Geotechnics take center stage in Berlin

This issue of NAUE News has a special meaning for our company. It doubles as a welcome letter to the world’s geosynthetics and geotechnical professionals. This month, the 10th International Conference on Geosynthetics (10ICG) (September 23 – 27) and the 23rd Baugrundtagung (September 23 – 26, German geotechnical conference) are being held in Berlin.

Uniquely, these events are being co-located. These geotechnical events often work side by side in the field, but they have seldom gathered together for a cornerstone event. The ICG is the global gathering for the International Geosynthetics Society (IGS). It happens only once every four years and is this year the International Geosynthetics Society meeting. These geotechnical experts often work side by side in the field, but they have seldom gathered together for a cornerstone event.

The ICG is the global gathering for the International Geosynthetics Society (IGS). It happens only once every four years and is this year being hosted by the German Chapter of IGS. The Baugrundtagung is the biennial conference of the German Geotechnical Society (DGGT), and it is among the largest, if not the largest, national geotechnical society events in the world.

These groups have worked incredibly hard to make this rare cross-over event a success. The technical programme is top-notch. The keynote speakers and lecturers are renowned. Simultaneous translation has been arranged to expand the dialogue as wide as possible between the English-language ICG and German-language DGGT event. And, as noted, the networking opportunity presented here between these geotechnical experts has almost no event precedent.

We are proud to welcome our friends and colleagues from the IGS, DGGT and affiliated societies such as the DSSME to the country in which NAUE’s international operations began over 50 years ago. Our headquarters is located here in Germany, as is most of our manufacturing.

It is an honour to have so many geotechnic companies and practitioners join us in historic Berlin for scientific transfer, knowledge exchange, project updates and so much more.

Our personnel have eagerly awaited the arrival of 10ICG and the Baugrundtagung. In addition to the company contributing sponsorship and exhibitor support, a number of our employees have contributed to the events’ communication and promotion efforts, the corporate and scientific committees, and the general technical programme.

For a list of the presentations to which NAUE’s team members have contributed, please see the article on page 4.

We’d also like to highlight the trade shows of 10ICG and the Baugrundtagung. These shows provide the always welcomed opportunity for us to meet face to face with old friends, industry colleagues, clients, and future project partners.

We look forward to bringing you in the exhibition hall at NAUE’s booth (S25 and S28).

The NAUE booth will be an active site. We will have, as you might expect, our latest literature and videos, as well as experts from our international network to answer your engineering questions.

We will also have plenty of other things to share with you and to make your experience in Berlin even more pleasant:

• Free coffee (including specialty drinks, such as espresso and cappuccino)
• A daily quiz competition to test your geosynthetic knowledge
• Prizes such as a Germany national team World Cup jersey (updated with a fourth star to indicate the number of titles the team has won)
• Happy hour! On Monday evening, September 22, NAUE’s booth will be the scene of a special happy hour featuring guests you won’t want to miss

We look forward to welcoming you to Berlin and the NAUE booth at 10ICG and the Baugrundtagung.

Extraordinary sites: from quarry to landfill

One of Australia’s largest landfills occupies a former quarry. The site, known as the Boral Western Landfill, has an available airspace totaling more than 15,000,000m³. Since 1999, the facility has offered municipal and commercial waste management services to metropolitan Melbourne. Today, more than 20 percent of Melbourne’s waste is managed there.

Of further note, the landfill also includes a substantial landfill gas (LFG) operation. The decomposing waste creates enough biogas to power 4,000 homes. An on-site plant converts the gas, which is generated in the waste piles and collected through an extensive network of pipes.

Gas collection is further enhanced by the utilisation of geosynthetic cover systems on closed cells.

The Boral Western Landfill operates in compliance with Victoria EPA regulations and Landfill Best Practice Environmen tal Management (BPEM) guidelines. These regulations are on par with the enhanced environmental protection standards used in many countries for waste management. Chiefly, these regulations are designed to protect groundwater supplies, such as from leachate and to do so, they require the use of geosynthetic lining systems.

The waste cells at the former quarry are managed largely in the same way as at more traditional landfill sites: the land is parcelled into multiple cells, each with its environmental protections and monitoring, and, when a cell is filled, it is capped and new waste is subsequently diverted into the next open cell.

