Triton® Coastal and Waterway Systems from Tensar International Corporation (Tensar) feature a number of innovative composite marine structures used for construction applications in and around water. Triton Systems are made of advanced geogrid and geotextile materials and are designed to be integrated with available fill and/or vegetation.

Triton Systems are typically used for the following applications:
- Erosion control projects
- Foundations or cores for breakwaters, groins, etc.
- High-strength fills built in submerged conditions or with weak fill materials
- Channel linings and bridge scour protection
- Causeways, levees, dikes and bridge approach projects
- In situ capping of contaminated sediments
- Shore protection and sediment dewatering

Increased hydraulic performance and constructability advantages mean the Triton Systems can be significantly less expensive than conventional solutions such as riprap. They also conform to land contours and site configurations while resisting scour far better than rigid systems. Because Tensar Geogrids enable the Triton Systems to resist all naturally occurring forms of chemical, biological and environmental degradation, they are often specified for salt water, industrial run-off conditions and contaminated sediment capping where other types of materials would deteriorate rapidly. Marine Mattresses are available in various styles and thickness options to meet specific project requirements.

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The Triton® Marine Mattress System is designed for demanding conditions associated with erosion control armoring and submerged foundation projects. The system’s effectiveness results from key features, including:

- Monolithic high mass and porosity
- Flexibility and hydraulic stability
- Durability and long-term tensile capacity of Tensar® Geogrids
- Energy dissipation characteristics
- Sensitivity to wave run-up or reflection

Triton Marine Mattresses have been widely used for revetment applications, as well as for scour protection and channel linings. They are especially applicable for heavy erosive action in any of the following conditions:

- Salt water or other harsh chemical environments
- Irregular subgrade surfaces or soft subgrade soils
- Steep slopes, stream or canal banks
- Wave or flow conditions that challenge the stability of a mat’s exposed edge
- Rapid installation or emergency repairs

Triton Marine Mattresses have also been specified for the construction of submerged foundations. Installation friendly and extremely adaptable, they simplify construction and increase the support over bottom soils prone to settlement or scour.

**APPLICATIONS**

- Shoreline revetments and dune stabilization
- Foundations for breakwaters, jetties, groins and dike
- Scour mats for underwater pipeline crossings and sewage outfalls
- Riverbank protection, channel lining and bridge scour abatement

Marine Mattress System

St. Andrews Bay, FL

Triton Marine Mattresses were placed over an exposed pipeline to protect it from marine traffic, tidal scour and storm impact.
The Triton® Grid Composite System is specially developed for use beneath riprap and armor stone. By combining Tensar® Geogrids with geotextiles, Grid Composites provide an improved foundation and filtration layer for a broad range of riprap, rubble-mound structures and similar installations. Nominal roll size is 12 ft wide and 164 ft long.

**IMPROVING PERFORMANCE**

The use of geotextile as riprap underlayer is well established. Geotextiles provide separation and filtration at the subgrade interface. Adding Tensar Geogrid further enhances performance by:

- Reducing settlement by distributing loads over a wider area (similar to the way a snowshoe works)
- Holding geotextile firmly against subgrade to guard against scour
- Providing a protective “cushion” for the geotextile during and after construction

The enhanced performance is important for a wide range of applications including revetments, channel linings, spillways, streambanks, scour protection, groins, jetties and breakwaters. Grid Composites can be particularly effective for improving performance and constructability in difficult conditions, including:

- Submerged construction
- Soft subgrade soils
- Steep slopes
- Jetty sand tightening

**INCREASING COST EFFICIENCY**

The primary purpose of using Grid Composite is to improve service life and performance, thereby reducing long-term costs for maintenance, repair and replacement. However, it can also facilitate initial cost savings by eliminating more expensive alternatives such as graded aggregate filters, excessively thick sections, over-excavation of soft subgrades or re-grading of steep slopes.

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**Grid Composite System**

Soft Soils Installation

Provides load distribution to improve constructability and reduce settlement.

