

COASTAL AND WATERWAY SYSTEMS

SYSTEM OVERVIEW



▶ Triton® Coastal and Waterway Systems are a durable, non-corrosive solution to many coastal and inland waterway erosion issues.



TENSAR® GEOGRIDS

Triton Systems owe their strength and durability to Tensar® Uniaxial (UX) Geogrids. These geogrids stand the test of time, performing better than other commercially available geosynthetics due to their stiff interlocking capability. For more information, visit www.tensarcorp.com.

Overview

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 used for the following applications:

- ▶ Bridge scour protection
- ▶ Channel lining
- ▶ Erosion control projects
- ▶ Causeway, levee, dike and bridge approach projects
- ▶ Capping of contaminated sediments
- ▶ Pipeline and cable protection
- ▶ Living shoreline projects
- ▶ Foundations for breakwaters, groins and jetties
- ▶ Erosion and scour control
- ▶ Underlayers for riprap in submerged and soft soils

Increased hydraulic performance and constructability advantages mean 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. Since Tensar® Geogrids enable 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.

TRITON Systems Components

COMPONENT	FUNCTION
Marine Mattress	Coastal Foundation, Riverbank and Shoreline Revetment
Filter Mattress	Bedding and Filtration, Deep Water Geotextile Installation
Gabions and Gabion Mats	Retention Structures, Channel Lining
Marine Cells	Breakwater Core, Embankment Foundation
Grid Composite	Riprap/Revetment Underlayer



Marine Mattress System

The Triton® Marine Mattress System is designed for demanding conditions associated with erosion control armoring, scour protection 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 Tensor® 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:

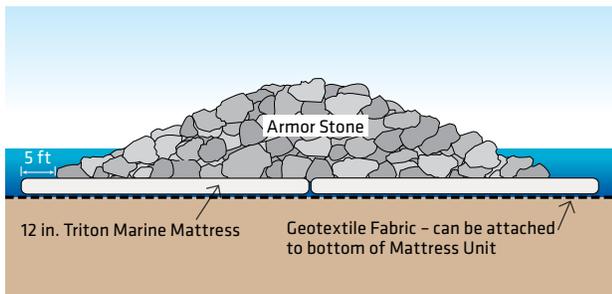
- ▶ Salt water or other harsh chemical environments
- ▶ Irregular subgrade surfaces or soft subgrade soils
- ▶ Steep slopes, stream or canal banks

- ▶ 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 dikes
- ▶ Scour mats for underwater pipeline crossings and sewage outfalls
- ▶ Riverbank protection, channel lining and bridge scour abatement.
- ▶ Bridge scour protection



Triton® Marine Mattress Breakwater Foundation

Marine mattresses simplify construction, increase support and reduce settlement caused by scouring action.



St. Andrews Bay, FL

Triton Marine Mattresses were placed over an exposed pipeline to protect it from marine traffic, tidal scour and storm impact.



Grid Composite System

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:

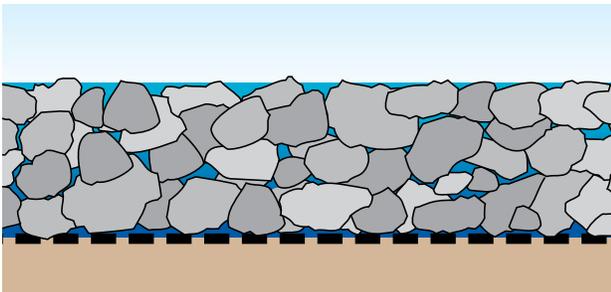
- ▶ Reducing settlement by distributing loads over a wider area (similar to the way a snowshoe works)
- ▶ Holding geotextile firmly against subgrade to guard against scour
- ▶ Providing a protective “cushion” for the geotextile during and after construction

The enhanced performance is important for a wide range of applications including revetments, channel linings, spillways, streambanks, scour protection, groins, jetties and breakwaters. Grid Composite can be particularly effective for improving performance and constructibility 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.



Soft Soils Installation

Provides load distribution to improve constructibility 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.



› Tensor® Geogrid composite eliminated the need for steel sheet piling for sand tightening this structure.



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

Dangerous metal corrosion, which causes billions of dollars in damage each year, is a primary reason to consider Triton Systems' solutions.



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.



Marine Cell Systems

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.

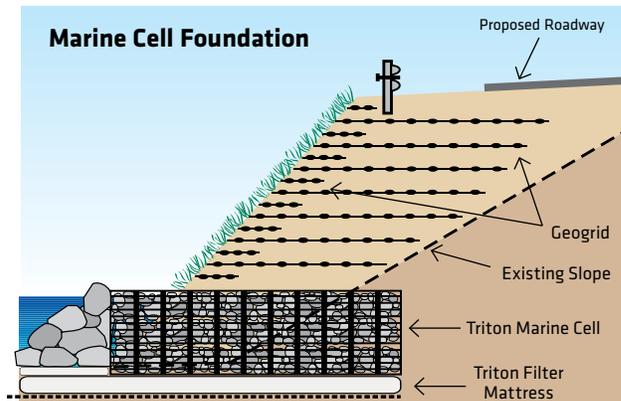
MARINE CELL ADVANTAGE

- ▶ 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



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.



