Geofabrics Centre for
GEOSYNTHETIC
RESEARCH,
INNOVATION &
DEVELOPMENT

Geosynthetic Clay Liners - BPEM Compliance and Erosion Resistance

One of the key research initiatives that the Geofabrics Centre of Geosynthetic Research Innovation & Development (GRID) has carried out over the past decade with industry partners Monash and Deakin Universities is based on the constituents of bentonite in Geosynthetic Clay Liners, how and what should be audited and how they impact GCL performance. This research has contributed to the methods of evaluation proscribed by the Victorian EPA BPEM Guidelines for critical landfill supply and adopted around Australia.

The GRID Laboratory has a vast library of documentation available upon request for designers and auditors that presents local GCL durability history based on internal and independent testing, academic reviews and site exhumations.

The long term performance of geosynthetics is critical with any project design and the aim has been to engineer GCLs for specific applications, by having an in depth understanding of the physical impacts of manufacturing, the key geotextile polymer requirements, and importantly understand the constituents of the bentonite, generally overlooked historically.

Quantifying the risk of downslope bentonite erosion for GCLs through laboratory analysis is widely supported by Australian designers and researchers, and has become particularly useful for supporting designs that require the Geomembrane exposed over the GCL for a defined period. The aim for the Geosynthetic Clay Liner is to present the designer with an established erosion resistant solution that meets the time to coverage with a Factor of Safety, and ensure that the GCLs hydraulic properties are maintained post coverage.

It is therefore worth highlighting the key test findings observed for select Polymer Modified Bentonites that have been subjected to independent audit verification by Dr Will Gates PhD at the Australian Centre for Infrastructure Durability (ACID) Deakin University. Part of this evaluation led to key longevity recommendations in the paper Gates et al 2018 “Resilience of Australian polymer-modified powdered Na Bentonite GCLs to Down Slope Erosion”;

1. Geofabrics GRID would only recommend specific bentonites for erosion resistance that have been subjected to extensive testing. Our most researched source is a Natural Sodium Bentonite source mined in Queensland, containing Soda Ash to meet the Sodium Content and Swell Index requirements in the BPEM Guidelines and contains <1% select polymers that we have released for independent audit.

   This bentonite is defined in our literature as the **pH+ Bentonite.**

2. We would also only recommend composite carrier geotextile GCLs such as our **X2000 pH+ and X3000 pH+** grades as they have shown extended longevity when subjected to drip erosion testing. We do not recommend the less robust grades **X800 pH+** and **X1000pH+** grades for slope erosion unless shear properties and exposure times can be strictly confirmed, as these have shown less erosion resistance.

Polymer Modified Bentonites – What is Critical?

The GRID research over 15 years has established that simply labelling the GCL as a Polymer Modified Bentonite type and applying performance expectations for these products as a group is technically incorrect. Every polymer modified bentonite source is different and must be analysed accordingly. The efficacy of the Polymer relies entirely on an understanding of the bentonite in its natural form, whether soda ash (a pH modifier) has been added, and the type of polymer that is added to maximise intercalation. All 3 factors interact; a basic analysis based on traditional properties like granularity, swell and fluid loss alone is simply insufficient information.

Geofabrics have a range of bentonite sources in Australia and overseas, that have been evaluated by independent laboratories and academia, and demonstrate that different raw material sources will require different additive loadings but can be utilised for specific applications.

For example, Geofabrics have an **AMB Bentonite** (Polymer added) GCL that has been subjected to a number of independent studies and developed for specific mining applications, particularly brines. This product shows remarkable hydraulic performance with specific leachates but is not designed to support long term exposure applications and would not be offered as "erosion resistant".

VICTORIAN EPA BPEM GUIDELINES

The focus of the Victorian EPA BPEM Guidelines already highlights the need to analyse bentonites in detail. The clause below requires demonstrated durability for polymers, but it also requires pH modifiers to be considered, that from our experience are not being audited;

*" …additives, such as polymers or **pH modifiers**, may be added to improve the swelling and sealing capability of sodium-activated bentonites. However, the nature and suitability of these additives is difficult to check. If used, the manufacturer should provide their details and demonstrate their nature, suitability and long-term durability."* BPEM Publication 788.3* August, 2015. Victorian EPA

pH Modifiers in Bentonites – Why also critical?

The most important aspect of any bentonite is the form, hence the important distinction between Natural Sodium Bentonites and Activated Bentonites. This BPEM clause requires that activated bentonites (added pH modifier), must demonstrate their "suitability and long-term durability".

The pH modifier aspect has been unaccounted for by auditors in our Victorian BPEM experiences to date, yet technical literature describes that activated bentonites will perform vastly different hydraulically and should be subjected to analysis.

In the key summary paper entitled, *"Investigation of Bentonite Requirements for Geosynthetic Clay Liners" (von Maubeuge, 2002)*, the author reports inferior hydraulic performance of activated bentonites, leading to key specification recommendations when they are being used and hence why long-term durability is required by the Vic EPA.

Geofabrics have key mine sites in Australia but the next likely source is India who state that there are no natural Sodium Bentonites, and their bentonites require pH modifiers to meet BPEM requirements. This highlights that to meet the elevated demands of the BPEM Guidelines, bentonites require pH modifier and/or polymer additions, and should be audited for durability.

Designers and auditors of landfill designs should demand identification of the source of bentonite when approving GCLs, including their long-term performance and constituents.

CONCLUSION

A good analysis of bentonites in GCLs should consider them for their function, and Australian Regulations unlike any others demand that close analysis of the bentonite be carried out in terms of Bentonite form, Activation with pH modifiers and polymer additions. It is incorrect to ascribe properties to a bentonite based on labelling it as an Activated Bentonite or Polymer Modified Bentonite only, without clear definition of these constituents and performance evaluation. Geofabrics and it's academic partners at Monash University and Deakin University will present further studies on these key topics in future, as the opportunity lies for design to link key bentonite performance properties to the application, in the same way it is being offered for Erosion Resistance.

Authored by the Geofabrics GRID Technical Team – August 2020

Gates et al (2018) "Resilience of Australian polymer-modified powdered sodium bentonite geosynthetic clay liners to downslope bentonite erosion" ICEG 2018

Von Maubeuge (2002) "Investigation of bentonite requirements for geosynthetic clay barriers" *Clay Geosynthetic Barriers, Zanzinger, Koerner & Gartung (eds), © 2002 Swets & Zeitlinger, Lisse,*