Ft. Clinch State Park, FL

Armorstone was placed directly on Triton® Grid Composite in constructing a coastal groin. Another width of grid composite will be placed next to overlap the exposed edge of Grid Composite. Stone placement will then proceed seaward toward the left.
Tensar® Geogrid composite eliminated the need for steel sheet piling for sand tightening this structure.

Stratford Causeway – Stratford, CT
Triton Systems were selected to replace riprap at this environmentally sensitive site. The mattress structure provides a habitat for native plants, organisms and other wildlife.

Savannah River – Savannah, GA
The Triton® Marine Mattress System was installed to counter these conditions: soft subgrade soils, irregular subgrade surfaces and salt water.

Triton® Systems are Non-Metallic
Destructive metal corrosion, which causes billions of dollars in damage each year, is a primary reason to consider Triton Systems’ solutions.
TRITON® MARINE CELLS FOR EARTH FILLS

Triton® Marine Cells are used to construct high-strength, composite earth fills in adverse conditions – including confined, structural-quality fills built below the water level or with weak fill materials (a geotextile liner placed within the cells enables the use of fine-grained fill materials). As a three-dimensional foundation mat, Triton Marine Cells can improve not only constructability but also stability, bearing capacity and distribution of pressure. Their rapid filling characteristics and ability to reduce dewatering requirements can shorten construction timetables and increase productivity.

MARINE CELL ADVANTAGE
- Non-corrosive materials
- Faster filling than Gabions
- Stone Veneer option
- Construct structural embankments with marginal fill or submerged conditions

APPLICATIONS

Triton Marine Cells are used for:
- Bulkheads (new construction or rehabilitation)
- Cores for breakwaters, groins, jetties and dikes
- Foundations for embankments or MSE slopes or walls
- Containment dikes for dredge spoils or other waste materials

Marine Cell Systems

Triton® Marine Cells provide foundations for embankments, MSE slopes or walls and improve not only constructability, but also stability, bearing capacity and distribution of pressure.

Lake Calcasieu, LA

Rectangular Marine Cells are used to construct high-strength embankments in submerged conditions using fine-grained fills. Here, a Marine Cell forms the core of a riprap breakwater installation.
SOIL BIOENGINEERING WITH TENSAR® MSE SYSTEMS

For centuries, soil bioengineering techniques have been used to protect and restore sensitive watersheds. Among its many applications, soil bioengineering sustains vegetated systems that provide erosion control with additional benefits including:

- Improved water and air quality
- Support for terrestrial, riparian and aquatic habitats
- Storm water management
- Aesthetic site enhancement

Integrated with Tensar’s mechanically stabilized earth (MSE) systems, soil bioengineering has the capacity to reach new heights – literally – with the construction of Vegetated Reinforced Soil Slopes (VRSS) on highly steepened sites. Fully engineered, these ecologically and structurally sound installations provide secure, cost-effective and environmentally responsible solutions on river, stream, waterfront, upland slope and flood control sites. VRSS installations ensure the stability necessary to protect sites while supporting healthy, vegetated, maintenance-free environments.

INNOVATIVE SYSTEMS FOR SOUND SLOPE INSTALLATIONS

Tensar® offers three systems for VRSS projects. Each features the use of Tensar Uniaxial (UX) and/or Biaxial (BX) Geogrids for structural reinforcement and surficial stability. Systems include:

- Triton® Coastal and Waterway Systems - Triton Marine Mattresses, Marine Cells, Gabions and Cabion Mats feature the flexibility, durability and hydraulic stability required, conforming to land contours and irregular subgrades for effective erosion control. (See specific product profiles within this brochure.)
- Sierra® Slope Retention System - The Sierra System renders a reinforced, natural sloping structure nearly indistinguishable from native terrain. Geogrids and facing materials work together to provide beauty, performance, economy and versatility.
- SierraScape® Wire-Formed Retaining Wall System - The only geogrid-reinforced, wire-formed wall system featuring a positive mechanical connection. The SierraScape System effectively withstands differential settlement and provides exceptional stability in areas of seismic activity or the prevalence of heavy external loads.

