Lining a Highly Irregular Vertical Wall with Polyurea/Conductive Geotextile Geomembrane

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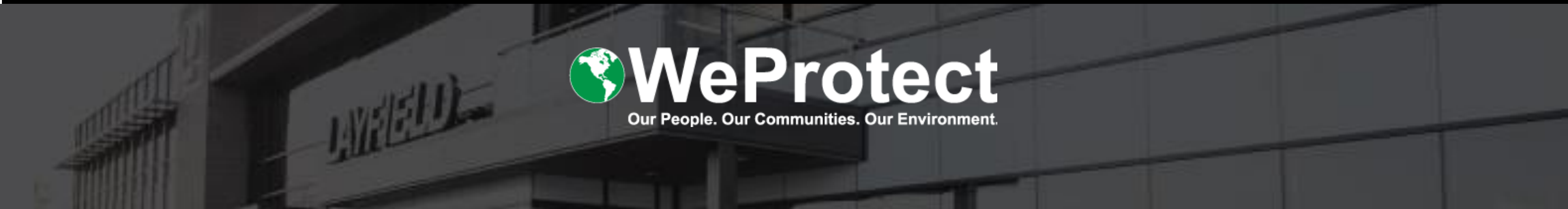
ABSTRACT

Vertical walls for a fire water containment pond were cut into bedrock and covered with shotcrete. The shotcrete was anchored into the bedrock at roughly 1m intervals. This created a highly uneven surface both on the macro level (with large bulges in the shotcrete at the anchor points), and at the micro level (with smaller dimples in the surface. A conductive geotextile was hung down the vertical walls, and anchored in place with mechanical connections. A spray applied fast set polyurea was applied over the geotextile to create a composite liner. Once filled the pond was over 9 m deep and the water pressure forced the liner to completely conform to the convoluted shape of the wall. The polyurea/geotextile composite liner was able to stretch over and into both the large scale and small scale irregularities in the subgrade. The conductive geotextile allowed spark testing of the composite liner before the pond was filled and after initial filling when the pond was drained. Spark testing was able to demonstrate that the composite liner provided an effective water barrier in this application.

INTRODUCTION

Lining a highly irregular subgrade presents challenges to the containment designer both from a standpoint of conforming to the substrate under pressure, and anchoring effectively to the substrate to avoid large scale movement of the liner during the construction and service phases of the ponds life. Often a floating liner design is chosen, consisting of a geotextile backing and spray applied polyurea lining system. The advantages of a floating liner design include the ease of anchoring the system to the substrate in a water tight fashion. The geotextile alone can be mechanically attached to the substrate at regular intervals, and then the geotextile and anchors are sealed with the application of polyurea. A pre-sprayed composite of polyurea and geotextile can also be mechanically attached to the substrate, with additional polyurea added to cover the anchor points and make them water tight. Fast set aromatic based polyureas are available that posses great toughness and elongation capabilities on their own. The elastic capabilities of polyurea (the ability to elongate without "yielding" or being damaged) are reduced somewhat when a composite of polyurea on geotextile is made. It is important when designing a polyurea floating liner to test the physical capabilities of the particular polyurea/geotextile combination to be used.



CONSTRUCTION

Figure 1. The Finished Floating Liner

The design uses a floating polyurea geomembrane (the finished liner is shown in Figure 1), attached to an irregular and uneven shotcrete wall. This style of liner involves mechanically attaching the geotextile to the wall at individual points and spraying over the textile and attachment hardware with polyurea. The use of a floating polyurea geomembrane to seal uneven, irregular concrete is routinely done in industry (Leonard, 2014).

The conductive geotextile consists of a conductive layer which is needle-punched into a nonwoven geotextile. This provides a conductive surface to facilitate spark testing, and a nonwoven geotextile surface (the white surface visible in Figures 2 and 3). Nonwoven geotextile is routinely used to create composite liners with polyurea, as it has a 3 dimensional felt like structure which absorbs a small amount of a fast set polyurea creating a true composite system.

The geotextile was hung vertically on the walls prior to coating, and was mechanically tacked in place using 1.5” nail attachments. An additional layer of black nonwoven geotextile was hung between the shotcrete and the conductive geotextile primarily to protect the composite liner from the rough subgrade. The vertical walls are made of porous and uneven shotcrete put in place on bedrock. A drain system exists between the shotcrete and the bedrock.

INSTALLATION OF THE POLYUREA

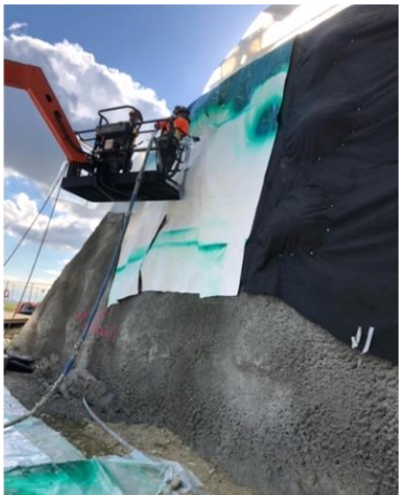


Figure 2. Applying Polyurea to the Conductive Geotextile

Figure 3. Conforming the Geotextile into A Corner

The geotextile was deployed and attached to the wall in sections. An effort was made to coat the geotextile with polyurea in a timely fashion, and not leave it exposed to the elements. As each section of polyurea was applied, a spark test was done to detect any voids in the polyurea. Polyurea has a recoat window, typically 24 hours in length. Fresh polyurea can be applied to polyurea that is within its recoat window and it will adhere quite well without any additional surface preparation. The application of the polyurea involved seaming the sections of conductive geotextile together as they hung vertically on the wall. An effort was made to install the polyurea in a continuous fashion, ensuring each section was joined to the previous one within the recoat window. This was not always possible due to weather interruptions. When sections needed to be joined outside of the recoat window a surface preparation method of abrasion and priming was used for the aged polyurea.

The finished floating liner faced several challenges upon filling the pond. The anchoring of the conductive geotextile to the subgrade created stress concentrations around the anchor points. The areas between the anchor points involved bridging and spanning between the large bulges in the shotcrete. The composite liner would have to stretch over these large scale bulges and stress concentration points and conform tightly to the subgrade under the head pressure of the filled pond. On a small scale the subgrade was deeply dimpled and rough, under the head pressure of 9 m of water the composite liner would have to stretch and conform on a small scale to these dimples. The pond was filled and drained within the span of 30 days, and visual inspection of the composite liner after the filling/emptying cycle confirmed the composite liner selected for the walls of this project was able to substantially meet these challenges. A second round of spark testing after the pond was emptied did show some thinning and possible pinholes had developed around some of the anchor points, and these areas were touched up with additional polyurea.

CONCLUSION

A floating liner design, consisting of a polyurea/geotextile combination, which is mechanically attached at regular intervals over the subgrade is a strong design option when faced with an irregular or damaged subgrade. In this case a highly irregular and challenging vertical subgrade was lined with a floating polyurea/geotextile liner in such a way that allowed the installation to be spark tested to detect any flaws in the completed system.

REFERENCES

Leonard, K. (2014) Polyurea "Loose" Liners: A Floating fix for Cracked Concrete Secondary Containment, Journal of Protective Coatings & Linings (February).
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