

# Bentofix® GCL selected for Dalton Lane flood defences

Cod Beck is a river in North Yorkshire with a catchment area of over 80 square miles, extending from above Cod Beck Reservoir on the edge of the North York Moors, running south through Thirsk, before skirting around the village of Dalton and Dalton Industrial Estate, and finally joining the River Swale just 500 metres south west of the Estate.

Cod Beck has a long history of flooding; the river depth typically ranges between 0.57 and 1.78 metres at Dalton, but above this level the surrounding highway is subject to flooding, and floodwaters frequently lead to the closure of Dalton Lane – the main access route to Dalton Industrial Estate.

The Estate, which is home to around 30 businesses, employing in the region of 850 people, derives economic and commercial benefits from its connection to the A168, which joins the A1(M) at Dishforth and links to the A19 at Thirsk. In addition, the East Coast Main Line provides a direct rail link from Thirsk to London.

## CASE STUDY

Project Name:	<b>Dalton Lane Highway and Bridge Improvement</b>
Date:	<b>June 2017 – October 2018</b>
Client:	<b>North Yorkshire County Council</b>
Contractor/Installer:	<b>Coffey Group</b>
Designer/Consultant:	<b>Sweco</b>
Products:	<b>Bentofix® BFG 5000</b>

**NAUE's Bentofix® BFG 5000 has been employed as a GCL in the construction of flood defences designed to protect a North Yorkshire industrial estate from the effects of perennial flooding of Cod Beck river at Dalton, near Thirsk.**

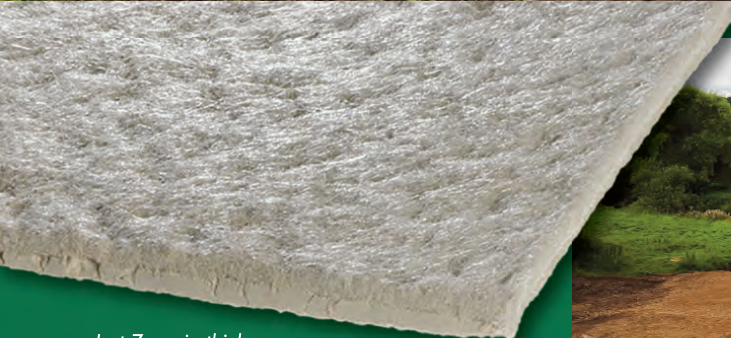
**NAUE's BENTOFIX® BFG 5000 provided immediate protection for flood defences being constructed at Dalton Lane, near Thirsk.**

The Geosynthetic Clay Lining material was placed directly onto the stepped embankment construction, followed by a covering layer of sand.





The embankments will protect access to Dalton Industrial Estate and provide the new bridge and elevated highway with 1 in 100 year flood protection.



Just 7mm in thickness, Bentofix® BFG 5000 instantly forms a waterproof barrier when hydrated.



Clay was imported for construction of the stepped embankments, but specification of Bentofix® BFG 5000, and its efficacy in the formation of an impervious barrier, minimised the amount of clay required.

The £4.1 million Dalton Lane project, which was the result of a partnership between businesses operating on Dalton Industrial Estate, the York, North Yorkshire and East Riding Enterprise Partnership, North Yorkshire County Council, Hambleton District Council and the Environment Agency, required the realignment of Dalton Lane, and works included the construction of flood protection embankments, a replacement bridge, and a new elevated section of highway; almost 2.5 metres higher than the existing level.

Construction design for the project was undertaken by civil engineering consultants Sweco UK and, based on previous experience with NAUE's geosynthetic clay liners on similar projects, specified Bentofix® BFG 5000 to be used to form an impervious barrier in construction of the steep embankments. Bentofix® BFG 5000 has BBA Certification for waterproofing and methane/radon barrier performance under confining pressure, and is ideally suited to the task at Dalton Lane.

Bentofix® BFG 5000 consists of two polypropylene geotextile layers; one woven and one non-woven layer. Between the two geotextiles is an integral layer of natural sodium bentonite and, in addition, the outer surface of the non-woven geotextile is impregnated with bentonite powder across its entire surface. The layers are mechanically joined by needle-punching the two geotextile layers; effectively pushing the fibres of the non-woven geotextile through the bentonite layer, securing them into the retaining woven layer and encapsulating the sodium bentonite.

