Onward to New Shores!

Geogrids Prevent Airplane Damage

Secugrid® stabilises take-off and landing strips in Berlin

What do geogrids have to do with airplanes? When Airbus and Boeing jets fly, their journeys must begin and end on a solid foundation, which includes essential support on the edges of these runways. At the Berlin-Brandenburg International Airport, Germany, NAUE products are used: Secugrid® for primary stabilisation and Carbofol® for surface runoff protection.

Runways at the Berlin-Brandenburg International Airport (under construction) cover an area of approximately 1,470ha. The design of the runways is quite complex. Runways are 60m wide but are complemented on both sides by a 75m wide strip, which is in turn divided into several functional areas. Immediately next to the runway is an asphalt strip with shoulder and fire protection zones in which, among other things, runway lighting sits.

Surface water flows from the runway onto the paved shoulder, then directly into a vegetated wetland with coarse drainage sand for filtering elements such as deicing agents, oils, fuels and more. These runoff collection zones (and the groundwater and soil beneath) are protected from seepage by geomembrane. More than 70,000m² of high-density polyethylene (HDPE) NAUE Carbofol® 508 were installed. Also, the filter strip area must be extremely strong and stable, in case a plane veers off the runway. Preventing a more serious accident includes making sure the wheels do not sink too deeply into the vegetated strip.

Also, these strips must support and allow quick, safe access for emergency personnel. To stabilize the runway edges, Secugrid® 80/80 Q1 reinforcement geogrids were installed above the soil filter layer. Secugrid® is characterized by exceptional durability, high rigidity, and strong resistance to tensile forces, including at low elongation. These factors distribute stress quickly, effectively and safely to maintain runway integrity.

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Conventional scour protections for off-shore installations are difficult to install and secure. Currents complicate foundations, creating a situation in which the installation will not be stable in the long term. Deep foundations are prohibitively expensive.

In the growing wind farm sector, the large, heavy turbines must be protected against the erosive effects of normal or sudden, strong and storm-induced currents. A durable and effective alternative has been found for securing these off-shore turbines: NAUE Soft Rock.

The Need
Scour protection has commonly been provided for underwater foundations by a combination of a low granular filter weighted down with stone armor. The hydrical impact in the design has determined the amount of heavy stone needed. The overall effect of these conventional systems is to delay water forces while preserving fibers. If the fibers were allowed to erode, the foundation might be evermore exposed until the stability of the structure above is threatened.

For the wind farm industry, which grows immensely in recent years, off-shore installations are highly attractive due to the space and the frequent, steady strong winds. Open water installations provide a steady source of alternative energy production.

The development of NAUE Soft Rock for monopile foundation scour protection brings a durable, flexible, softer and well-established alternative technology to turbine foundation stability. Soft Rock sand containers have been used in many flood control installations. For example, more than 48,000 Soft Rock sand containers were installed in 1993 for one of Germany’s largest-ever flood barrier and scour protection installations.

That installation, overseen by the German Federal Waterways Engineering and Research Institute (BAW), took place on the Eider River and helped underscore how effectively mechanically bonded nonwoven geosynthetic containers could be. Proving their durability, the containers were even installed using a stone dumper.

In 1997, a permanent scour protection installation was carried out along the Peene River in Germany. Pile moorings were secured with 1m³ sand containers.

Advantages
Soft Rock is a sand-filled container made of nonwoven staple-fiber geotextiles. They provide durable, wave energy-diffusing, erosion-limiting performance but allow enough porosity that some water may dissipate through the Soft Rock container’s three-dimensional, nonwoven matrix. This energy absorbing approach allows for softer deflection and dispersal of waves.

Needle-punched Terrafix® and Secutex® nonwovens have high elongation characteristics due to the “flexible,” non-brittle fiber junctions created by the manufacturing process.

Due to their superior high elongation characteristics, needle-punched non-wovens are more capable of accommodating soil irregularities, and are more resistant to puncture from imbedded stone or similar potentially damaging sources than geosynthetic products with low elongation properties, such as thermally bonded nonwovens or woven geotextiles.

