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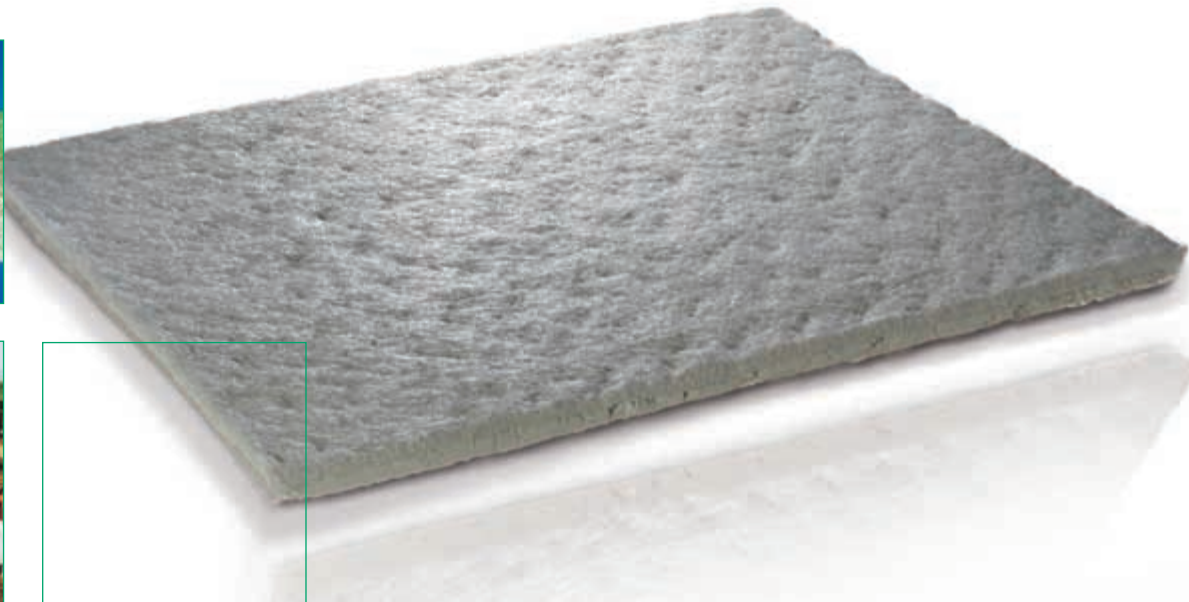
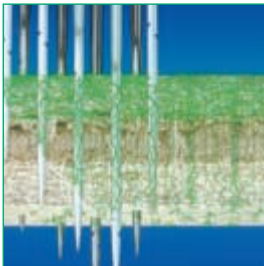


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Advantages of needle-punched **Bentofix®** Geosynthetic Clay Liners (GCLs)

- ✓ versatile sealing applications with different GCL types and sodium bentonite
- ✓ can reduce construction costs by replacing compacted clay
- ✓ robust geotextiles encapsulate and contain the bentonite
- ✓ withstands differential settlement
- ✓ uniform peel strength provides multi-directional shear strength
- ✓ Thermal Lock process increases internal shear strength and interface friction angles
- ✓ self-sealing overlaps available
- ✓ installation advantages with 4.85 m wide rolls
- ✓ quick and easy to install
- ✓  BBA certified waterproofing systems (Bentofix® BFG 5000)
- ✓ ISO 9001 certified
- ✓ CE marked



