SUSTAINABLE

Geocellular confinement systems stabilize soil, promote plant growth

By Bryan Wedin, P.E., & Patricia Stelter

Engineers and consultants often are challenged with resolving difficult soil stabilization problems using sustainable and vegetated solutions. Confining infill material in a geocellular system is a proven method that provides long-term, sustainable soil stabilization on mild-steep embankments, on vegetated retaining walls and in channels exposed to mild-high velocities.

The 3-D geocellular structure solves slope-surface stability problems by confining infill in the system's interconnected cells, stabilizing the upper soil layer. This stabilized system creates an environment that supports vegetation on surfaces that otherwise could not.

Case Study 1: Pulp Mill Geomembrane Cover

Bahia is the fourth most populous Brazilian state, located in the northeastern part of the country. The rainy season is typically from April to September.

After a heavy rainfall, an unconfined soil cover on a 3H:1V residue waste slope with heights of 66 ft to 115 ft failed at the geotextile-geomembrane interface. Large volumes of soil slid down the slope and tore the geotextile in some areas, exposing the geomembrane.

A relatively low interface friction angle between the geotextile and the textured geomembrane increased load from the saturated soil. Seepage forces due to water flow within the soil cover layer were contributing factors to the slope cover failure. Urgent repair was needed to prevent damage to the geomembrane. The Geoweb geocellular slope cover system best addressed all critical details and would provide a self-sustaining vegetated cover and functional long-term life.

The new cover consisted of a 3-in.-deep sand-filled geocell drainage layer installed directly over the textured geomembrane. Topsoil was placed over the geocell to allow the growth of desired vegetation. This geocellular solution offered a significant cost benefit, an overall low environmental impact and a more stable cover solution.

Heavy rain exposed the geomembrane on a Brazilian residue waste slope.

Sustainable Vegetation Over Geomembranes

For more challenging applications over impervious geomembranes, a geocellular system with integral tendons creates a suspended protective cover that prevents sliding, accidental puncturing and natural degradation of the liner.

Soil and aggregate protective covers can be used with slopes of 3H:1V or less. Unconfined soil and aggregate covers on slopes greater than 3H:1V typically are considered unstable. The geocellular system can be applied effectively over geomembranes on 1H:1V slopes, allowing slopes to be built steeper, reducing land requirements and cost.

Sustainable Vegetation in High-Velocity Channels

Geocellular systems are also effective for stabilizing intermittent-flow ditches and channels. The growing desire to eliminate hard surfaces (e.g., riprap and concrete) with vegetated surfaces creates protection challenges.

Protecting vegetated channels exposed to low- to moderate-velocity flows and associated shear stresses includes erosion control blankets (ECBs) and turf reinforcement mats (TRMs). ECBs are designed to resist low flows of approximately 5 to

6 ft/second, and TRMs are designed to resist moderate and longer-term flows up to 20 ft/second. Both solutions have limited effectiveness with higher velocities and longer-term flows when underlying soils become saturated.

When exposed to concentrated sheet flow, over-extension of these erosion materials can result in mild to significant surface erosion, rill/gully formation, undermining and removal of the upper soil layer and vegetative root loss. In severe cases, soil saturation and weakening of the subsoils may result in critical sloughing of the soil layer and even failure.

Case Study 2: Roadside Storm Water Ditch Remediation

A geocellular/TRM system was chosen to repair a severely eroded roadside storm water ditch in Florence, Ala. The system offered a vegetated subsurface and surface protection solution able to resist flows up to 30 ft/second—far greater than the resistance of the products working alone.

Erosion of the original unprotected ditch was caused by runoff from a 630-ft embankment drop-off on Highway 157 north of Florence. The Alabama Department of Transportation installed a TRM in areas with milder flows and the geocellular/TRM system in areas where the velocities were deemed to exceed the TRMs' effectiveness.

Compared to riprap, the geocellular/TRM solution is more economical. Grassed greenways also offer a higher aesthetic appeal than rock channels. The components are transported easily to difficult or remote locations where riprap is expensive or difficult to source, and they are easy to install. Simple mowing and turf maintenance reduce maintenance requirements. For landscape planning, the system is less obtrusive and can be incorporated as a "soft" solution for grassed conveyances with the same capabilities of hard-armored systems.

An Alabama roadside storm water ditch before (top) and after (bottom) TRM/geocellular systems.

Solution Summary

Geocellular systems are an environmentally friendly and economical solution in challenging soil stability environments where sustainable vegetation is desired. Because of variability of slope angle, shear stresses, flow velocity, duration and infill type, care should be exercised to ensure all parameters are considered in the planning and design process. SWS

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