NAUE Soft Rock advantages for turbine wind farm stability include:

- Proven long-term stability in marine/saltwater environments
- High abrasion-resistance
- Excellent frictional behaviour, including when containers are stacked
- Extremely robust against mechanical loads
- Flexibility adjusts to subsoil variations
- 100% of the seam tensile strengths in the base geotextile can be achieved
- Prefabrication ability produces high quality in each container in the system
- Mobile sand-filling stations greatly improve site construction economics for large-scale installations
- As a soft armor solution, there is no risk of damage to the turbine and monopile foundation during NAUE Soft Rock installation, even in the case of mass installation
- Supported by research

Though NAUE Soft Rock has been proven in numerous scour protection applications over the past 17 years, the suitability of the materials for off-shore wind turbine protection needed to be determined.

Large scale model tests were performed in the Large Wave Flume (GWK) at the Coastal Research Centre (FZK) in Hannover, Germany. Then, Germany’s first deep sea wind farm, Alpha Ventus, confirmed the results.
Applying GCL Knowledge: Bentofix® IQ

When NAUE invented the needle-punching method of manufacturing geosynthetic clay liners (GCLs) in 1987 it entirely changed the field. The innovation significantly increased the shear strength of GCLs, which expanded their range of applications. Now, NAUE celebrates the 25th anniversary of this development, the company is drawing upon its quarter-century of Bentofix® GCL expertise in a new information series called Bentofix® IQ.

Bentofix® IQ addresses four subject keys to understanding geosynthetic clay liners (GCLs): Technics, Quality, Application and Ecology. To provide a general thematic guide to understanding the essential design and barrier selection criteria, the Bentofix® IQ approach utilises the classical four elements of water, fire, earth and air in describing proper GCL production, design, application and installation. Technics (Water) focuses on how the high-quality, high-swelling powdered sodium bentonite in the core of Bentofix® GCLs creates the exceptional barrier against liquids that defines this class of geosynthetic. Also, the Technics brochure looks at how the unique needle-punching increases the internal shear strength and how the nonwoven geotextile outer layers provides the necessary long-term protection against physical, mechanical and hydraulic stresses. Quality (Fire) analyses the importance of GCL components from the standpoint of the bentonite grade to selection of nonwoven fibres for the protective geotextile layers. The Quality brochure also outlines the importance of the Bentofix® Thermal Lock process which uses heat to thermally bond the entwined nonwoven geotextile fibres with the high grade bentonite, thus increasing pullout resistance. GCL service life is extended and factors of safety improved. Application (Earth) explores the wide range of uses for Bentofix® GCLs: hydraulic applications like dams, canals, and levees; landfill applications such as caps and base seals; infrastructure environmental protection such as beneath roads and railways and within noise barriers; and other containment applications such as used in the mining industry, secondary containment (e.g., tailings ponds), turbine lining, and more. Ecology (Air) shows the many ways in which the selection of Bentofix® leads to significant environmental benefits. For example, the carbon footprint of a project is greatly reduced when GCLs are used instead of conventional compacted clay for a barrier layer. Though significantly thinner, Bentofix® greatly outperforms clay-only layers and requires only a fraction of the site space and transportation and installation costs. Backed by data proving the success of Bentofix® GCLs in the reduction of energy consumption, the Ecology is an essential reminder of just how important the proper barrier design and selection is not just for project performance but for the long-term protection of the environment. We invite you to experience the Bentofix® IQ series. And we hope you will share your project stories with us so that we may continue to share and apply our joint knowledge regarding better barrier and smarter engineering.

To order your own copy of the Bentofix® IQ series, contact: karsten.marburger@bentofix.com.

Combigrid® Reinforces the Sălbatica Wind Farm, Romania

The Sălbatica Wind Farm in Romania’s Dobrogea region near Tulcea is operated by an Italian energy producing company, which has installations not just in Europe but in North and South America. From an energy generation perspective, Dobrogea is one of the best places in Europe for the construction and operation of a wind farm. Its open lands are characterised by some of the continent’s most dependable, strong winds. The Italian producer foresees developing as much as 560MW of renewable energy in Romania.

