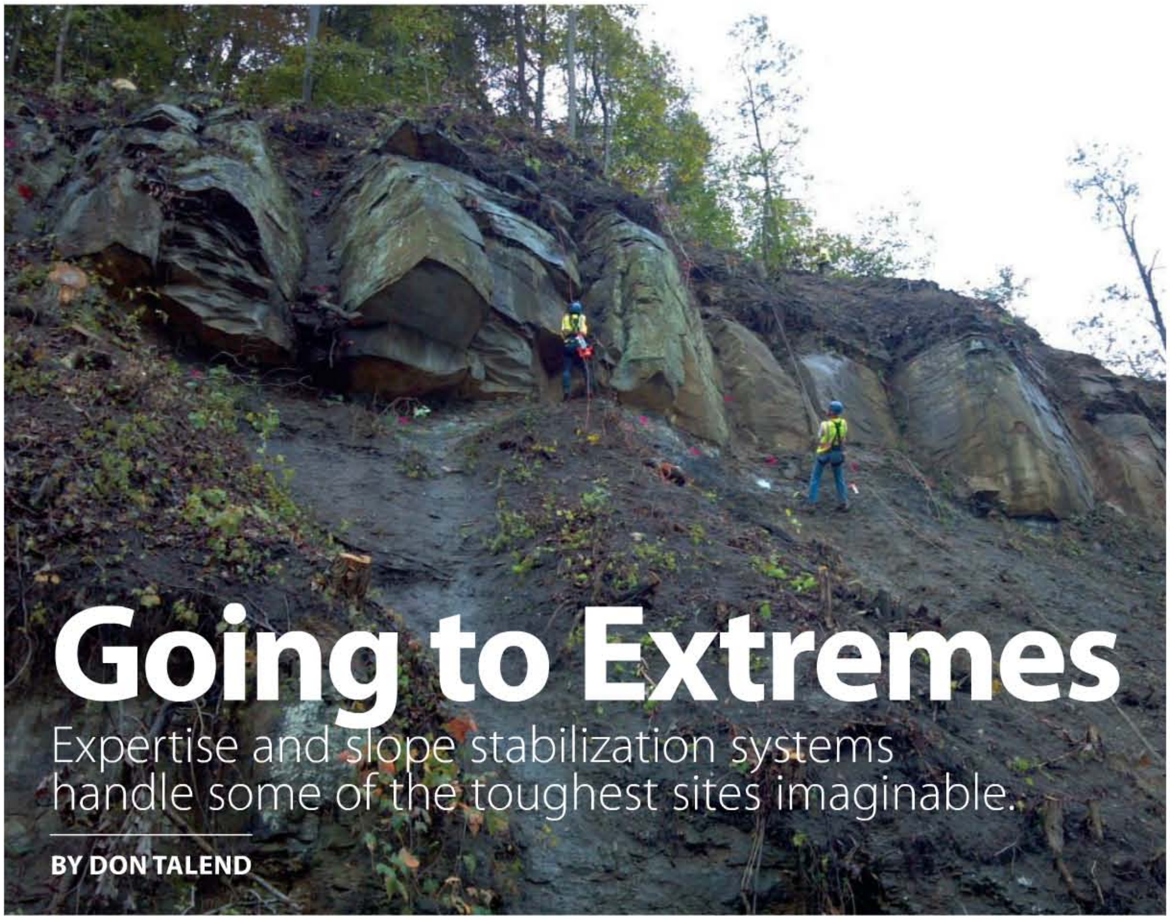


AMERITECH SLOPE CONSTRUCTORS

Going to Extremes

Expertise and slope stabilization systems handle some of the toughest sites imaginable.

BY DON TALEND

Slope stabilization work becomes particularly urgent when an unstable hillside dislodges rocks at heights of several stories and potentially cause injuries or property damage. That was the case in September 2011 in Weston, WV, when general contractor Orders Construction of Charleston, WV, was awarded a contract to eliminate the potential for large sandstone blocks to fall from a slope rising nearly 10 stories above a roughly 1,000-foot-long stretch of State Route 19 that runs along the West Fork River. The slopes are steeper than 1:1—roughly 60 to 65 degrees.