Vegetated Reinforced Soil Slopes

Manufactured from durable polymers, these geogrids resist chemical, biological and environmental degradation to ensure long-term structural integrity and service life.

Tensar® VRSS promote the propagation of native vegetative root systems to strengthen reinforcement structures over time.

Cross section view of VRSS showing marine mattresses as toe protection and foundation support at the submerged toe of the reinforced slope.
INNOVATIVE SEDIMENT DEWATERING
Geotextile tube systems are among the newest solutions for sediment dewatering and containment. These systems offer an economical and environmentally friendlier alternative for conventional remediation and civil engineering projects including:
- Dewatering and containment of fine-grained, silty materials
- Dewatering and containment of mining and industrial waste, sewage sludge and contaminated waste
- Dredging and erosion control

UNIQUE, HIGH-STRENGTH FABRICATION
Triton® Geotextile Tubes are stronger and more durable than tubes made from conventional woven fabrics. They’re manufactured from a high-tenacity polyester yarn using a weft insertion knitting (WIK) process. WIK prevents the yarns from becoming crimped during production; as a result, the yarns achieve full tensile strength when subjected to loads, without the constraining deformations common to conventionally woven products. With that, Triton Geotextile Tubes can typically be pumped longer than conventional tube products. And because WIK fabrics incorporate a lightweight, non-woven geotextile backing, Triton Geotextile Tubes reliably contain even fine-grained, highly organic materials; effluents with less than 50 ppm total suspended solids (TSS) are not uncommon. Runoff from these tubes can generally comply with National Pollutant Discharge Elimination System (NPDES) regulations.

RESEARCH, FIELD-TESTED & PROVEN
Research at Drexel University and experience in the field have both demonstrated that flow rates for Triton Geotextile Tube fabric’s remain constant, even under peak tensile loadings. This result is attributed to the WIK manufacturing process. Consistent, high flow rates result in faster dewatering and reduced labor on site. Field testing and experience have also shown that Triton Geotextile Tubes are effective at dewatering a wide range of fine-grained sludge.

Triton® Geotextile Tubes

Triton Geotextile Tubes reliably contain fine-grained, highly organic materials. Triton Geotextile Tubes provide dewatering and containment of mining and industrial waste as well as fine-grained silty materials.
Gabions and Gabion Mats

Triton® Gabions offer a durable, non-corrosive and installation-friendly alternative to conventional steel wire gabions – including those galvanized and PVC-coated. They are advantageous for a number of earth stabilization and erosion protection applications.

Triton Gabion Mats are available in prefabricated units or in unfabricated roll form. The mat dimensions (up to 13 ft width and 164 ft length) can be customized to limit waste and to increase installation productivity, while the grid aperture can be reduced to accommodate smaller stone infill and to reduce mat thickness. Lighter in weight than metallic mats, Triton Gabion Mats are easier and less costly to transport, handle and install.

APPLICATIONS

Triton Gabion Mats are used for:
- Channel linings, ditches and spillways
- Scour aprons
- Shoreline protection
- Canal and stream bank protection

Triton Gabions and Gabion Mats are frequently specified for use where there is high potential for corrosion, such as:
- Salt water
- De-icing salt run-off
- Acidic environments (mining)

In addition to corrosion resistance, the lightweight materials are ideal for use on remote access locations, where getting to the site is a significant challenge.

The special, liftable configurations of Triton Gabion Mats also make a more lightweight version of a marine mattress. Ideal for light-to-moderate energy conditions or applications – they can be used as:
- Scour mats/substrate for artificial reefs, oyster beds, etc.
- Armoring steep slopes
- Foundation filtration or drainage for boat ramps, pipelines, low energy breakwaters and structures

Port of Spain – Trinidad

Triton® Gabion Mats provide long-term performance even in harsh chemical environments such as this saltwater tidal zone.

Cuenca del Rio Guayas – Guayaquil, Ecuador

Triton Gabion Mats are lightweight, customizable, and easy to handle – features which significantly ease installation.

