

ADD³® CAPACITY IMPROVEMENT SYSTEMS

SYSTEM OVERVIEW



› The ADD³® Systems offer owners solutions that maximize the economy, life span and security of landfill sites.

Solutions for Waste Containment and Management Challenges

The decreasing number of potential waste containment sites, along with the general public mindset of “not-in-my-backyard,” makes optimization of sites a top priority for owners and engineers. Today’s state-of-the-art waste containment facilities often require the regulated use of specially designed systems to assure long-term collection, detection and containment. When placed over marginally stable or highly compressible foundation soils, the long-term performance of these systems becomes even more critical to leading owners, regulators and engineers in waste management.

Tensar International Corporation (Tensar) offers innovative solutions to these challenges. The ADD³® Capacity Improvement Systems are performance-based designs which can be customized to meet owners’ economic needs by optimizing the configuration of waste containment facilities based on site-specific conditions. The ADD³ Systems’ integrated approach to landfill construction can maximize the life span and security of both municipal and industrial landfills while reducing costs associated with construction and expansion.

Without increasing site boundaries, ADD³ Systems allow landfill construction and expansion, thereby increasing the

containment volume and extending service life of a waste containment facility. The systems can be used to:

- ▶ Construct new landfill cells that meet capacity criteria while reducing footprint requirements
- ▶ Allow construction of landfill cells over marginal foundations
- ▶ Structurally support new landfill cells built on top of existing landfill cells
- ▶ Build safer, structurally stable, steeper slopes to reduce land requirements and increase capacity

ADD³ Systems have also been used to build containment facilities for fly ash, mine slurry and heap leaching projects. Additionally, they are used to construct higher berms that increase the capacity and extend the life of such facilities.

ADD³ Systems may not only extend the life of a landfill, but they can also simplify the closure of impoundments and sludge ponds. Even when all other conventional technologies have failed, Tensar’s ADD³ Capacity Improvement Systems have been able to successfully and securely close sites while reducing expenses.



ADD³ steep berms increase landfill capacity within boundary constraints.



ADD³® System Components

COMPONENT	FUNCTION
Tensor® Uniaxial (UX) Geogrids	High-density polyethylene (HDPE) structural geogrids provide primary reinforcement allowing near-vertical construction of engineered berms. Highly resistant to chemical degradation, they can be used with non-select fill or even crushed stone.
Tensor® Biaxial (BX) Geogrids	High-density polypropylene (HDPP) structural geogrids provide durable reinforcement to the face of engineered berms.
Tensor® TriAx® (TX) Geogrids	Support soil cover layers of sludge or ash ponds.
Facing Elements	Wire-formed baskets provide temporary facial stability during placement and compaction of fill material and simplify facing alignment.
Connection Rods	These HDPE components facilitate a positive, mechanical connection between ends of rolls of Uniaxial Geogrid reinforcement.
Struts	Support struts are secured to the wire form and help stiffen the facing element and maintain facing alignment.
Turf Reinforcement Mats	Biodegradable erosion control blankets aid in vegetation establishment on the face of engineered berms.
Geotextiles	Non-woven, separation fabric provides filtration for the structural fill at the face of engineered berms. Only used in stone-faced or drainage applications.
Engineering Services	Engineering and design drawings are available for certain applications by separate contract, permit-level design drawings are prepared to assist owners with permit application, while more detailed construction-level design drawings for certain applications provided at time of construction.



Proven geosynthetic and structural components.

- › Tensar® Geogrids can reshape landfills, maximizing their capacity without changing their permitted footprint.

Tensar® Structural Geogrids for Reinforcement

The use of Tensar Geogrids as a support for critical waste containment systems is based on proven technology pioneered by Tensar in response to similar needs encountered worldwide in the civil marketplace. Unique in their quality, consistency and durability, Tensar Geogrids are composed of materials resistant to physical deterioration and loss of strength caused by aggressive chemical environments. They can be used to:

- ▶ Reshape landfills, maximizing their capacity at lower unit cost
- ▶ Provide structural support for lining systems underlain by municipal solid waste
- ▶ Cap and close sludge or ash facilities
- ▶ Help optimize the construction for secondary containment of chemical and petrochemical products

TENSAR® TRIAX® (TX) AND BIAxIAL (BX) GEOGRIDS

Tensar TX and BX Geogrids are created using select grades of polypropylene. TX Geogrids are specifically designed to reinforce fill materials for unpaved roads and capping applications. BX Geogrids are designed to reinforce fill materials for small dikes, berms and similar structures, as well as provide reinforcement to the face of engineered berms.

TENSAR® UNIAXIAL (UX) GEOGRIDS

Tensar UX Geogrids are manufactured using select grades of high-density polyethylene (HDPE) resins that are highly oriented and resist elongation (creep) when subjected to high tensile loads for long periods of time. These geogrids carry large tensile loads applied in one direction, and their open aperture structure interlocks with natural fill materials. They are ideally suited to reinforce soil slopes and buttresses, to support lining and cover systems and to prevent slippage of protective soil layers (veneers) on interior and exterior berm slopes.



