EROSION CONTROL

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Shoreline Protection Strategies

Temporary and permanent methods to save beachfront property

By Roberta Baxter

When the devastating storms of 2005 hit coastal areas of the United States, the news media showed a plethora of pictures of destroyed homes and businesses. We saw the matchstick remains, interior walls covered with mud and mold, and torn-off roofs. What was shown less often was the devastation to shorelines.

Shoreline erosion is an annual event. Beaches along the Atlantic coast typically experience a 2- to 3-foot loss per year, while along the Gulf of Mexico, the losses are higher, about 6 feet per year. During hurricanes and tropical storms, the losses are accelerated. Whole sections of shorefront can disappear. With the prediction of more violent storms and the forecast of rising sea levels around the world, shoreline protection becomes critical.

Shoreline protection projects draw on a variety of techniques, from building permanent structures to dewatering areas so repairs or construction can occur. A variety of products are available to meet these requirements. These products can be temporary structures or permanent.

Cofferdams

Cofferdams are temporary structures used to expose the bed of a water body so that construction or restoration work can occur.

Two years ago, an engineer contacted Portadam Inc., based in Williamstown, NJ, about a seawall rebuild project. Portadam's Gerry Mann recalls that the project involved a revetment stabilization project at Wilde Lake in Columbia, MD. The lake belongs to the Columbia Association and facilities include a clubhouse and boat dock. An existing bulkhead was failing, putting the dock and shorefront at risk. Construction of a replacement bulkhead was about to begin. However, the area of the lake would need to be dewatered for construction purposes. During what Mann calls "lunch and learn," representatives of Portadam showed their product, portable cofferdams.

Once a contract for a Portadam project is awarded, site surveys and planning begin. For each project, a person in a wetsuit performs an underwater survey, checking the bottom of the water body for characteristics such as type of soil and compactness. Mann says that contrary to what many people might think, both sandy soil and clay present challenges. Coarse sandy soil allows more seepage after the area has been dewatered. Clay soils seal better but also permit more settling once the cofferdam is installed. So each soil has advantages and disadvantages, and installers are familiar with the conditions needed for the best outcome.

For the Wilde Lake project, a three-sided cofferdam was built around the work area. The Portadam system consists of A-frame steel pipe supports, fabric lining sides, and sealing sheet for the bottom of the area. The design allows loading to be transferred to an almost vertical load, giving strength and support without extensive bracing. Installation does not require heavy equipment and the cofferdam is free-standing on the lake bed. The entire structure is lightweight enough to be installed on top of levees that are in danger of being overtopped. The steel frames can be adjusted to the corner angle needed and the water bottom does not have to be flat. The structure can be built to accommodate slopes.

Carl Tidliskey, Portadam project manager, says the Wilde Lake installation had a crew of two divers, a supervisor, and two laborers who pinned the frame together. The frame was floated into place on inner tubes and then placed on the lake bed. The divers swam around the perimeter, sealing the edges with sandbags where needed. The three-sided cofferdam installed at Wilde Lake measured 20 feet by 150 feet by 30 feet. Dewatering required about four hours, and then maintenance pumping was performed at intervals to handle seepage. The excavator for the project was able to drive his equipment on the lake bed to rebuild the revetment.

Chris Reid, project manager for Payne Landscaping, was contractor for the Wilde Lake project. When I spoke to him, the Portadam had been in place for three weeks with no problems. He says that the Portadam had been specified by the owner

because he had used other cofferdam systems in the past and experienced failures. Reid says the system is holding back 7 feet of water, adding that the technique of the water holding the dam in place is “so simple, but works great.”

Portadam structures have also been configured with four sides to handle dewatering around bridge pier projects. Portadam is available in 3-, 5-, 7-, and 10-foot sections and will retain water up to its full height. The system can be installed in flowing water and the cost is less than for sheet piling. Portadam rents the cofferdam structure, so the cost is less than purchasing equipment.

Sheet Piling

Tampa General Hospital in Tampa, FL, was planning a new parking garage along a beachfront near the hospital. An existing steel bulkhead near the hospital had deteriorated and needed to be replaced, and a new structure was needed to protect the shoreline in front of the garage. The product chosen was ShoreGuard vinyl sheet piling manufactured by Crane Materials International (CMI) of Atlanta, GA.

Vinyl sheet piling is lightweight but strong and long-lasting, and it has an aesthetic appeal. The ShoreGuard product comes as a box design or a Z design. Cap pieces and parts for angle corners are available from CMI. The ShoreGuard comes in three colors, gray, clay, and brown, so the piling can be chosen to blend in with surroundings. During the design phase, the project should be carefully planned in respect to corners so the sheets can be placed properly. A temporary driving guide may be used to ensure a straight wall, or the wales and poles of the project can serve as a true guide.

