Composite Testing Data - Table of Contents

- Northstar CSP Standard Test Data
- Endurance Polaris Standard Test Data
- Endurance Polaris CE Standard Test Data
- Impact Testing of Endurance Polaris CE vs. SG 950 Data
- Endurance Polaris CE Interlock Strength Data
- Endurance Polaris CE Sheet Friction/Adhesion Data
- Endurance Resin System UV Testing
- Endurance Polaris CE Water Absorption Test Data

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MATERIALS TEST REPORT

Ref. D59303 Rev. 1* **Date** September 10, 2004 **Page** 1 **of** 2

Carl Hazenberg, P.E.
Northstar Vinyl Products, LLC
225 Town Park Drive, Suite 300
Kennesaw, Georgia 30144-5509

Purchase Order #: Verbal

Procedure

Test Performed: Tensile

Method: ASTM D 638-03

Material: Northstar CSP

Results

Test Sample	Ultimate Tensile Strength (psi)	Average Tensile Strength (psi)	Modulus of Elasticity (10^6)	Average Modulus of Elasticity (10^6)
Longitudinal				
1	92,414		5.06	
2	89,554		4.19	
3	96,113	93,235	4.60	4.44
4	90,209		4.10	
5	97,884		4.27	
Transverse				
1	11,914		1.77	
2	12,395		1.86	
3	8,130	11,256	2.14	1.69
4	12,404		1.54	
5	11,435		1.16	

* Revision 1: Modulus values have been recalculated for the transverse samples

ISO 9001

Prepared by: Eric W. Sproat
Materials Testing

Approved by: Erin Riddick
Materials Testing

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MATERIALS TEST REPORT

Ref. D59303 Rev. 1 **Date** September 10, 2004 **Page** 2 **of** 2

Carl Hazenberg, P.E.
Northstar Vinyl Products, LLC
225 Town Park Drive, Suite 300
Kennesaw, Georgia 30144-5509

Purchase Order #: Verbal

Procedure

Test Performed	Method
Izod Impact	ASTM D 256-00
Charpy Impact	ASTM A 370-03a (As a Guide)

Material

Northstar CSP

Results

Test Sample	Izod Impact (ft ·lb/in)	Average Izod Impact (ft ·lb/in)	Charpy Impact (ft ·lb/in)	Average Charpy Impact (ft ·lb/in)
Longitudinal				
1	65.17		60.98	
2	64.64		56.45	
3	53.62	58.60	60.73	61.55
4	54.60		69.11	
5	54.95		60.48	
Transverse				
1	19.65		16.26	
2	18.56		20.33	
3	18.64	18.80	20.33	18.72
4	16.27		20.33	
5	20.88		16.33	

Note: All breaks were partial in the above impact tests.

ISO 9001

Prepared by: Eric W. Sproat
Materials Testing

Approved by: Erin Riddick
Materials Testing

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MATERIALS TEST REPORT

Ref. D75703 **Date** October 6, 2005 **Page** 1 **of** 3

Nathan Touchstone
Northstar Vinyl Products, LLC
225 Town Park Drive, Suite 300
Kennesaw, Georgia 30144-5509

Purchase Order #: Verbal – Touchstone

Procedure

Test Performed	Method
Tensile Properties	ASTM D 638-03 Type 1, 0.2 inch/minute test speed Samples were conditioned per ASTM requirements.
Material	**Requirements**
USC Polaris VE 092705	None Supplied

Results

Test Sample	Tensile Strength (psi)	Average Tensile Strength (psi) [Std. Dev]	Tensile Modulus (Mpsi)	Average Tensile Modulus (Mpsi) [Std. Dev]
Longitudinal				
1	81,300		3.93	
2	85,900	**84,720**	3.67	**3.93**
3	82,600	**[3,740]**	3.51	**[0.37]**
4	83,100		4.46	
5	90,700		4.07	
Transverse				
1	8,450		1.32	
2	8,420	**8,800**	1.82	**1.48**
3	8,420	**[900]**	1.48	**[0.24]**
4	8,280		1.58	
5	10,430		1.20	

ISO 9001

Prepared by: Meredith Najewicz
Materials Testing

Approved by: Erin Riddick
Polymer Specialist

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MATERIALS TEST REPORT

Nathan Touchstone
Northstar Vinyl Products, LLC
225 Town Park Drive, Suite 300
Kennesaw, Georgia 30144-5509

Purchase Order #: Verbal – Touchstone

Procedure

Test Performed	Method
Notched Izod Impact	ASTM D256-03
	Samples were conditioned per ASTM requirements.

Material	Requirements
USC Polaris VE 092705	None Supplied

Results

Sample	Width (inch)	Energy Absorbed ($ft\text{-}lb_f$)	Impact Resistance ($ft\text{-}lb_f$/inch)	Break Type
Longitudinal (16 $ft\text{-}lb_f$ arm used)				
1	0.261	15.94	61.08	Non Break
2	0.260	15.95	61.34	Non Break
3	0.260	15.94	61.32	Non Break
4	0.261	15.94	61.18	Non Break
5	0.260	15.94	61.30	Non Break
Average			**61.24**	
Standard Dev.			**0.11**	
Transverse (8 $ft\text{-}lb_f$ arm used)				
1	0.266	4.84	18.21	Partial Break
2	0.269	5.33	19.84	Partial Break
3	0.267	4.92	18.47	Partial Break
4	0.267	5.41	20.30	Partial Break
5	0.266	5.25	19.74	Partial Break
Average			**19.31**	
Standard Dev.			**0.92**	

ISO 9001

Prepared by: Meredith Najewicz
Materials Testing

Approved by: Erin Riddick
Polymer Specialist

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MATERIALS TEST REPORT

Ref. D75703 **Date** October 5, 2005 **Page** 3 **of** 3

Nathan Touchstone
Northstar Vinyl Products, LLC
225 Town Park Drive, Suite 300
Kennesaw, Georgia 30144-5509

Purchase Order #: Verbal – Touchstone

Procedure

Test Performed	Method
Flexural Properties	ASTM D 790-03 Procedure A, 0.112 in/minute test speed. Span to depth ratio – 16 to 1 Samples were conditioned per ASTM requirements.

