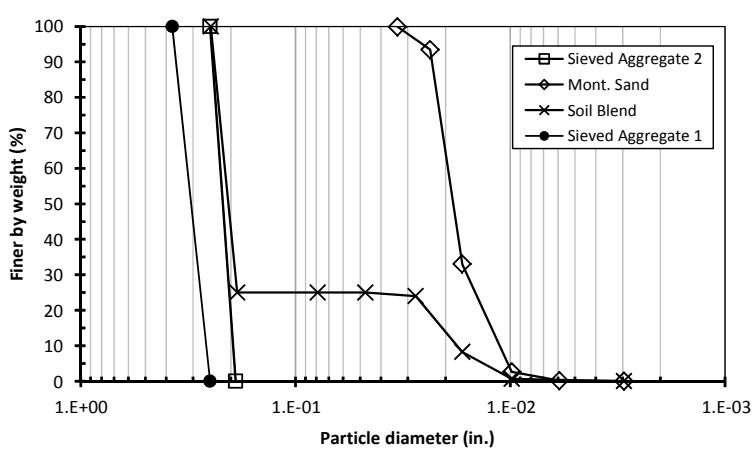
Pullout Rate	
1.0 mm/min.	0.04 in/min

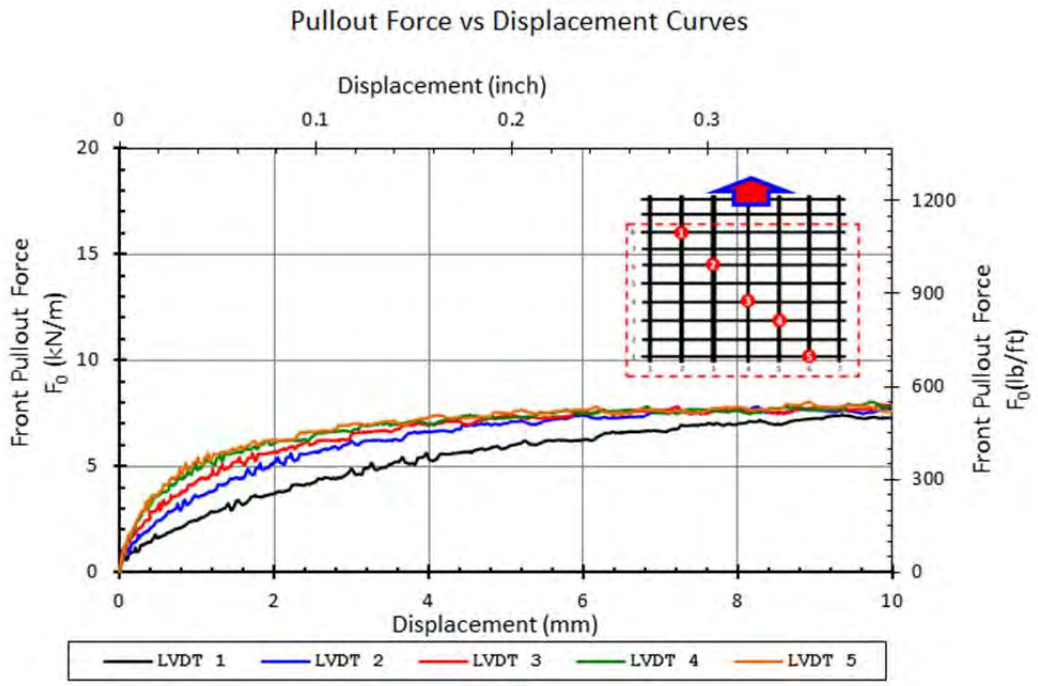
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.582 g/cm^3	99 pcf

Note: particle size distribution curve shown below

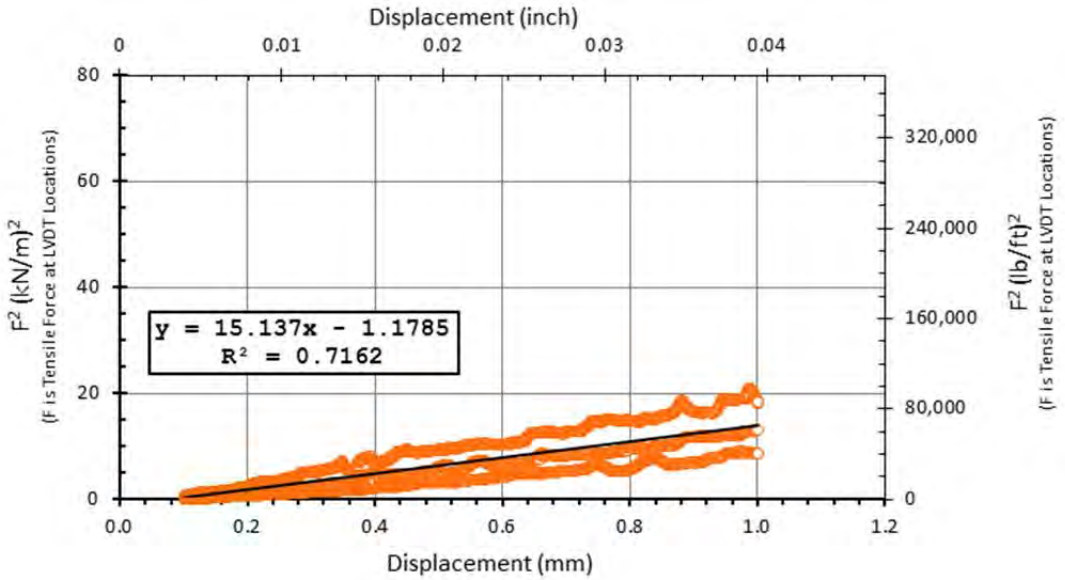
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.0	kN/m	551	lb/ft
Max Pullout Load	P_{max}	2.15	kN	504	lb
Max Shear Stress	τ_{max}	28.8	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
15.1	$(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/31/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.267	m	0.245	m
	8	0.902	ft	0.875	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	6.6	0.259
2	97.8	3.851
3	136.1	5.358
4	172.7	6.800
5	231.2	9.100

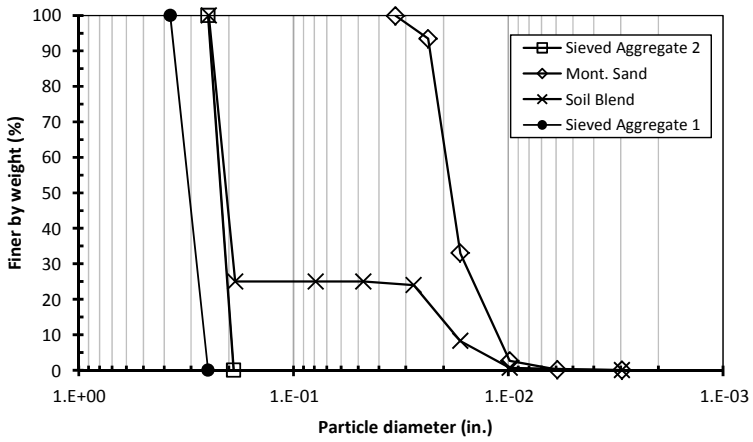
Pullout Rate	
1.0 mm/min.	0.04 in/min

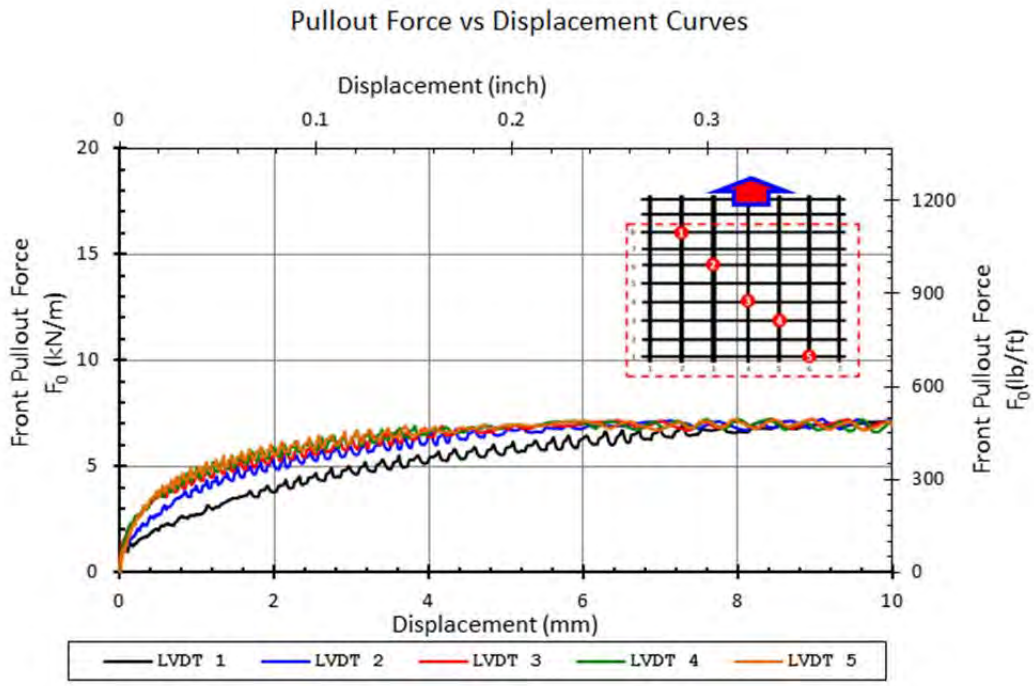
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

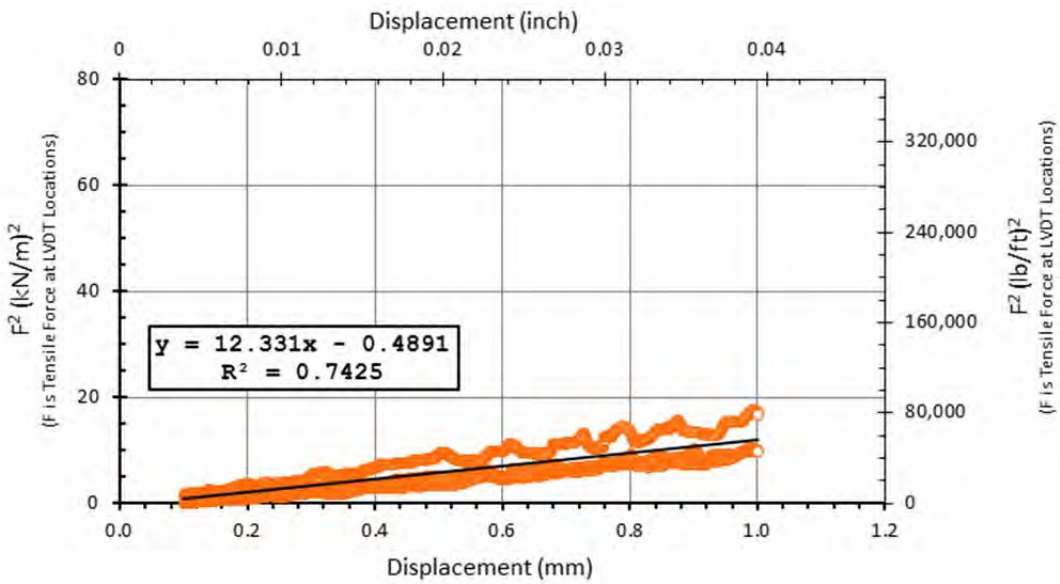
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.3	kN/m	500	lb/ft
Max Pullout Load	P_{max}	1.95	kN	467	lb
Max Shear Stress	τ_{max}	26.2	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
12.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/11/2012 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	9	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	0.4	0.017
2	76.6	3.014
3	114.5	4.507
4	154.2	6.070
5	229.9	9.052

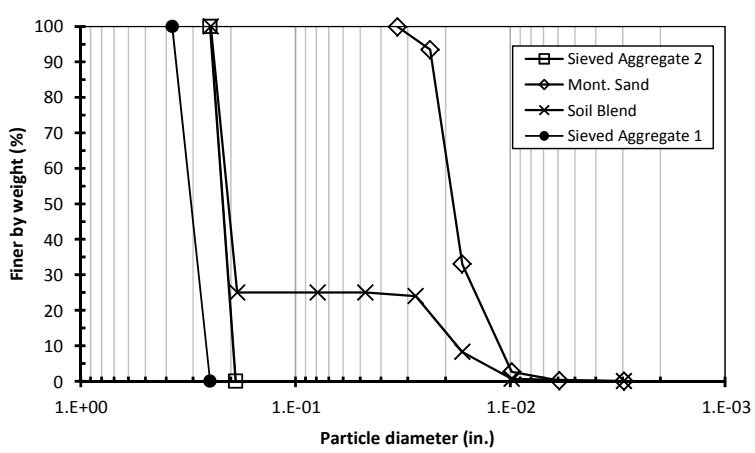
Pullout Rate	
1.0 mm/min.	0.04 in/min

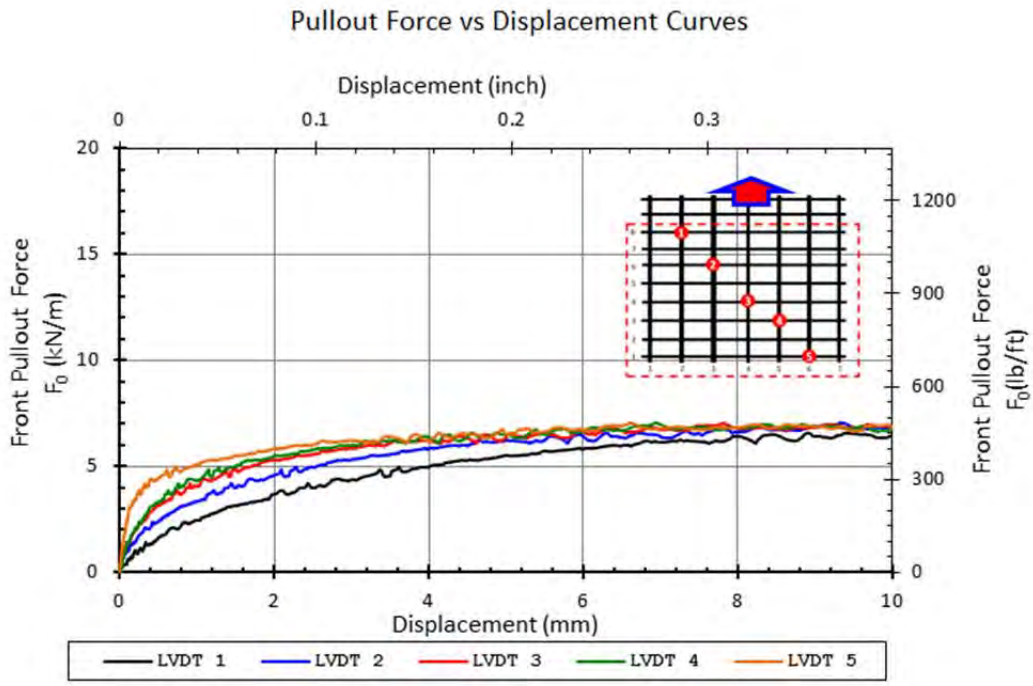
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

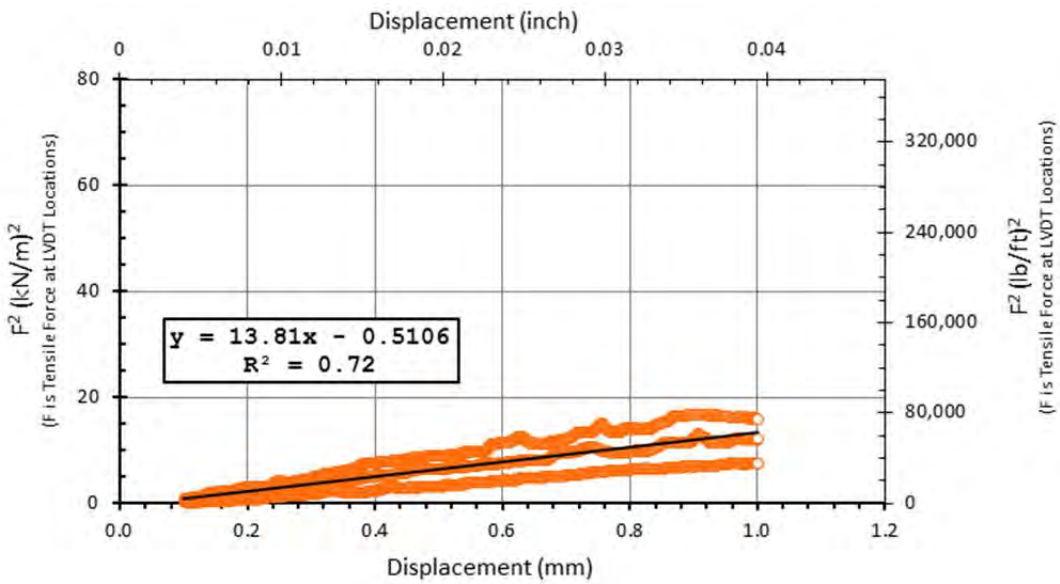
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	484	lb/ft
Max Pullout Load	P_{max}	2.12	kN	504	lb
Max Shear Stress	τ_{max}	28.5	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
13.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 1 + 5 inside the box comes out with bent wire

Appendix A2

This appendix presents the results of the small pullout tests for geosynthetic specimens tested on the Machine Direction (MD) with the final configuration of the test: confining pressure of 3 psi (21 kPa), Sieved Aggregate 2, use of torque wrench and digital air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	2/9/12 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.263	m	0.245	m
	7	0.915	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.7	1.367
2	90.9	3.580
3	118.0	4.645
4	146.0	5.749
5	230.4	9.070

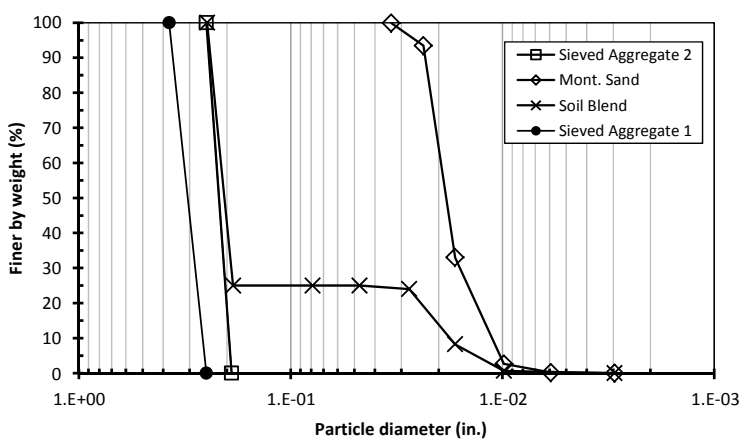
Pullout Rate	
1.0 mm/min.	0.04 in/min

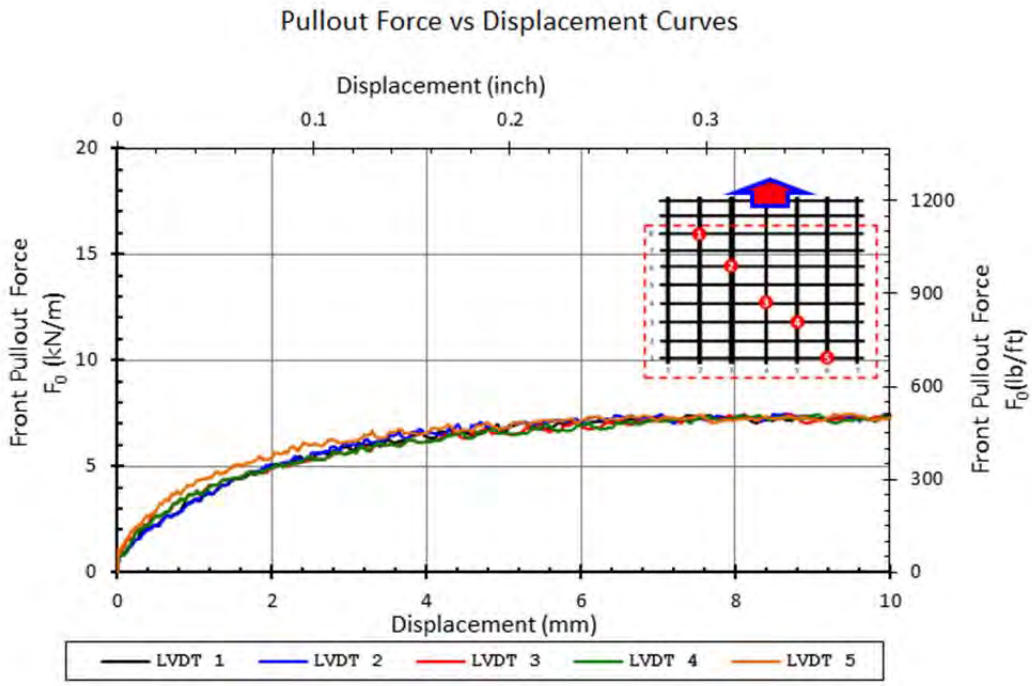
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

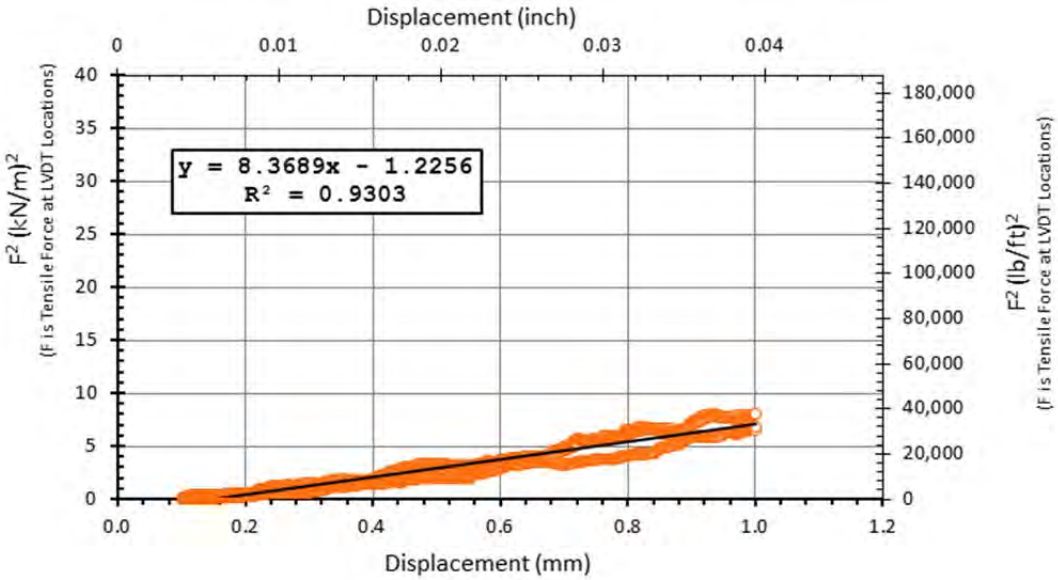
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	512	lb/ft
Max Pullout Load	P_{max}	1.96	kN	471	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
8.4 (kN/m)^2/mm





K_{SGI} plot



Comments:
Slightly tilted to right

SMALL PULLOUT TEST

Date test conducted	2/9/12 PM
Done by	Pong/Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	37.5	1.476
2	94.5	3.721
3	122.7	4.832
4	151.4	5.961
5	237.3	9.344

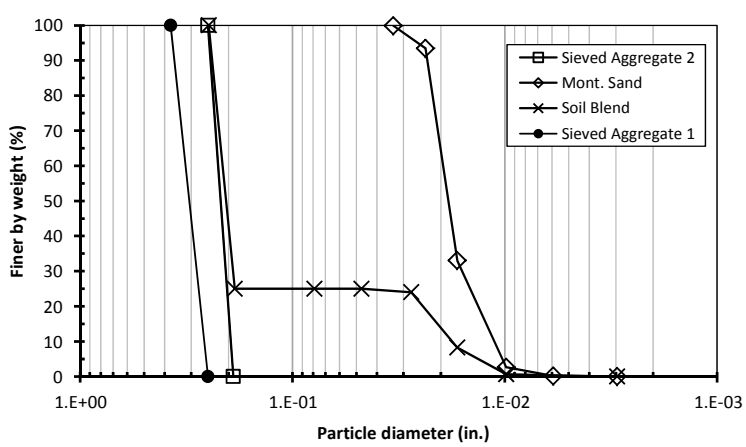
Pullout Rate	
1.0 mm/min.	0.04 in/min

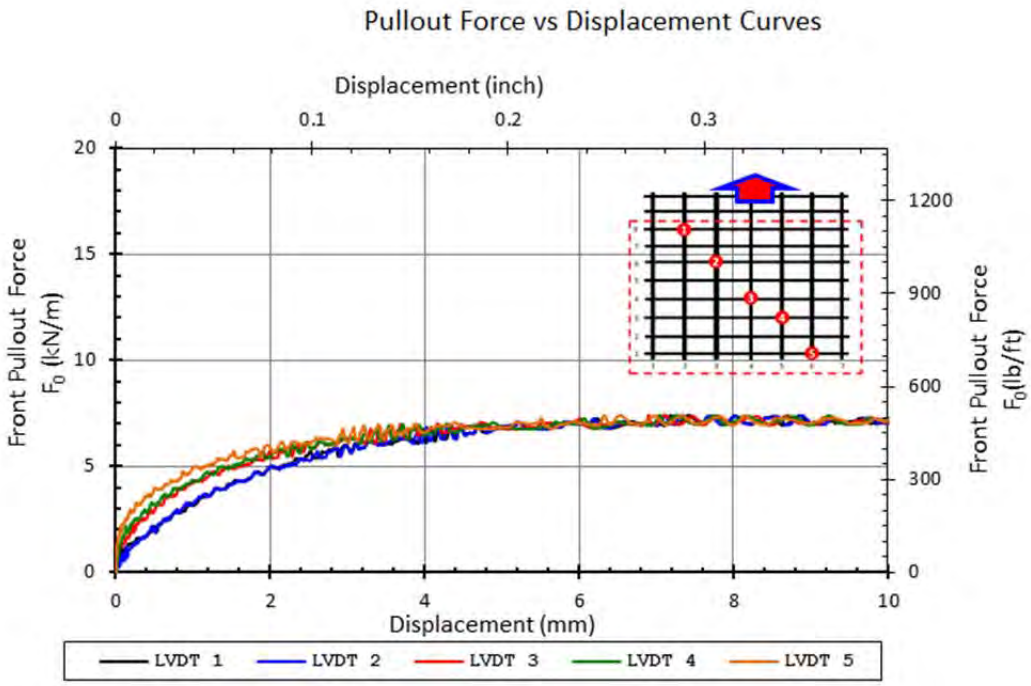
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.493 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

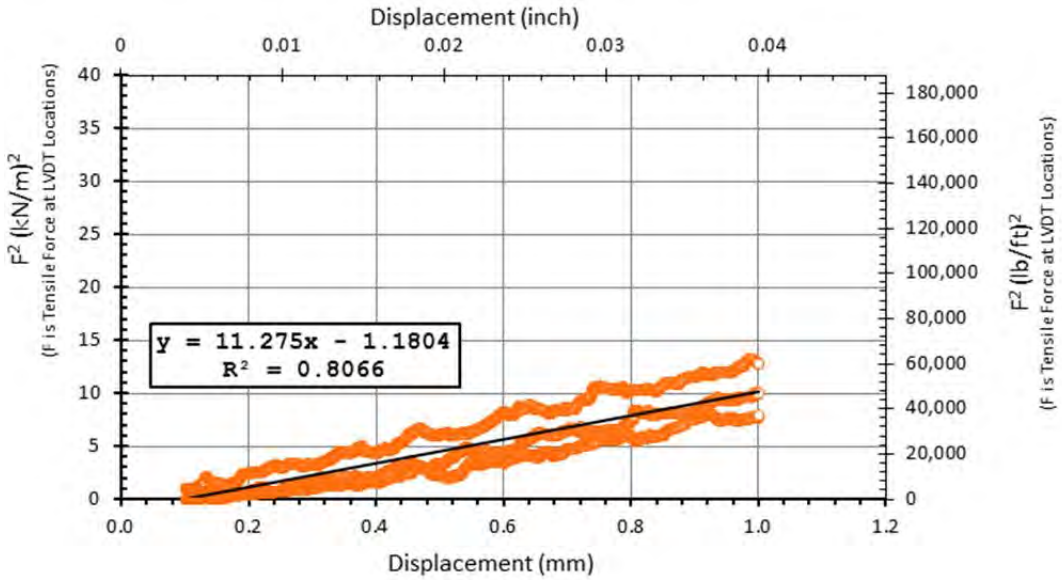
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	512	lb/ft
Max Pullout Load	P_{max}	1.96	kN	473	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
11.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT5 is skewed to the right

SMALL PULLOUT TEST

Date test conducted	2/10/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.1	1.263
2	88.6	3.488
3	117.2	4.612
4	145.7	5.738
5	232.1	9.137

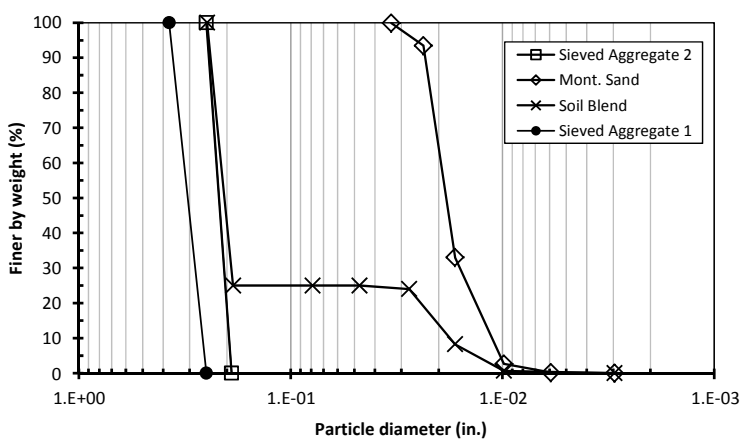
Pullout Rate	
1.0 mm/min.	0.04 in/min

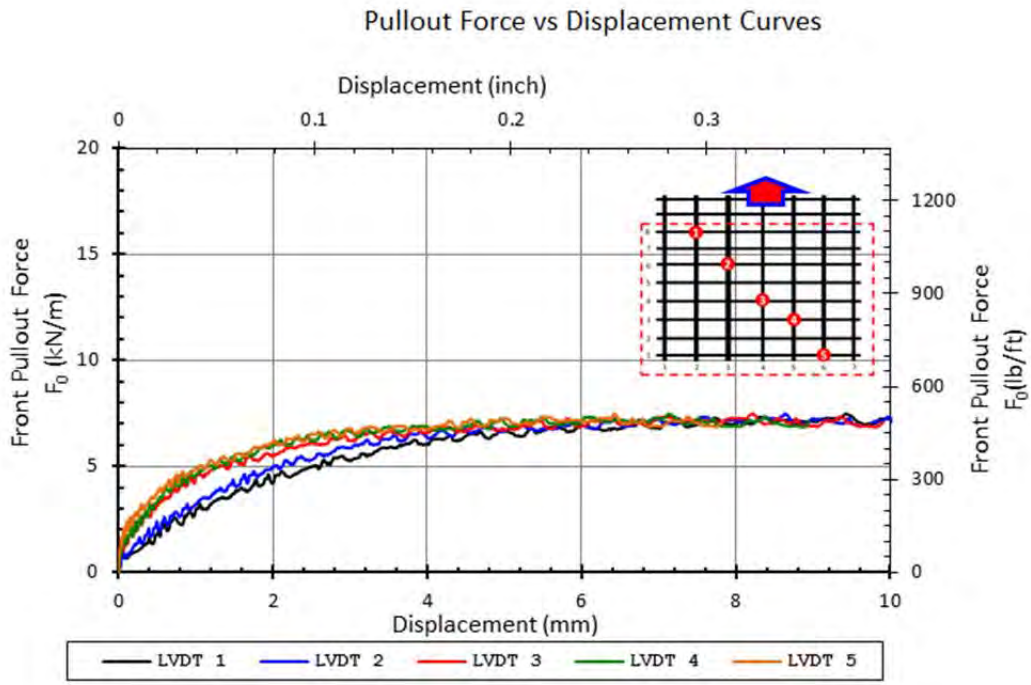
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.555 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

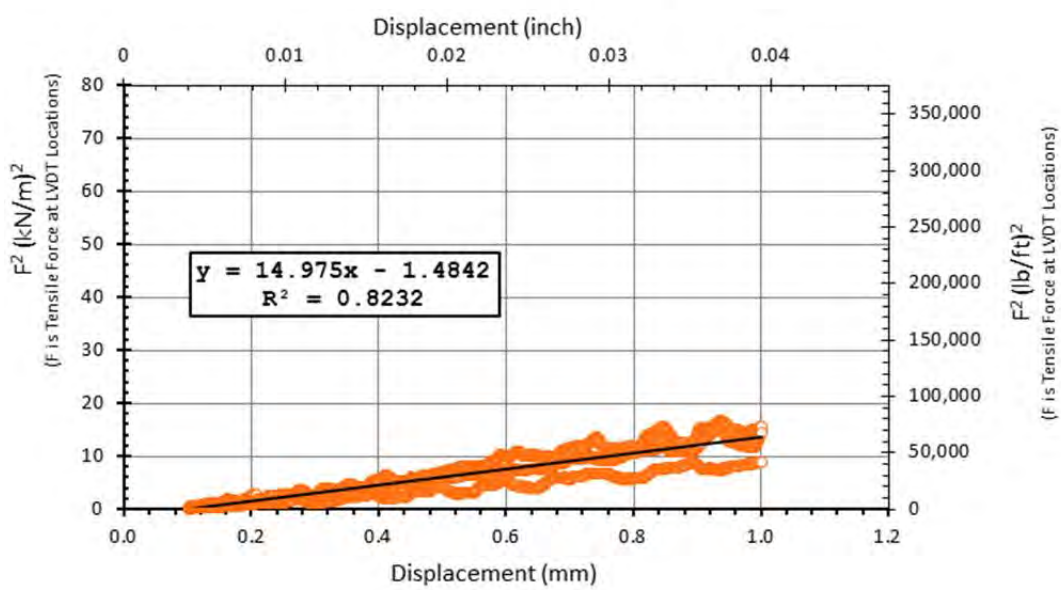
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	513	lb/ft
Max Pullout Load	P_{max}	1.96	kN	474	lb
Max Shear Stress	τ_{max}	26.4	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
15.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

Slight tilt to right to begin test

SMALL PULLOUT TEST

Date test conducted	5/15/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	26.6	1.047
2	84.0	3.305
3	112.7	4.437
4	140.4	5.526
5	227.1	8.942

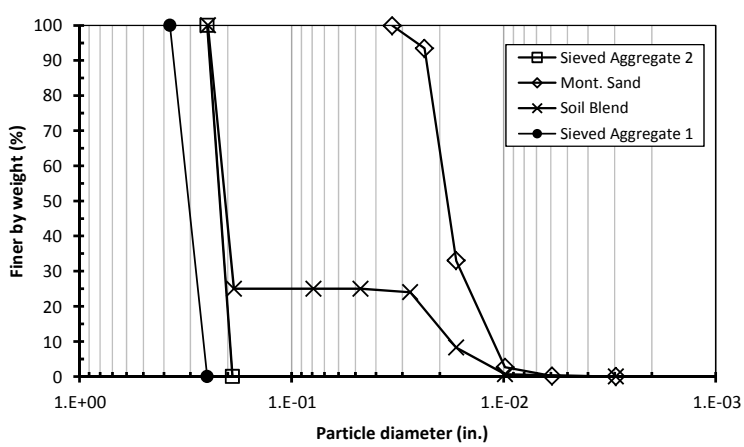
Pullout Rate	
1.0 mm/min.	0.04 in/min

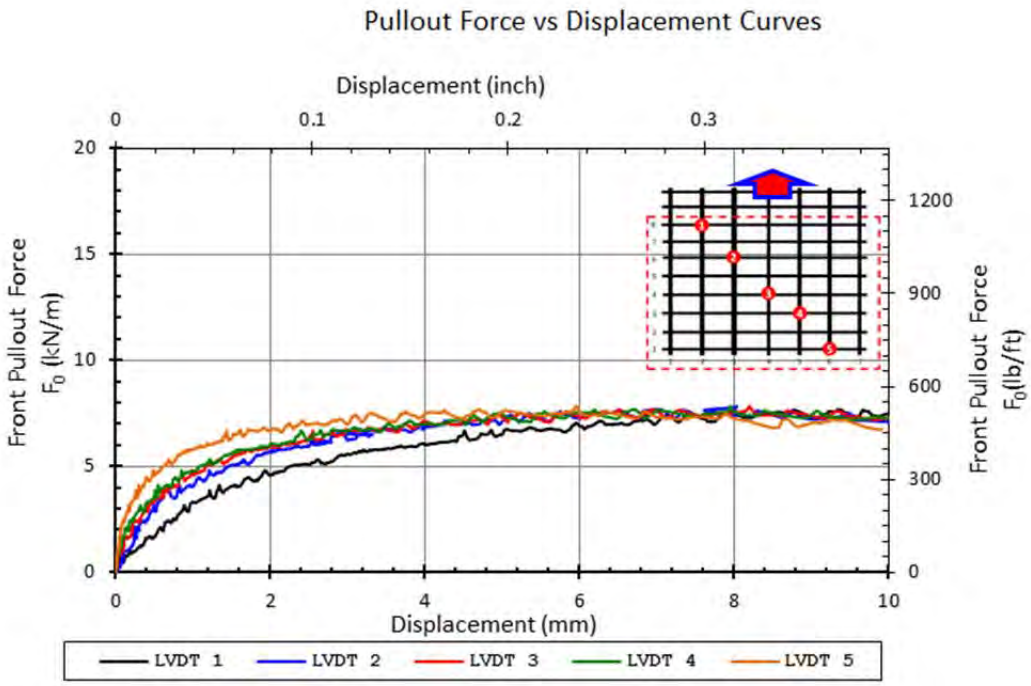
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

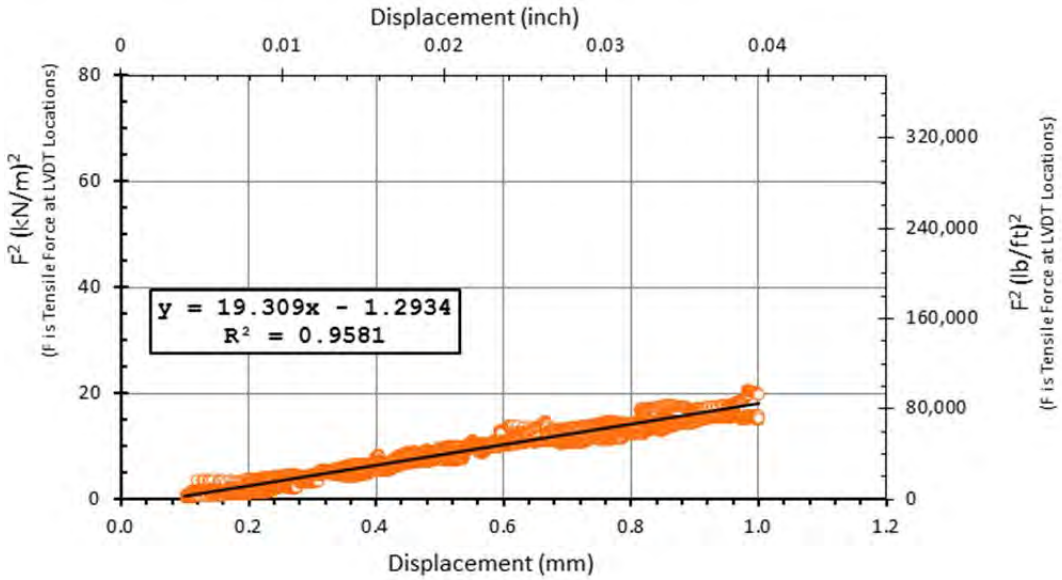
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.8	kN/m	537	lb/ft
Max Pullout Load	P_{max}	2.06	kN	495	lb
Max Shear Stress	τ_{max}	27.7	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
19.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 5 off to the right

SMALL PULLOUT TEST

Date test conducted	7/26/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.263	m	0.245	m
	7	0.922	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	29.0	1.142
2	84.9	3.343
3	113.7	4.477
4	143.2	5.639
5	227.5	8.955

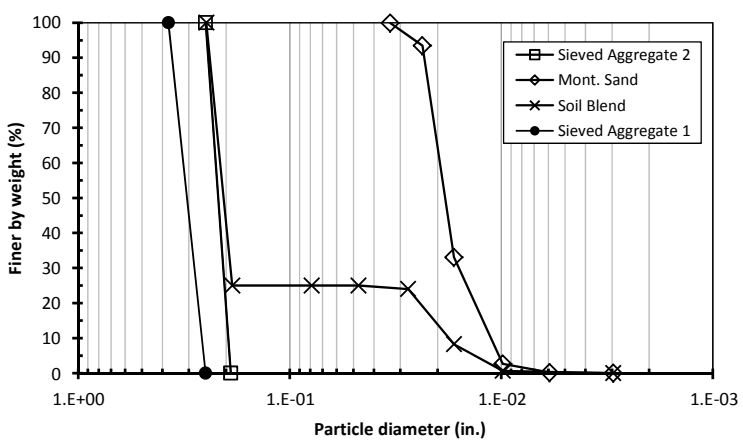
Pullout Rate	
1.0 mm/min.	0.04 in/min

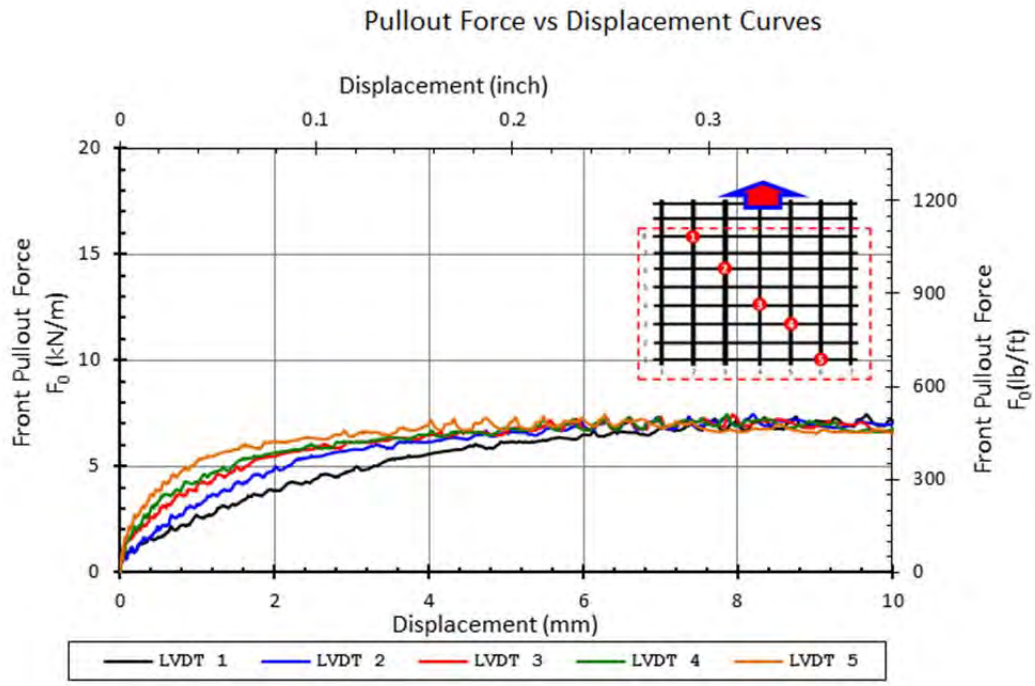
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

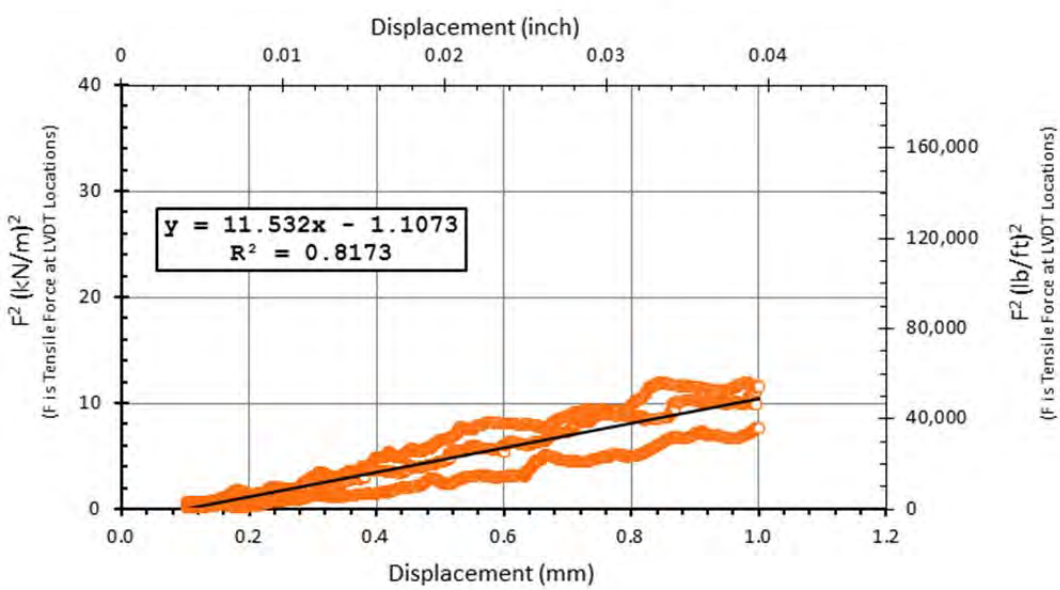
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	511	lb/ft
Max Pullout Load	P_{max}	1.96	kN	465	lb
Max Shear Stress	τ_{max}	26.3	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
11.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 1 is constrained from being completely vertical by the back wall opening.

LVDT 5 off slightly to the right

SMALL PULLOUT TEST

Date test conducted	7/27/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.0	1.104
2	84.4	3.322
3	113.8	4.478
4	142.1	5.593
5	227.1	8.943

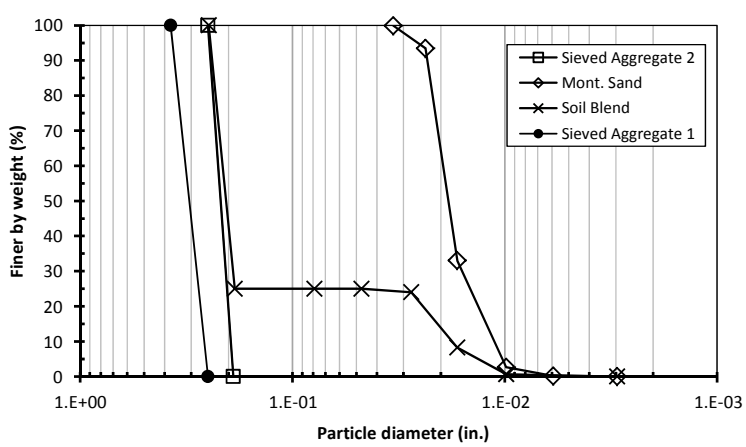
Pullout Rate	
1.0 mm/min.	0.04 in/min

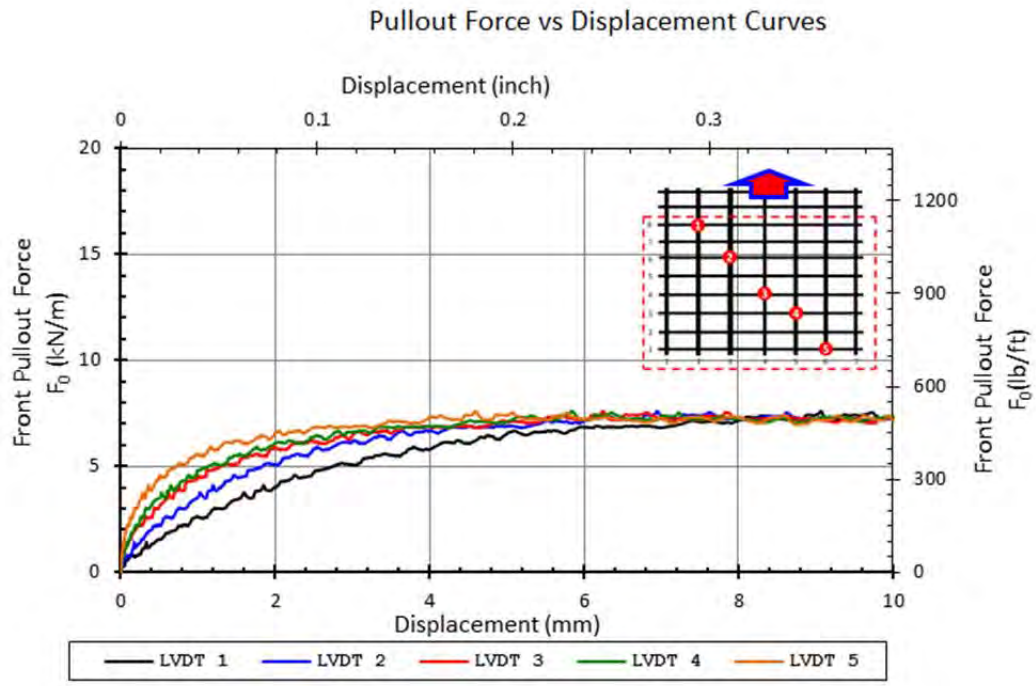
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

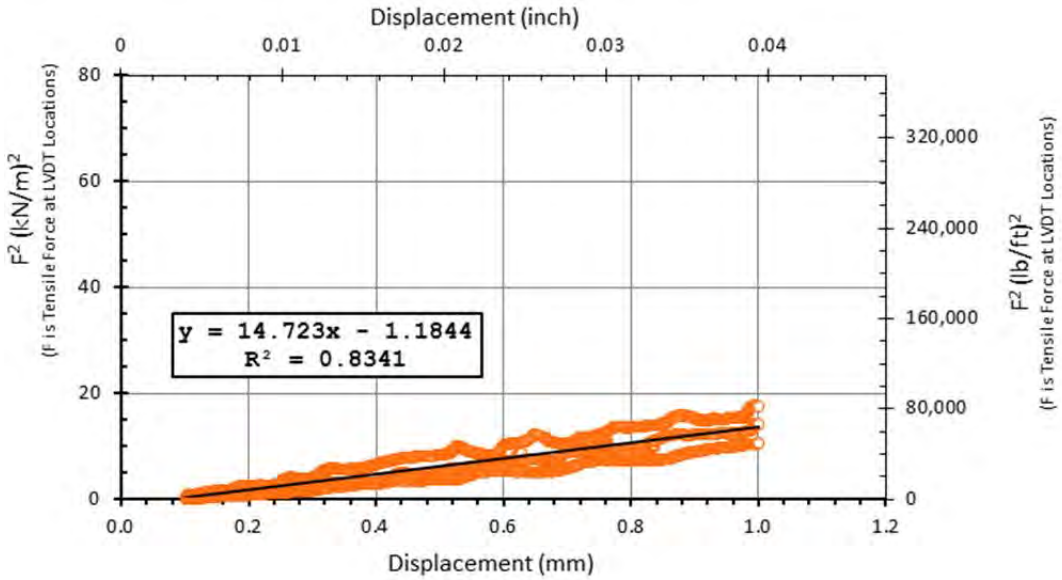
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	520	lb/ft
Max Pullout Load	P_{max}	1.99	kN	472	lb
Max Shear Stress	τ_{max}	26.8	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
14.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/21/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.270	m	0.245	m
	10	0.925	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.3	0.955
2	90.6	3.567
3	125.5	4.941
4	160.2	6.306
5	228.0	8.976

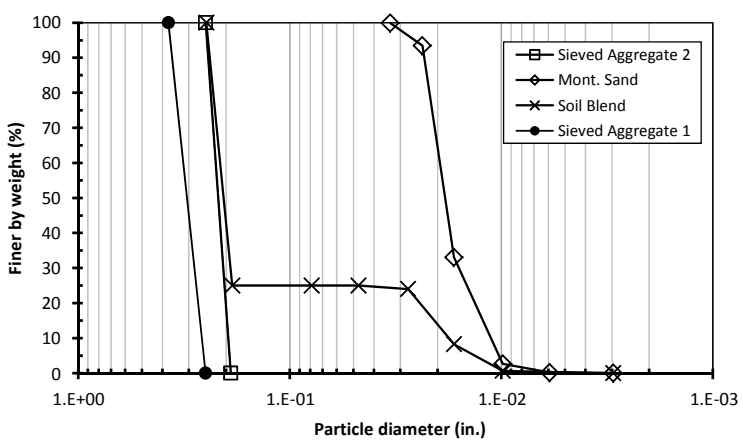
Pullout Rate	
1.0 mm/min.	0.04 in/min

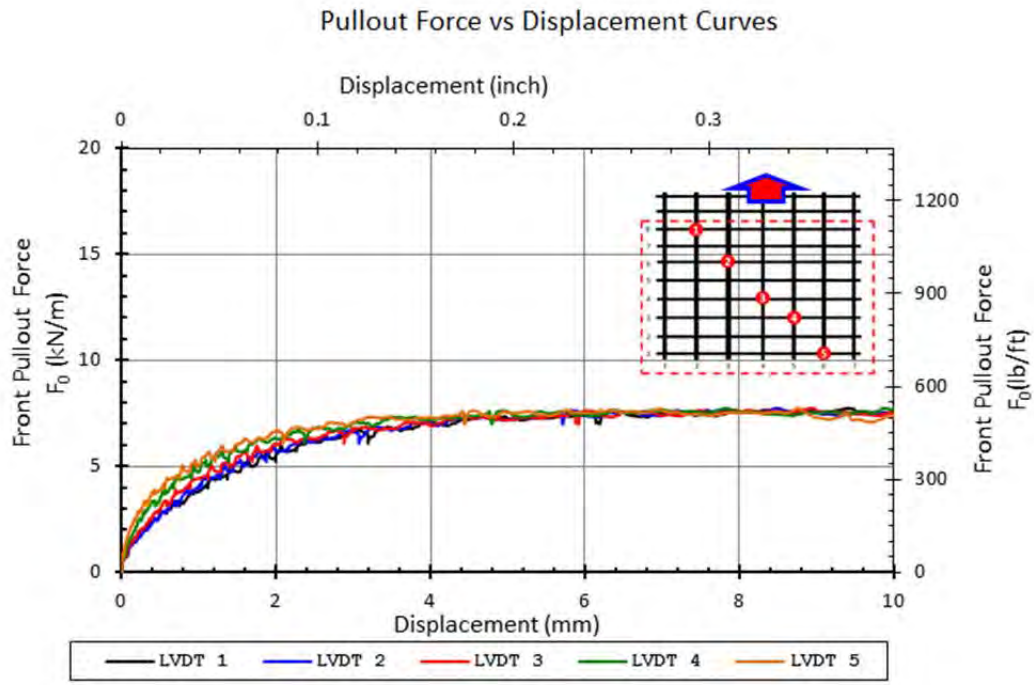
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

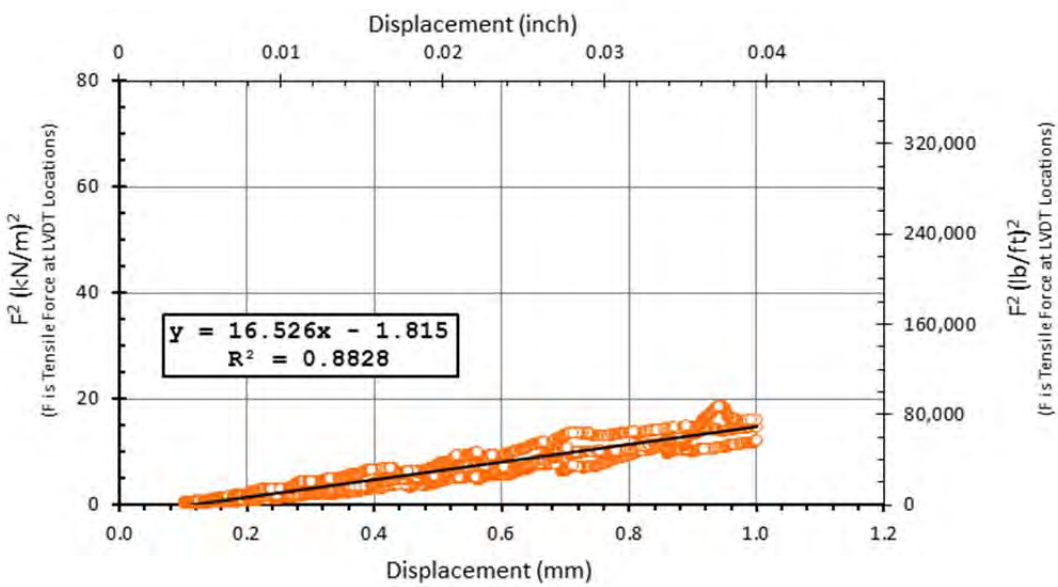
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.8	kN/m	531	lb/ft
Max Pullout Load	P_{max}	2.09	kN	508	lb
Max Shear Stress	τ_{max}	28.1	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
16.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/23/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.270	m	0.245	m
	10	0.915	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	20.2	0.795
2	87.2	3.433
3	122.3	4.815
4	157.8	6.211
5	225.0	8.857

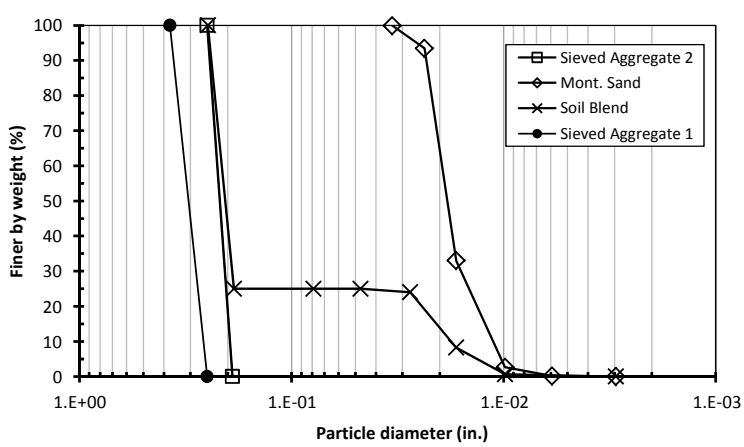
Pullout Rate	
1.0 mm/min.	0.04 in/min

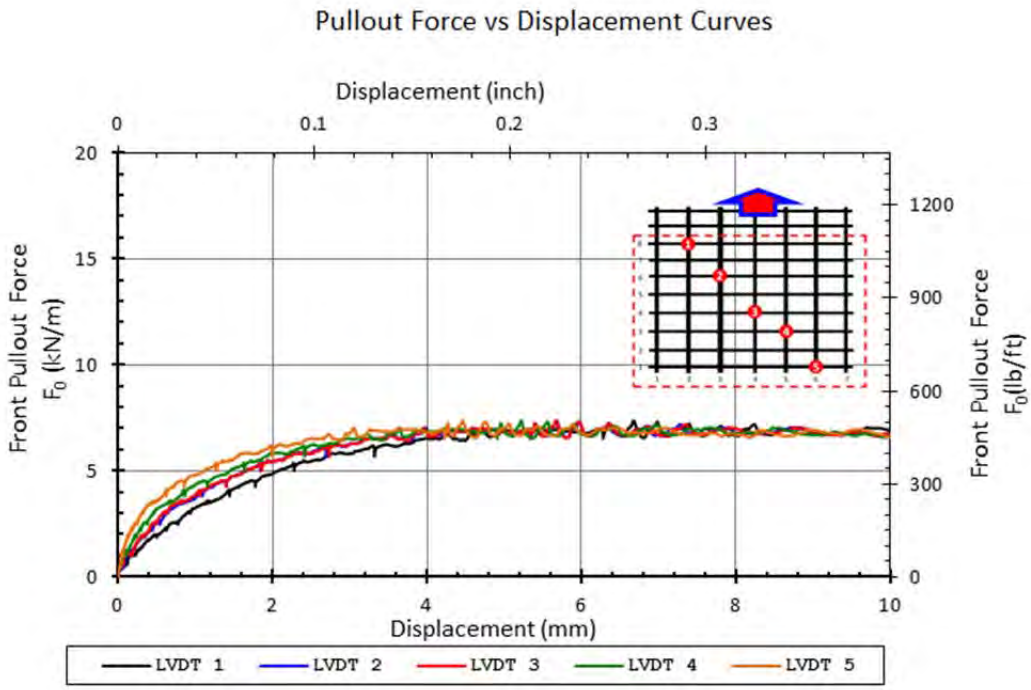
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

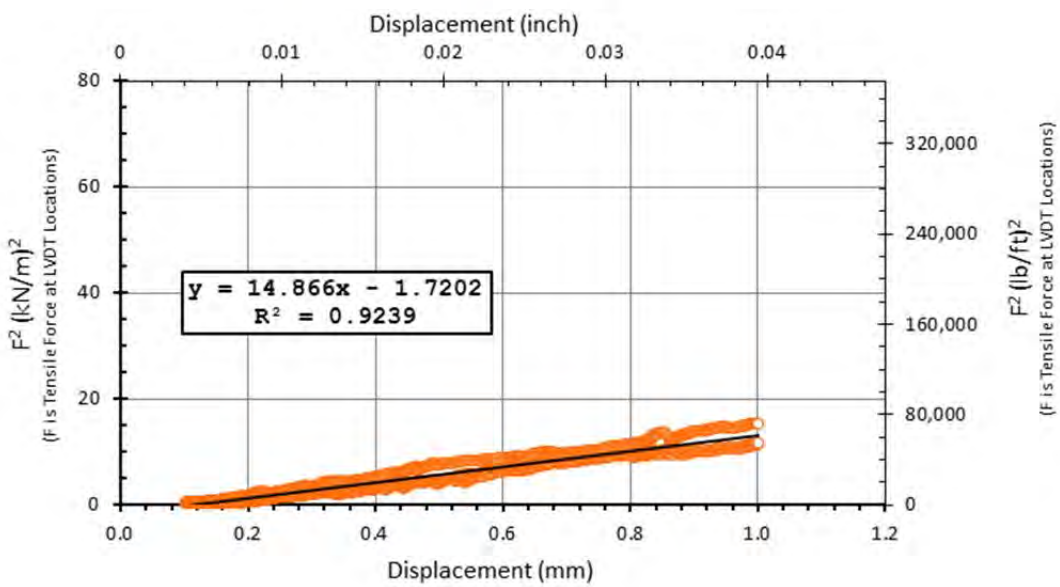
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	504	lb/ft
Max Pullout Load	P_{max}	1.98	kN	515	lb
Max Shear Stress	τ_{max}	26.7	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
14.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/27/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.270	m	0.245	m
	10	0.919	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.5	0.924
2	90.5	3.563
3	124.6	4.907
4	157.8	6.212
5	226.3	8.908

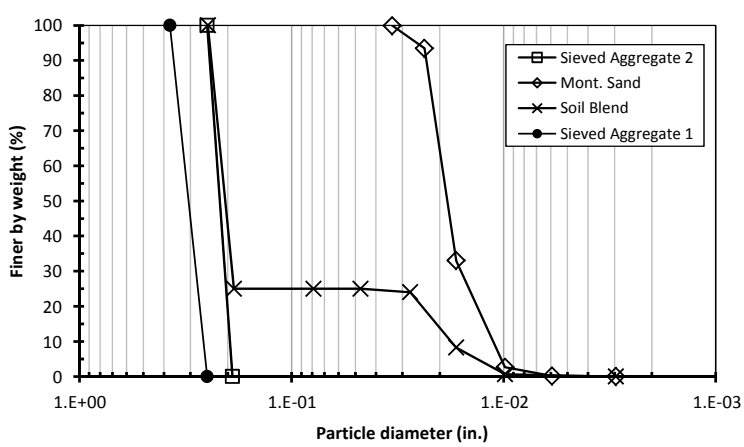
Pullout Rate	
1.0 mm/min.	0.04 in/min

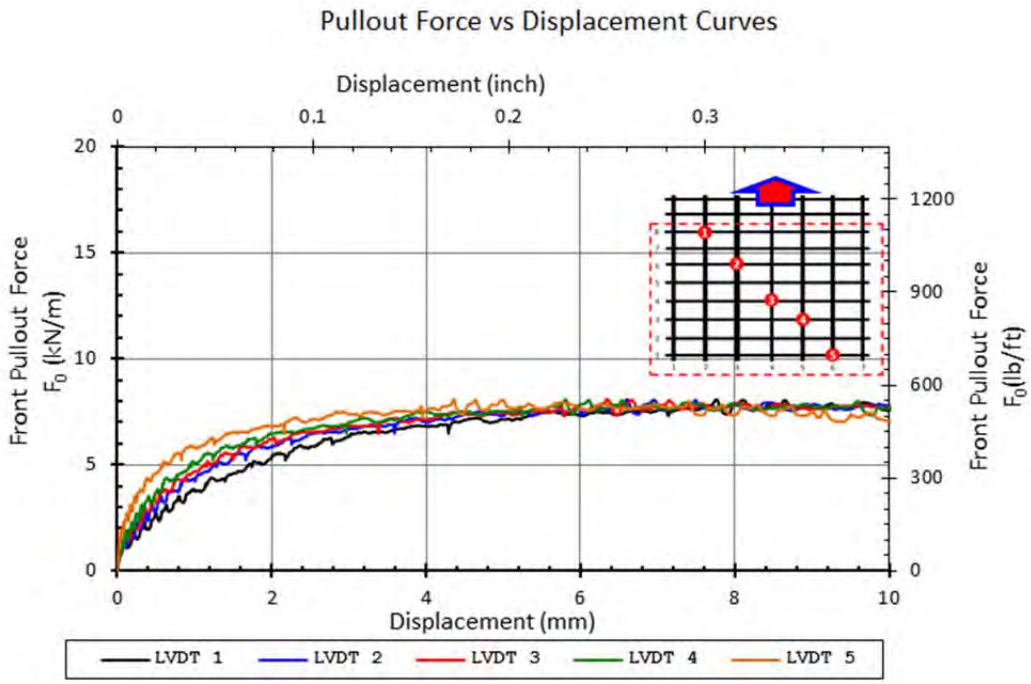
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

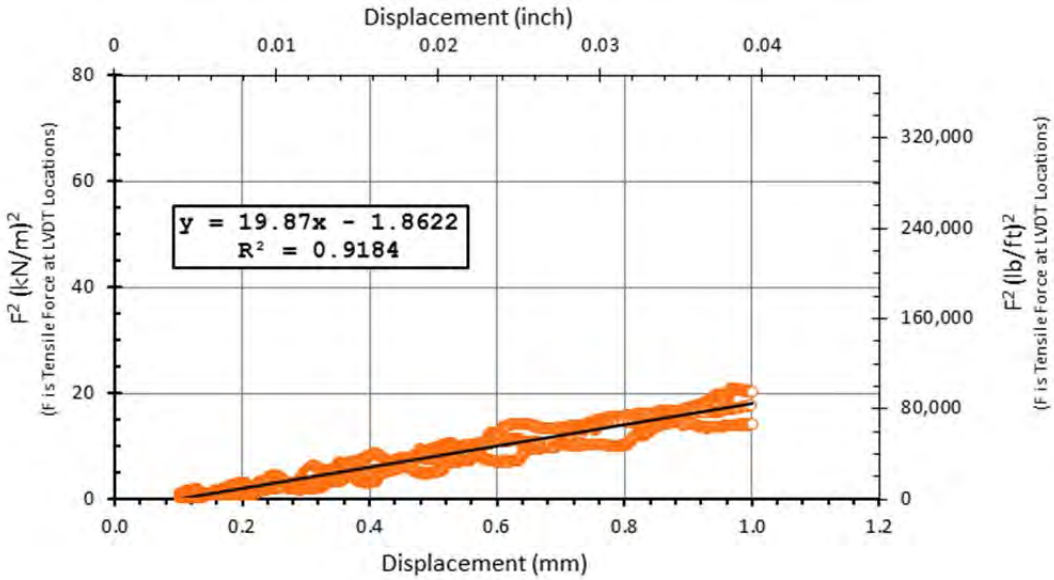
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.1	kN/m	553	lb/ft
Max Pullout Load	P_{max}	2.18	kN	527	lb
Max Shear Stress	τ_{max}	29.3	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
19.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/2/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.270	m	0.245	m
	10	0.922	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.9	0.942
2	90.2	3.553
3	124.9	4.919
4	157.9	6.216
5	227.1	8.939

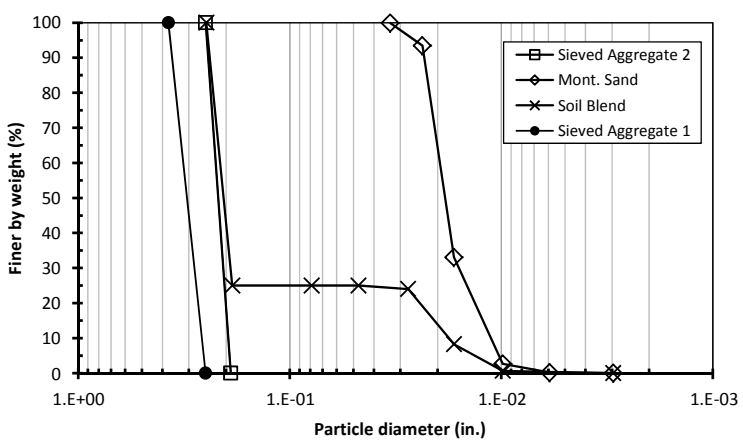
Pullout Rate	
1.0 mm/min.	0.04 in/min

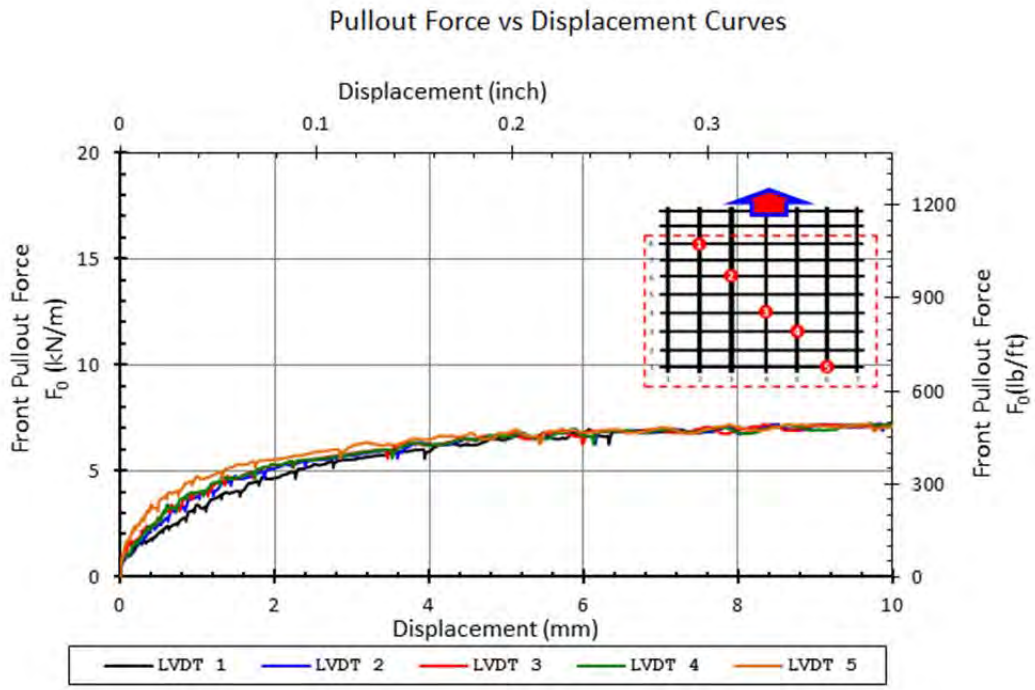
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

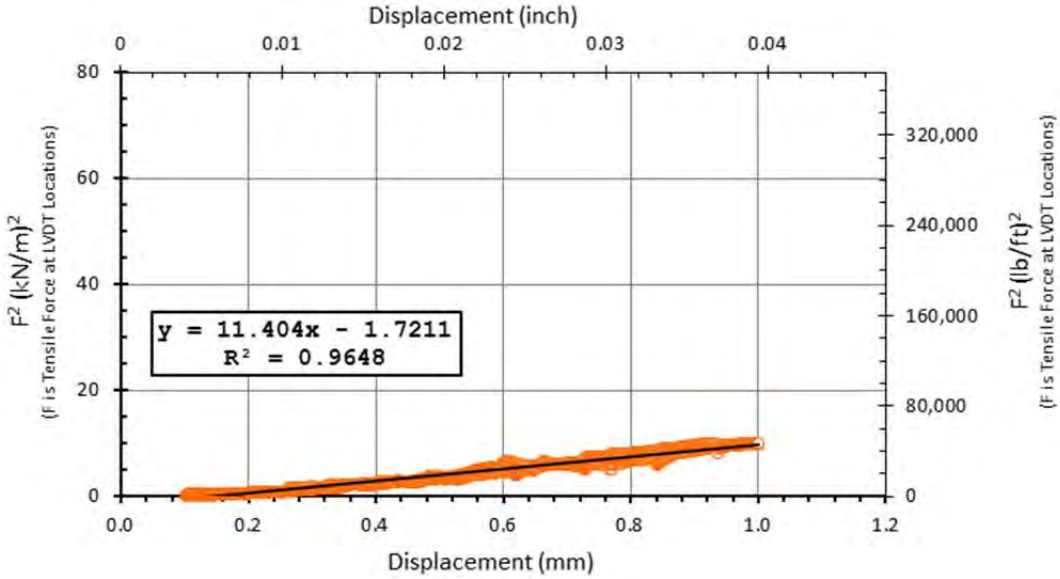
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	520	lb/ft
Max Pullout Load	P_{max}	2.05	kN	477	lb
Max Shear Stress	τ_{max}	27.5	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
11.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/3/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.270	m	0.245	m
	10	0.922	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.3	0.918
2	90.8	3.576
3	125.9	4.956
4	156.7	6.167
5	226.5	8.917

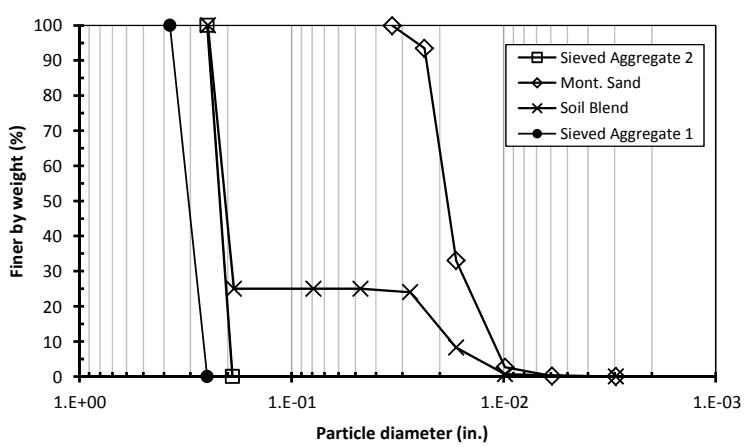
Pullout Rate	
1.0 mm/min.	0.04 in/min

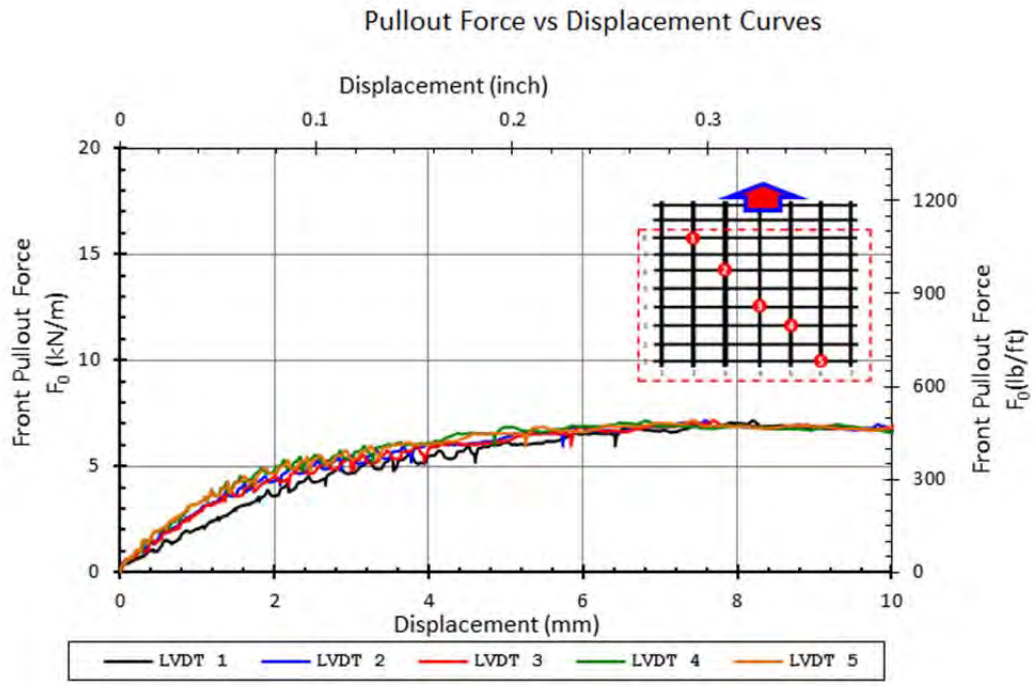
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

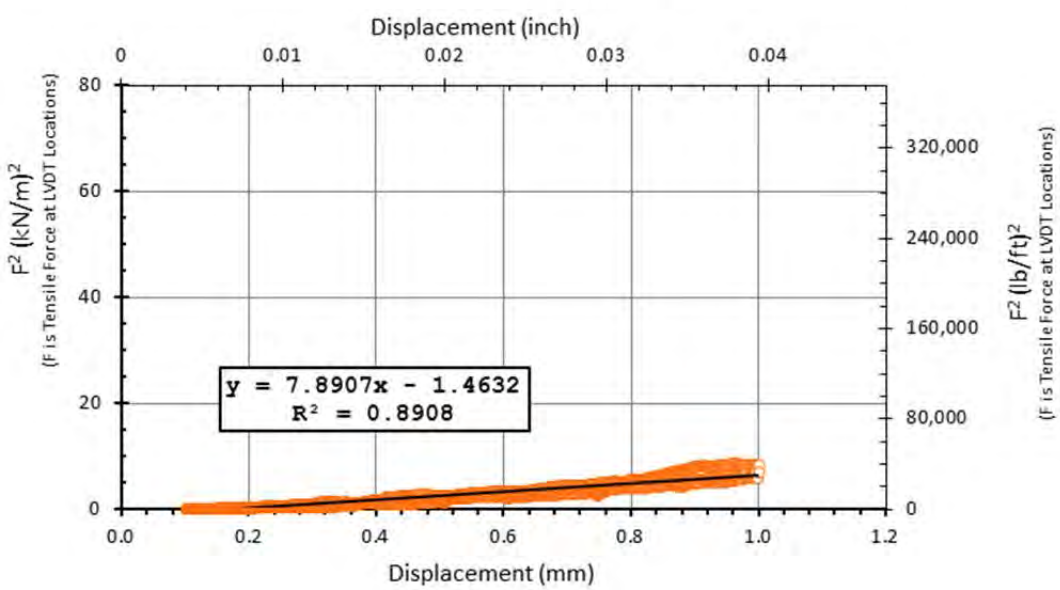
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	490	lb/ft
Max Pullout Load	P_{max}	1.93	kN	467	lb
Max Shear Stress	τ_{max}	25.9	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
7.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/29/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	N/A	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	9.4	0.372
2	105.7	4.161
3	121.5	4.784
4	134.9	5.309
5	236.7	9.320

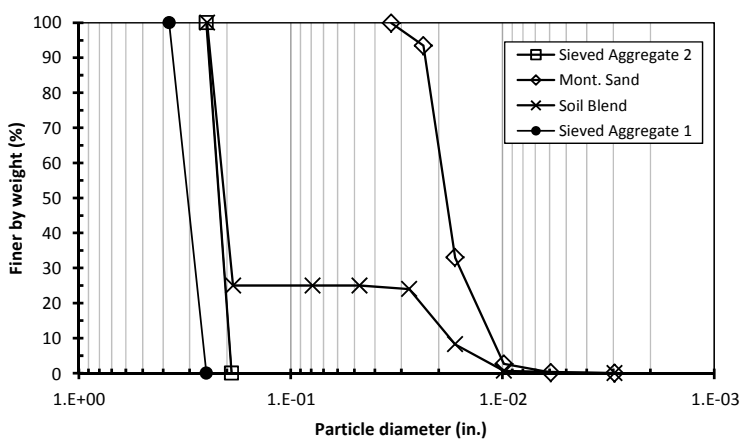
Pullout Rate	
1.0 mm/min.	0.04 in/min

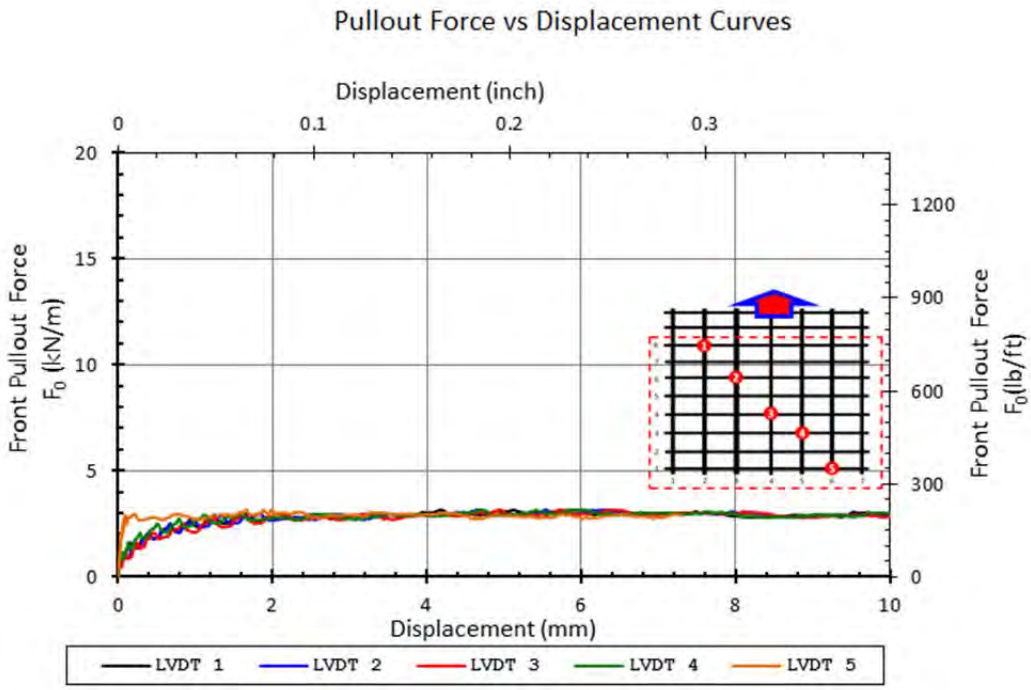
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

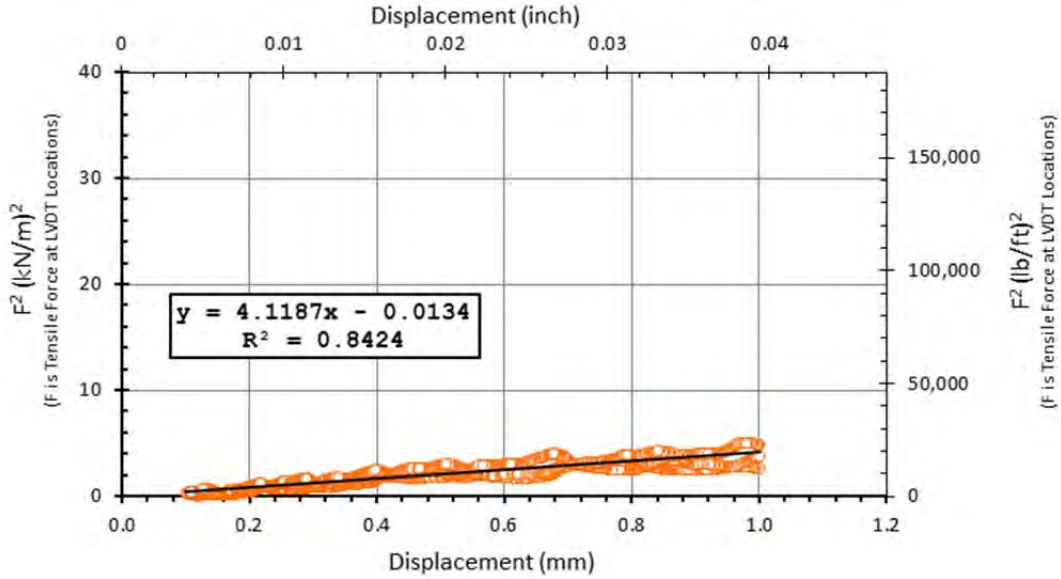
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	3.2	kN/m	216	lb/ft
Max Pullout Load	P_{max}	0.88	kN	241	lb
Max Shear Stress	τ_{max}	11.8	kPa	1.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.4			

Reported K_{SGI}
4.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/31/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	N/A	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-4.5	-0.176
2	96.7	3.807
3	113.4	4.465
4	126.9	4.995
5	225.9	8.893

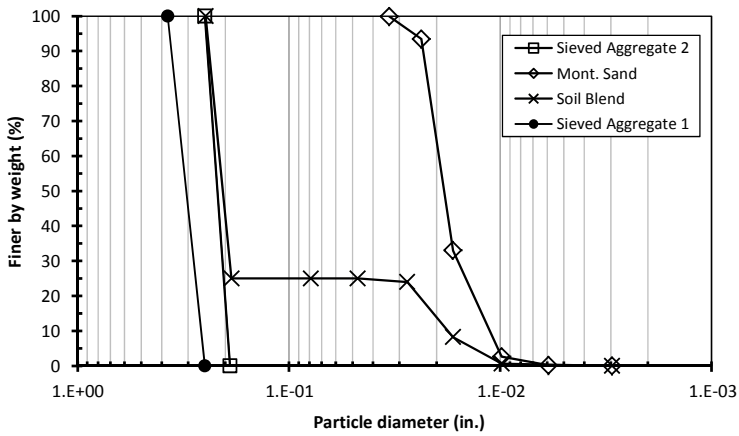
Pullout Rate	
1.0 mm/min.	0.04 in/min

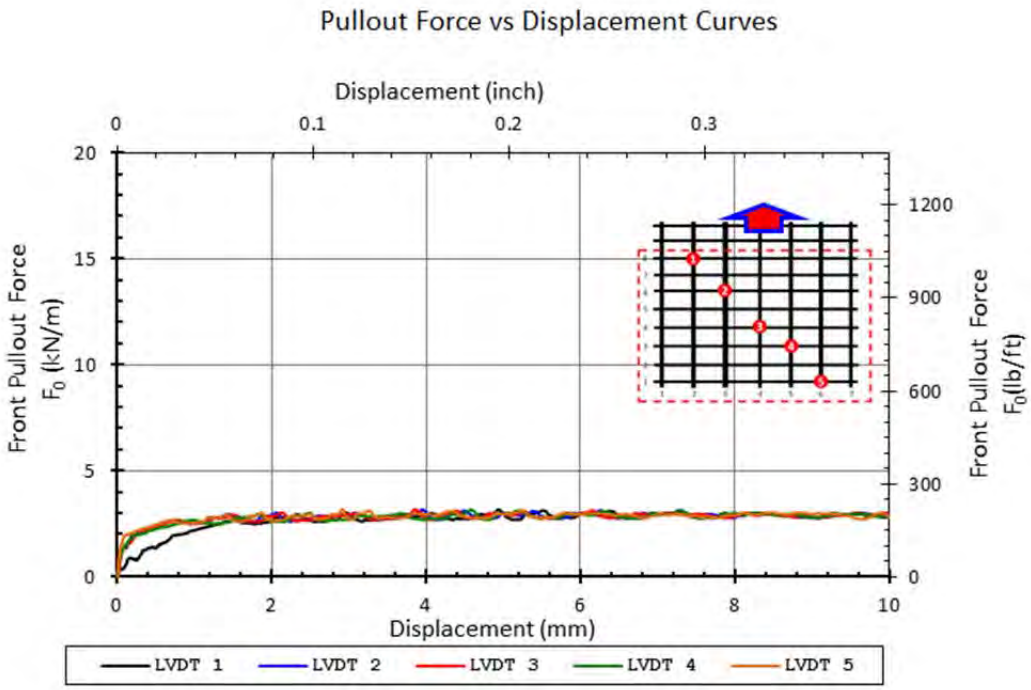
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

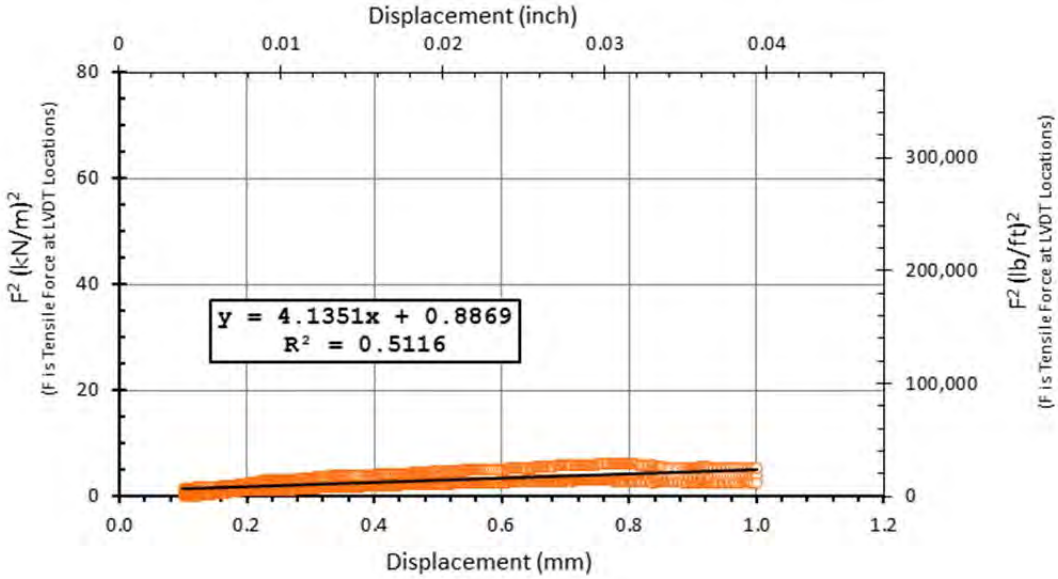
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	3.2	kN/m	217	lb/ft
Max Pullout Load	P_{max}	0.89	kN	248	lb
Max Shear Stress	τ_{max}	11.9	kPa	1.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.4			

Reported K_{SGI}
4.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/2/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	---	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	1.2	0.048
2	99.4	3.914
3	116.9	4.600
4	134.5	5.295
5	238.7	9.399

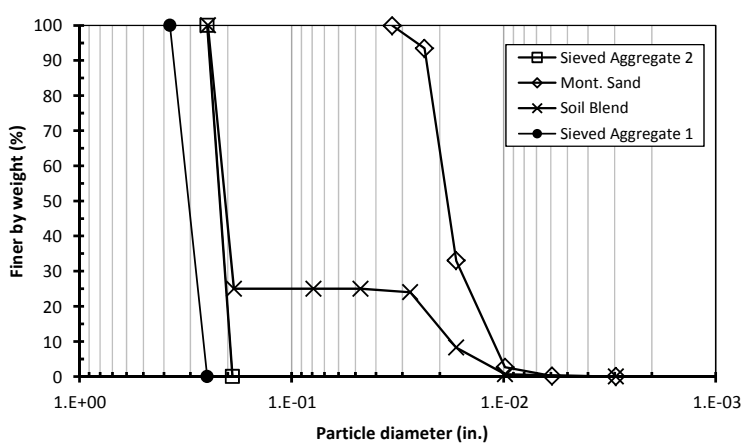
Pullout Rate	
1.0 mm/min.	0.04 in/min

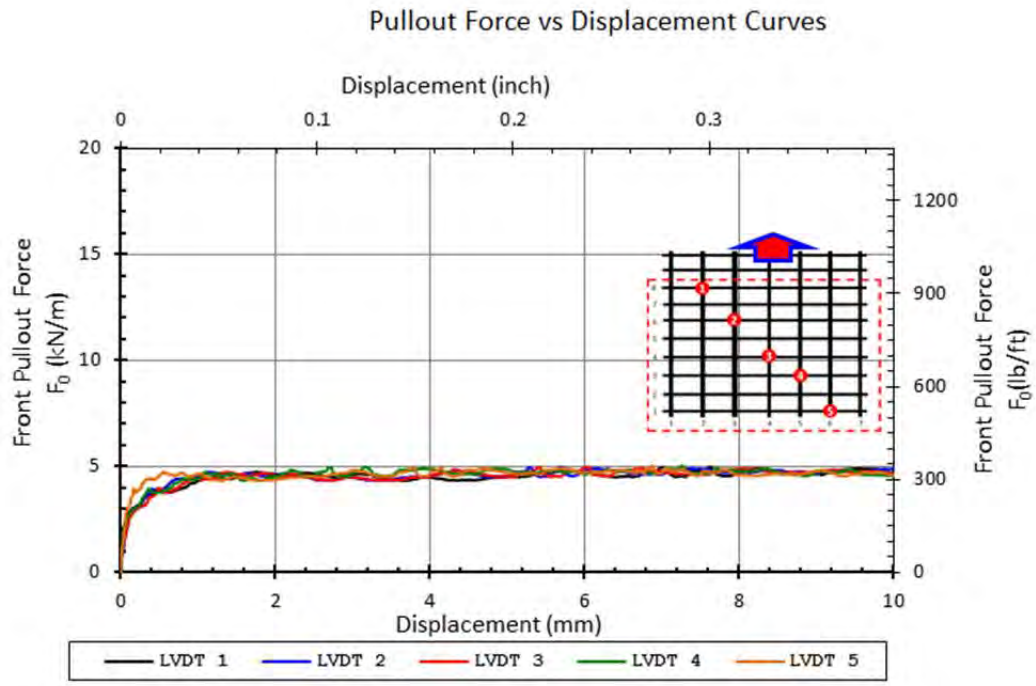
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

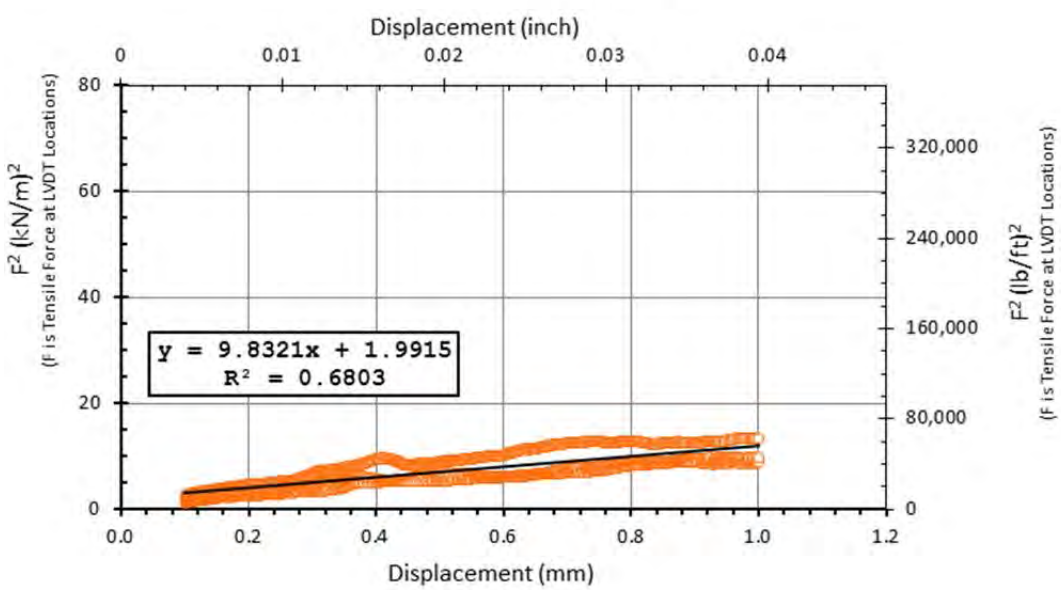
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.0	kN/m	345	lb/ft
Max Pullout Load	P_{max}	1.41	kN	364	lb
Max Shear Stress	τ_{max}	18.9	kPa	2.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
9.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/4/2012
Done by	Pong/Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.290	m	0.245	m
	N/A	0.951	ft	0.951	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.4	0.960
2	116.6	4.589
3	129.6	5.104
4	143.3	5.642
5	230.3	9.066

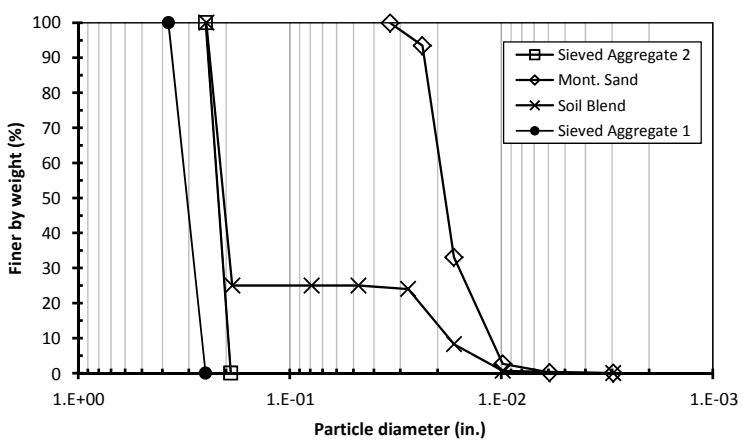
Pullout Rate	
1.0 mm/min.	0.04 in/min

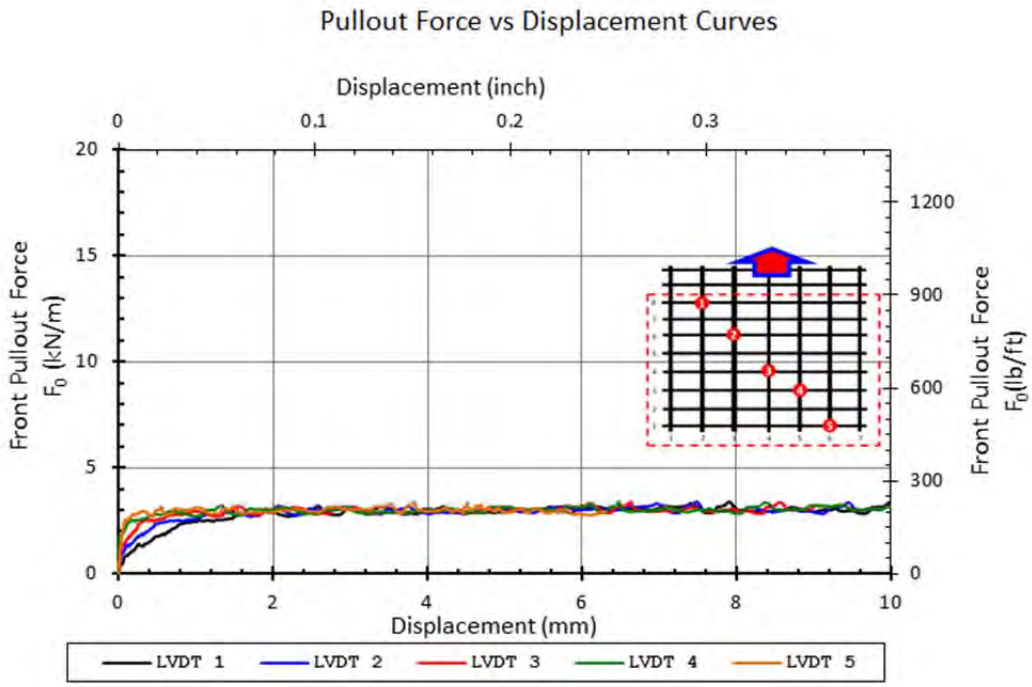
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

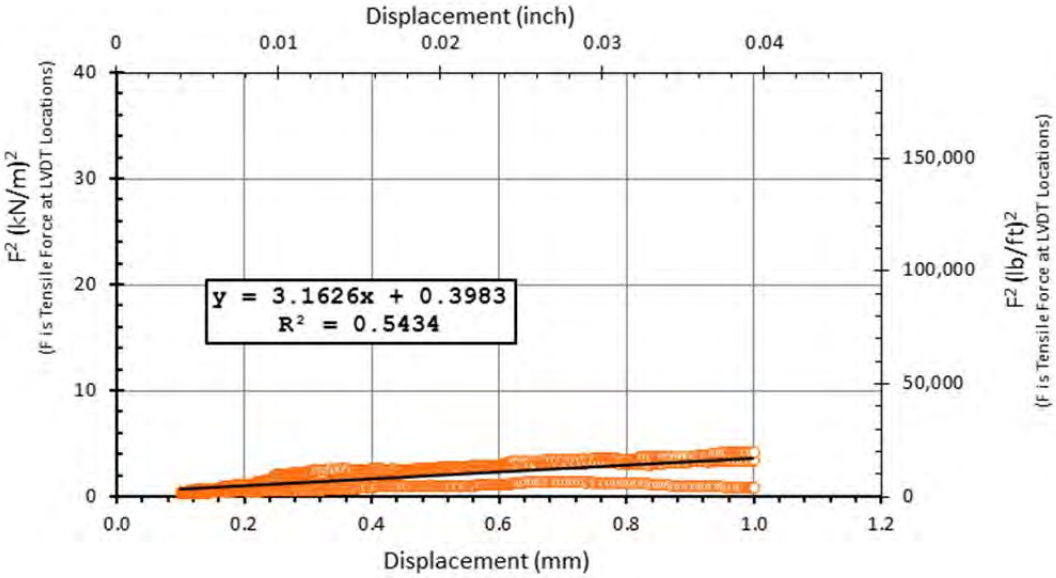
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	3.4	kN/m	233	lb/ft
Max Pullout Load	P_{max}	0.99	kN	261	lb
Max Shear Stress	τ_{max}	13.3	kPa	1.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.4			

Reported K_{SGI}
3.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/21/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.283	m	0.283	m	0.245	m
	---	0.929	ft	0.929	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.6	0.731
2	108.5	4.270
3	121.2	4.770
4	136.5	5.373
5	227.8	8.970

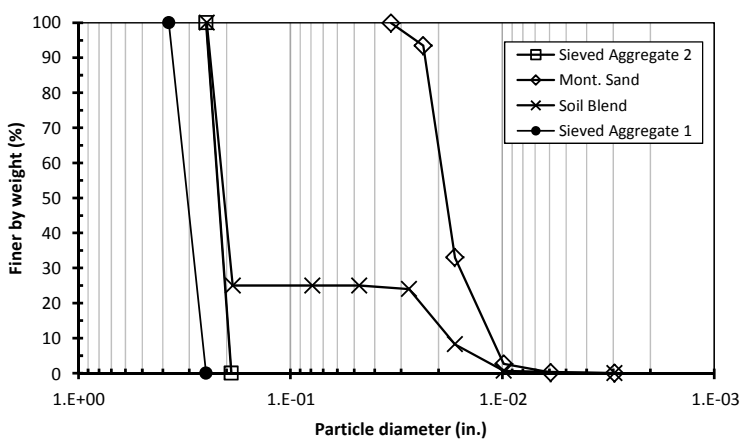
Pullout Rate	
1.0 mm/min.	0.04 in/min

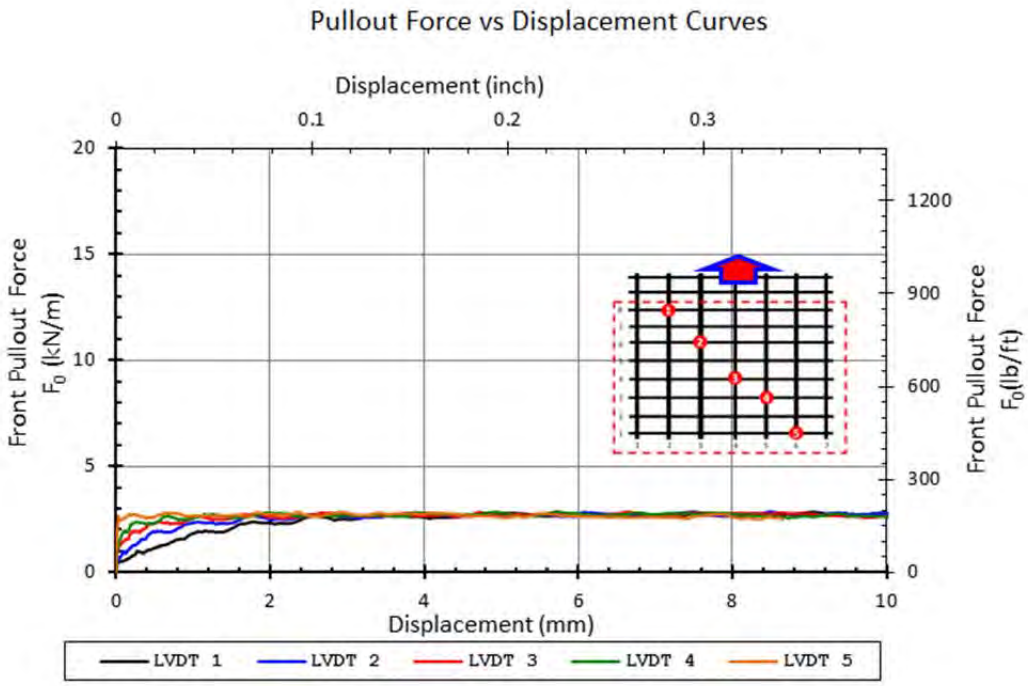
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

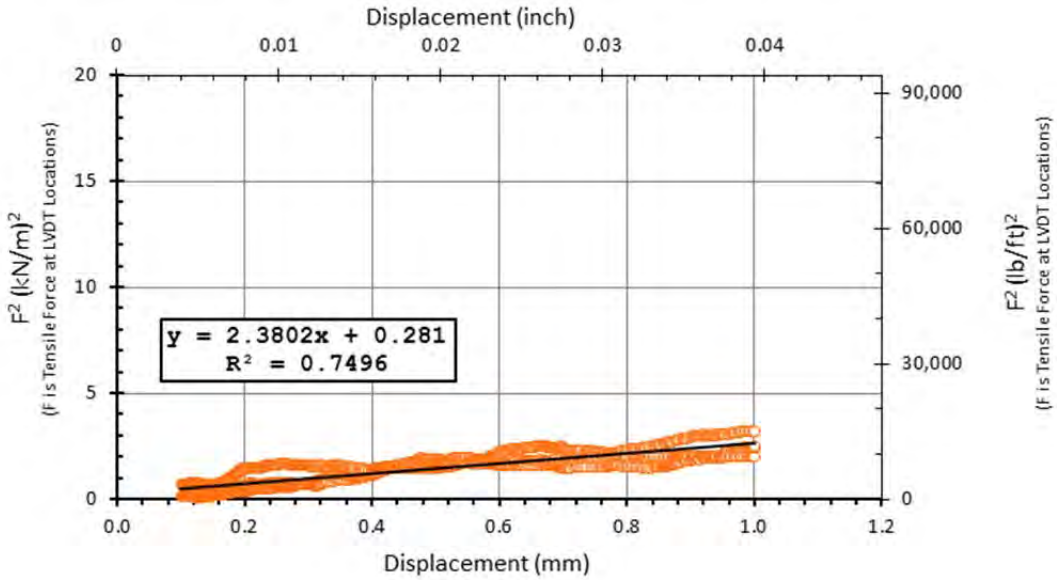
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	2.9	kN/m	196	lb/ft
Max Pullout Load	P_{max}	0.81	kN	207	lb
Max Shear Stress	τ_{max}	10.9	kPa	1.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.3			

Reported K_{SGI}
2.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/13/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.3	0.406
2	71.8	2.828
3	100.6	3.960
4	131.6	5.182
5	222.3	8.751

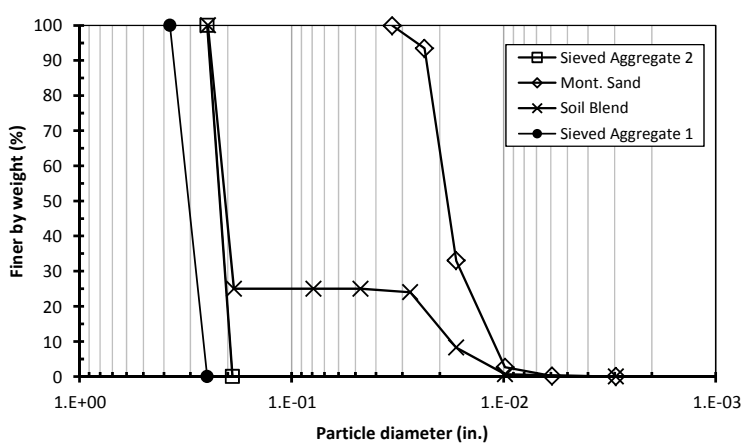
Pullout Rate	
1.0 mm/min.	0.04 in/min

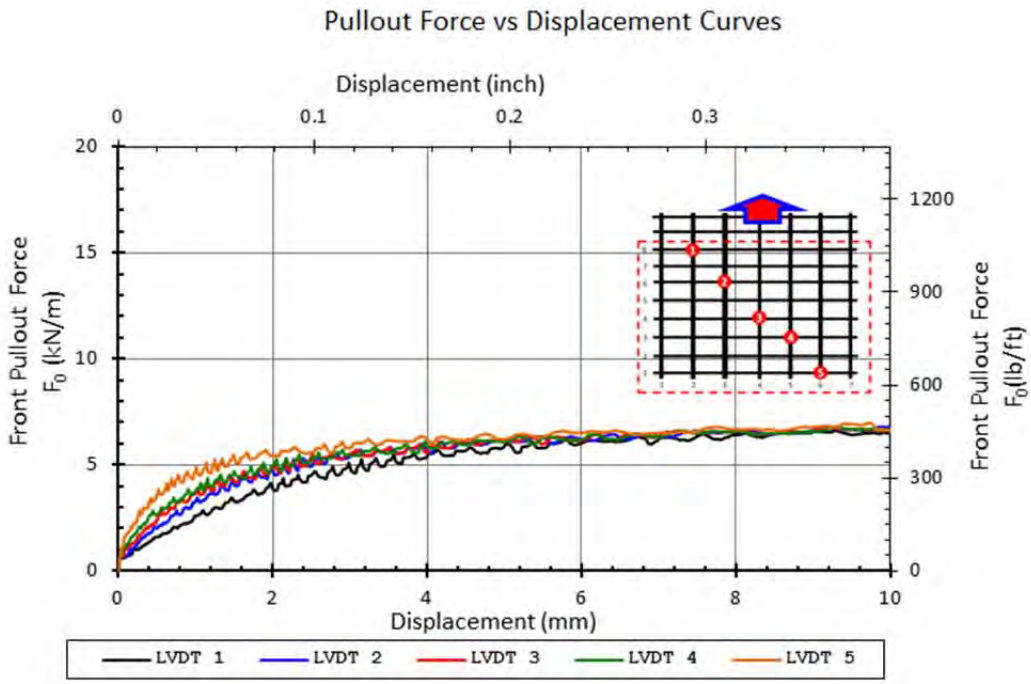
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

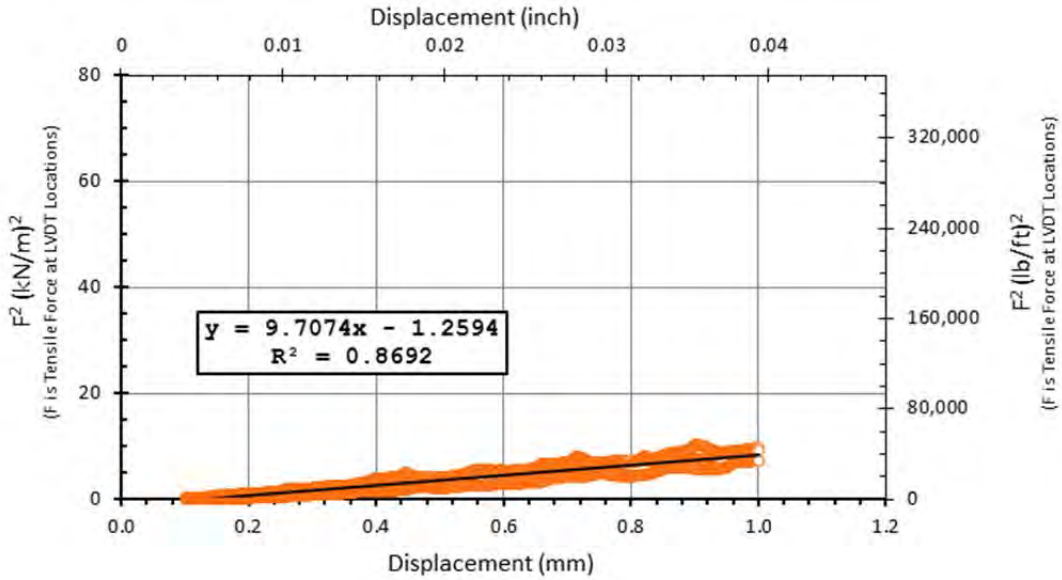
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	478	lb/ft
Max Pullout Load	P_{max}	2.12	kN	503	lb
Max Shear Stress	τ_{max}	28.5	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
9.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT #5 significantly off to the right

SMALL PULLOUT TEST

Date test conducted	7/15/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.304	m	0.245	m
	7	0.922	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.8	0.463
2	72.1	2.839
3	102.5	4.034
4	132.2	5.206
5	222.4	8.757

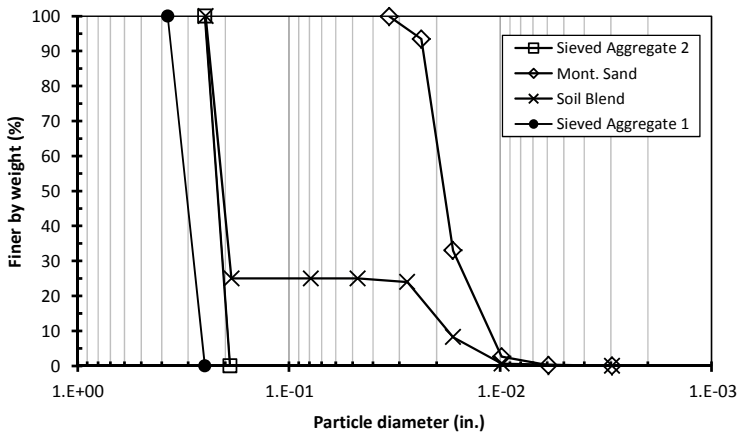
Pullout Rate			
1.0	mm/min.	0.04	in/min

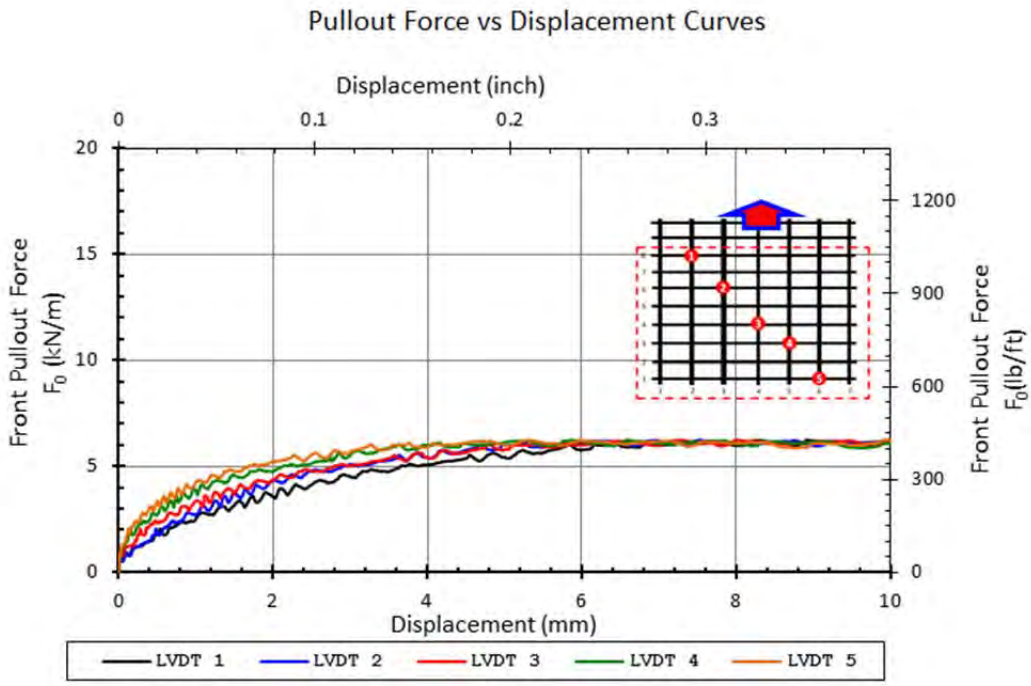
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

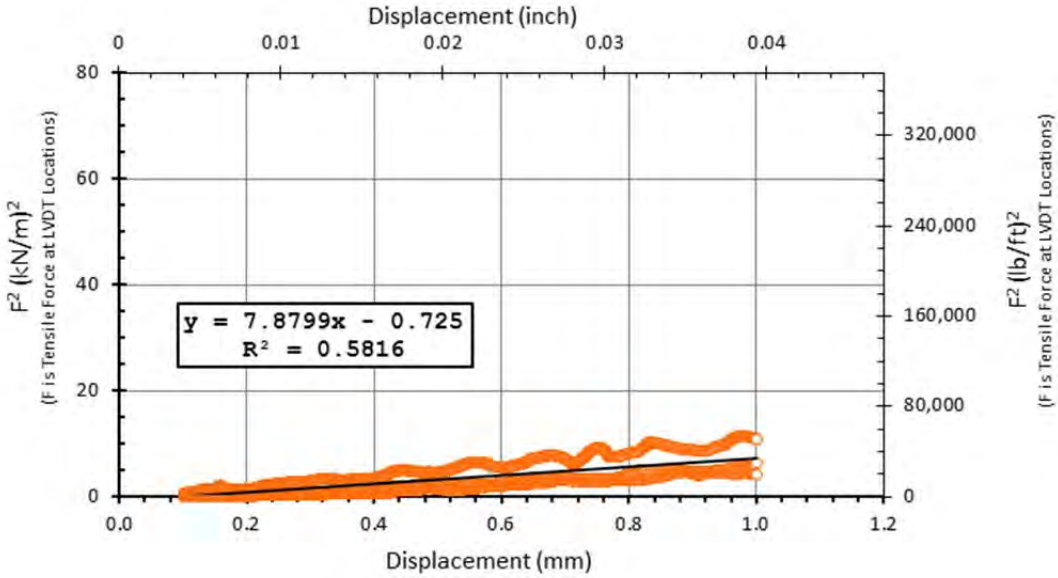
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	429	lb/ft
Max Pullout Load	P_{max}	1.91	kN	454	lb
Max Shear Stress	τ_{max}	25.6	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
7.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT # 5 slightly off to the right.

SMALL PULLOUT TEST

Date test conducted	7/16/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	245.0	9.646
2	245.0	9.646
3	245.0	9.646
4	245.0	9.646
5	245.0	9.646

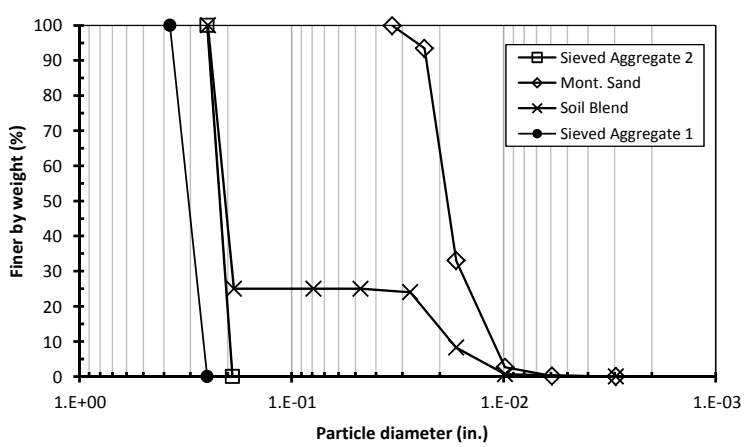
Pullout Rate	
1.0 mm/min.	0.04 in/min

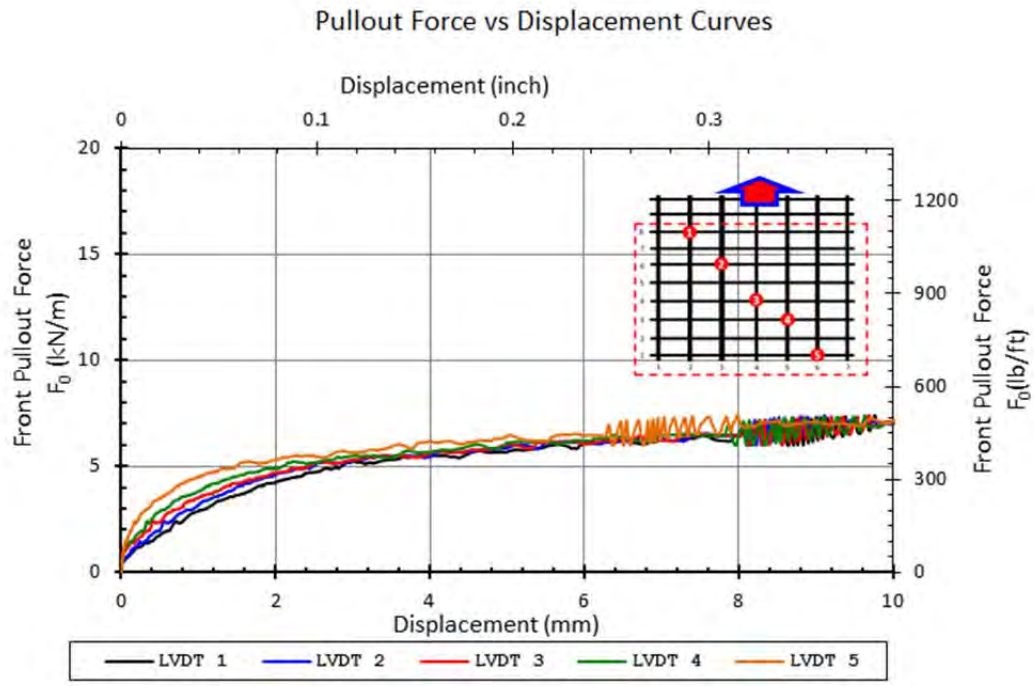
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

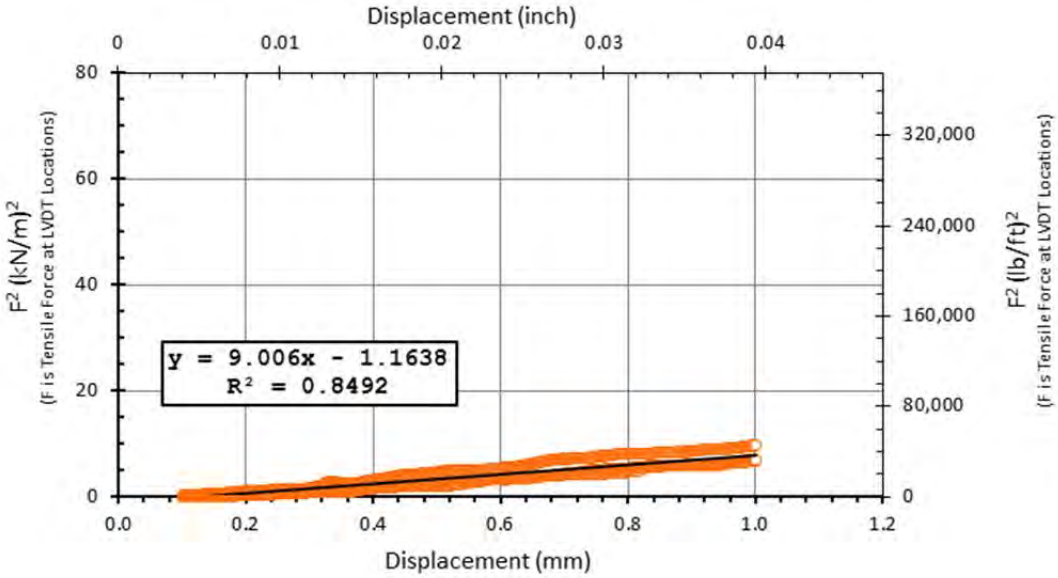
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.8	kN/m	532	lb/ft
Max Pullout Load	P_{max}	2.36	kN	560	lb
Max Shear Stress	τ_{max}	31.8	kPa	4.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
9.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT #5 off to the right.

SMALL PULLOUT TEST

Date test conducted	8/22/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.304	m	0.245	m
	7	0.902	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.6	0.731
2	78.4	3.085
3	107.9	4.246
4	136.8	5.385
5	226.4	8.913

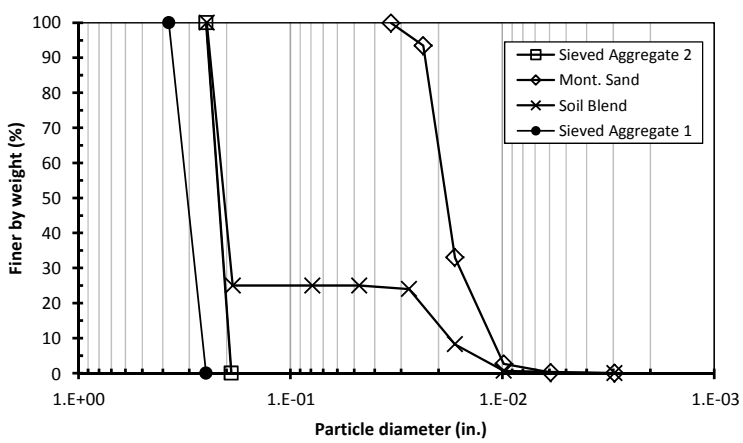
Pullout Rate	
1.0 mm/min.	0.04 in/min

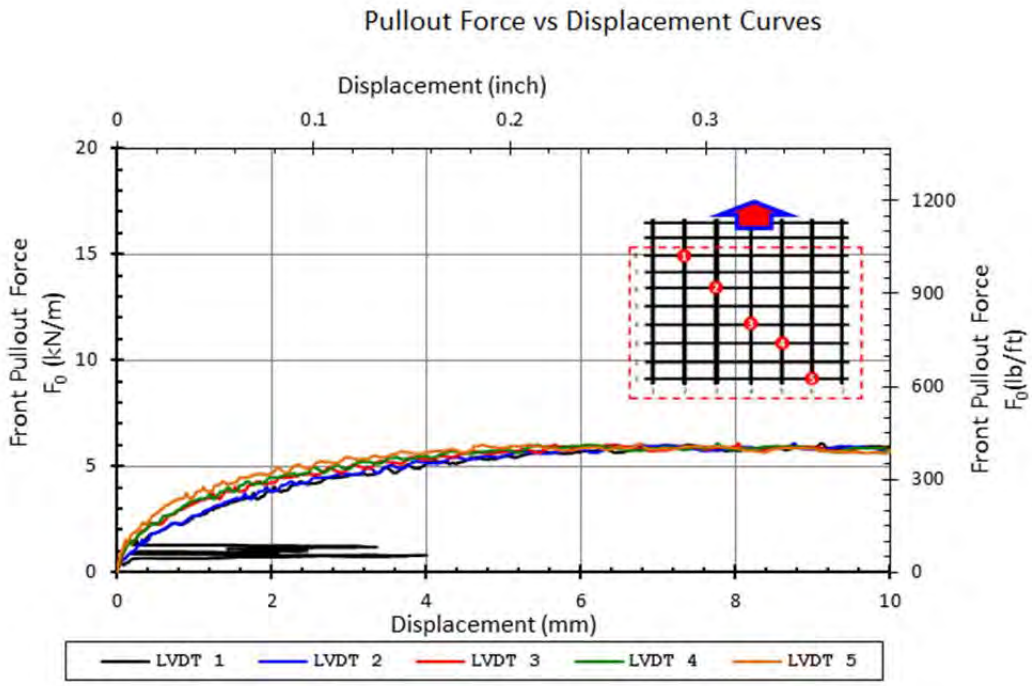
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

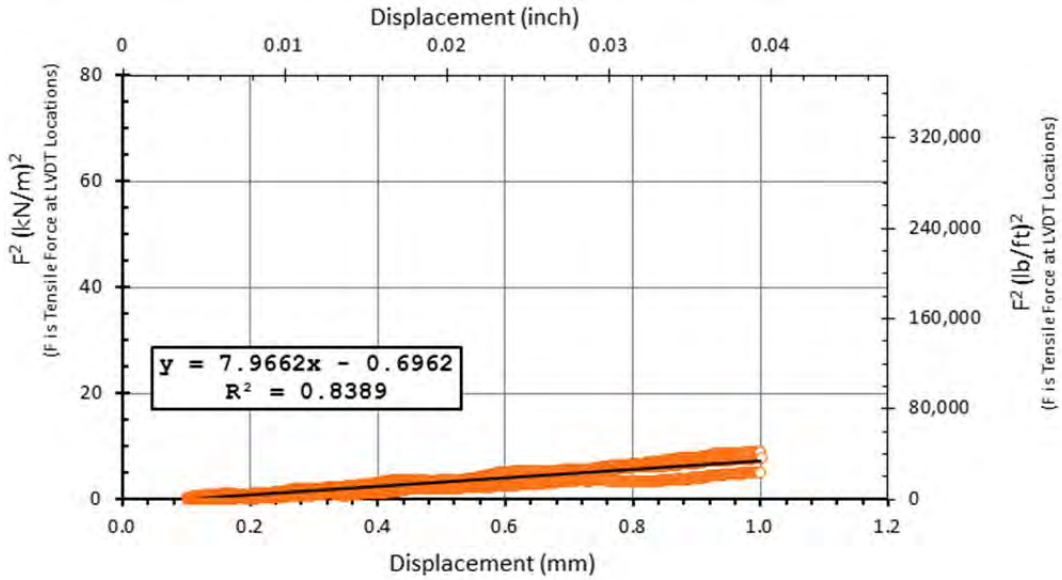
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.1	kN/m	416	lb/ft
Max Pullout Load	P_{max}	1.85	kN	456	lb
Max Shear Stress	τ_{max}	24.9	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.0	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

LVDT #5 off to the right. Problems with LVDT 1 data.

SMALL PULLOUT TEST

Date test conducted	8/22/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.7	0.460
2	71.8	2.828
3	102.8	4.046
4	135.3	5.326
5	226.9	8.932

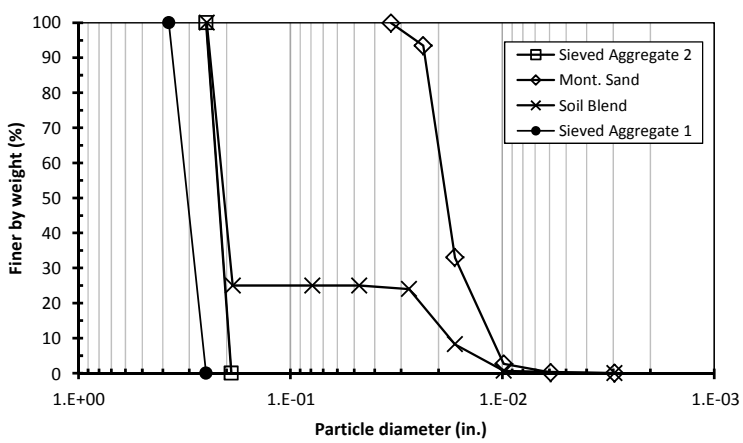
Pullout Rate	
1.0 mm/min.	0.04 in/min

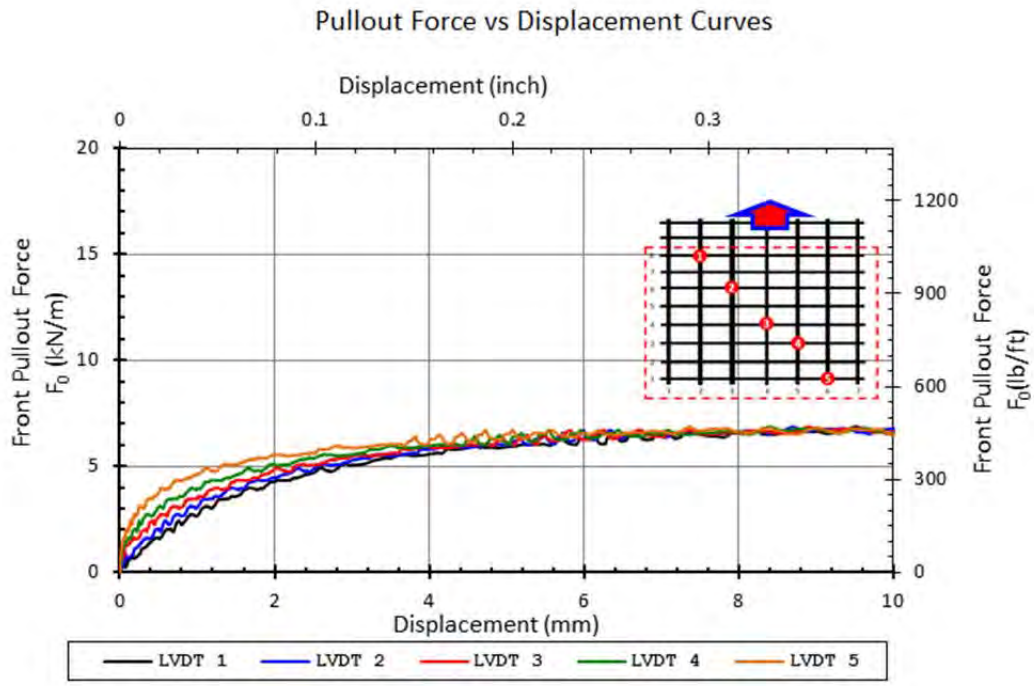
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

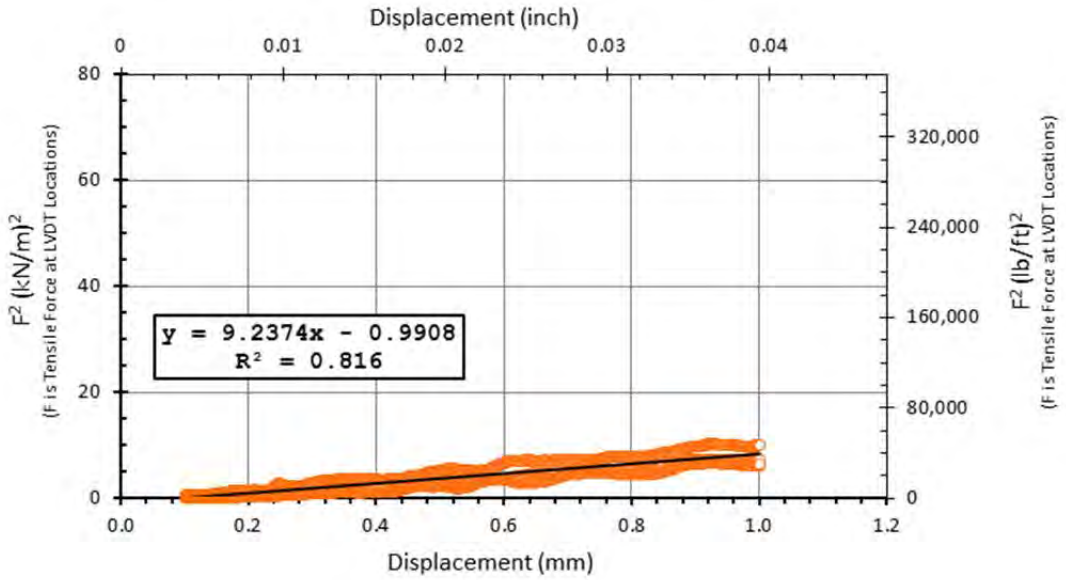
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.1	kN/m	484	lb/ft
Max Pullout Load	P_{max}	2.15	kN	505	lb
Max Shear Stress	τ_{max}	28.9	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
9.2	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT#5 off to the right

SMALL PULLOUT TEST

Date test conducted	2/10/12 AM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	20.2	0.794
2	64.4	2.536
3	109.1	4.297
4	151.1	5.948
5	236.6	9.315

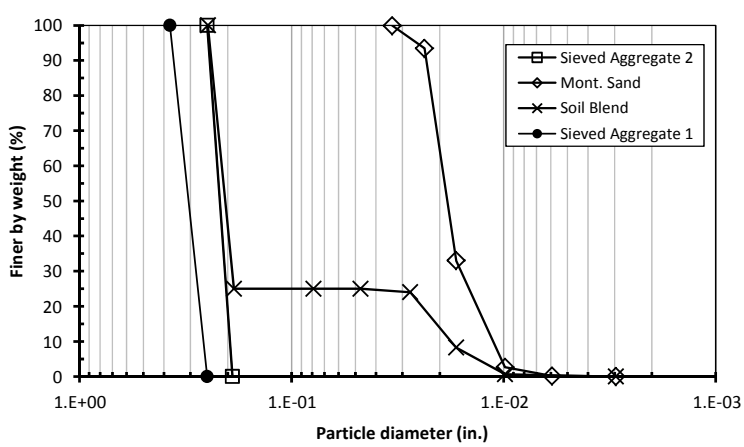
Pullout Rate	
1.0 mm/min.	0.04 in/min

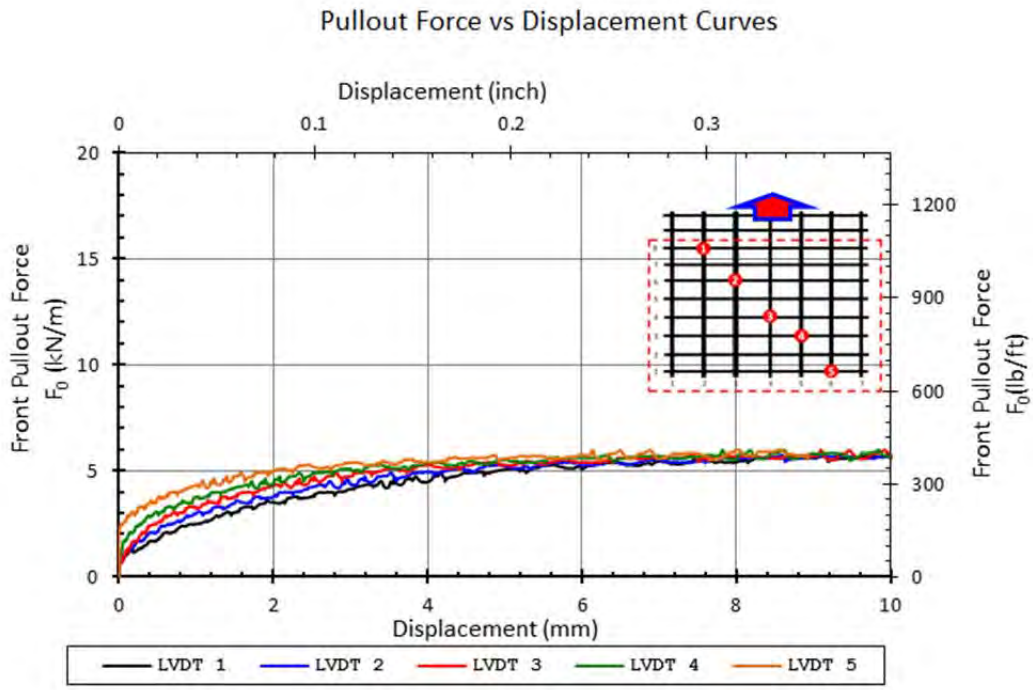
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.538 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

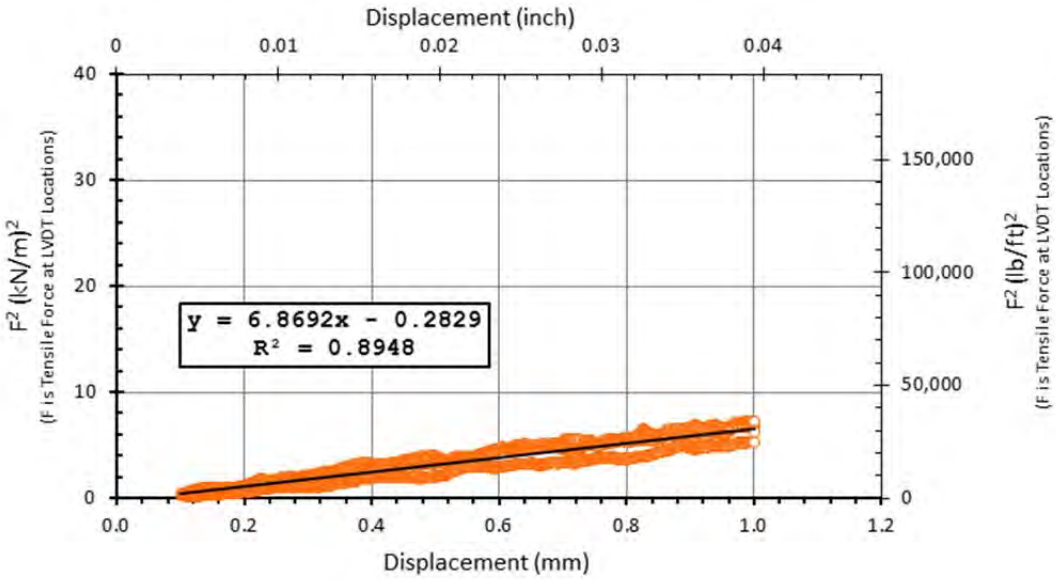
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.0	kN/m	410	lb/ft
Max Pullout Load	P_{max}	2.18	kN	512	lb
Max Shear Stress	τ_{max}	29.3	kPa	4.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
6.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:
Slight tilt to right

SMALL PULLOUT TEST

Date test conducted	2/13/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.364	m	0.245	m
	17	0.915	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.8	0.583
2	59.5	2.342
3	104.3	4.105
4	147.8	5.818
5	233.6	9.198

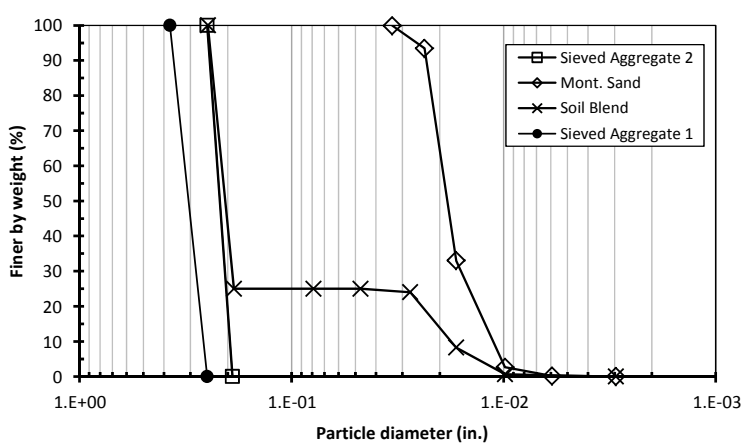
Pullout Rate	
1.0 mm/min.	0.04 in/min

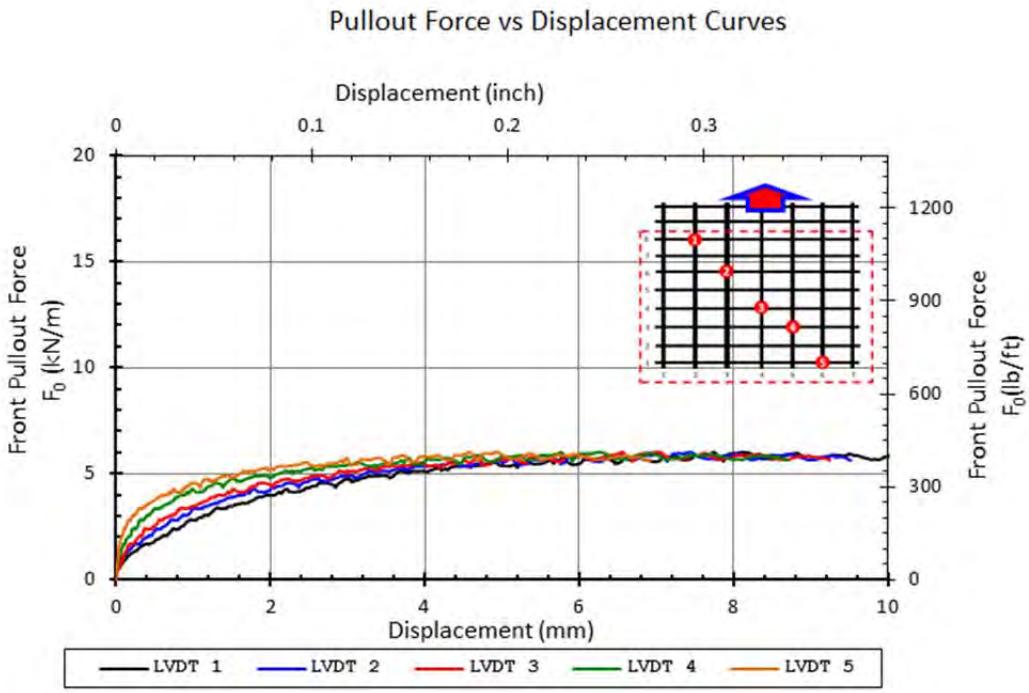
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

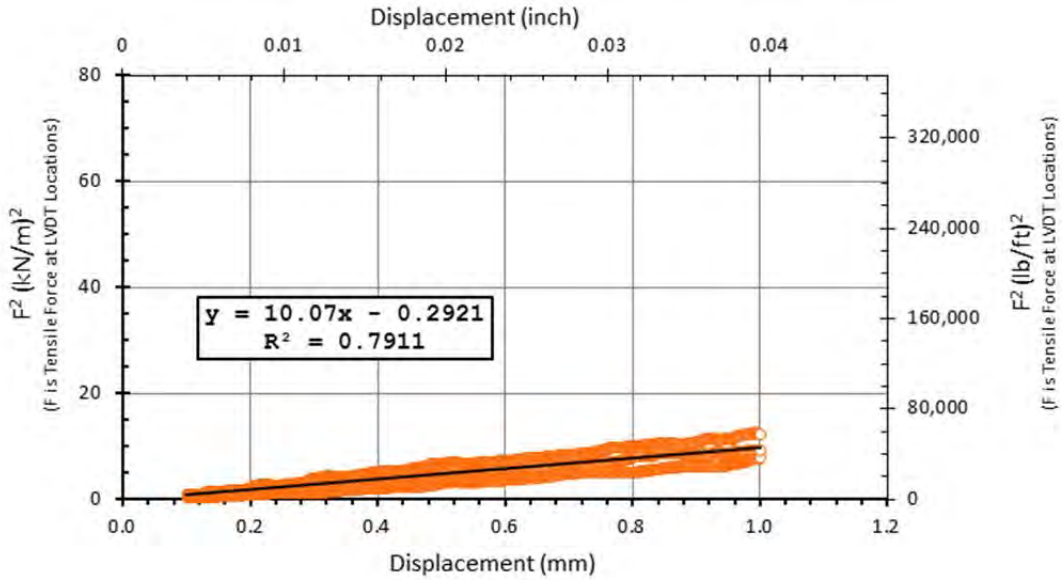
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.0	kN/m	413	lb/ft
Max Pullout Load	P_{max}	2.19	kN	524	lb
Max Shear Stress	τ_{max}	29.5	kPa	4.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
10.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/23/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.7	0.774
2	62.5	2.459
3	105.8	4.164
4	148.3	5.839
5	234.4	9.227

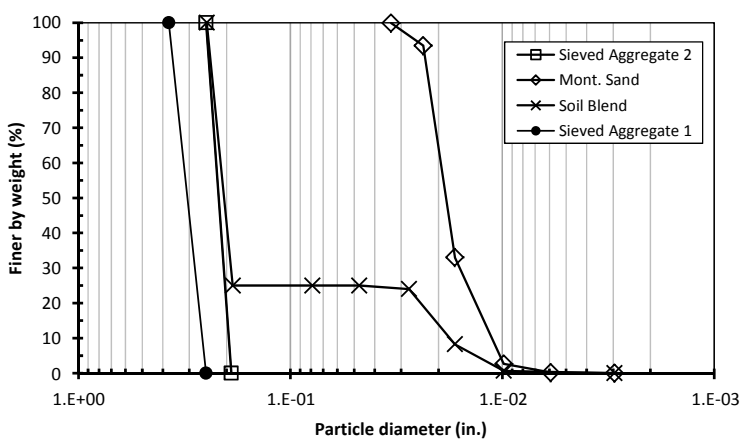
Pullout Rate	
1.0 mm/min.	0.04 in/min

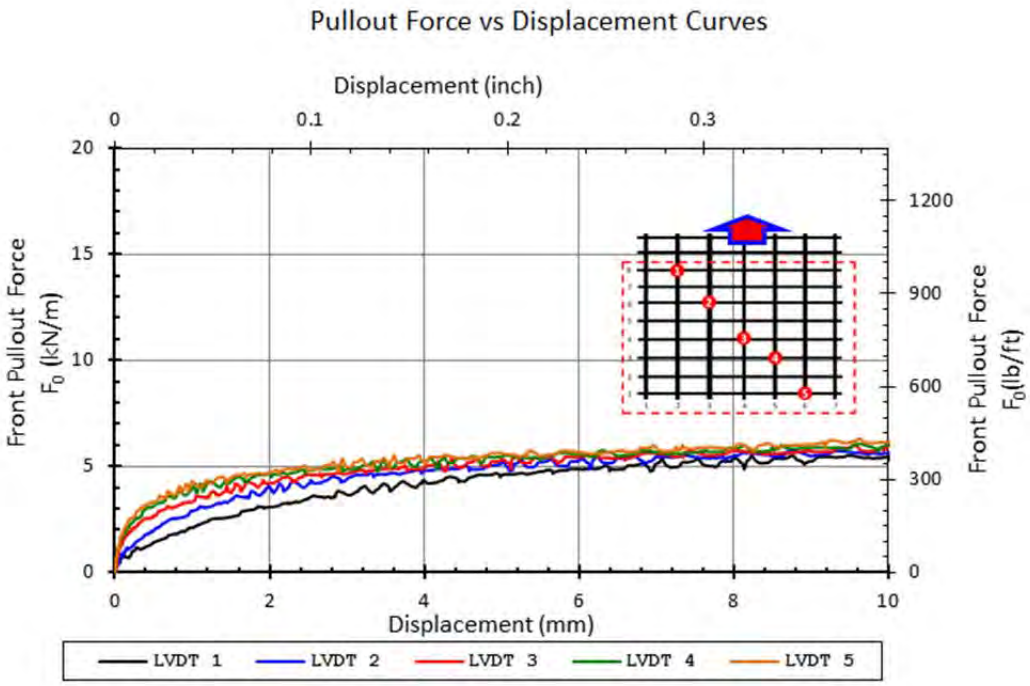
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

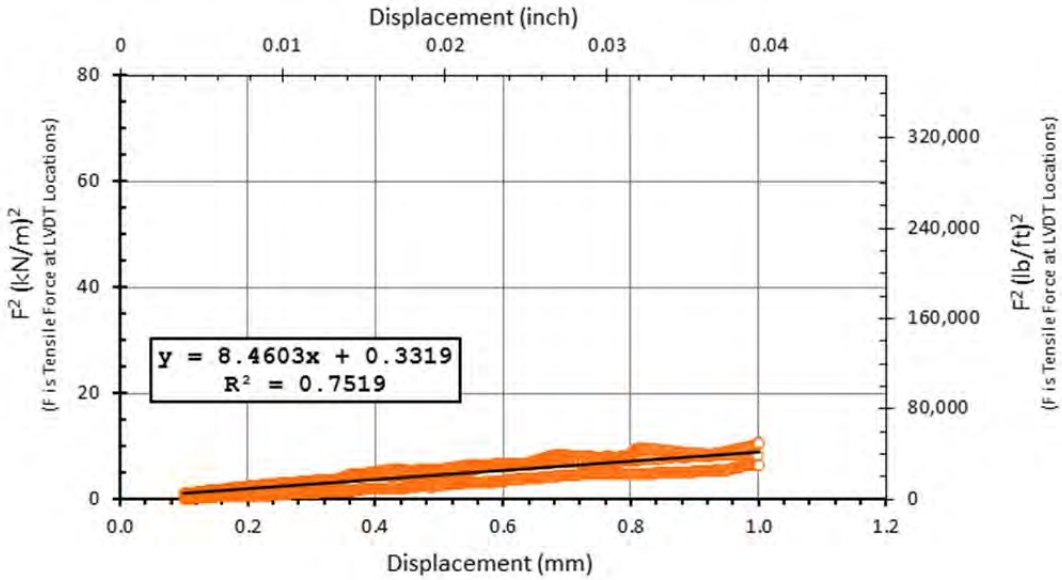
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	431	lb/ft
Max Pullout Load	P_{max}	2.29	kN	542	lb
Max Shear Stress	τ_{max}	30.8	kPa	4.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.5	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/23/12 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.5	0.571
2	57.9	2.280
3	101.0	3.977
4	143.7	5.656
5	229.4	9.030

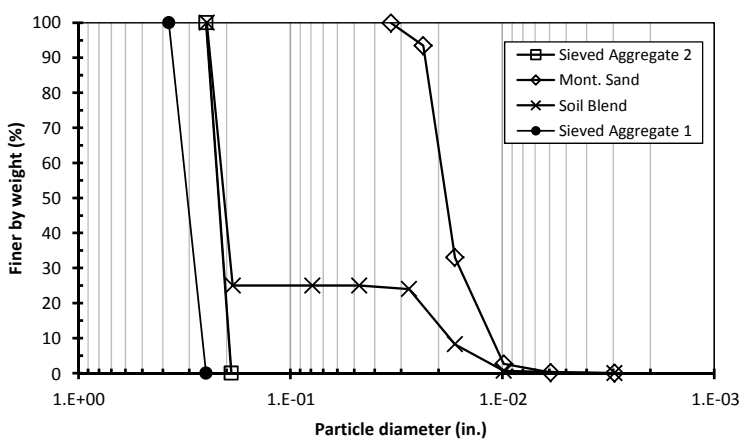
Pullout Rate	
1.0 mm/min.	0.04 in/min

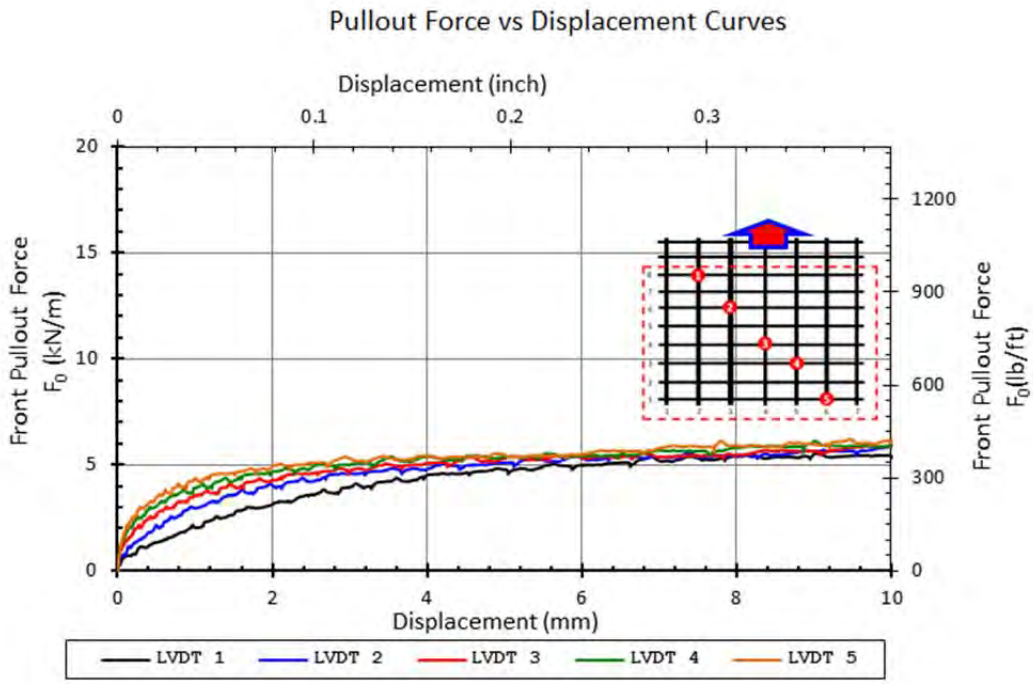
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

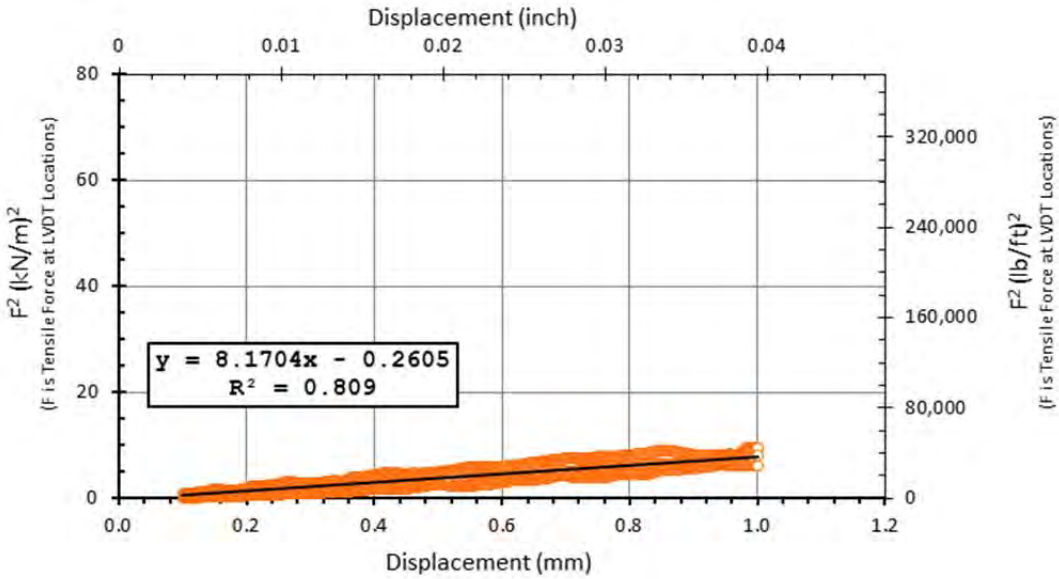
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	427	lb/ft
Max Pullout Load	P_{max}	2.27	kN	536	lb
Max Shear Stress	τ_{max}	30.5	kPa	4.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.2	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/24/2012 AM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.4	0.606
2	58.4	2.300
3	102.0	4.015
4	144.4	5.685
5	230.5	9.076

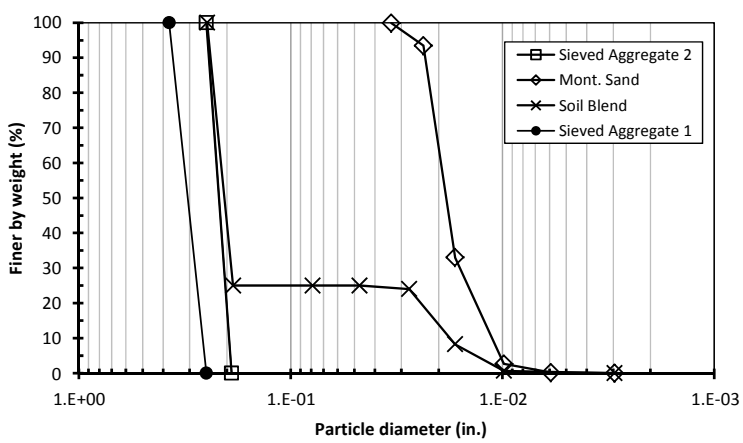
Pullout Rate	
1.0 mm/min.	0.04 in/min

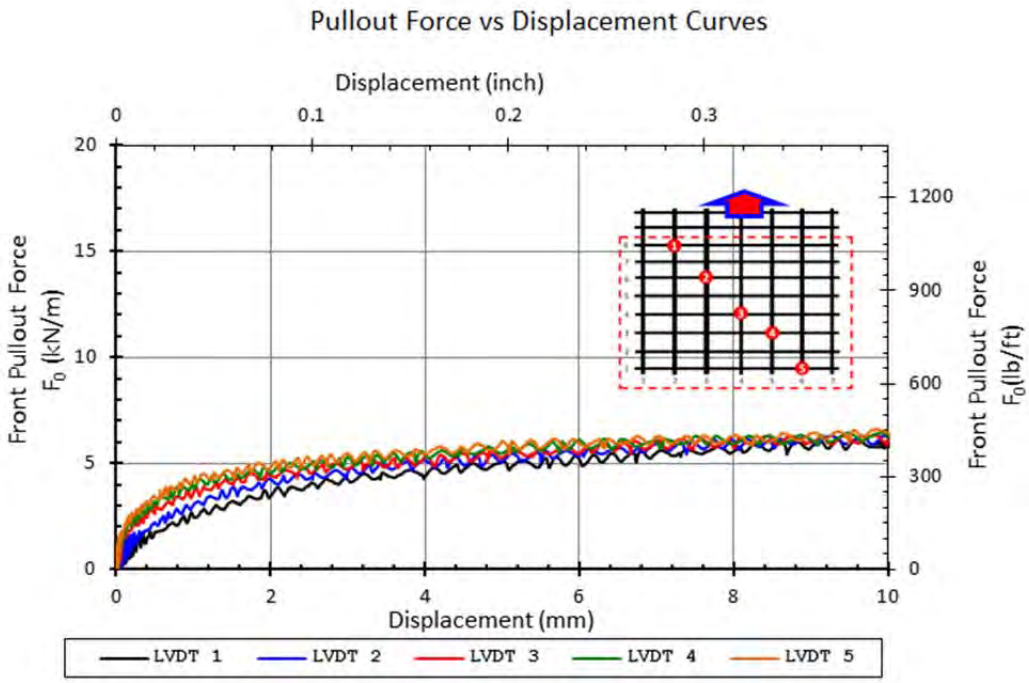
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

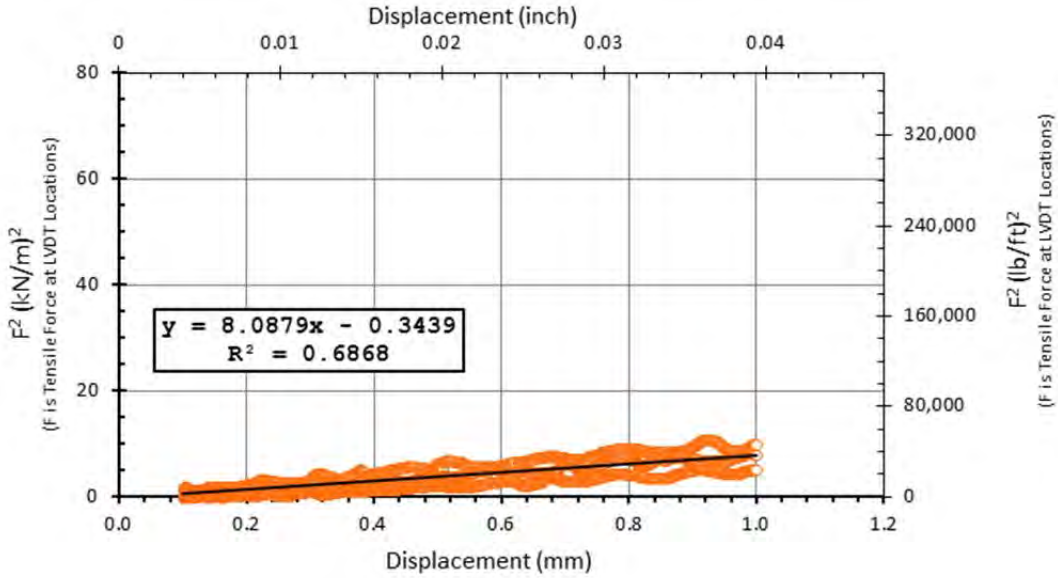
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	479	lb/ft
Max Pullout Load	P_{max}	2.55	kN	596	lb
Max Shear Stress	τ_{max}	34.2	kPa	5.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
8.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/18/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	6	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	51.6	2.031
2	95.2	3.748
3	137.3	5.405
4	180.5	7.107
5	224.5	8.838

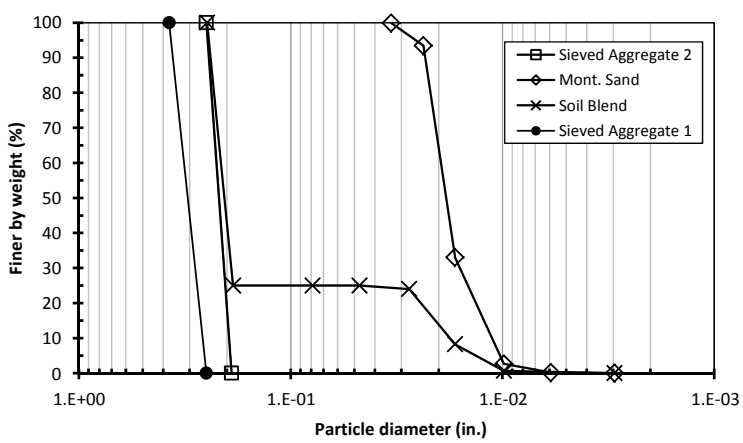
Pullout Rate	
1.0 mm/min.	0.04 in/min

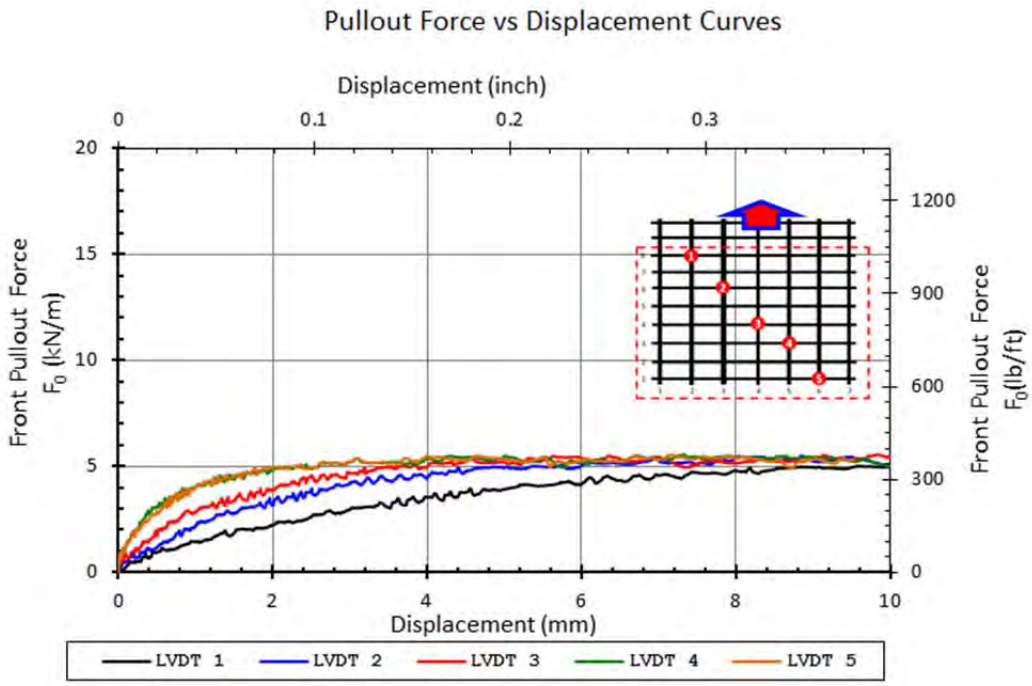
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

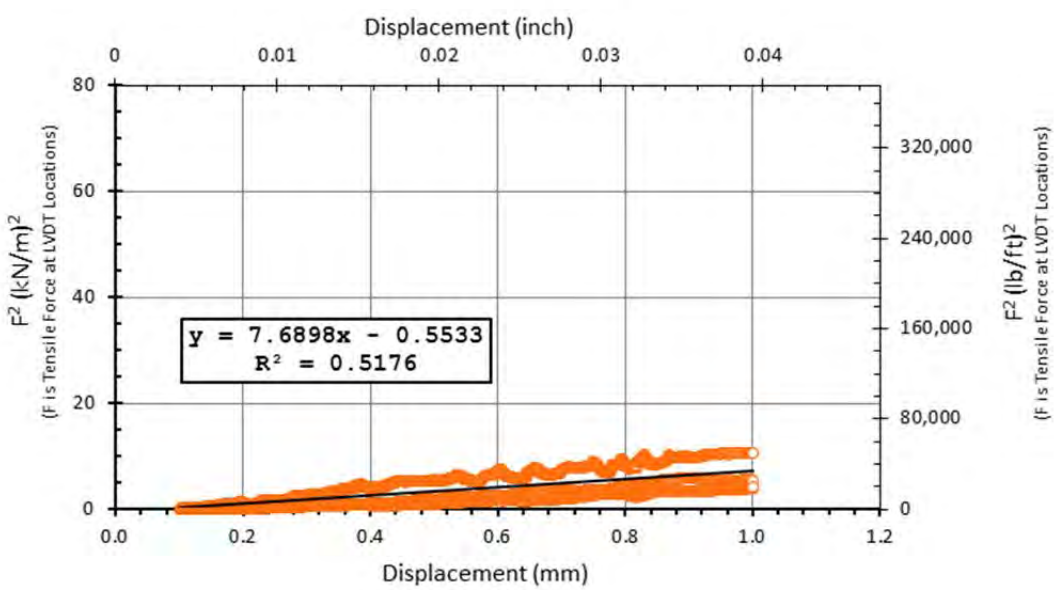
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.6	kN/m	380	lb/ft
Max Pullout Load	P_{max}	1.67	kN	390	lb
Max Shear Stress	τ_{max}	22.4	kPa	3.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
7.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Rib 1 was too far to the left, so the wire was constrained from being completely vertical by the back wall opening which is not wide enough.