Photo: CMI

Failing steel bulkhead (top), wall during construction (middle), parking garage wall (bottom)

Photo: CMI

The sheet pilings can be installed by excavators, water jets, drop hammers, or vibratory hammers. Once the sheet piling is driven into the seabed, wales and tie rods are added for strength. If additional support is needed, CMI can supply TimberGuard poles, which are similar to wood but have a polymer sleeve to protect the pole from the elements.

Fred Haynes of Skanska USA is the general contractor for the seawall and garage at Tampa General Hospital. He says ShoreGuard was chosen for the speed of installation, cost, and appearance. The project is being completed in two phases; phase one was installation of the piling in front of the deteriorating steel bulkhead, and phase two was building the new wall. Haynes says that the structure has worked out well and has already withstood a couple of storms. The project was on budget and installation was rapid with no problems, so Haynes is well satisfied with the performance of the product.

Photo: CMI

Vinyl sheet piling from CMI is the product being tested in a project in Louisiana. Wade Wright, technical manager/designer for the Army Corps of Engineers Civil Division, says the project, called the Larose to Golden Meadow Hurricane Protection Project, is a one-year “test balloon.” The area is a marshy section along the bank of Bayou LaFourche near the town of Golden Meadow, LA. Wave action from Little Lake and Barataria Bay scoured the levee toe, and daily tidal action has caused sporadic scour along the levee alignment. The Gulf of Mexico is right at the doorstep of the region, so corrosion protection is necessary for any structure.

Wright says the project was started to determine if the vinyl sheet piling would provide a lasting solution. In past projects, the corps had used riprap for similar problems. However, the rock is heavy, so settling is a challenge, and it is expensive to install and hard to maintain.

The vinyl sheet piling was chosen for the test due to its resistance to corrosion over the long haul, and because its light weight makes it easy to transport to point of placement through the marsh area. Another consideration is the 40% cost savings when compared to steel. “The vinyl will outlast us,” Wright says.

The piling was driven down 13 feet into the soil. Small rock was placed in front of it. Some splashover has been observed, but the backfill is staying in place.

Gabions

Sometimes, the best way to prevent beach erosion is to build structures a distance into the water. A breakwater, built with gabions, might be the best solution. This method was chosen for a resort hotel in Anegada, British Virgin Islands.

Because of the storm surge from two hurricanes in 1995, the Anegada Reef Hotel had lost up to 60 feet of beachfront, and the main building of the hotel was threatened. Several methods of shoreline protection and restoration were considered. Wire net,

rock-filled gabions manufactured by Modular Gabion Systems (MGS) of Houston, TX, were the chosen solution.

The owner and his employees, with no experience in constructing gabion systems, were able to install the 1,000-foot breakwater with the rolled gabion mesh. Sections of mesh were joined with spiral connectors supplied by MGS. They placed the gabion structure at the pre-erosion line in the water and then filled the mesh with rock brought by barge from Tortola. Equipment required was a backhoe and hand tools.

Photo: EcoShore International

To mitigate erosion, a beach needs to drain effectively after each high tide.

Gabion systems are cost-effective, especially if rock is available locally. Their design allows them to flex and deform under stress rather than break. The systems are easily installed, even by unskilled laborers, and do not require pilings or temporary cofferdam construction, as they can be installed in water. Very little maintenance is required.

Photo: EcoShore International

Before the project was completed, Hurricane Bertha struck the island. Six- to 10-foot swells overtopped the gabion wall for about eight hours. After the storm had passed, the hotel owners found that the 60-foot deep, 1,000-foot-long shoreline behind the gabion breakwater had almost completely filled with sand. The storm surge transported large amounts of sand over the gabion wall, where it fell out of suspension and settled into a new beach.

The porous composition of the gabion seawall absorbs wave energy without reflecting it. Sand carried by the waves drops out of the water and into the beach area, gradually replacing the beach. The gabions, now mostly covered with sand, still provide protection to the beach. Vegetation has reestablished on the beach, providing extra erosion control. The beach has remained unaffected by exposure to at least six Category 3 hurricanes and numerous tropical storms.

The Family Campground at Patrick Air Force Base in Florida was also threatened by shoreline erosion. A 1,000-foot stretch of shore had lost several feet of beach, and some campsites were on the verge of falling into the ocean. Plans were to establish a mangrove network to provide an appealing and effective erosion control system.

Stainless steel gabion baskets from MGS were buried parallel to the beach, filled with rock, and covered with sand. Mangrove trees were planted among the gabions and seaward, and other areas were seeded with grasses. Because the gabions were buried, they don't detract from the look of the beach. But they still provide erosion control during storm events and strength to the beach. In the years since installation, the trees and other vegetation have grown and the beach has been preserved.

ACBs

Articulated concrete blocks (ACBs) have a variety of uses, including shoreline protection. After three hurricanes made landfall in 2004, the Indian River Drive in St. Lucie County, FL, was near collapse. ArmorFlex 50S was chosen to line 13 miles of shoreline along the drive. With money from the Federal Emergency Management Agency, the county plan was to reinforce the banks back to a 2:1 grade and line the bottom with ACBs. The project needed to be completed quickly, and the modular aspect of the ArmorFlex allowed for the necessary speed. Ease of installation and cost were added benefits for this project.

