Riding the wave

*An artificial surfing lake project near Bristol has given ABG Geosynthetics the perfect opportunity to put its geocomposite drainage layer to the test. **Michaila Hancock** reports.*

The Wave is a new inland surfing lake and the first facility of its kind in the UK to use Wavegarden Cove technology which can produce over 1,000 waves an hour. Located 10km north of Bristol city centre, the site is on a greenfield, former agricultural, low lying area of the Pilning Levels.

The lake is cast insitu with reinforced concrete walls on a 150mm thick fibre reinforced concrete slab. It is triangular and approximately 180m long and 200m wide at its widest point and can hold more than 19,000m³ of water. The lake features a pier running down the centre, with the wave making mechanics at one end. The £25M development is powered by 100% renewable electricity and is open all year round, regardless of the weather conditions.

Working for consulting engineer Hydrock and main contractor Andrew Scott, ABG Geosynthetics designed the geocomposite drainage for the lake, which is located close to the Severn Estuary and its flood plains.

Due to this, Hydrock and ABG also had to carry out design work for the management of groundwater and uplift pressure. In places the water table was only 145mm below ground level, which meant the design had to take into consideration the potential flotation of the concrete-lined wave pool when it was empty, as it is sunk 1.5m into the ground.

"Creating a 20,000m² lake in the ground which has a very high water table was always going to be a fascinating project," says ABG Geosynthetics managing director Alan Bamforth.

"When it is empty, it will float, but when it is full of water, everything is going to be equally balanced and sit nicely in the ground.

"But what the designer Hydrock needed to do was consider the eventuality that the lake would need to be drained and emptied at some stage for maintenance or cleaning, and in those circumstances, it could suffer from potential floatation."

DRAINAGE SOLUTION

One potential solution for counteracting uplift forces would have been to build an extremely thick and heavy concrete base to weigh the lake down. Another would have been to pile the base into the rock below. Both are costly, Bamforth says.

"Another option is to put a drainage layer underneath, which consists of a stone drainage blanket over the whole base area. In this case it would be 20,000m² of crushed stone, leading to drainage trenches, which can take the groundwater away to a safe discharge point as fast as it comes to the underside of the tank," explains Bamforth. "It's constantly removing the groundwater, so it can't build up a head and cause the floatation."

This was the solution that Hydrock was considering when it consulted ABG.

"We were able to offer a better geocomposite solution called Pozidrain," says Bamforth, "It's a drainage layer that will isolate the lake bed from the groundwater."

Pozidrain is made up of a 6mm thick cuspated high-density polyethylene (HDPE) core bonded to a non-woven geotextile to form a geocomposite layer.

Channels between the matrix of cuspates provide a clear passage for water to flow in all directions.

It is this clear passage for water that Bamforth believes is key to the geocomposite being a more effective alternative to the stone drainage blanket.

"In comparison to a 250mm crushed stone drainage layer that is prone to localised blockages, the geocomposite design has a much faster and more reliable flow rate," he explains.

"The geocomposite creates a drainage void within the cuspates core that is protected from soil ingress by the filter textile. This has sufficient compressive strength of 250kPa to resist the forces that are going to be

imposed during construction and the subsequent use of the wave.

"In terms of equivalence to drainage capacity, [the] crushed stone [layer] would have to be 250mm thick to get adequate drainage. Of the 250mm thickness, most of it is actually stone, with the water going through the gaps between the stones. But there is roughly more stone than space, so the water moves very slowly, and you need quite a thick layer to get the discharge.

"With a geocomposite the voids are all aligned, so the water is moving much more quickly. As a result, the core can be much thinner, only 6mm."

This can create significant savings due to reduced excavation – around £800,000 in savings on this project – and reduced transport movement to site. Carbon dioxide savings from not having to import and place an equivalent crushed stone drainage layer, are according to ABG, around 79%. Around 128t of CO_2 was saved on this project.

For this scheme, a heavy-duty geotextile was bonded to the flat side of the HDPE core. It was installed at the bottom of the lakebed to prevent any damage to the waterproofing liner during installation.

The at-places high water table in the area could have caused 'floatation' of the concrete-lined wave pool when empty

This replaced the need for a separate 400g/m^2 geotextile protection layer originally specified below the lake's rubber lining.

"We have installed the geocomposite before on smaller projects, such as sewage works, but this is the first time we have installed it that way on a large project," explains Bamforth.

"The other feature of the Pozidrain is that one side of the core is impermeable. By taping the joints of the product together, which is 4.4m wide, it forms a smooth base for the concrete pour."

During manufacture, a non-woven geotextile filter fabric is bonded to the dimpled underside of the HDPE core to ensure that it does not deform into the spaces between the cuspates and restrict flow rate upon loading. The geocomposite drainage layer functions as an impermeable barrier to groundwater ingress and acts to lower the water table beneath the lake, channeling the groundwater away to the nearby attenuation basin, thus reducing the uplift pressure.

TESTING FOR THE LONG TERM

ABG undertook creep compressive strength testing to prove that its solution would be suitable for the scheme.

"This is a long-term test to make sure that the product can survive a load over the 120 years," explains Bamforth.

"We used a technique called stepped isothermal method, which is an accelerated creep test. It increases temperature to simulate increasing time, over a period of three days, in steps, on the specimen. This is then plotted and calculated so you can see how much compression is going to occur at the end of 120 years.

"We submitted these calculations for the long-term creep compressive strength, in-plane water flow, and pore size compatibility with the ground, and convinced everybody that our solution would do the job."

Bamforth believes that identifying opportunities to use value engineering, as ABG has for this project, remains a challenge for the industry.

"The engineers that have used the geocomposites tend to come back time and again, but there's still so many people out there that have yet to experience them for the first time.

"What seems very logical to save cost sometimes isn't always taken up because of lack of time in the design process and lack of trust in the solution.

"You would think that you would win hands down if you're offering benefits all round, but that is not always the case.

"The challenge is to strike it lucky and everything comes together where the client, designer and the contractor all believe the product is going to work. This is what happened on this project."

And has Bamforth used the surf lake?

"No, I haven't, I'm afraid," he laughs. "It's one of those things; we tend to roll onto the next client and the next project. There is a constant stream of things to do."