SMALL PULLOUT TEST

Date test conducted	7/19/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	6	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	50.7	1.998
2	94.8	3.732
3	138.4	5.447
4	181.0	7.124
5	224.3	8.829

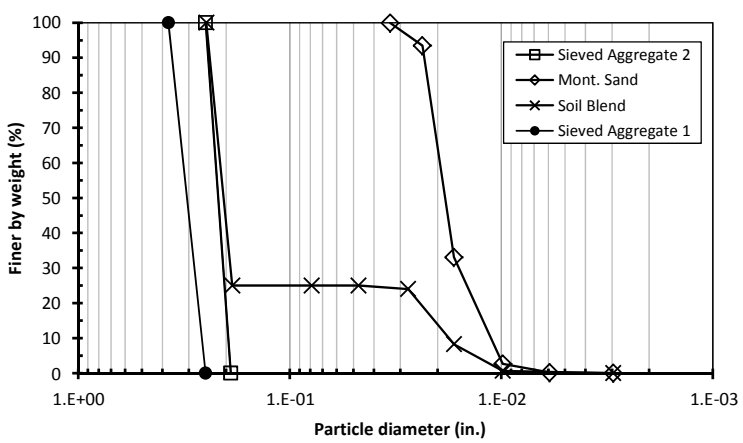
Pullout Rate	
1.0 mm/min.	0.04 in/min

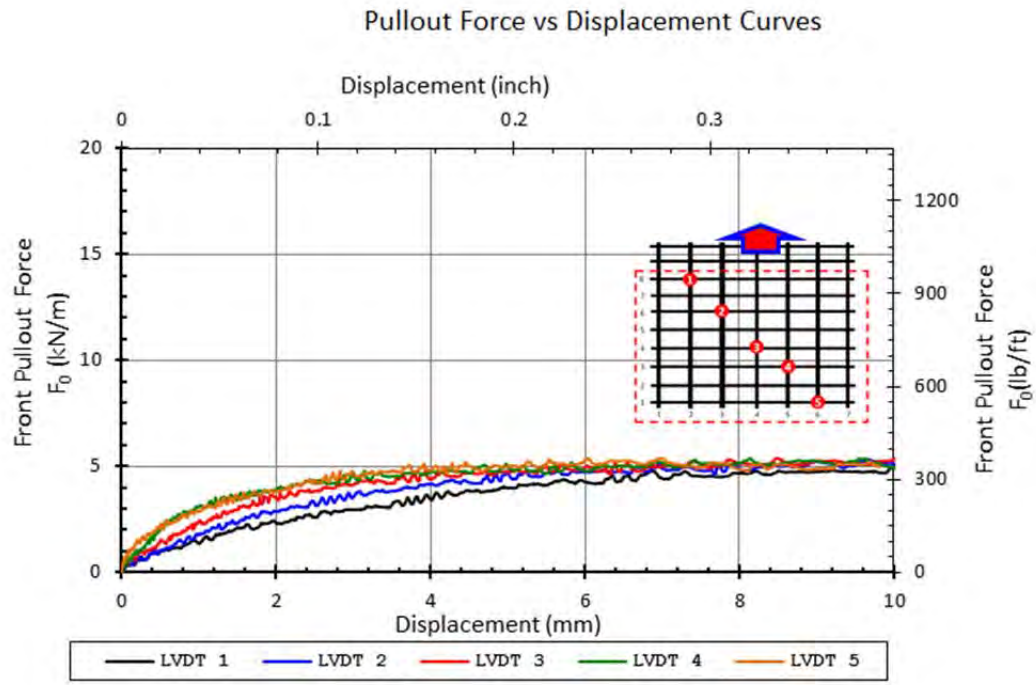
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

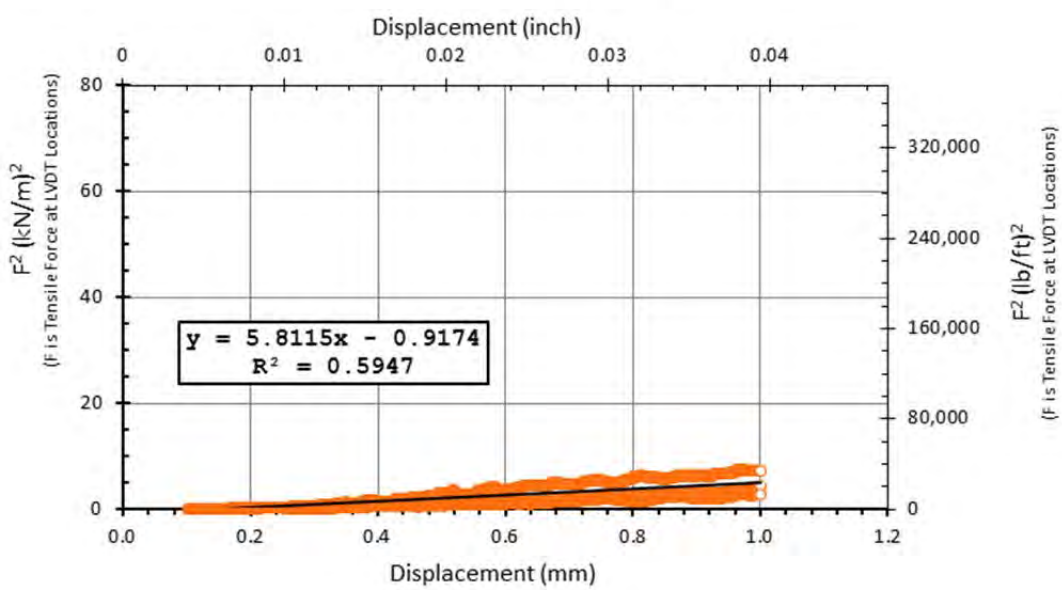
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.4	kN/m	368	lb/ft
Max Pullout Load	P_{max}	1.61	kN	380	lb
Max Shear Stress	τ_{max}	21.7	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
5.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Rib 1 was too far to the left, so the wire was constrained from being completely vertical by the back wall opening which is not wide enough.

SMALL PULLOUT TEST

Date test conducted	7/23/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.300	m	0.245	m
	6	0.922	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	35.2	1.384
2	79.8	3.142
3	125.2	4.930
4	170.3	6.705
5	215.8	8.494

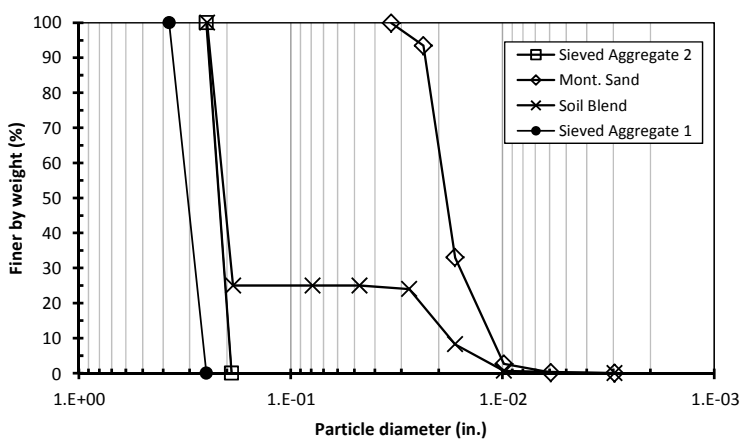
Pullout Rate	
1.0 mm/min.	0.04 in/min

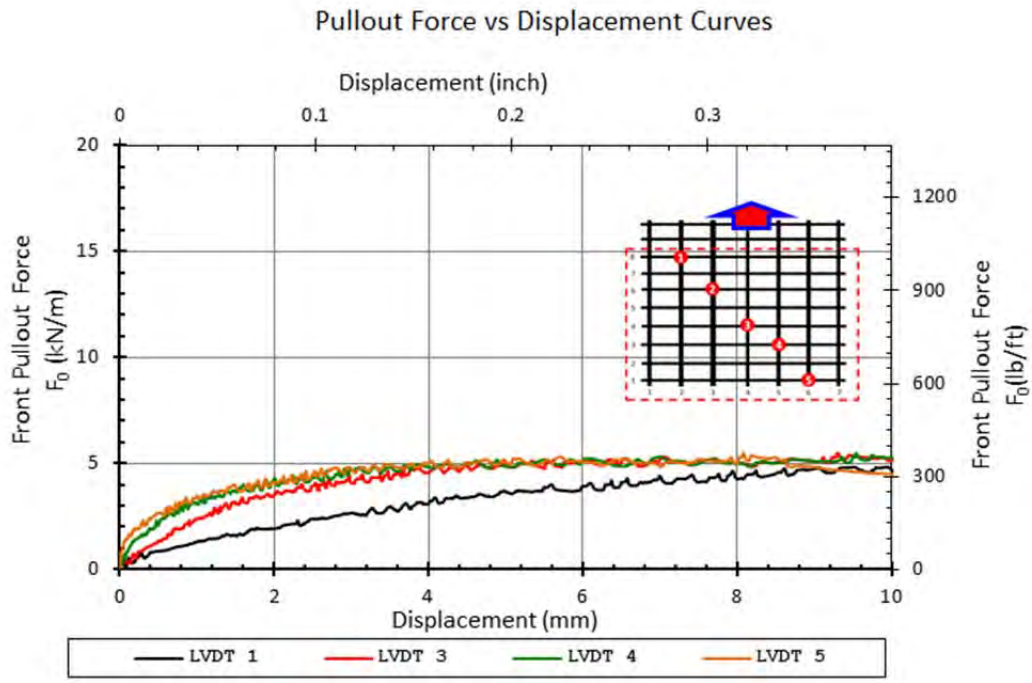
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

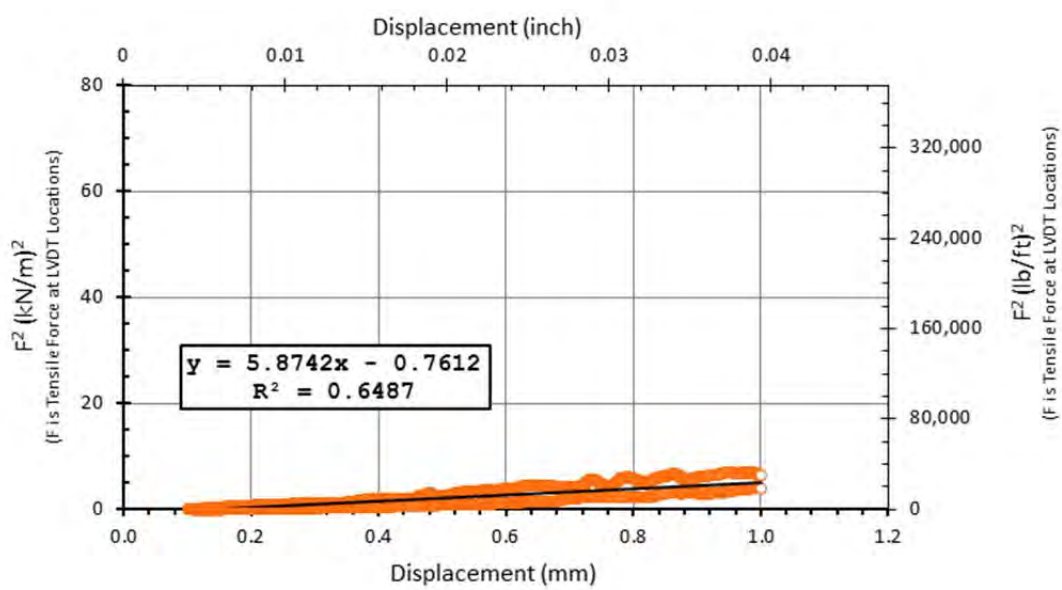
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.5	kN/m	376	lb/ft
Max Pullout Load	P_{max}	1.65	kN	375	lb
Max Shear Stress	τ_{max}	22.2	kPa	3.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
5.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Rib 1was too far to the left, so the wire was constrained from being completely vertical by the back wall opening.
Problem with LVDT 2 readings, thus KSGI obtained with data from LVDTs 3 and 4 only.

SMALL PULLOUT TEST

Date test conducted	8/24/2012 PM
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.300	m	0.245	m
	6	0.922	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	44.4	1.746
2	89.6	3.527
3	135.2	5.324
4	181.1	7.128
5	225.9	8.893

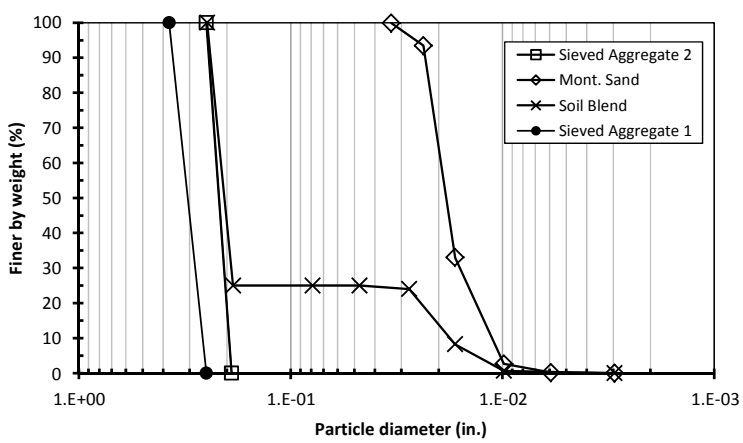
Pullout Rate			
1.0	mm/min.	0.04	in/min

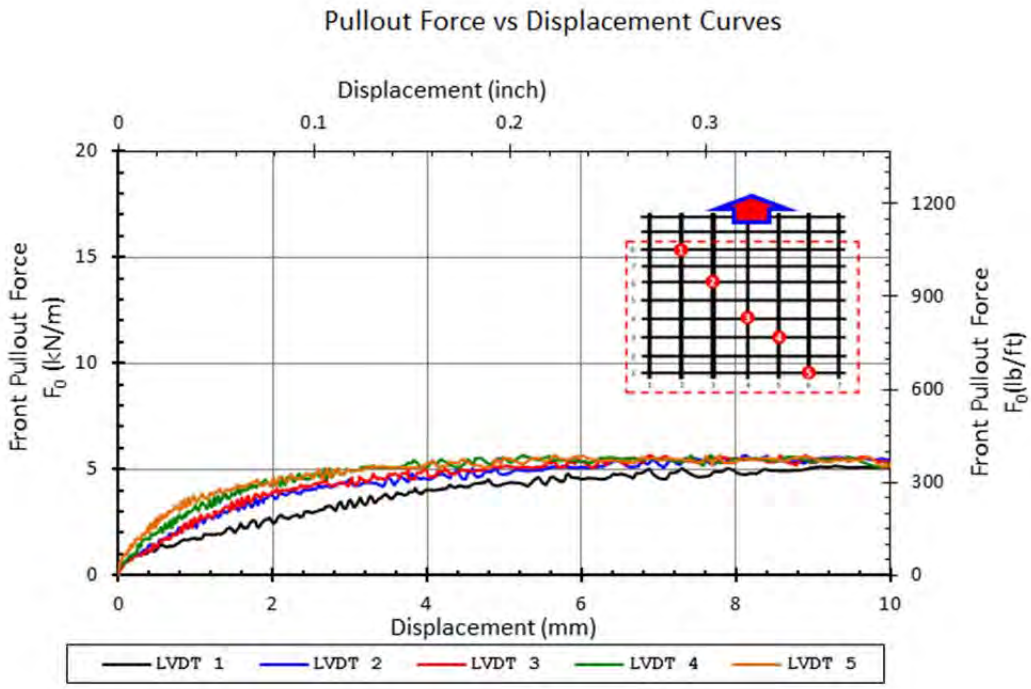
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.564 **g/cm^3**	**98**	**pcf**

Note: particle size distribution curve shown below

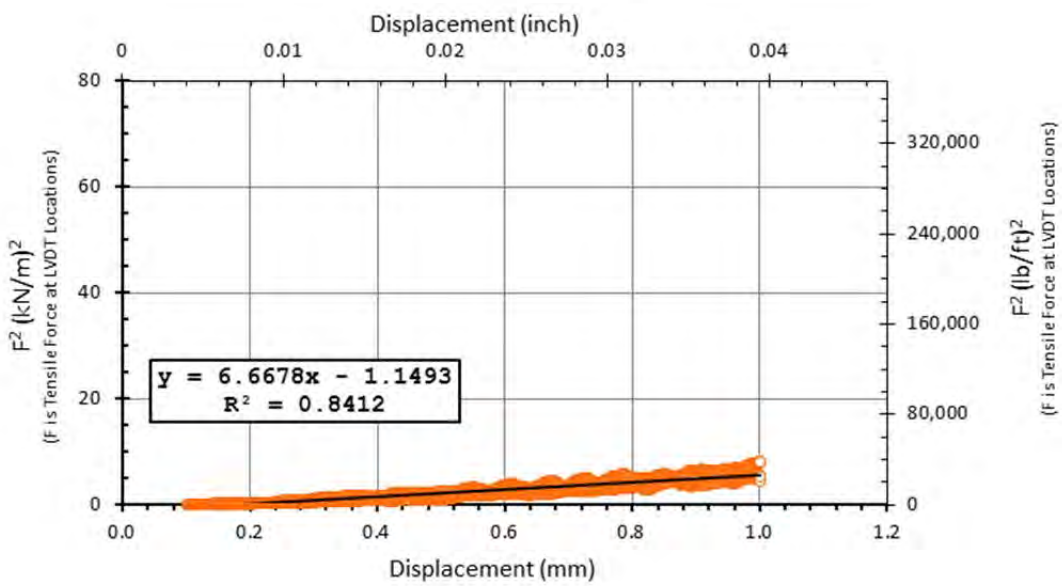
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.7	kN/m	388	lb/ft
Max Pullout Load	P_{max}	1.70	kN	399	lb
Max Shear Stress	τ_{max}	22.8	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
6.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/25/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	6	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	38.9	1.533
2	86.2	3.393
3	133.1	5.239
4	179.7	7.074
5	226.2	8.907

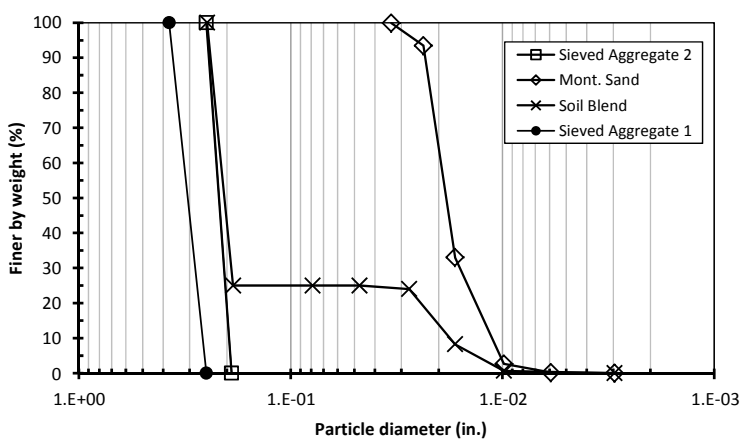
Pullout Rate	
1.0 mm/min.	0.04 in/min

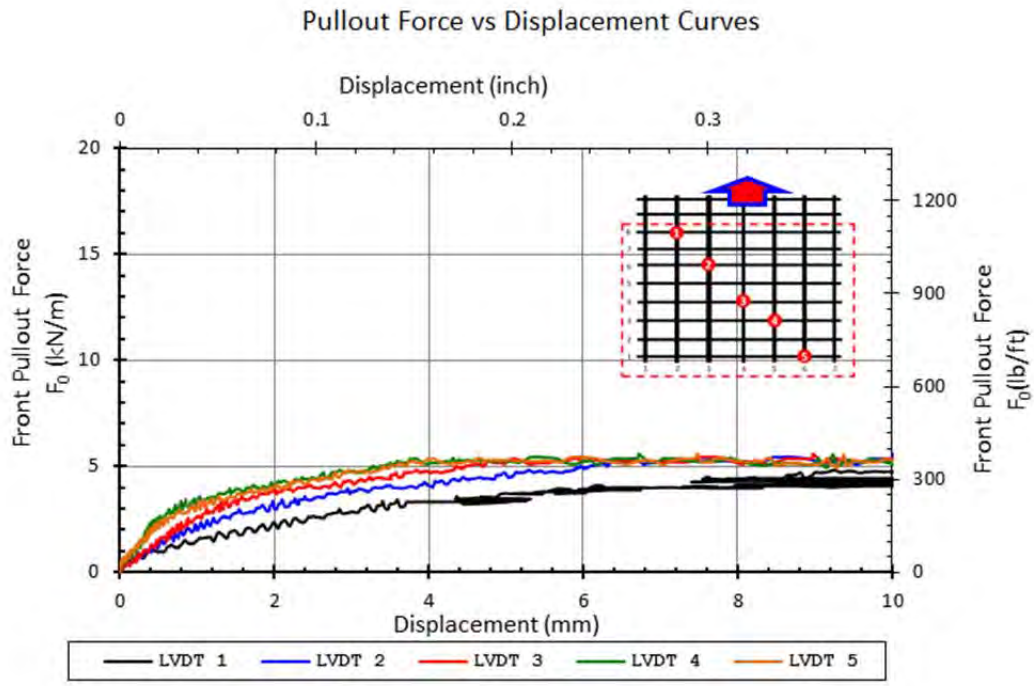
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

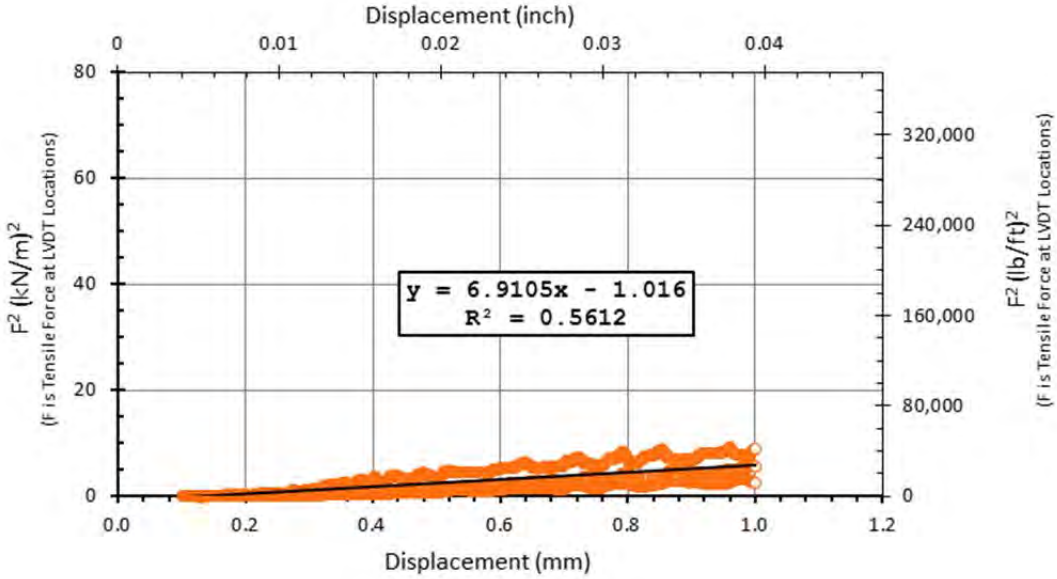
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.6	kN/m	383	lb/ft
Max Pullout Load	P_{max}	1.68	kN	401	lb
Max Shear Stress	τ_{max}	22.6	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
6.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Problems with LVDT 1 data towards the end of the test.

SMALL PULLOUT TEST

Date test conducted	7/24/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	12	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	44.3	1.745
2	90.0	3.542
3	134.5	5.297
4	180.0	7.087
5	225.3	8.869

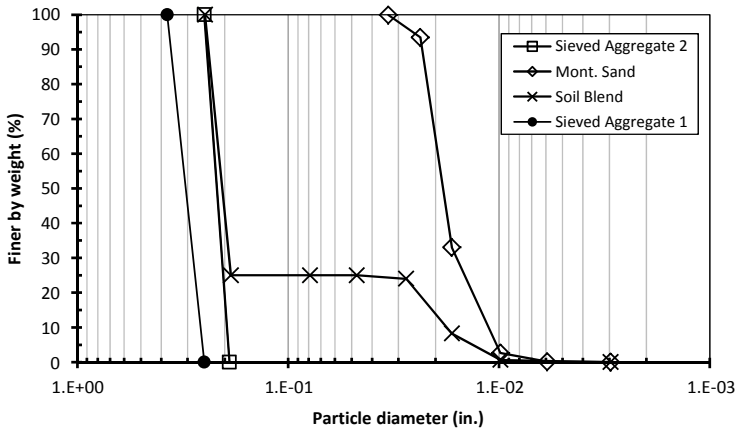
Pullout Rate	
1.0 mm/min.	0.04 in/min

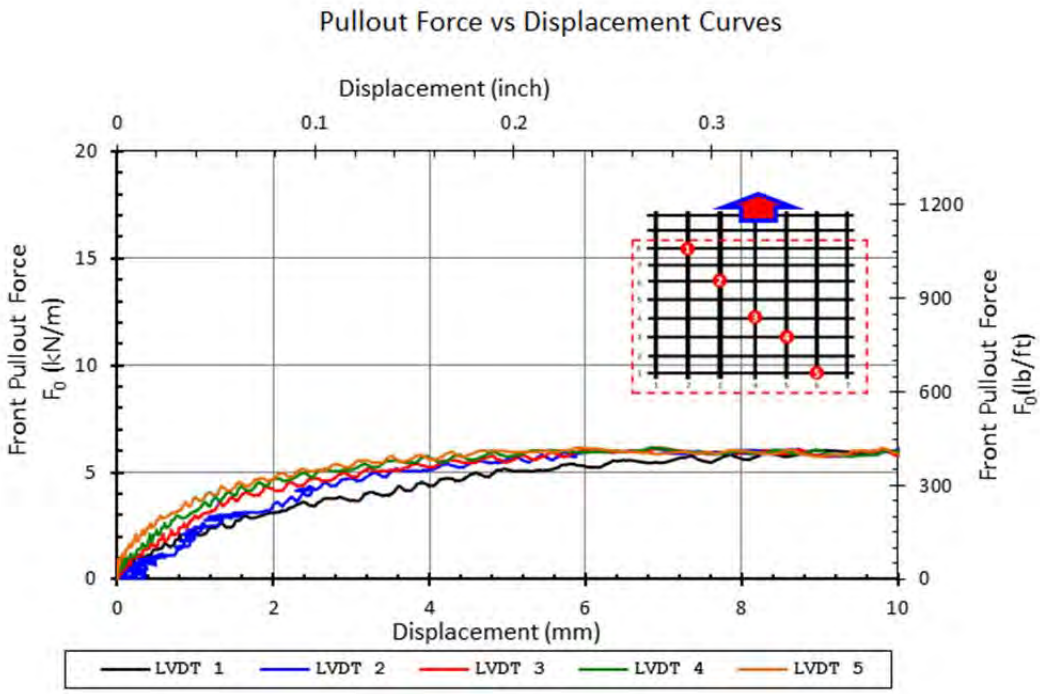
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

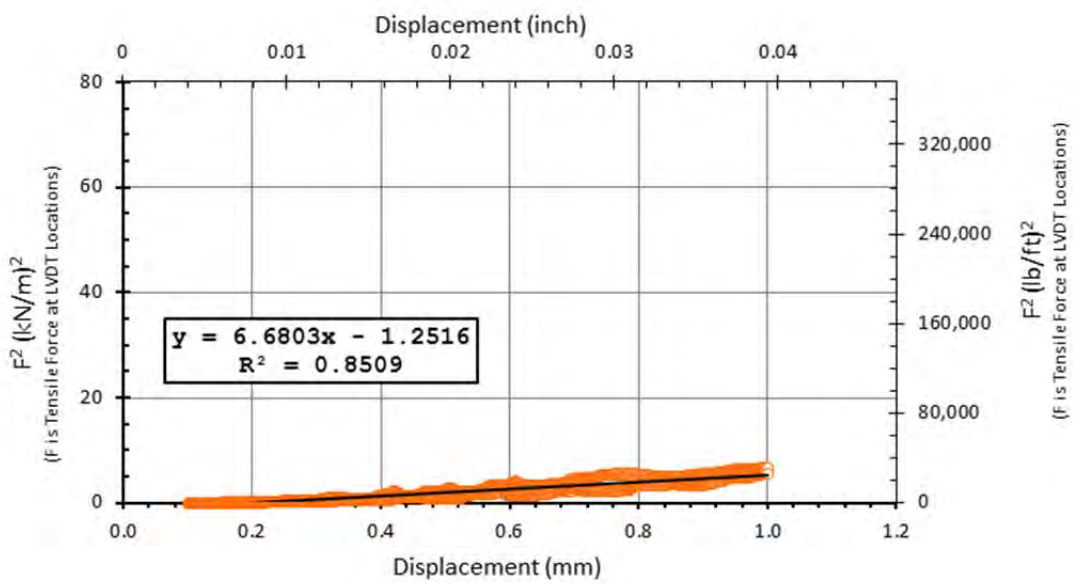
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	424	lb/ft
Max Pullout Load	P_{max}	1.86	kN	437	lb
Max Shear Stress	τ_{max}	24.9	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
6.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Problems with readings from LVDT 2. Data from LVDT 2 not used for the calculation of the KSGI.

SMALL PULLOUT TEST

Date test conducted	7/25/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	12	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	40.9	1.608
2	87.4	3.442
3	133.7	5.265
4	180.1	7.092
5	226.1	8.900

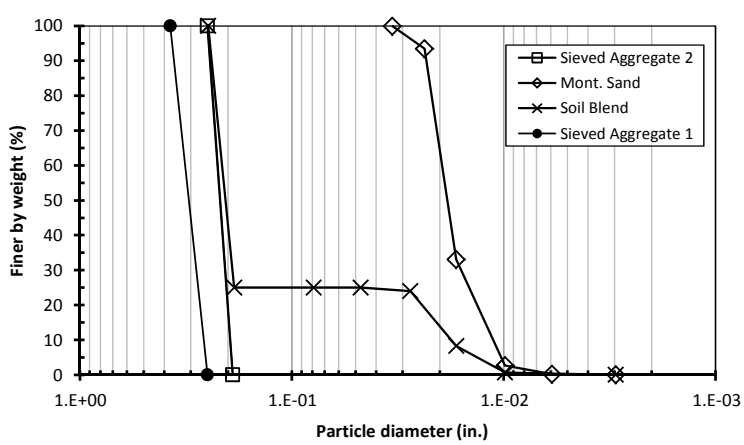
Pullout Rate	
1.0 mm/min.	0.04 in/min

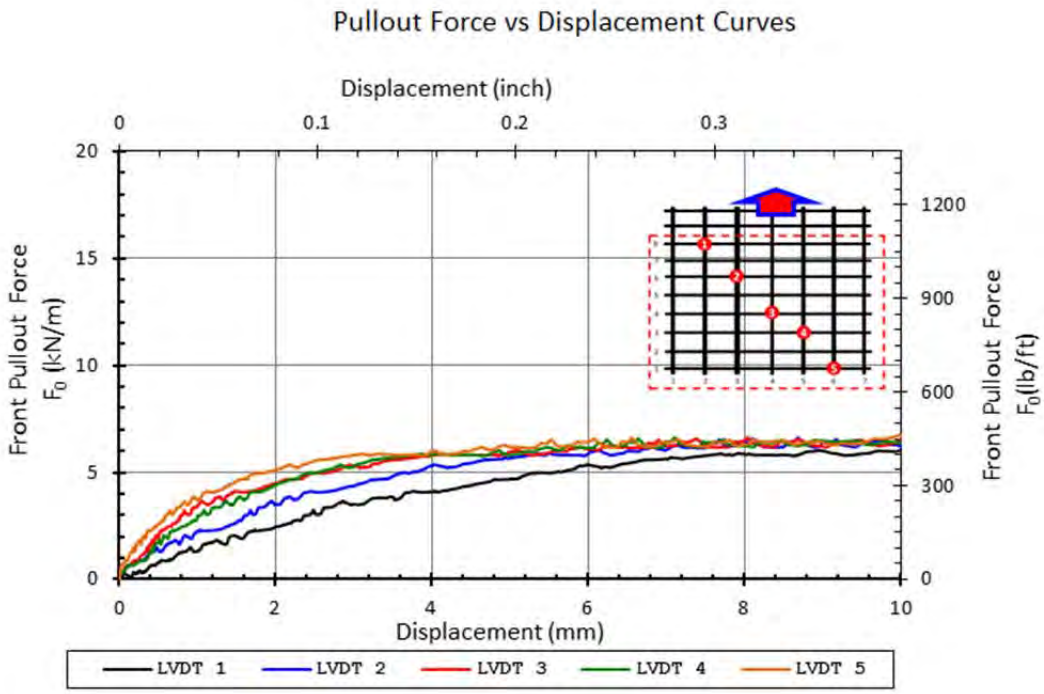
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

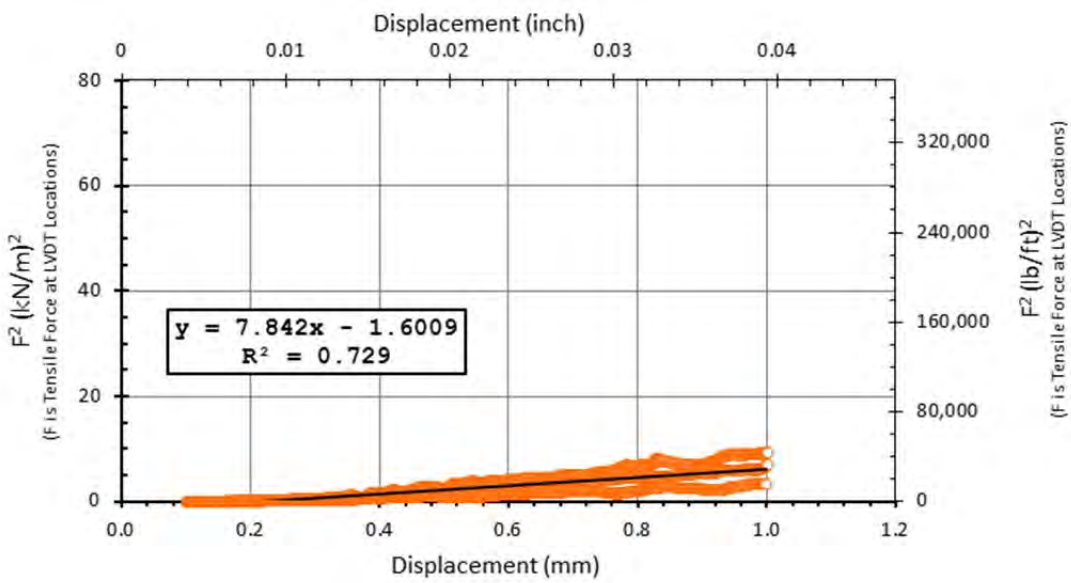
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	475	lb/ft
Max Pullout Load	P_{max}	2.08	kN	485	lb
Max Shear Stress	τ_{max}	28.0	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
7.8 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/27/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	12	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	42.5	1.674
2	89.3	3.515
3	134.7	5.302
4	180.7	7.113
5	226.2	8.906

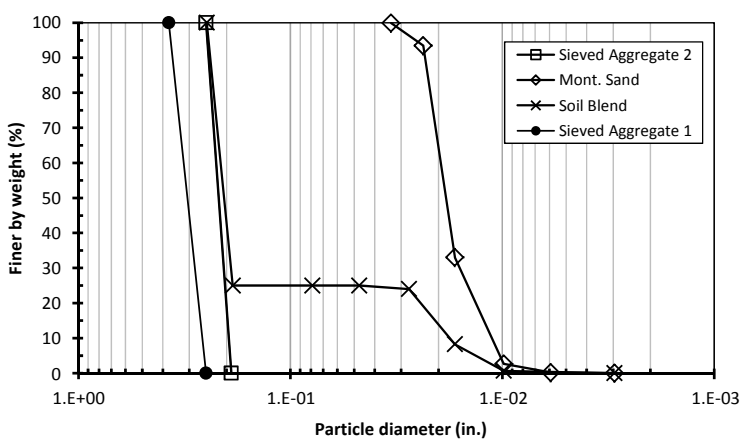
Pullout Rate	
1.0 mm/min.	0.04 in/min

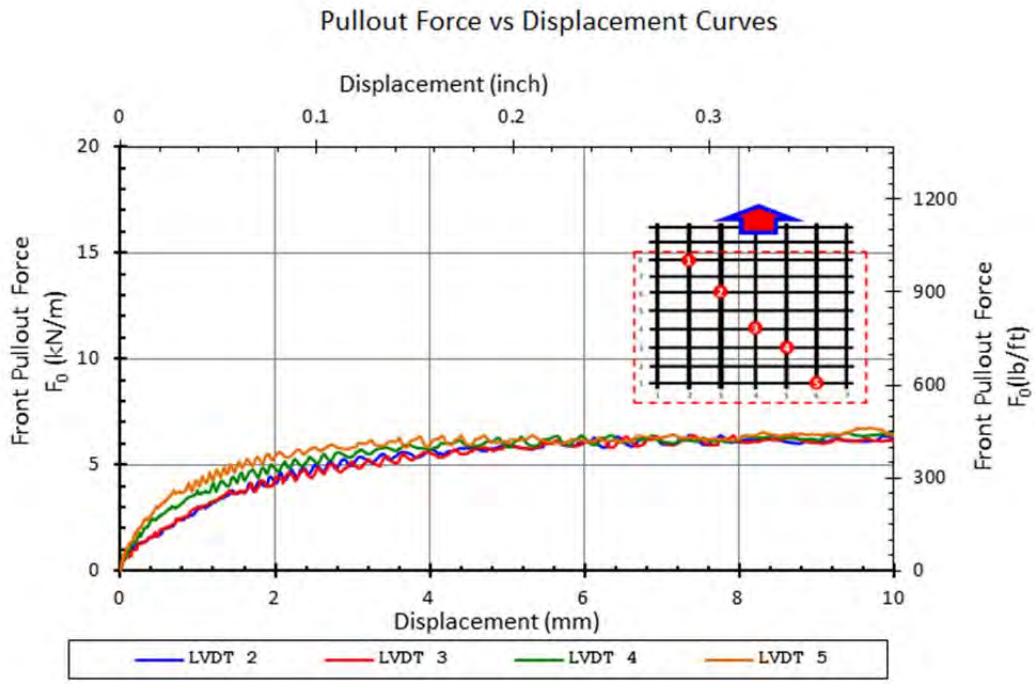
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

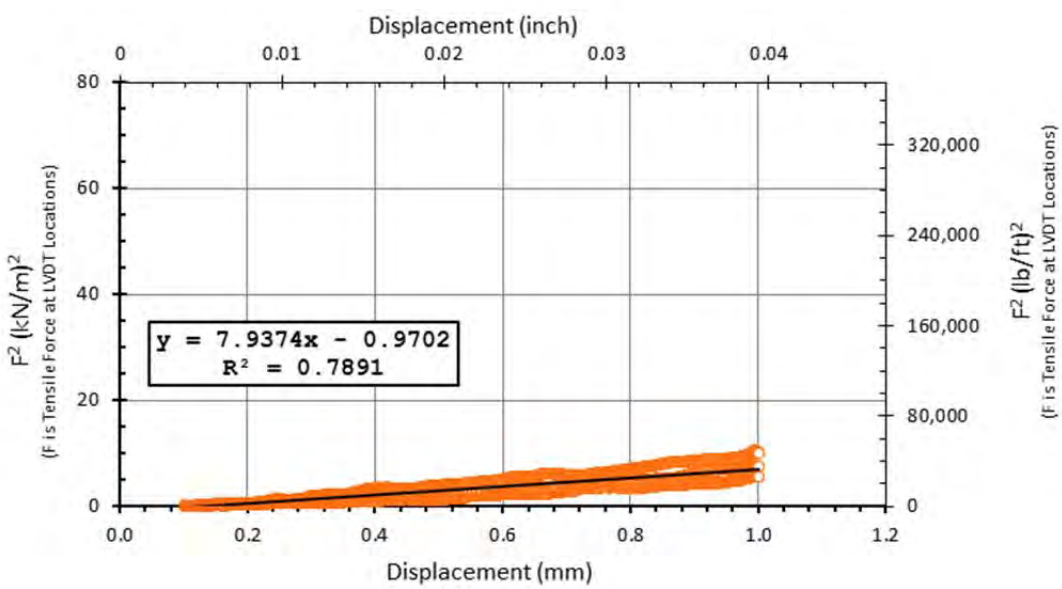
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.8	kN/m	463	lb/ft
Max Pullout Load	P_{max}	2.03	kN	486	lb
Max Shear Stress	τ_{max}	27.2	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
7.9	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

Problems with readings from LVDT 1. Data from LVDT 1 not used in this test.

SMALL PULLOUT TEST

Date test conducted	8/28/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	12	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	46.0	1.811
2	92.1	3.625
3	137.3	5.404
4	181.9	7.161
5	225.7	8.885

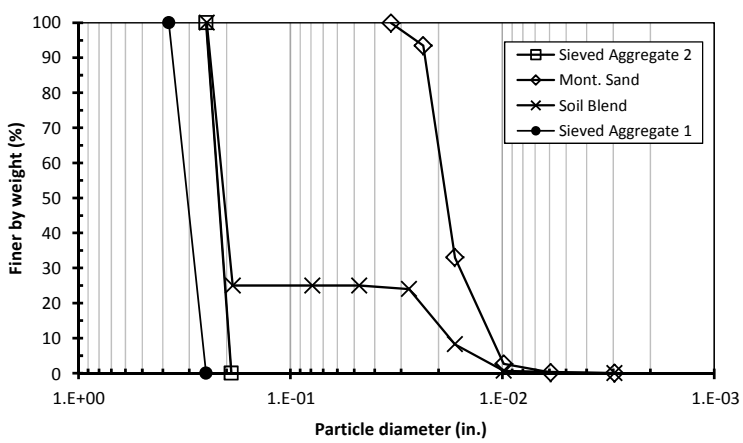
Pullout Rate	
1.0 mm/min.	0.04 in/min

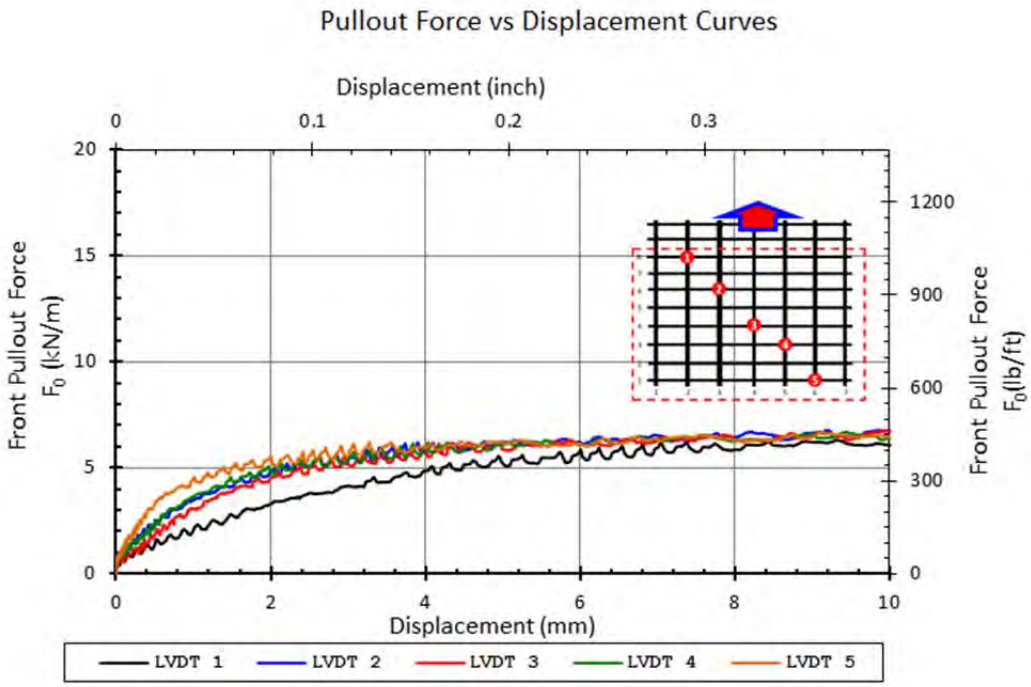
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

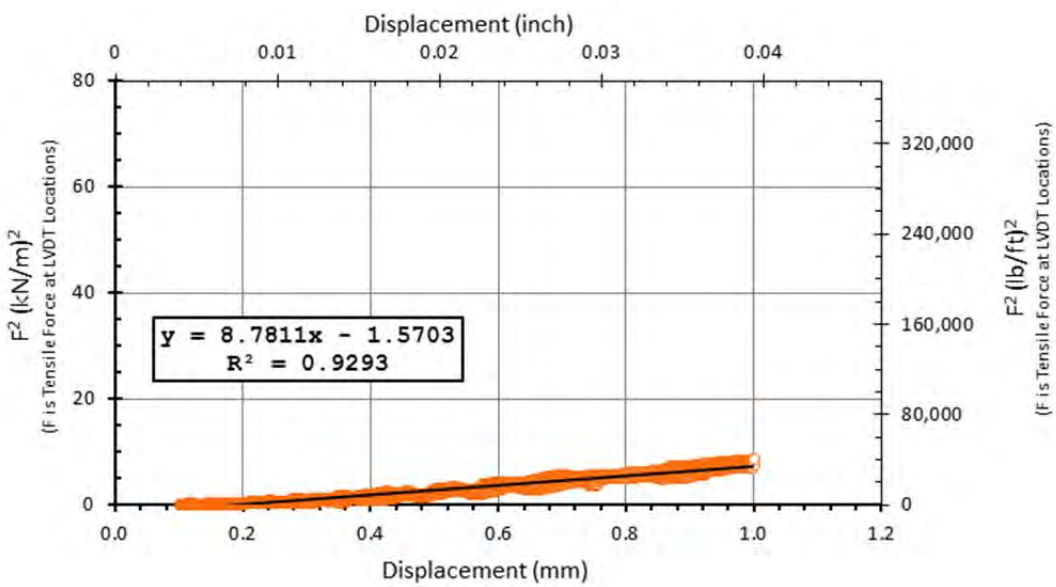
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	477	lb/ft
Max Pullout Load	P_{max}	2.09	kN	495	lb
Max Shear Stress	τ_{max}	28.1	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
8.8	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

Grip sligthly tilted clockwise as test progressed.

SMALL PULLOUT TEST

Date test conducted	8/29/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	12	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	38.4	1.510
2	85.0	3.346
3	132.5	5.217
4	178.6	7.031
5	225.0	8.856

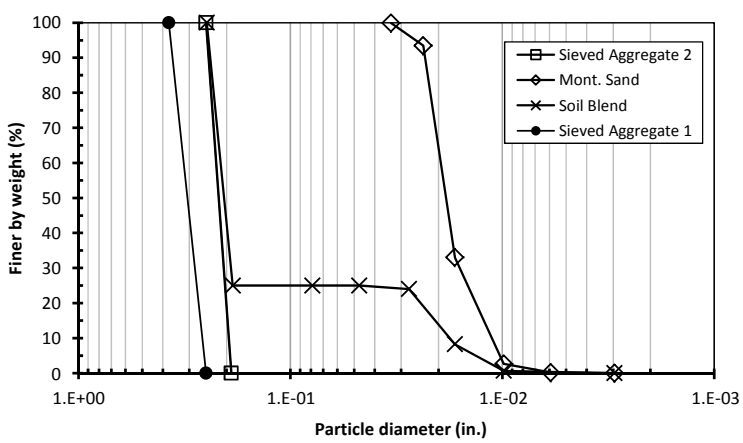
Pullout Rate	
1.0 mm/min.	0.04 in/min

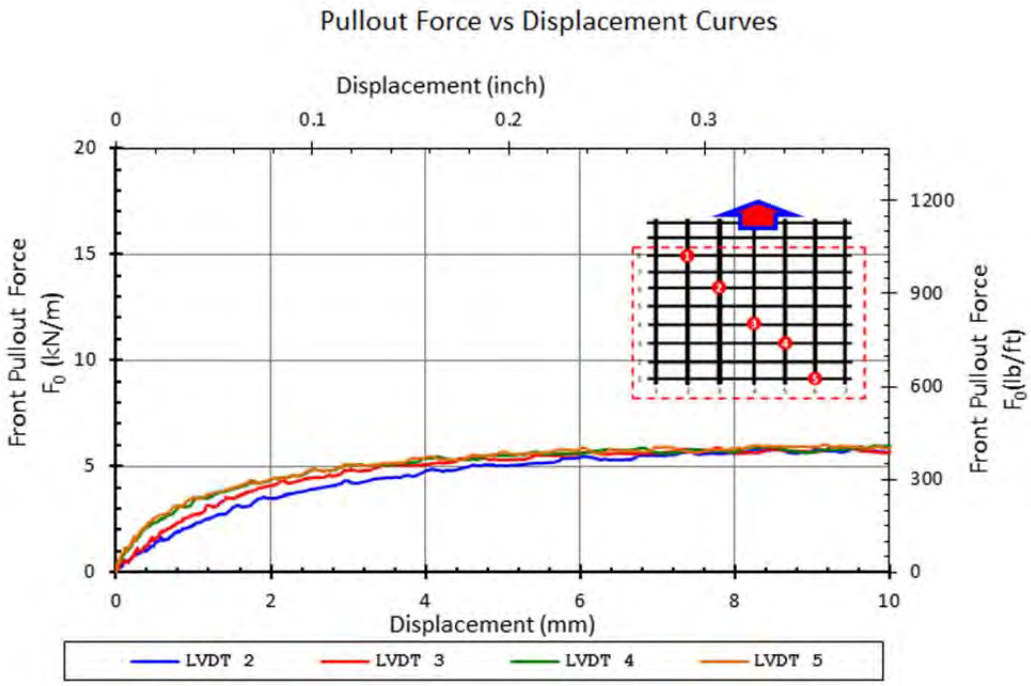
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

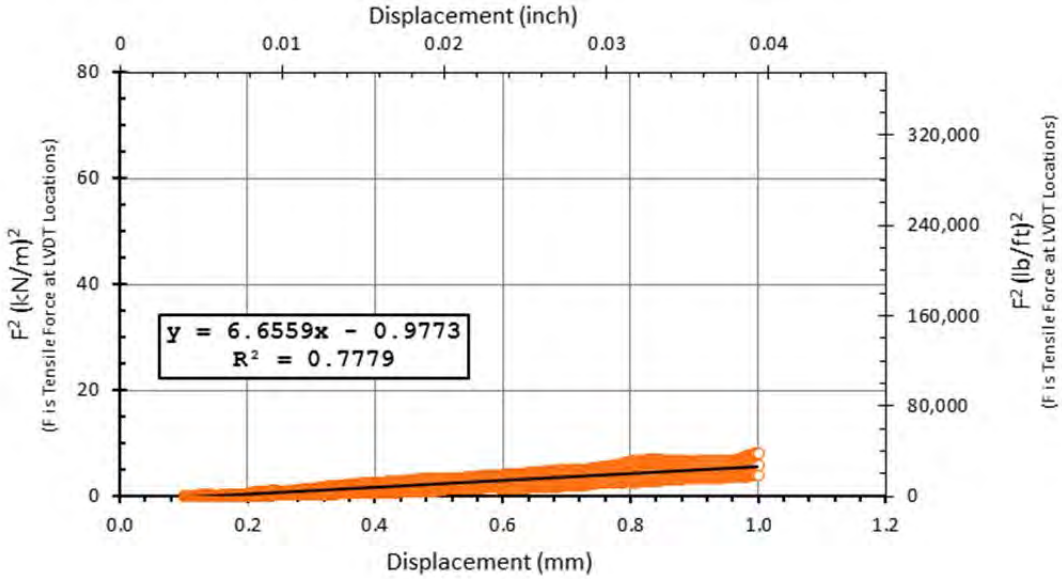
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	424	lb/ft
Max Pullout Load	P_{max}	1.86	kN	449	lb
Max Shear Stress	τ_{max}	25.0	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
6.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Did not use LVDT#1

SMALL PULLOUT TEST

Date test conducted	11/1/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	7	0.912	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	29.2	1.148
2	68.8	2.708
3	106.6	4.196
4	149.0	5.867
5	226.2	8.904

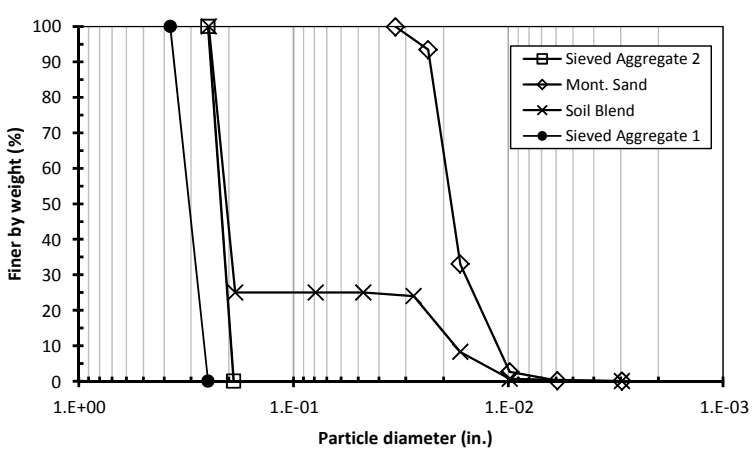
Pullout Rate	
1.0 mm/min.	0.04 in/min

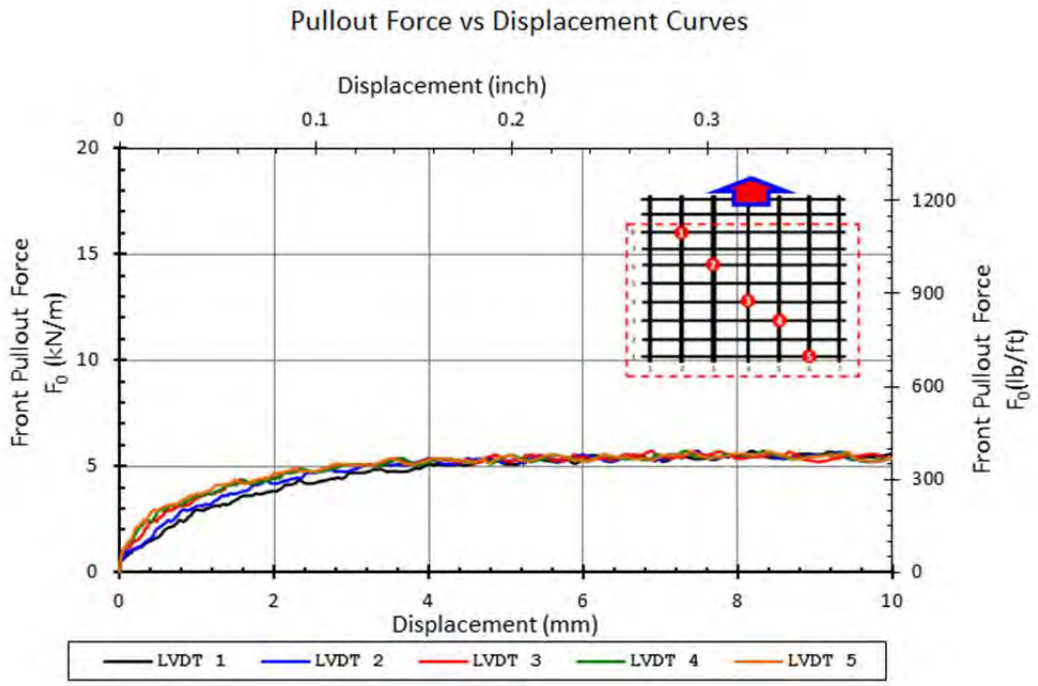
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

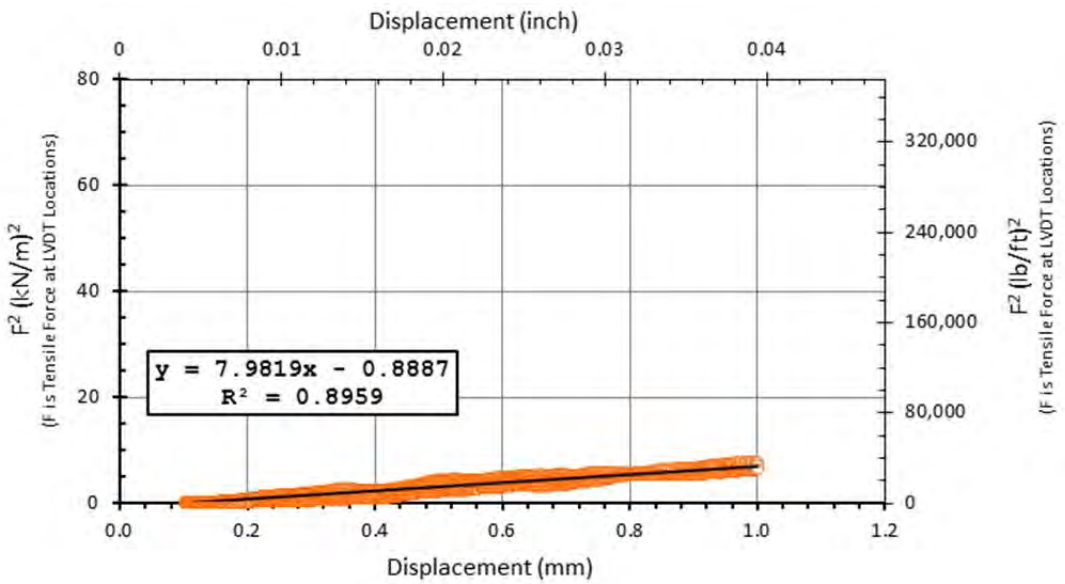
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.8	kN/m	397	lb/ft
Max Pullout Load	P_{max}	1.59	kN	397	lb
Max Shear Stress	τ_{max}	21.4	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/2/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.275	m	0.245	m
	7	0.909	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	22.8	0.896
2	64.8	2.550
3	103.9	4.092
4	143.7	5.659
5	225.0	8.857

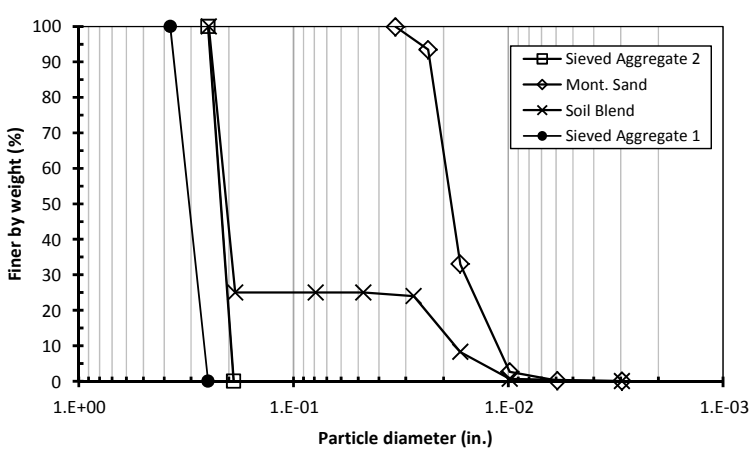
Pullout Rate	
1.0 mm/min.	0.04 in/min

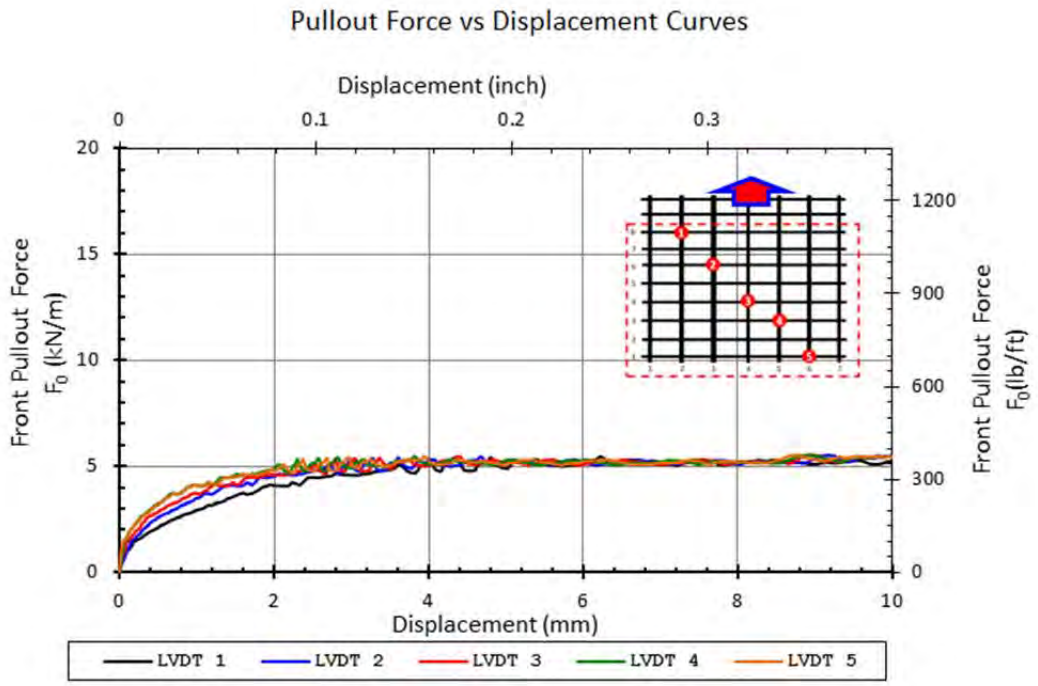
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

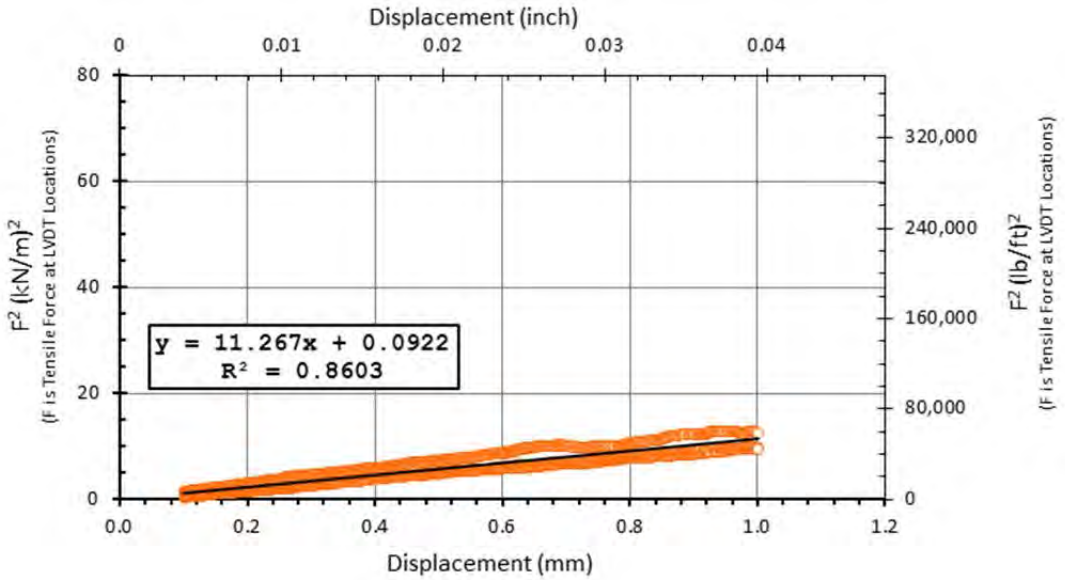
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.7	kN/m	392	lb/ft
Max Pullout Load	P_{max}	1.57	kN	392	lb
Max Shear Stress	τ_{max}	21.1	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
11.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/6/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	7	0.915	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	27.2	1.072
2	68.2	2.687
3	107.6	4.235
4	146.7	5.774
5	226.0	8.896

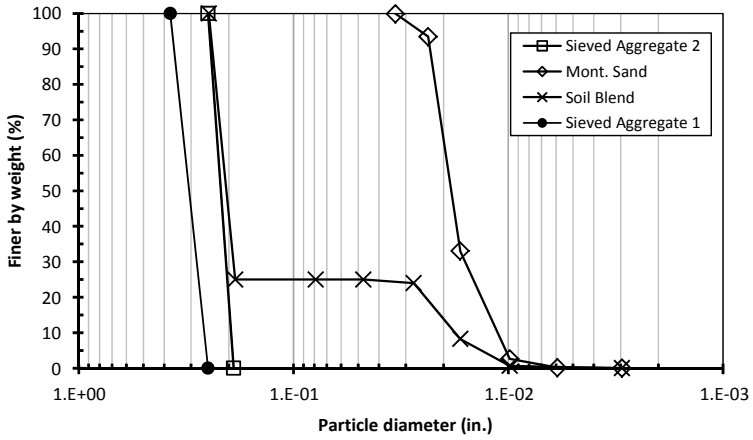
Pullout Rate	
1.0 mm/min.	0.04 in/min

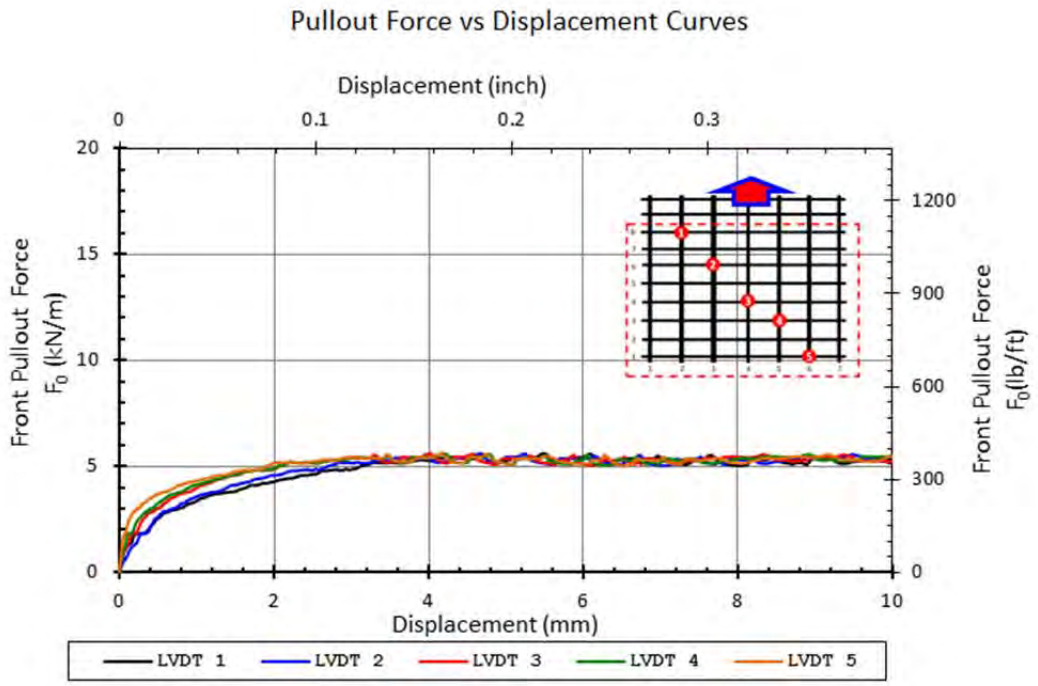
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

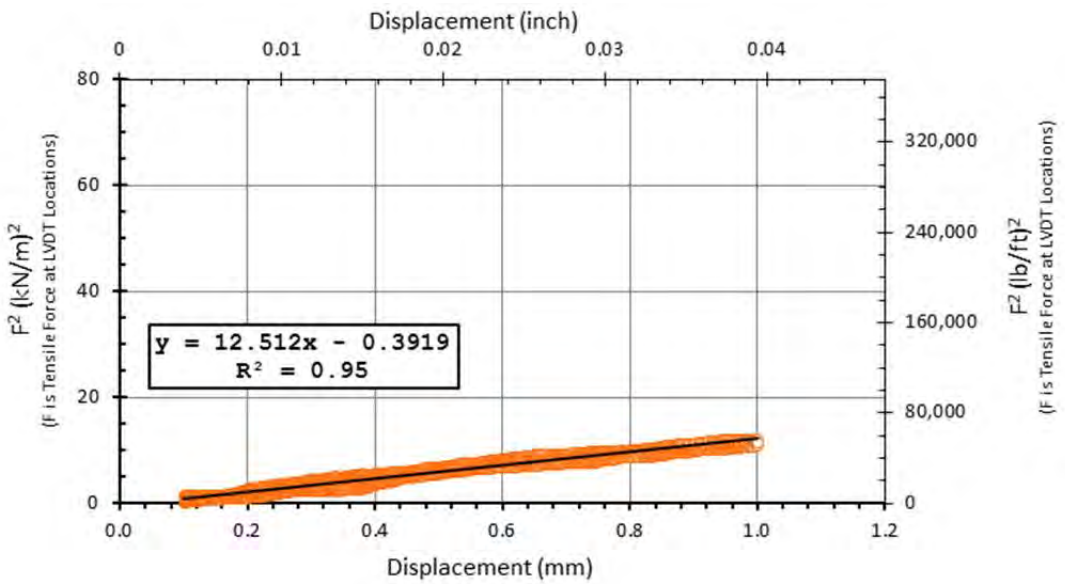
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.6	kN/m	384	lb/ft
Max Pullout Load	P_{max}	1.54	kN	391	lb
Max Shear Stress	τ_{max}	20.7	kPa	3.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
12.5	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/8/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.275	m	0.245	m
	7	0.909	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	25.0	0.985
2	63.6	2.503
3	103.3	4.067
4	146.3	5.761
5	224.5	8.838

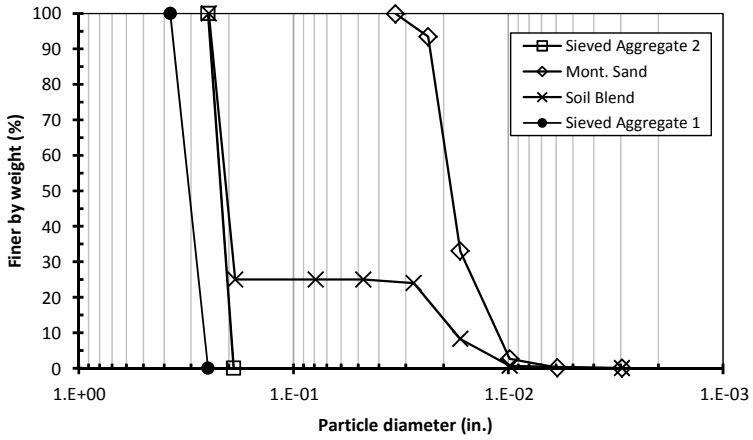
Pullout Rate	
1.0 mm/min.	0.04 in/min

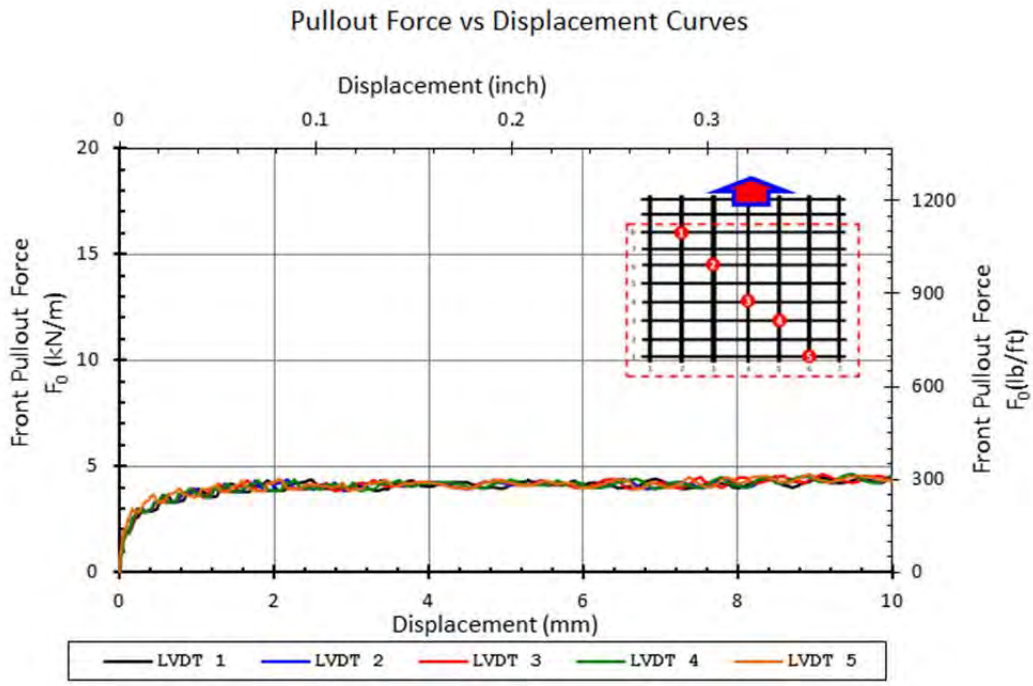
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

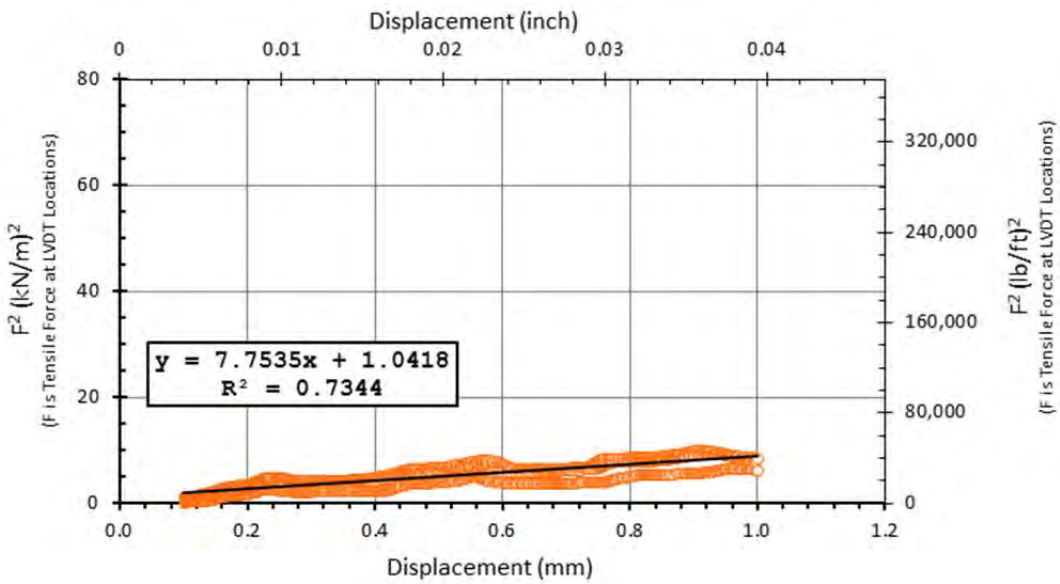
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.7	kN/m	323	lb/ft
Max Pullout Load	P_{max}	1.30	kN	330	lb
Max Shear Stress	τ_{max}	17.4	kPa	2.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}	
7.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Restarted test. Load cell was reading constant null value.

SMALL PULLOUT TEST

Date test conducted	11/12/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP5

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	7	0.912	ft	0.901	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	29.5	1.161
2	69.6	2.741
3	108.3	4.264
4	147.3	5.800
5	226.1	8.902

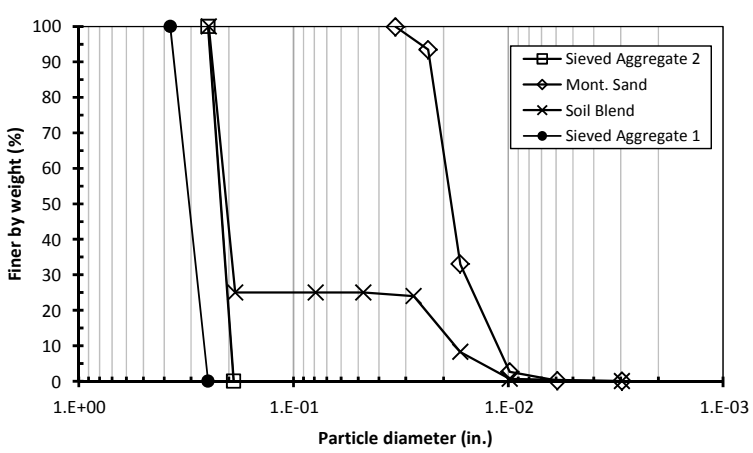
Pullout Rate	
1.0 mm/min.	0.04 in/min

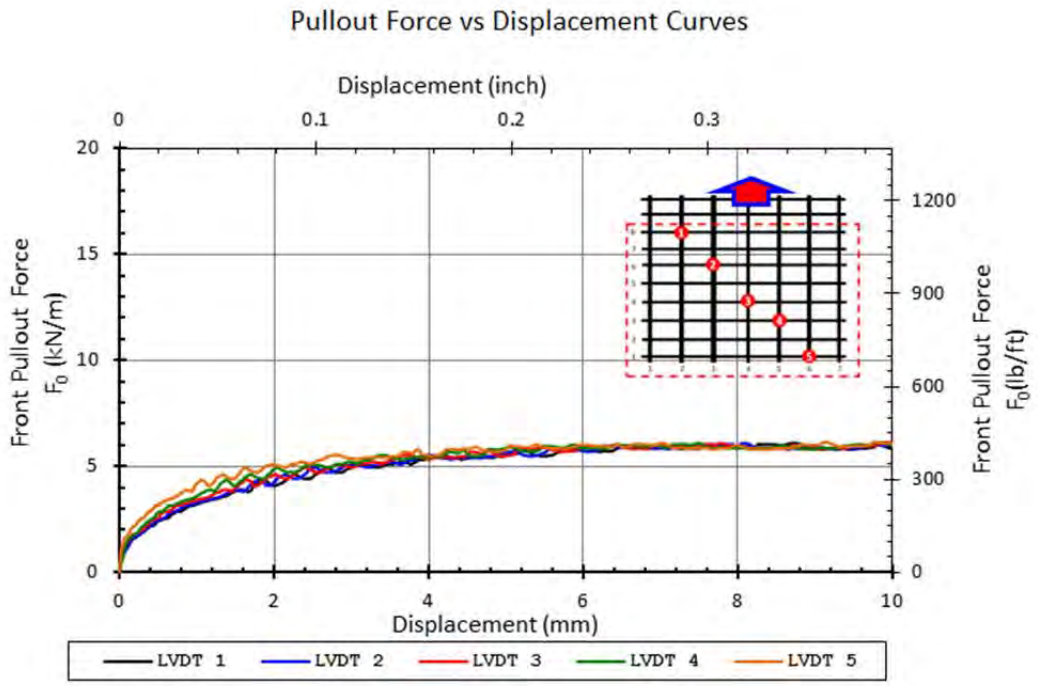
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.573 g/cm^3	**98 pcf**

Note: particle size distribution curve shown below

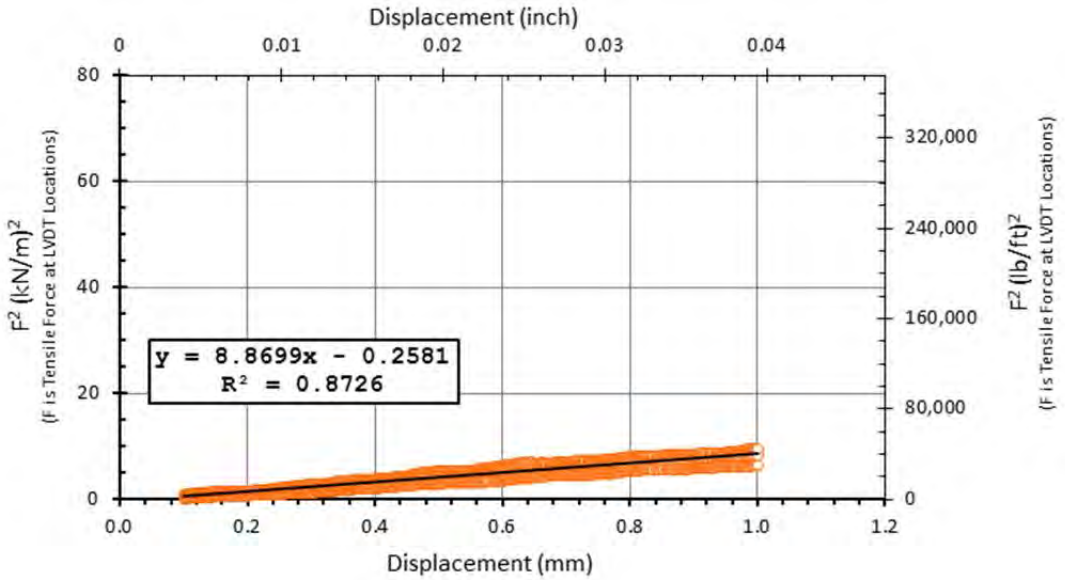
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	422	lb/ft
Max Pullout Load	P_{max}	1.69	kN	413	lb
Max Shear Stress	τ_{max}	22.7	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.9	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/13/2012 AM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.282	m	0.245	m
	9	0.919	ft	0.927	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	12.9	0.507
2	76.0	2.990
3	107.3	4.225
4	137.5	5.413
5	229.9	9.053

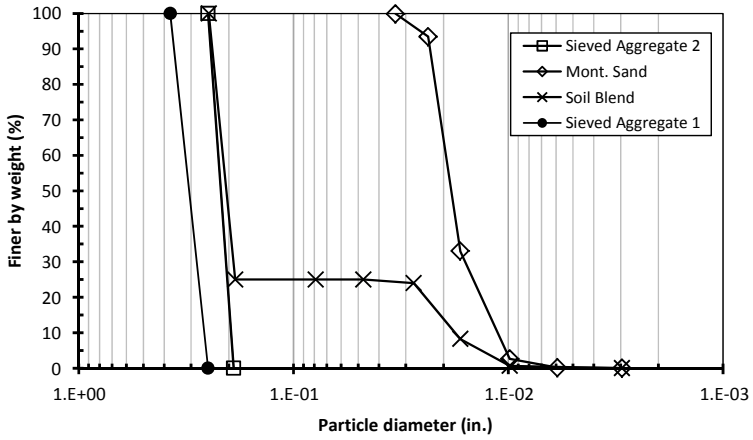
Pullout Rate	
1.0 mm/min.	0.04 in/min

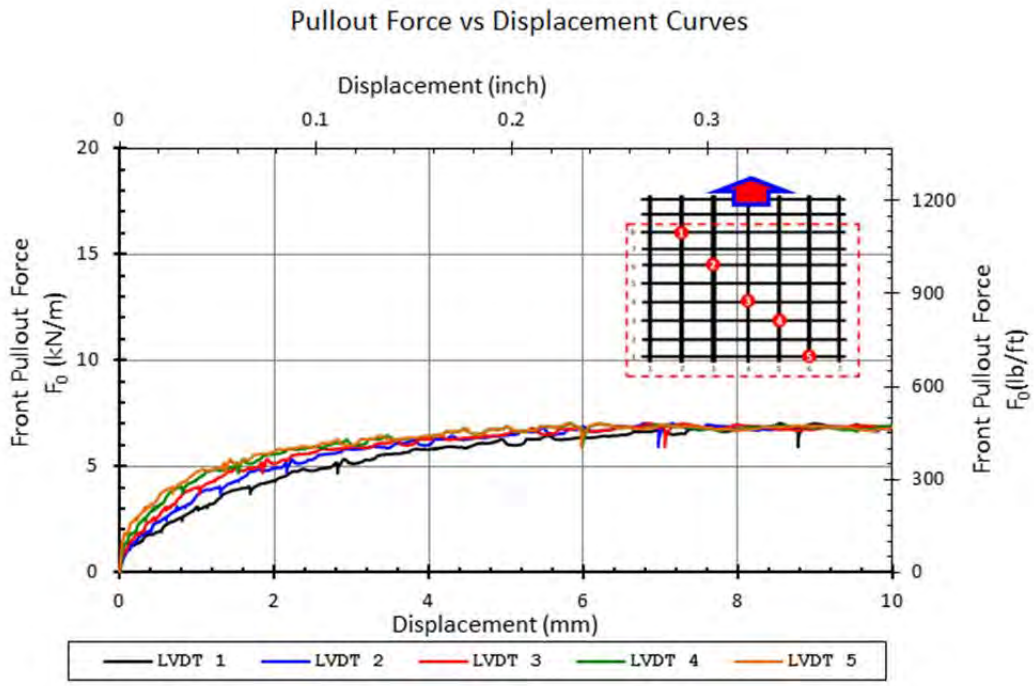
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

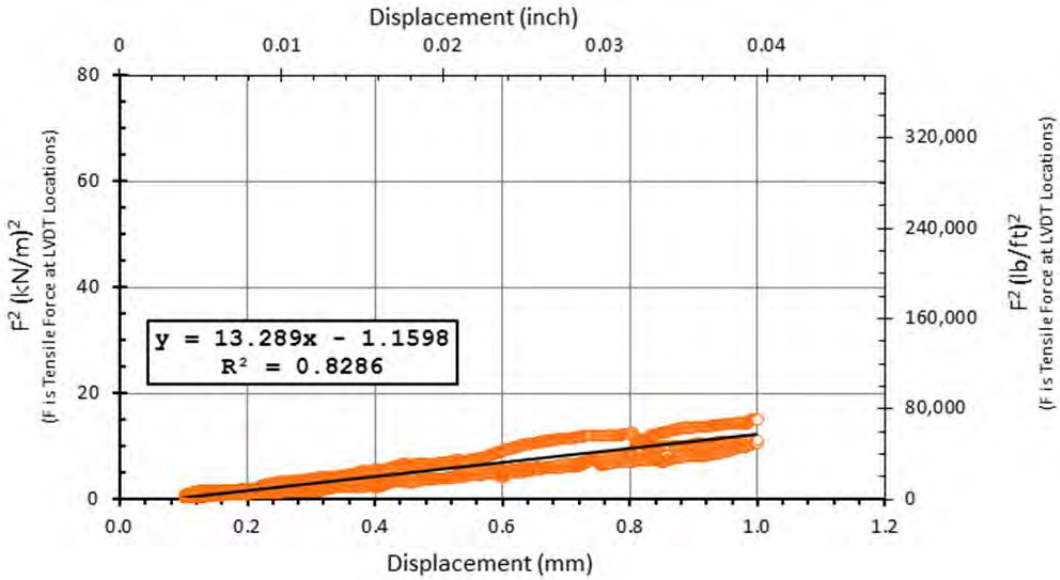
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	482	lb/ft
Max Pullout Load	P_{max}	1.99	kN	484	lb
Max Shear Stress	τ_{max}	26.7	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
13.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 5 slightly to the right

SMALL PULLOUT TEST

Date test conducted	11/13/2012 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.282	m	0.245	m
	9	0.922	ft	0.927	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	11.4	0.449
2	74.8	2.945
3	105.6	4.157
4	136.4	5.371
5	229.9	9.049

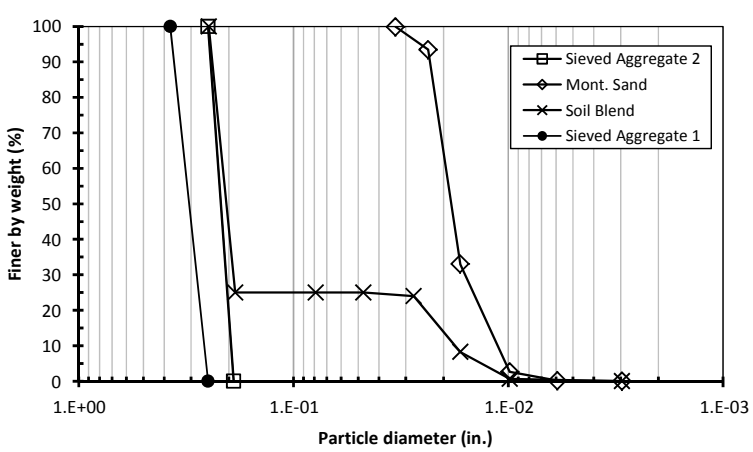
Pullout Rate	
1.0 mm/min.	0.04 in/min

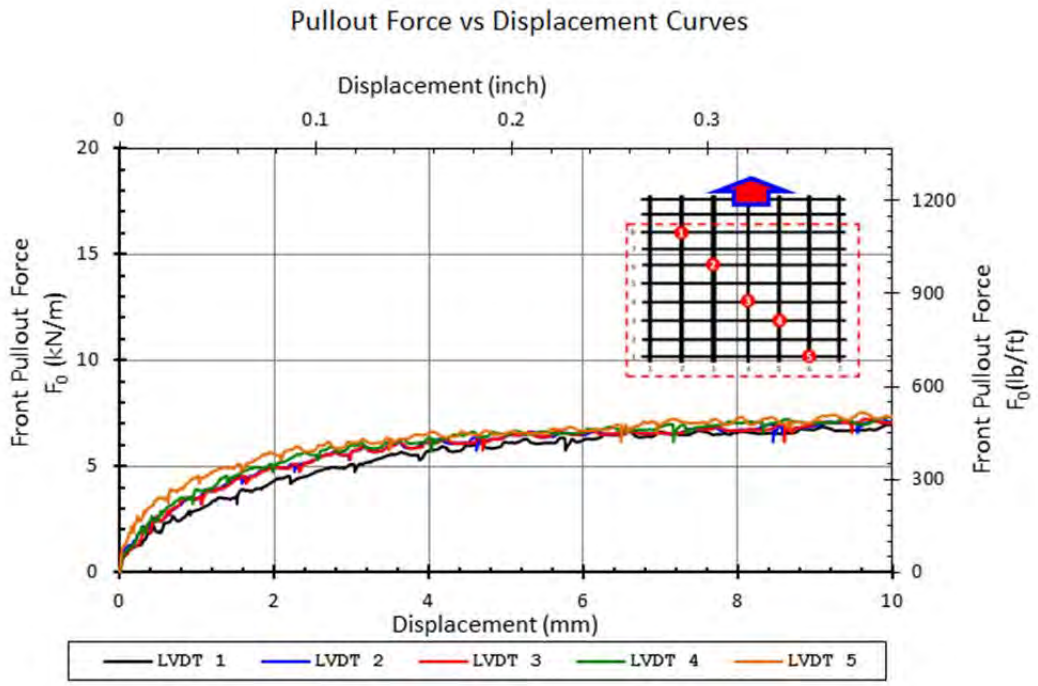
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

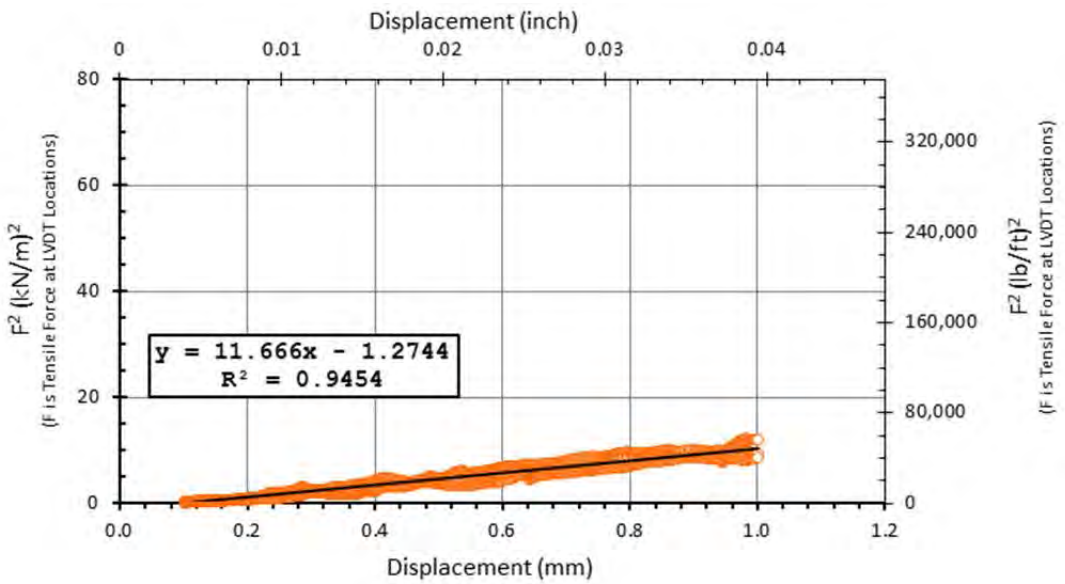
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	518	lb/ft
Max Pullout Load	P_{max}	2.14	kN	521	lb
Max Shear Stress	τ_{max}	28.7	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
11.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/15/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.282	m	0.245	m
	9	0.922	ft	0.927	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	9.5	0.374
2	72.6	2.859
3	103.8	4.085
4	135.6	5.339
5	229.4	9.031

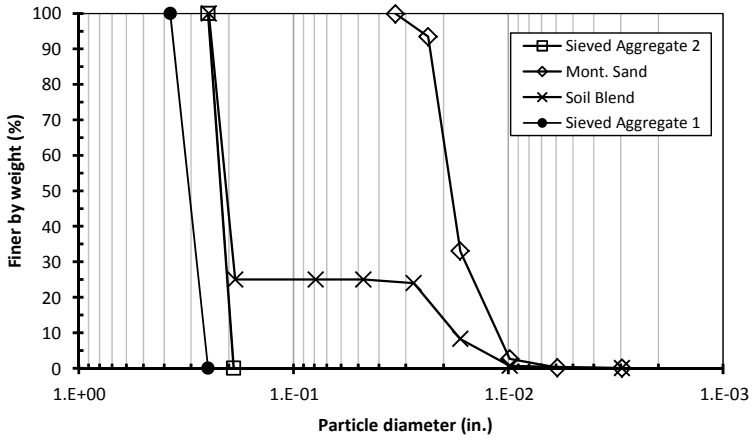
Pullout Rate	
1.0 mm/min.	0.04 in/min

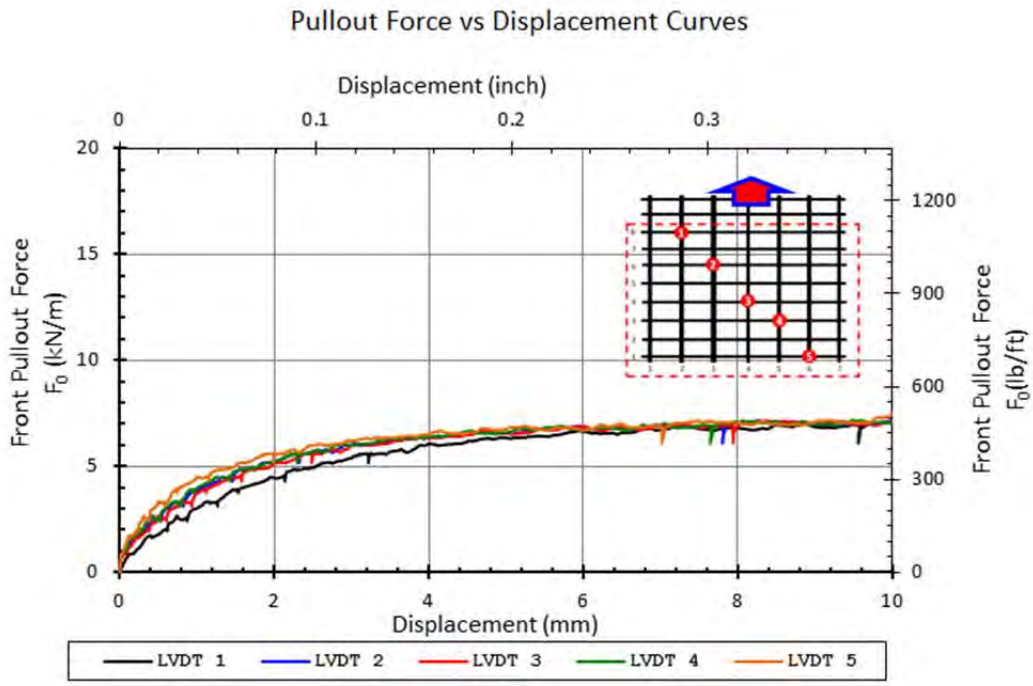
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

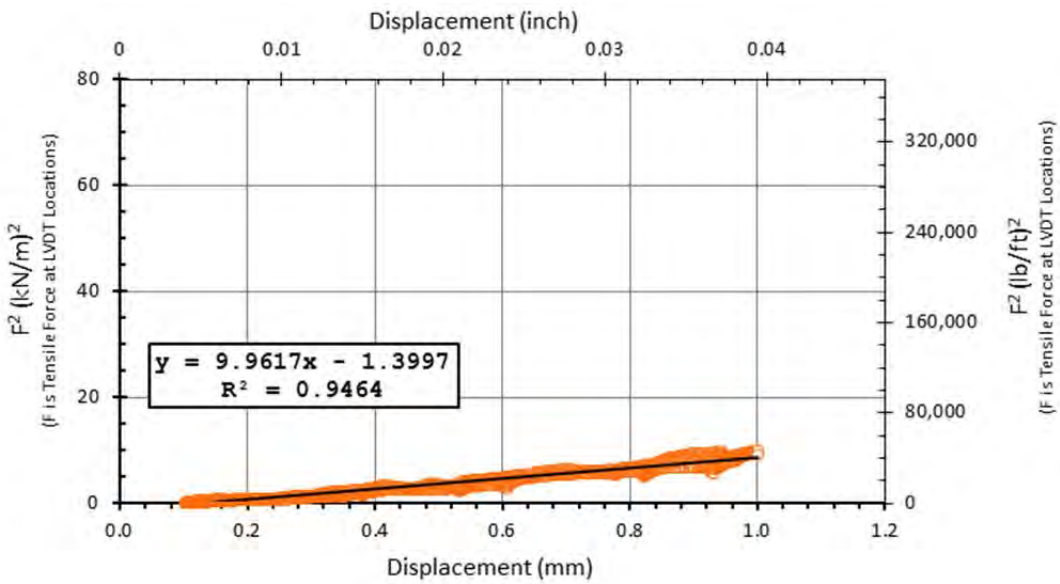
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.0	kN/m	546	lb/ft
Max Pullout Load	P_{max}	2.25	kN	536	lb
Max Shear Stress	τ_{max}	30.3	kPa	4.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
10.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/16/2012
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.282	m	0.245	m
	9	0.919	ft	0.927	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	13.2	0.519
2	76.3	3.004
3	106.7	4.201
4	138.6	5.455
5	232.2	9.141

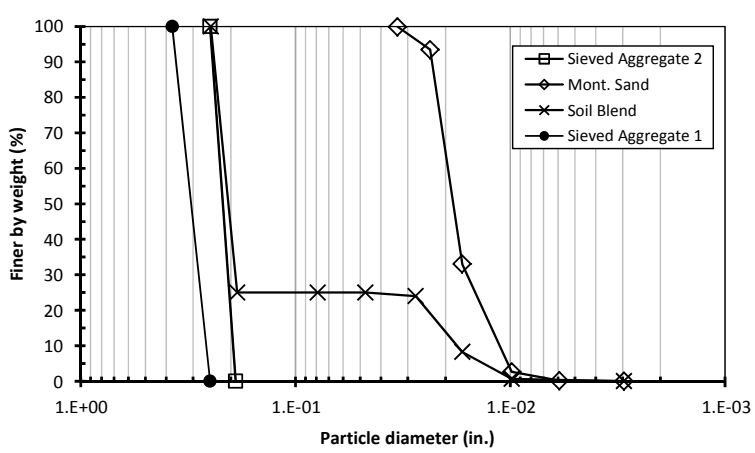
Pullout Rate	
1.0 mm/min.	0.04 in/min

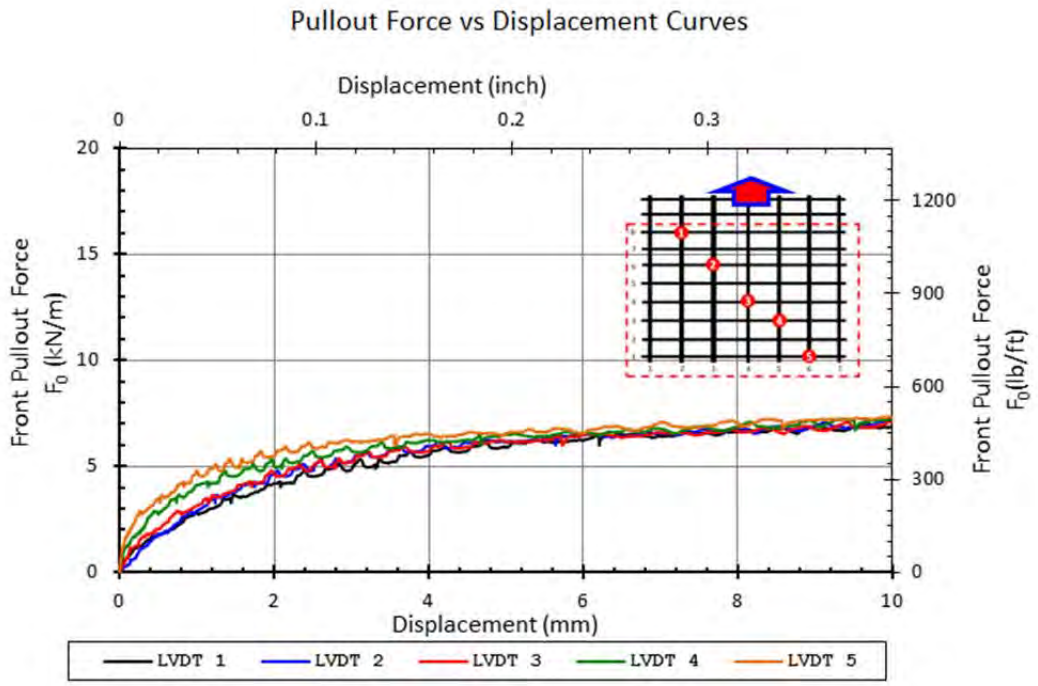
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

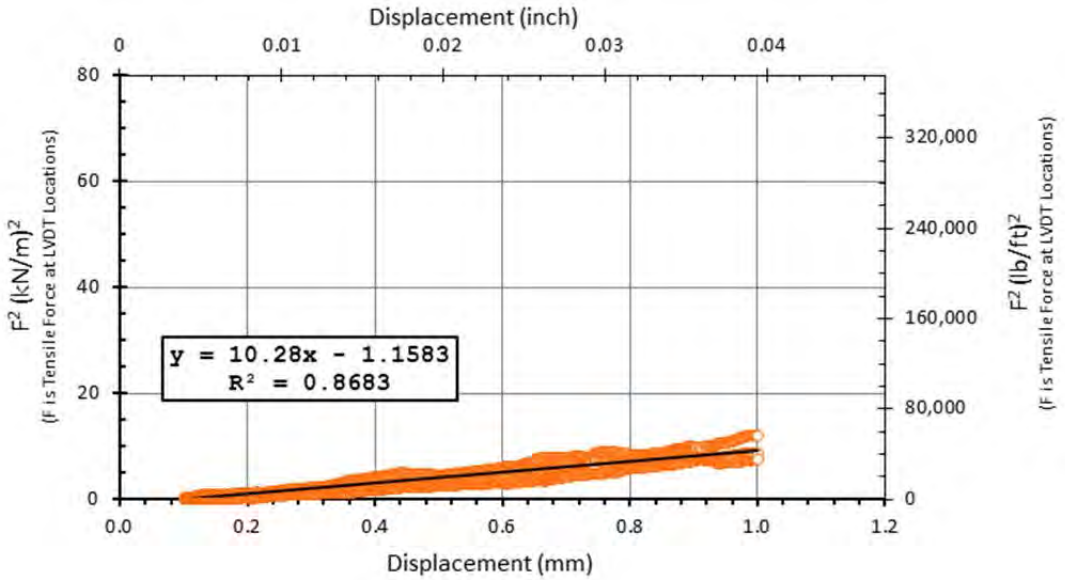
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	515	lb/ft
Max Pullout Load	P_{max}	2.13	kN	525	lb
Max Shear Stress	τ_{max}	28.6	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
10.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/19/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.282	m	0.245	m
	9	0.919	ft	0.927	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	10.6	0.416
2	72.9	2.868
3	104.8	4.125
4	135.7	5.342
5	228.3	8.986

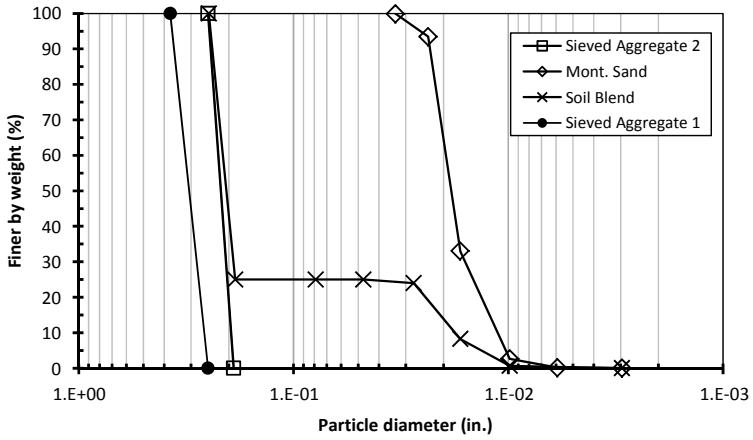
Pullout Rate	
1.0 mm/min.	0.04 in/min

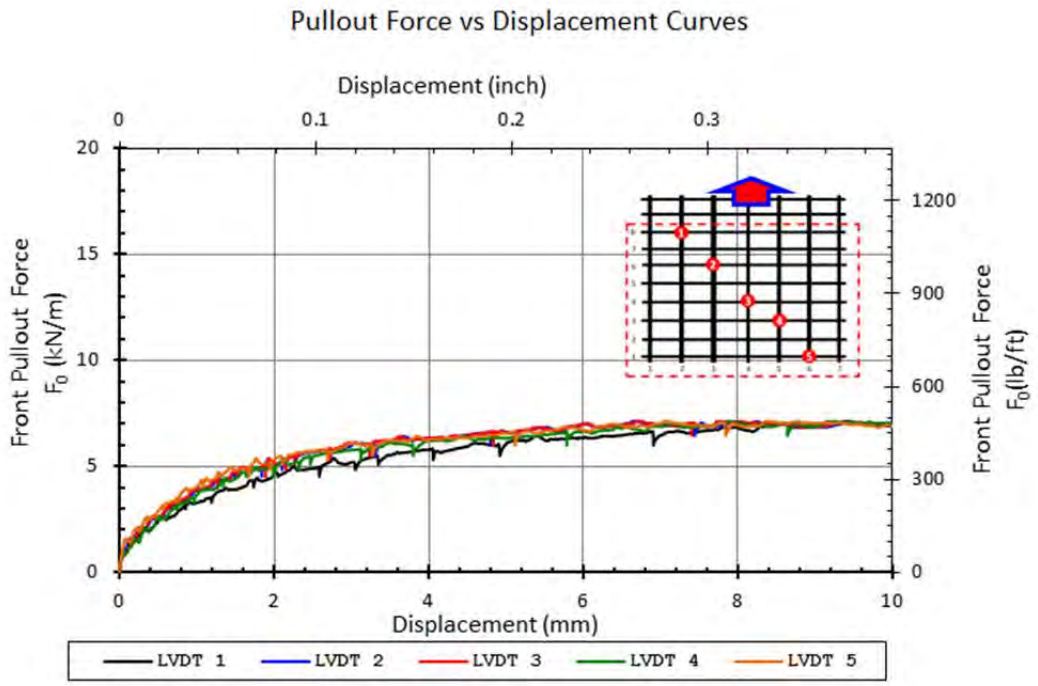
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.582 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

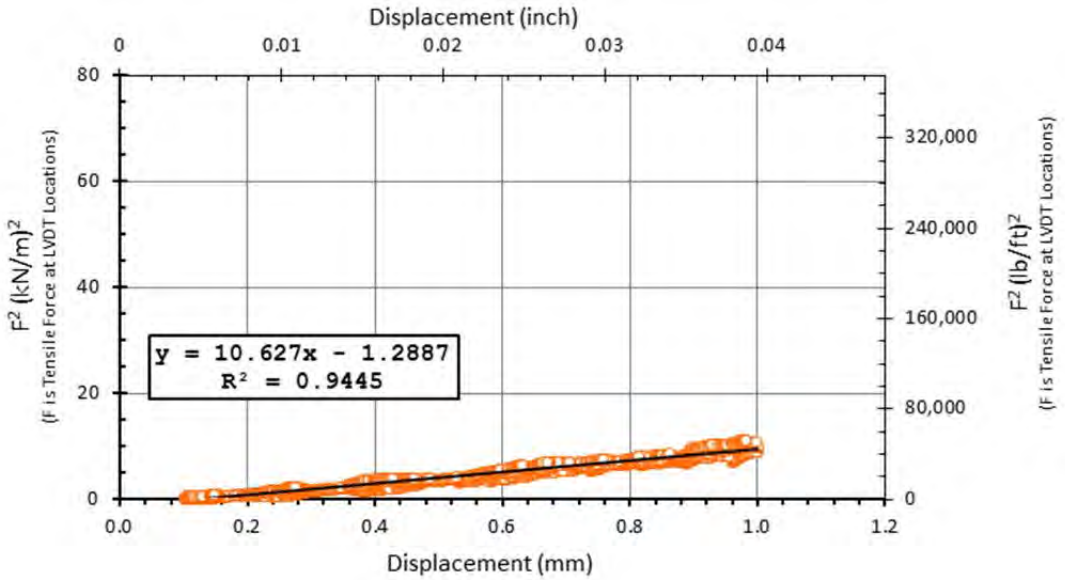
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	497	lb/ft
Max Pullout Load	P_{max}	2.05	kN	492	lb
Max Shear Stress	τ_{max}	27.5	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
10.6	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/26/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.280	m	0.245	m
	7	0.902	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	25.8	1.016
2	95.3	3.752
3	117.9	4.642
4	163.8	6.449
5	232.1	9.138

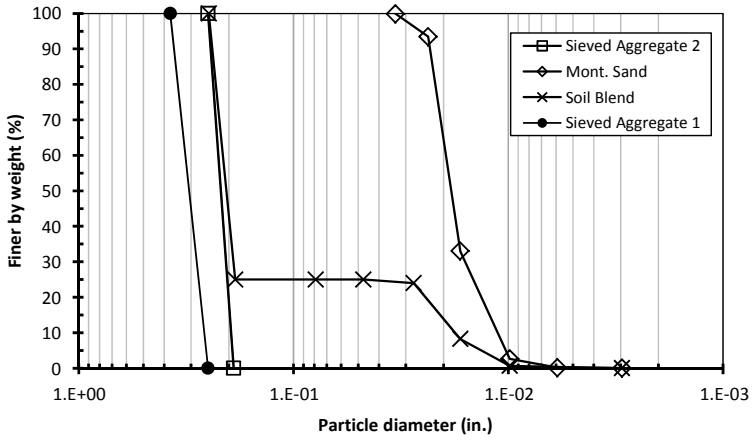
Pullout Rate	
1.0 mm/min.	0.04 in/min

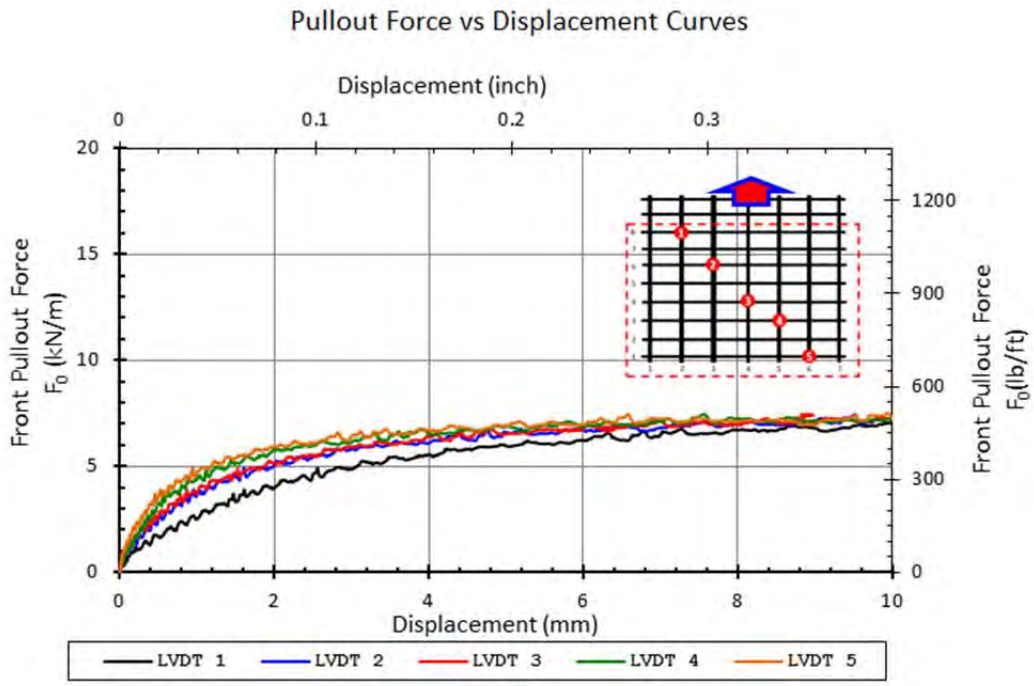
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.587 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

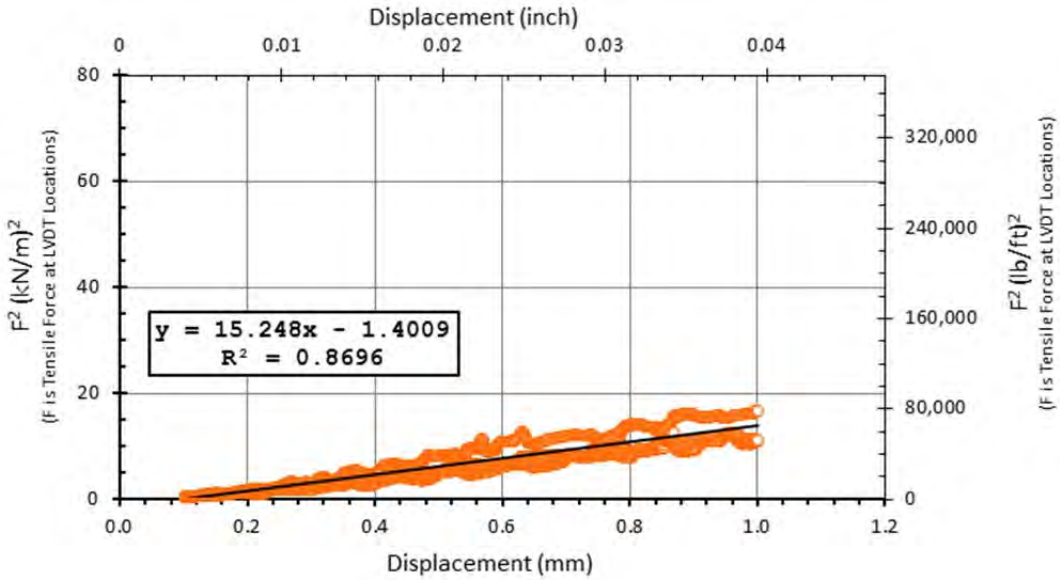
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.2	kN/m	559	lb/ft
Max Pullout Load	P_{max}	2.29	kN	511	lb
Max Shear Stress	τ_{max}	30.7	kPa	4.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
15.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT # 1 and 5 off slightly to the left

SMALL PULLOUT TEST

Date test conducted	11/27/12 AM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.280	m	0.245	m
	7	0.902	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	14.7	0.577
2	83.4	3.281
3	107.5	4.231
4	155.2	6.109
5	230.3	9.067

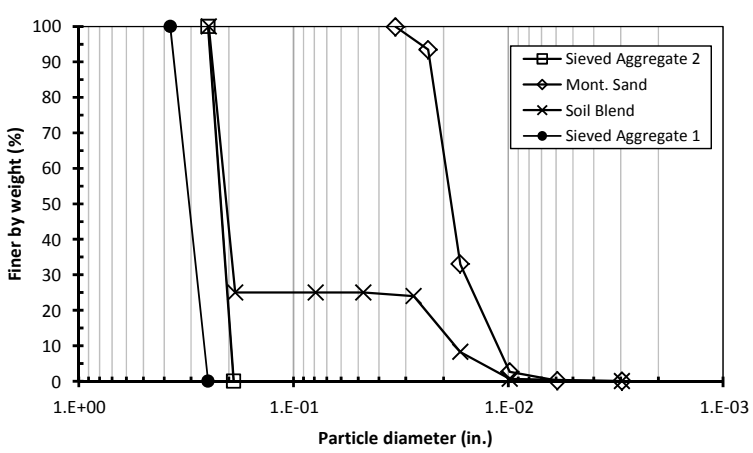
Pullout Rate	
1.0 mm/min.	0.04 in/min

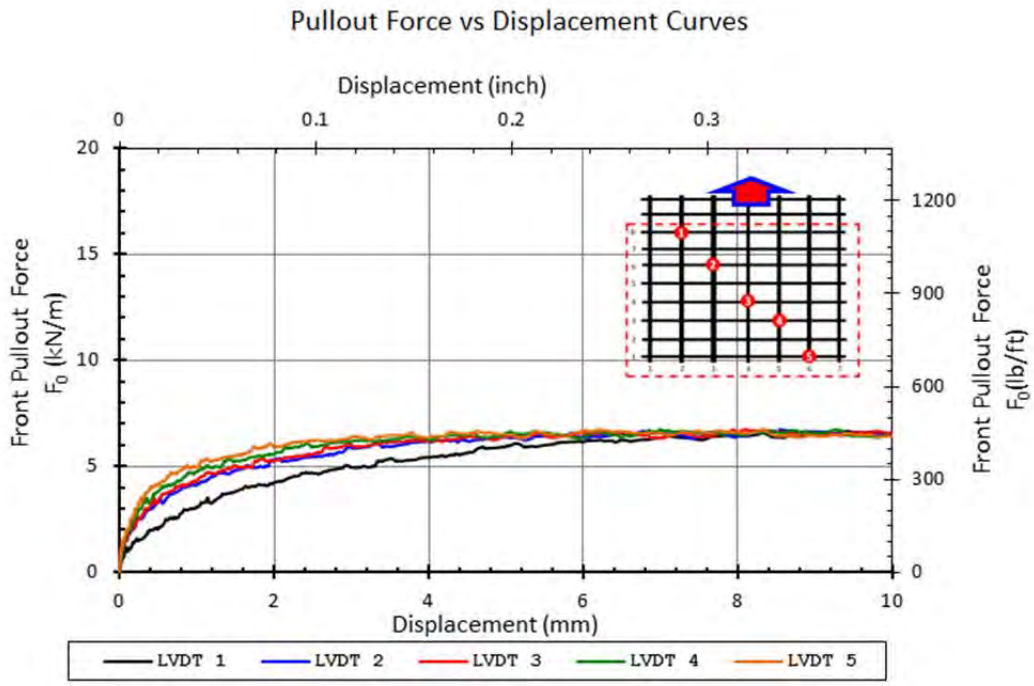
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

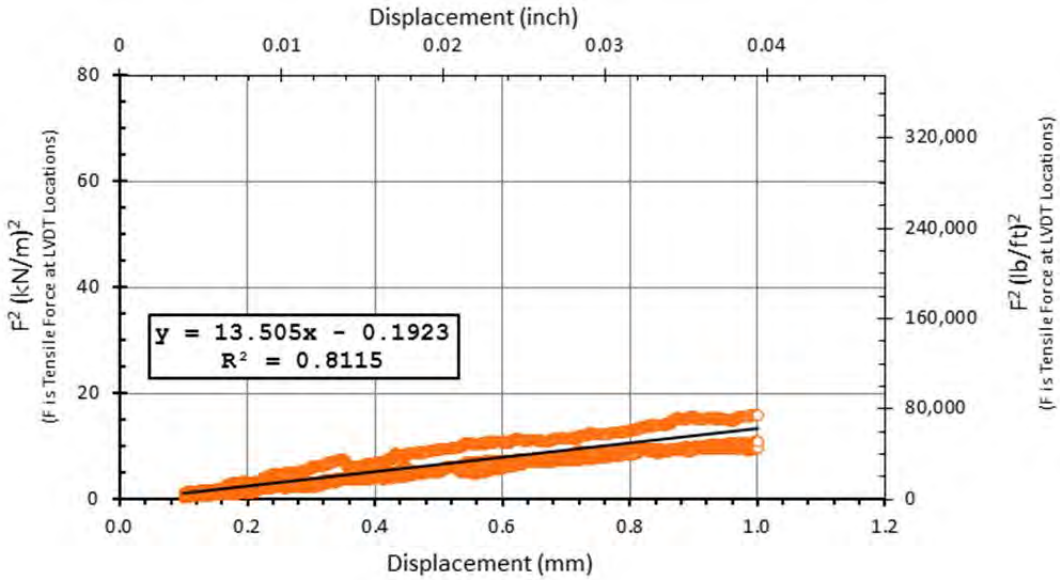
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.7	kN/m	461	lb/ft
Max Pullout Load	P_{max}	1.89	kN	452	lb
Max Shear Stress	τ_{max}	25.4	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
13.5	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 1 slightly to the left

SMALL PULLOUT TEST

Date test conducted	11/27/12 PM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.271	m	0.280	m	0.245	m
	7	0.889	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	15.3	0.602
2	86.4	3.400
3	111.6	4.394
4	160.5	6.320
5	231.8	9.128

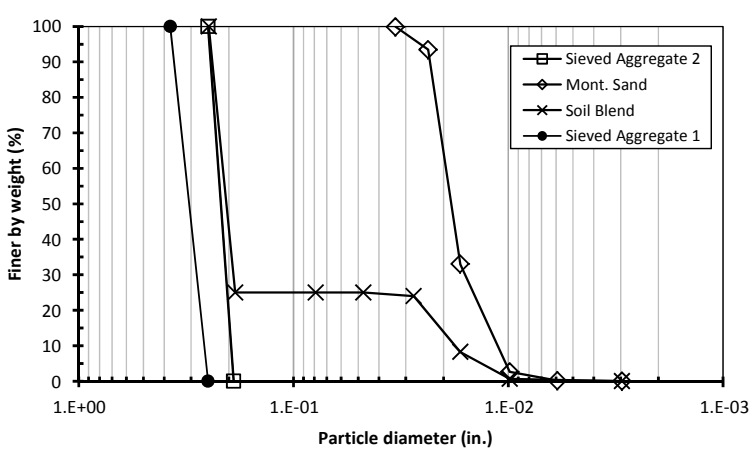
Pullout Rate	
1.0 mm/min.	0.04 in/min

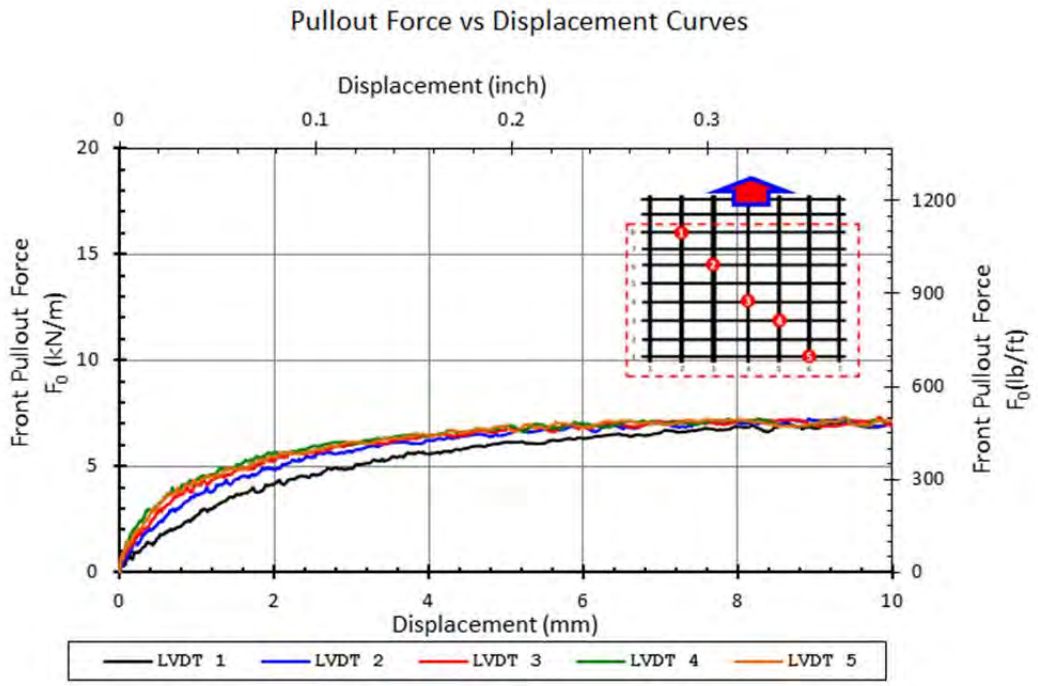
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

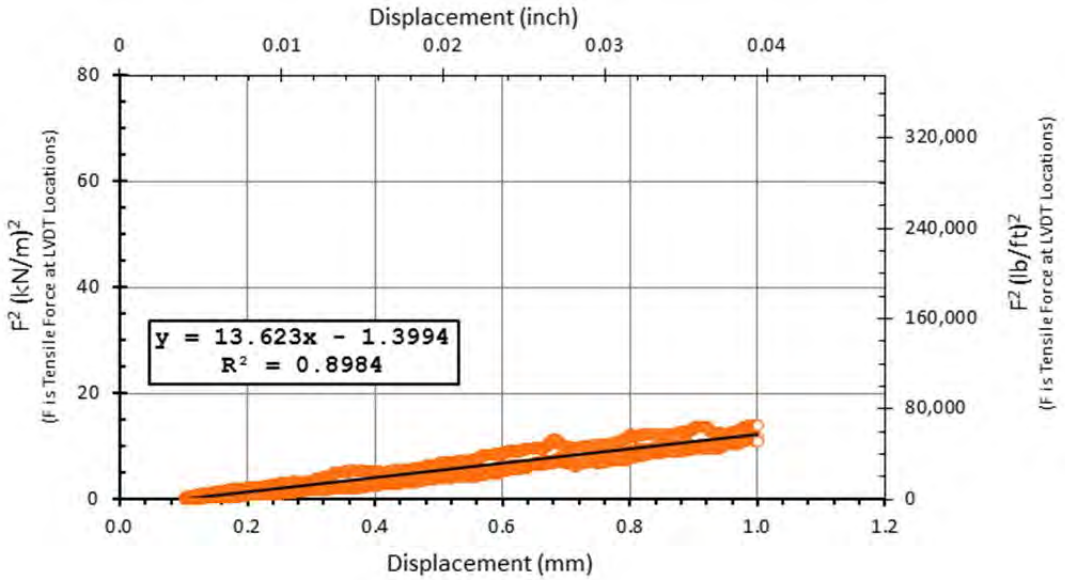
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	506	lb/ft
Max Pullout Load	P_{max}	2.07	kN	493	lb
Max Shear Stress	τ_{max}	27.8	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
13.6	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT #1 off to the left

SMALL PULLOUT TEST

Date test conducted	11/28/12 AM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.280	m	0.245	m
	7	0.902	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	26.3	1.036
2	94.8	3.732
3	117.4	4.623
4	162.3	6.388
5	230.7	9.081

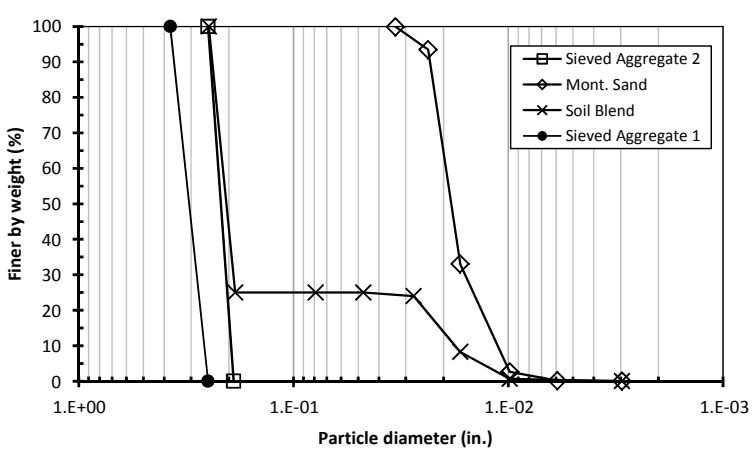
Pullout Rate	
1.0 mm/min.	0.04 in/min

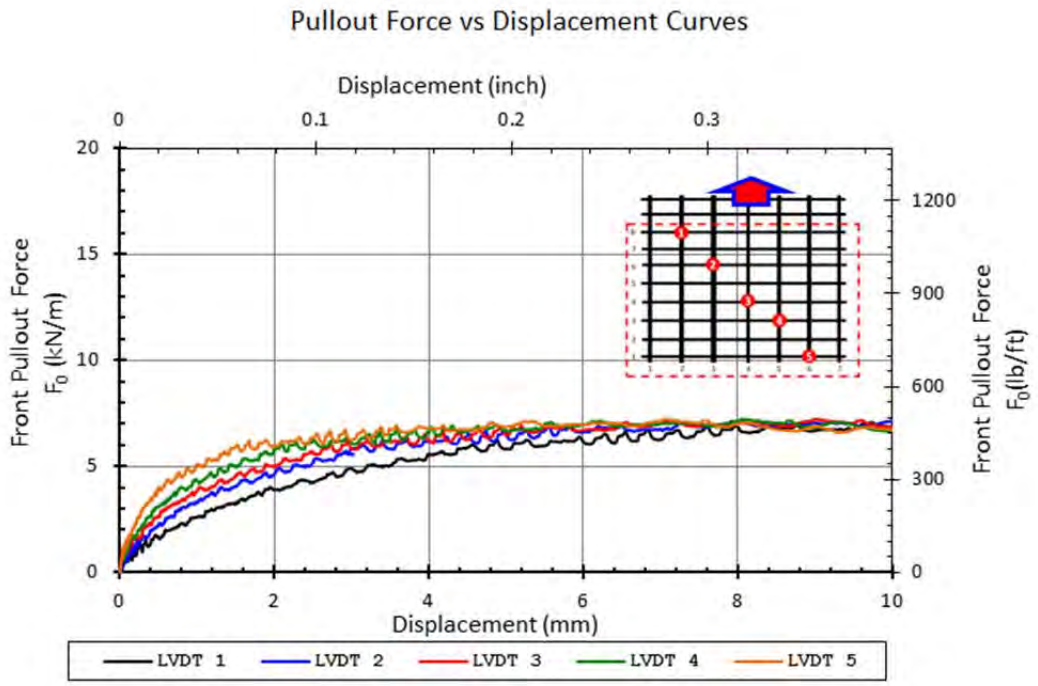
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.581 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

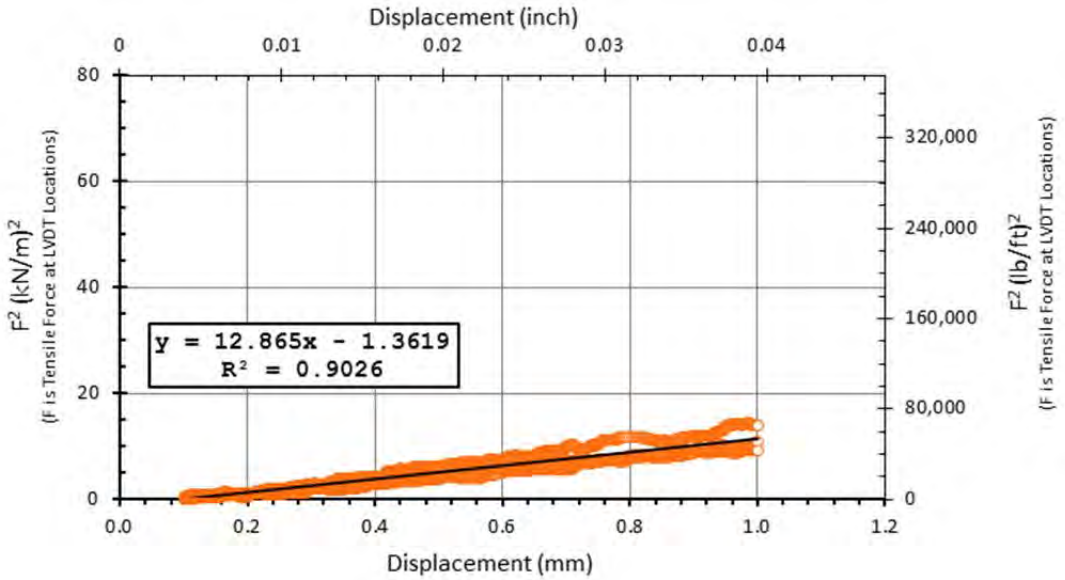
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	495	lb/ft
Max Pullout Load	P_{max}	2.02	kN	493	lb
Max Shear Stress	τ_{max}	27.2	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
12.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/28/12 PM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.274	m	0.280	m	0.245	m
	7	0.899	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	26.6	1.048
2	94.5	3.720
3	116.5	4.588
4	161.0	6.339
5	230.6	9.079

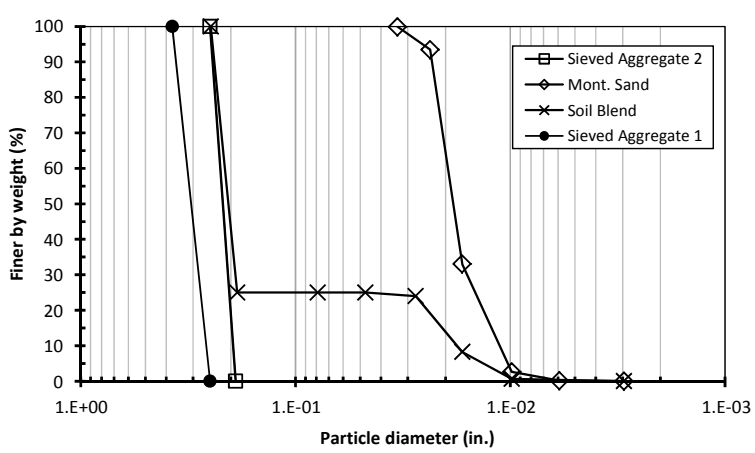
Pullout Rate	
1.0 mm/min.	0.04 in/min

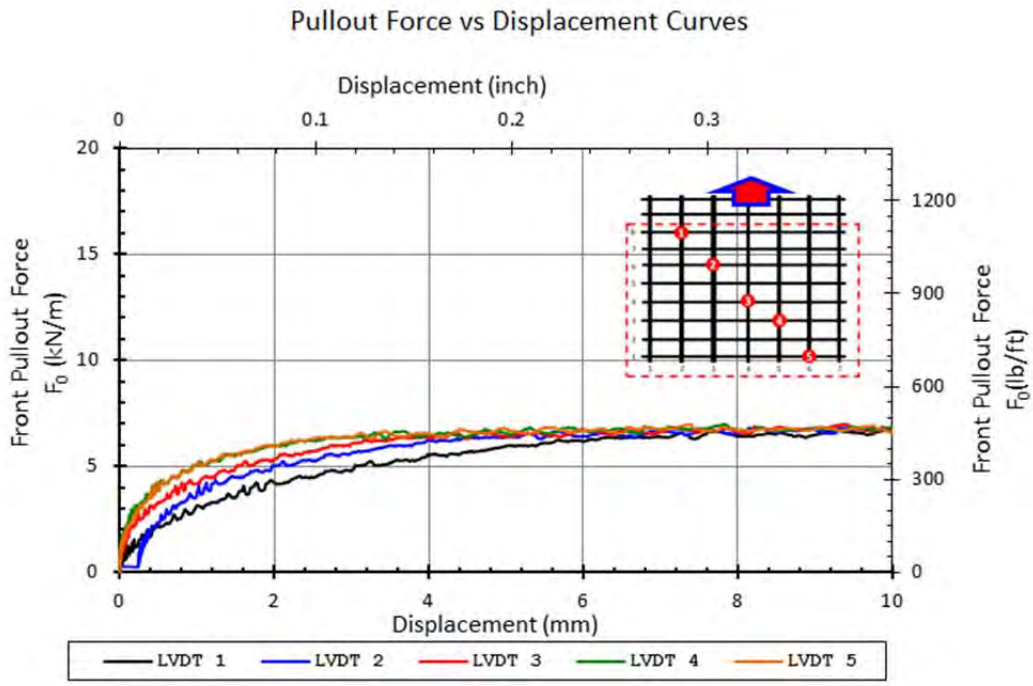
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

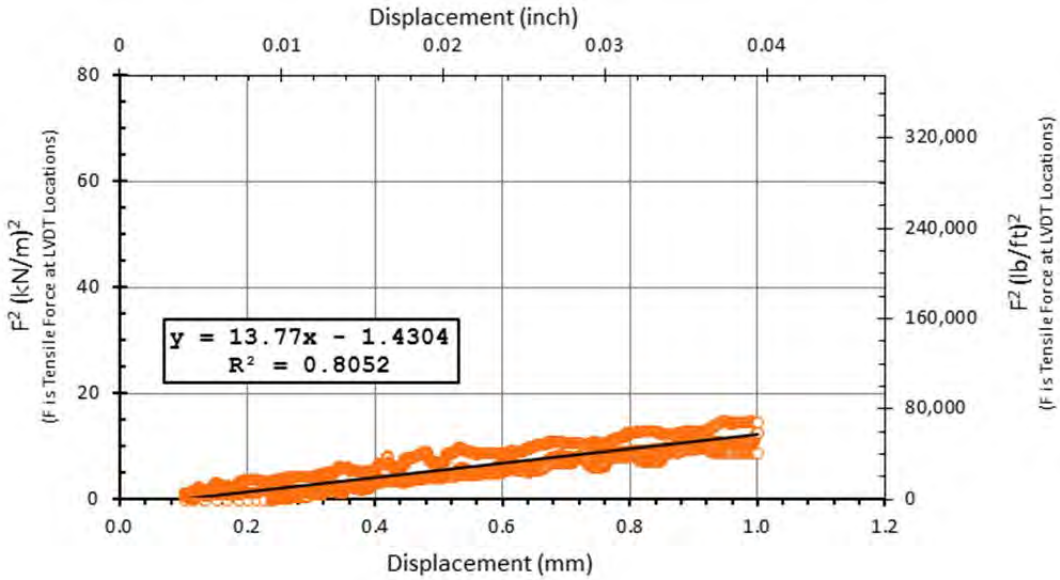
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	478	lb/ft
Max Pullout Load	P_{max}	1.96	kN	455	lb
Max Shear Stress	τ_{max}	26.3	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
13.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 1 to the left

SMALL PULLOUT TEST

Date test conducted	11/29/2012 AM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.273	m	0.260	m	0.245	m
	8	0.896	ft	0.853	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	-3.3	-0.130
2	94.9	3.736
3	135.3	5.327
4	174.1	6.854
5	231.9	9.130

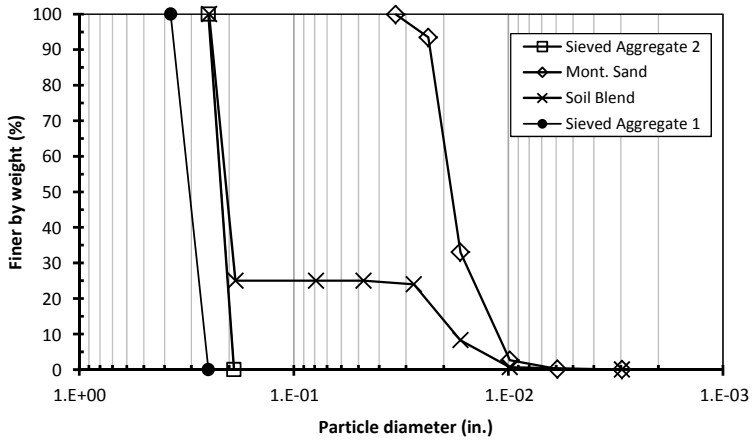
Pullout Rate	
1.0 mm/min.	0.04 in/min

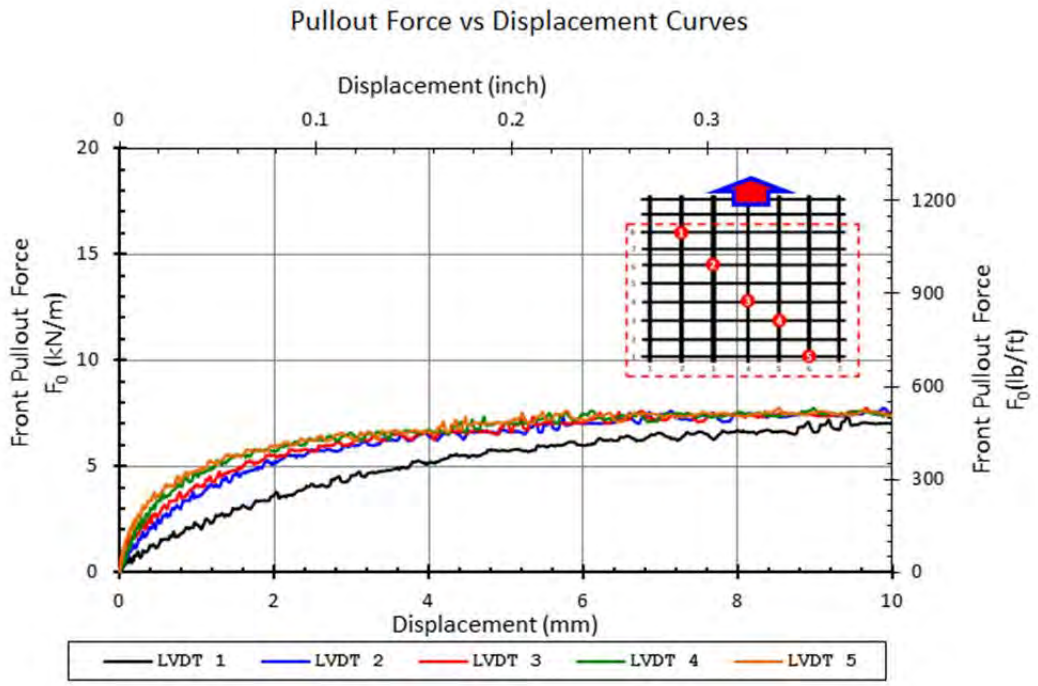
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

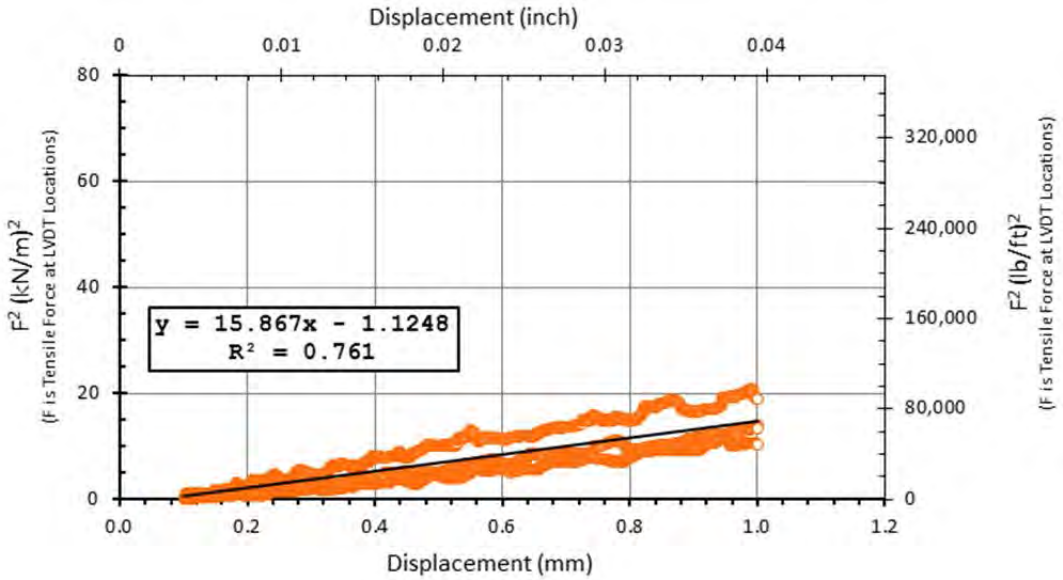
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.9	kN/m	542	lb/ft
Max Pullout Load	P_{max}	2.06	kN	487	lb
Max Shear Stress	τ_{max}	27.6	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
15.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/29/2012 PM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.273	m	0.260	m	0.245	m
	8	0.896	ft	0.853	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	57.8	2.274
2	118.4	4.659
3	156.8	6.172
4	194.7	7.663
5	231.7	9.121

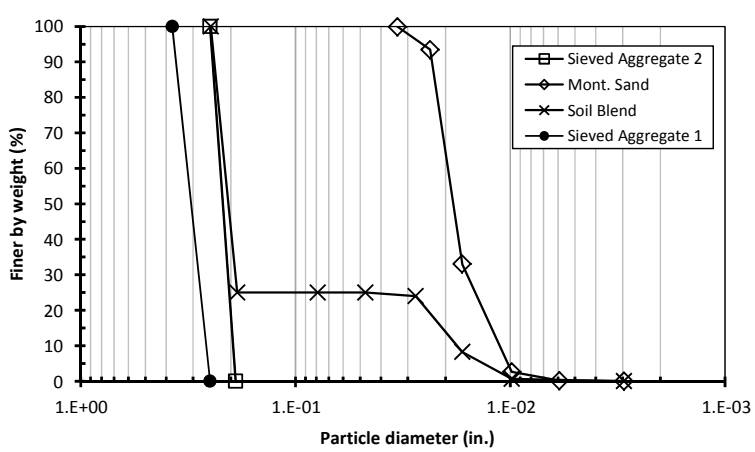
Pullout Rate	
1.0 mm/min.	0.04 in/min

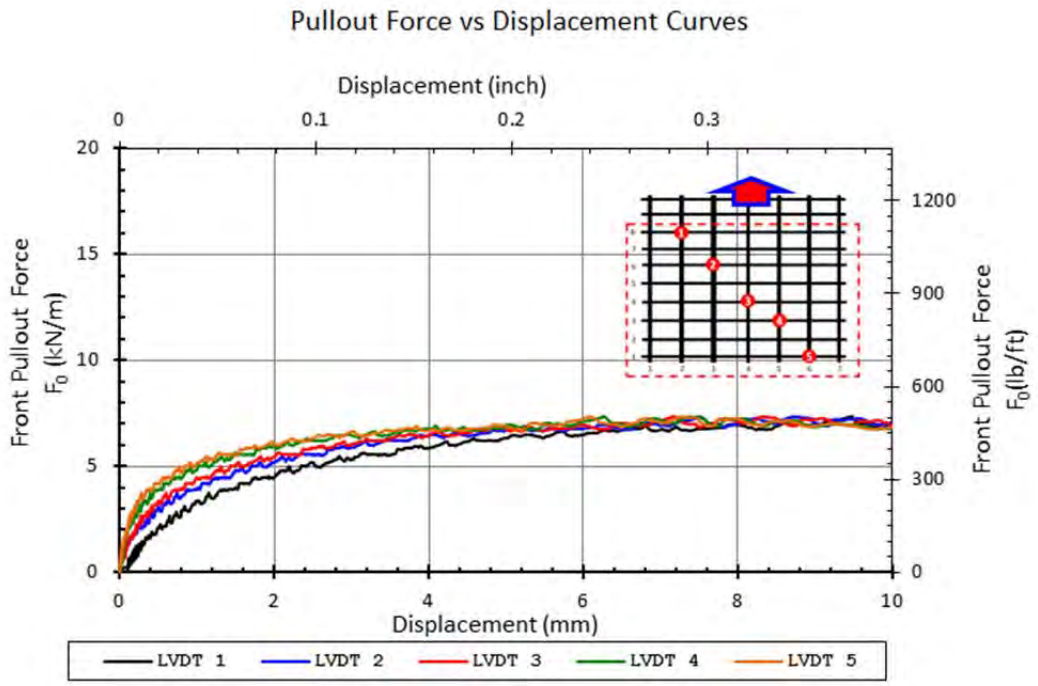
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

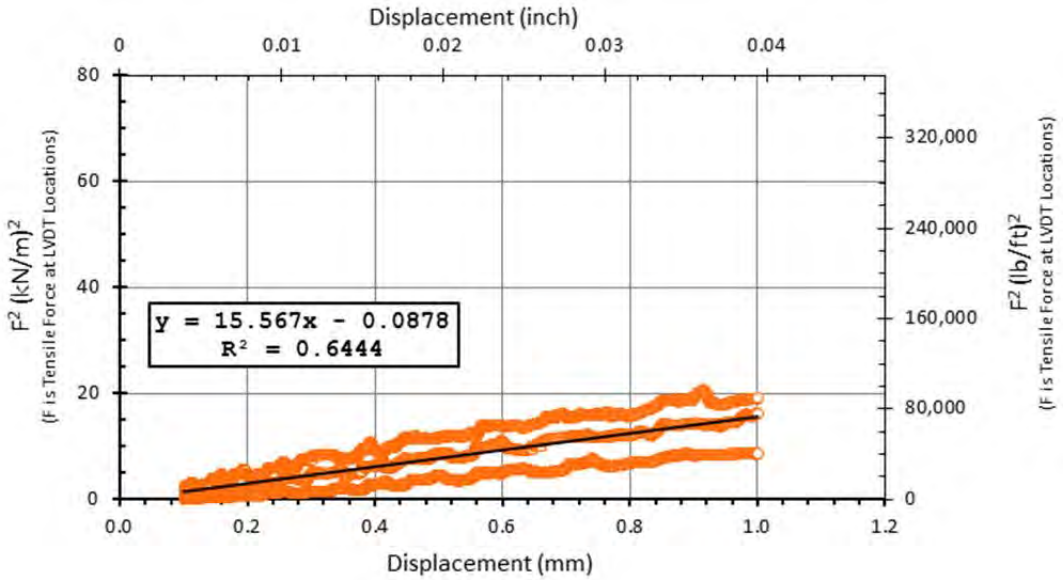
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	504	lb/ft
Max Pullout Load	P_{max}	1.91	kN	465	lb
Max Shear Stress	τ_{max}	25.7	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
15.6	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/3/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.276	m	0.260	m	0.245	m
	8	0.906	ft	0.853	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	34.2	1.347
2	92.9	3.657
3	133.2	5.244
4	171.5	6.752
5	230.4	9.071

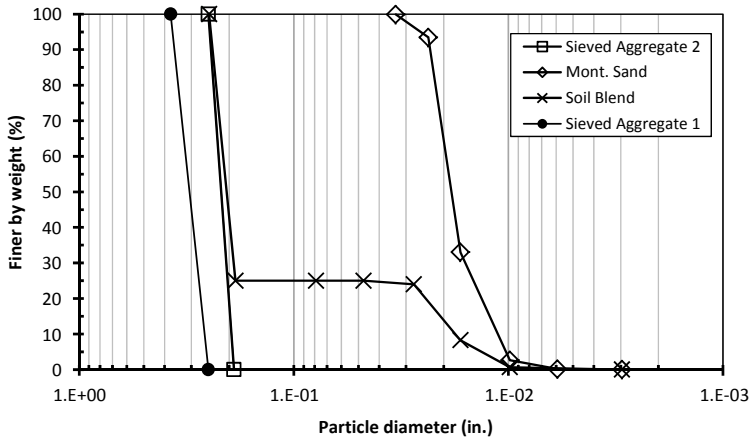
Pullout Rate	
1.0 mm/min.	0.04 in/min

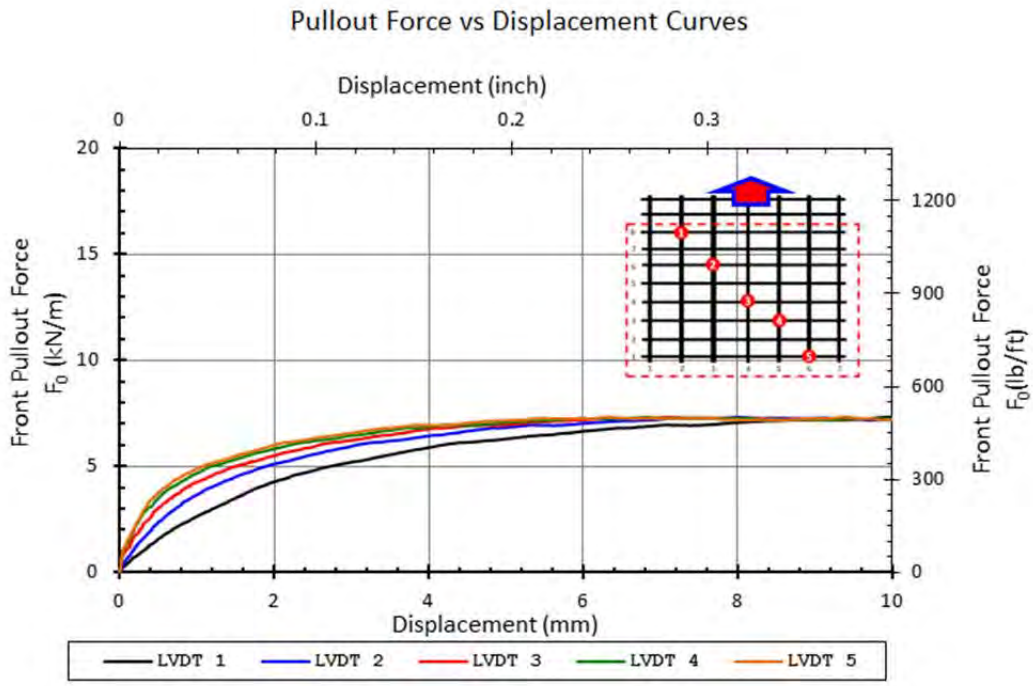
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

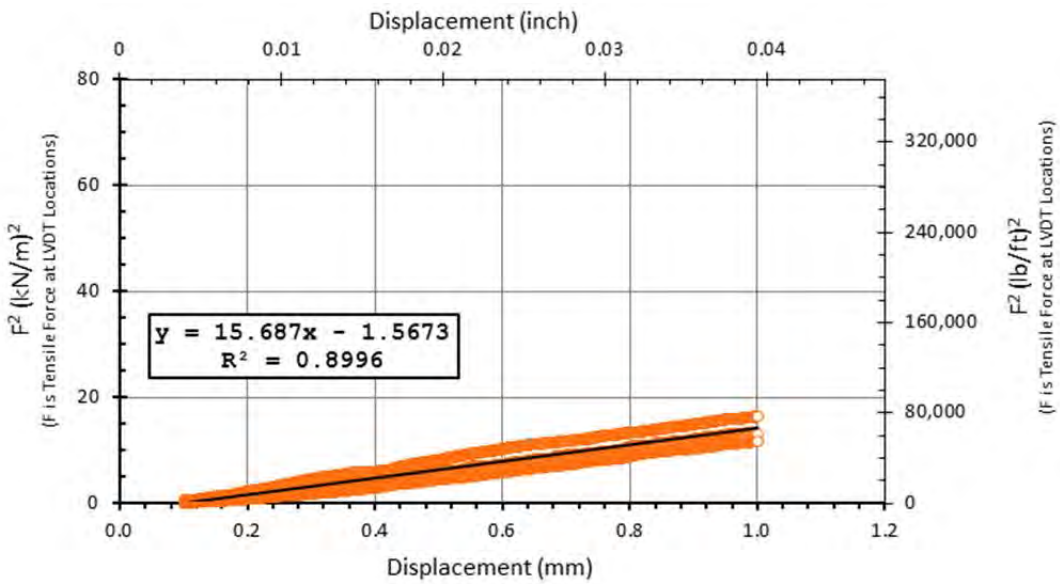
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	506	lb/ft
Max Pullout Load	P_{max}	1.92	kN	453	lb
Max Shear Stress	τ_{max}	25.8	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
15.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Grip slightly tilted to the left.