Tensar Uniaxial HDPE Geogrids and Biaxial Polypropylene Geogrids are durable and reliable.



Tensar TriAx Geogrids, designed to interlock and confine aggregate particles to create a mechanically stabilized layer with improved bearing capacity.



Engineered Berms Maximize Landfill Capacity

The use of engineered berms allows for a custom-engineered reconfiguration of a waste containment facility, maximizing disposal capacity while meeting all regulatory requirements and enhancing the overall revenue potential of the site. They can be used to detail the exterior or interior slope of a perimeter berm to optimize the geometry of the containment berm of a landfill cell within the permitted limits of construction.

The use of an engineered berm at a waste containment facility provides a landfill owner with the following:

- ▶ Additional revenue-generating airspace within the originally permitted landfill footprint (versus that generated by conventional berm construction)
- ▶ Additional time to permit future landfill cells; the typical engineered berm is smaller than its conventional counterpart of the same height. This smaller berm geometry also brings about an associated reduction in fill requirements.
- ▶ Construction that accommodates site geometry challenges such as sedimentation basins, existing roadways, creeks and rivers, or weak and compressible soils

- ▶ Optimization of berm geometry and maximization of containment volumes for fly ash and bottom waste at power generating facilities

Since the early 1990s, Tensar has helped municipal solid waste facilities optimize their financial performance and environmental security through the design of engineered berms. Using structural geogrids and engineering expertise, we help to reconfigure landfills while ensuring long-term stability.

Tensar can help increase the waste containment capacity of any site to its maximum potential, reducing long-term costs and assuring a higher level of environmental security.



Standard construction techniques with proven MSE technology.



- ▶ **Tensor® Uniaxial Geogrids . . . high load carrying capability at low strain levels.**

Liner Support and Veneer Stability

LINER SUPPORT – A STRAIN MANAGEMENT APPLICATION

The construction of a new landfill cell over an existing one can offer significant advantages, especially when permitting concerns exist for a new site. However, when existing Subtitle D landfill cells are expanded vertically or laterally over existing cells, care must be taken to protect the integrity of the new lining system. Tensor® Uniaxial (UX) Geogrids, when designed into the liner system of vertical or horizontal expansion, can be used to manage the strains created by the new construction, thus allowing the expansion to generate new usable airspace without sacrifice to the lining system’s integrity.

A liner support solution allows you to:

- ▶ Create new, usable airspace via vertical or horizontal expansion of an existing cell
- ▶ Construct a new landfill cell over marginal foundations

By reinforcing the lining system, you gain:

- ▶ Additional cost saving by not having to permit a new site
- ▶ Relatively fast regulatory approval

The components of a containment system typically include synthetic or clay liners together with synthetic drainage media. The performance of these components is critical. A rupture or leak could result in contamination of the surrounding groundwater.

Although the barrier and leachate collection/detection components of these systems may be functionally superior to their conventional soil counterparts, they have no significant tensile strength. This lack of tensile resistance prevents these components from contributing meaningfully as a support constituent for the lining system. In particular, the critical geomembrane component of the lining system is strain-sensitive since its ability to function as a barrier is directly related to its thickness. For those instances where there is marginal subgrade under the lining system, the strains that could develop in the lining system must therefore be managed.

TENSAR STRUCTURAL SECURITY

Due to the punched and drawn manufacturing process used to produce Tensor UX Geogrids, these products have essentially been “pre-stressed,” allowing them to provide high strength



Tensor UX Geogrids can protect the integrity of lining systems by managing lateral strains created by new landfill construction.



Tensor UX Geogrid structural connections minimize waste factors.



at low strain. This characteristic makes them ideally suited for strain-management applications such as liner support. Whether the marginal support conditions are the result of heterogeneous municipal solid waste construction, or due to the construction of a new landfill cell where foundation soils are weak and compressible, Tensar® UX Geogrids can be used to minimize the distortions and deformations within a landfill lining system and reduce the induced tensile stresses and associated strains to within acceptable limits. The high performance and structural characteristics of Tensar® Geogrids are a result of extraordinary tensile strength, tensile modulus, durability and soil interaction.

VENEER STABILITY

Soil covers are often employed at waste containment facilities to provide a protective cover for other abrasion or ultraviolet (UV) sensitive geosynthetic components of a liner system. The weight of these soil or aggregate veneer covers, in combination with the inherently weak interface friction characteristics between many commonly used geosynthetics, may facilitate a sliding failure and possibly result in a rupture within the lining system. Our engineered solutions, using Tensar UX Geogrids, can support the soil cover, reducing the stress placed on the underlying lining system and ensuring the long-term stability of the waste containment facility.

A veneer stability application utilizing Tensar UX Geogrids allows you to:

- ▶ Introduce a load-carrying component to the lining system to ensure veneer stability
- ▶ Construct steeper side slopes, allowing for additional containment capacity

A PROVEN TECHNOLOGY

Tensar Uniaxial “SB” Geogrids have been used to address the veneer stability of landfill interior and exterior side slopes since the 1980s. The SB series of geogrids, with their pronounced and more closely spaced transverse bars, allow interlock with the sloping soil layer, so the weight of the soil is transferred to the geogrid. The geogrid is securely anchored at the top of the slope in an anchor trench, while the tension in the geogrid prevents downslope sliding of the soil layer. As a result, the Tensar Geogrid protects the integrity of the lining system. The SB Series of geogrids is also used to address the veneer stability of aggregate layers as required by containment berms at tank farms.