The Sălbatica Wind Farm involved the construction of 70 turbines each producing 2MW of power. The annual production of the site is 85.5 million kWh/year. This is enough to power 28,000 households. Equally important, from an environmental standpoint, is the reduced carbon footprint. Sălbatica’s turbines produce power that if produced by traditional means would have released 48,000 metric tons of CO2 per year. That pollution is prevented through Sălbatica’s renewable energy approach.

Phase II of the project started in 2010. Additional 35 Moline Gamexa G 90 windmills were planned, each possessing the same 2MW output of the first phase’s turbines. The logistics involved in constructing wind turbines of this size are not simple. The towers are 100m high and built of 5 segments that weigh roughly 65 tons each. For every windmill, eight transport stages are needed: 5 for the pole segments, 1 for the blades, 1 for the nacelle and 1 for the propeller axle. Erecting them requires heavy cranes. Here, Liebherr 750Tn cranes (roughly 550 tons themselves) were used, assisted by auxiliary cranes of 150, 200 and 500 tons.

Without the aid of reinforcement, just getting the materials and equipment to the construction sites will be a significant challenge. Site access roads are subject to tremendous loads and must be properly designed and supported.

The existing modus at the roadway excavation level, for example, was 40-50MPa. This would not be sufficient to support the designed loads of Sălbatica’s second phase. Approximately 40km of access roads were to be constructed and each turbine would require its own crane pad. Roughly 80 truckloads of crushed stone were delivered each day, and each truck carried 35 to 45 tons of aggregate.

The design called for roads that could resist 10,000 traffic cycles, and of the oversized transport means that additional loads of 65 to 90 tons per truck were regularly rolling across the site.

Furthermore, the heavy need for concrete in the turbine/crane pads meant that another 20 to 80 trucks per day (the concrete mixers) were needed. To manage access road performance and survivability, engineers specified the installation of 150,000m² of Combigrid® 30/30 Q1 151 GKR 3C reinforcement geogrids.

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Did you know...?

New Principles for Geotechnical Design - Eurocode 7

In December 2004, Eurocode 7: Geotechnical Design - Part 1: General Rules (EC 7-1) was ratified by the European member states.

This prompted a two-year calibration period, during which member states had to write the National Annex to EC 7-1 that serves as the link between EC 7-1 and national standards.

Following this calibration period, culminating in EC 7-1 becoming valid in all member states around 2009, National standards covering the Annex of the respective member state as their de facto guideline for the design of the geosynthetic components.

For the design of Geosynthetic Reinforced Soil Structures, the 2010 issue of e.g. BRGO (Germany) and BS5906 (UK) are referred to.

The new EC 7-1 moves away from “Working Stresses” and uses partial safety factors for actions (loads), material (stresses) and load effects (stresses). This prompted a two-year calibration period, culminating in EC 7-1 becoming valid in all member states around 2009.

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Preserving Arran’s Coastline

When the picturesque shore on the Isle of Arran in the Firth of Clyde (just off the west coast of Scotland) was threatened by erosion, NAUE geosynthetics were brought in to provide an environmentally welcomed, aesthetic, long-term design.

Brodick, Arran’s main town, is situated on the island’s eastern coast. The shore is comprised of a fairly narrow band of mixed grass, sand, rock and shingle. The coastline suffers significant erosion from constant wave attack. This affects some 250m of beach and has been a cause of concern for local residents.

The erosion even unearthed a restored landfill, which heightened the concern with the stability and environmental soundness of the beachfront. The landfill in question was closed around 1950 and restored with topsoil and marram grass (a simple, common approach in the time before geosynthetic capes). When this site was exposed by shoreline wave erosion, a rectification project was undertaken by North Ayrshire Council’s Infrastructure and Design Service. This included the selection of two geosynthetic solutions: Soft Rock Type E (RF301) sand containers and Terrafix® 609 geotextile for filtration, erosion control and scour protection.

