


FIGURE 1 Overhead view of geomembrane being pulled across the water surface





Motorway underpass using geomembranes as a groundwater barrier

Geomembrane construction installed by submerging it into underwater excavated pit.

By Dick van Regteren

In some places in the Netherlands, there is an absence of natural clay so groundwater flushes easily through the soil. As soon as excavation starts, groundwater will be present. Groundwater must be removed or taken care of to build roads, tunnels, etc. in dry conditions. This article describes a technique using geosynthetic materials for creating dry building pits.

To create two road tunnels under an existing motorway in Raalte in the Netherlands, Genap submerged several prefabricated geotextile and geomembrane panels to create a groundwater barrier underneath the tunnel ramps of the two tunnels.

One of the project conditions was that the existing motorway could not be closed for more than 48 hours on a weekend. The normal way to build underpass access ramps by pit dewatering was impossible because of the high groundwater table and the large influx of groundwater that would cause too much discharge water. In this case, the contractor chose to build the access ramps by using a geomembrane construction, installed with a special submerging technique, to create the groundwater barrier.

The Geosyntec groundwater barrier system consists of a three-layer construction, a 40 mil (1 mm) thick PVC geomembrane underlain and overlain by a nonwoven geotextile of 93 grams/foot² (1000 gr/m²) for protection.

Project implementation

The tunnel parts under the motor road were the first to be made using sheet piles and underwater concrete. In one weekend, the sheet piles were placed across the motor road and a prefab concrete

PROJECT HIGHLIGHTS

PROJECT TITLE

LOCATION

N348 Raalte-Ommen Netherlands
Tunnel 1: GPS 52.48117473313358,
6.364705114997263
Tunnel 2: GPS 52.42441097067405,
6.333877127837819

OWNER

Province of Overijssel Zwolle
The Netherlands

GENERAL CONTRACTOR

BAM Infra Regionaal Nieuwleusen
The Netherlands

PRODUCTS GEOSYNTHETIC CONSTRUCTION

Geotextile

Genatex PES non-woven 1000gr/m², produced by Manifattura Fontane Spa, Italy

Geomembrane

Aquatex PVC-P 1,0mm (Food Applied), produced by SIKA Germany GmbH

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FIGURE 2 Excavation by hydraulic excavators



FIGURE 3 Unrolling prefabricated geotextile



FIGURE 4 Pulling the geotextile across the water surface

deck was placed on top of the permanent sheet piles. As a result, traffic could drive over the tunnel basin again within 48 hours. Underwater concrete made this tunnel section water-resistant in relation to the groundwater.

As mentioned, a geomembrane construction was used as a groundwater barrier for the tunnel ramps. The principle of this geomembrane construction is that it must be installed at a certain depth and ballasted with sand until the membrane construction is in equilibrium, i.e., the pressure on the geomembrane construction is greater than the water pressure under the geomembrane construction.

The special thing about this project is that the geomembrane construction was installed by submerging (sinking) it into the underwater excavated pit. Also, the geomembrane needed to be fixed at a certain depth to the permanent sheet piles of the tunnel part.

For the connection of the membrane construction to the permanent sheet

piles, a second temporary sheet pile in front of the permanent sheet piles was needed. The space between the sheet piles (10 feet [3 m]) was dewatered and excavated. On the bottom of this temporary pit, a concrete beam with a clamping construction regarding the geomembrane was built against the permanent sheet piles.

The three-layer geomembrane construction was placed and clamped watertight to the concrete beam in this temporary pit. The pit was filled with water and the three-layer geomembrane construction was pulled up to the water surface by a small winch system.

At this point, the ramp excavation started using hydraulic excavators and a GPS to dig to the right depth (**Figure 1**). The sand was placed in the depot so it could be used as ballast sand after the installation of the three-layer geomembrane construction.

After excavation, the temporary sheet piles were removed to create one

open-water surface of the ramp. To ensure there were no sharp objects in the excavation, divers checked the underground.

In a later stage, the water was pumped out of the pit to submerge the geomembrane. Therefore, a drainage system was installed on the bottom of the pit.

The first layer installed was a protection geotextile. This layer was prefabricated in five big rolls of 23 feet (7 m) width because of the volume (thickness) of the geotextile. The rolls were transported to the project, unrolled and stitched together to one part of 65 feet² (6 m²) (Figure 2). In front of the geotextile, an air tube was stitched for preventing the layer from sinking during pull over (Figure 3).

After compiling the geotextile layer, it was pulled over the water surface by using winches and cables (Figure 4). The pulling must be performed in one continuous movement because the geotextile that is heavier than water wants to sink. Once on the other side, the excess length was pulled onto the water surface, and the geotextile was allowed to sink to the bottom of the pit (Figure 5).

The second layer installed was the PVC-P geomembrane. The total needed surface for each ramp (65 feet² [6 m²]) was prefabricated into two parts of 32.5 feet² (3 m²) (Figure 6). The prefabricated parts were folded and rolled on a 23 foot (7 m) long steel pipe. The two parts were unrolled at the project site and welded together into one large membrane construction. The same winches and cables were used to pull the membrane across the water's surface.

