



The Pioneer Of Geosynthetics  
S I N C E 1 9 7 2

## Product Shear Strength for Fabric Encased GCL Products

### OVERVIEW

GSE Bentoliner fabric encased geosynthetic clay liners (GCLs) are industrially manufactured composite materials combining high swelling bentonite clay and geosynthetics for sealing applications. Given their proven hydraulic performance, with a hydraulic conductivity  $\leq 5 \times 10^{-11}$  m/s, GSE Bentoliner GCLs can be utilized as a replacement for standard low permeability ( $\leq 1 \times 10^{-9}$  m/s) compacted clay liners (CCLs). Their proven effectiveness on slopes and ease of installation provide several performance and economic benefits as a liner (Figure 1).



Figure 1. GSE Bentoliner fabric encased GCL.

### REINFORCEMENT ADVANTAGE

When typically installed over a soil subgrade, the bentonite component will hydrate via soil suction of adjacent soil moisture. The low hydrated shear strength of the bentonite component is overcome by needlepunching the cap and carrier geotextiles together (Figure 2). Approximately 2.5 million polypropylene fibers per  $m^2$  reinforce the bentonite clay layer by connecting the cap geotextile to the carrier geotextile. This creates internal reinforcement in the product. After the needlepunching process, the surface of the carrier geotextile is heat-burnished further bonding the reinforcing fibers into the carrier geotextile.

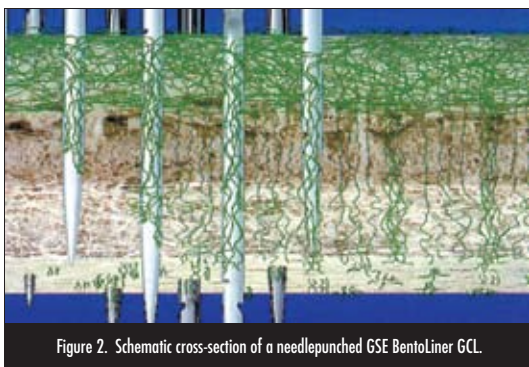


Figure 2. Schematic cross-section of a needlepunched GSE Bentoliner GCL.

One main advantage of needlepunched GCLs is they can be installed on projects requiring high internal and interface shear strength in lining or cap systems (Figure 3). A variety of GSE Bentoliner products, with various woven and nonwoven geotextiles and needlepunch reinforcement strengths, are available to ensure maximum long-term hydraulic and slope performance.

Four standard GSE Bentoliner products are available, depending on project slopes, normal loads placed on the liner system, and resulting GCL internal and interface shear strength requirements.

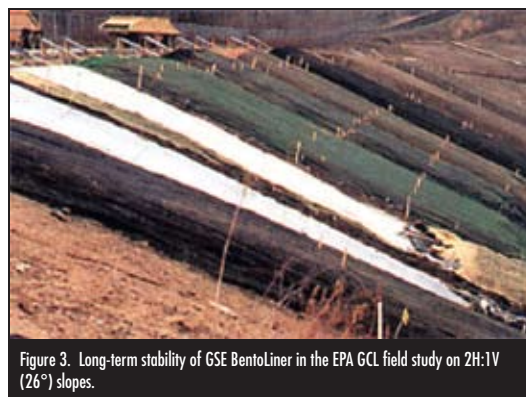


Figure 3. Long-term stability of GSE Bentoliner in the EPA GCL field study on 2H:1V (26°) slopes.

### PRODUCT SERIES

**1. GSE Bentoliner EC Series.** For flat lying areas generally  $< 6H:1V$  ( $9^\circ$ ) and projects where slope stability is of minimal concern, EC series consist of bentonite encapsulated between two lightweight [3.0 oz/yd<sup>2</sup> (100 g/m<sup>2</sup>)] geotextiles with light needlepunched reinforcement.

**2. GSE Bentoliner NSL Series.** For applications which require improved GCL internal shear strength, such as on slopes ranging up to approximately 4H:1V ( $14^\circ$ ) and/or projects with higher normal loads, NSL is manufactured with the bentonite encased between a 6 oz/yd<sup>2</sup> (200 g/m<sup>2</sup>) nonwoven geotextile and a carrier 3.1 oz/yd<sup>2</sup> (105 g/m<sup>2</sup>) slit-film woven geotextile with needlepunched reinforcement.

**3. GSE Bentoliner NWL Series.** For applications which require high GCL internal strength as well as increased friction resistance (interface shear strength) against adjacent materials, such as textured geomembranes and soils, NWL is produced with a

6 oz/yd<sup>2</sup> (200 g/m<sup>2</sup>) scrim nonwoven geotextiles with needlepunched reinforcement between the geotextiles.

**CONCLUSION**

All standard products include 0.75 lb/ft<sup>2</sup> (3.7 kg/m<sup>2</sup>) bentonite mass loading. GSE BentoLiner GCLs are also available with bentonite loading up to 1.1 lb/ft<sup>2</sup> (5.5 kg/m<sup>2</sup>). These products are also available with enhanced bentonite for improved hydraulic performance with harsher leachates and liquids. A polypropylene coating or a laminated polyethylene liner can be added to these standard products, further increasing the barrier properties. The variety and flexibility of available GSE BentoLiner products provides both economical and performance benefits to most all composite lining projects as a replacement for CCLs.

Project specific slope stability and shear strength requirements must be evaluated in selecting the appropriate GSE BentoLiner product for each application. For direct shear test results or slope performance information contact GSE.

**ADDITIONAL INFORMATION**

If you have an upcoming project please give us a call. We will provide you with recommendations for material and installation.