Their pronounced and more closely spaced transverse bars makes the Tensar SB products ideal for veneer stability applications.

► Tensar® TriAx® Geogrids can be used to facilitate cap construction when incorporated in an engineered design and construction plan.

Waste Containment Pond Closures

Owners of industrial facilities are regularly faced with the challenges linked to disposal of the liquid and solid wastes associated with their manufacturing process. Typically, these wastes are either landfilled, or they are transported hydraulically for eventual deposition in a containment pond, where they are then often called sludges or tailings. Although these ponds do provide a temporary solution to the disposal challenges presented by the waste, unfortunately, new problems are introduced that are as daunting as the original disposal problem.

These new challenges range from maintenance issues, such as the ongoing cost of treating the runoff from the containment ponds, to the safety issue of preventing animals and people from accessing what is often an unsafe environment.

One permanent solution to the ongoing challenges listed above is to construct a soil cap over the containment facility. This soil cap would allow surface water runoff to be treated as natural storm water and, since the soil results in the placement of a barrier between the waste and the environment, the consequences of animal or human interaction with the containment area are significantly reduced.

When used in a sludge-capping application, Tensar® TriAx® (TX) Geogrids can be used to:

- Allow for final closure of waste containment facilities
- Eliminate the ongoing costs of water runoff treatment from the containment area
- Eliminate the danger of animal or human access to the contaminated area

Tensar TriAx (TX) Geogrids achieve the benefits listed above by serving as one component of a system that allows the safe construction of soil caps over a range of sludge or other waste deposits. When properly accompanied by adequate geotechnical design and a proper construction scheme executed by experienced, qualified contractors, even weak compressible sludges can be safely and economically capped.

Since the design and construction of successful capping projects are necessarily linked, Tensar does not currently offer stand-alone design services related to sludge capping. The success of a given sludge cap is very much a function of execution. Referrals are available to entities who are qualified and experienced in the design and construction of sludge caps using Tensar Geogrids.



Stiff TriAx Geogrids are ideal for soft soil applications.





Land Revitalization of Environmentally Contaminated Sites

It is the goal of Tensar to be an outstanding corporate citizen dedicated to developing earth stabilization solutions that are structurally sound and environmentally responsible. To meet current practices of the U.S. Environmental Protection Agency (EPA) to revitalize contaminated land into economically productive green space, Tensar can help to redevelop sites such as Brownfield properties that include closed waste containment sites and abandoned industrial facilities.

Brownfields are real property by which the expansion, redevelopment or reuse may be complicated by the presence of a hazardous substance, pollutant or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, while improving and protecting the environment (source – USEPA website).

Environmentally challenging sites like Brownfields often present marginal subgrade conditions due to the inherent heterogeneity of the site foundation soils, where the costs and viability of developing these sites can be significantly impacted by the treatment costs associated with mitigating these conditions. Tensar® TriAx® (TX) Geogrids can be used to improve the otherwise marginal support capability of a typical contaminated site. And because Tensar Geogrids are backed

by more than 25 years of research, their proven performance can translate into predictable construction costs and schedules once incorporated over these poor foundation soils.

When faced with the high-cost option of undercutting the variable subgrade offered by a typical environmentally contaminated site, the inclusion of a stiff, Tensar TriAx Geogrid layer offers an economically attractive and practical alternative. Potential applications of Tensar Geogrids include the development of parking lots, sports fields and bike paths constructed over closed waste containment structures.



Land revitalization made possible with geosynthetics.

➤ Tensar's Engineering Department can provide permit-level and construction-level designs for engineered berms.



Design Services and Site Assistance

In addition to manufacturing the highest quality geogrids with performance proven over 25 years, Tensar also offers support for its products in the form of design, design assistance and site assistance.

Tensar's Engineering Department offers permit and construction-level design services for the engineered berm application featured in this brochure. Tensar's experienced Engineering Department can offer a fast turnaround on stamped drawings for final construction-level projects or work with regulators and state agencies to help obtain permits. For liner support, veneer stability and Brownfield applications of its products, Tensar offers conceptual design assistance.

Most projects involving the environmental application of Tensar products require the owner to retain full-time CQA oversight of the contractor. On projects utilizing Tensar products, Tensar personnel can, by separate contract, provide a supplementary part-time presence on-site to offer suggestions regarding installation of Tensar products. During-construction, site assistance and participation in planned post-construction monitoring programs are two ways that Tensar can, by separate contract, provide further services in support of its products in the field.

For more information on the ADD³® Capacity Improvement Systems featuring Tensar® Geogrids, call **800-TENSAR-1**, visit **www.tensarcorp.com** or e-mail **info@tensarcorp.com**.



Years of experience from the industry leader make Tensar Engineering and field support services second to none.



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