EROSION CONTROL

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Streambank Stabilization

Helping streams and channels withstand high-velocity flows.

By Bill Tice

Engineers, construction crews, and government employees frequently need to look at ways of rehabilitating streambanks that may be eroding because of increased stream velocity. Sometimes, this increased velocity is caused by manmade changes to the surrounding environment, such as the removal of natural vegetation for construction projects or an overall increase in the amount of impervious surface upstream. In other cases, it is natural events, like a heavy rainfall, that cause the increased velocity and the resulting erosion problems.

PHOTO: ARMORTEC

ACB protects a bank at a wastewater treatment plant.

Rebuilding a Dangerous Embankment

When an empty school bus went off a rural secondary road near Richardsville, KY, in April 2005, staff at the state's Department of Transportation (DOT) office in nearby Bowling Green took notice. The roadway where the accident occurred was adjacent to a stream called Taylor Branch, and the accident was attributed to shoulder collapse on the roadway, a situation that was caused by severe embankment erosion beginning from the toe of the stream to the top of the bank.

"Fortunately, only the driver was on board at the time of the accident, and he was not injured," explains John Hepner, a Kentucky DOT bridge inspector for District 3, who headed up the crew that did the stabilization repair work on the streambank. "We were concerned about further shoulder collapses over an area adjacent to the roadway that covered approximately 250 linear feet, so we wanted to make sure we came up with a long-lasting and effective repair method."

PHOTO: ARMORTEC

Embankment before project began

During A-Jacks installation

The section of embankment adjacent to Taylor Branch, which runs parallel to the road, has an average horizontal width of approximately 4 to 5 feet, while the vertical depth from the top of the roadway surface to the bottom of the creek varied anywhere from 8 to 10 feet. “We think that over time, the stream continually migrated towards the roadway, and that is what started the failure,” adds Hepner, who has been with the Kentucky DOT in the south-central part of the state for 23 years. “Once the erosion reached the loose soil, it just took over from there.”

Hepner says the department looked at a number of possible solutions for stabilizing the streambank, but decided to go with 24-inch A-Jacks concrete units from Armortec in Bowling Green, partly because of how quickly the situation could be corrected with this method and partly because of his past experience with these products. “We really needed to fix this problem quickly, and with the A-Jacks units as a base we could achieve that goal. I have also had previous successful experience with these products, so I know how they are used, and I was confident they would work for us in this situation.”

According to Hepner, a crew of 14 mobilized on September 20, 2005, and completed the job just two-and-a-half days later on September 22. “The A-Jacks units, which look like giant versions of the jacks kids used to play with, come in different sizes. For this job, we went with the 24-inch units, which are the smallest Armortec makes. These make up what essentially becomes the new toe of the embankment, and they are aligned in the streambed along the entire project.”

After the units were placed, Class II channel lining stone from a local quarry was delivered by dump truck and used to backfill the A-Jacks and rebuild the 8 to 10 vertical feet of embankment with a final 2:1 ratio slope. “In addition to the hard armor, we installed a geotextile filter fabric between the stone and the exposed soils throughout the project area,” adds Hepner, who notes that all of the stakeholders are happy with the results. “So far, everyone is pleased with the project. The new streambank has not been challenged by a high-water event as of yet, but we have always been satisfied with how these systems have performed in the past, and I am sure we will be pleased with how they will perform on this application.”

PHOTO: ARMORTEC

Hand-placing the A-Jacks in matrix

PHOTO: ARMORTEC

Finished Project

Protection With Concrete Mats

Chris Richard, P.E., needed to protect a $22 million wastewater treatment facility upgrade from potential rising water and erosion from the Vermillion Bayou, a significant body of water that is influenced by rainfall and serves as a recreational and scenic waterway for the citizens of Lafayette, LA. Richard, who is a project manager with Domingue, Szabo & Associates, a civil consulting engineering firm in Lafayette, specified Armortec’s ArmorFlex Class 70 articulating concrete block (ACB) mats as part of the wastewater treatment plant project. Construction on the plant, which is being built by the City of Lafayette, started in June 2005 and is expected to take two years.

“The City of Lafayette has a very limited site for the wastewater treatment plant upgrade, and the size of the site is constrained by the river, the highway, and other private property,” explains Richard. “We needed to construct a 7-million-gallon equalization basin that goes 15 feet into the ground, and due to the site constrictions, we wanted to build that basin as close to the river as possible. This meant that we had to take measures that would protect the riverbank from erosion, which could be caused by a number of factors, including the construction of the basin, other construction related to the project, and the fact that the project is situated close to a bridge and a bend in the river—two scenarios that can cause increased velocity in the river. We also had to remove a number of trees from the site, so we lost some of the natural protection the area had in the past.”

PHOTO: SUBMAR

A mat system covers exposed pipelines.

By using the ACBs, Richard says his company was able to quickly and cost-effectively protect the site from erosion. “Installing the ACBs on the bank was a small part of the overall project, but it was one of the first things we did.”