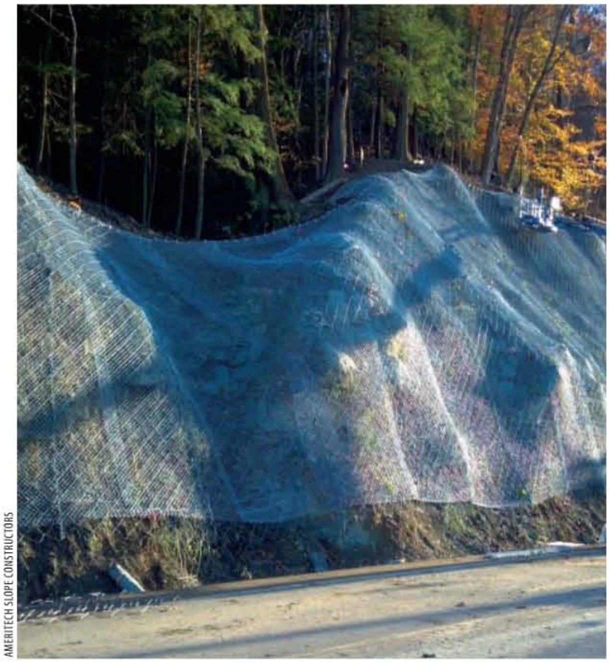
It's one example of how engineers and contractors are addressing extreme situations requiring serious slope stabilization. Available slope stabilization solutions are aiding their rigorous planning and execution when tackling these situations.

The stretch of Route 19 in West Virginia that needed improvements goes through Weston—the Lewis County seat—and carries an appreciable volume of traffic. Orders Construction hired Ameritech Slope Constructors of Asheville, NC, to install Geobrugg Spider spiral net to contain the sandstone blocks and Geobrugg rolled cable nets as a drape to control slides of shale and limestone. According to Roger Moore, P.G., P.E., project engineer and principal with Ameritech, clearing of brush and trees on the slopes revealed differential weathering of shale and coal layers beneath massive sandstone beds, causing cantilevering of the sandstone beds. Weathering of these softer rocks undermined them, exposing the slopes and occasionally causing large sandstone pieces to break off and roll downhill. The weathering was a long-term concern because the area receives about 45 to 50 inches of precipitation annually.

To address the situation, the West Virginia Department of Transportation put out a bid request for an emergency rockfall protection contract. "West Virginia DOT had a schematic design in mind as to what they wanted," Moore says. Once the slope was cleared of brush and trees, the geotechnical engineer, Bill Kane of Kane GeoTech in Stockton, CA, designed a rockfall protection system that included the Geobrugg Spider spiral net and submitted the design to WV-DOT. Although WV-DOT did not specify a particular product or manufacturer, it had an idea of how it wanted the rockfall protection solution to be designed.

At first, Moore recalls, it was assumed that a mesh "draping" method would be sufficient to stabilize the blocks on the slope. But once the site was physically inspected, it was determined that merely installing a large drape would not be enough, given the block sizes. "After looking at sandstone blocks that are 10 or 12 feet in each dimension, there were concerns about public safety as far as material coming down, even under a drape," Moore says. "They're very large sandstone blocks, and a drape doesn't really work very well in that situation. In fact, they would just take the drape down. The blocks needed to be anchored to keep them from moving."

Kane GeoTech was familiar with the Geobrugg steel Spider spiral rope net and designed the solution based on the use of Spider S4-230 mesh. The solution consists of high-tensile 4-millimeter steel wire strand, a fine secondary mesh, nails and anchors, spike plates as standard anchorage, border and temporary ropes, and net connection elements that cover large areas. Isolated unstable blocks are wrapped with the spiral net and anchored all around with boundary ropes. The solution is designed to secure loose blocks, rock spurs and overhangs, and unstable rock formations with a very irregular surface structure and coarse block weathering, and it was well suited to the Weston slopes.



AMERITECH SLOPE CONSTRUCTORS

For the drape, cable anchors were installed at the top of the slope and grouted into place.

