Geocell Shoreline Cover Supports Aquatic Plantings Over Impervious Liner

The fully stabilized and vegetated shoreline hosts a variety of aquatic plantings.

by Lee Bull, Greg Kramer and Patricia Stelter

Liner Creates Slippery Slope

OWNERS of a residential property in a rural, wooded area of Westmoreland County in Western Pennsylvania experienced more challenges than they expected during construction of a man-made pond at their property. The pond was built as a water feature to enhance the natural setting of this 100-acre property.

Problem 1: After the 0.7 acre pond was constructed and filled with water, unexpected soil permeability resulted in leakage which prevented the pond from being filled completely. The owners' site engineer recommended that an impervious liner be placed completely over the bottom and side slopes to prevent water leakage. Taking that advice, the pond was subsequently drained, lined with a 40-mil PVC liner and refilled with water.

Problem 2: Now realizing that the lined embankment prevented the planting of desired water lilies and other aquatic plantings, the owner sought the help of Lee Bull, Sr. Landscape Architect, Pennoni Associates, of Pittsburgh for a solution.

"The owner called me and said, 'the pond is full of water, but how are we going to plant over the liner?' I considered some type of structural planting boxes supported from the top of the slope that would drape down and hold the select plantings. The problem with this idea was that there was not a good way to anchor them, they would be cumbersome and could also puncture the liner and cause additional leaks. We were literally scratching our heads trying to find an option that made sense," says Bull.

Problem 3: Because the pond was an attraction for the local deer and wildlife population, the liner would need to be protected from damage caused by their contact.

The unprotected liner already showed signs of damage from deer tracking across the surface of it to access water from the pond. Algae build up on the liner further compounded the problem by creating a slippery surface, causing deer

to slip into the pond and damage the liner as they struggled to get back out.

In addition to wanting vegetation and water plantings, the shoreline's visual appeal had deteriorated to the point where remediation was deemed necessary by the owner. The geomembrane would need to be repaired or replaced and covered to protect it from future damage.

Remediation Considerations

Covering the geomembrane with topsoil and vegetation was a possible solution that would create the natural environment the owner was looking for, but the problem remained how to keep soil stable on a slick liner on the 1.65H:1V side slopes?

Bull continued to search for a solution when he noticed information on the Presto-Alcoa Geoweb® (geocell) cellular confinement system in his office.

"In looking at the type of problems that were solved by the cellular confinement system, I thought this just might work for this shoreline challenge. I thought the perforations in the cell walls would create stability by allowing the plantings to lock up between cells," says Bull. This would be key to minimizing any vegetation/soil loss associated with water contact and expected wave action.

Geoweb sections are secured over the geotextile and geomembrane layers with tendons tied to a deadman anchor.

Lee met with geosynthetic supplier, Greg Kramer, ACF Environmental, to discuss this idea.

Manufactured from polyethylene, three-dimensional geocell systems have a long history of providing protection for geomembranes in many applications including shorelines, diversion channels,

lagoons, detention ponds, storm water and waste water containment basins, and landfill covers. A variety of infill materials can be used to provide armor protection to impervious liners or covers so they maintain their integrity.

These systems confine selected infill material to resist anticipated hydraulic flows, reduce erosion and minimize the downward movement of embankment materials by functioning as stabilized containers in the upper soil layer. On vegetated slopes, the system increases erosion resistance by encapsulating and interlocking with the vegetation.

Topsoil within the geocell sections creates a planting medium for the desired water plants.

"The Geoweb® shoreline protection system was ultimately chosen to create a protective cover over the liner, allow natural pond plantings and prevent further damage by wildlife. This solution would meet all of the requirements of the project," explains Kramer.

"An added benefit of the geocell-stabilized shoreline is improving overall water quality by reducing the amount of suspended solids," states Kramer.

Preventing soil erosion and solids from entering the water may enhance the aquatic habitat and provide a cleaner and healthier aquatic ecosystem.

"Because this pond would be subjected to six inch to one foot waves, the protection system had to have sufficient mass to withstand negative pressures from wave action as well as maintain stability in the near surface soil of the earthen slopes," adds Bull.

Constructing the Cover

Graham Incorporated, of Ligonier, PA, the mason contractor onsite placing sand stone on a barn veneer, was called to handle the remediation. Although not experienced with installing geosynthetics, they were able to follow the architect's and manufacturer's recommendations for installation of all the required components.

The first step in remediation of the shoreline was to repair the damaged geomembrane. The pond was again drained down about 10 feet to allow full access to the liner. A two foot trench was dug around the perimeter to place a PVC dead man crest anchor system to constrain the tendoned geocell system. Tendons threaded through the geocell sections would be secured to the dead man anchor, allowing the sections to be securely suspended over the liner without the use of typical array of stake anchors which would puncture the liner.

"The plan was to lay the sections on the embankment so that the bottom six feet of the geocell material would ultimately be under water. The six inch deep sections would allow a good depth-of-soil to support the water plantings," says Lee.

A 6 oz. non-woven geotextile was placed over the geomembrane between the liner and the geocell sections to act as a cushioning layer preventing potential abrasion to the liner.

The large cell geocell material (18.7 in x 20 in expanded cell size), 6 inches in depth was the appropriate cell type and depth for this application. To meet the required slope length, expedite construction on site and minimize any need for cutting during site assembly, two different geocell section lengths were provided.

To hold the sections open on the embankment prior to infilling with topsoil, wooden stretcher frames were used. Working from the downslope end up to the top of the slope, tendons and bricks were threaded through select rows of cells.

"We used tendons and red bricks left over from the barn work at predetermined intervals to help weigh down the geocell material. This would prevent the material from floating if the cells underwater were to experience any soil loss," explains Kramer.

At the crest of the embankment, the tendons were tied to the dead man anchor. To accommodate the pond's continuous radius, two to three sections were placed in one direction and two to three sections in the other direction leaving an occasional small wedge-shaped gap in between. The gap was filled in with a cut section to fit the irregular shape.

After adjacent sections were stapled side to side, topsoil was dumped from a

bobcat to cover the anchor trench and to infill the geocell sections. Topsoil was then raked flush to the top of the cells.

Sod was placed over the bank in the areas that had been excavated and refilled. A variety of water plantings, including white and colored water lily, yellow and blue water iris, pickerel rush, sago pond weed and wild celery were added around the perimeter at select locations. Finally, with remediation completed, the pond was refilled to its normal level.

Completed Water Feature

The use of impervious liners on the slopes of ponds and storm water basins has increased significantly over the years. But because geomembrane materials have low frictional properties, stability problems exist for unconfined soil cover. The geocell system with tendoned anchoring has proven to be an ideal solution to this problem, offering sustainable, long term performance.

While the owner may not be able to prevent wildlife from returning to the pond, the stabilized, vegetative cover now protects the geomembrane from puncture and any negative effects associated with those close encounters.

The owner was pleased with the resulting water garden achieved by combining man-made geosynthetics with natural vegetation and aquatic plantings. A second, larger pond was constructed at this property the same way with excellent results.

Kramer has made yearly visits to the site to observe the establishment of vegetation. "It's been great to watch it mature. Each year the vegetation gets fuller and lusher."

Bull seconds that sentiment. "When the owner told me he just wanted normal pond vegetation, my first reaction was that it would be impossible with the liner. Our solution worked out well, it looks great and most importantly, we satisfied the owner." **L&W**

For more information contact Patricia Stelter, Presto Products Company, Patricia.Stelter@alcoa.com.