The mats stretch 40 feet from the top of the bank into the river and 400 feet in length for a total of 16,000 square feet. Before installation, the bank was graded and a filter cloth was laid in place. The mats were linked together using a cable and the joints between the mats were grouted. The mats were then anchored at the top to prevent movement.

“We were actually lucky that the water level was low when we did the installation, so we were able to install the mats dry, which made it easier,” says Richard. “Once the mats were installed, soil and sediment from the river covered the mats naturally and we covered the anchors and the top sections with soil. This was then hydroseeded and by the fall we had grass growing along the top of the bank.”

Richard has used other streambank stabilization techniques in the past, such as riprap, but had not used the ArmorFlex product until now. “We had seen the product used up and down the river and the city had used it for other projects, so we were comfortable specifying it for the wastewater treatment plant upgrade.”

Keeping Pipes Underground

Butch Till, a technical specialist with the Lake Charles, LA–based Trunkline Gas Co., which is part of Houston, TX–headquartered Panhandle Energy, recently used concrete mats to stabilize the bank along a 150-yard section of Hickahala Creek, which is located in the Yazoo Basin and close to Senatobia, MS.

“The creek actually looks wide enough to be a river because it was redirected by the Army Corps of Engineers for drainage purposes,” explains Till. “The widening project was doing what it was supposed to do in terms of drainage, but increasing water levels during high-water events coupled with sandy, loose soil that is uncompacted was beginning to expose our pipes, which carry natural gas from the Gulf Coast to the country’s heartland. We have two pipes running through this area. One is a 30-inch-diameter pipe and the other is a 36-inch-diameter pipe, and they must remain underground.”

PHOTO: SUBMAR

A project two years after installation

Till worked with Submar Inc. of Houma, LA, to correct the problem. “We brought Submar in and they installed their 9-inch Construction Mats, which are 8-foot by 20-foot articulating mats in a thickness of 9 inches. The concrete mats were positioned with an excavator and then tied together with stainless steel bands. They go over top of the pipes, preventing any further erosion of the bank. Rock structures were also placed in the creek to work in conjunction with the mats.”

Submar’s 9-inch mats are well known in the pipeline business and are primarily used for separation, stabilization, and protection of underwater pipelines in both deep and shallow water. The design of the mats allows for self-silting and proper separation between the pipelines. Submar introduced concrete mat technology to the Gulf of Mexico in 1990 as a replacement product for sand or cement bags that had been used for this purpose in the past.

PHOTO: ERCA

Weirs, serving as inlet and outlet controls for potential floodwaters, are protected from overtopping flows by concrete mats.

PHOTO: ERCA

Till notes that for the Hickahala Creek project, which took approximately two weeks to complete, the Submar mats have been a success. “We have had a number of high-water events since the Submar mats were installed, including Hurricane Katrina, and to the best of my knowledge, we have not had any further erosion or damage to the bank.”

Preparing for a 100-Year Flood

Even if water levels in the Little River in Essex, ON, reach the 100-year flood level, the residents of housing developments close by should be able to rest easy thanks to a project completed this past summer by the Essex Region Conservation Authority (ERCA).

The ERCA was established more than 30 years ago, in 1973, and has the mandate of managing natural resources in the Essex region. This is completed in partnership with the Province of Ontario and nine member municipalities, including the City of Windsor, which is a major center with a population exceeding 300,000 people. Windsor is located on the banks of the Detroit River and is directly across the river from the city of Detroit, MI.

Last summer’s project on the Little River involved lowering two sections of dikes to provide emergency overflows into parklands east of the dikes and south of the Little River Sewage Treatment Plant. The ERCA oversaw the project, which included constructing two weirs, one as an inlet for the potential floodwaters and one as an outlet. Paul Mourad, a watershed engineer with the ERCA, describes a weir as a section of berm that is cut down in elevation to allow water to flow over it at a desired flow rate.

“The Little River is one of the many water courses in our area that drains a fairly significant area into the mouth of Lake St. Clair,” explains Mourad. “On either side of the Little River are dikes, and the elevation of the dikes is at the 100-year-flood level for the area. We wanted to establish additional storage for floodwaters that would increase the detention time in the event of a flood. The weirs draw water into the storage area and allow us to release the volume through culverts over an extended time period.”

Mourad says that the ERCA was concerned about erosion of the weirs or berms caused by the quantity of flow and rate of velocity over top of the weirs. “With a velocity of 1 meter per second and flow of 19.4 cubic meters per second, we needed to stabilize the weirs, so we decided to go with concrete mats from International Erosion Control in West Lorne, Ontario.”

The concrete mats are draped over the berms or weirs and are submerged into the water to create a stable structure. Both the inlet weir and the outlet weir required 65 meters (approximately 200 feet) of the concrete mats. “We started the project in the late spring of 2005, and the installation was done over the summer,” notes Mourad. “International Erosion Control Systems supplied the mats, and our contractor placed them with an excavator. On the river side of the weir, they were anchored in a shallow trench on the river bottom and backfilled with riprap. On the land side of the weir, the mats were anchored in a shallow trench at the toe of the slope and backfilled with a few feet of clay. A geotextile filter fabric was also used underneath the mats.”