Armoured rock solutions were considered, but these were deemed to be prohibitive (in part due to scarce, acceptable local supply). Also, they were not considered aesthetic enough. Sandfilled geotextile bags, however, met the project’s budgetary goals and could be blended into the environment.

NAUE’s sand containers arrived on site in an unfilled state. This minimised transportation costs and allowed the project to utilise locally sourced fill. It also helped the small island’s economy, as a local contractor, Murchie Sand and Gravel Ltd., was able to carry out the work. No special labour was required.

The Soft Rock Type E B601 sand containers used on the project are made from a white polypropylene, single-layered, mechanically bonded non-woven geotextile sewn with a special seam to form a seal. The sand containers have a floor area of about 3.5 sqm and each container is able to carry a mass of up to 2 tonnes. When sealed, the pillow-shaped sand containers measure about 300mm thick.

Material was excavated to show the front row of sand containers to be placed to a depth of about 1m below the surface of the beach. NAUE’s Terrafix® 609 was designed here to replicate the buffeting effects of sand without the sand being removed. The excavated material was installed as a filter/separater between the sand containers and the loose material to ensure material stayed in place to provide the protection from the coastal erosion. Able to trap sand in its pore spaces, Terrafix® 609 is a staple fibre needle-punched non-woven geotextile. This three-dimensional fibre structure creates labyrinth-like pore openings that closely simulate soil structure and its hydraulic properties. In retaining soil while remaining permeable to water, the geotextile allows root growth to further enhance protection structures will blend unobtrusively with the natural environment but is durable enough to resist being torn apart by these roots. More than 30 years of projects have proven the versatility, filter stability, and resistance to abrasion of Terrafix® geotextiles.

Once all of the sand containers had been placed in position, they were covered with more sand - a planning requirement which met the concerns of the local residents about the appearance of the finished job.

The work has created a new and definitive boundary between the marram grass and the beach, whilst providing a 4m corridor of newly reclaimed beach. Most importantly, the work has overcome the problem of 70-year-old rubbish finding its way onto the coastline.

Today, Brodick’s coastline is safer and more aesthetic, and its aesthetic character has been preserved.

Psst! It’s Secutex® PSS and Secugrid® beneath the Heidebahn

The Heidebahn is a important piece of Germany’s railway system, connecting Hamburg/Buchholz in Nordhelle with Hanover, the capital of the German state of Lower Saxony. This old connection is used significantly by both commuters and visitors between these two major urban centres. To modernise the network and increase its value to the region, the Northern Region division of Deutsche Bahn AG (DB) decided to expand the line, investing more than 100 million euros in the project. Construction measures included establishing hand-accessible train stations, installing a new signal technology, and increasing the maximum speed from 80 to 120km/h. However, the tracks would need to be reinforced or entirely replaced to support higher speeds, and track equipment would need to be adapted. NAUE geosynthetics were identified as an ideal solution to the track improvement concerns. Over the past two years, various sections of this key railway link have been upgraded with NAUE reinforcement and subsoil securing technologies.

Improved Load Distribution

The route’s various subsoil conditions, which ranged from sandy to cohesion soils, needed to be strengthened. Combigrid® 40/40 Q1 151 GRK 3, Secugrid® 40/40 Q1 and Secutex® PSS contributed to the line’s successful renovation.

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NB: The image contains schedules for various exhibitions and seminars around Europe, including dates and locations. The information is not relevant to the text and can be ignored.

The machine was easy to incorporate Combigrid® reinforcement layers. When Secutex® PSS nonwoven mats were installed, the track gravel was placed directly atop the Secutex® without any additional PSS. These rolls of geosynthetic materials thread smoothly into the work process of the subsoil improvement machine.

Finally, the new construction’s superstructure was compacted as the final step to ensuring safe, long-term performance without additional maintenance.

To date, almost 50,000m² of Combigrid® 40/40 Q1 151 GRK 3, 24,000m² of Secugrid® 40/40 Q1 and more than 27,000m² of Secutex® PSS have been installed.