Composite protection for slopes

Geocells, geotextiles and geomembranes resolve the chronic erosion problems of a municipal levee.

In 1996, consulting engineers under contract to the City of Dallas contacted Soil Stabilization Products Company Inc. (SSPCo) to discuss solutions for chronic problems caused by more than a dozen sliding failures per year on the outer slopes of a water treatment facility's lagoon. The facility, administered by Dallas Water Utilities, consisted of a series of water retention lagoons enclosed within a perimeter levee. The lagoons were constructed with flexible membrane containment liners. The tops of the levees were capped with a paved access road.

Site conditions

A geotechnical engineering firm was retained to evaluate the problem soils and develop alternate means of resolving the sliding issues. Several approaches were considered as possible solutions. The exterior slopes, which had been constructed at a gradient of 3H: IV, were composed of highly expansive clay soils with PI (plasticity index) ranging from 21 to 75.

Because of the expansive nature of the levee embankment soils, the slope surfaces suffered from severe shrinkage cracking during the dry summer months. Water entered these cracks during the rainy season and found pathways into the deeper soil layers, creating instability in the slope structure.

Based on the findings of the geotechnical engineers, it was agreed that sliding failures triggered by saturation of the deeper soil layers had to be stopped. With the levee embankment already partially encapsulated by the lagoon liner on the inside slope and the surface treatment on top, it was decided to further encase the levee by placing a liner system and surface erosion control on the outer slope. The liner system, which consisted of a 40-mil textured HDPE lining and a 28 oz. nonwoven geotextile, would help maintain even moisture distribution within the levee embankment soils and protect the structure from the major changes in moisture content that were driving the volume change and cracking of the expansive clay soils. The installation would also use an erosion resistant slope cover to protect the liner. The Geoweb® cellular confinement system was specified with crushed granite gravel infill for the final slope cover.

Photo 1. Prior to the installation of geosynthetics, the levee was plagued by erosion.

Installation

The slopes were stripped of vegetative cover and graded in preparation for the new slope protection system. An upper anchor trench was excavated along the outside perimeter of the access road at the top of the slope to anchor the various geosynthetic products that formed the liner system and final slope cover. The waterproof layer of textured HDPE lining was installed over the prepared subgrade followed by a 28-ounce nonwoven geotextile protection fabric. With the composite liner system in place and tested, installation of the geocell layer began.

A deadman anchor system–4 in. schedule 40 PVC pipe–was installed in the trench at the top of the slope and then the perforated geocell system sections were placed. Heavy-duty TP-91 tendons were run through the pre-drilled 4 in. cells and secured by wrapping and tying to the deadman anchor. The use of ATRA® restraint clips spread the working load of the gravel infill from the geocells to the tendons.

The large cell size enabled Colorado Lining International's installation team to work efficiently on the 3:1 slope face-running tendons, expanding, orienting and then securing the sections.

The final step involved filling the cells with crushed stone material to provide

a final cover for the protected slope. The aggregate contractor, AAA Sand & Stone Inc., designed a conveyor system to efficiently deliver materials to the slope. Upon delivery, a labor crew using long handled rakes spread the materials evenly in the cells. In all, 1,500,000 ft.² of geosynthetic products were installed, tested and back- filled on this project. The installation began in late August 2002 and was completed in early November.

Conclusions

The geocellular system was well suited to this application as it restrained the sliding forces of the stone without requiring staking through the liner system. The perforated cells also enabled heavy water flows accumulating above the liner to quickly move down the covered slope without loss of the stone infill. This composite slope protection installation gave the owner a long-term, low maintenance solution for a difficult problem.

Combining various geosynthetics to create composite systems can provide cost effective solutions for complex erosion control and containment problems faced by civil and environmental engineers. **GFR**

Erika Pryor is a marketing manager for Soil Stabilization Products Co.

John Heap is president and owner of Colorado Lining International.

Photo 2. Installation of the geocellular system over geotextile and geomembrane.

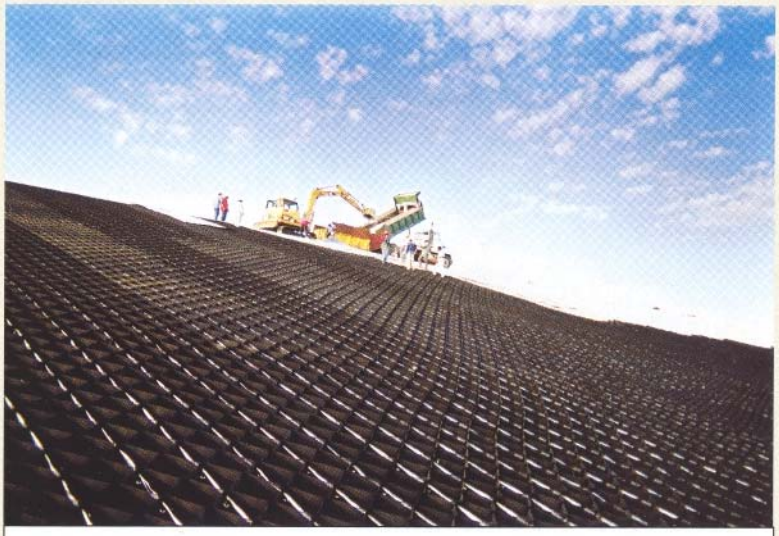

Photo 3. The slope during its final stage: aggregate is unloaded and raked into the cells.

Project information

Design: Camp Dresser McKee

General contractor:
Archer Western Contractors

Aggregate subcontractor:
AAA Nursery Sand & Stone Inc.

Installation subcontractor:
Colorado Lining International

Technical consultants:
Soil Stabilization Products Company Inc.

Geotextile: 28 oz. nonwoven from Synthetic Industries

Geomembrane: 40 mil textured HDPE from Agru America

Geocellular system: Geoweb® from Presto Products Company