Once the mats were positioned, crews placed topsoil over top of the mats and planted a seed mix, which Mourad says germinated quickly and has already provided vegetation for a natural look.

PHOTO: FASTDITCH

Broken lining allows water to leak from irrigation ditches.

The Little River project was part of a major Flood Control and Stormwater Management Program for the East Riverside planning area in Windsor and was designed and implemented jointly by the ERCA, the City of Windsor, and major developers in the area, including the consultant firm HGS Ltd. The ERCA was successful in obtaining $350,000 Canadian (approximately $300,000 US) in funding from the Ontario Provincial Government.

The Little River project ties into other projects the ERCA is exploring, and in October 2005, the organization announced that it had obtained $1 million Canadian (approximately $850,000 US) to assist the City of Windsor in a major shoreline protection and flood control project. The ECRA had previously commissioned engineering studies for shoreline protection and related improvements for half a kilometer (0.3 mile) of waterfront within the city, an area that includes Windsor's Central Riverfront parks.

PHOTO: FASTDITCH

Flexible liner is installed over concrete liner using hand tools.

Conserving a Precious Commodity
Ken Suazo and his family have been working hard for the past 12 years to develop a method of conserving water that is transported through New Mexico's thousands of miles of irrigation ditches. Up until now, almost two-thirds of the water moving through the irrigation systems could be lost due to cracks and leaks in what are predominantly concrete-lined ditches. The solution Suazo came up with is a corrugated, high-density polyethylene product called SmartDitch, which can be used to line both old and new ditches, preventing erosion problems and minimizing leakage of the precious commodity that is used to irrigate the state's crops.

"Several members of my family are involved in this project, and we are all engineers and graduated from New Mexico State University, with the exception of my uncle who graduated from Kansas State," explains Suazo. "Most of us are still working for the federal government National Laboratories and the National Nuclear Security Administration as engineers, but we also have a family ranch and farm in northern New Mexico. Our initial concept was to develop a cost-effective and flexible liner for the irrigation ditches that could be installed in remote areas with only hand tools. My parents came up with some ideas and showed us paper models, which we took to the drawing board. With the help of my uncle, Ed Suazo, who was an executive with one of the large chemical companies, we took our prototype designs and went to the Penn State University Plastics Technology Deployment Center in Erie, Pennsylvania, where we developed our first prototype—a rotationally molded liner."

After incorporating their company, which is called FastDitch Inc., Suazo and his parents, along with his sister Dawn Harder, cousin Juan Griego, and uncle Ed Suazo, tested the liners on their ranch and spent the next eight years fine-tuning the product. Water conservation in New Mexico was also important to the state government, and when New Mexico Governor Bill Richardson announced that $10 million worth of grant money would be available for the development of water-saving measures through the state's Water Innovation Fund, the Suazos applied and were granted almost $500,000.

With extensive testing under their belt and a product that Suazo felt was almost ready for the mass market, the family teamed up with Penda Corp., a national company that is known for its pickup truck–bed liners. Penda would be the manufacturer and distributor outside of New Mexico, while FastDitch would distribute the product in its home state.

The first big test of the product came in the summer of 2005, when the company ran a trial of the product for the Acoma Pueblo in New Mexico, which has about 40 miles of concrete-lined ditches. The company selected about a mile-and-a-half of the irrigation system and installed SmartDitch, and then turned on the taps. "They were losing up to 63% of their water volume with the concrete-lined ditches, and it is estimated that they are losing less than 1% in the newly lined sections," notes Suazo.

In terms of cost, 1 linear mile of SmartDitch installed runs at about $220,000, compared to more than $600,000 per mile of installed concrete ditch. More importantly, though, the Pueblo could save close to 200 million gallons of water on an annual basis by converting all its ditches.

PHOTO: FASTDITCH

Crews can install up to 1,300 feet of liner per day.

Installation of SmartDitch is fairly straightforward, and Suazo estimates that an experienced installation crew can install up to 1,300 linear feet on a good day. "The old concrete portions that have fallen into the ditch need to be removed, which can be done with a small excavator, but most of the existing concrete is left in place and then the banks have to be cleaned. The liner is delivered in 8-foot sections, which weigh about 50 pounds each and can easily be carried and positioned by two men. Once the liners have been placed in the ditch, they are connected with rivets and anchored using Better Built Earth Anchors, which are driven in with either a sledgehammer or a hammer drill."

For Suazo, the real test will be in the spring of 2006. “The project for the Acoma Pueblo was a success, and we completed several other small projects during the prototyping stage,” says Suazo. “Eight years of testing have led us to where we are today and we now have all our ducks lined up and the product is set to be released into the mass market. We will be offering solutions that include a water conveyance system used in agriculture for irrigation, and another product line that can be used in stormwater management.”

Topics:

- Streambank Repair,
- BMP Manufactured,
- Channel Armoring