NAUE's Bentofix BFG 5000 is robust and resistant to normal site activities and will provide a permanent and effective waterproof barrier for the life of the structure in which it is incorporated. During installation, dropping heavy objects on the geotextile will normally have no damaging effect, yet the material is easily trimmed to shape on site with standard trimming knives. No specialised tools are required for installation and the presence of bentonite powder ensures that any accidental damage or cuts 'self-heal' once the product is hydrated.



Long-established civil engineering and public works contractor Coffey Group, was responsible for construction of the flood embankments and installation of the GCL, and feedback received from Coffey's installation team, during site visits by NAUE's sales engineer Jason Bland, emphasised the product's ease of handling and simplicity of use. Rolls of Bentofix are deployed onsite with the aid of a loader fitted with a spreader bar, and simple overlap joints of approximately 250mm are sufficient to achieve a continuous waterproof seal.

In total, NAUE supplied 8,000m<sup>2</sup> of Bentofix® BFG 5000 for the project; all supplied on standard 40m long, 5m wide rolls.



### NAUE Geosynthetics Ltd.

The Genesis Centre, Unit G14, Birchwood, Warrington WA3 7BH, United Kingdom  
Phone: +44 1925 810280 Fax: +44 1925 810284 email: [enquiries@naue.co.uk](mailto:enquiries@naue.co.uk)

# Controlling floodwaters in Elgin, Scotland

The historic city of Elgin, situated between Aberdeen and Inverness in North East Scotland, has suffered recurring flooding for over 250 years, with 11 floods recorded in the last 50 years; the most recent in 2009. Construction on the Elgin Flood Alleviation Scheme started in April 2011 and is due for completion in May 2015. The scheme will alleviate flooding in Elgin by recreating the flood plains and constructing additional flood defences. It will create a sustainable flood corridor along the River Lossie, relieving constrictions to water flow, and allowing high flows of water to be conveyed safely through the city, using a combination of embankments, walls and lowered flood plains.

## CASE STUDY

Project Name:	<b>Elgin Flood Alleviation Scheme</b>
Client / Project Manager:	<b>The Moray Council</b>
Date:	<b>September 2012</b>
Main Contractor:	<b>Morrison Construction</b>
Consultants:	<b>Royal Haskoning</b>
Product:	<b>Bentofix<sup>®</sup> NSP 4900, Terrafix<sup>®</sup> 813</b>

**The Elgin Flood Alleviation Scheme is the largest flood alleviation project ever to be undertaken in Scotland. It will protect 600 homes and 250 businesses, and will cope with up to 190 tonnes of floodwater per second – something that's expected only once every 200 years.**





The works include the construction of a flood relief channel (approximately 5km in length) along the line of the River Lossie, and the construction of floodwalls (approximately 2km long) at several locations throughout Elgin. A series of set-back flood embankments are being constructed and the flood plains between the set-back defences will be lowered to form a two-stage flood channel.

A key element of the project involved the design and construction of embankment structures for the set-back defences, as well as embankments to form the lowered flood plain channel. NAUE Geosynthetics worked with engineering and environmental consultants Royal Haskoning to design a scheme where cost-saving geosynthetics could be employed as an engineered alternative to traditional clay

lining of the embankment structures.

Bentofix® geosynthetic clay liners (GCL), an economic and environmentally advantageous replacement for very thick layers of compacted clay, were used as a water barrier for the set-back flood embankments. Bentofix® consists of a layer of 100% natural sodium bentonite encapsulated between two layers of needle-punched geotextile material. When hydrated, the natural sodium bentonite expands to form an impermeable barrier against water, with virtually unlimited lifespan, whilst the reinforcement layers ensure that the geotextile retains its integrity during laying and overfilling. At Elgin, Bentofix® NSP4900 was supplied in 5 metre wide rolls, and 30,000m<sup>2</sup> were installed by simply unrolling and overlapping at the joints.

Terrafix® 813, a high quality, robust and filter-

stable geosynthetic, was selected for use in construction of the flood plain channel embankments. Terrafix® 813 is a unique, polypropylene/polyester mix, needle-punched, non-woven geotextile. This versatile material acts as a separator/filter between the rock armour and soil subgrade of the structures, and is specifically designed to filter sediments in a hydraulic environment; preventing clogging and build-up of pore water pressure behind the structures. Terrafix® was specified because of its compatibility with the different soil types used on site, as defined by the German Federal Waterways Engineering & Research Institute (BAW). In total, 25,000m<sup>2</sup> of Terrafix® 813 was installed. Because Terrafix® 813 is denser than water, it sinks – allowing for easier and safer installation in fluvial environments.