Route 19 was closed along the stretch where the work was done, and traffic was detoured. On the $1.5 million Weston project, holes were drilled into the large block outcroppings, threaded bars were inserted into the holes and grouted into place, Spider wire was placed over the bar anchors and tensioned using the spike plates, and cables were stretched and tensioned along the Spider wire boundaries. For the drape, cable anchors were installed at the top of the slope and grouted into place. The backing mesh and rolled cable nets were installed in panels and clipped together at each edge. A top boundary cable helps support the load between the cable anchors. Because determining the depth of the large jointed sandstone blocks was difficult, WV-DOT specified that the thread bars be drilled into the sandstone to a depth of 25 feet.

"One of the reasons we like to use that solution is that it is very user friendly, fairly easy to install, and fairly rapidly installed," Moore says. "The way it's designed, it's flexible—the material can be moved and shifted on the slope, and even after it's installed, you can move it. The connections are pretty easy to make with whatever anchoring systems you use. The spike plates install easily. It's easy for a crew to get it installed quickly, and that's always the biggest part of a job: how much labor time you need to get something installed."

Moore recalls that, as on many of these types of projects, access was difficult. "Anytime you're working on a steep slope, access is always an issue, getting manpower and equipment to the location you want," he notes. Orders Construction provided a crawler crane and drill platform. Ameritech provided the drill to mount on the platform for drilling the holes in the block face from the crane. Still, the area had significant rainfall and workers had to use ropes rather than walking along the top of the slope to complete their work at the highest elevations because the surface was wet, Moore recalls.

The work was completed just before Thanksgiving 2011, and the stretch of highway is now much safer. The slopes even look a lot better since they were hydroseeded. Of course, the revegetation of the slope serves a functional purpose and promises to slow down the loosening of the sandstone boulders from the block face. But besides its functional purpose, the grass has filled in quickly and improved the appearance of the area alongside the river, according to Moore.

Moore is glad that a viable block face stabilization solution was available following a physical site inspection. "You've got to flow with what the findings are after doing further assessments on the site as far as the geology," he says.

Landslides Pose Major Site Challenges

A long-term landslide problem on the Palos Verde Peninsula, located due south of Los Angeles, demonstrates the power of Mother Nature. Basically, the entire peninsula is gradually eroding into the ocean thanks to a landslide that is left over from the Ice Age and that was reactivated by post-World War II development. A residential property located in Rolling Hills, CA, damaged by a landslide several years ago was recently remediated with mechanically stabilized earth (MSE) walls and geogrid to prevent future landslides.

Significant rainfall occurred on the peninsula back in 2005, notes Greg Silver, M.S.c., P.E., G.E., vice president and geotechnical engineer at GMU Geotechnical in Rancho Santa Margarita, CA. This served to exacerbate the existing erosion problem in the area and spelled big trouble for the property on Poppy Trail in Rolling Hills, which covers nearly 8 acres. Failure of the slope descending to the Poppy Trail property in March 2005 caused a large landslide that undermined the foundation of a guesthouse that had been converted from a barn. The debris from the landslide blocked Poppy Trail.

GMU Geotechnical investigated the site and determined

"A 2:1 slope wouldn't work under the normal grading code, so we had to use a combination of steeper-than-normal slopes and MSE walls to make up that difference between the building pad at the top and our constraints on the roadway down below."

that development in the early 1970s had included grading of the site to create building pads for the main residence, the tennis courts, the stable, and the barn. Apparently, the development included grading the slope descending to Poppy Trail to create a larger pad space and to construct the driveway for the residence.

According to Silver, a combination of factors likely caused the landslide that forced the evacuation and abandonment of the home. For one, spring 2005 was very wet. Also, a percolation sewage system was constructed on the property in the 1970s, keeping the soil unstable in one area. "All of the gray water and so on goes into a seepage pit, and one seepage pit was put in a very bad place; that added groundwater to the sloped surface," Silver says. "And, the rainfall broke the camel's back."

