

# Bentofix®

## Geosynthetic Clay Liner (GCL) as geobarrier to levees

- **Project Name**  
Levee reinforcement in Beesel, The Netherlands
- **Building owner**  
Waterboard Limburg, Roermond, The Netherlands
- **Construction company**  
Mourik Infra, Groot-Ammers, The Netherlands  
FL B.V. / Reyrink Groep, Haghorst, The Netherlands
- **Designer**  
ABT, Velp, The Netherlands  
Arcadis, Arnhem, The Netherlands  
Witteveen + Bos, Deventer, The Netherlands
- **Product**  
Bentofix® B 4000 (Brad 16)



## Challenge

Due to the consequences of climate change and increased river discharges, the levees in the Maas Valley were raised and strengthened in several places to protect the village of Beesel from flooding in the future. This usually requires large quantities of erosion-resistant clay to build the levee, embankment stabilisation and sealing. Clay deposits are rather scarce in the Maas Valley, so long transport routes are required to bring good-quality clay to the project site. When using bentonite mats (Geosynthetic Clay Liners – GCLs), which take over the function of the clay cover, local soil can be used for levee construction. As the availability of clay is a problem in many regions of the Netherlands and the purchase of clay from other regions can be costly, alternative solutions were highly desirable. A major solution was seen in the use of geosynthetic clay liners, which have been successfully used as levee liners in Germany for more than two decades.

Applying GCLs eliminates the need for clay resource extraction and transport from other locations. Application of the GCL is in transport intensity a big difference with mineral clay: one truck of GCLs is roughly equivalent to 250 trucks of clay. As a result, residents experience much less nuisance from a single truck transporting GCLs to the site.

## Application Guideline

In order to make the application of geosynthetic clay liners in Dutch levee construction possible, an extensive guideline was drafted by experts in a technical working group. With contribution from the Limburg Water Board, Arcadis and other co-authors an application guideline is written 'Levees with GCL – bentonite mat, guideline for the application of GCL in forelands and on slopes of primary and regional flood defence'. The guideline describes design, application, specification and testing criteria for geosynthetic clay liners in levee construction.

The application of bentonite mats fits as a technique in the national program of Flood Protection in the Netherlands (HWBP). Innovations for levee reinforcements play an important role within this program. By applying a bentonite mat, the reuse of local soil is strongly stimulated.

In this way, the application fits very well within the program to use area-specific soils (Programma Overstijgende Verkenningen – POV gebiedseigen grond). The guideline is based on the design, application experience and knowledge about bentonite mats in German levee construction and extended to Dutch circumstances for levees. Detailed requirements for the geosynthetic clay liner were defined within this framework. The guideline is applied, verified and supplemented within the framework of the Beesel construction project.

## Solution to Beesel

The engineering office ABT was commissioned with the detailed design, including stability calculations with the finite-element program PLAXIS. Naue provided technical support and detailed three-dimensional (3D) installation drawings. The installation of GCLs was implemented in two levee sections. The geosynthetic clay liner Bentofix® B 4000 from Naue was installed on the water side of the 1:2.5 sloping levee embankments and the approx. 3.5m wide levee crest. Depending on the location the levees have a varying height between 2 and 4 meters. A total of 13,500m<sup>2</sup> of Bentofix® B 4000 bentonite mat was delivered and installed. Naue Bentofix® B 4000 is a special high-performance GCL developed for application in levees.

All organisations involved were positive about the construction progress and the final result. Deviating from the complex quality monitoring, labour-intensive and cost-intensive installation of thick mineral clay layers, the geosynthetic clay liner was delivered on rolls and installed on site with a spreader bar. In the process, the longitudinal overlaps were sealed via the fully bentonite-impregnated and marked prefabricated overlap areas. Further attention was paid to connection details, which were carried out in coordination between the companies involved.

The organisations are proud to have been part of this ultimate and nice construction project introducing bentonite mats to levees in the Netherlands. The technique, benefits and experience create significant potential for other flood defence projects facing the same challenges.

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