*NAUE Geosynthetics Ltd thank  
The Moray Council for their kind permission  
to publish this document.*



# Bentofix® GCL used in scheme to protect Scottish town

The River Deveron flows for 60 miles through Aberdeenshire in the north east of Scotland and, some 17 miles downstream from its source in the Grampian Mountains, the river runs due east across the northern outskirts of Huntly, before continuing its journey to the Moray Firth.

Between the river and the town of Huntly is a low-lying area, known as the Meadows, which has been subject to repeated flooding over the last 200 years. And, with river levels rising significantly during more recent storm events, over 100 residential properties and 50 non-residential properties have been identified as being at risk; with the annual cost of damages averaging around £450,000.

## CASE STUDY

Project Name:	<b>Huntly Flood Alleviation</b>
Date:	<b>October 2016 – August 2017</b>
Client:	<b>Aberdeenshire Council</b>
Contractor/Installer:	<b>Wills Bros Civil Engineering Ltd</b>
Consultant:	<b>Atkins</b>
Product:	<b>Bentofix® NSP 4900</b>

**NAUE's Bentofix® Geosynthetic Clay Liner has been utilised in the construction of raised flood defences that will play a key role in protecting the town of Huntly, in North East Scotland.**





The River Deveron runs west to east across the breadth of the town, and the area is also subject to flooding from other local sources; notably the River Bogie, to the east of the town, Ittingstone Burn to the west, and Meadow Burn which traverses the Meadows.

Residents have been evacuated from the area several times over recent years but, in addition to the 160 or so properties identified as being at risk from flooding, a caravan park, sports facilities, and several cultural heritage sites are located within this area, along with adjacent agricultural land and strategic transport links, including the A96 and A920.

Development of a flood protection scheme for the town of Huntly marks the end of years of effort to provide more security for local residents and businesses, and the physical measures now in place will help to reduce the risk posed by flooding to the Meadows area of the town.

This £3.5million scheme, delivered by Wills Bros Civil Engineering Ltd, took around 10 months to complete and, as well as new embankments both in the Meadows area and adjacent to the A920 at the Ittingstone Burn, the work included new culverts, piling, various utility diversions, property reinstatement and the creation of a new walkway along some of the embankments.

Wills Bros constructed the embankments between the river and the Meadows, and an integral part the construction process included the installation of a Geosynthetic Clay Liner from NAUE to create an impermeable barrier; designed to hold back the floodwaters when the

river inevitably overflows its banks in the future, and prevent washout and undercutting of the defensive structure.

From the outset, design consultant Atkins had always considered the inclusion of a GCL in this construction as an alternative to using compacted clay. Employing a GCL affords significant cost and environmental benefits, and helps to preserve natural resources. When used in place of a traditional compacted clay layer, Bentofix® provides the same sealing efficiency but, at around 1% of the weight, transport costs to site are significantly lower, and installation time is reduced considerably.

Bentofix® NSP 4900 is an extremely versatile clay-based lining product which is very easy to install, and requires no welding at the joints. Supplied in 40 metre long rolls, 5 metres wide, it is rolled out on-site, using a simple 'lap and lay' technique.

NAUE's Bentofix® NSP 4900 incorporates a layer of natural sodium bentonite, encapsulated

between two strong, durable geotextile layers; a needle-punched non-woven, and a woven carrier geotextile. Once installed and covered with a confining layer of topsoil, the bentonite-impregnated, self-sealing overlaps hydrate and swell to create a safe and effective barrier.

The quality-controlled manufacture of Bentofix® means it arrives on site ready for installation. At Huntly, NAUE Geosynthetics supplied 30,000m<sup>2</sup> of Bentofix® NSP 4900 and Project Manager for Wills Bros, Steve Adams, had nothing but praise for the technical support provided: "Naue staff visited the site several times during the project, and were always on hand to offer advice on product installation."

Bentofix® is suitable for installation in steep slope applications and, at just 6mm in thickness, is easy to fit around the undulating contours of an embankment, and yet the robust geotextile layers provide protection for the sodium bentonite layer; guaranteeing its long term performance.