Material	Requirements
USC Polaris VE 092705	None Supplied

Results

Test Sample	Flexural Strength (psi)	Average Flexural Strength (psi) [Std. Dev]	Flexural Modulus (Mpsi)	Average Flexural Modulus (Mpsi) [Std. Dev]
Longitudinal				
1	99,800	**101,620 [1,890]**	2.89	**2.95 [0.21]**
2	102,700		2.96	
3	100,500		2.63	
4	104,400		3.18	
5	100,700		3.07	
Transverse				
1	27,500	**26,320 [1,020]**	1.62	**1.61 [0.02]**
2	26,600		1.59	
3	26,800		1.62	
4	25,900		1.59	
5	24,800		1.64	

ISO 9001

Prepared by: Meredith Najewicz
Materials Testing

Approved by: Erin Riddick
Polymer Specialist

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PHYSICAL TESTING OF "POLARIS" COMPOSITE SHEET

ATS JOB # D52550 Revision 1

PURCHASE ORDER # VERBAL-HAZENBERG

Prepared for

JEFF MOREAU
NORTHSTAR VINYL PRODUCTS
225 TOWN PARK DRIVE, SUITE 300
KENNESAW, GEORGIA 30144-5509

*Prepared by*_____
Eric Sproat, Materials Testing

*Approved by*_____
Semih Genculu, P.E., Manager

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MATERIALS TEST REPORT

Subject

Physical Testing: Charpy & Izod Impact, Tensile, Flexural

Material

"Polaris" Composite Sheet

Objective and Background

To determine impact resistance using both izod and charpy methods, tensile strength and modulus of elasticity, flexural strength and modulus of bending as well as short beam shear strength.

Test Procedure and Results

1. Izod Impact Testing Per ASTM D 256-00, Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastics

Samples were prepared per Figure 5 of ASTM D 256-00 and tested using Method A. Five samples were prepared in the transverse direction. From previous testing it was known that the largest available (15.9 ft-lbf) pendulum was capable of breaking the transverse samples but not the longitudinal samples. The lower half of Table 1 presents an example of values obtained from longitudinal samples in the past.

Table 1: Data From Izod Pendulum Impact Testing

Sample	Sample Depth Under Notch (in)	Sample Thickness (in)	Impact Resistance (ft-lbf/in)	Type of Failure	Average Impact Resistance (ft-lbf/in)	Std. Dev.
T-1	0.3975	0.2450	30	PB	40	6
T-2	0.3950	0.2470	40	PB		
T-3	0.3965	0.2470	30	HB	30	1
T-4	0.3945	0.2470	30	HB		
T-5	0.3950	0.2460	30	HB		
Minimum Requirement					**30**	**NA**
L-1	0.4000	0.2500	>60	PB	>60	N/A
L-2			>60			
L-3			>60			
L-4			>60			
L-5			>60			
Minimum Requirement					**NA**	**NA**

T=Transverse, L= Longitudinal, PB=Partial Break, HB = Hinge Break
NA=Not Available
* Minimum Requirement line added and values reported to the same level of significant digits.

Per ASTM D 256-00, averages can only be determined for samples having the same type of break; therefore more than one average is listed in Table 1 for a given set of samples.

2. Tensile Testing Per ASTM D 638-00, Standard Test Method For Tensile Properties of Plastics

Samples were prepared according to Section 6.1, Figure 1, Type I per ASTM D 638-00. Five samples each were prepared in the transverse and longitudinal directions. "Speed of testing" was set at 0.2 in/min per Table 1. A class B-1 extensometer was used to determine modulus of elasticity.

Table 2: Data From Tensile Testing

Sample	Ultimate Tensile Strength[1] (ksi)			Modulus of Elasticity[1] (psi)		
	Actual	Avg	Std. Dev.	Actual	Avg	Std. Dev.
T-1	9.4	12	1.9	1,600,000	1,700,000	130,000
T-2	12			1,800,000		
T-3	14			1,500,000		
T-4	14			1,800,000		
T-5	11			1,800,000		
Minimum Requirement		**12**	**NA**		**1,700,000**	**NA**
L-1	97	96	1.8	4,800,000	4,700,000	140,000
L-2	98			4,800,000		
L-3	94			4,600,000		
L-4	94			4,600,000		
L-5	97			4,500,000		
Minimum Requirement		**85**	**NA**		**4,600,000**	**NA**

T = Transverse, L = Longitudinal
NA=Not Available
* Minimum Requirement line added and values reported to the same level of significant digits.

Note[1]: Metal inserts were used in the tensile grips to aid in transverse sample testing. As a result, slight slippage of the metal tabs affected the calculation of modulus of elasticity. Separate results for samples that fractured in the tensile grip area were used for modulus values.

3. Flexural Testing Per ASTM D 790-00, Standard Test Method For Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

Samples were prepared according to customer specifications having a span to depth ratio of 16 to 1, with a minimum overhang of 5% of span. Five samples each were prepared in the transverse and longitudinal directions. Procedure A was used as outlined in ASTM D 790-00 and as such a strain rate of 0.01 in/in/min was used with a calculated cross head speed of 0.11 in/min per Equation 1 of Section 10.1.4. The test was terminated at failure of the specimen or at a midspan deflection of 0.53 in. as calculated by Equation 2 of Section 10.1.6, whichever came first. Tangent Modulus was calculated from the load deflection curve per Equation 6 of Section 12.9.1.

