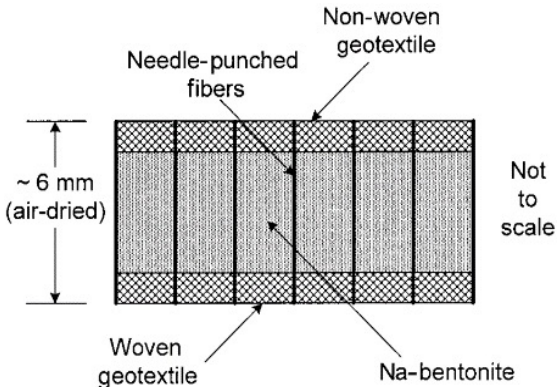
Geosynthetic Material Tests

GCLs applied in a reservoir

At Alliance we provide the client with a suite of hydro-mechanical tests on geosynthetic materials, especially on the geosynthetic clay liners (GCLs).

GCLs have become popular in the geotechnical and geoenvironmental engineering practices. They are used as a part of the composite liner system, working as hydraulic and chemical barriers in reservoirs, landfills, tailing dams, etc. While GCLs come with their design parameters given by the suppliers, it has been well acknowledged that these parameters may change with the site-specific stress conditions and hydro-chemical environments.



(a) A typical GCL formed in a sandwich structure

(b) A typical GCL

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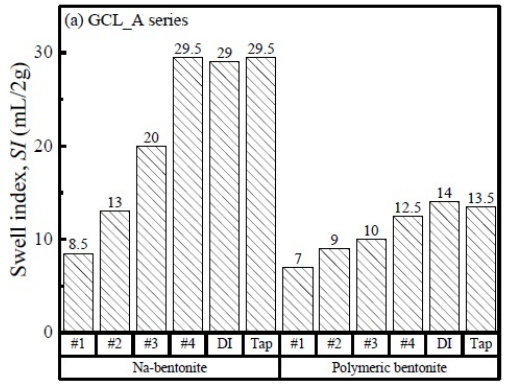
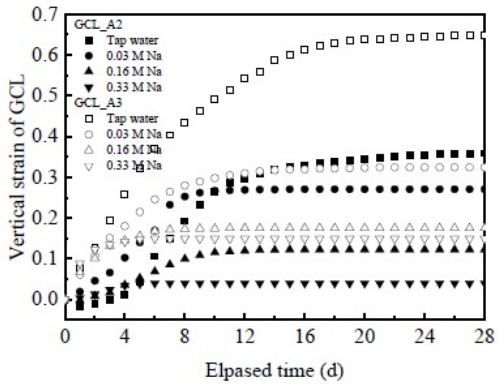
Geosynthetic Material Tests

Bentonite clay property tests

A typical GCL consists of one thin layer of bentonite clay sandwiched by two layers of geotextile. The swelling bentonite layer, while it is only ~8-10 mm thick when fully saturated, serves as the main hydraulic and chemical barrier as it remains a very low permeability (~10-10 to 10-12 m/s). However, whether such low permeability can be achieved in practice depends on many factors, e.g., overburden stress, chemical compositions of the wetting liquid and leachates, etc.



(a) Bentonite swell index decrease in leachate



(b) Cation concentration effects on GCL swelling

Here at Alliance, a series tests are available to supply the client with bentonite properties using site specific conditions. These tests include: Atterberg limits (AS1289.3.1.1&3.2.1&3.3.1), swell index (ASTM D5890), free swell (ASTM D4546), one dimensional consolidation (AS1289.6.6.1), swelling pressure index (AS4133.3.3), etc. The client will be able to specify the type of test water, magnitude of stress conditions, etc., or further discuss with our experienced laboratory staff for customized test methods.

Permeability of GCLs

The permeability of the GCL supplied by the manufacturer is generally tested at an ideal condition, i.e., GCL is fully saturated by the clean water and permeated with clean water. However, such ideal environments may not exist in a real world. Research on GCL has found that the prehydration and permeation liquid can notably influence the permeability of GCLs. For example, if a GCL with a low saturation degree is subjected to the permeation of a contaminated leachate, it is very possible that the GCL will have a permeability that is 2-3 orders of magnitudes higher than its designed value. Such increase of the GCL permeability due to the environment changes must be taken consideration into the barrier system design to ensure its long-term performance.

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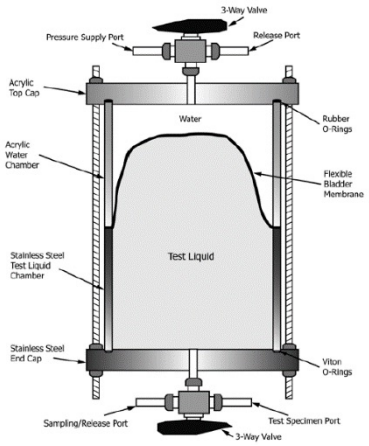
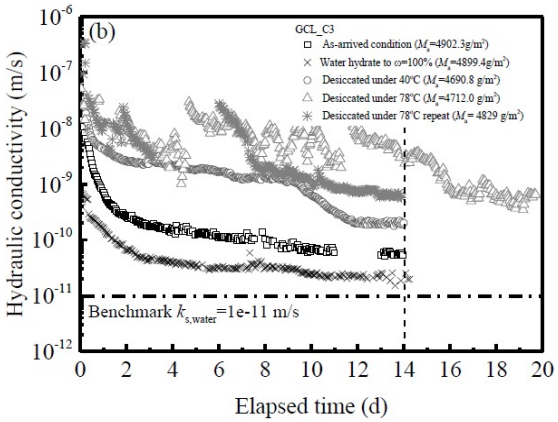
Geosynthetic Material Tests



(a) Diagram of the toxic interface chamber



(b) Poorly wetted GCL permeated with salt water

At Alliance we provide customized permeability tests on GCL materials. Test methods such as AS1289.6.7.3 and ASTM D5887 and D6766 are suggested. The 100 mm sample size can minimize the side bentonite loss effects on the permeability measurement. Toxic interface chambers are used to permeate the GCL with site water or contaminated leachates. The permeation tests can also be carried out on the dry GCL to simulate the worst-case scenario, i.e., contaminated permeation through a poorly saturated bentonite liner.

References

ASTM D5887 Measurement of index flux through saturated geosynthetic clay liner specimens using a flexible wall permeameter
ASTM D6766 Standard test method for evaluation of hydraulic properties of geosynthetic clay liners permeated with potentially incompatible aqueous solutions
ASTM D5890 Standard test method for swell index of clay mineral component of geosynthetic clay liners
ASTM D2435 Standard test methods for one-dimensional consolidation properties of soils using incremental loading
ASTM D5084 Standard test methods for measurement of hydraulic conductivity of saturated porous materials using a flexible wall permeameter
ASTM D4546 Standard test methods for one-dimensional swell or collapse of soils
AS 1289.6.6.1 Determination of the one-dimensional consolidation properties of a soil - Standard method
AS 1289.6.7.3 Determination of permeability of a soil-Constant head method using a flexible wall permeameter
AS 4133.3.3 Determination of the swelling pressure index under conditions of zero volume change
Yu, B. (2020). Engineering Performance of Geosynthetic Clay Liners in Contact with Brine under High Temperature (Doctoral dissertation, University of Sydney).
Yu, B., El-Zein, A., & Rowe, R. K. (2020). Effect of added polymer on the desiccation and healing of a geosynthetic clay liner subject to thermal gradients. Geotextiles and Geomembranes, 48(6), 928-939.

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