The site was partially remediated in two phases several years earlier. The initial phase included demolishing the guesthouse and layback of the failed slope to minimize continued movement and to create temporary access for the residents. The second phase included further grading of the failed slope and construction of a debris wall at the toe of the landslide. This work facilitated the construction of a paved roadway at the toe of the landslide to create paved vehicular access for the residents. These first two phases of remediation were not intended to repair the landslide, and no geotechnical analyses were included to show the slope demonstrated adequate stability safety factors.

Following the initial phases of remediation, the residence remained unoccupied when GMU Geotechnical made an assessment of the property for the California Joint Powers Insurance Authority (CJPIA), the city of Rolling Hills' insurance company. A building pad supporting the main house and guesthouse at the top of the slope had failed, causing significant damage to the guesthouse and resulting in its eventual demolition. Portions of the improvements, including the upper driveway and concrete site drainage, were removed. The slope remained in its "layback" condition and was covered with plastic, sandbags, and a landscape mesh fabric. Vegetation was overgrown around the residence, and the slopes were covered with weeds and brush.

GMU Geotechnical oversaw a final $5 million remediation of the site, starting in mid-2011. The repair included excavation of a keyway primarily within the Catalina Schist bedrock and removal of all failed material on the slope. In addition, the existing fill and colluvial soils were removed in areas where the slope was regraded. Silver says that, besides these measures, it became apparent that robust stabilization methods would be required between the abandoned house and the roadway.

"We were stuck with trying to make a finished slope after we did all of the remediation work below those two fixed points [new building pads at the top of the slope and the edge at the widened roadway at its toe]," he says. "A 2:1 slope wouldn't work under the normal grading code, so we had to use a combination of steeper-than-normal slopes and MSE walls to make up that difference between the building pad at the top and our constraints on the roadway down below. When developing the plan, we put MSE walls in where we could—that kept the slopes as flat as we could make them. We really tried to keep those slopes as flat as possible for performance reasons.

"We had a preliminary design with more MSE walls on it, but the cost came in too high," Silver continues. "We had to scale back the walls and steepen the slopes. The revised design involved more slope geogrid but cut down on the square footage of the walls and also the cost. Some slopes needed to be as steep as 1.5:1, and everything steeper than 2:1 we had to reinforce with geogrid. That's really where the geogrids came into place—where we had slopes steeper than 2:1." Three grades of Mirafi Miragrid—a high-molecular-weight, high-tenacity polyester multifilament yarns woven in tension and finished with a PVC coating—were used. Earth Construction & Mining of Garden Grove, CA, used Mirafi 5XT for the MSE walls, which were up to 9 feet tall. The contractor also used Mirafi 2XT for surficial stability and Mirafi 24XT for mobile stability. The higher the grade number, the greater the tensile strength per ASTM D 6637 and soil creep resistance per ASTM D 5262.

For the MSE walls, GMU Geotechnical selected the plantable Soil Retention Verdura retaining wall system. The system is designed with a positive mechanical connection between the block and the geosynthetic reinforcement using PVC pipe. The mechanical connection is engineered to provide a uniform distribution of tensional strength that does not rely solely on frictional forces generated from a stack height of the block units or point load from pins or clips. The units have a 14-degree batter from vertical and a unit weight at the face that is roughly equivalent to the weight of most soils—averaging about 120 pounds per cubic foot at the face. The front block is plantable, Silver adds.

"The look of the walls was important to the planning department—it would be a completely green wall,"

GMU GEOTECHNICAL

The slope is seen as it appeared following remediation and with the creation of a safer roadway at the bottom.

Silver says. "We liked the connection the Verdura product has; it's a nice, strong, positive connection. There was also the look of the block, the plantability of the block, and the batter. We just have a lot of experience with it and pushed it for a lot of reasons for this project."

The site was divided into two near-level graded lot areas, one 4.7 acres, the other 2.7 acres. Graded slopes of up to approximately 145 feet were constructed at inclinations as steep as 1.7:1. In total, eight MSE toe-of-slope and mid-slope walls were also constructed throughout the property. In addition, a bridle trail and two driveways were constructed to provide access to the two lots. Drainage at the site is now controlled by surface flow and improved surface and underground drainage devices. Septic systems were constructed in the corners of each lot area to minimize any future impact of these systems on the lots or adjacent slopes. The existing house and all associated structures and improvements were completely demolished and removed offsite. The landscaping plan included hydroseeding of the slopes.