Table 3: Data From Flexural Testing

Sample	Sample Width (in)	Sample Thickness (in)	End of Test	Max. Flexural Strength (ksi)	Avg. Max. Flexural Strength (psi)	Std. Dev.	Modulus of Elasticity (psi)	Avg. Modulus of Elasticity (x 10^6 psi)	Std. Dev.
T-1	0.499	0.250	Failure	33			1,600,000		
T-2	0.503	0.250	Failure	43			1,700,000		
T-3	0.501	0.250	Failure	37	38		1,600,000	1,600,000	26,000
T-4	0.500	0.250	Failure	38			1,700,000		
T-5	0.501	0.250	Failure	38			1,600,000		
Minimum Requirement					**35**	**NA**		**NA**	**NA**
L-1	0.505	0.250	Failure	90			2,800,000		
L-2	0.500	0.250	Failure	90			2,900,000		
L-3	0.503	0.250	Failure	100	100		2,900,000	2,800,000	20,000
L-4	0.502	0.250	Failure	100			2,900,000		
L-5	0.501	0.250	Failure	100			2,400,000		
Minimum Requirement					**100**	**NA**		**NA**	**NA**

T = Transverse, L = Longitudinal

NA=Not Available

* Minimum Requirement line added and values reported to the same level of significant digits. Standard Deviation of Transverse (T) samples also corrected.

While all samples broke well before 5% strain (i.e. midspan deflection of 0.53 in.), not all samples failed in the outer surface: all longitudinal samples failed near the centerline, while all transverse samples failed at the outer surface.

4. Shear Strength per ASTM E 2344-00, Standard Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

Samples were prepared having a span to depth ratio of 4 to 1, with a minimum overhang of the specimen thickness. Five samples each were prepared in the transverse and longitudinal directions. "Speed of testing" was set at 0.05 in/min.

Table 4: Data From Short Beam Shear Testing

Sample	Sample Width (in)	Sample Thickness (in)	Max. Load (lbf)	Short Beam Strength (psi)	Avg. Short Beam Strength (psi)	Standard Deviation	Failure Mode
T-1	0.496	0.248	556	3,390	3,349	175	Intralaminar Shear
T-2	0.497	0.249	596	3,612			Intra and Interlaminar Shear
T-3	0.500	0.249	546	3,289			Intralaminar Shear
T-4	0.499	0.248	517	3,133			Intra and Interlaminar Shear
T-5	0.498	0.249	549	3,321			Intra and Interlaminar Shear
Minimum Requirement					**NA**	**NA**	
L-1	0.496	0.250	1,069	6,466	6,124	283	Inelastic Deformation
L-2	0.499	0.251	1,033	6,186			Interlaminar Shear
L-3	0.498	0.249	939	5,679			Interlaminar Shear
L-4	0.500	0.250	1,027	6,162			Inelastic Deformation
L-5	0.500	0.250	1,021	6,126			Inelastic Deformation
Minimum Requirement					**NA**	**NA**	

T = Transverse, L = Longitudinal
NA=Not Available
* Minimum Requirement line added and values reported to the same level of significant digits.

5. Impact Testing Using ASTM D 6110-00, Standard Test Method for Determining Charpy Impact Resistance of Notched Specimens of Plastics, as a guide

Due to the impact strength observed in previous Izod testing, a 300 ft-lbf capacity Satec Charpy impact tester was used. This tester is typically used for metallic specimens per ASTM E 23-00 and has a striking edge different in dimensions than that called for per ASTM D 6110-97. Critical differences are noted below. Samples were prepared having dimensions of approximately 2.165"x 0.500" x 0.250" with 0.100" notch depth. Five samples each were prepared in the transverse and longitudinal directions.

Table 5: Data From Charpy Impact Testing

Sample	Sample Width (in)	Sample Depth Under Notch (in)	Impact Resistance (ft-lbf/in)	Type of Failure	Average Impact Resistance (ft-lbf/in)	Std. Dev.
T-1	0.2496	0.3985	30	PB	30	2
T-2	0.2491	0.3990	30	PB		
T-3	0.2496	0.3990	30	PB		
T-4	0.2500	0.4000	30	HB	28	0
T-5	0.2495	0.3990	30	HB		
Minimum Requirement					**NA**	**NA**
L-1	0.2501	0.4000	100	PB	100	8
L-2	0.2499	0.3980	100	PB		
L-3	0.2517	0.3980	100	PB		
L-4	0.2497	0.3995	100	PB		
L-5	0.2492	0.3990	100	PB		
Minimum Requirement					**100**	**NA**

T=Transverse, L=Longitudinal, PB=Partial Break, HB = Hinge Break
NA=Not Available
* Minimum Requirement line added and values reported to the same level of significant digits.

Type of Pendulum: "U"- type
Pendulum Capacity: 300 ft-lbf
Span: 42 mm cf. 101.6 mm per ASTM D 6110-97
Striking Radius: 8mm with 4 mm striking face cf. 3.17 mm radius per ASTM D 6110-97
Vertical Height of Fall: 1.3m V=5.1m/s cf. 3.46 m/s per ASTM D 6110-97

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MATERIALS TEST REPORT

Ref. D48457 **Date** December 17, 2003 **Page** 1 **of** 1

Carl Hazenberg
Northstar Vinyl Products
225 TownPark Drive, Suite 300
Kennesaw, GA 30144

Purchase Order #: Verbal

Procedure

Test Performed	Method
Charpy Impact of Plastics	ASTM E23-01
Test Material	**Requirements**
Endurance Polaris Sheet Pile (Fiberglass) Shore Guard 950 Sheet Pile (PVC)	N/A

Results

Sample	Thickness (inch)	Width (inch)	Energy Absorbed (ft-lb)	Impact Resistance (ft-lb/inch)
Endurance				
1	0.400	0.257	27	105.1
2	0.406	0.254	31	122.0
3	0.399	0.257	26	101.2
4	0.403	0.255	31	121.6
5	0.404	0.254	29	114.2
Average			29	112.8
Shore Guard				
1	0.403	0.565	5.0	8.8
2	0.403	0.625	4.0	6.4
3	0.405	0.623	2.0	3.2
4	0.402	0.696	4.0	5.7
5	0.404	0.698	3.0	4.3
Average			4.0	5.7

The samples were prepared per the Charpy test method for plastics (ASTM D6110-02), but the equipment used for this test is typically used for metals. The metal testing equipment was selected due to the strength of the materials and utilized a 300 ft-lb arm. The differences between this equipment and standard plastic Charpy impact equipment are noted here: Span of 42 mm, Striker Radius of 4 mm, and impact velocity of 5.1 m/s vs. Span of 101.6 mm, Striker Radius of 3.17 mm and impact velocity of 3.5 m/s for ASTM D6110-02.

