Construction of Columbus Water Reservoir Geosynthetic Liner System

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EXTENDED ABSTRACT

This presentation will describe a unique comparison of geomembrane factory and field welded thermal seams for a large off-stream water reservoir project. The results of the comparison show that factory welded seams exhibit higher seam peel and shear strengths at yield, less variability, and more consistency than field welded thermal seams. In particular, the results show that factory seams are about 10% stronger than field seams in shear and about 9% stronger in peel strength at yield. More importantly, this resulted in 100% of the factory welded seams passing the project seam strength requirements. Conversely, about 25% of the field welded seams did not pass the specified field seam shear strength requirement, which caused significant delays, scheduling, and other construction issues. As a result, the field seam shear strength requirement was reduced from 9.6 kN/m to 8.2 kN/m to increase the number of field seams that achieved project requirements. The field shear strength requirement of 9.6 kN/m corresponds to about 80% of the peak tensile strength of the fPP geomembrane and the new peel strength requirement corresponds to only about 65% of the peak tensile strength of 12.6 kN/m. In addition, some peel strengths did not satisfy specifications. Because the geomembrane was primarily factory fabricated, there were about 78% less field seams on this project than if the geomembrane was entirely field fabricated. The use of a factory fabricated geomembrane resulted in improved quality of the completed geomembrane and protection of the prepared subgrade because it could be covered quicker to minimize environmental degradation.

This unique comparison of factory and field welded thermal seams was made possible by the John R. Doutt Upground Reservoir (JRD-UGR) project, which is a 27.6 billion liter off-stream water reservoir that covers a plan area of 314 hectares. The JRD-UGR is located near Columbus, Ohio and was constructed between 2011 and 2013. Factory prefabrication allowed 2.6 hectares of the bottom geosynthetic liner system to be completed per day. This required nine (9) prefabricated panels to be deployed and seamed per day. The use of factory prefabricated panels provided a significant cost savings due to reduced field time, non-unionized workers used in the factory versus the field, and quicker seaming and testing in the factory.

Prior to the JRD-UGR, this area was primarily used for farming and is fairly flat. The reservoir was constructed by creating a zoned embankment around the reservoir with a height of about 10.7 m. The zoned embankment consists of low hydraulic conductivity fine-grained soils on the upstream side of the embankment (see Zone 1 Fill in **Figure 1**) and the embankment downstream of the centerline consists of both fine and coarse-grained soils, i.e., a higher hydraulic conductivity, (see Zone 2 Fill in **Figure 1**). The length of the zoned embankment is about 8.5 km (5 miles) and consists of about 3.5 million cubic meters (4.6 million cubic yards) of fill material.

Prior to this project, it was long presumed that factory welded seams were of higher quality, less variability, and higher predictability than field welded seams due to the controlled and consistent indoor conditions, little dirt and moisture in the seam, no wind or significant ambient

temperature changes in the factory, more rested technicians, and no changes in cloud cover. These consistent environmental conditions result in a larger and constant "welding window" (discussed below) than in the field. In terms of thermal seams, higher quality means factory welded seams exhibit higher and more consistent seam shear strengths than field welded seams and less variability. However, a large database of both factory and field welded seams has not been available for a project to prove this presumption because the objective of most projects is to minimize the amount of lower quality field seams that have to be created. As a result, typical projects have a lot of data on factory seam strengths and consistency but a minimal database on field welded seams.

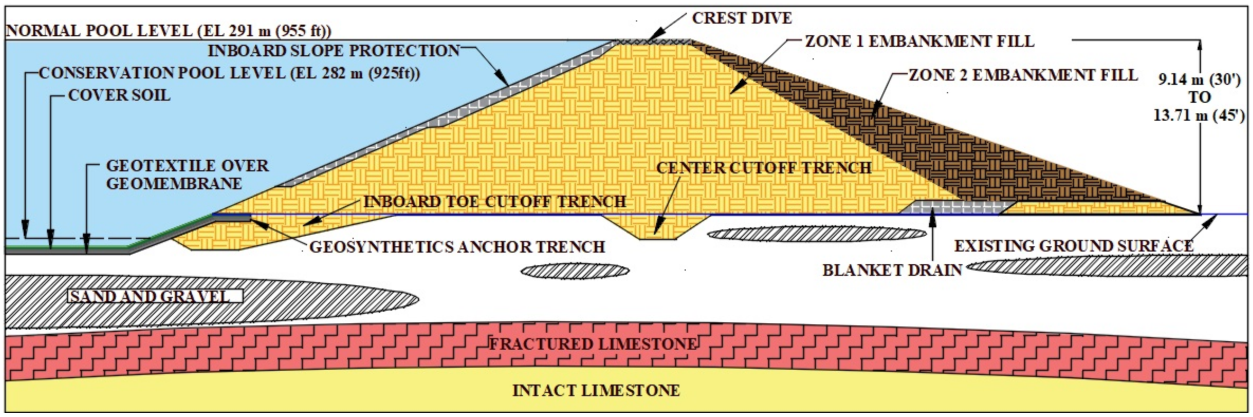

Figure 1. Typical embankment section showing subsurface conditions and geosynthetic liner system and anchor trench.

This is due to projects that utilize factory fabricated geomembranes reduce the amount of field seams by as much as 80% over a geomembrane that is completely field fabricated. In other words, geomembranes that are factory fabricated can have up to 85% of their seams welded in the factory and as little as 15% welded in the field. Therefore, it is difficult to develop a meaningful database of both factory and field welded seams for a particular project. This dilemma was finally resolved with the JRD-UGR because it is the largest geomembrane lined project in the world and thus has a sufficient number of field seams to make a meaningful comparison even though only about 78% of the geomembrane seaming occurred in the factory.

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SUMMARY

The data analysis performed on test results from factory and field welded seams from the JRD-UGR project yielded the following observations:

- The use of fabricated panels allowed the lengthy project schedule to be compressed.

- The average peel strength at yield of factory thermally welded seams is about 8.8% and 6.2% greater than the peel strength of the two field seam datasets, i.e., Field Peel A and Field Peel B, respectively. The average factory seam shear strength at yield is 9.3% greater than the shear strength of the field seams.
- More importantly, 24.5% of the field seams failed the initial seam shear strength requirement, which caused additional testing, repairs, costs, and construction time. In contrast, zero (0) percent of the factory seams failed the initial seam shear strength requirement.
- Analysis of the factory welded seam shear and peel strength data shows that for a given seam sample these strengths are more consistent and higher due to a lower standard deviation than the field seam data. Conversely, the field seam shear and peel test data show higher standard deviations, which is attributed to the variable field conditions, e.g., temperature, cloud cover, wind, direct, moisture, etc., compared to the clean and consistent conditions in a factory.