For the construction of the two most recent cells at the site, the operators followed their standard approach in a lining system (noted from bottom-up): clay, geosynthetic clay liner (GCL), high-density polyethylene (HDPE) geomembrane and protection and drainage layers.

NAUE Bentofix® GCLs were selected for the newest lining system.

Bentofix® has been used as a base liner or barrier system component for landfills and leachate ponds around the world. It has also been used routinely for cover systems when waste cells are closed. The GCL is a composite product that features robust geotextile layers on top and bottom and a central core of high-swelling, powdered sodium bentonite. The needle punched nonwoven geotextiles provide excellent frictional characteristics and long-term durability, as well as the flexibility to accommodate normal waste settlement variances, so Bentofix® is appropriate for flat, sloped, or curved soil and cell geometries. The bentonite core provides an exceptional barrier to liquid. It swells in contact with water and, subsequently, becomes too dense for other liquid to flow through.

Importantly, Bentofix® GCLs enable a higher level of environmental protection than just compacted clay, which is why modern landfill barrier designs use significantly less traditional clay, opting instead for thinner, more efficient, more economical and more durable GCL layers.

All of these reasons made Bentofix® an attractive option for the Boral Western Landfill. In total, 160,000m² of Bentofix® GCLs were installed by our partner Global Synthetics to secure the future of Melbourne’s waste management system and groundwater.

The Boral Western Landfill continues to evolve, having been a quarry, then an asphalt plant and now a landfill and renewable energy producer. It does so with state-of-the-art environmental controls.
Floating roads for onshore wind farms

The United Kingdom is one of the world’s biggest wind energy developers, but developing wind farms in the UK is not easy. Sometimes the remote areas needed, to construct large wind energy sites, contain areas of peat. The individual components of a modern wind turbine generator can weigh as much as 100t. Getting the components successfully across any peat encountered to each turbine foundation and hardstanding is the key to the success of each project.

For the new Camster Wind Farm near Wick, Scotland, geosynthetic reinforcement materials have been utilised to build more than 10km (6.2mi) of roads, 8km of which have been constructed over peat with an average depth of 3.5m. To enable the wind farm’s economical and safe construction, the project team “floated” the roads with the help of geosynthetics.

Floating is a common strategy for wind farm access road construction over peat but the weakness of the peat at Camster was of great concern. The roads were successfully floated using a combination of geosynthetic separation and reinforcement strength between the road and the peat as a way to enable equilibrium to develop between the road’s weight and the peat’s situ strength. This equilibrium creates a semi-stable system. Long term settlements are expected but have been mitigated by developing an alternative layout avoiding the areas of deeper peat.

The only other solutions would be prohibitively expensive and environmentally unsound (e.g. substantial excavation of peat in search of enough bearing strength). The Camster site was found to have peat deposits as deep as 6m. The ability to float the road would be far quicker and much more economical to construct and also has the benefit of reducing peat excavation which has huge environmental benefits.

Geosynthetics made it happen.

The geosynthetic consulting firm BBG Bauberatung Grokunststoffe worked on the site’s design with Morrison Construction, one of the UK’s most experienced wind farm construction companies.

The 25-turbine site needed to be secured against some very heavy traffic over the variable peat. Each of the Vestas V100-2.5 MW turbines requires eight major component deliveries on specialised delivery vehicles the heaviest of which are the mid tower section at 60t and the nacelle at 71t. The heaviest single vehicle is the 1,200t telescopic crane used to erect the towers at 108t without ballast. Prior to the delivery of the wind turbine components, some sections of the track would have had over 8,000 passes of 25 and 30t articulated dump trucks which generally have the highest axle load of any vehicle expected on site.

The floating road reinforcement strategy used two types of geo-text: a flat, extruded and drawn geogrid with welded junctions and a composite product with a nonwoven geotextile inserted between the geogrid bars in the manufacturing process to create a single-layer geogrid-geotextile material. The products selected were NAUE Combigrd® 40/40 Q1 151 GRK 3 and NAUE Secugrid®. The former is the composite product and utilizes a type of the latter grid in its composite structure. Both products are designed to provide high strength at low strains and be resistant to chemical and biological attack.

The composite reinforcement material allowed the team to address the more difficult peat thicknesses and strengths by installing a single-layer material that, with its embedded, highly durable nonwoven Secutex® geotextile, provided reinforcement (with the geogrid) and soil separation, filtration and drainage functions (with the geotextile).