ISO 9001

Prepared by: Erin Riddick
Polymer Specialist

Approved by: S. Genculu, P.E.
Manager

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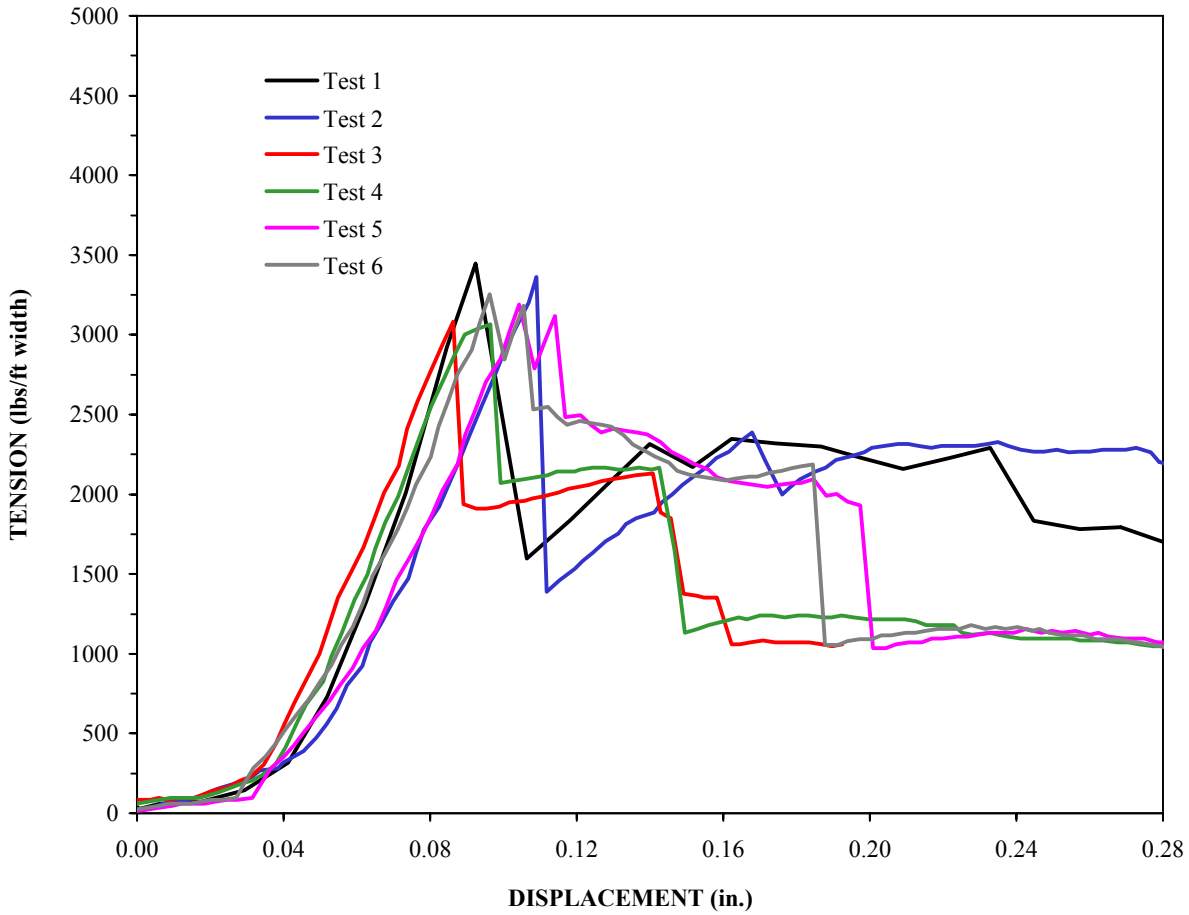
NORTHSTAR VINYL PRODUCTS, LLC.
JOINT STRENGTH OF SHEET PILE (ASTM D 4884 MODIFIED)
Joint of Northstar Endurance Composite Sheet Pile
SGI Sample ID No. S109893



Test No.	Maximum Joint Strength (lbs/ft)	Displacement at Maximum (in.)	Time to Failure (min.)	Failure Mode (-)	Ultimate Strength of Sheet Pile (lbs/ft)	Joint Efficiency (%)
1	3447	0.09	0.2	Cracking of "T" and C" Component		
2	3362	0.11	0.3	Cracking of "T" and C" Component		
3	3082	0.09	0.2	Cracking of "T" and C" Component		
4	3066	0.10	0.2	Cracking of "T" and C" Component		
5	3191	0.10	0.3	Cracking of "T" and C" Component		
6	3255	0.10	0.2	Cracking of "T" and C" Component		
Mean	3234	0.10	0.2	Not Applicable		
STD	152	0.01	0.0	Not Applicable		

Notes:
Clamp: Hydraulic grips
Padding: none
Specimen Width: 4 in.
Gage Length: 4.0 in.
Strain Rate: 10% per minute

DATE REPORTED: 9/18/2003

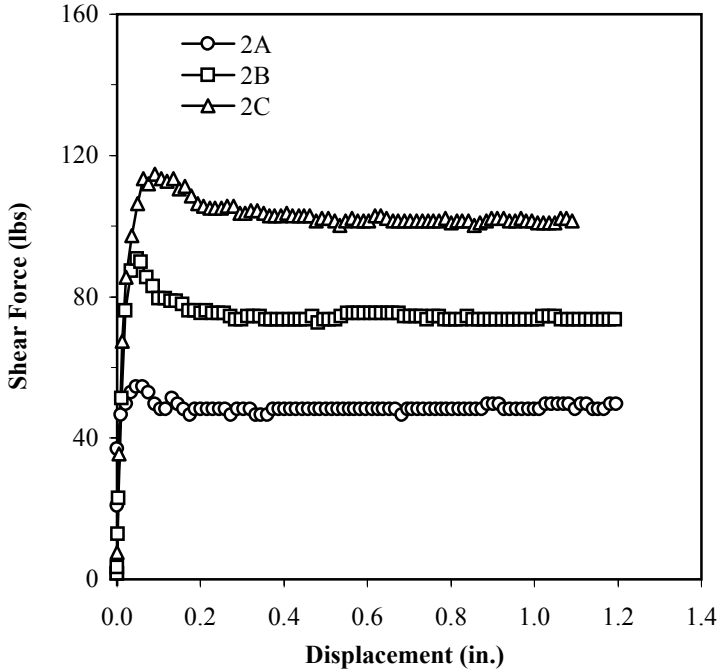
SGI TESTING SERVICES, LLC

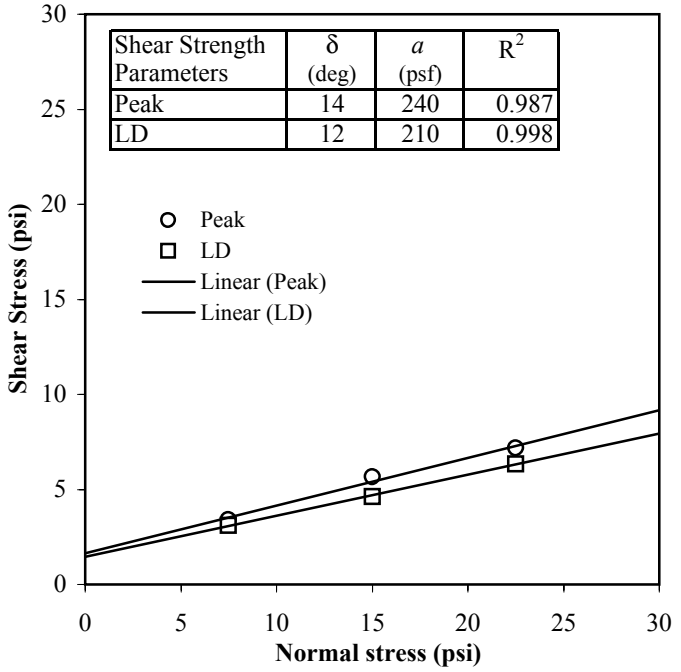
FIGURE NO.	1
PROJECT NO.	SGI3004
DOCUMENT NO.	
FILE NO.	

NORTHSTAR VINYL PRODUCTS, LLC.

INTERFACE DIRECT SHEAR TESTING (ASTM D 5321 MODIFIED)

Test Series 2: clay soil compacted to approximately 95% of standard Proctor at optimum moisture content/Endurance composite sheet pile with direction of shearing parallel to the vertical direction of sheet pile





Shear Strength Parameters	δ (deg)	*a* (psf)	R^2
Peak	14	240	0.987
LD	12	210	0.998

Test No.	Shear Box Size (in. x in.)	Normal Stress (psi)	Shear Rate (in./min)	Soaking		Consolidation		Lower Soil			Upper Soil			Soil Strength		Shear Stress		Failure Mode
				Stress (psi)	Time (hour)	Stress (psf)	Time (hour)	γ_{di} (pcf)	ω_i (%)	ω_f (%)	γ_{di} (pcf)	ω_i (%)	ω_f (%)	ϕ_r (deg)	c_r psf)	τ_p (psi)	τ_{LD} (psi)	
2A	4 x 4	7.5	0.200	7.5	24						112.9	12.3	13.9			3.41	3.11	(1)
2B	4 x 4	15.0	0.200	15.0	24						112.6	12.5	14.1	38	75	5.67	4.60	(1)
2C	4 x 4	22.5	0.200	22.5	24						112.2	12.1	14.0			7.17	6.35	(1)

Notes: (1) Sliding (i.e., shear failure) occurred at the soil-sheet pile interface in each test.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for application involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.
(3) Soil shear strength parameters were determined from a series of direct shear tests.

DATE OF TEST: 7 to 10 August 2003

SGI TESTING SERVICES, LLC

FIGURE NO.	3
PROJECT NO.	SGI3004
DOCUMENT NO.	
FILE NO.	

SGI Testing Services, LLC

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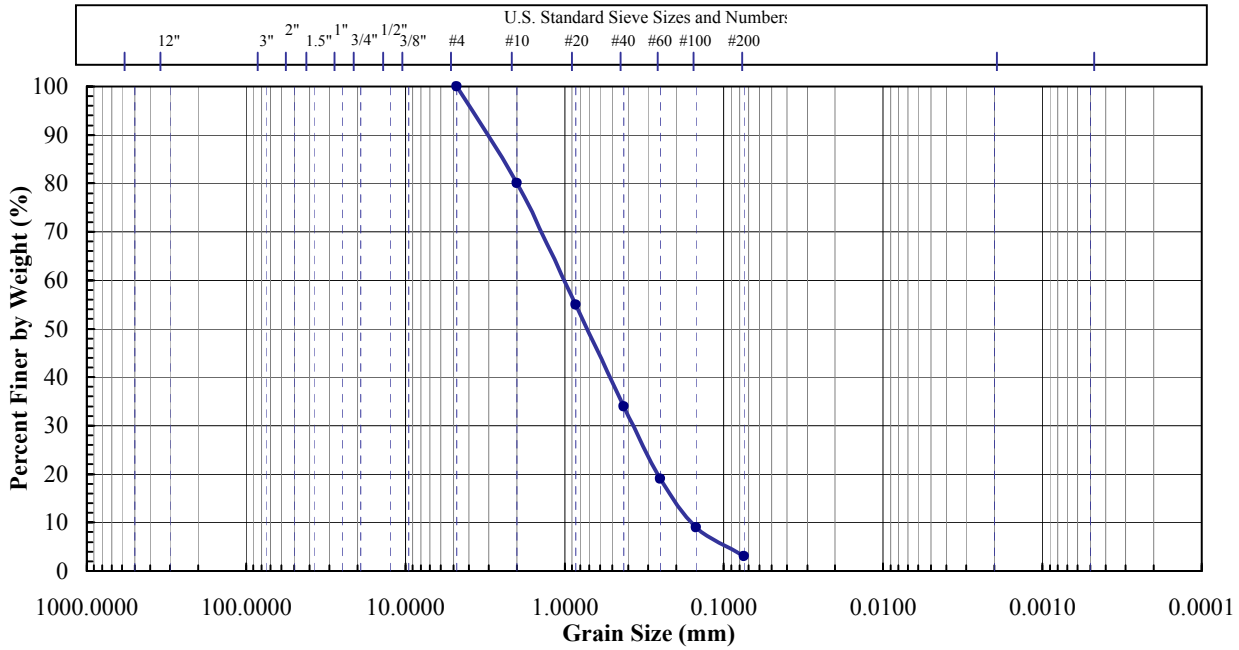
Project Name:	Sheet Pile Testing
Project No:	SGI3004
Client Sample ID:	Concrete Sand
Lab Sample No:	AL5012

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

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification

Boulder	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt	Fines: Clay

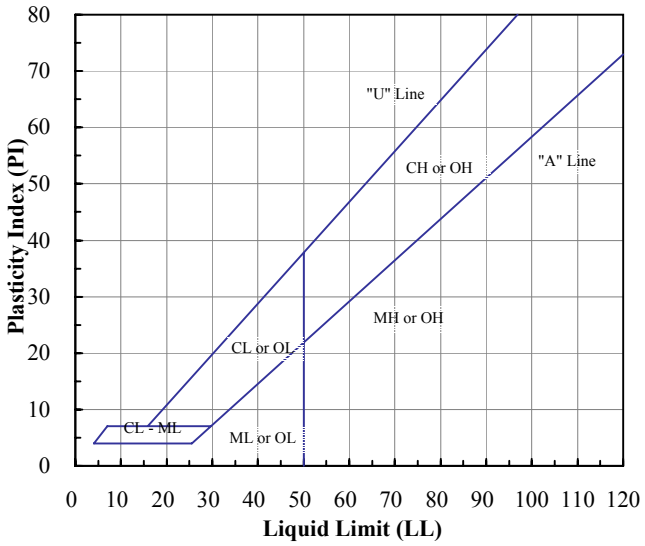


Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
1/2"	12.5	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	80.0
#20	0.850	55.0
#40	0.425	34.0
#60	0.250	19.0
#100	0.150	9.0
#200	0.075	3.0

Hydrometer Particle Diameter (mm)	% Finer
0.0500	
0.0200	
0.0050	
0.0020	
0.0012	

Gravel (%):	
Sand (%):	97.0
Fines (%):	3.0
Silt (%):	
Clay (%):	

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



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI (-)	Engineering Classification
Concrete Sand	AL5012	-	3.0	NP	NP	NP	SP (Poorly Graded Sand)

Note(s):

SGI Testing Services, LLC

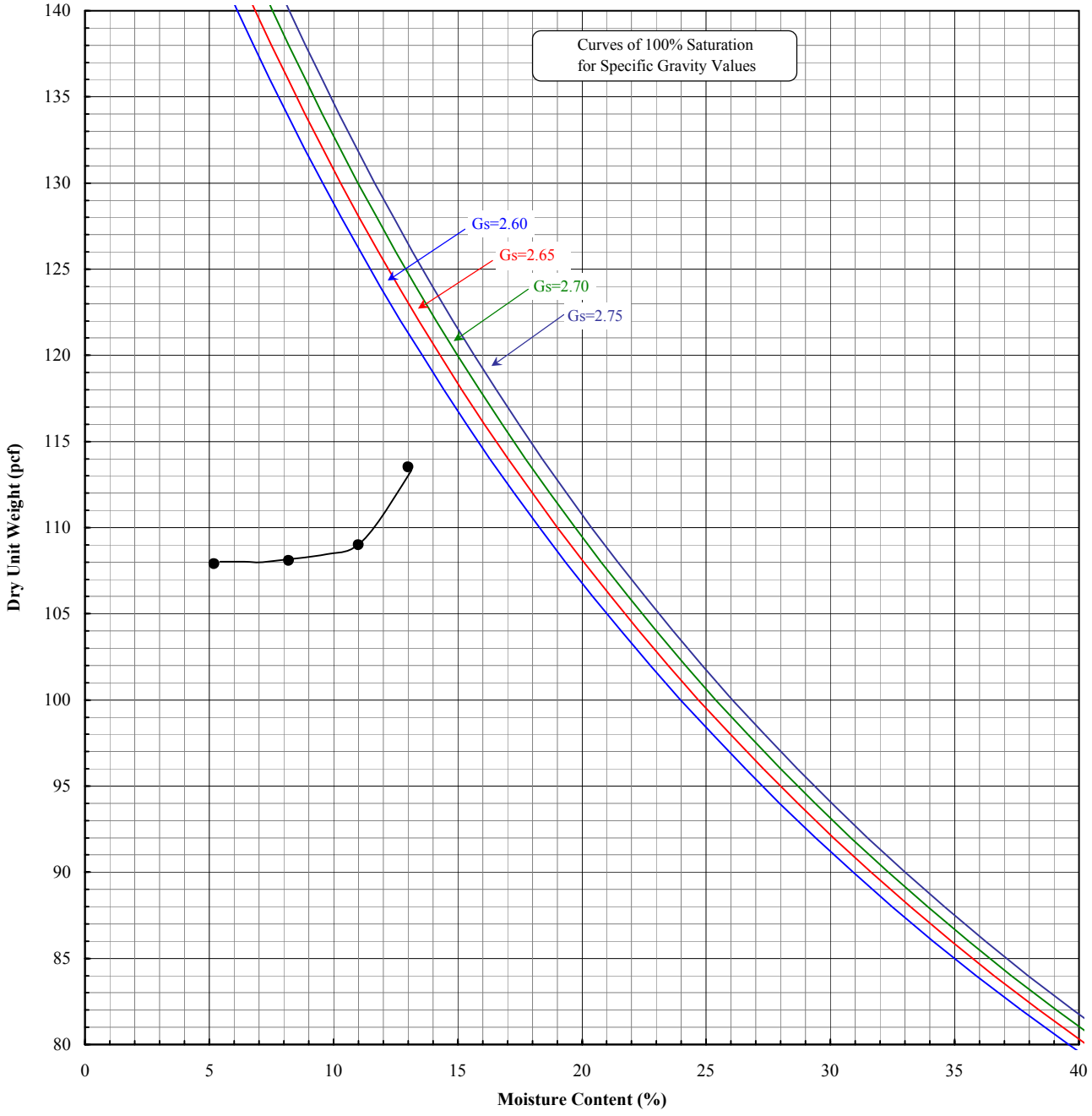
4405 International Blvd., Suite B-117, Norcross, GA 30093
Ph: (770) 931 8222 Fax: (770) 931 8240

Project Name:	Sheet Pile Testing
Project No:	SGI3004
Client Sample ID:	Concrete Sand
Lab Sample No:	AL5012

ASTM D698

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Standard - Method A



Client Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Concrete Sand	AL5012	109.0	11.0	Concrete Sand

Note(s):

SGI Testing Services, LLC

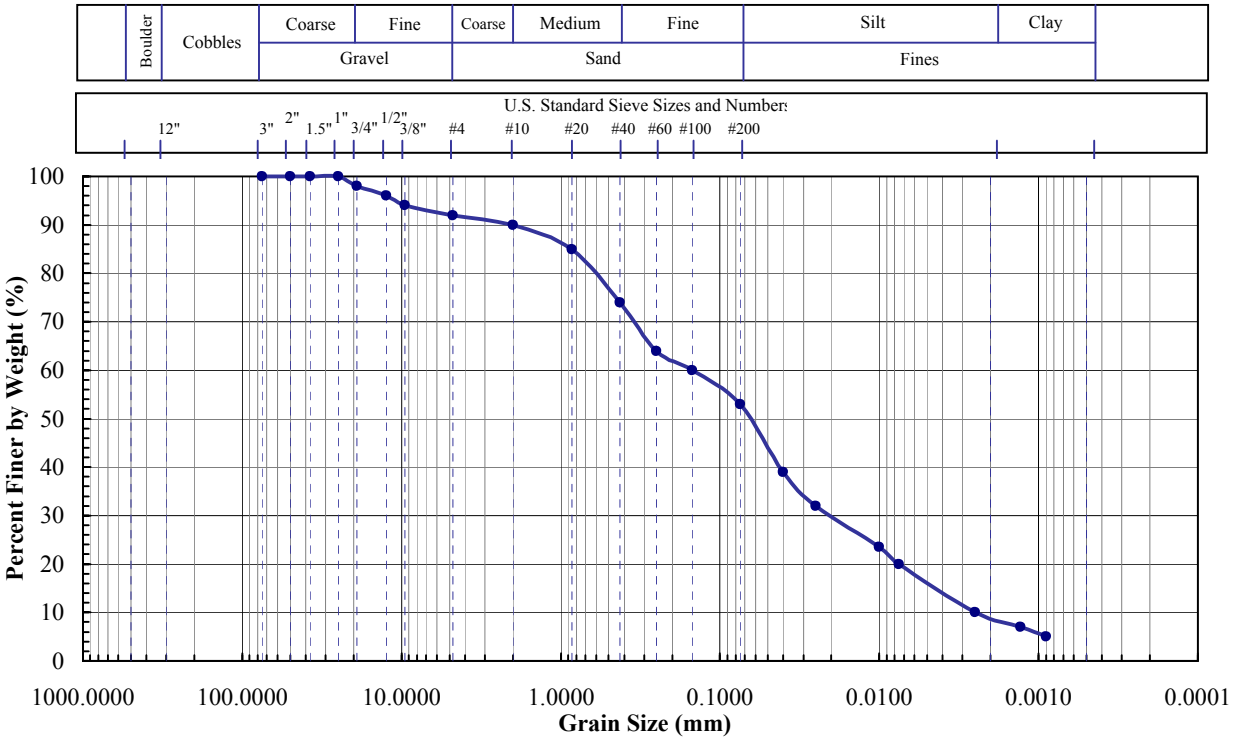
4405 International Blvd., Suite B-117, Norcross, GA 30093
Ph: (770) 931 8222 Fax: (770) 931 8240

Project Name:	Sheet Pile Testing
Project No:	SGI3004
Client Sample ID:	Barrel A Soil
Lab Sample No:	AL1001

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

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification

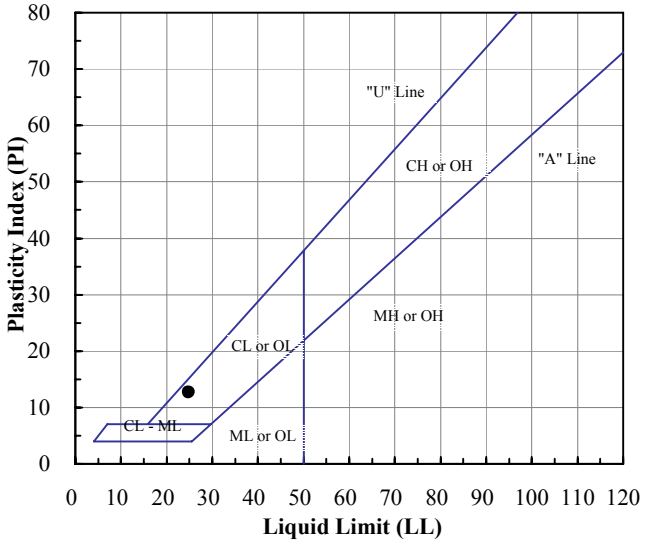


Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	98.0
1/2"	12.5	96.0
3/8"	9.5	94.0
#4	4.75	92.0
#10	2.00	90.0
#20	0.850	85.0
#40	0.425	74.0
#60	0.250	64.0
#100	0.150	60.0
#200	0.075	53.0

Hydrometer Particle Diameter (mm)	% Finer
0.0400	39.0
0.0250	32.0
0.0100	23.5
0.0075	20.0
0.0009	5.0

Gravel (%):	8.0
Sand (%):	39.0
Fines (%):	53.0
Silt (%):	45.0
Clay (%):	8.0

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



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI (-)	Engineering Classification
Barrel A Soil	AL1001	-	53.0	25	12	13	CL (Lean Clay with Sand)

Note(s):

SGI Testing Services, LLC

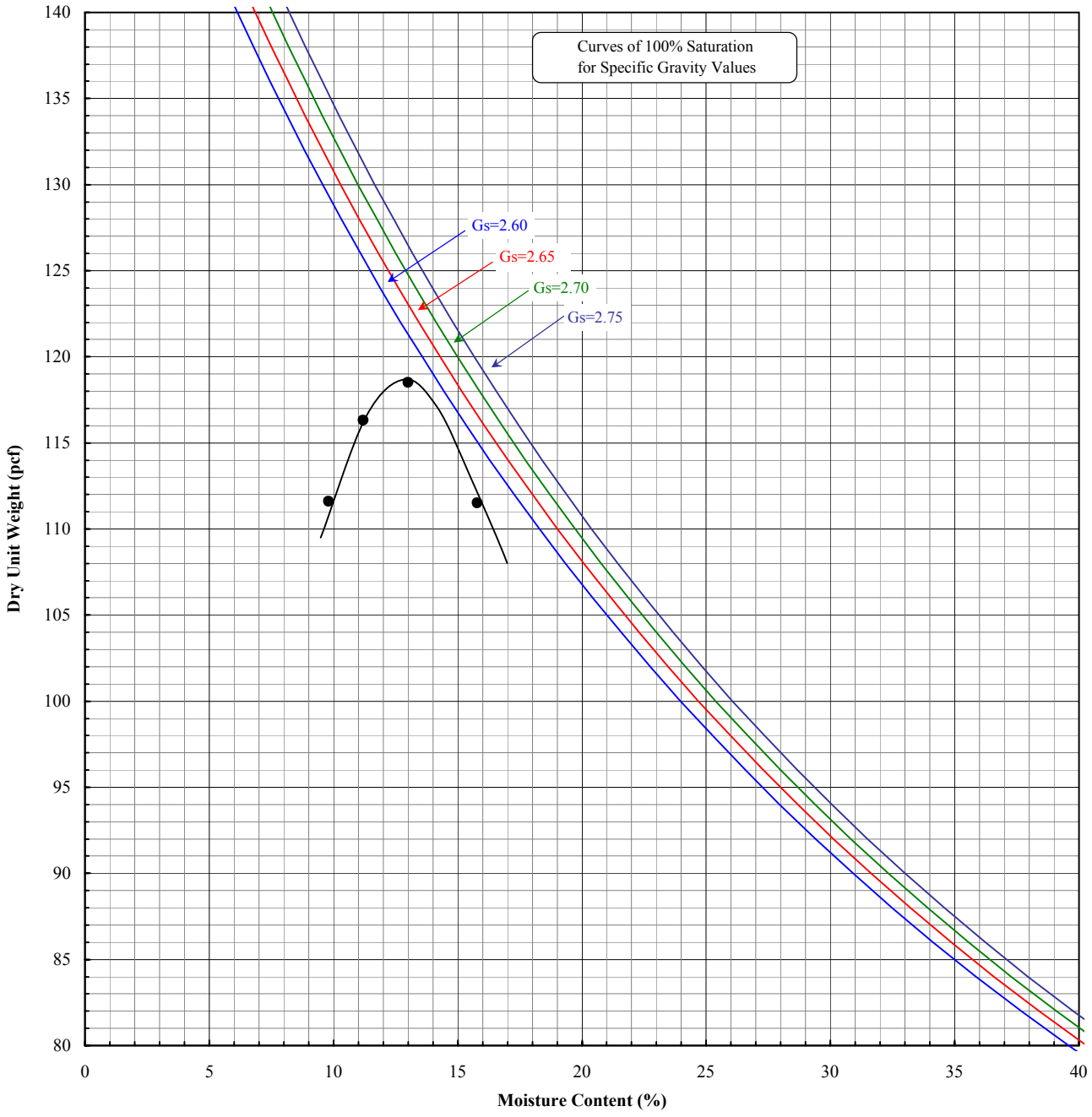
4405 International Blvd., Suite B-117, Norcross, GA 30093
Ph: (770) 931 8222 Fax: (770) 931 8240

Project Name:	Sheet Pile Testing
Project No:	SGI3004
Client Sample ID:	Barrel A Soil
Lab Sample No:	AL1001

ASTM D698

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Standard - Method A



Client Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Barrel A Soil	AL1001	118.5	12.5	Clay Soil

Note(s):

February 6, 2003

Carl Hazenberg
Northstar Vinyl Products
225 TownPark Drive
Suite 300
Kennesaw, GA 30144

Dear Carl,

Per our recent discussions concerning the UV stability of composite seawall structures, I have enclosed documentation on QUV studies conducted on representative pultruded substrates. The three resin systems evaluated in this study are typically used in structural waterfront applications. Both DION 31022-00 and 31031-00 are isophthalic based polyester resins and 31040-00 is a premiere hybrid polyurethane resin.

The UV stability of the composite system can be influenced by a number of factors including inorganic filler type, UV stabilizer type and amount, pigment composition, surfacing veils as well as the base polymer itself. For this study, we maintained an optimized formulation and only varied one parameter, the base resin. Formulation (1) which is based on DION 31040-00 is consistent with the resin system utilized by Fiberglass Innovations to manufacture Endurance seawall products for Northstar Vinyl Products.

The change from the initial (as manufactured) substrate is indicated by a numerical value (ΔEab). A higher value represents a greater change. In this series of evaluations, the panels manufactured with DION 31040-00 provided the lowest ΔEab and thus the smallest overall change. This gives us an indication, although not exact, of the expected changes that will normally occur when composite substrates are exposed to the elements over a period of time. Obviously, the projected time versus change will vary depending on the environment and climate. Composite panels used in south Florida will most likely change differently than those in northern Canada.

This change (ΔEab) occurs only in the outermost surface of the composite and normally results in only a slight color variation from the original as manufactured profile. Long-term QUV (500 hours minimum) exposure to these structures has shown no degradation to the inherent mechanical properties.

If there are any questions or any additional information I can provide, please feel free to contact me at any time.

Sincerely,

Nelson H. Douglass
Global Composites Specialist