*A walkway now runs along the top of some of the new embankments.*



### NAUE Geosynthetics Ltd.

The Genesis Centre, Unit G14, Birchwood, Warrington WA3 7BH, United Kingdom  
 Phone: +44 1925 810280 Fax: +44 1925 810284 email: enquiries@naue.co.uk

# Bentofix® X2 GCL Specified for Detention Basins

Located close to the border of Surrey and West Sussex, just a 5-minute taxi ride from Gatwick Airport, and with fast, round-the-clock train links to London, Horley has developed as a significant commuter town.

However, with local business parks and a prominent high street, Horley also has a thriving economy of its own and, with all this just 45 minutes' drive away from the south coast resorts, residential property in this area is understandably in high demand.

In December 2014, outline planning permission was granted for a major new development on land to the north west of the town, to include over 1,500 homes, a new primary school, and a neighbourhood centre with shops, pub/restaurant and other community facilities.

## CASE STUDY

Project Name:	Horley Detention Basins
Date:	Summer 2016
Client/Contractor:	Brehey Civil Engineering
Consultant:	WSP Parsons Brinckerhoff
Product:	Bentofix® X2 NSP4900

**NAUE Bentofix® X2 Geosynthetic Clay Lining has been selected as the material of choice by WSP Parsons Brinckerhoff for creation of four detention basins to protect the western boundary of a new housing development to the north west of Horley, Surrey.**





The site, which will be known as West Vale, is being developed by a consortium of four main partners – Crest Nicholson, A2Dominion, Taylor Wimpey and Persimmon – and has secured over £40 million of infrastructure and service improvements for Horley.

Covering approximately 99 hectares, the site is an irregular crescent-shaped area of land wrapping around the existing north west edge of Horley. The first phase of the development will include around 600 residential properties, and planning permission was subject to the satisfactory construction of four detention basins.

Prior to development, the site was a gently undulating arable field with its outer boundary formed by the River Mole to the west, and Burstow Stream to the north. At its southern end, the site is bounded by a sewage treatment works and, at its eastern end, by a small area of woodland. The existing urban area of Horley lies to the southeast.

During the planning process, detailed flood modelling work was carried out by the Environment Agency to identify the potential extent of flooding from the River Mole and Burstow Stream and, prior to commencement of any building works the Borough Council required drainage works to be undertaken which would store and gradually release flood water at the same rate as it previously ran off the undeveloped site. The surface water drainage design provides attenuation, with water quality treatment, and a flow control device in each basin will discharge water to the River Mole.

Consulting design engineers for the project, WSP Parsons Brinckerhoff, worked in conjunction with NAUE's design team on the material specification for lining the four detention basins. Prior to installing the liner, the ponds would be excavated to an average depth of around 6.0 metres, and NAUE carried out slope stability analysis to ensure the suitability of the selected liner for the sides of the ponds which would have 20 to 25% inclines.

The general underlying geology of the site consists of Alluvium, River Gravels and London Clay but, due to the fact that cement stabilised fill materials were being used, WSP specified NAUE's Bentofix® X2 NSP4900 for the project.

Bentofix® X2 NSP4900 is a needle-punched Geosynthetic Clay Liner (GCL) with a uniform layer of natural sodium bentonite powder encapsulated between two strong and durable polypropylene geotextile layers – one layer woven and the other non-woven.

In addition, a polyethylene coating is bonded to the woven layer which, even prior to hydration, creates an immediate low permeability barrier and counteracts any

incompatibility between the sodium bentonite and the cementitious backfill material.

Steep slope applications are also easily accommodated by Bentofix® – a unique fibre-bonding process locks the needle-punched fibres into place creating high internal shear strength with unsurpassed creep resistance.

Installation itself is quick and easy – Bentofix® X2 NSP4900 is simply rolled out on-site with a 30cm overlap and, once hydrated, the bentonite swells to form a low permeability gel layer, which exhibits a hydraulic performance equal to or better than a thick, compacted clay lining, and self-seals any unexpected mechanical damage sustained during installation.

Contractor for the project, Breheny Civil Engineering, laid a total of 30,000m<sup>2</sup> of the Bentofix® X2 liner, which is just 6mm in thickness and supplied in 5m wide rolls. NAUE planned full truckload deliveries to meet the construction site schedule, with each load sufficient to cover around 4,000m<sup>2</sup>. In comparison, a traditional clay lining would be 500mm in thickness, and one truckload would typically cover just 40m<sup>2</sup>.



