

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.

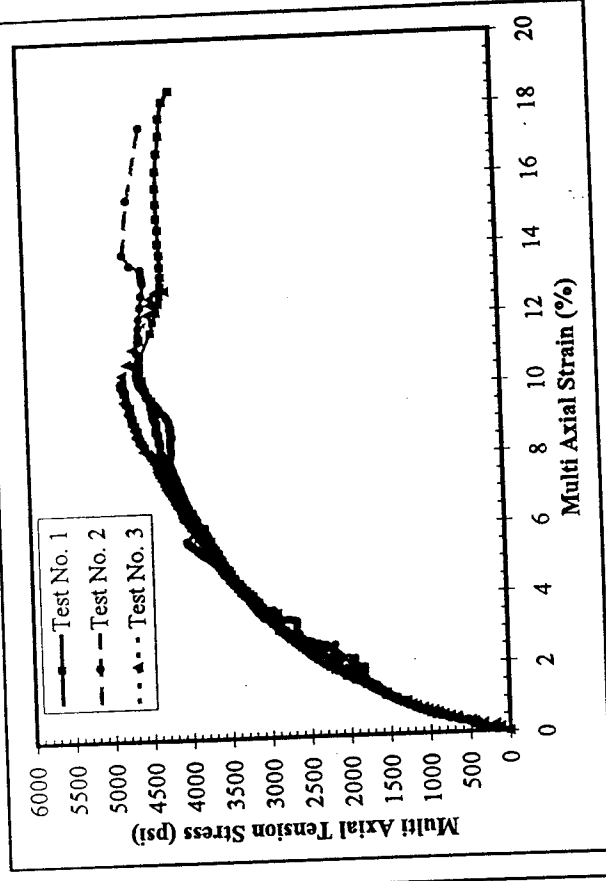
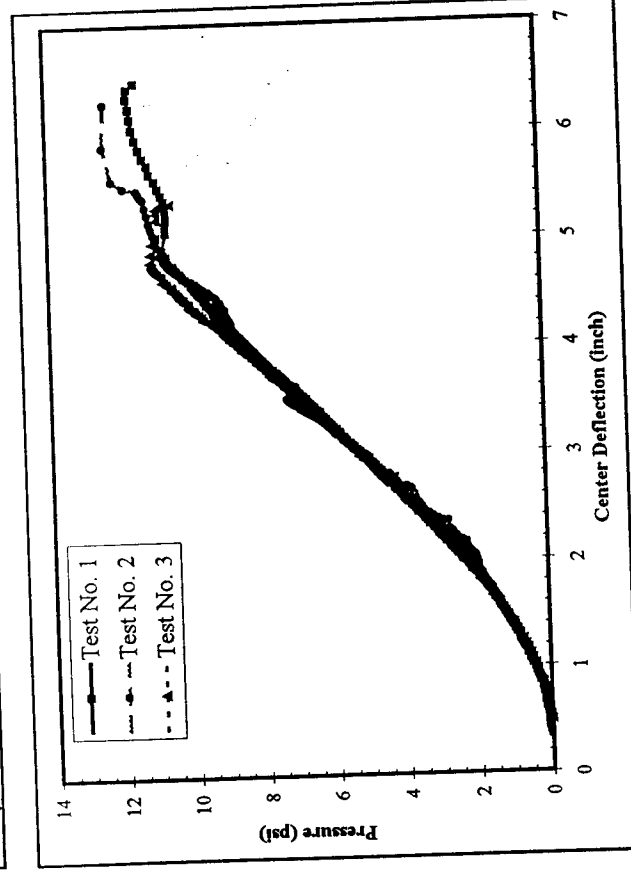
The test results indicate that Claymax 600CL achieved the highest multiaxial tension at rupture, 21,774 psi, and the highest multiaxial strain at rupture, 23.85%. Bentomat CL achieved multiaxial tension of 16,976 psi and 9.49% strain. These tests demonstrate the high strength properties associated with 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 demonstrate an ability to withstand a multiaxial strain of at least 6%.

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

MULTI AXIAL TENSION (ASTM D 5617)

Client:	Colloid Environmental Technologies Company
Client Project Reference:	Laminated GCL Testing
GeoSyntec Project No.:	GL11104
Test Material:	Bentomat CL20 (1)
GeoSyntec Sample No.:	AL7743



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.).

Reviewed by:

Cuneyt Gokmen, Program Manager

Date of Report: 17 May 2000

MULTI AXIAL TENSION (ASTM D 5617)

Client:	Colloid Environmental Technologies Company
Client Project Reference:	Laminated GCL Testing
GeoSyntec Project No.:	GLI1104
Test Material:	Bentomat CL20 ⁽¹⁾
GeoSyntec Sample No.:	AL7743

Test No.	Pressure at Rupture (psi)	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%)
1	11.67	6.33	4208	17.77
2	12.38	5.88	4662	15.44
3	11.09	4.80	4782	10.44
Mean	11.71	5.67	4551	14.55
STD	0.65	0.79	302	3.75

NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

Test Configuration: Laminated side against the pressure.