Carraro del Rio Guayas – Guayaquil, Ecuador

Triton® Gabion Mats are lightweight, customizable, and easy to handle – features which significantly ease installation.
Triton® Filter Mattresses were developed in response to challenging conditions described by a project engineer. The problem was a deep scour hole that threatened an existing historical structure. The engineer knew what to do: place geotextile on the subgrade and place armor stone riprap on the geotextile to prevent further scour. The problem was how to keep the geotextile fabric in place until the contractor could get the armor stone in place. By encapsulating the geotextile fabric within a stone-filled geogrid mattress, the contractor was able to construct the revetment with the assurance that the geotextile fabric was exactly where it needed to be. Thus, Triton Filter Mattresses were designed for challenging underwater installation. They provide a deployment method to place geotextile fabric in deep water and strong currents.

The stone fill provides:
- Ballast weight for the geotextile fabric
- Bedding layer for additional riprap/armor stone

The Triton Filter Mat is designed to meet the challenges of effective scour protection in difficult installation conditions. The custom-fabricated "Filter Mat" (shown above) encapsulates geotextile fabric and six inches of aggregate. The filter mat serves two primary functions: deployment of geotextile in fast-moving water and foundation/scour protection for the armor stone riprap placed to protect the existing sea wall.

Features include:
- Job specific geotextile
- Thickness options
- Various installation or handling configuration options

Applications include:
- Submerged revetment foundation
- Submerged geotextile deployment

Triton® Filter Mattress System

Hereford Inlet Sea Wall – North Wildwood, NJ

The Triton® Filter Mattress System was installed to help improve the performance of the sea wall protection at the Hereford Inlet Sea Wall project.
PROTECTING AND RESTORING OUR WATERWAYS

The Triton® Marine Mattress™ System is a proven leader in the coastal and waterway erosion control market. Some of the characteristics that make the Marine Mattress Systems so effective for erosion control also make them effective for in situ capping of contaminated sediments. In addition to providing superior erosion control, Triton Marine Mattresses address industry concerns regarding:

- Potential for re-suspension of contaminants
- Erodibility of capping material
- Constructability
  - Uniform cap thickness
  - Over-design of capping layer to compensate for loss during construction
- Maintenance Concerns
  - Cost
  - Accessibility
- Overall durability of capping materials

Used in conjunction with the CETCO® Reactive Core Mat®, Triton Marine Mattresses have been deployed as part of a modular reactive capping system for the remediation of Non-Aqueous Phase Liquids (NAPL) contaminated sediments. The Triton Marine Mattress Systems have been used to provide effective capping for a wide range of contaminated sediment projects.

Triton Mattresses can also be configured to encapsulate alternative fill materials, such as sand, carbon or CETCO® Organoclay® materials in order to provide site-specific remediation solutions for a broad range of in situ capping applications.

In Situ Capping of Contaminated Sediment

Triton® Marine Mattresses have been deployed as part of a reactive capping system for the remediation of NAPL when used with CETCO® Reactive Core Mat®.

Triton Marine Mattresses have been used to provide effective capping for a wide range of contaminated sediment projects.
The Triton® Systems surpass traditional materials with highly adaptive, long-term solutions that are economical and easy to install. They conform to site conditions and project requirements to provide efficient erosion protection. Their inert materials resist rust, rot, and corrosion, even in harsh chemical environments. And with their use of available fill, environmentally friendly Triton Systems are cost-effective as well.

Tensar provides one other critical component with each Triton System – complete customer support. Our services support the entire process, from on-site evaluation to technical assistance during installation. And, our professional staff helps assure product availability and a prompt response. We’re committed to providing the right solution for your needs.

For more information on Triton Systems, call 800-TENSAR-1, visit [www.tensarcorp.com](http://www.tensarcorp.com) or e-mail info@tensarcorp.com. We are happy to supply you with additional system information, complete installation and design guidelines, system specifications, design details, conceptual designs, preliminary cost estimates, sealed construction drawings, summaries of completed projects and much more.

The Engineered Advantage