

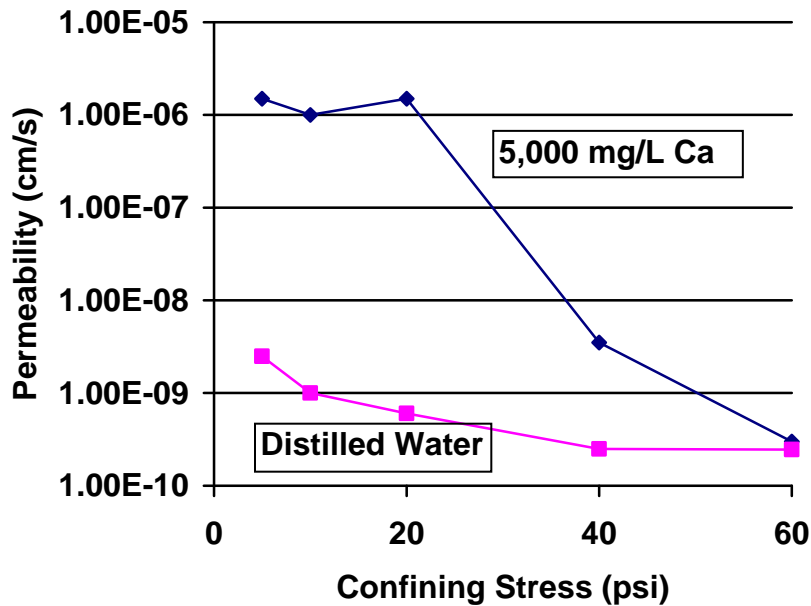
GCL PERFORMANCE IN A CONCENTRATED CALCIUM SOLUTION

Permeability vs. Confining Stress

The following test data was developed by Daniel in 2000 and published in the reference listed below. However, unpublished details about the testing, including this graph, were provided to CETCO in separate correspondences from Daniel. The purpose of this summary is to present all the data and information about the test program in one document.

The graph compares the effects of confining stress on the permeability of GCLs permeated with both water and a concentrated calcium chloride (CaCl_2) solution. The graph demonstrates that even when a highly contaminated liquid is permeated through a GCL, it still maintains an acceptable permeability of $\leq 5 \times 10^{-9}$ cm/sec when the confining stress exceeds 40 psi or 275 kPa. Based on this data, Daniel concluded that, “chemical attack is of much less concern for a landfill liner than for a landfill cover.” In other words, the high confining stress environment of a landfill bottom liner protects the GCL from permeability increases observed in low confining stress environments such as landfill final covers.

Test specimens were set up in flexible-wall permeameters, subjected to the final confining pressure, and then hydrated and subsequently permeated with either distilled water or a calcium chloride solution. For the calcium chloride tests, both the hydration liquid and the permeation liquid were the same calcium chloride solution. This solution was 13,700 mg/L CaCl_2 , which is equal to 5,000 mg/L Ca^{++} . This liquid is believed to represent worst-case conditions in that the concentration was very high, and no fresh water permeation was allowed as would typically occur in real-world applications when the GCL is placed on a soil subgrade. Specimens were permeated for 10 pore volumes of flow, which was more than enough to achieve full ion exchange and equilibrium conditions.



The data shows that the decrease in permeability with increasing confining stress is even more dramatic than when fresh water is used as the permeant. Even in a highly contaminated liquid such as this, however, the GCL still functioned effectively when the confining stress reached approximately 40 psi (275 kPa).

References:

Daniel, D.E. (2000), "Hydraulic Durability of Geosynthetic Clay Liners," *Proceedings of the GRI-14 Conference on 'Hot Topics in Geosynthetics - I'*, R.M. Koerner, Y.G. Hsuan, and M.V. Ashley (Eds.), Gil Publications, Folsom, P.A. , pp. 116-135.

Daniel, D.E., Correspondence to J. Olsta, 19 March 2001 and 22 November 2000.