SMALL PULLOUT TEST

Date test conducted	12/4/2012 AM
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.272	m	0.302	m	0.245	m
	8	0.892	ft	0.990	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	37.0	1.455
2	95.3	3.752
3	132.4	5.213
4	173.6	6.835
5	233.3	9.185

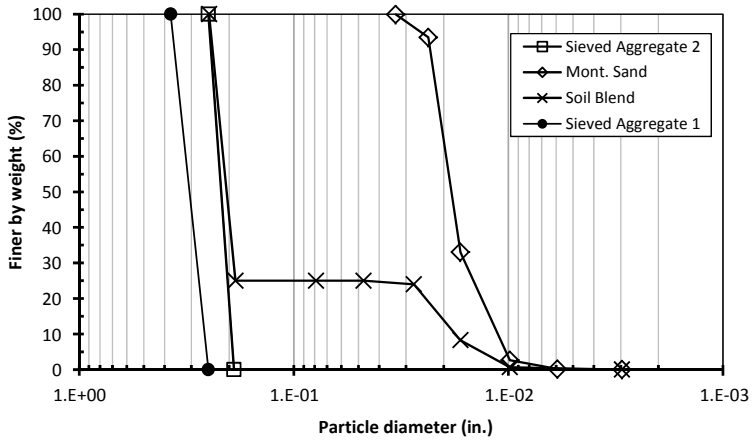
Pullout Rate	
1.0 mm/min.	0.04 in/min

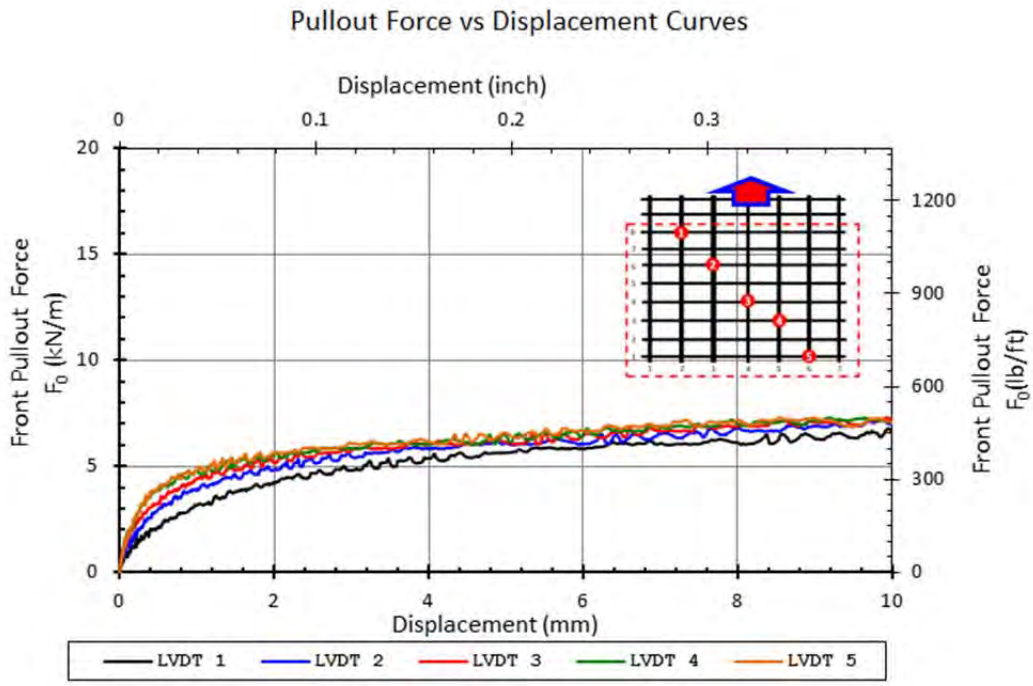
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

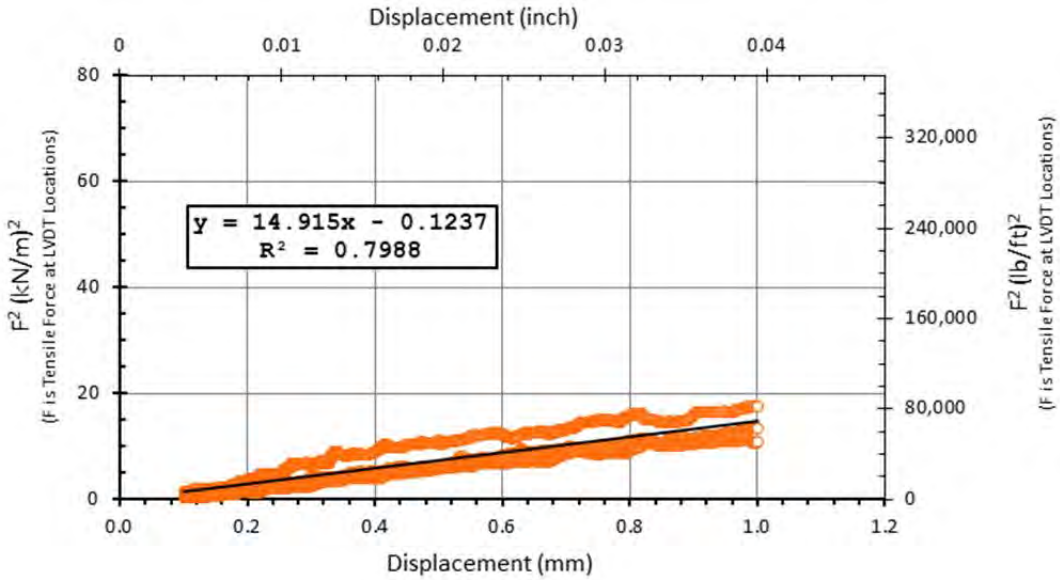
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	507	lb/ft
Max Pullout Load	P_{max}	2.23	kN	488	lb
Max Shear Stress	τ_{max}	30.0	kPa	4.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
14.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/4/12 PM
Conducted by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		DD	GG PPTG3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.260	m	0.245	m
	8	0.902	ft	0.853	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	39.3	1.546
2	96.0	3.780
3	136.4	5.370
4	175.7	6.916
5	232.4	9.148

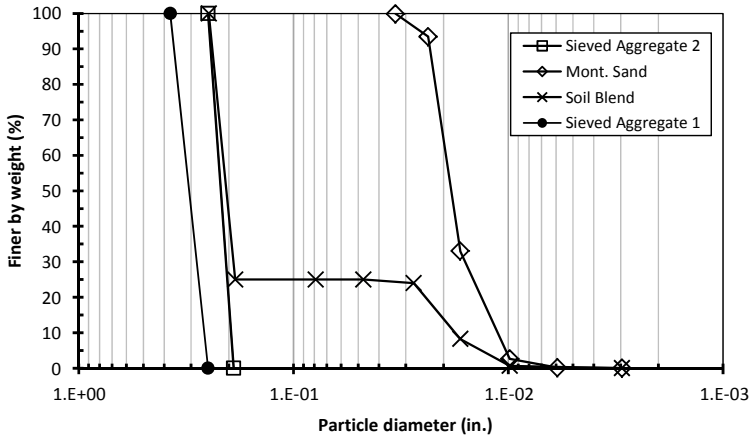
Pullout Rate	
1.0 mm/min.	0.04 in/min

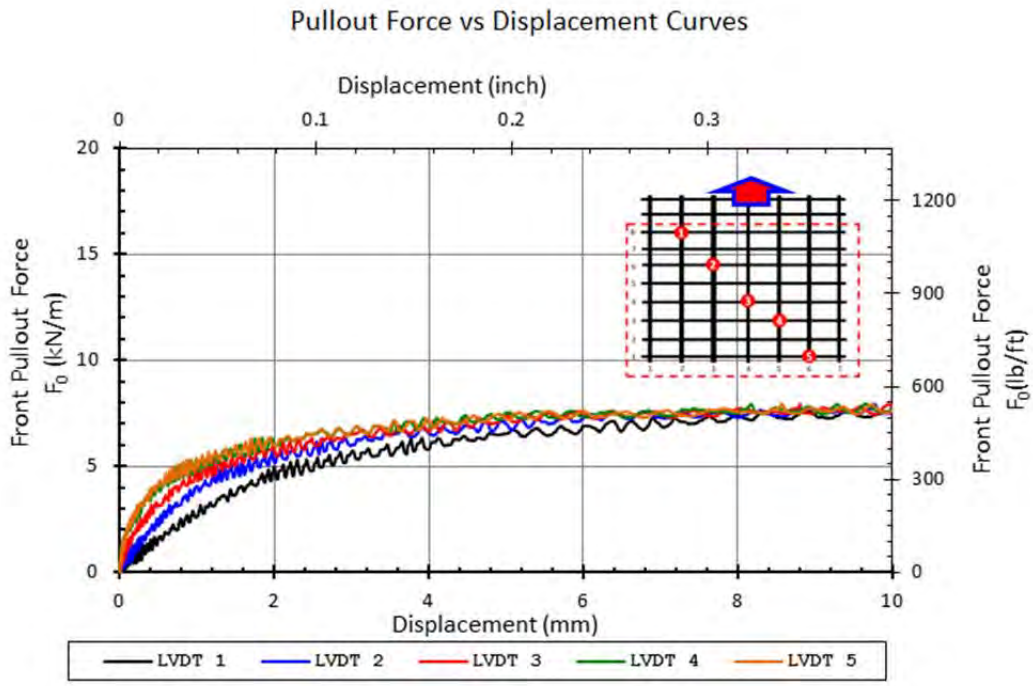
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.569 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

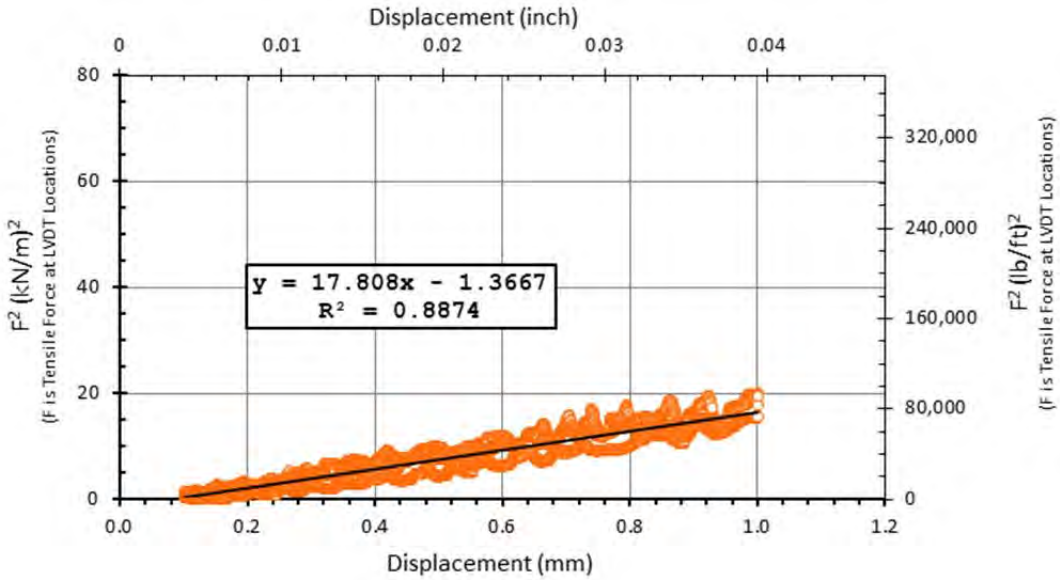
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.1	kN/m	553	lb/ft
Max Pullout Load	P_{max}	2.10	kN	488	lb
Max Shear Stress	τ_{max}	28.2	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}	
17.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Appendix A3

This appendix presents the results of tests used to evaluate the influence on the results of the clamping rod of the grip and the influence of the use of torque wrench. These tests were performed with Sieved Aggregate 2 and Monterey Sand, GG PP CD, confining pressure of 3 psi (21 kPa) and analog air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	10/25/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.268	m	0.275	m	0.245	m
	10	0.879	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	38.0	1.495
2	116.4	4.581
3	116.4	4.581
4	116.4	4.581
5	235.4	9.267

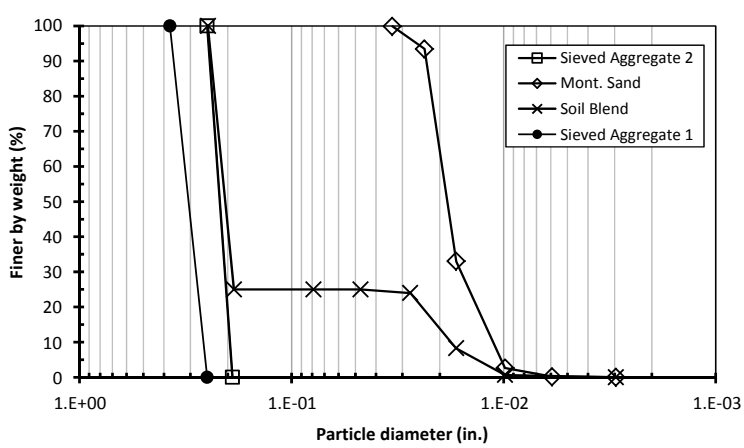
Pullout Rate	
1.0 mm/min.	0.04 in/min

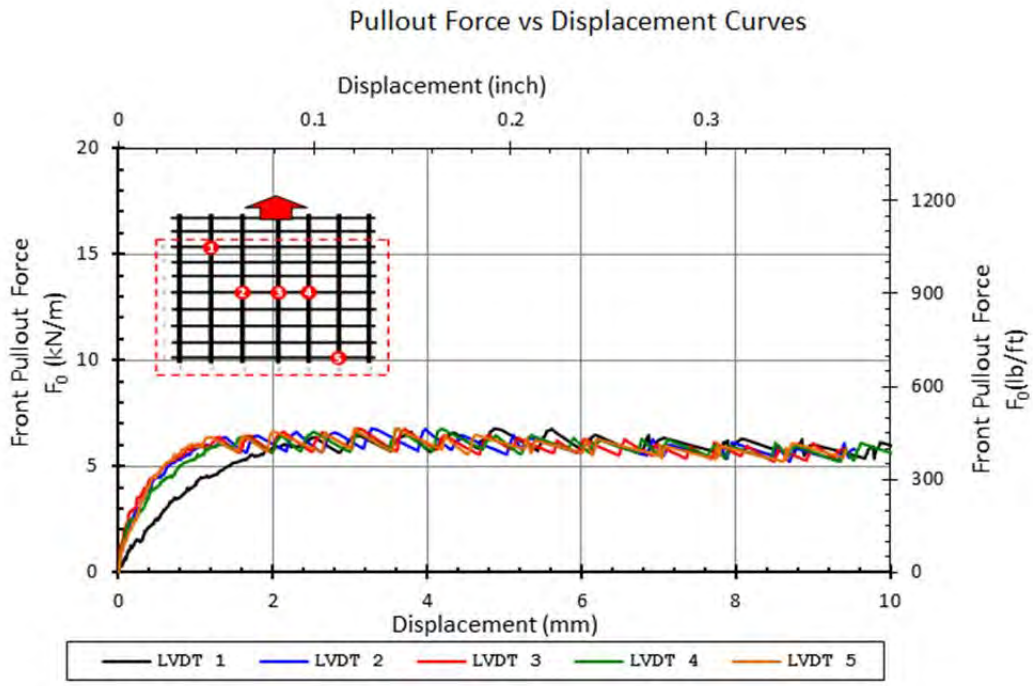
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.502 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

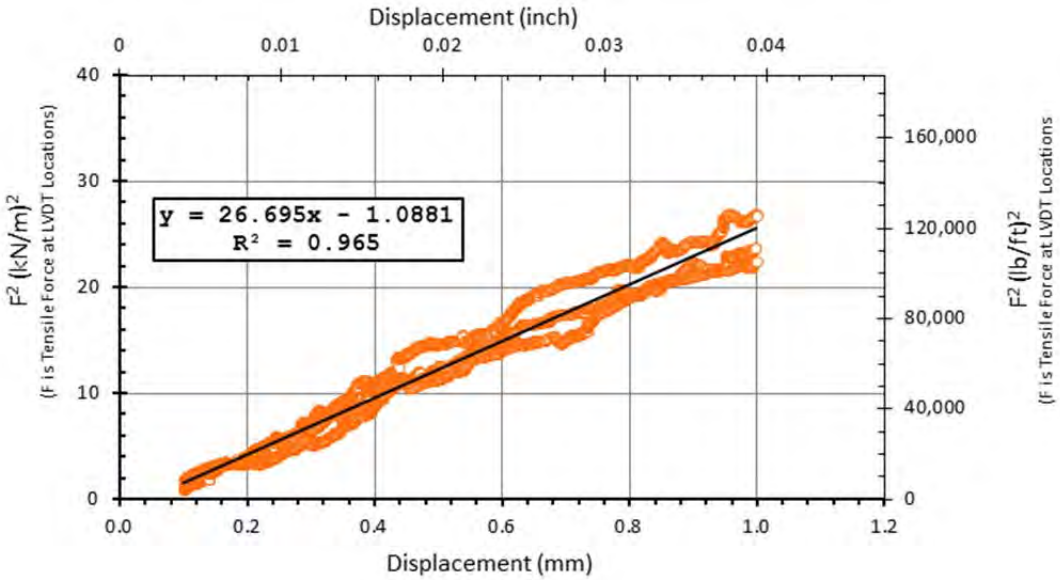
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.8	kN/m	465	lb/ft
Max Pullout Load	P_{max}	1.87	kN	456	lb
Max Shear Stress	τ_{max}	25.1	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
26.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. No torque wrench used.

SMALL PULLOUT TEST

Date test conducted	10/26/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	31.4	1.236
2	111.8	4.403
3	111.8	4.403
4	111.8	4.403
5	233.9	9.207

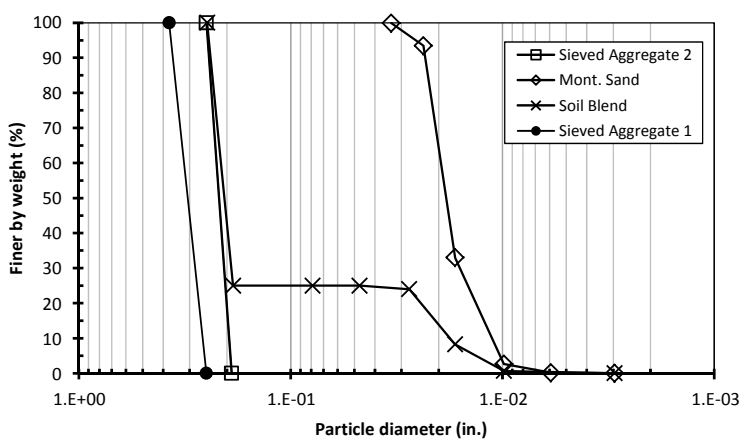
Pullout Rate			
1.0	mm/min.	0.04	in/min

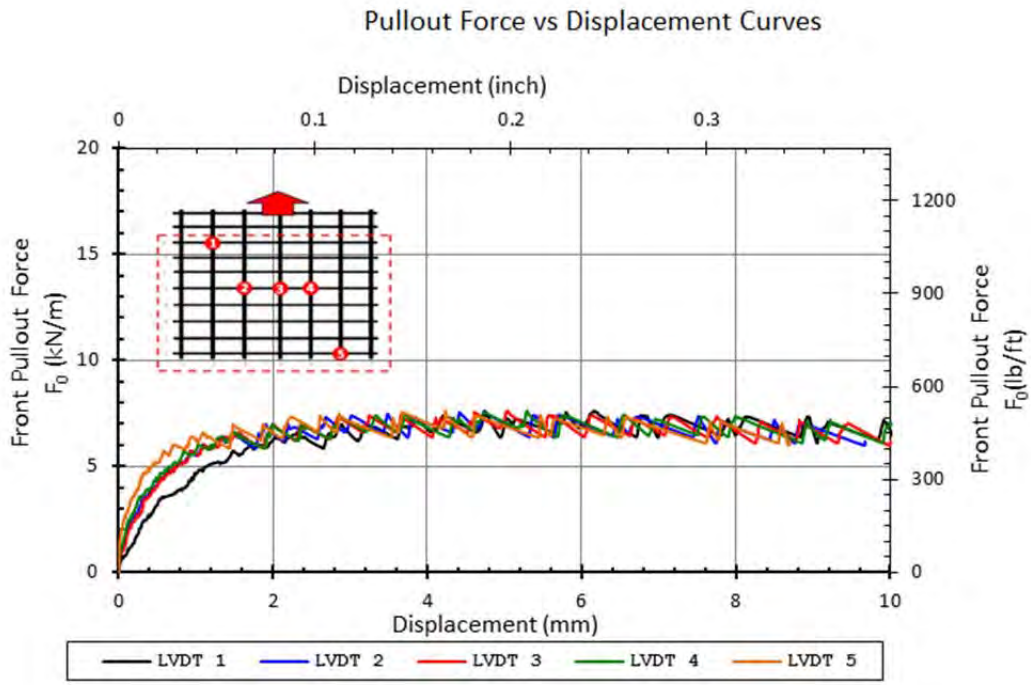
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.50	**%**	
Dry Density (ρ_d)	1.489 **g/cm^3**	**93**	**pcf**

Note: particle size distribution curve shown below

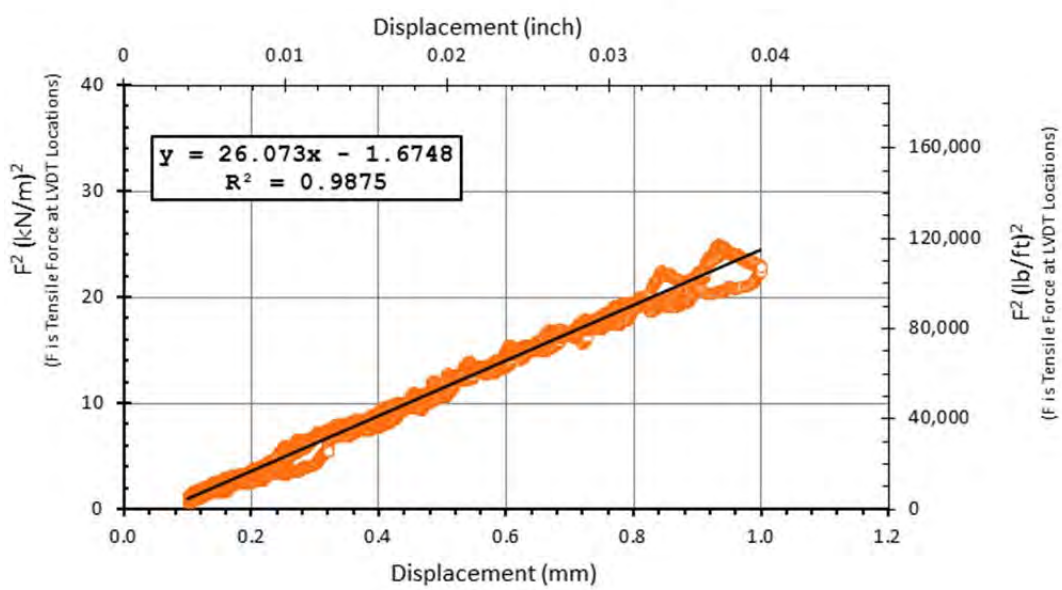
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	522	lb/ft
Max Pullout Load	P_{max}	2.10	kN	506	lb
Max Shear Stress	τ_{max}	28.2	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
26.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3 and 4 with wires attached to the same transverse rib. No torque wrench used.

SMALL PULLOUT TEST

Date test conducted	10/28/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.275	m	0.245	m
	10	0.925	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	31.7	1.246
2	112.2	4.416
3	112.2	4.416
4	112.2	4.416
5	234.1	9.217

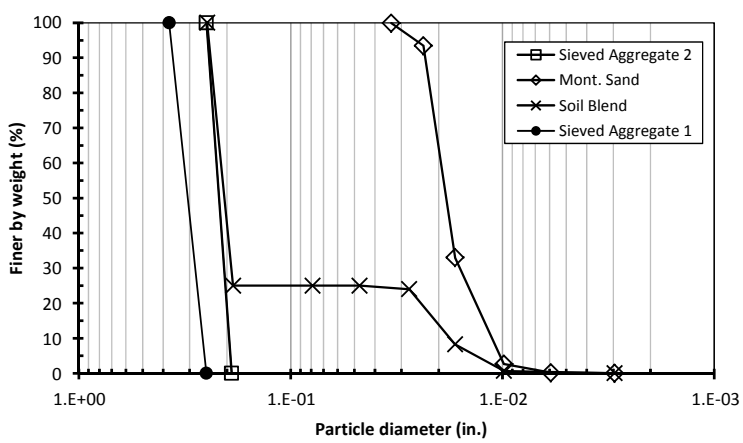
Pullout Rate			
1.0	mm/min.	0.04	in/min

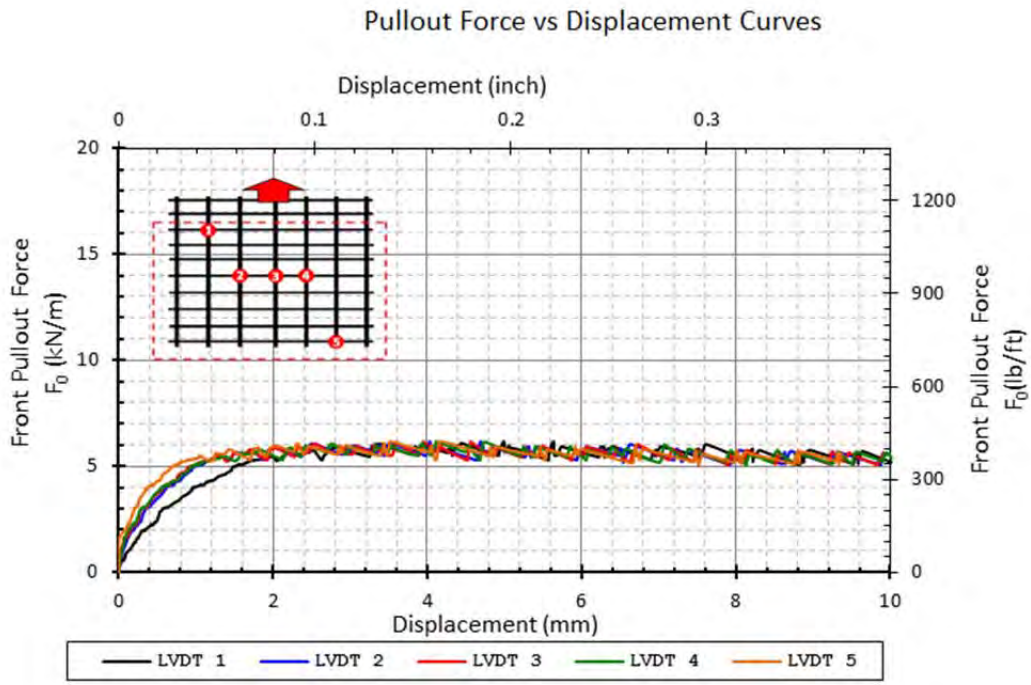
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.50	**%**	
Dry Density (ρ_d)	1.467 **g/cm^3**	**92**	**pcf**

Note: particle size distribution curve shown below

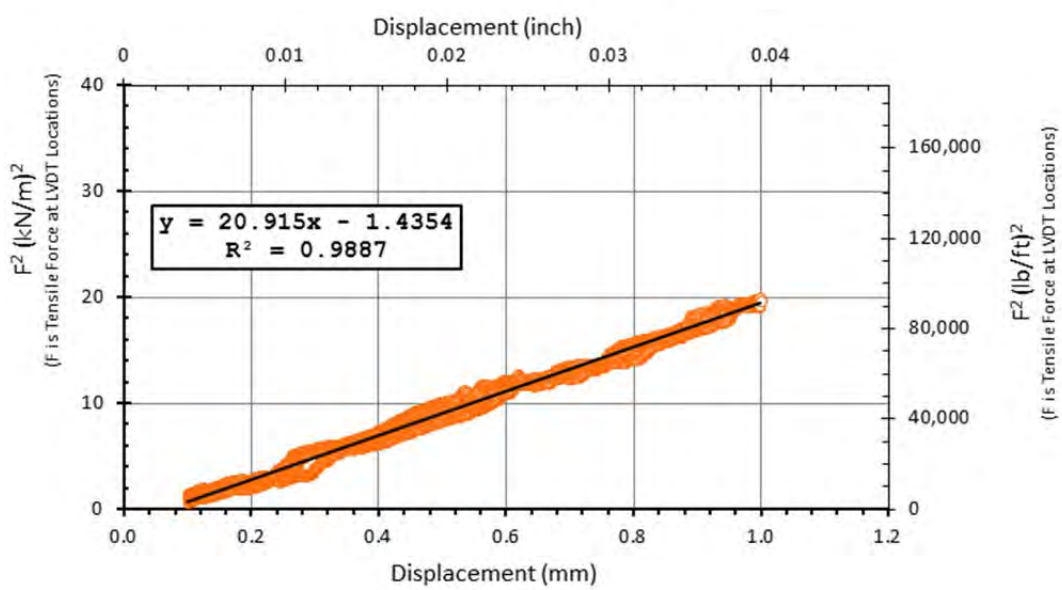
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	423	lb/ft
Max Pullout Load	P_{max}	1.70	kN	415	lb
Max Shear Stress	τ_{max}	22.8	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
20.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. Torque of 12.5 lbf-ft used.

SMALL PULLOUT TEST

Date test conducted	10/31/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.3	1.349
2	114.4	4.505
3	114.4	4.505
4	114.4	4.505
5	235.1	9.255

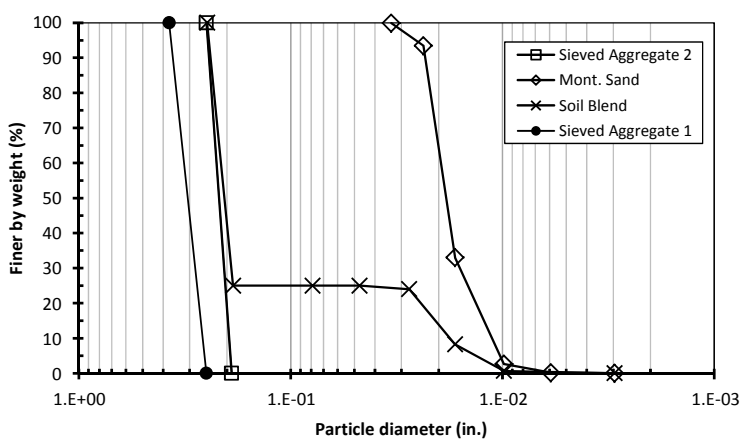
Pullout Rate			
1.0	mm/min.	0.04	in/min

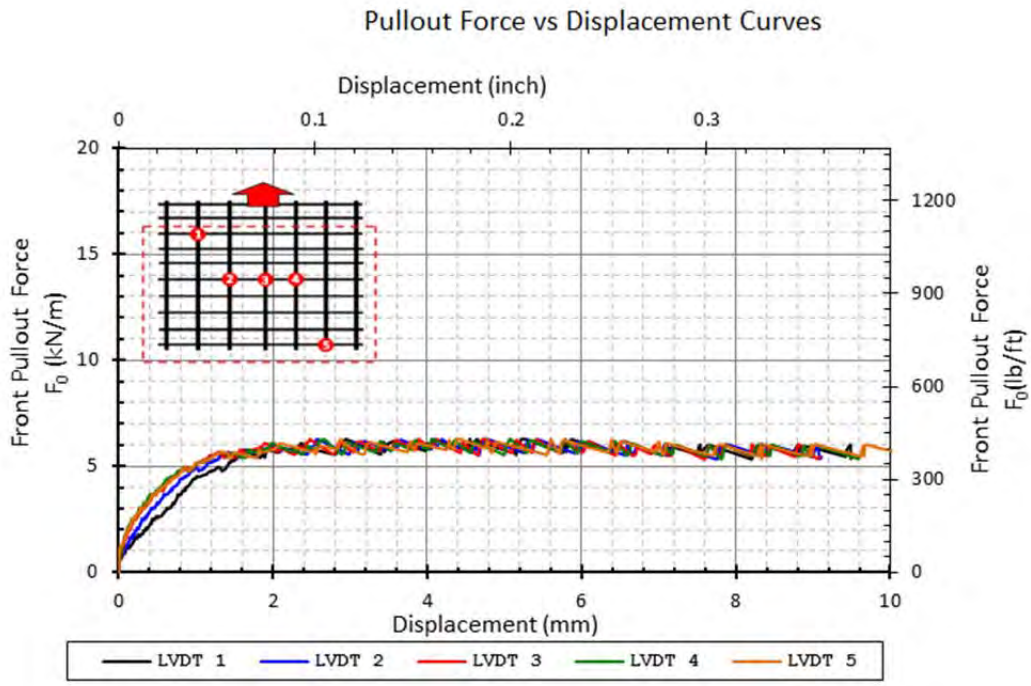
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.50	**%**	
Dry Density (ρ_d)	1.432 **g/cm^3**	**89**	**pcf**

Note: particle size distribution curve shown below

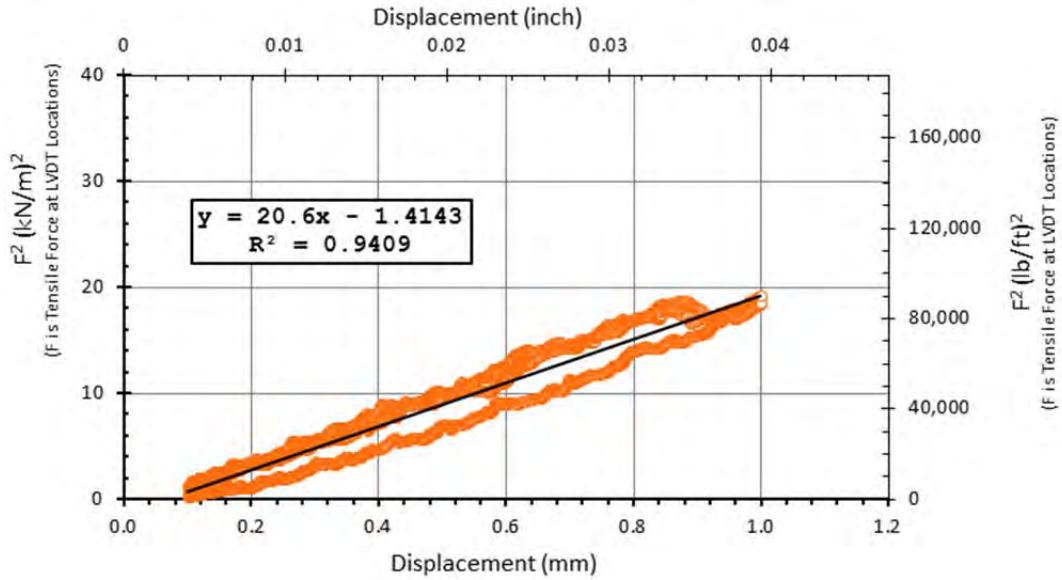
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	432	lb/ft
Max Pullout Load	P_{max}	1.73	kN	414	lb
Max Shear Stress	τ_{max}	23.3	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
20.6	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. Torque of 12.5 lbf-ft used.

SMALL PULLOUT TEST

Date test conducted	11/17/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.276	m	0.275	m	0.245	m
	10	0.906	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	120.0	4.724
2	120.0	4.724
3	120.0	4.724
4	120.0	4.724
5	120.0	4.724

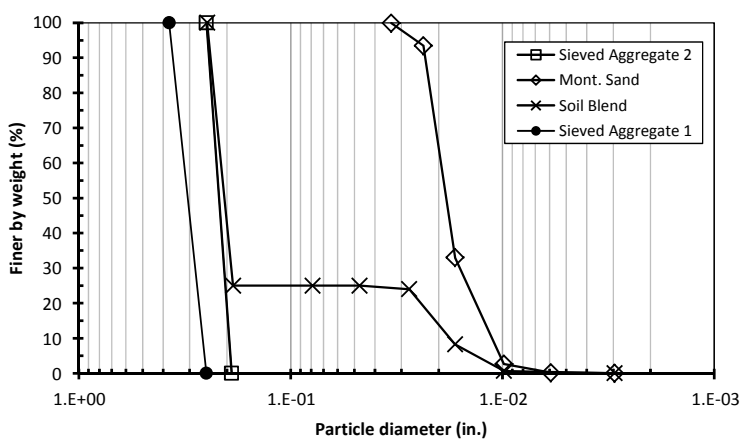
Pullout Rate			
1.0	mm/min.	0.04	in/min

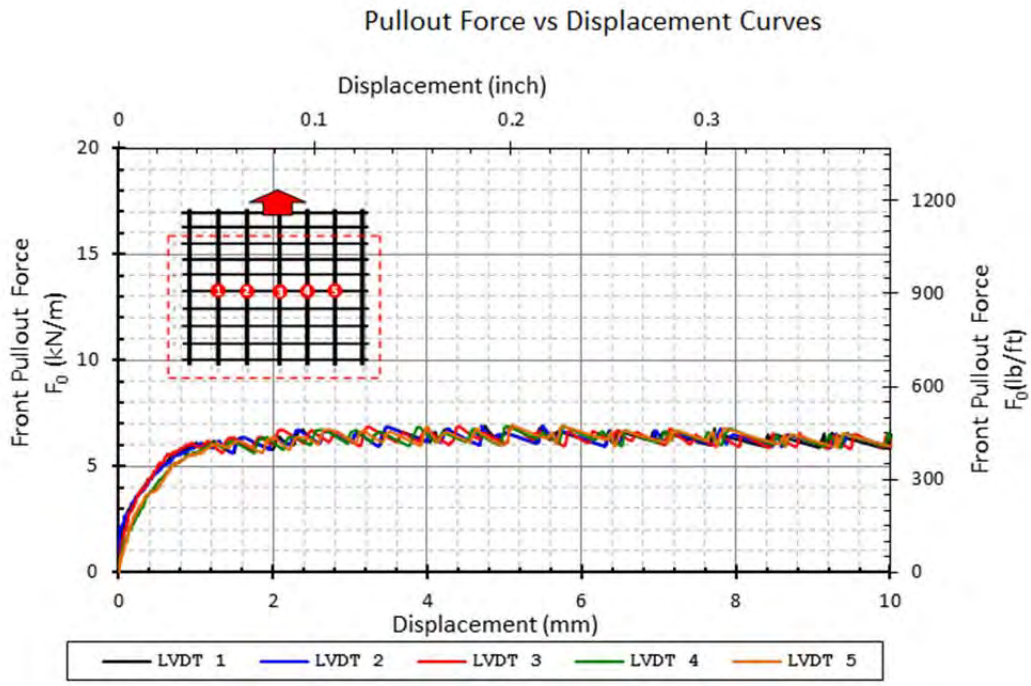
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.50	**%**	
Dry Density (ρ_d)	1.493 **g/cm^3**	**93**	**pcf**

Note: particle size distribution curve shown below

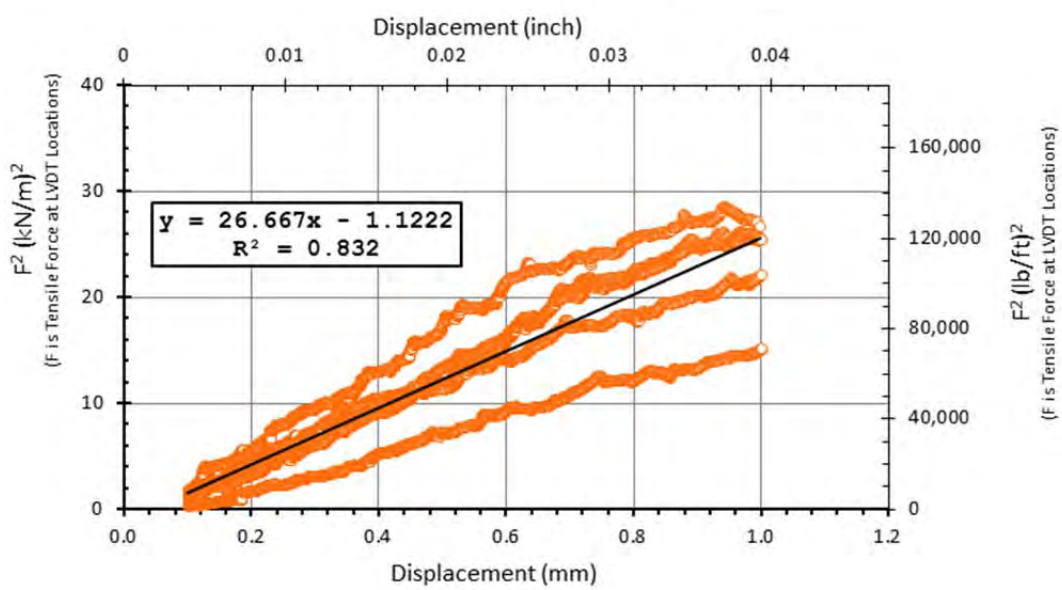
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	472	lb/ft
Max Pullout Load	P_{max}	1.90	kN	463	lb
Max Shear Stress	τ_{max}	25.5	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
26.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

All LVDTs with wires attached along the same transverse rib. Torque at 12.5 lb-ft.

SMALL PULLOUT TEST

Date test conducted	11/21/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	10	0.912	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	117.2	4.614
2	117.2	4.614
3	117.2	4.614
4	117.2	4.614
5	117.2	4.614

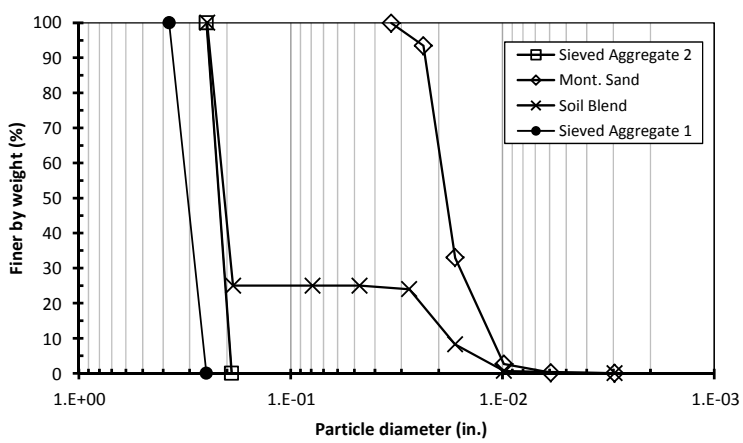
Pullout Rate			
1.0	mm/min.	0.04	in/min

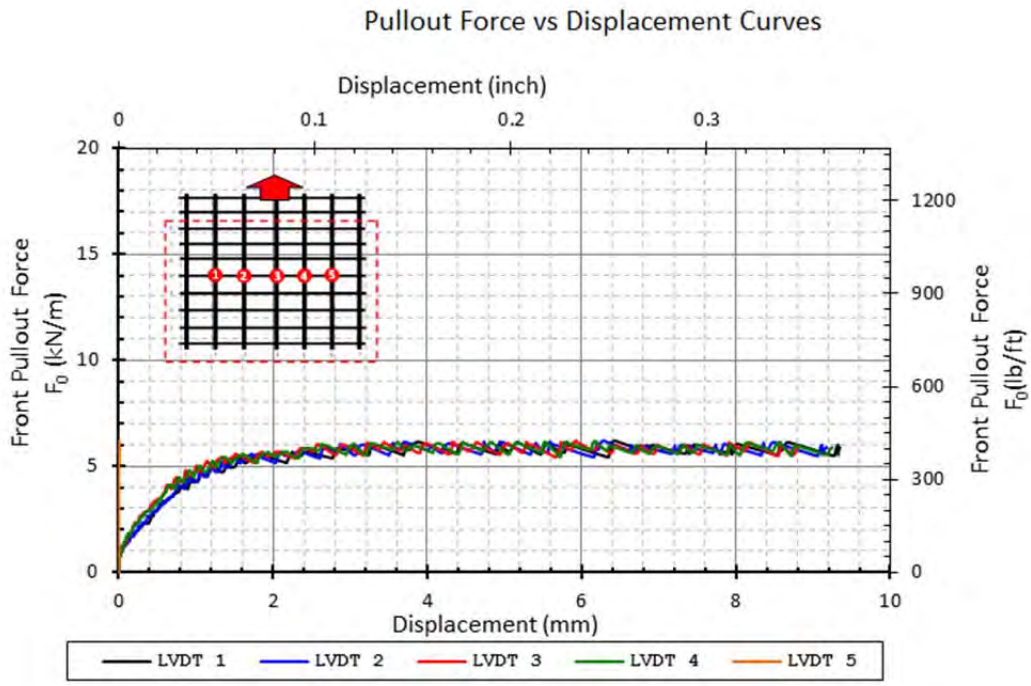
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.467 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

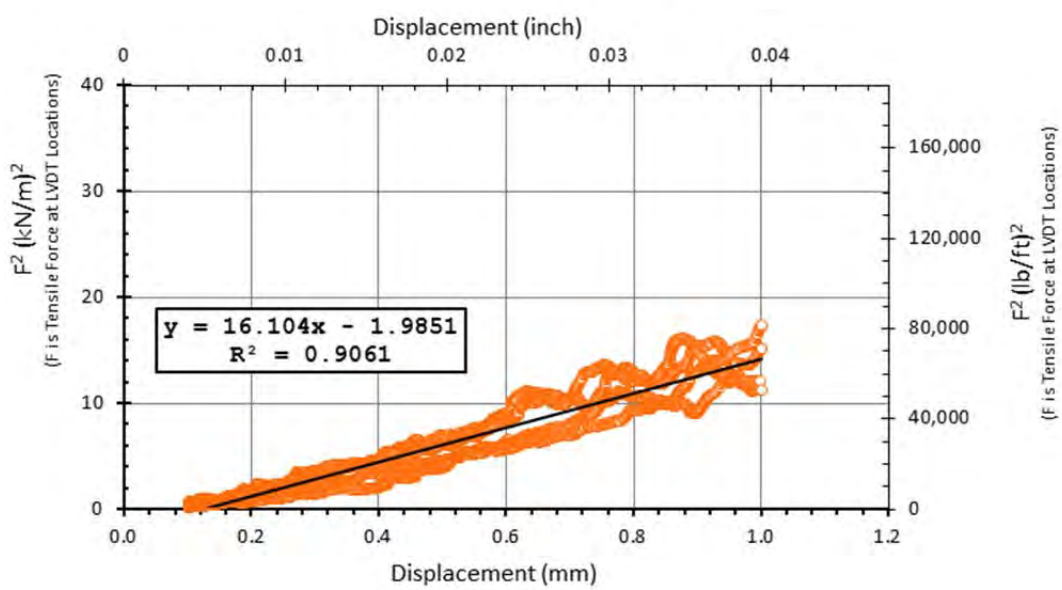
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.2	kN/m	425	lb/ft
Max Pullout Load	P_{max}	1.71	kN	417	lb
Max Shear Stress	τ_{max}	23.0	kPa	3.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
16.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT 5 not working. Data of LVDTs 1, 2, 3 and 4 used to calculate KSGI. All LVDTs with wires attached along the same transverse rib. Torque at 12.5 lb-ft. Sample slightly skewed.

SMALL PULLOUT TEST

Date test conducted	9/20/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.269	m	0.275	m	0.245	m
	10	0.883	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	35.4	1.394
2	117.0	4.608
3	117.0	4.608
4	117.0	4.608
5	238.1	9.373

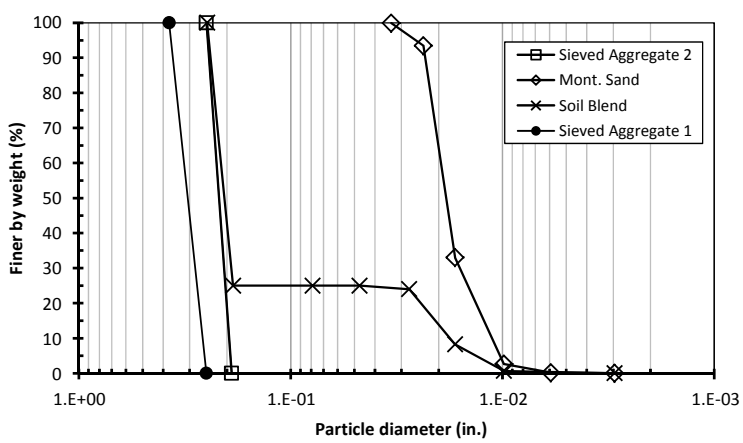
Pullout Rate			
1.0	mm/min.	0.04	in/min

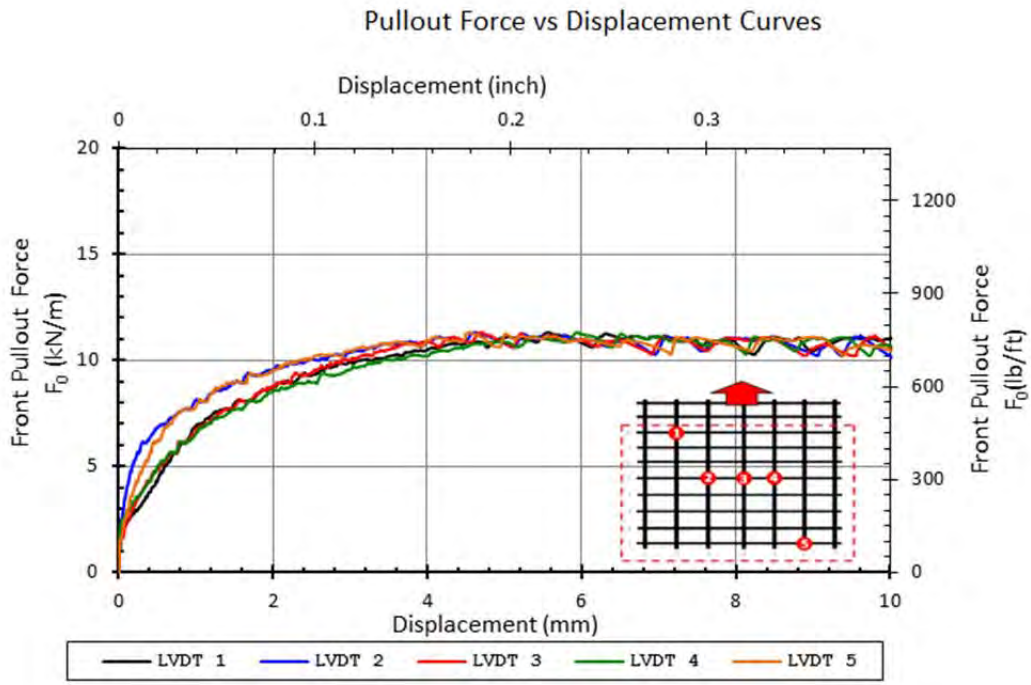
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.547 **g/cm^3**	**97**	**pcf**

Note: particle size distribution curve shown below

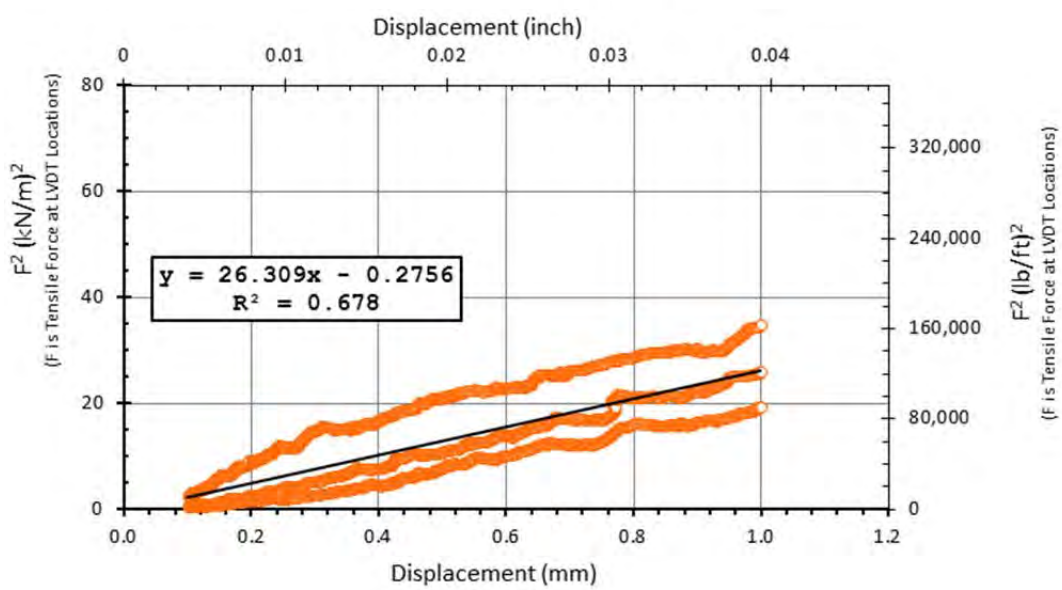
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.3	kN/m	775	lb/ft
Max Pullout Load	P_{max}	3.11	kN	715	lb
Max Shear Stress	τ_{max}	41.8	kPa	6.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
26.3	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. No torque wrench used.

SMALL PULLOUT TEST

Date test conducted	10/24/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.2	1.346
2	115.1	4.532
3	115.1	4.532
4	115.1	4.532
5	237.3	9.341

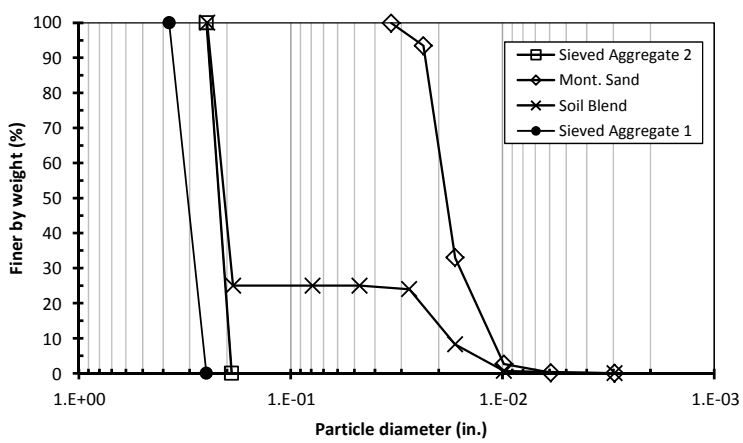
Pullout Rate			
1.0	mm/min.	0.04	in/min

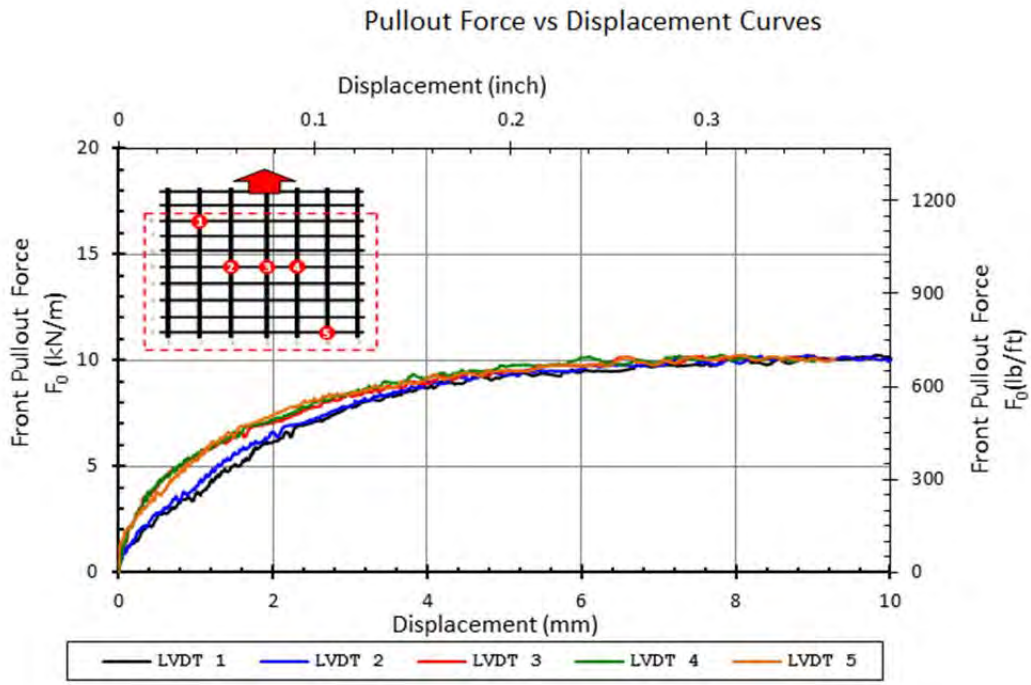
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.489 **g/cm^3**	**93**	**pcf**

Note: particle size distribution curve shown below

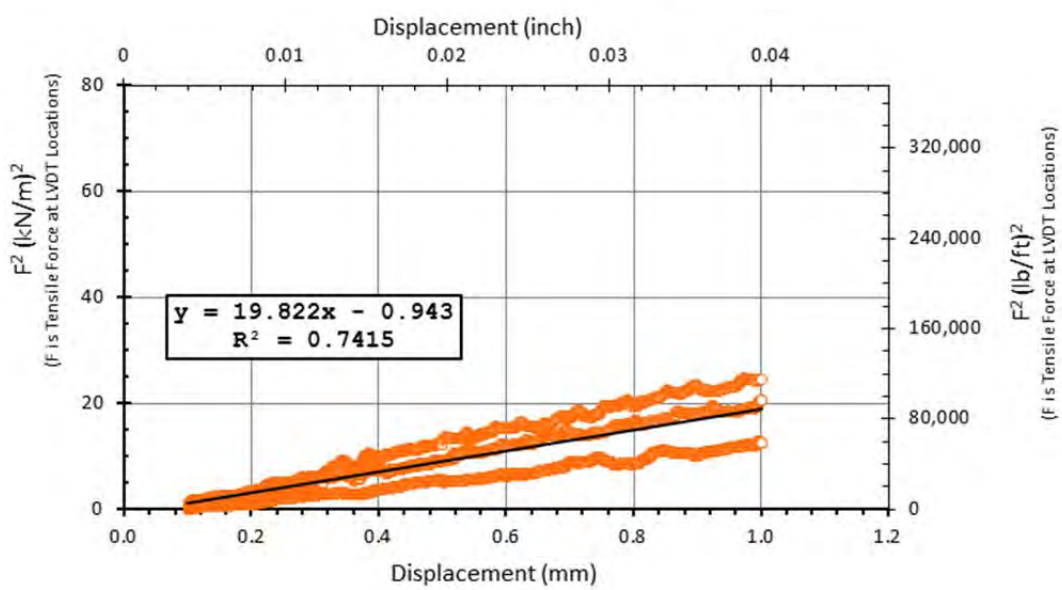
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.2	kN/m	702	lb/ft
Max Pullout Load	P_{max}	2.82	kN	659	lb
Max Shear Stress	τ_{max}	37.9	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
19.8	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. No torque wrench used.

SMALL PULLOUT TEST

Date test conducted	11/1/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.275	m	0.245	m
	10	0.902	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	33.8	1.329
2	113.6	4.474
3	113.6	4.474
4	113.6	4.474
5	235.0	9.251

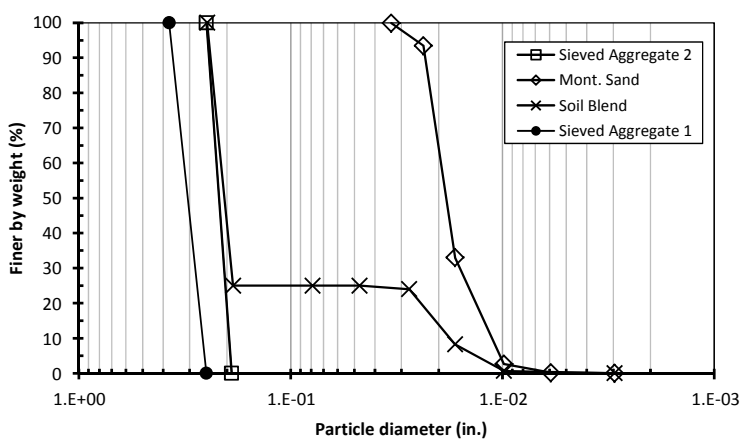
Pullout Rate			
1.0	mm/min.	0.04	in/min

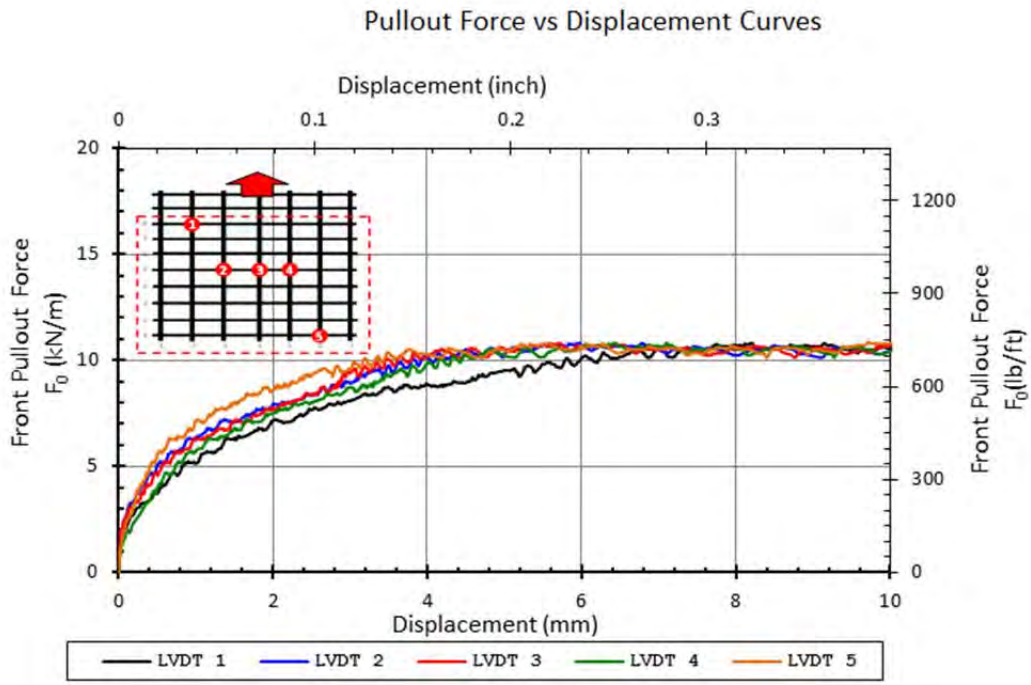
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.498 **g/cm^3**	**94**	**pcf**

Note: particle size distribution curve shown below

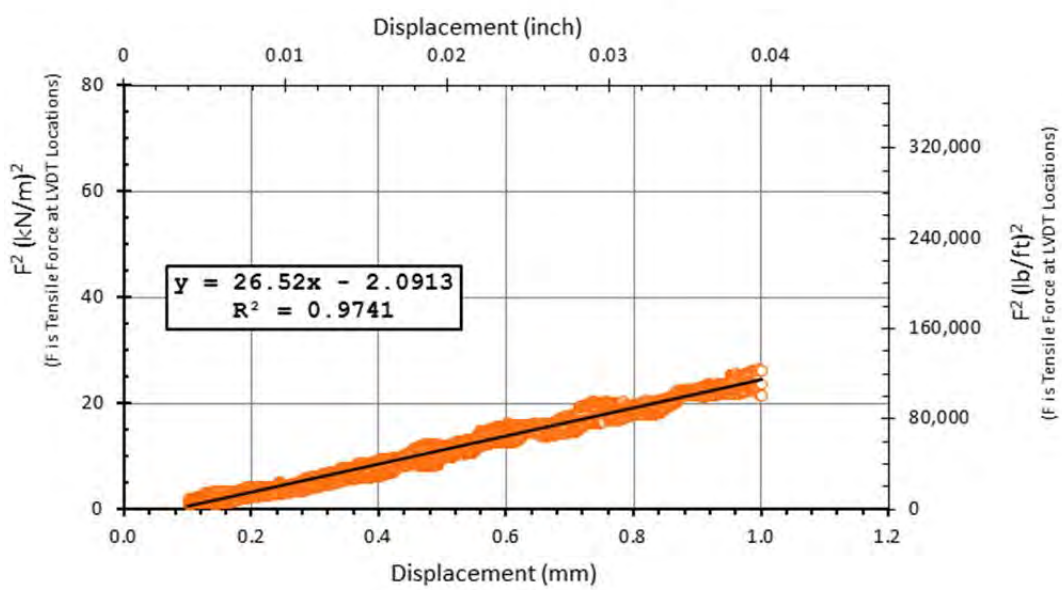
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.2	kN/m	764	lb/ft
Max Pullout Load	P_{max}	3.07	kN	696	lb
Max Shear Stress	τ_{max}	41.2	kPa	6.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
26.5	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. Torque of 12.5 lbf-ft used.

SMALL PULLOUT TEST

Date test conducted	11/2/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	10	0.912	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	38.9	1.533
2	113.6	4.471
3	113.6	4.471
4	113.6	4.471
5	234.9	9.247

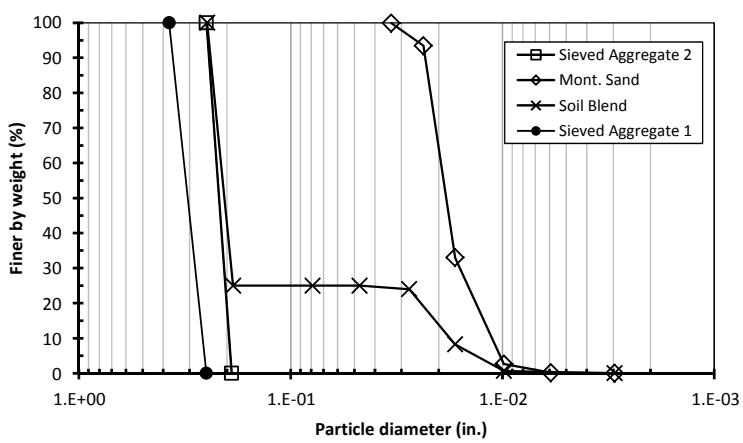
Pullout Rate			
1.0	mm/min.	0.04	in/min

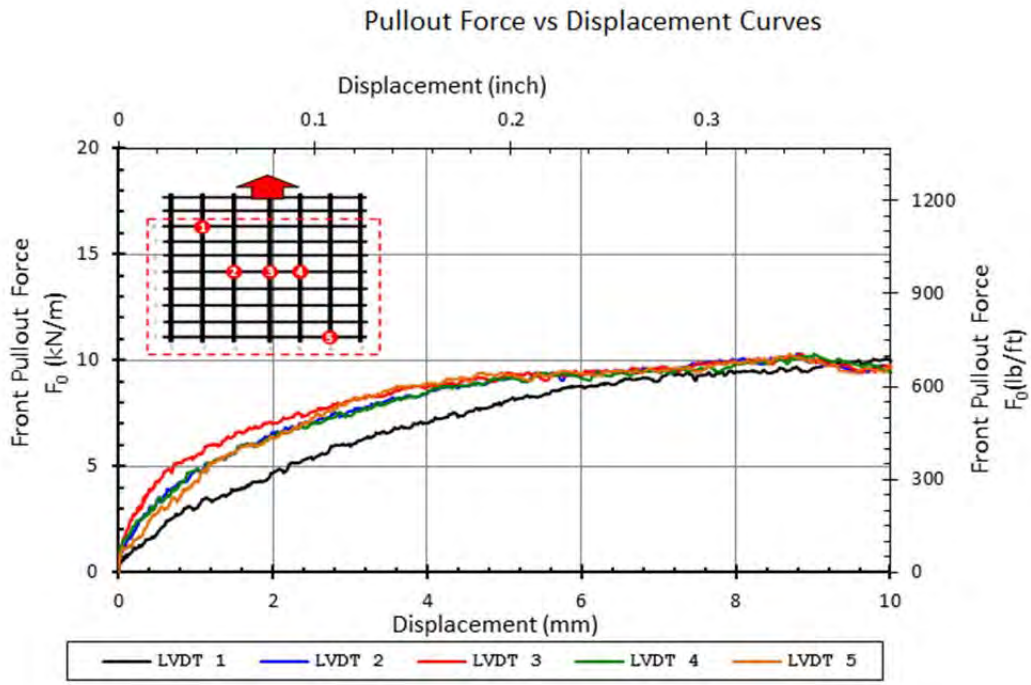
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.471 **g/cm^3**	**92**	**pcf**

Note: particle size distribution curve shown below

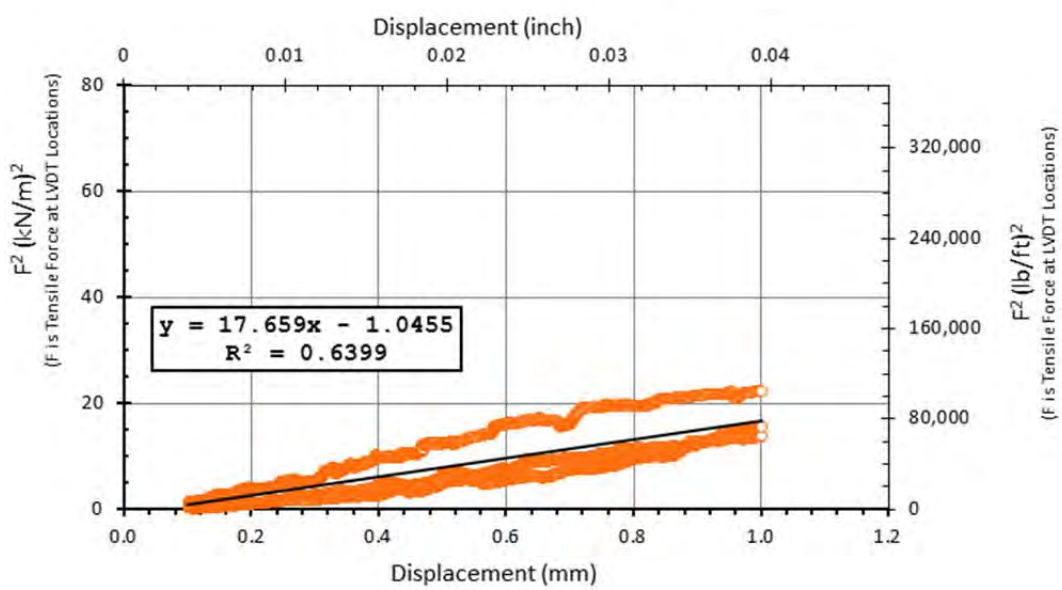
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.3	kN/m	706	lb/ft
Max Pullout Load	P_{max}	2.84	kN	665	lb
Max Shear Stress	τ_{max}	38.1	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
17.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDTs 2, 3, and 4 with wires attached along the same transverse rib. Torque of 12.5 lbf-ft used.

Appendix A4

This appendix presents the results with different products tested with Monterey Sand with confining pressures of 3 and 5 psi (21 and 35 kPa). These tests were performed with analog air pressure gauge and no use of torque wrench.

SMALL PULLOUT TEST

Date test conducted	12/18/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.0	1.180
2	84.9	3.341
3	143.4	5.647
4	168.4	6.628
5	227.0	8.937

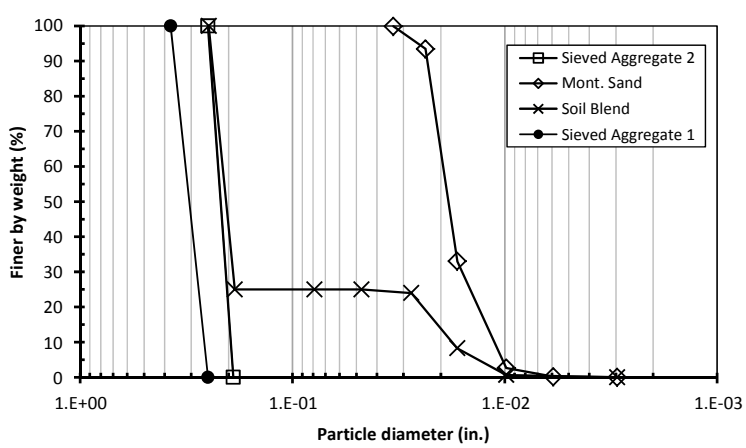
Pullout Rate	
1.0 mm/min.	0.04 in/min

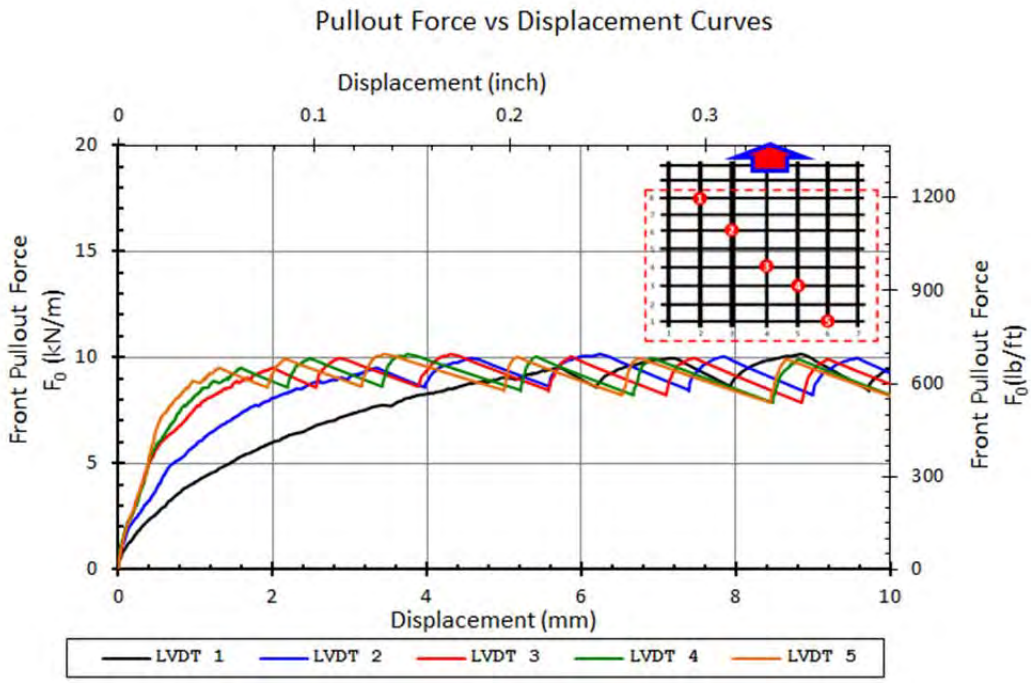
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	2.25	**%**
Dry Density (ρ_d)	1.526 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

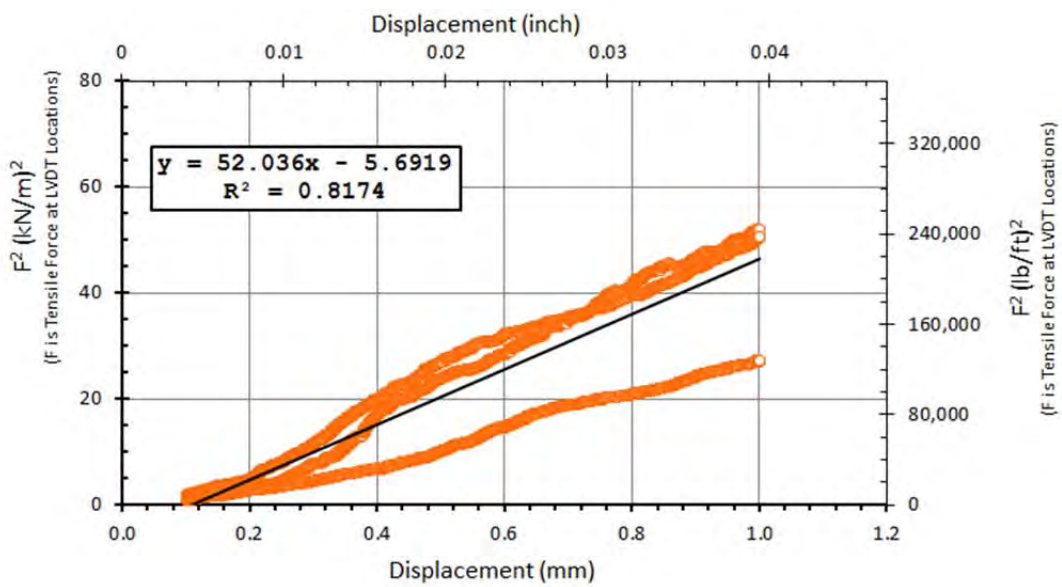
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.2	kN/m	696	lb/ft
Max Pullout Load	P_{max}	2.67	kN	605	lb
Max Shear Stress	τ_{max}	35.8	kPa	5.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
52.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/4/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	10	0.912	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	25.3	0.996
2	105.1	4.139
3	145.9	5.743
4	188.1	7.406
5	228.6	9.000

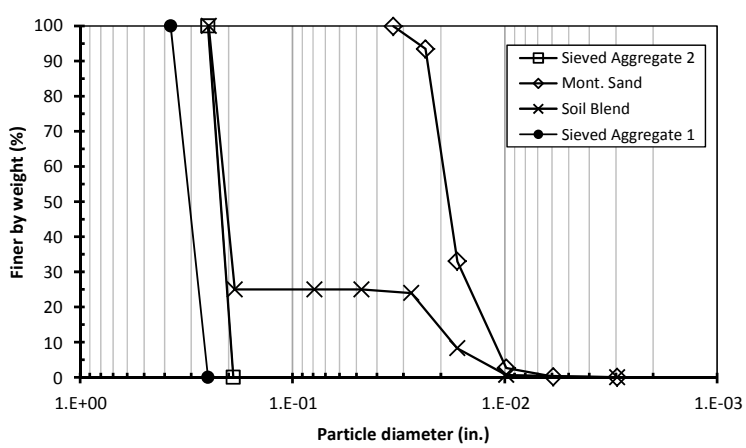
Pullout Rate	
1.0 mm/min.	0.04 in/min

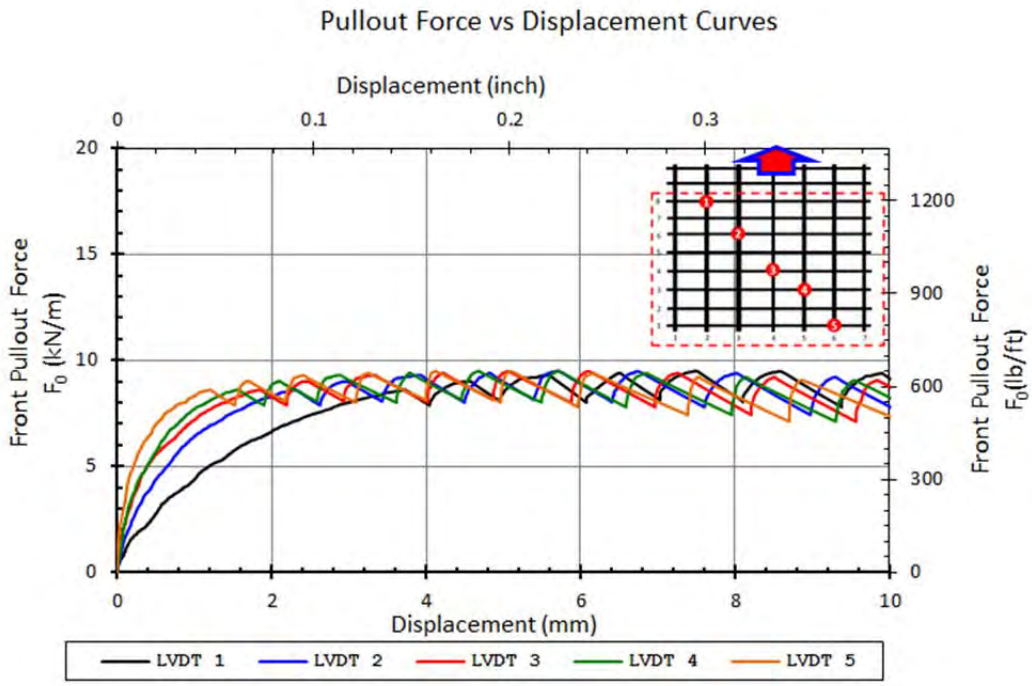
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.47	**%**
Dry Density (ρ_d)	1.498 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

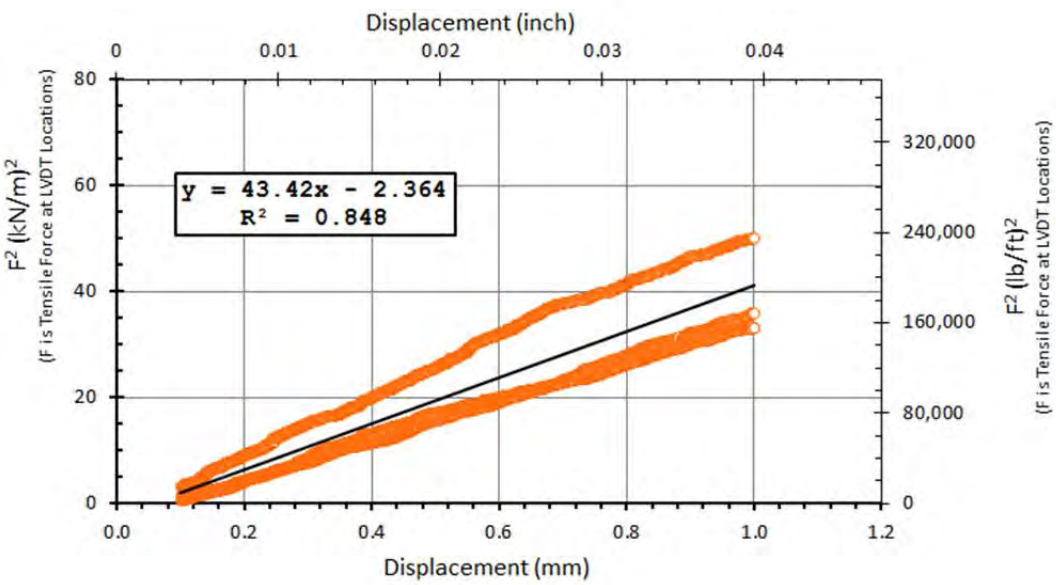
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.5	kN/m	651	lb/ft
Max Pullout Load	P_{max}	2.61	kN	617	lb
Max Shear Stress	τ_{max}	35.1	kPa	5.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
43.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/17/2008 PM
Done by	Eddy/Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.297	m	0.245	m
	11	0.919	ft	0.973	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.4	0.960
2	91.6	3.606
3	125.7	4.949
4	157.0	6.180
5	221.7	8.726

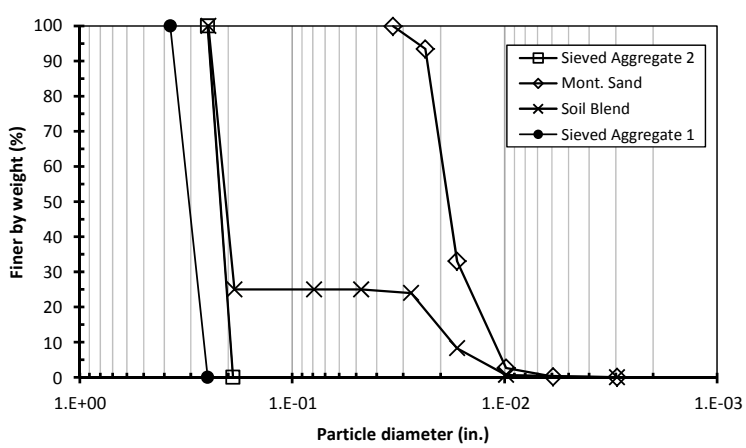
Pullout Rate	
1.0 mm/min.	0.04 in/min

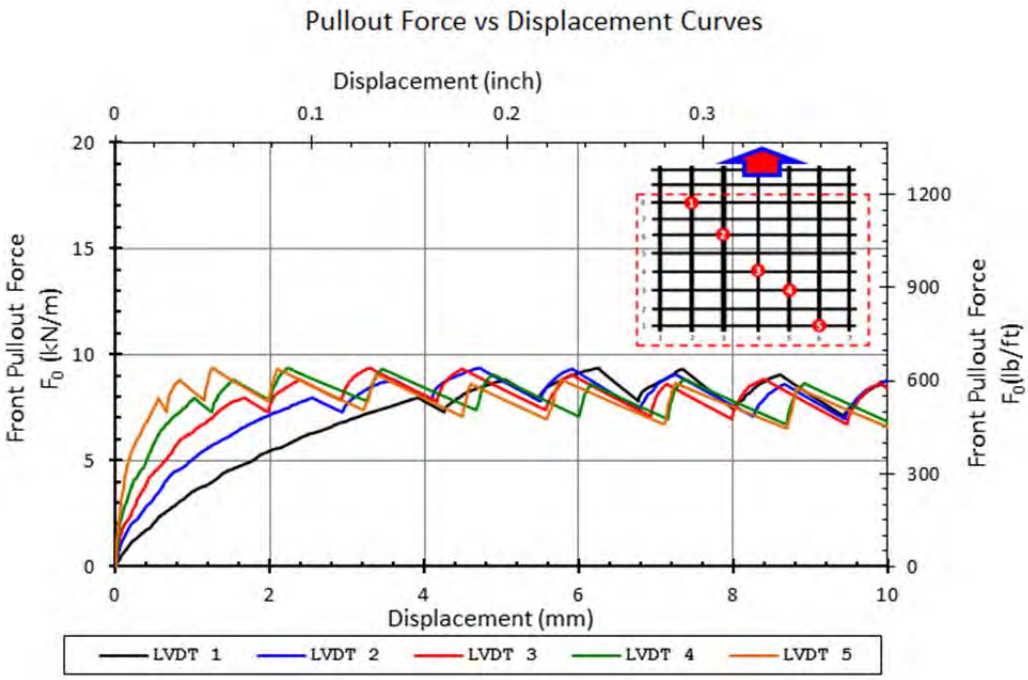
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.526 **g/cm^3**	**95 pcf**

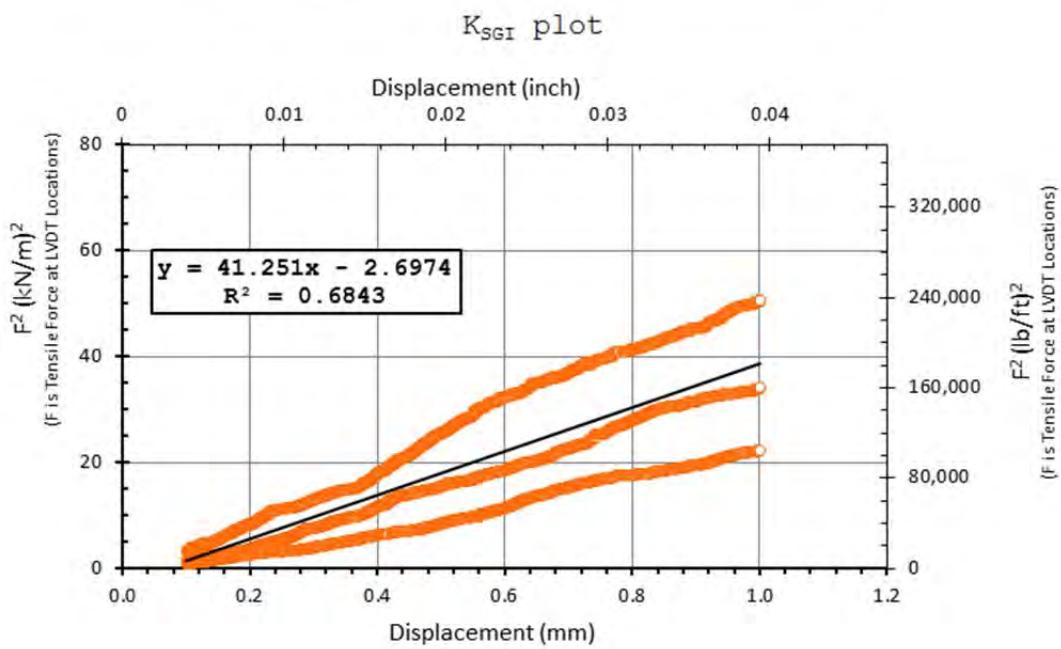
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.4	kN/m	642	lb/ft
Max Pullout Load	P_{max}	2.78	kN	645	lb
Max Shear Stress	τ_{max}	37.3	kPa	5.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
41.3 (kN/m)^2/mm




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.1
0.2
0.3
Front Pullout Force
F0 (kN/m)
20
15
10
5
0
Front Pullout Force
F0(lb/ft)
1200
900
600
300
0
0
2
4
6
8
10
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


KSGI plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
F2 (kN/m)2
(F is Tensile Force at LVDT Locations)
80
60
40
20
0
y = 41.251x - 2.6974
R2 = 0.6843
F2 (lb/ft)2
(F is Tensile Force at LVDT Locations)
320,000
240,000
160,000
80,000
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	7/30/2009
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.276	m	0.270	m	0.245	m
	10	0.906	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.1	1.106
2	92.9	3.657
3	128.1	5.043
4	161.0	6.339
5	227.5	8.957

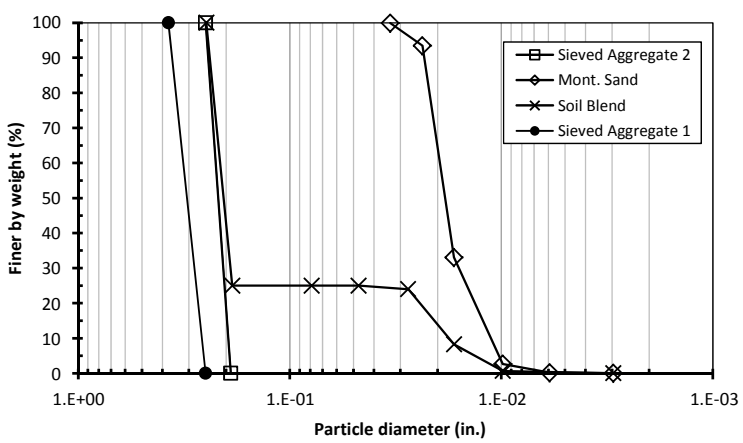
Pullout Rate	
1.0 mm/min.	0.04 in/min

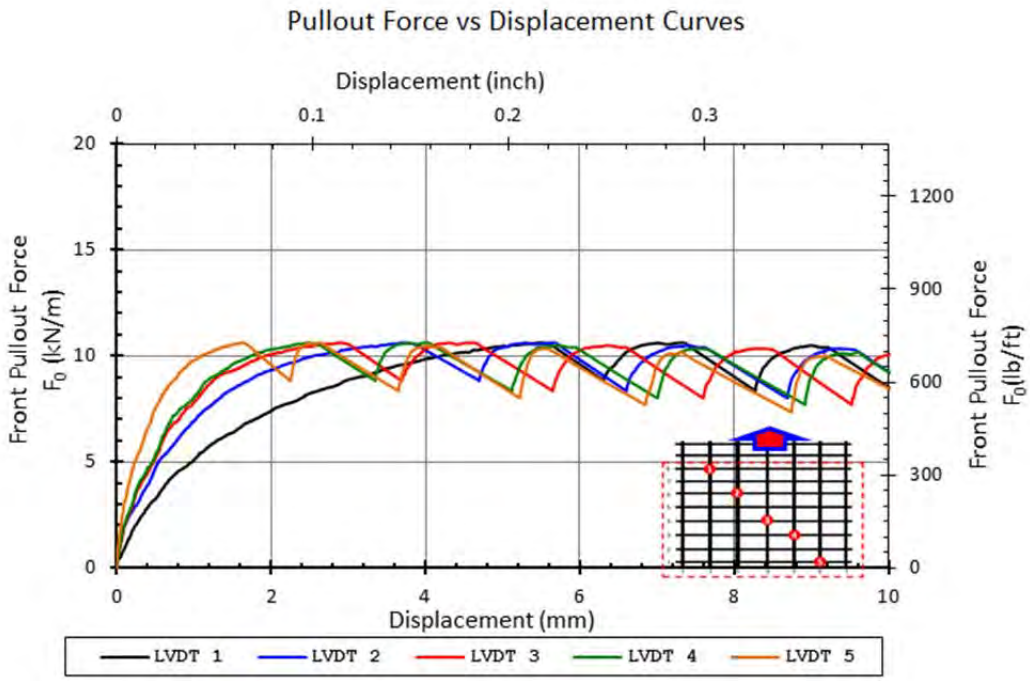
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.41	**%**
Dry Density (ρ_d)	1.525 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

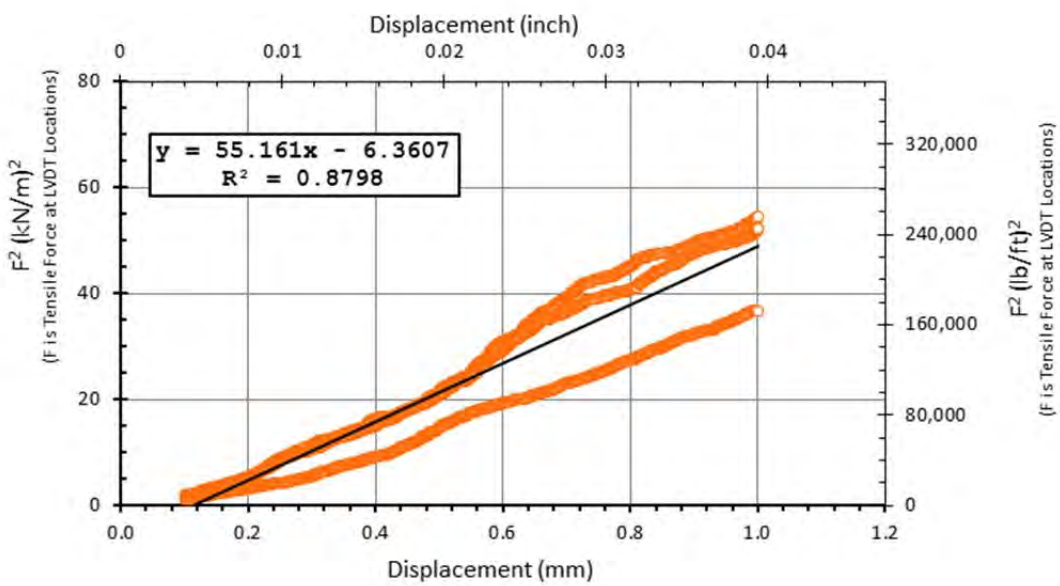
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.6	kN/m	728	lb/ft
Max Pullout Load	P_{max}	2.87	kN	656	lb
Max Shear Stress	τ_{max}	38.5	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
55.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/17/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.294	m	0.245	m
	9	0.919	ft	0.964	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.6	0.419
2	94.4	3.716
3	122.0	4.804
4	150.5	5.923
5	234.0	9.212

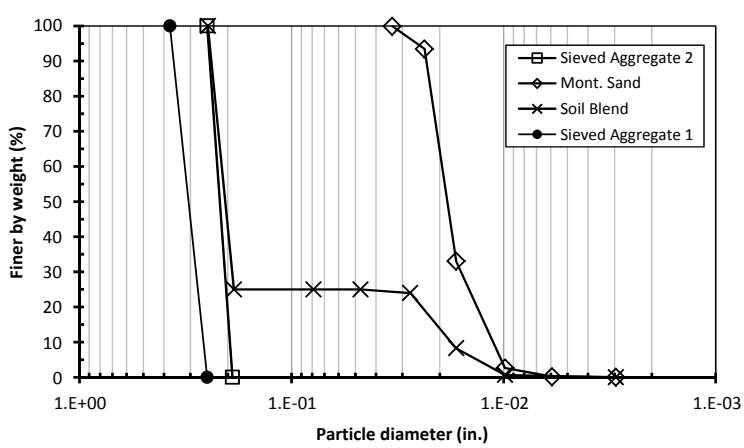
Pullout Rate	
1.0 mm/min.	0.04 in/min

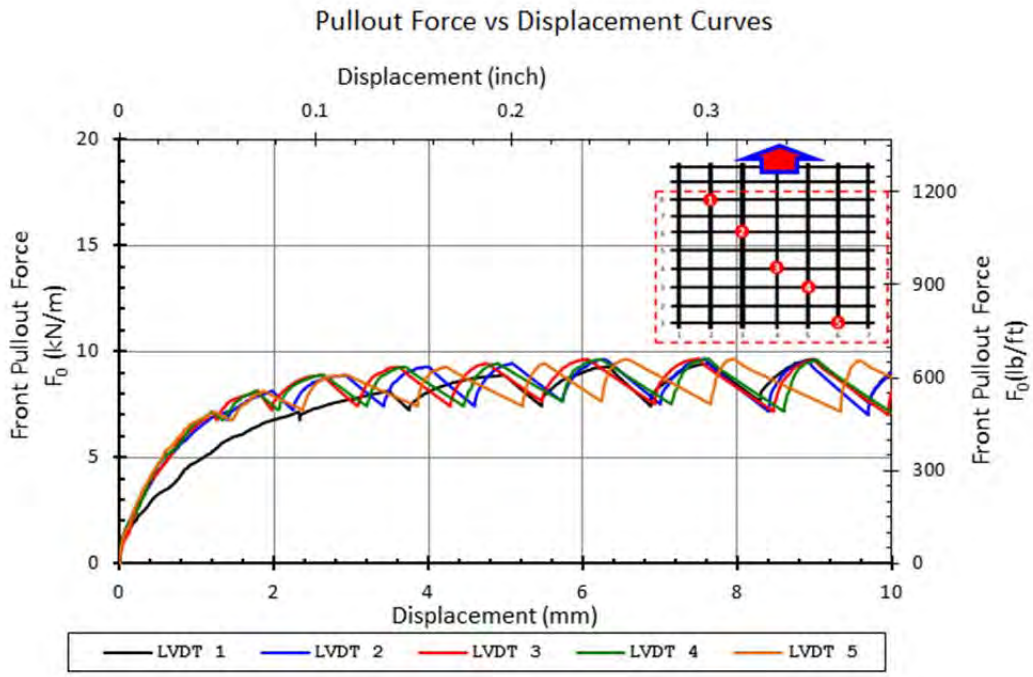
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	2.25	**%**
Dry Density (ρ_d)	1.523 **g/cm^3**	**95 pcf**

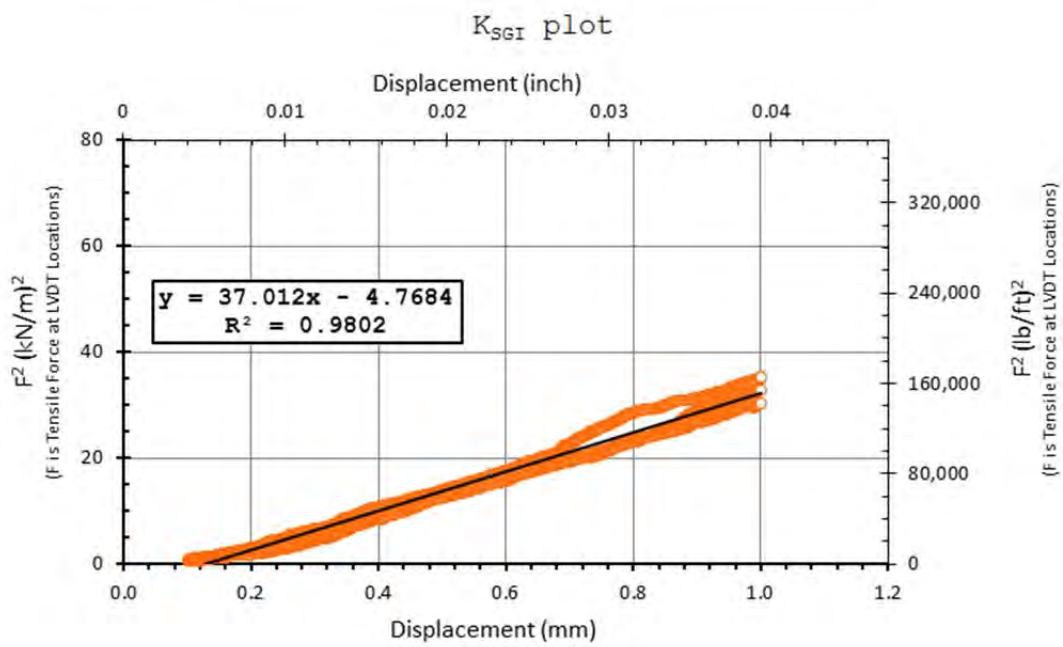
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.7	kN/m	662	lb/ft
Max Pullout Load	P_{max}	2.84	kN	648	lb
Max Shear Stress	τ_{max}	38.1	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
37.0 (kN/m)^2/mm







Comments:

Grip tilted a bit to the right

SMALL PULLOUT TEST

Date test conducted	12/19/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.294	m	0.245	m
	9	0.919	ft	0.964	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.4	0.330
2	91.6	3.605
3	121.5	4.784
4	154.3	6.076
5	237.9	9.367

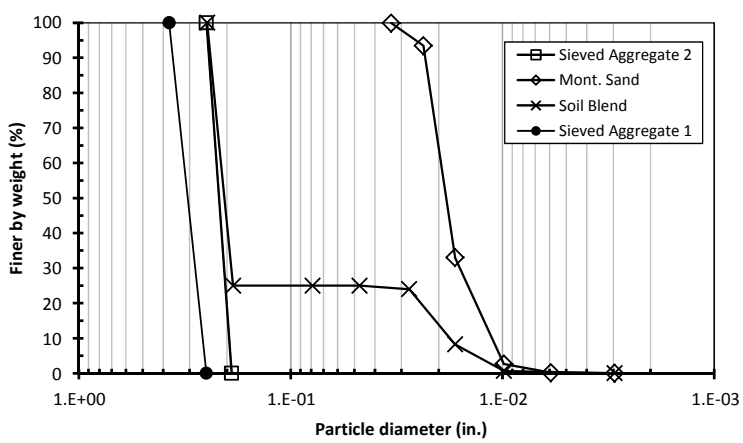
Pullout Rate	
1.0 mm/min.	0.04 in/min

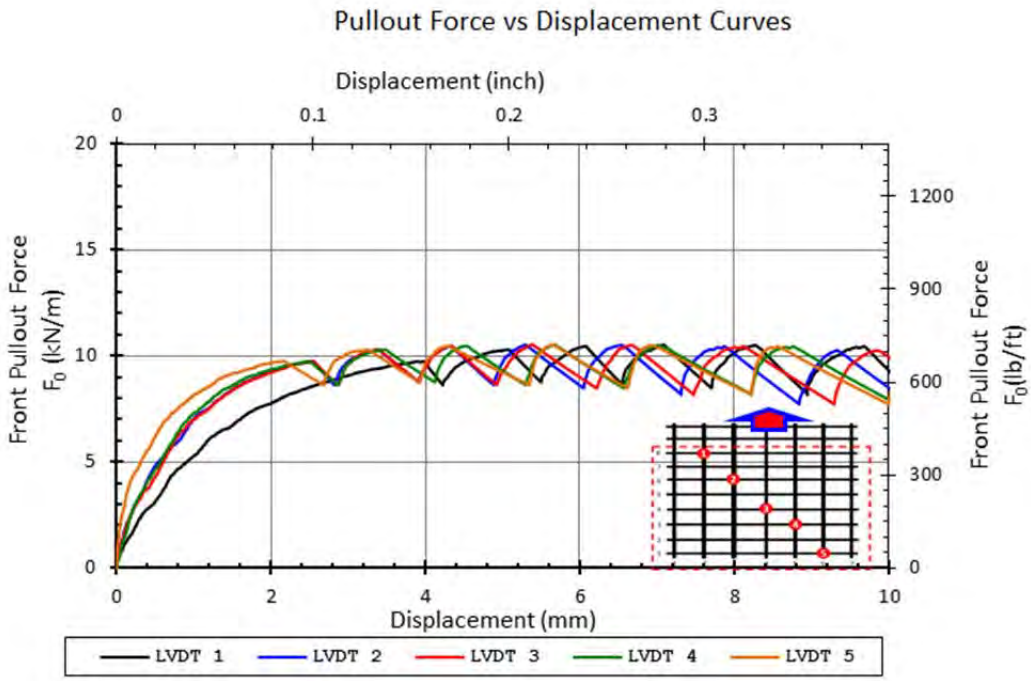
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	2.25	**%**
Dry Density (ρ_d)	1.535 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

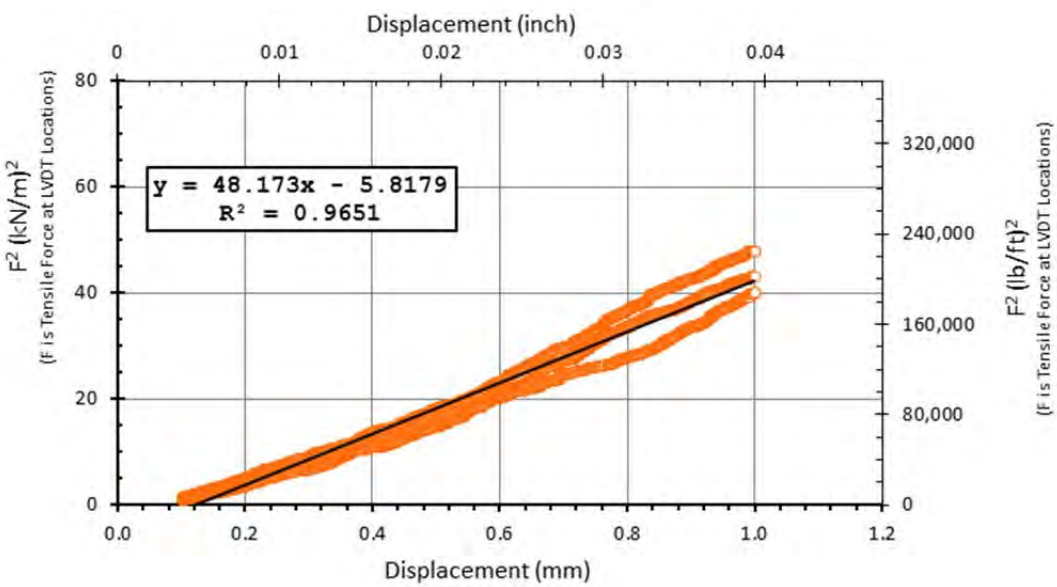
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.5	kN/m	722	lb/ft
Max Pullout Load	P_{max}	3.09	kN	712	lb
Max Shear Stress	τ_{max}	41.6	kPa	6.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
48.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	9/29/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.285	m	0.245	m
	---	0.935	ft	0.935	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	46.8	1.841
2	84.0	3.307
3	120.2	4.734
4	154.1	6.065
5	225.8	8.889

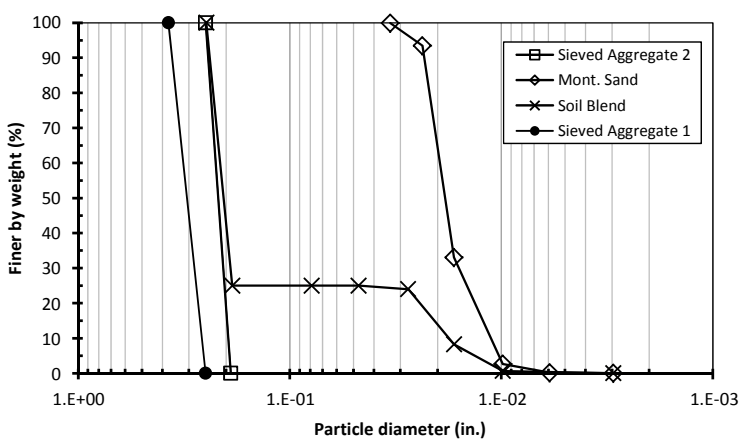
Pullout Rate	
1.0 mm/min.	0.04 in/min

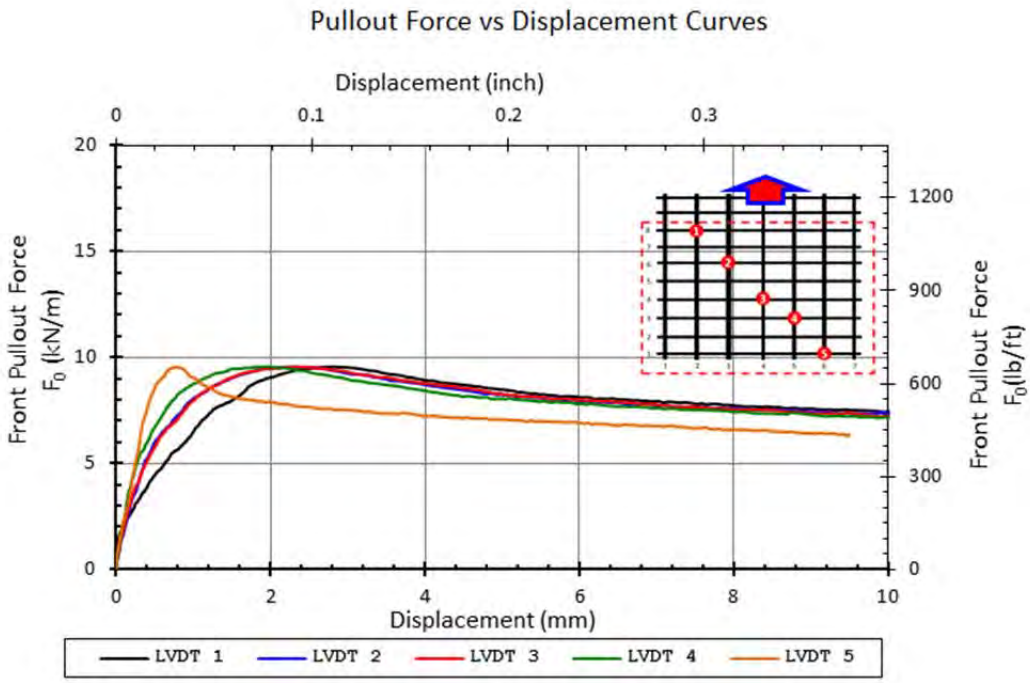
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	2.21	**%**
Dry Density (ρ_d)	1.525 **g/cm^3**	**95 pcf**

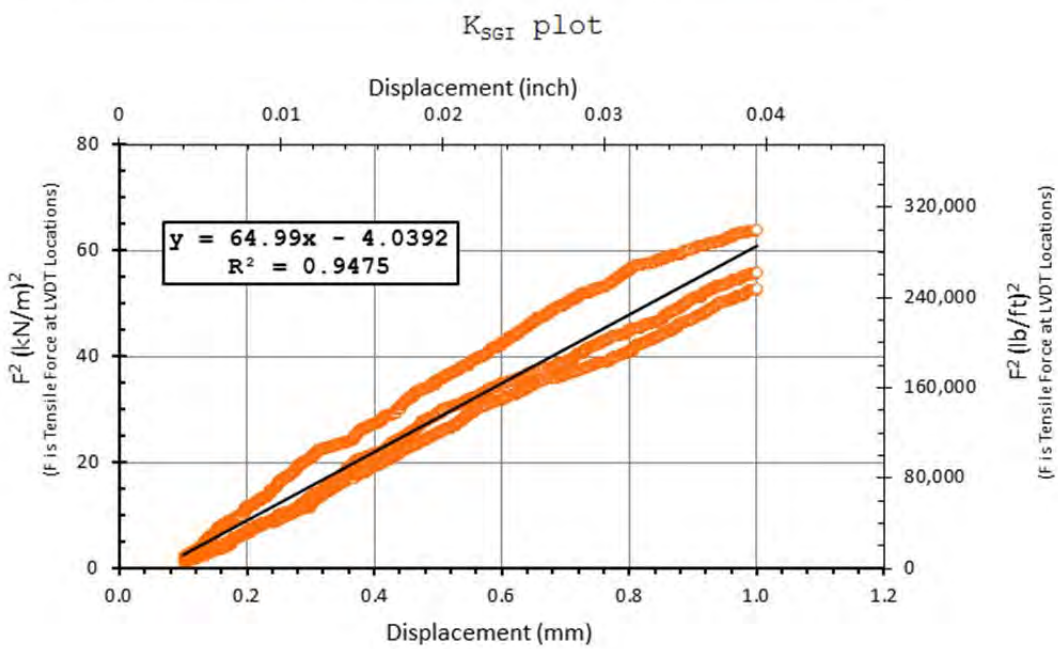
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.6	kN/m	655	lb/ft
Max Pullout Load	P_{max}	2.73	kN	628	lb
Max Shear Stress	τ_{max}	36.6	kPa	5.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
65.0 (kN/m)^2/mm




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.1
0.2
0.3
Front Pullout Force
F0 (kN/m)
20
15
10
5
0
Front Pullout Force
F0(lb/ft)
1200
900
600
300
0
0
2
4
6
8
10
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


KSGI plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
F2 (kN/m)2
(F is Tensile Force at LVDT Locations)
80
60
40
20
0
y = 64.99x - 4.0392
R2 = 0.9475
F2 (lb/ft)2
(F is Tensile Force at LVDT Locations)
320,000
240,000
160,000
80,000
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	10/18/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.285	m	0.245	m
	---	0.935	ft	0.935	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.0	1.181
2	80.0	3.150
3	115.0	4.528
4	145.0	5.709
5	225.0	8.858

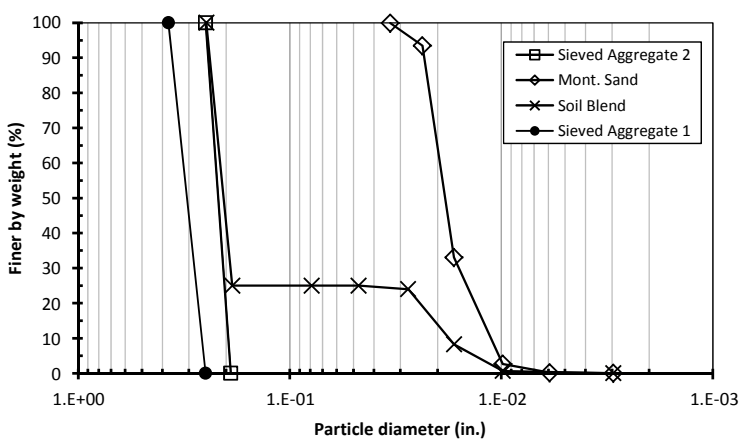
Pullout Rate	
1.0 mm/min.	0.04 in/min

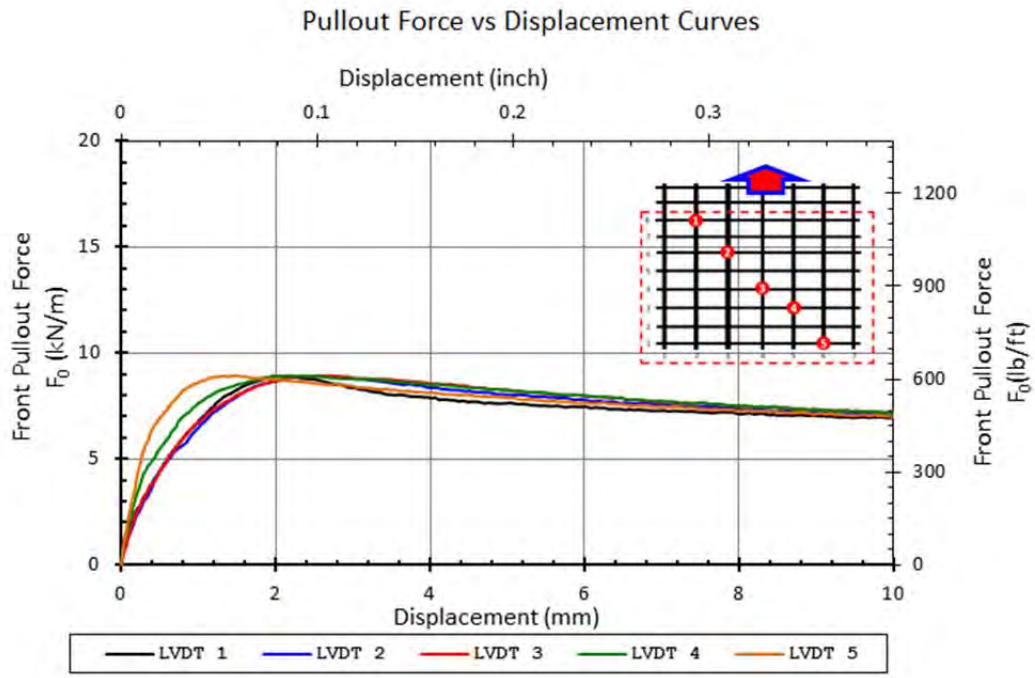
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.13	**%**
Dry Density (ρ_d)	1.545 **g/cm^3**	**96 pcf**

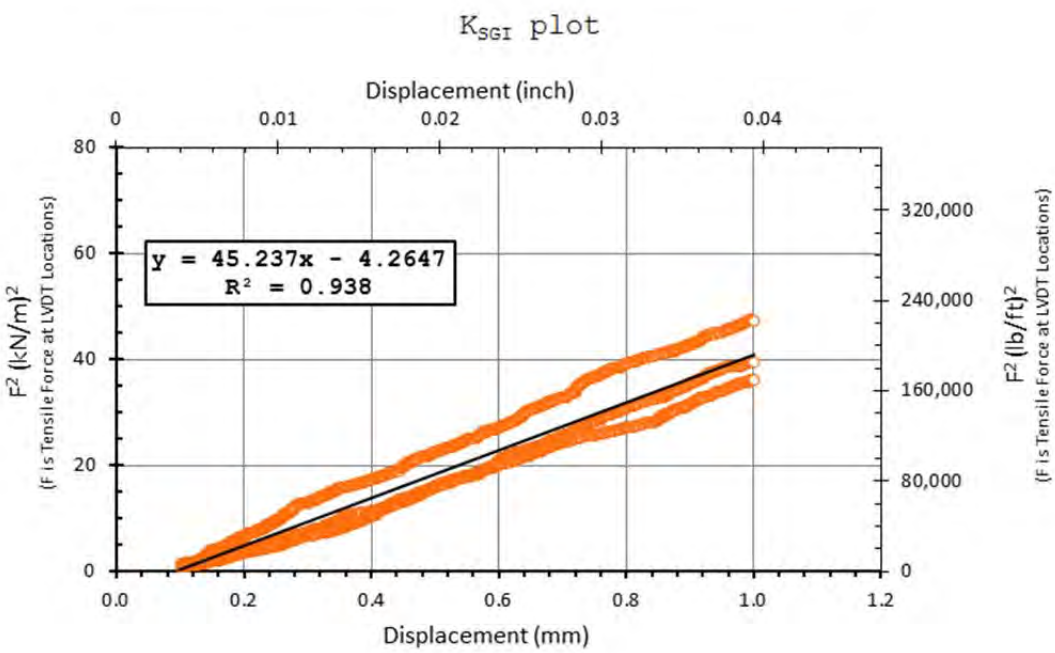
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.9	kN/m	612	lb/ft
Max Pullout Load	P_{max}	2.55	kN	602	lb
Max Shear Stress	τ_{max}	34.2	kPa	5.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
45.2 (kN/m)^2/mm







Comments:

Distance between LVDTs wires on the specimen were not measured and are based on the distances in previous tests.

SMALL PULLOUT TEST

Date test conducted	11/15/2008
Done by	Eddy/Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.285	m	0.245	m
	---	0.935	ft	0.935	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.7	0.698
2	103.4	4.071
3	131.9	5.191
4	160.9	6.336
5	222.1	8.744

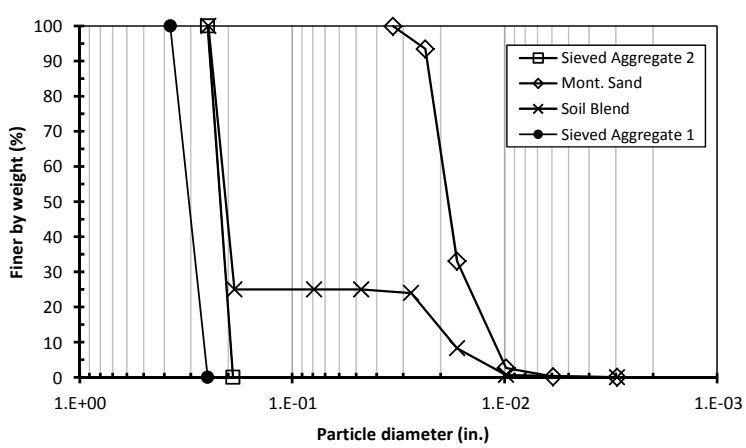
Pullout Rate	
1.0 mm/min.	0.04 in/min

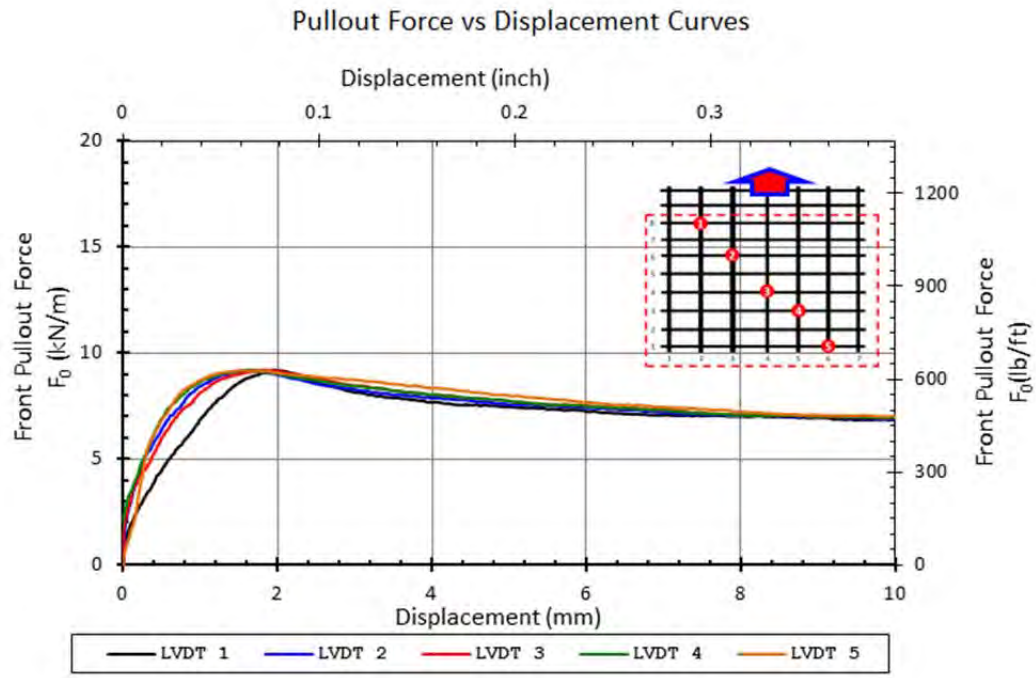
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.13	**%**
Dry Density (ρ_d)	1.570 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

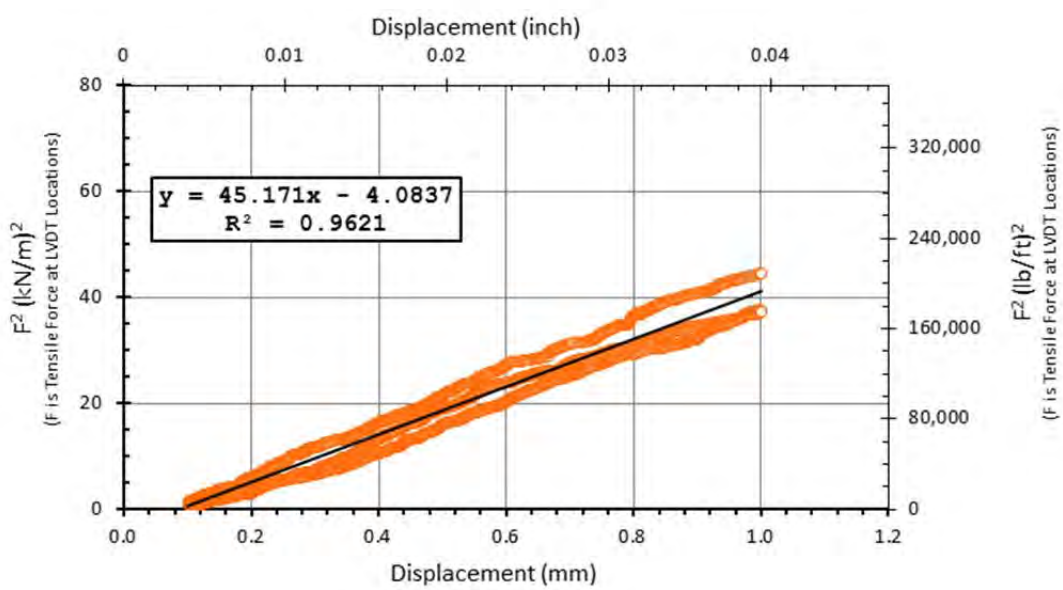
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.2	kN/m	630	lb/ft
Max Pullout Load	P_{max}	2.62	kN	606	lb
Max Shear Stress	τ_{max}	35.2	kPa	5.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	33	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
45.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/25/2008
Done by	Eddy

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	---	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	5.2	0.206
2	46.4	1.828
3	100.0	3.937
4	140.3	5.523
5	213.7	8.415

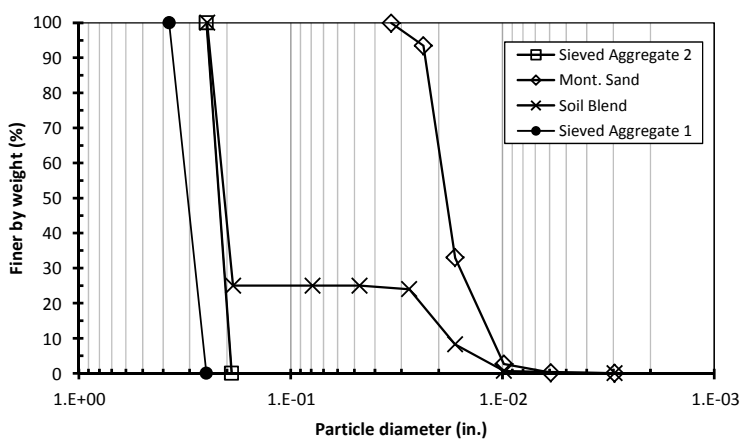
Pullout Rate	
1.0 mm/min.	0.04 in/min

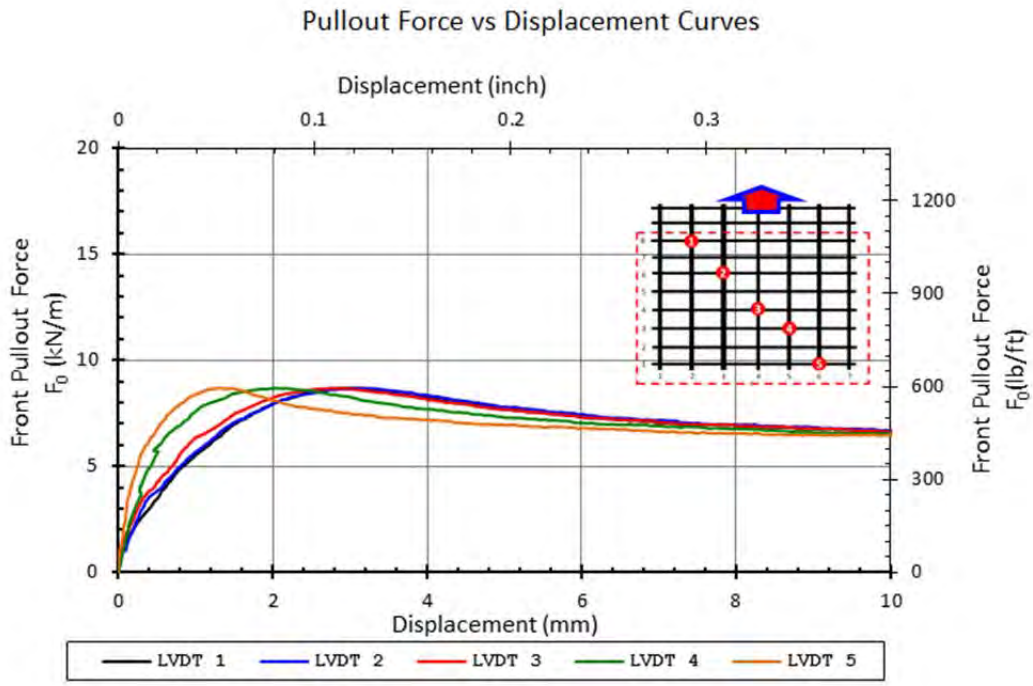
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.13	**%**
Dry Density (ρ_d)	1.538 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

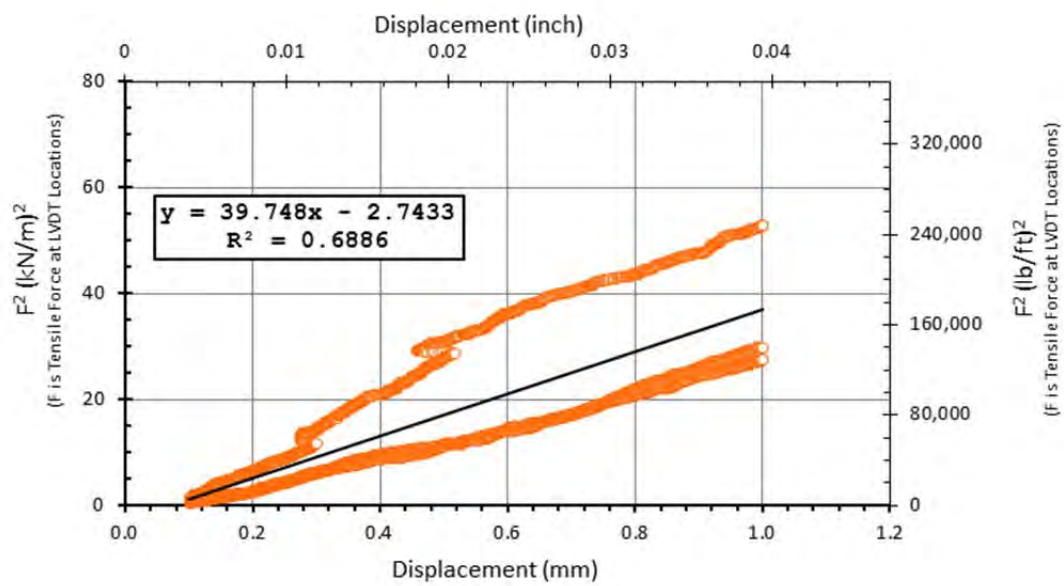
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.7	kN/m	595	lb/ft
Max Pullout Load	P_{max}	2.43	kN	555	lb
Max Shear Stress	τ_{max}	32.7	kPa	4.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
39.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Grip slightly tilted to the right at the end of test.

SMALL PULLOUT TEST

Date test conducted	10/17/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.276	m	0.276	m	0.245	m
	---	0.906	ft	0.906	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.0	0.748
2	86.0	3.386
3	119.5	4.705
4	153.0	6.024
5	220.0	8.661

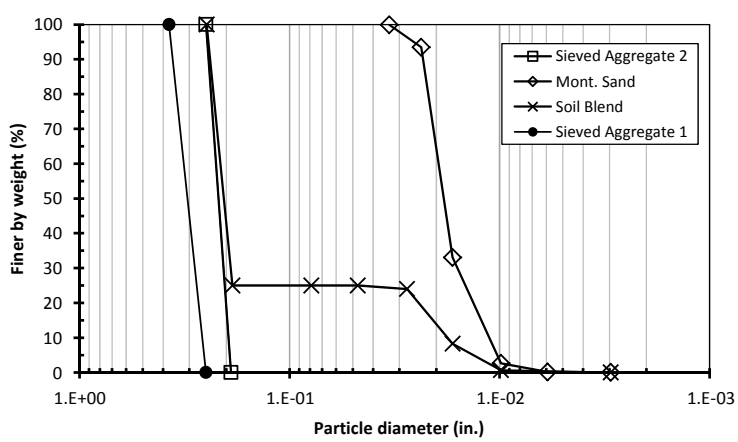
Pullout Rate	
1.0 mm/min.	0.04 in/min

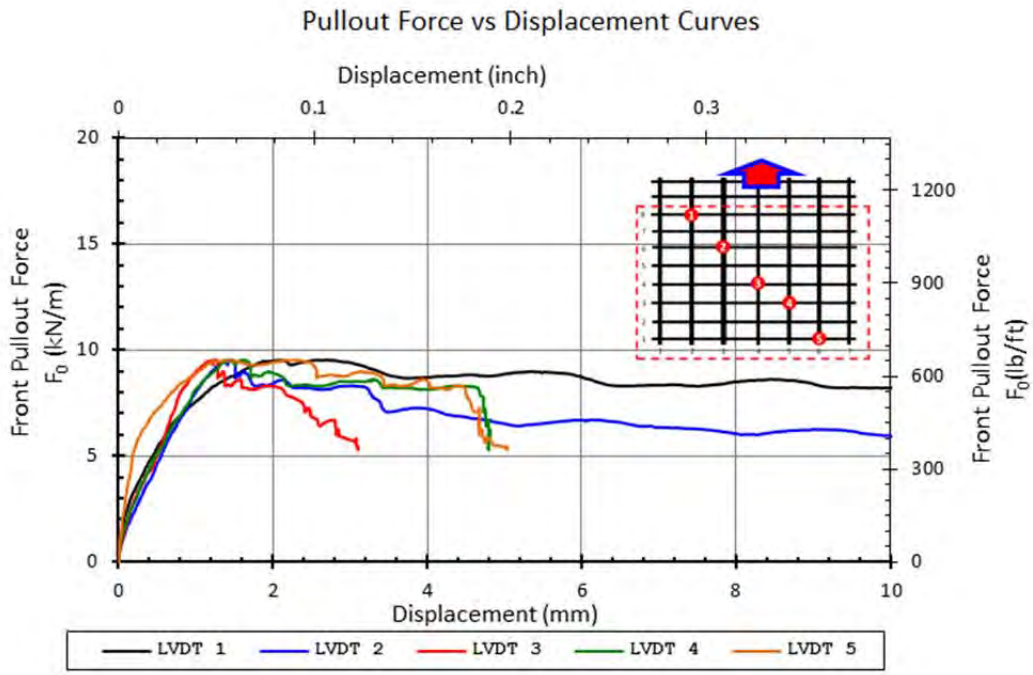
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.540 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

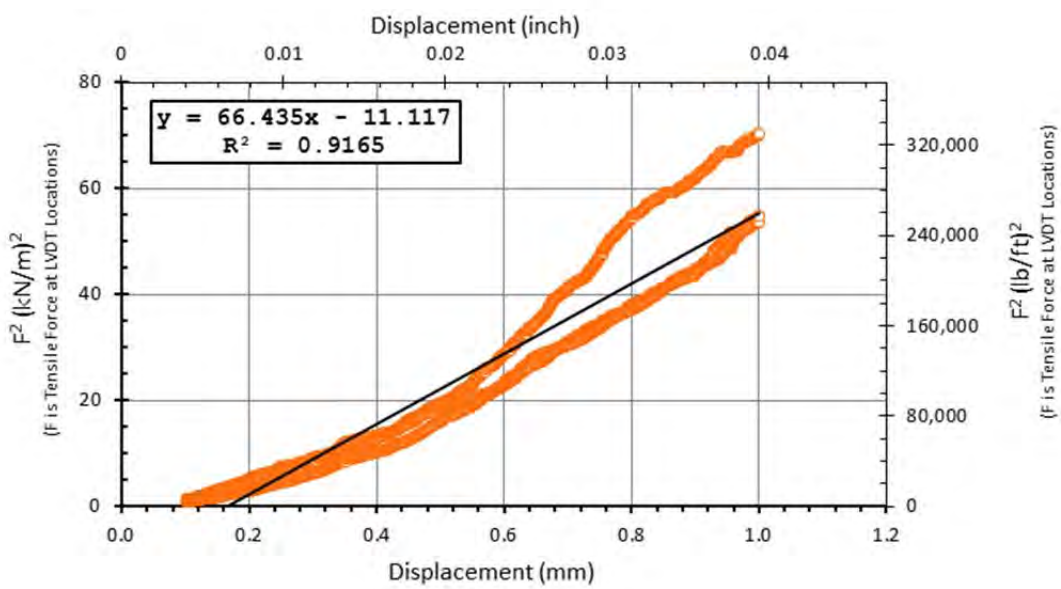
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.5	kN/m	653	lb/ft
Max Pullout Load	P_{max}	2.63	kN	620	lb
Max Shear Stress	τ_{max}	35.4	kPa	5.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
66.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	12/5/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.276	m	0.276	m	0.245	m
	0	0.906	ft	0.906	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	0.9	0.035
2	41.4	1.630
3	96.5	3.798
4	137.7	5.422
5	208.7	8.215

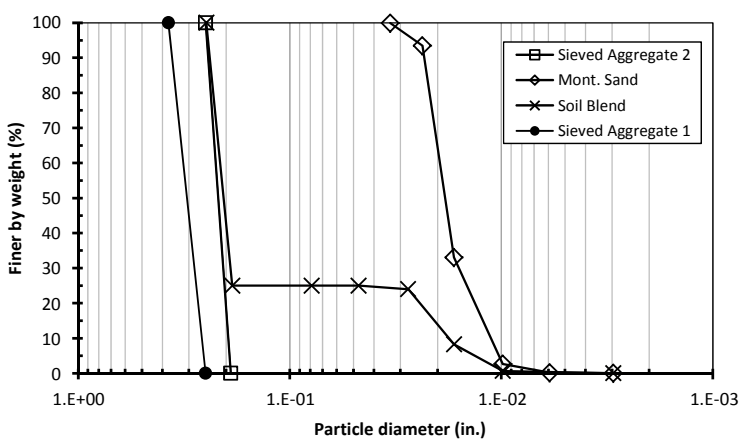
Pullout Rate	
1.0 mm/min.	0.04 in/min

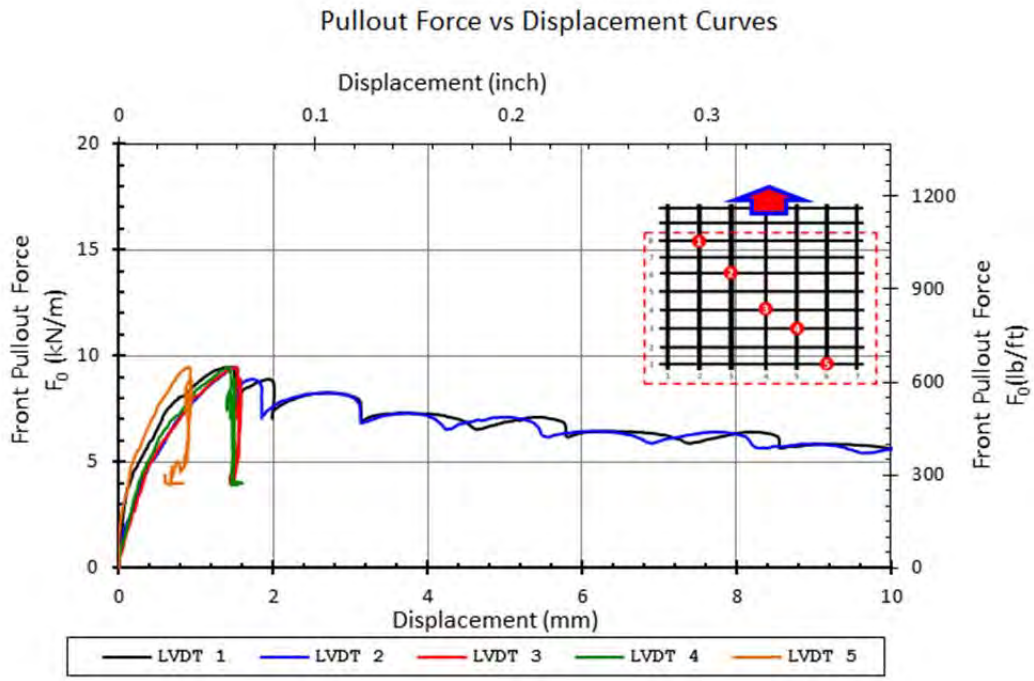
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.13	**%**
Dry Density (ρ_d)	1.545 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

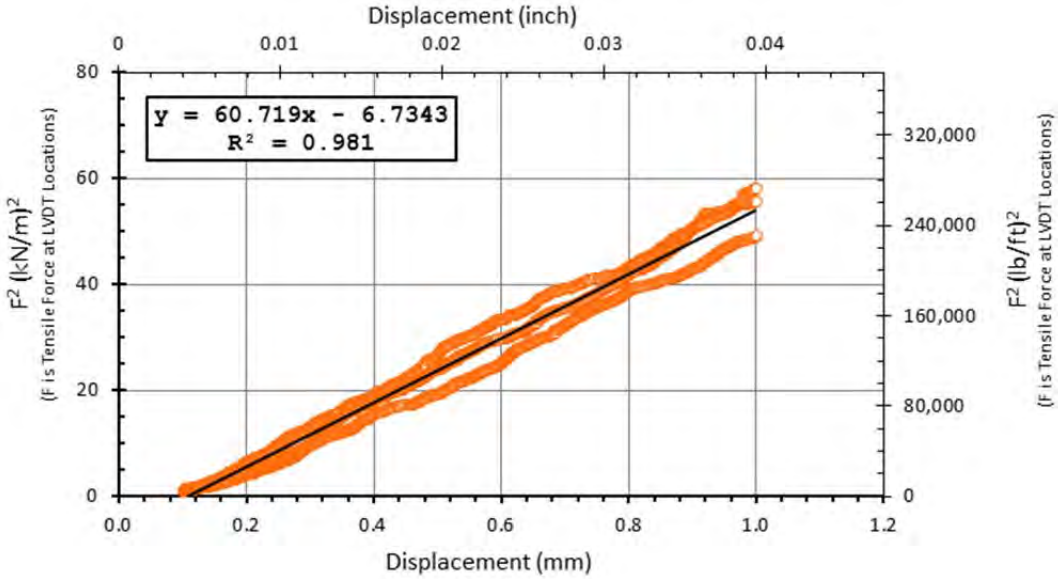
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.5	kN/m	649	lb/ft
Max Pullout Load	P_{max}	2.61	kN	608	lb
Max Shear Stress	τ_{max}	35.1	kPa	5.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
60.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/17/2009
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.304	m	0.245	m
	7	0.902	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.0	1.180
2	84.9	3.341
3	143.4	5.647
4	168.4	6.628
5	227.0	8.937

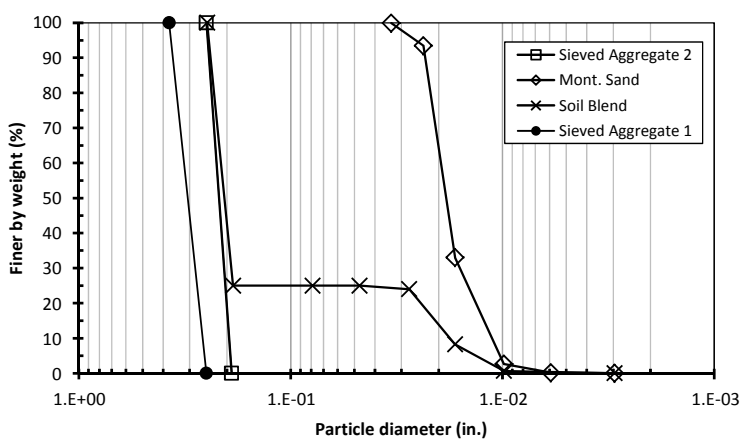
Pullout Rate	
1.0 mm/min.	0.04 in/min

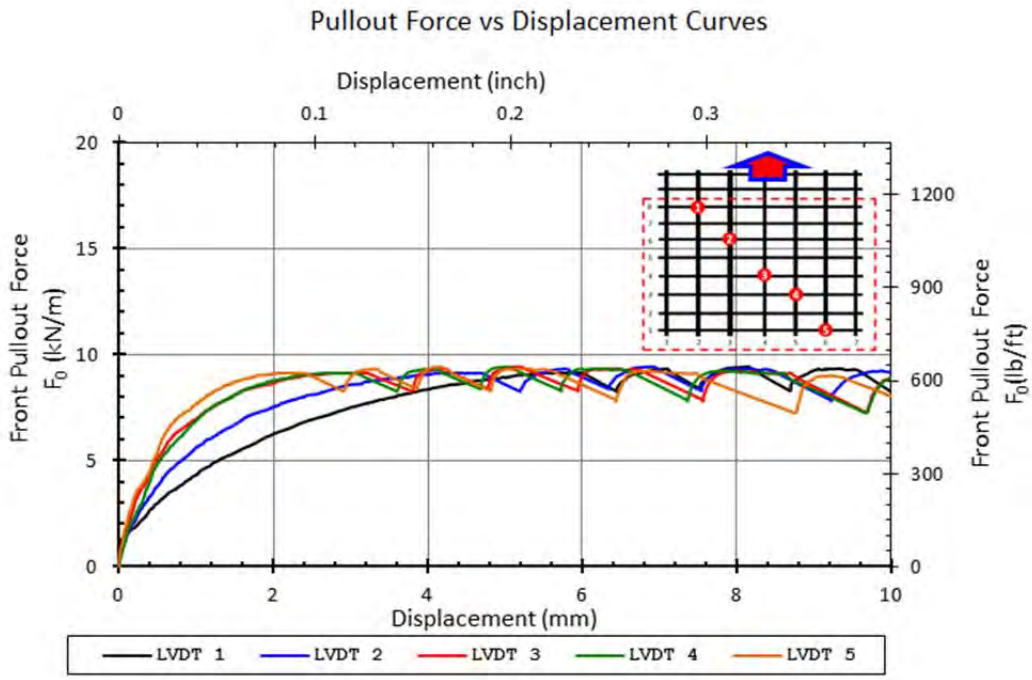
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.86	**%**
Dry Density (ρ_d)	1.532 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

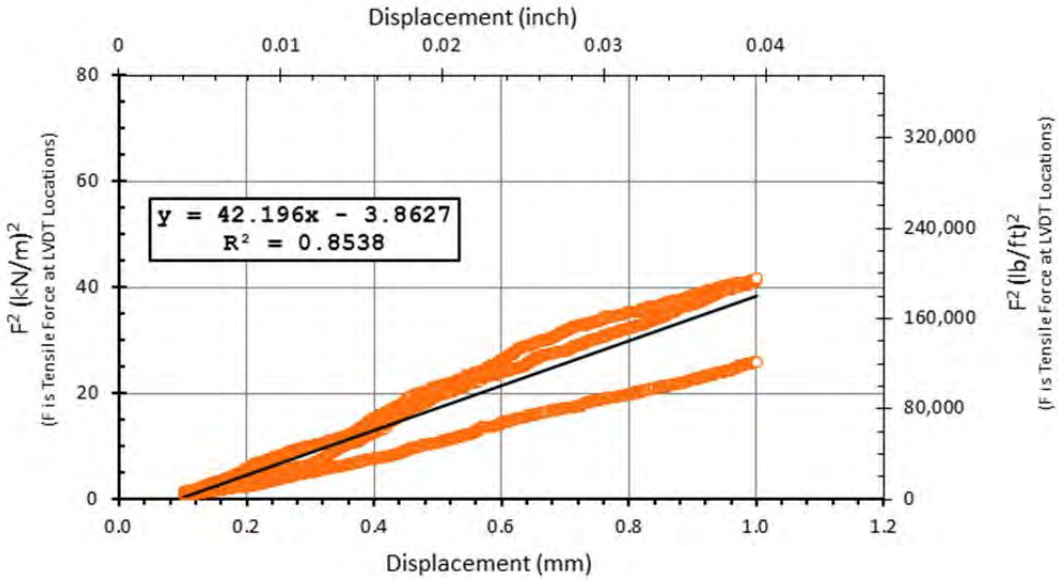
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.4	kN/m	645	lb/ft
Max Pullout Load	P_{max}	2.87	kN	654	lb
Max Shear Stress	τ_{max}	38.5	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
42.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	5/20/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.917	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.4	0.844
2	81.4	3.205
3	141.9	5.586
4	172.8	6.801
5	230.2	9.064

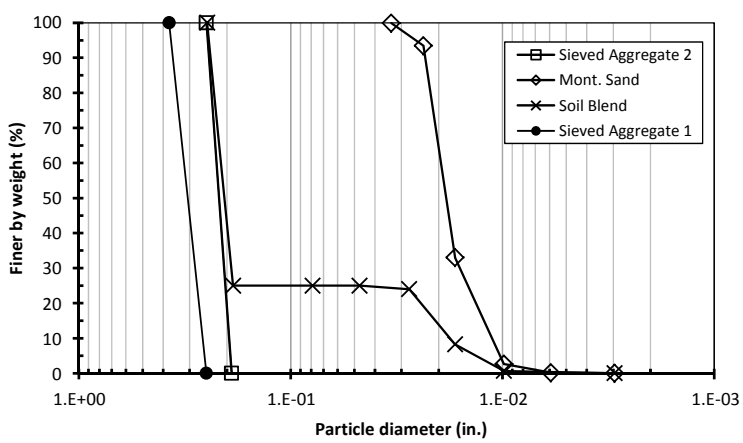
Pullout Rate	
1.0 mm/min.	0.04 in/min

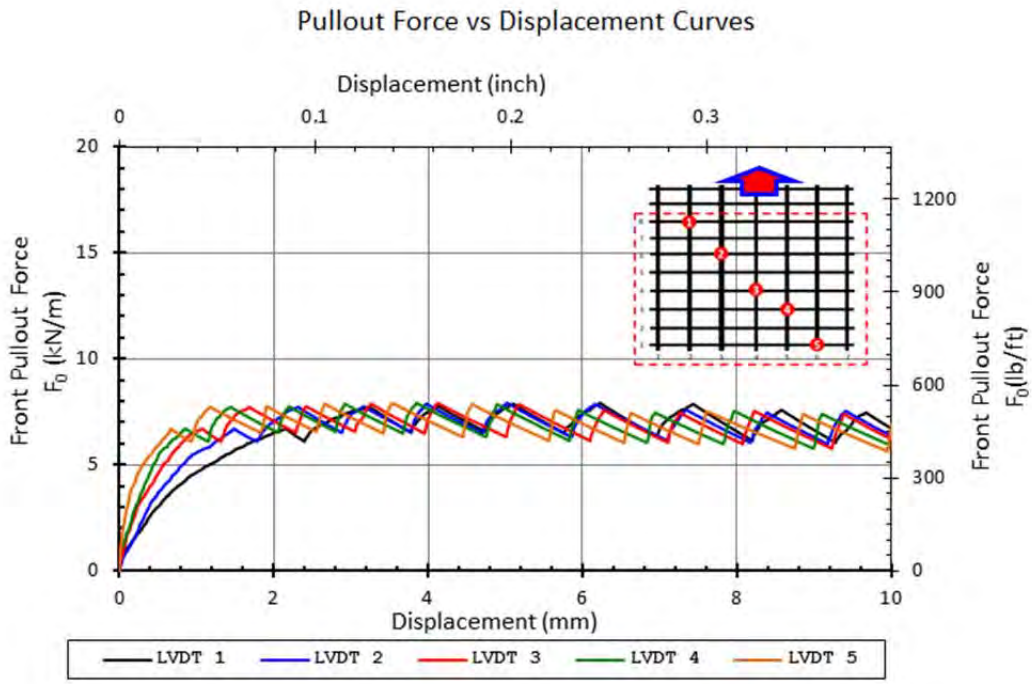
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.45	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

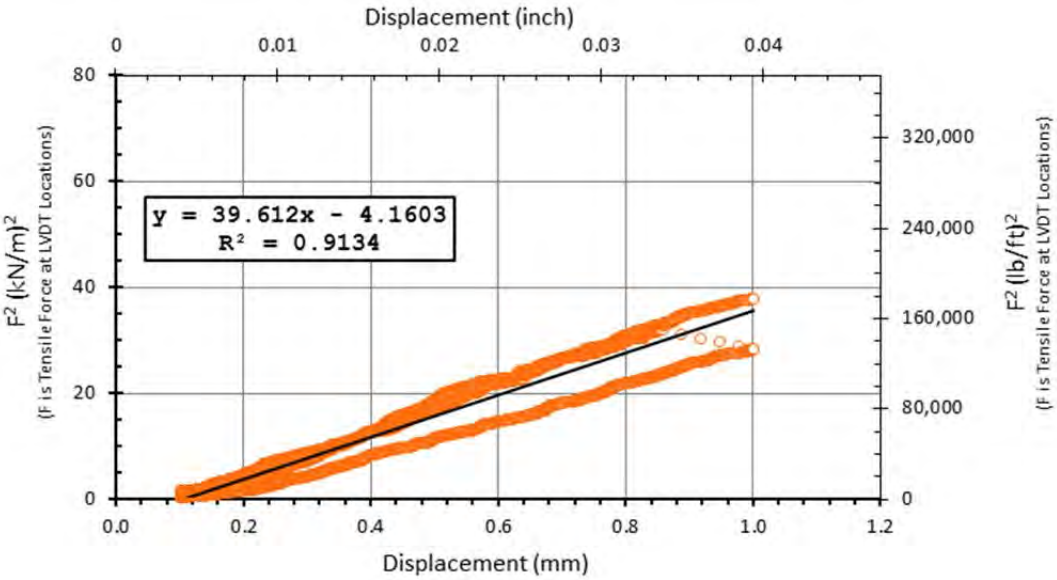
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.9	kN/m	543	lb/ft
Max Pullout Load	P_{max}	2.41	kN	560	lb
Max Shear Stress	τ_{max}	32.4	kPa	4.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
39.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/23/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.291	m	0.294	m	0.245	m
	10	0.955	ft	0.965	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	6.8	0.270
2	94.9	3.735
3	138.6	5.458
4	182.5	7.186
5	226.5	8.917

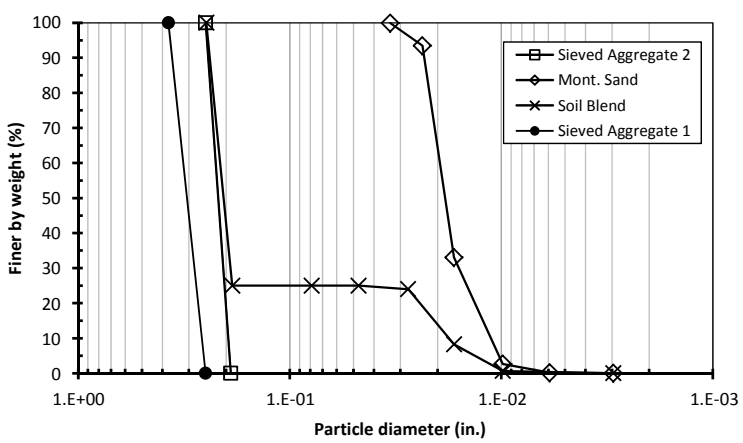
Pullout Rate	
1.0 mm/min.	0.04 in/min

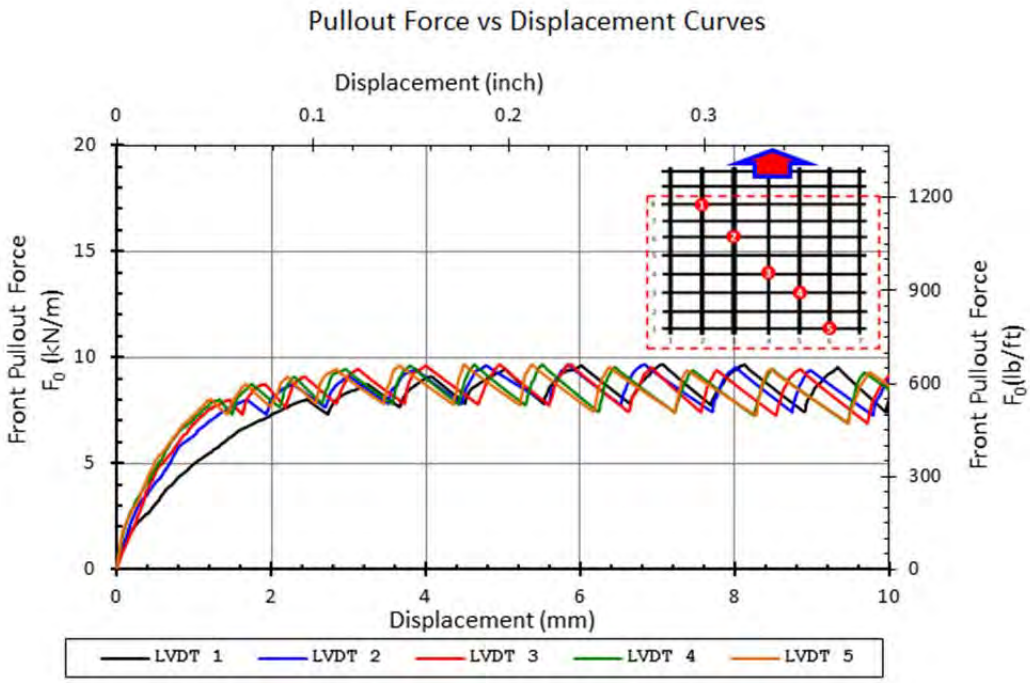
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.56	**%**
Dry Density (ρ_d)	1.532 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

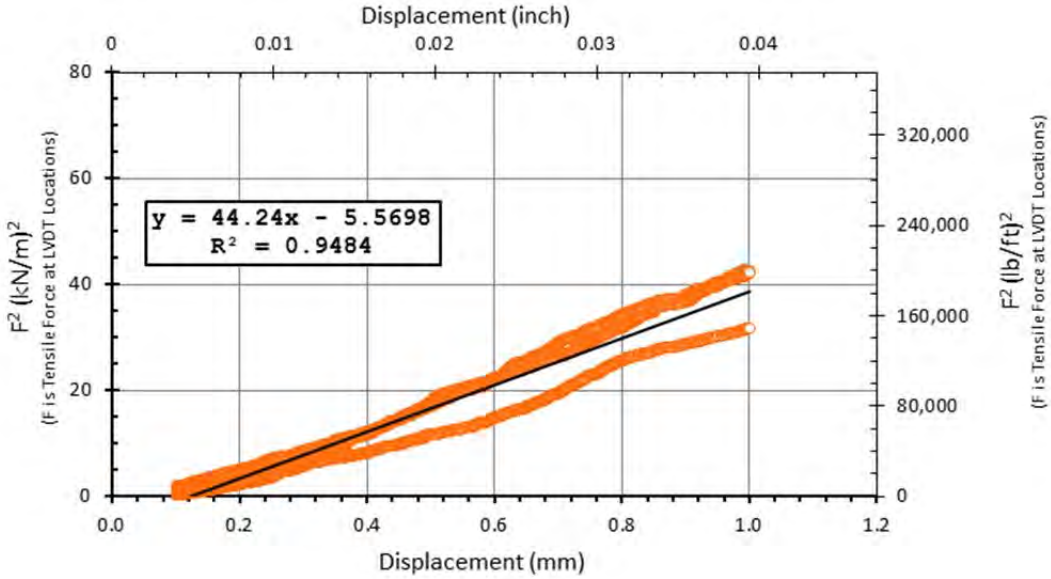
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.7	kN/m	662	lb/ft
Max Pullout Load	P_{max}	2.84	kN	649	lb
Max Shear Stress	τ_{max}	38.2	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
44.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/19/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.364	m	0.245	m
	17	0.925	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.5	0.452
2	54.5	2.146
3	98.6	3.882
4	141.9	5.585
5	227.7	8.966

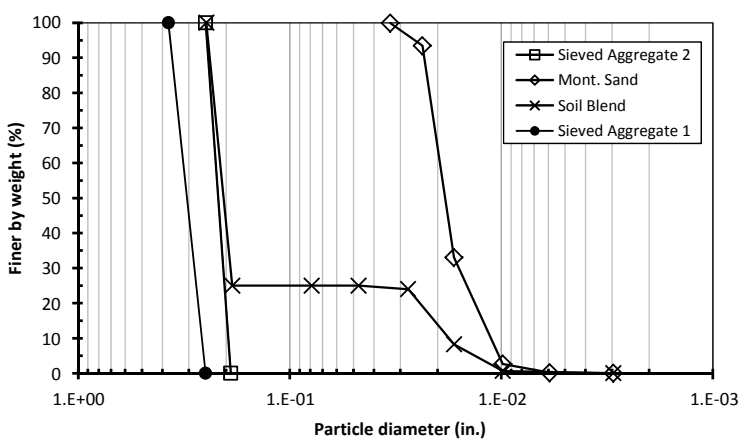
Pullout Rate	
1.0 mm/min.	0.04 in/min

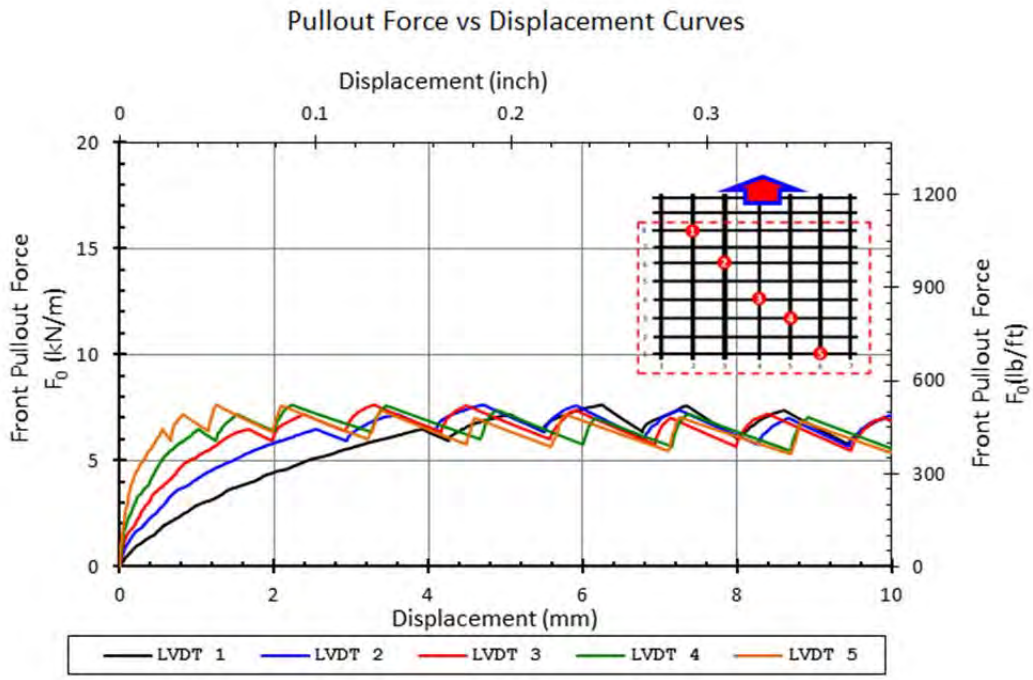
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.528 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

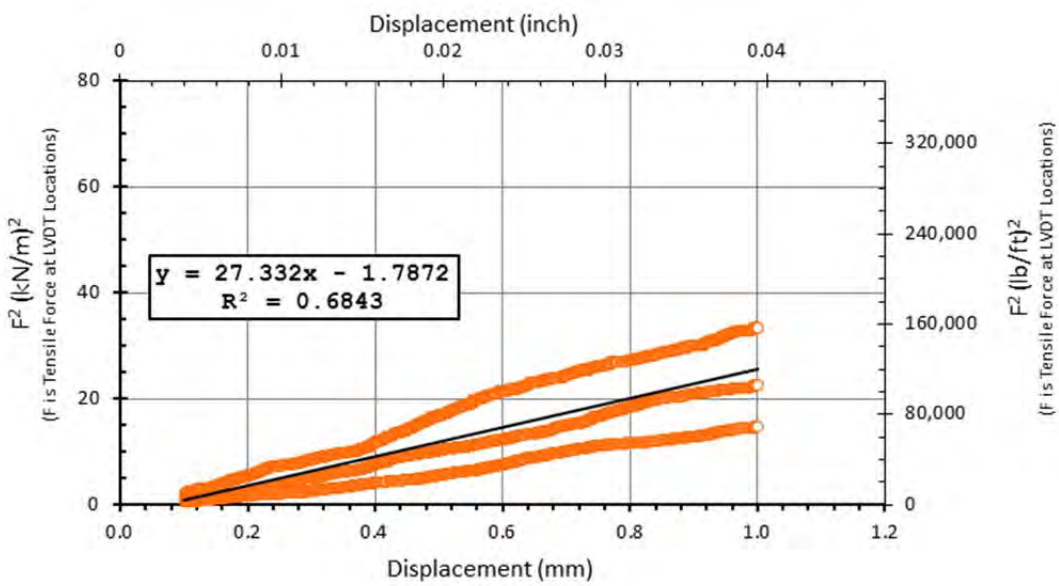
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	522	lb/ft
Max Pullout Load	P_{max}	2.78	kN	645	lb
Max Shear Stress	τ_{max}	37.3	kPa	5.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
27.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Water content measurements were for calculations of correcting the water content. The water content was corrected to 1.50% before running this test.