Photo: Portadam

Photo: Portadam

The Portadam system comprises A-frame steel pipe supports, fabric lining sides, and sealing sheet for the area bottom.

ArmorFlex is a division of Contech, located in West Chester, OH. The ArmorFlex product is a matrix of concrete blocks connected by cables into mats. The articulation of the blocks gives the system flexibility and strength. The mats are installed over geofabric. The open blocks can be backfilled and vegetation planted in the cells.

The Indian River project involved 1.2 million square feet of mat, and the entire project was completed on time.

ArmorFlex was used in a project in the Florida Keys in 1999, and according to Dan Hunt, erosion control specialist with Contech Earth Stabilization Solutions, it still looks great. The original plan was to haul riprap from distant quarries, resulting in a high cost just for transportation. Instead, ArmorFlex was installed along a landfill on Fleming Key for the 1,800 feet of the project. Once the mats were installed, the blocks near the water level were filled with aggregate in the wave zone. Topsoil was imported (there is very little good topsoil in the Keys), and vegetation planted in the upper areas of the slope.

The maintenance of the ACBs is minimal. The vegetation may have to be tamed on the Fleming Key due to the heavy growth of tropical plants.

Submar Inc. of Houma, LA, also manufactures and sells ACBs. The 4.5-inch revetment mat is constructed of concrete blocks and measures 8 feet by 20 feet. The blocks are connected by UV-protected copolymer ropes.

For coastal marsh open to the Gulf of Mexico, the Submar mats were installed along 80 feet of shoreline. Spaces in the mat are planted to allow vegetation to increase erosion control and aesthetics.

PEM

A Danish invention is making inroads into the US market for shoreline protection. The pressure equalizing modules (PEM) system was developed in Denmark and has been used at sites around the world, including Africa, Europe, and Malaysia. EcoShore International of Boca Raton, FL, is the exclusive licensee of PEM in the United States. According to Kenneth Christensen, president of EcoShore, the company is focused on Florida, California, New York, and New Jersey and plans eventual expansion into other states. EcoShore is presently in the process of obtaining permits for projects in the United States.

The PEM system starts from the principle that a wet beach is an eroding beach. When a beach is retaining water, an incoming wave cannot deposit its sand load because it can't sink into the beach. The wave retains its load of sand as it withdraws and carries more from the beach with it because the particles don't stick together.

By contrast, if the beach is drier, the swash infiltrates the sand and slows down, and deposition is increased. So, to mitigate beach erosion, the area needs to drain effectively after each high tide.

The PEM system accomplishes this drying-out task by allowing the beach to drain more effectively. The system consists of permeable tubes placed vertically into the beach in a grid pattern. The usual density is 70 to 100 tubes per mile of beach. The tubes are 2.5 inches in diameter and 6 feet long with a screen cap on the top, and they sit about a foot below beach level.

Different layers in the sand have different abilities to drain the water. Layers of coarser sand typically drain effectively. The PEM connects the different strata of sand, and water flows in the PEM tube where it can escape from the layer with the easiest flow route. Because the groundwater pressure equalizes, the beach becomes more permeable and less erosion prone.

A large test of the PEM system is occurring in Denmark. Along a 7-mile stretch of beach near Skodbjerge, erosion had been occurring at a rate above 1.5 million cubic yards a year. Control areas were laid out, alternating with areas of PEM installation. The plan is to observe the areas and measure beach erosion or restoration in each section.

After the first year, which was unusually calm, the PEM areas had increased in height by 44% while the control areas had been reduced by 3%.

From December 2006 until January 2007, four big storms hit the area and storm surges struck the beach. According to Christensen, the areas without the PEM had no beach left and the dunes were losing several meters. Beaches that had been nourished—that is, had sand added to them—suffered, too. In the PEM areas, the beach had not changed significantly and the dunes were still intact. "It was the ultimate test," Christensen says, "and we're very pleased with the result."

With the PEM system, the beach is nourished with the same type of sand as the original beach, rather than with imported sand that may be of a different consistency or particle size. The PEMs are buried, so they are not obstacles on the beach, and the system can be easily removed if desired. And installation equipment is light and does not impact the beach environment. Each tube operates independently, so if one fails, the rest still work. No power is required for operation, and the system requires little maintenance.

Costs for the PEM are about $200,000 for the first mile and $100,000 for each additional mile per year on a leasing basis. In some areas of Florida, costs of beach nourishment projects range up to $1 million per mile per year.

Whatever your needs for shoreline protection, you can find products to fill the bill. You might need temporary cofferdams to dewater an area while construction is happening or some type of permanent beach protection. With the multitude of products on the market today, you will find a system to protect our shores.

Topics:

- Shoreline Protection,
- BMP Manufactured,
- Channel Armoring