After the excess length was pulled onto the water surface, and before the submerging process could be started, the connection to the geomembrane from the tunnel part was made. The geomembrane from the tunnel and the pulled-over part were pulled onto a raft, cleaned and then welded together. After removing the

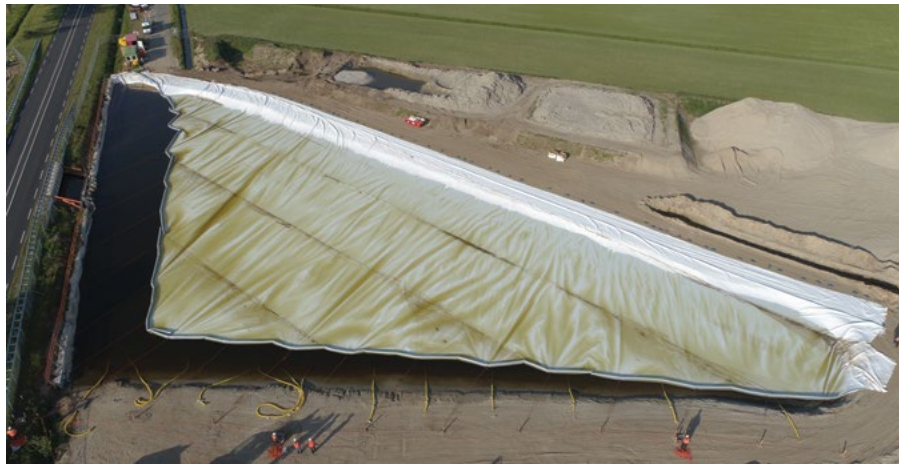


FIGURE 5 Another view of pulling the geotextile across the water surface



FIGURE 6 Overhead view of the geotextile starting to sink

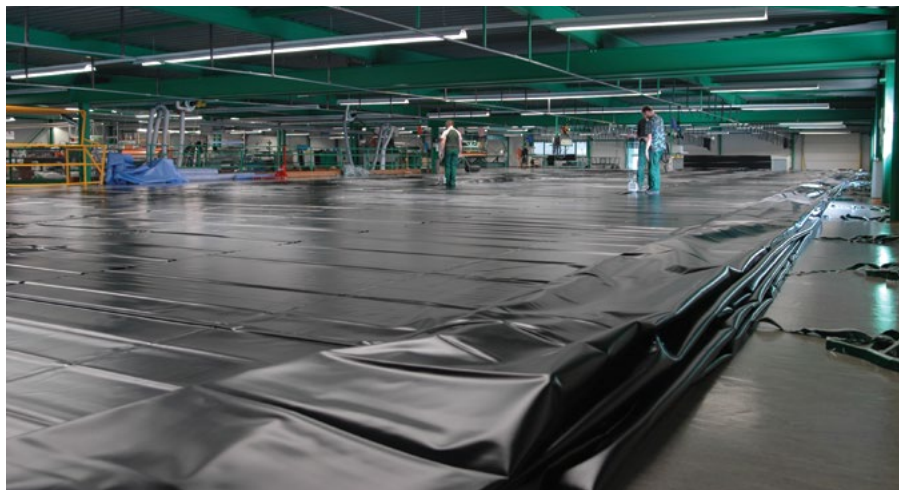


FIGURE 7 Geomembrane prefabrication



FIGURE 8 Drainage system installation



FIGURE 9 Aerial view of the geomembrane being pulled over the water surface



FIGURE 10 Close-up of geomembrane being pulled over the water surface

raft, the submerging process could start (**Figures 8, 9 and 10**).

This submerging process was accomplished as follows: After completing the excavation, Genap installed a drainage system onto the bottom of the excavation (**Figure 7**). This system was used to pump the water underneath the geomembrane onto the top of the geomembrane.

During this process the geomembrane sank to the bottom under its weight during pumping because the material is heavier than water. Once the geomembrane reaches the bottom, the pumps stopped because there is no more water underneath the geomembrane. The submerging process was complete.

Divers checked once again that the geomembrane was fully pressed onto the bottom.

Subsequently, geoelectrical leak detection was carried out and it was demonstrated that the geomembrane construction was 100% watertight. The geoelectric measurement system used for this was the so-called electrical flux tracking. For this process, an electric field is applied outside the structure, which is conducted to the other side of the structure using an opposing pole. The power flow follows the easiest route and moves through any openings in the geomembrane construction. The electrical potential is measured using sensors placed in a grid. Elevated potentials indicate leaks.

The last step was to install the third layer, the protection geotextile on top of the geomembrane. When this layer was submerged to the bottom, a drainage system was installed on top of the protection geotextile that would be needed to dewater the pit after filling it with ballast sand.

Hydraulic excavators placed the ballast sand back into the excavation in a controlled manner. After sufficient sand had been replaced, the construction was pumped dry using the drainage system (**Figure 11**).

The opening to the tunnel part underneath the motorway was made by partly burning away the final sheet pile wall. Afterward, the contractor started compacting and installing the road construction (Figure 12).


This project shows that a geosynthetic barrier system is effective. Also, the geosynthetic barrier to the groundwater allowed the soil along the sides of the ramps to be seeded with grass for a natural look.

Lessons learned

The immersion of geosynthetics is possible and has already proven itself in several projects where dimensions of 1,300,000 feet² (120,773 m²) as one sheet were submerged. However, this technique is not known to many contractors, so coordination between different

construction activities is of great importance and must be worked out before construction starts.

Conclusion

Welding the individual rolls of geomembrane at the confined site was impossible because of the level of water tightness required, time available, site access and logistical constraints. The use of prefabricated geomembrane panels also required only one seam or weld to be performed on-site, reducing construction time, cost and equipment. In addition, the prefabricated panels were created in the exact shape of the ramps, which resulted in no waste generation on-site. 

>> For more, search "turf reinforcement geotextiles" at GeosyntheticsMagazine.com

UPDATE



FIGURE 11 Pit after backfilling and dewatering



FIGURE 12 Tunnel N348 after completion