SMALL PULLOUT TEST

Date test conducted	1/20/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.2	0.402
2	54.6	2.150
3	96.5	3.799
4	140.0	5.512
5	226.5	8.917

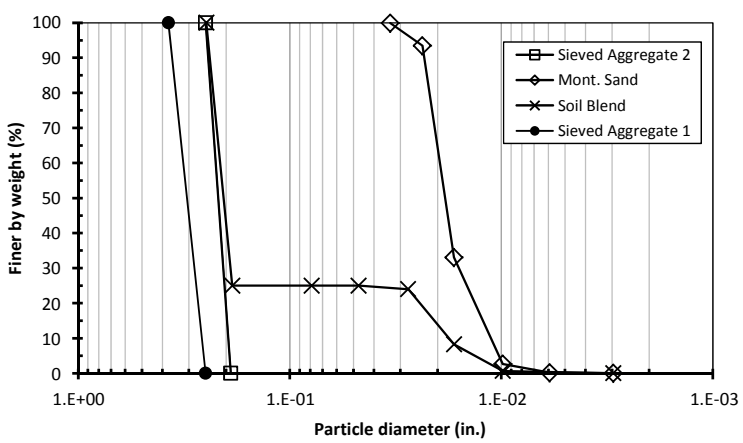
Pullout Rate	
1.0 mm/min.	0.04 in/min

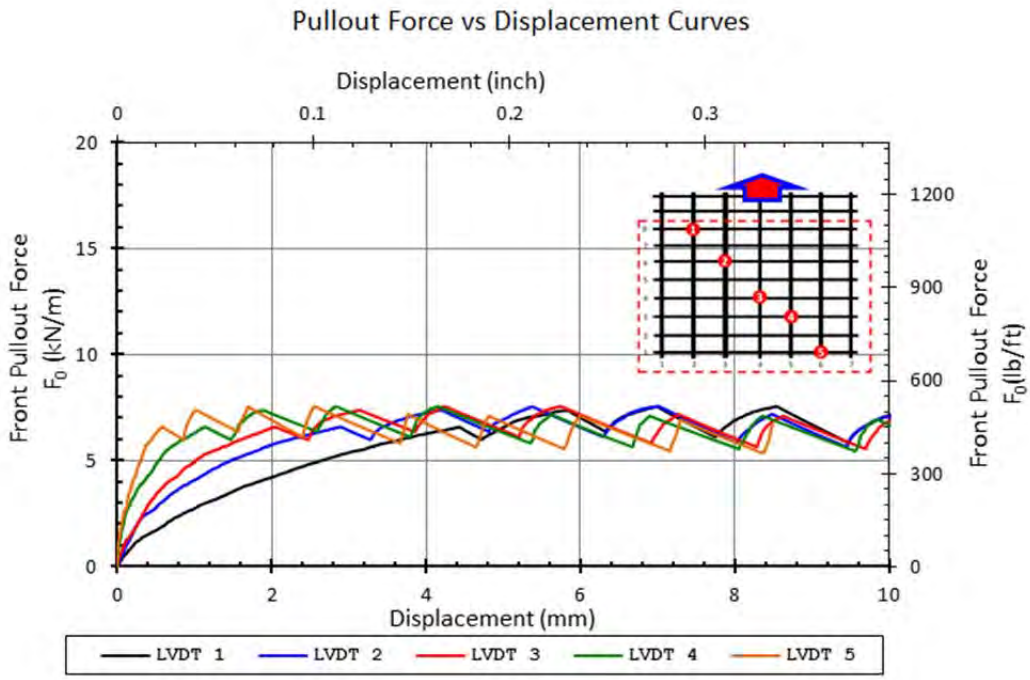
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.78	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

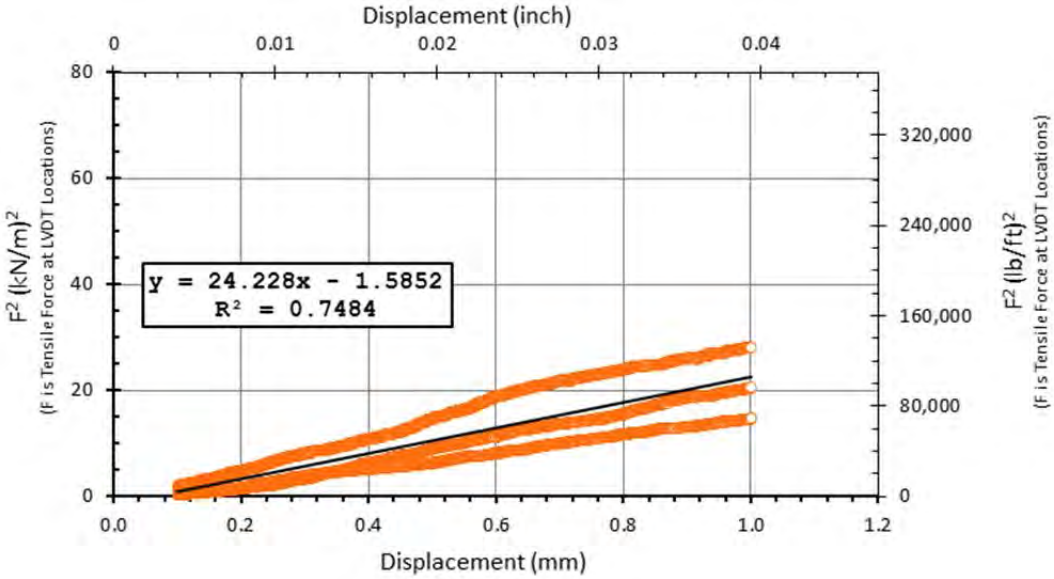
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	518	lb/ft
Max Pullout Load	P_{max}	2.75	kN	636	lb
Max Shear Stress	τ_{max}	37.0	kPa	5.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
24.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/21/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.3	0.326
2	54.0	2.126
3	97.1	3.823
4	142.2	5.598
5	230.1	9.059

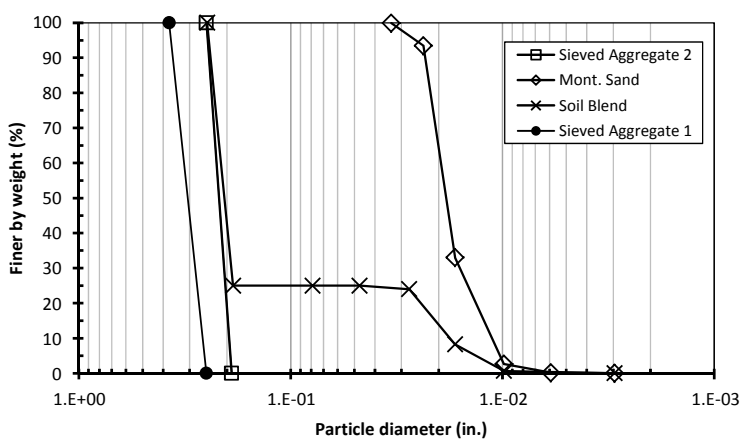
Pullout Rate	
1.0 mm/min.	0.04 in/min

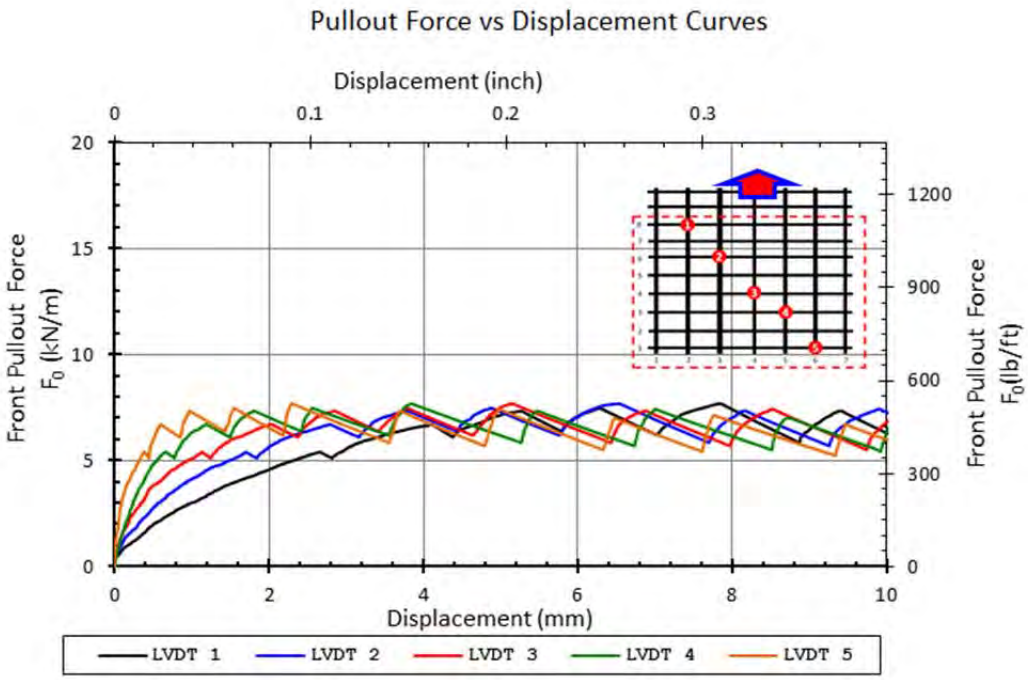
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.78	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

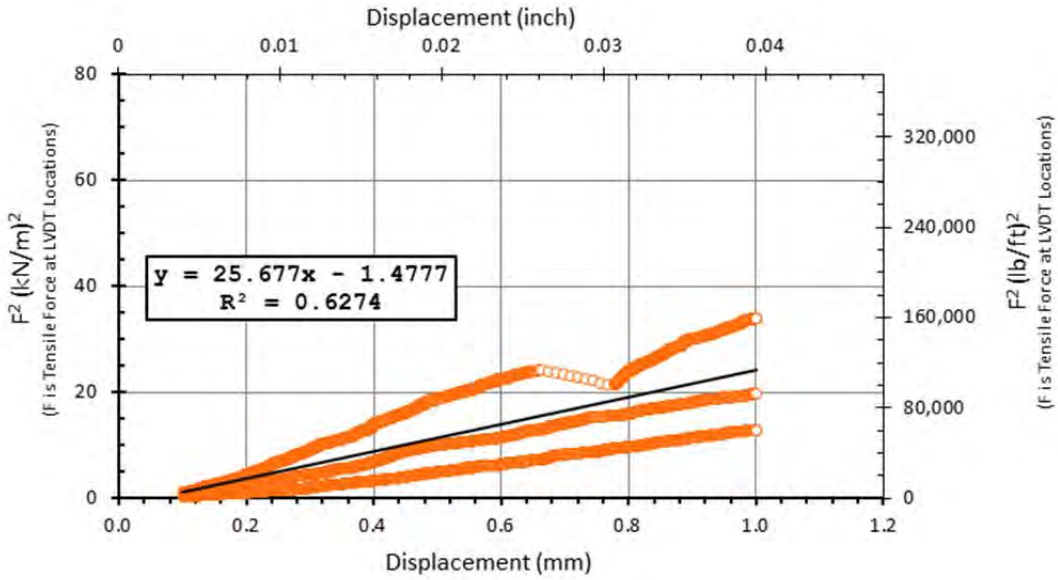
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.7	kN/m	527	lb/ft
Max Pullout Load	P_{max}	2.80	kN	631	lb
Max Shear Stress	τ_{max}	37.7	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
25.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/2/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	3.3	0.130
2	70.0	2.756
3	103.9	4.091
4	138.3	5.445
5	222.7	8.768

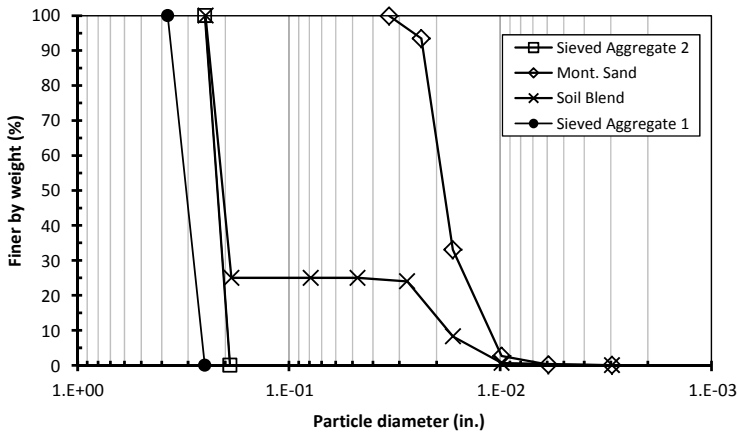
Pullout Rate			
1.0	mm/min.	0.04	in/min

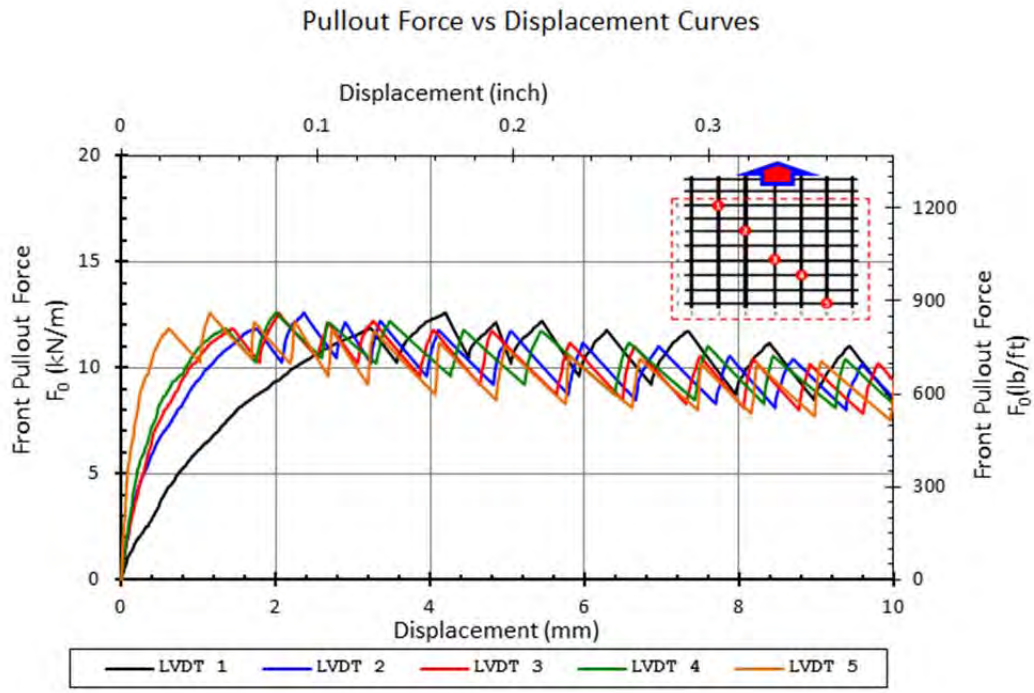
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.50	**%**	
Dry Density (ρ_d)	1.379 **g/cm^3**	**86**	**pcf**

Note: particle size distribution curve shown below

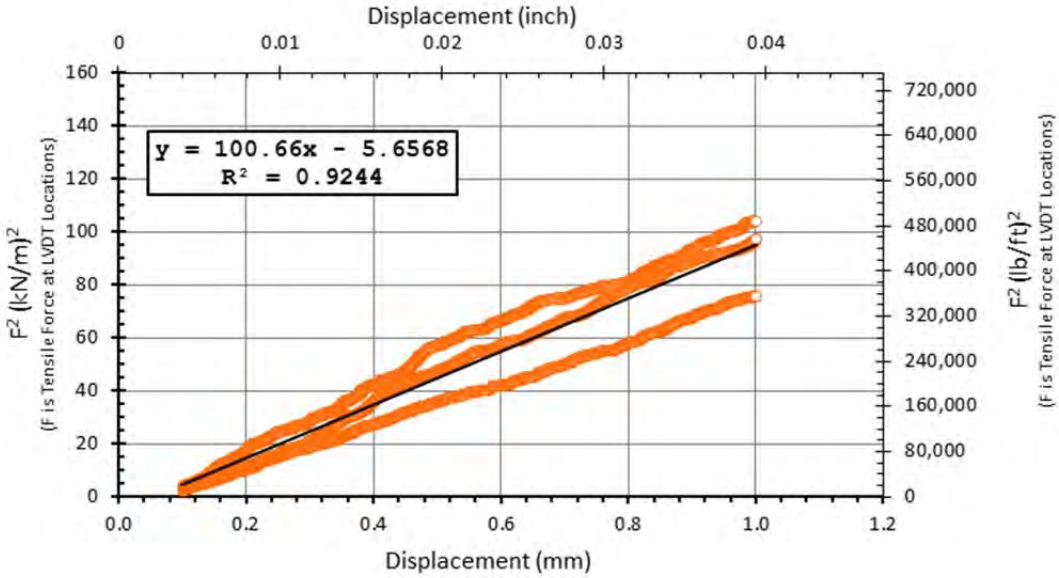
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.6	kN/m	863	lb/ft
Max Pullout Load	P_{max}	2.66	kN	617	lb
Max Shear Stress	τ_{max}	35.7	kPa	5.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
100.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/3/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	4.3	0.168
2	71.6	2.819
3	105.2	4.143
4	138.4	5.448
5	222.8	8.770

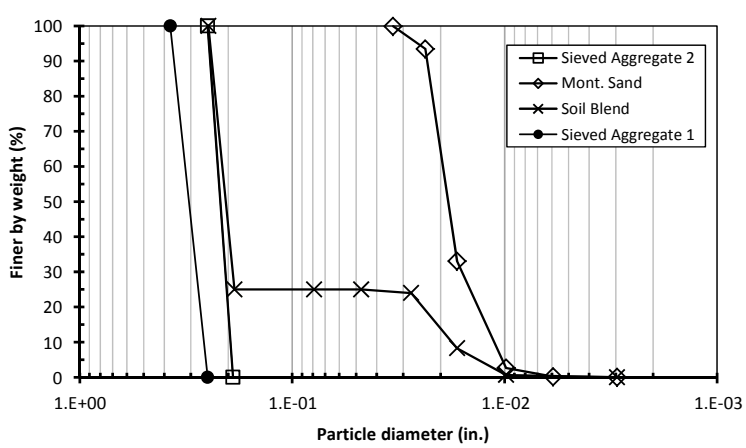
Pullout Rate	
1.0 mm/min.	0.04 in/min

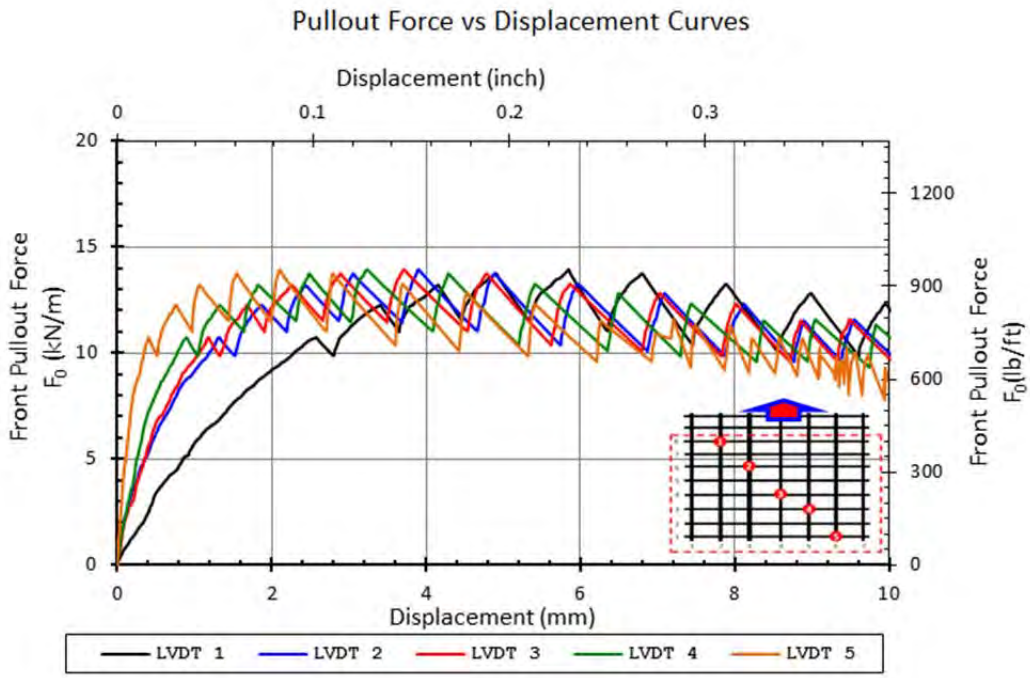
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.489 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

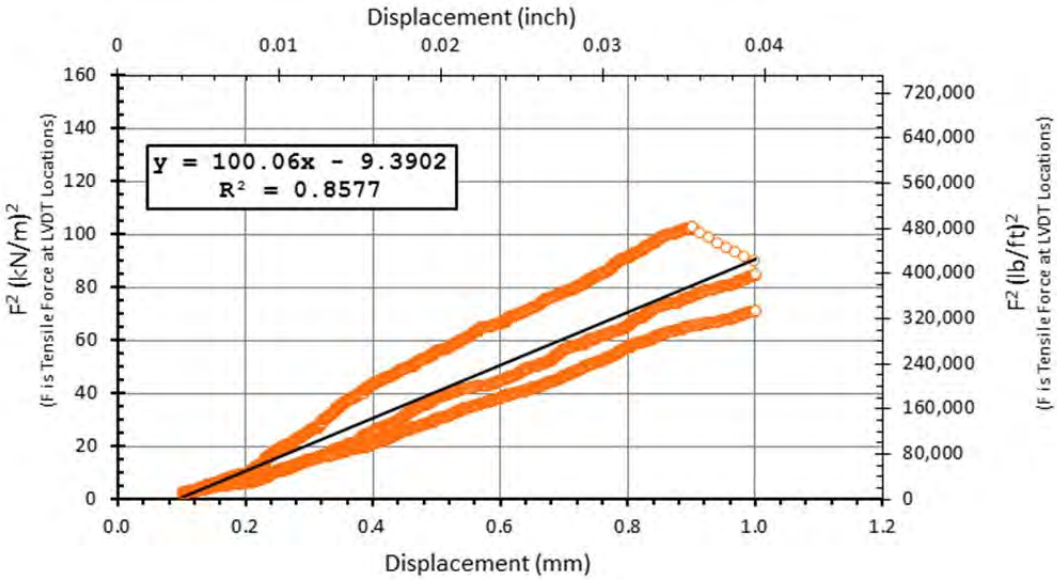
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.9	kN/m	955	lb/ft
Max Pullout Load	P_{max}	2.94	kN	681	lb
Max Shear Stress	τ_{max}	39.5	kPa	5.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
100.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/16/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	6	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.3	0.325
2	52.9	2.081
3	98.7	3.885
4	143.5	5.648
5	233.3	9.185

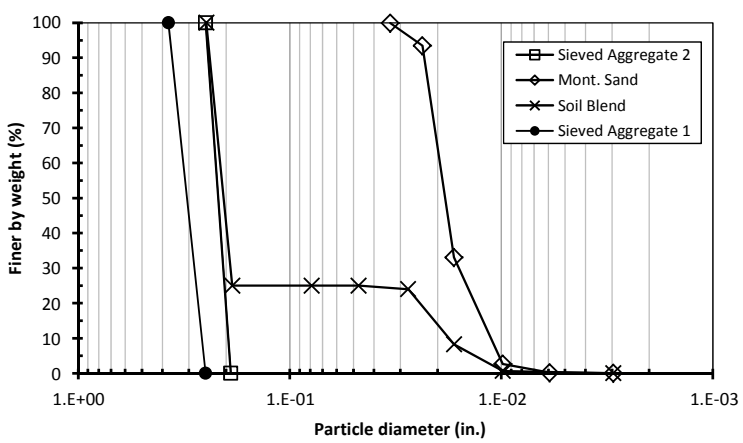
Pullout Rate	
1.0 mm/min.	0.04 in/min

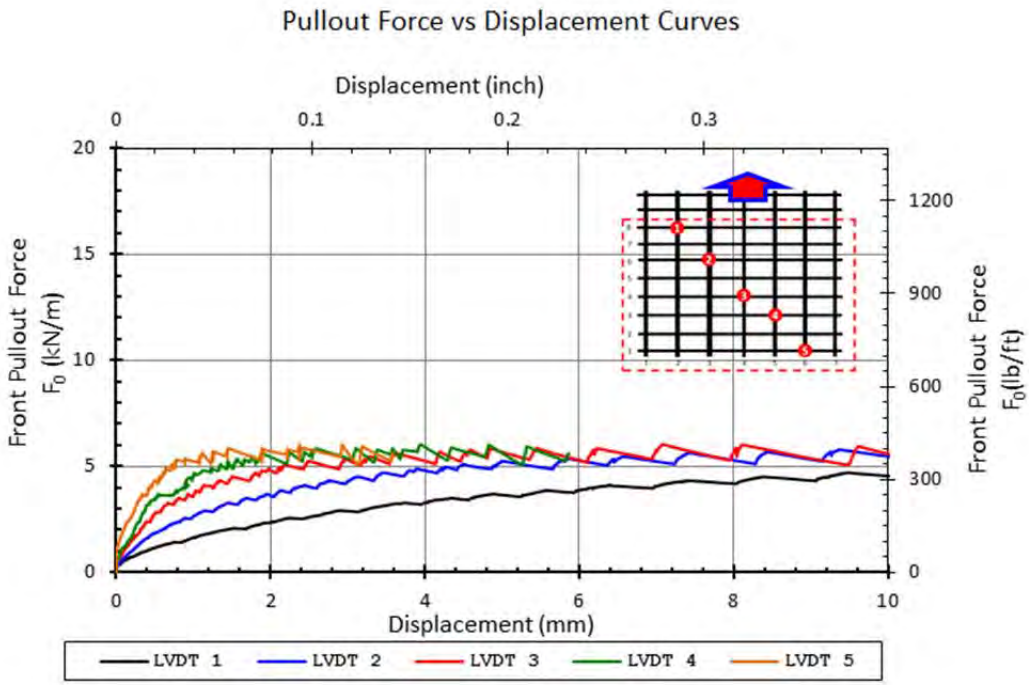
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.554 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

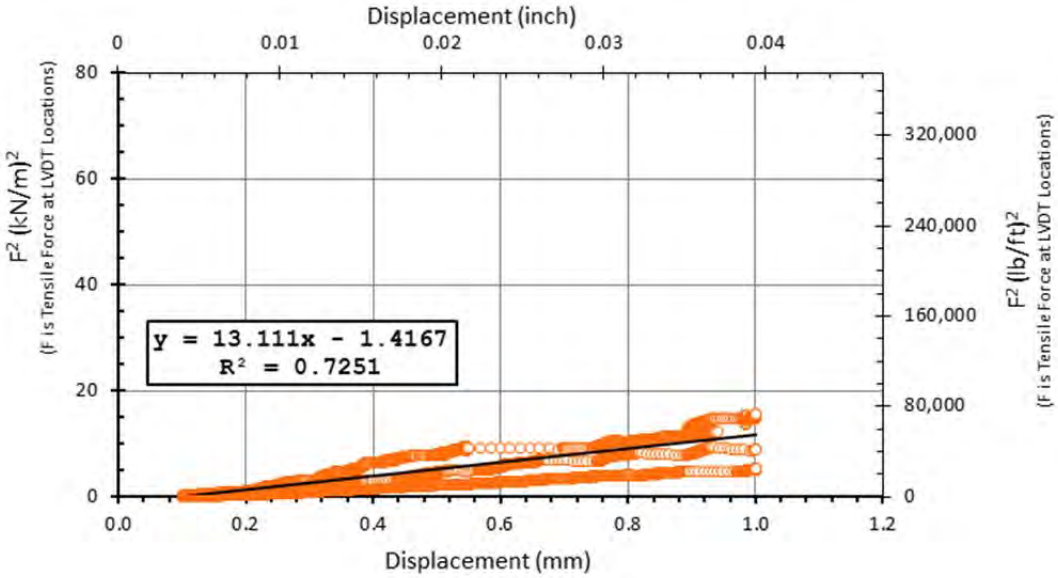
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.0	kN/m	413	lb/ft
Max Pullout Load	P_{max}	1.81	kN	358	lb
Max Shear Stress	τ_{max}	24.3	kPa	3.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	32	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
13.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/19/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.300	m	0.245	m
	6	0.925	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	4.5	0.178
2	51.5	2.028
3	97.9	3.853
4	144.4	5.684
5	234.0	9.214

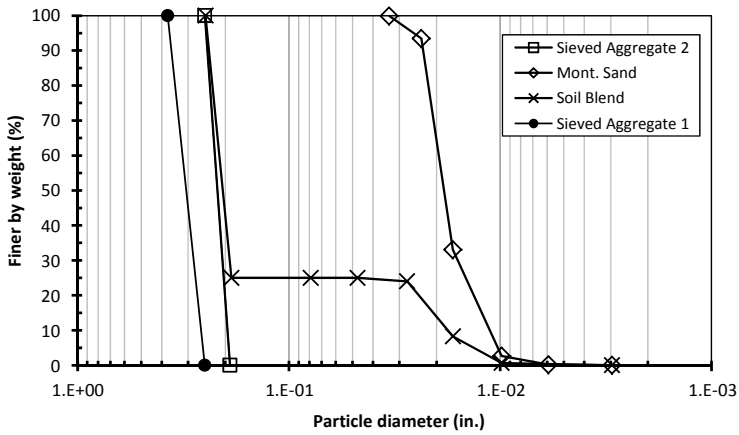
Pullout Rate	
1.0 mm/min.	0.04 in/min

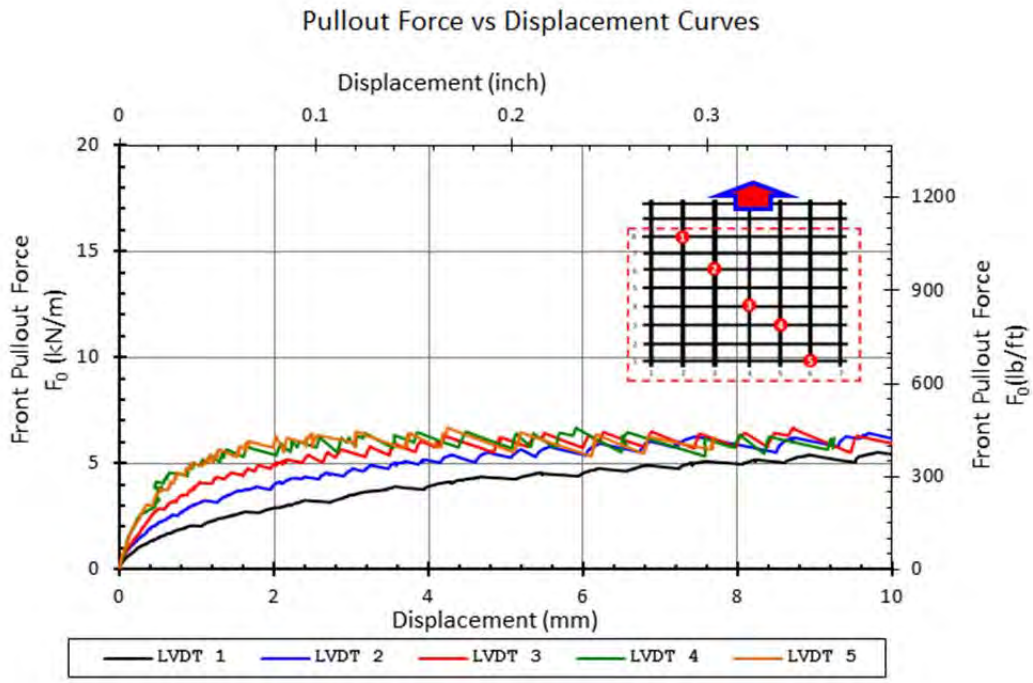
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.45	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

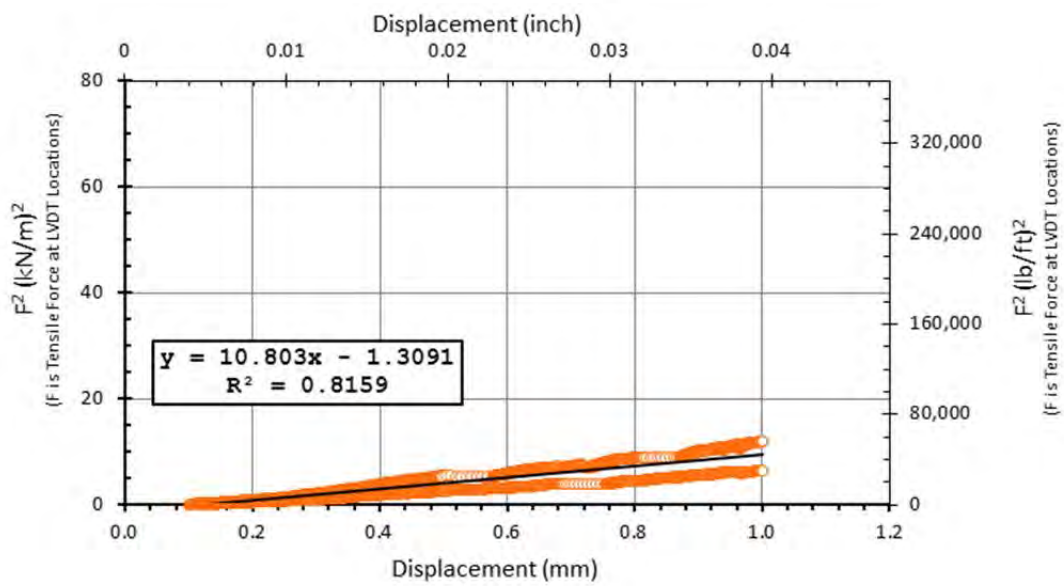
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.7	kN/m	457	lb/ft
Max Pullout Load	P_{max}	2.00	kN	408	lb
Max Shear Stress	τ_{max}	26.9	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
10.8 (kN/m)^2/mm





K_{SGI} plot



Comments:

Problems with readings of LVDT 4, whose data was not used in the calculation of the KSGI

SMALL PULLOUT TEST

Date test conducted	3/5/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	6	0.919	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.0	0.512
2	62.9	2.475
3	110.5	4.352
4	160.1	6.302
5	208.5	8.210

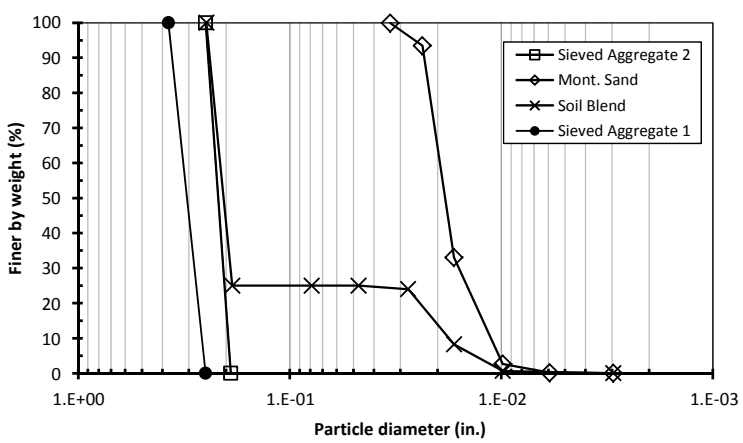
Pullout Rate	
1.0 mm/min.	0.04 in/min

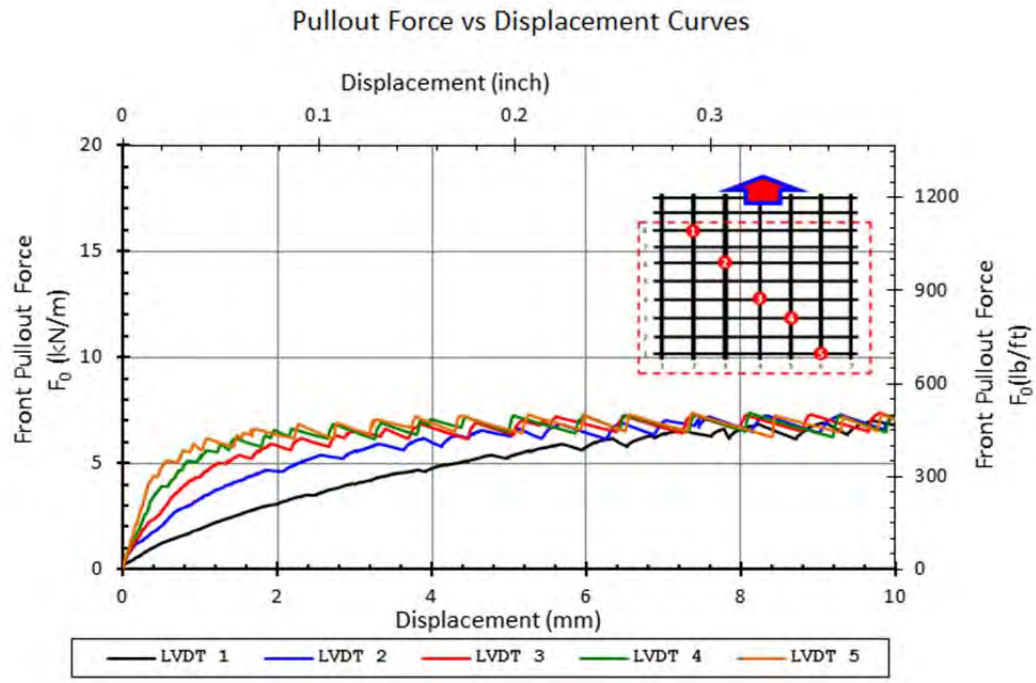
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.62	**%**
Dry Density (ρ_d)	1.522 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

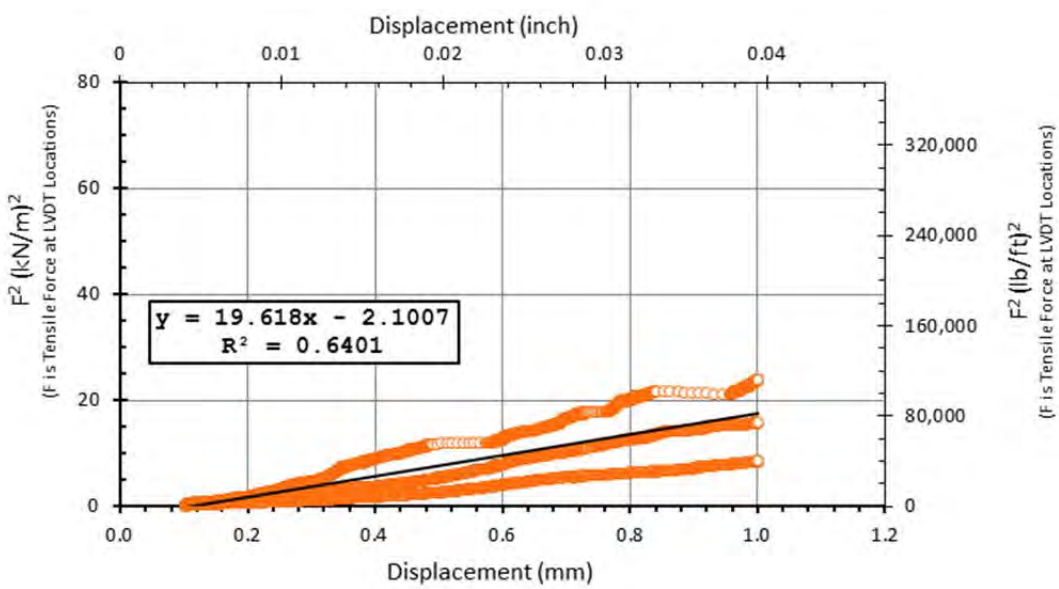
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	506	lb/ft
Max Pullout Load	P_{max}	1.93	kN	424	lb
Max Shear Stress	τ_{max}	25.9	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
19.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/9/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.261	m	0.245	m
	6	0.902	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	16.8	0.660
2	68.9	2.711
3	121.0	4.762
4	173.3	6.824
5	224.6	8.841

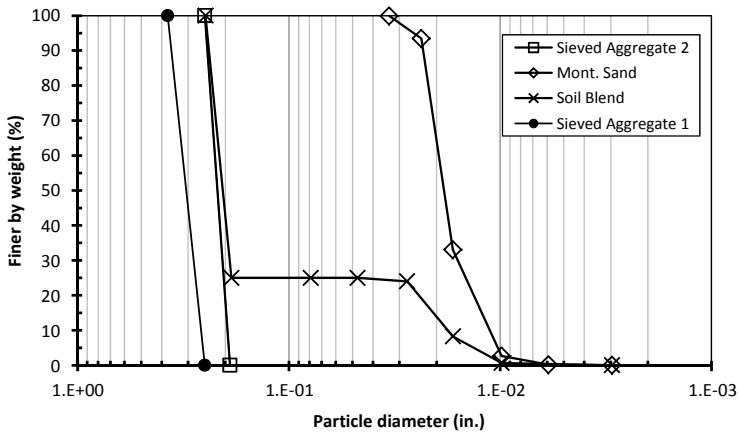
Pullout Rate			
1.0	mm/min.	0.04	in/min

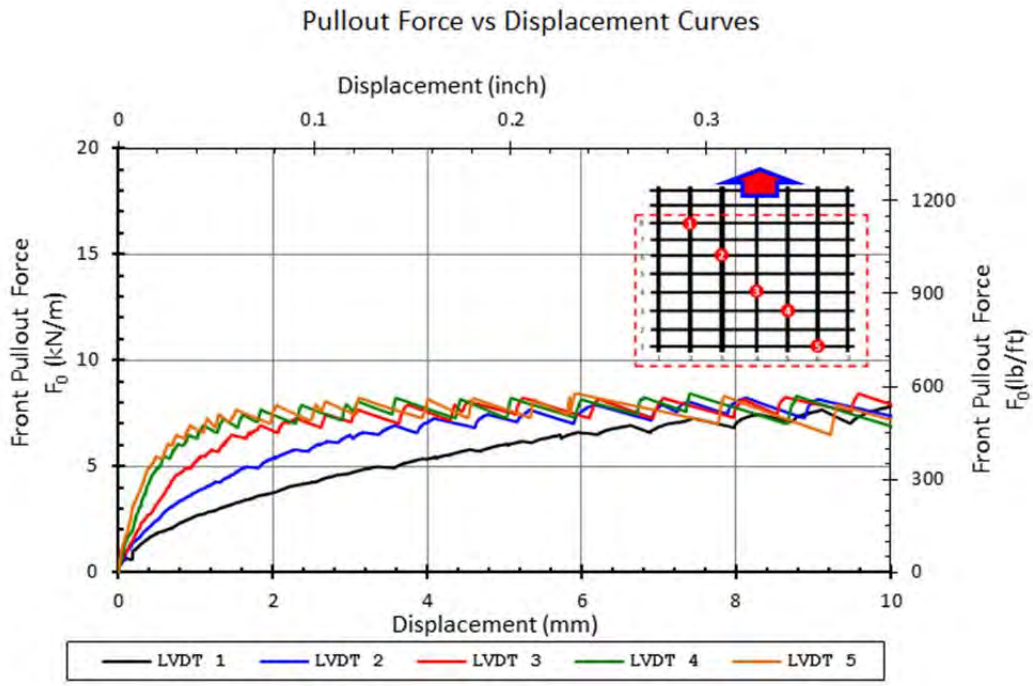
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.53	**%**
Dry Density (ρ_d)	1.523 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

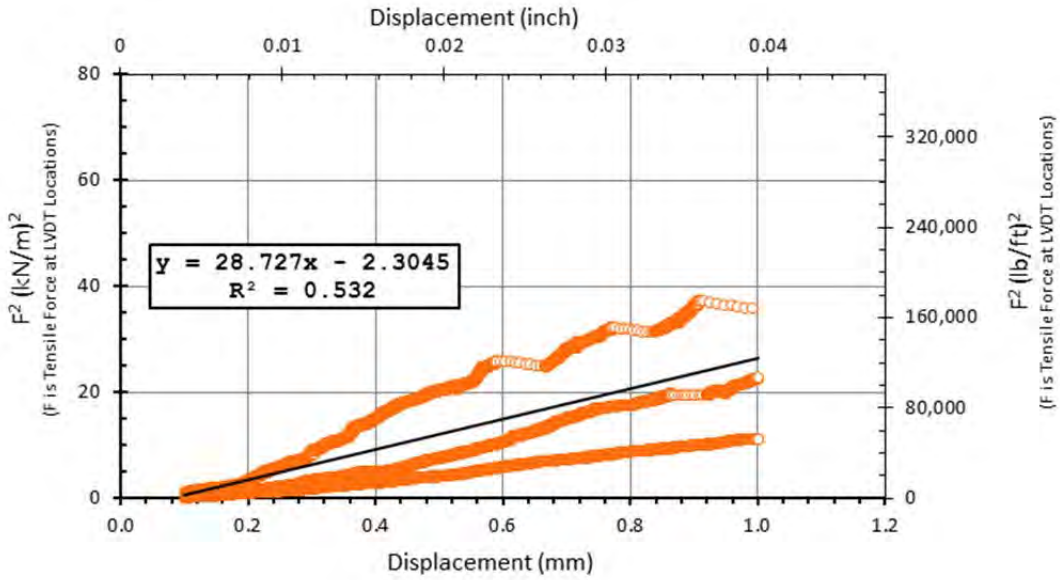
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.4	kN/m	577	lb/ft
Max Pullout Load	P_{max}	2.20	kN	444	lb
Max Shear Stress	τ_{max}	29.5	kPa	4.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
28.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/7/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.273	m	0.250	m	0.245	m
	10	0.896	ft	0.820	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	0.3	0.010
2	87.8	3.455
3	130.4	5.134
4	174.2	6.858
5	218.5	8.604

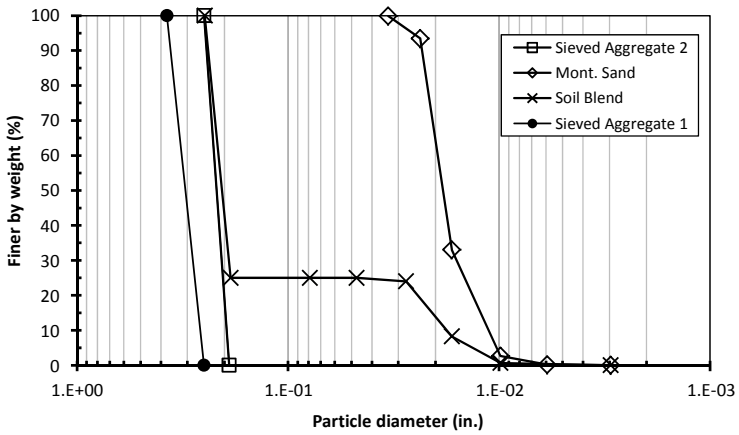
Pullout Rate			
1.0	mm/min.	0.04	in/min

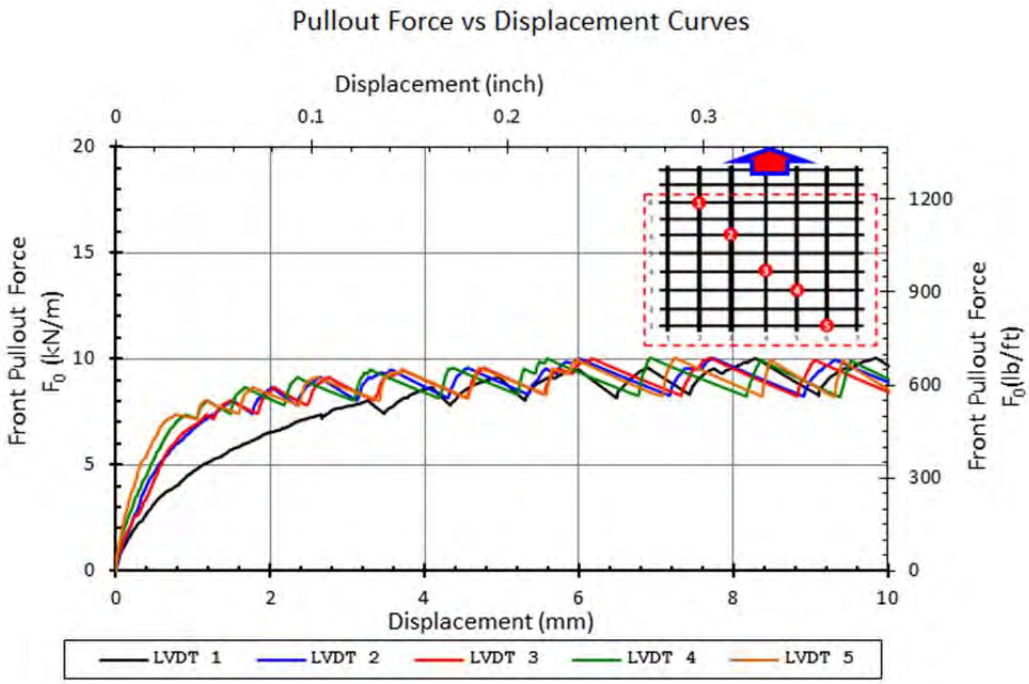
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.44	**%**	
Dry Density (ρ_d)	1.533 **g/cm^3**	**96**	**pcf**

Note: particle size distribution curve shown below

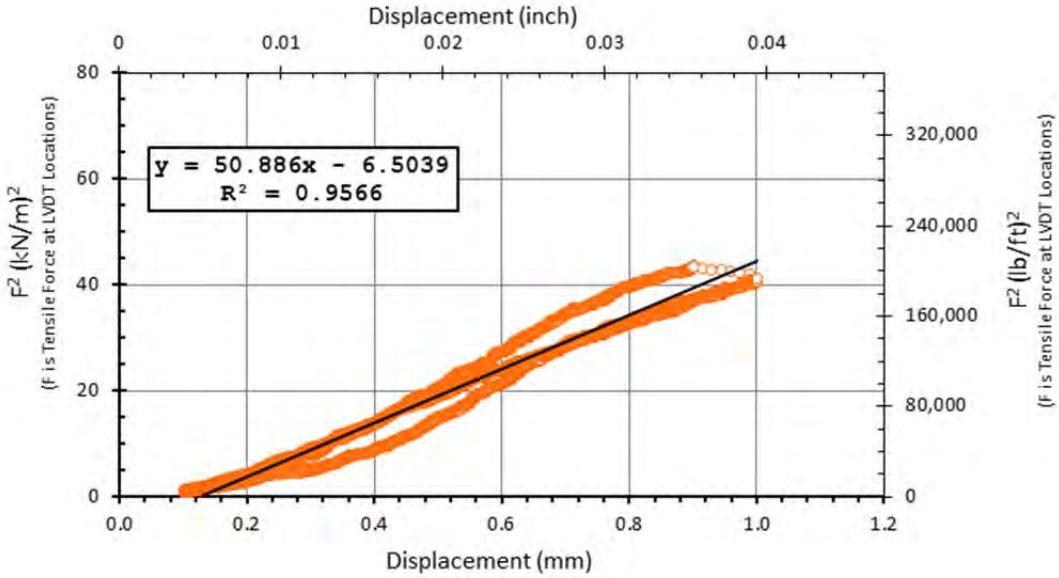
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.1	kN/m	690	lb/ft
Max Pullout Load	P_{max}	2.52	kN	579	lb
Max Shear Stress	τ_{max}	33.8	kPa	4.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
50.9	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/11/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.271	m	0.250	m	0.245	m
	10	0.889	ft	0.820	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	6.9	0.272
2	95.3	3.752
3	140.3	5.522
4	184.3	7.256
5	229.6	9.041

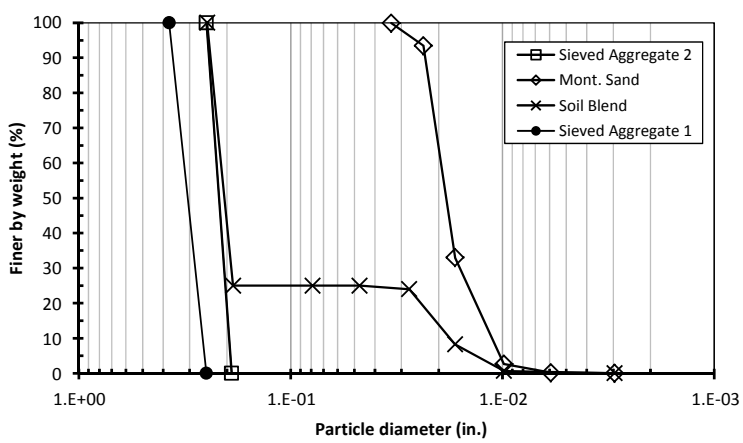
Pullout Rate	
1.0 mm/min.	0.04 in/min

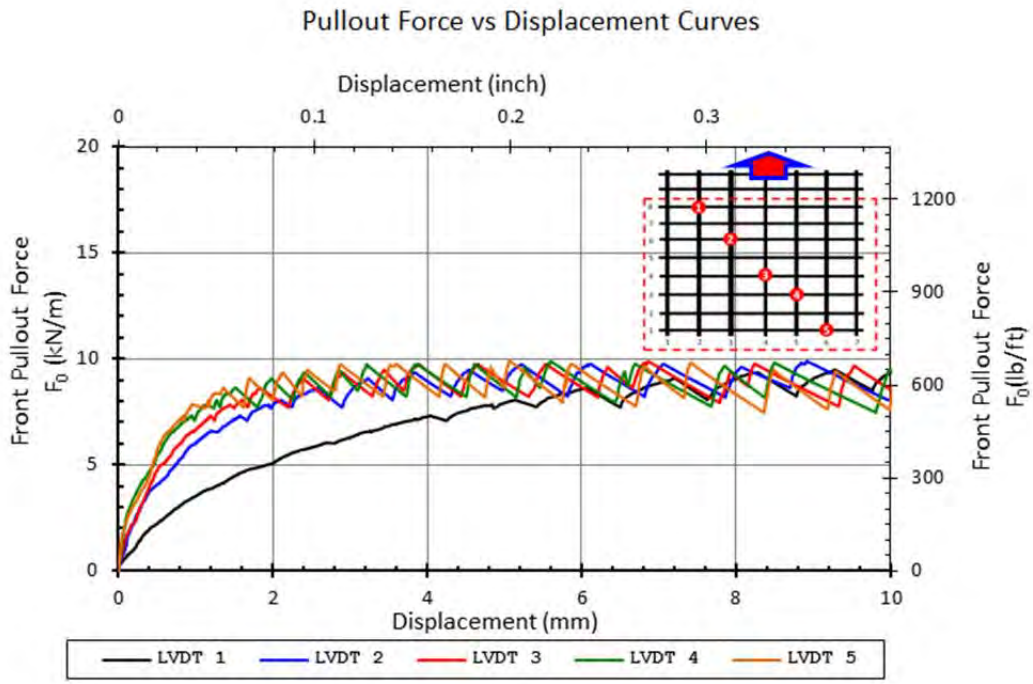
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.58	**%**
Dry Density (ρ_d)	1.518 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

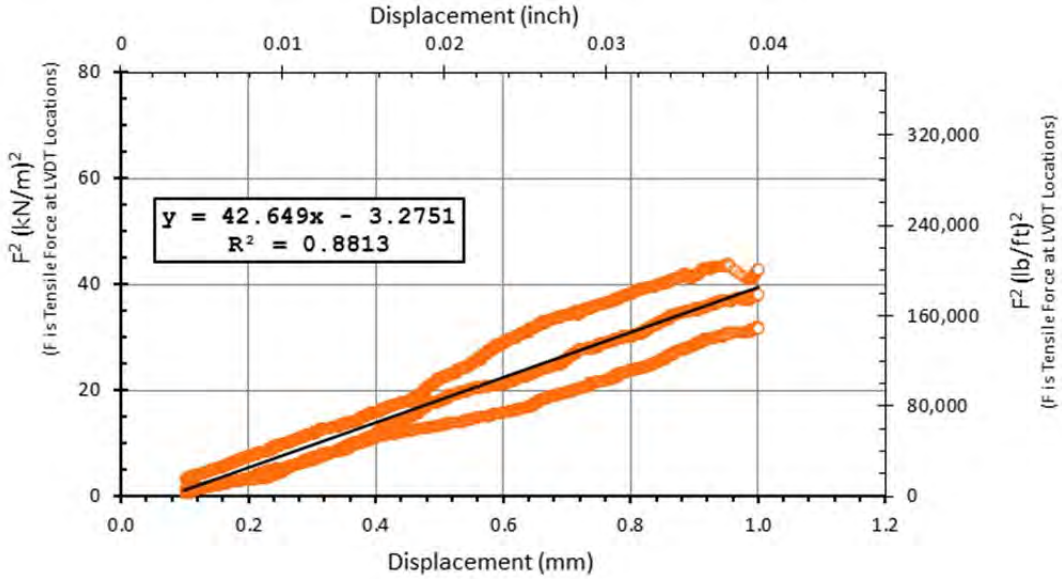
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.9	kN/m	677	lb/ft
Max Pullout Load	P_{max}	2.47	kN	562	lb
Max Shear Stress	τ_{max}	33.2	kPa	4.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
48.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/31/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.270	m	0.261	m	0.245	m
	12	0.886	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.5	0.925
2	74.9	2.950
3	126.2	4.968
4	176.5	6.950
5	226.2	8.904

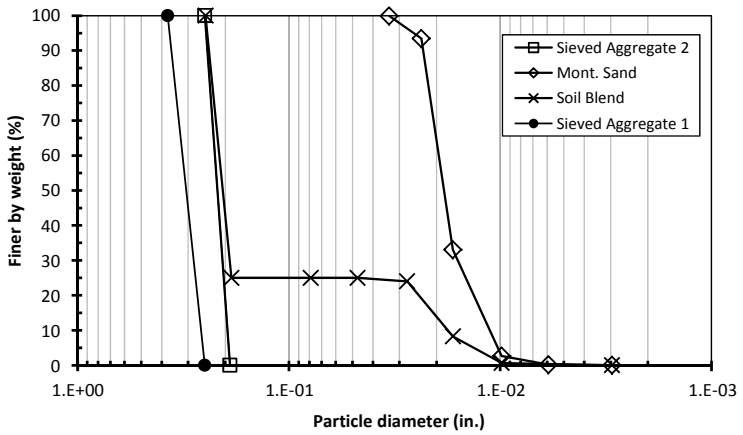
Pullout Rate	
1.0 mm/min.	0.04 in/min

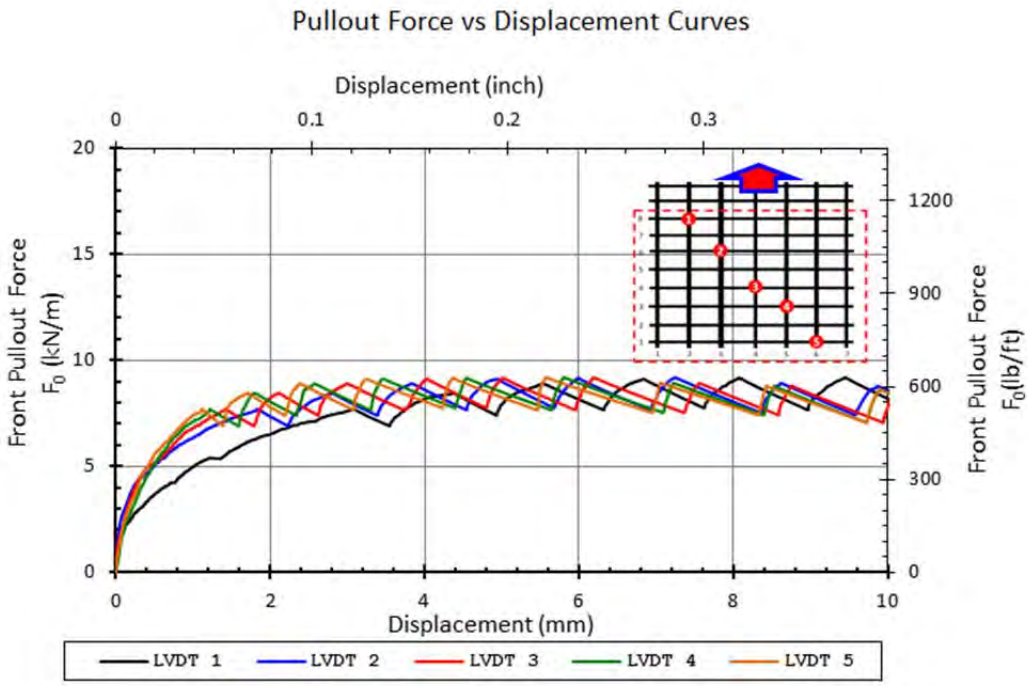
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.48	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

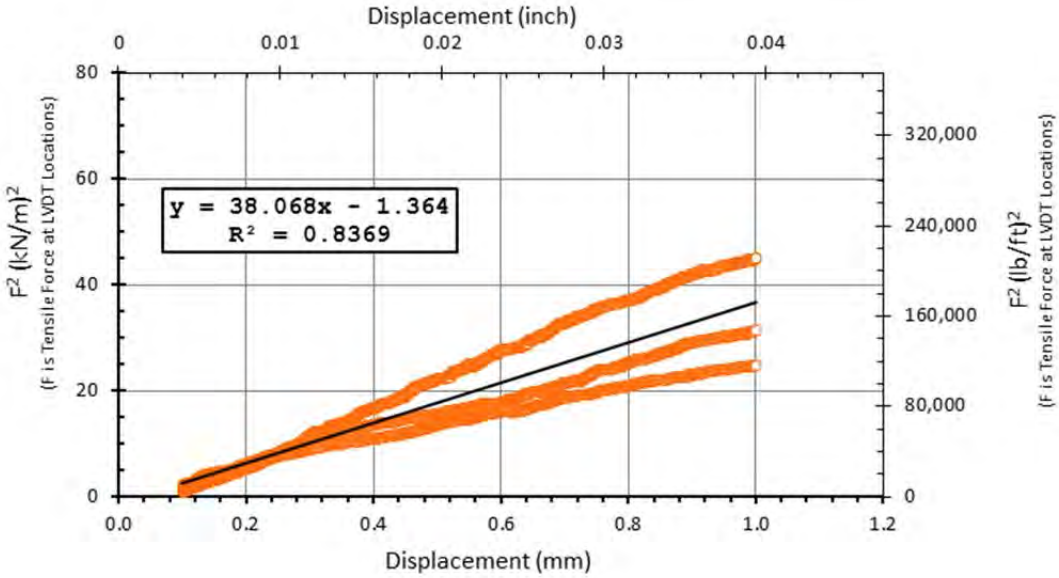
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.2	kN/m	630	lb/ft
Max Pullout Load	P_{max}	2.40	kN	548	lb
Max Shear Stress	τ_{max}	32.2	kPa	4.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
38.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/1/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.270	m	0.261	m	0.245	m
	12	0.886	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.8	0.465
2	64.6	2.543
3	116.6	4.590
4	167.3	6.585
5	217.4	8.561

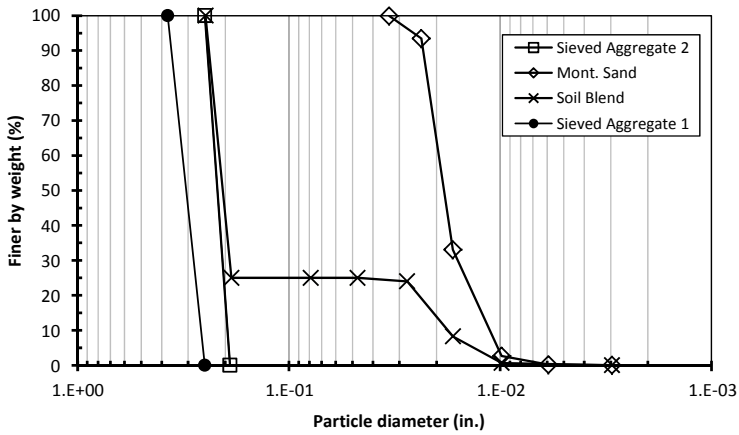
Pullout Rate	
1.0 mm/min.	0.04 in/min

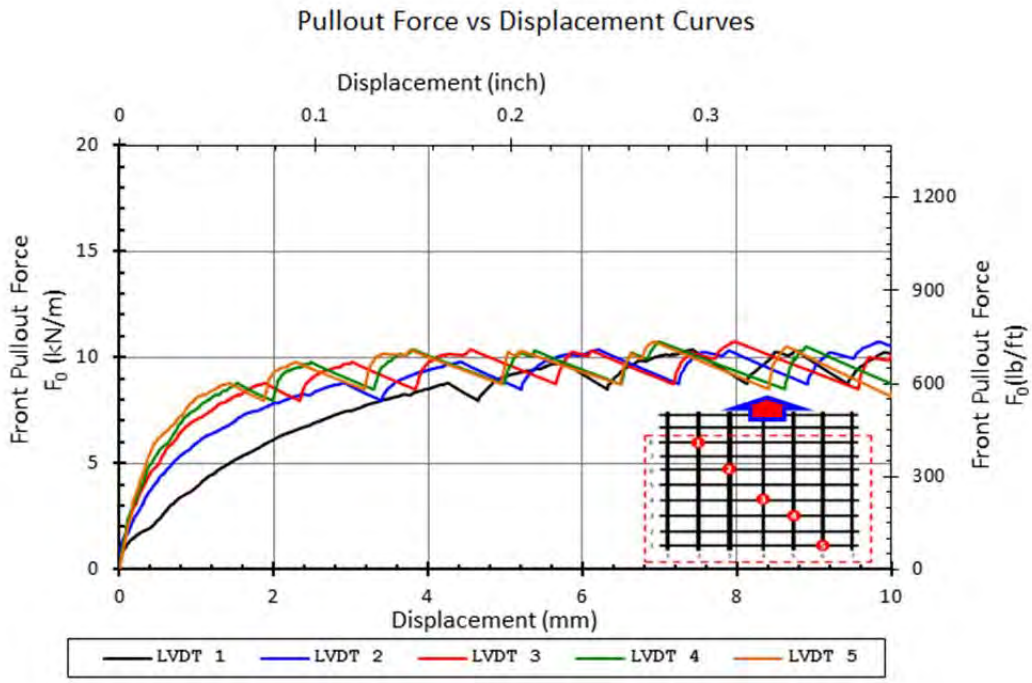
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.44	**%**
Dry Density (ρ_d)	1.406 **g/cm^3**	**88 pcf**

Note: particle size distribution curve shown below

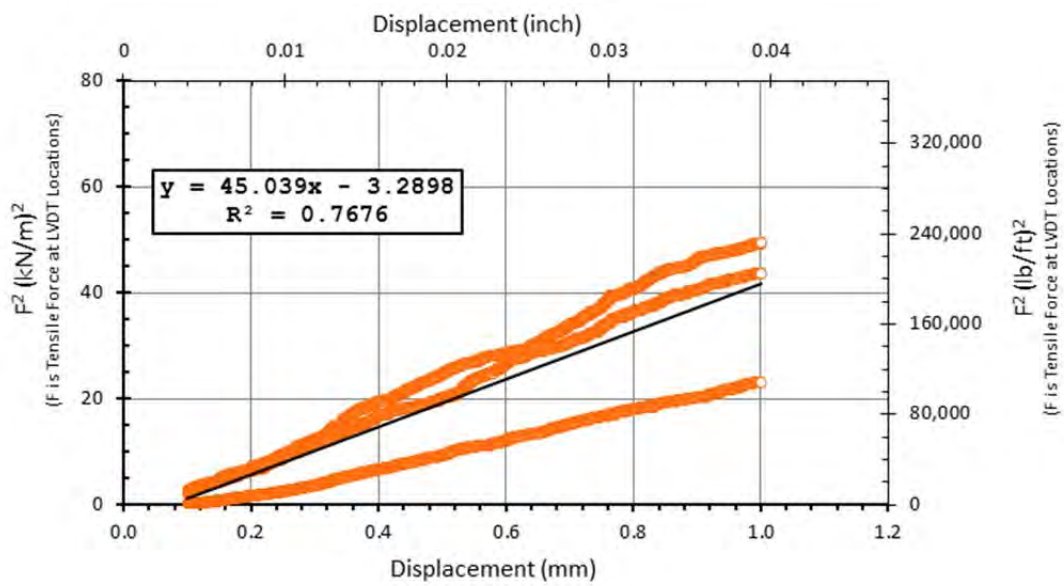
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.7	kN/m	736	lb/ft
Max Pullout Load	P_{max}	2.80	kN	642	lb
Max Shear Stress	τ_{max}	37.7	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
45.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	5/20/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.284	m	0.275	m	0.245	m
	10	0.932	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.8	0.896
2	101.4	3.992
3	141.1	5.557
4	181.2	7.133
5	220.6	8.683

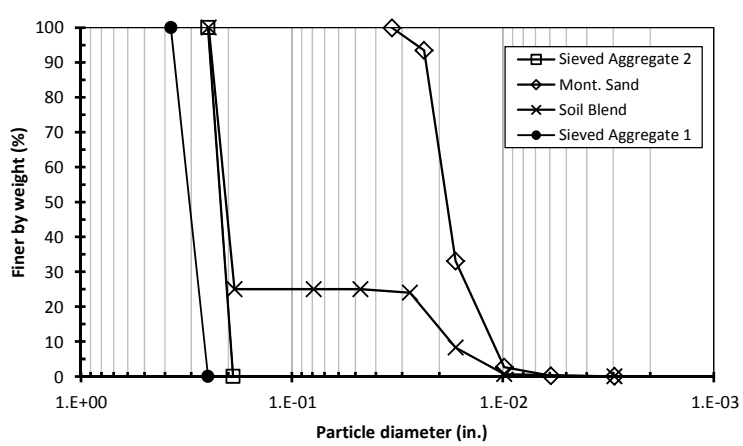
Pullout Rate	
1.0 mm/min.	0.04 in/min

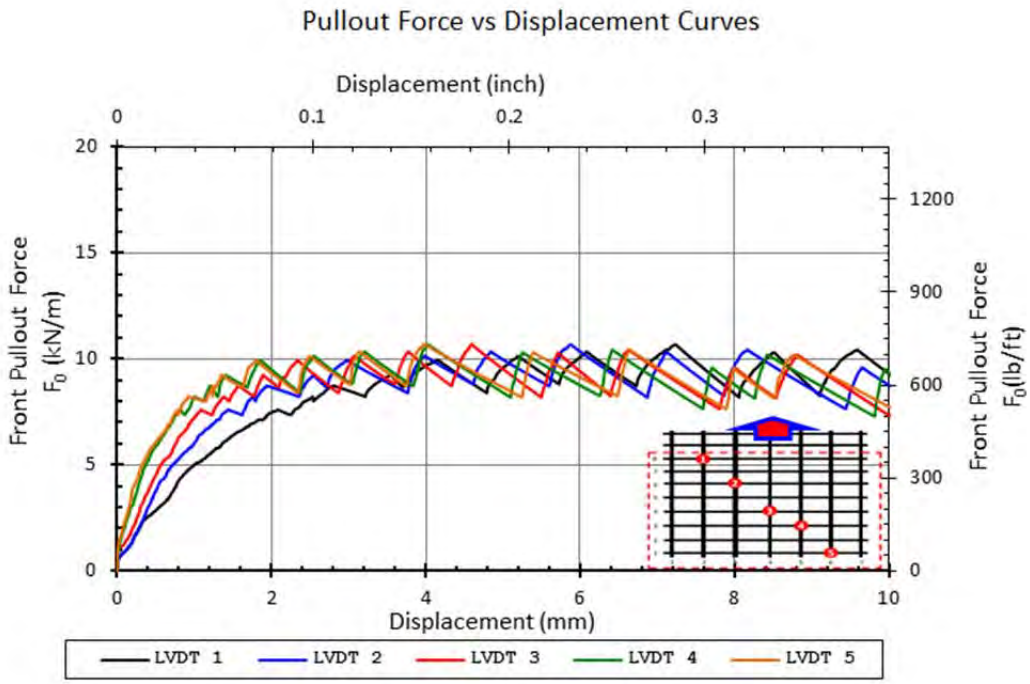
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.45	**%**
Dry Density (ρ_d)	1.476 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

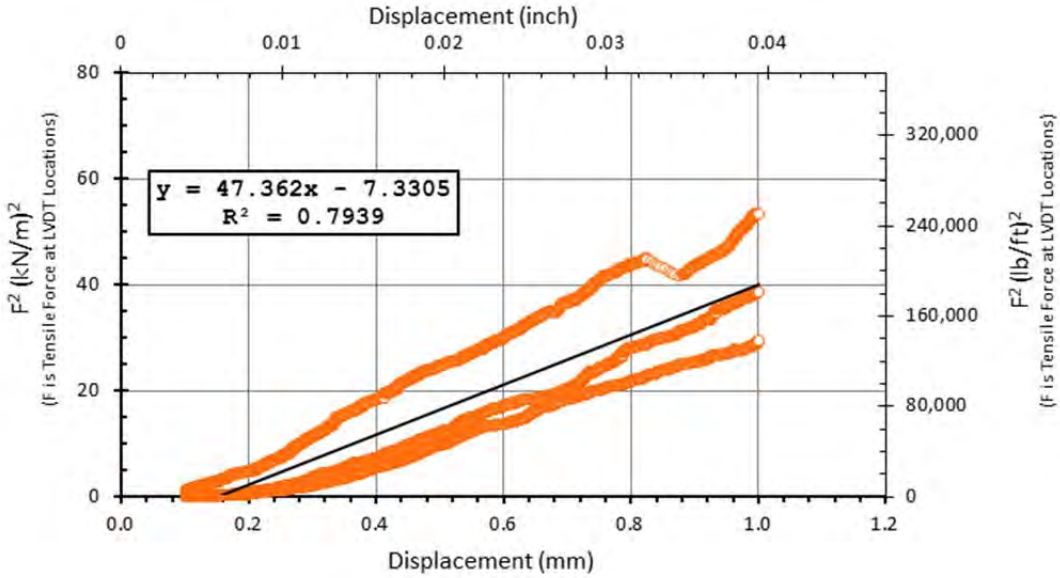
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.7	kN/m	732	lb/ft
Max Pullout Load	P_{max}	2.94	kN	669	lb
Max Shear Stress	τ_{max}	39.5	kPa	5.7	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
47.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/3/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
			m	0.275	m	0.245	m
	10		ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.1	0.948
2	105.0	4.134
3	143.9	5.665
4	185.7	7.311
5	227.0	8.938

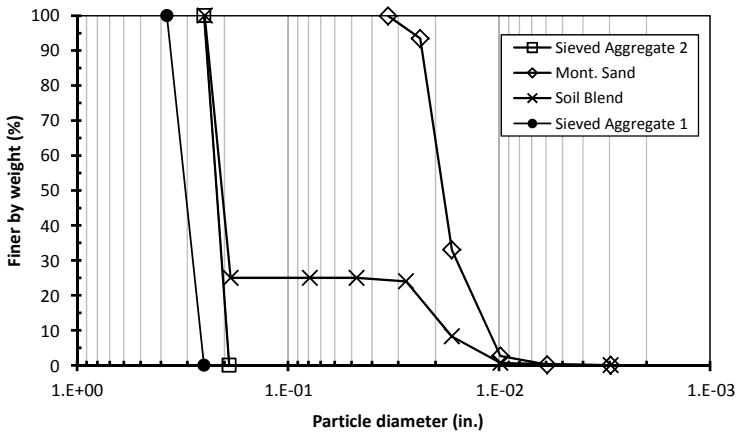
Pullout Rate	
1.0 mm/min.	0.04 in/min

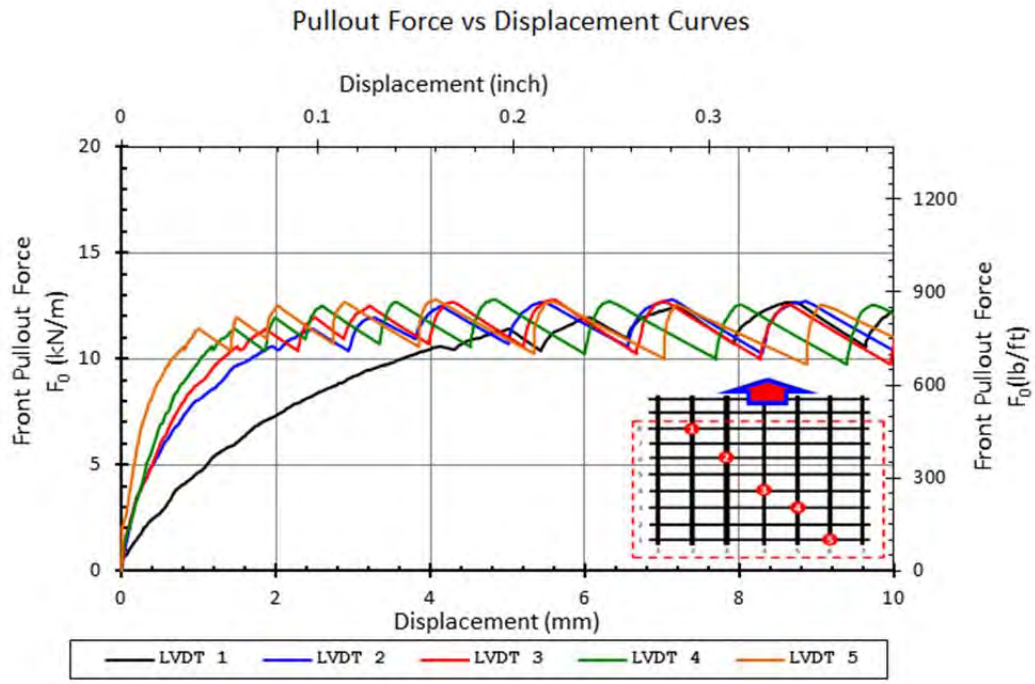
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.47	**%**
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

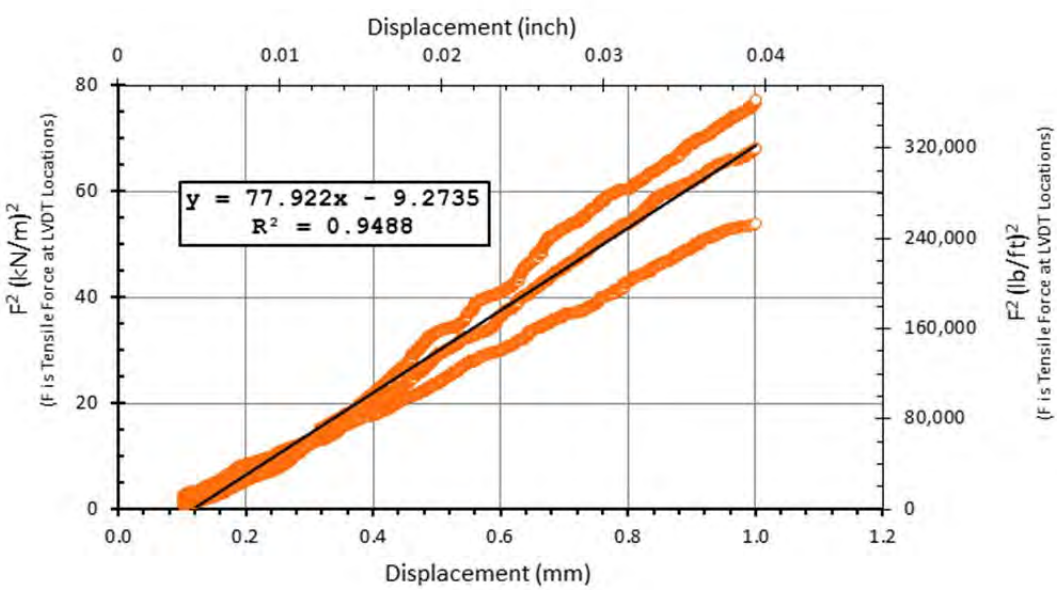
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.8	kN/m	877	lb/ft
Max Pullout Load	P_{max}	3.52	kN	808	lb
Max Shear Stress	τ_{max}	47.3	kPa	6.9	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
78.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/27/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
			m	0.270	m	0.245	m
	10		ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	25.5	1.004
2	95.1	3.744
3	127.6	5.024
4	161.4	6.354
5	230.3	9.067

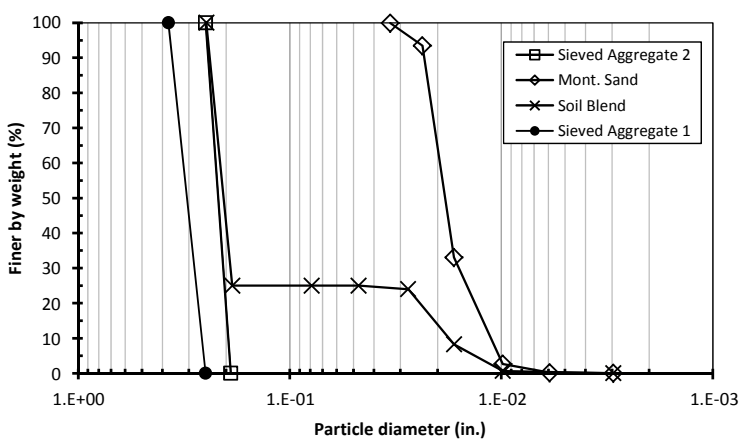
Pullout Rate	
1.0 mm/min.	0.04 in/min

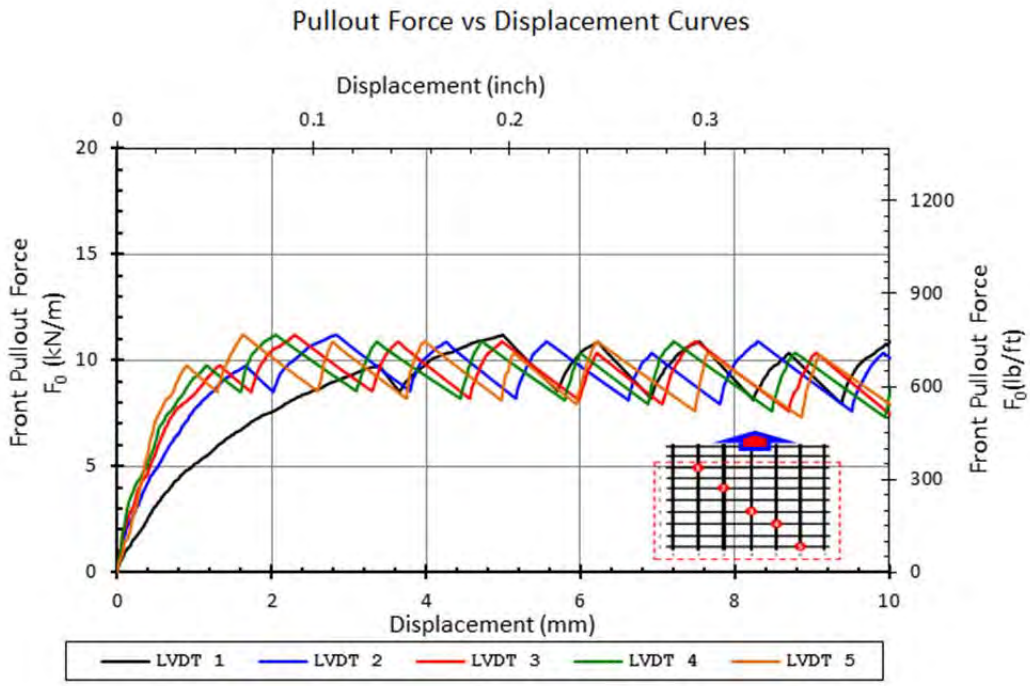
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.03	**%**
Dry Density (ρ_d)	1.487 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

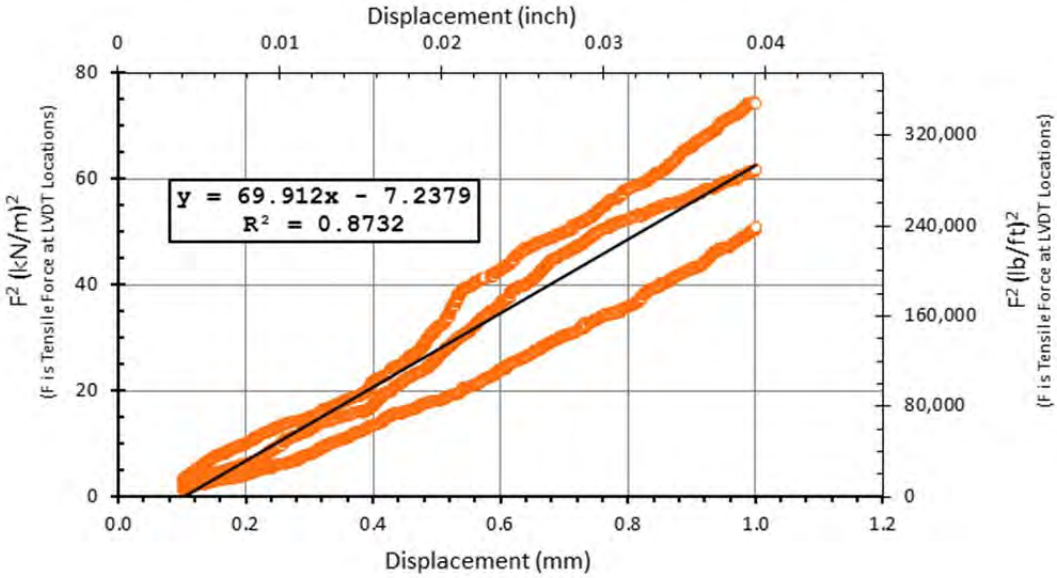
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.2	kN/m	767	lb/ft
Max Pullout Load	P_{max}	3.02	kN	695	lb
Max Shear Stress	τ_{max}	40.6	kPa	5.9	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
70.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

low water content.

SMALL PULLOUT TEST

Date test conducted	1/15/2009
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.294	m	0.245	m
	9	0.935	ft	0.964	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.2	0.755
2	103.1	4.057
3	130.4	5.132
4	157.8	6.214
5	238.9	9.404

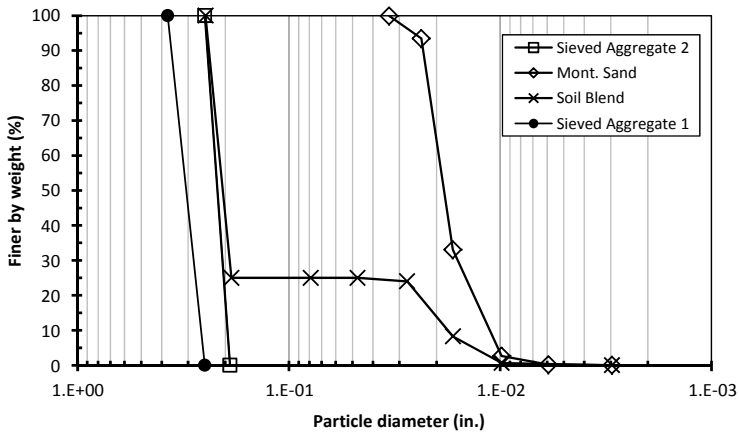
Pullout Rate	
1.0 mm/min.	0.04 in/min

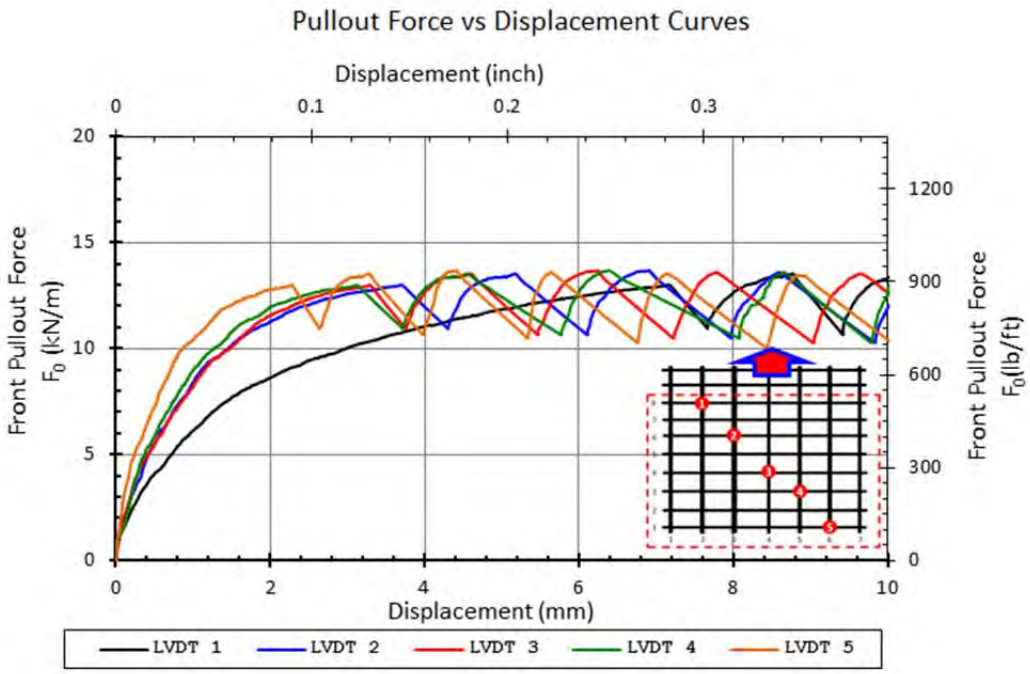
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.90	**%**
Dry Density (ρ_d)	1.520 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

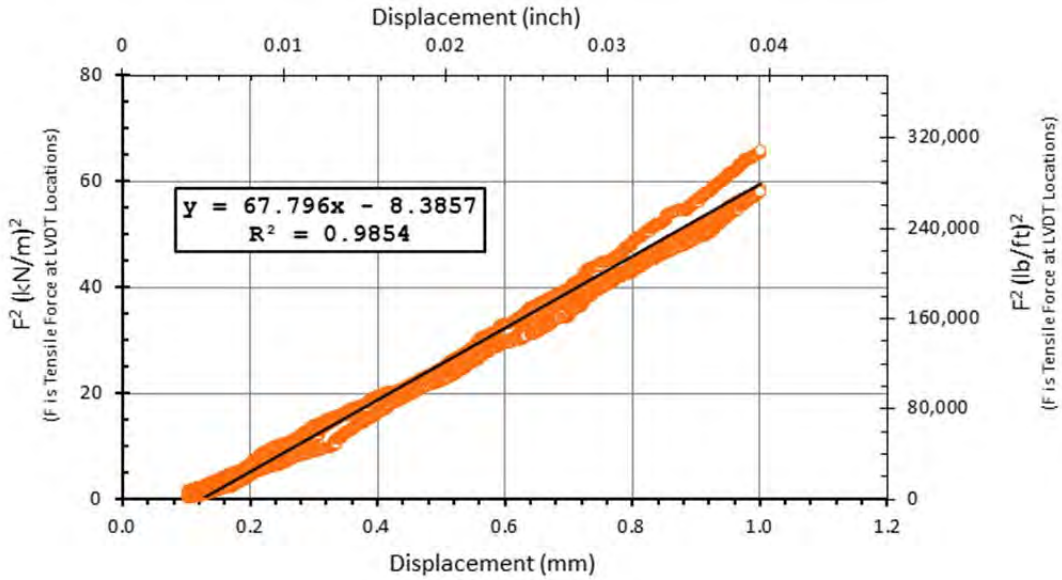
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.7	kN/m	938	lb/ft
Max Pullout Load	P_{max}	4.02	kN	907	lb
Max Shear Stress	τ_{max}	54.0	kPa	7.8	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
67.8 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/6/2008
Done by	Julio

GEOSYNTHETIC Information	Type	Manufacter & Model	Direction Pulled	UT Product Name
	Geotextile	Mirafi Geolon HP570	MD	GT

SPECIMEN Dimensions	# Ribs Pulled	Measured Width	Units	Equivalent Width	Units	Embedded Length (L)	Units
		0.280	m	0.280	m	0.245	m
	---	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	Area (A)	Units
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	Distance from Front Wall (mm)	(inch)
1	21.1	0.831
2	73.4	2.890
3	111.2	4.378
4	145.8	5.739
5	223.1	8.785

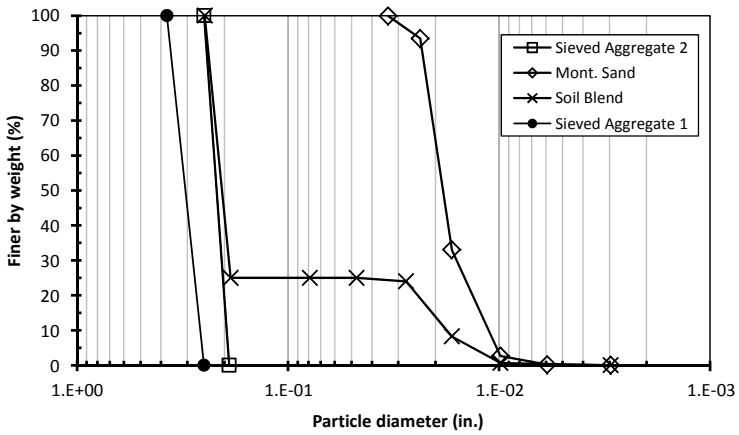
Pullout Rate			
1.0	mm/min.	0.04	in/min

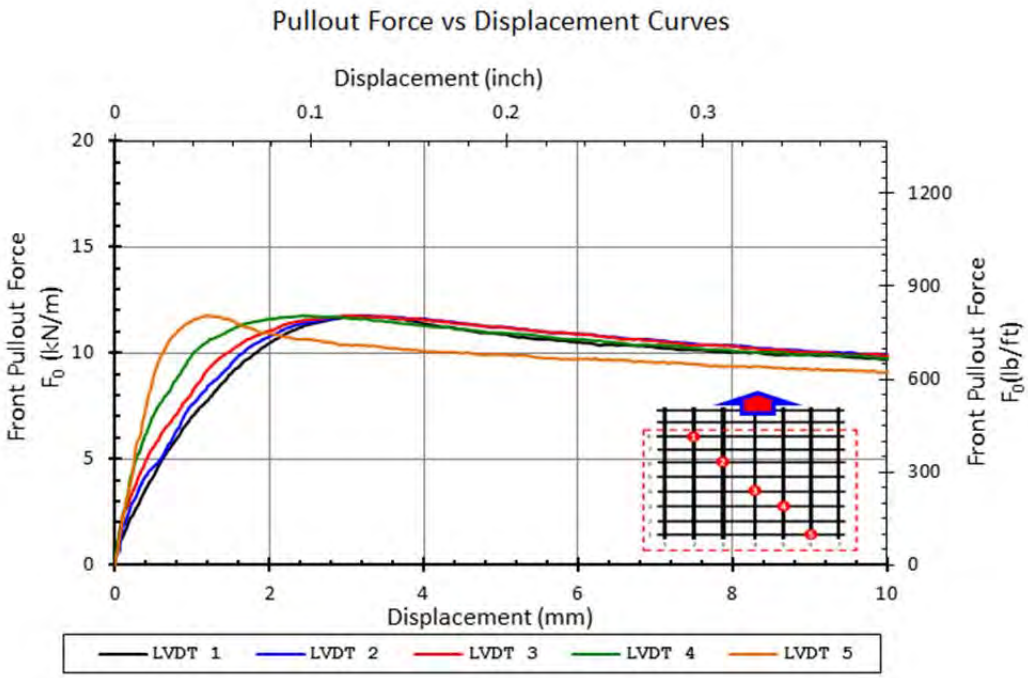
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	2.04	%
Dry Density (ρ_d)	1.530 g/cm^3	**95 pcf**

Note: particle size distribution curve shown below

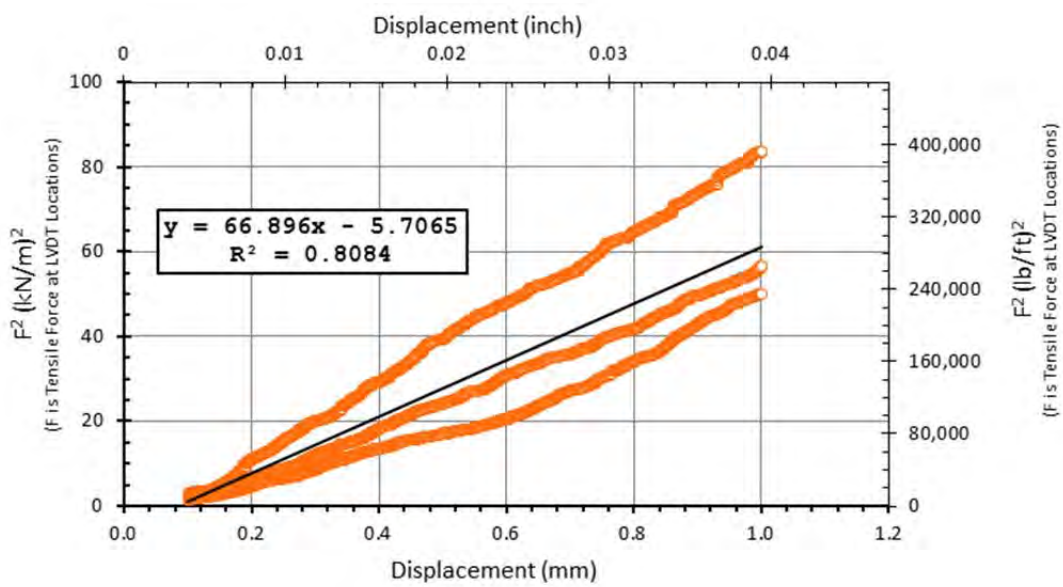
RESULTS		Values	Units	Values	Units
Max Pullout Force	F_{max}	11.8	kN/m	806	lb/ft
Max Pullout Load	P_{max}	3.29	kN	779	lb
Max Shear Stress	τ_{max}	44.3	kPa	6.4	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
66.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Water content is estimated

SMALL PULLOUT TEST

Date test conducted	12/16/2008
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.277	m	0.245	m
	---	0.909	ft	0.909	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	6.1	0.241
2	79.3	3.122
3	112.8	4.442
4	149.9	5.903
5	229.5	9.034

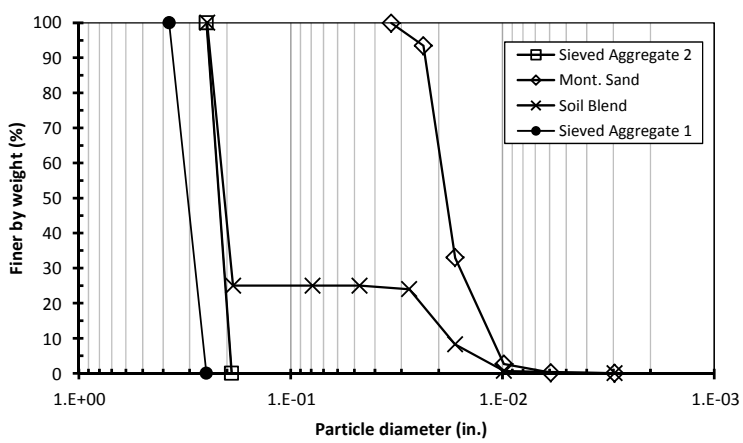
Pullout Rate	
1.0 mm/min.	0.04 in/min

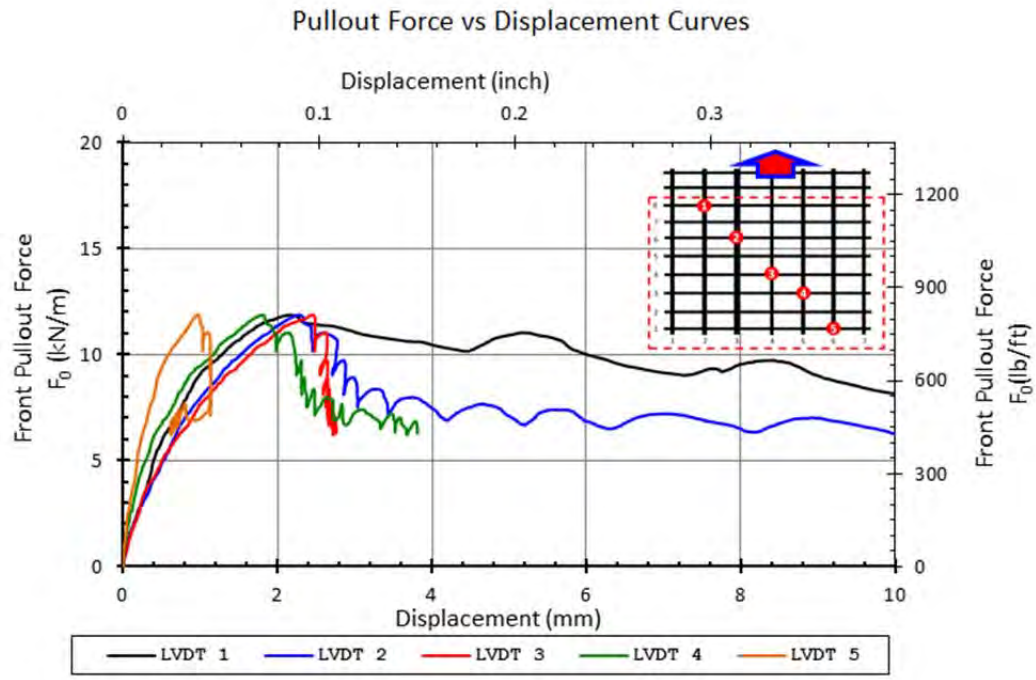
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.26	**%**
Dry Density (ρ_d)	1.541 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

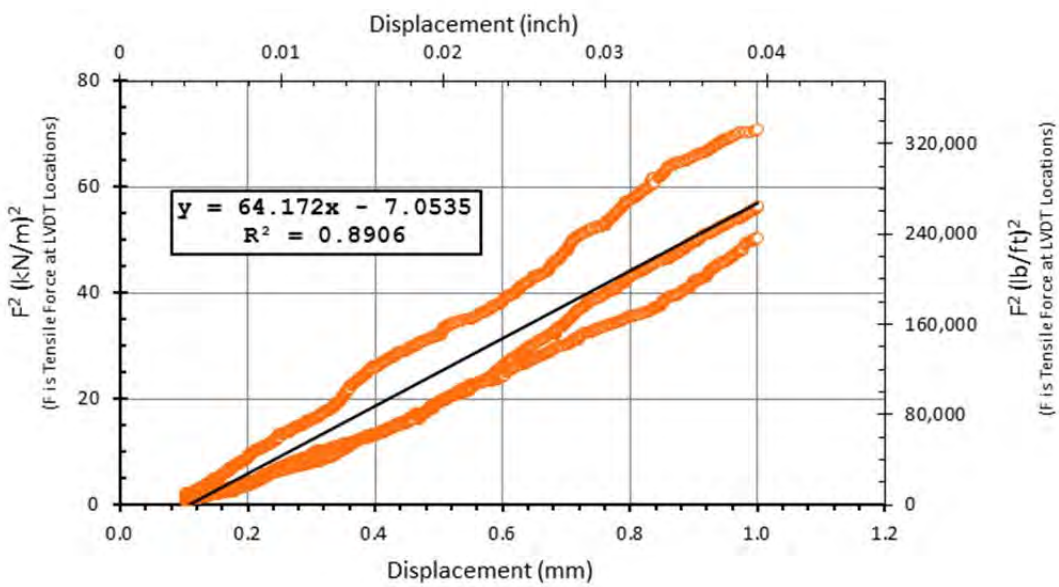
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.9	kN/m	813	lb/ft
Max Pullout Load	P_{max}	3.29	kN	751	lb
Max Shear Stress	τ_{max}	44.2	kPa	6.4	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
64.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	5/19/2010
Done by	julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.270	m	0.265	m	0.245	m
	9	0.886	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	47.4	1.865
2	117.0	4.607
3	153.4	6.039
4	190.1	7.486
5	226.7	8.925

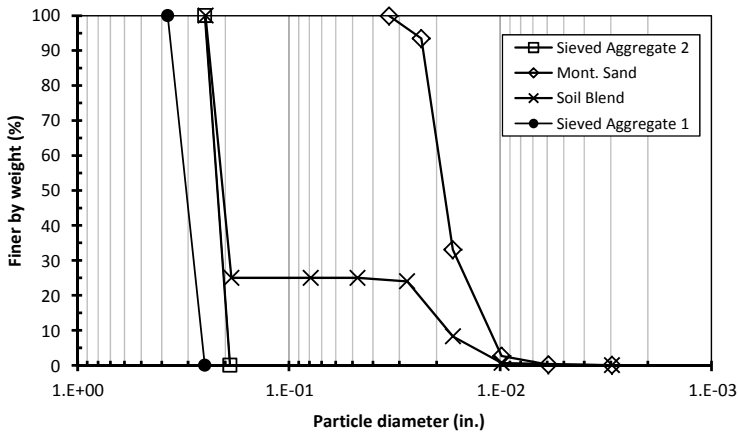
Pullout Rate	
1.0 mm/min.	0.04 in/min

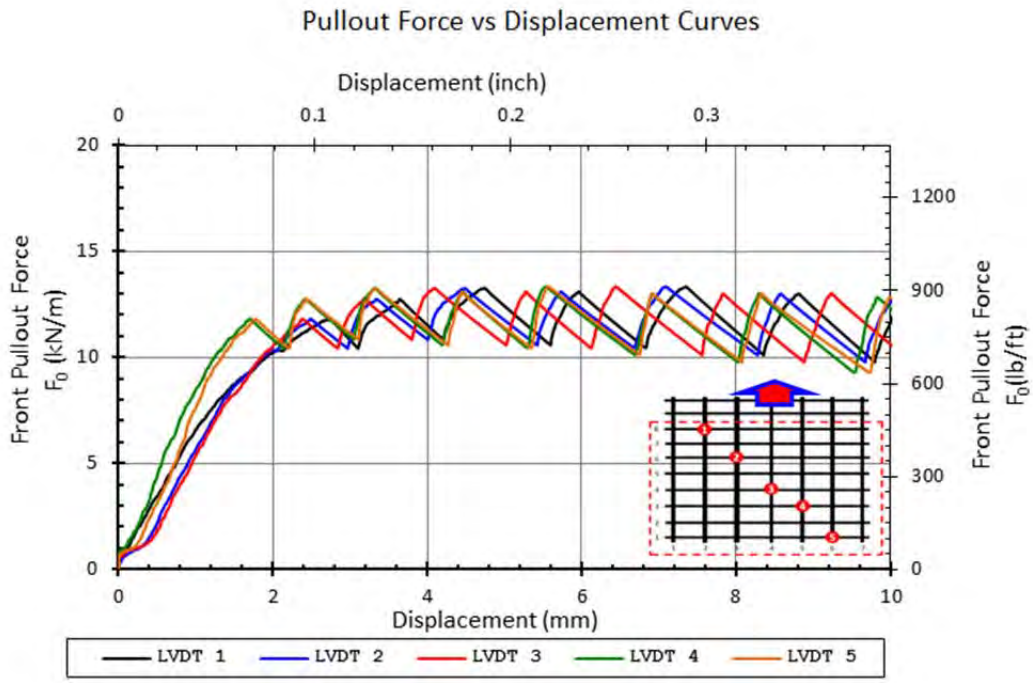
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.467 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

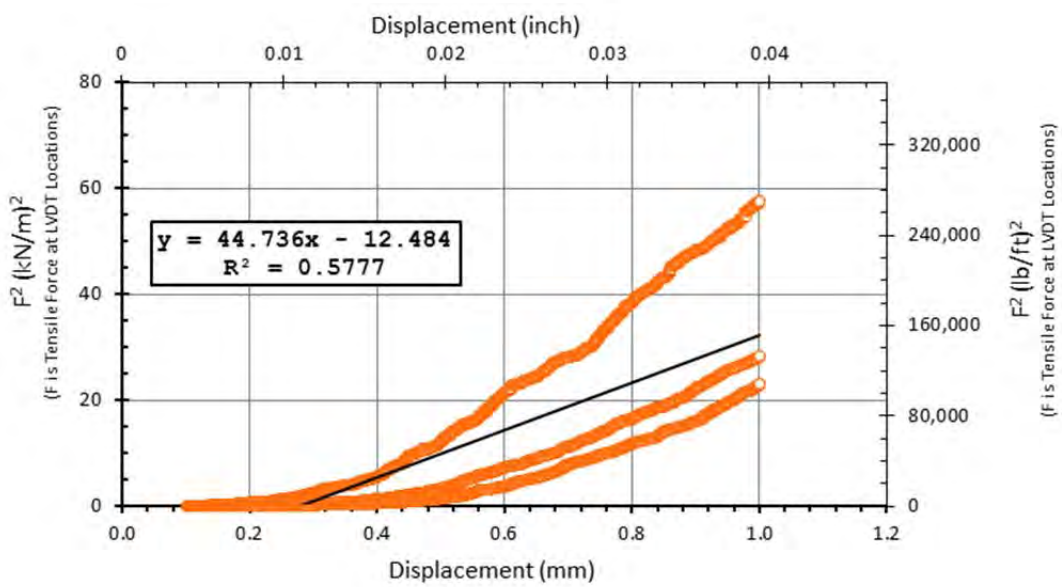
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.3	kN/m	914	lb/ft
Max Pullout Load	P_{max}	3.53	kN	819	lb
Max Shear Stress	τ_{max}	47.5	kPa	6.9	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
44.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	1/27/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.3	0.406
2	54.1	2.130
3	99.5	3.917
4	141.1	5.555
5	229.6	9.039

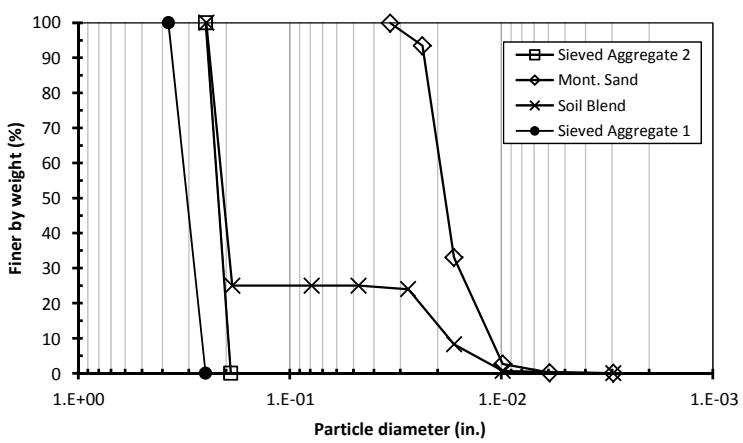
Pullout Rate	
1.0 mm/min.	0.04 in/min

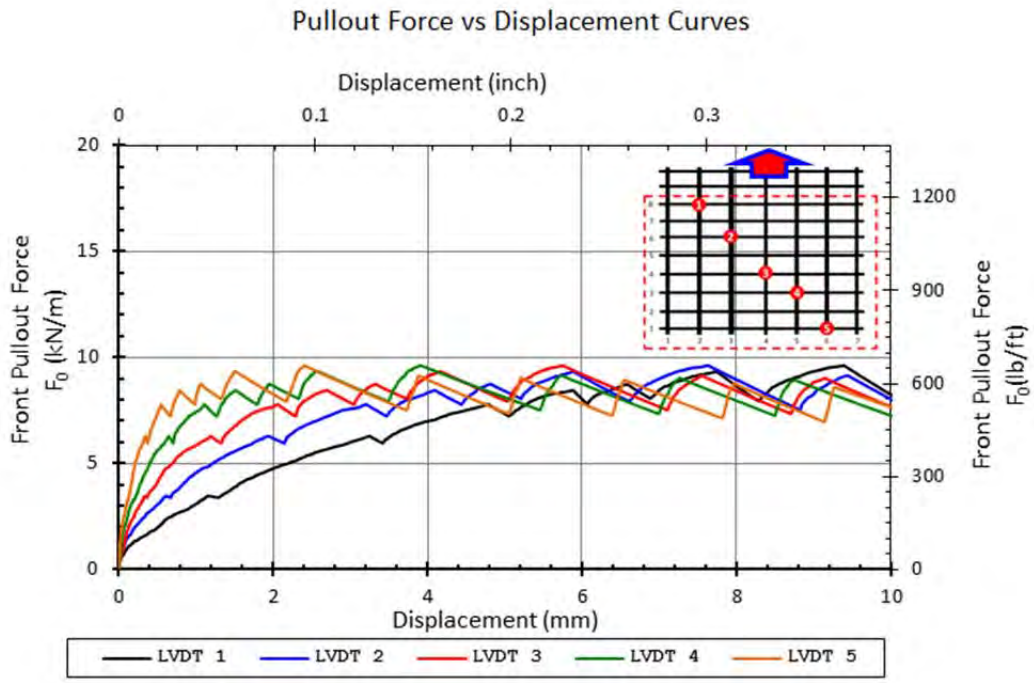
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.56	**%**
Dry Density (ρ_d)	1.514 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

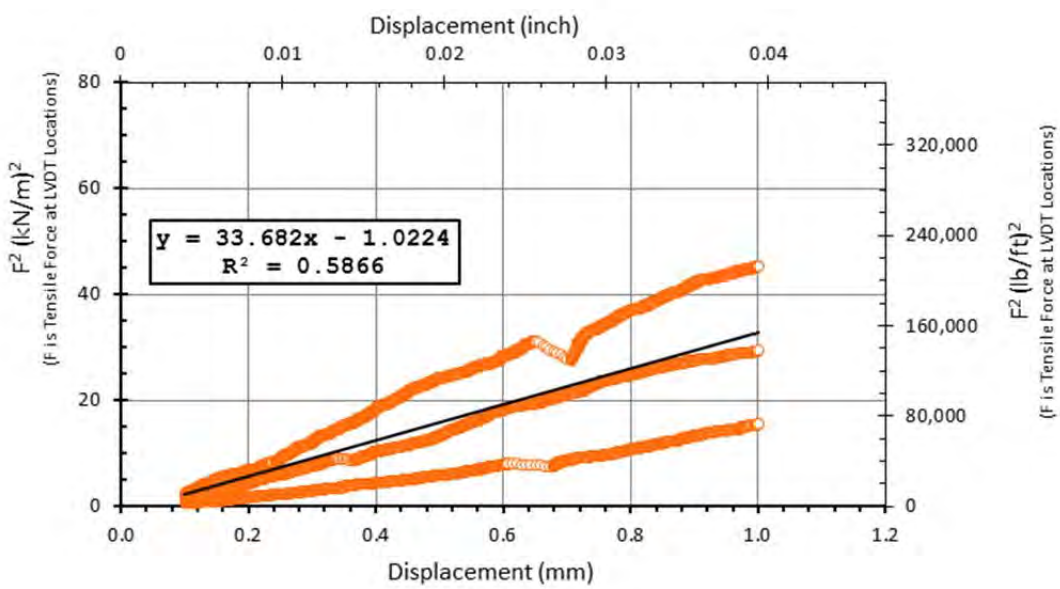
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.6	kN/m	659	lb/ft
Max Pullout Load	P_{max}	3.51	kN	786	lb
Max Shear Stress	τ_{max}	47.1	kPa	6.8	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
33.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/28/2010
Done by	julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.364	m	0.245	m
	17	0.924	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.7	0.422
2	51.9	2.041
3	93.7	3.691
4	137.5	5.413
5	228.5	8.996

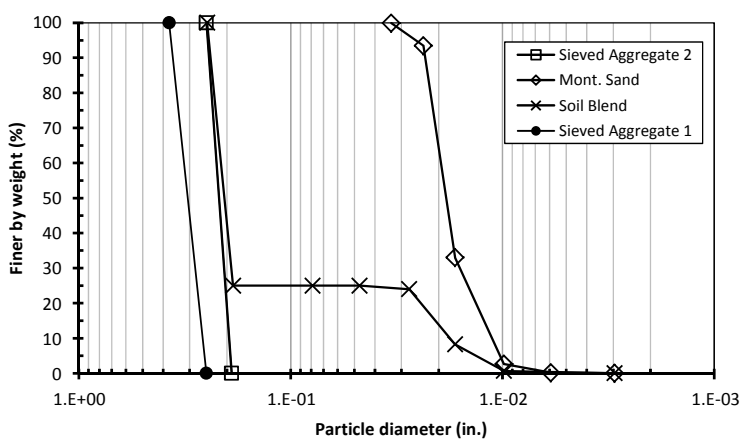
Pullout Rate	
1.0 mm/min.	0.04 in/min

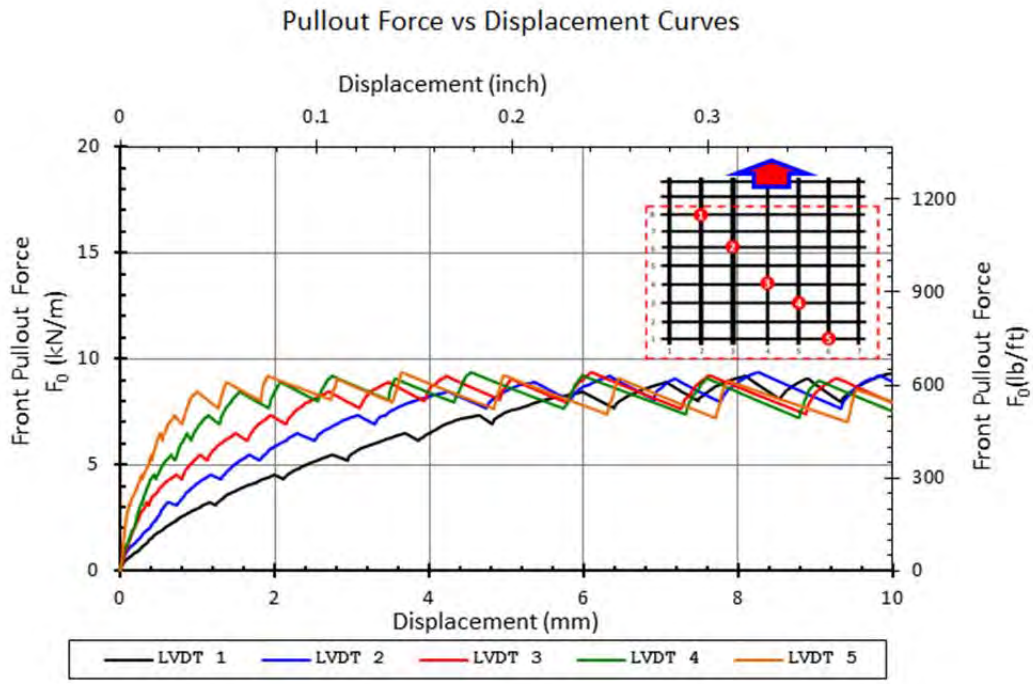
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.38	**%**
Dry Density (ρ_d)	1.534 **g/cm^3**	**96 pcf**

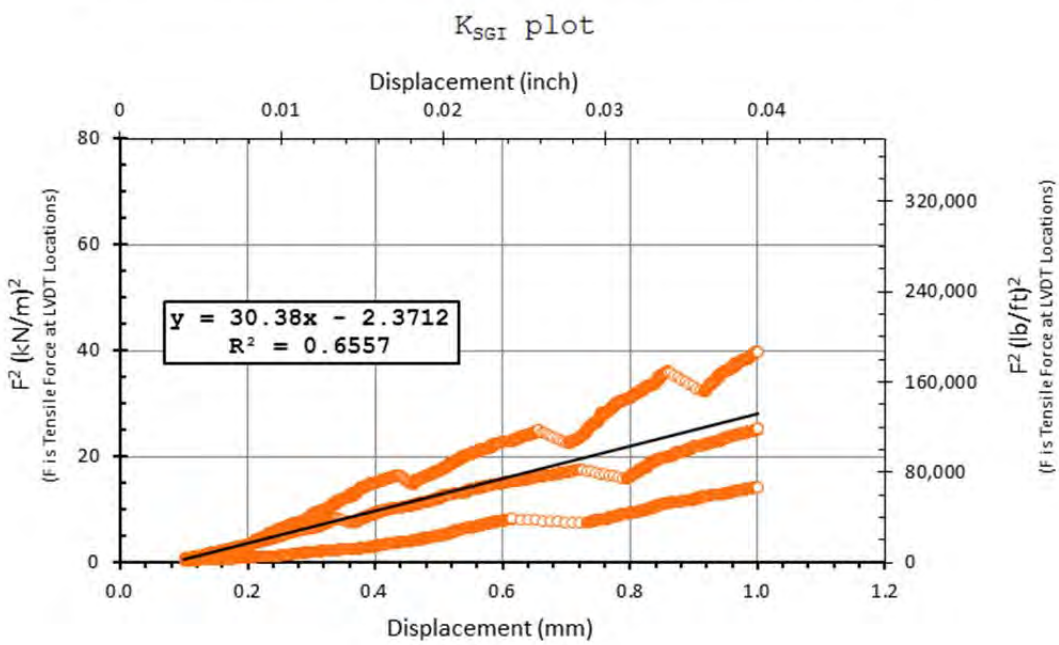
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.4	kN/m	642	lb/ft
Max Pullout Load	P_{max}	3.41	kN	785	lb
Max Shear Stress	τ_{max}	45.9	kPa	6.7	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
30.4 $(kN/m)^2/mm$




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.1
0.2
0.3
Front Pullout Force
F_0 (kN/m)
20
15
10
5
0
Front Pullout Force
F_0(lb/ft)
1200
900
600
300
0
0
2
4
6
8
10
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


K_{SGI} plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
F^2 (kN/m)^2
(F is Tensile Force at LVDT Locations)
80
60
40
20
0
F^2 (lb/ft)^2
(F is Tensile Force at LVDT Locations)
320,000
240,000
160,000
80,000
0
y = 30.38x - 2.3712
R^2 = 0.6557
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	2/6/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.920	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	5.4	0.212
2	72.6	2.857
3	105.9	4.168
4	139.2	5.481
5	223.5	8.798

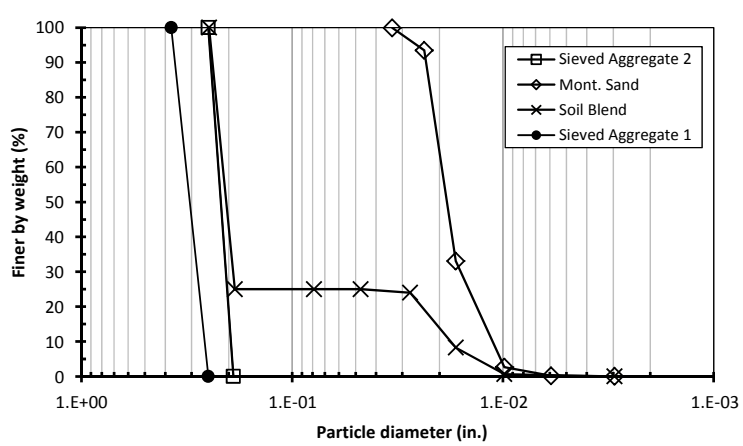
Pullout Rate	
1.0 mm/min.	0.04 in/min

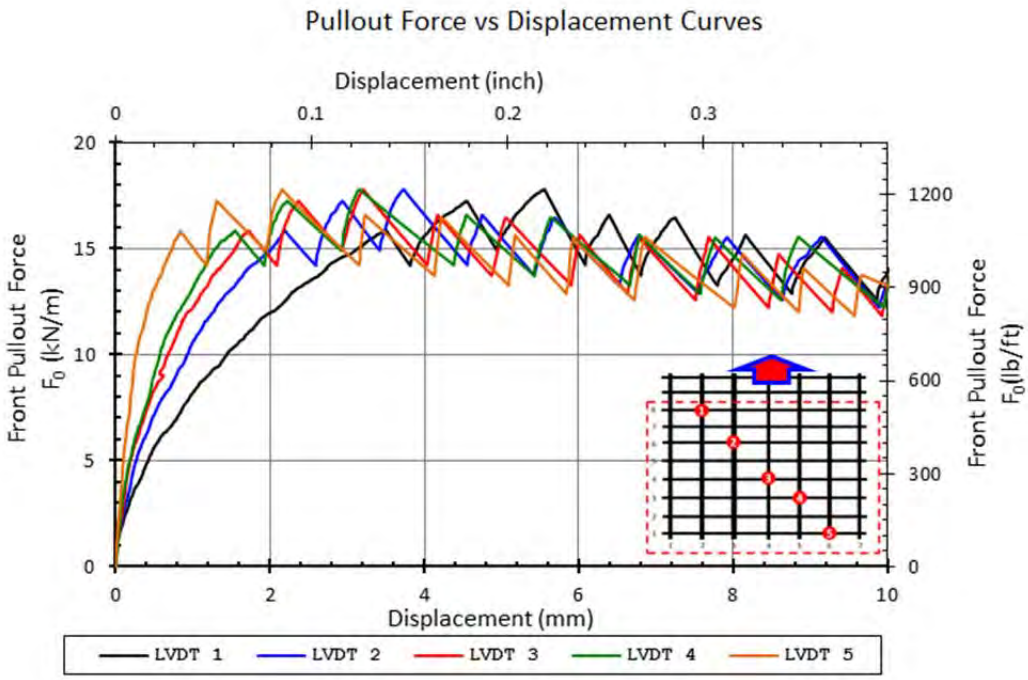
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.28	**%**
Dry Density (ρ_d)	1.505 **g/cm^3**	**94 pcf**

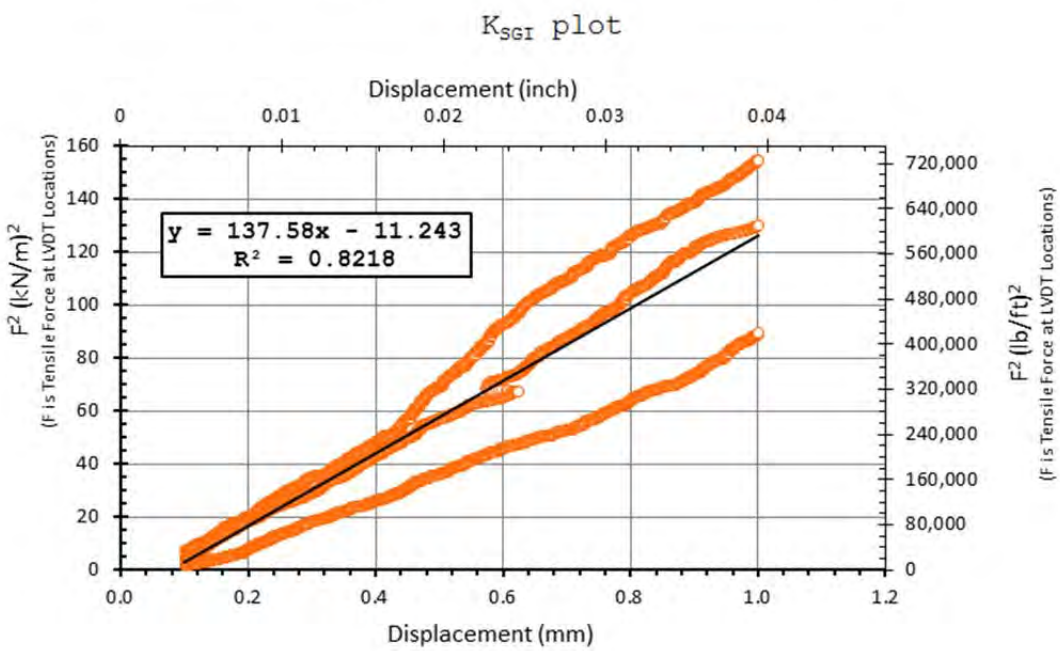
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	17.8	kN/m	1,219	lb/ft
Max Pullout Load	P_{max}	3.75	kN	856	lb
Max Shear Stress	τ_{max}	50.4	kPa	7.3	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
137.6 (kN/m)^2/mm







Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	2/11/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.211	m	0.245	m
	13	0.915	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	3.6	0.141
2	71.0	2.793
3	104.2	4.103
4	137.9	5.428
5	220.9	8.698

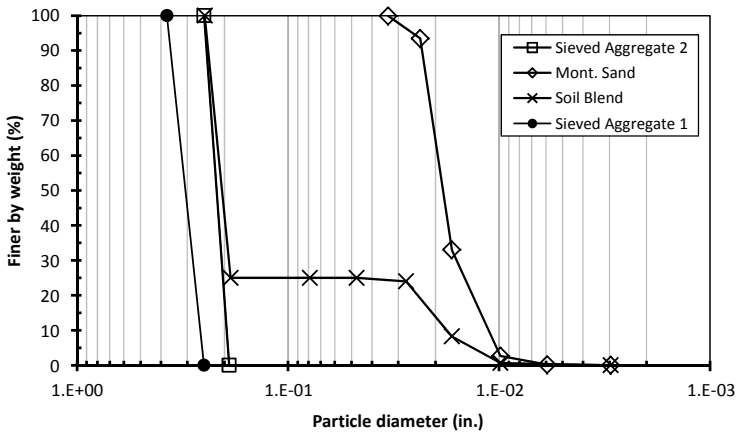
Pullout Rate	
1.0 mm/min.	0.04 in/min

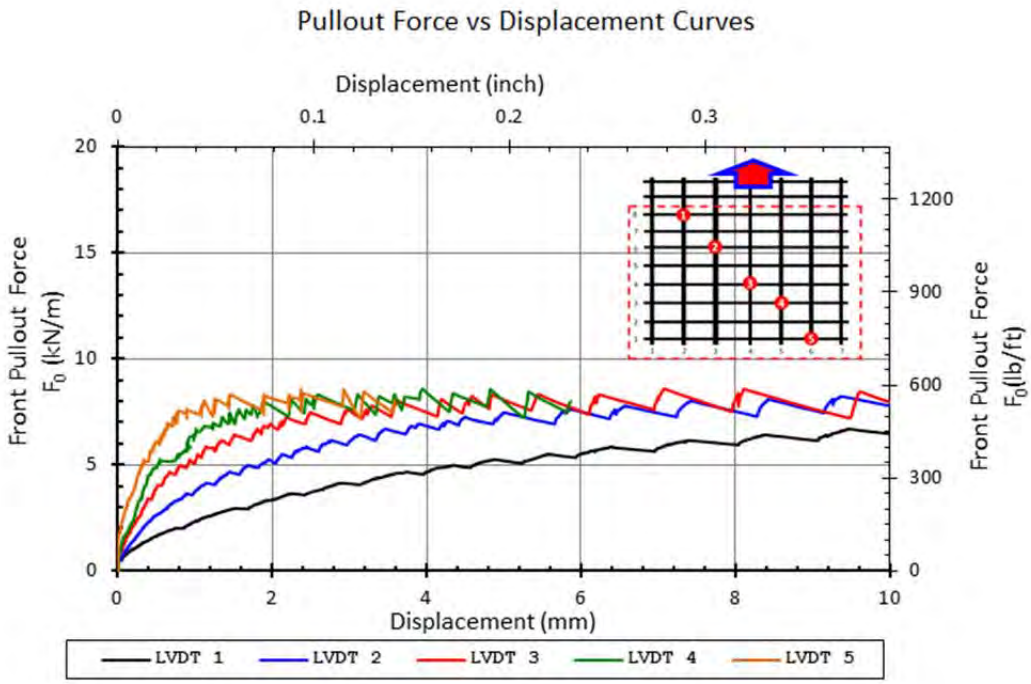
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.10	%
Dry Density (ρ_d)	1.490 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

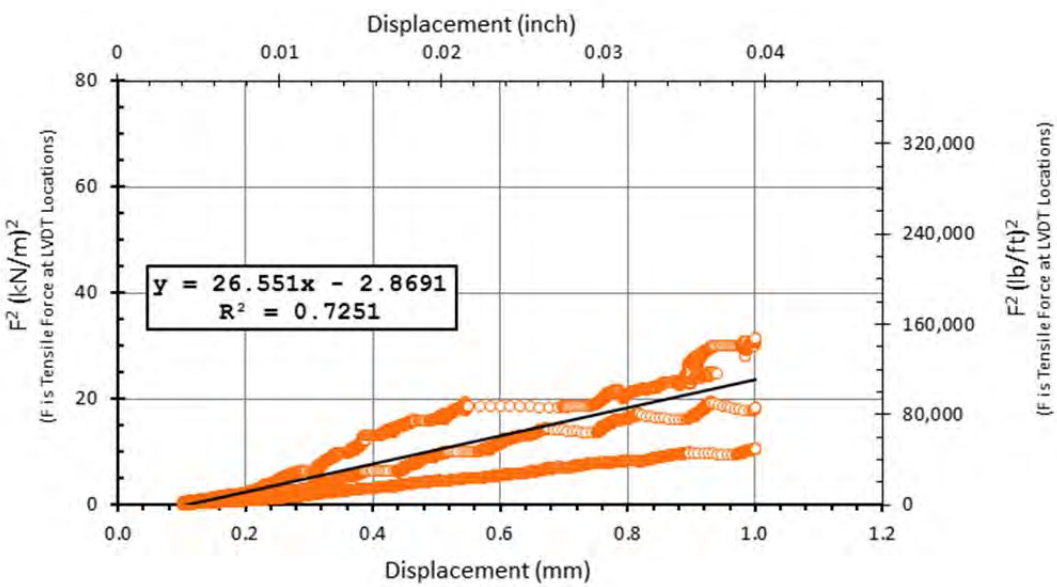
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.6	kN/m	588	lb/ft
Max Pullout Load	P_{max}	1.81	kN	358	lb
Max Shear Stress	τ_{max}	24.3	kPa	3.5	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
26.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	2/17/2010
Done by	julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.300	m	0.245	m
	6	0.912	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	2.7	0.105
2	48.7	1.915
3	94.5	3.719
4	139.7	5.500
5	230.2	9.065

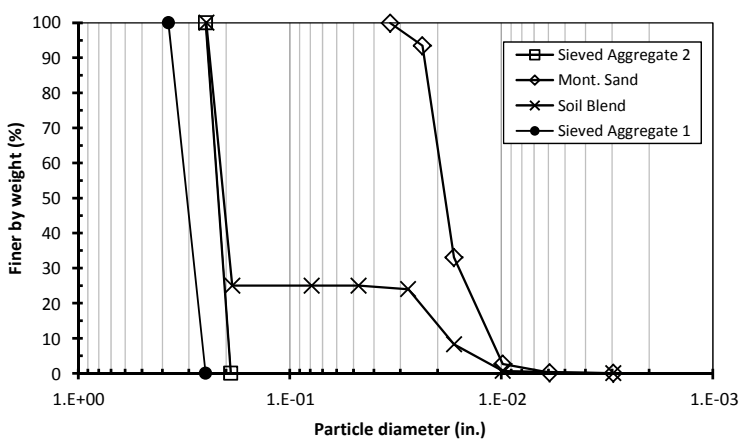
Pullout Rate	
1.0 mm/min.	0.04 in/min

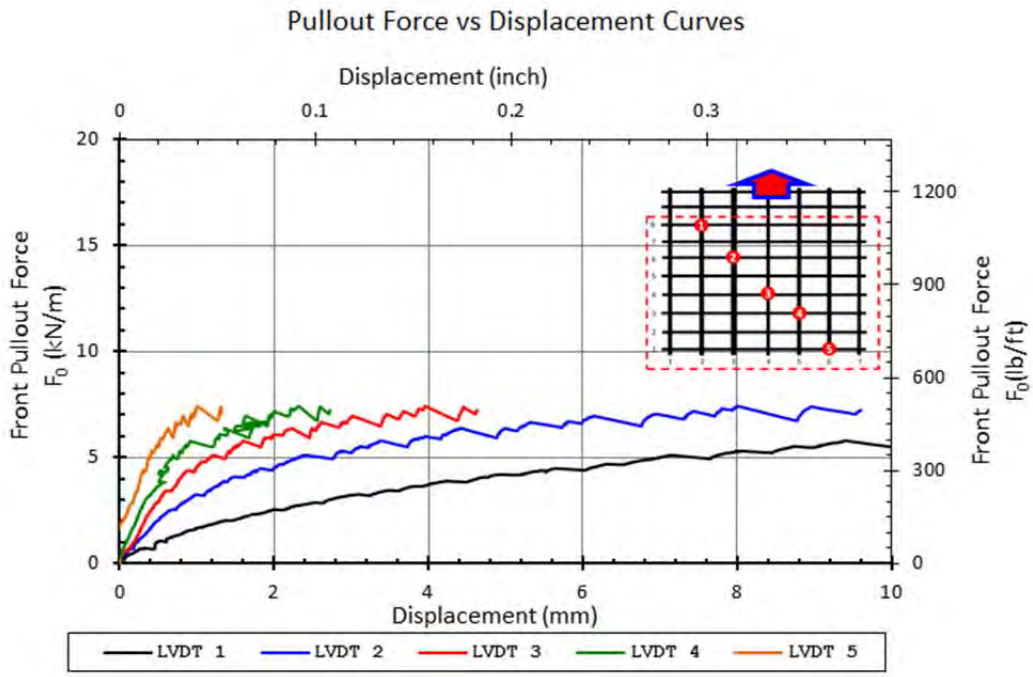
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

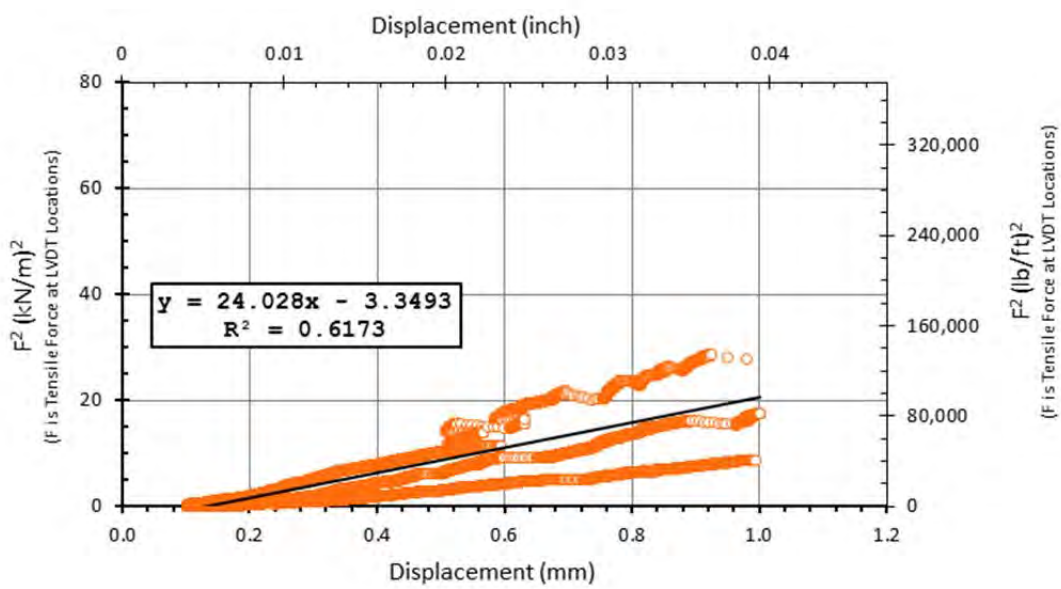
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	509	lb/ft
Max Pullout Load	P_{max}	2.23	kN	399	lb
Max Shear Stress	τ_{max}	30.0	kPa	4.3	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
24.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	2/21/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.300	m	0.245	m
	6	0.915	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.5	0.452
2	54.8	2.157
3	99.6	3.922
4	144.3	5.680
5	233.0	9.172

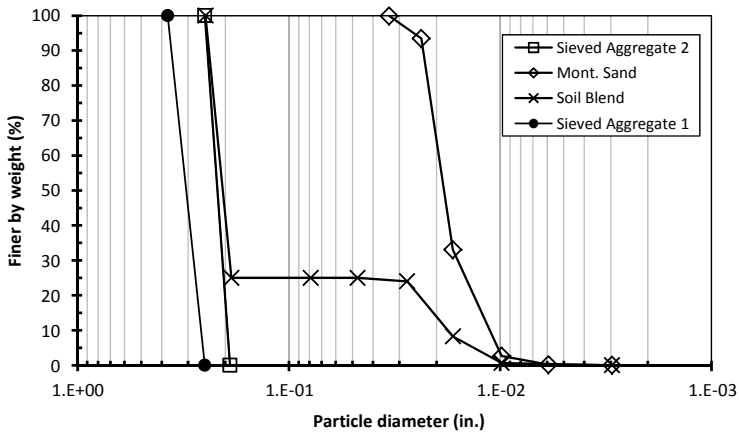
Pullout Rate			
1.0	mm/min.	0.04	in/min

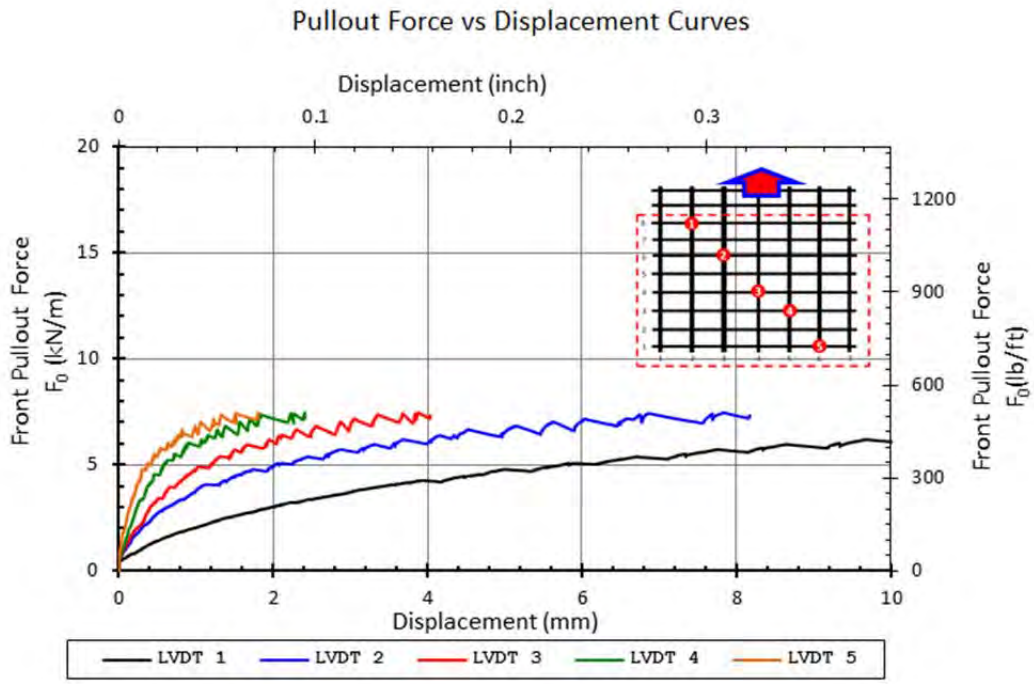
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.528 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

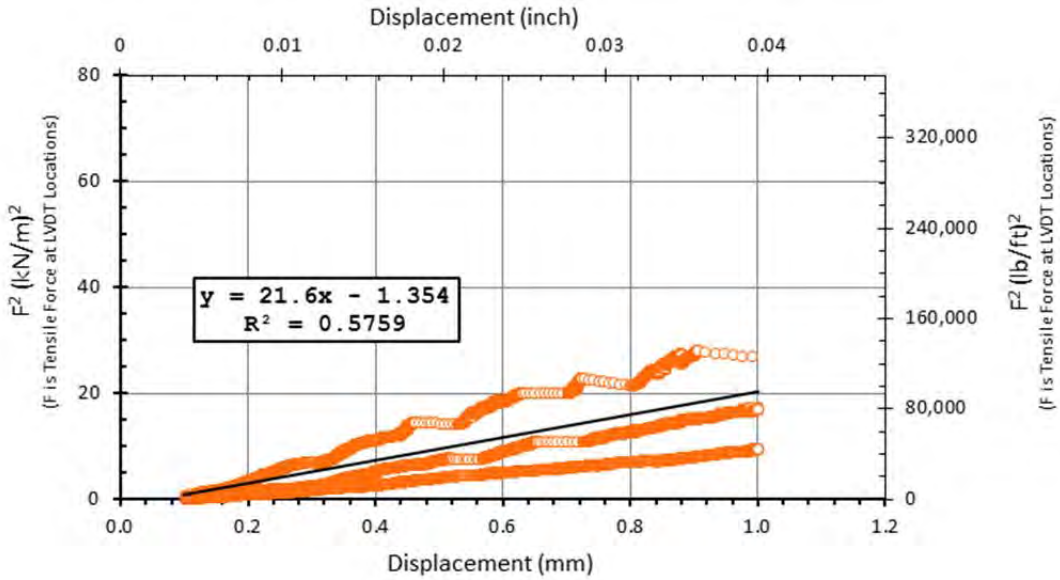
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	511	lb/ft
Max Pullout Load	P_{max}	2.24	kN	407	lb
Max Shear Stress	τ_{max}	30.1	kPa	4.4	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}
21.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	3/24/2010
Done by	julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.274	m	0.261	m	0.245	m
	6	0.899	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-2.1	-0.084
2	51.2	2.017
3	105.0	4.135
4	157.4	6.198
5	209.4	8.245

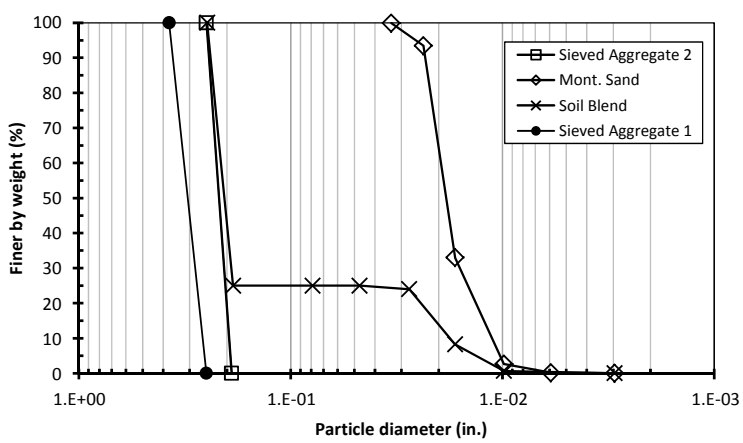
Pullout Rate	
1.0 mm/min.	0.04 in/min

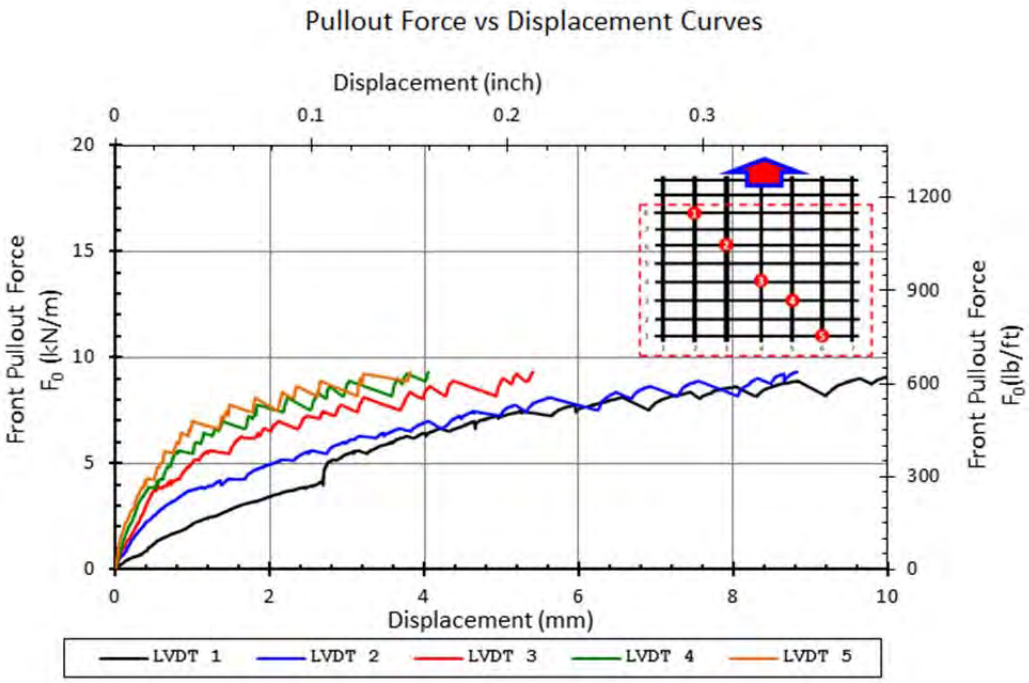
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.58	**%**
Dry Density (ρ_d)	1.531 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

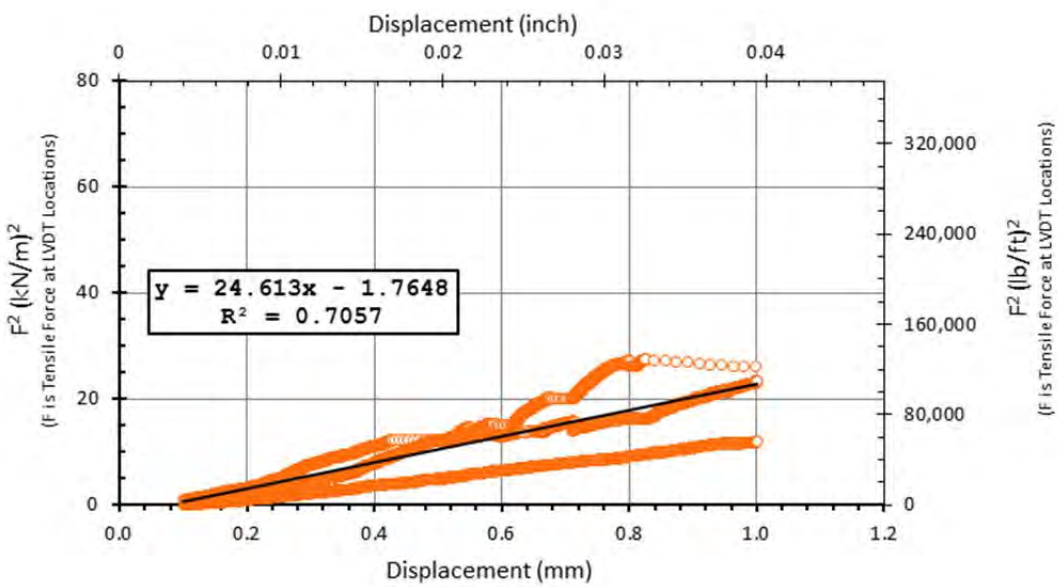
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.3	kN/m	638	lb/ft
Max Pullout Load	P_{max}	2.43	kN	421	lb
Max Shear Stress	τ_{max}	32.7	kPa	4.7	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
24.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	3/24/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.274	m	0.261	m	0.245	m
	6	0.899	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-2.1	-0.084
2	51.2	2.017
3	105.0	4.135
4	157.4	6.198
5	209.4	8.245

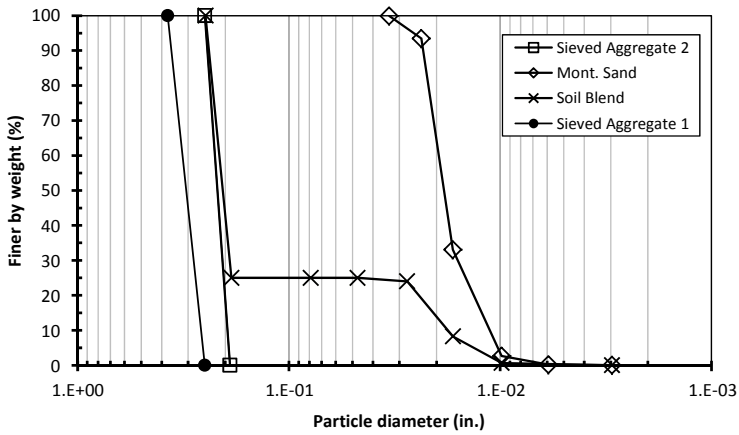
Pullout Rate			
1.0	mm/min.	0.04	in/min

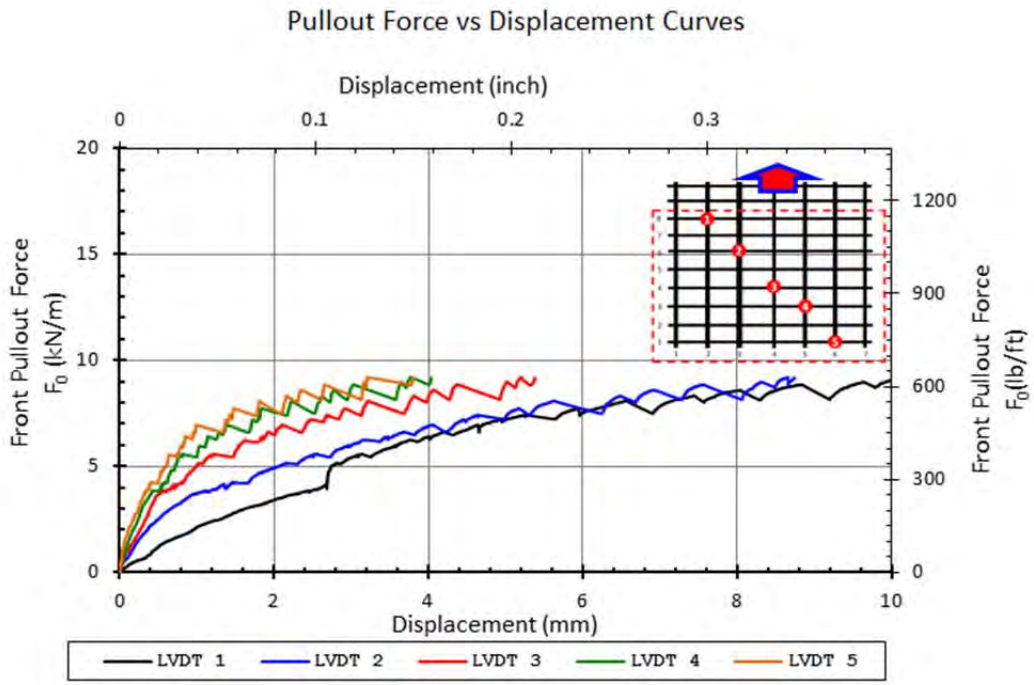
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	1.58	**%**	
Dry Density (ρ_d)	1.531 **g/cm^3**	**96**	**pcf**