### NAUE Geosynthetics Ltd.

The Genesis Centre, Unit G14, Birchwood, Warrington WA3 7BH, United Kingdom  
Phone: +44 1925 810280 Fax: +44 1925 810284 email: [enquiries@naue.co.uk](mailto:enquiries@naue.co.uk)



# Secugrid® HS

Basal reinforced embankments

## Project name

Reconstruction of Oder dyke in Uckermark county,  
Polder 5/6, Part 15, Lot 67

## Engineer

Ingenieurgemeinschaft WTU GmbH, Bad Liebenwerda

## Installation contractor

Streicher Tief- und Ingenieurbau Jena GmbH & Co. KG,  
Jena

## Product

Secugrid® HS 1000/100 R6





### Problem

In the summer of 1997, the largest known flood occurred along the German-Polish border river Oder. Due to the flood situation lasting several weeks, around 5,500 hectares of agricultural land and residential area with about 400 houses were flooded as a result of multiple dyke failures. Several thousand people had to be evacuated.

As a result of the flood in 1997 and subsequent smaller flood events, the dykes showed numerous breaches. These were caused by weak points in the dyke geometry as well as by problems in the foundation soil.

### Solution

In order to withstand future flood events, an existing dyke was reconstructed over a length of 3km between the municipality of Friedrichsthal and the city of Gartz. Soil investigations below the old dyke revealed relatively deep soft layers of peat, organic silt and clay. In order to ensure sufficient stability of the new dyke, the geogrid Secugrid® HS was installed as basal reinforcement. The individual

geogrid panels were installed with their main stress direction perpendicular to the dyke axis by using a spreader bar. Adjacent panels were overlapped by 50cm transverse to the direction of installation. Over the entire length of the dyke between Friedrichsthal and Gartz, a total of approx. 63,000 m<sup>2</sup> of the high-strength geogrid was installed.

The reconstruction of the dyke was carried out by partial removal of the old dyke and a reconstruction as a so called “3-zone dyke”. On the slope, facing the water-side, a geosynthetic clay liner (GCL) was installed as sealing system.

Due to its high robustness and long-term tensile strength, Secugrid® HS contributes substantially to the flood control measures along the German-Polish border.



