Geotube® for Marine and Hydraulic Engineering

Geotube® containers are geotextile encapsulated soils that may be used to replace rock as conventional building blocks in marine and hydraulic engineering structures. Geosystems tend to be more stable hydraulically and geotechnically because they are heavier units with larger width to height ratio and have better boundary contacts with adjacent units.

Rock may not be available within economical hauling distances in many river, lake, coastal or offshore marine construction projects. Sometimes the use of rock may be undesirable as it can pose high risk to cargo ships whereas a Geotube® provides a soft contact. Geosystems are often competitive solutions in marine and hydraulic engineering by enabling the use of finer materials to be used as fill material for construction of marine and hydraulic engineering structures.

A Geotube® is a long geotextile tube, hydraulically filled with soil to be used as marine and hydraulic structures. Each Geotube® is custom made and supplied in various sizes and lengths to suit design and installation requirements. They are ideal for installations on dry land or in water depths to 15 ft (5 m).

A Geocontainer® is a very large sized geotextile bags filled with soil. A split bottom hopper barge is used to form, transport and install the Geocontainer®. Each Geocontainer® is custom made to fit the split bottom hopper barge. They are generally installed in water depths of over 15 ft (5 m).

A Geobag® geotextile container is designed to be filled with soil and installed for construction of marine and hydraulic structures. Each Geobag® is custom made and supplied in various forms and sizes to suit design and installation requirements. They are ideal for installations on dry land or placed into water of any depth.
Containment Dyke
Shamrock Island, Corpus Christi, Texas, USA
Geotube® for containment dyke to reclaim a rapidly eroding island.

Geotube® containers were used to construct containment dykes for land reclamation and coastal protection for Shamrock Island. Shamrock Island is rapidly eroding and is close to the point of vanishing completely.

Approximately .5 mile (1 km) of tubes were installed as part of the works to rehabilitate the rapidly eroding island. After the Geotube® containers were installed, sand was pumped to create a wetland habitat. March grass was planted to help establish the migratory bird sanctuary.

The project was extremely successful. The Geotube® protected coastline is no longer eroding and a bird habitat has been created from an island that was close to disappearing.
Containment Dyke
Naviduct, Lake IJssel, The Netherlands
Geotube® containers for a dyke to retain dredged material from the Naviduct project.

A total of 4.5 miles (7.5 km) of Geotube® containers were used to contain dredged material. Each Geotube® had an initial theoretical diameter of nearly 13 ft (4 m) and were filled hydraulically at a rate of 1,800 m³ per hour of sand slurry to attain a filled height of approximately 10 ft (3 m). The tube lengths were manufactured such that each Geotube® could be completely filled within a working shift of between 8 to 10 hours.

Finally, a rip-rap cover was placed on the outer edge of the Geotube® containment dyke. The containment dyke project was completed within a relatively short period of 20 weeks.
Artificial Islands
Amwaj Islands, Bahrain
Geotube® for containment dykes to create artificial islands.

Geotube® structures were used as containment dykes to create artificial islands for the Amwaj Islands Project in Bahrain. This project is a prestige housing development site in the Persian Gulf.

Reclamation was carried out in two stages. The first stage involved the installation of a Geotube® of height approximately 8.5 ft (2.6 m) followed by hydraulic filling of sand behind the Geotube®. The second stage involved installation of another Geotube®, followed by further hydraulic filling of sand to achieve the finished platform level of Chart Datum of 3.6 m.

Upon completion of the reclamation, rock armour of 130-650 lbs (60-300 kg) was placed in front of the Geotube® dyke.

Eventually, submerged reef breakwaters are to be constructed about 1000 ft (300 m) from the Geotube® dyke to create artificial beaches.
Shoreline Revetment  
Shell Island, North Carolina, USA  
Geotube® for shoreline revetment to reconstruct a badly eroded slope.

Geotube® containers were used for erosion protection to reconstruct a badly eroded shoreline slope on Shell Island, North Carolina.

The erosion was so bad that it was threatening an adjacent resort complex.

The slope reconstruction consisted of a seven tier Geotube® structure. The installed Geotube® structure halted further erosion and maintained stability of the exposed structure.

Geotube® facing the sea.  
Aerial view of area badly eroded.  
Sections of Geotube® containers being installed.  
Cross section of Geotube® dyke.
Shoreline Protection
Sea Isle City, New Jersey, USA
Geotube® containers for construction of hidden protection dyke within a frontal sand dune to protect area behind the dyke from flooding.

Geotube® containers were used to internally reinforce a frontal sand dune to protect the coastal road and properties in Sea Isle City from flooding.

With each hurricane season, Sea Isle City, on the Atlantic coast, would be subjected to strong winds and waves that would cause extensive flooding along coastal areas. Damage costs were continually high.

The Geotube® structures, buried within the frontal sand dune, prevent breaching of the protection dyke during heavy storms. Furthermore, the tubes prevent erosion of the dyke structure.

Installation of Geotube®.

Installation of Geotube® containers.

Since installation of the protection dyke, no further flooding has occurred.

Wave and surge attacking Geotube® structures during construction.
Shoreline Protection
Bolivar Peninsular, Texas, USA
Geotube® structures for construction of shoreline protection within the sand dune flood protection.

With each hurricane season, homes built along the coastline of the Bolivar Peninsular would be subject to damage by the sea. During bad seasons, homes would be lost through erosion and undermining of foundations.

