FINAL COVER STABILITY

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Checked by: JBF
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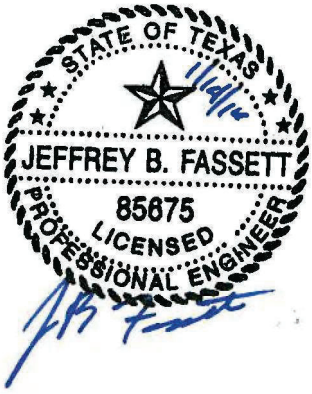
1.0 OBJECTIVE

To investigate the stability of the final cover lining system.



Golder Associates Inc.
F-2578

2.0 GIVEN

Maximum slope of the geomembrane within the final cover is approximately 6%.
Length of maximum slope is conservatively assumed to be 100 ft.

3.0 ASSUMPTIONS

Proposed final cover liner system consists of (from top to bottom):

36-inch Soil Cover
Non-Woven Geotextile
60-mil HDPE smooth geomembrane
GCL

The soil cover is assumed to be saturated.

Based on a review of available data, the following parameters were assigned to the materials.

Material	Strength Parameters		Unit Weight (pcf)		Reference
	ϕ	c	Moist	Saturated	
Soil cover	28	0	115	132	Estimate-conservative
Soil cover/Nonwoven Geotextile	29	0	N/A	N/A	Golder*
Nonwoven Geotextile/Smooth Geomembrane	11	0	N/A	N/A	Koerner and Narejo, 2005**
Smooth Geomembrane/GCL	14	0	N/A	N/A	Golder*

* Based on unpublished testing data for similar materials presented later in Figure 1 and Figure 3.

** The data indicates an average peak friction angle of 11 degrees - see Figure 2.

Based on the shear strength parameters, the critical interface occurs along the nonwoven geotextile/smooth geomembrane interface; this interface has a friction angle of 11 degrees.

4.0 METHOD

A model was created representing the final cover slopes. A limit equilibrium analysis was performed to determine the minimum factor of safety against a sliding block failure along the critical interface.

Infinite Slope Analysis

$$FS = \frac{c + (\gamma b \cos\beta - \gamma_w d \cos\beta)\tan\phi}{\gamma b \sin\beta}$$

based on Soong and Koerner 1996.

Sliding at Nonwoven Geotextile/Smooth Geomembrane Interface

ϕ =	11	interface friction angle	
β =	6%	slope angle - max	
	3.4	slope angle - max (degrees)	0.05992816
c =	0	cohesion of soil (psf)	
γ =	125	saturated unit weight of soil (pcf)	
b =	3.0	soil thickness (ft)	
d =	3	water depth in cover (ft)	
γ_w =	62.4	unit weight of water (pcf)	
FS =	**1.64**		

5.0 RESULTS

Using the Golder Associates and GRI interface friction angle data, the critical angle of internal friction was conservatively assumed to be 11 degrees. The resulting minimum factor of safety was calculated to be 1.64.

6.0 CONCLUSION

Through analysis of the lining system, the final cover slope is found to be stable.

7.0 REFERENCE

Te-Yang Soong and Robert M. Koerner, "Cover Soil Slope Stability Involving Geosynthetic Interfaces," GRI Report #18, Geosynthetic Research Institute, Drexel University, Philadelphia, PA, December 1996.

Rombert M. Koerner and Dhani Narejo, "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces," GRI Report #30, Geosynthetic Research Institute, Drexel University, Philadelphia, PA, June 2005.

FIGURE 1 Peak shear strength based on testing performed by Golder Associates Inc.