Fig. 1: Impression of Oder flood in 1997, Germany

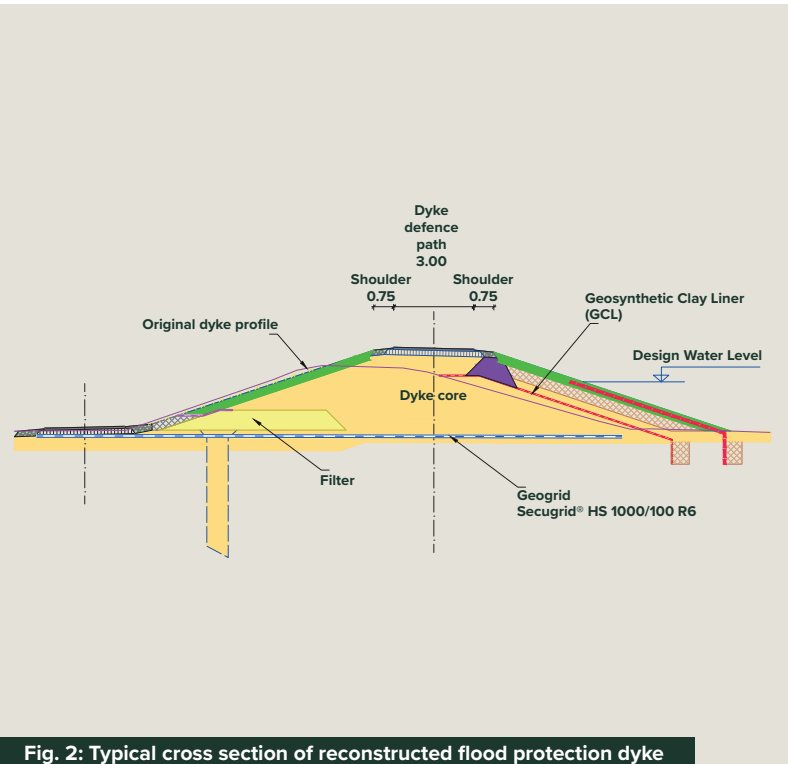


Fig. 2: Typical cross section of reconstructed flood protection dyke

# Secugrid®

Roadway Embankment Reconstruction

## Project name

Repair of flood damage „Leubethaer Street“ in  
Freiberg, Germany

## Designer

Ökoplan Bauplanung GmbH, Plauen, Germany

## General contractor

UTR Umwelt-, Tiefbau und Recycling GmbH,  
Schönbrunn/Vogtland, Germany

## Subcontractor GRS

GGs TerraCon GmbH, Moritzburg, Germany

## Products

Secugrid® 80/20 R6

Secugrid® 40/20 R6

Secumat® ES 401 G4





Fig. 1: Landslide in the area of „Leubethaer Street“



Fig. 2: Installation of fill soil above Secugrid® geogrid

## Problem

In May 2018 a storm front hit the Vogtland region in Germany with full force. Up to 150l of rainfall were measured in one hour. In the Adorf district of Freiberg the heavy rainfall caused the greatest damage of the storm. Over a length of 30m the Leubethaer Street was washed away. A culvert located in this area could no longer absorb the enormous quantities of water. This led to a water accumulation within the road embankment. Fine particles of the fill soil were successively washed out and the slope collapsed completely.

## Solution

With financial support from the Federal State of Saxony, the failed slope was rehabilitated. The reconstruction of the embankment was carried out as geogrid-reinforced soil structure (GRS) with Secugrid® geogrids from Naue. Over a length of approx. 54m the road embankment was rebuilt with a slope inclination of 70°.

The Naue Steel P system was used for the design of the facing. This system consists of galvanized steel mesh units, which can be adapted to the planned contour of the slope. By overlapping the horizontal part of the steel mesh with the uniaxial Secugrid® geogrid a frictional connection is achieved. A total of 11 geogrid layers were installed for the maximum embankment height of 7.7m. The individual geogrids were each covered with 50cm of fill soil and then compacted in layers.

To prevent soil erosion at the slope face, a Secumat® erosion control mat was installed between the steel mesh and the filling soil. The subsequent greening of the embankment surface ensures that the GRS integrates perfectly into the existing landscape. With the GRS solution chosen in this project, an economical and ecological rehabilitation has been achieved which will safely withstand future flood events.

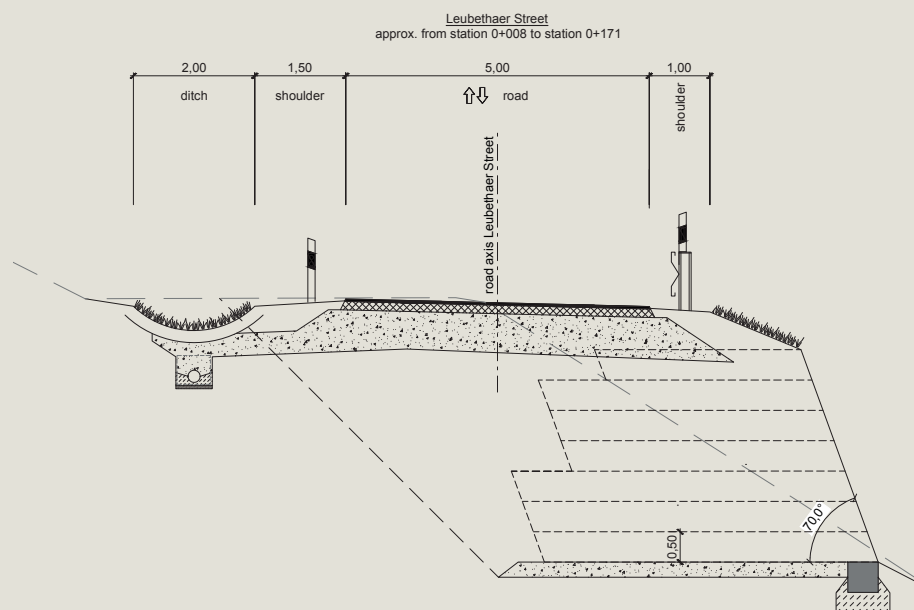


Fig. 3: Typical cross-section of the geogrid-reinforced soil structure

Secugrid® und Secumat® are registered trademarks of Naue GmbH & Co. KG in various countries.

The information contained herein is, to the best of our knowledge, true and accurate. There is no implied or expressed warranty.