All materials were delivered in wide (4.75m) rolls that did not require specialised labour to install and that minimised cutting/wasting of material. Roughly 175,000m² of Combigrd® and 195,000m² of Secugrid® were installed in the floating road system. The strategy has proved to be a perfect one for this northern region’s increasing renewable energy profile. And after more than 8,000 passes of tipper trucks, no significant road damage had occurred despite the 3.5m average depth of peat beneath the floating road.

Once fully operational the Camster Wind Farm is expected to provide enough electricity for 37,000 homes and save more than 75,000 tons of CO₂ per year.
A pioneering geosynthetic application

This installation is not only important for flood control but for the field of geosynthetics. It represents a remarkable application of these materials in dam structures. Although geosynthetics have been frequently and successfully used in hydraulic engineering for 40 years, the general field awareness of geosynthetics in these applications has been low. The Glashütte project has provided an exemplary case for the beneficial impact of scaling systems on flood control and dam safety and performance.

The FRB Glashütte I is a "dry" or "green" retention basin. From the foundation of the dam seal to its crest, the dam is around 27m high. The basin holds up to 1 million m³. The upstream face is sloped at 1:2.5 with an intermediate berm approximately 9m below the crest. The downstream slope ranges from 1:2 to 1:2.8 and includes two berms to accommodate route K 9036. The dam was built as an earth-fill dam with an inclined inner seal. Up to a height of 16m, it has an impervious core of cohesive soil (k-value < 1 x 10^-6 m/s) varying thicknesses, depending on the geometry.

The drainage composite is part of the leak-detection system. Ideally, it should always remain dry. At its lower end, the seal feeds into a drainage prism filled with granular material 5.6/63mm and a drainage pipe. At the side of the dam, the sloping drainage pipe connects to the downstream face of the dam by a solid-wall pipe installed at a gradient. The monitoring pipe penetrates the lower GCL. In a critical situation, the pipe shows whether the dam or its sealing system is holding. When the basin is full, there should not be any water leakage.

Drainage composite:
- NAUE Secudrain® 131 C WD 401 131 C
- Upper GCL NAUE Bentofix® NSP 10300 a
- Approx. 60cm cover layer Ø12mm (sewed), of which 30 - 40cm was immediately applied on the day of placement
- Overlying embankment-fill material (see above) with top-soil cover and grass seeding

The drainage prism is in the region of the bentonite seal, and it is thus protected against water ingress from above and below by the two GCLs. The GCLs are brought together below the drainage prism and lead into the mineral seal. The GCLs are set at a slope of 1:3. The transition to the upstream overall inclination of 1:2.5 has been made using the embankment-fill material.

The most important characteristics of the GCL (Bentofix® NSP 10300) are:
- Mass per unit area: 10.4/10.5g/m² of which:
  - Substrate (PP woven) 300g/m²
  - Bentonite (Na Bentonite) 110g/m²
- k-value: 2 x 10^-17 m/s
- Permeability: < 5 x 10^-11 m/s
- Thickness: 9mm

Thus, NAUE fulfilled the design requirements, in particular the weight of bentonite (> 9kg) and the permeability (< 5 x 10^-11 m/s).

It is worth mentioning that NAUE uses only high-quality sodium bentonite. This grade of bentonite would even have met the required permeability with only 5kg of bentonite and a layer thickness of 6mm. Nevertheless, NAUE won the tender with 10kg of bentonite, which, in terms of scaling safety, meant twice the safety while still at a lower price.

A total of 12,000m² of Bentofix® and 6,000m² Secudrain® were installed.

Careful protection of the installation joints

The installation of the approximately 6,000m² of verifiable seal started in the second week of November 2012, but by the end of the month the installation had to be interrupted due to the early onset of what turned out to be a long winter. The edges of the GCL were covered with a geomembrane to protect them from the weather. This “winter joint” strategy (wrapping the edges in geomembrane) and the sufficiently thick cover material atop the GCLs ensured the integrity of the material until the spring.

Construction resumed in late April 2013 and, shortly thereafter, the scaling system was completed.