Triton Circular Marine Cells anchored by Tensar® Geogrid, provide economical, easy-to-install solutions for applications like this channel wall in a residential community.



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



Vegetated Reinforced Soil Slopes

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.

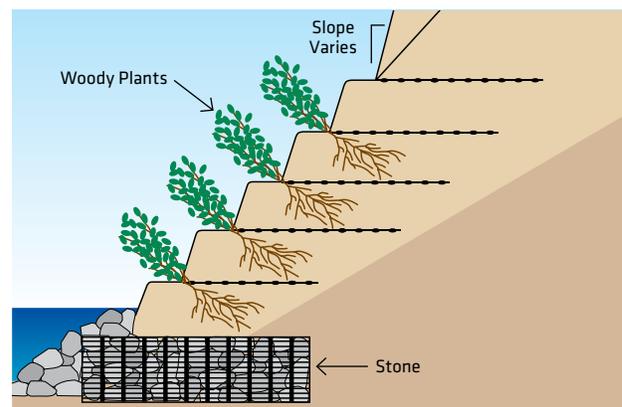


Tensar® VRSS promote the propagation of native vegetative root systems to strengthen reinforcement structures over time.

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 Gabion 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.



Cross section view of VRSS showing marine mattresses as toe protection and foundation support at the submerged toe of the reinforced slope.



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



Cuenca del Rio Guayas – Guayaquil, Ecuador

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



Gabion Mat – Chiapas, Mexico

Triton Gabion Mats provide protection to several kilometers of drainage canals. They were selected over competitive solutions due to superior performance and competitive cost.



Port of Spain – Trinidad

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



Triton® Filter Mattress System

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



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.



As a revetment foundation, the Filter Mat provides bedding and filtration, helping to prevent differential settlement. The mats also protect against scour at the toe of the revetment.





In Situ Capping of Contaminated Sediment

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.



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



Triton Marine Mattresses have been used to provide effective capping for a wide range of contaminated sediment projects.



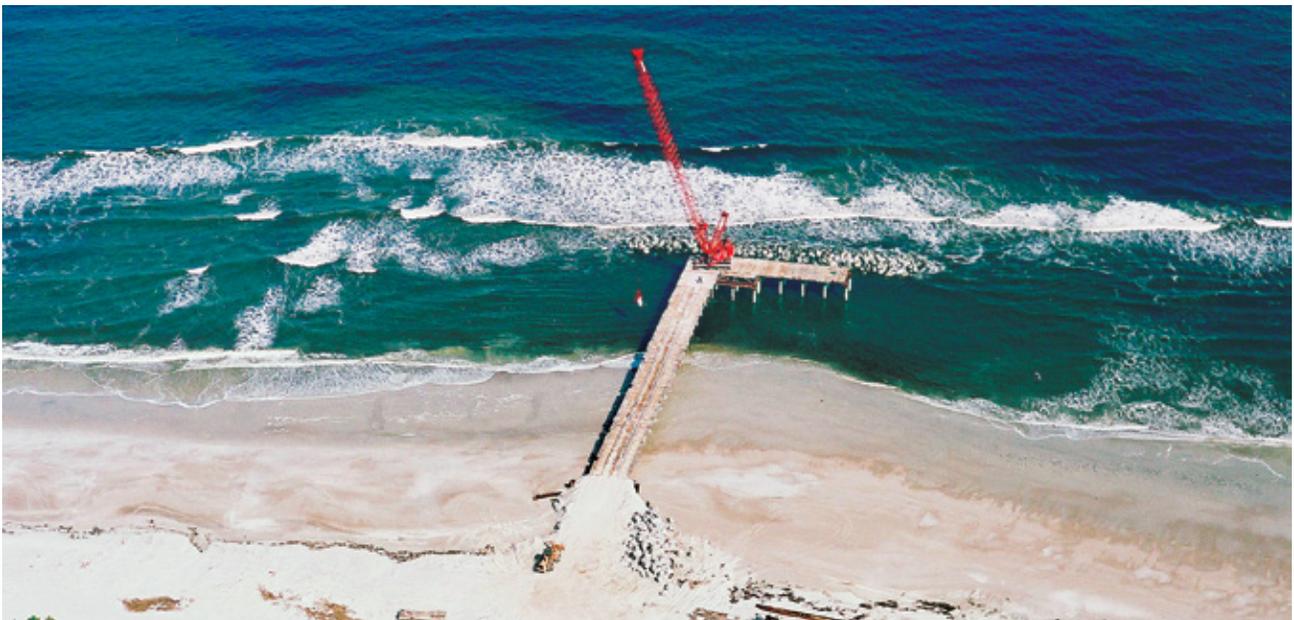


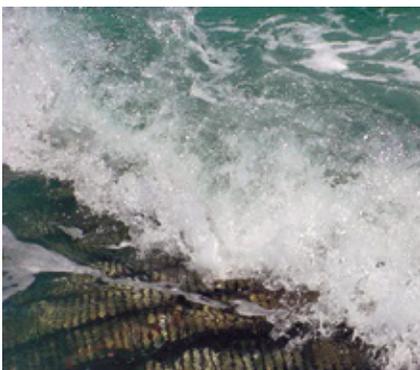
The Engineered Advantage

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, please call **800-TENSAR-1**, e-mail info@tensarcorp.com or visit www.tensarcorp.com/marine. 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.





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