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

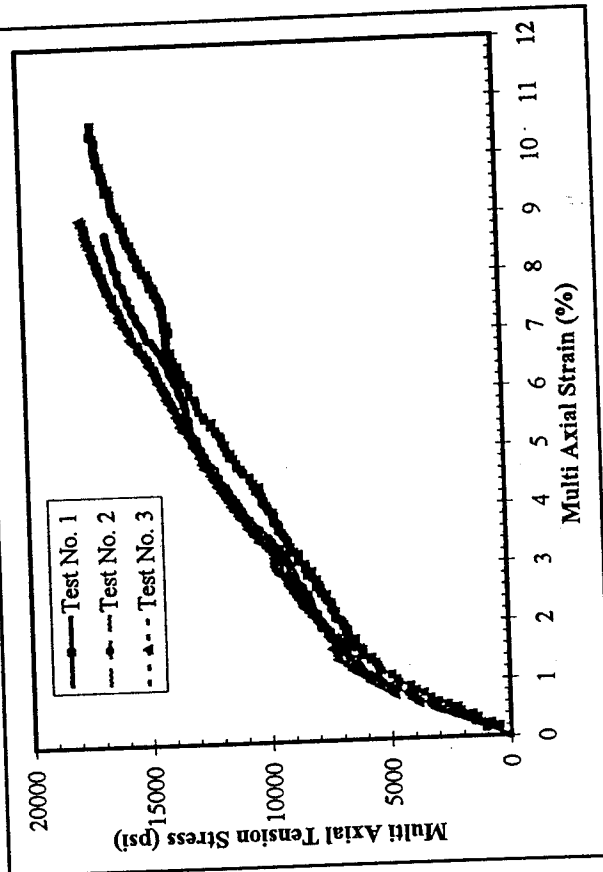
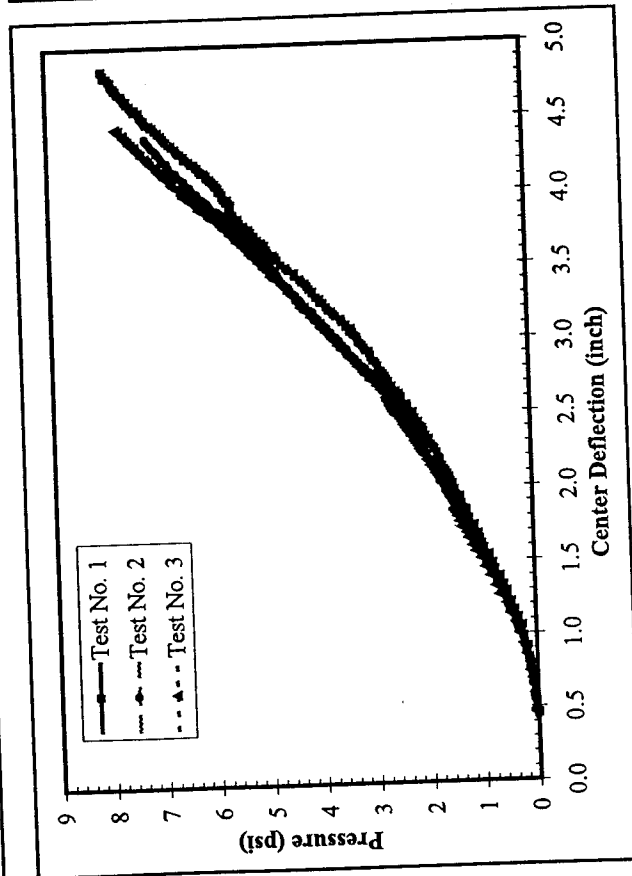
Reviewed by:

Cuneyt Gokmen, Program Manager

Date of Report: 17 May 2000

MULTI AXIAL TENSION (ASTM D 5617)

Client:	Colloid Environmental Technologies Company
Client Project Reference:	Laminated GCL Testing
GeoSynTec Project No.:	GL11104
Test Material:	Bentomat CL (1)
GeoSynTec Sample No.:	AL7742



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.).

Reviewed by:

Cuneyt Gokmen, Program Manager

Date of Report: 17 May 2000

MULTI AXIAL TENSION (ASTM D 5617)

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

Test No.	Pressure at Rupture (psi)	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%)
1	7.92	4.85	16939	10.67
2	7.14	4.39	16464	8.77
3	7.69	4.45	17527	9.03
Mean	7.58	4.56	16976	9.49
STD	0.40	0.25	533	1.03

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.).