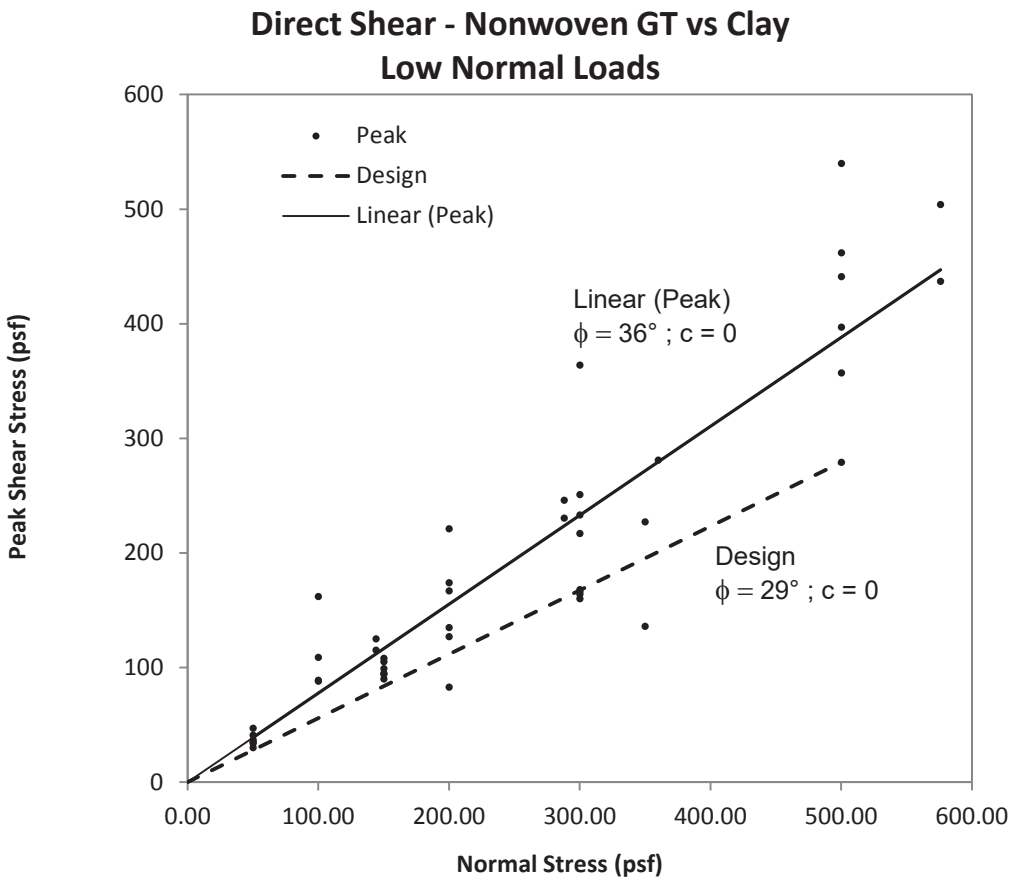


FIGURE 2

Peak Shear Strength; Smooth HDPE against NW-NP Geotextile (Figure from Koerner and Narejo 2005)

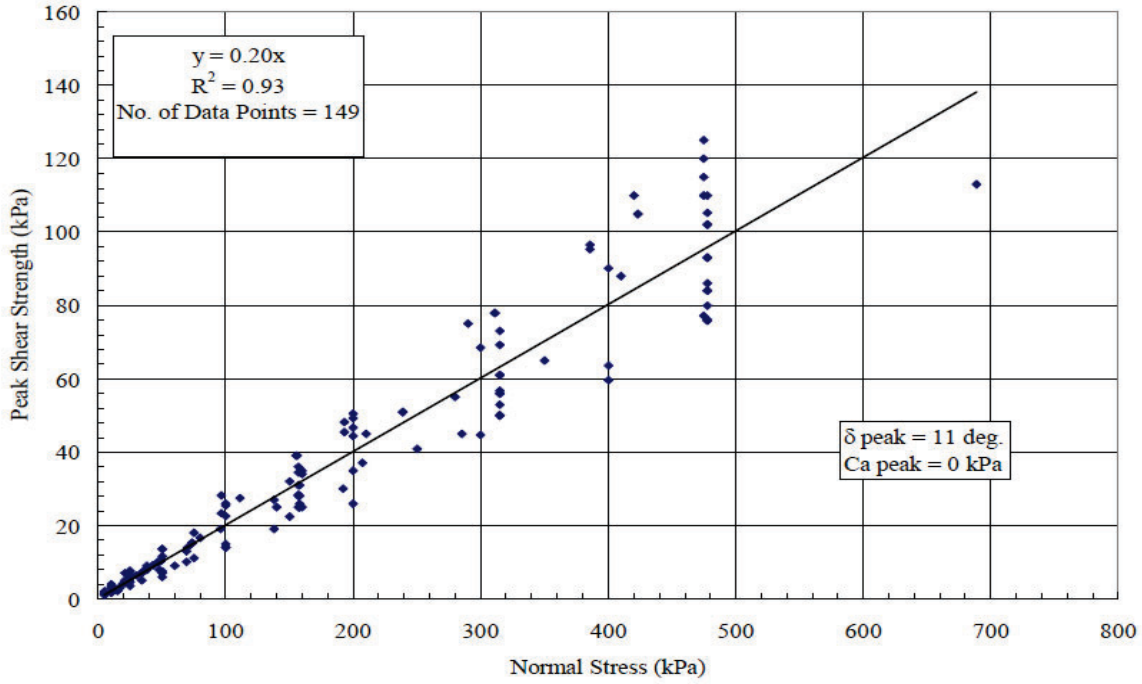


FIGURE 3 Peak shear strength based on testing performed by Golder Associates Inc.