Construction proved to be quite challenging, Silver recalls. "It was very, very tricky. Basically, the entire lot was regraded. The keyway had to be constructed in very narrow slots to prevent the landslide from undermining the keyway. The first half of the repair was a little nail-biting in that parts of the slide kept moving as excavation continued, and there was no room to put the dirt—there was limited space available. We had to take slope inclinometer readings on a daily to weekly basis up there."

By mid-2012, final remediation was complete, for the most part. The CJPIA is in the process of selling the lots.

Silver notes that the location of the project raises the stakes for slope stabilization. The original site development used woefully inadequate methods, he says. "You have to be very careful how you put seepage into the ground and think about how it affects local slope stability. Your grading techniques and construction have to be great. You have to make sure you're benching out all of the bad material and getting nice, solid material. There are lots of big, famous landslides in that area, so it's important to do everything quite right. This is a development that did a lot of things wrong. On top of that, they really didn't maintain their property that well, so drainage swales got clogged and you had water coming over the top of the slopes."

Holding Subgrade Under Bridge Approach Slabs

Maintaining some traffic flow during bridge rehabilitation can be a challenge. Greggo & Ferrara of New Castle, DE, a contractor specializing in bridge, tunnel, and elevated highway construction, has faced such a challenge since spring 2011, when it began rehabilitating the 2,000-foot-long Newport Viaduct, which crosses the Christina River. The structure, built in 1978, serves a vital link in the Delaware highway network.

Among work on the project is rehabilitation of cracked and deteriorated reinforced concrete abutments, piers, deck, and approach slabs. According to the Delaware Department of Transportation (DelDOT), the bridge needed immediate repair. For example, reinforced concrete abutments, piers, deck, approach slabs, and parapets exhibited various degrees of deterioration such as cracks, spalling, and delimitation.

The rehabilitation has been staged to ensure access throughout the project. As the contractor has kept a lane of traffic open in one direction on State Route 141 in the process of replacing concrete bridge approach slabs, the danger of soil displacement under the adjacent open traffic lane has been a real possibility.

For related articles:
www.erosioncontrol.com/slope-stabilization

Greggo & Ferrara, the general contractor on a project initially budgeted for $50 million, is replacing thick approach slabs on the subgrade on either side of the bridge one lane at a time and shoring the adjacent open lane with oak planking. The contractor has installed shoring between lanes and stabilized the soil underneath the open traffic lanes using a temporary but stay-in-place solution.

Workers drill holes in the planking and drive Foresight Products' galvanized ductile iron Manta Ray anchors into the subgrade to stabilize it. Normally, hydraulic/pneumatic equipment is used to drive anchor tendons holding the anchors into the soil, and workers then rotate the anchors into a perpendicular locked position with an upward pull on the anchor tendon that also releases the anchor from the tendon. In their locked position, the Manta Ray anchors compact the soil and prevent erosion. An anchor locker is used to load test the anchors to the desired holding capacity, from light to heavy-duty.

For this project, however, the contractor has used an excavator bucket to drive the anchors into the soil, notes Rod Dennett, superintendent with Greggo & Ferrara, who adds that the soil stabilization solution used here is handy, given the space constraints. "The biggest problem is that there's very little room to work," Dennett says, adding that the project completion is not expected until 2014. "It's pretty handy to be able to stabilize the soil in certain places where it's so tight. We're working in an area that's maybe 20 feet wide. It just doesn't leave you much room for equipment. It's time-consuming work, and it's tight."

Dennett worked with Foresight Products on a solution to stabilizing the subgrade underneath the approach slabs that are being removed adjacent to open traffic lanes. Greggo & Ferrara submitted the Manta Ray solution to DelDOT and got approval. Dennett is grateful for that.

"We're using the Manta Rays because it's a fairly simple setup and it's inexpensive compared to sheeting or anything like that," he says. "It has made good sense to use them on this project." EC

Don Talend *is a print and e-content developer specializing in covering sustainability, technology and innovation.*