Geotube® structures were used to reinforce the frontal sand dune along approximately 4 miles (6 km) of the beach front coastline to prevent further damage and erosion.

Tropical storm Allison made a direct hit on the area in June, 2001 and the Geotube® revetments performed extremely well. This prevented millions of dollars in damage. The project was so successful that an additional 3 miles (5 km) of Geotube® shoreline was constructed to protect the Bolivar Peninsular.
Intake Jetties
Pacific Coast, Mexico
Geotube® for jetties and bunds to construct the water intake channel to the pump station of a shrimp farm in Mexico.

Geotube® structures were used for jetties to protect the water intake channel to the pump station of a shrimp farm located on the Pacific coast of Mexico.

The jetties were constructed to heights of 10 ft (3 m), using a 1-2-3 stacked Geotube® structure. Sand from the beach was used to fill the Geotube® using sand slurry pumps.

The portion of Geotube® jetty on shore also serves to prevent sand from being washed into the intake channel.
Geotube® structures were used to construct offshore breakwaters to widen the beach front and protect the jetty of the El Dorado Royale resort in Mexico.

The Geotube® structures were installed offshore in waters about 6 ft (2 m) in depth to protect the beach. An additional Geotube® breakwater was constructed in a water depth of 13 ft (4 m) to protect the foundation of the jetty.

Marine growth was evident even during the construction period helping the geotube breakwater to appear as a natural reef sheltering swimmers and other users along the beach.

Sand accretion was evident following installation of the Geotube® structures and a new perched beach is the result.
Geocontainer® dykes created a submerged containment dyke between two existing breakwaters to create a disposal area for excavated spoil.

The river sediments of the River Elbe consist of sand and silt, and this material was used to fill the Geocontainer®. Over 600 Geocontainer® dykes of 392 cy³ (300 m³) each were installed over a period of 6 months.

The project was extremely cost effective and successful, demonstrating the beneficial use of dredged spoil to construct stable hydraulic structures.
Buttress Support
Zoutkamp, The Netherlands
Geocontainer® dykes to form a submerged buttress support for reconstructing a scoured slope underwater.

Geocontainer® dykes were used to construct submerged buttress support to reconstruct a failed underwater slope that was threatening to undermine an adjacent gas pipeline.

The reconstruction of the slope involved several tiers of Geocontainer® dykes and backfilling combinations. The containment dykes were constructed with sand used as the fill material. The lowest tier of Geocontainer® dykes were placed about 65 ft (20 m) below water surface level.

The project was extremely cost effective and successful. The slope has been stabilized with the innovative use of Geocontainer® dykes.
Geobag® structures were used for buttress protection to stabilize an eroding shoreline slope along the Pacific Coast.

The Geobag® containers were placed on a dump-truck bed and then taken to a local ready mixed concrete plant, where they were dry filled with sand. The filling ports of each Geobag® were then closed using hog rings. At site, the Geobag® structures were lifted and placed using a lifting harness and spreader beam arrangement.

Under California law, the permit would not allow the placement of the Geobag® structures at the toe of a slope. Consequently, to prevent further erosion of the coastline, the Geobag® containers were placed on the top of the slope, so when the next storm occurred, the sand under the geotextile bags was scoured away, and the bags literally moved en-mass downslope by themselves.
Cavity Sealing
Chivor Dam, Colombia
Geotube® structures as closure units to seal the openings of a bypass construction tunnel inadvertently left open.

During maintenance and inspection of the generator turbine blades of the Chivor Dam, it was found that undue wear and damage had occurred. The source of the problem was traced to the impact and abrasion of reservoir bottom sediments entering the bypass construction tunnel that was inadvertently left open since the construction and filling of the reservoir.

The opening, which had to be closed, was located 330 ft (100 m) below water surface. Closure was carried out using Geotube® containers filled with concrete and lowered using four winches to the reservoir bottom. The concrete was pumped through pipe on floating rafts to the barge where the Geotube® containers were filled.

Since completion of the sealing using Geotube®, sealing solids passing the turbine blades have reduced significantly and the solution has been deemed highly successful.
**Artificial Reef**
Pratts Reef, El Segundo, California, USA
Geobag® containers to construct an artificial reef to create surfing conditions for recreational purposes.

Geobag® structures were used to construct an artificial surfing reef at El Segundo in California.

The geometry of the reef was designed to intensify wave heights to allow recreational surfing activities on the coast.

Geobag® structures were chosen because they were easy to install and, unlike rock fill, would not injure surfers. Also, submerged bags do not pose any danger to other recreational activities.

The project was so successful that it literally as well as metaphorically made new waves.
Design Assistance:
Ten Cate Nicolon uses the Sofftwin™ computer design software to model the dimensions of the Geotube®, Geobag®, or Geocontainer® structures. Sofftwin™ also provides the expected filling volumes, and calculates the stresses that the structure will experience during the critical time of filling.

Custom Fabrication:
Ten Cate Nicolon has been fabricating Geotextiles for over 25 years. The Geotube®, Geobag®, or Geocontainer® can be custom fabricated to meet the requirements of each specific project. Ten Cate Nicolon has more than 100 types of geotextiles from which Geosystems can be fabricated. Also, Ten Cate Nicolon has fabricated structures with circumferences up to 120 ft. and lengths up to 1,000 ft.

Installation Assistance:
Ten Cate Nicolon has the largest staff of experienced technicians and sales personnel that can provide field installation assistance in the most challenging environments.

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