Note: particle size distribution curve shown below

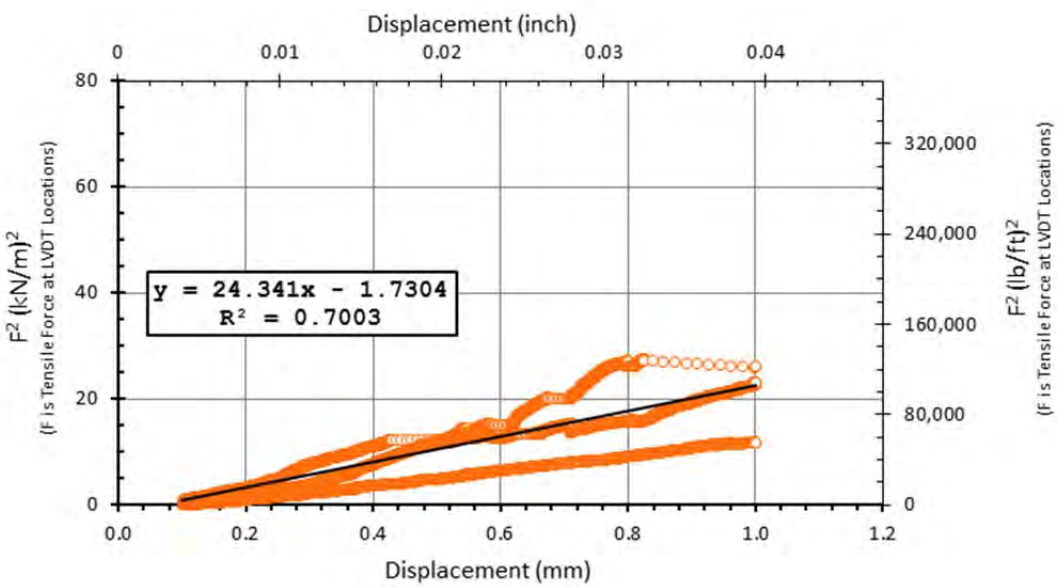
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.2	kN/m	630	lb/ft
Max Pullout Load	P_{max}	2.40	kN	421	lb
Max Shear Stress	τ_{max}	32.3	kPa	4.7	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
24.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	3/30/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.261	m	0.245	m
	6	0.902	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	9.9	0.389
2	63.0	2.478
3	116.1	4.570
4	169.0	6.655
5	221.5	8.719

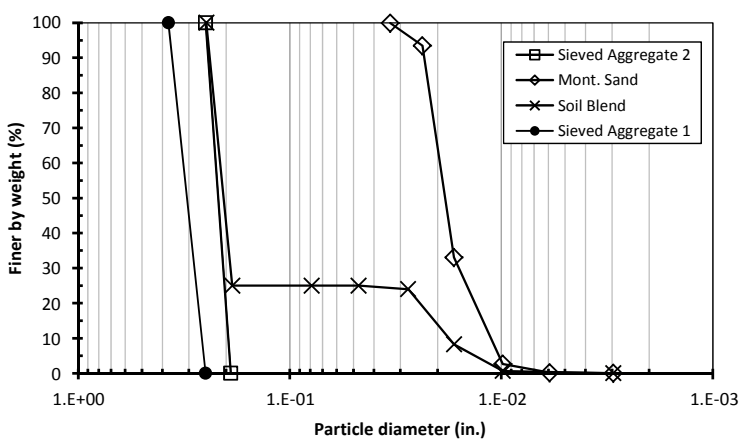
Pullout Rate	
1.0 mm/min.	0.04 in/min

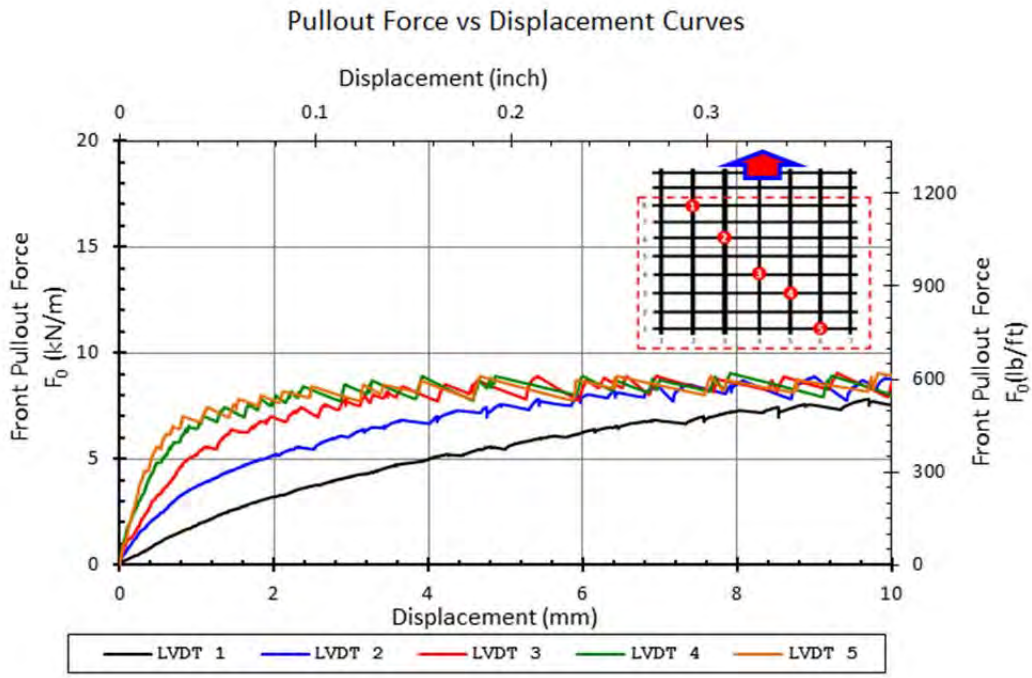
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.52	**%**
Dry Density (ρ_d)	1.515 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

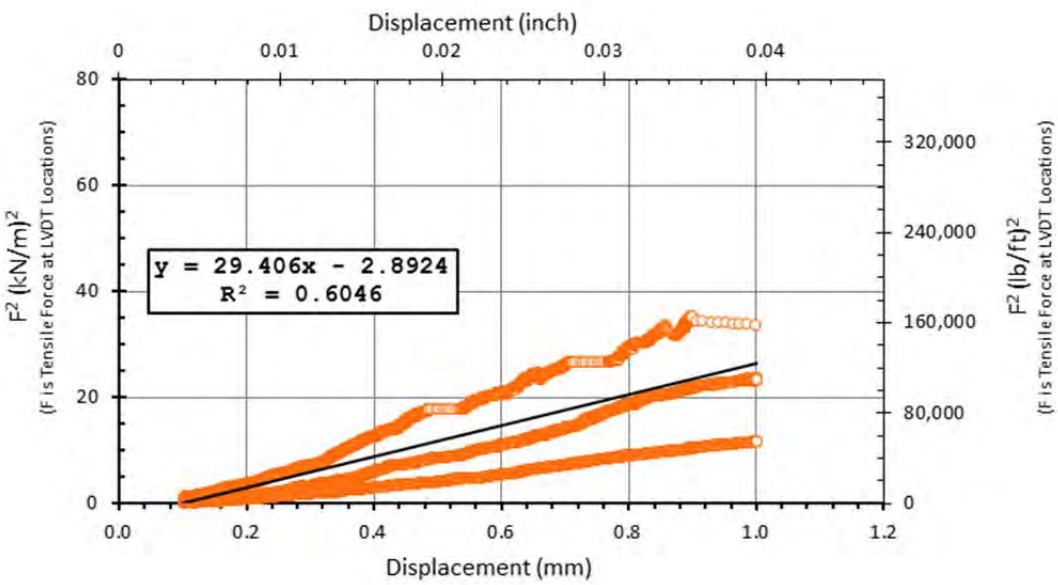
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.1	kN/m	620	lb/ft
Max Pullout Load	P_{max}	2.36	kN	501	lb
Max Shear Stress	τ_{max}	31.7	kPa	4.6	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
29.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	4/18/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.261	m	0.250	m	0.245	m
	10	0.856	ft	0.820	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	0.2	0.008
2	91.2	3.591
3	136.8	5.386
4	182.0	7.163
5	228.0	8.975

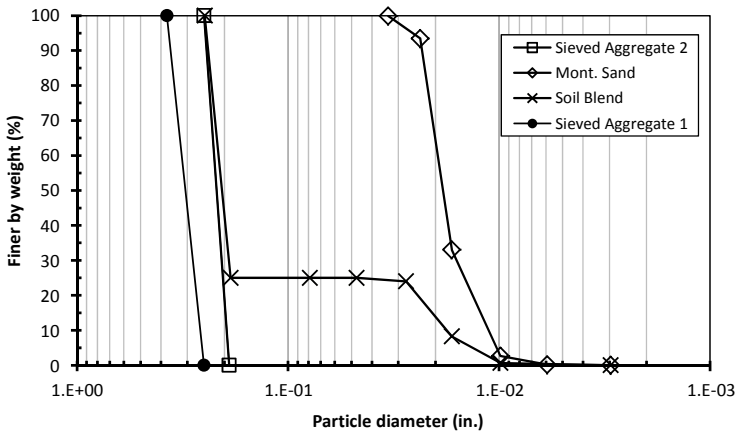
Pullout Rate	
1.0 mm/min.	0.04 in/min

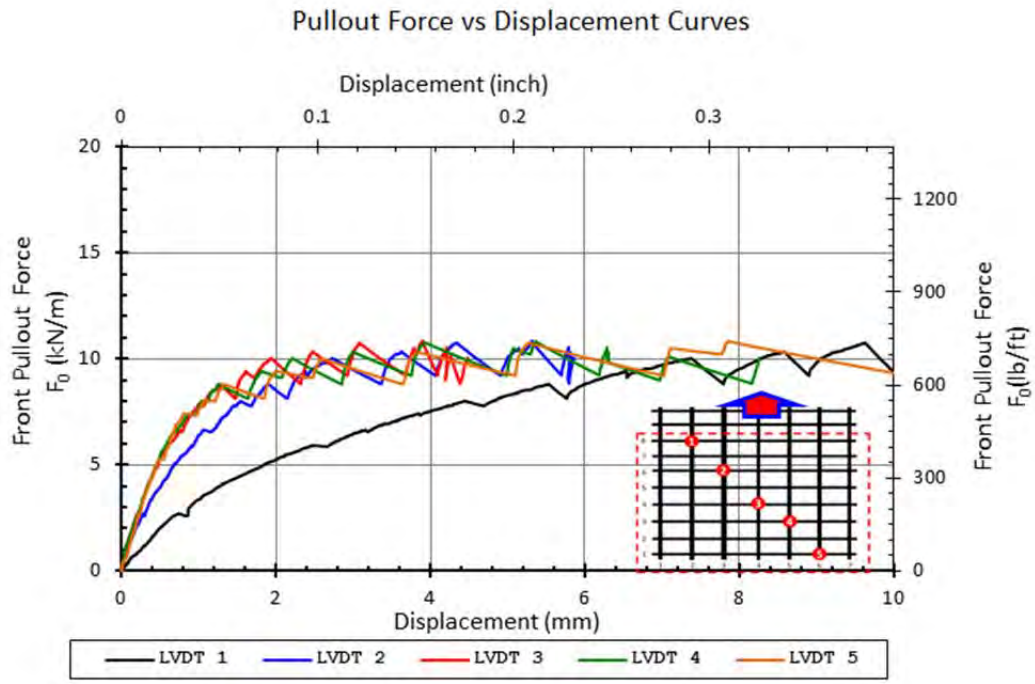
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.49	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

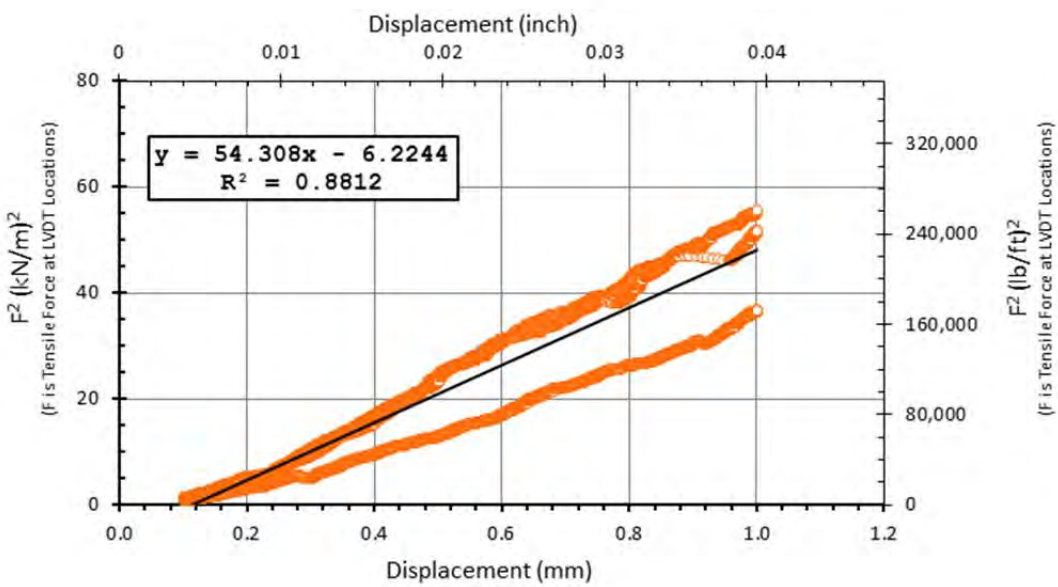
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.8	kN/m	743	lb/ft
Max Pullout Load	P_{max}	2.71	kN	622	lb
Max Shear Stress	τ_{max}	36.4	kPa	5.3	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
54.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	5/2/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.255	m	0.250	m	0.245	m
	10	0.837	ft	0.820	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.6	0.534
2	99.3	3.908
3	142.7	5.620
4	186.4	7.337
5	228.3	8.988

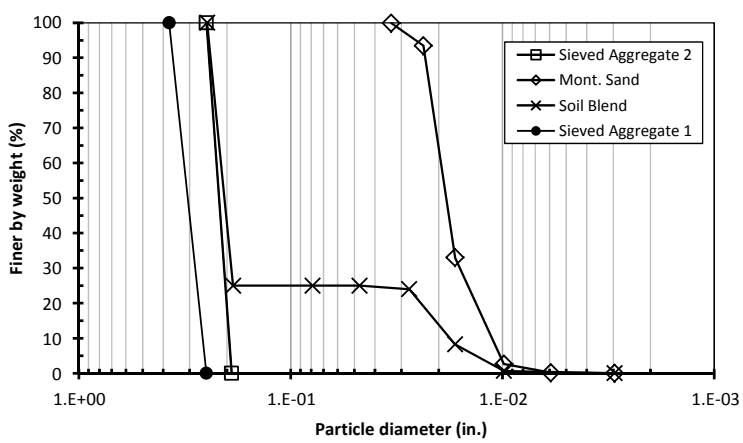
Pullout Rate	
1.0 mm/min.	0.04 in/min

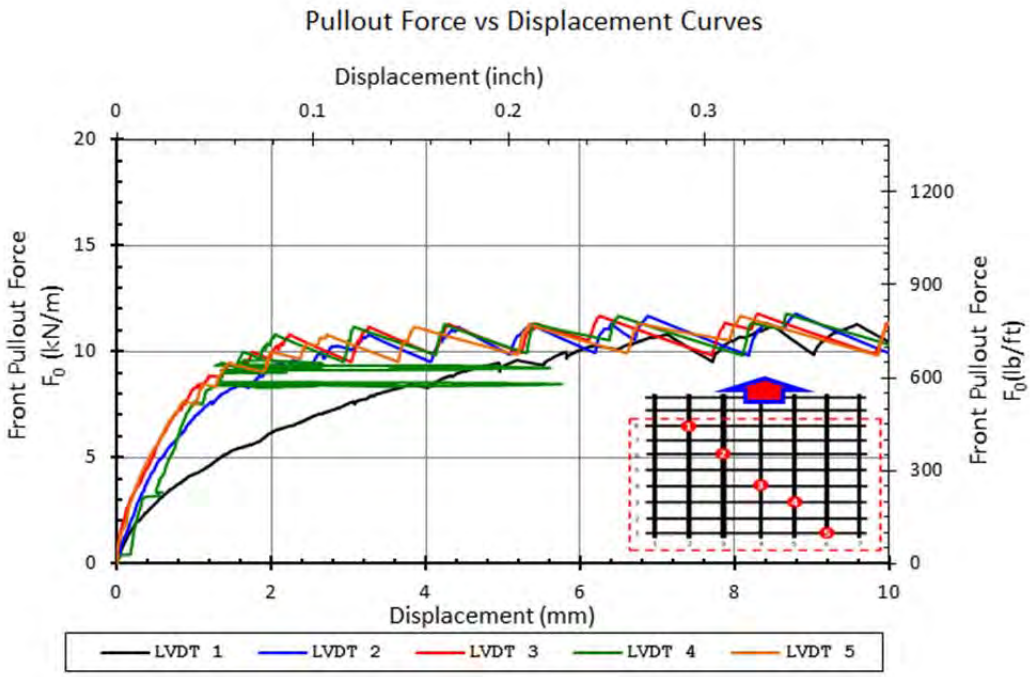
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	1.50	**%**
Dry Density (ρ_d)	1.511 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

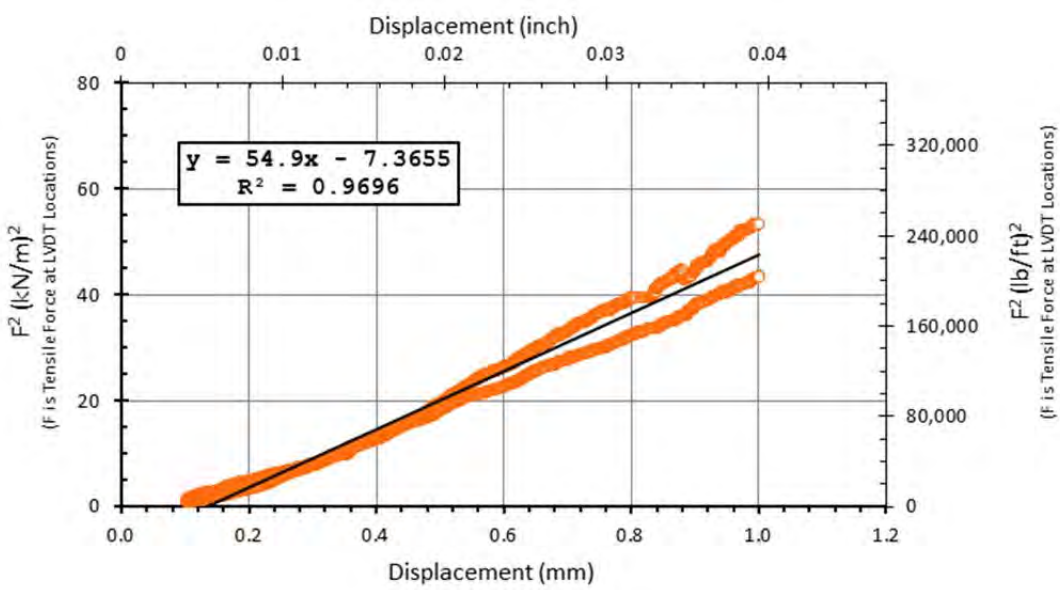
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.0	kN/m	823	lb/ft
Max Pullout Load	P_{max}	3.00	kN	669	lb
Max Shear Stress	τ_{max}	40.4	kPa	5.9	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
54.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content. Problems with readings of LVDT 4. Data from LVDT 4 not used in the calculations of Ksgi

SMALL PULLOUT TEST

Date test conducted	5/4/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.260	m	0.250	m	0.245	m
	10	0.853	ft	0.820	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-1.5	-0.060
2	91.5	3.601
3	136.8	5.387
4	181.1	7.131
5	226.7	8.924

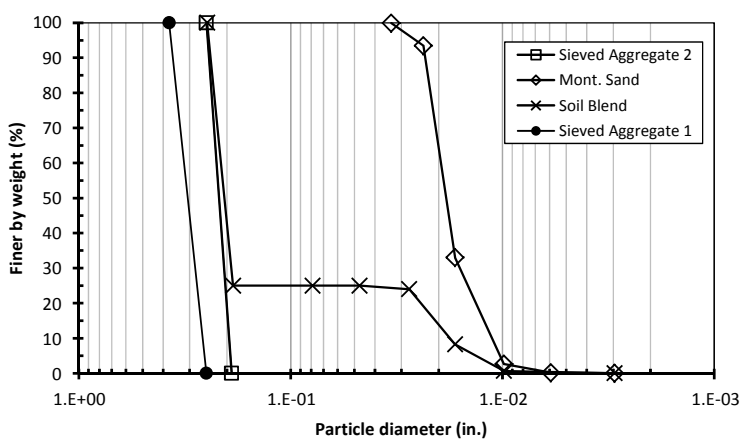
Pullout Rate			
1.0	mm/min.	0.04	in/min

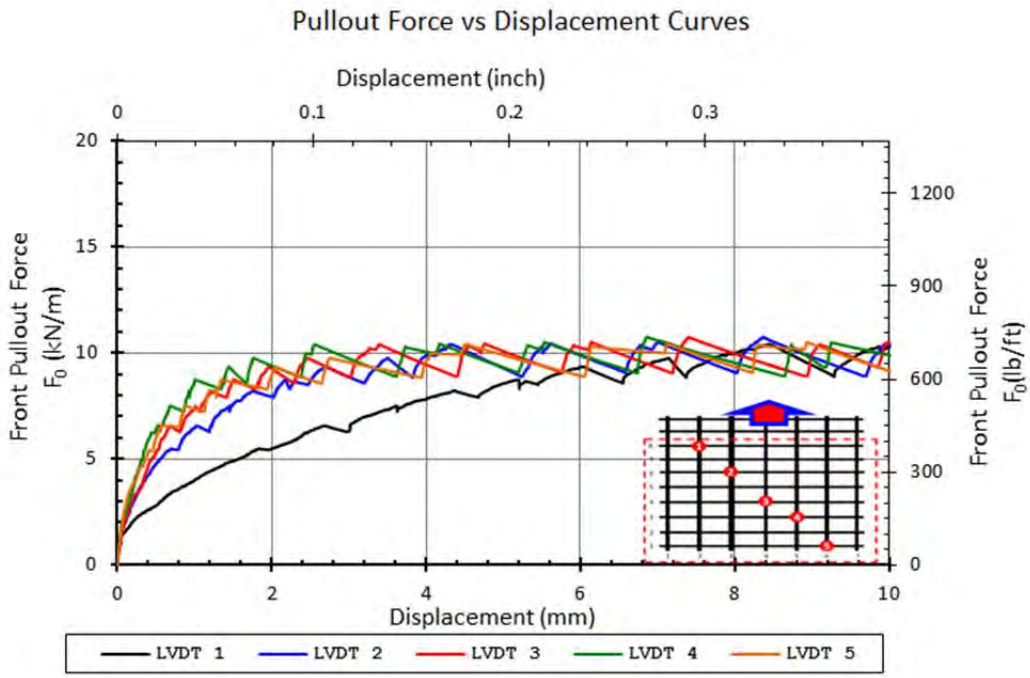
SOIL Information			
Soil	Monterrey #30 Sand		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.547 **g/cm^3**	**97**	**pcf**

Note: particle size distribution curve shown below

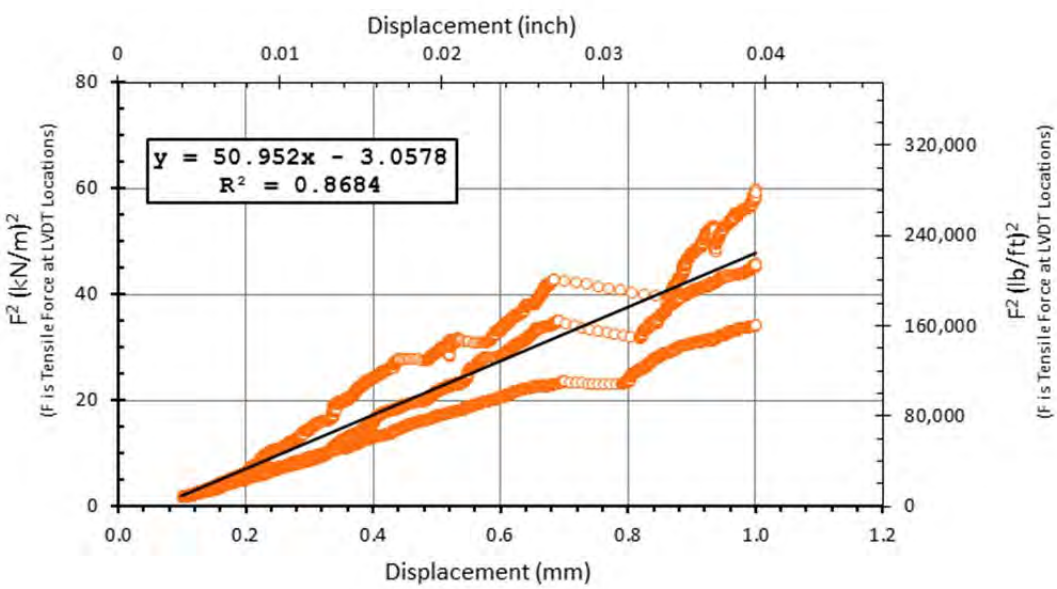
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.8	kN/m	737	lb/ft
Max Pullout Load	P_{max}	2.69	kN	601	lb
Max Shear Stress	τ_{max}	36.1	kPa	5.2	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	31	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
51.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	4/4/2010
Done by	julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.261	m	0.245	m
	12	0.902	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	59.6	2.345
2	108.2	4.259
3	159.2	6.269
4	210.1	8.273
5	216.1	8.509

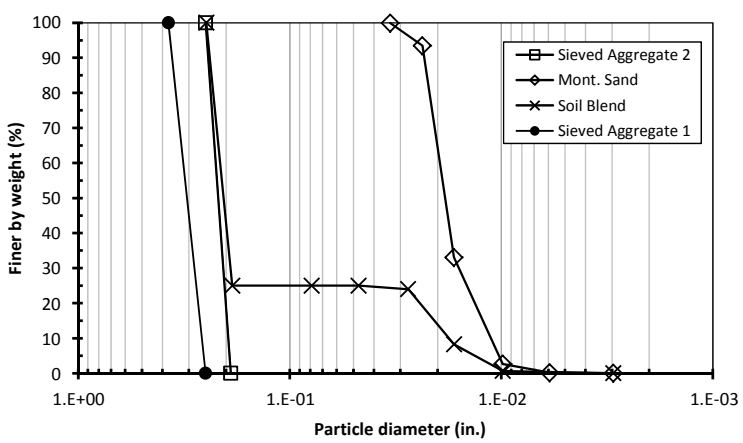
Pullout Rate	
1.0 mm/min.	0.04 in/min

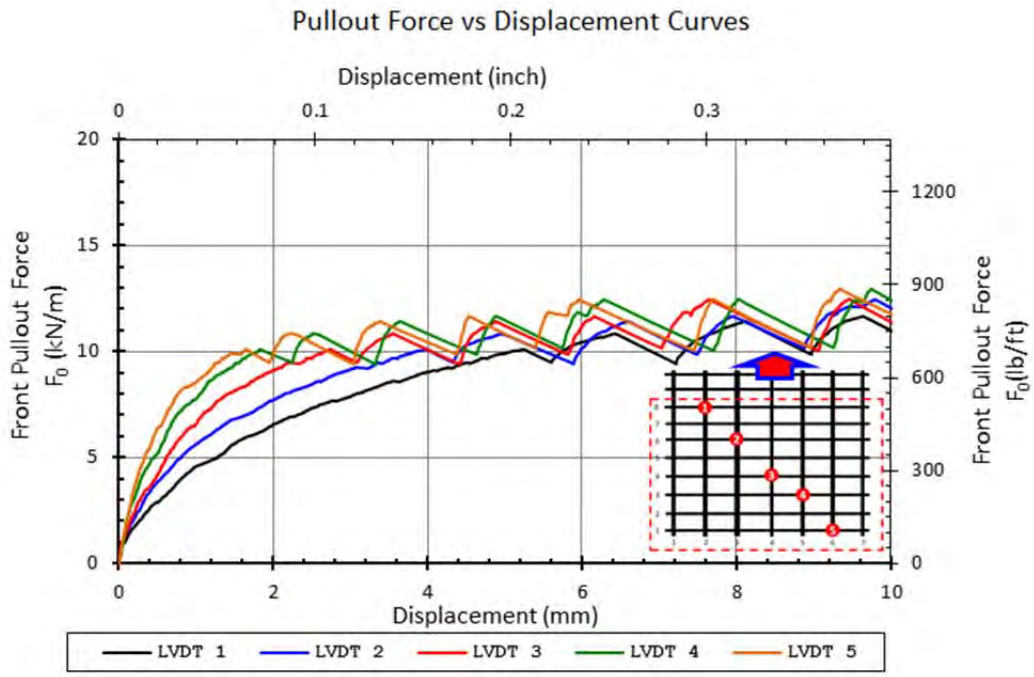
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

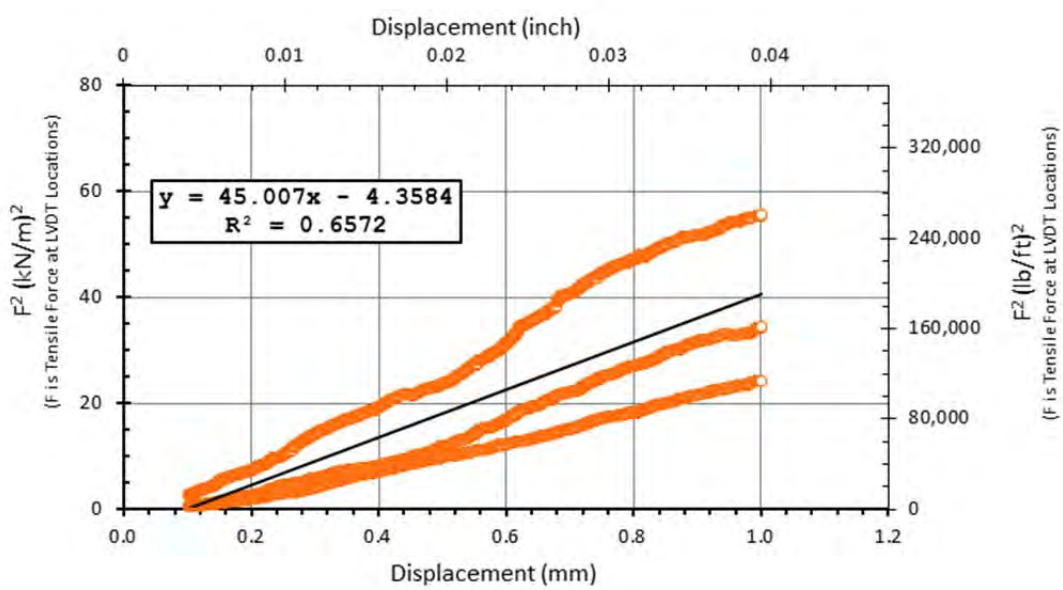
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.9	kN/m	887	lb/ft
Max Pullout Load	P_{max}	3.38	kN	771	lb
Max Shear Stress	τ_{max}	45.4	kPa	6.6	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	32	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
45.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

SMALL PULLOUT TEST

Date test conducted	4/4/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.271	m	0.261	m	0.245	m
	12	0.889	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.0	0.710
2	68.5	2.695
3	120.2	4.733
4	171.9	6.768
5	222.7	8.769

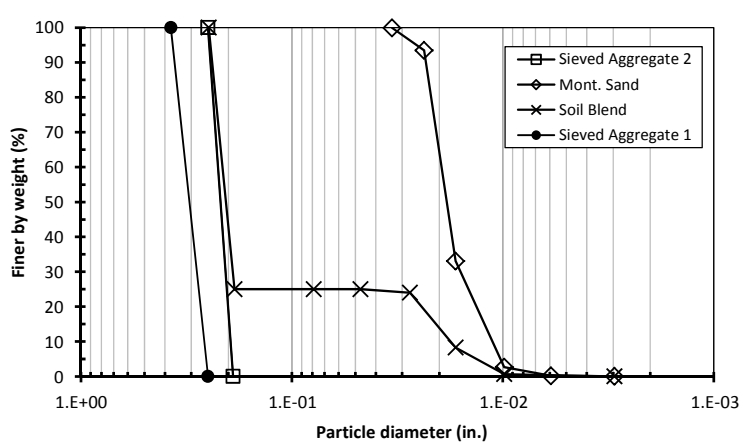
Pullout Rate	
1.0 mm/min.	0.04 in/min

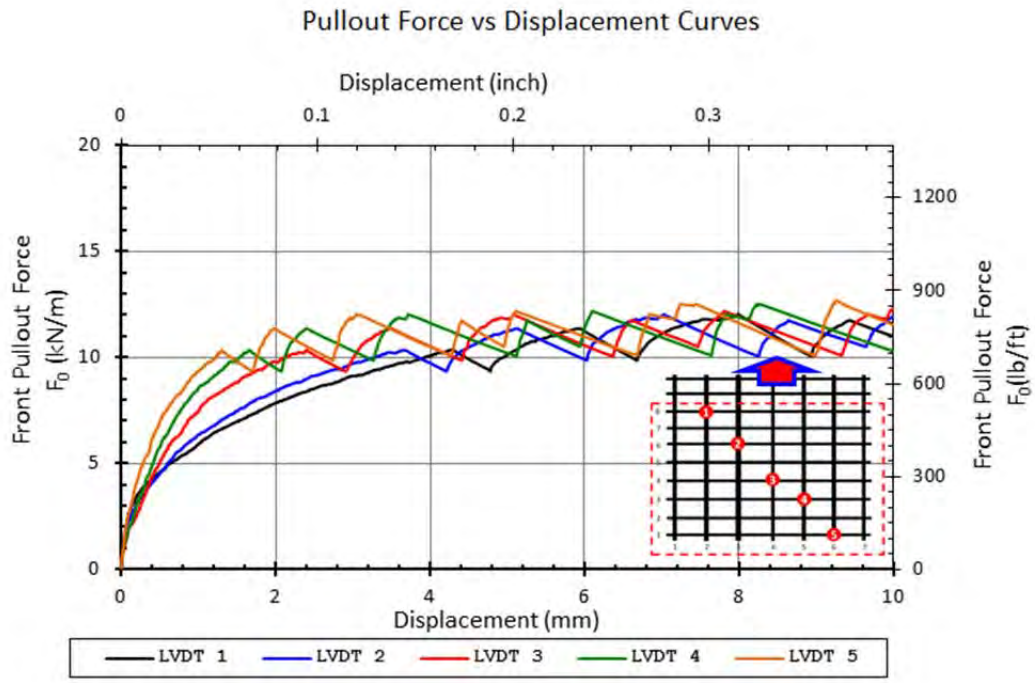
SOIL Information		
Soil	Monterrey #30 Sand	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

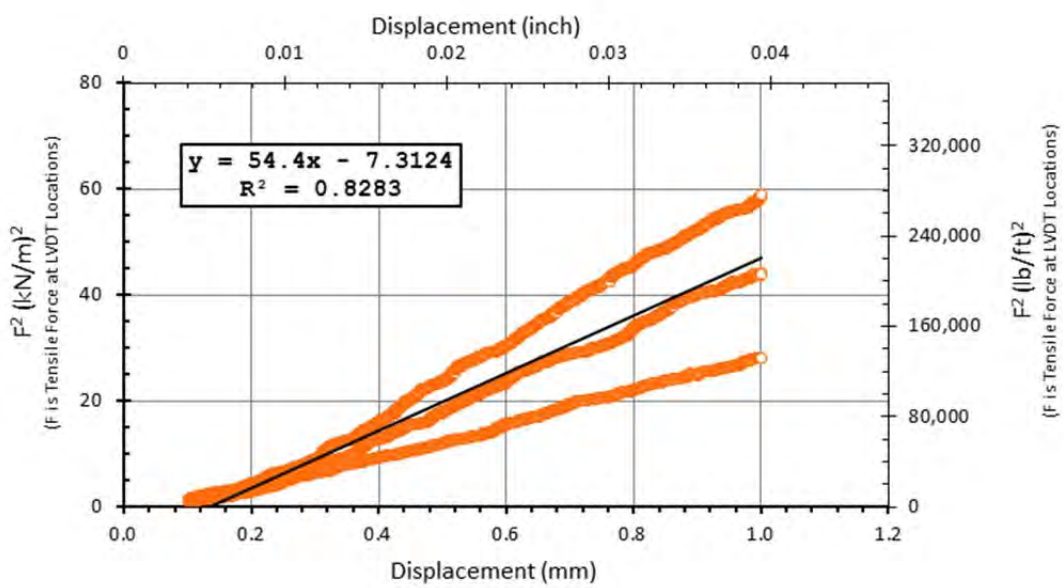
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.0	kN/m	891	lb/ft
Max Pullout Load	P_{max}	3.39	kN	752	lb
Max Shear Stress	τ_{max}	45.6	kPa	6.6	PSI
Confining Pressure	σ	34	kPa	5.0	PSI
Estimated Friction Angle of Soil	ϕ	32	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
54.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

Water content measurements are for calculations of correcting the water content.

Appendix A5

This appendix presents the results of tests in which the geosynthetic specimen was loaded until a displacement of 0.04 in. (1.0 mm) was reached by LVDTs 2, 3 and 4, then unloaded and reloaded until pullout failure. These tests were performed with geosynthetic specimens on the CD with the final configuration of the small pullout test: Sieved Aggregate 2, confining pressure of 3 psi (21 kPa), digital air pressure gauge and use of torque wrench.

In this series of tests, seven geosynthetic products were tested and replicate tests were conducted for each product. Once the 0.04 in. (1.0 mm) of displacement was reached, the tests were stopped and the geosynthetic unloaded back to 30 lbf (0.15 kN). Next, a new data acquisition file was started and the test was re-started similarly to a regular test and conducted until pullout failure.

The results of the tests conducted until 0.04 in. (1.0 mm) of displacement was reached by LVDTs 2, 3, and 4 were presented in Appendix A1. However, for convenience, these results are also presented in this appendix. Each test result is followed by the corresponding reloading test.

SMALL PULLOUT TEST

Date test conducted	4/10/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	10	0.915	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	36.0	1.419
2	76.3	3.003
3	116.5	4.587
4	156.3	6.154
5	236.8	9.322

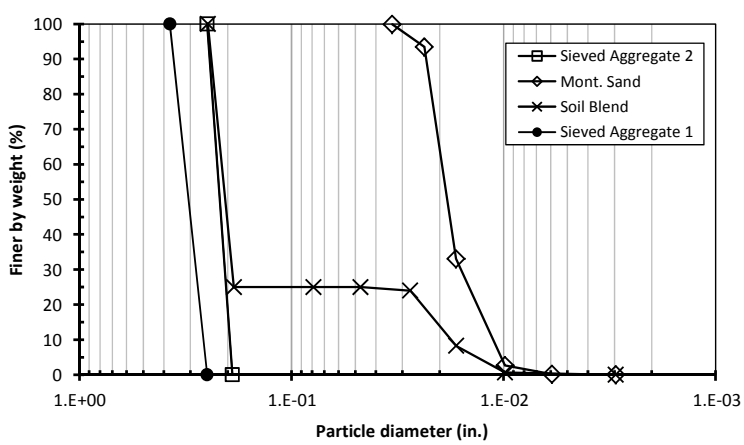
Pullout Rate	
1.0 mm/min.	0.04 in/min

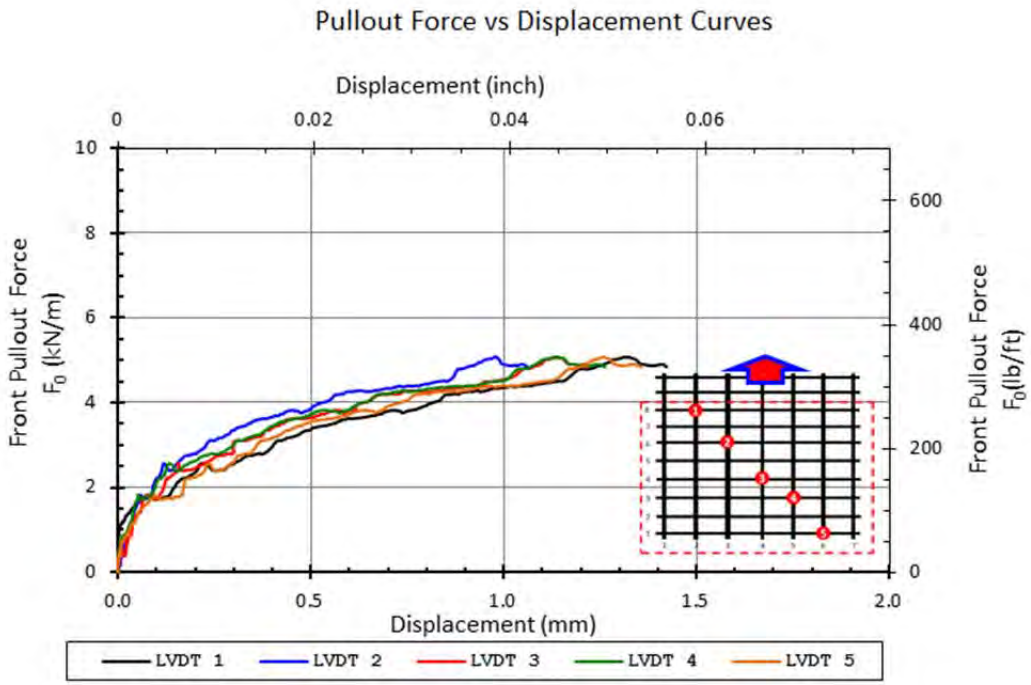
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

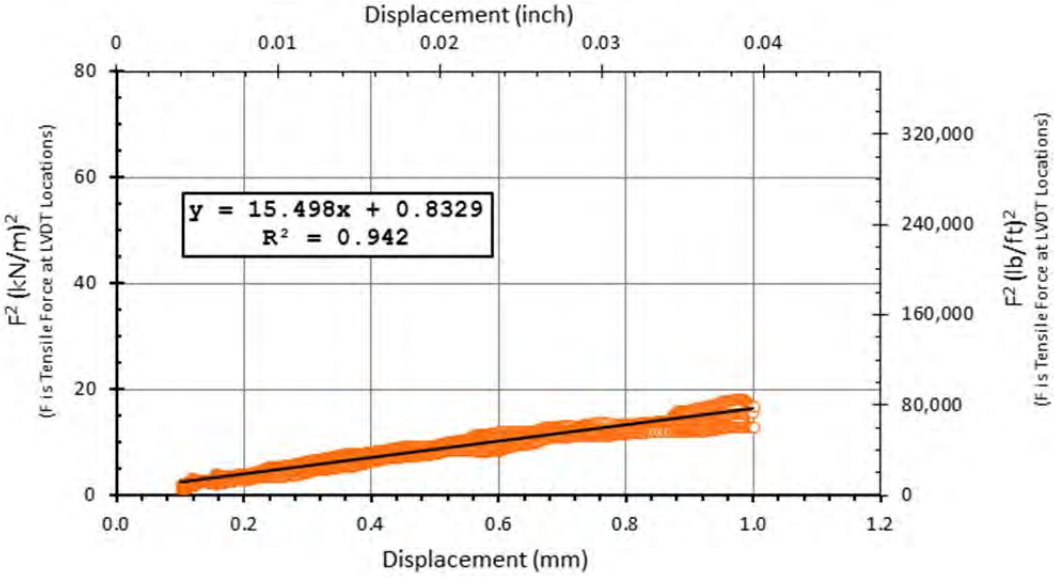
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
15.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/10/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	10	0.915	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	36.0	1.419
2	76.3	3.003
3	116.5	4.587
4	156.3	6.154
5	236.8	9.322

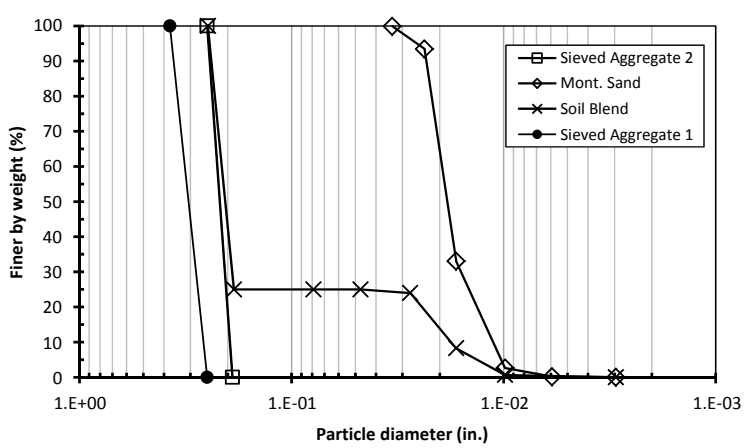
Pullout Rate	
1.0 mm/min.	0.04 in/min

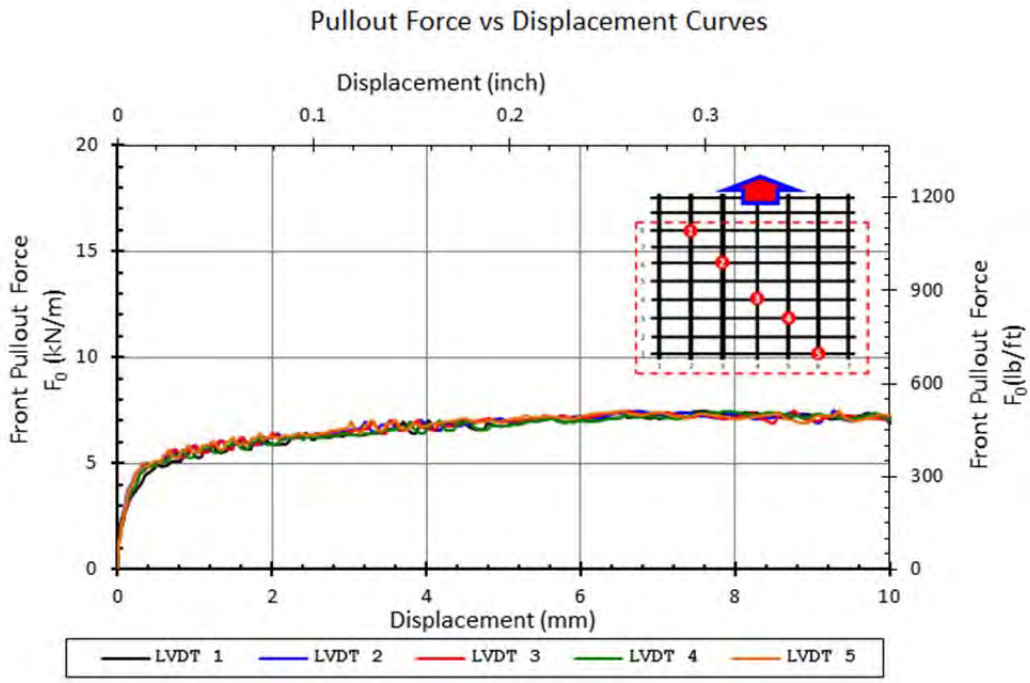
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

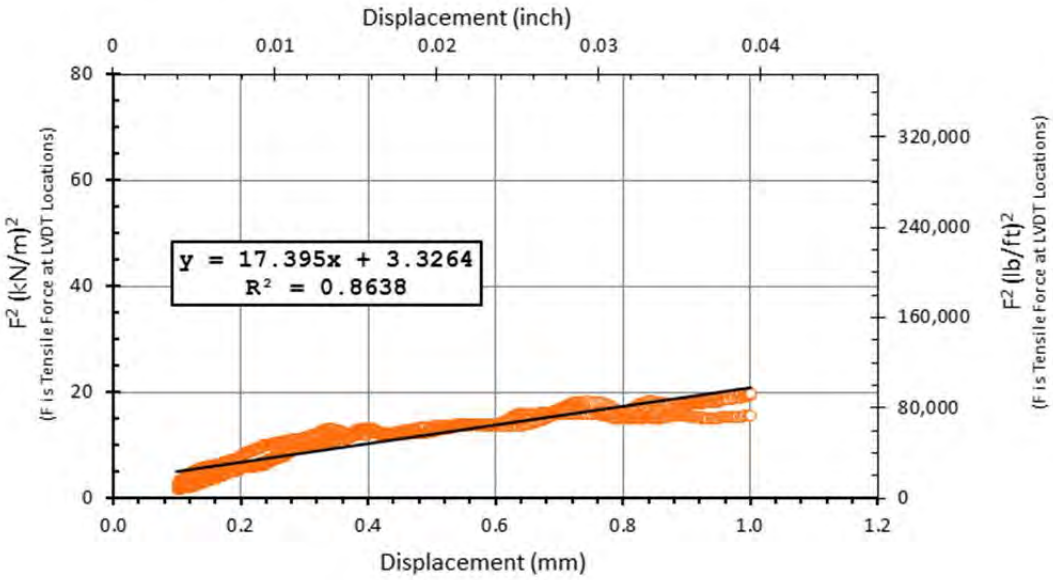
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	513	lb/ft
Max Pullout Load	P_{max}	2.06	kN	512	lb
Max Shear Stress	τ_{max}	27.7	kPa	4.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
17.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/11/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.7	0.894
2	62.1	2.446
3	102.6	4.041
4	142.5	5.610
5	223.0	8.778

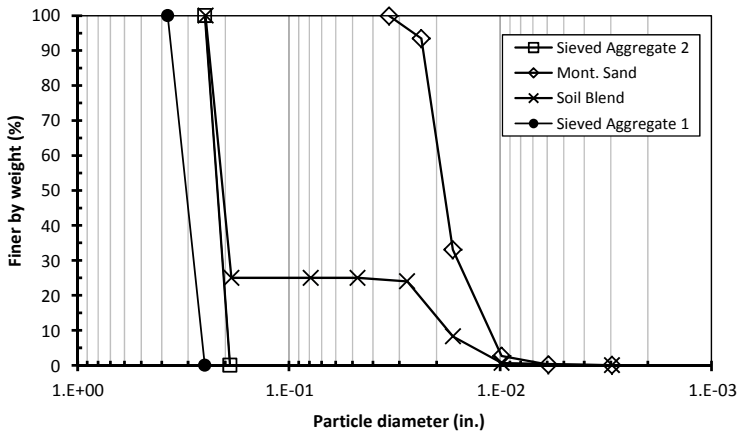
Pullout Rate	
1.0 mm/min.	0.04 in/min

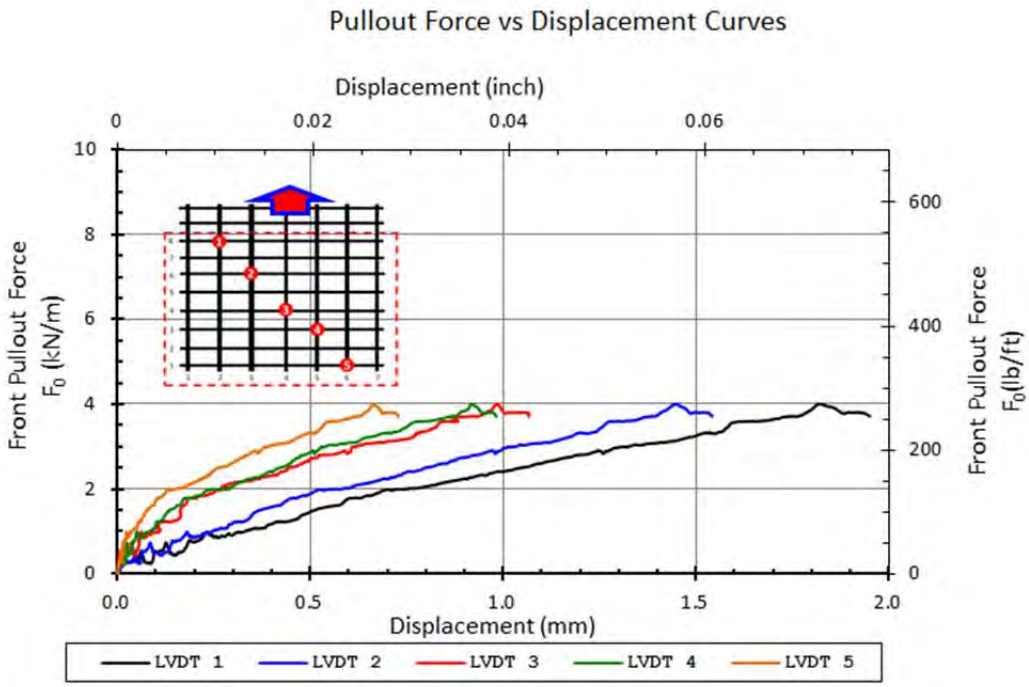
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.524 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

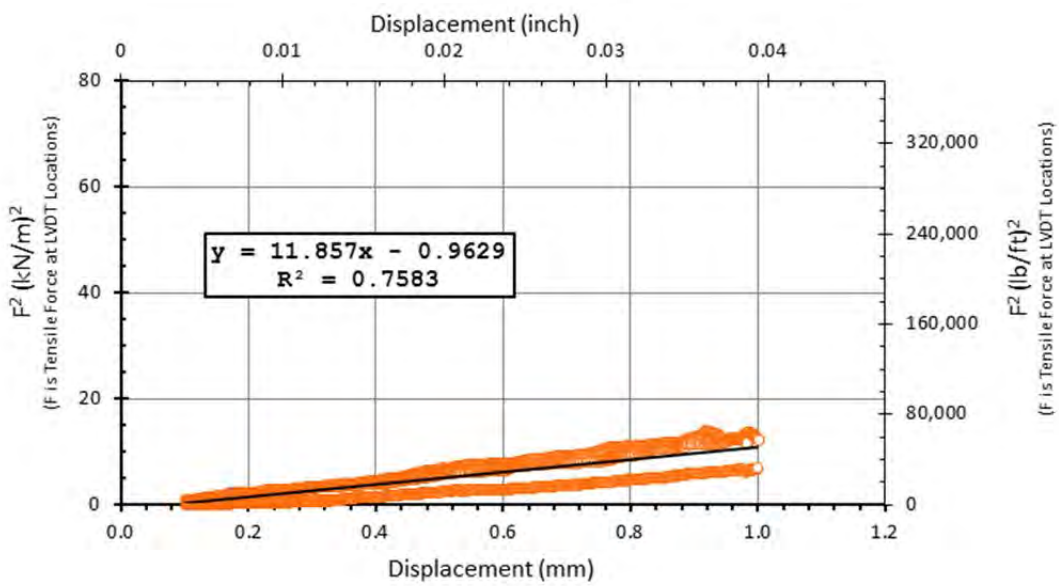
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
11.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test conducted up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/11/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.2	0.875
2	61.6	2.426
3	102.1	4.021
4	142.0	5.590
5	223.0	8.778

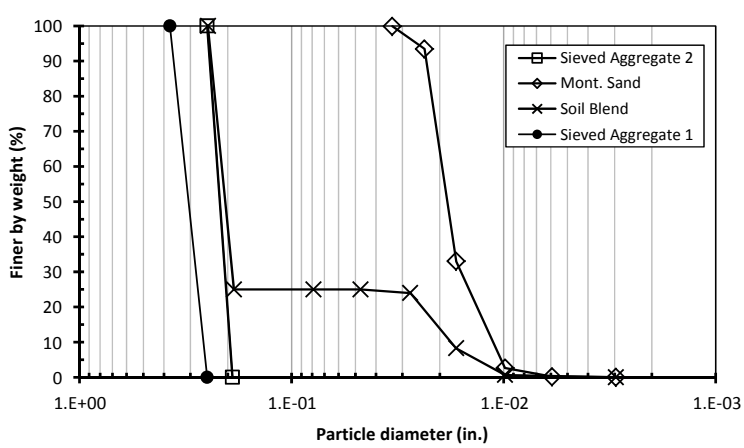
Pullout Rate	
1.0 mm/min.	0.04 in/min

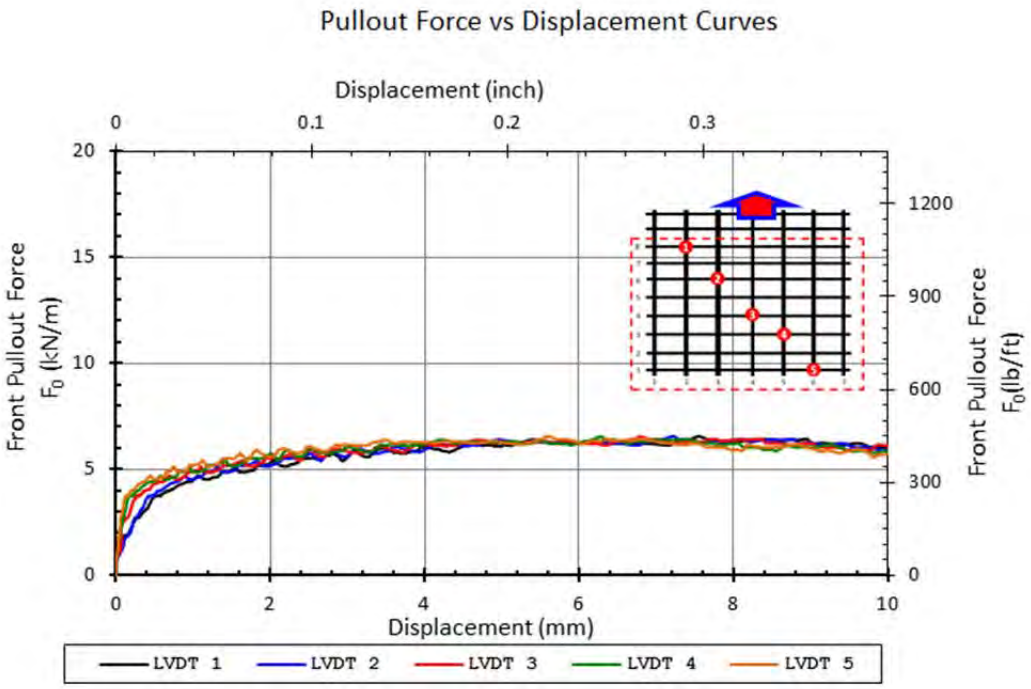
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.524 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

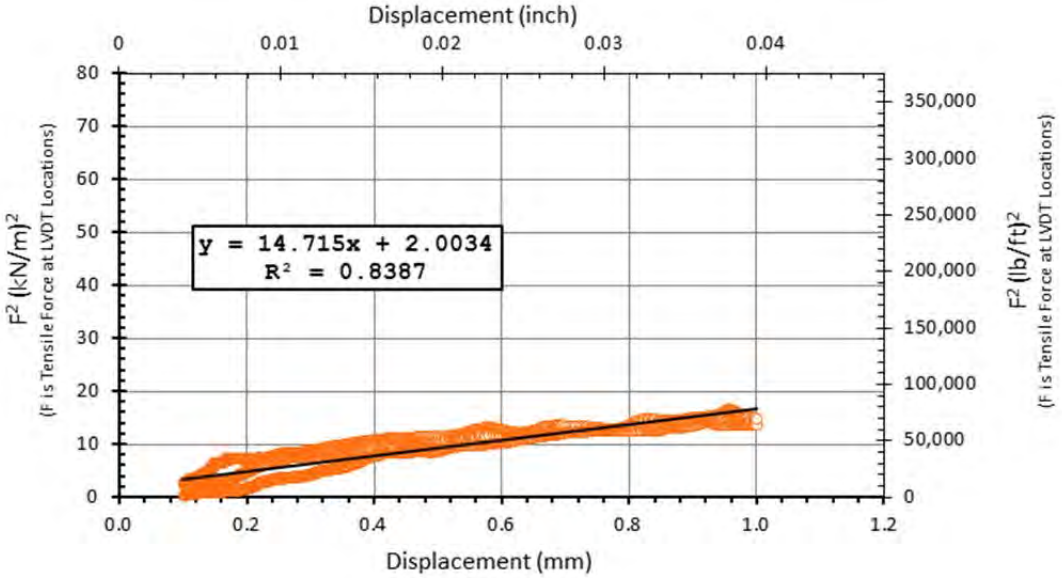
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.6	kN/m	449	lb/ft
Max Pullout Load	P_{max}	1.80	kN	442	lb
Max Shear Stress	τ_{max}	24.2	kPa	3.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
14.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/13/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	8	0.915	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.2	1.269
2	88.0	3.466
3	115.0	4.529
4	170.9	6.729
5	227.1	8.943

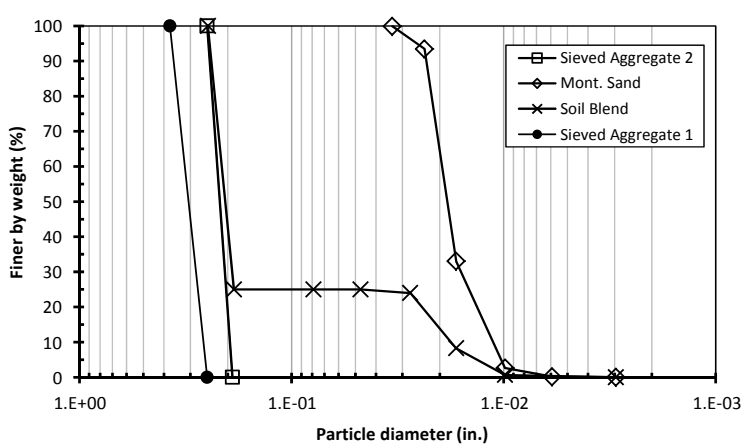
Pullout Rate	
1.0 mm/min.	0.04 in/min

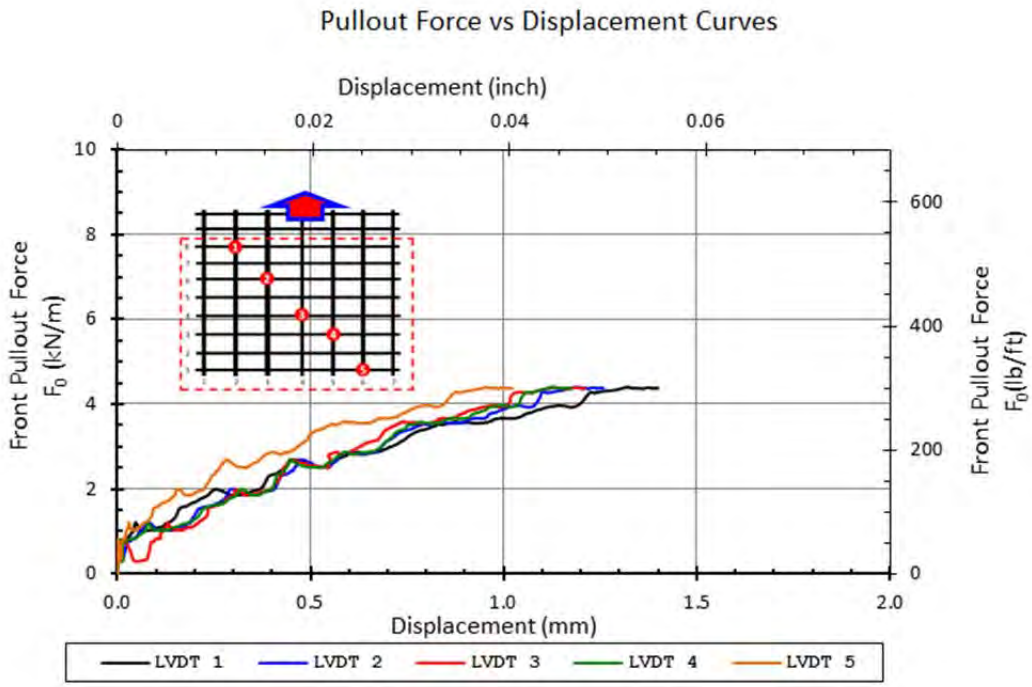
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

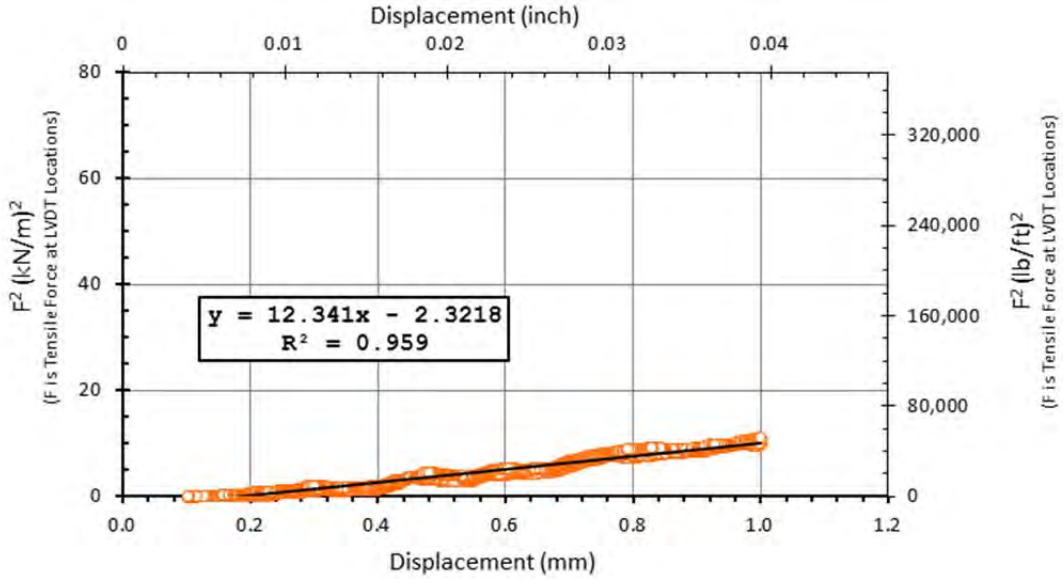
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.4	kN/m	302	lb/ft
Max Pullout Load	P_{max}	1.15	kN	282	lb
Max Shear Stress	τ_{max}	15.5	kPa	2.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.5			

Reported K_{SGI}
12.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test ran up to 1 mm of displacement of LVDTs. LVDT 5 off to the right.

SMALL PULLOUT TEST

Date test conducted	4/13/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	8	0.915	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.2	1.268
2	88.0	3.465
3	115.0	4.528
4	170.9	6.728
5	227.1	8.941

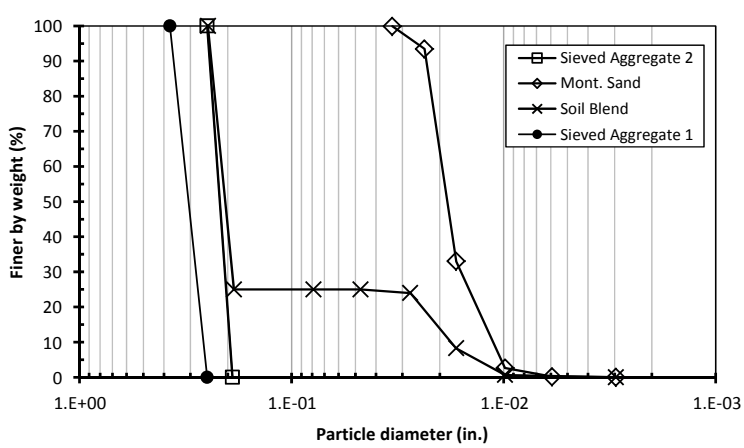
Pullout Rate	
1.0 mm/min.	0.04 in/min

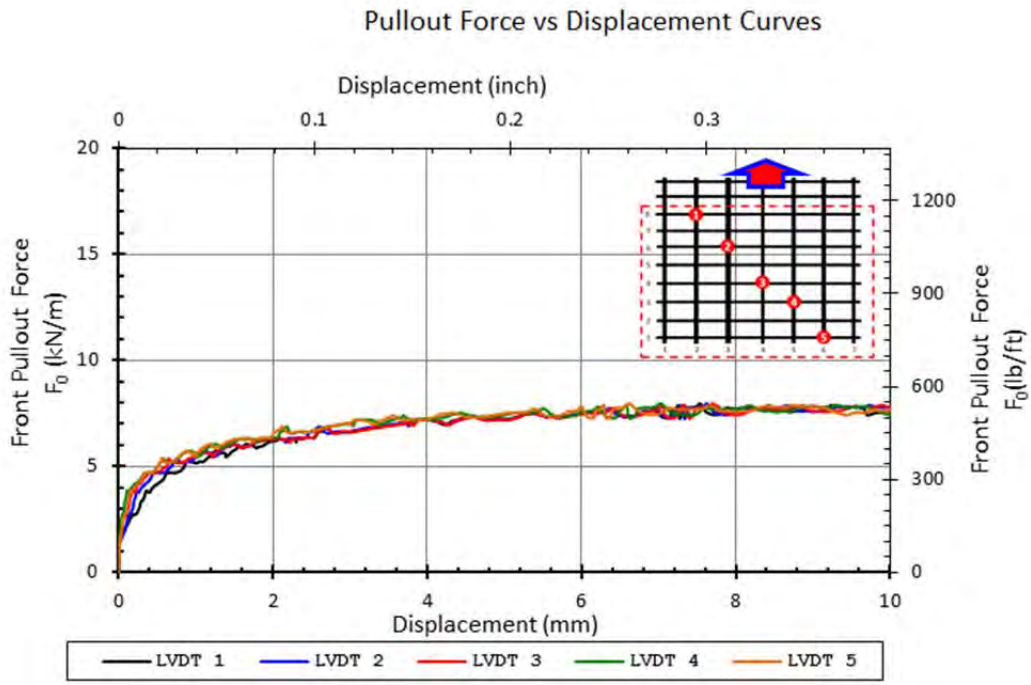
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.556 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

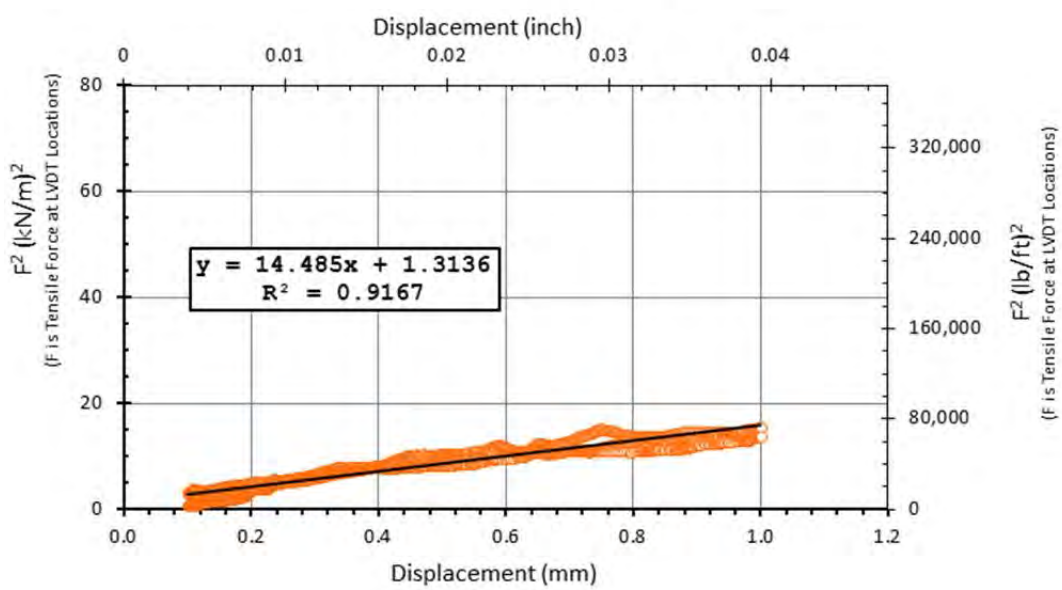
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.0	kN/m	546	lb/ft
Max Pullout Load	P_{max}	2.08	kN	499	lb
Max Shear Stress	τ_{max}	28.0	kPa	4.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
14.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT 5 off to the right. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/14/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.9	1.136
2	84.8	3.338
3	111.9	4.406
4	168.8	6.645
5	225.4	8.872

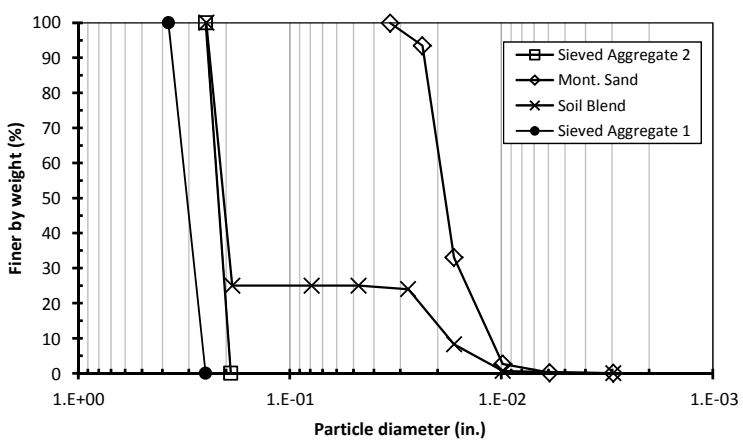
Pullout Rate	
1.0 mm/min.	0.04 in/min

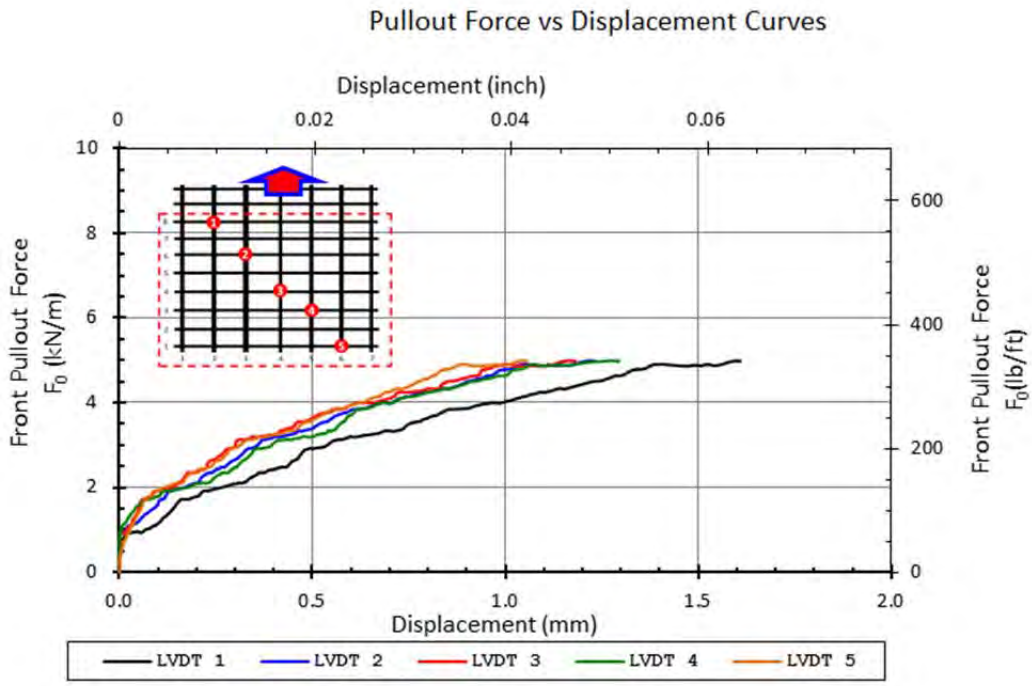
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

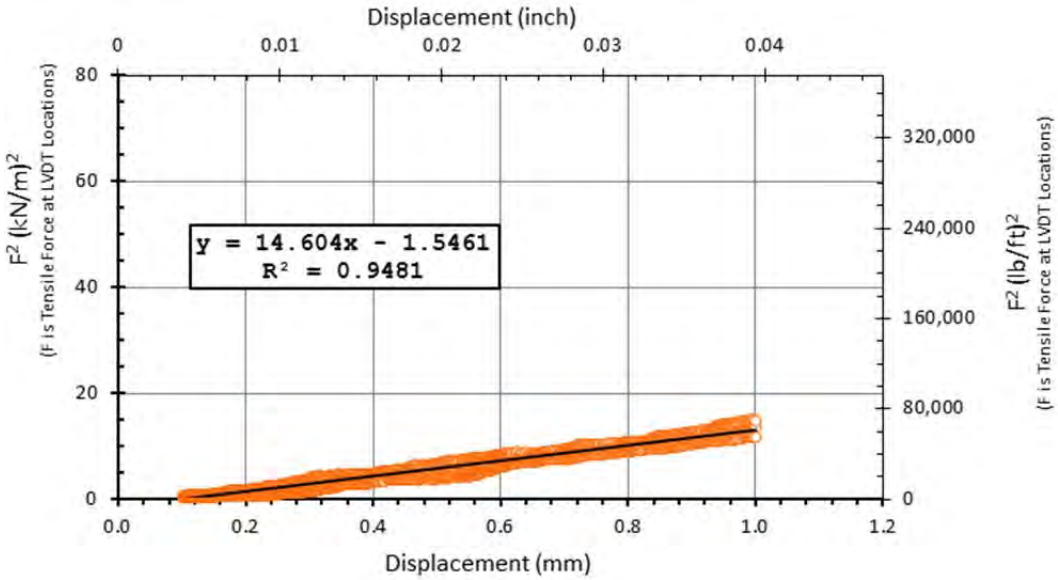
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.0	kN/m	342	lb/ft
Max Pullout Load	P_{max}	1.30	kN	326	lb
Max Shear Stress	τ_{max}	17.5	kPa	2.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
14.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test conducted up to 1 mm of displacement of LVDT 3. LVDT 5 off to the right.

SMALL PULLOUT TEST

Date test conducted	4/14/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.9	1.136
2	84.8	3.338
3	111.9	4.406
4	168.8	6.645
5	225.4	8.872

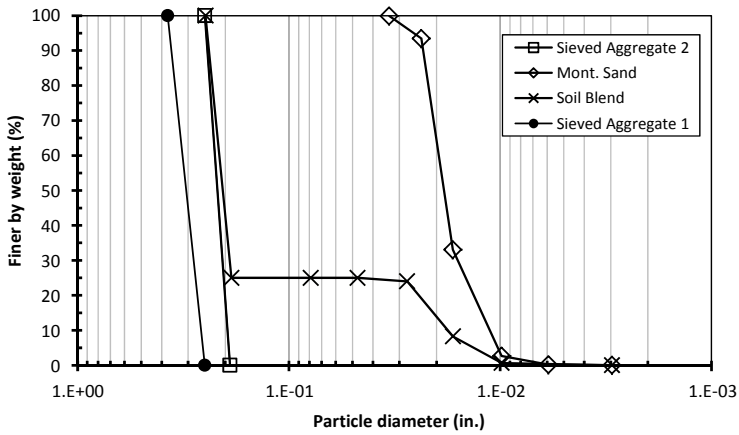
Pullout Rate			
1.0	mm/min.	0.04	in/min

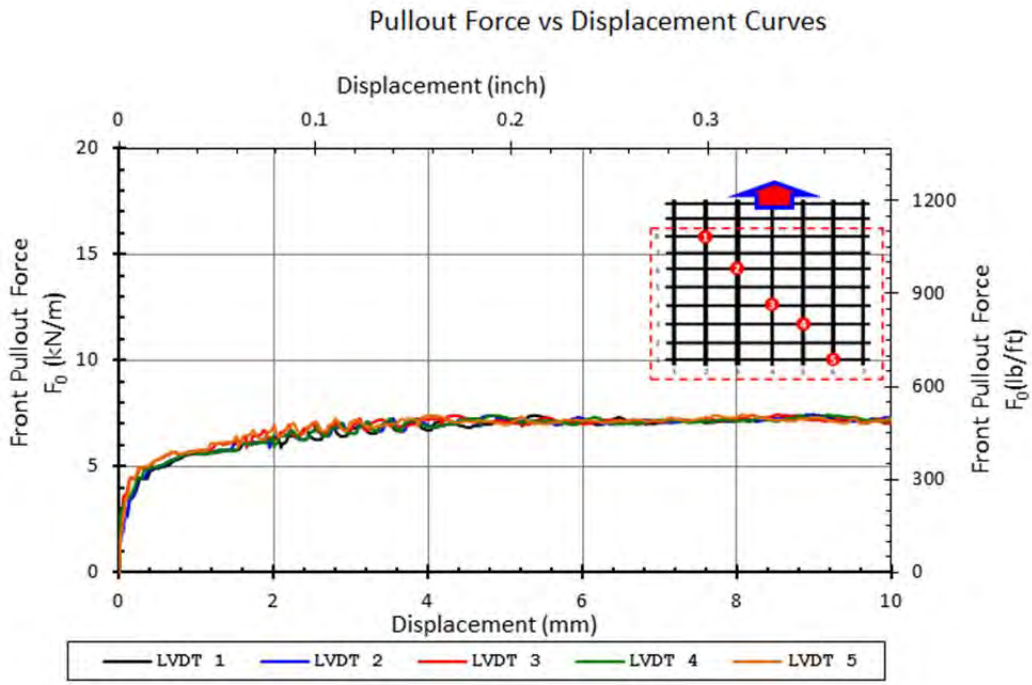
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

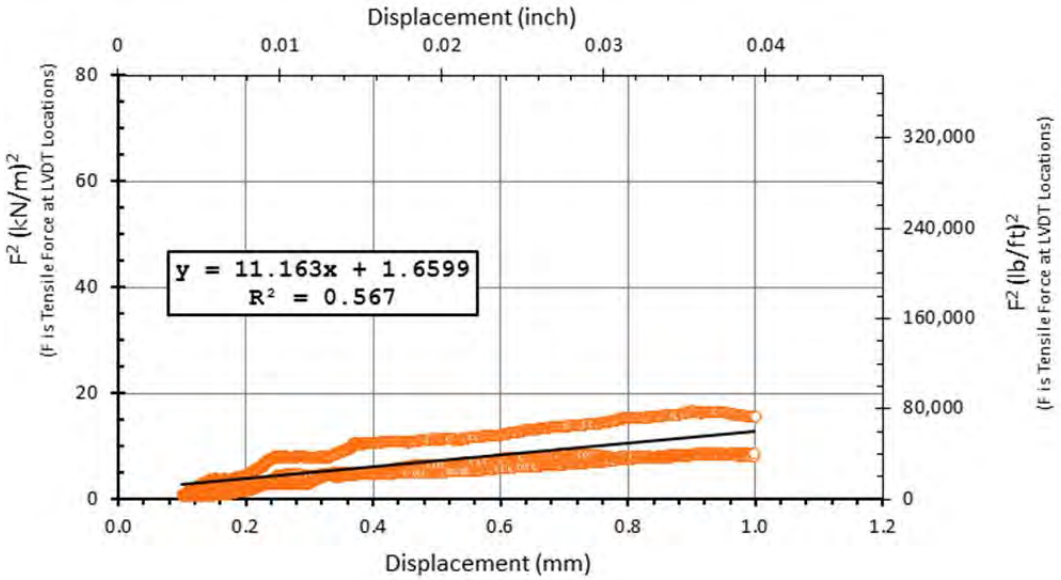
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	509	lb/ft
Max Pullout Load	P_{max}	1.94	kN	489	lb
Max Shear Stress	τ_{max}	26.1	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
11.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 off to the right. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/7/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	N/A	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-2.9	-0.116
2	96.8	3.810
3	112.3	4.420
4	126.9	4.994
5	225.2	8.866

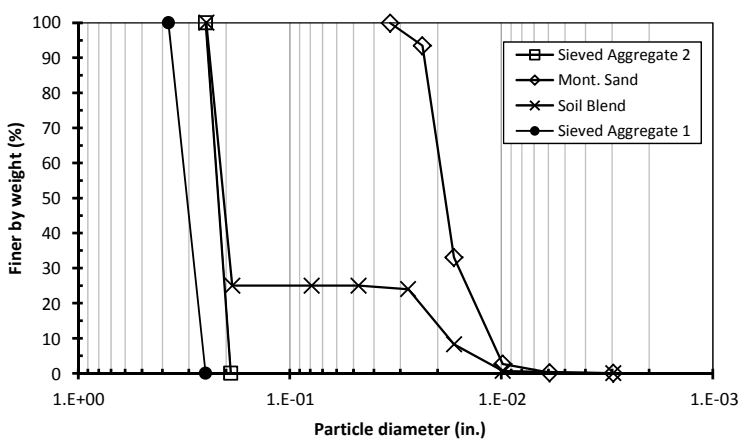
Pullout Rate	
1.0 mm/min.	0.04 in/min

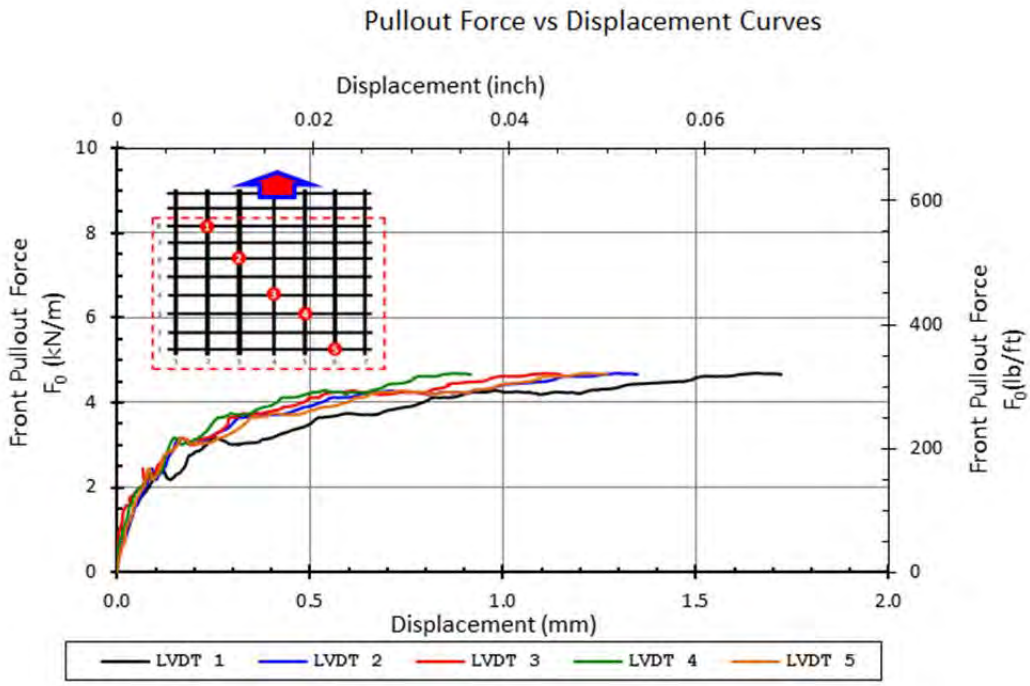
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

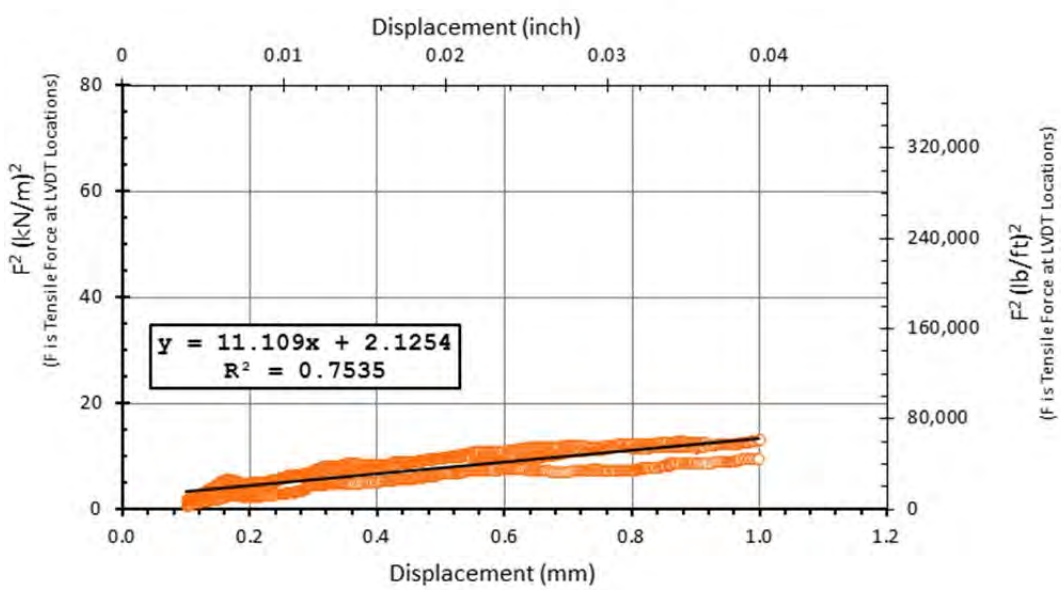
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
11.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run only up to 1 mm of displacement of LVDTs 2, 3 and 4.

SMALL PULLOUT TEST

Date test conducted	4/7/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	N/A	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-2.9	-0.116
2	96.8	3.810
3	112.3	4.420
4	126.9	4.994
5	225.2	8.866

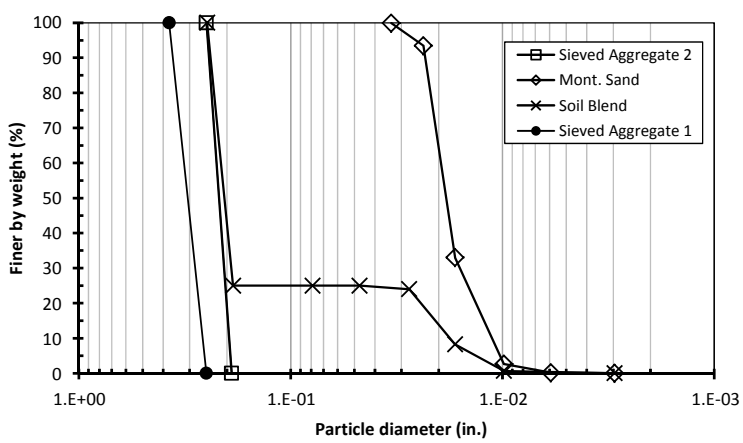
Pullout Rate	
1.0 mm/min.	0.04 in/min

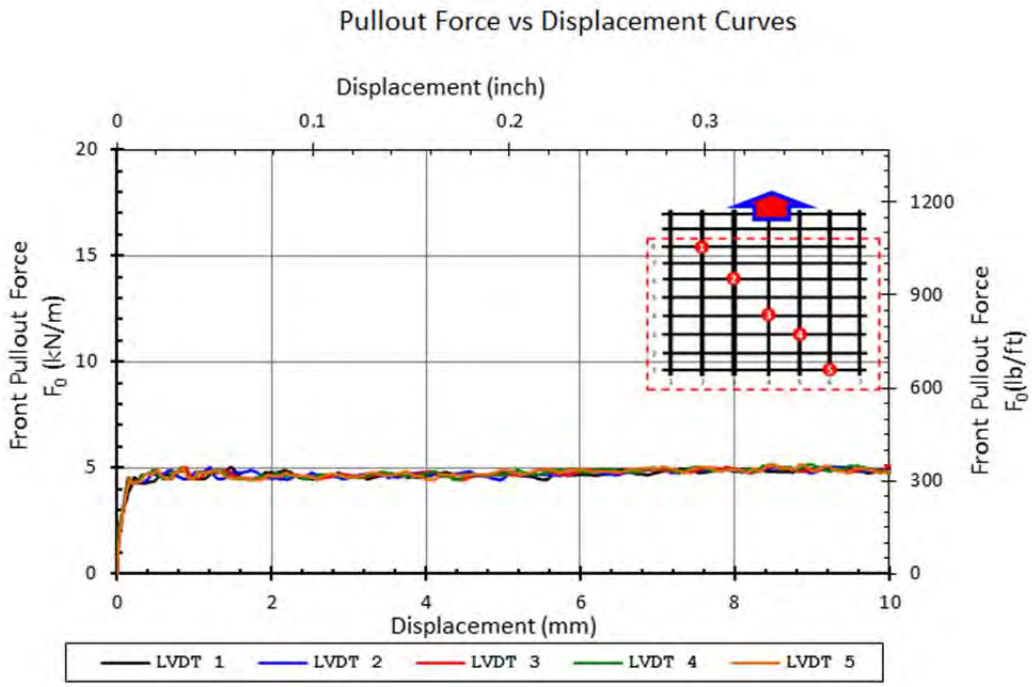
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

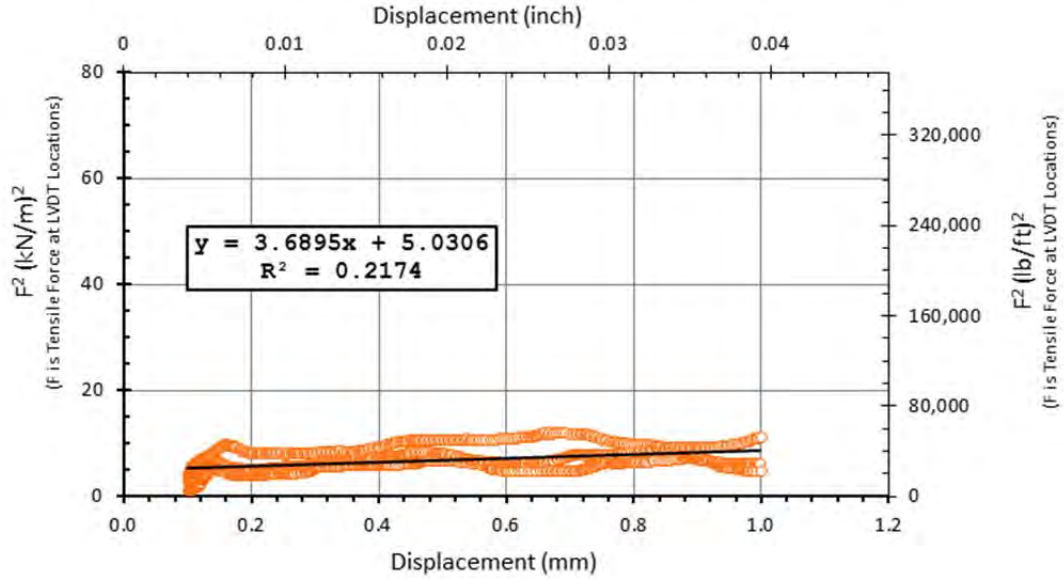
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.3	kN/m	361	lb/ft
Max Pullout Load	P_{max}	1.47	kN	365	lb
Max Shear Stress	τ_{max}	19.8	kPa	2.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
3.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/9/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	N/A	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.2	0.559
2	107.8	4.244
3	123.6	4.867
4	138.8	5.463
5	239.9	9.445

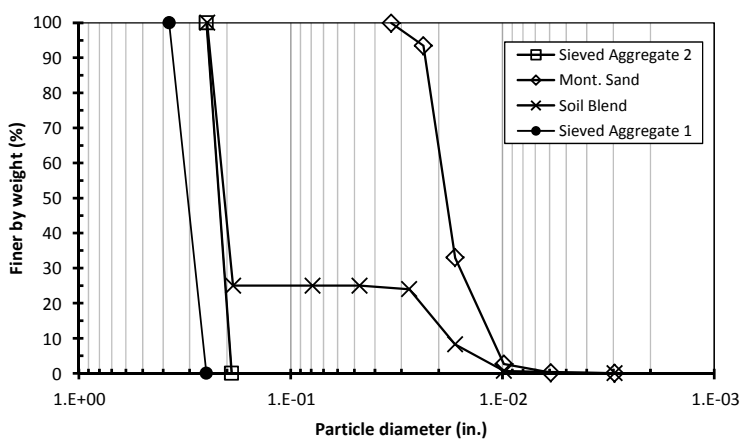
Pullout Rate			
1.0	mm/min.	0.04	in/min

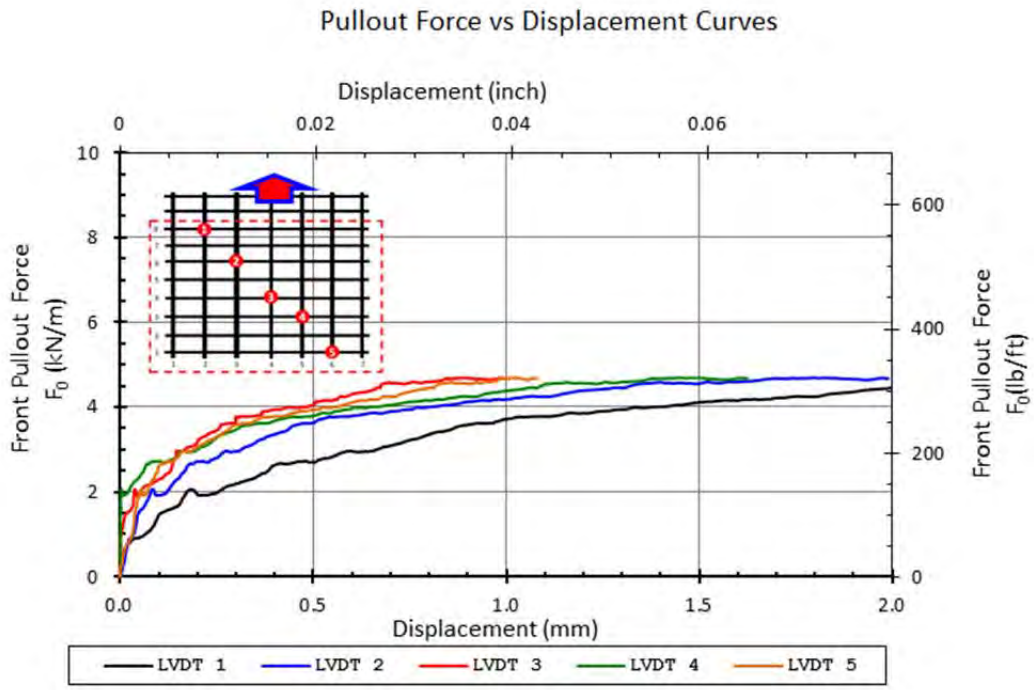
SOIL Information			
Soil	Sieved Aggregate 2		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.560 **g/cm^3**	**97**	**pcf**

Note: particle size distribution curve shown below

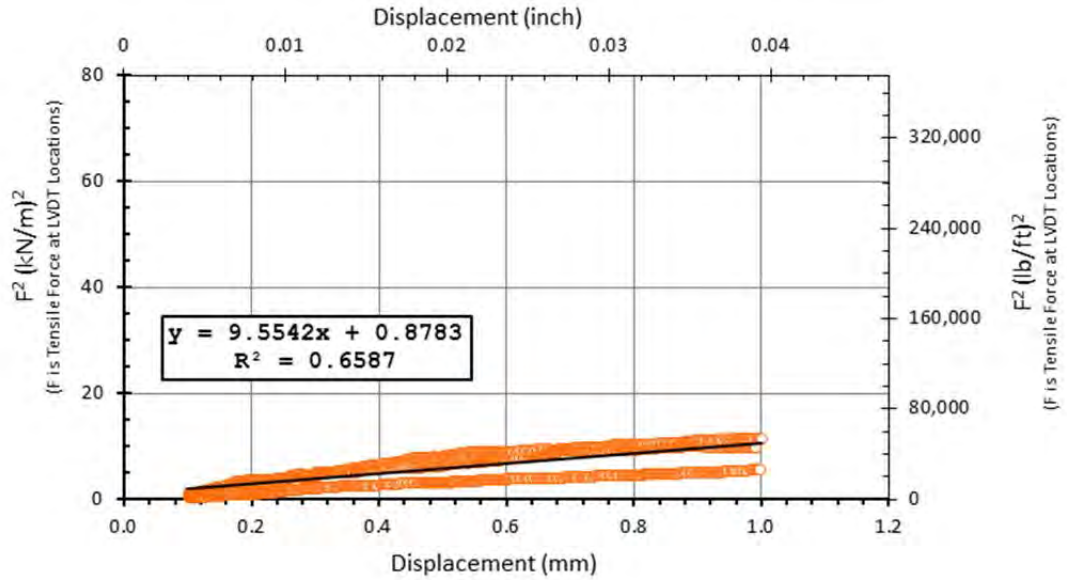
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}	
9.6	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Test run only up to 1 mm of displacement of LVDTs 2, 3 and 4.

SMALL PULLOUT TEST

Date test conducted	4/9/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	---	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.2	0.559
2	107.8	4.244
3	123.6	4.867
4	138.8	5.463
5	239.9	9.445

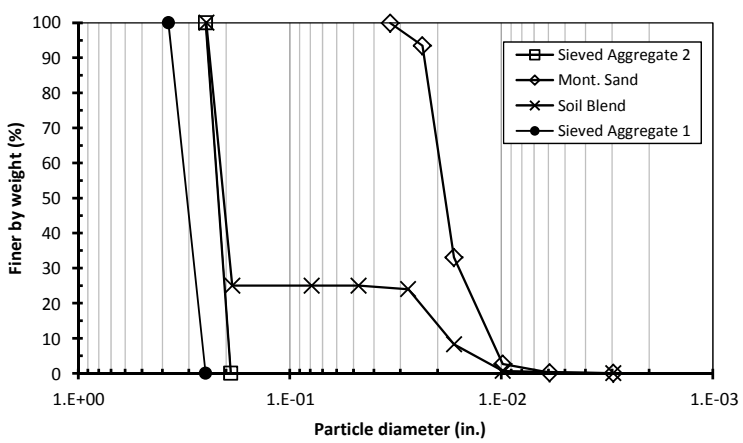
Pullout Rate	
1.0 mm/min.	0.04 in/min

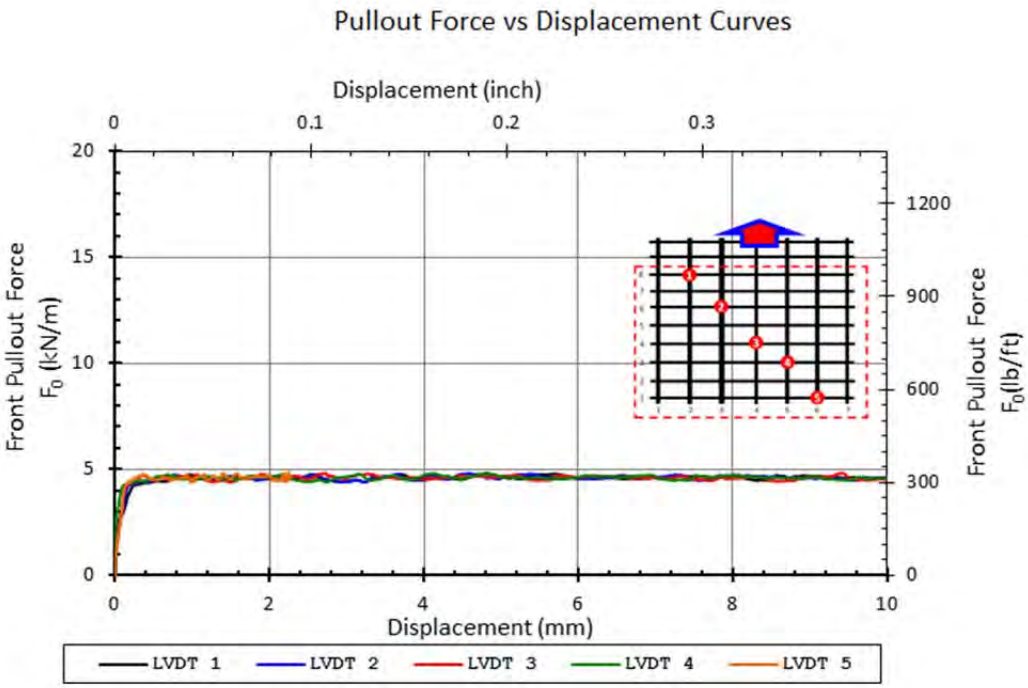
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

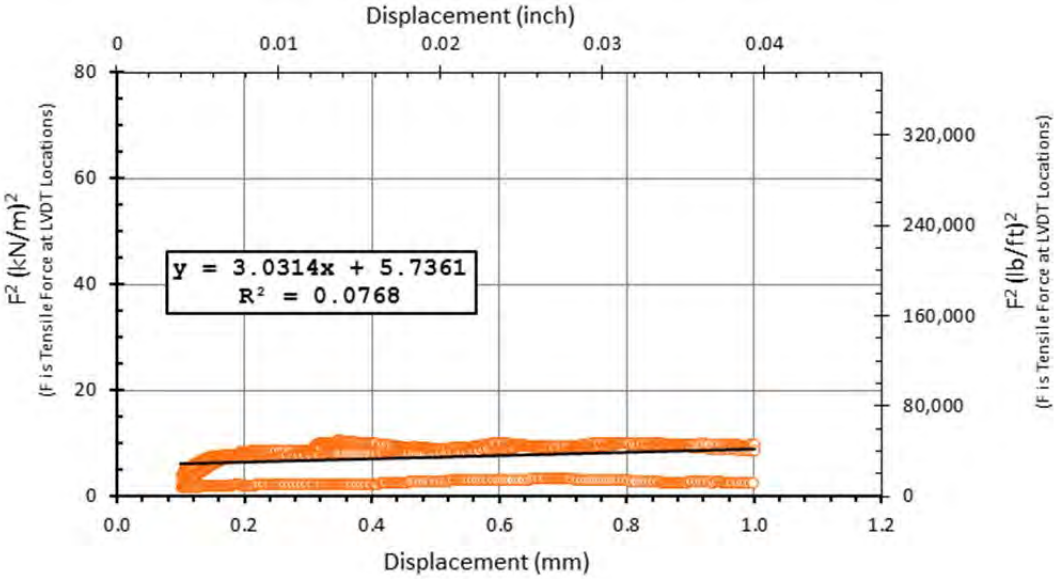
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.9	kN/m	334	lb/ft
Max Pullout Load	P_{max}	1.37	kN	352	lb
Max Shear Stress	τ_{max}	18.3	kPa	2.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
3.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/17/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.265	m	0.245	m
	9	0.915	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	3.0	0.118
2	47.9	1.885
3	92.5	3.641
4	137.0	5.394
5	223.5	8.799

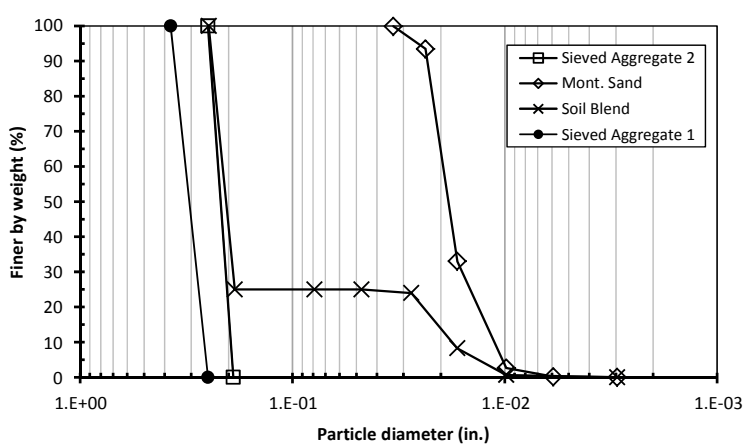
Pullout Rate	
1.0 mm/min.	0.04 in/min

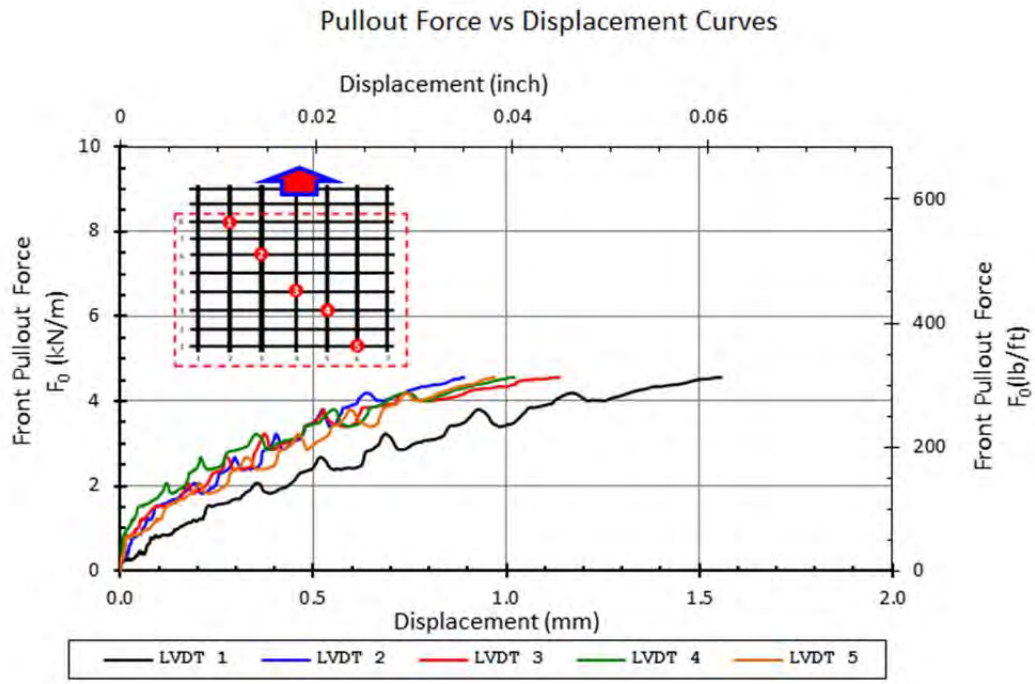
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

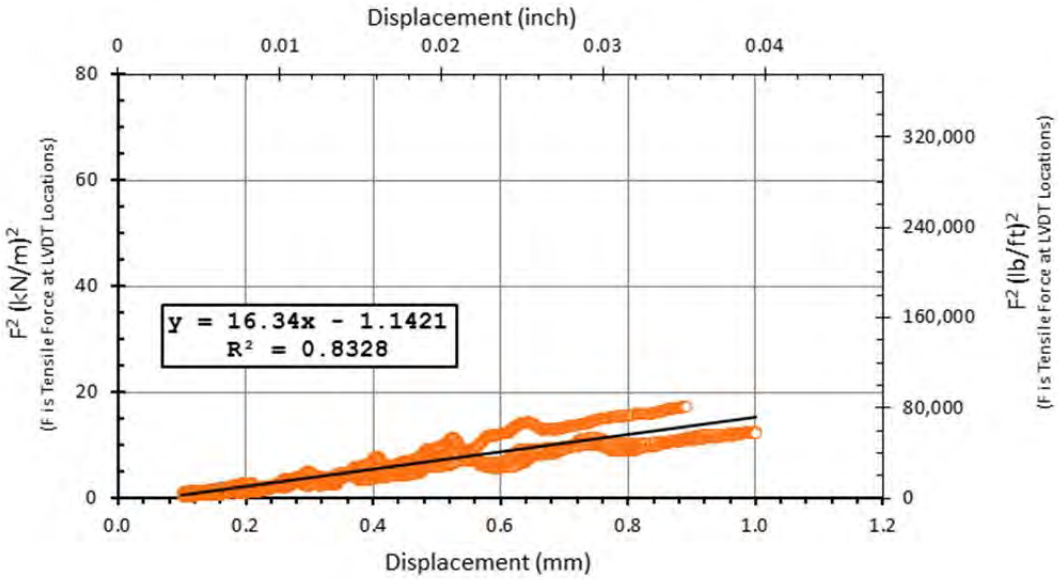
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
16.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/17/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.265	m	0.245	m
	9	0.915	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	3.0	0.118
2	47.9	1.885
3	92.5	3.641
4	137.0	5.394
5	223.5	8.799

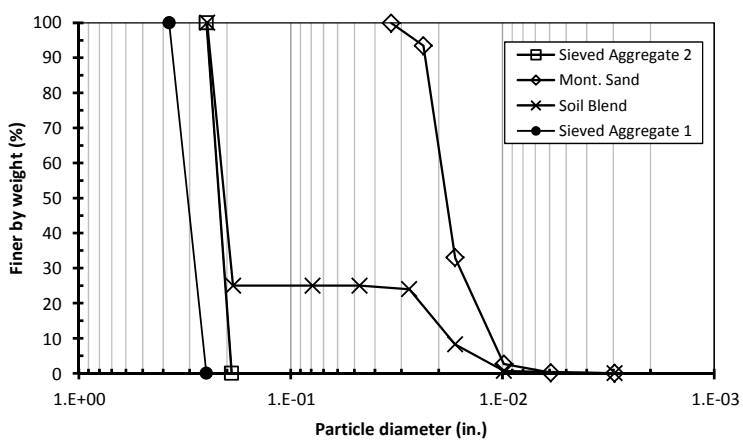
Pullout Rate	
1.0 mm/min.	0.04 in/min

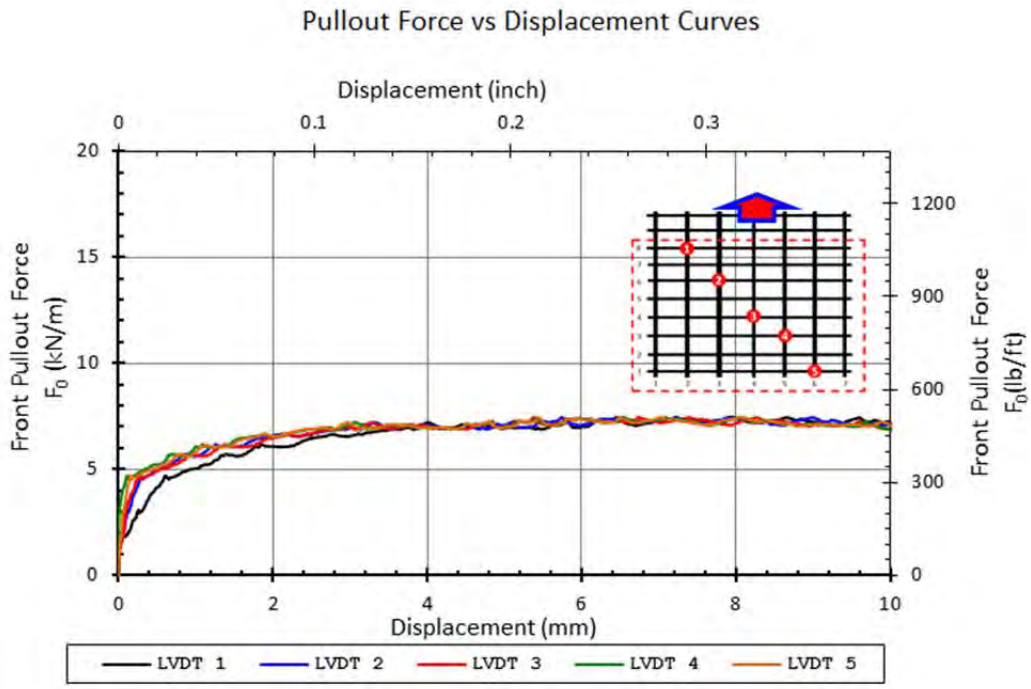
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

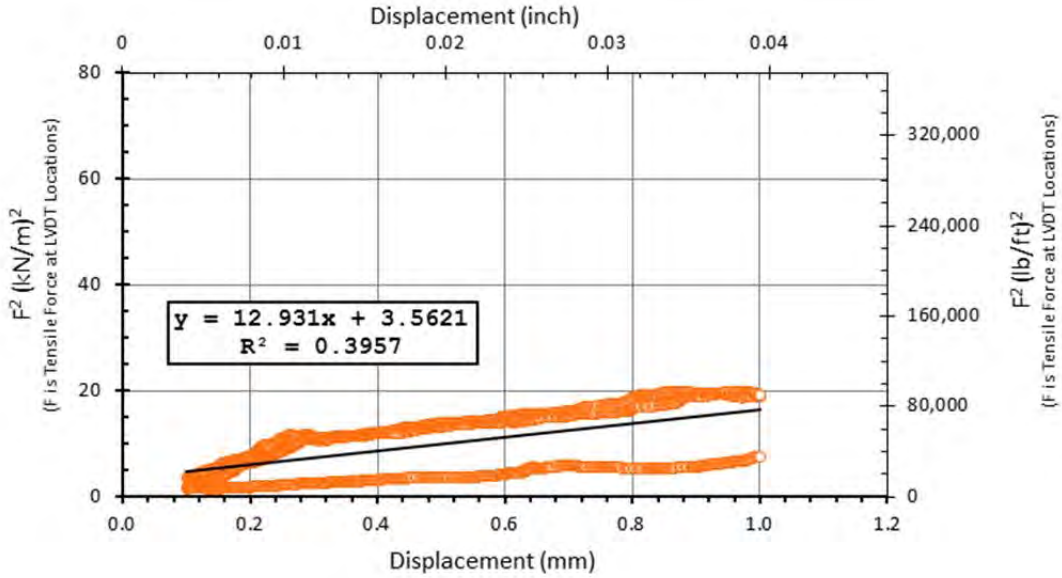
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.5	kN/m	511	lb/ft
Max Pullout Load	P_{max}	1.97	kN	483	lb
Max Shear Stress	τ_{max}	26.5	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
12.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/18/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.9	0.470
2	53.7	2.113
3	94.6	3.725
4	136.5	5.374
5	222.0	8.739

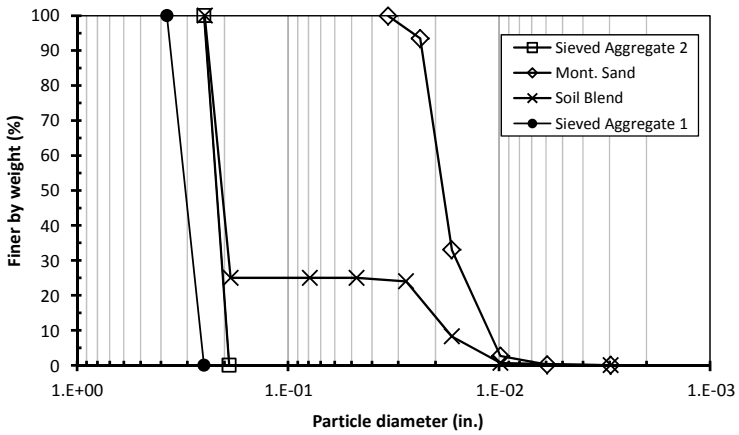
Pullout Rate	
1.0 mm/min.	0.04 in/min

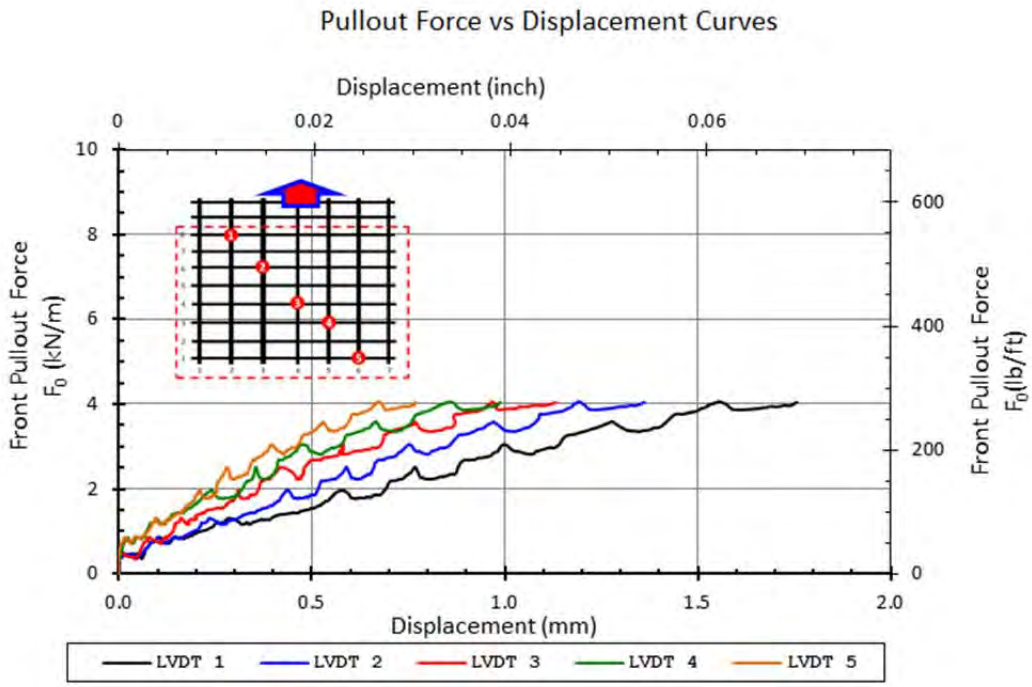
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

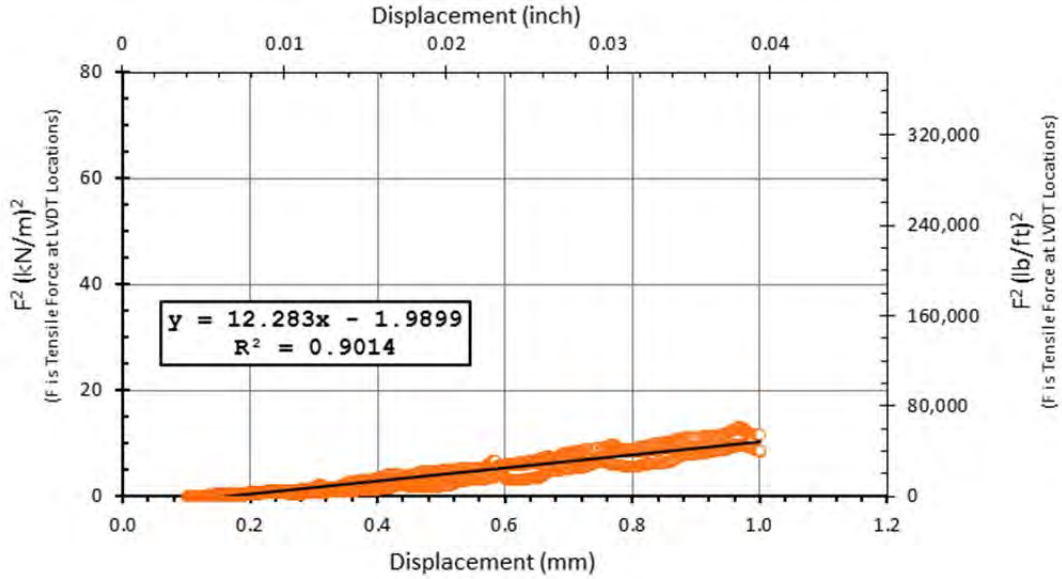
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
12.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/18/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.9	0.469
2	53.6	2.110
3	94.6	3.724
4	136.5	5.374
5	222.0	8.740

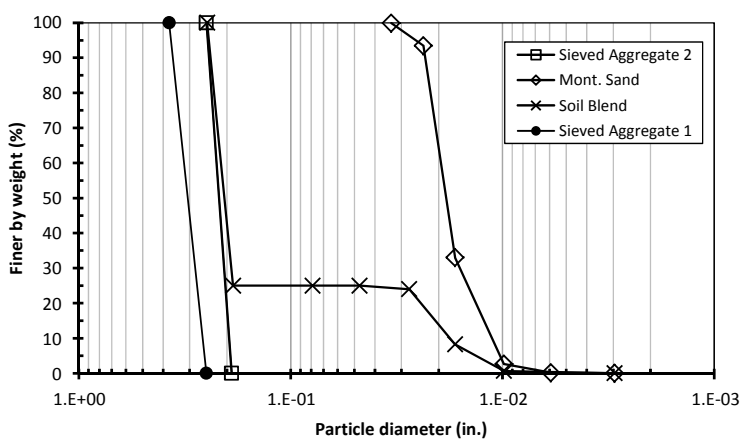
Pullout Rate	
1.0 mm/min.	0.04 in/min

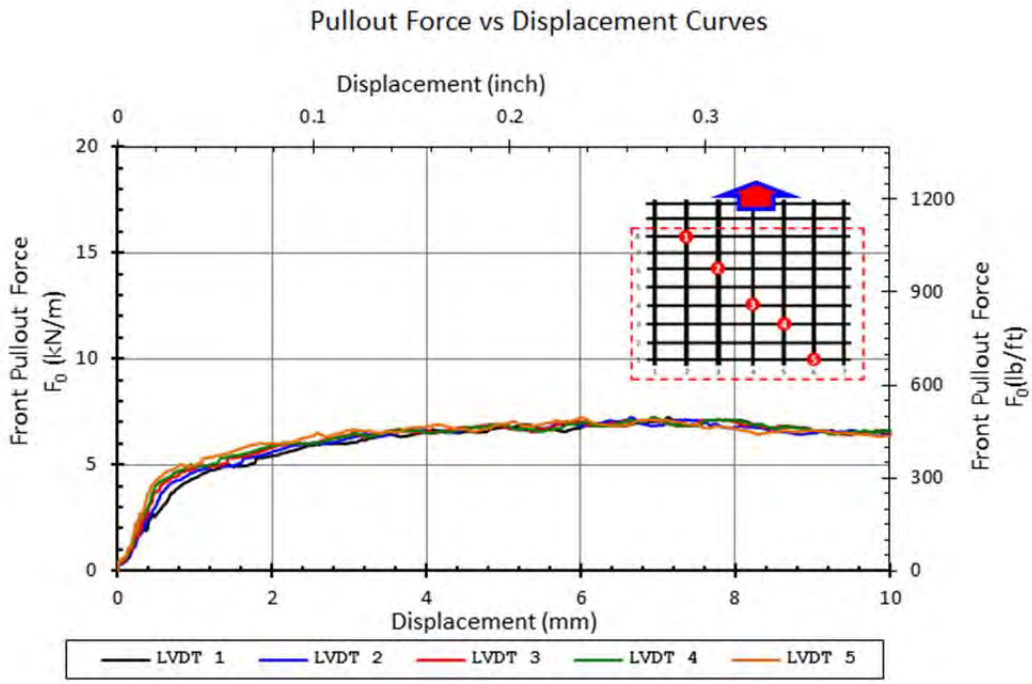
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.542 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

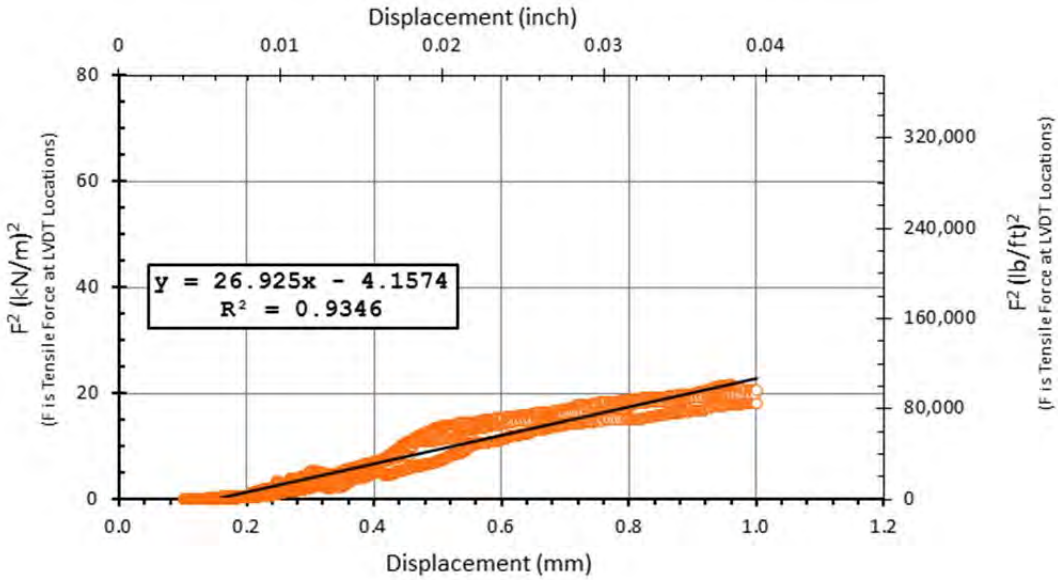
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.2	kN/m	495	lb/ft
Max Pullout Load	P_{max}	1.91	kN	466	lb
Max Shear Stress	τ_{max}	25.7	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
26.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/19/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.1	0.516
2	65.2	2.566
3	100.1	3.940
4	134.1	5.281
5	218.7	8.611

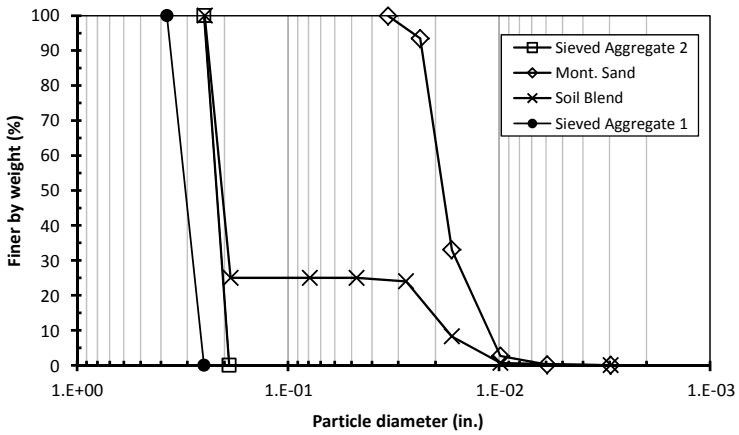
Pullout Rate	
1.0 mm/min.	0.04 in/min

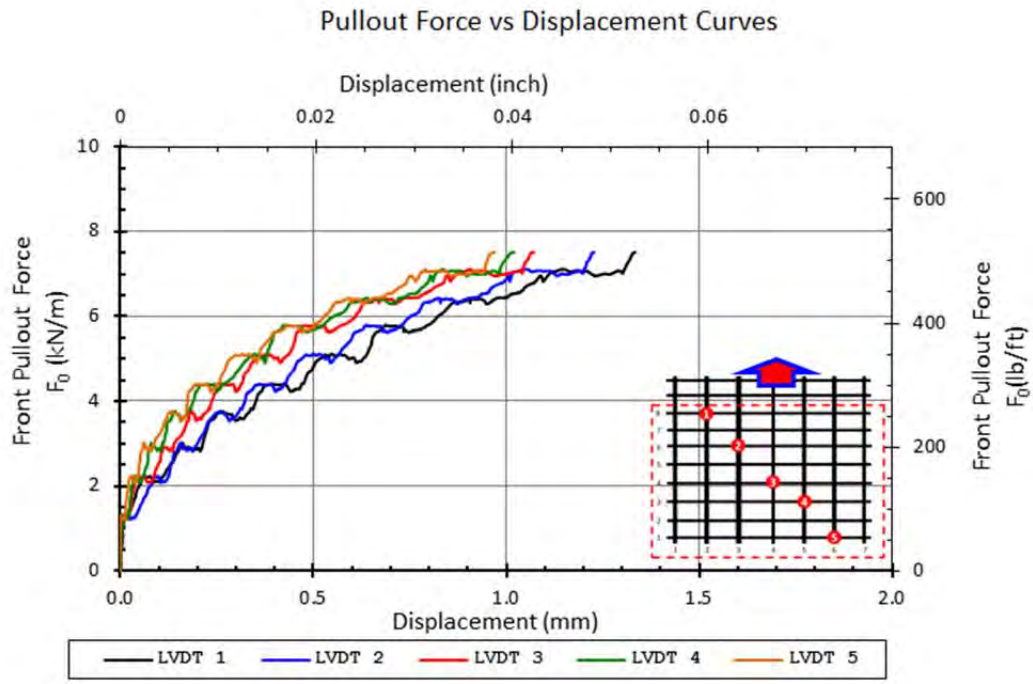
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

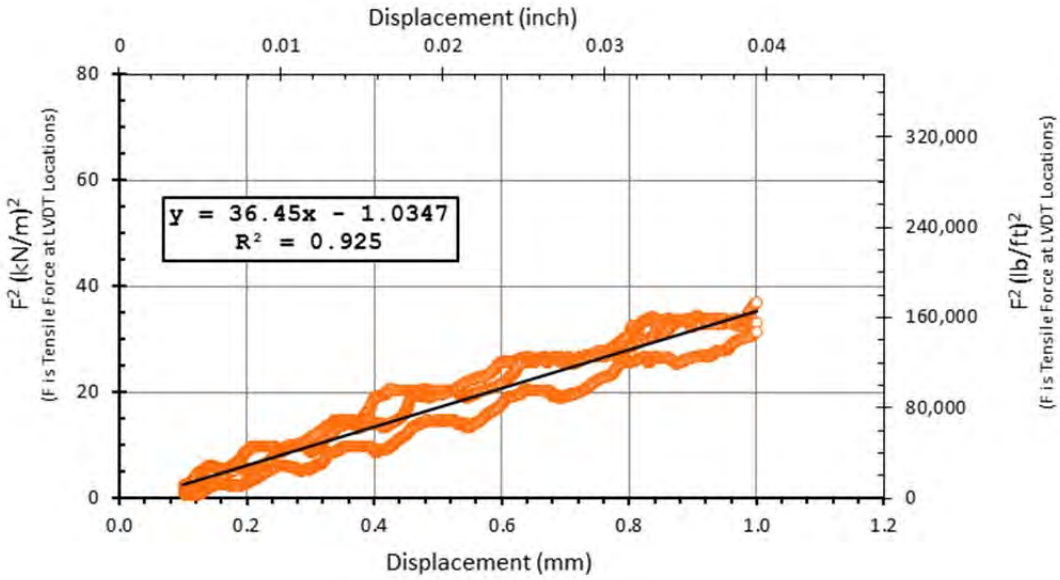
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
36.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Grip slightly slanted right.

SMALL PULLOUT TEST

Date test conducted	4/19/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.1	0.516
2	65.2	2.566
3	100.1	3.940
4	134.1	5.281
5	218.7	8.611

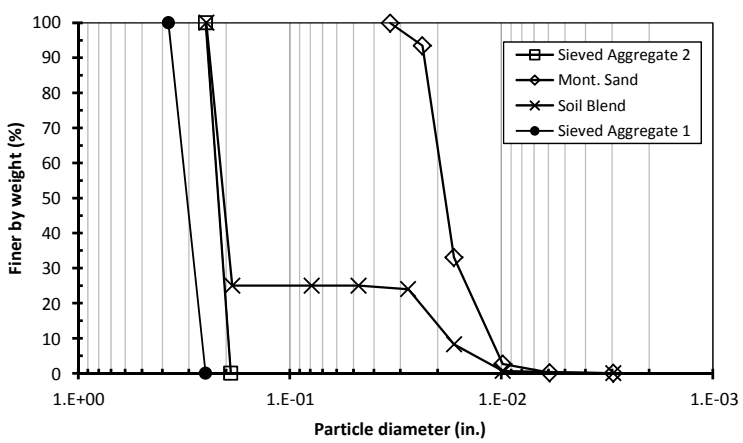
Pullout Rate	
1.0 mm/min.	0.04 in/min

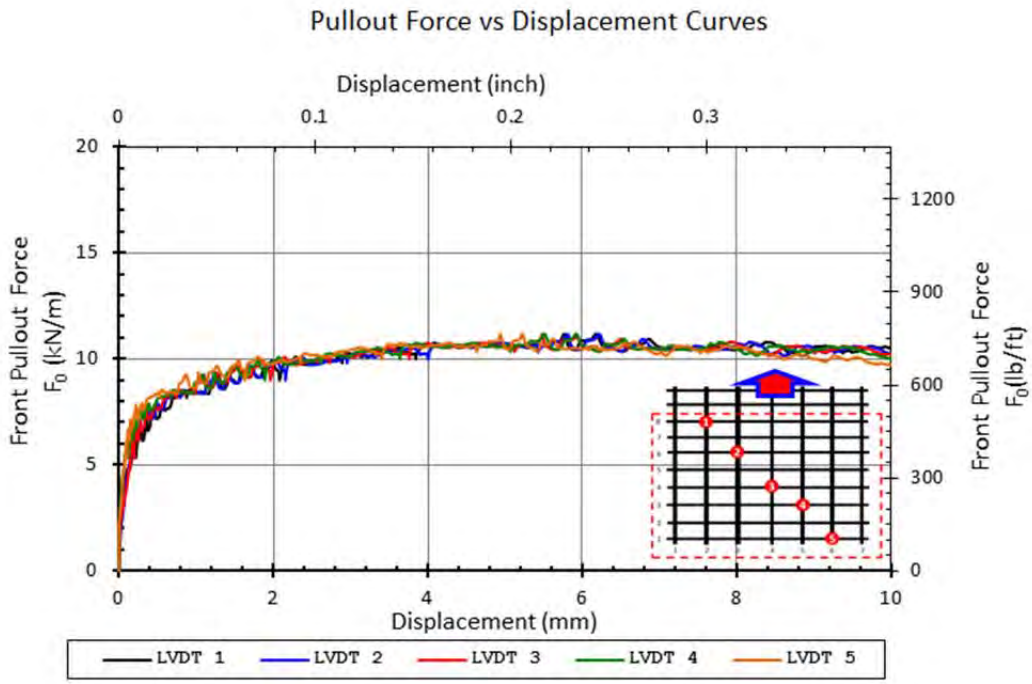
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

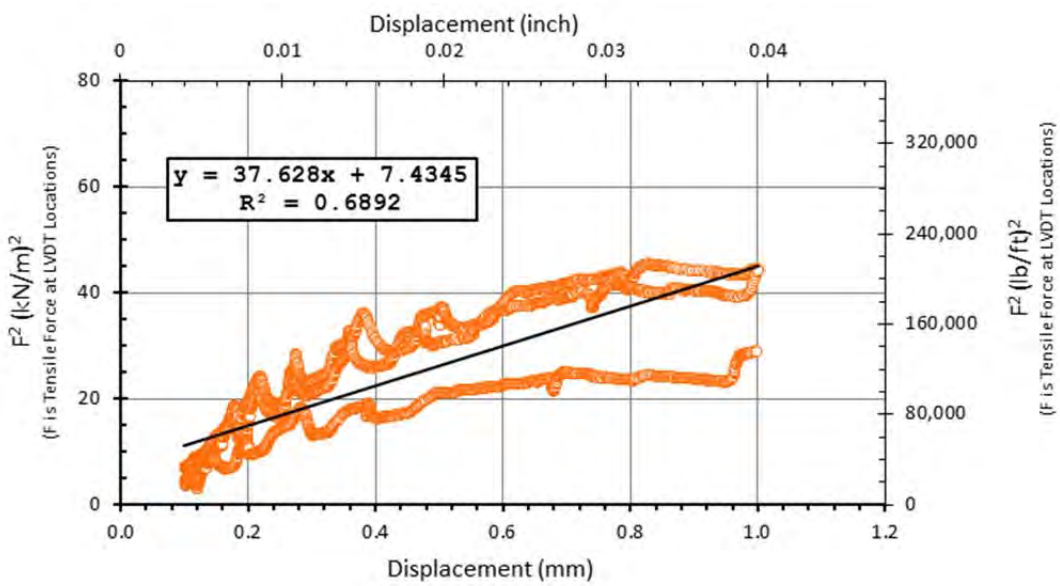
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.2	kN/m	766	lb/ft
Max Pullout Load	P_{max}	2.36	kN	563	lb
Max Shear Stress	τ_{max}	31.7	kPa	4.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
37.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Grip slightly slanted right. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/20/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.4	0.528
2	65.1	2.563
3	99.4	3.914
4	132.9	5.233
5	218.0	8.583

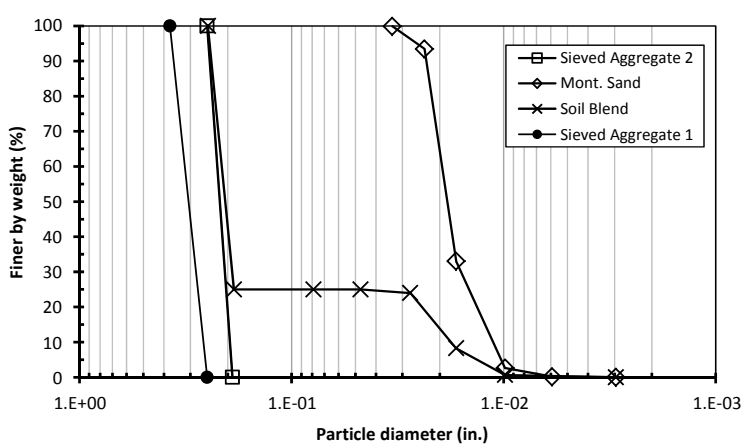
Pullout Rate	
1.0 mm/min.	0.04 in/min

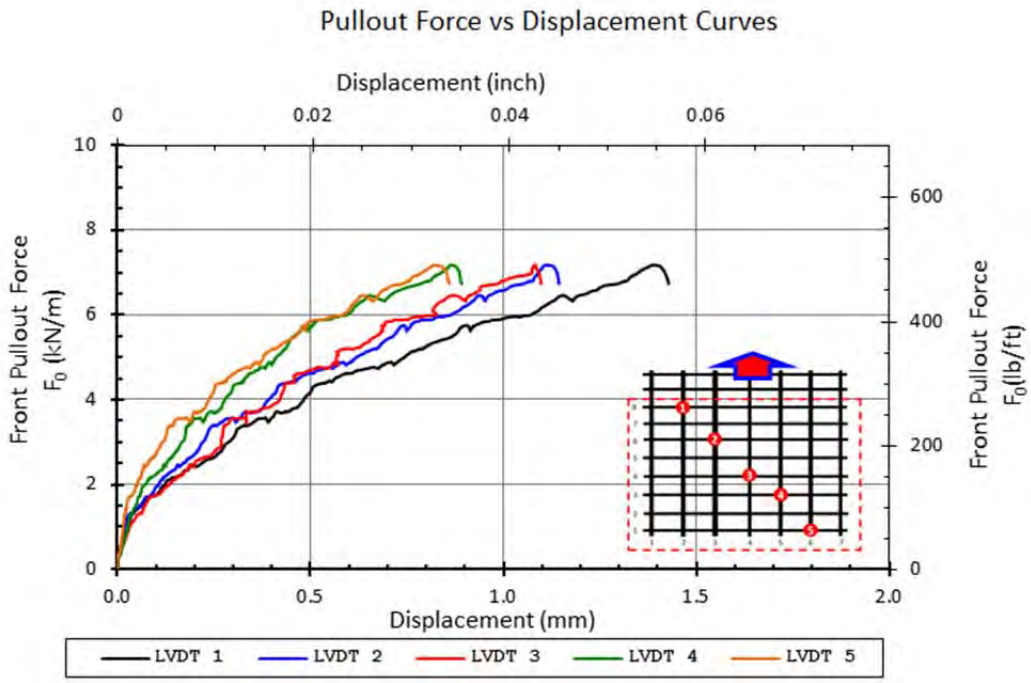
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

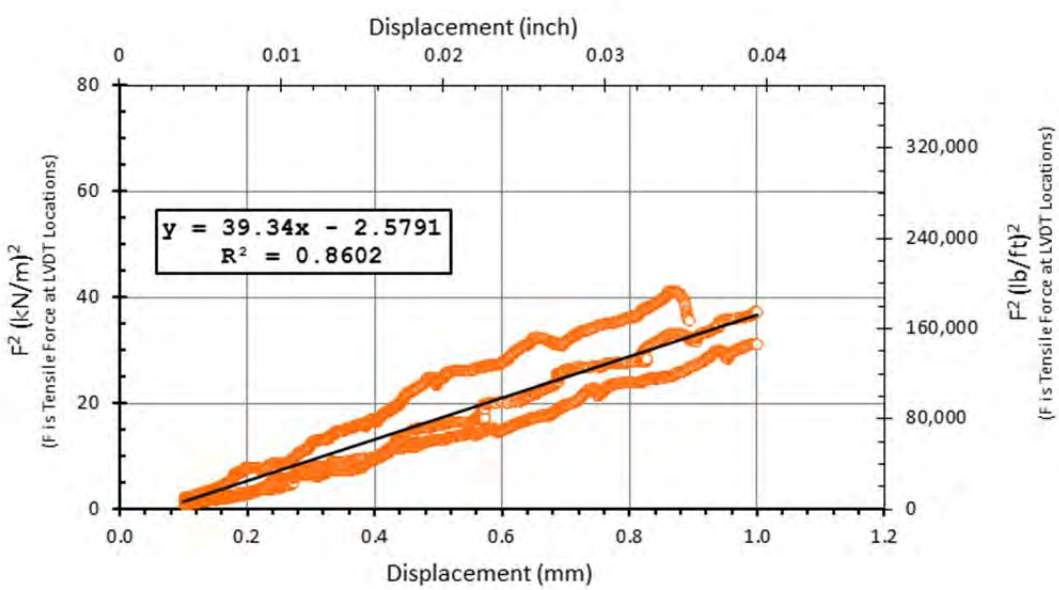
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
39.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/20/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	13.4	0.528
2	65.1	2.563
3	99.4	3.913
4	132.9	5.232
5	218.0	8.583

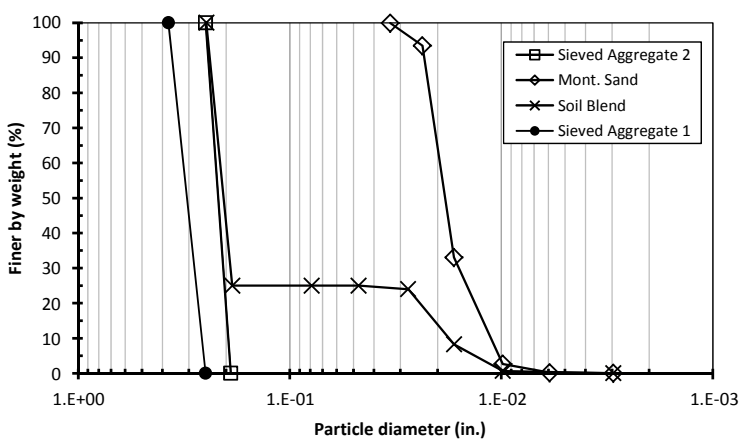
Pullout Rate	
1.0 mm/min.	0.04 in/min

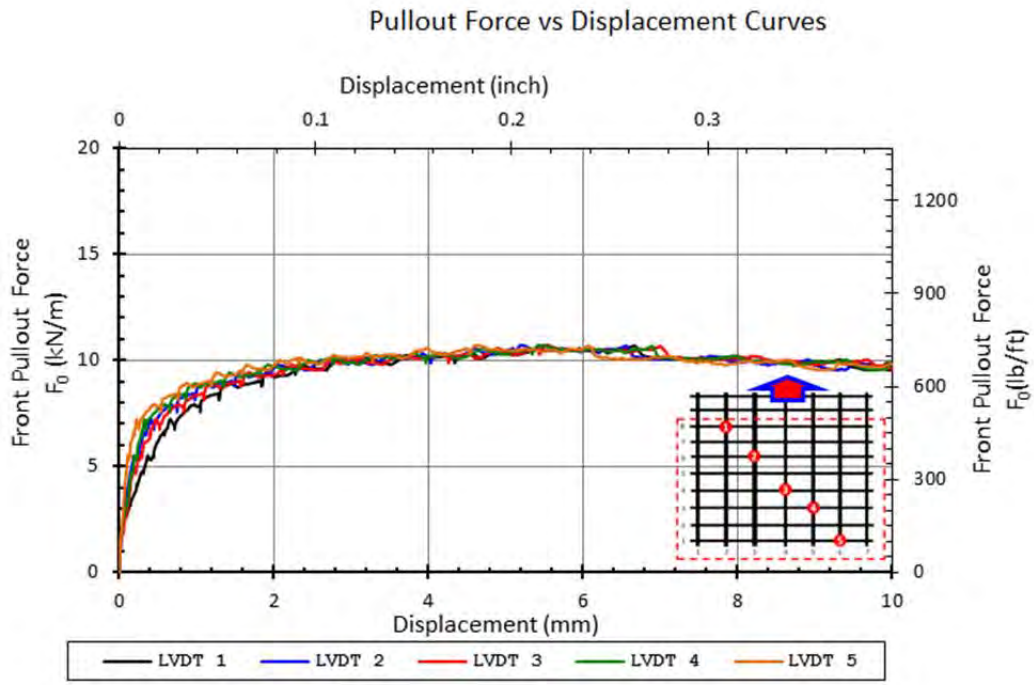
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

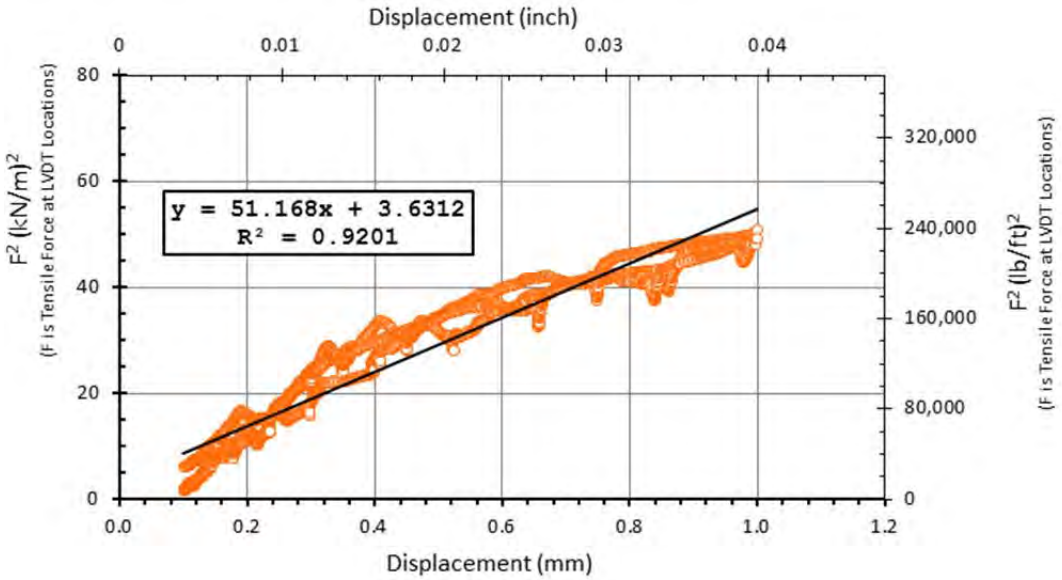
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.7	kN/m	734	lb/ft
Max Pullout Load	P_{max}	2.26	kN	562	lb
Max Shear Stress	τ_{max}	30.4	kPa	4.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
51.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/21/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.1	0.870
2	71.4	2.812
3	121.3	4.775
4	172.3	6.782
5	224.1	8.821

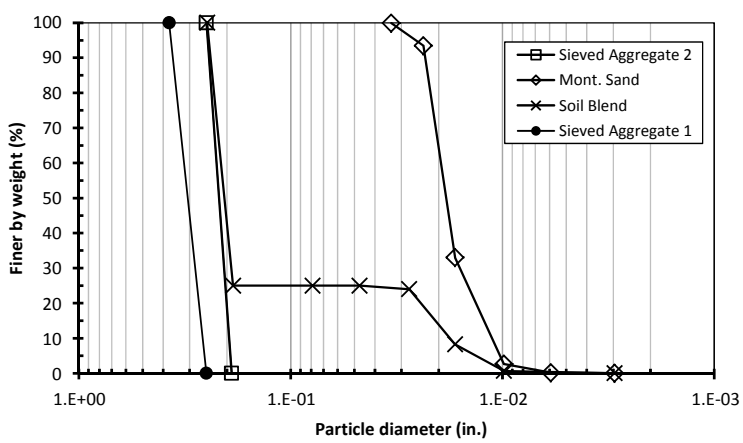
Pullout Rate	
1.0 mm/min.	0.04 in/min

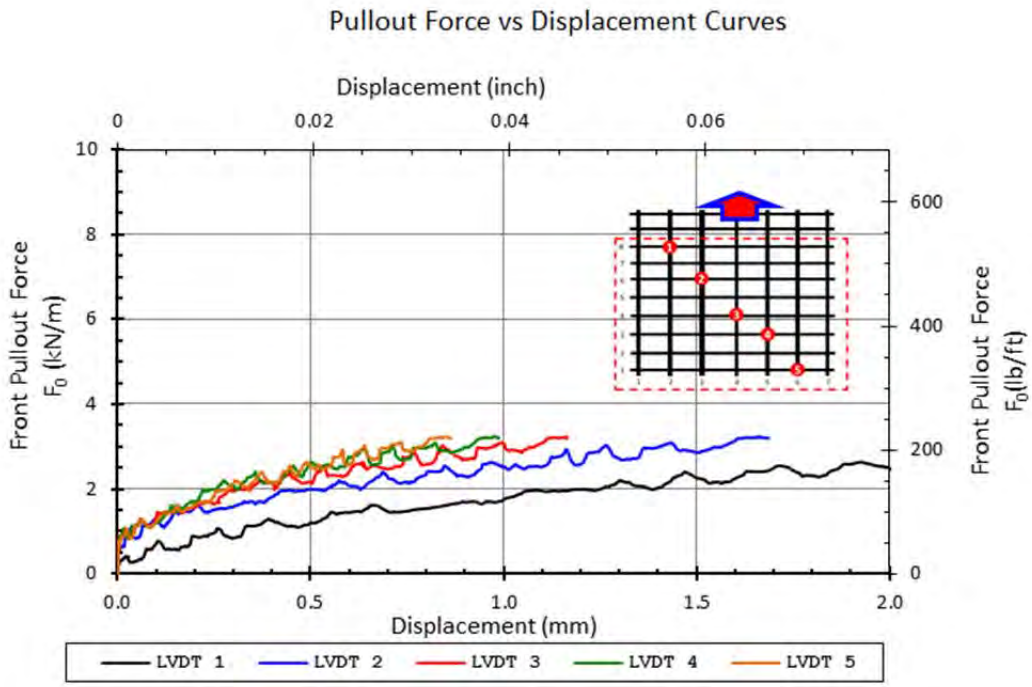
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

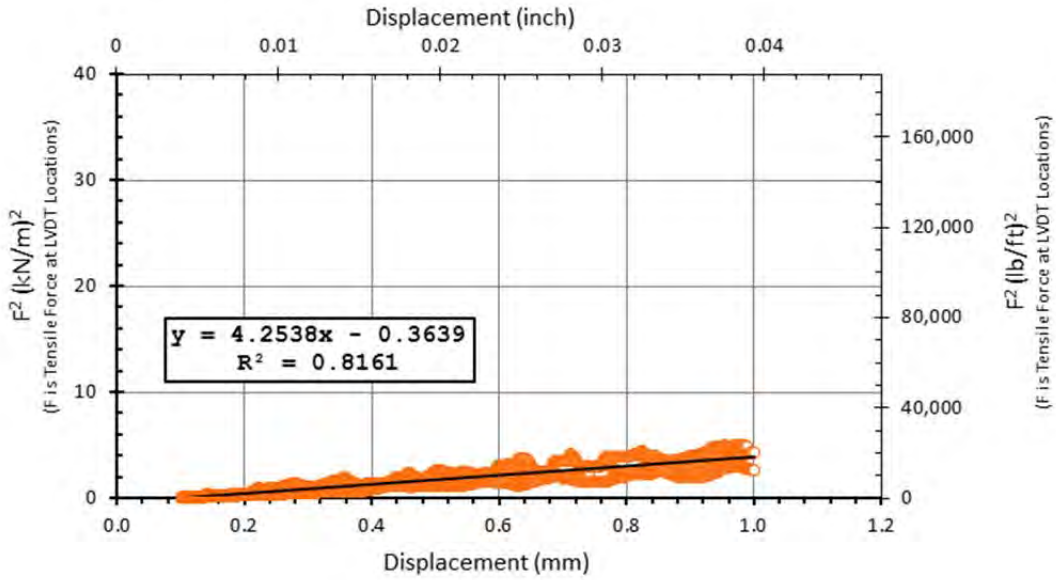
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
4.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Test taken to only 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/21/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.304	m	0.245	m
	7	0.919	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.1	0.870
2	71.4	2.812
3	121.3	4.775
4	172.3	6.782
5	224.1	8.821

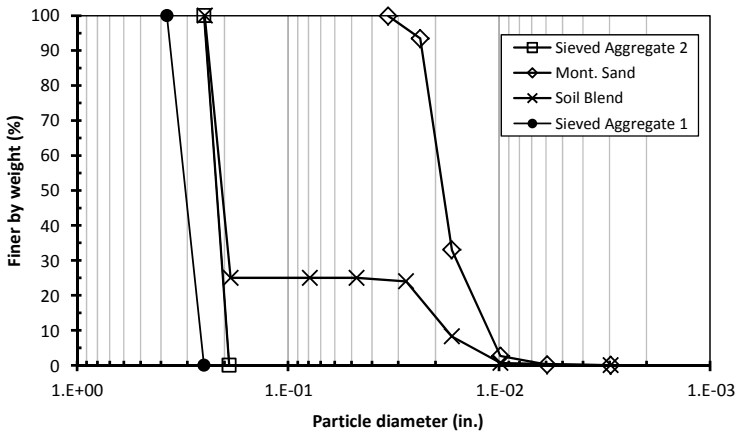
Pullout Rate	
1.0 mm/min.	0.04 in/min

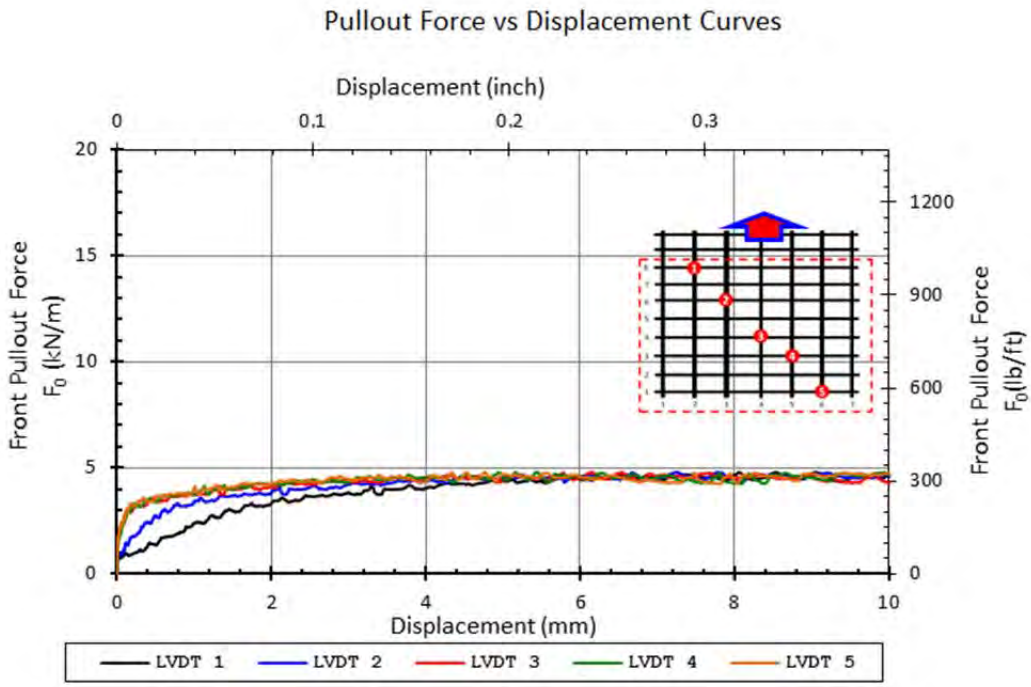
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

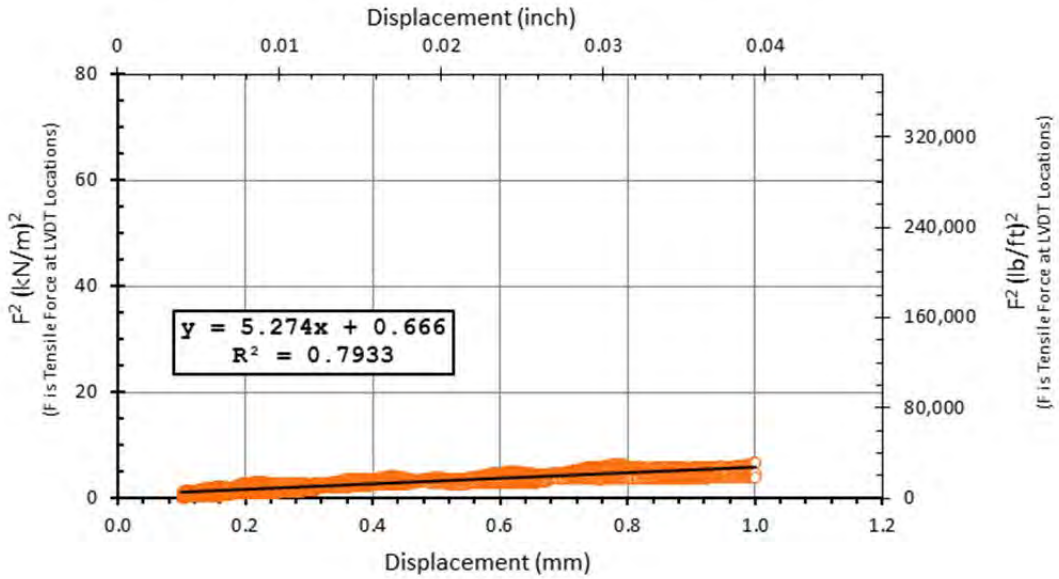
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	4.8	kN/m	329	lb/ft
Max Pullout Load	P_{max}	1.46	kN	360	lb
Max Shear Stress	τ_{max}	19.6	kPa	2.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
5.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/24/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.304	m	0.245	m
	7	0.935	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.1	0.948
2	74.5	2.935
3	126.3	4.971
4	176.2	6.937
5	228.9	9.012