General

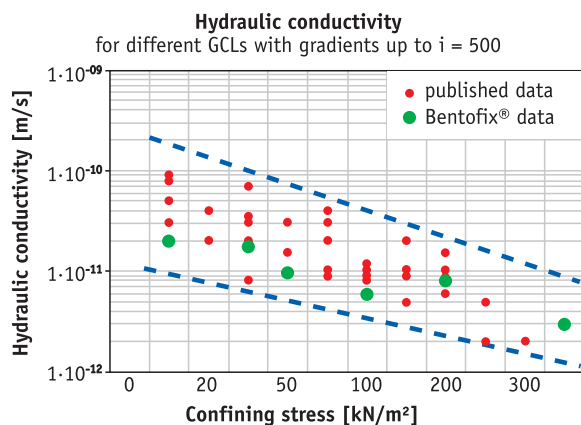
Bentofix® Thermal Lock geosynthetic clay liners (GCLs) are needle-punched reinforced composites which combine two durable geotextile outer layers and a uniform core of high swelling powder sodium bentonite clay to form a hydraulic barrier. When hydrated with fresh water, the bentonite swells to form a

ability layer with the equivalent hydraulic protection

of a thick compacted clay liner. A proprietary heat treating process – Thermal Lock – in addition permanently locks the needle-punched fibres, increases the pull-out resistance of the fibres and ensures long term shear resistance. Bentofix® GCLs are part of an important trend toward the combined use of geosynthetics and clay materials in barrier applications as a stand alone liner system or synergistically with geomembranes to maximise liner system efficiency. Bentofix® Thermal Lock GCLs are used but not limited to the following applications: landfill caps, closures, base seals; environmental protection under roads; railways, airports; dams and dykes; vertical barriers; pond applications; waterproofing and secondary containment.

Advantage: Water permeability

Bentofix® Thermal Lock GCLs are designed for applications to replace relatively thick, hard and expensive to install compacted clay layers (CCL) and bentonite



enriched soils (BES) due to their numerous advantages when contrasted to a CCL or BES. Bentofix® Thermal Lock consists of an evenly distributed layer of high swelling sodium bentonite powder encapsulated between two geotextile components acting as the sealing element. The main advantage of the powder bentonite

is its uniform distribution and its immediate sealing performance. When hydrated and permeated under confinement with fresh water the bentonite layer swells and forms a gel-like low permeable barrier. Over a range of normal loads Bentofix® Thermal Lock GCLs provide an excellent hydraulic performance and can be significantly lower than a typical CCL or BES, even under high gradient conditions. Another beneficial feature of Bentofix® is the bentonite impregnation of the longitudinal edges during the manufacturing process. These overlapped areas are immediately sealed without needing to add any additional bentonite on site.

Advantage: Shear resistance

By needlepunching fibres from the cover nonwoven through the layer of sodium bentonite into the carrier geotextile, a completely uniform, reinforced GCL is

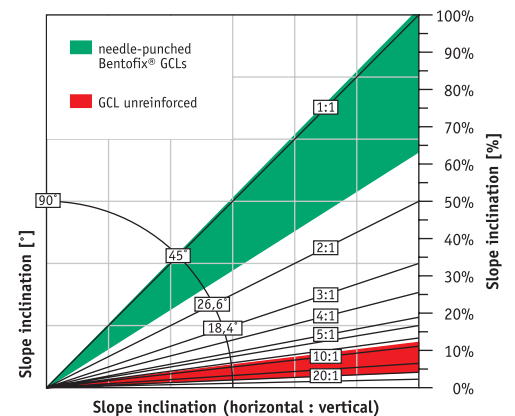
produced with long-term high shear strength, excellent creep resistance, and stability advantages important to any application. The Thermal Lock process is then used to more permanently lock the

needle-punched fibres into place. This process reduces the pull-out of fibres and increases the GCL shear stress and additionally increases the interface friction properties of the Thermal Lock side due to its rough surface. Bentofix® Thermal Lock replaces other GCLs as well as other soil barriers on steep side slopes and assures low permeability without sacrificing slope stability.

Advantage: Bentofix® extra coated

Bentofix® "X" types are a needlepunched GCL comprising a uniform layer of powder sodium bentonite encapsulated between a slit-film woven and a staple fiber nonwoven geotextile. The woven fabric is coated with a low permeability and gas-tight polyolefin coating to achieve an immediate gas and radon barrier prior to hydration.