Due to the sensitivity of the site and the innovative design, a specialist technical installation company was retained for the work. Quality assurance (QA) was given the highest priority. All work involving geosynthetics was carried out according to landfill-construction QA specifications, which are the most stringent available. The client, LTV, appointed an accredited office/laboratory not only for overall construction but for site supervision, external testing, and the suitability testing of the specialist installation company.

External site testing was demonstrated on all operations involving geosynthetics. Installation was performed strictly in accordance with NAUE’s instructions, which are also part of the positive assessment of the GCLs by the LAGA. QA paid particular attention to the winter joint. Sampling and laboratory testing verified the integrity of the GCL at the winter joint.

As noted earlier, geosynthetics have not been as deeply utilised in dam engineering applications as they have in other sectors of infrastructure. Prior to the Glashütte site’s incorporation of geosynthetics, the materials’ frictional stability was investigated and successfully confirmed. The Institute of Geotechnical Engineering at Leibniz University of Hanover conducted several experiments with a large direct shear box. They tested the internal shear strength of the GCLs and all “joints” (or interfaces) between:
- GCL (bottom and sand layer)
- GCL (top and bottom) and drainage composite
- GCL (top) and the capping layer

The use of a verifiable seal on the dam enabled not only a modern but a highly efficient design. A trial filling of the basin (January 2015, depending on the water availability) is planned to confirm the effectiveness of the geomembrane sealing system’s monitoring when the reservoir is full.

It is anticipated that this design will make a truly beneficial contribution to improving the understanding of geosynthetics in hydraulic engineering. It will provide a strong precedent for adapting these construction materials and methods to similar sites going forward for better flood control and flood safety.

Thanks to the professional implementation by the construction company (STABAG AG, NL Dippoldiswalde/Dresden) and the specialist installer for GCLs (ENIG GmbH, Arnstadt) - in spite of partially adverse weather conditions - a flood retention basin has been created which will be groundbreaking for similar projects worldwide due to its progressive design and economical structure.
Hydrostatic pressure-resistant sealing of tunnels in northern Bavaria

The tunnels at Höhnberg and Füllbach near Coburg use a Carbofol® tunnel liner to ensure their impermeability under hydrostatic pressure.

As part of the Deutsche Einheit (German Unification) Traffic Project 8.1, the Deutsche Bahn Netz AG (German Railways) ordered the construction of the Höhnberg and Füllbach tunnels on the Coburg-South section of the new twin-track line between Ebensfeld and Erfurt. The two tunnels cross one another with a vertical offset of 16m, which meant an enormous challenge for the tunnel design. The all-round sealing, however, was “standard” in the best sense of the word. The structure and approach of the specialist installer NAUE Sealing are a model example of a lining system capable of resisting hydrostatic pressure.

The Füllbach tunnel is 1,113m long and designed as a single-track branch line for train concreting, it pulls off the localised protection nonwoven is attached at the block joints. Six-rib Carbofol® waterstops are placed at the strut zone and as the geosynthetic (Carbofol® tunnel liner) against mechanical damage. The protection nonwoven is attached using Carbofol® discs with predetermined breaking points. If the tunnel liner (GMB) is subjected to tensile stress during concreting, it pulls off the discs without damaging them.

The 3mm thick Carbofol® tunnel liner is the main component of the sealing system. It is installed as a single, tunnel-encompassing layer. It, too, is attached using Carbofol® discs with predetermined breaking points and resists hydrostatic pressure. A white, light-reflecting signal layer on the inner face of the liner ensures good light conditions for the work underground and allows effective visual checking of the entire installed surface for damage.

NAUE Carbofol® tunnel liners are approved under both RE.BS3 and ZTV-ING. They exhibit exceptional behaviour opposite high temperatures and aggressive liquids, bridge spontaneous cracking of the concrete structure without loss of functionality, are environmentally safe and extremely durable. Six-rib Carbofol® waterstops are welded on at the block joints. They fulfill several functions:

- Any damage is more easily localised.
- Seepage is avoided.

The liner was installed during 2012/2013. A total of 80,000m² SeCutex® nonwoven R 1011-B2, 80,000m² Carbofol® tunnel liner 3mm, 20,000m² Carbofol® protective layer, 6,000m² Carbofol® waterproofing SAA 600/6 and 190,000 Carbofol® discs were used. The tunnels are due for completion in 2014 and the route is scheduled to be operational in 2017.