

Flexible Alternative for Irrigation Canal Linings



Geoweb sections with a tendon anchoring system and concrete infill protect the impervious channel liner.

Owners and engineers are often challenged with determining the most cost effective and longest lasting

channel liner system for water conveyance. In Colorado, numerous channel liner systems have been installed over the years

with limited success. The most common are clay or shotcrete lined channels because of their low installed cost. Due to the se-



Concrete is pumped into the Geoweb system with a telescoping boom truck.

vere weather and fluctuating temperatures, however, many of these channels deteriorate due to cracking which eventually leads to leakage of water and increased channel maintenance.

USBOR Channel Study

To evaluate the performance of different channel lining systems, the US Bureau of Reclamation (USBOR) conducted a 10-year study, “R-02-03, Canal-Lining

Demonstration Project Year 10 Final Report”. The report evaluated the four most common type of channel lining systems being installed in 4 Western states including: fluid applied membrane, concrete, exposed geomembrane and geomembrane covered with concrete. The report objective was to determine the most effective channel lining system based on installed costs, water retention, durability and long term performance. The study showed that geomembranes with a concrete cover provided the best, long term performance. The installed cost of the geomembrane covered with concrete was slightly higher than the other options but this cost difference was outweighed by the concrete lined channels ability to prevent leakage and limit maintenance. A breakdown of the construction costs associated with various types of canal lining options ranged from \$1.40/ft² for fluid applied to \$2.54/ft² for concrete covered geomembrane. This information along with estimated durability and yearly maintenance costs were factored in to create a cost to benefit ratio. The 40 - 60 year estimated durability, low annual maintenance and reduced seepage costs gave the concrete covered geomembrane the highest



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benefit to cost ratio of 3.5- 3.7 which was substantially higher than the ratio of alternate lining options. The subgrades in the various test sections ranged from rocky to silty loam type soils.

Construction and Maintenance Advantages

Joe Kaul, Kaul Corporation and Presto Geosystems' Western states representative introduced the USBOR to an effective geomembrane cover solution utilizing a concrete filled Geoweb® cellular confinement system. Cellular confinement provides many benefits from construction and long term maintenance standpoints. During construction, the cellular structure retains the concrete and prevents it from migrating down to the bottom of the channel. Joe Kaul stated the USBOR showed several channels where unconfined concrete-lined channels were two to three times thicker at the channel base as compared to the crest which led to weak spots



The 3D cellular structure holds concrete on the 1.5H:1V embankments.

and poor long term performance. The network of cells in the cellular confinement system provides a method to maintain a consistent depth of concrete across the channel bed slope and side walls. Additional construction benefits include the ability to use a thinner, "poured-in-place" cross section of concrete (3 inch vs. 6 inch), and an easier to install, lower slump concrete due to the network of HDPE reinforcement strips that outline each cell.

The cellular network is beneficial to long term maintenance because the system flexes, allowing the concrete to crack in a controlled manner along the cell walls, much like a contraction joint. The cell walls are perforated and textured which provides reinforcement and prevents the concrete from "popping out" as the USBOR experienced in concrete channels not lined with the geocell structure.

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Water Conservation is Key

Arid climates provide challenges in canal lining to maximize water availability. USBOR has accepted concrete lined channels utilizing cellular confinement as a preferred system as it provides the best cost benefit ratio for conserving water, and reducing seepage and long term maintenance. Presto Geosystems worked with the USBOR to provide a channel design to optimize functionality and installed costs for Florida Farmers Ditch, an open water irrigation canal near Durango, CO. The canal was exposed to multiple freeze thaw cycles each winter as is typical for this part of the country. These conditions tend to be the most destructive for concrete lined channels as the concrete is fully hydrated during the summer months and then it is put through multiple freeze thaw cycles in the winter months when the canal section empty.

The channel base was fine graded to allow installation of a 30 mil PVC liner on top of a non-woven geotextile separation layer to prevent damage to the liner during construction. A 3-inch deep cell was utilized and the system was anchored with 3 polyester tendons running through

each panel. The tendons were tied off to a 3-inch PVC deadman pipe which was placed in the liner anchor trench. Polymer clips were tied to each tendon per the design to transfer the load from the panel to the tendon. The cells were filled with a low strength 2500 psi concrete which was pumped into the cells from a concrete truck. After concrete was placed, it was screed flush with the cell walls and a curing agent applied to the finished areas.

With the newly lined section, seepage is greatly reduced, erosion of the side slopes is virtually eliminated and the amount of annual maintenance required is reduced drastically. Costs for this type of system depend on the amount and extent of earthwork to be done prior to geotextile and liner installation. Remote locations and project area also greatly affect the installed costs.

Proven Performance

The concrete filled cellular confinement system has emerged as the best long term canal lining approach based on the recent performance of these installations. USBOR has installed over 300,000 feet of geocell lined concrete channels over the past 5 years with Jackson Gulch the first

project completed in 2011 consisting of over 1600 lineal feet.

Kevin Moran, USBOR engineer stated, "The Florida Farmers Ditch and similar projects including Jackson Gulch and Orchard Mesa concrete filled geocell irrigation channels have all held up well and have come thru the winter months with no problems whatsoever".

With water becoming scarcer in the Western US and population increases putting more demands on this valuable resource, the concrete filled geocell liner channel protection system provides irrigation companies, municipalities and water conservation districts a long term solution to meet challenging conditions. **L&W**

by Bryan Wedin, P.E., Presto Geosystems & Joe Kaul, Kaul Corporation

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