A Case Study of the Construction of a Roadway Fill over a Large Water Body Utilizing a Geotextile Reinforced Earth Foundation with Challenging Soil and Construction Conditions.

Brent Marjerison, M.Sc., P.Eng., FEC., [1]Brock Nesbit, AScT. [2] and Adrien Blais, P.Eng. [3]

[1]WSP Canada Inc., Saskatoon, SK, Canada; e-mail: brent.marjerison@wsp.com
[2] TenCate Geosynthetics Americas, Surrey, BC, Canada; e-mail: b.nesbit@tencategeo.com
[3] Ministry of Highways, Saskatoon, SK, Canada; e-mail: adrien.blais@gov.sk.ca

EXTENDED ABSTRACT

Successful performance of newly constructed roadways is directly related to the bearing capacity of underlying soils. In Saskatchewan, due to the topography, there are occasions whereby a new roadway must be constructed through large bodies of water. This creates a significant series of challenges such as the potential for differential settlement due to the organics and soft underlying soils and extreme construction problems in trying to bridge large and deep-water bodies. To mitigate the these challenges a combination of the use of geotextiles and winter construction was utilized to facilitate the successful construction of the subject roadway.

Project History

In the summer of 2017, the Ministry of Highways (MHI) SK was completing construction of a new set of lanes on Highway 7, west of the town of Vanscoy, SK. The design location for the new set of lanes was directly through a large water body that was approximately 1000 metres long and 750 metres wide with the maximum depth of water approximately 3.0 metres. MHI requested that a combination of geotextiles and winter construction be investigated as an option to traverse the water body. This process had been used several years prior on another section of highway with great success. WSP Canada Inc. was retained to investigate the potential for utilizing a similar methodology for crossing the subject location which included a dialogue with the previous geotextile supplier, a review of logistics, geotextile design options and cost comparisons and recommendations for the design option.

Unique Factors and Challenges

Several challenges existed for this project with respect to utilizing standard construction techniques such as the size of the water body (Figure 1), the soft foundation material and poor quality borrow (clayey silt). Additional challenges included siltation of the water body during construction, requirement to "bog" in fill with no potential for compaction, requirement for in-water work and excessive disturbance of the water body. The proposed location for the new set of lanes was paramount as cost was also a mitigating factor because if the water body could not be traversed then a new location would have needed to be determined which would mean a substantial increase in project costs.

Due to the numerous challenges and obstacles presented by standard construction, a winter construction option utilizing geotextiles was chosen with several benefits: construct one set of lanes instead of two; lower risk of shear failure and differential settlement; able to construct grade in successive lifts with some compaction of each; use of geotextile to bridge the soft material and provide strength and bearing capacity.

Product Selection and Design

To minimize risk, MHI requested a higher strength woven geotextile (HP770PET) in comparison to the geosynthetic used previously. The requirements of the woven geotextile were: high permittivity; specific gravity of approximately 1 (prevent floating) and polyester yarns (helps fabric to sink naturally and evenly). The design width was 60.0 metres and rolls had to be prefabricated at the factory into panels that were seven rolls wide by 91 metres long with a total of 16 panels required to complete the crossing. The type of seam that was utilized was a Butterfly Seam – Double Chain Stitch using polyester thread.

The advantage of the specified geotextile is that it is a blended product with polypropylene yarns in both the machine direction and the cross-machine direction which facilitates the ability to achieve a seam strength equal to or greater than 5% strain value of the geotextile in any direction. In applications of this nature, the 5% strain is the critical value. The panels were 5100 pounds and were supplied with steel cores for ease of use on site. Total width of coverage was sixty metres and total length was 800 metres. The contractor chose to sew the panels together on site as opposed to utilizing a 2.0 metre overlap to mitigate risk. The panels were placed parallel to the existing set of lanes extending approximately 2.0 metres beyond the expected edge of new subgrade. Roll ends of the fabric were overlapped a minimum of 4.0 metres to ensure proper load transfer and to protect the integrity of the fabric system as it sank to the bottom of the water body.

Construction

Construction of the subgrade took place in March of 2018. The contractor worked from west to east, constructing the center core of the fill and working his way outwards towards both edges of the embankment. The “dump and doze” technique was used which consisted of large rock trucks loaded with fill material dumping the load at the proper location and the contractor then dozing the material evenly over the fabric outwardly to both sides of the embankment. The main core of the fill was completed during the winter months of 2018. The remainder of the grade was completed in the spring of 2019 and the new section of the roadway was opened to traffic in October of 2019. Figure 2 and Figure 3 respectively show construction and post construction phases of the project.

Conclusion

The construction of the major highway through the large water body brought with it numerous challenges from a construction, cost, environmental and logistical perspective. Through the use of geotextiles, combined with proper engineering, careful planning, proper technical design and prior project experience, these challenges were overcome. Construction of a major highway through a large water body was brought to a successful conclusion on time and on budget with minimal impact on the environment.

Figure 1 – Pre-construction

Figure 2 – Construction

Figure 3 – Post Construction