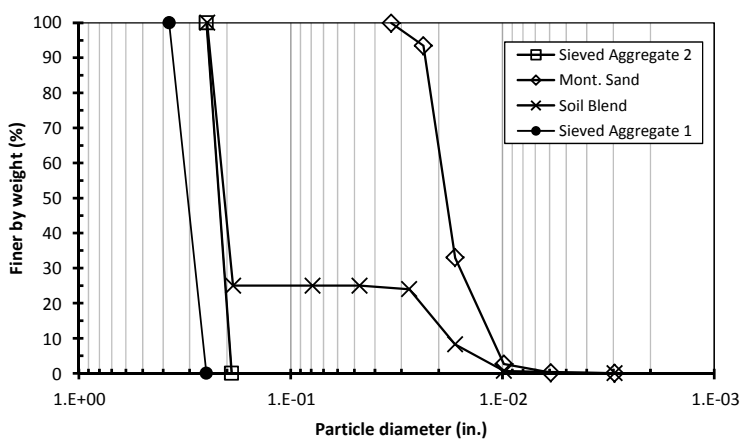
Pullout Rate	
1.0 mm/min.	0.04 in/min

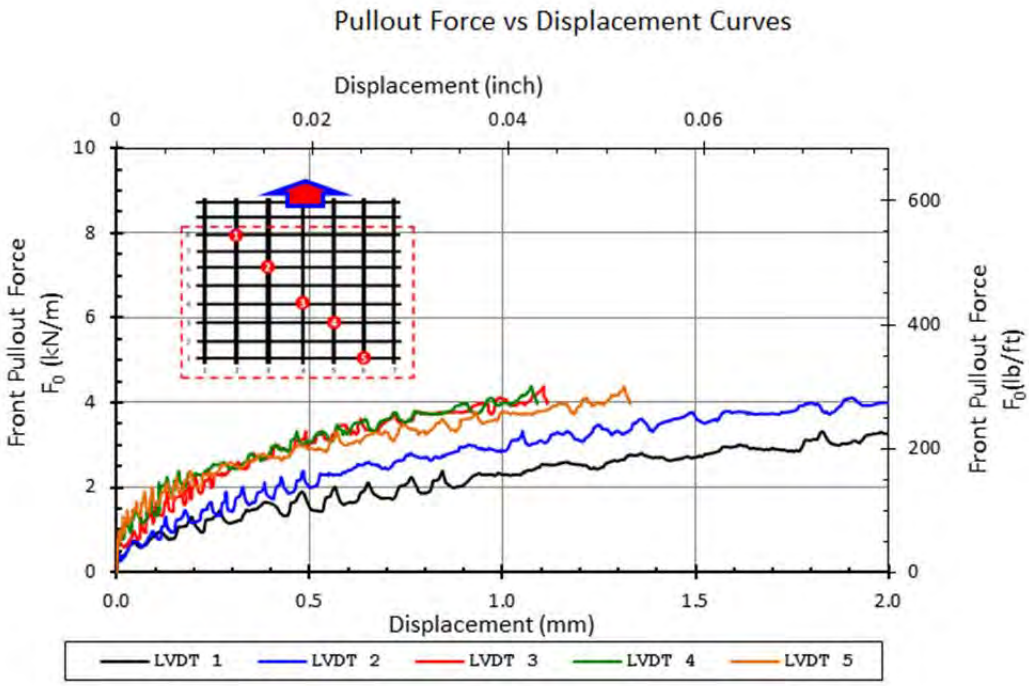
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

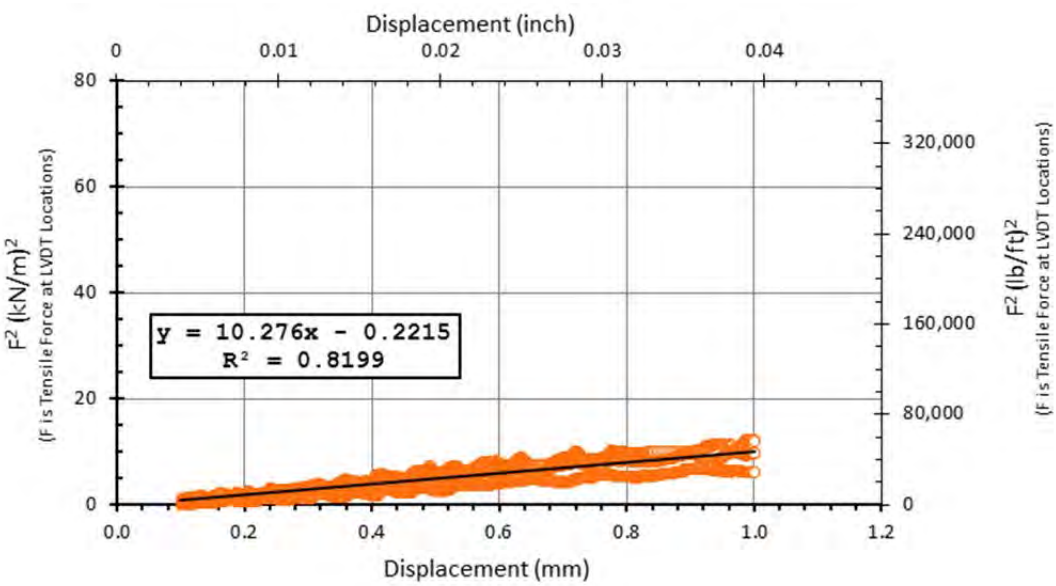
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 off slightly to the right. Grid slightly tilted right. Test conducted up to 1.1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/24/2012 - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.304	m	0.245	m
	7	0.935	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.1	0.948
2	74.5	2.935
3	126.3	4.971
4	176.2	6.937
5	228.9	9.012

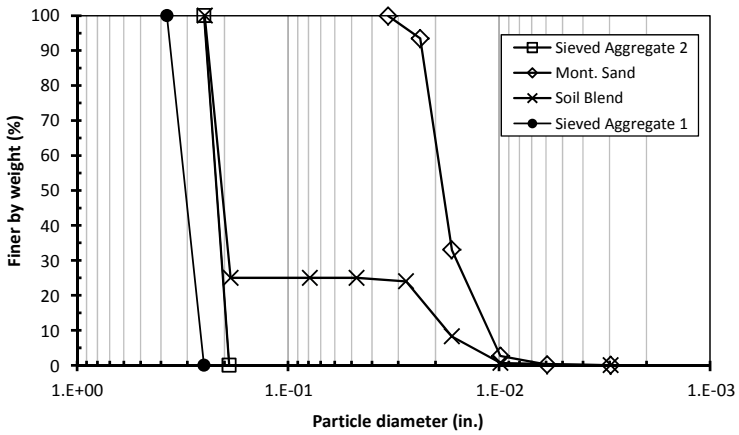
Pullout Rate	
1.0 mm/min.	0.04 in/min

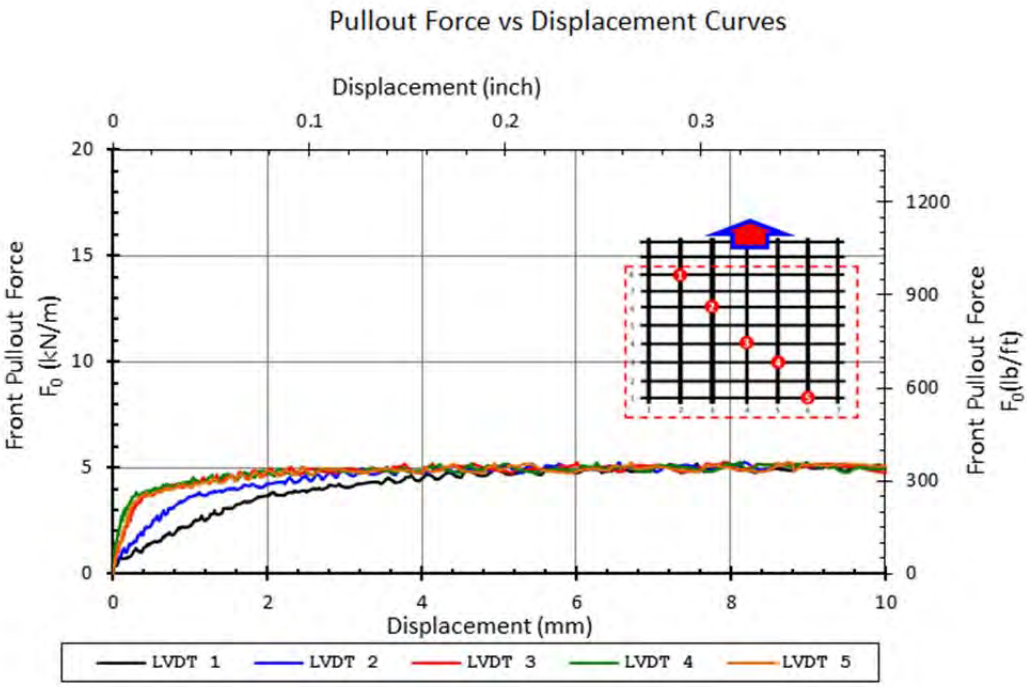
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

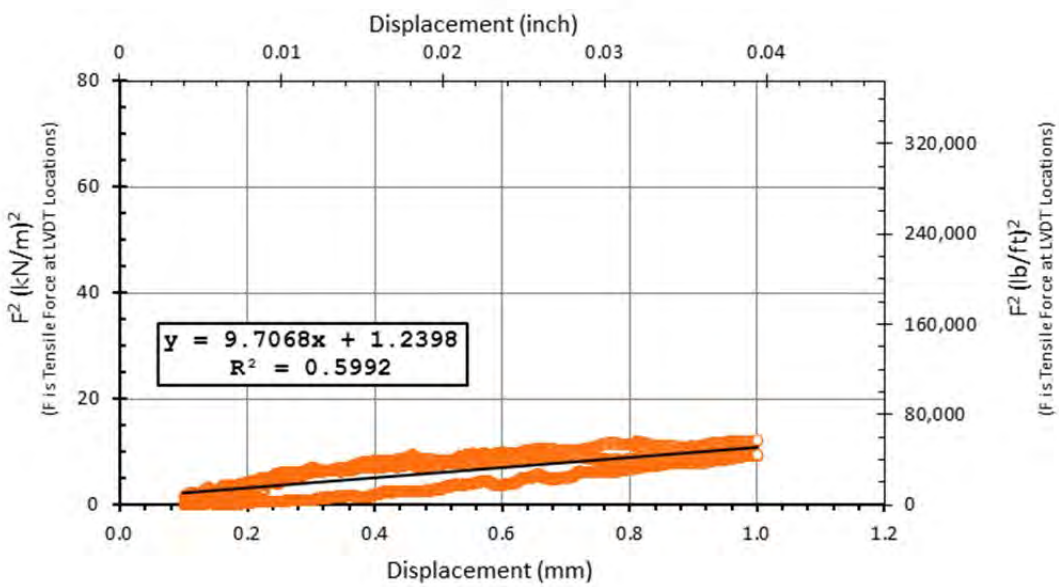
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.3	kN/m	362	lb/ft
Max Pullout Load	P_{max}	1.61	kN	420	lb
Max Shear Stress	τ_{max}	21.6	kPa	3.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.6			

Reported K_{SGI}
9.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT 5 off slightly to the right. Grid slightly tilted right. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	4/25/2012
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.304	m	0.245	m
	14	0.951	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.8	0.700
2	69.8	2.749
3	121.7	4.791
4	174.3	6.860
5	224.4	8.835

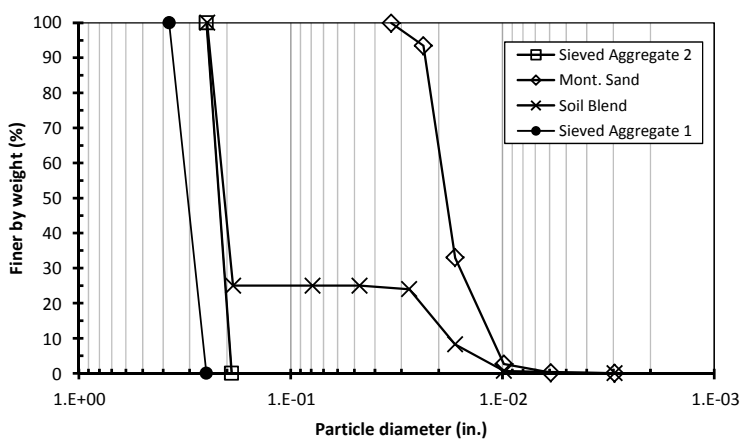
Pullout Rate	
1.0 mm/min.	0.04 in/min

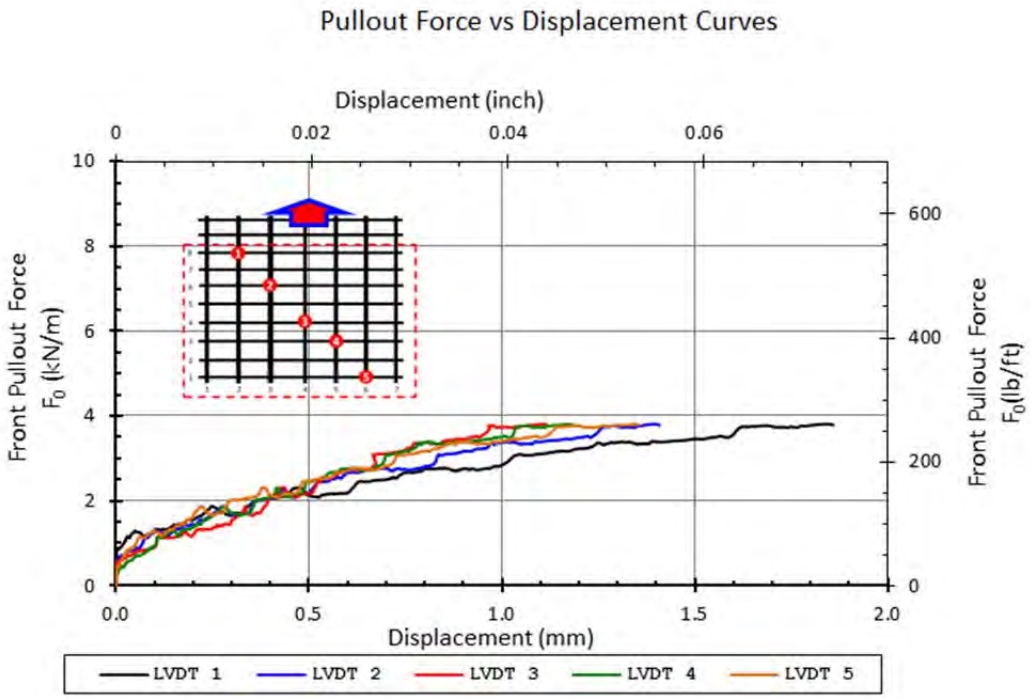
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

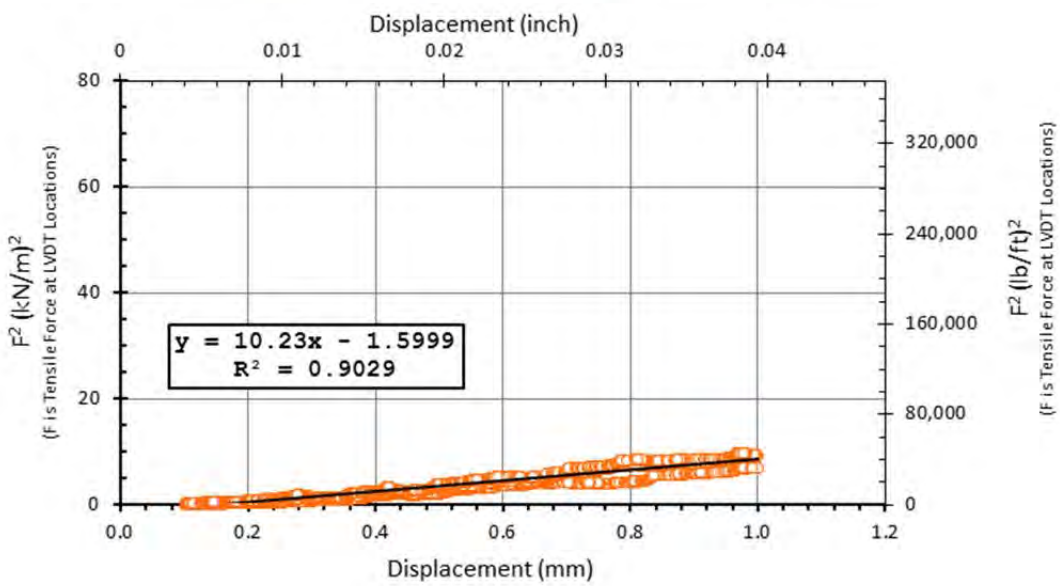
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	4/25/2012 - Rld
Done by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.304	m	0.245	m
	14	0.951	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.7	0.697
2	69.7	2.744
3	121.6	4.787
4	174.2	6.858
5	224.4	8.835

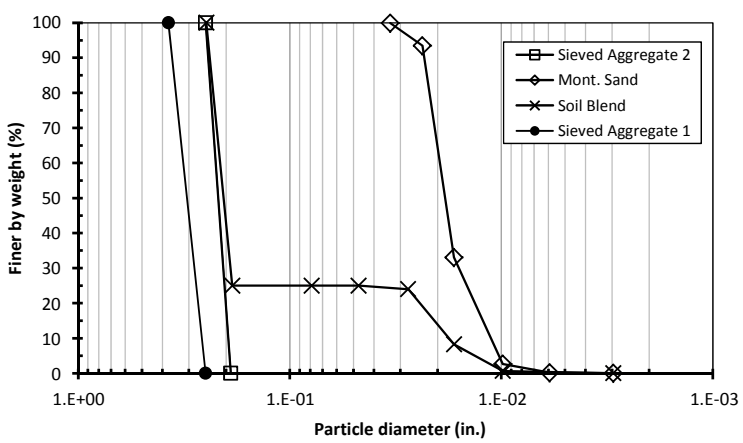
Pullout Rate	
1.0 mm/min.	0.04 in/min

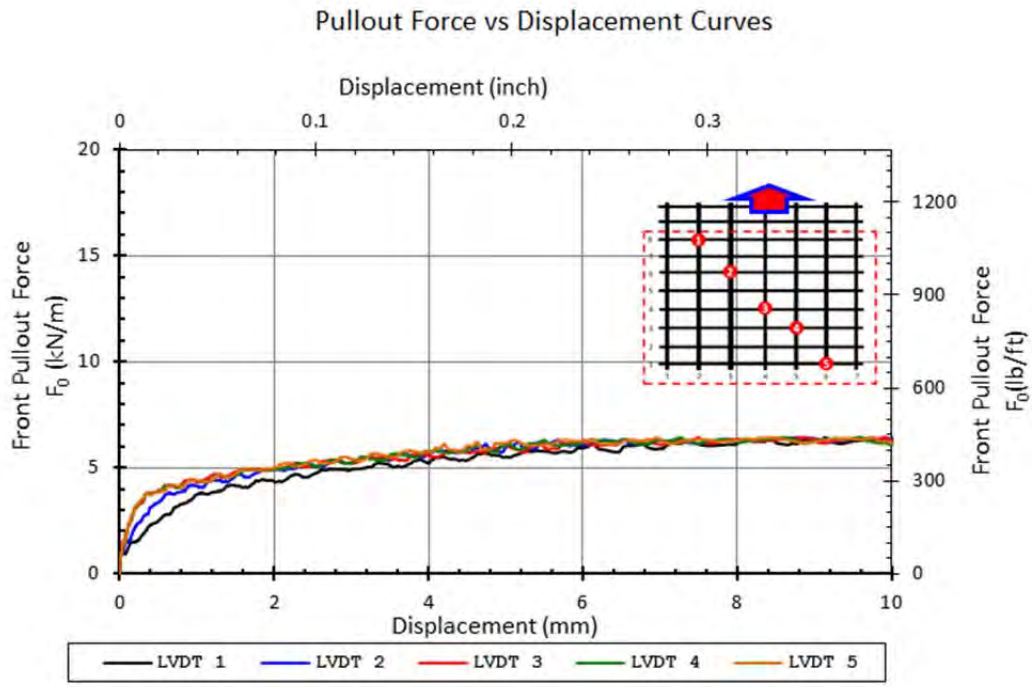
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

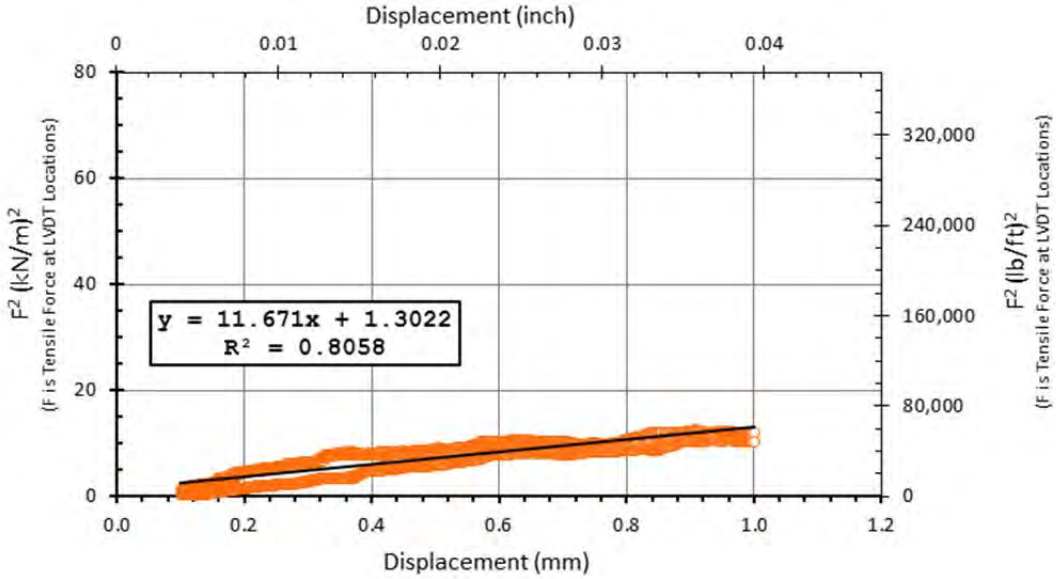
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.5	kN/m	447	lb/ft
Max Pullout Load	P_{max}	1.99	kN	486	lb
Max Shear Stress	τ_{max}	26.7	kPa	3.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
11.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	5/1/12 AM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.261	m	0.245	m
	12	0.912	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.0	0.707
2	69.2	2.726
3	121.8	4.795
4	172.8	6.804
5	224.9	8.854

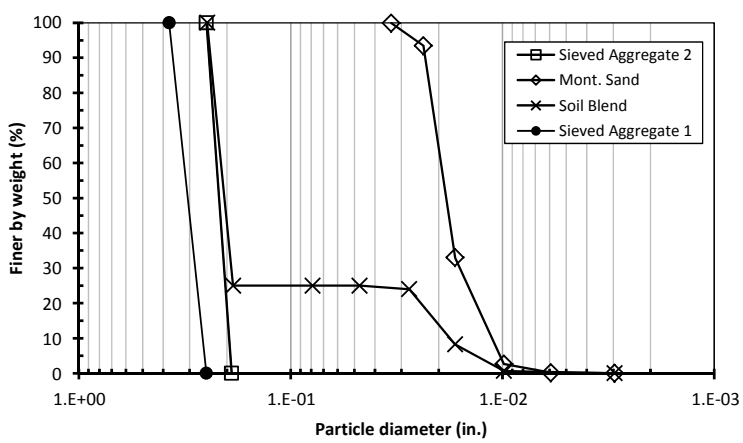
Pullout Rate	
1.0 mm/min.	0.04 in/min

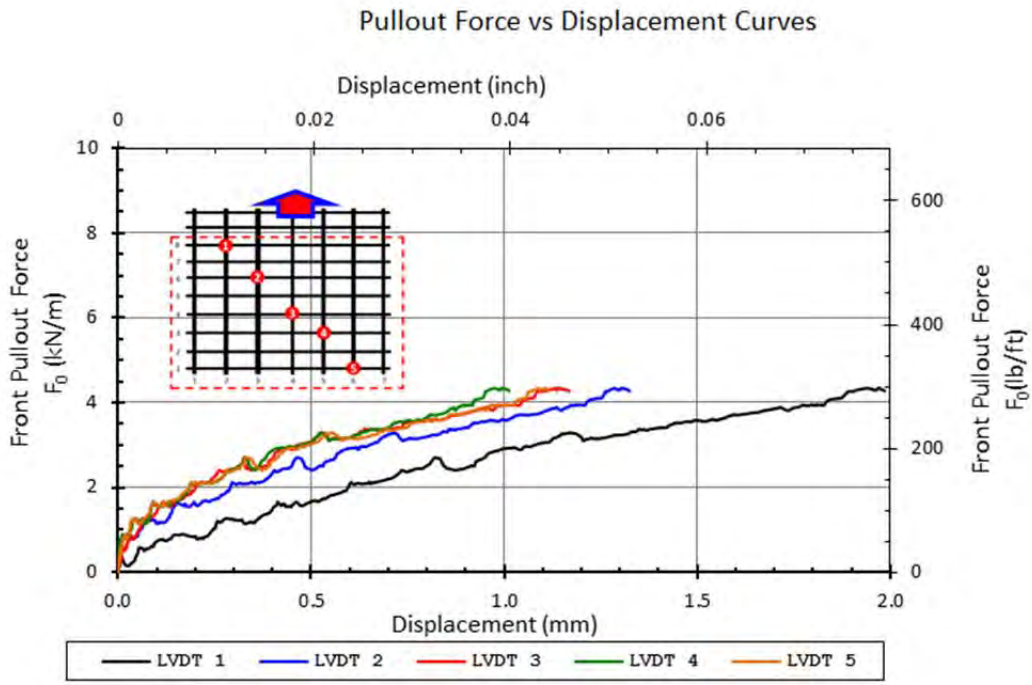
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

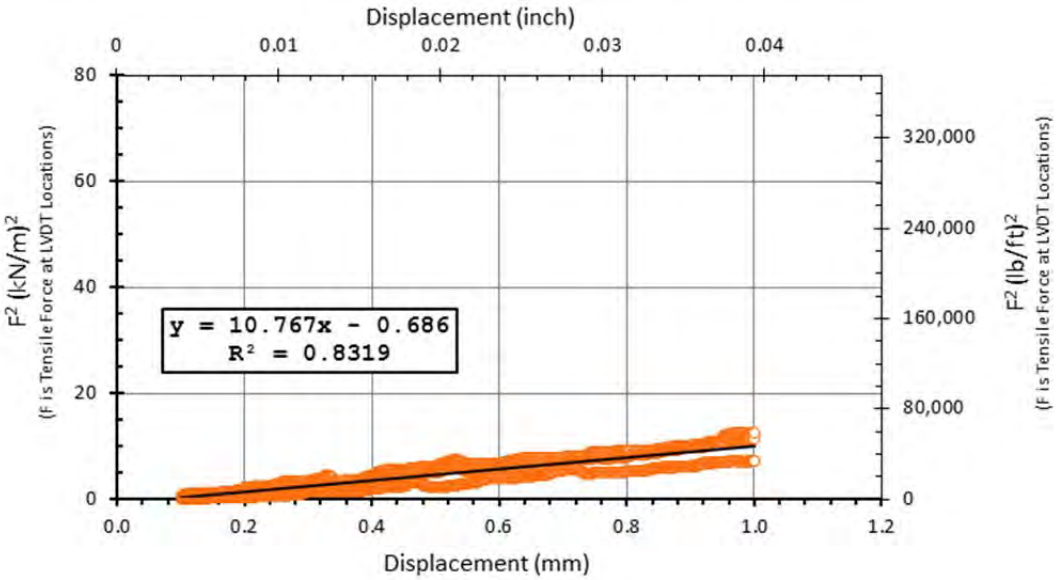
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
10.8 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Specimen with 12 ribs instead of 14 due to variation of aperture sizes of the product. PSI slightly increased as test begins and decreased as test ends. Adjusted constantly back to 3 psi throughout the test.

SMALL PULLOUT TEST

Date test conducted	5/1/12 AM - Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.261	m	0.245	m
	12	0.912	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.0	0.707
2	69.2	2.726
3	121.8	4.795
4	172.8	6.804
5	224.9	8.854

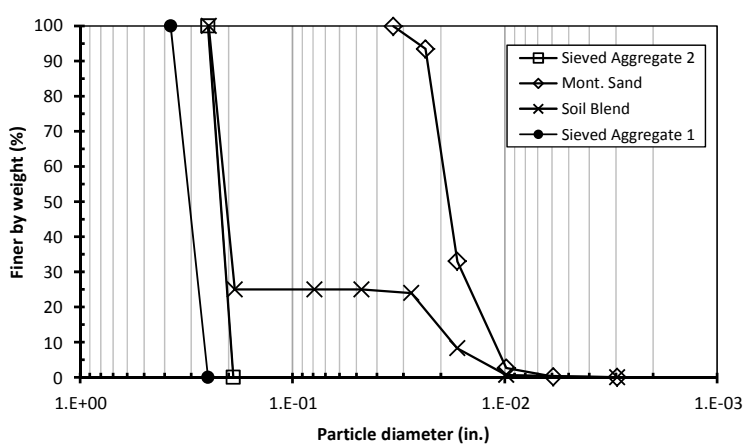
Pullout Rate	
1.0 mm/min.	0.04 in/min

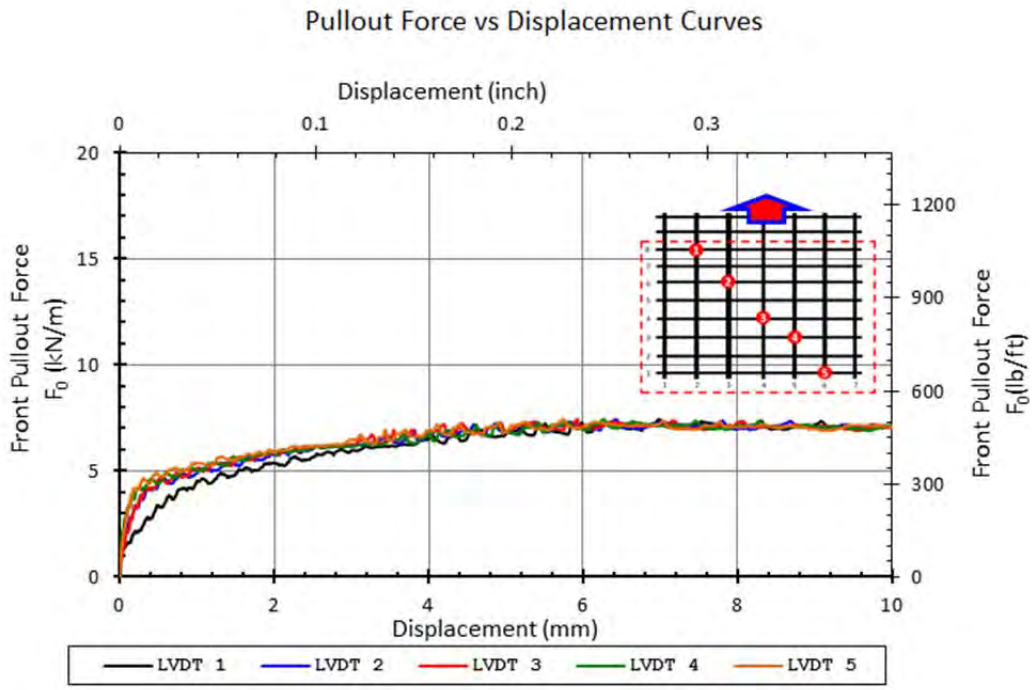
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.533 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

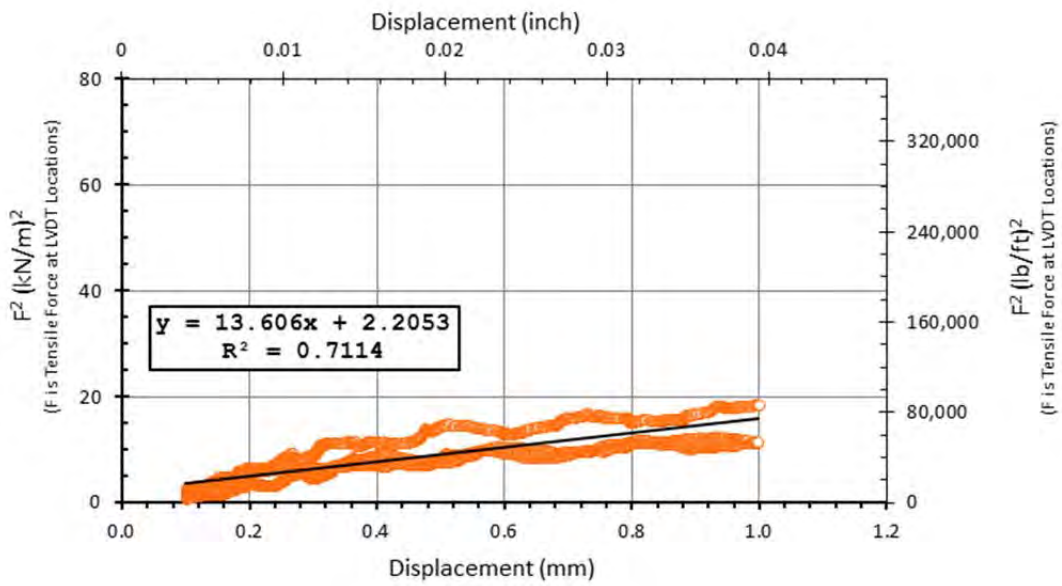
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	509	lb/ft
Max Pullout Load	P_{max}	1.94	kN	484	lb
Max Shear Stress	τ_{max}	26.1	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
13.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

PSI increased as test began and decreased as test ended. PSI adjusted constantly back to 3 psi throughout test. Specimen with 12 ribs instead of 14 due to variability of aperture sizes of the product throughout the roll. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

SMALL PULLOUT TEST

Date test conducted	5/1/12 PM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	12	0.915	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.5	0.610
2	67.4	2.654
3	120.2	4.733
4	170.5	6.711
5	222.7	8.768

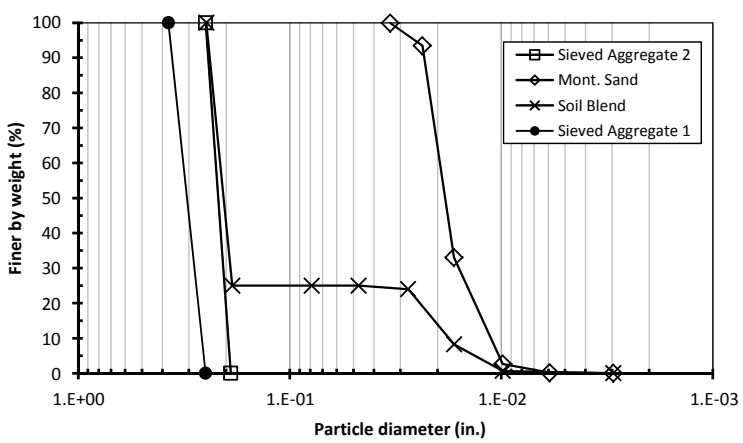
Pullout Rate	
1.0 mm/min.	0.04 in/min

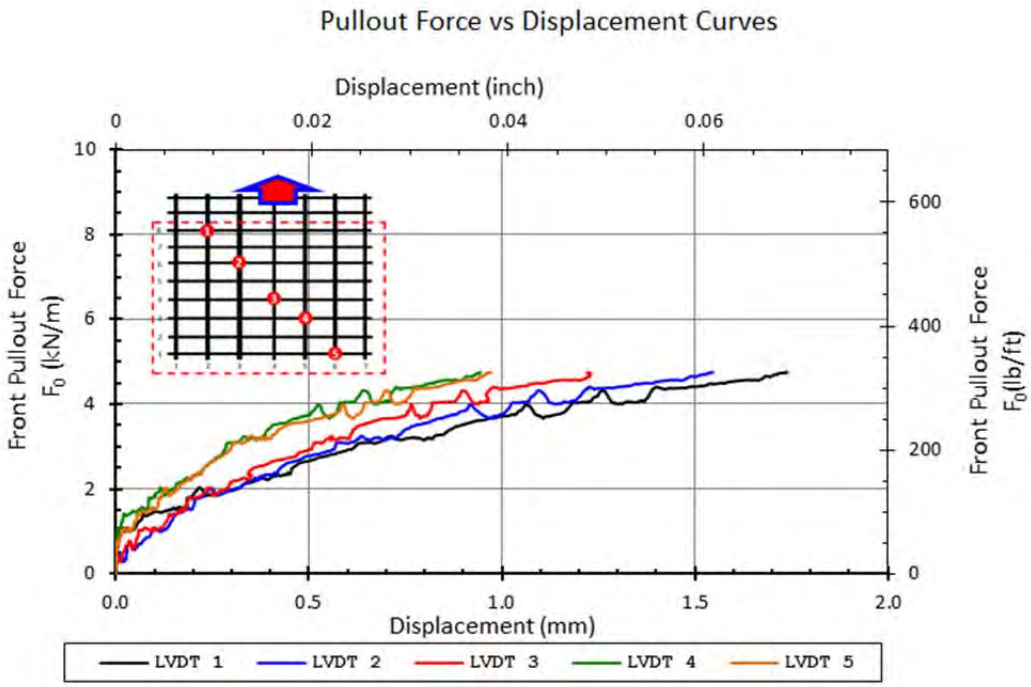
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

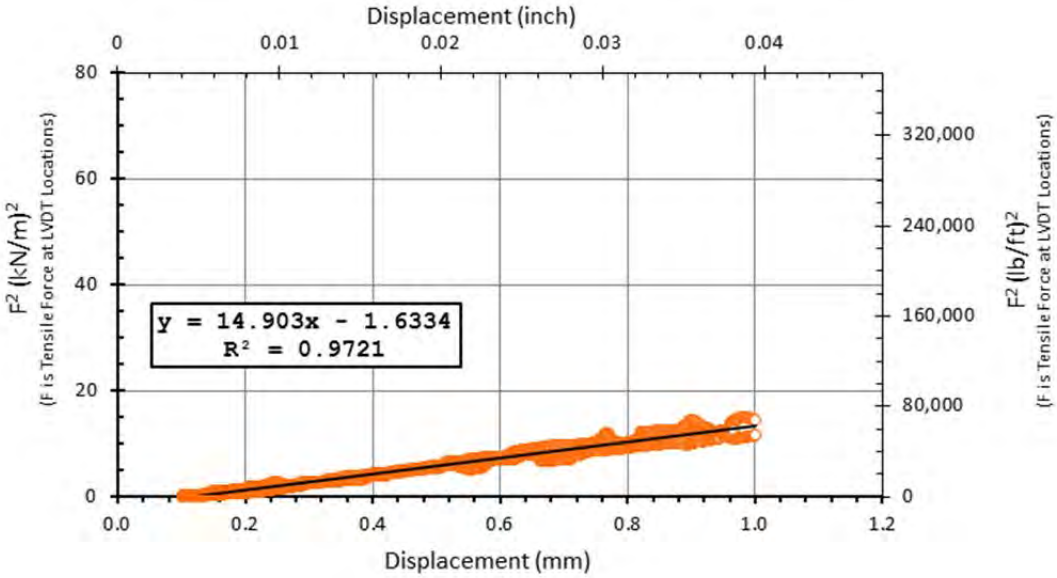
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
14.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Test run up to 1 mm of displacement of LVDT 3. Specimen with 12 ribs instead of 14 due to variation of aperture sizes of the product. PSI slightly increased as test began and decreased as test ended. No adjusting of overburden pressure throughout the test.

SMALL PULLOUT TEST

Date test conducted	5/1/12 PM -Rld
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	12	0.915	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.5	0.610
2	67.4	2.654
3	120.2	4.733
4	170.5	6.711
5	222.7	8.768

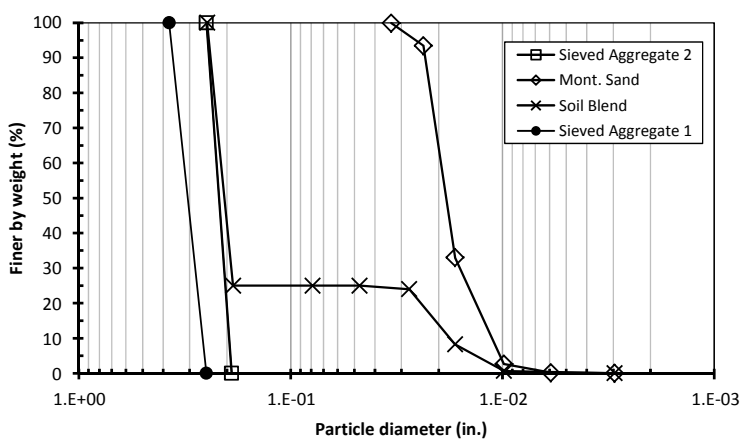
Pullout Rate	
1.0 mm/min.	0.04 in/min

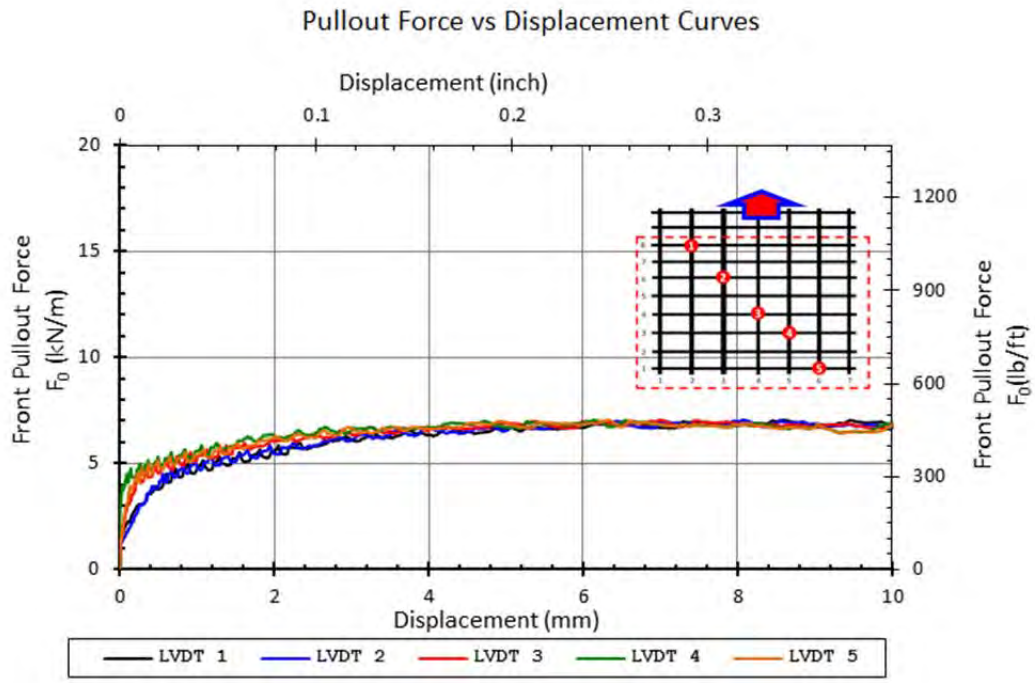
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.529 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

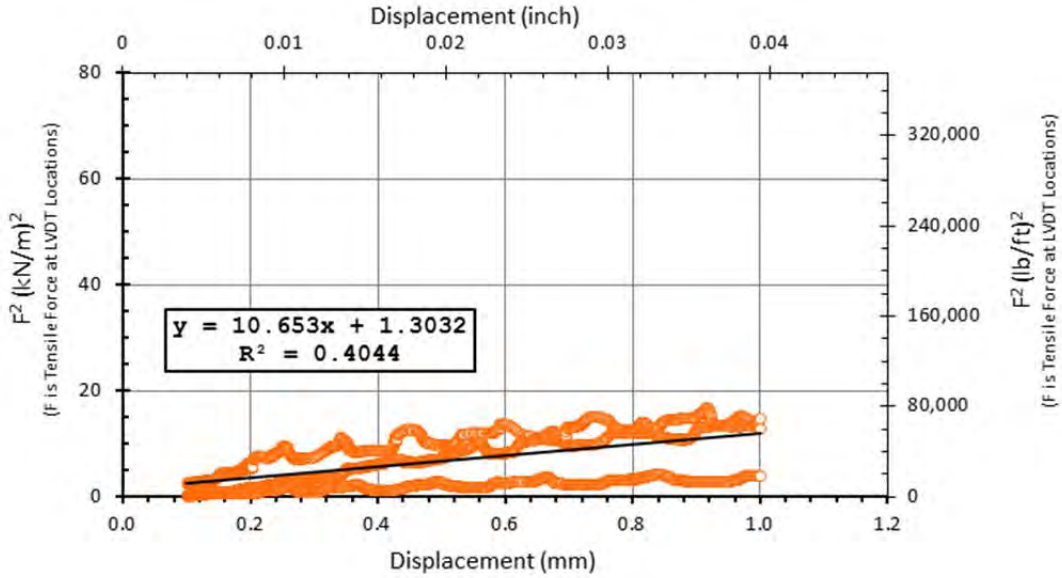
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.0	kN/m	483	lb/ft
Max Pullout Load	P_{max}	1.84	kN	455	lb
Max Shear Stress	τ_{max}	24.7	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
10.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

PSI increased as test began and decreased as test ended. No adjustment made of overburden pressure during test. Specimen with 12 ribs instead of 14 due to variability of aperture sizes of the product throughout the roll. Previously loaded and unloaded geosynthetic specimen. Specimen reloaded to pullout failure in this test.

Appendix A6

This appendix presents the results of the tests with Sieved Aggregate 2 without the use of torque wrench. These tests were performed with a confining pressure of 3 psi (21 kPa) and analog air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	8/4/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.275	m	0.245	m
	10	0.915	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	26.2	1.031
2	66.5	2.618
3	107.3	4.224
4	148.2	5.835
5	245.0	9.646

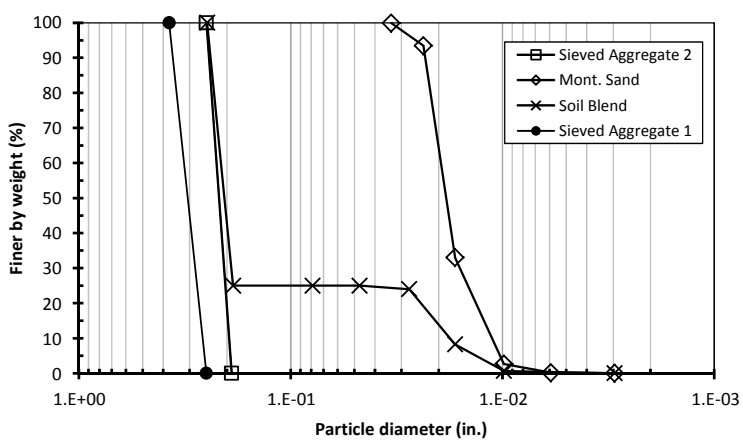
Pullout Rate	
1.0 mm/min.	0.04 in/min

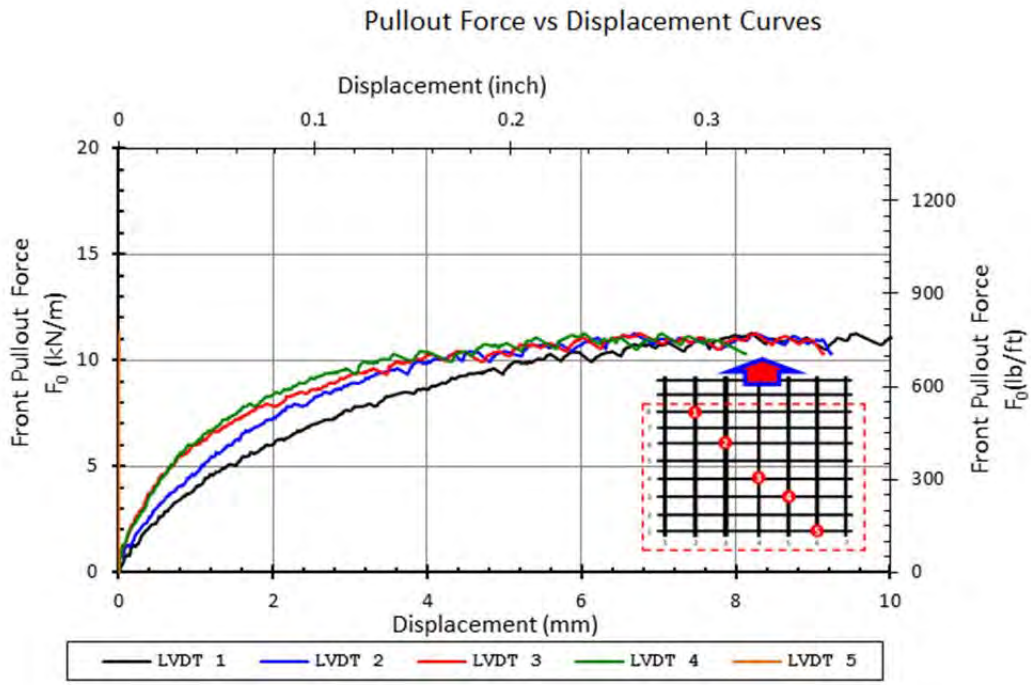
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.498 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

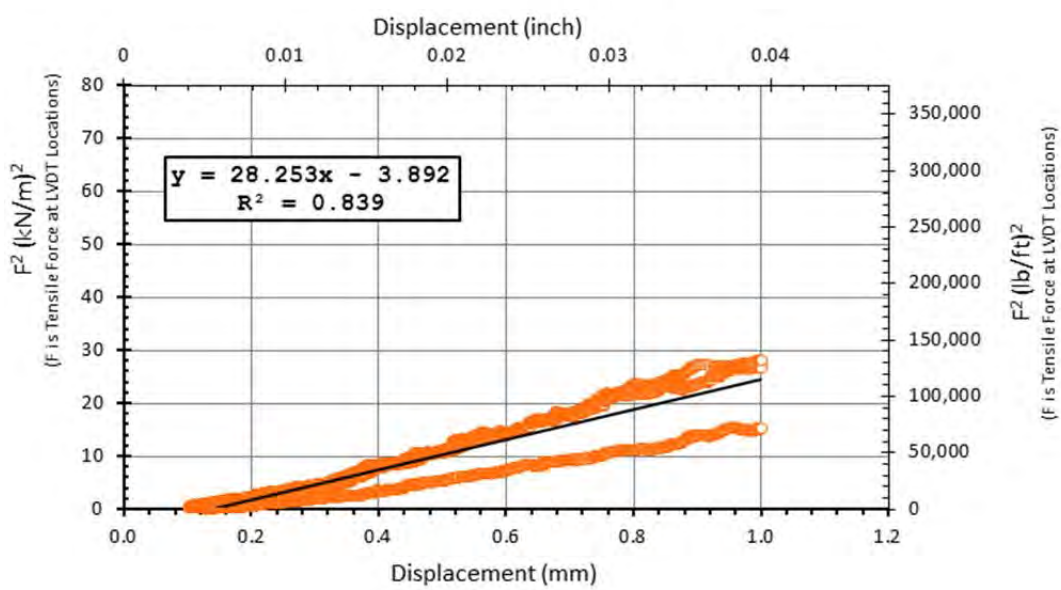
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.3	kN/m	772	lb/ft
Max Pullout Load	P_{max}	3.10	kN	725	lb
Max Shear Stress	τ_{max}	41.7	kPa	6.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
28.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

P5 moved to be LVDT #2. P2 was broken. Thus no data for LVDT #5.

SMALL PULLOUT TEST

Date test conducted	9/7/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.275	m	0.245	m
	10	0.922	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	27.6	1.086
2	67.8	2.670
3	111.2	4.376
4	150.7	5.933
5	232.7	9.159

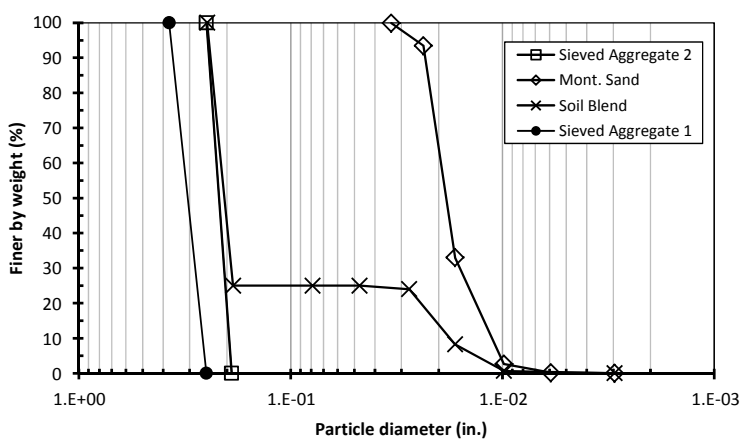
Pullout Rate	
1.0 mm/min.	0.04 in/min

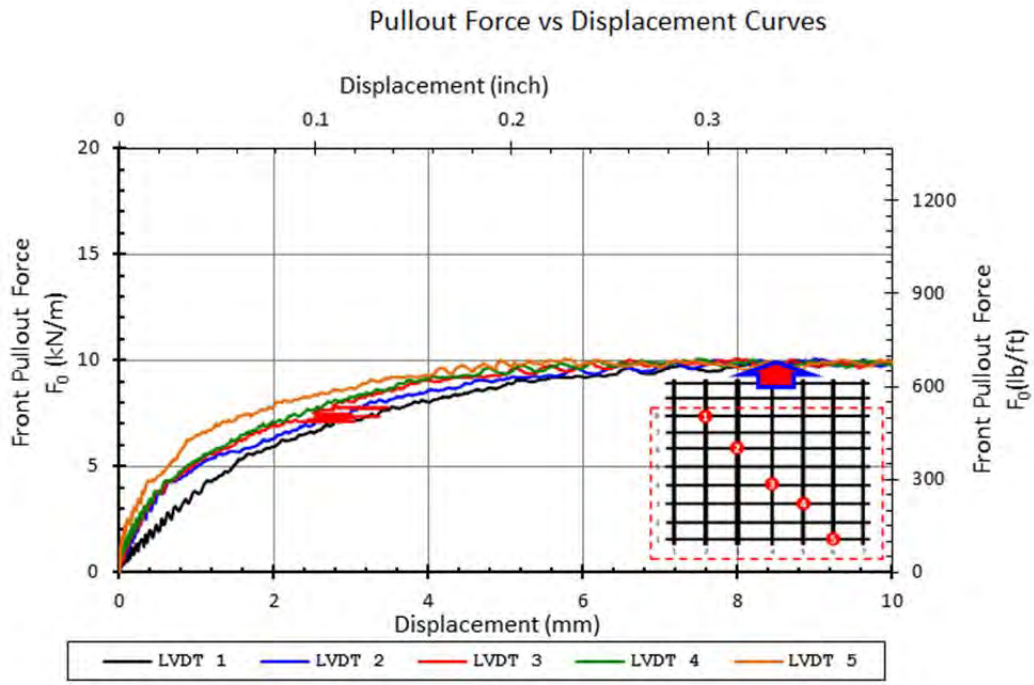
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.502 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

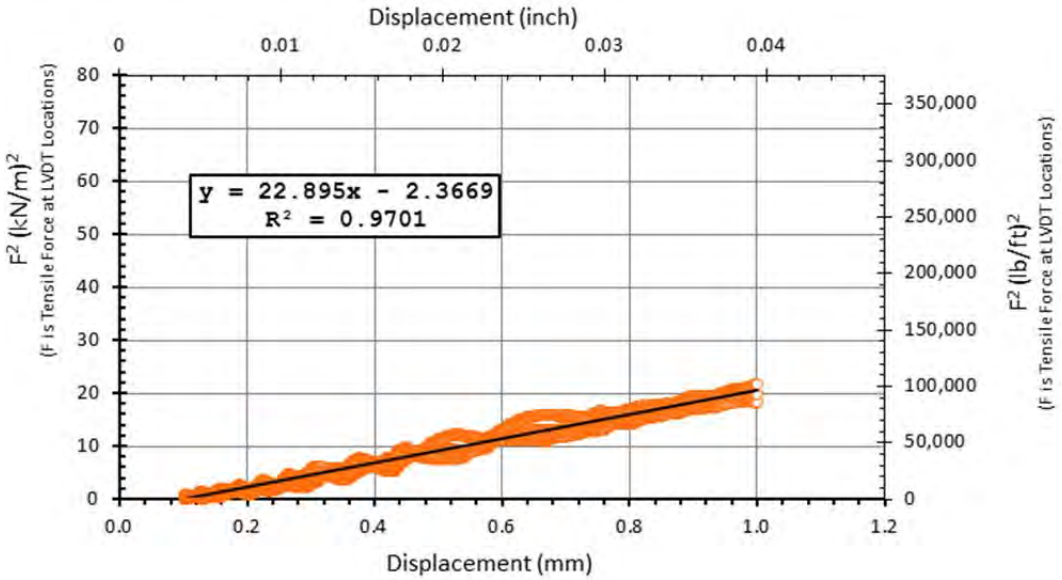
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.1	kN/m	690	lb/ft
Max Pullout Load	P_{max}	2.77	kN	666	lb
Max Shear Stress	τ_{max}	37.3	kPa	5.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
22.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

LVDT #1 was skewed (slightly tilted to the right); test was restarted after 50 lb.

SMALL PULLOUT TEST

Date test conducted	9/8/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	33.6	1.323
2	73.8	2.904
3	114.0	4.487
4	155.0	6.102
5	234.9	9.250

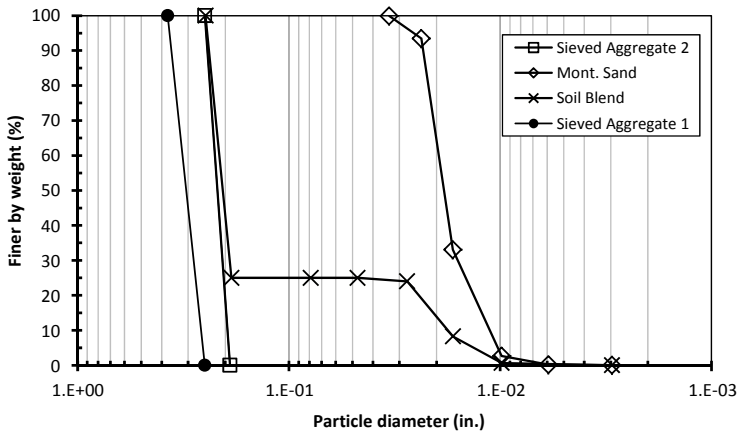
Pullout Rate	
1.0 mm/min.	0.04 in/min

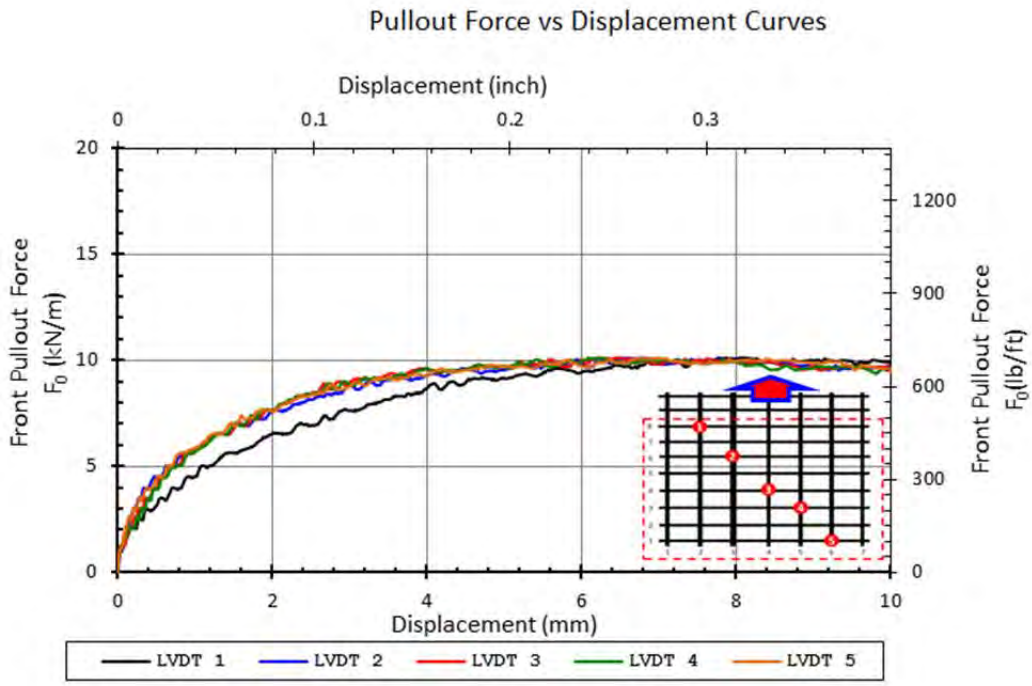
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

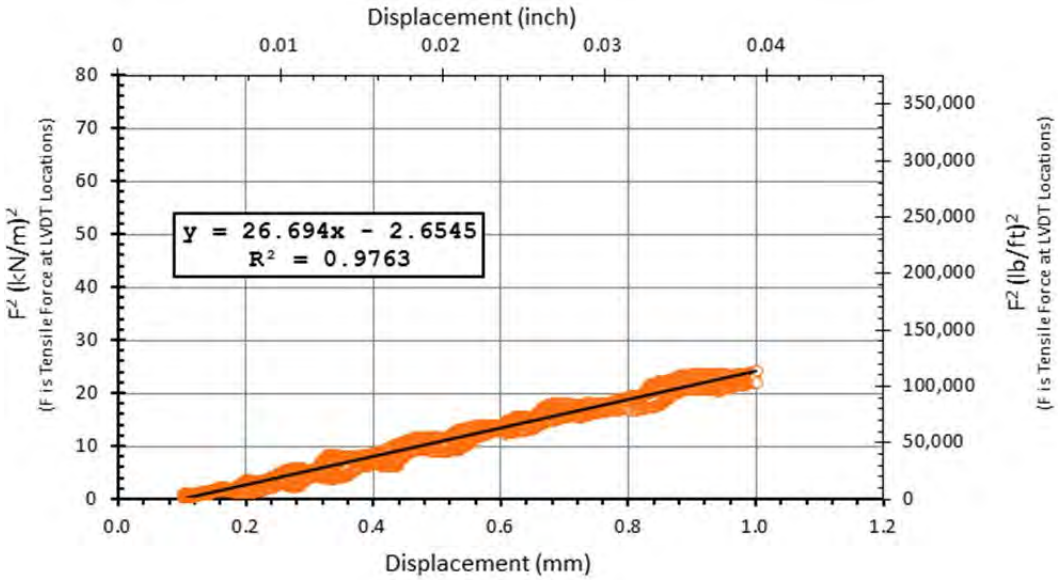
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.2	kN/m	697	lb/ft
Max Pullout Load	P_{max}	2.80	kN	648	lb
Max Shear Stress	τ_{max}	37.6	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
26.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Slanted right from the start.

SMALL PULLOUT TEST

Date test conducted	10/18/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.265	m	0.275	m	0.245	m
	10	0.869	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.0	1.260
2	72.2	2.844
3	112.2	4.416
4	152.7	6.013
5	232.3	9.145

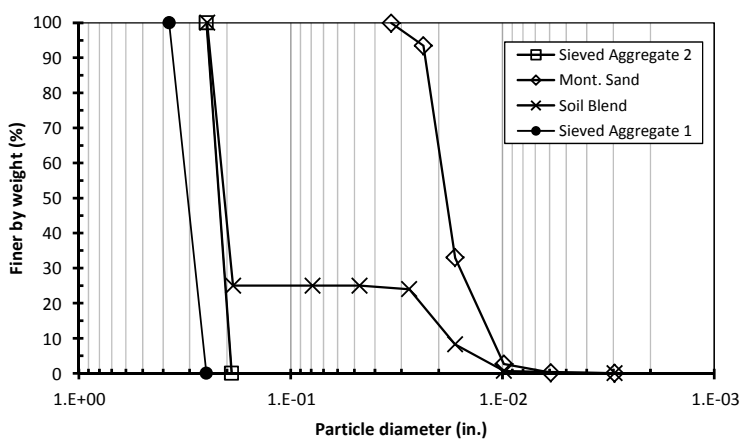
Pullout Rate			
1.0	mm/min.	0.04	in/min

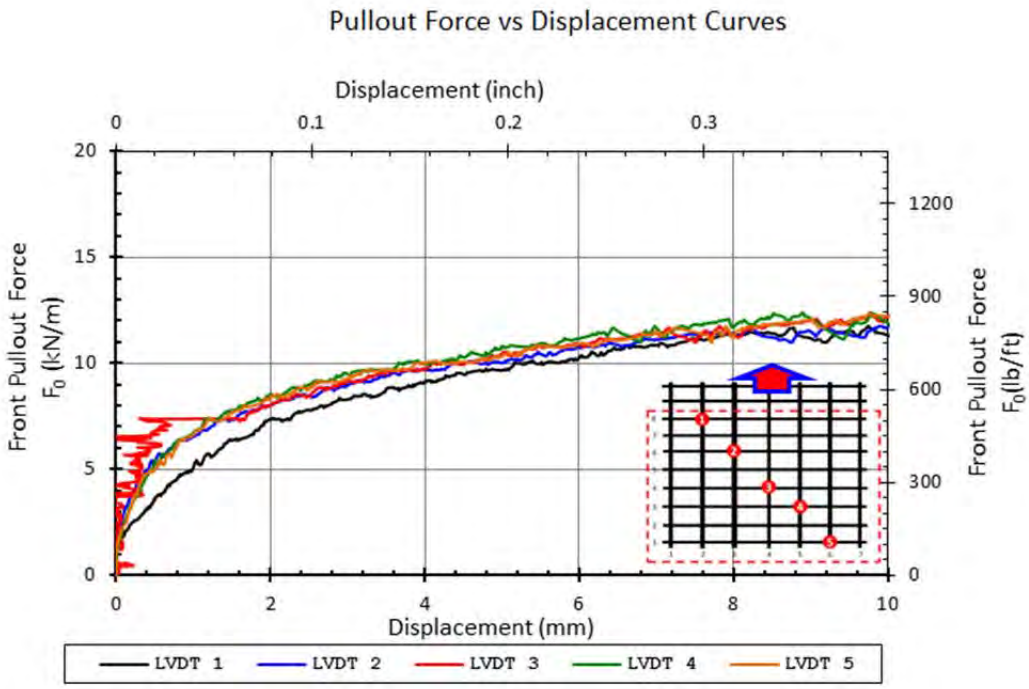
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.538 **g/cm^3**	**96 pcf**

Note: particle size distribution curve shown below

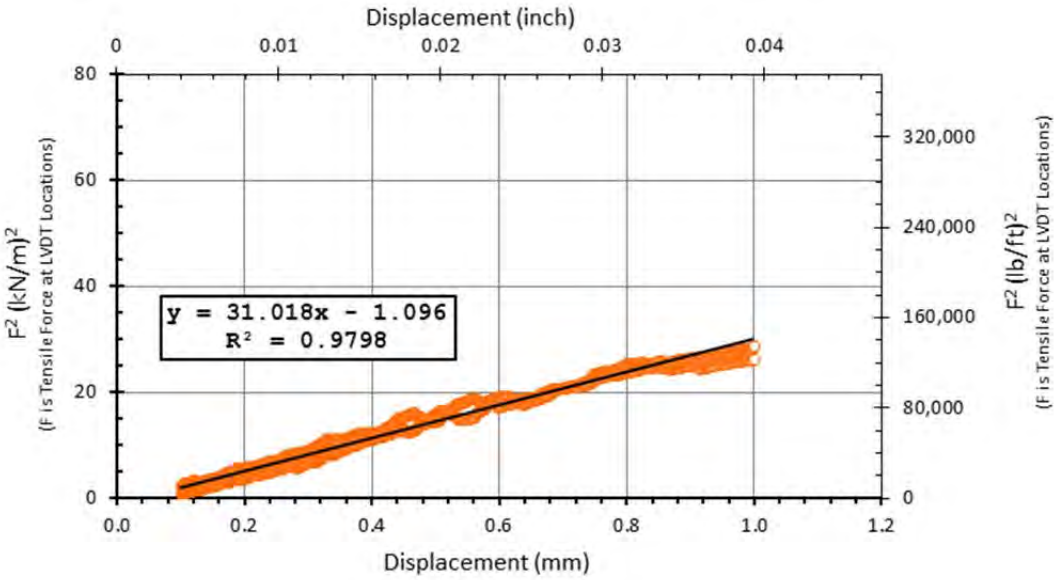
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.8	kN/m	879	lb/ft
Max Pullout Load	P_{max}	3.53	kN	757	lb
Max Shear Stress	τ_{max}	47.4	kPa	6.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
31.0	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Problems with LVDT 3. KSGI calculated with the data from LVDTs 2 and 4 only.

SMALL PULLOUT TEST

Date test conducted	7/22/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.274	m	0.261	m	0.245	m
	8	0.899	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.1	1.343
2	89.5	3.524
3	118.2	4.654
4	174.3	6.862
5	230.3	9.067

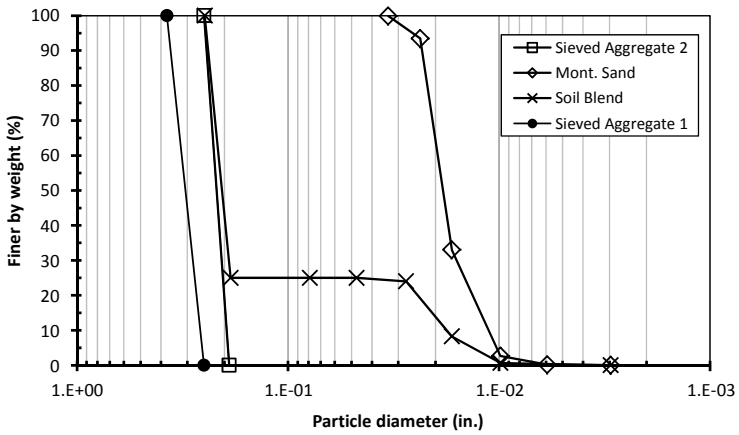
Pullout Rate	
1.0 mm/min.	0.04 in/min

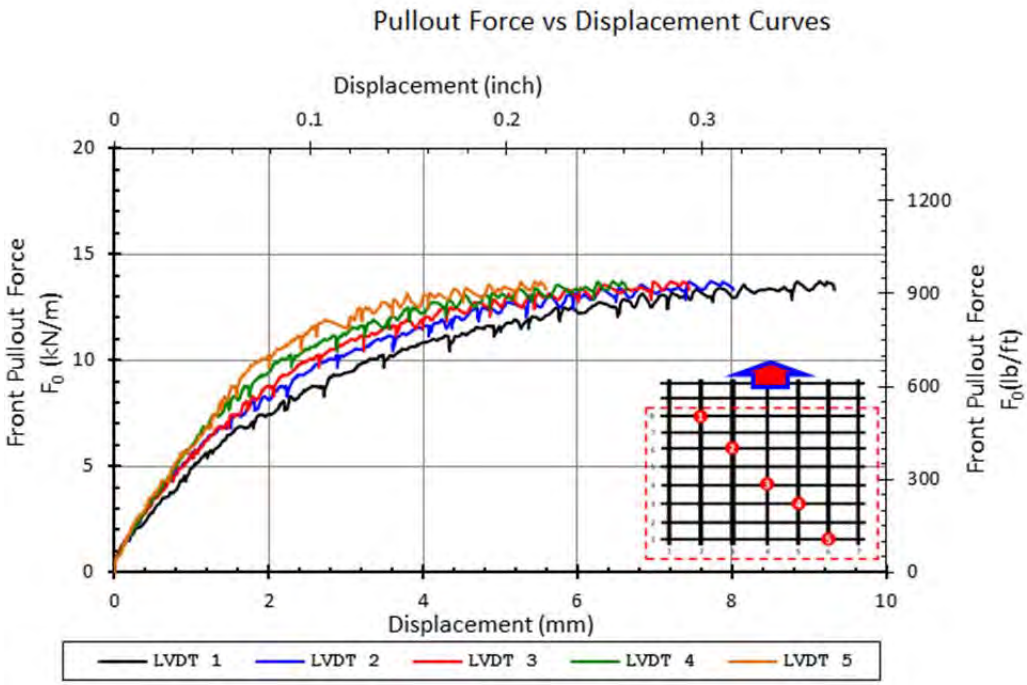
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

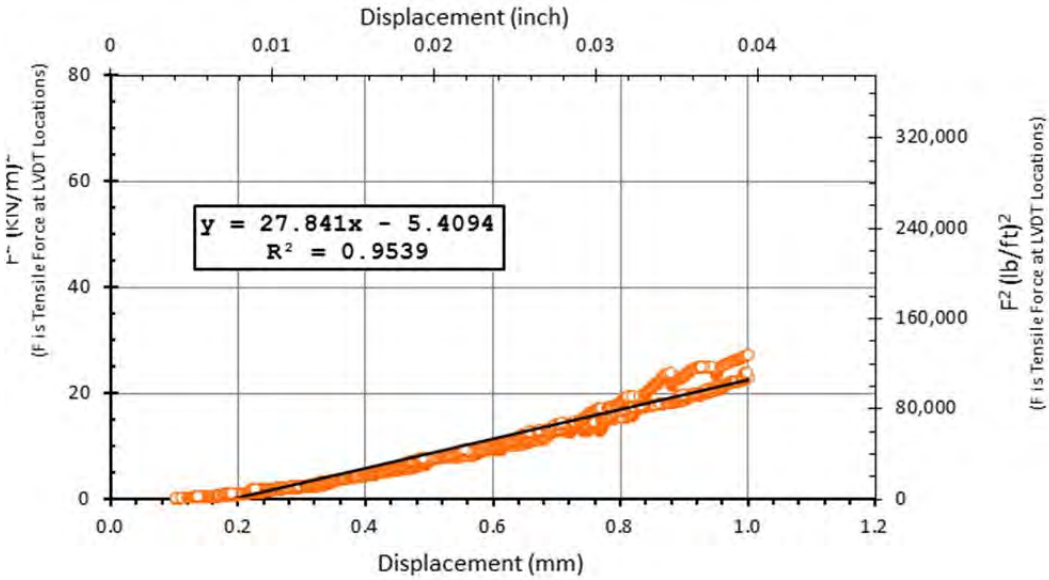
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.7	kN/m	940	lb/ft
Max Pullout Load	P_{max}	3.58	kN	840	lb
Max Shear Stress	τ_{max}	48.2	kPa	7.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
27.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT #5 a little skewed to the right.

SMALL PULLOUT TEST

Date test conducted	7/25/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.261	m	0.245	m
	8	0.902	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	37.4	1.472
2	93.2	3.669
3	120.3	4.736
4	176.0	6.929
5	231.7	9.122

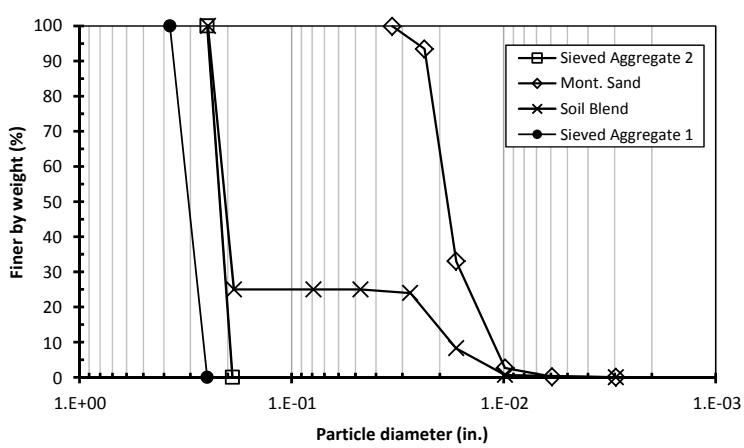
Pullout Rate	
1.0 mm/min.	0.04 in/min

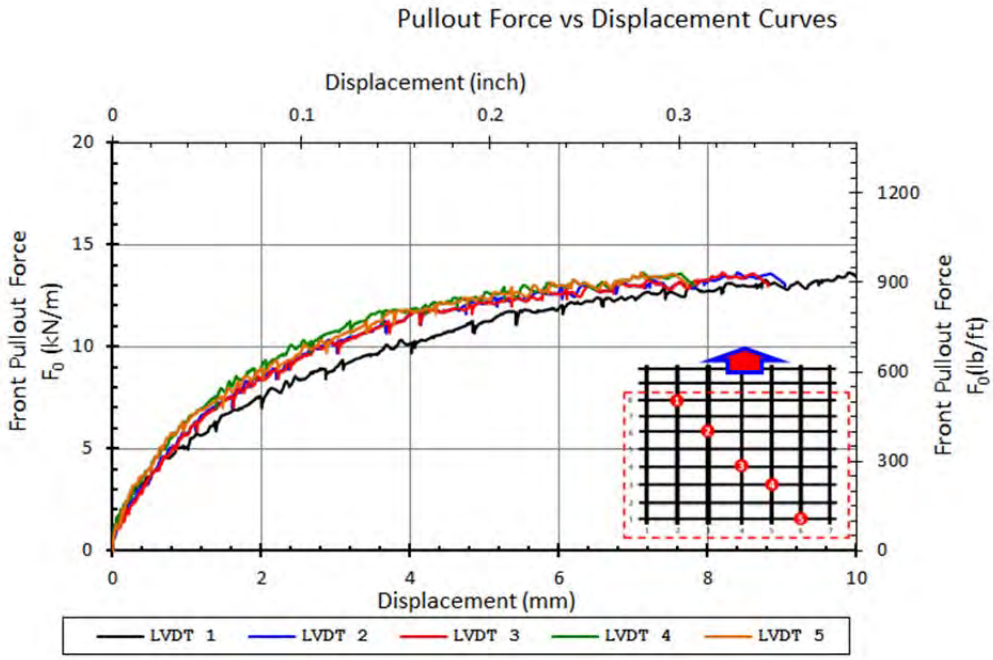
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.493 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

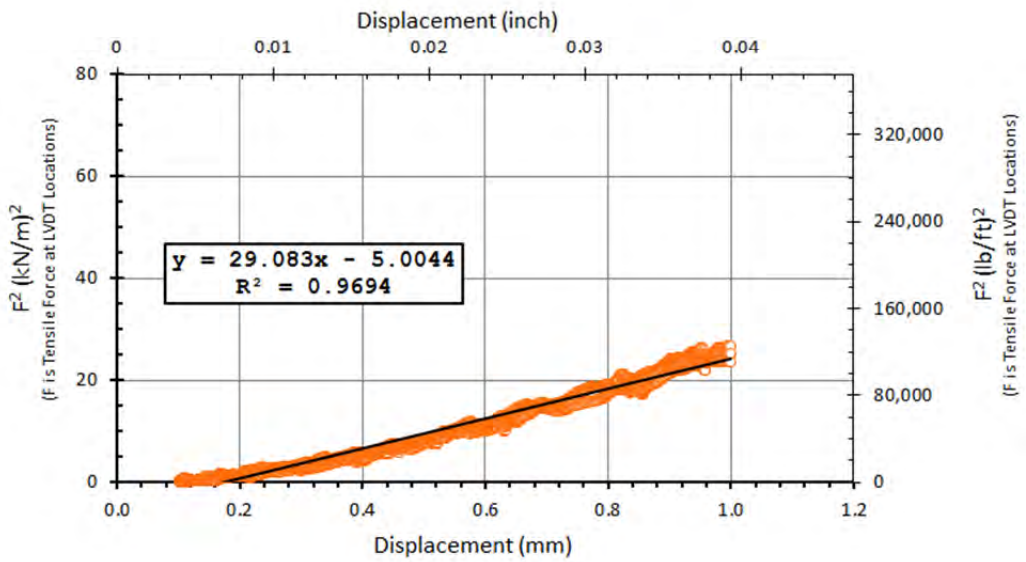
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.6	kN/m	934	lb/ft
Max Pullout Load	P_{max}	3.56	kN	826	lb
Max Shear Stress	τ_{max}	47.8	kPa	6.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
29.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/26/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.261	m	0.245	m
	8	0.909	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.4	1.354
2	89.6	3.528
3	117.9	4.642
4	174.4	6.866
5	230.6	9.079

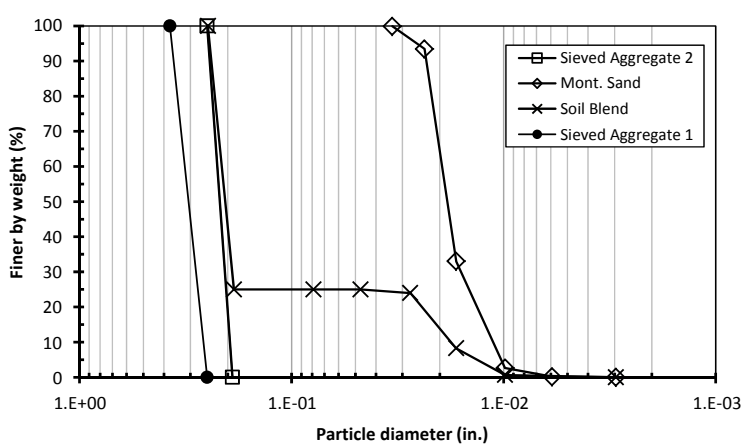
Pullout Rate	
1.0 mm/min.	0.04 in/min

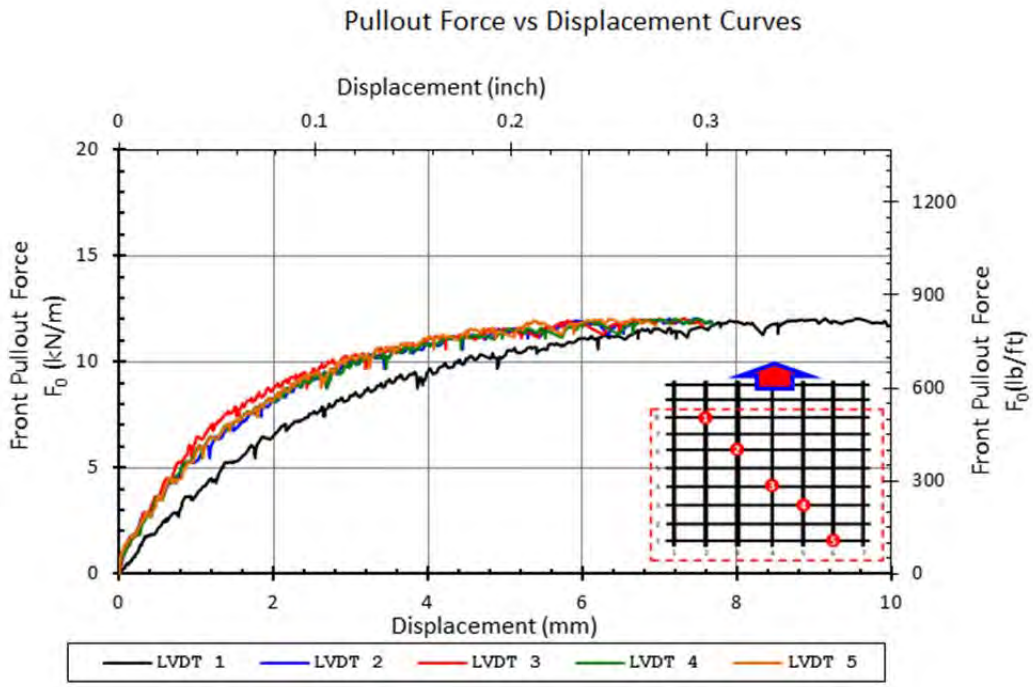
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.458 **g/cm^3**	**91 pcf**

Note: particle size distribution curve shown below

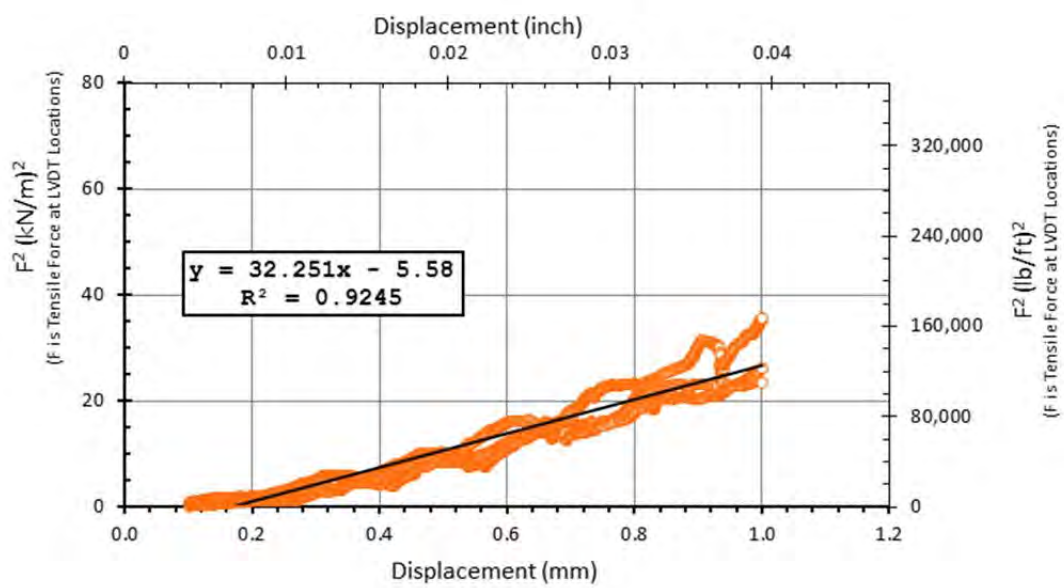
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.0	kN/m	825	lb/ft
Max Pullout Load	P_{max}	3.14	kN	741	lb
Max Shear Stress	τ_{max}	42.2	kPa	6.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
32.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LVDT #5 a little skewed to the right

SMALL PULLOUT TEST

Date test conducted	11/3/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.265	m	0.265	m	0.245	m
	9	0.869	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	12.8	0.504
2	56.1	2.207
3	96.7	3.808
4	140.9	5.547
5	224.0	8.819

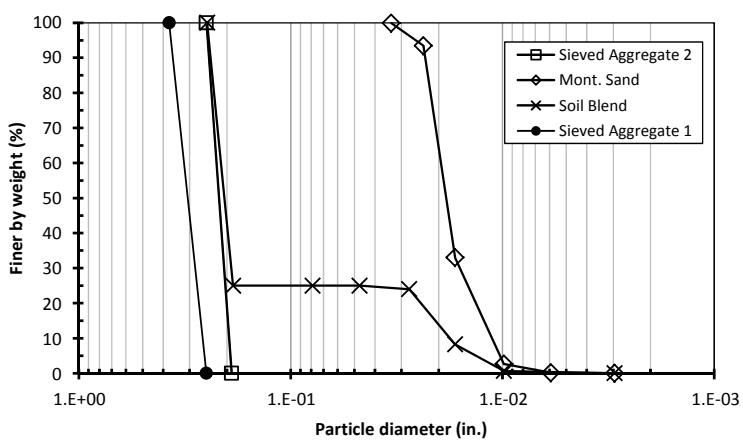
Pullout Rate	
1.0 mm/min.	0.04 in/min

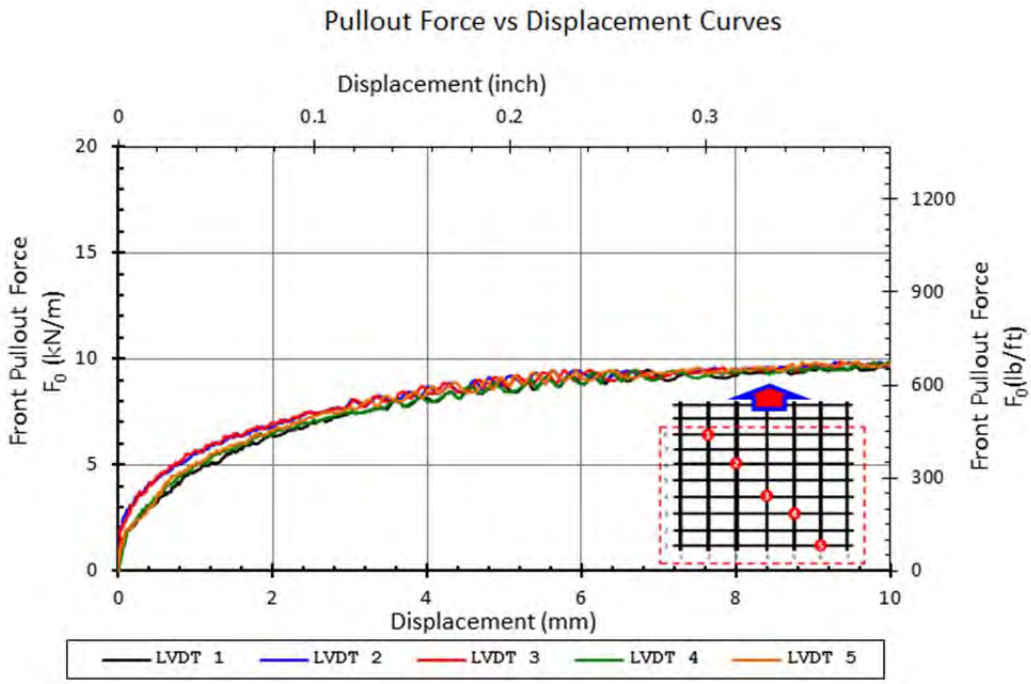
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.484 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

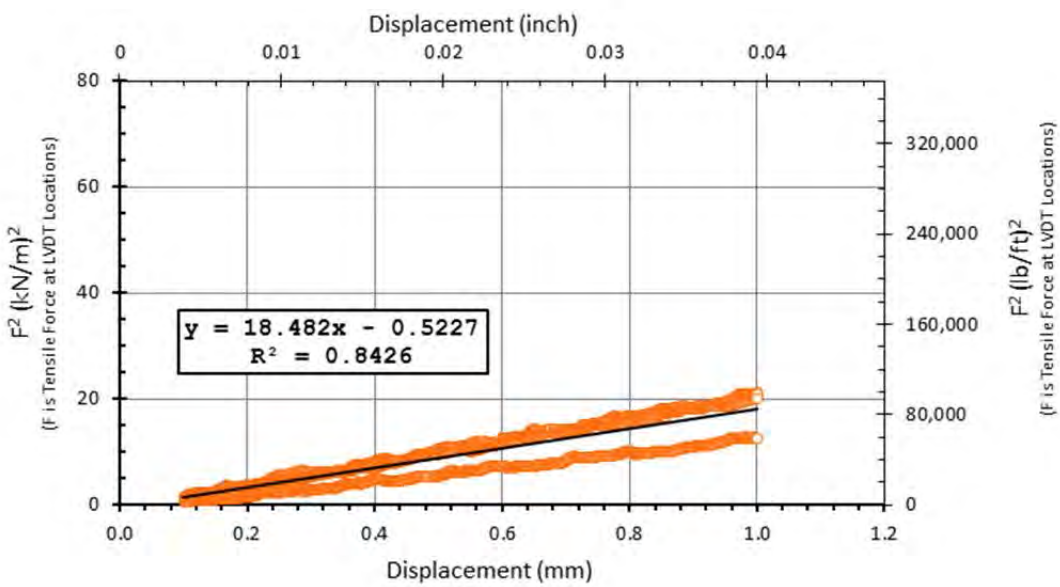
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.8	kN/m	675	lb/ft
Max Pullout Load	P_{max}	2.61	kN	618	lb
Max Shear Stress	τ_{max}	35.0	kPa	5.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
18.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/8/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.270	m	0.265	m	0.245	m
	9	0.886	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-4.0	-0.157
2	42.6	1.679
3	87.4	3.442
4	132.5	5.215
5	221.8	8.732

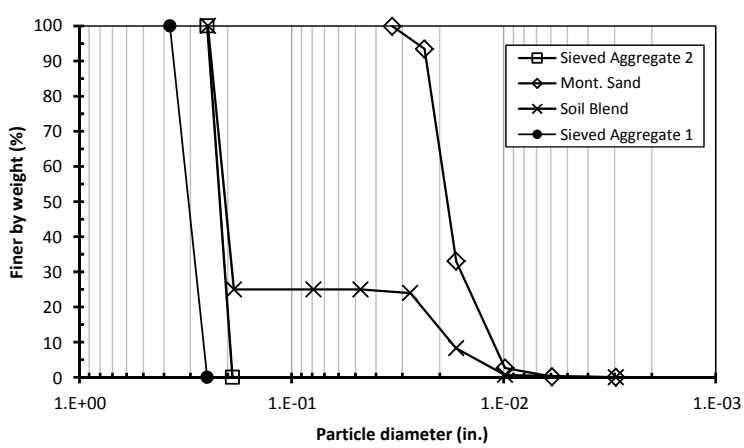
Pullout Rate	
1.0 mm/min.	0.04 in/min

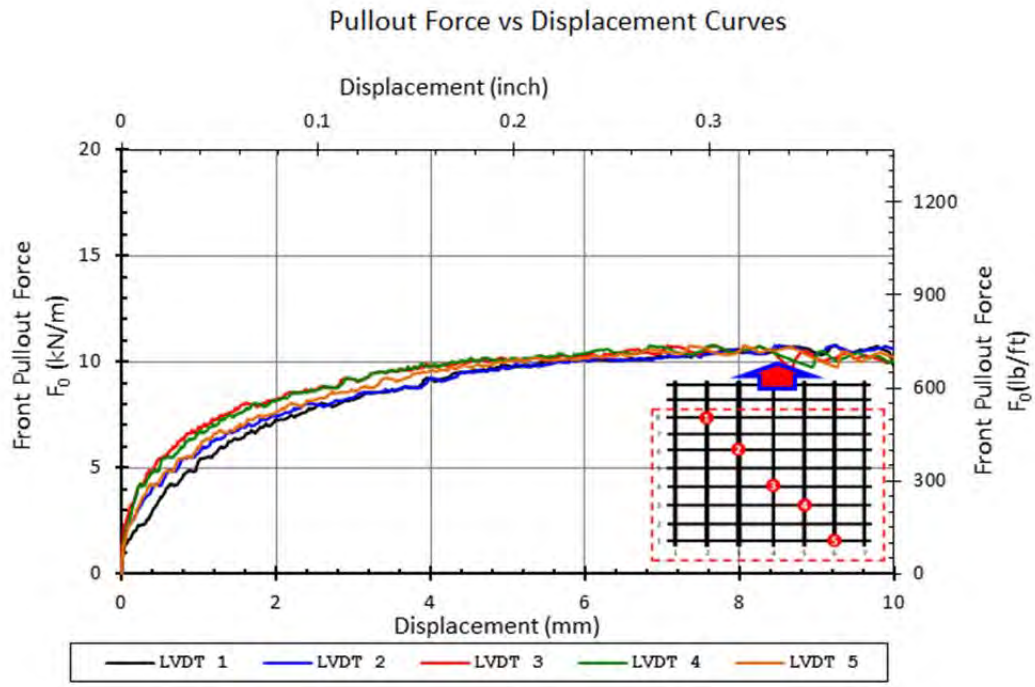
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.484 **g/cm^3**	**93 pcf**

Note: particle size distribution curve shown below

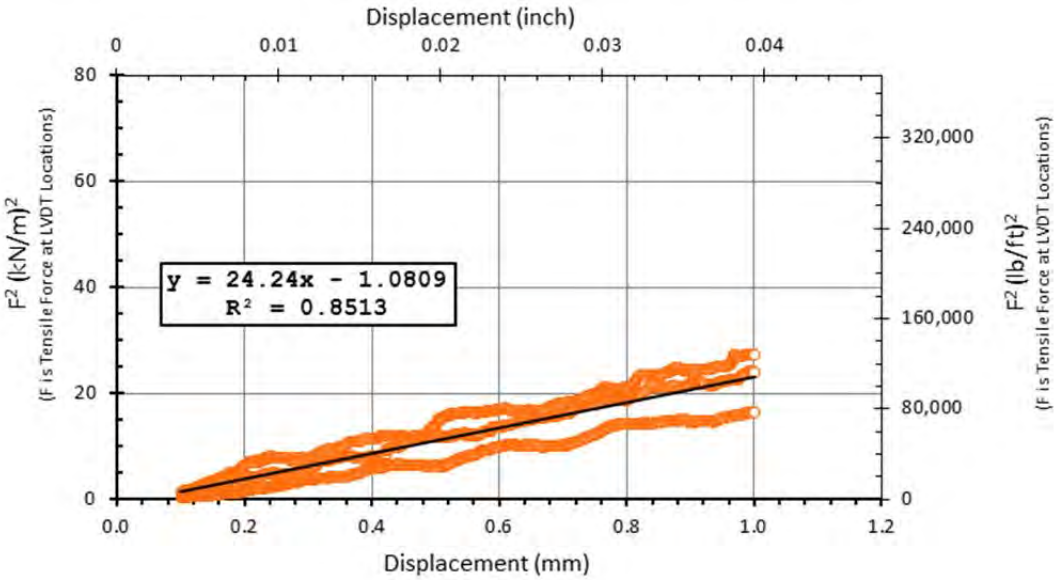
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.8	kN/m	738	lb/ft
Max Pullout Load	P_{max}	2.85	kN	658	lb
Max Shear Stress	τ_{max}	38.3	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
24.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

Rib#1 is already out of box at beginning of test

SMALL PULLOUT TEST

Date test conducted	11/11/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.265	m	0.245	m
	9	0.922	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	41.1	1.617
2	79.7	3.139
3	117.2	4.613
4	156.3	6.153
5	233.8	9.205

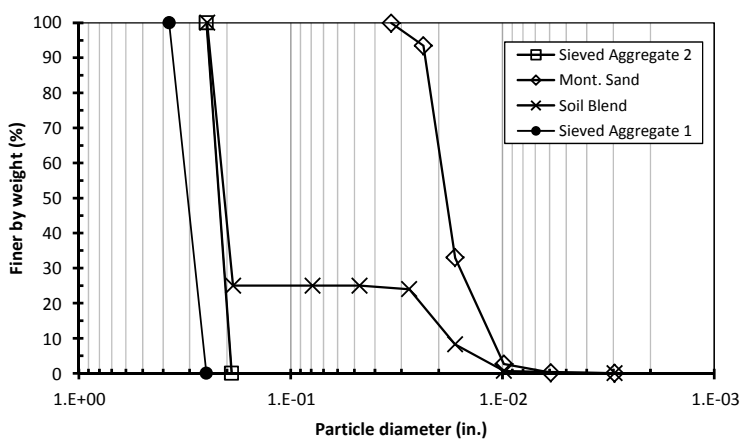
Pullout Rate	
1.0 mm/min.	0.04 in/min

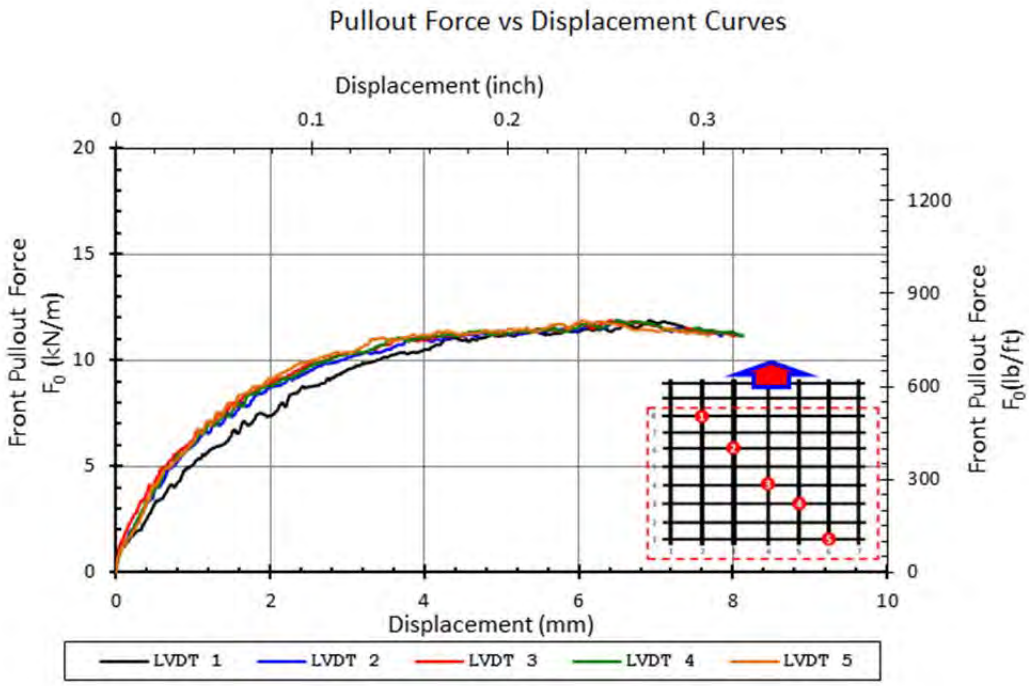
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.551 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

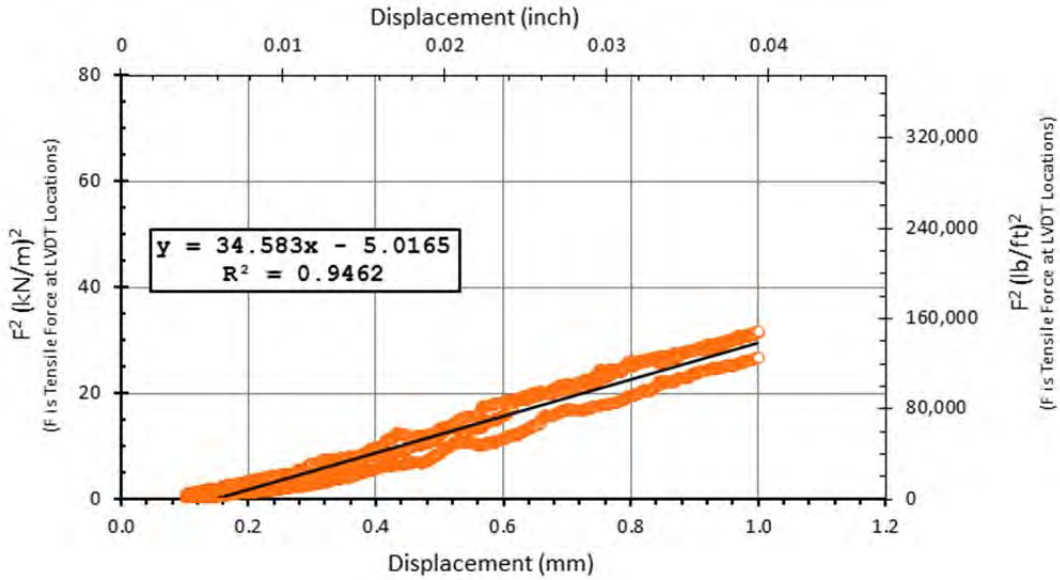
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.9	kN/m	815	lb/ft
Max Pullout Load	P_{max}	3.15	kN	779	lb
Max Shear Stress	τ_{max}	42.3	kPa	6.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
34.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/19/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.4	0.685
2	60.5	2.382
3	104.0	4.094
4	148.4	5.843
5	235.5	9.272

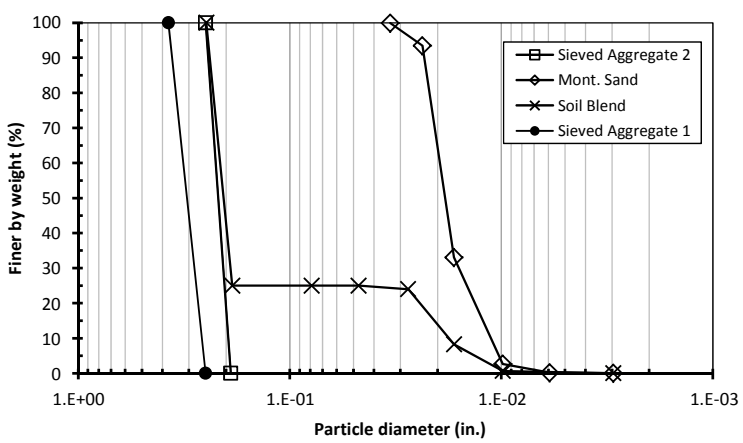
Pullout Rate	
1.0 mm/min.	0.04 in/min

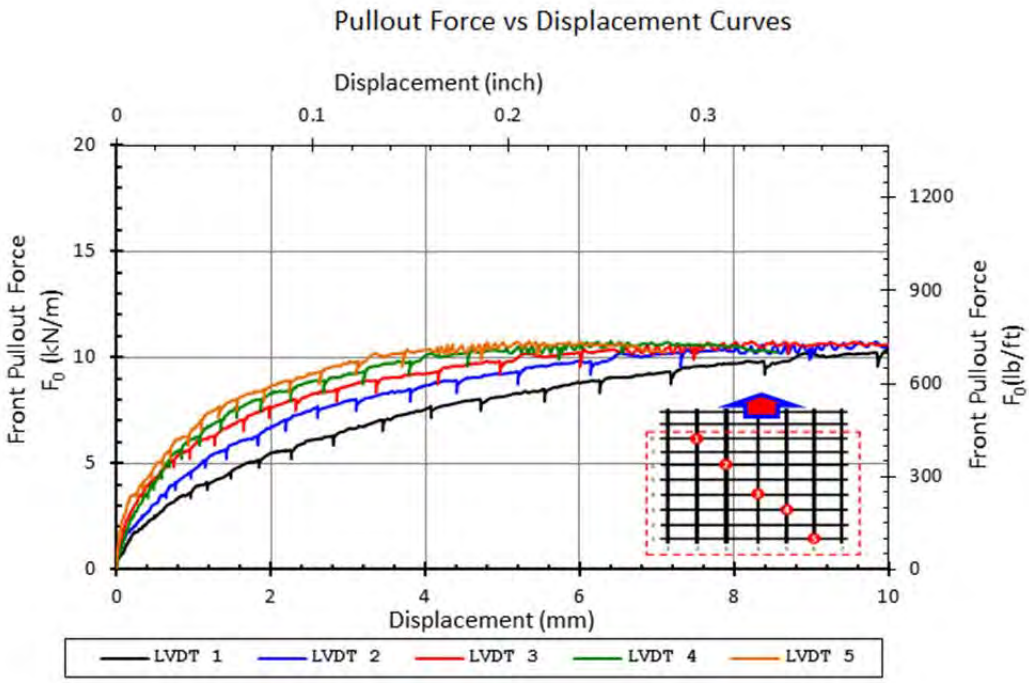
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.467 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

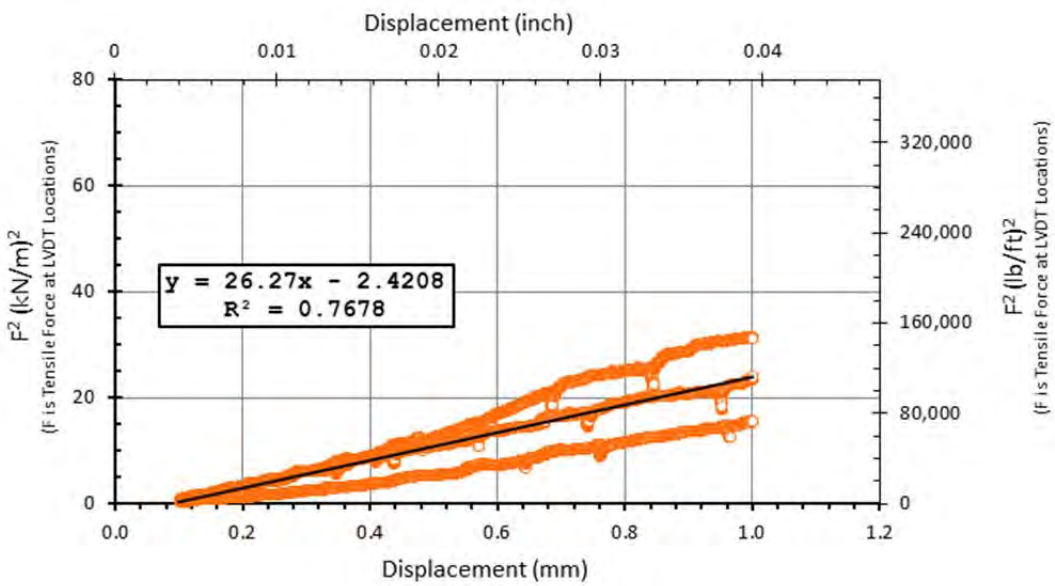
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.8	kN/m	737	lb/ft
Max Pullout Load	P_{max}	3.92	kN	896	lb
Max Shear Stress	τ_{max}	52.7	kPa	7.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
26.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/20/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.4	0.764
2	62.4	2.457
3	105.5	4.154
4	149.6	5.890
5	235.7	9.280

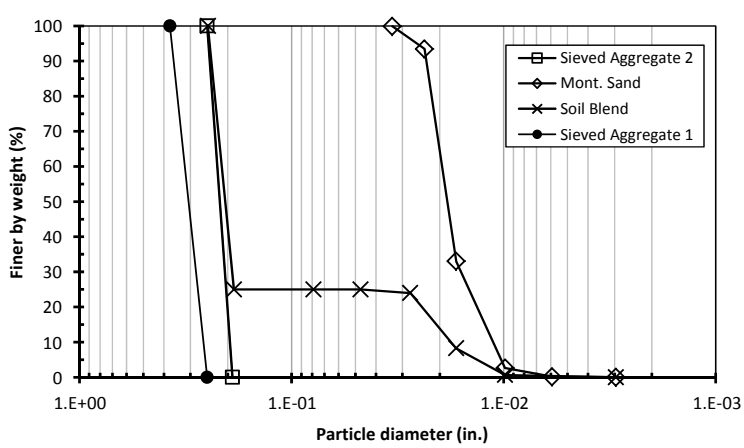
Pullout Rate	
1.0 mm/min.	0.04 in/min

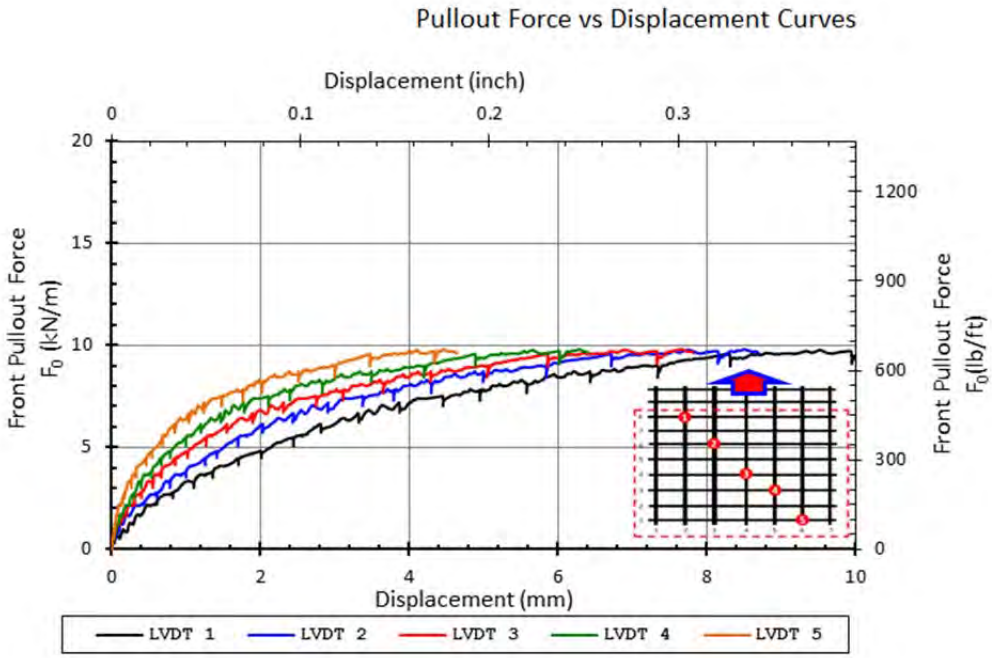
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.471 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

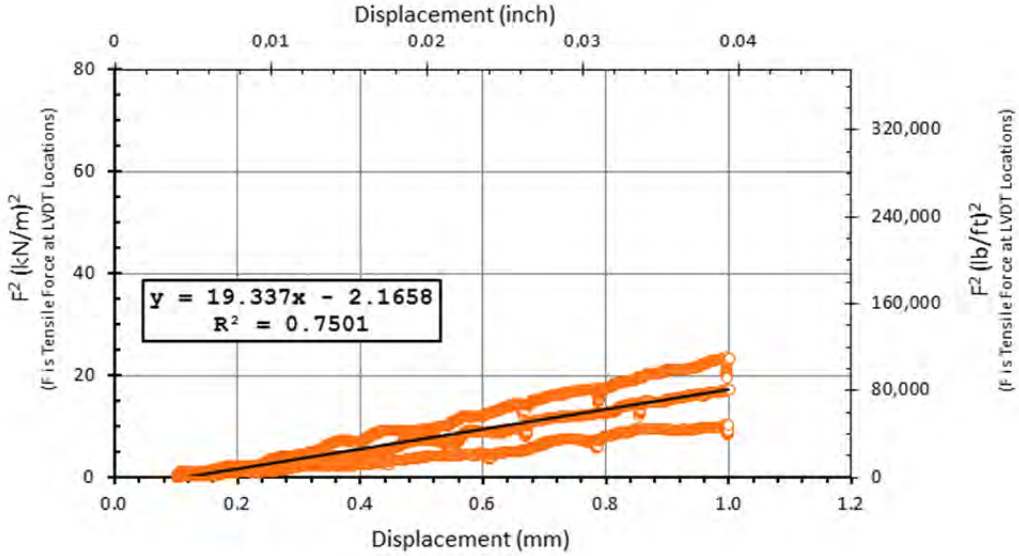
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.8	kN/m	672	lb/ft
Max Pullout Load	P_{max}	3.57	kN	833	lb
Max Shear Stress	τ_{max}	48.0	kPa	7.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
19.3 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/21/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	16.2	0.638
2	59.7	2.350
3	103.4	4.071
4	146.7	5.776
5	233.3	9.185

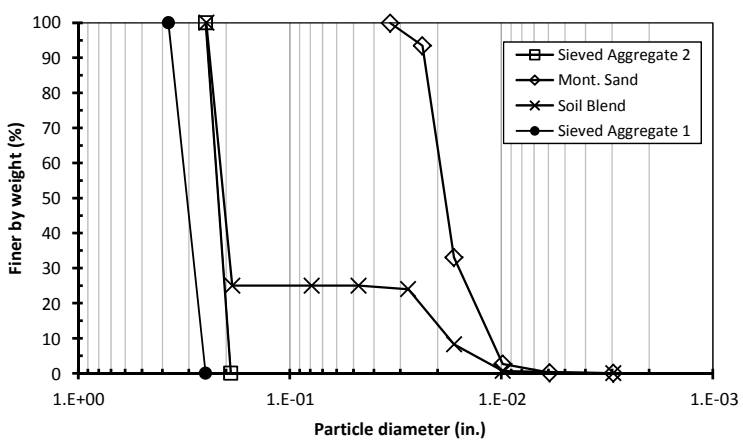
Pullout Rate	
1.0 mm/min.	0.04 in/min

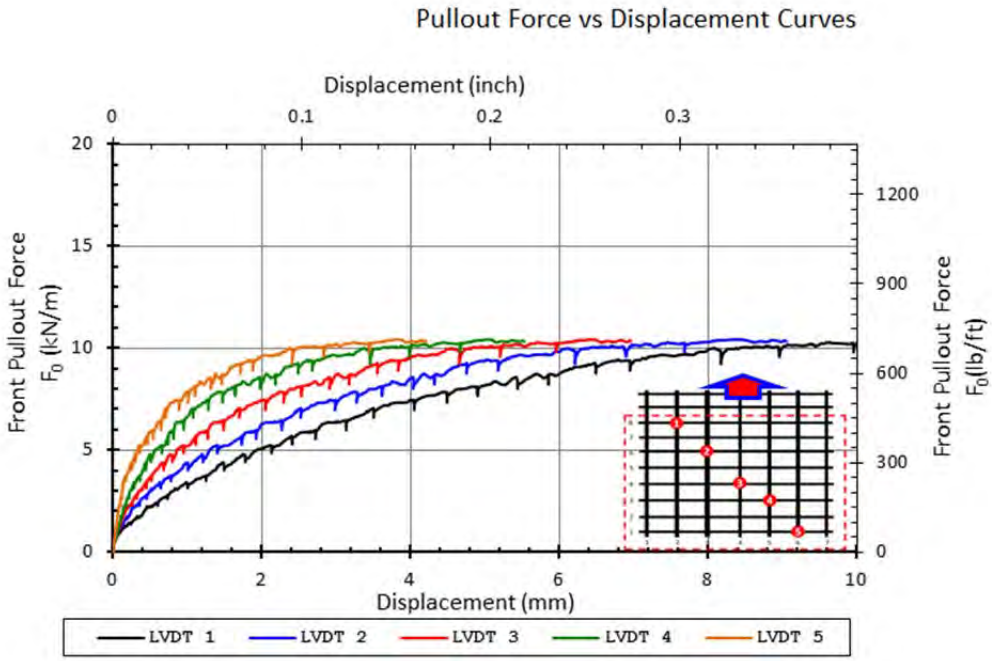
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.547 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

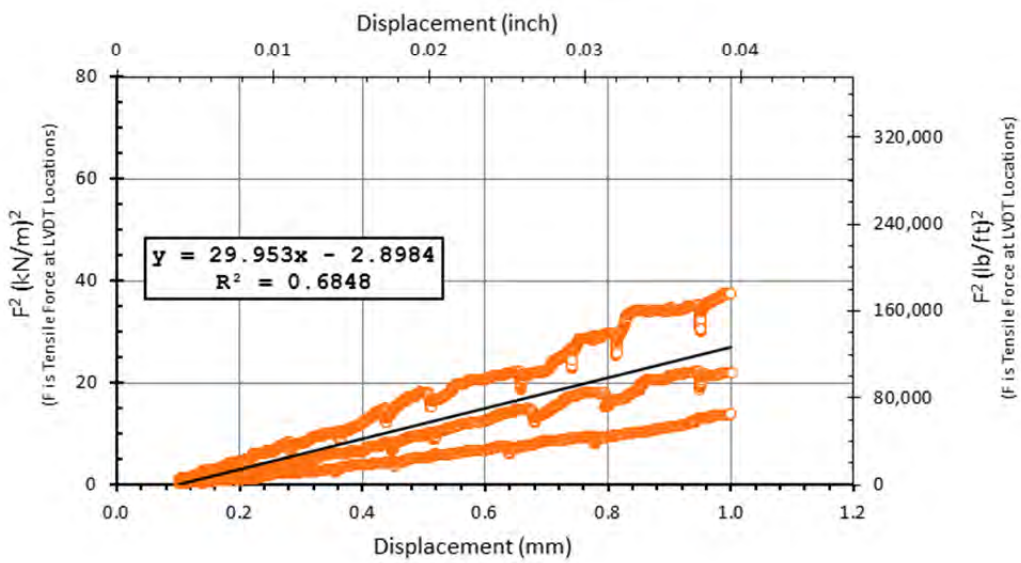
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.4	kN/m	714	lb/ft
Max Pullout Load	P_{max}	3.80	kN	881	lb
Max Shear Stress	τ_{max}	51.0	kPa	7.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
30.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/25/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.288	m	0.364	m	0.245	m
	17	0.945	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.8	0.701
2	61.1	2.406
3	104.2	4.102
4	146.8	5.780
5	232.6	9.157

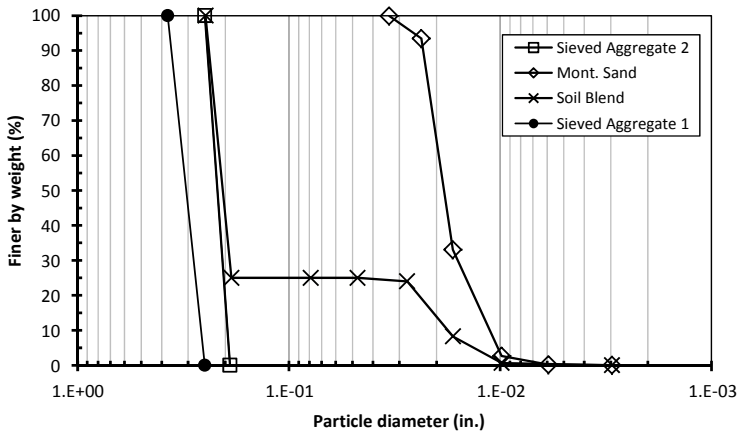
Pullout Rate			
1.0	mm/min.	0.04	in/min

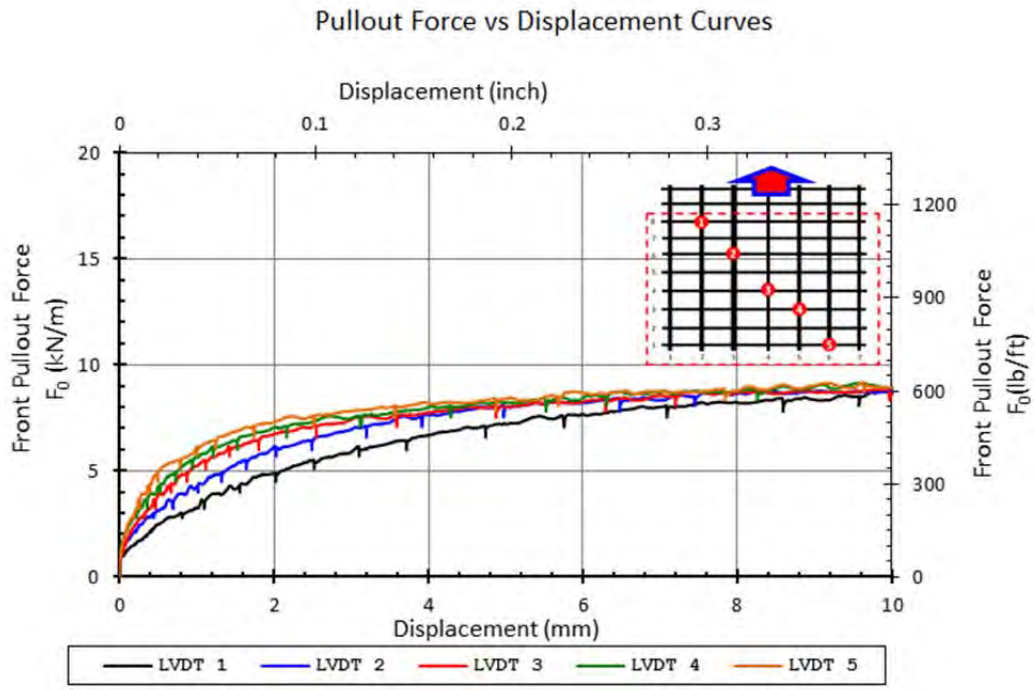
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.502 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

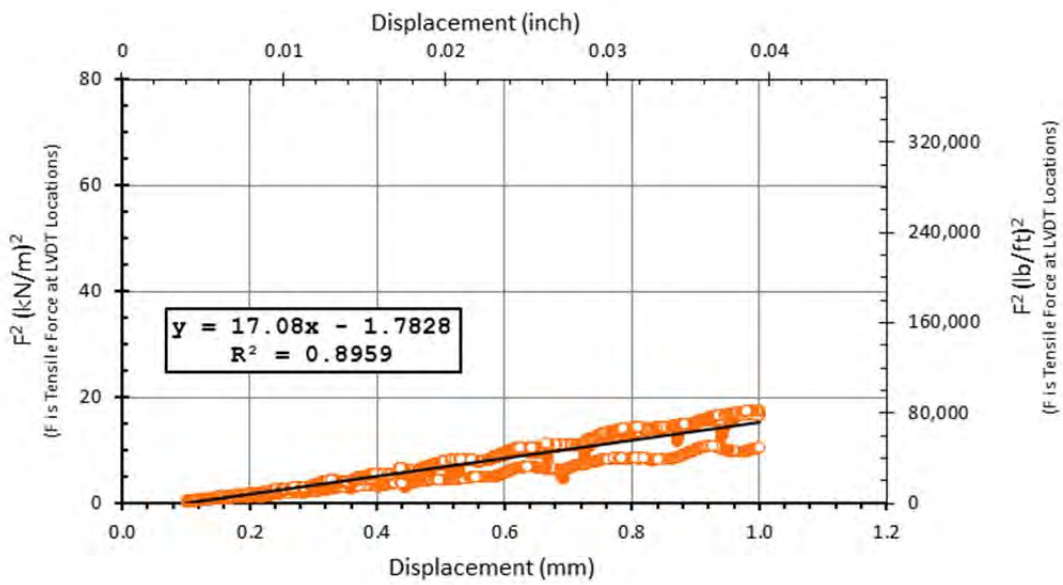
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.2	kN/m	630	lb/ft
Max Pullout Load	P_{max}	3.35	kN	769	lb
Max Shear Stress	τ_{max}	45.0	kPa	6.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
17.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/26/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.283	m	0.364	m	0.245	m
	17	0.929	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.0	0.669
2	62.2	2.449
3	106.9	4.209
4	148.6	5.850
5	234.9	9.248

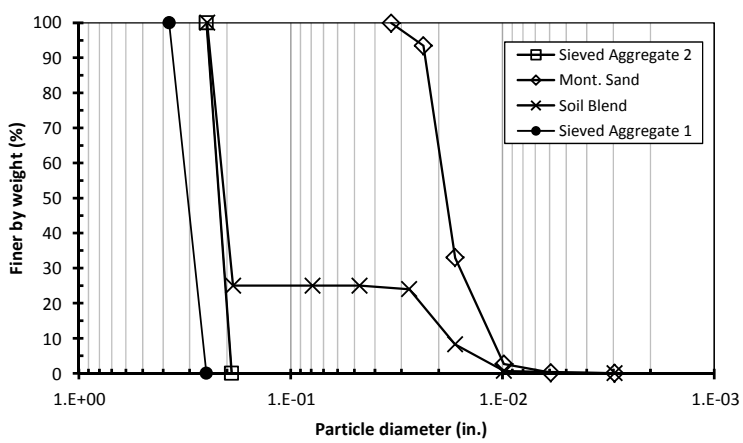
Pullout Rate	
1.0 mm/min.	0.04 in/min

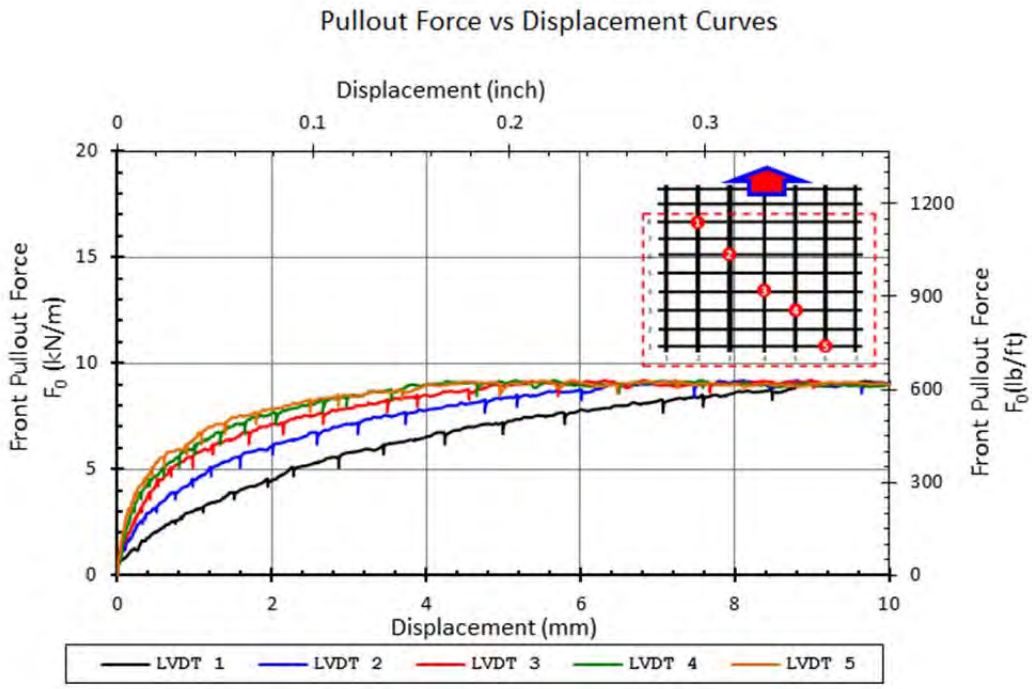
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.516 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

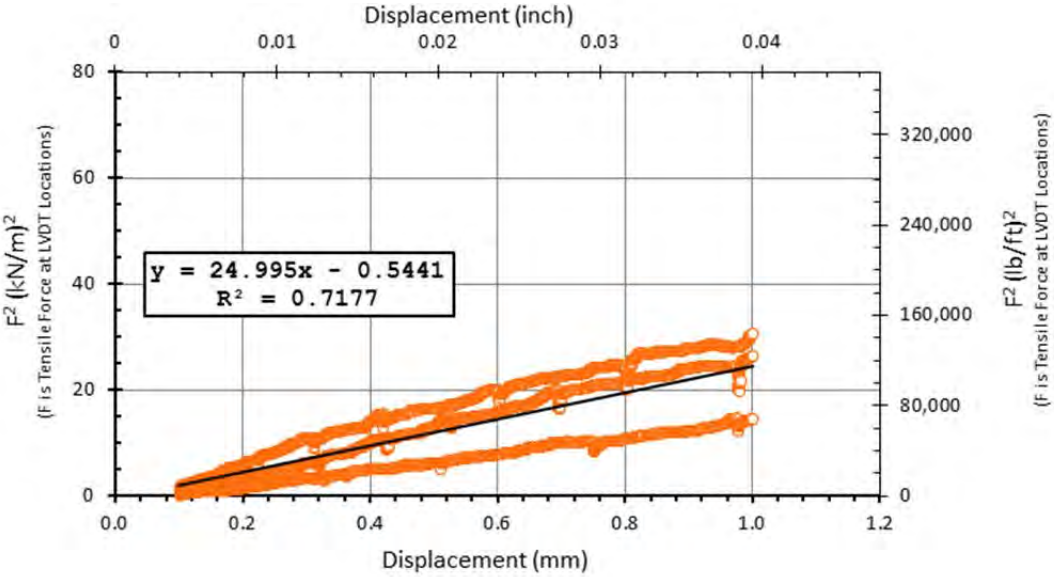
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.2	kN/m	631	lb/ft
Max Pullout Load	P_{max}	3.36	kN	776	lb
Max Shear Stress	τ_{max}	45.1	kPa	6.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
25.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/29/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.364	m	0.245	m
	17	0.922	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.0	0.709
2	60.9	2.398
3	104.7	4.122
4	148.6	5.850
5	236.3	9.303

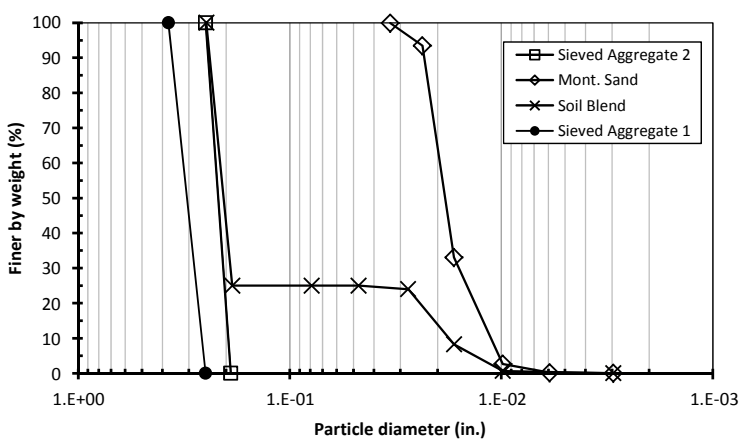
Pullout Rate	
1.0 mm/min.	0.04 in/min

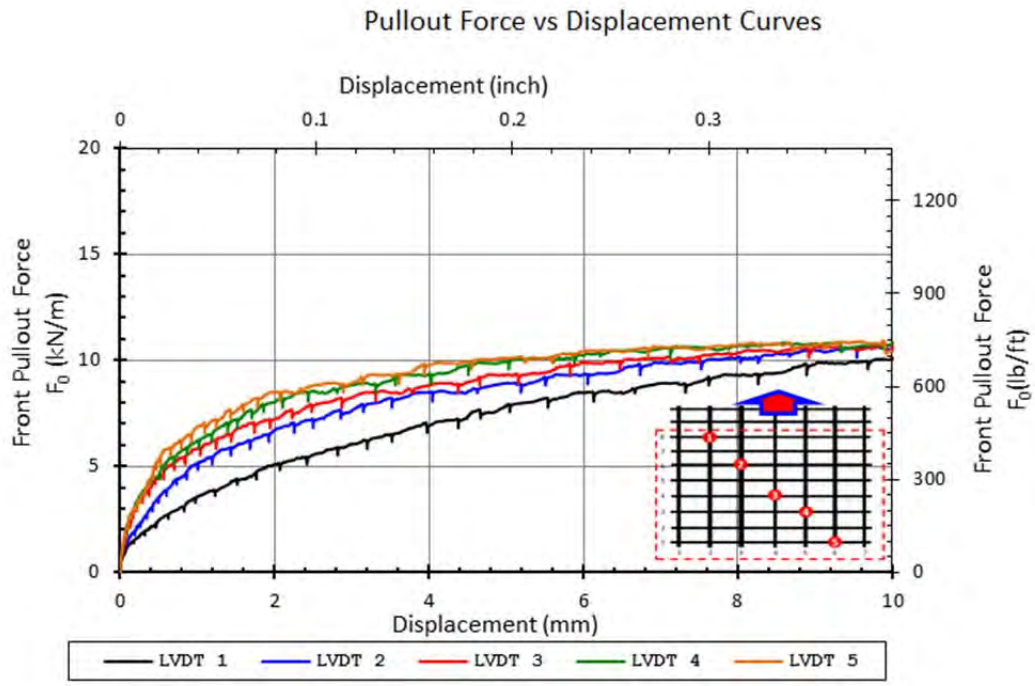
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.480 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

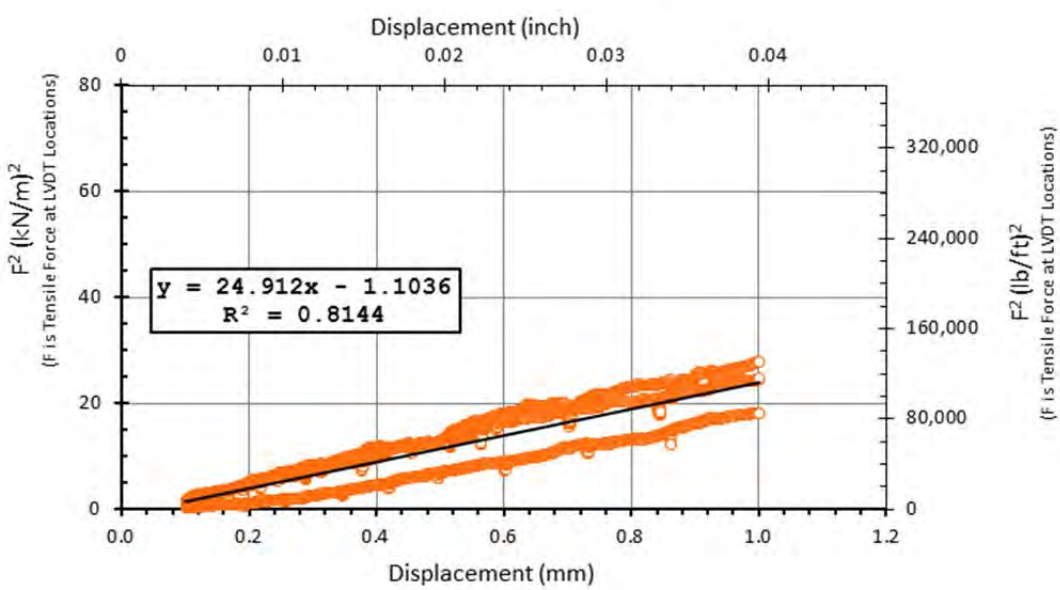
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.9	kN/m	748	lb/ft
Max Pullout Load	P_{max}	3.98	kN	899	lb
Max Shear Stress	τ_{max}	53.5	kPa	7.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
24.9 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Failure (rupture) of specimen ocurred on left side at the end of the test, with 12.5 mm of displacement of LVDT 3.

SMALL PULLOUT TEST

Date test conducted	8/6/2011
Done by	Chris/Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.9	0.861
2	73.0	2.874
3	105.7	4.161
4	138.1	5.437
5	245.0	9.646

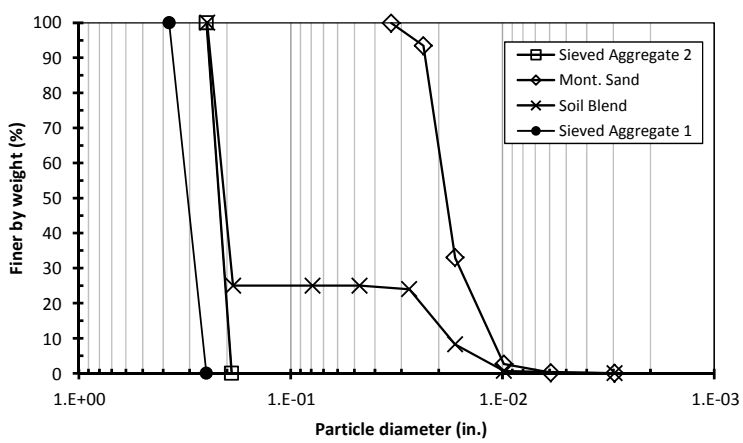
Pullout Rate	
1.0 mm/min.	0.04 in/min

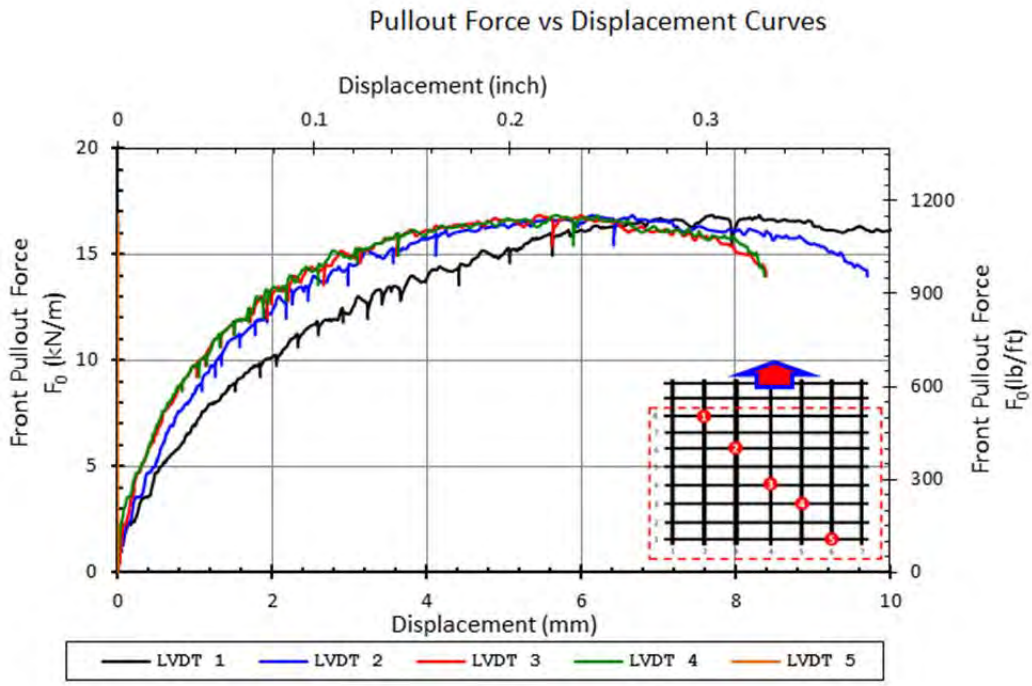
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.507 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

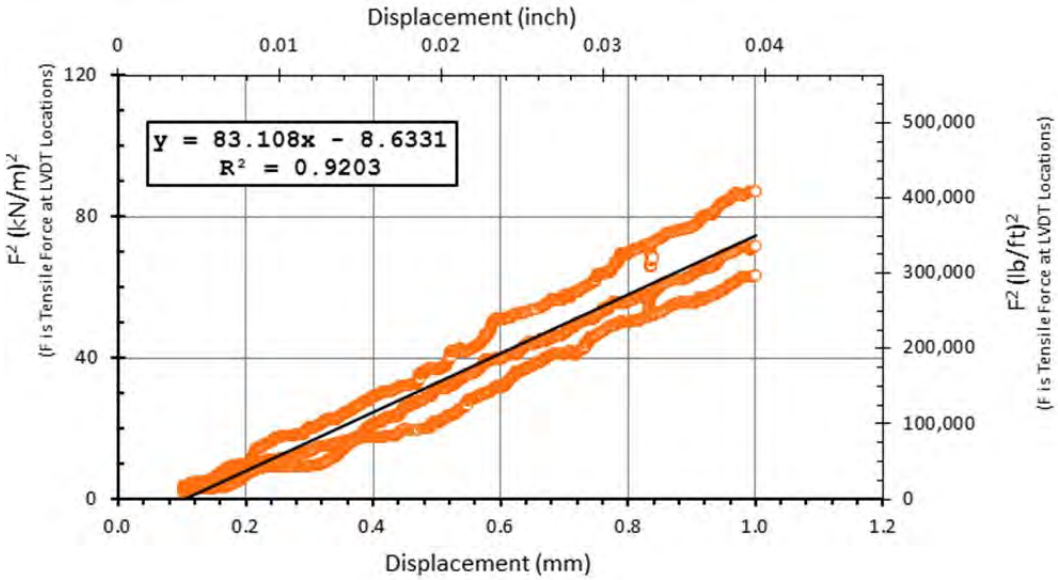
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	16.9	kN/m	1,155	lb/ft
Max Pullout Load	P_{max}	3.55	kN	839	lb
Max Shear Stress	τ_{max}	47.8	kPa	6.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
83.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	8/31/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.211	m	0.245	m
	13	0.909	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.3	0.680
2	68.1	2.680
3	102.3	4.027
4	136.2	5.360
5	219.6	8.645

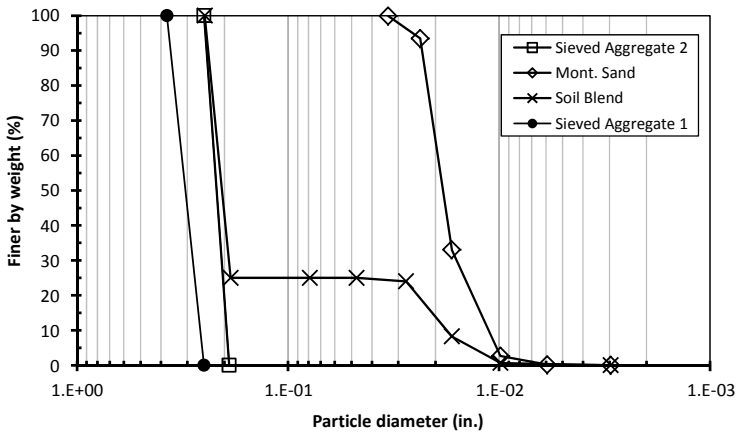
Pullout Rate	
1.0 mm/min.	0.04 in/min

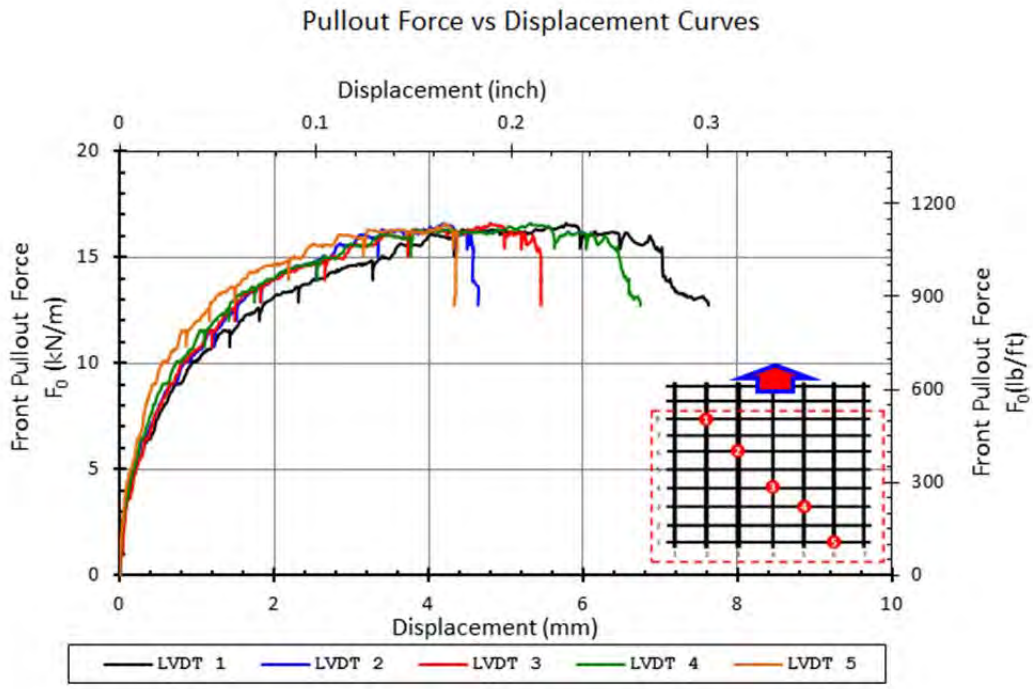
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.520 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

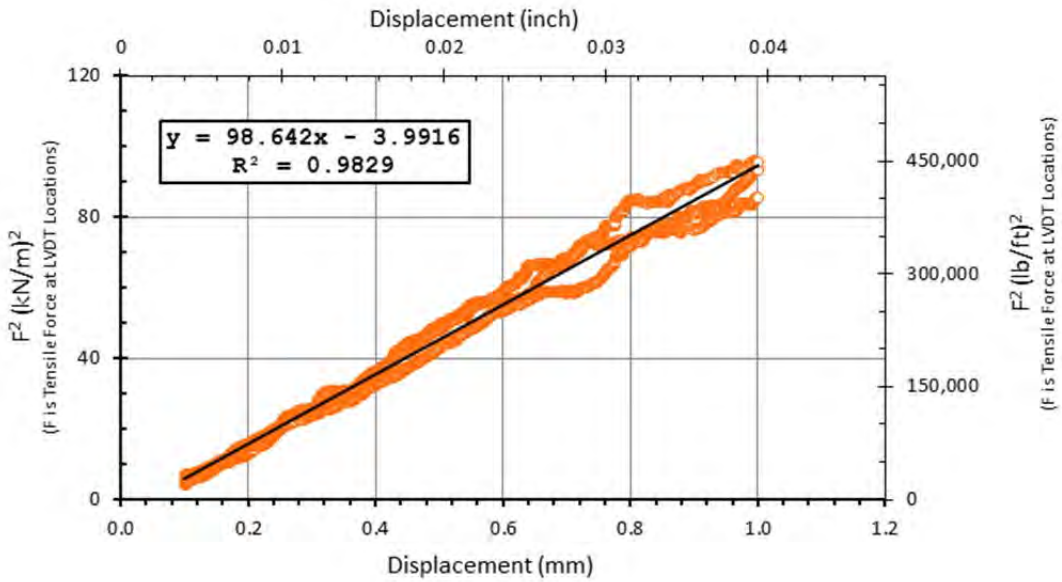
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	16.6	kN/m	1,138	lb/ft
Max Pullout Load	P_{max}	3.50	kN	812	lb
Max Shear Stress	τ_{max}	47.1	kPa	6.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
98.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	9/1/2011
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.211	m	0.245	m
	13	0.915	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	22.0	0.865
2	71.4	2.812
3	104.7	4.120
4	138.1	5.437
5	222.1	8.743

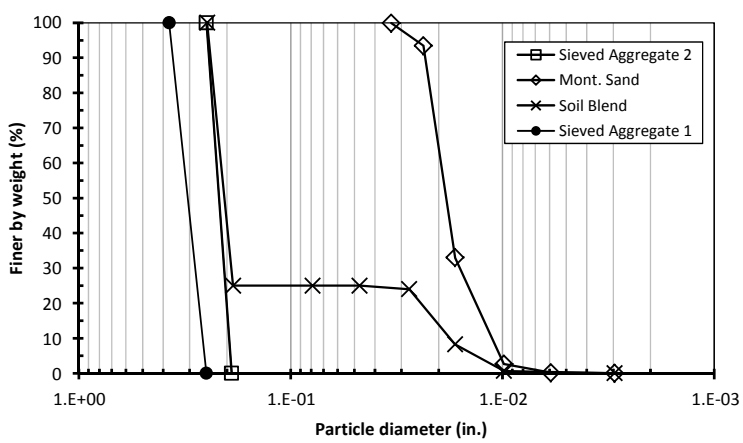
Pullout Rate	
1.0 mm/min.	0.04 in/min

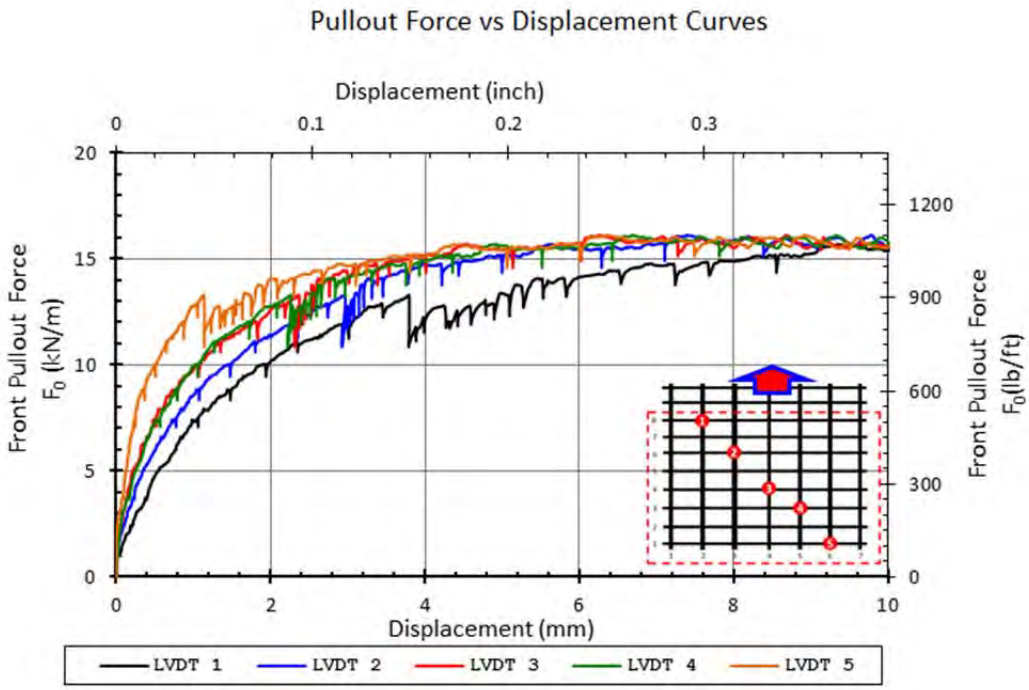
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.520 **g/cm^3**	**95 pcf**

Note: particle size distribution curve shown below

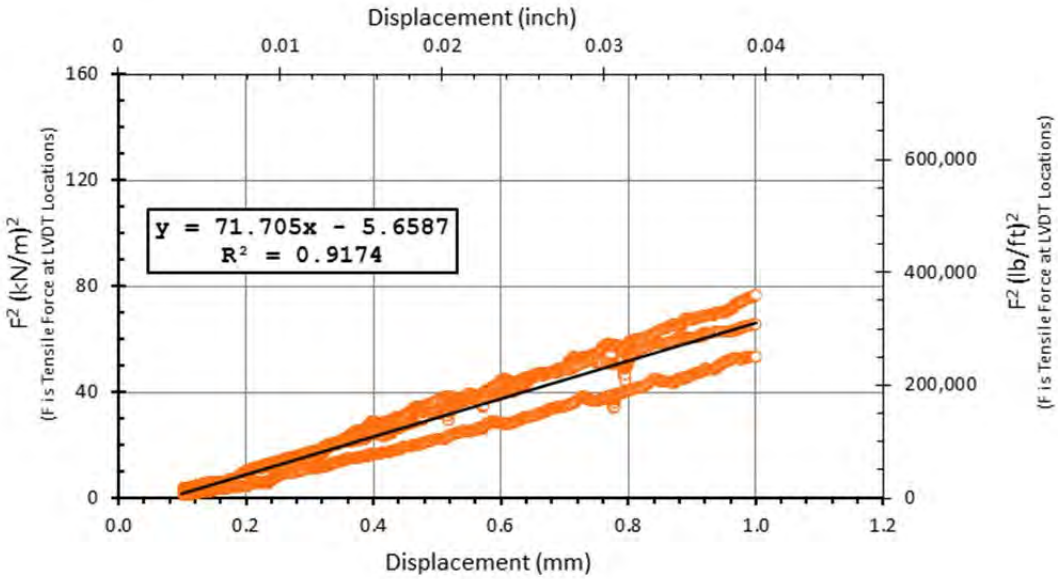
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	16.1	kN/m	1,105	lb/ft
Max Pullout Load	P_{max}	3.40	kN	783	lb
Max Shear Stress	τ_{max}	45.7	kPa	6.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
71.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/29/2011
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.304	m	0.245	m
	7	0.915	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	18.6	0.732
2	70.7	2.783
3	122.1	4.807
4	172.0	6.772
5	220.0	8.661

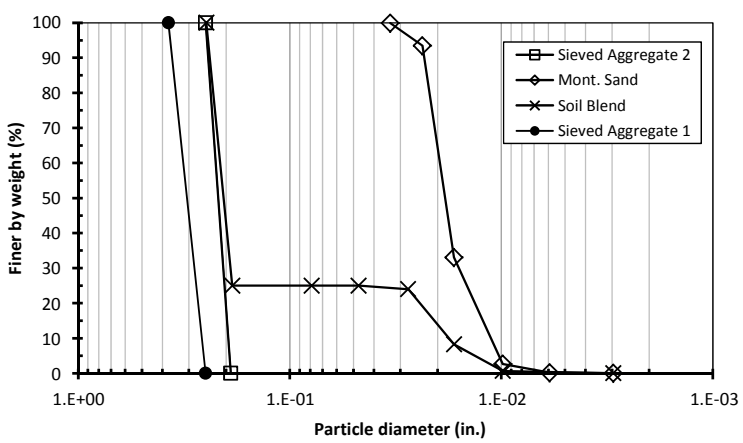
Pullout Rate	
1.0 mm/min.	0.04 in/min

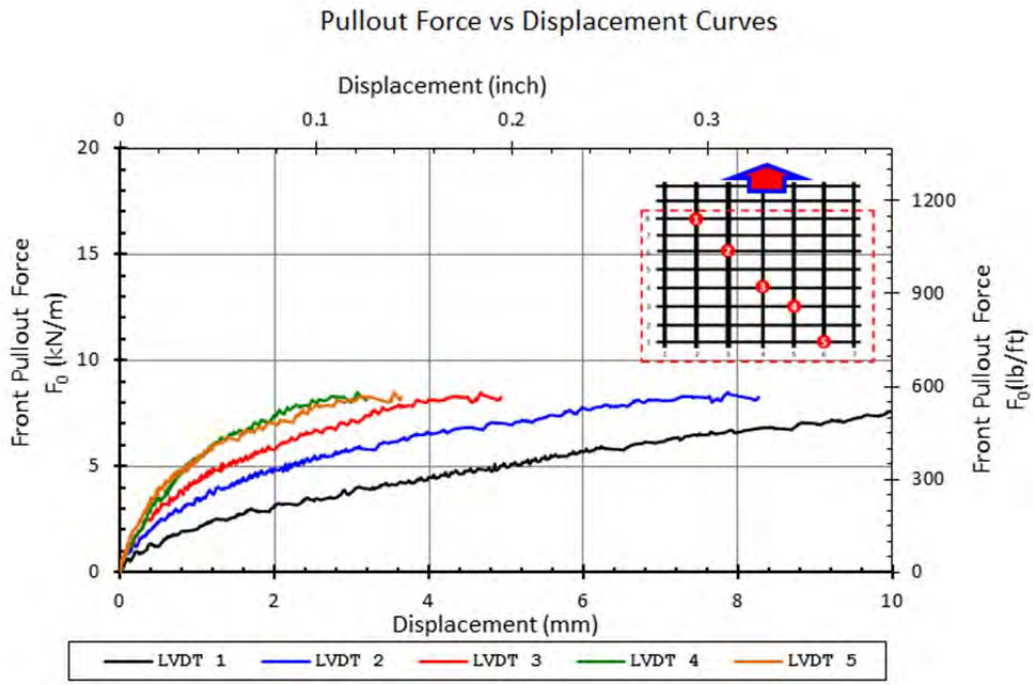
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.471 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

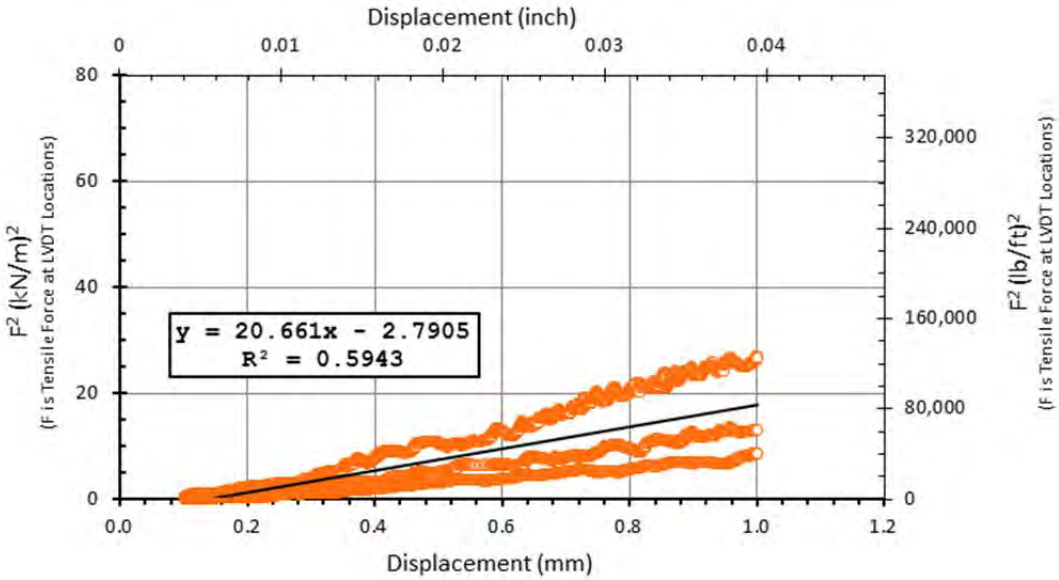
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.5	kN/m	581	lb/ft
Max Pullout Load	P_{max}	2.58	kN	556	lb
Max Shear Stress	τ_{max}	34.7	kPa	5.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
20.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Wire for LVDT #1 is not straight inside the box because the rib is too close to the left wall

SMALL PULLOUT TEST

Date test conducted	8/15/2011
Done by	Julio/Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.290	m	0.304	m	0.245	m
	14	0.951	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.9	0.705
2	71.9	2.831
3	126.0	4.961
4	179.4	7.063
5	232.0	9.134

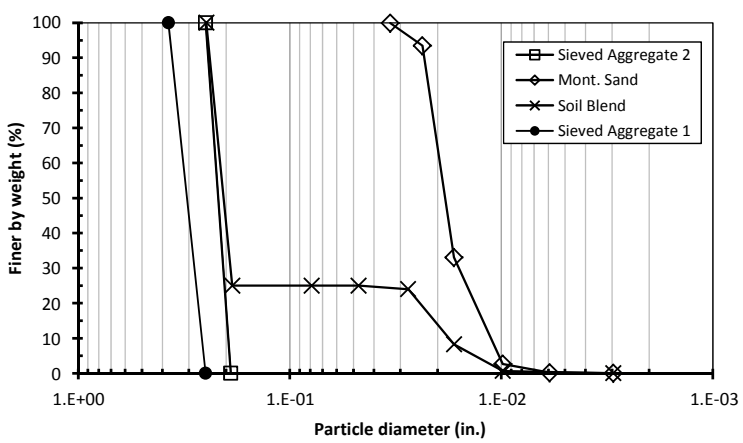
Pullout Rate	
1.0 mm/min.	0.04 in/min

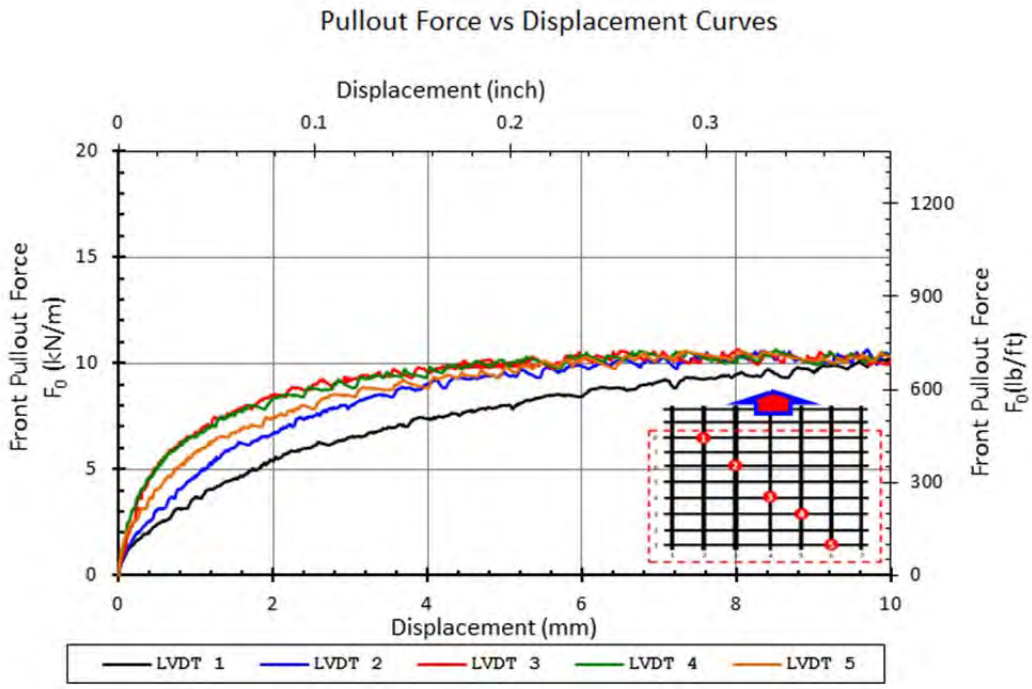
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.480 **g/cm^3**	**92 pcf**

Note: particle size distribution curve shown below

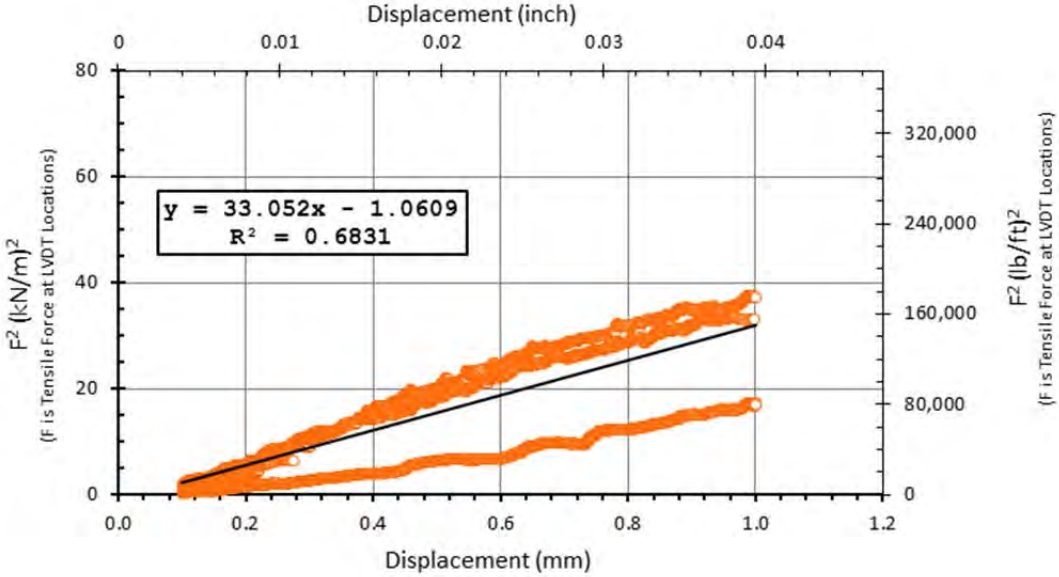
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.6	kN/m	729	lb/ft
Max Pullout Load	P_{max}	3.24	kN	730	lb
Max Shear Stress	τ_{max}	43.5	kPa	6.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
33.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

GG Section streched in middle portion of grip but didn't appear to slip

SMALL PULLOUT TEST

Date test conducted	8/24/11 PM
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.289	m	0.304	m	0.245	m
	14	0.948	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.1	0.831
2	71.2	2.803
3	123.2	4.850
4	175.1	6.894
5	225.9	8.894

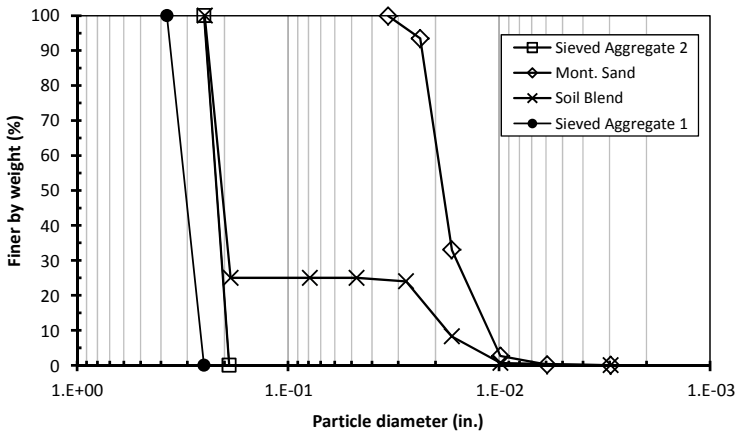
Pullout Rate	
1.0 mm/min.	0.04 in/min

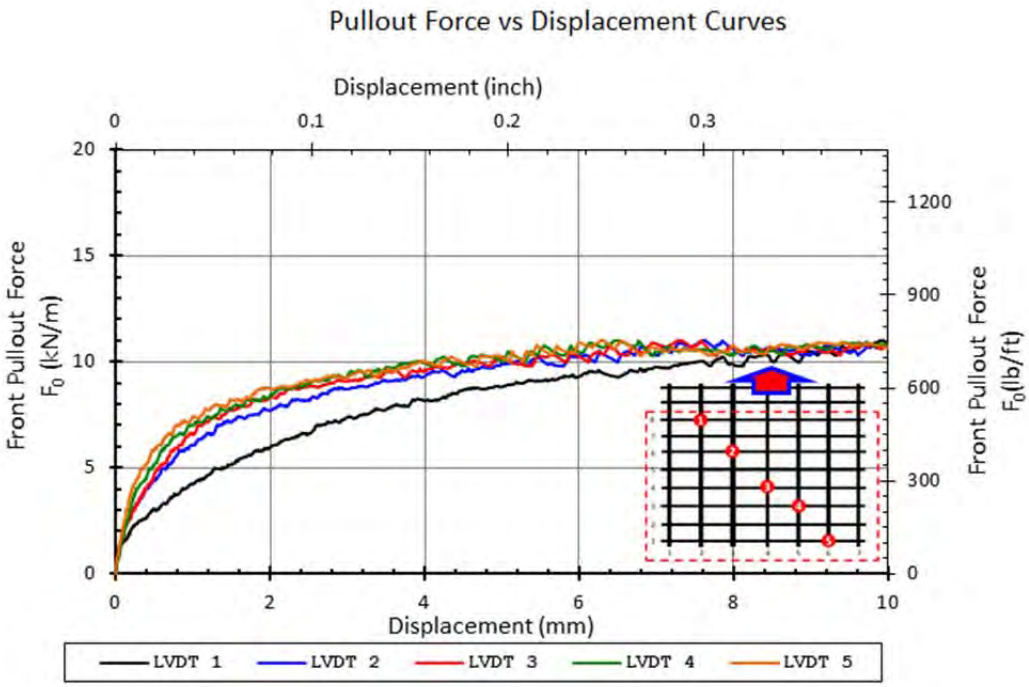
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.502 **g/cm^3**	**94 pcf**

Note: particle size distribution curve shown below

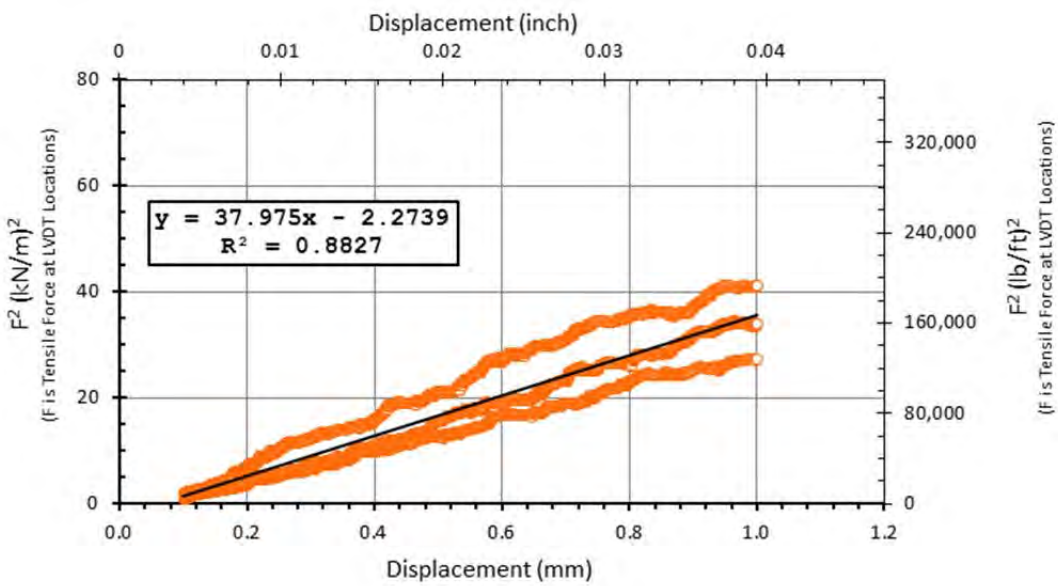
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.0	kN/m	754	lb/ft
Max Pullout Load	P_{max}	3.35	kN	735	lb
Max Shear Stress	τ_{max}	45.0	kPa	6.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
38.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

Appendix A7

This appendix presents the results of the tests with GG PP3 CD in which the wires of LVDTs 2, 3, and 4 were attached to the geogrid specimen with epoxy on the longitudinal ribs instead of tightened around the junctions. Epoxy was employed because failed junctions were observed on exhumed specimens after testing to pullout failure. However, the exhumed specimen from a test conducted until 0.05 in. (1.2 mm) of displacement of LVDTs 2, 3, and 4 showed no failed junctions. This test was interrupted before pullout failure was reached, but with displacements in the range used for the calculation of the K_{SGI} coefficient. Although no failed junction was observed in the latest test, two tests using epoxy to attach the wires of the LVDTs to the geogrid specimens were conducted. One test was performed to pullout failure and the other test to the point of 0.043 in. (1.1 mm) of displacement of LVDTs 2, 3, and 4. No significant difference was observed on the results, independent of the use of epoxy.