© 2022 Naue GmbH & Co. KG, Espelkamp, Germany · All rights reserved · No. 00578 · Status 21.01.2022

naue.com

# Secugrid®

Stable embankment on soft soil

**Project name**

Pekan – Terapai Slope Repair, Malaysia

**Responsible authority**

Jabatan Kerja Rakyat (JKR) /  
Malaysia Public Works Department

**Product**

Secugrid® 80/20 R6



 Naue



**Fig. 1: Failed road embankment**



**Fig. 2: Rehabilitated road section using Secugrid® geogrid reinforcement**

Pahang is the largest federal state in Peninsular Malaysia. Pekan is the royal capital city and it used to be the capital city in the past. With a population that is considered high in Peninsular Malaysia, an adequate infrastructure within or intercity of Pahang is required.

### Challenge

After a rainy season, a section of road embankment between Pekan and Terapai collapsed. The 20m high embankment has been investigated and it was found that there are 4 main reasons for the collapse, namely:

- excessive surface runoff seeping into road embankment
- insufficient road side drain
- damaged existing pipe culvert at the toe of slope, which caused water ponding
- flood during the monsoon season, which lasted almost 4 months, had softened the existing foundation soil

Since the intercity road is one of the critical connections in Pahang, fast and reliable repair was required.

### Solution

In order to comply with the project demands, it was decided to construct a reinforced soil embankment using an uniaxial PET Secugrid® geogrid. Secugrid® geogrids are made of stretched, flat monolithic

polyester (PET) bars with welded junctions. The main feature of Secugrid® is its high strength mobilisation at low strain with immediate force absorption and low creep tendency. It perfectly matched the project conditions to reinforce the backfilled soil. Secugrid® provides interlocking of the granular fill material and friction on both sides to increase the shear resistance. Secugrid® has a low creep tendency, which ensures the stability of the structure over a long service life. Secugrid® also helps to distribute the vertical load from the pavement more evenly, ensuring the stability of the whole structure and reducing the tendency for differential settlement within the reinforced soil structure.

A design analysis was carried out for the reinforced soil structure and Secugrid® was found to be sufficient for this structure. The Naue Wrap system was chosen as facing system for the 75° slope angle. This system consists of a non-galvanized steel mesh which acts as temporary formwork and a Secugrid® geogrid that encapsulates the reinforced fill using the wrap-around method. An erosion control mat placed behind the geogrid prevents soil erosion in the facing area.

A total of 25.000m<sup>2</sup> of Secugrid® was supplied to site. With the success of the proposed Secugrid® solution, the traffic between Pekan and Terapai can now be accommodated efficiently.



**Fig. 3: Installation of steel mesh as temporary formwork**

# Bentofix® X

Environmental protection along the  
UK's HS2 railway

Project name  
HS2 Railway, UK

Designer  
Ramboll

Product  
Bentofix® X2 NSP 4900





**Fig. 1: On-site transportation of GCL**

HS2 is a new high-speed railway under development in the United Kingdom. It will link up London, the Midlands and the North along lines that serve eight of the country's 10 largest cities.

The state-of-the-art HS2 high-speed line is a critical component in the UK's low carbon transport future. It will provide much-needed rail capacity across the country and will quickly enhance railway connectivity in the North and Midlands. HS2 is widely viewed as an efficiency-oriented way to help rebalance the UK economy.

### Challenge

Naue was approached by the designer to propose a suitable product to be used as lining system for an attenuation pond. The initial specification was for a puddle clay. However, the contractor was unable to find a suitable source, so they sought suitable alternatives. The attenuation pond was needed in the short term to manage runoff from railway construction activities (potential for hydrocarbons). In the long term, the pond would be used to manage the runoff from the HS2 line (potential for heavy metals from brake linings, hydrocarbons from trains).

### Solution

After analysis of the short and long-term potential for contaminants in the runoff, Bentofix® X2 NSP 4900 was used to ensure suitable protection against potential groundwater contamination from runoff. Bentofix® X is a shear strength transmitting coated geosynthetic clay liner (GCL), also known as multi-component GCL. The robust geotextile cover and carrier layers provide exceptional strength in the installation while the addition of a polymeric coating on one side of the GCL enhances the containment performance of the liner. It is stronger against the potential contaminants in runoff than a standard GCL and the coating also improves performance against roots and desiccation. The use of high-quality sodium bentonite powder in the core of the product plus edge impregnation of bentonite for each panel ensures a very low permeability for the attenuation ponds.

The GCL used for the HS2 is as innovative as the high-speed railway itself.



**Fig. 2: Cutting the coated GCL to length**



**Fig. 3: Cover soil placement over the protection nonwoven of the coated GCL**