Internal shear angle of needle-punched Bentofix® GCLs for a confining stress up to 100 kN/m².



APPLICATION

BENTOFIX® SEALING AT TOULOUSE-BLAGNAC AIRPORT

One of the largest infrastructure projects in Europe in recent years has been in Toulouse-Blagnac in France on the premises of the airport and the Airbus factory where the new Airbus A 380 is built. During this construction project not only hangars were built but the whole infrastructure was aligned to accommodate the new dimensions of the Airbus A 380. Runway No. 2, which was originally built as a test track for the super-sonic Concorde, serves now the Airbus A 380. The necessary construction work includes widening the almost 4 km long runway by two meters in order to accommodate the 700 ton „silver bird“ with its wing span of almost 80 meters.

The conceptual design and advisory services for the client were carried out in a cooperation between the airport operating company ADP Aeroport de Paris and the engineering company Scéauroute and the decision was taken to employ Bentofix® NSP 4900 to seal the runway. The whole system prevents any contaminated drainage water polluting the ground water. The earth-moving activities, installation of sewer pipes, service lines and pipelines, construction of roads and

Fig. 1
Runway widening
with Bentofix® for
environmental
protection



approach runways had to be completed within two months, without any hindrance to air traffic. As Bentofix® can be installed easily and extremely quickly in comparison to other conventional sealing systems, general construction work went ahead smoothly; in fact the Bentofix® installation work was completed earlier than scheduled.

In total, 40,000 m² of Bentofix® and 24,000 m² of the separation nonwoven Secutex® 201 GRK 3 were installed within just two weeks by a pool of contractors - SCAM TP, SOGEA Hydraulique and AMEC Spie.

LANDFILL IN ESTONIA

The largest landfill in Estonia, Pääsküla Landfill, just outside the capital city of Tallinn, was capped in 2005 and 2006. Several parts of the landfill had been filled over the past years so that substantial settlements were expected. To verify this fact the owner has carried out several in-situ measurements even during the capping operation. The original design considered a soil-gas-drainage layer, covered by a GCL, a 300 mm thick rainwater drainage layer of coarse gravel and a 1 m thick cover soil layer. After analysing the settlement data the designer came to the conclusion that further differential settlement had to be



expected so that the final capping system would have to be able to withstand such stresses. After comparing various GCL types Bentofix® B4000 was approved as the capping GCL. Bentofix® B4000 is a needle-punched GCL with a cover nonwoven and a scrim reinforced carrier nonwoven, which encapsulates the bentonite sealing core. Numerous studies have shown that this Bentofix® type can easily withstand differential settlement of at least 30 % without any reduction of its hydraulic performance and is therefore perfectly suited where differential settlement is expected. Additionally the two nonwoven surfaces allowed an excellent interface shear performance on steeper slopes as high as 28° – 32° and allowed a steeper slope design than the anticipated 18°. At the same time the nonwoven geotextiles on both sides are a protection against any installation stresses occurring on site, since a nonwoven is less vulnerable than the typical used slit-film wovens. During the construction the contractor had issues on maintaining a high quality for the gravel of the rainwater collection layer. It was decided to replace the gravel drainage layer with a geosynthetic drainage system - Secudrain® 151 WD 501. The German geosynthetic consultant BBG, Bauberatung Geokunststoffe GmbH & Co. KG, supported the local designer and proved that the Secudrain® solution was equivalent to the gravel rainwater collector.

Fig. 2
Bentofix®
capping
installation

The main contractor for this capping project was Skanska's Estonian company. The installation of each 260,000 m² of Bentofix® GCL and Secudrain® drainage system was carried out by NAUE's agent in Estonia, Via Con Eesti. The supervisors for this project were C + E from Chemnitz, Germany.

INSTALLATION



Bentofix®
transportation



Storage on site



Subgrade
preparation



Bentofix®
installation



Bentofix®
self-sealing
overlap



Penetration detail




Geomembrane
installation
over GCL



Cover soil
distribution



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