These tests were performed with the final configuration of the small pullout test: confining pressure of 3 psi (21 kPa), Sieved Aggregate 2, use of torque wrench and digital air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	9/10/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	12.6	0.495
2	54.0	2.128
3	88.7	3.491
4	121.9	4.800
5	214.1	8.427

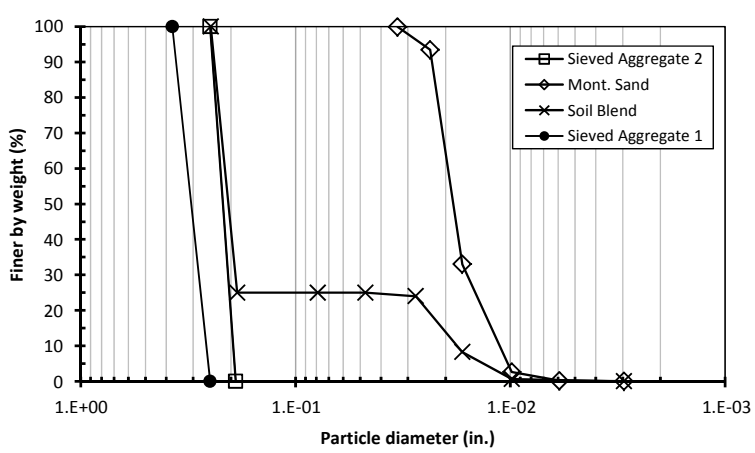
Pullout Rate	
1.0 mm/min.	0.04 in/min

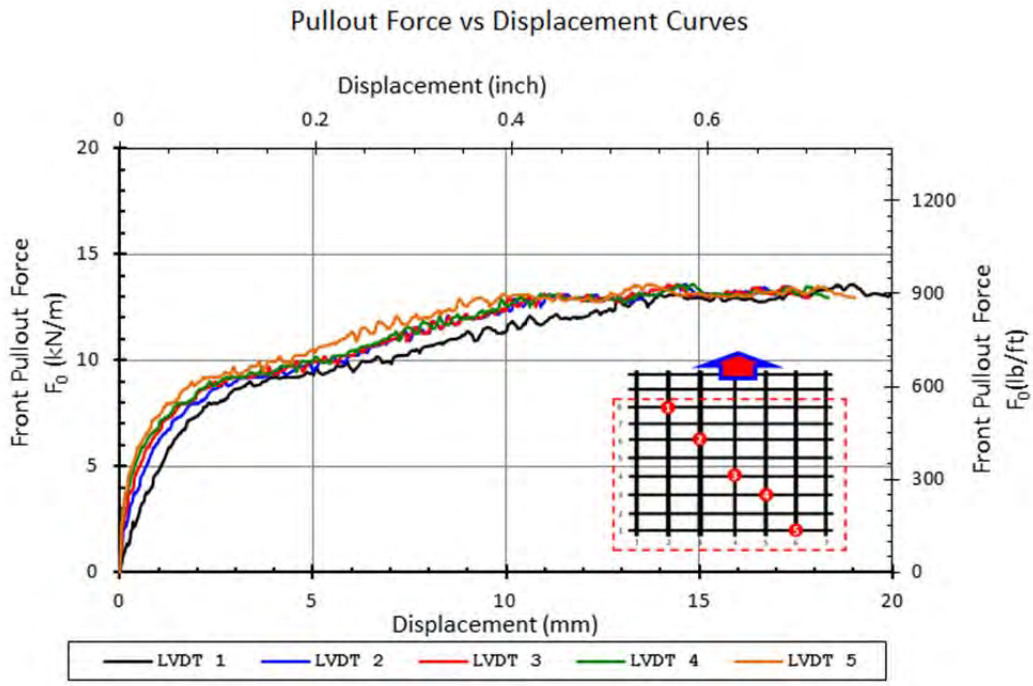
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

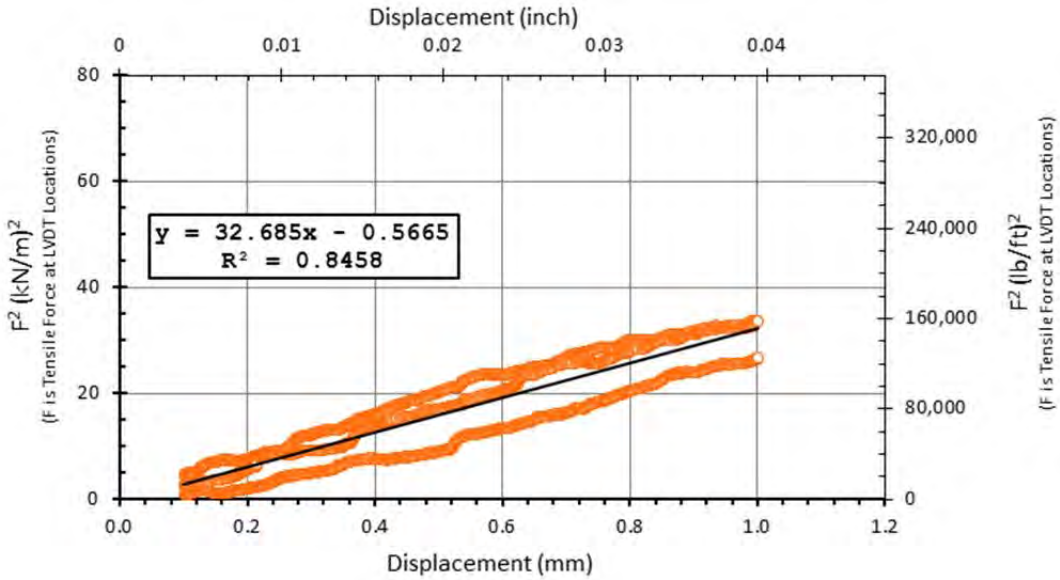
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.6	kN/m	931	lb/ft
Max Pullout Load	P_{max}	2.87	kN	682	lb
Max Shear Stress	τ_{max}	38.5	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
32.7	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT's #2,3, and 4 are tied in the middle of the longitudinal ribs around an epoxy coating.

SMALL PULLOUT TEST

Date test conducted	9/11/2012
Conducted by	Jose

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	13.1	0.517
2	53.0	2.087
3	88.8	3.497
4	123.4	4.857
5	213.6	8.409

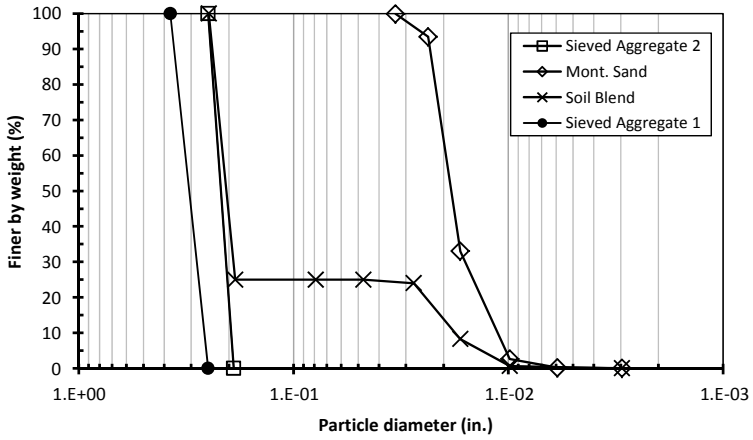
Pullout Rate	
1.0 mm/min.	0.04 in/min

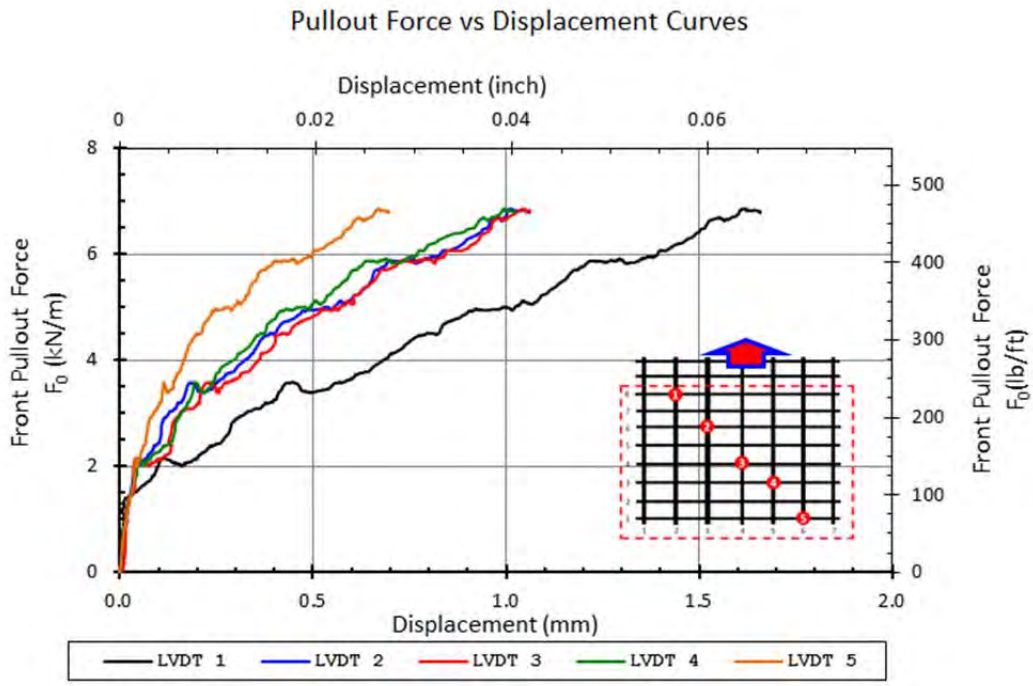
SOIL Information		
Soil	Sieved Aggregate 2	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

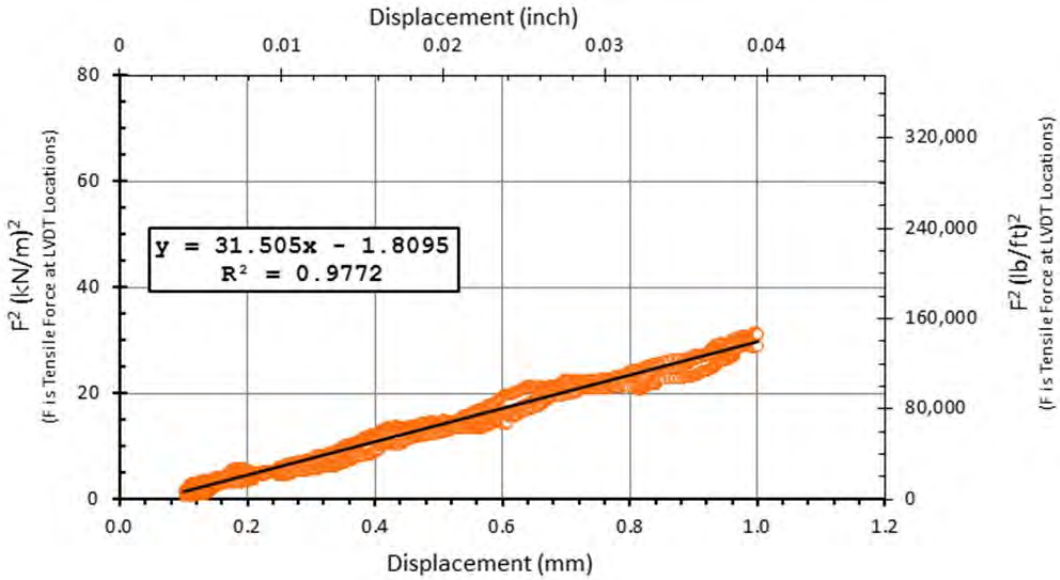
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	470	lb/ft
Max Pullout Load	P_{max}	1.45	kN	352	lb
Max Shear Stress	τ_{max}	19.4	kPa	2.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}	
31.5	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

LVDT's #2,3, and 4 were tied in the middle of the longitudinal ribs around an epoxy coating.
Specimen only loaded until LVDT's #2,3, and 4 reached a 1.1 mm displacement.

Appendix A8

This appendix presents the results of the tests with Soil Blend. Besides the soil, these tests were performed with the final configuration of the small pullout test: confining pressure of 3 psi (21 kPa), use of torque wrench and digital air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	2/2/2012 am
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.286	m	0.304	m	0.245	m
	7	0.938	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.9	0.626
2	67.0	2.638
3	116.4	4.583
4	166.0	6.535
5	217.7	8.571

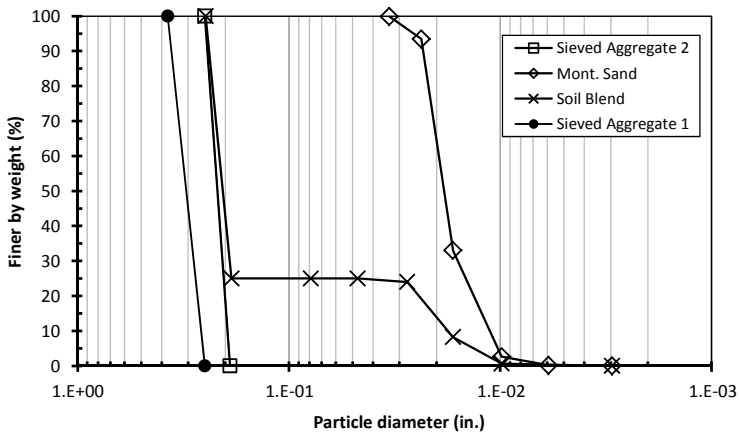
Pullout Rate			
1.0	mm/min.	0.04	in/min

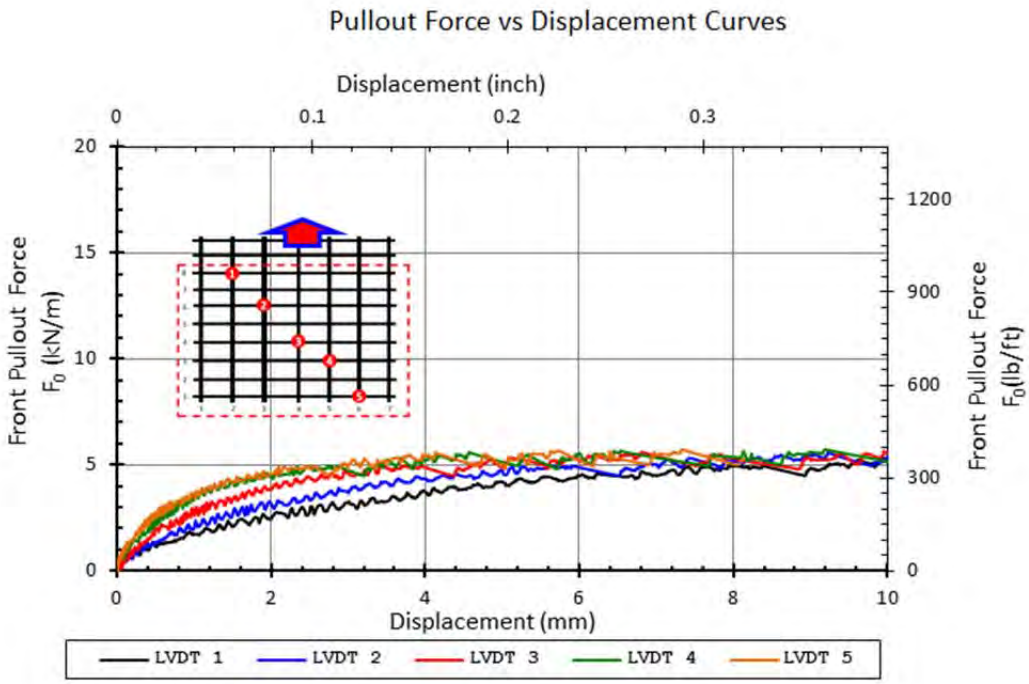
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.802 **g/cm^3**	**113 pcf**

Note: particle size distribution curve shown below

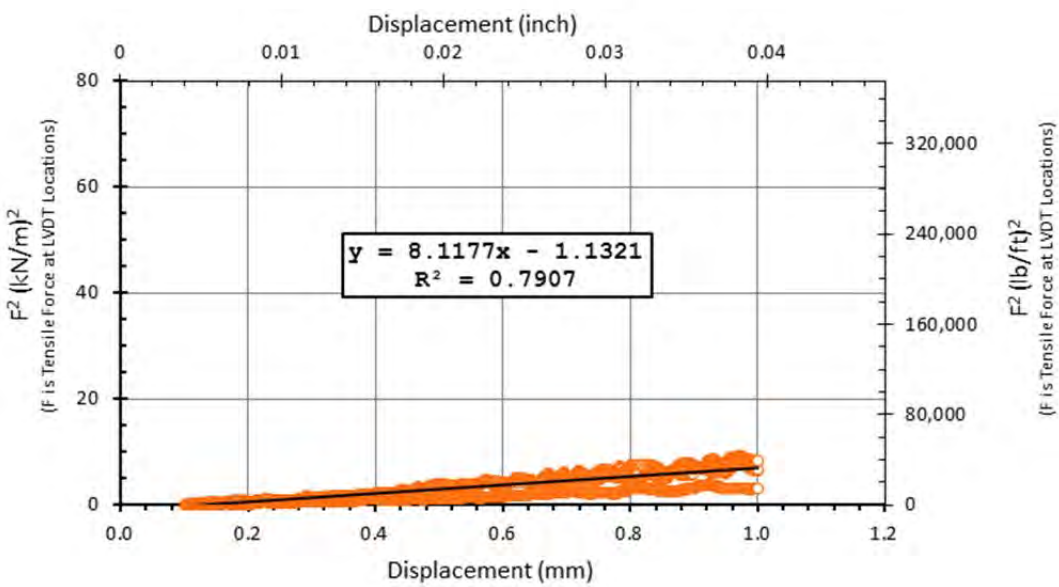
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.7	kN/m	392	lb/ft
Max Pullout Load	P_{max}	1.74	kN	419	lb
Max Shear Stress	τ_{max}	23.4	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Slight tilt to the right.

SMALL PULLOUT TEST

Date test conducted	1/12/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.271	m	0.275	m	0.245	m
	10	0.889	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.2	1.189
2	70.2	2.764
3	109.4	4.307
4	150.1	5.909
5	230.4	9.071

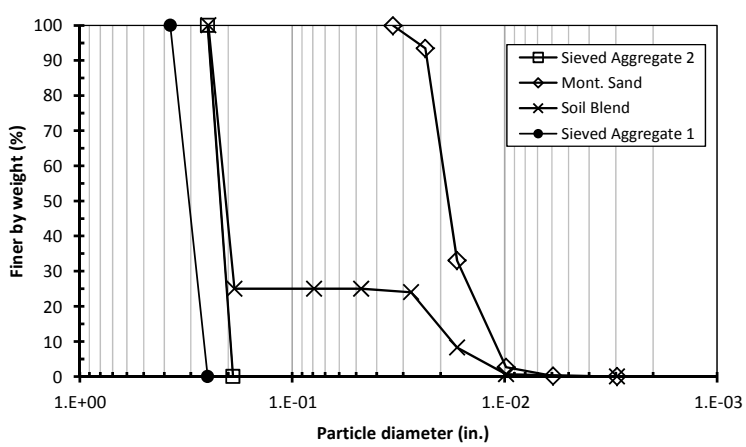
Pullout Rate	
1.0 mm/min.	0.04 in/min

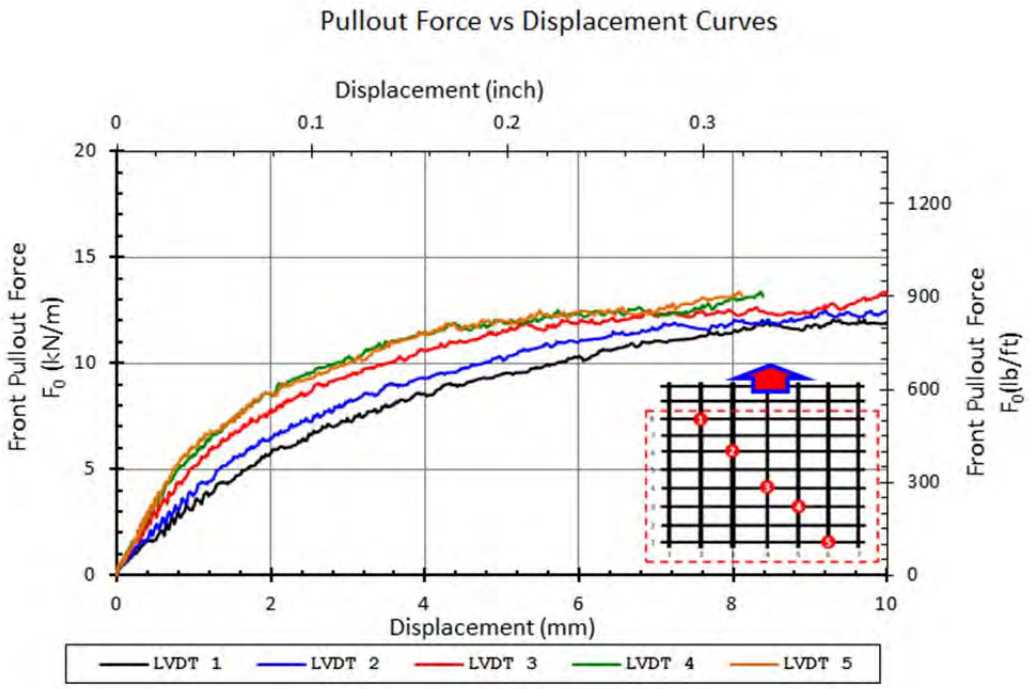
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.855 **g/cm^3**	**116 pcf**

Note: particle size distribution curve shown below

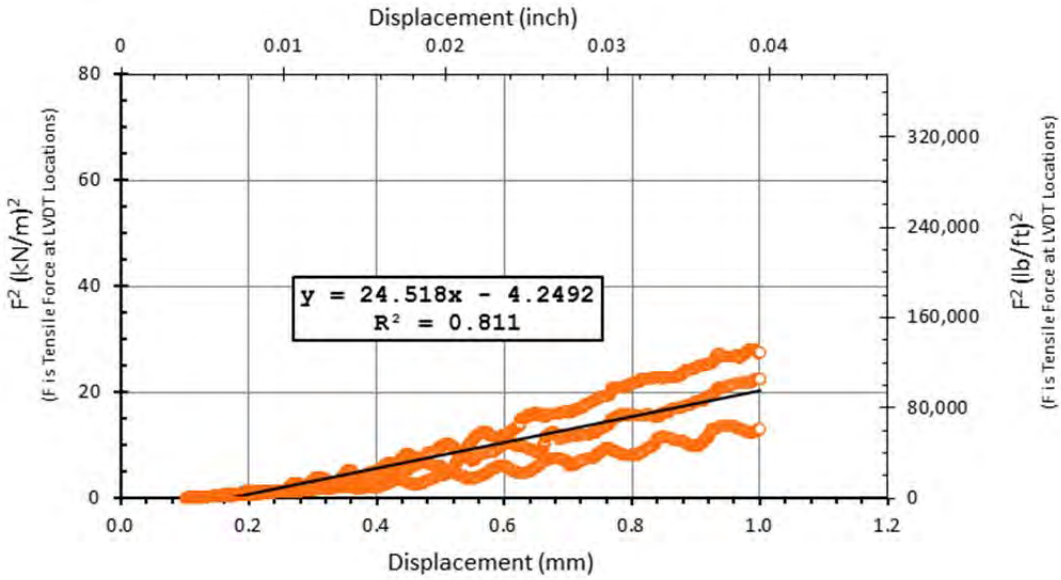
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.3	kN/m	915	lb/ft
Max Pullout Load	P_{max}	3.67	kN	838	lb
Max Shear Stress	τ_{max}	49.4	kPa	7.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
24.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Need to reduce bottom layer by .15kg as not enough compaction for geogrid, Water content if the sand in the blend = 1.5%, thus overall wc= 0.37%.

SMALL PULLOUT TEST

Date test conducted	1/17/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.267	m	0.275	m	0.245	m
	10	0.876	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.5	1.122
2	69.6	2.740
3	110.2	4.339
4	149.4	5.882
5	230.2	9.063

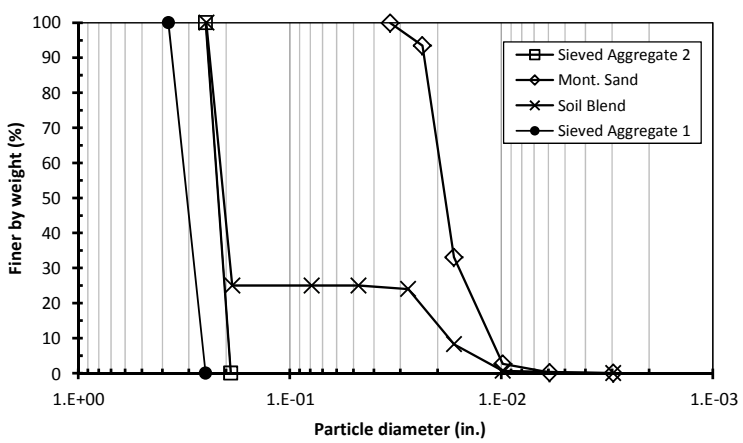
Pullout Rate	
1.0 mm/min.	0.04 in/min

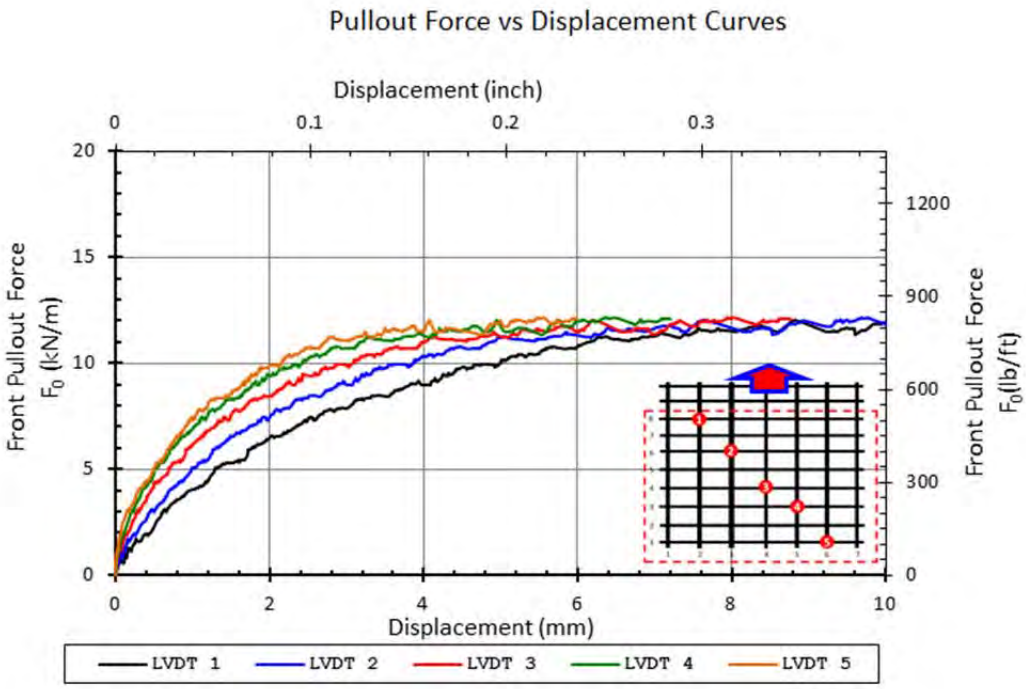
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.829 **g/cm^3**	**114 pcf**

Note: particle size distribution curve shown below

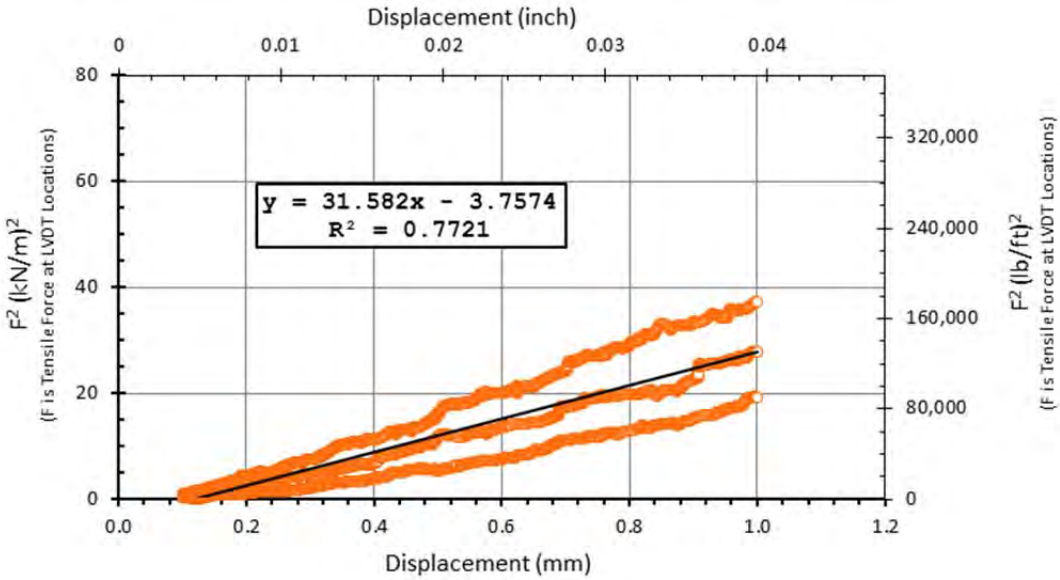
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.1	kN/m	832	lb/ft
Max Pullout Load	P_{max}	3.34	kN	783	lb
Max Shear Stress	τ_{max}	44.9	kPa	6.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
31.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

Began by slipping slightly towards right. Pulled against opening. Used bottom lifts of 5.45kg and top lifts of 5.35kg.

SMALL PULLOUT TEST

Date test conducted	1/17/2012 PM
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	10	0.912	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	26.2	1.031
2	67.2	2.646
3	107.5	4.232
4	148.1	5.831
5	229.3	9.028

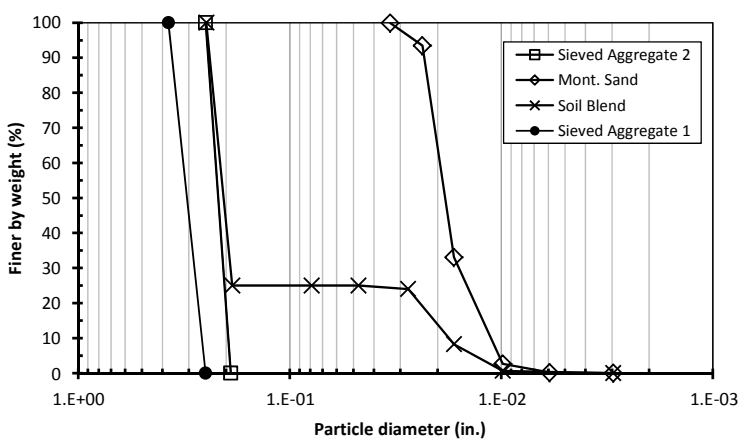
Pullout Rate	
1.0 mm/min.	0.04 in/min

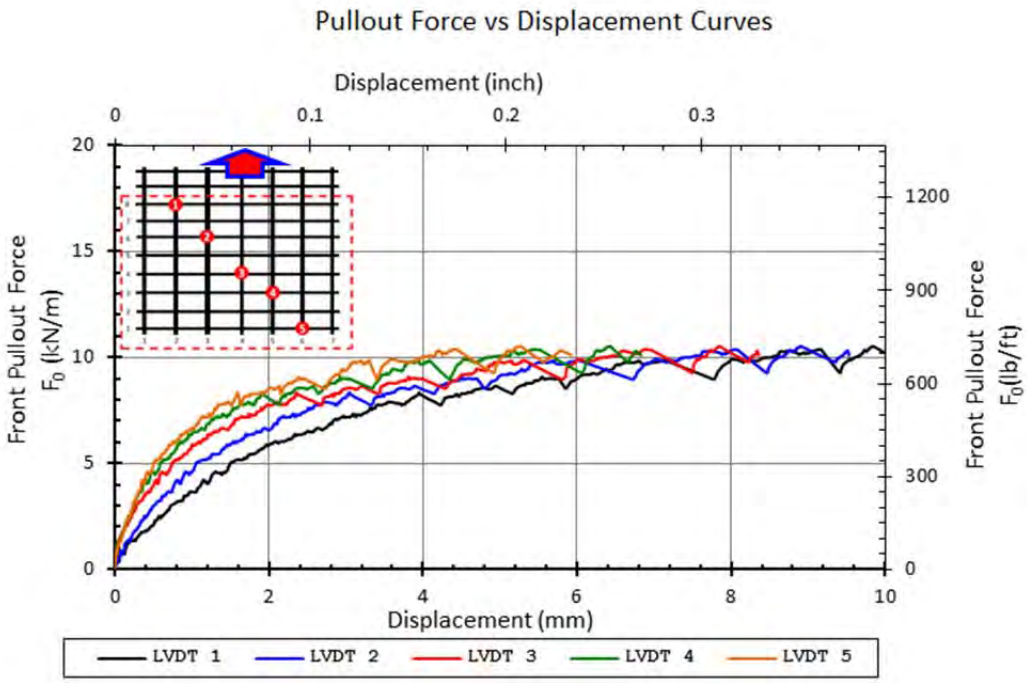
SOIL Information		
Soil	Soil Blend	
Water Content	0.15	**%**
Dry Density (ρ_d)	1.771 **g/cm^3**	**111 pcf**

Note: particle size distribution curve shown below

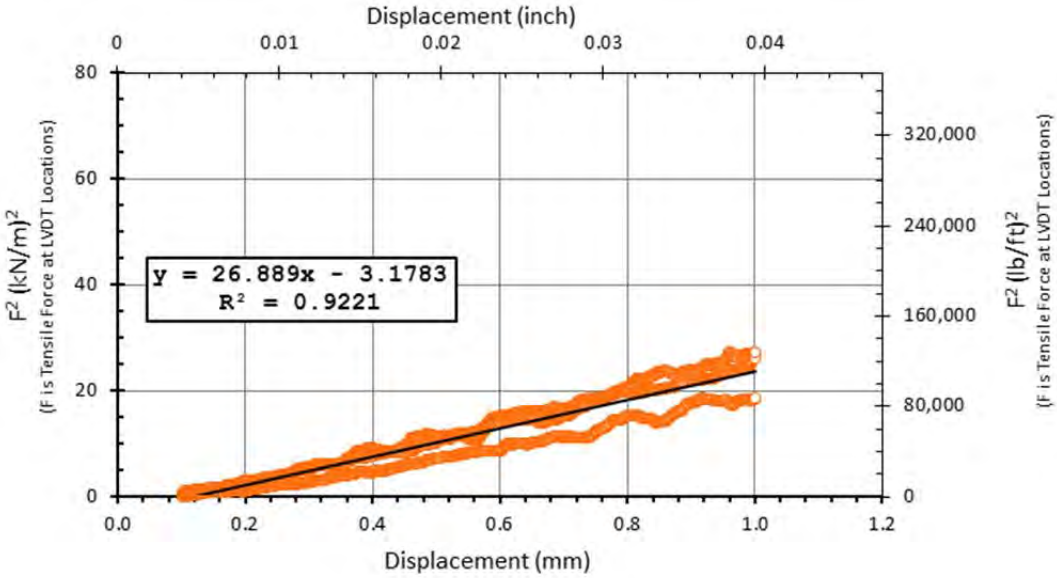
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.5	kN/m	721	lb/ft
Max Pullout Load	P_{max}	2.89	kN	687	lb
Max Shear Stress	τ_{max}	38.9	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
26.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

Sand was dry, caved in on 3rd/4th lift. Rocks seemed to get stuck in the opening towards the end.

SMALL PULLOUT TEST

Date test conducted	2/6/2012
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	42.3	1.665
2	79.7	3.138
3	119.5	4.705
4	158.0	6.220
5	235.8	9.283

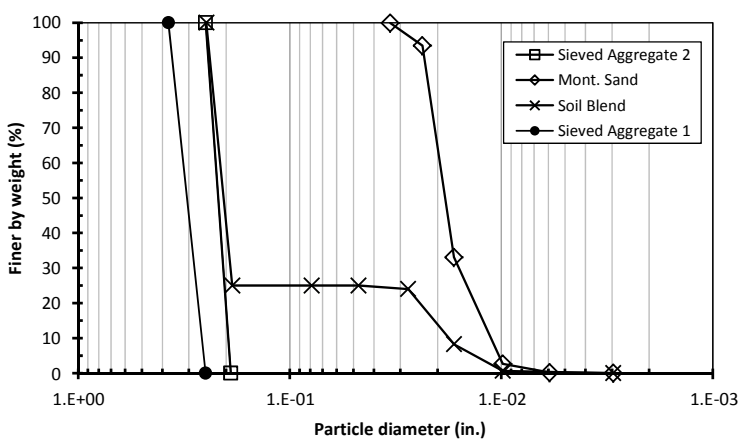
Pullout Rate	
1.0 mm/min.	0.04 in/min

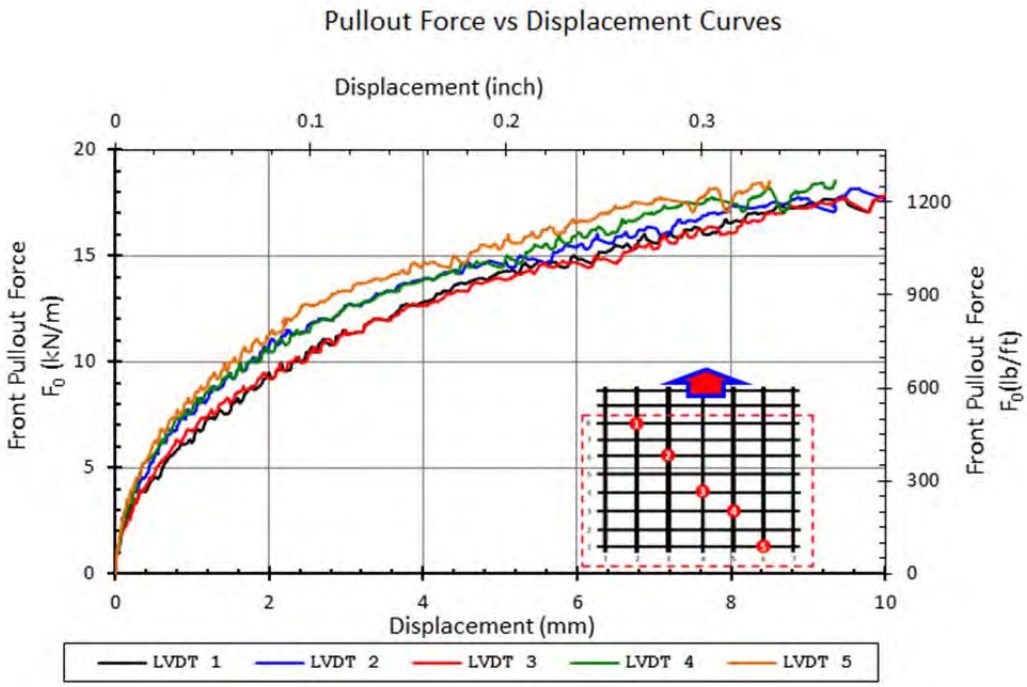
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.882 **g/cm^3**	**117 pcf**

Note: particle size distribution curve shown below

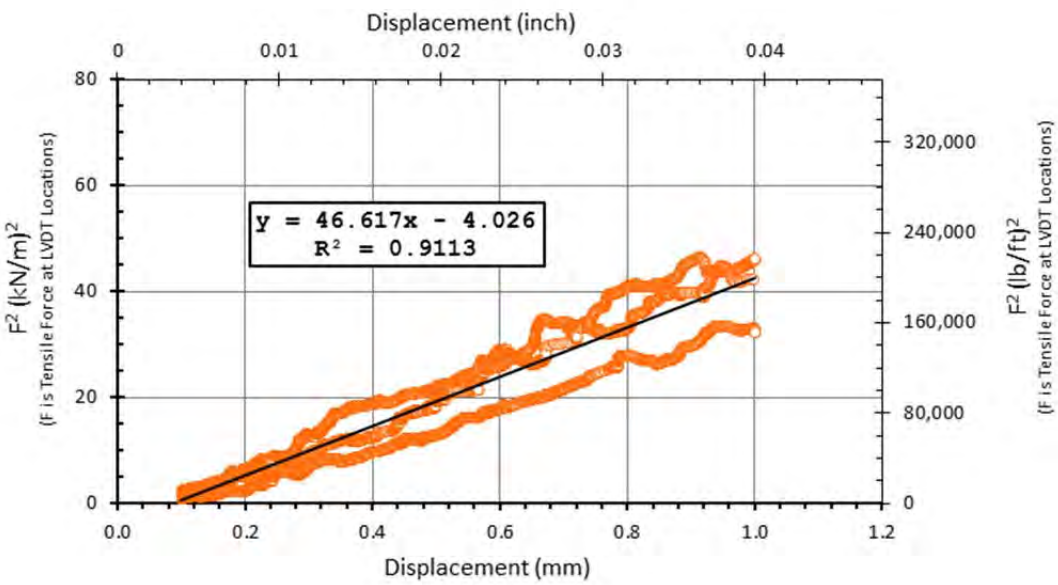
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	18.5	kN/m	1,269	lb/ft
Max Pullout Load	P_{max}	4.91	kN	1125	lb
Max Shear Stress	τ_{max}	65.9	kPa	9.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
46.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/8/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.265	m	0.245	m
	9	0.915	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.5	1.201
2	70.2	2.764
3	109.7	4.319
4	150.3	5.917
5	233.5	9.193

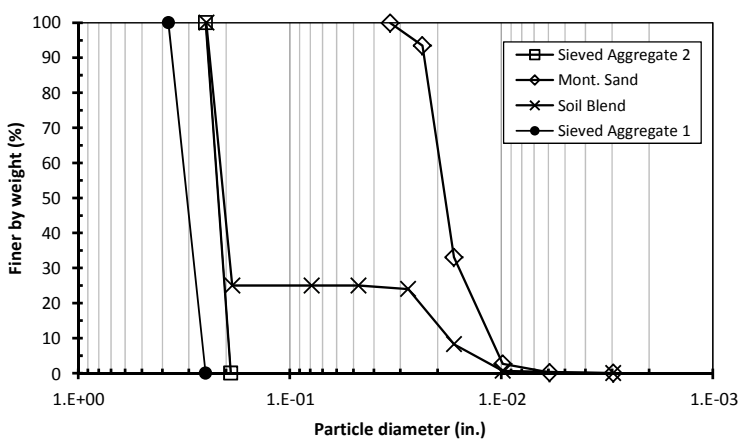
Pullout Rate	
1.0 mm/min.	0.04 in/min

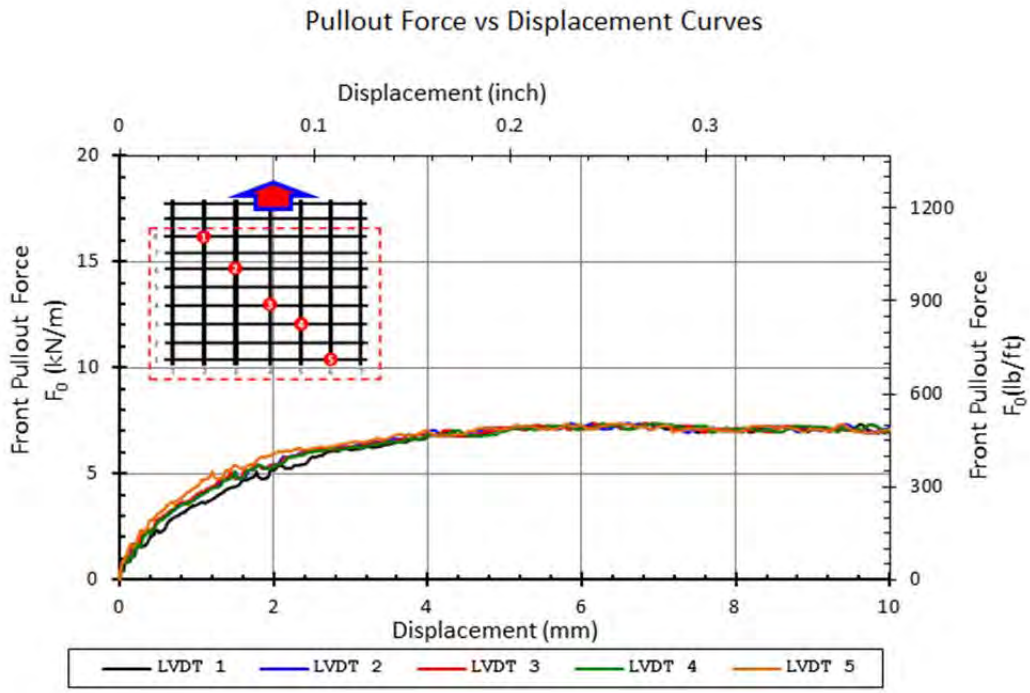
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.807 **g/cm^3**	**113 pcf**

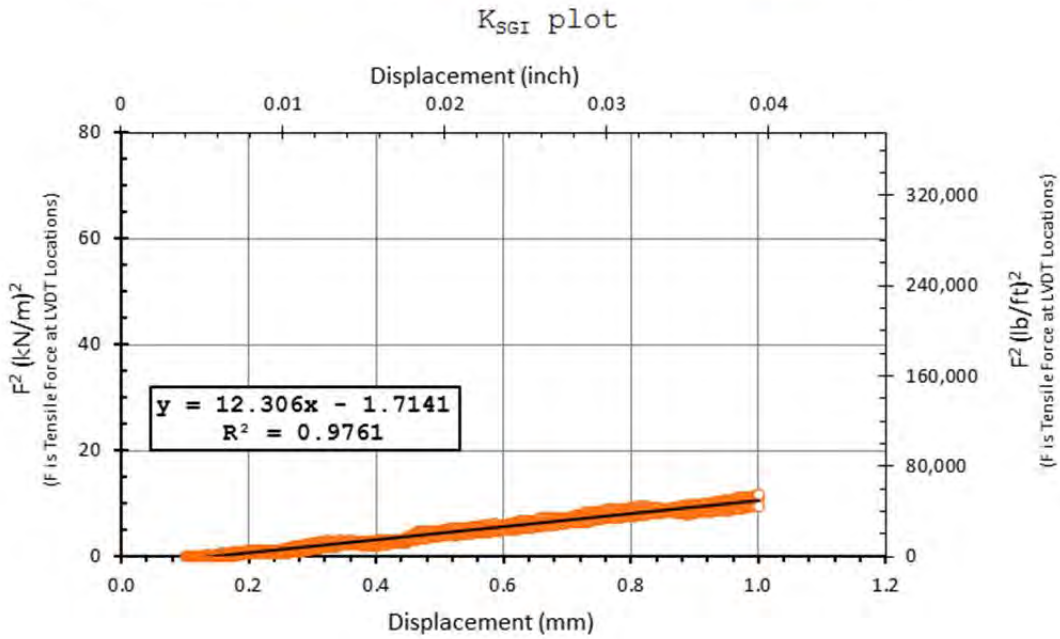
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.4	kN/m	505	lb/ft
Max Pullout Load	P_{max}	1.95	kN	480	lb
Max Shear Stress	τ_{max}	26.2	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	0.9			

Reported K_{SGI}
12.3 (kN/m)^2/mm







Comments:

LVDT 2 is slightly skewed

SMALL PULLOUT TEST

Date test conducted	1/31/2012 am
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.9	0.587
2	65.8	2.591
3	100.9	3.972
4	136.0	5.354
5	221.0	8.701

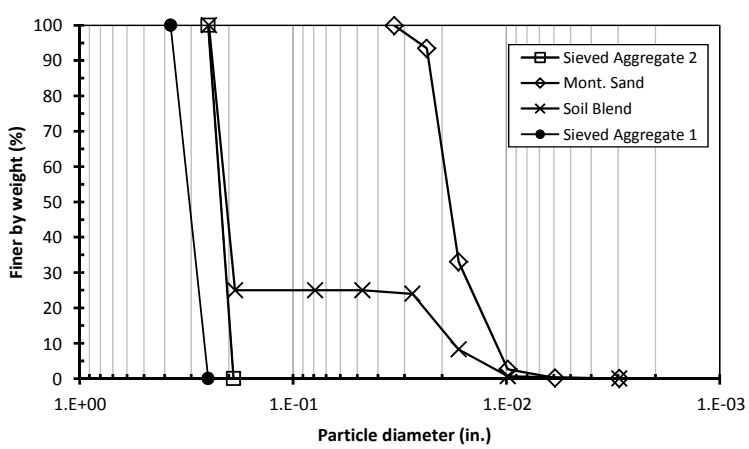
Pullout Rate	
1.0 mm/min.	0.04 in/min

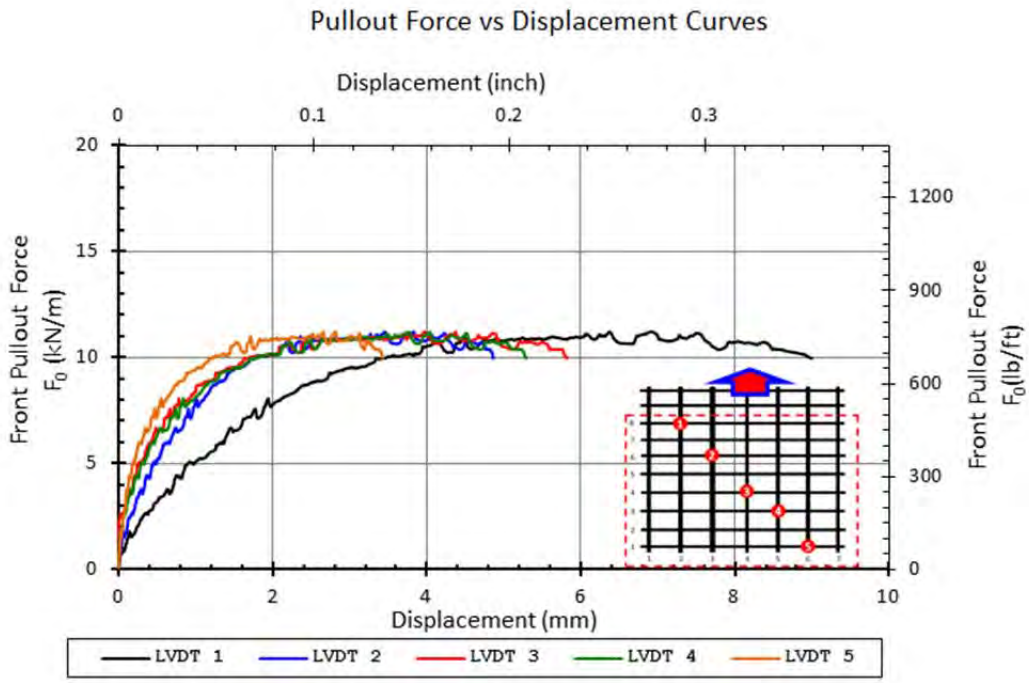
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.851 **g/cm^3**	**116 pcf**

Note: particle size distribution curve shown below

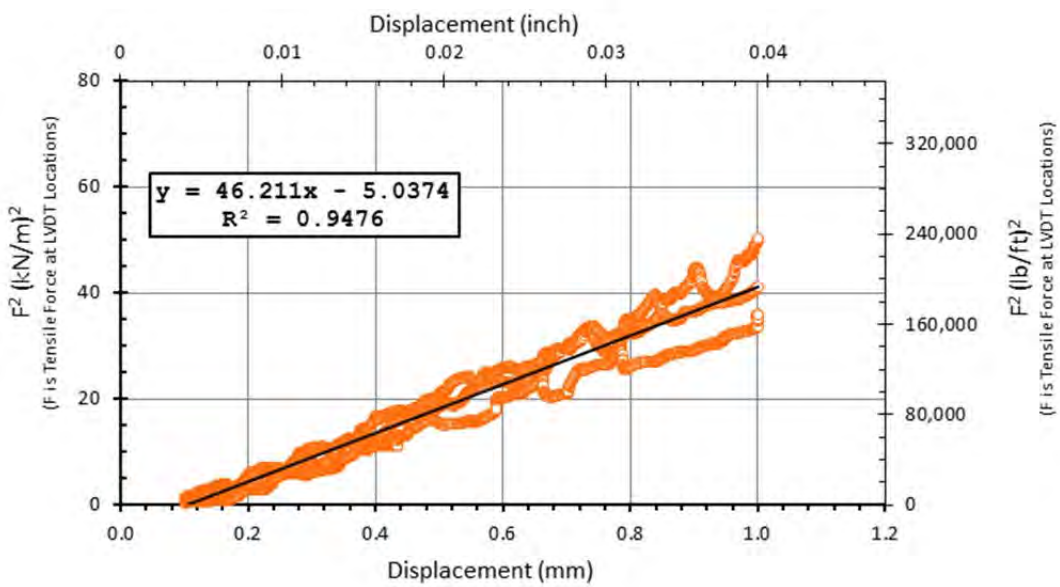
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.2	kN/m	768	lb/ft
Max Pullout Load	P_{max}	2.36	kN	563	lb
Max Shear Stress	τ_{max}	31.8	kPa	4.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
46.2 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	1/31/2012 pm
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.9	0.705
2	69.2	2.724
3	102.6	4.039
4	136.3	5.366
5	220.2	8.669

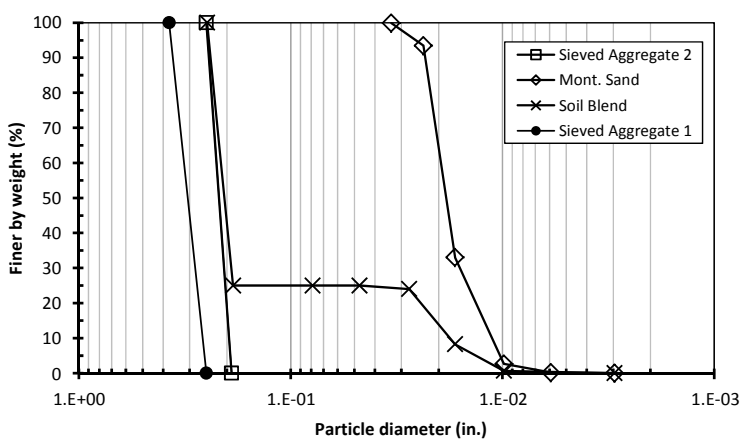
Pullout Rate	
1.0 mm/min.	0.04 in/min

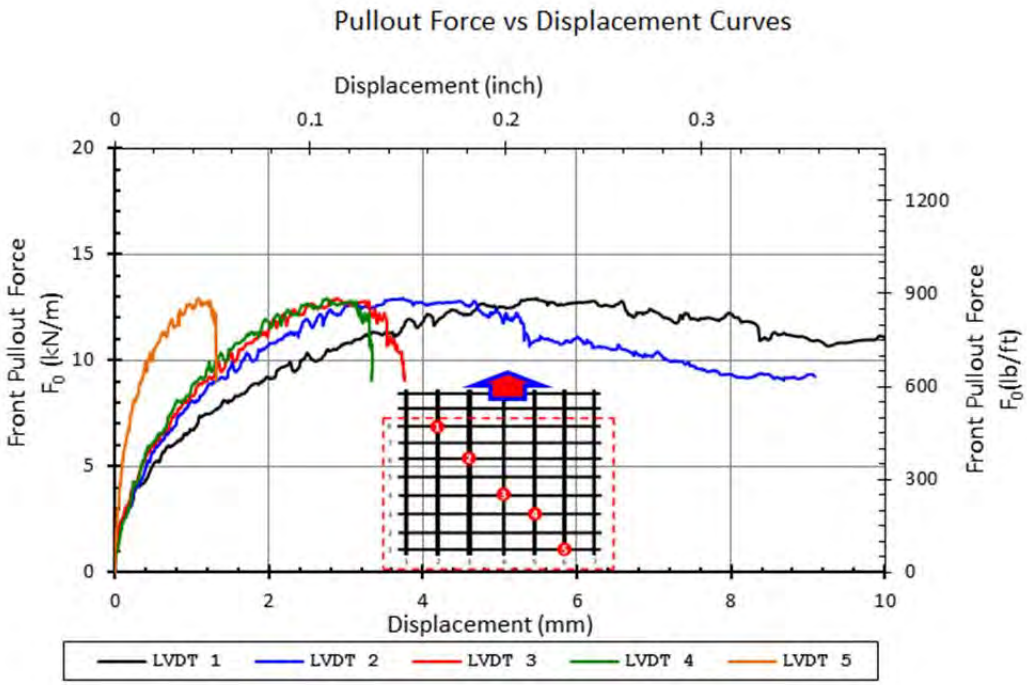
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.864 **g/cm^3**	**116 pcf**

Note: particle size distribution curve shown below

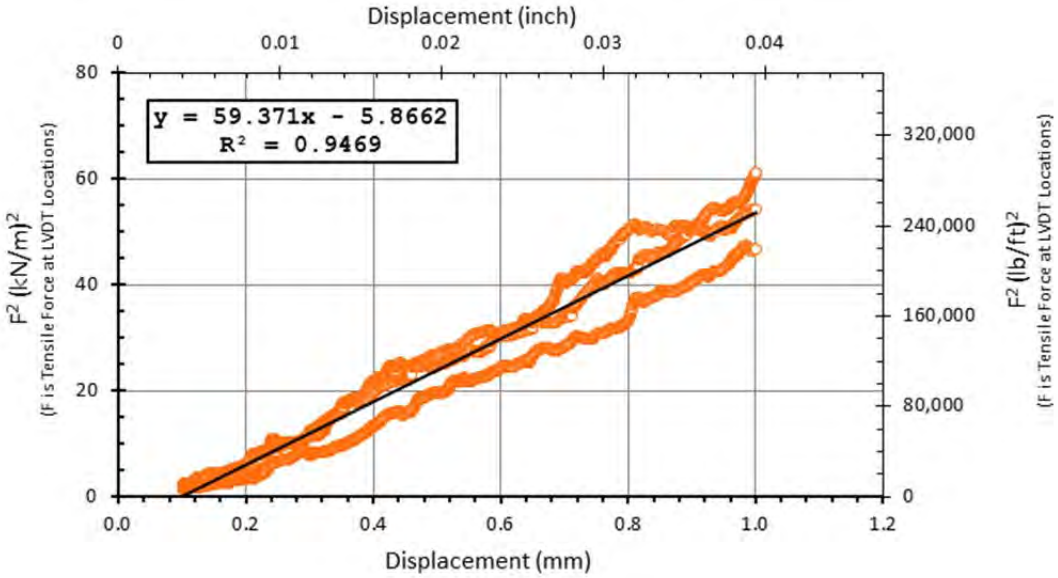
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.9	kN/m	885	lb/ft
Max Pullout Load	P_{max}	2.72	kN	656	lb
Max Shear Stress	τ_{max}	36.6	kPa	5.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
59.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

Slang right towards the end.

SMALL PULLOUT TEST

Date test conducted	2/1/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.211	m	0.245	m
	13	0.915	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.4	0.331
2	59.5	2.343
3	94.6	3.724
4	129.5	5.098
5	214.9	8.461

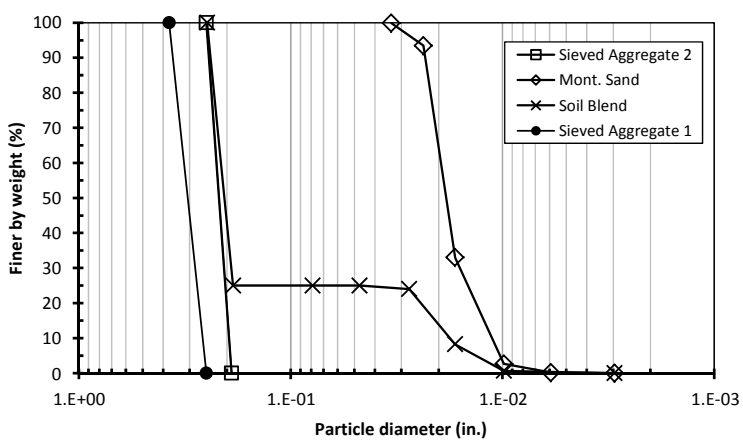
Pullout Rate	
1.0 mm/min.	0.04 in/min

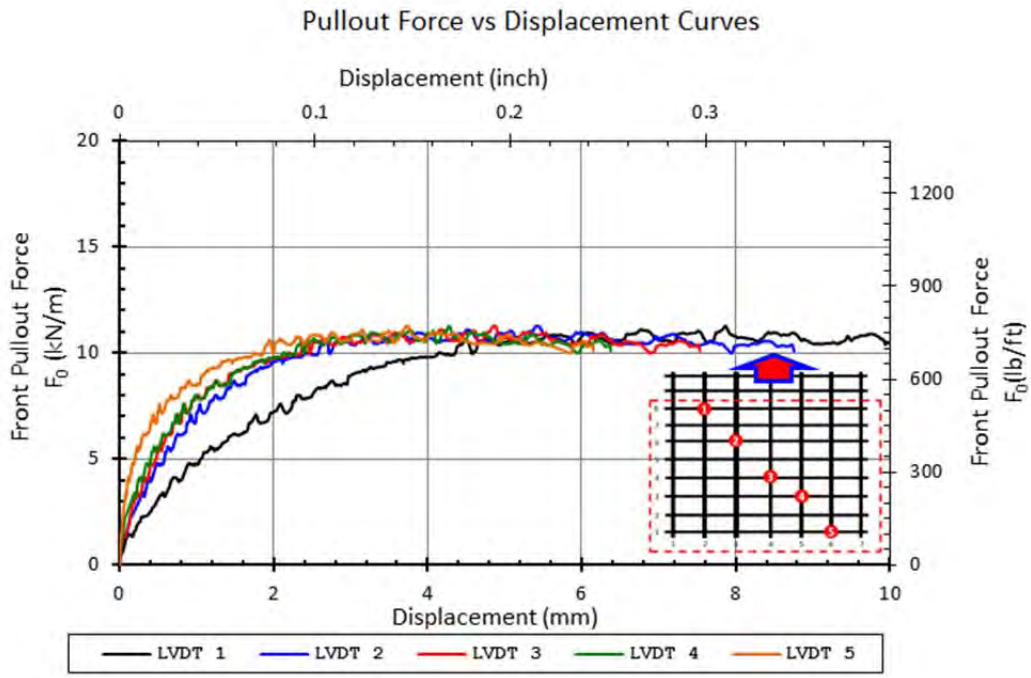
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.829 **g/cm^3**	**114 pcf**

Note: particle size distribution curve shown below

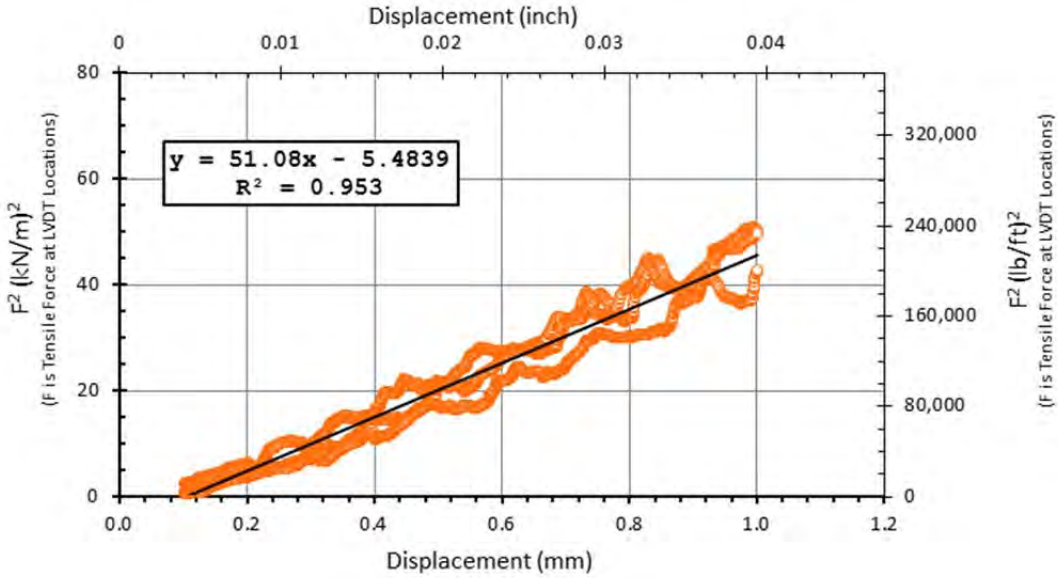
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	11.3	kN/m	773	lb/ft
Max Pullout Load	P_{max}	2.38	kN	564	lb
Max Shear Stress	τ_{max}	32.0	kPa	4.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
51.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	2/1/2012
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.286	m	0.304	m	0.245	m
	7	0.938	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	5.5	0.217
2	60.1	2.366
3	113.5	4.469
4	166.7	6.563
5	219.2	8.630

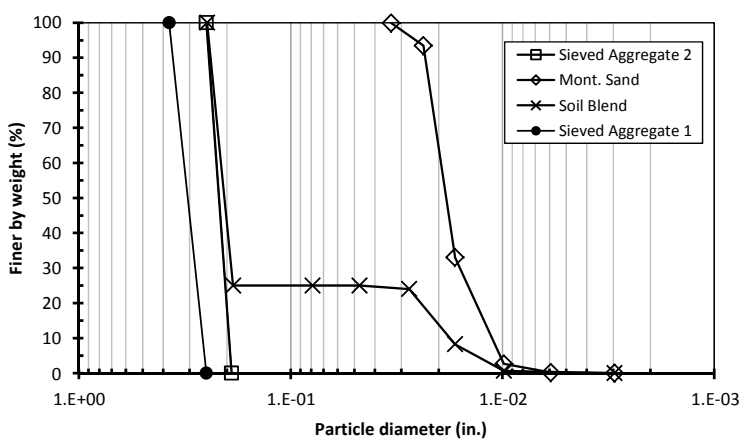
Pullout Rate	
1.0 mm/min.	0.04 in/min

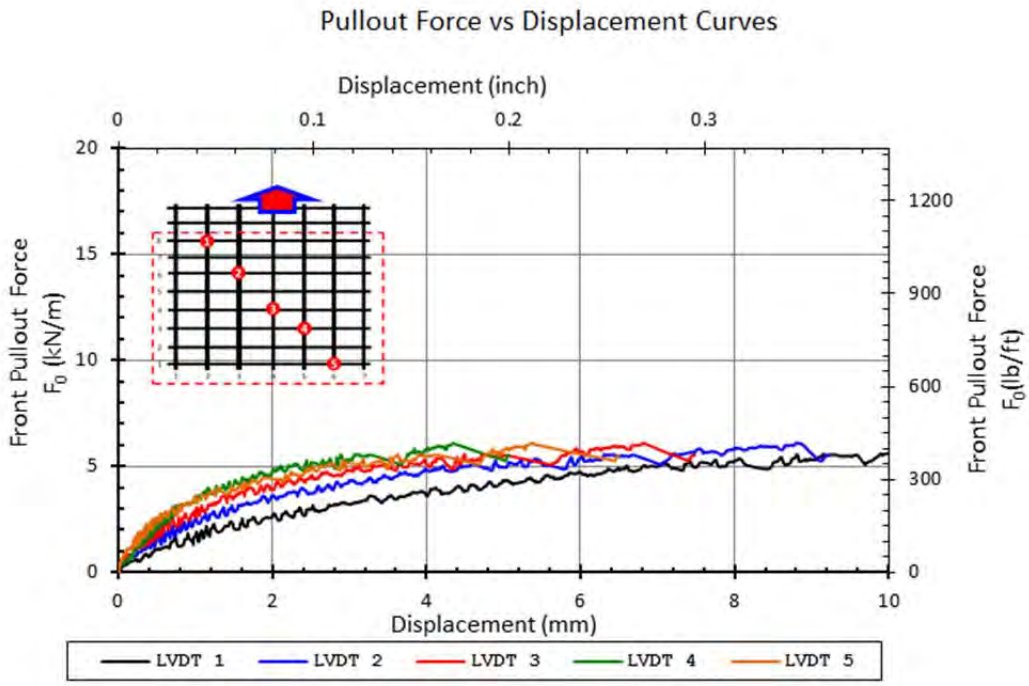
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.824 **g/cm^3**	**114 pcf**

Note: particle size distribution curve shown below

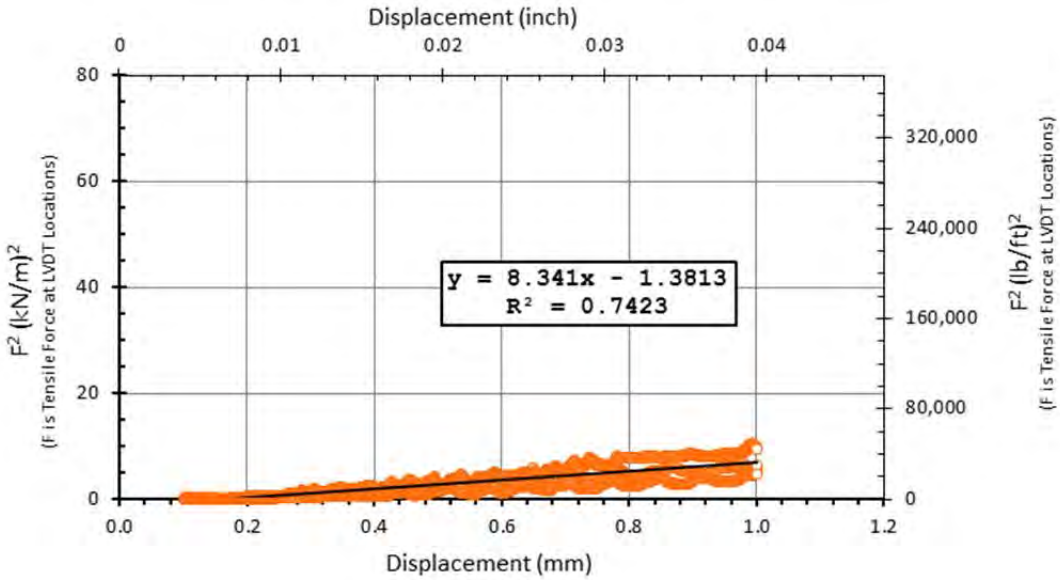
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.1	kN/m	418	lb/ft
Max Pullout Load	P_{max}	1.86	kN	449	lb
Max Shear Stress	τ_{max}	25.0	kPa	3.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
8.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Slight tilt to the right.

SMALL PULLOUT TEST

Date test conducted	2/2/2012 am
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.286	m	0.304	m	0.245	m
	7	0.938	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.9	0.626
2	67.0	2.638
3	116.4	4.583
4	166.0	6.535
5	217.7	8.571

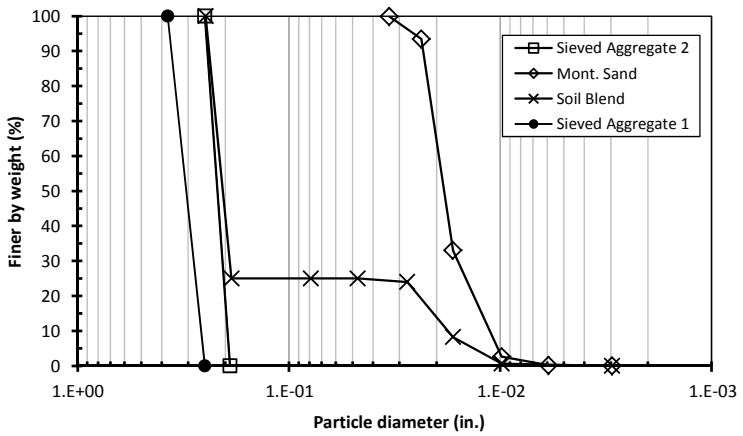
Pullout Rate			
1.0	mm/min.	0.04	in/min

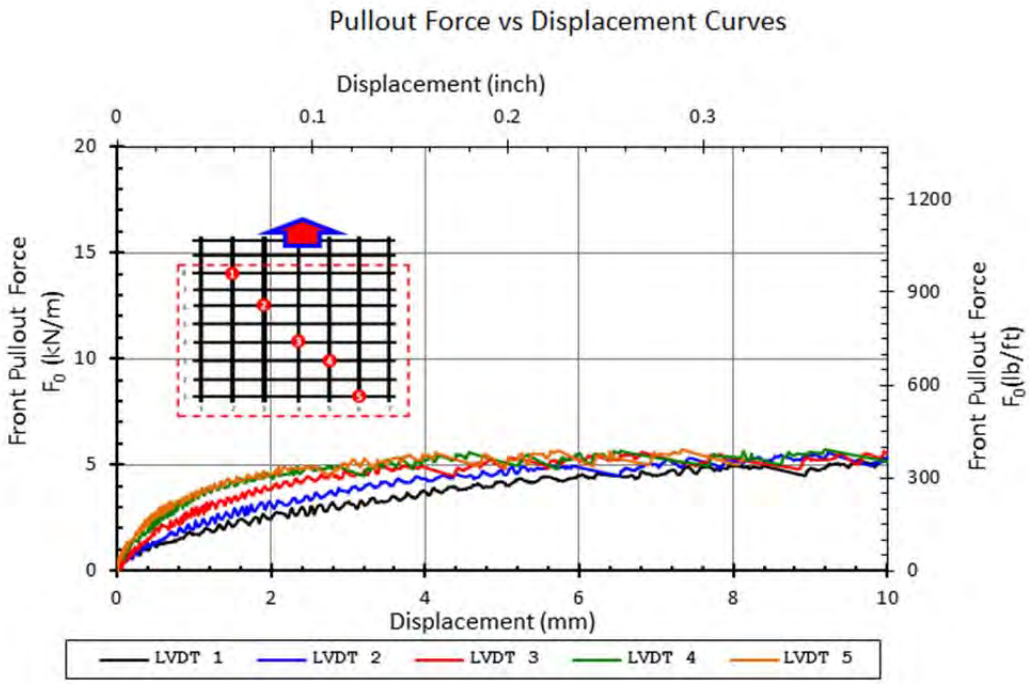
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.802 **g/cm^3**	**113 pcf**

Note: particle size distribution curve shown below

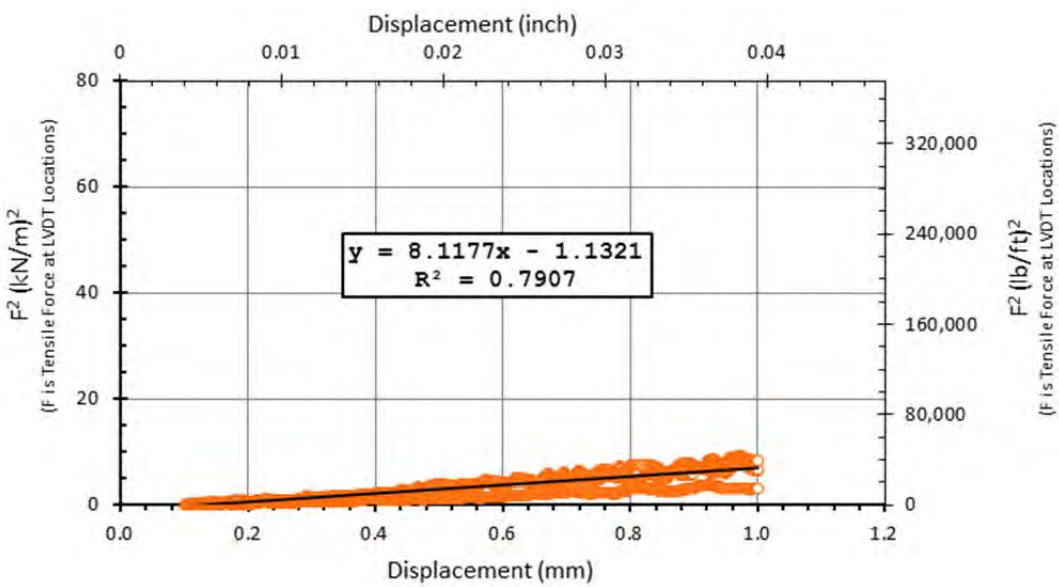
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	5.7	kN/m	392	lb/ft
Max Pullout Load	P_{max}	1.74	kN	419	lb
Max Shear Stress	τ_{max}	23.4	kPa	3.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	0.7			

Reported K_{SGI}	
8.1	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Slight tilt to the right.

SMALL PULLOUT TEST

Date test conducted	2/2/2012 pm
Done by	Pong

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.304	m	0.245	m
	7	0.935	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.9	1.138
2	80.4	3.165
3	132.8	5.228
4	184.0	7.244
5	238.3	9.382

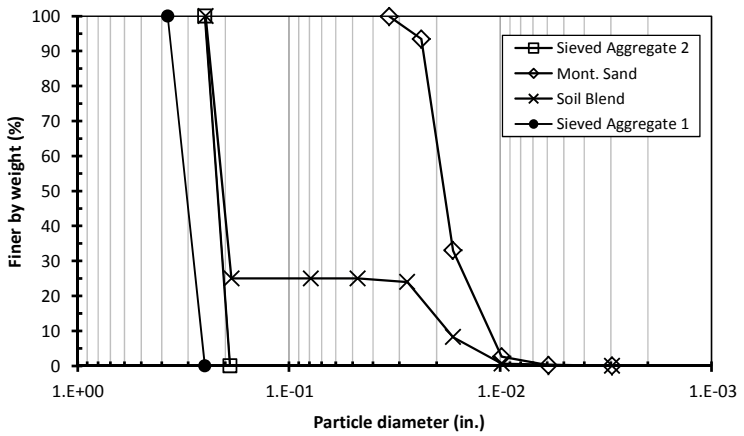
Pullout Rate			
1.0	mm/min.	0.04	in/min

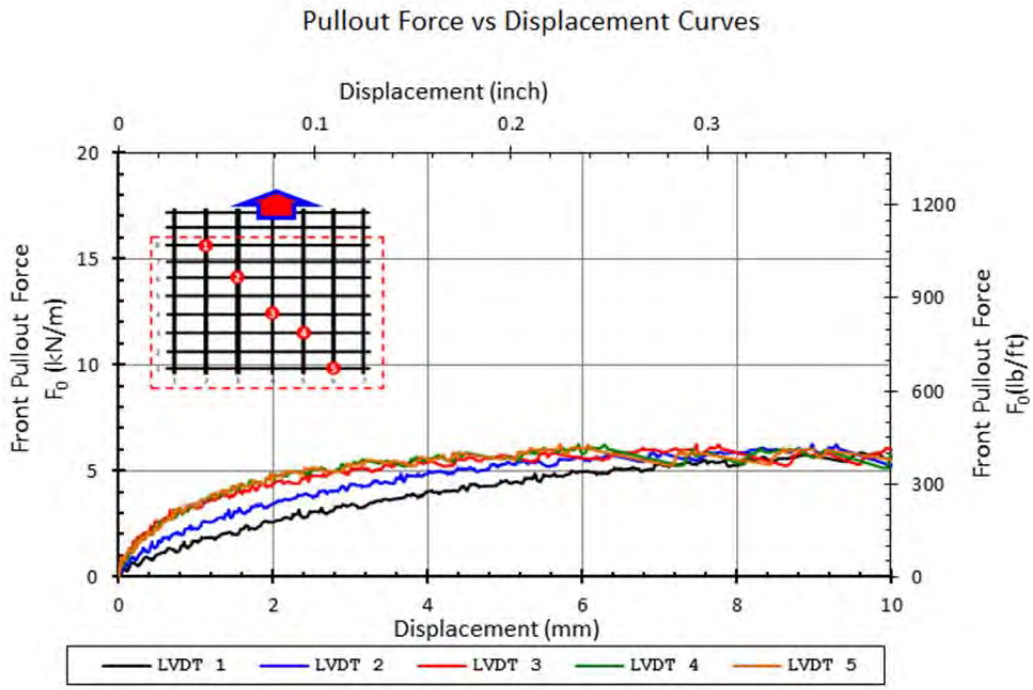
SOIL Information		
Soil	Soil Blend	
Water Content	0.37	**%**
Dry Density (ρ_d)	1.833 **g/cm^3**	**114 pcf**

Note: particle size distribution curve shown below

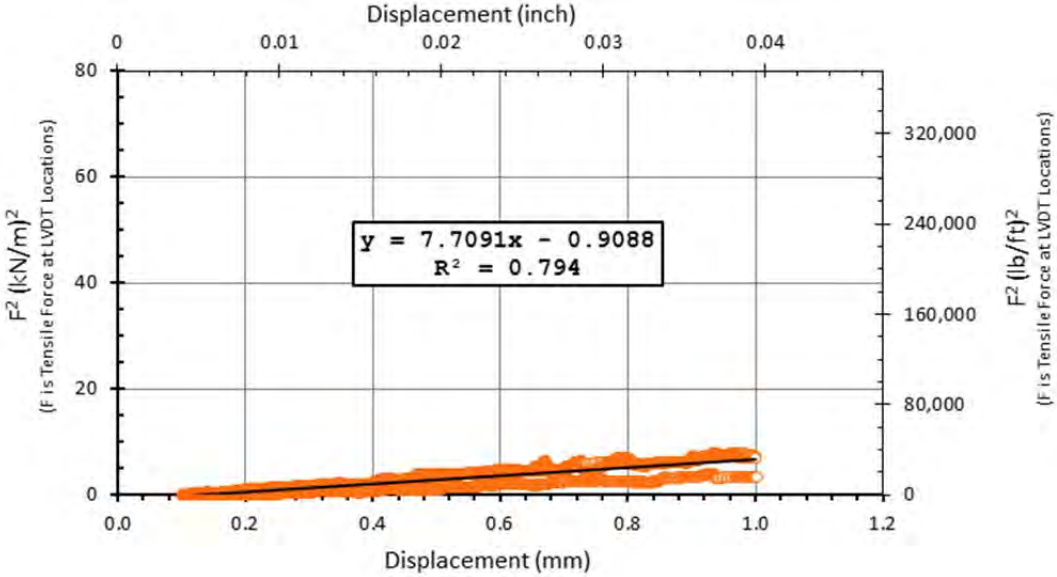
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.3	kN/m	428	lb/ft
Max Pullout Load	P_{max}	1.90	kN	459	lb
Max Shear Stress	τ_{max}	25.6	kPa	3.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	38	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
7.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

Appendix A9

This appendix presents the results of the tests with Sieved Aggregate 1. These tests were performed with a confining pressure of 3 psi (21 kPa), and no use of torque wrench and analog air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	7/25/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.263	m	0.245	m
	7	0.919	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	29.3	1.154
2	86.1	3.390
3	143.6	5.654
4	172.7	6.799
5	231.2	9.102

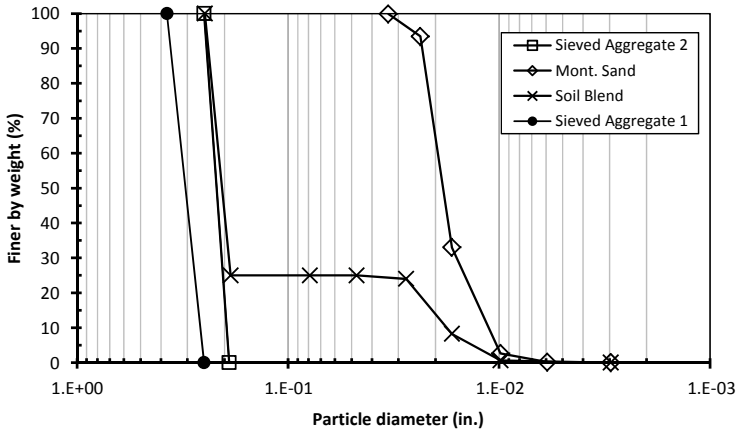
Pullout Rate	
1.0 mm/min.	0.04 in/min

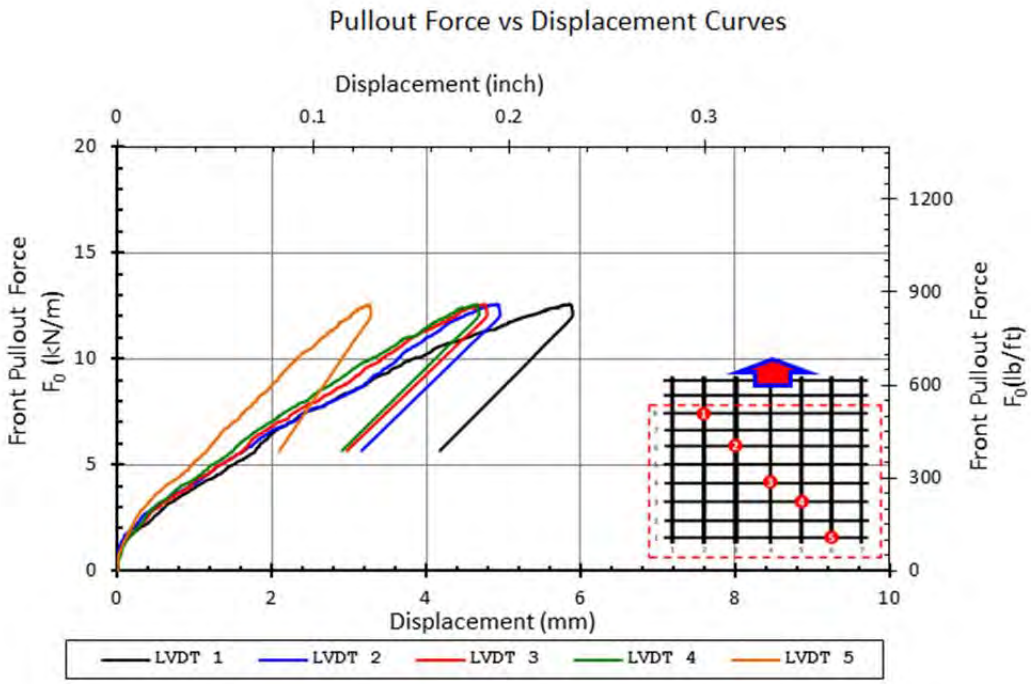
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

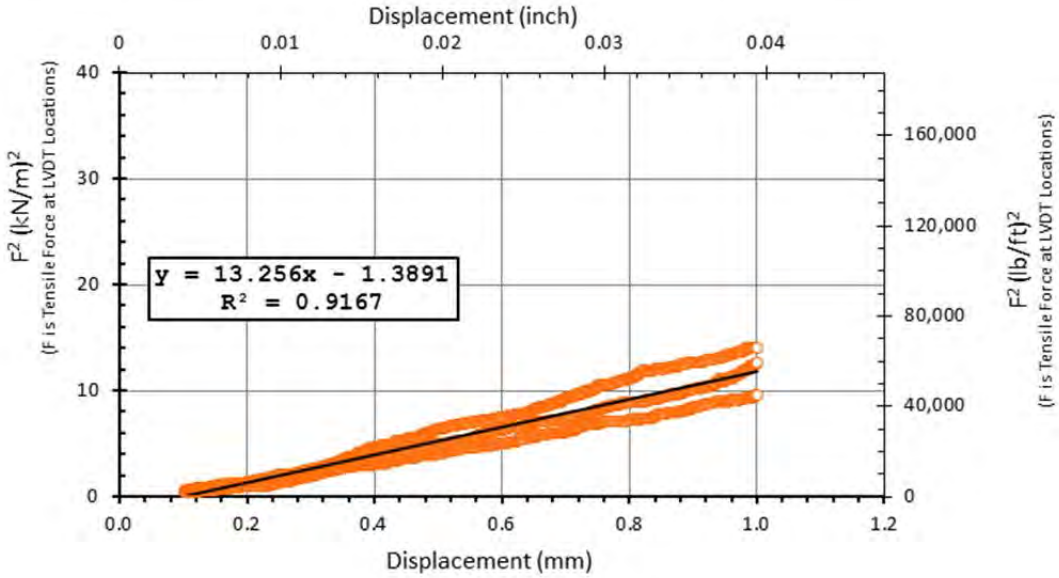
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.6	kN/m	862	lb/ft
Max Pullout Load	P_{max}	3.30	kN	697	lb
Max Shear Stress	τ_{max}	44.4	kPa	6.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
13.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Lab View load cell regression line change = -65.9

SMALL PULLOUT TEST

Date test conducted	12/1/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.268	m	0.275	m	0.245	m
	10	0.879	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	14.7	0.579
2	56.1	2.209
3	97.1	3.823
4	137.1	5.398
5	217.2	8.551

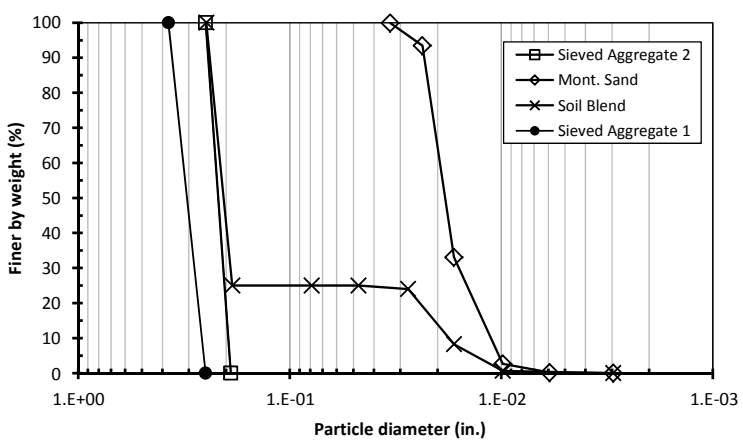
Pullout Rate	
1.0 mm/min.	0.04 in/min

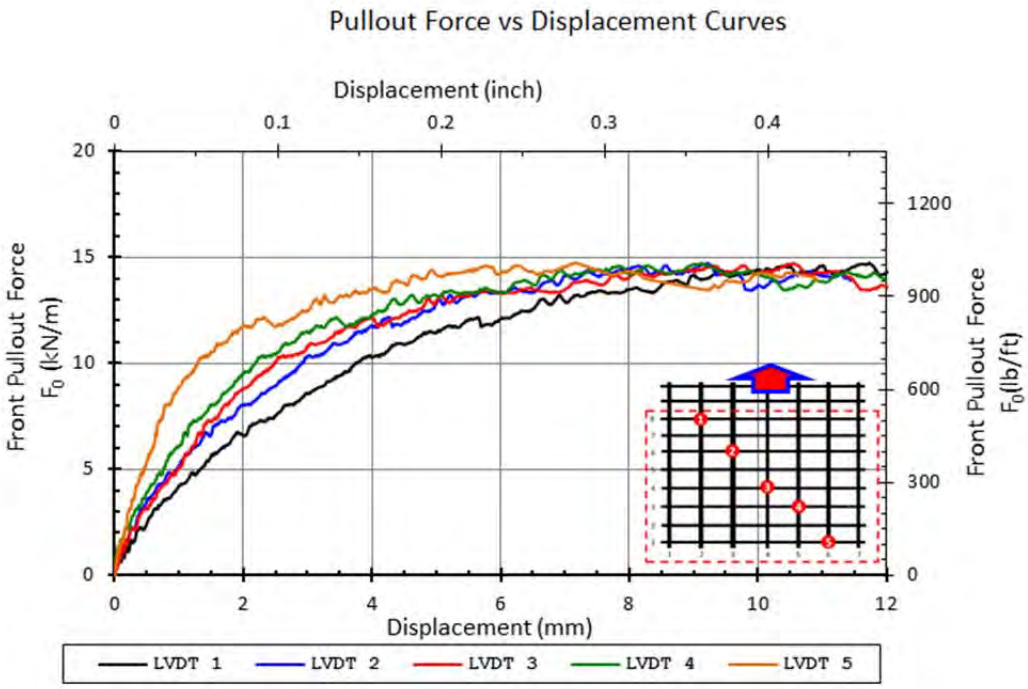
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.596 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

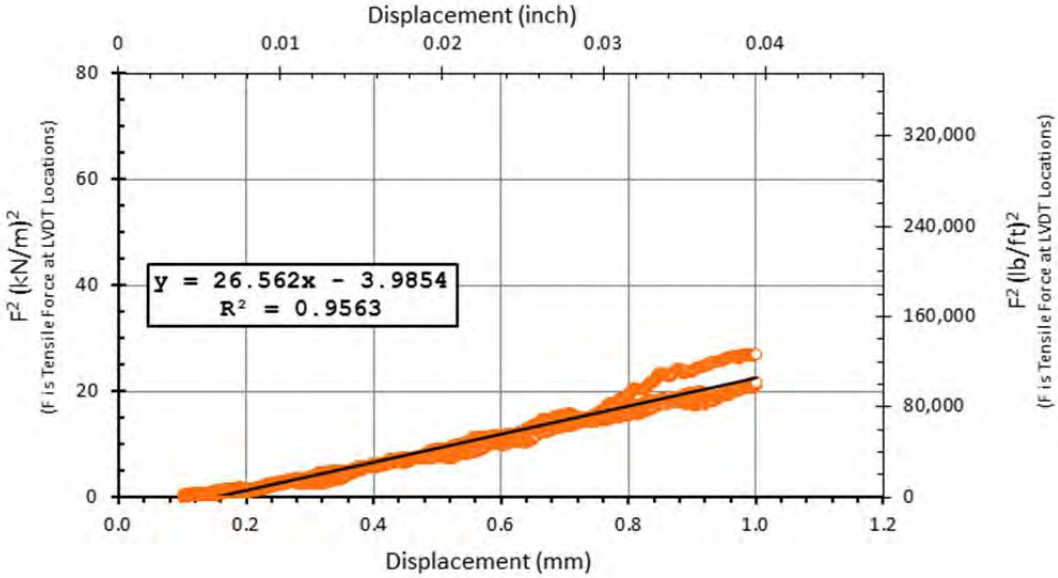
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	14.7	kN/m	1,009	lb/ft
Max Pullout Load	P_{max}	4.05	kN	914	lb
Max Shear Stress	τ_{max}	54.4	kPa	7.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
26.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LabView load cell regression line changes = -65.9

SMALL PULLOUT TEST

Date test conducted	12/2/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.275	m	0.245	m
	10	0.912	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.7	0.697
2	58.1	2.287
3	99.1	3.902
4	139.3	5.484
5	219.0	8.622

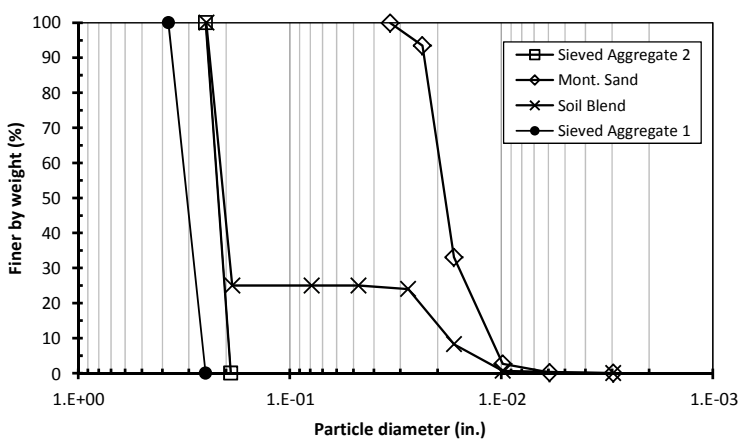
Pullout Rate	
1.0 mm/min.	0.04 in/min

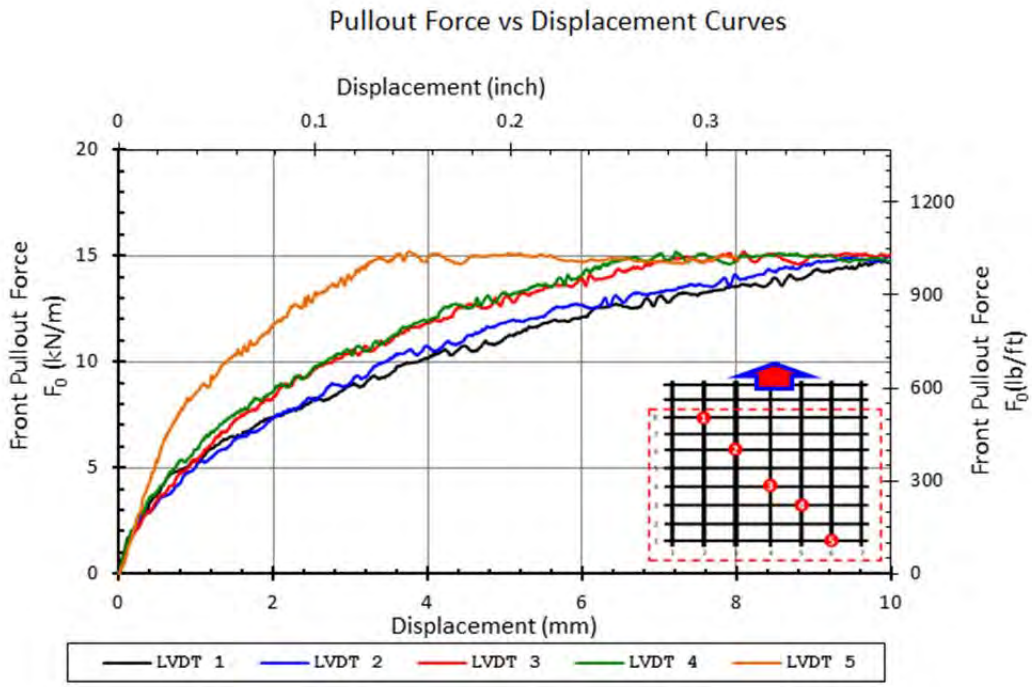
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	%
Dry Density (ρ_d)	1.604 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

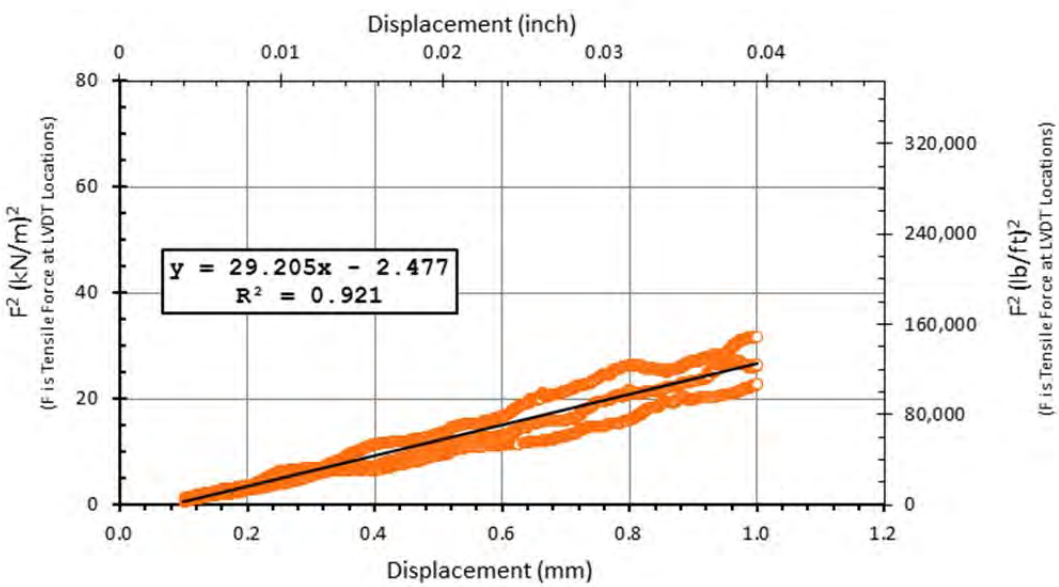
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	15.2	kN/m	1,041	lb/ft
Max Pullout Load	P_{max}	4.18	kN	966	lb
Max Shear Stress	τ_{max}	56.2	kPa	8.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
29.2 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LabView load cell regression line change = -65.9

SMALL PULLOUT TEST

Date test conducted	10/26/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.270	m	0.245	m
	10	0.912	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.8	1.134
2	97.0	3.819
3	127.8	5.031
4	161.8	6.370
5	229.2	9.024

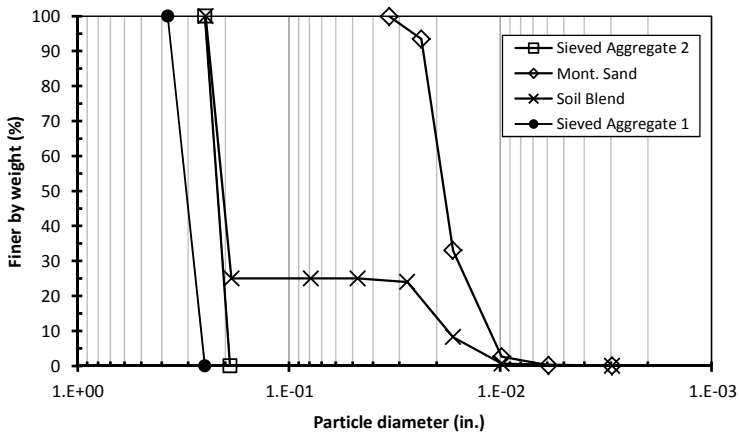
Pullout Rate			
1.0	mm/min.	0.04	in/min

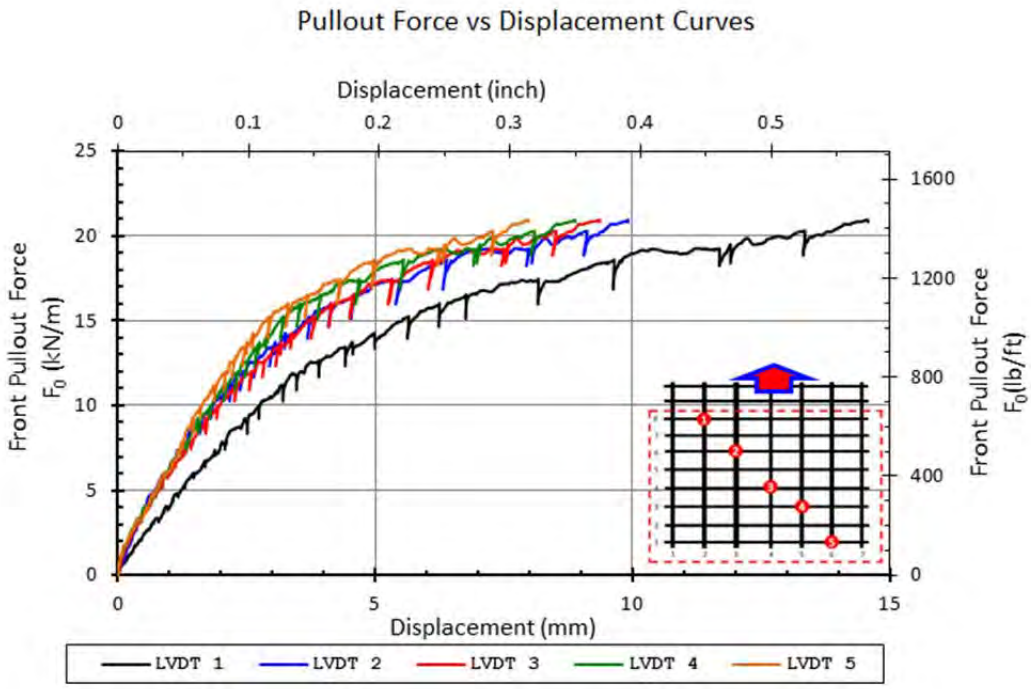
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.596 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

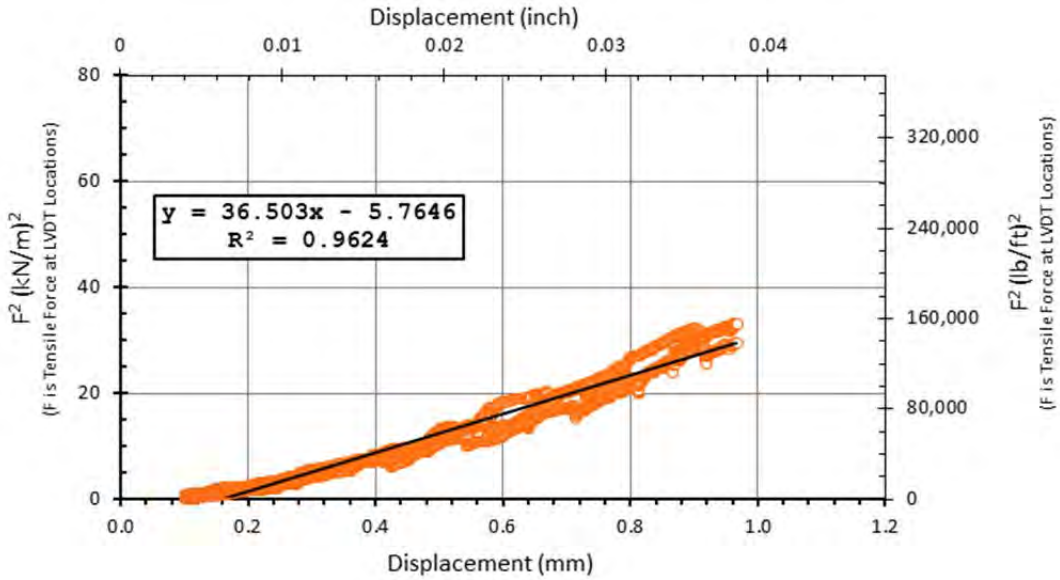
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	21.0	kN/m	1,436	lb/ft
Max Pullout Load	P_{max}	5.65	kN	1187	lb
Max Shear Stress	τ_{max}	75.9	kPa	11.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
36.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

LabView load cell regression line change = -65.9

SMALL PULLOUT TEST

Date test conducted	7/29/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.261	m	0.245	m
	8	0.915	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	27.8	1.094
2	84.4	3.323
3	140.4	5.528
4	169.9	6.689
5	226.3	8.909

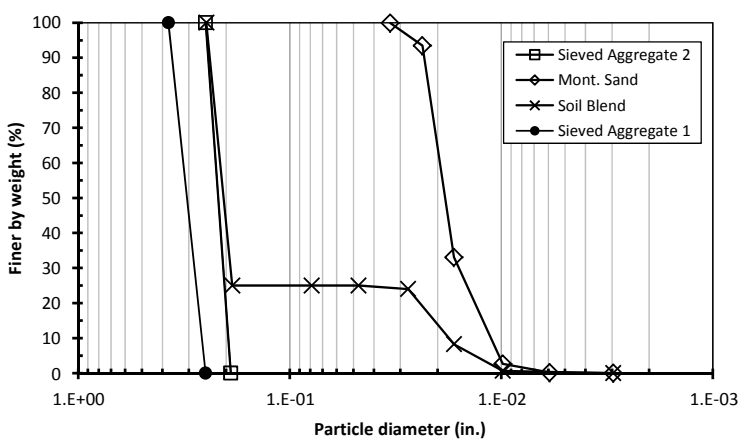
Pullout Rate	
1.0 mm/min.	0.04 in/min

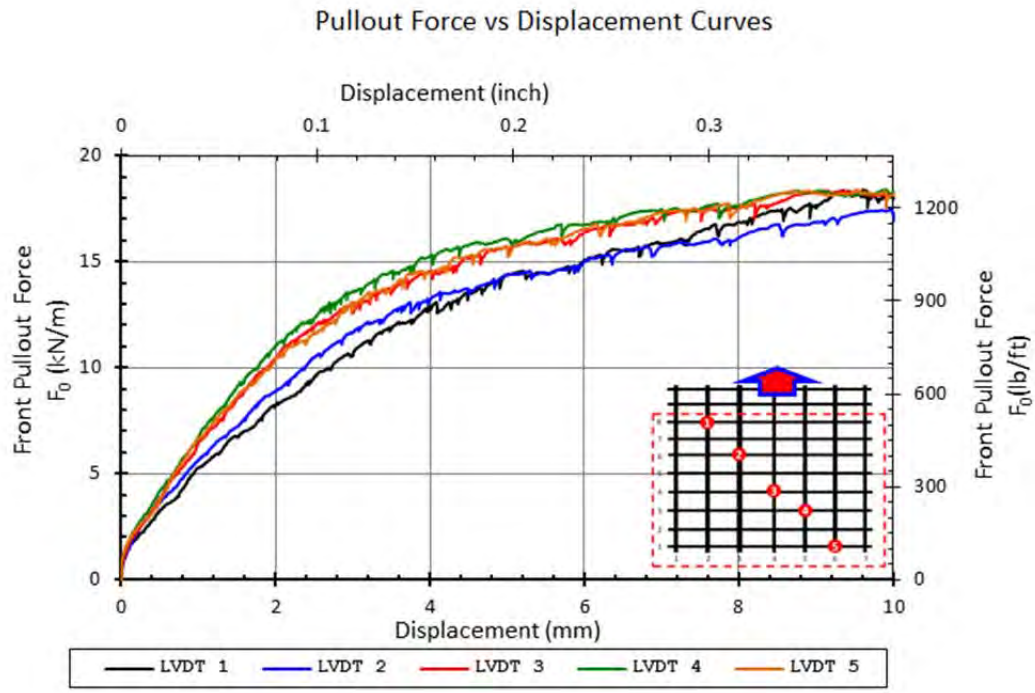
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.564 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

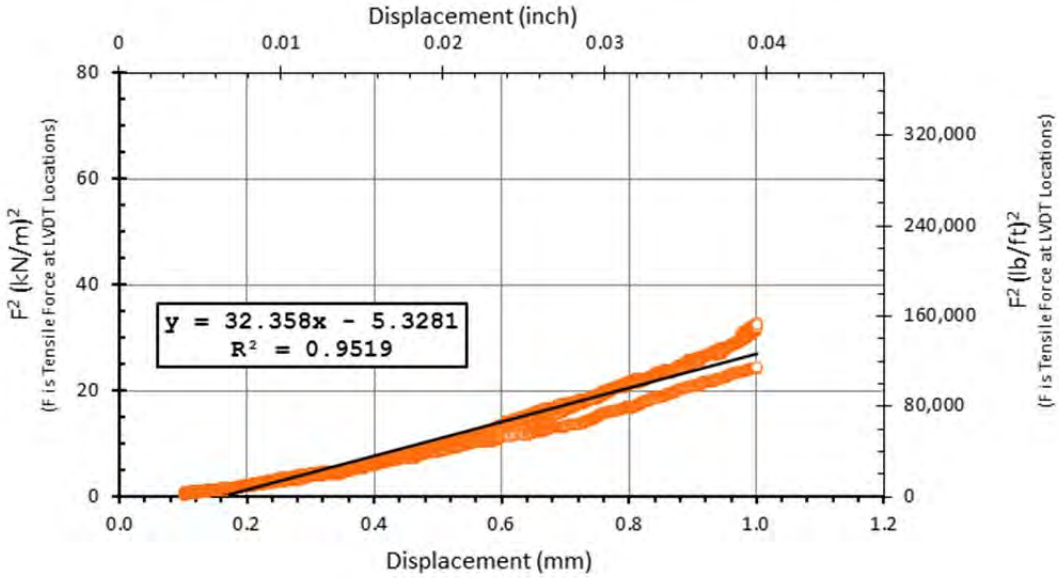
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	18.4	kN/m	1,261	lb/ft
Max Pullout Load	P_{max}	4.80	kN	1022	lb
Max Shear Stress	τ_{max}	64.6	kPa	9.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
32.4 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/22/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.273	m	0.261	m	0.245	m
	8	0.896	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	26.8	1.055
2	82.8	3.260
3	110.8	4.362
4	166.5	6.555
5	222.5	8.760

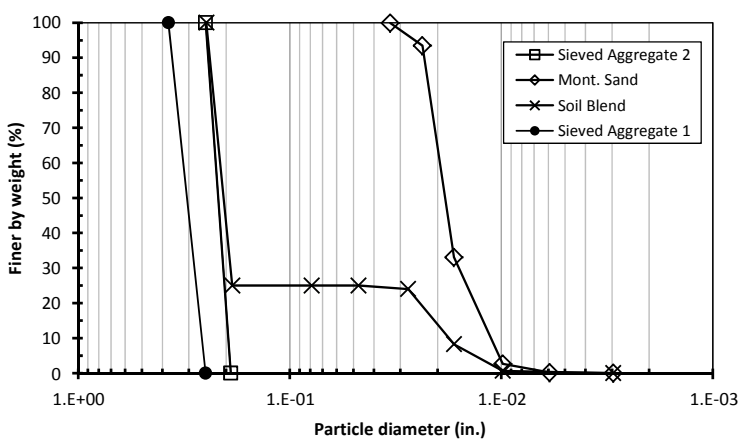
Pullout Rate	
1.0 mm/min.	0.04 in/min

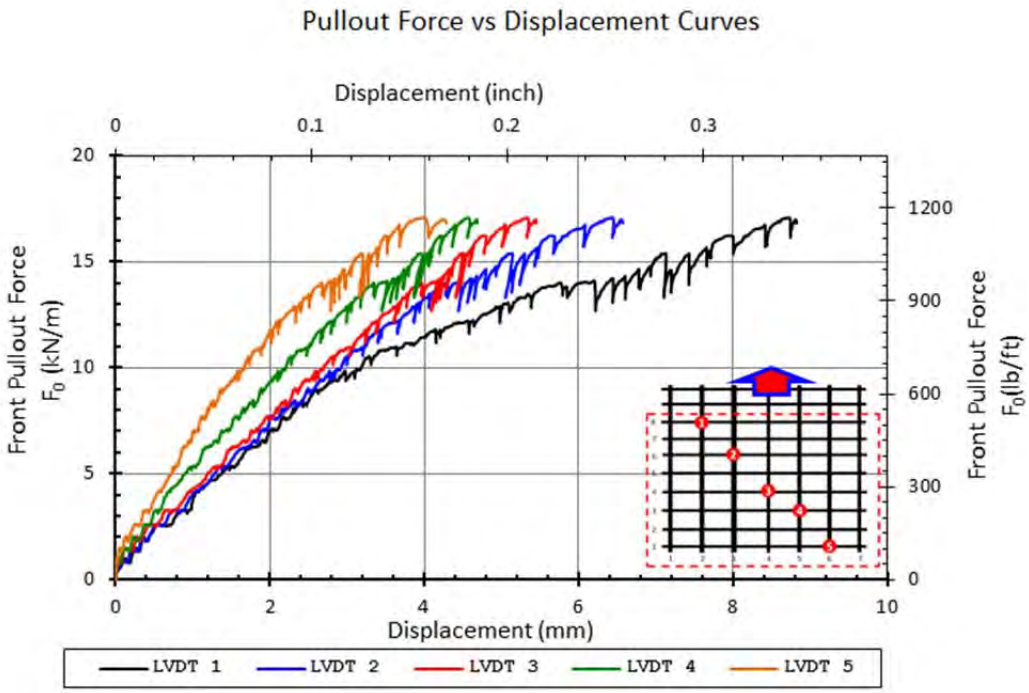
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	%
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

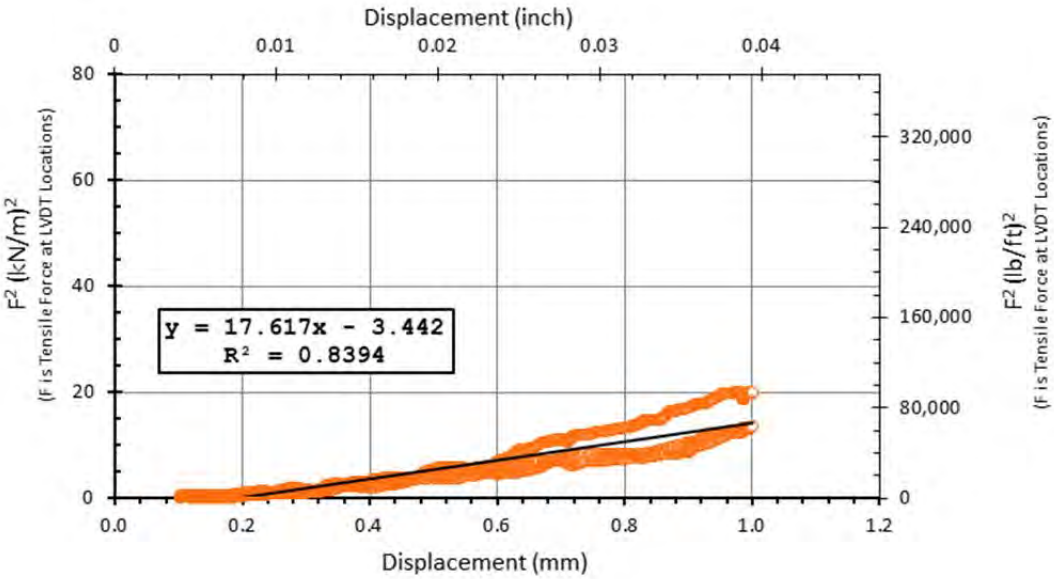
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	17.1	kN/m	1,170	lb/ft
Max Pullout Load	P_{max}	4.46	kN	1014	lb
Max Shear Stress	τ_{max}	59.9	kPa	8.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
17.6 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	4/2/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.273	m	0.261	m	0.245	m
	8	0.896	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	32.2	1.268
2	89.3	3.516
3	146.2	5.756
4	174.7	6.878
5	230.2	9.063

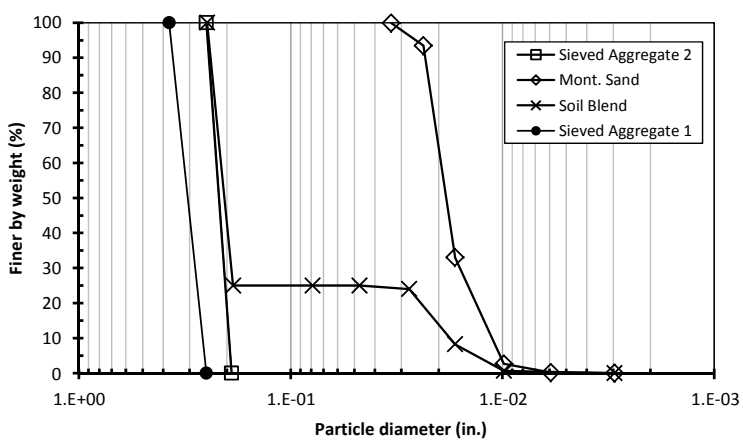
Pullout Rate	
1.0 mm/min.	0.04 in/min

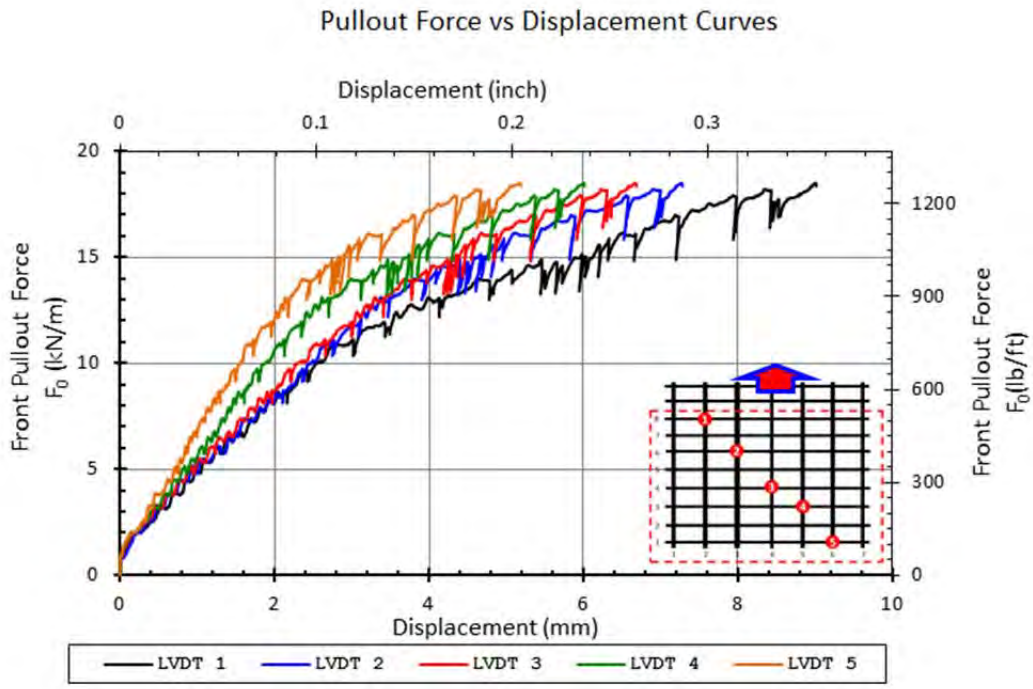
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

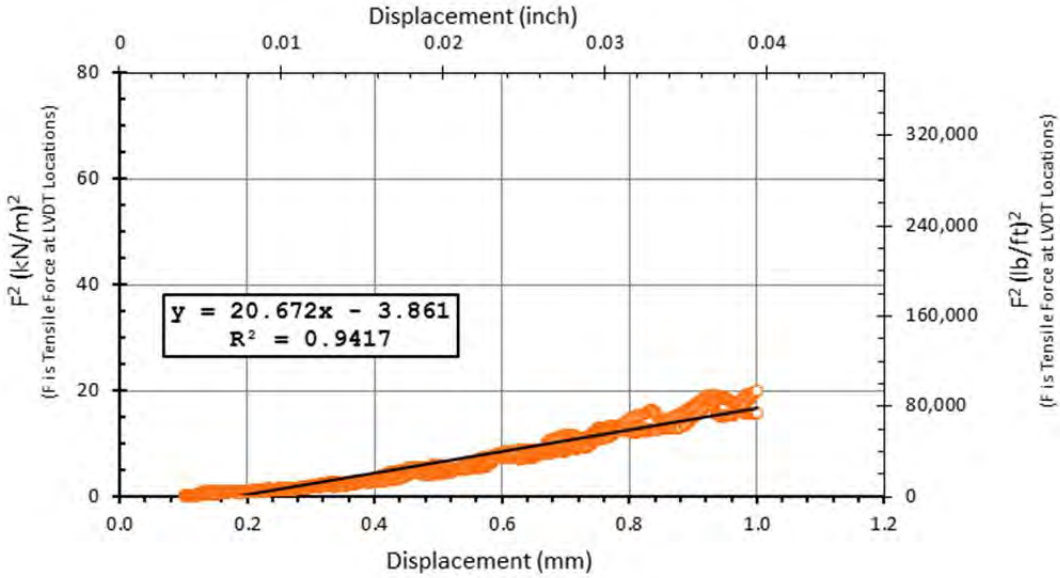
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	18.5	kN/m	1,267	lb/ft
Max Pullout Load	P_{max}	4.83	kN	1072	lb
Max Shear Stress	τ_{max}	64.9	kPa	9.4	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
20.7 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/16/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.280	m	0.245	m
	---	0.919	ft	0.919	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	23.0	0.906
2	95.0	3.740
3	130.9	5.154
4	170.8	6.724
5	223.8	8.811

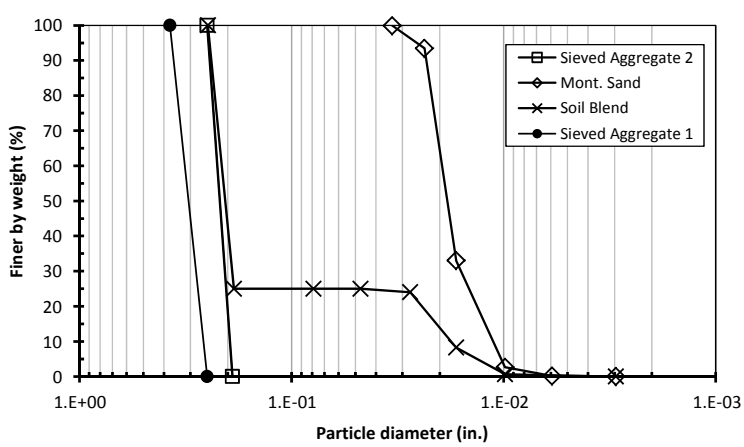
Pullout Rate	
1.0 mm/min.	0.04 in/min

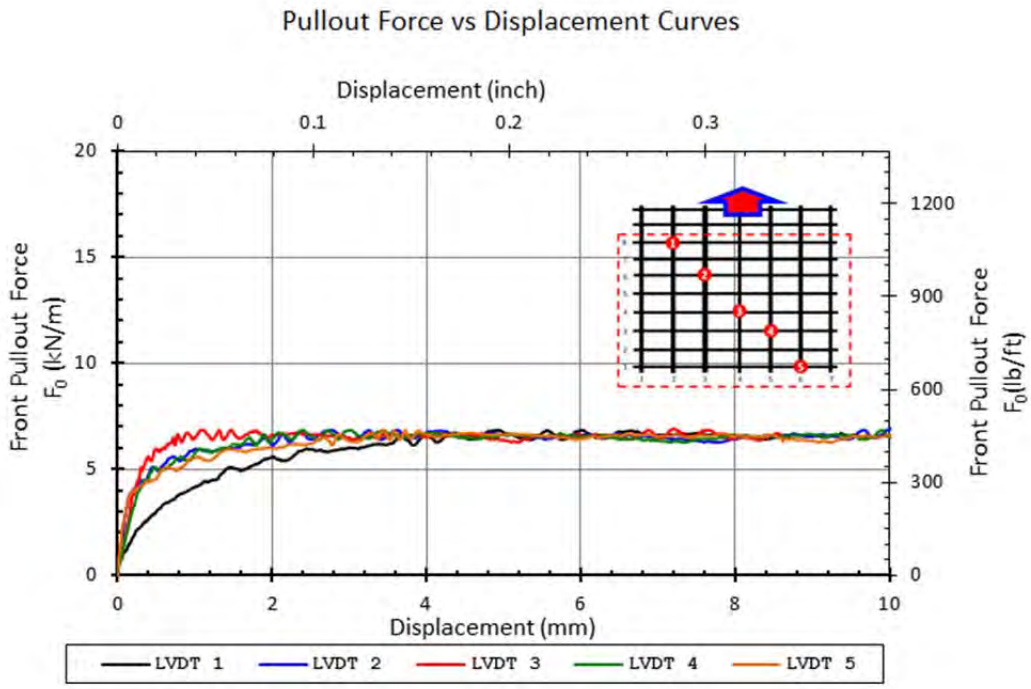
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

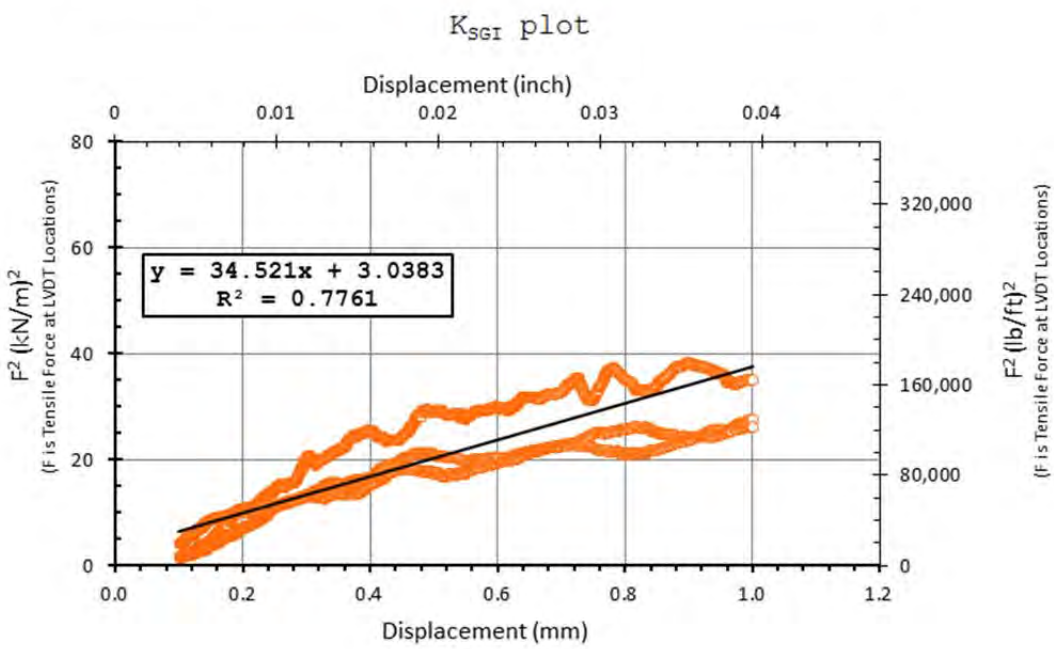
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	6.9	kN/m	474	lb/ft
Max Pullout Load	P_{max}	1.94	kN	467	lb
Max Shear Stress	τ_{max}	26.0	kPa	3.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
34.5 $(kN/m)^2/mm$




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.1
0.2
0.3
20
15
10
5
0
Front Pullout Force
F_0 (kN/m)
1200
900
600
300
0
Front Pullout Force
F_0(lb/ft)
0
2
4
6
8
10
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


K_{SGI} plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
80
60
40
20
0
F^2 (kN/m)^2
(F is Tensile Force at LVDT Locations)
y = 34.521x + 3.0383
R^2 = 0.7761
320,000
240,000
160,000
80,000
0
F^2 (lb/ft)^2
(F is Tensile Force at LVDT Locations)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	11/18/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	---	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	16.8	0.661
2	95.4	3.756
3	130.5	5.138
4	160.8	6.331
5	220.0	8.661

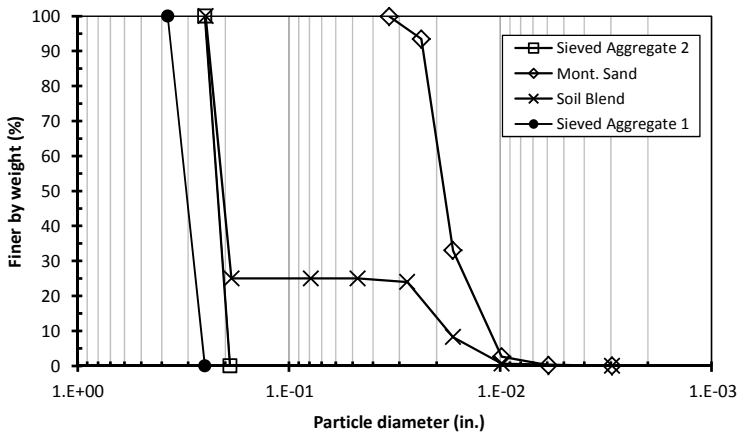
Pullout Rate			
1.0	mm/min.	0.04	in/min

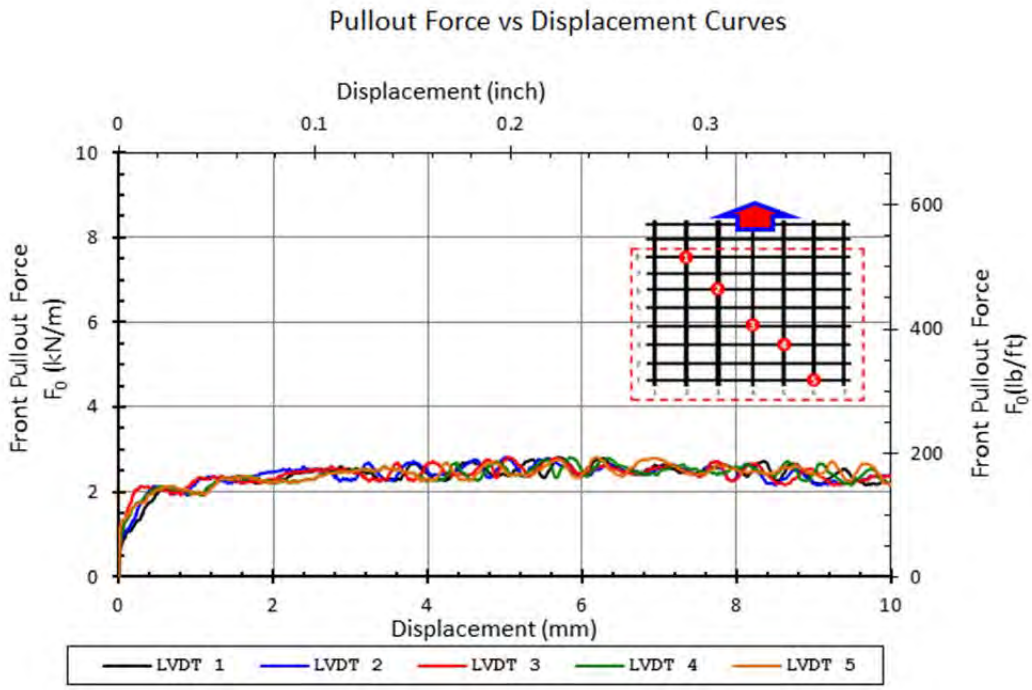
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.613 **g/cm^3**	**101 pcf**

Note: particle size distribution curve shown below

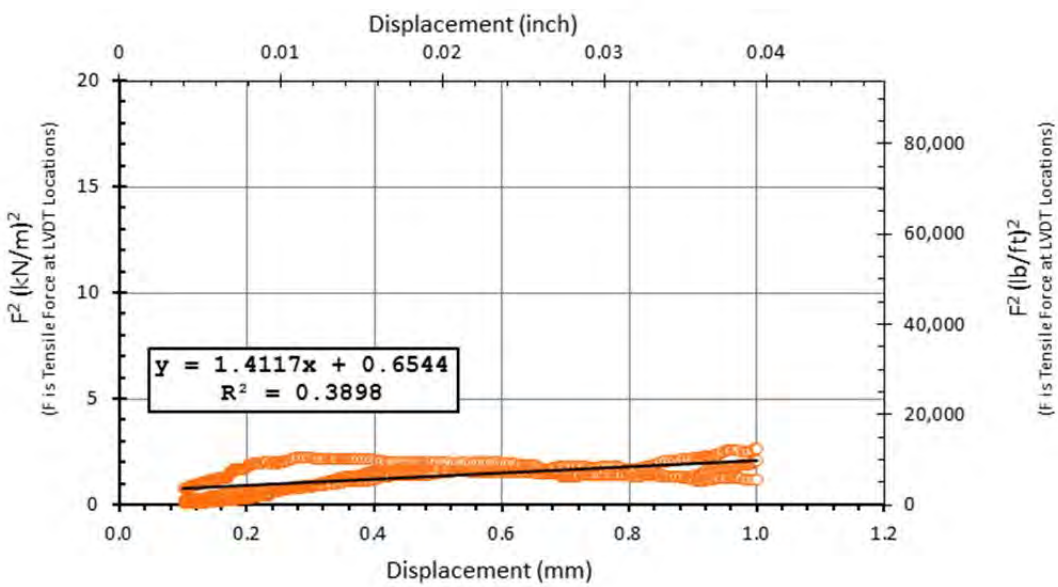
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	2.8	kN/m	193	lb/ft
Max Pullout Load	P_{max}	0.79	kN	202	lb
Max Shear Stress	τ_{max}	10.6	kPa	1.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	0.3			

Reported K_{SGI}
1.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/9/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.285	m	0.245	m
	---	0.935	ft	0.935	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.3	0.760
2	92.9	3.657
3	137.6	5.417
4	179.3	7.059
5	225.2	8.866

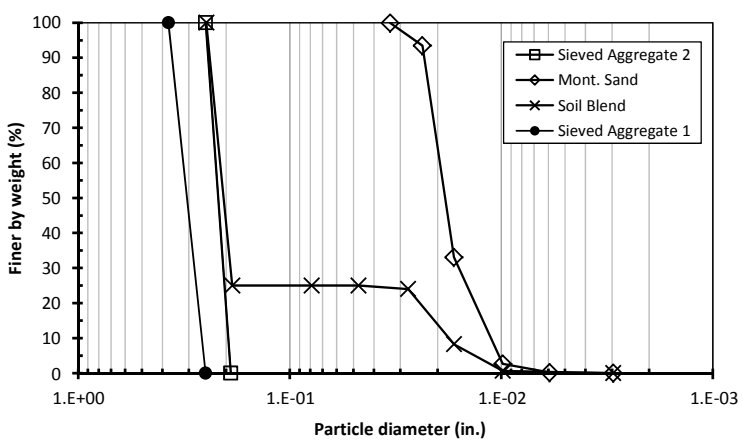
Pullout Rate	
1.0 mm/min.	0.04 in/min

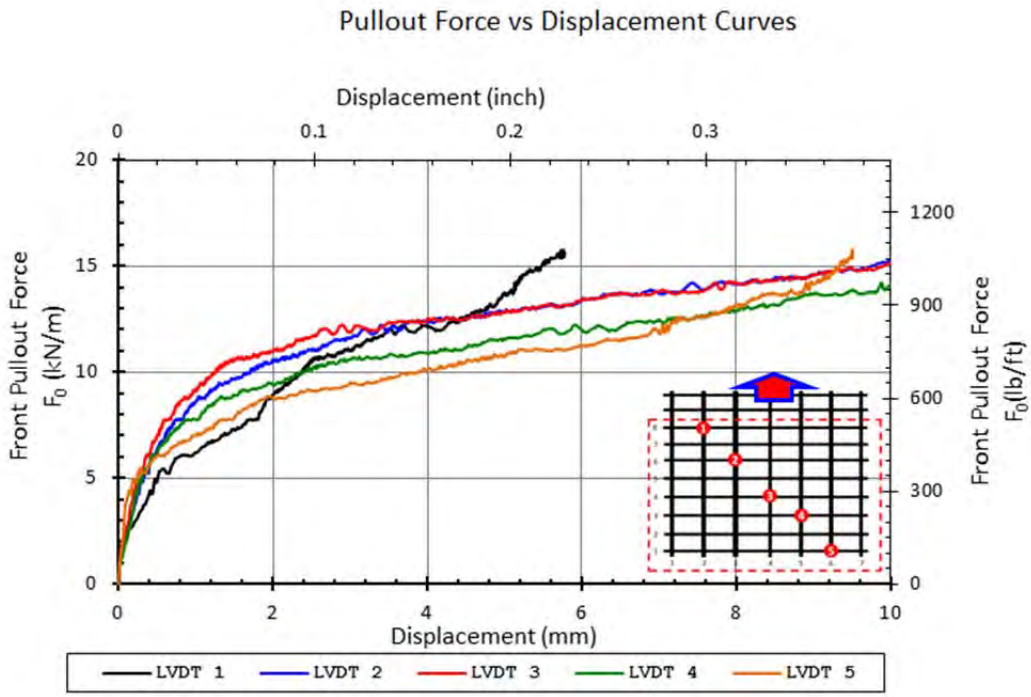
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

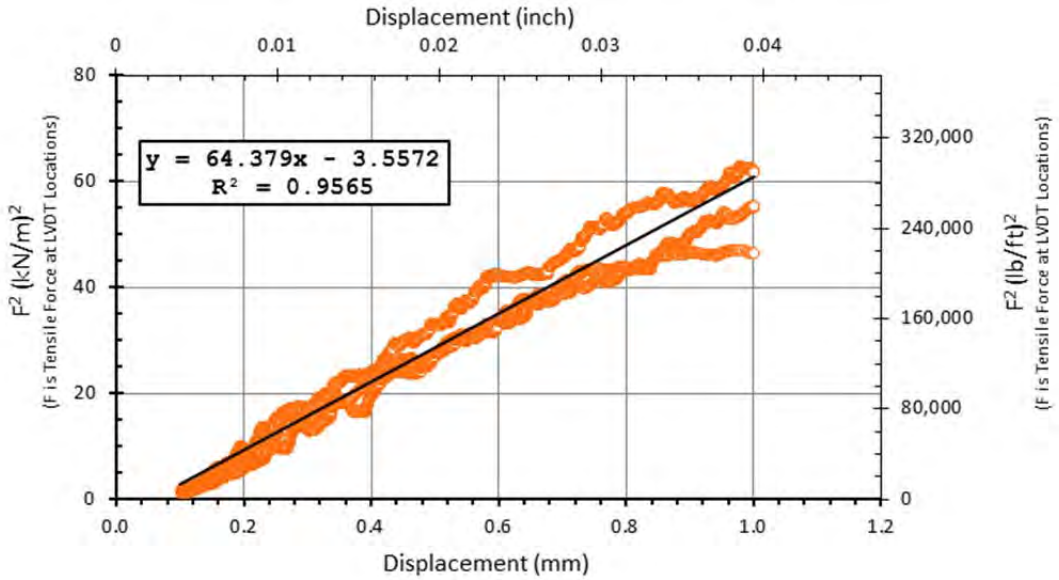
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	15.8	kN/m	1,081	lb/ft
Max Pullout Load	P_{max}	4.50	kN	967	lb
Max Shear Stress	τ_{max}	60.4	kPa	8.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
64.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

Forgot to take weight of the box. Input weight based on values from previous tests.

SMALL PULLOUT TEST

Date test conducted	11/11/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.279	m	0.245	m
	---	0.915	ft	0.915	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.8	1.134
2	101.3	3.989
3	141.7	5.579
4	174.3	6.863
5	225.2	8.867

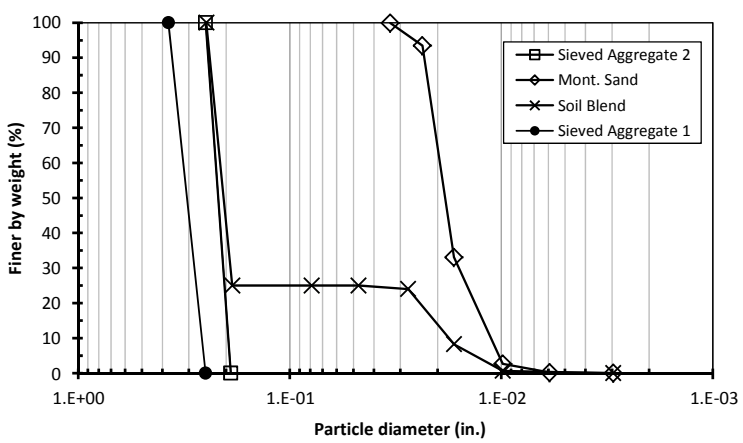
Pullout Rate	
1.0 mm/min.	0.04 in/min

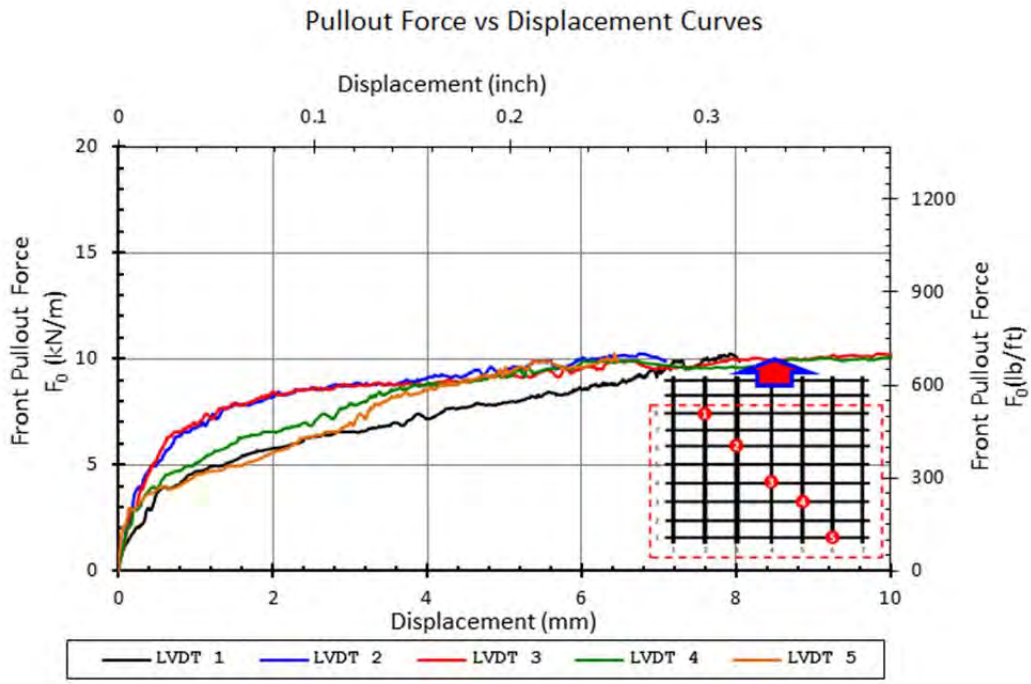
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	%
Dry Density (ρ_d)	1.591 **g/cm^3**	**99 pcf**

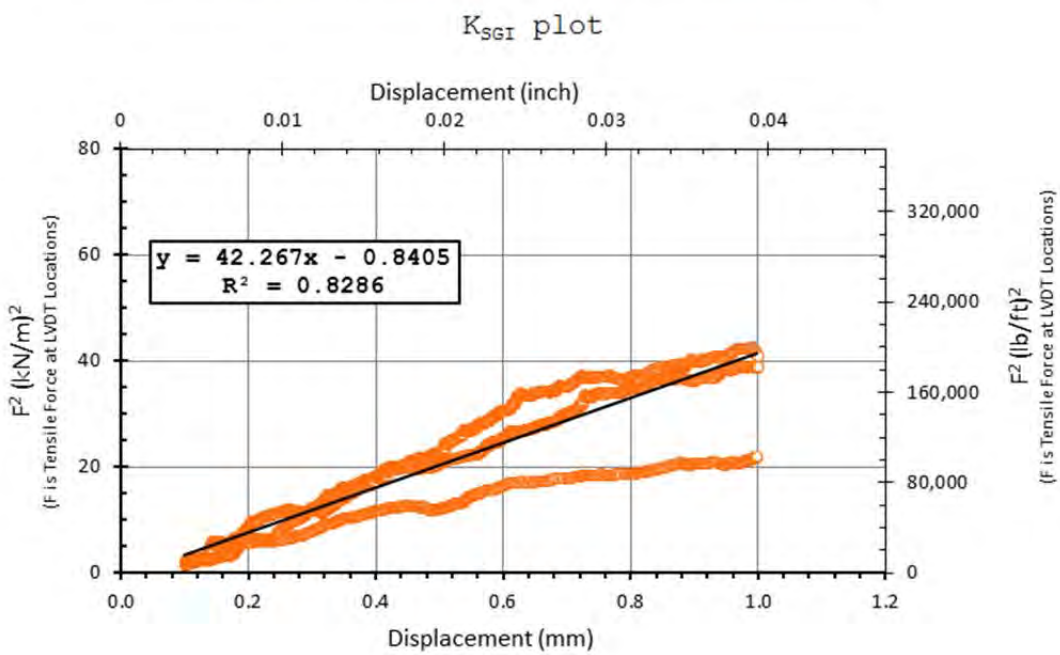
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	10.2	kN/m	702	lb/ft
Max Pullout Load	P_{max}	2.86	kN	690	lb
Max Shear Stress	τ_{max}	38.4	kPa	5.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
42.3 (kN/m)^2/mm




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.1
0.2
0.3
Front Pullout Force
F_0 (kN/m)
20
15
10
5
0
1200
900
600
300
0
Front Pullout Force
F_0(lb/ft)
0
2
4
6
8
10
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


K_{SGI} plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
F^2 (kN/m)^2
(F is Tensile Force at LVDT Locations)
80
60
40
20
0
y = 42.267x - 0.8405
R^2 = 0.8286
320,000
240,000
160,000
80,000
0
F^2 (lb/ft)^2
(F is Tensile Force at LVDT Locations)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	11/16/2010 AM
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		CD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.278	m	0.245	m
	---	0.912	ft	0.912	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.2	0.323
2	87.1	3.429
3	117.5	4.626
4	159.6	6.283
5	221.3	8.713

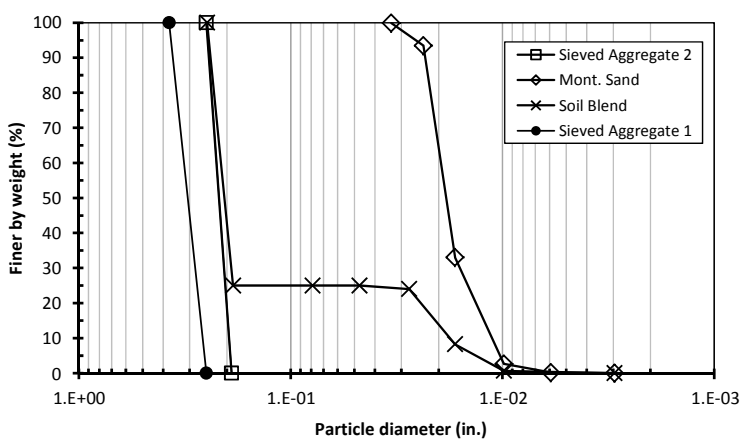
Pullout Rate	
1.0 mm/min.	0.04 in/min

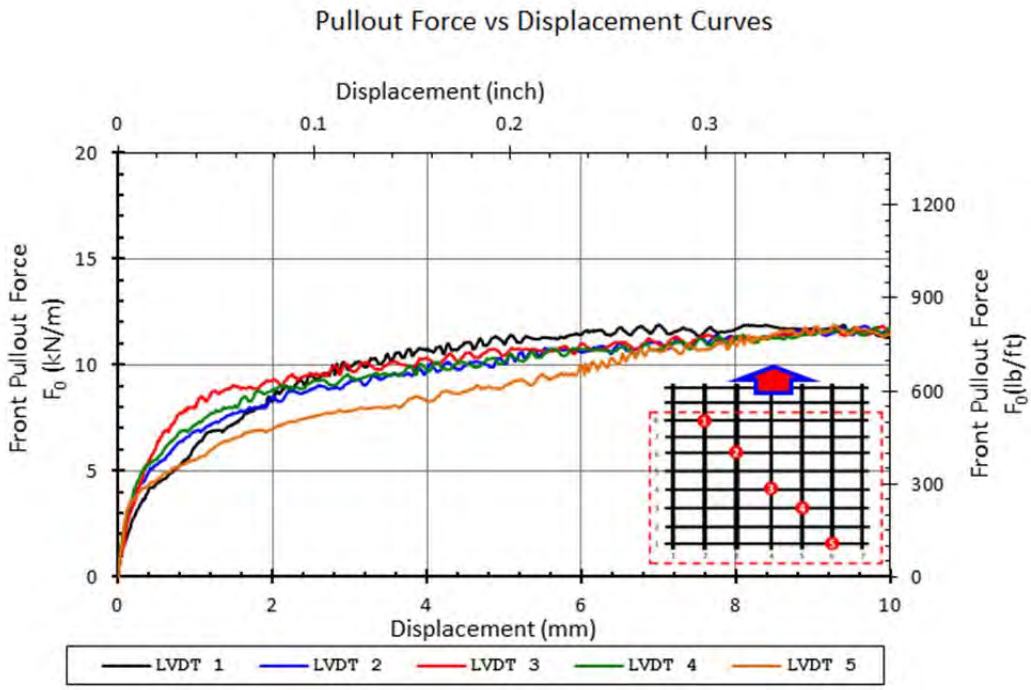
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.604 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

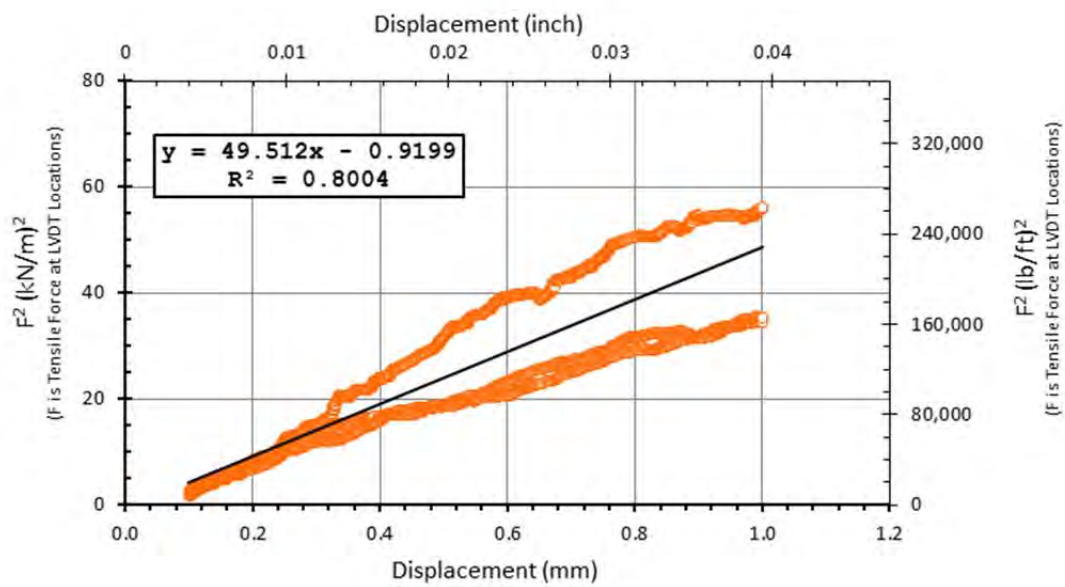
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.2	kN/m	835	lb/ft
Max Pullout Load	P_{max}	3.39	kN	806	lb
Max Shear Stress	τ_{max}	45.6	kPa	6.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
49.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	10/29/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.257	m	0.263	m	0.245	m
	7	0.843	ft	0.863	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-47.1	-1.856
2	44.2	1.739
3	76.1	2.996
4	134.3	5.287
5	225.6	8.882

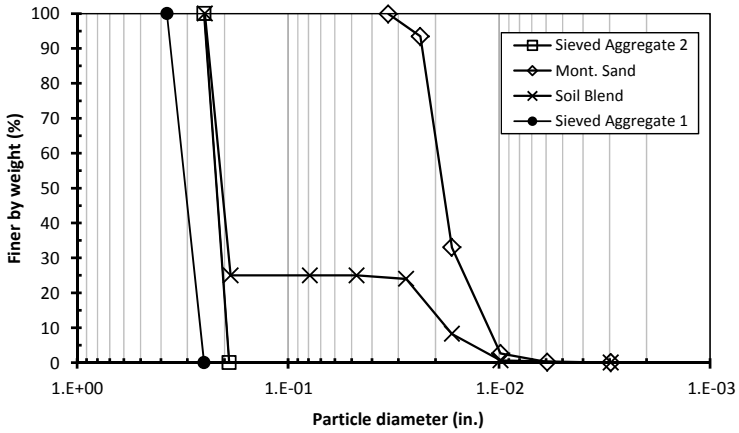
Pullout Rate			
1.0	mm/min.	0.04	in/min

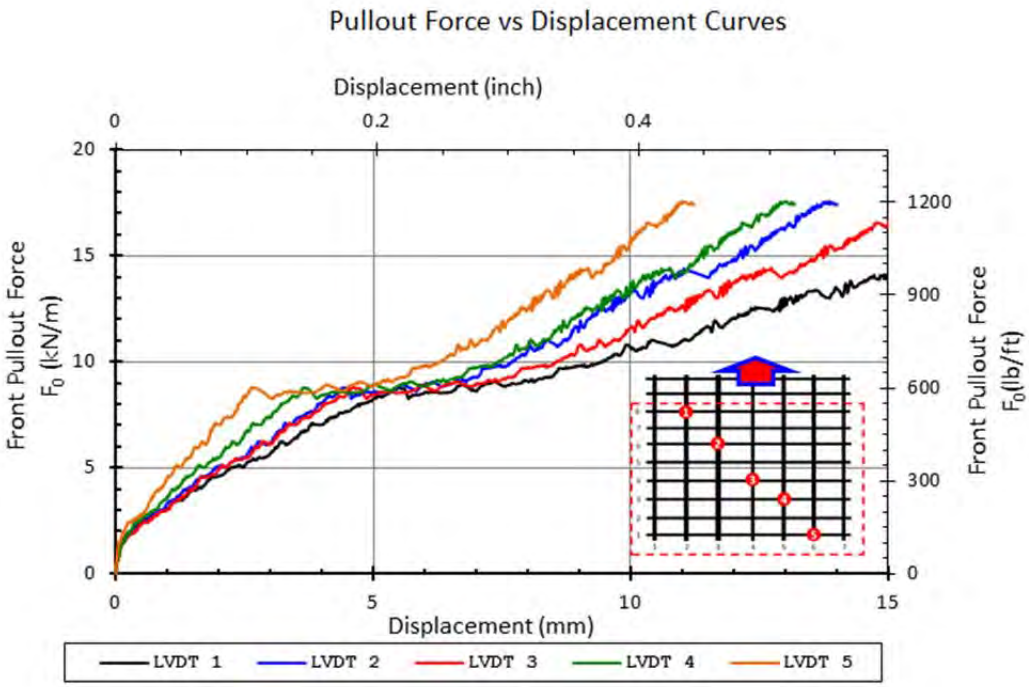
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.618 **g/cm^3**	**101 pcf**

Note: particle size distribution curve shown below

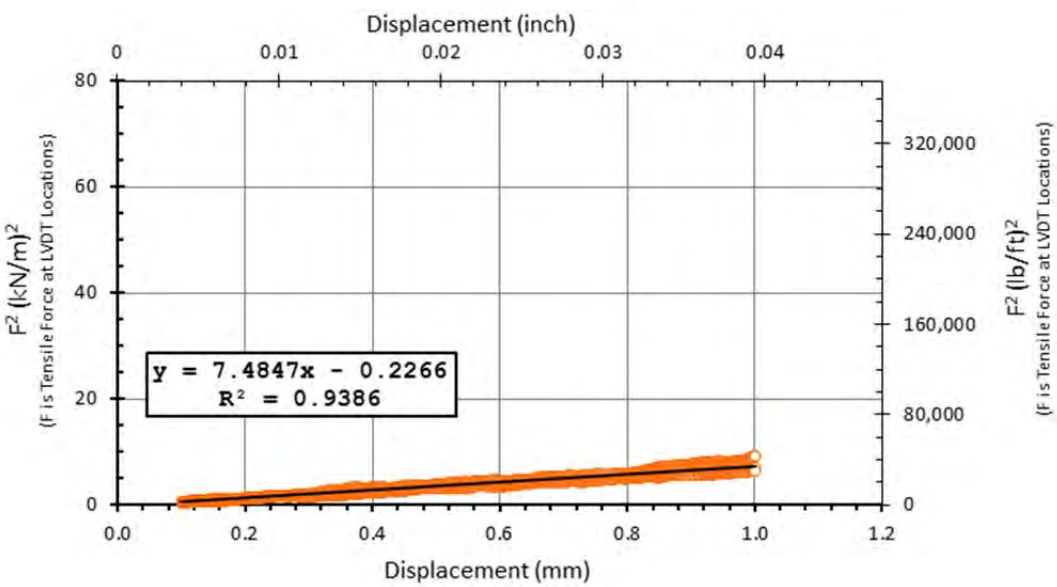
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	17.6	kN/m	1,204	lb/ft
Max Pullout Load	P_{max}	4.62	kN	816	lb
Max Shear Stress	τ_{max}	62.1	kPa	9.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
7.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

Junction of geogrid to which wire to LVDT 1 was attached is outside the box at the beginning of the test.

