GCL VS. COMPACTED CLAY: CONSTRUCTION SURVIVABILITY COMPARISON

Introduction

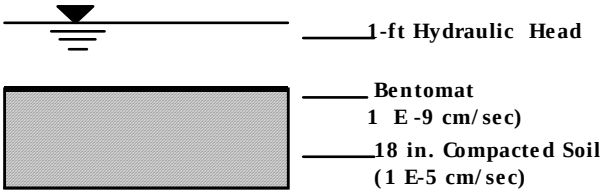
It is commonly perceived that geosynthetic clay liners (GCLs) are at a disadvantage to compacted clay liners (CCLs) only because they are less resistant to puncture or other kinds of mechanical damage. While it is obvious that a thin GCL can be damaged more easily than a two-foot thick CCL, it is not as obvious that even a severely compromised GCL will outperform a CCL. A series of liner system leakage calculations demonstrates this conclusion.

A straightforward hydraulic performance comparison of GCL vs. a CCL is presented in CETCO's GCL Technical Reference TR-300. This new comparison uses similar procedures to examine how much damage a GCL can sustain during installation before its leakage exceeds the leakage from a CCL. Two scenarios are examined. In the first scenario, a GCL replaces compacted clay in a liner system, which has no other barrier component (a MSWLF cover, for example). In the second scenario, a GCL replaces compacted clay in a composite liner system, where a geomembrane is placed directly over the GCL.

Scenario 1 - No other barrier component

To begin, the two liner systems depicted below are evaluated for steady-state leakage using Darcy's Law. The hydrated thickness of the GCL is assumed to be 0.375 inches or 0.03125 ft. The term 9.225×10^8 is a conversion from cm/sec to gal/acre-day.

BENTOMAT STEADY-STATE LEAKAGE



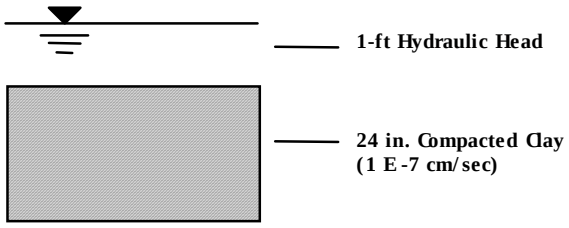
Steady-state leakage =

$Q = k\,i\,A$

$= (1 \times 10^{-9}\ \text{cm/sec}) \dfrac{(1 + 0.03125)}{0.03125} (1)\,(9.225 \times 10^8) =$

30 gal/acre-day

CCL STEADY-STATE LEAKAGE



Steady-state leakage =

$Q = k\,i\,A$

$= (1 \times 10^{-7}\ \text{cm/sec}) \dfrac{(1 + 2)}{2} (1)(9.225 \times 10^8) =$

138 gal/acre-day

The above calculations demonstrate that the undamaged Bentomat will allow far less leakage than a typical CCL.

800.527.9948 Fax 847.577.5566

Scenario 2 – GCL and Geomembrane

Next we must assume that the GCL is damaged during installation. Based on CETCO's prior experience, it is believed that the placement of soil backfill is the only activity that could significantly damage the GCL. For the purposes of this discussion, it is assumed that a careless bulldozer operator inadvertently drops the scraping blade into the liner/cover system during backfill placement, gouging a defect into the liner that is 3 feet wide, 6 feet long, and 6 inches deep (an 18 sq. ft area). We will further assume that the gouge defect goes unnoticed and becomes a permanent feature of the cover system.

The leakage through each liner due to these defects would be calculated as follows:

LEAKAGE THROUGH GCL DEFECT

$$Q = k\,i\,A$$
$$= (1 \times 10^{-5}\ \text{cm/sec})\ \frac{(1+1)}{1}\ (18\ \text{sq. ft})\ (21{,}179) =$$

7.6 gal/day

LEAKAGE THROUGH CCL DEFECT

$$Q = k\,i\,A$$
$$= (1 \times 10^{-7}\ \text{cm/sec})\ \frac{(1+1.5)}{1.5}\ (18\ \text{sq ft})\ (21{,}179) =$$

0.064 gal/day

Thus, the flow through an installation-induced GCL defect is greater than through a similar defect in a CCL. A proper comparison, however, requires us to calculate the total flow through each liner, which is the sum of the steady-state flow and the defect-related flow:

TOTAL GCL FLOW

Number of Defects/Acre	Flow Through Defects (gpd)	Total Flow (gal/acre-day)
0	0	30
5	38	68
10	76	106
15	114	144

TOTAL CCL FLOW

Number of Defects/Acre	Flow Through Defects (gpd)	Total Flow (gal/acre-day)
0	0	138
5	0.3	138
10	0.6	139
15	1	139

The above table demonstrates that it is possible to have 14 installation-related defects per acre before the performance of the GCL is as poor as the performance of a defect-free CCL. It is highly unlikely that the GCL would be so severely compromised, even by the most unskilled and careless installer. Based on the above information, and in consideration of the long-term deterioration of a CCL (due to settlement, freeze/thaw, and desiccation), there is little reason to design a cover system with a CCL rather than GCL.

References

Giroud, J.P., K. Badu-Tweneboah, and R. Bonaparte. "Rates of Leakage Through a Composite Liner Due to Geomembrane Defects." Journal of Geotextiles and Geomembranes, Elsevier Science Publication, Ltd. England, 1990.
Bonaparte, Rudolph, and Gross, Beth. "field Behavior of Double Liner Systems." "Waste Containment Systems: Construction, Regulation, and Performance." ASCE Geotechnical Special Publication No. 26, pp 52-83, 1990.
CETCO Technical Reference TR-300. "A Performance Comparison of Liners for Wastewater Lagoons."