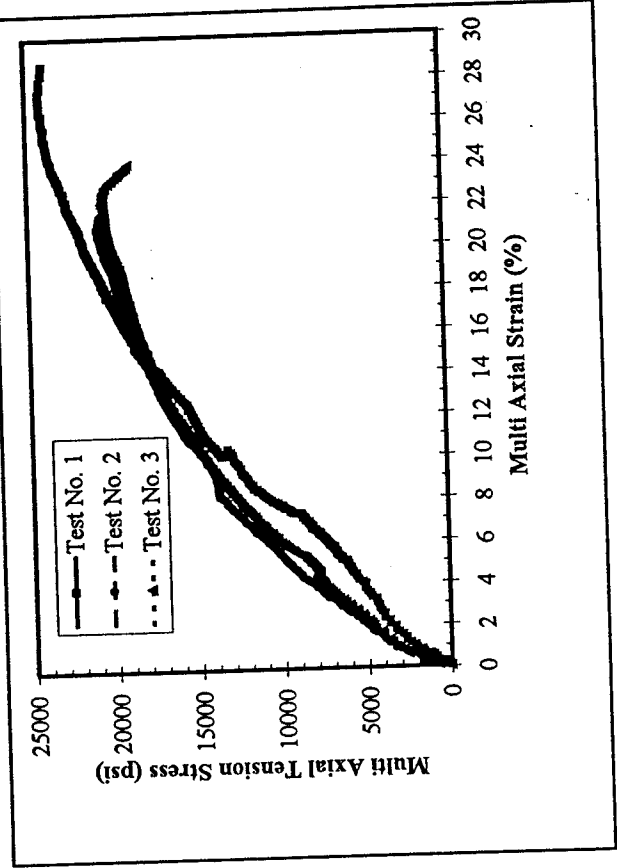
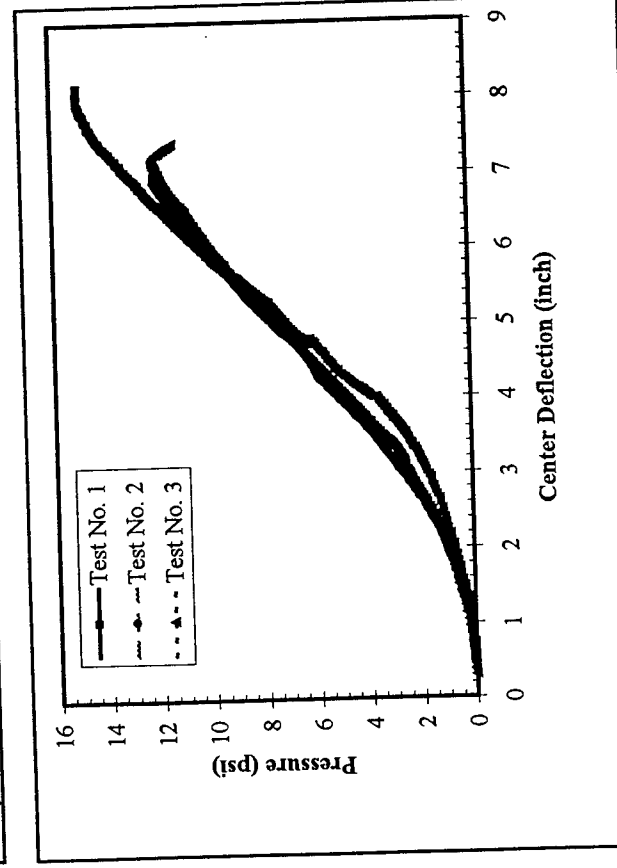
Reviewed by:

Cuneyt Gokmen, Program Manager

Date of Report: 17 May 2000

MULTI AXIAL TENSION (ASTM D 5617)

Client:	Colloid Environmental Technologies Company
Client Project Reference:	Laminated GCL Testing
GeoSyntec Project No.:	GL11104
Test Material:	Claymax 600CL (1)
GeoSyntec Sample No.:	AL7744



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.

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

Reviewed by:

Cuneyt Gokmen, Program Manager

Date of Report: 17 May 2000

MULTI AXIAL TENSION (ASTM D 5617)

Client:	Colloid Environmental Technologies Company
Client Project Reference:	Laminated GCL Testing
GeoSyntec Project No.:	GLII 104
Test Material:	Claymax 600CL ⁽¹⁾
GeoSyntec Sample No.:	AL7744

Test No.	Pressure at Rupture (psi)	Center Deflection at Rupture (in.)	Multi Axial Tension ⁽²⁾ at Rupture (psi)	Multi Axial Strain at Rupture (%)
1	14.96	8.05	24082	28.01
2	12.09	6.90	20819	20.95
3	12.09	7.18	20421	22.59
Mean	13.05	7.38	21774	23.85
STD	1.66	0.60	2009	3.69

NOTES:

STD = standard deviation

Specimen Test Diameter: 23.88 in.

Pressure Rate: Approximately 1 psi/min.

Test Configuration: Laminated side against the pressure.

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

Date of Report: 17 May 2000

Reviewed by:

Cuneyt Gokmen, Program Manager