SMALL PULLOUT TEST

Date test conducted	7/28/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.265	m	0.245	m
	9	0.912	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	34.9	1.374
2	110.3	4.343
3	148.5	5.846
4	186.6	7.346
5	225.5	8.878

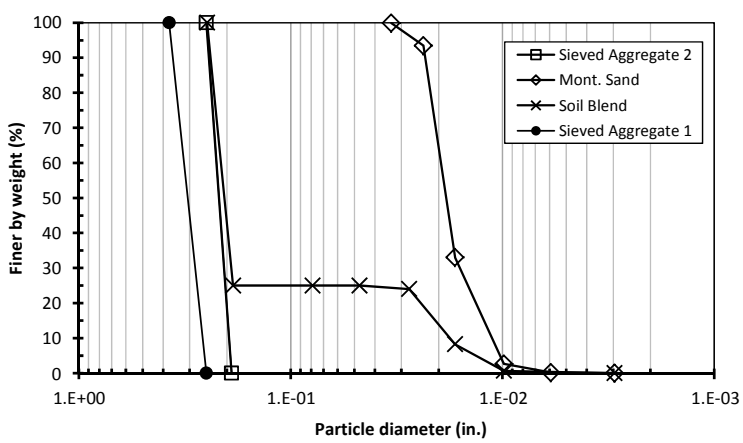
Pullout Rate	
1.0 mm/min.	0.04 in/min

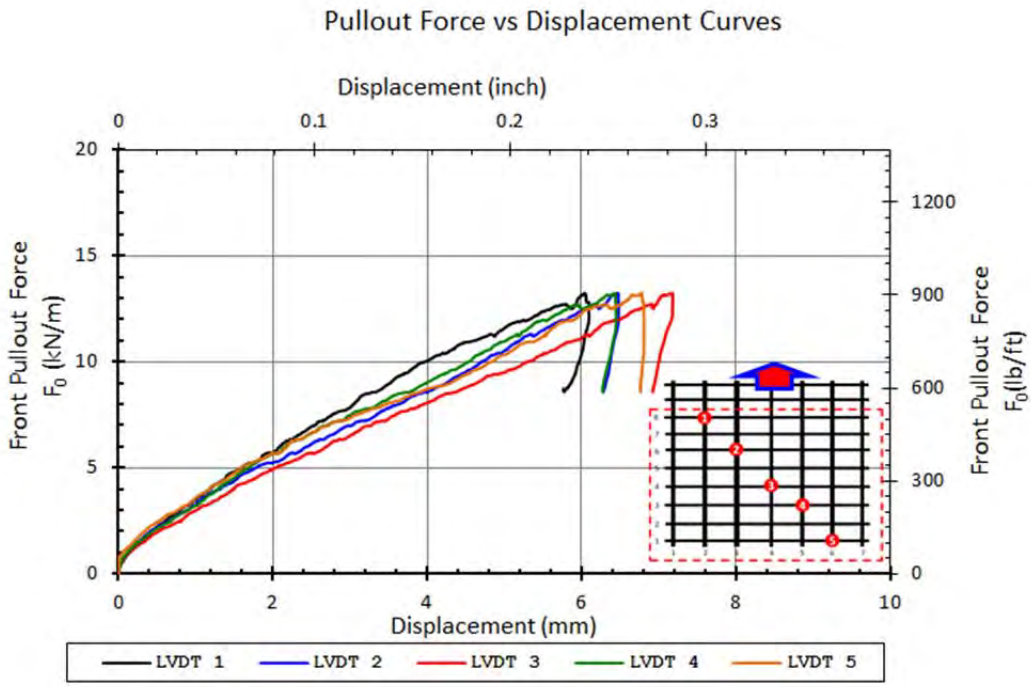
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.622 **g/cm^3**	**101 pcf**

Note: particle size distribution curve shown below

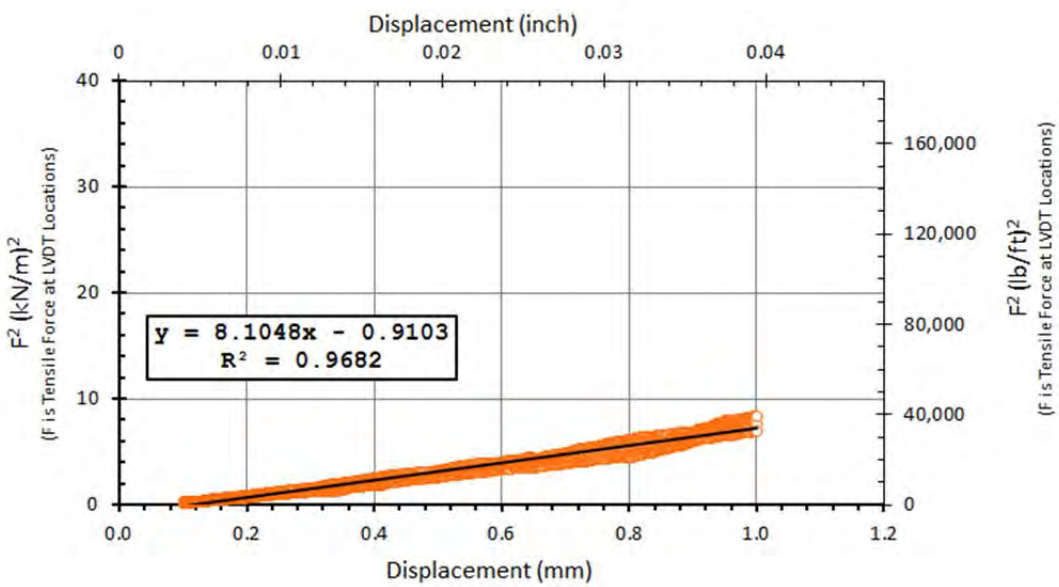
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.2	kN/m	907	lb/ft
Max Pullout Load	P_{max}	3.50	kN	813	lb
Max Shear Stress	τ_{max}	47.1	kPa	6.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
8.1 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Geogrid specimen ruptured in tension during the test.

SMALL PULLOUT TEST

Date test conducted	7/30/2010
Done by	Julio

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.265	m	0.245	m
	9	0.919	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	27.0	1.063
2	108.7	4.280
3	148.5	5.846
4	188.6	7.425
5	227.9	8.972

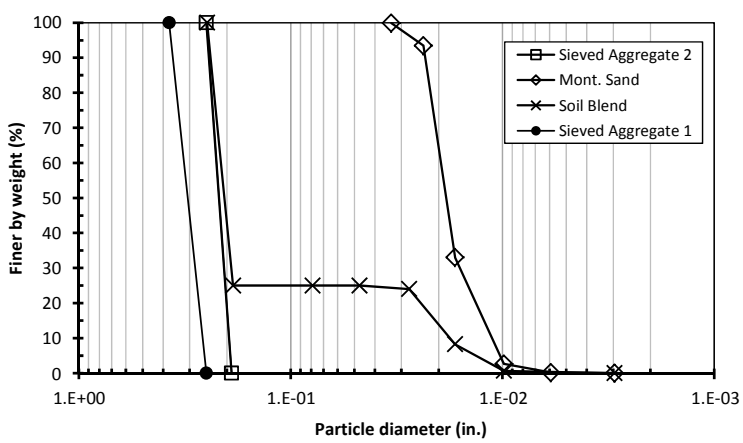
Pullout Rate	
1.0 mm/min.	0.04 in/min

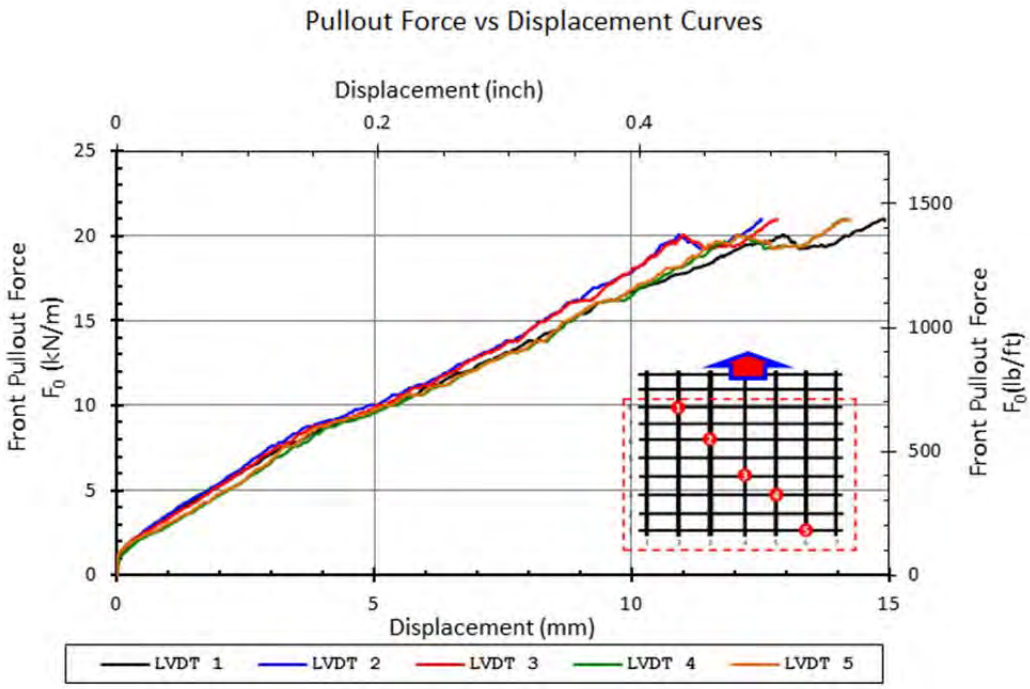
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

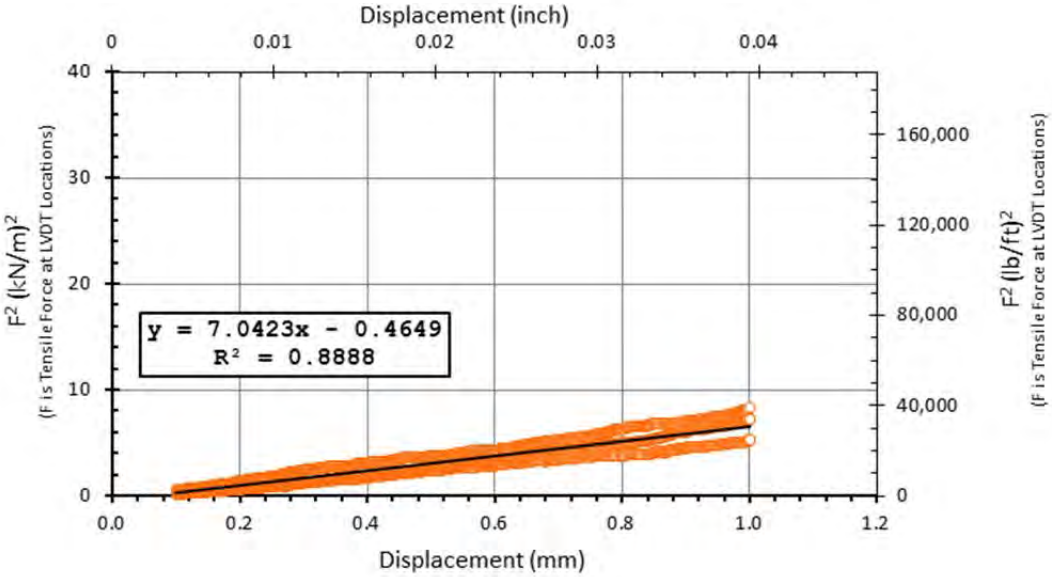
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	21.0	kN/m	1,439	lb/ft
Max Pullout Load	P_{max}	5.56	kN	1091	lb
Max Shear Stress	τ_{max}	74.7	kPa	10.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
7.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/23/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.282	m	0.364	m	0.245	m
	17	0.925	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	9.9	0.390
2	53.8	2.118
3	96.8	3.811
4	141.5	5.571
5	229.6	9.039

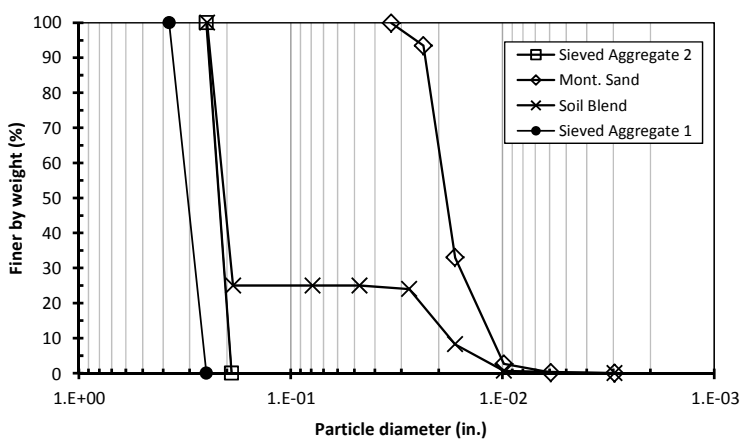
Pullout Rate	
1.0 mm/min.	0.04 in/min

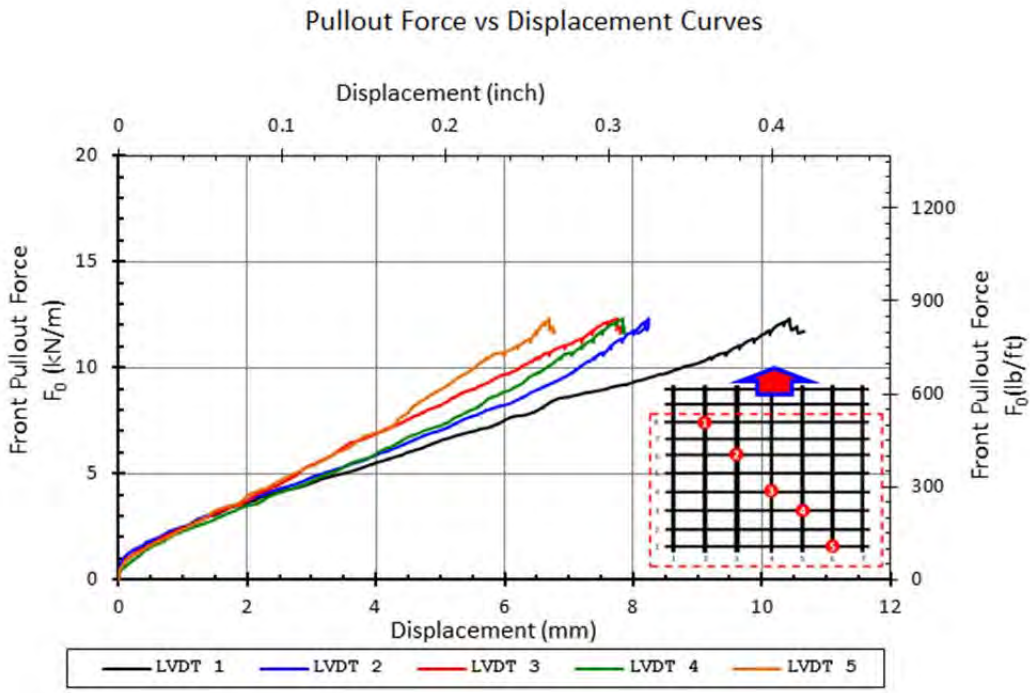
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

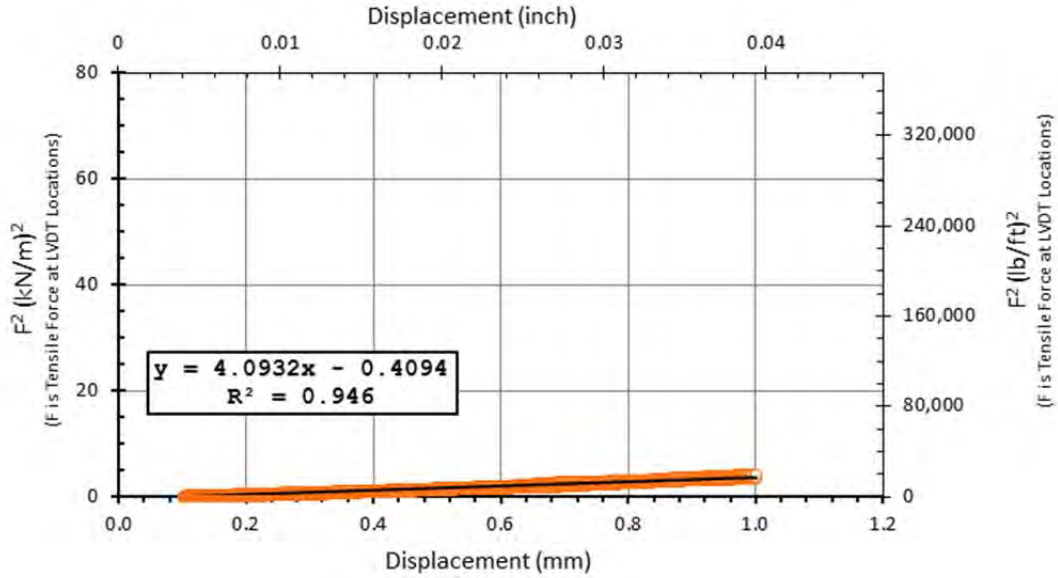
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.3	kN/m	844	lb/ft
Max Pullout Load	P_{max}	4.49	kN	1021	lb
Max Shear Stress	τ_{max}	60.3	kPa	8.7	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
4.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/24/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	15.9	0.626
2	58.6	2.307
3	101.6	4.000
4	144.7	5.697
5	230.4	9.071

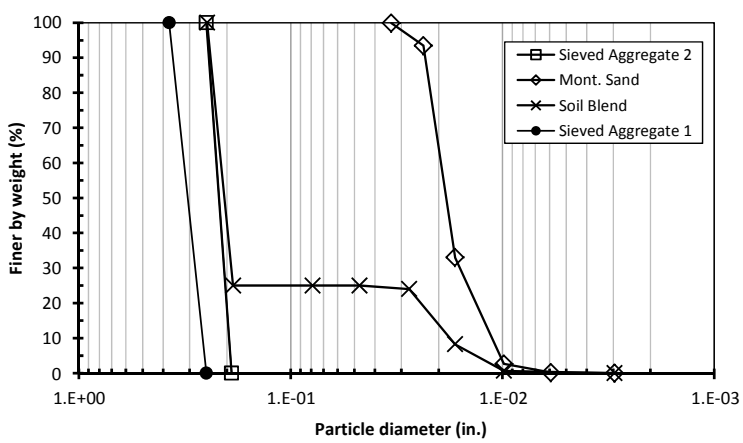
Pullout Rate	
1.0 mm/min.	0.04 in/min

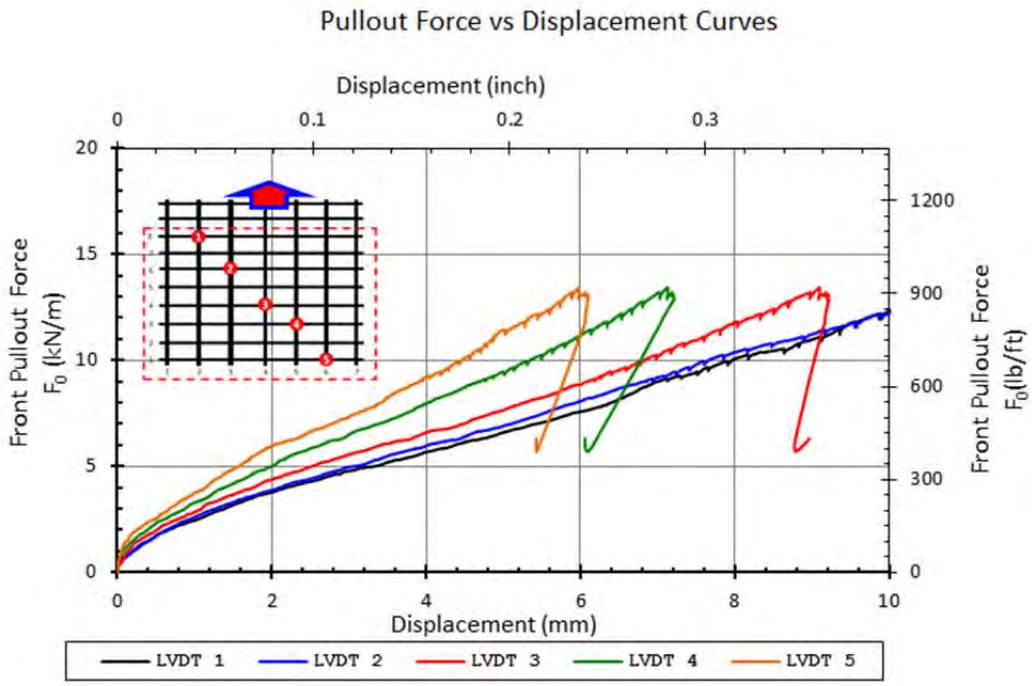
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

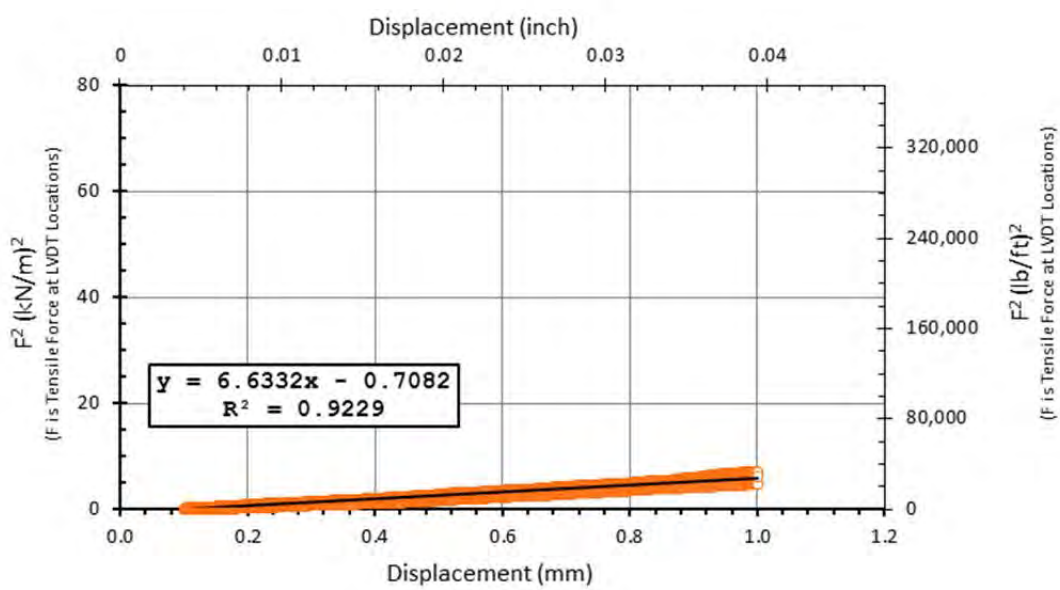
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
6.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Geogrid breakage during test. Thus, maximum pullout force not valid.

SMALL PULLOUT TEST

Date test conducted	7/29/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.211	m	0.245	m
	13	0.919	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	16.3	0.642
2	66.0	2.598
3	100.1	3.941
4	134.6	5.299
5	218.7	8.610

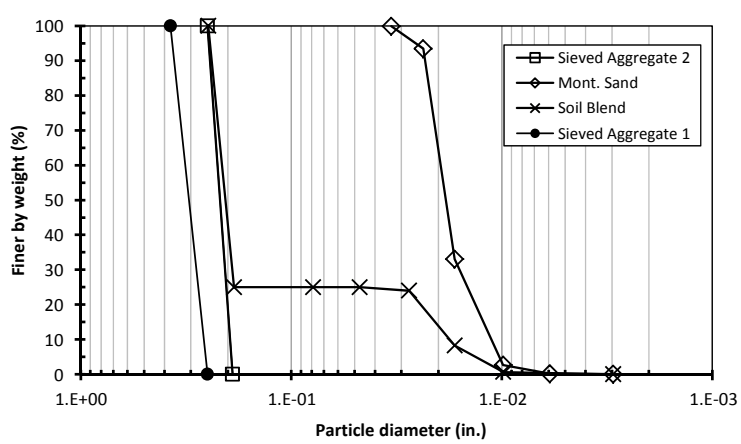
Pullout Rate	
1.0 mm/min.	0.04 in/min

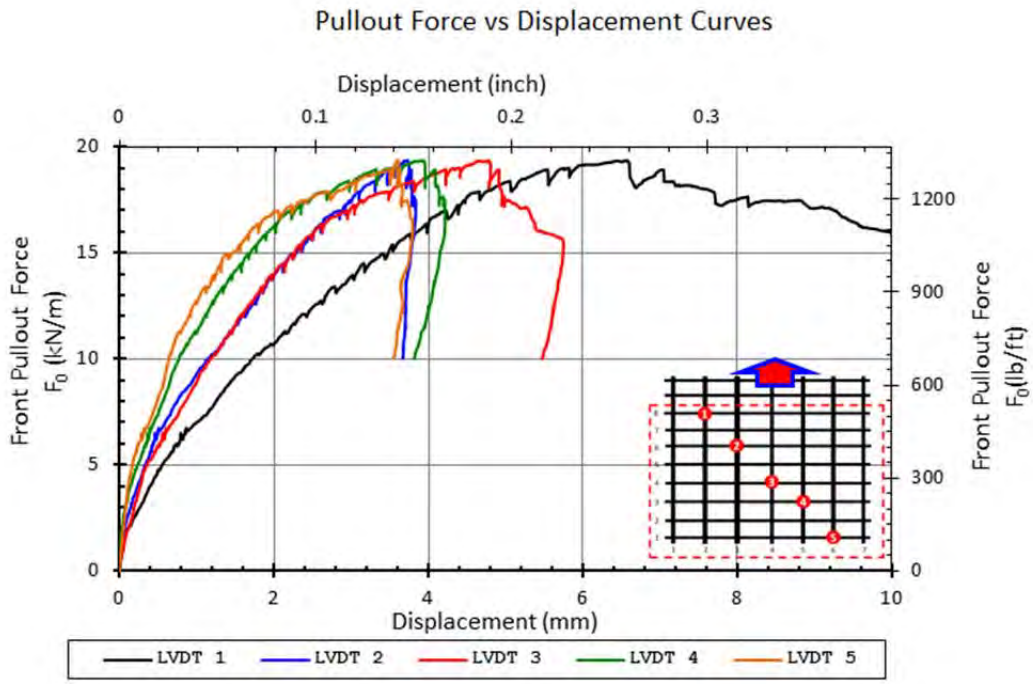
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

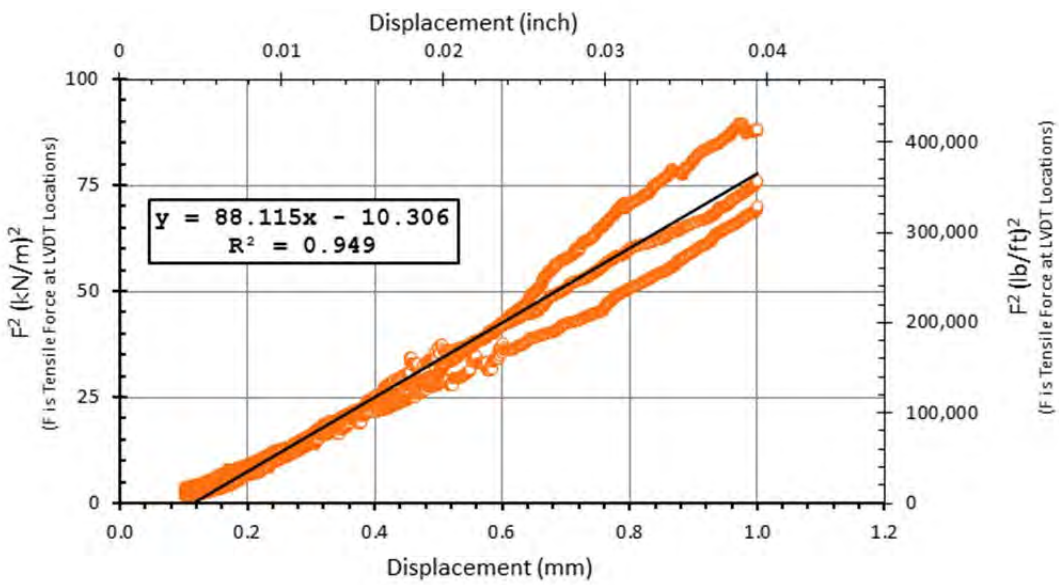
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
88.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

Geogrid breakage during test. Thus, maximum pullout force not valid.

SMALL PULLOUT TEST

Date test conducted	3/23/2011
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.211	m	0.245	m
	13	0.922	ft	0.692	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.9	0.705
2	67.8	2.669
3	101.8	4.008
4	135.9	5.350
5	219.8	8.654

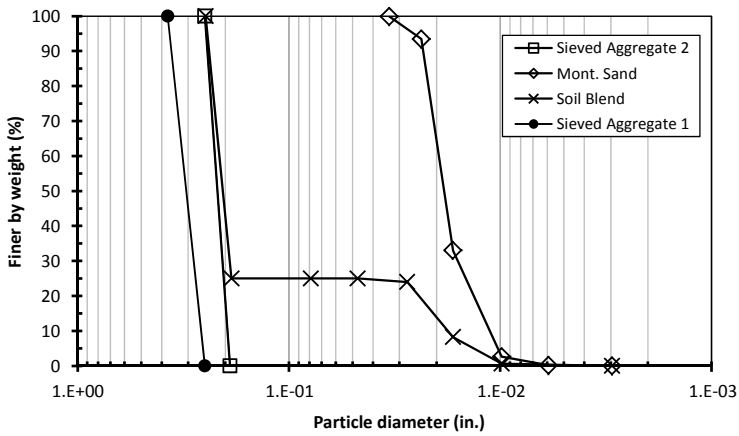
Pullout Rate			
1.0	mm/min.	0.04	in/min

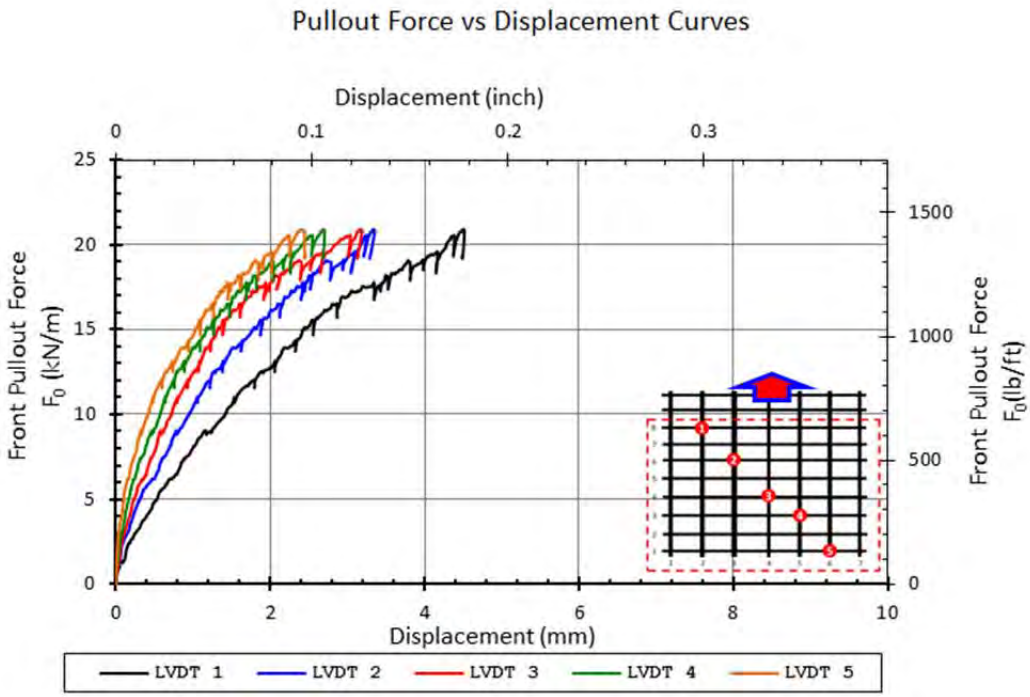
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.596 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

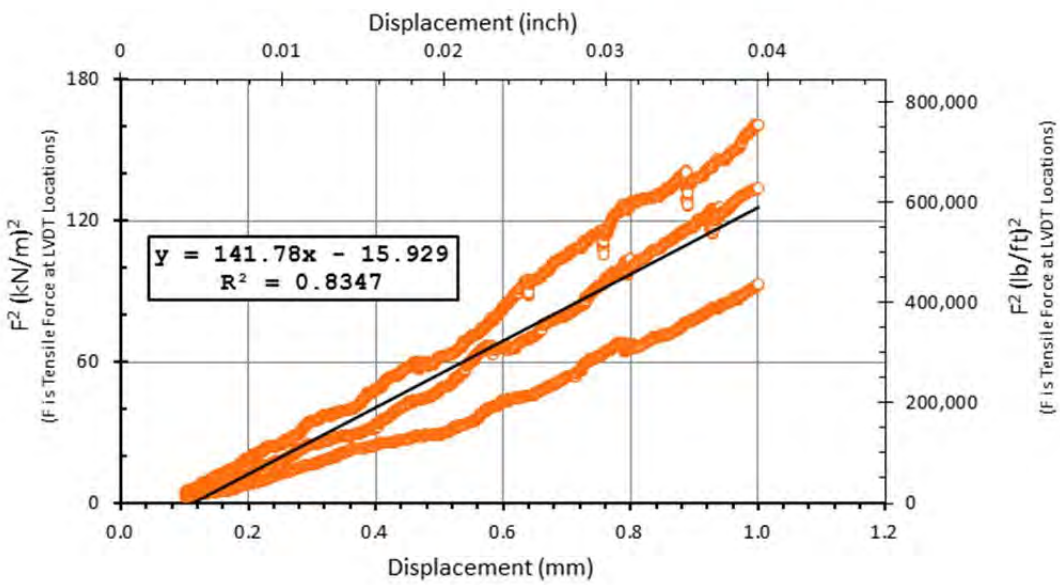
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	20.9	kN/m	1,434	lb/ft
Max Pullout Load	P_{max}	4.41	kN	1003	lb
Max Shear Stress	τ_{max}	59.3	kPa	8.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
141.8 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/2/2010
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.268	m	0.300	m	0.245	m
	6	0.879	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	30.7	1.209
2	76.4	3.008
3	121.2	4.772
4	164.8	6.488
5	209.4	8.244

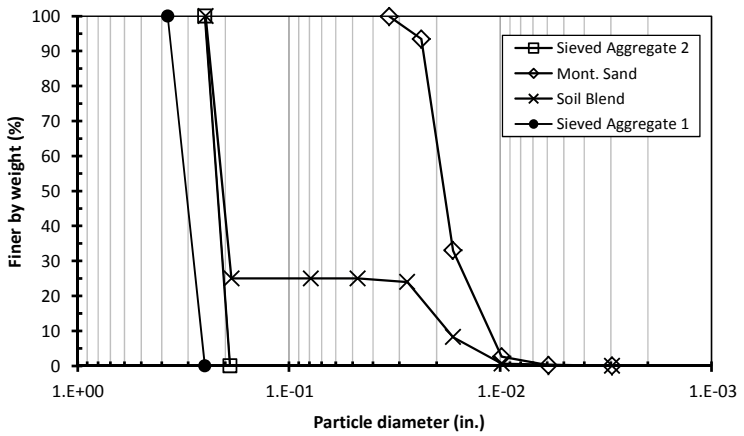
Pullout Rate			
1.0	mm/min.	0.04	in/min

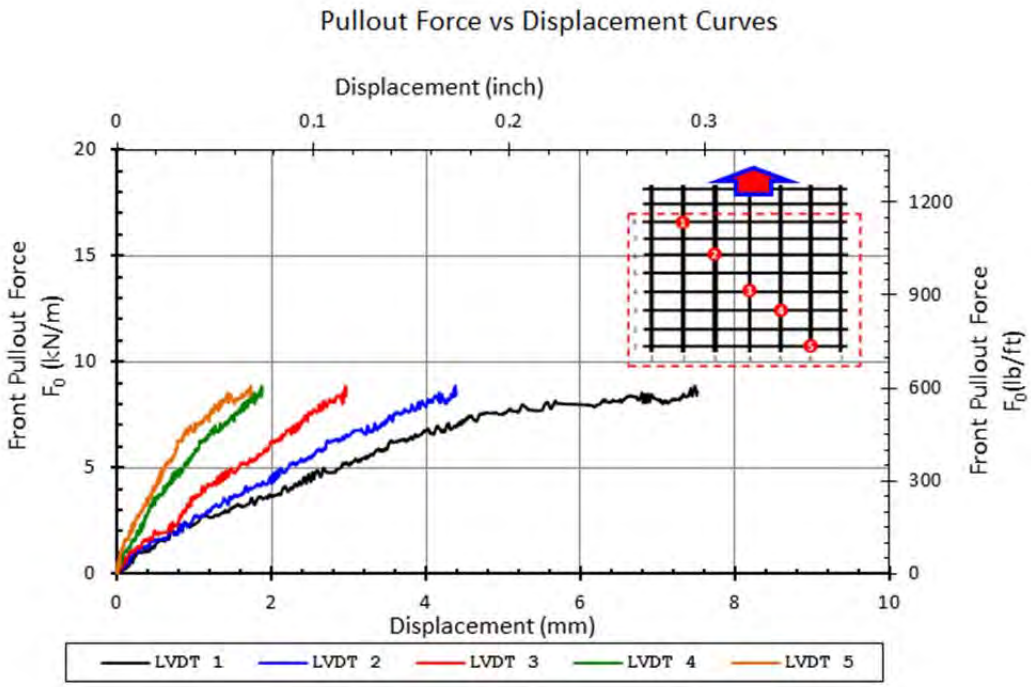
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.596 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

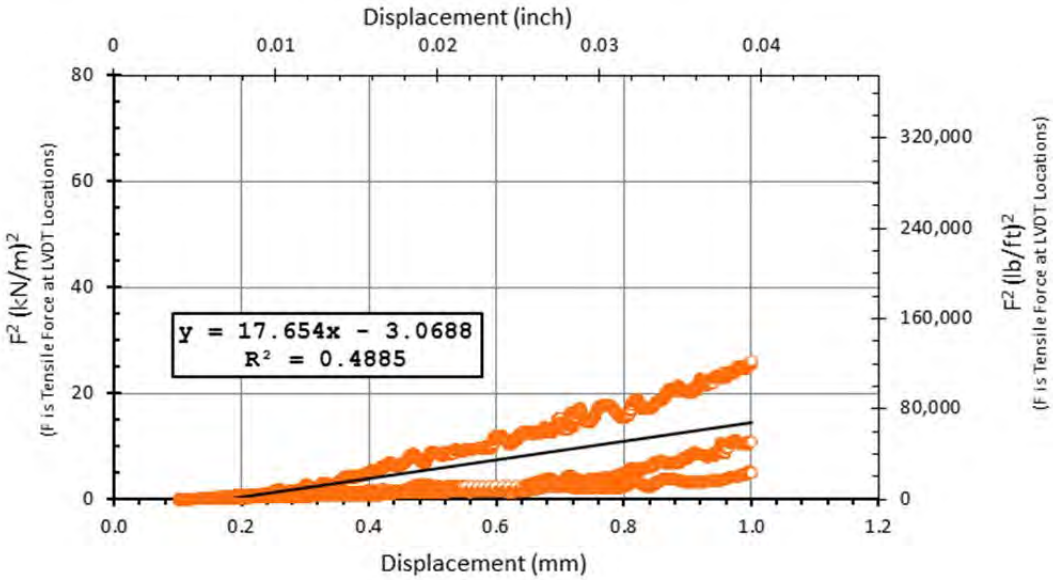
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.5	kN/m	585	lb/ft
Max Pullout Load	P_{max}	2.56	kN	476	lb
Max Shear Stress	τ_{max}	34.4	kPa	5.0	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
17.7	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/19/2010
Done by	Chris

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.300	m	0.245	m
	6	0.912	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	25.6	1.008
2	71.8	2.827
3	116.7	4.594
4	164.8	6.488
5	210.8	8.299

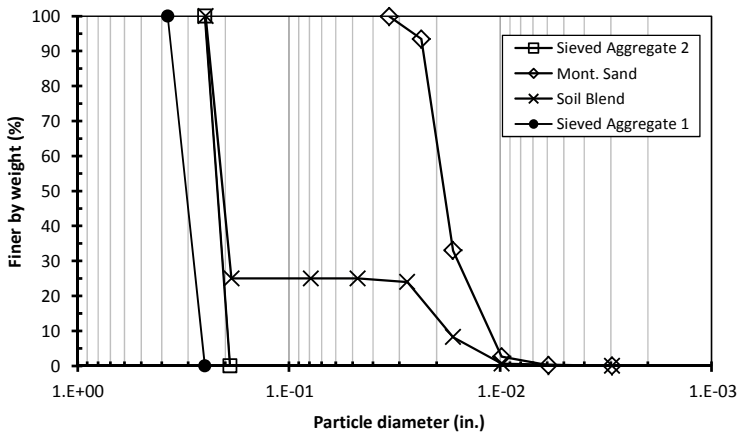
Pullout Rate			
1.0	mm/min.	0.04	in/min

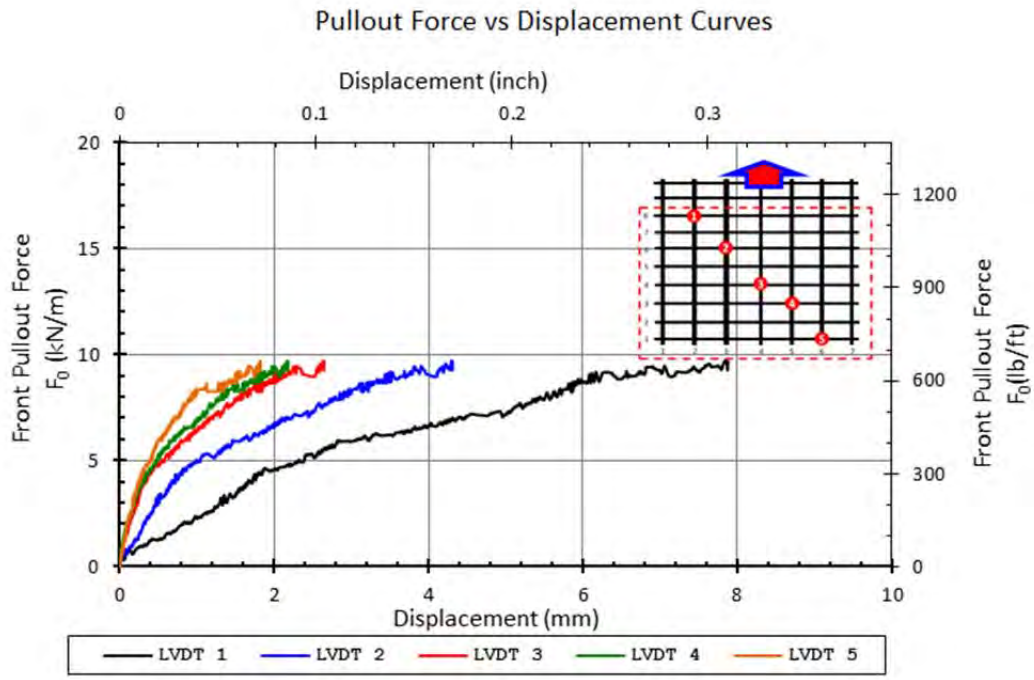
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.591 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

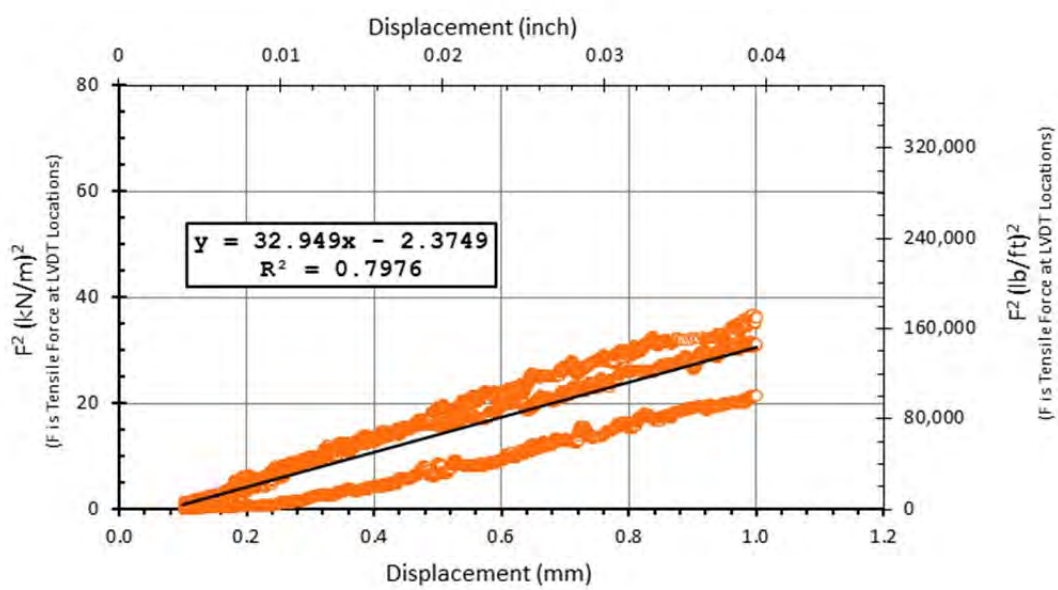
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.4	kN/m	646	lb/ft
Max Pullout Load	P_{max}	2.83	kN	542	lb
Max Shear Stress	τ_{max}	38.0	kPa	5.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
33.0 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	11/23/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.304	m	0.245	m
	7	0.915	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	21.7	0.854
2	76.1	2.996
3	130.4	5.134
4	183.6	7.228
5	234.6	9.236

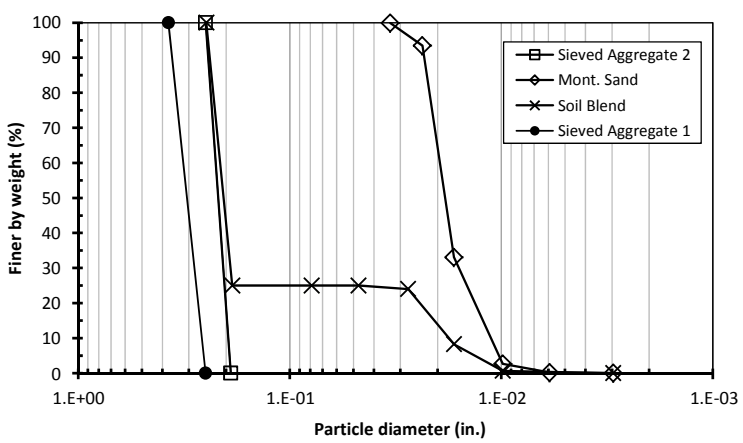
Pullout Rate	
1.0 mm/min.	0.04 in/min

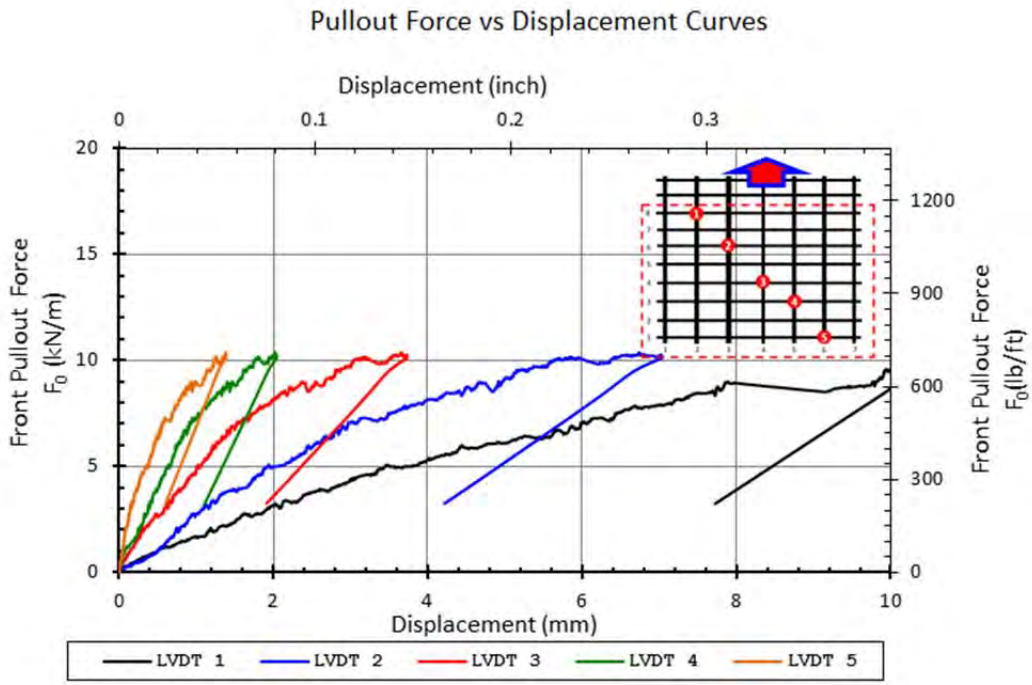
SOIL Information		
Soil	Sieved Aggregate 1	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.596 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

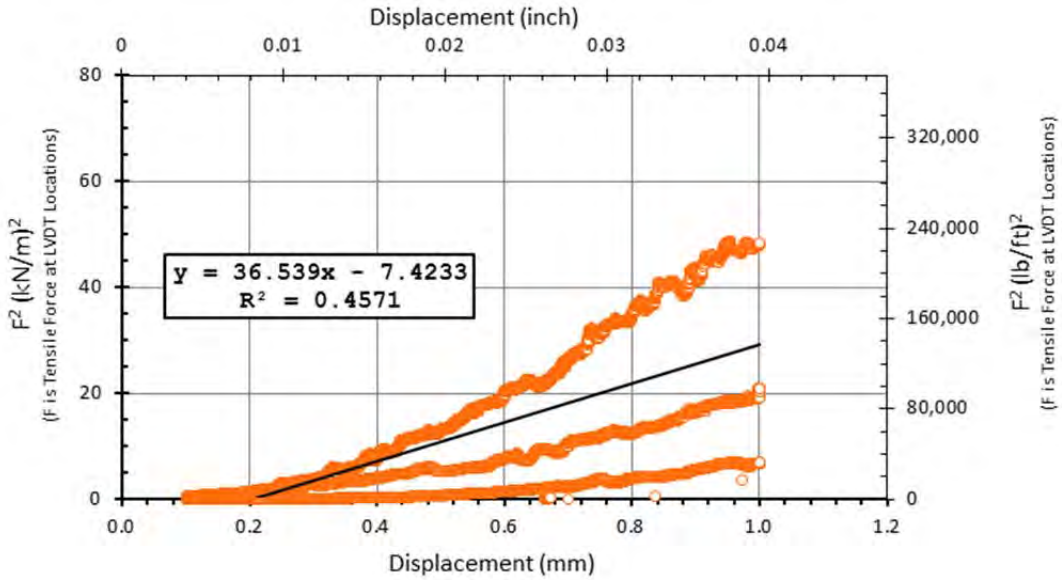
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
36.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Geogrid brekage during test. Thus, maximum pullout force not valid.

SMALL PULLOUT TEST

Date test conducted	11/29/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.289	m	0.304	m	0.245	m
	7	0.948	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.9	0.783
2	70.6	2.780
3	121.7	4.791
4	175.2	6.898
5	226.2	8.906

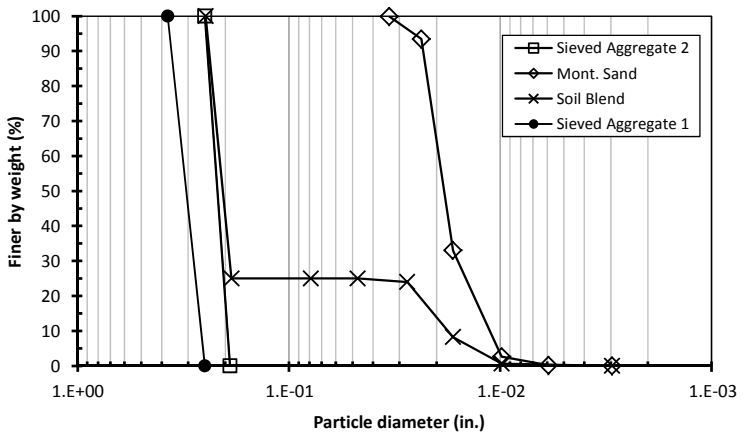
Pullout Rate			
1.0	mm/min.	0.04	in/min

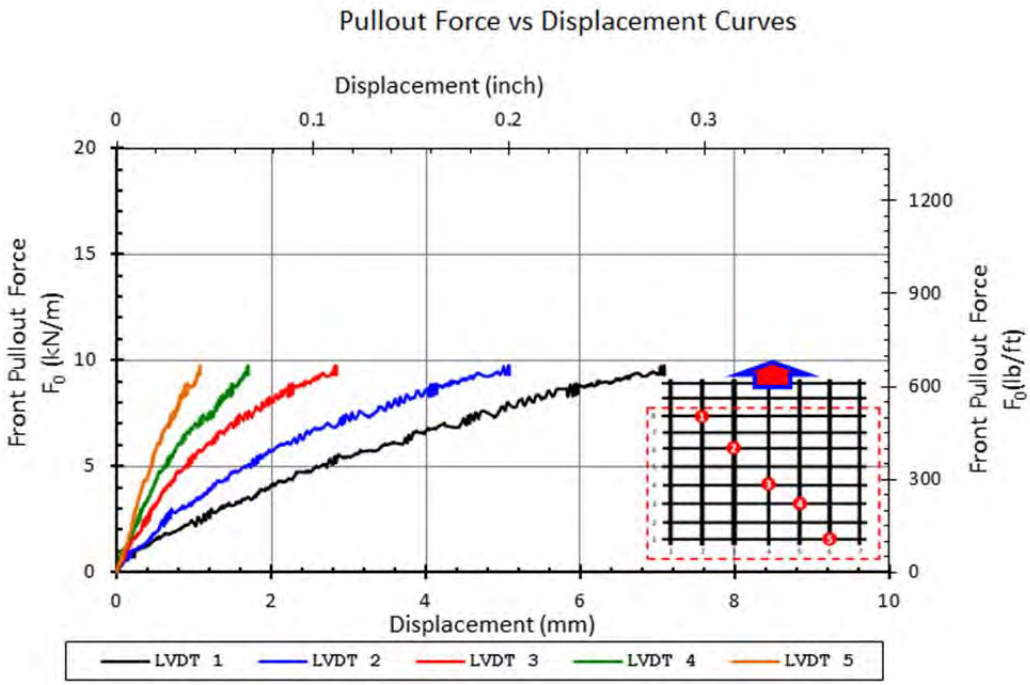
SOIL Information			
Soil	Sieved Aggregate 1		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.600 **g/cm^3**	**100**	**pcf**

Note: particle size distribution curve shown below

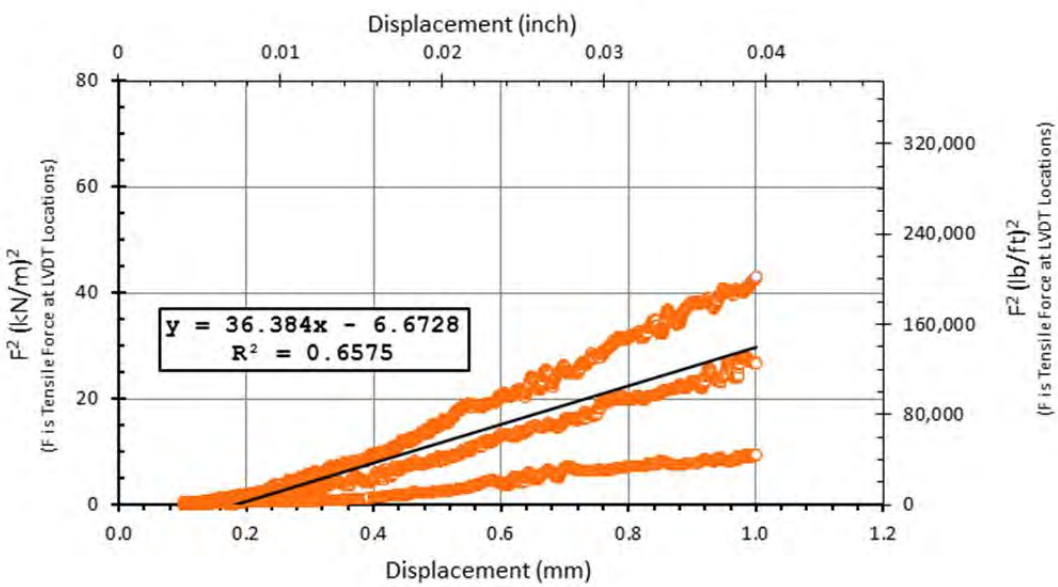
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	9.8	kN/m	669	lb/ft
Max Pullout Load	P_{max}	2.97	kN	592	lb
Max Shear Stress	τ_{max}	39.9	kPa	5.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
36.4	**(kN/m)^2/mm**





K_{SGI} plot



Comments:

Appendix A10

This appendix presents the presented the results of the tests with Aggregate. These tests were performed with a confining pressure of 3 psi (21 kPa), and no use of torque wrench and analog air pressure gauge.

SMALL PULLOUT TEST

Date test conducted	7/21/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.279	m	0.263	m	0.245	m
	7	0.915	ft	0.861	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	28.3	1.114
2	86.0	3.386
3	145.7	5.737
4	173.7	6.839
5	231.9	9.129

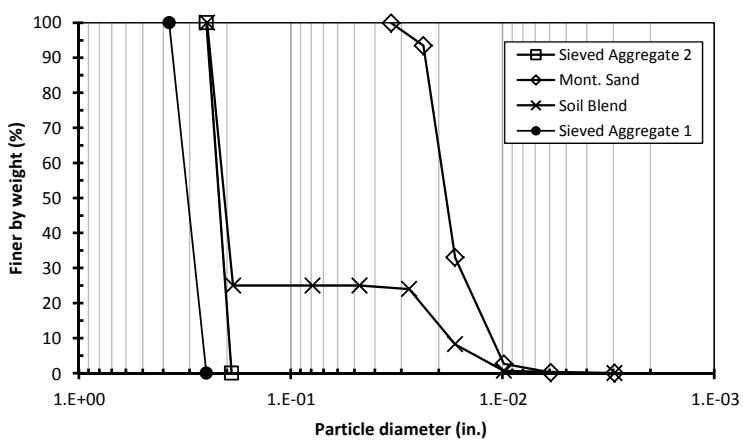
Pullout Rate	
1.0 mm/min.	0.04 in/min

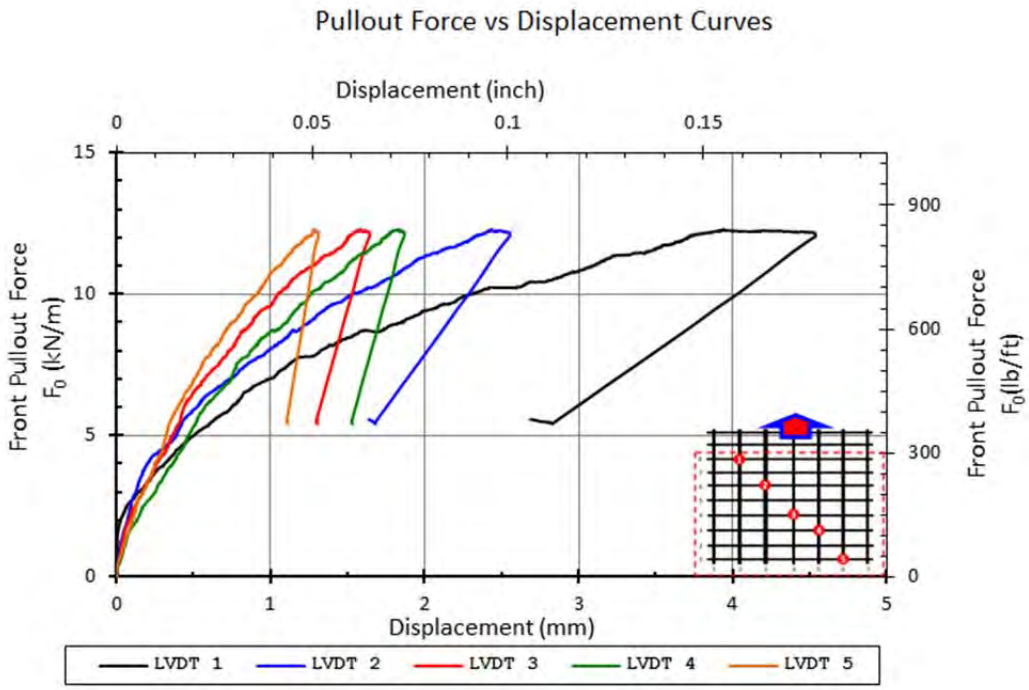
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.604 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

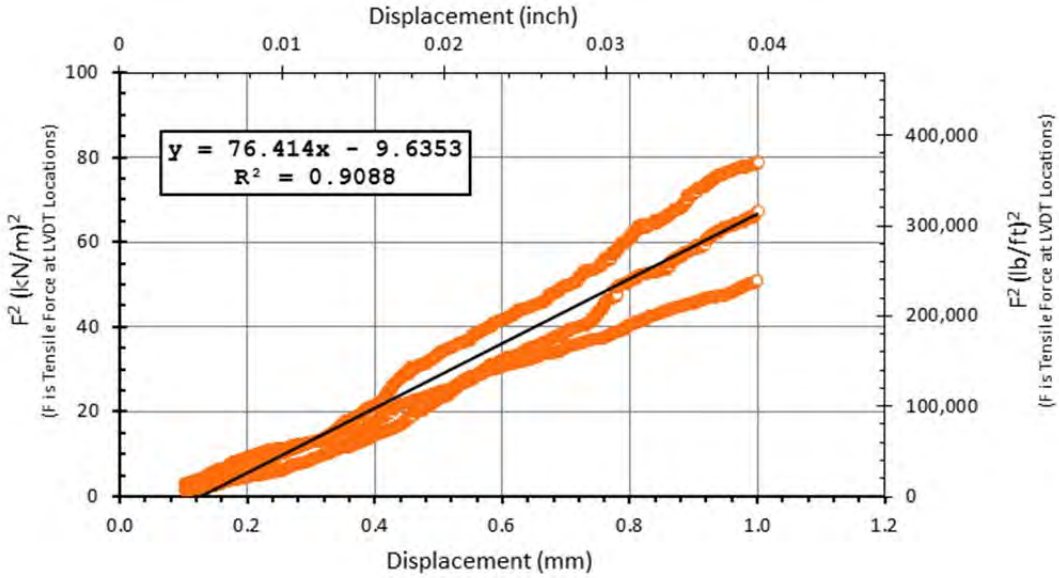
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
76.4 (kN/m)^2/mm





K_{SGI} plot



Comments:

Geogrid breakage during the test. Thus, maximum pullout force not applicable to report.

SMALL PULLOUT TEST

Date test conducted	7/27/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.275	m	0.245	m
	10	0.919	ft	0.902	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	24.5	0.966
2	105.2	4.143
3	145.8	5.740
4	186.4	7.339
5	226.1	8.900

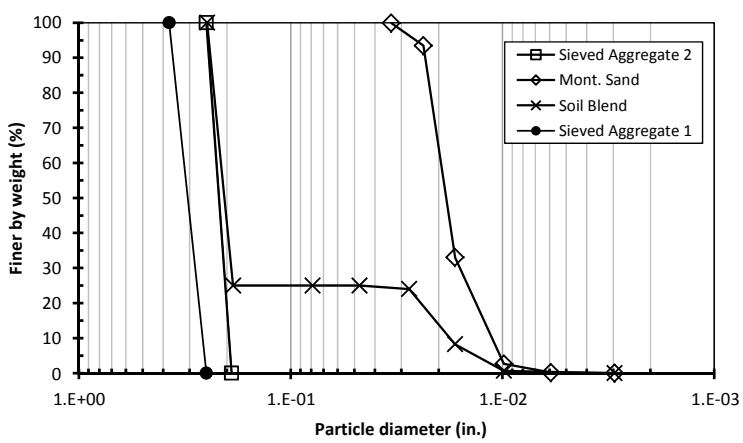
Pullout Rate	
1.0 mm/min.	0.04 in/min

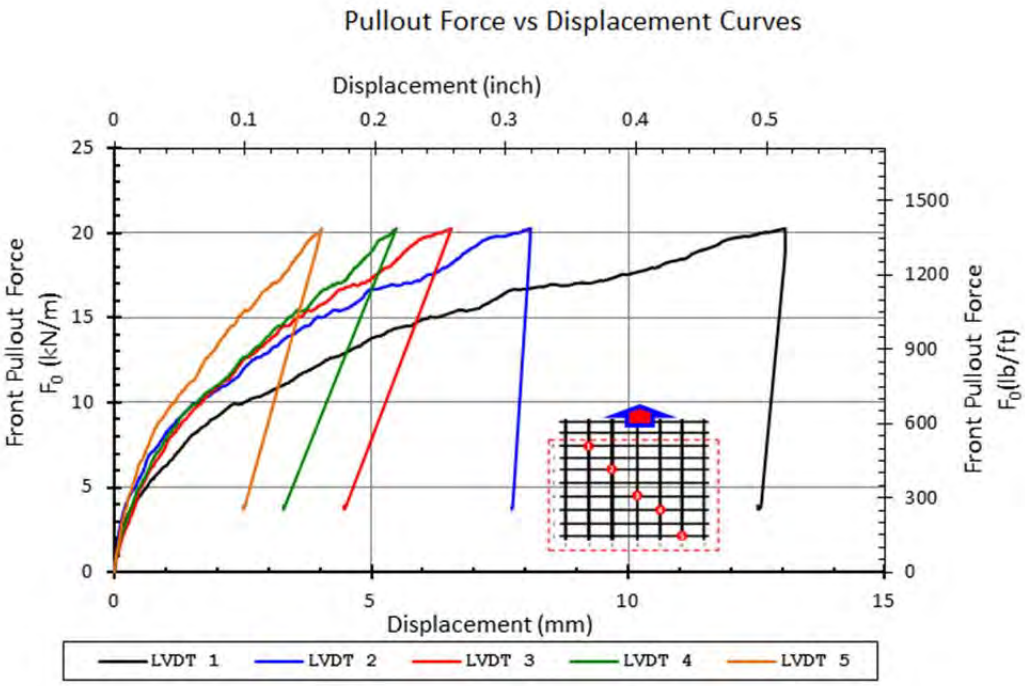
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

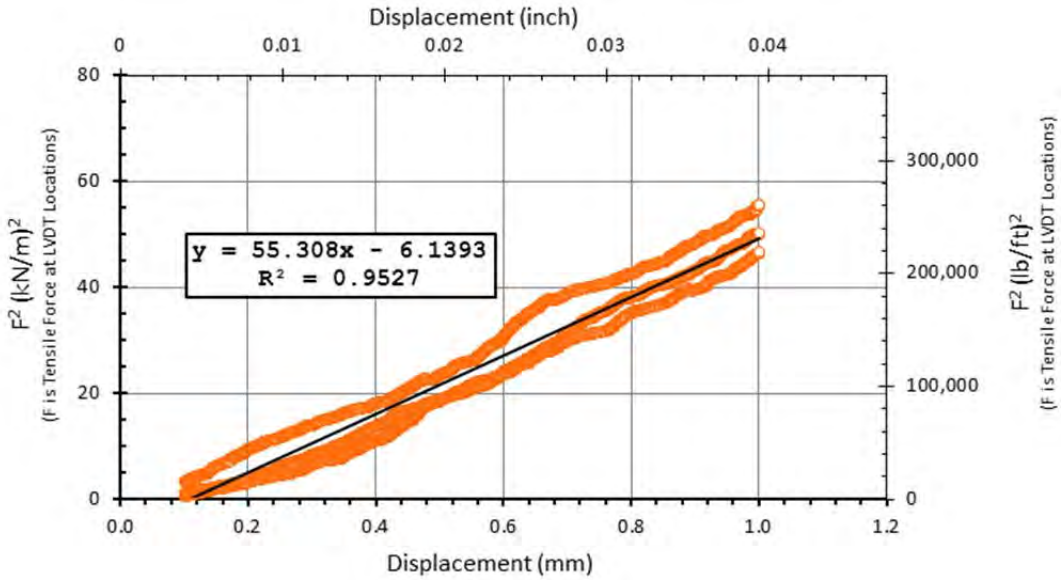
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
55.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

Geogrid breakage during the test. Thus, maximum pullout force not applicable.

SMALL PULLOUT TEST

Date test conducted	7/22/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.278	m	0.270	m	0.245	m
	10	0.912	ft	0.884	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	19.1	0.752
2	88.4	3.480
3	122.0	4.803
4	159.8	6.291
5	228.9	9.012

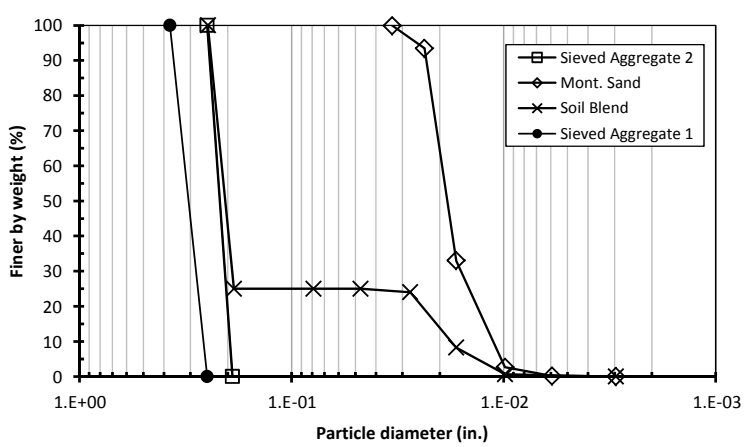
Pullout Rate	
1.0 mm/min.	0.04 in/min

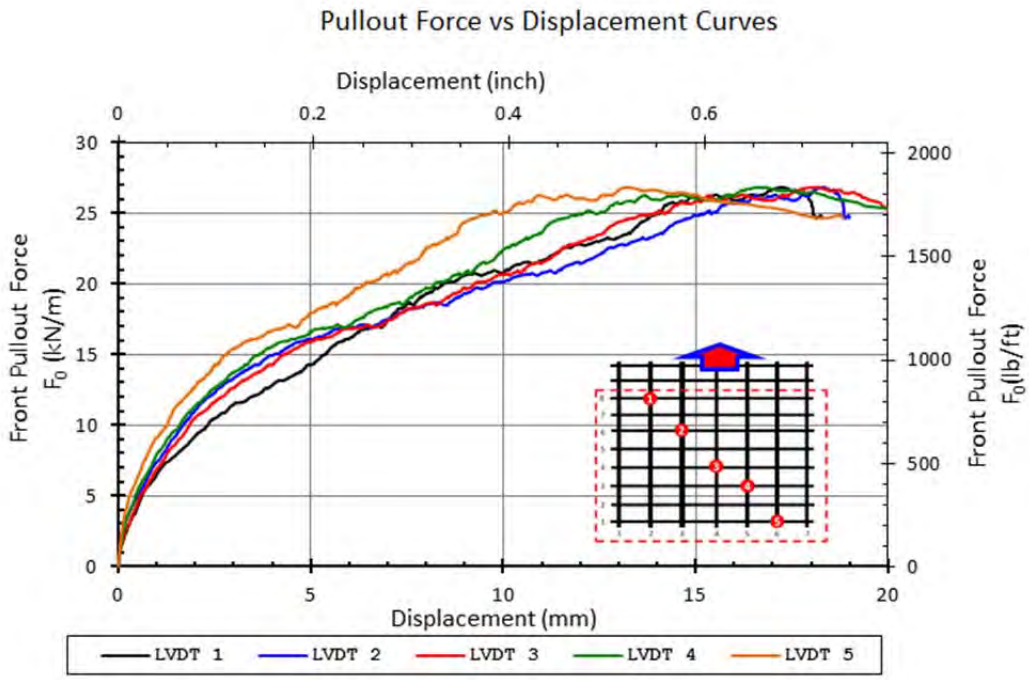
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.604 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

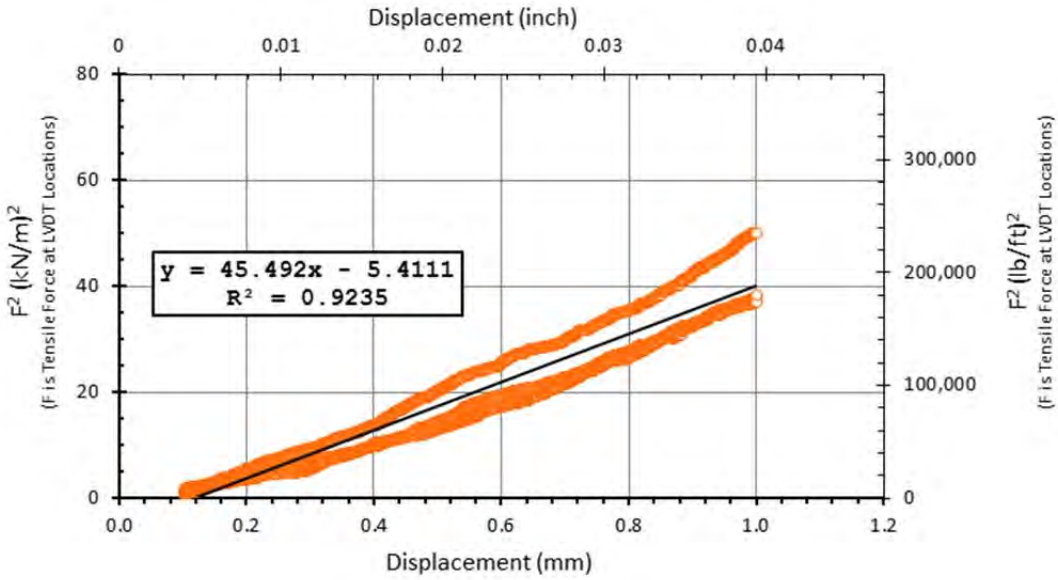
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	26.3	kN/m	1,802	lb/ft
Max Pullout Load	P_{max}	7.09	kN	1152	lb
Max Shear Stress	τ_{max}	95.3	kPa	13.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
45.5 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/1/2010 AM
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	35.1	1.382
2	88.4	3.480
3	145.4	5.724
4	173.4	6.827
5	227.0	8.937

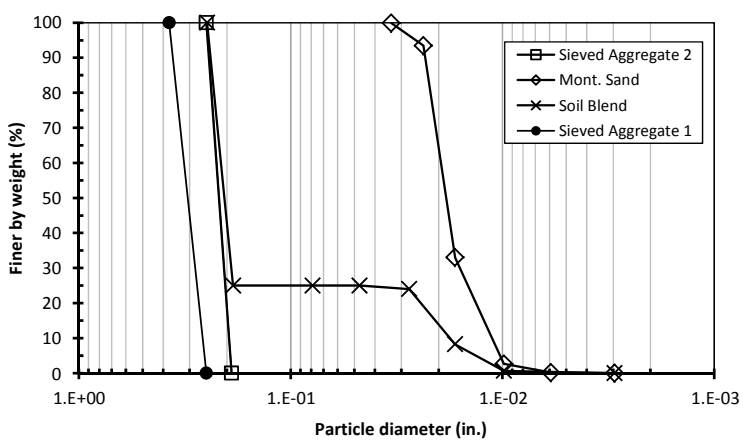
Pullout Rate	
1.0 mm/min.	0.04 in/min

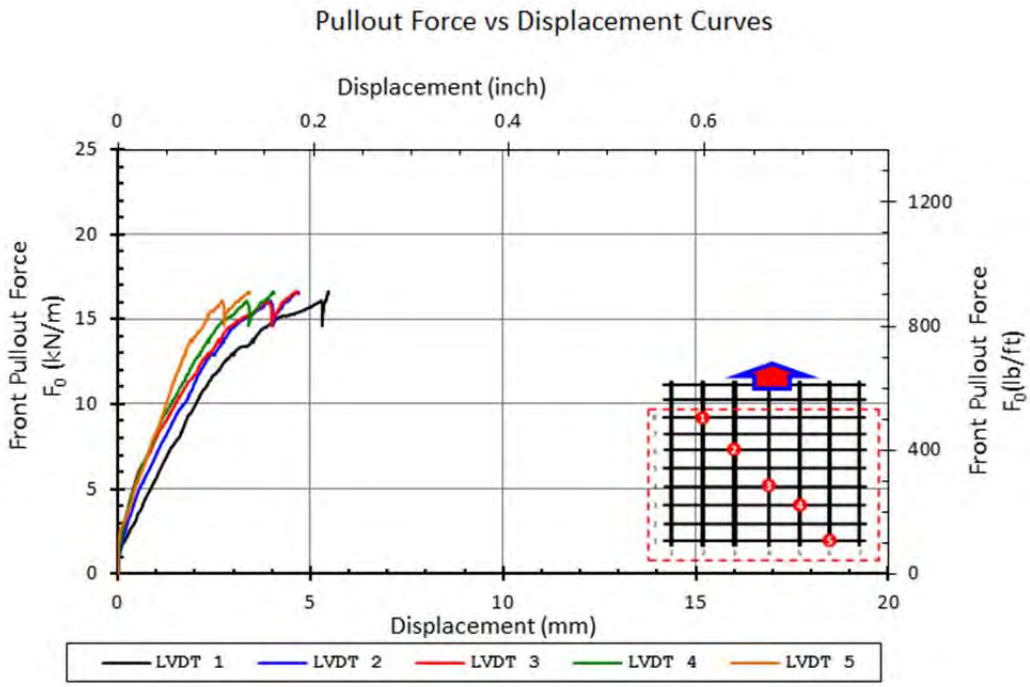
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

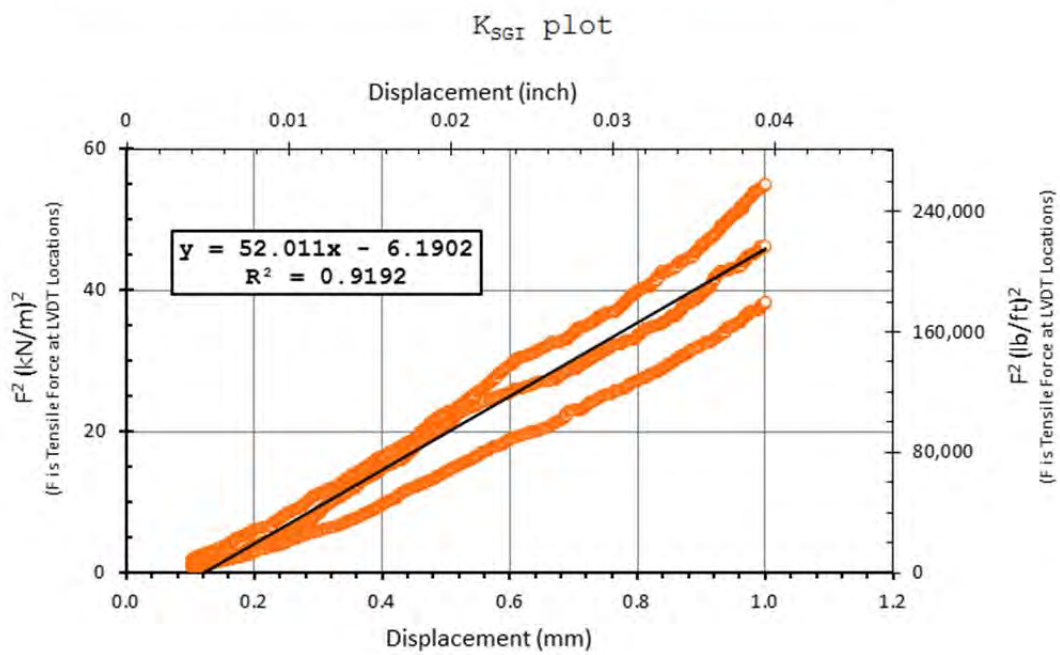
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	16.6	kN/m	1,140	lb/ft
Max Pullout Load	P_{max}	4.35	kN	996	lb
Max Shear Stress	τ_{max}	58.4	kPa	8.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
52.0 (kN/m)^2/mm




Pullout Force vs Displacement Curves
Displacement (inch)
0
0.2
0.4
0.6
25
20
15
10
5
0
Front Pullout Force
F0 (kN/m)
1200
800
400
0
Front Pullout Force
F0(lb/ft)
0
5
10
15
20
Displacement (mm)
LVDT 1
LVDT 2
LVDT 3
LVDT 4
LVDT 5


KSGI plot
Displacement (inch)
0
0.01
0.02
0.03
0.04
60
40
20
0
F2 (kN/m)2
(F is Tensile Force at LVDT Locations)
y = 52.011x - 6.1902
R2 = 0.9192
240,000
160,000
80,000
0
F2 (lb/ft)2
(F is Tensile Force at LVDT Locations)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Displacement (mm)

Comments:

SMALL PULLOUT TEST

Date test conducted	7/1/2010 PM
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	35.1	1.382
2	88.4	3.480
3	145.4	5.724
4	173.4	6.827
5	227.0	8.937

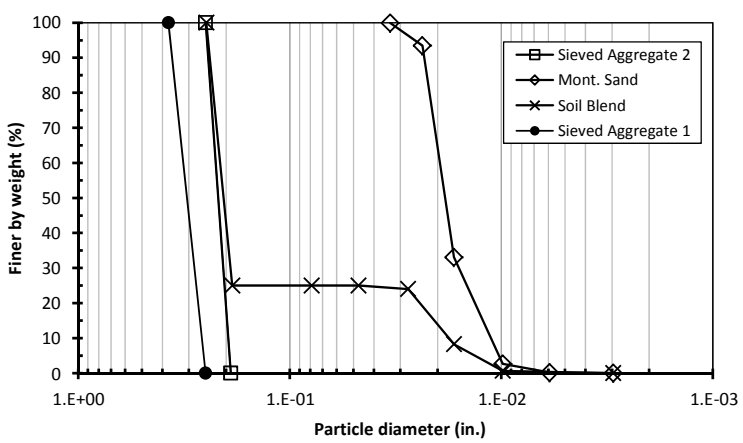
Pullout Rate	
1.0 mm/min.	0.04 in/min

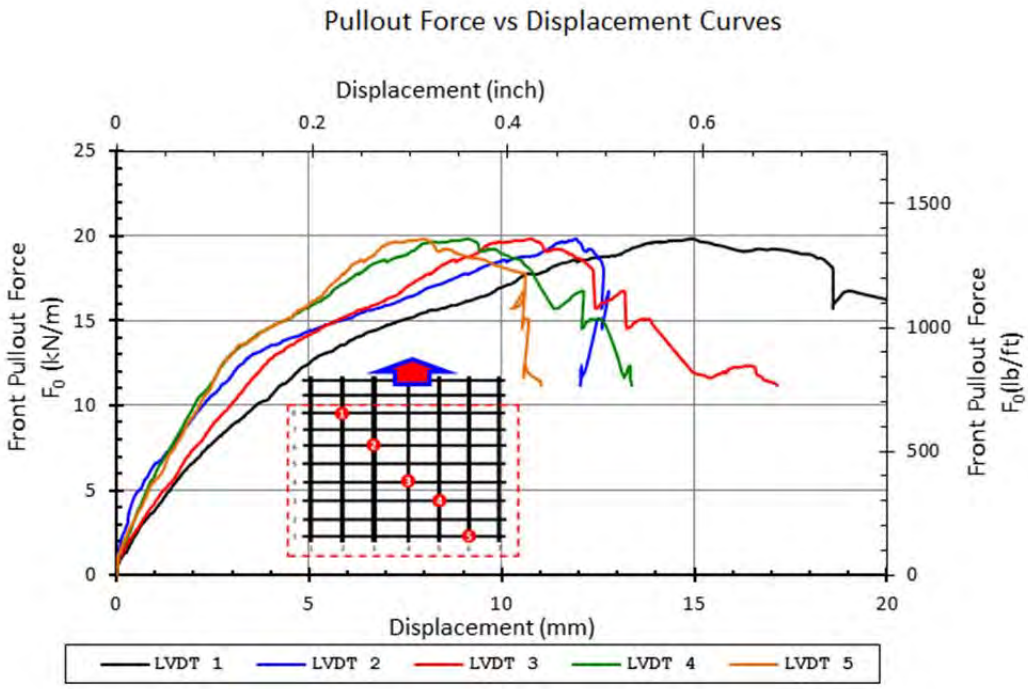
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.578 **g/cm^3**	**98 pcf**

Note: particle size distribution curve shown below

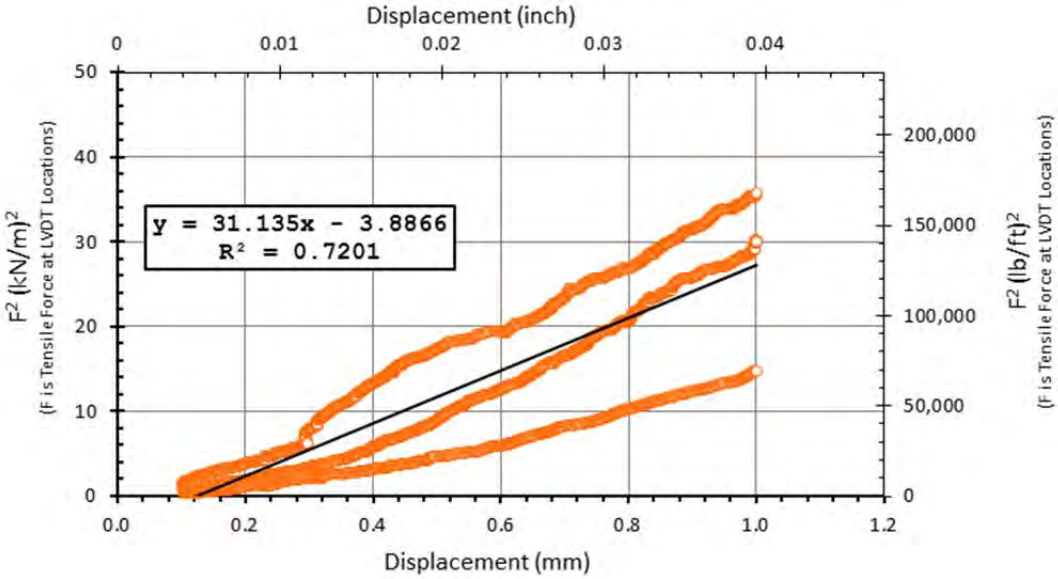
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	N/A	kN/m	N/A	lb/ft
Max Pullout Load	P_{max}	N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	N/A	kPa	N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	N/A			

Reported K_{SGI}
31.1 (kN/m)^2/mm





K_{SGI} plot



Comments:

Geogrid partial breakage during test. Thus, maximum pullout force not applicable.

SMALL PULLOUT TEST

Date test conducted	7/5/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PET

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.261	m	0.245	m
	8	0.919	ft	0.857	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	25.5	1.004
2	82.3	3.240
3	140.0	5.512
4	169.7	6.681
5	226.9	8.933

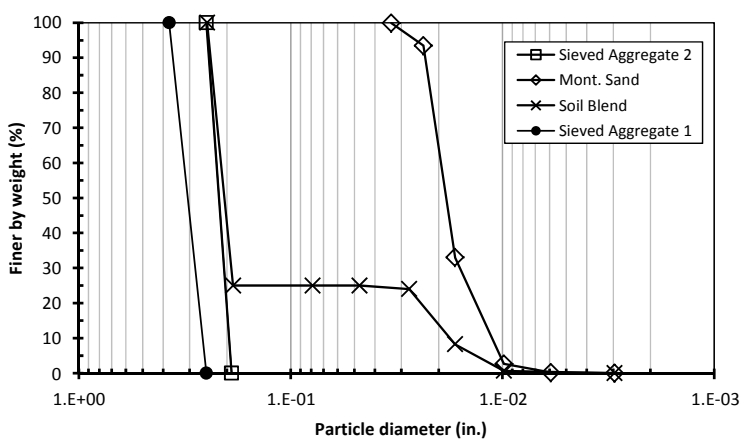
Pullout Rate	
1.0 mm/min.	0.04 in/min

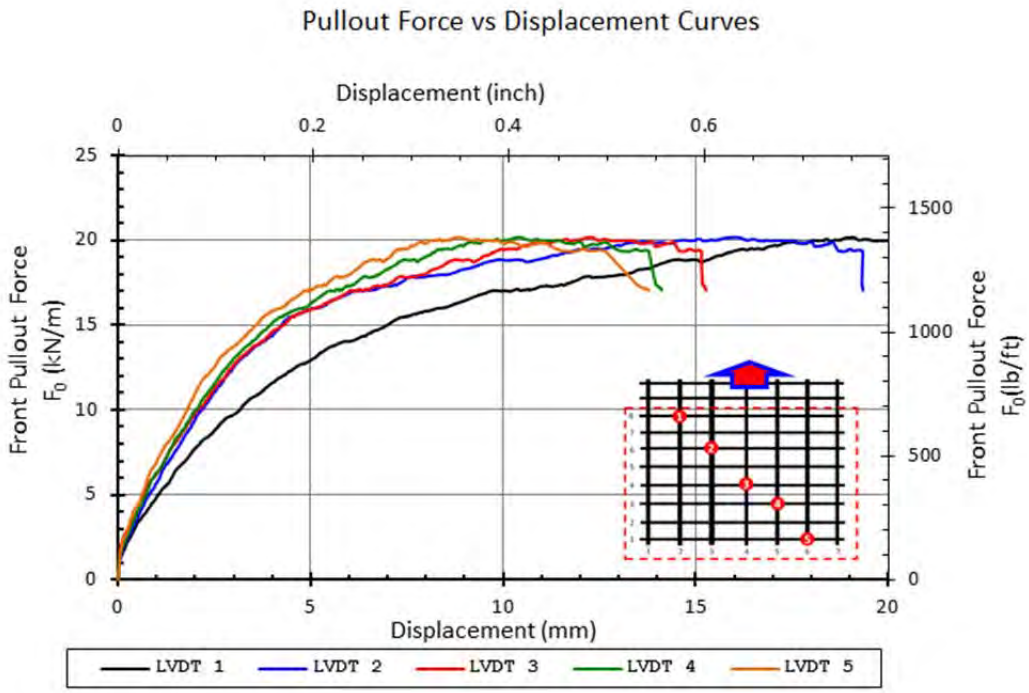
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.587 **g/cm^3**	**99 pcf**

Note: particle size distribution curve shown below

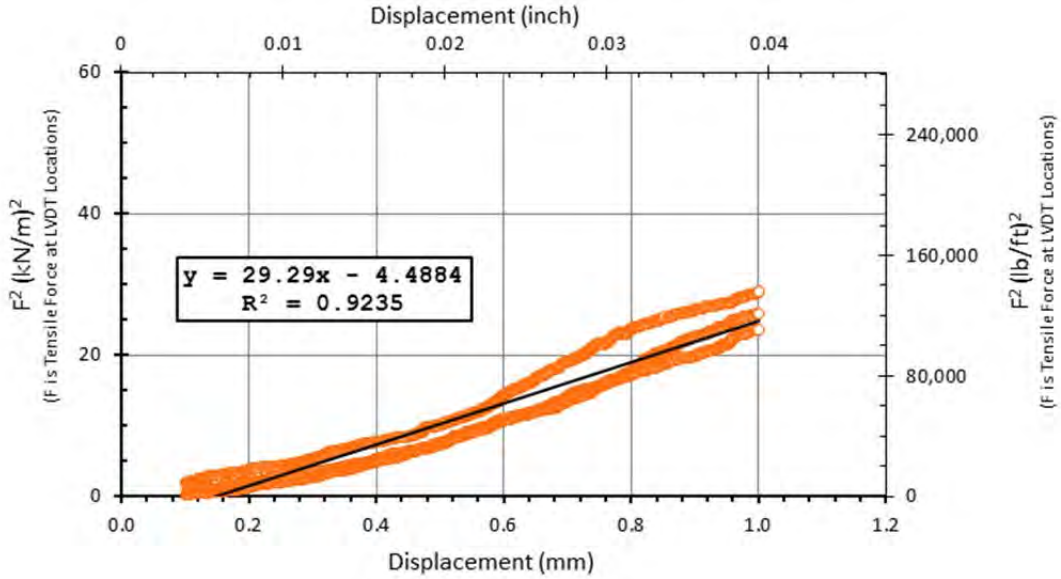
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	20.2	kN/m	1,384	lb/ft
Max Pullout Load	P_{max}	5.27	kN	1098	lb
Max Shear Stress	τ_{max}	70.9	kPa	10.3	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
29.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/18/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geotextile		MD	GT

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.285	m	0.285	m	0.245	m
	---	0.935	ft	0.935	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	8.3	0.327
2	85.7	3.374
3	124.9	4.917
4	167.5	6.594
5	217.8	8.575

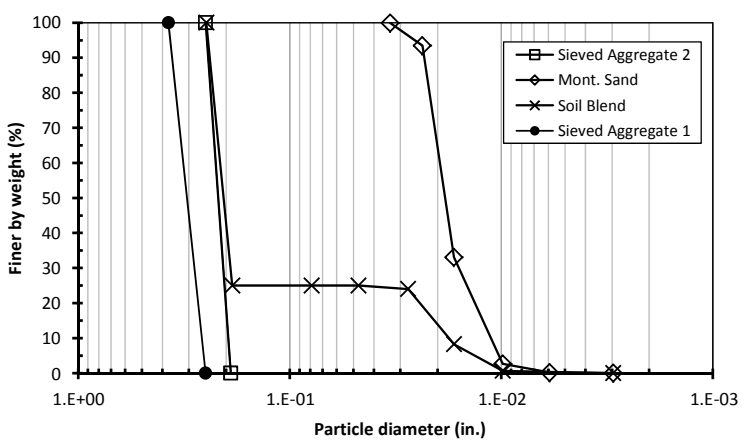
Pullout Rate	
1.0 mm/min.	0.04 in/min

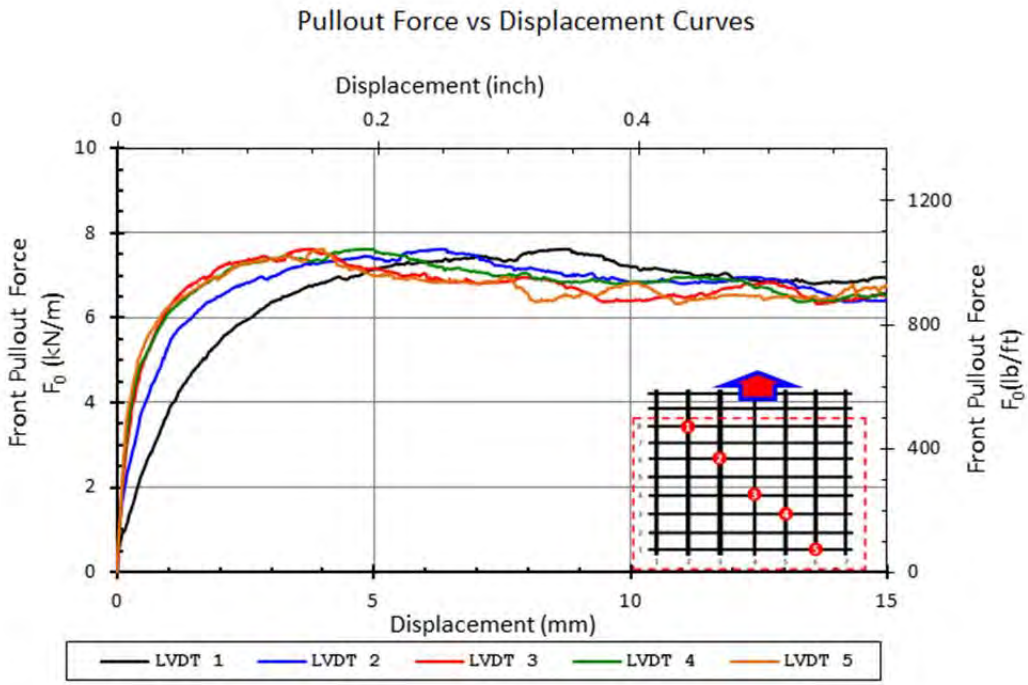
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

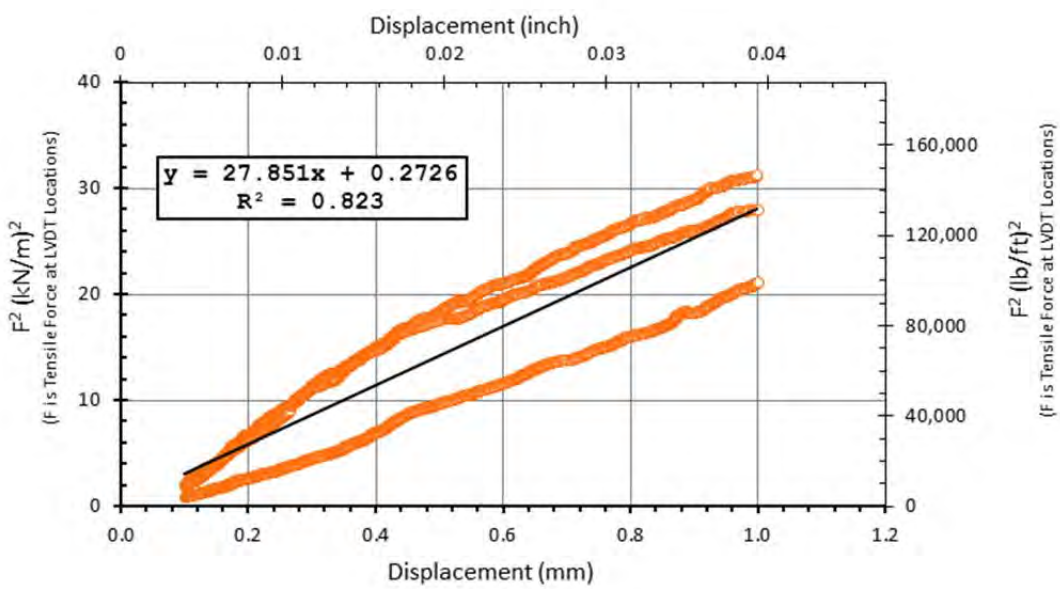
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	7.6	kN/m	523	lb/ft
Max Pullout Load	P_{max}	2.17	kN	503	lb
Max Shear Stress	τ_{max}	29.2	kPa	4.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	0.8			

Reported K_{SGI}
27.9 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/14/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.281	m	0.304	m	0.245	m
	7	0.922	ft	0.999	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	17.7	0.697
2	77.3	3.043
3	136.7	5.382
4	168.4	6.630
5	230.1	9.059

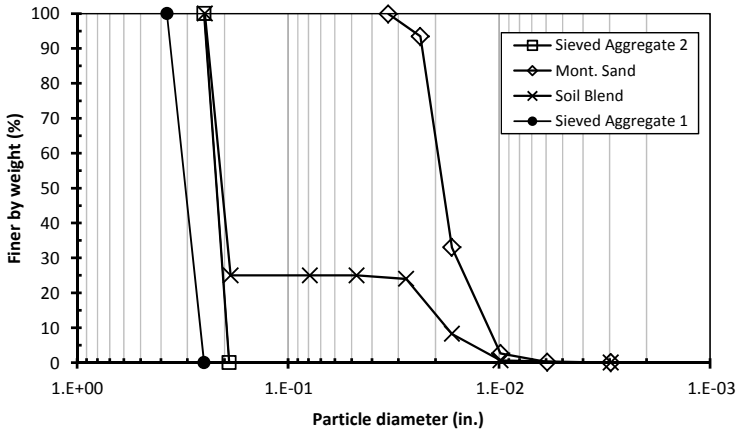
Pullout Rate			
1.0	mm/min.	0.04	in/min

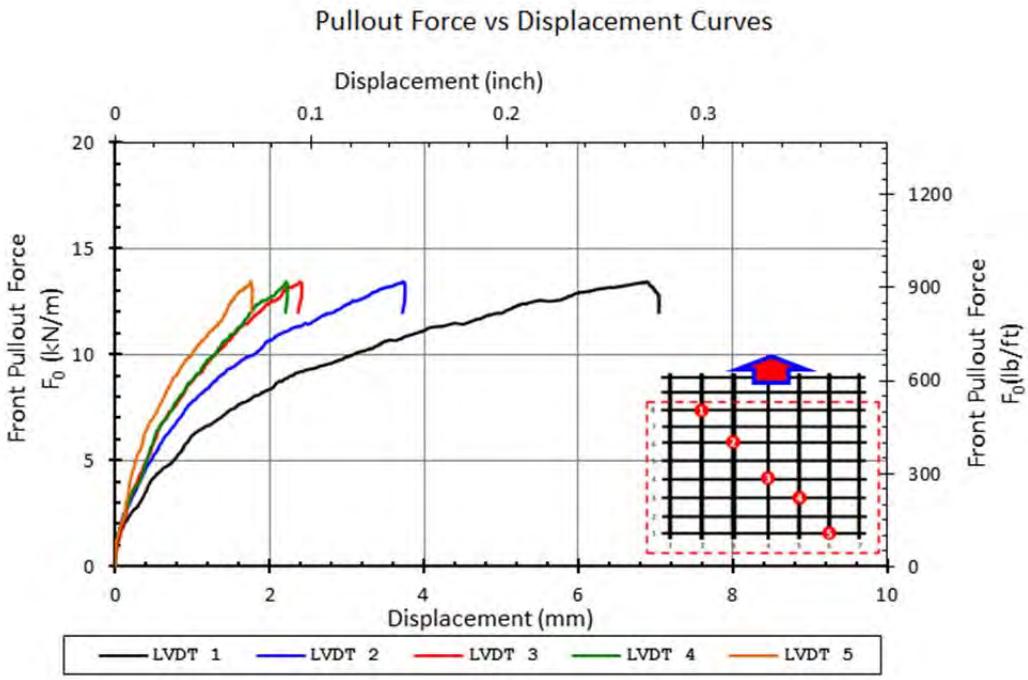
SOIL Information			
Soil	Aggregate		
Water Content	0.00	**%**	
Dry Density (ρ_d)	1.604	**g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

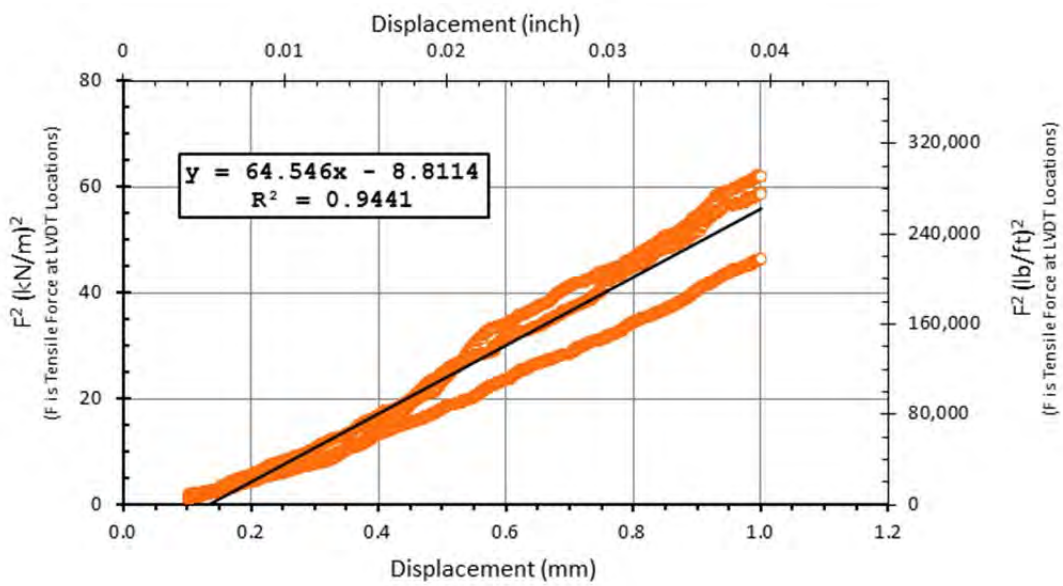
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	#N/A	kN/m	#N/A	lb/ft
Max Pullout Load	P_{max}	#N/A	kN	N/A	lb
Max Shear Stress	τ_{max}	#N/A	kPa	#N/A	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	#N/A			

Reported K_{SGI}
64.6 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Geogrid breakage during test. Thus, maximum pullout force not applicable.

SMALL PULLOUT TEST

Date test conducted	6/8/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.275	m	0.265	m	0.245	m
	9	0.902	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.5	0.413
2	99.8	3.929
3	143.9	5.665
4	187.9	7.398
5	230.8	9.087

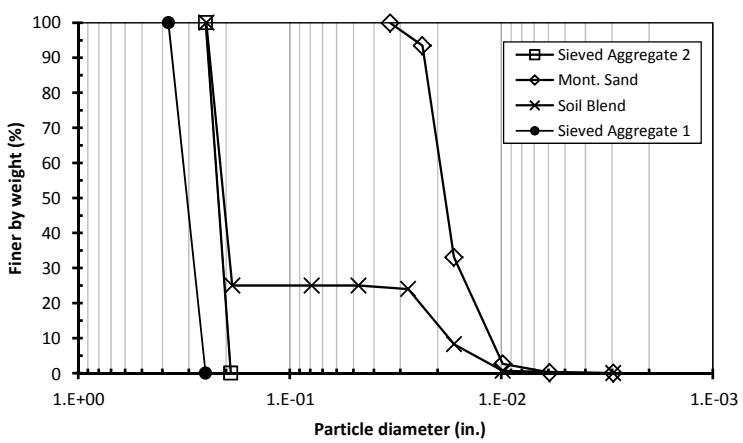
Pullout Rate	
1.0 mm/min.	0.04 in/min

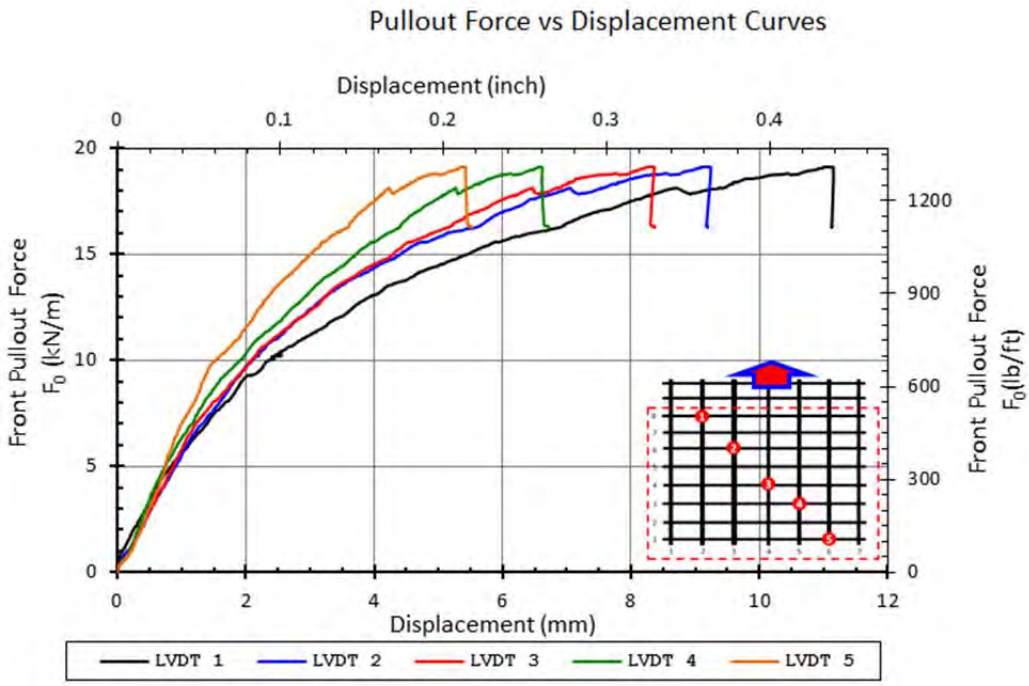
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.560 **g/cm^3**	**97 pcf**

Note: particle size distribution curve shown below

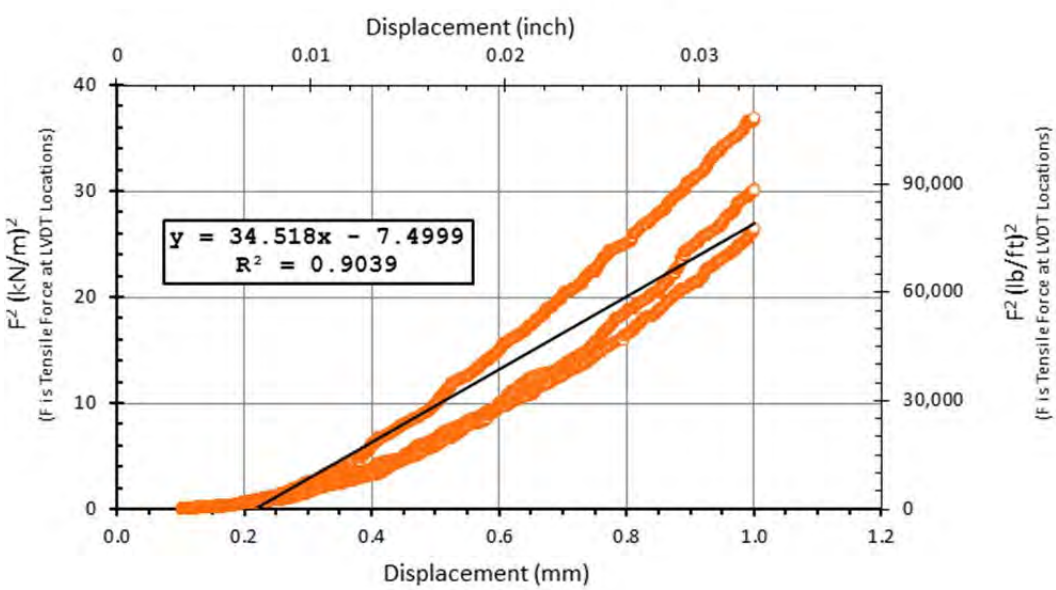
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	19.1	kN/m	1,311	lb/ft
Max Pullout Load	P_{max}	5.07	kN	1150	lb
Max Shear Stress	τ_{max}	68.1	kPa	9.9	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
34.5 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	6/12/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.266	m	0.265	m	0.245	m
	9	0.873	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	43.8	1.724
2	119.7	4.713
3	157.5	6.201
4	194.8	7.669
5	231.6	9.118

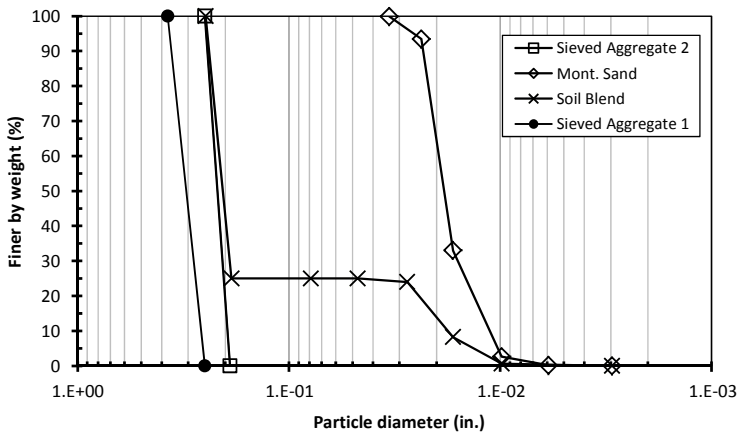
Pullout Rate			
1.0	mm/min.	0.04	in/min

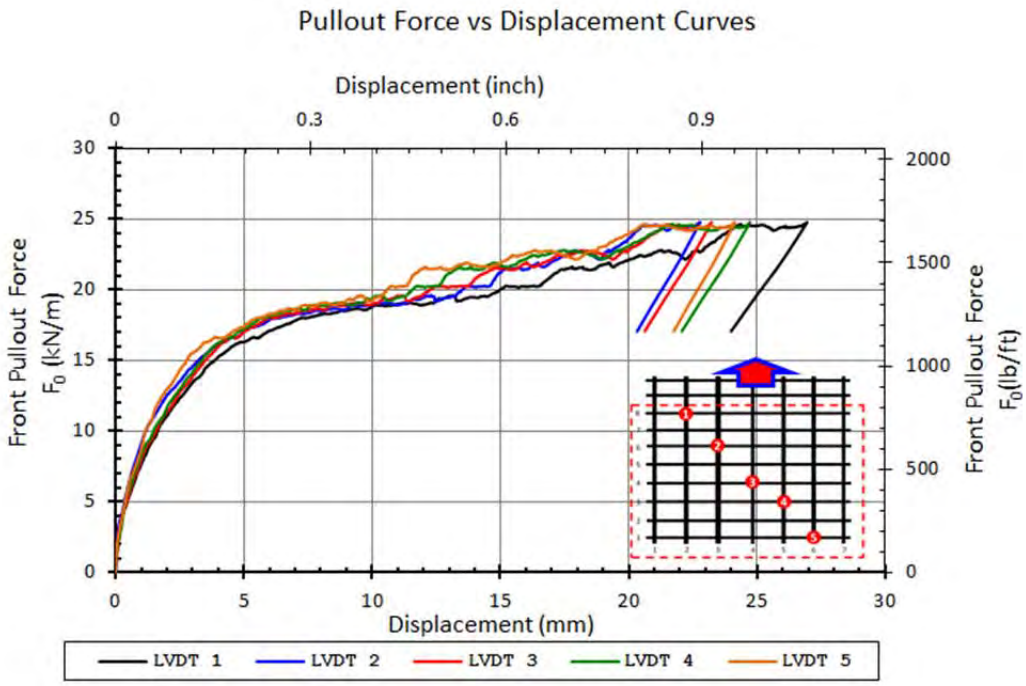
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.627 **g/cm^3**	**102 pcf**

Note: particle size distribution curve shown below

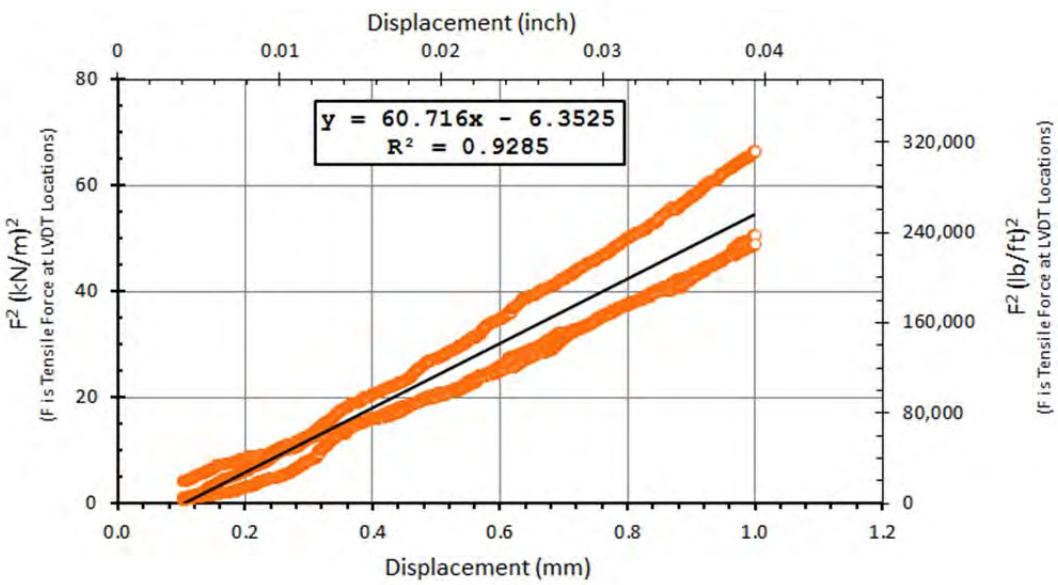
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	22.8	kN/m	1,561	lb/ft
Max Pullout Load	P_{max}	6.03	kN	1148	lb
Max Shear Stress	τ_{max}	81.1	kPa	11.8	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
60.7 $(kN/m)^2/mm$





K_{SGI} plot



Comments:

Geogrid specimen failure in tension during test.

SMALL PULLOUT TEST

Date test conducted	7/10/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.277	m	0.265	m	0.245	m
	9	0.909	ft	0.869	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	10.4	0.409
2	99.5	3.917
3	143.3	5.642
4	185.3	7.295
5	225.8	8.890

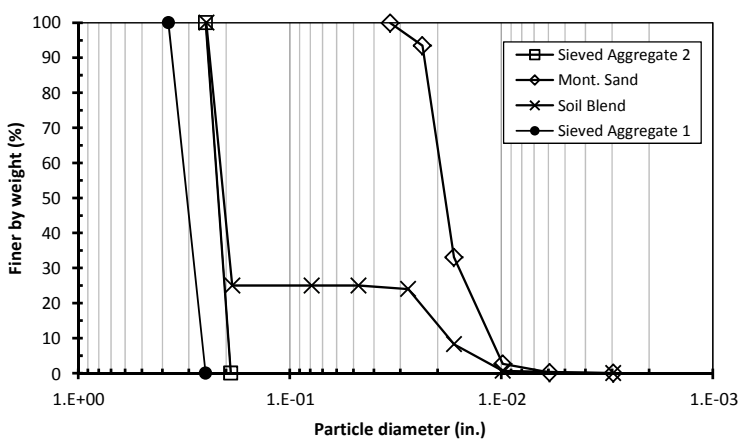
Pullout Rate	
1.0 mm/min.	0.04 in/min

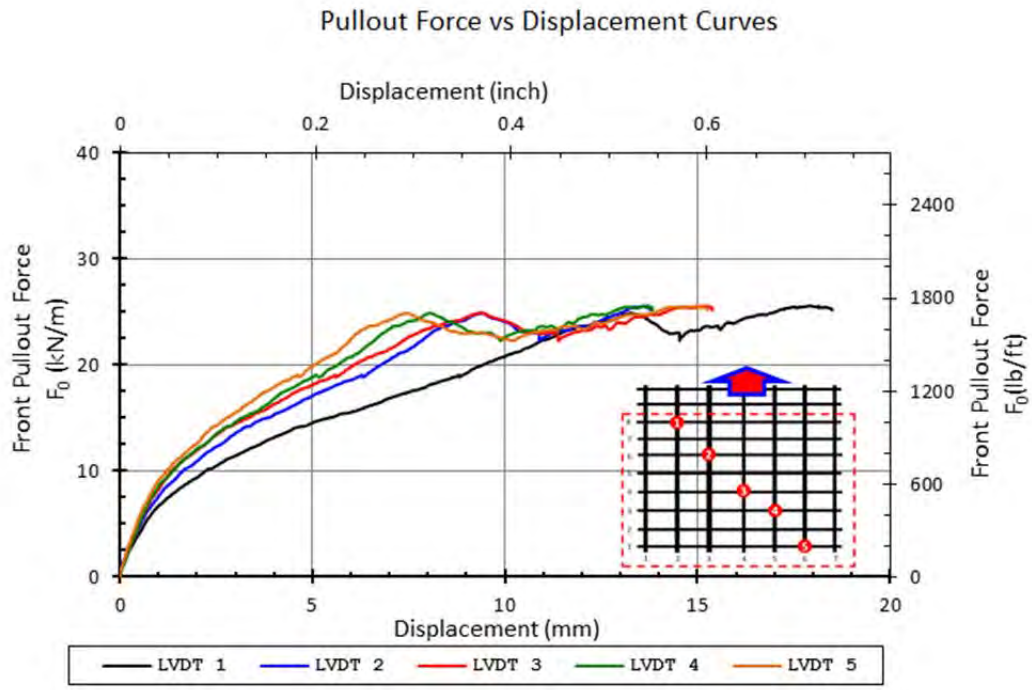
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.627 **g/cm^3**	**102 pcf**

Note: particle size distribution curve shown below

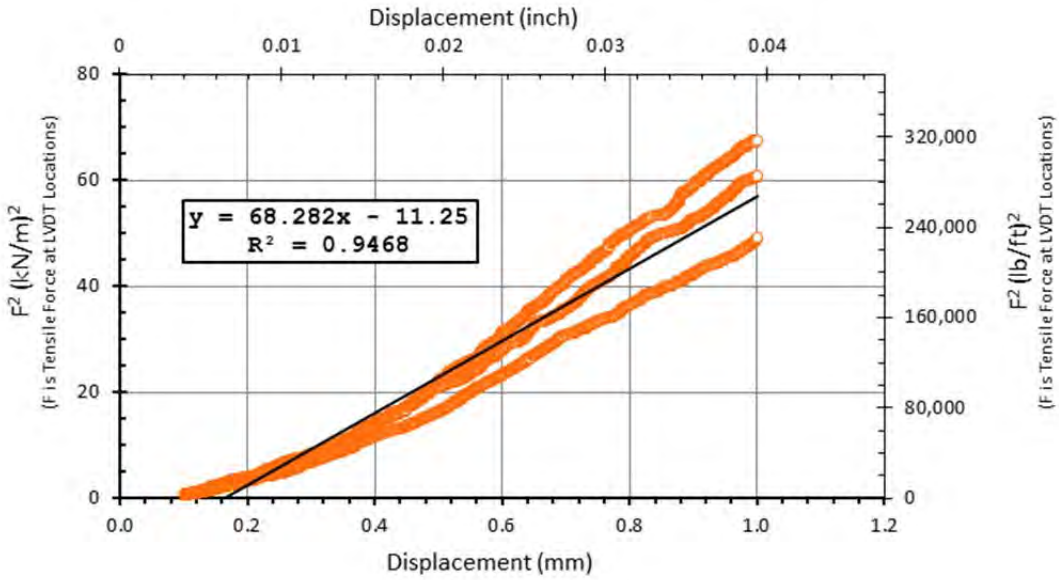
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	25.6	kN/m	1,751	lb/ft
Max Pullout Load	P_{max}	6.77	kN	1390	lb
Max Shear Stress	τ_{max}	91.0	kPa	13.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
68.3 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/7/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.9	0.469
2	55.3	2.177
3	99.6	3.921
4	144.1	5.673
5	231.2	9.102

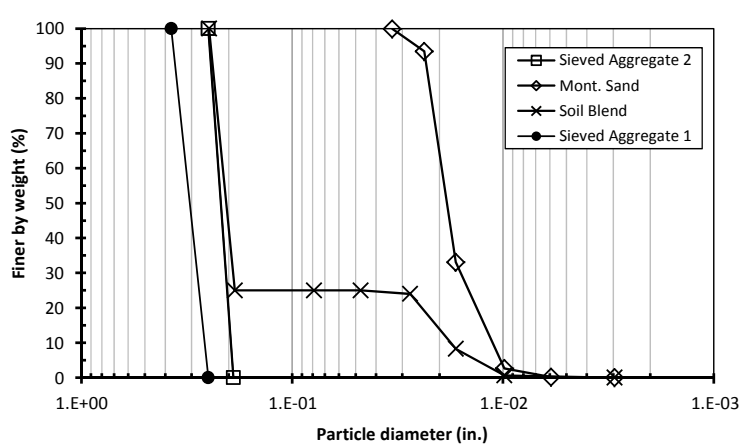
Pullout Rate	
1.0 mm/min.	0.04 in/min

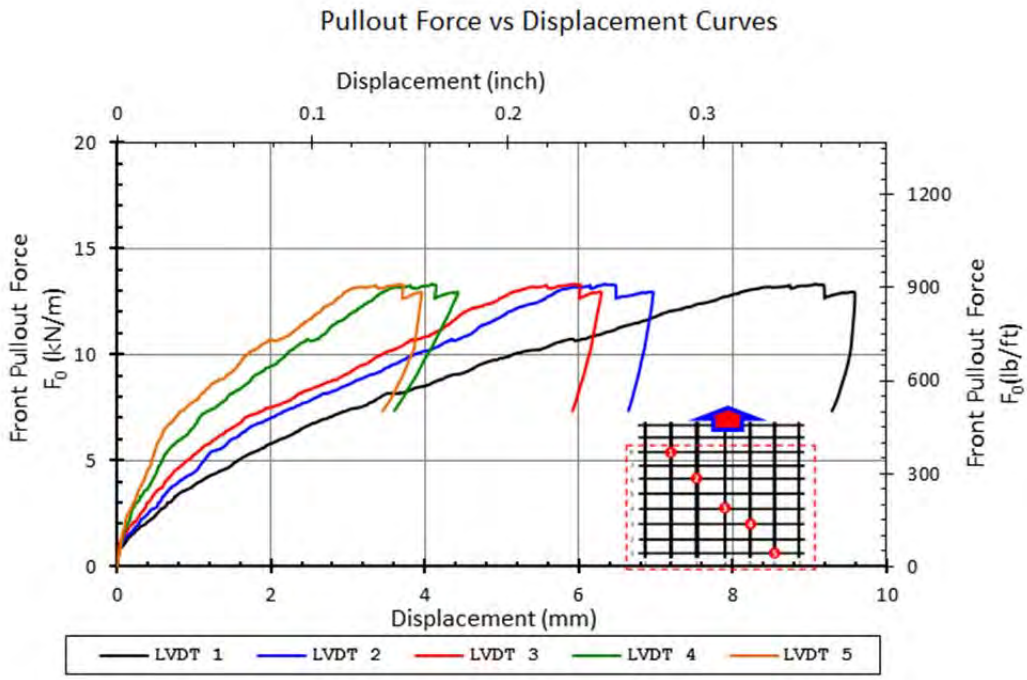
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.613 **g/cm^3**	**101 pcf**

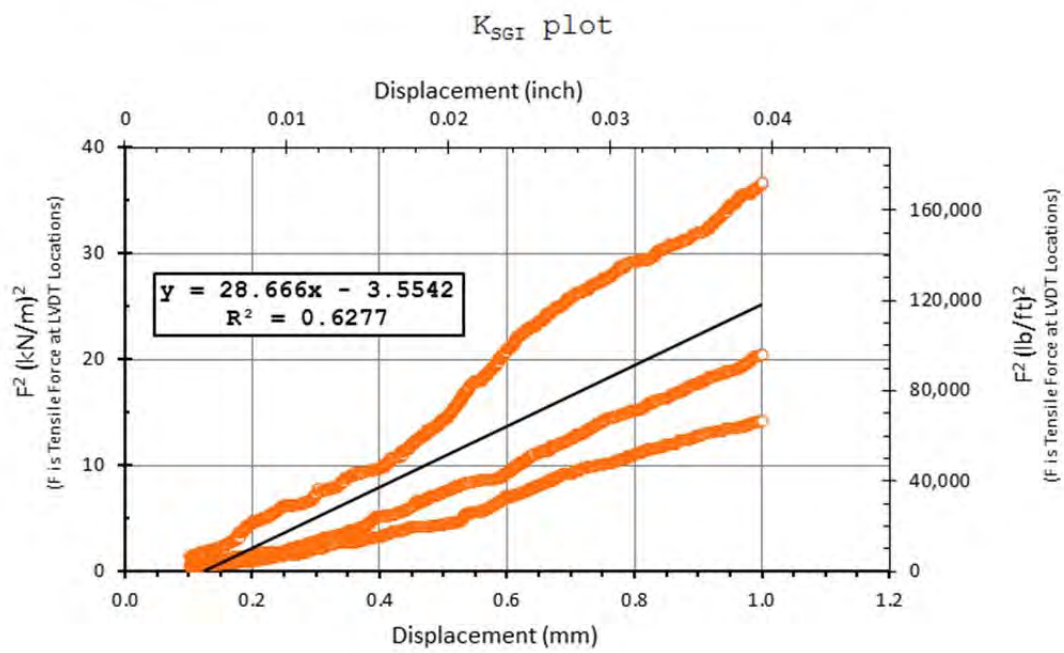
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	13.3	kN/m	912	lb/ft
Max Pullout Load	P_{max}	4.85	kN	1109	lb
Max Shear Stress	τ_{max}	65.2	kPa	9.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
28.7 $(kN/m)^2/mm$







Comments:

Geogrid specimen breakage during the test.

SMALL PULLOUT TEST

Date test conducted	7/8/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.364	m	0.245	m
	17	0.919	ft	1.195	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	11.8	0.465
2	55.4	2.181
3	98.5	3.878
4	142.9	5.626
5	229.3	9.028

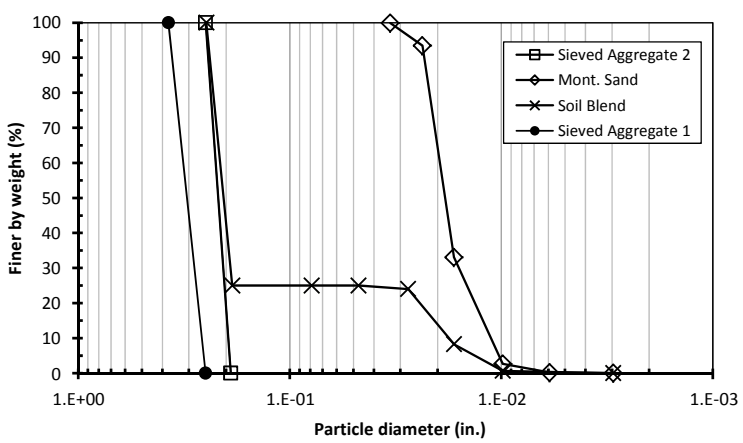
Pullout Rate	
1.0 mm/min.	0.04 in/min

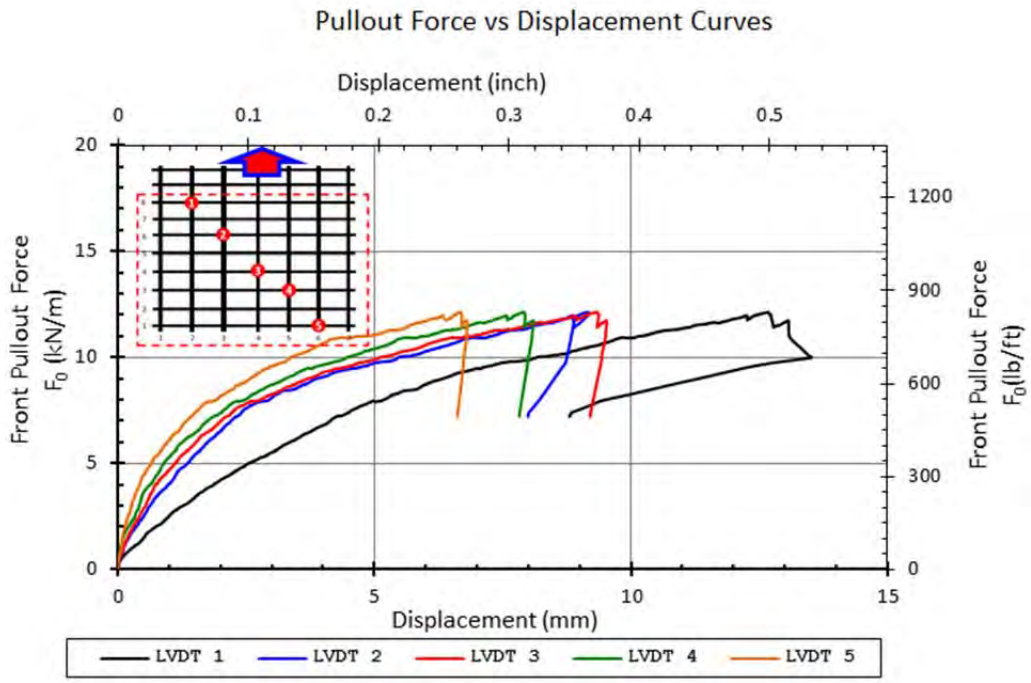
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.591 **g/cm^3**	**99 pcf**

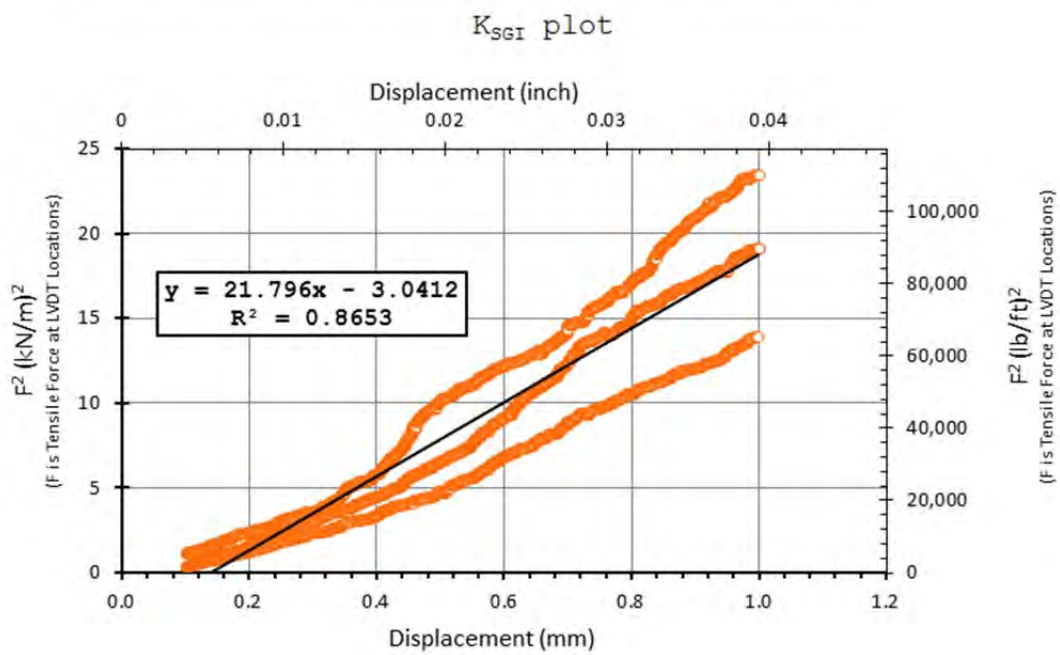
Note: particle size distribution curve shown below

RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	12.1	kN/m	832	lb/ft
Max Pullout Load	P_{max}	4.43	kN	1000	lb
Max Shear Stress	τ_{max}	59.5	kPa	8.6	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
21.8 (kN/m)^2/mm







Comments:

Geogrid breakage during the test.

SMALL PULLOUT TEST

Date test conducted	7/1/2010
Conducted by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP3

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.130	m	0.245	m
	8	0.919	ft	0.426	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall (mm)**	**(inch)**
1	35.1	1.382
2	88.4	3.481
3	145.4	5.725
4	173.4	6.827
5	227.0	8.937

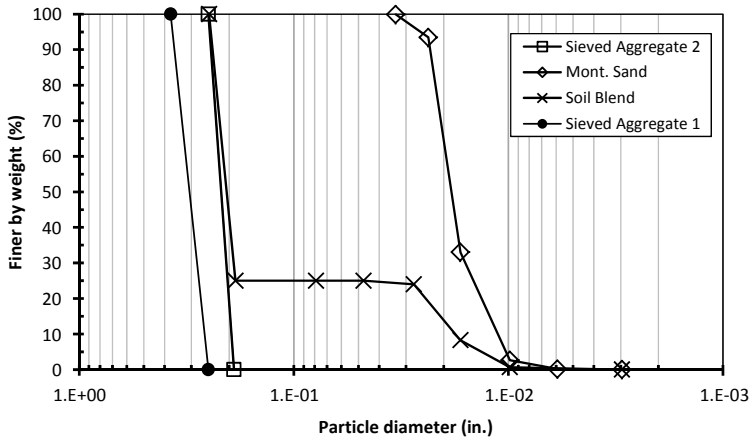
Pullout Rate	
1.0 mm/min.	0.04 in/min

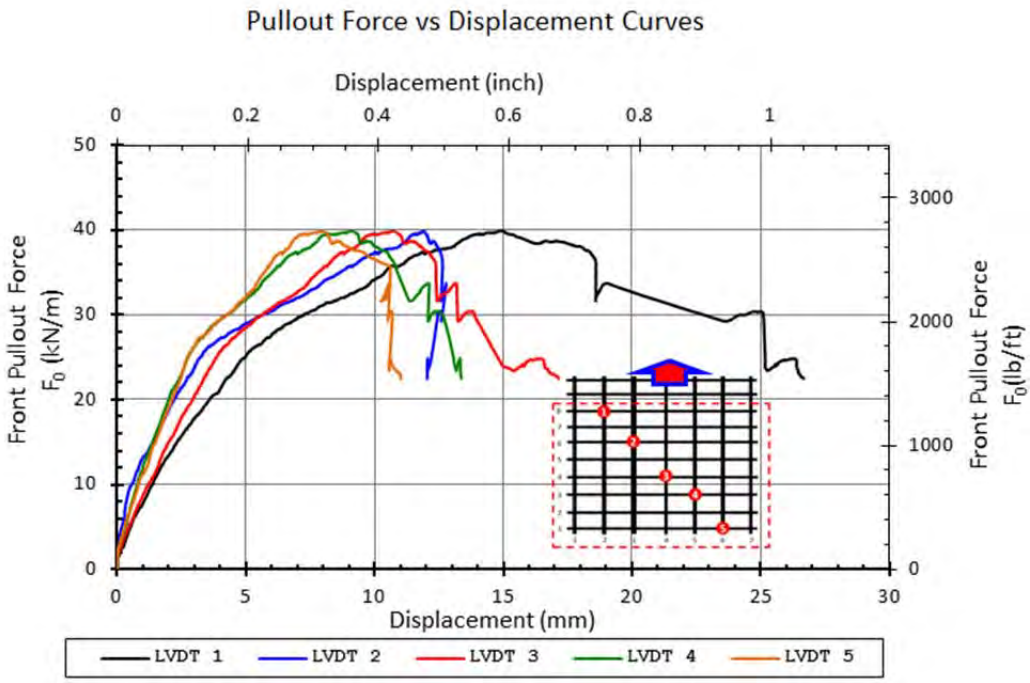
SOIL Information		
Soil	Aggregate	
Water Content	0.00	%
Dry Density (ρ_d)	1.578 g/cm^3	**98 pcf**

Note: particle size distribution curve shown below

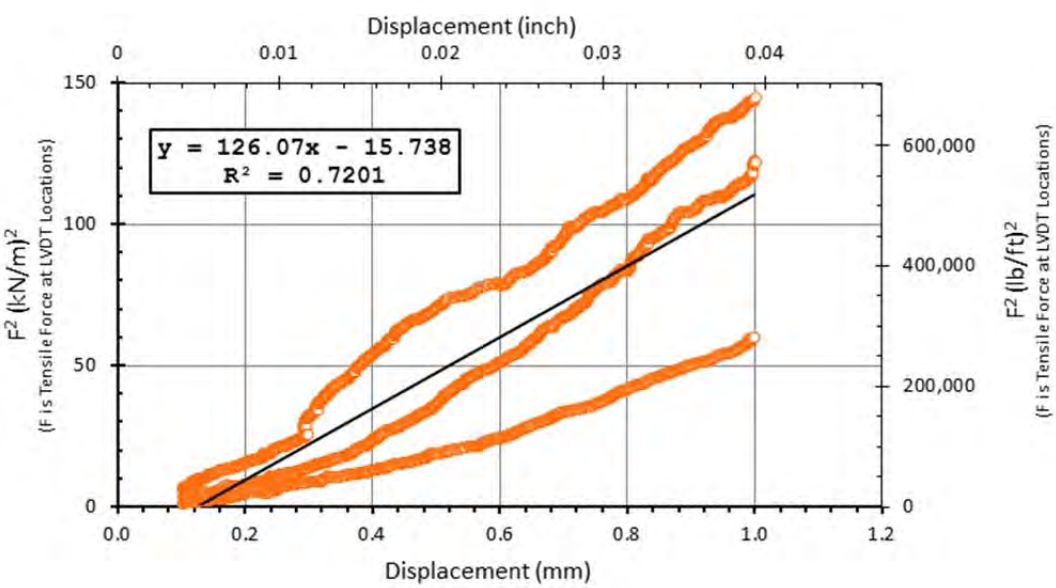
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	39.9	kN/m	2,736	lb/ft
Max Pullout Load	P_{max}	5.18	kN	1130	lb
Max Shear Stress	τ_{max}	69.7	kPa	10.1	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	40	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}	
126.1	**$(kN/m)^2/mm$**





K_{SGI} plot



Comments:

Geogrid speciment partial breakage during the test.

SMALL PULLOUT TEST

Date test conducted	7/11/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		MD	GG PP4

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.280	m	0.300	m	0.245	m
	6	0.919	ft	0.984	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-8.4	-0.331
2	38.8	1.528
3	85.0	3.346
4	131.0	5.157
5	224.6	8.843

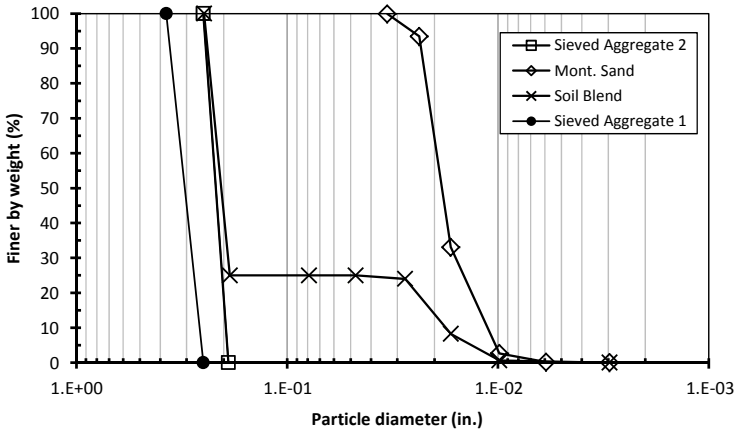
Pullout Rate	
1.0 mm/min.	0.04 in/min

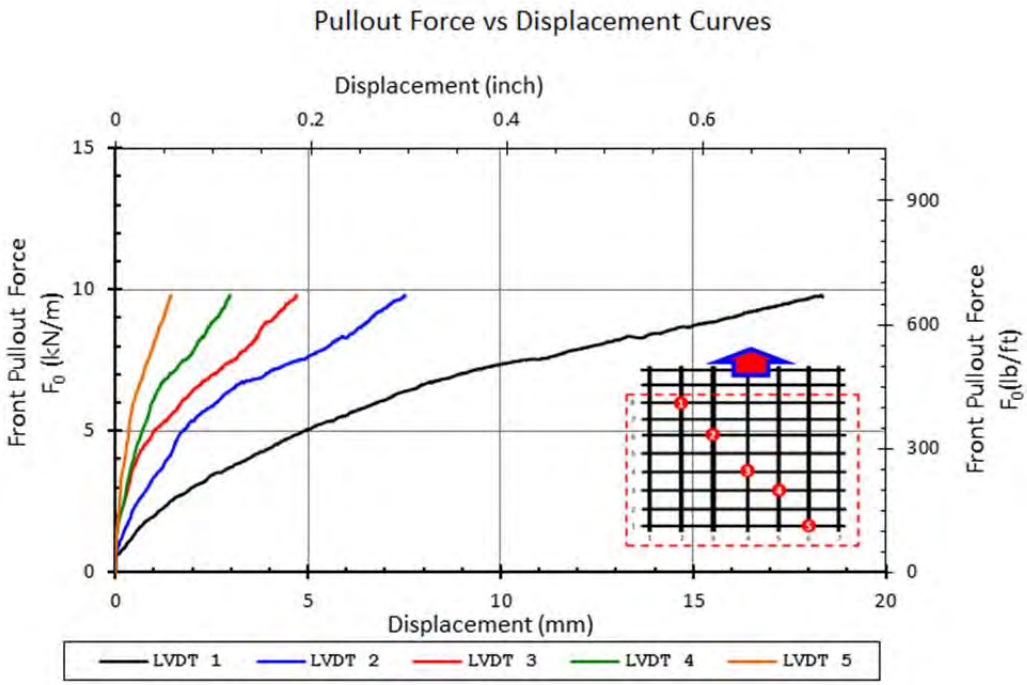
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.609 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

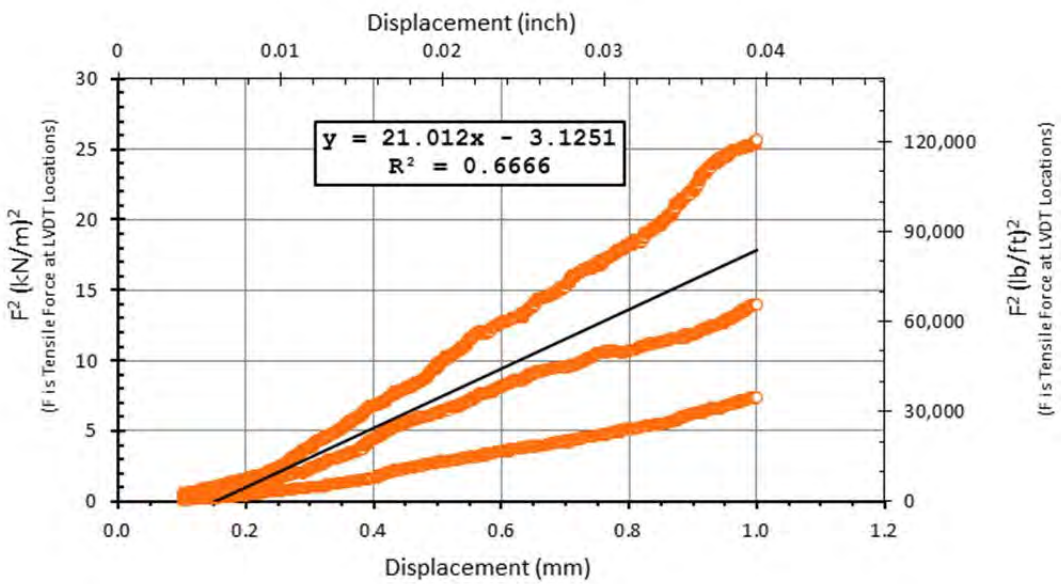
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	8.9	kN/m	613	lb/ft
Max Pullout Load	P_{max}	2.68	kN	476	lb
Max Shear Stress	τ_{max}	36.1	kPa	5.2	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
21.0 (kN/m)^2/mm





K_{SGI} plot



Comments:

SMALL PULLOUT TEST

Date test conducted	7/21/2010
Done by	Alejandro

GEOSYNTHETIC Information	**Type**		**Direction Pulled**	**UT Product Name**
	Geogrid		CD	GG PP4x2

SPECIMEN Dimensions	**# Ribs Pulled**	**Measured Width**	**Units**	**Equivalent Width**	**Units**	**Embedded Length (L)**	**Units**
		0.272	m	0.261	m	0.245	m
	12	0.892	ft	0.856	ft	0.804	ft

BOX Dimensions	Width	Units	Length	Units	**Area (A)**	**Units**
	300	mm	250	mm	0.0744	m^2
	11.81	in	9.84	in	115.3	in^2

POSITION OF LVDTs		
LVDT #	**Distance from Front Wall**	
	(mm)	**(inch)**
1	-38.6	-1.520
2	14.3	0.563
3	65.8	2.591
4	118.1	4.650
5	221.9	8.736

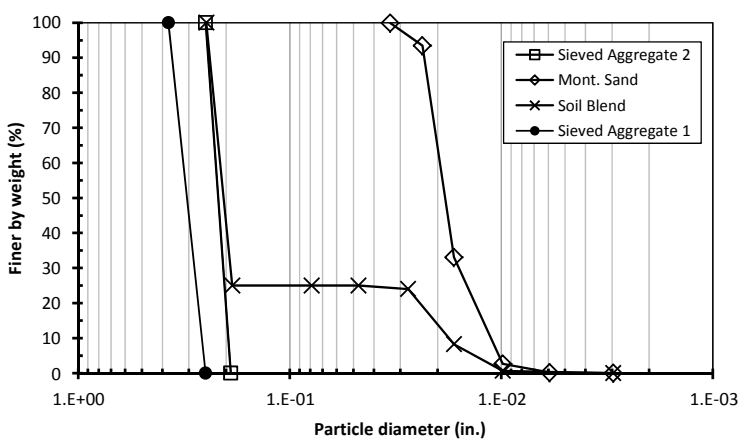
Pullout Rate	
1.0 mm/min.	0.04 in/min

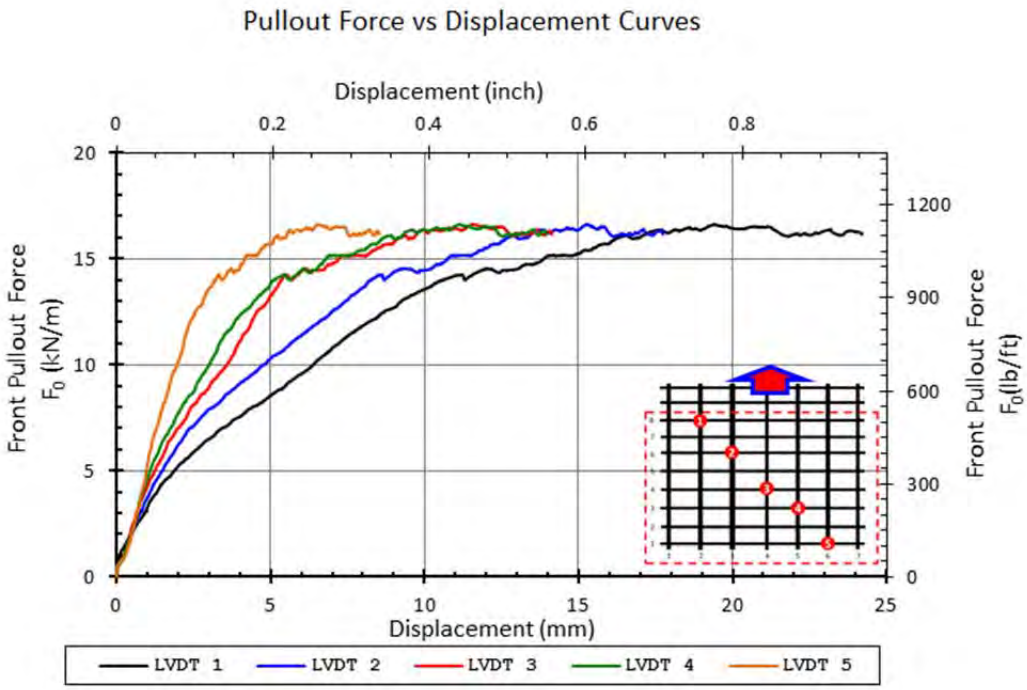
SOIL Information		
Soil	Aggregate	
Water Content	0.00	**%**
Dry Density (ρ_d)	1.600 **g/cm^3**	**100 pcf**

Note: particle size distribution curve shown below

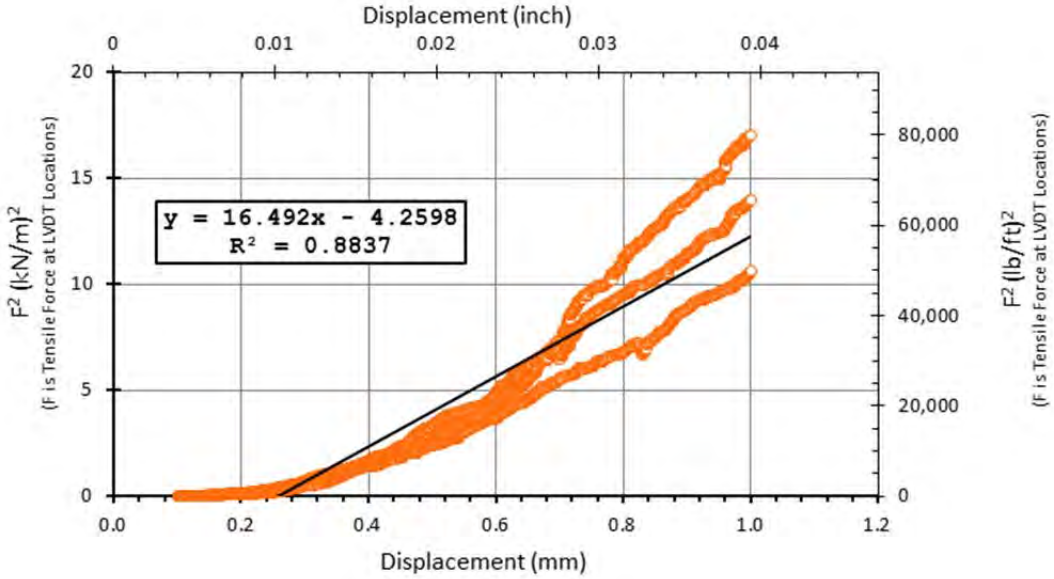
RESULTS		**Values**	**Units**	**Values**	**Units**
Max Pullout Force	F_{max}	16.6	kN/m	1,139	lb/ft
Max Pullout Load	P_{max}	4.34	kN	864	lb
Max Shear Stress	τ_{max}	58.3	kPa	8.5	PSI
Confining Pressure	σ	21	kPa	3.0	PSI
Estimated Friction Angle of Soil	ϕ	42	degrees		
Coefficient of Interaction	C_i	1.0			

Reported K_{SGI}
14.9 (kN/m)^2/mm





K_{SGI} plot



Comments: