

MULTI AXIAL TENSION TESTING OF "CL" SERIES PRODUCTS

GeoSyntec Consultants performed multiaxial tension testing in accordance with ASTM D5617 on CETCO's CL series of geosynthetic clay liners (GCLs). Multiaxial tension testing provides an indication of the ability of a membrane to sustain deflections that could occur to the liner when subjected to pressures from differential settlement, subgrade irregularities, other localized stresses on the liner system.

The products evaluated were Claymax[®] 600CL, Bentomat[®] CL and Bentomat CLT. Claymax 600CL and Bentomat CL utilize a smooth polyethylene membrane, and Bentomat CLT utilizes a textured HDPE membrane.

The test results indicate that Claymax 600CL achieved the highest multiaxial tension at rupture, 21,774 psi, and the highest multiaxial strain at rupture, 23.85%. Bentomat CL achieved multiaxial tension of 16,976 psi and 9.49% strain. These tests demonstrate the high strength properties associated with the composite construction of the products. The products also exhibit a relatively large multiaxial strain. The Bentomat CLT also possessed a multiaxial tension at rupture of 4,551 psi and multiaxial strain at rupture of 14.55%.

Due to differential settlement, applications such as landfill caps can be expected to sustain a strain of 6% (LaGatta, 1992). Thus, when used in cap applications, it is important to evaluate whether the proposed liner materials can demonstrates an ability to withstand a multiaxial strain of at least 6%.

<u>Reference</u>: LaGatta, M. *Hydraulic Conductivity Tests on Geosynthetic Clay Liners Subjected to Differential Settlement,* Master's Thesis, University of Texas at Austin, August 1992.

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MULTI AXIAL TENSION (ASTM D 5617)

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NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

1. The test sample (Bentomat CL20) is a GCL product with an upper backing of a 20-mil thick textured FML and 6-oz. nonwoven geotextile composite and a lower backing of 3.2-oz woven geotextile. The overall thickness of the test sample is approximately 0.32 in.

2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{PML} = 0.020$ in.).

Cuneyt Gokmen, Program Manager Reviewed by:

Date of Report: 17 May 2000

BentomatCL20.MAxial

GeoSyntec Consultants Soil-Geosynthetic Interaction Testing Laboratory 5775 Peachtree Dunwoody Road, Suite 11D Atlanta, Georgia 30342 Phone: (404) 705-9500 Fax: (404) 705-9300

MULTI AXIAL TENSION (ASTM D 5617)

	Colloid Environmental Technologies Company
(lient:	Laminated GCL Testing
Olient Project Reference:	GLI1104
Cheffit Project Notice	Bentomat CL20 ⁽¹⁾
GeoSyntee Flojeet No	AL7743
Test Material:	
GeoSyntec Sample No.:	

Test No.	Pressure at Rupture (psi)	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%) 17.77
1	11.67	6.33	4208	15.44
2	12.38	5.88	4002	10.44
3	11.09	4.80	4782	14.55
Mean	11.71	5.07	302	3.75
STD	0.65	0.79		

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NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

Test Configuration: Laminated side against the pressure.

1. The test sample (Bentomat CL20) is a GCL product with an upper backing of a 20-mil thick textured FML and 6-oz. nonwoven geotextile composite and a lower backing of 3.2-oz woven geotextile. The overall thickness of the test sample is approximately 0.32 in.

2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{FML} = 0.020$ in.).

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MULTI AXIAL TENSION (ASTM D 5617)

Colloid Environmental Technologies Company Laminated GCL Testing	GLJ1104	Bentomat CL			20000
	Client Client Project Reference:	GeoSyntec Project No.:	Test Material:	Geosyntee sample two.	



NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

1. The test sample (Bentomat CL) is a GCL product with an upper backing of a 4-mil thick FML and 6-oz. nonwoven geotextile composite and a lower backing of 3.2-oz woven geotextile. The overall thickness of the test sample is approximately 0.3 in.

Date of Report: 17 May 2000

2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{PML} = 0.004$ in.).

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BentomatCL.MAxial

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MULTI AXIAL TENSION (ASTM D 5617)

	Colloid Environmental Technologies Company
Client:	Laminated GCL Testing
Client Project Reference:	GLI1104
GeoSyntec Project No.:	Bentomat CL ⁽¹⁾
Test Material:	AL7742
GeoSyntec Sample No.:	

Test No.	Pressure at Rupture	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%)
	(psi) 7 02	4.85	16939	10.67
1	7.52	4 39	16464	8.77
2	7.14	4.45	17527	9.03
3	7.69	4.45	16976	9.49
Mean	7.58	4.50	533	1.03
STD	0.40	0.25		1

NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

Test Configuration: Laminated side against the pressure.

1. The test sample (Bentomat CL) is a GCL product with an upper backing of a 4-mil thick FML and 6-oz. nonwoven geotextile composite and a lower backing of 3.2-oz woven geotextile. The overall thickness of the test sample is approximately 0.3 in.

2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{FML} = 0.004$ in.).

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MULTI AXIAL TENSION (ASTM D 5617)

Colloid Environmental Technologies Company Laminated GCL Testing GLI1104 Claymax 600CL ⁽¹⁾ AL7744	25000 25000 15000 5000 5000 5000 5000 50	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 Multi Axial Strain (%)
lient: lient Project Reference: eoSyntec Project No.: sst Material:	Pressure (psi) Pressure (psi) Pressure (psi) Pressure (psi) Pressure (psi)	0 1 2 3 4 5 6 7 8 9 Center Deflection (inch)

NOTES:

Specimen Test Diameter: 23.88 in. STD = standard deviation

Pressure Rate: Approximately 1 psi/min.

1. The test sample (Claymax 600CL) is a GCL product with an upper backing of a 4-mil thick FML and 2.7-oz. nonwoven geotextile composite and a lower backing of 2.8-oz woven geotextile. The overall thickness of the test sample is approximately 0.25 in.

; 2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{FML} = 0.004$ in.).

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Reviewed by:

Cuneyt Gokmen, Program Manager

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Date of Report: 17 May 2000

Claymax600CL.MAxial

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MULTI AXIAL TENSION (ASTM D 5617)

	Colloid Environmental Technologies Company
Client:	Laminated GCL Testing
Client Project Reference:	GLI1104
GeoSyntec Project No.:	Claymax 600CL ⁽¹⁾
Test Material:	AL7744
GeoSyntec Sample No.:	

Test No.	Pressure at Rupture (psi)	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%)
	14 96	8.05	24082	28.01
1	12.00	6.90	20819	20.95
2	12.09	7 19	20421	22.59
3	12.09	7.18	21774	23.85
Mean	13.05	7.38	21/14	2.60
STD	1.66	0.60	2009	3,09

NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

Test Configuration: Laminated side against the pressure.

1. The test sample (Claymax 600CL) is a GCL product with an upper backing of a 4-mil thick FML and 2.7-oz. nonwoven geotextile composite and a lower backing of 2.8-oz woven geotextile. The overall thickness of the test sample is approximately 0.25 in.

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2. For multi axial tension analysis, the nominal thickness of the FML is used ($t_{FML} = 0.004$ in.).

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Cuneyt Gokmen, Program Manager

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