Earthstopping Solutions™

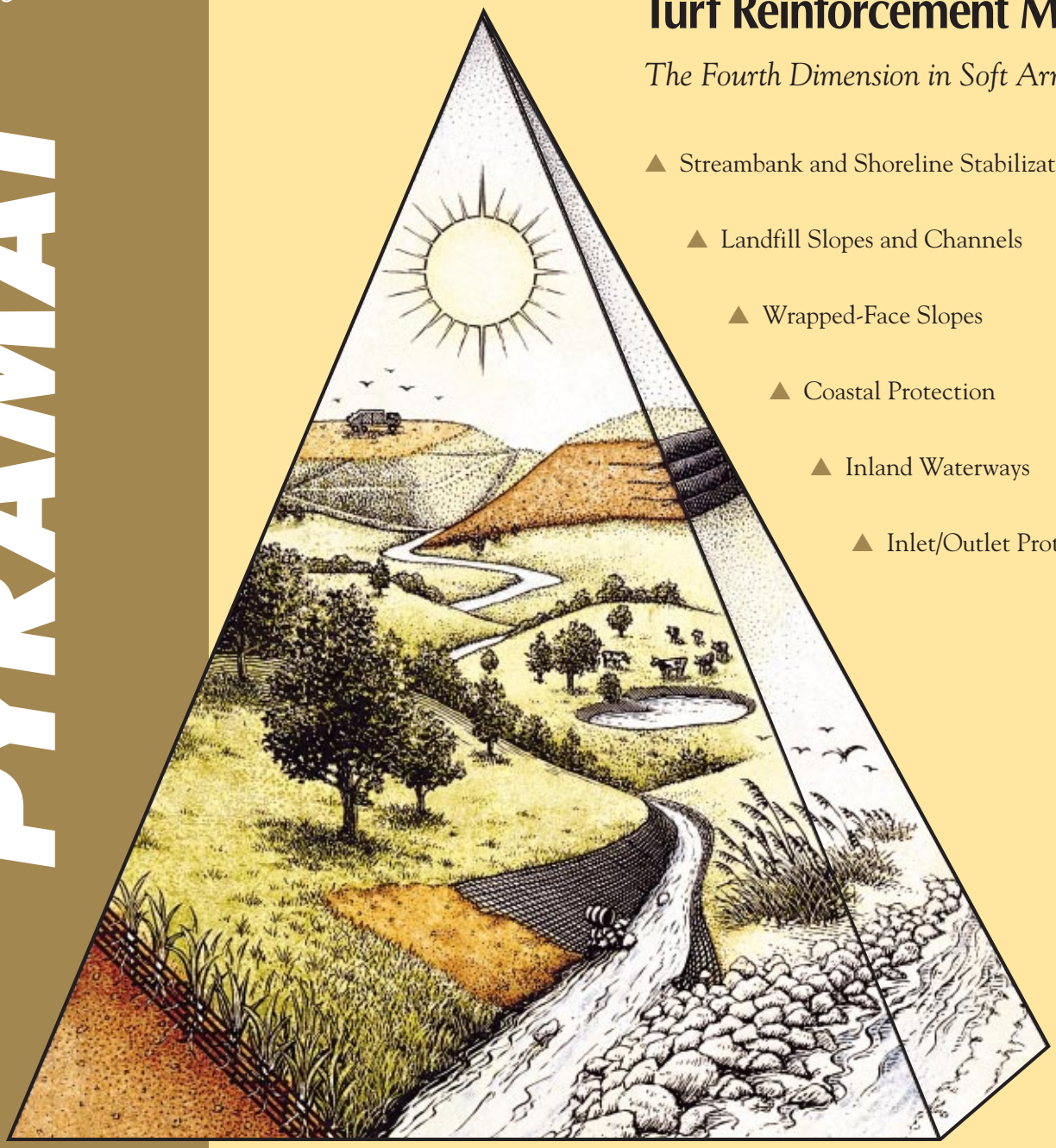
PYRAMAT®

Pyramat
Earthstopping Solutions.

High Performance Turf Reinforcement Mat

The Fourth Dimension in Soft Armor

- Streambank and Shoreline Stabilization
- Landfill Slopes and Channels
- Wrapped-Face Slopes
- Coastal Protection
- Inland Waterways
- Inlet/Outlet Protection



SI® Geosolutions

The Mystery of the Pyramids

Pyr-a-mid \ 'pir-ə-mid \ n [L *pyramid -, pyramis*, fr. Gk. of unknown origin] (1549) 1 a: an ancient massive structure found esp. in Egypt having typically a square ground plan, outside walls in the form of four triangles that meet in a point at the top, and inner sepulchral chambers **b:** a structure or object of similar form.

Throughout the sands of time, the word "pyramid" has brought to mind images of strength, power, dominance and permanence all shadowed by a mystique of strange and unusual properties. Ancient civilizations constructed massive pyramid structures as ceremonial monuments.

Thousands of years later, these structures remain intact. Scholars still attempt to comprehend and chronicle the enigmatic history, construction and often inexplicable properties of these highly efficient structures.

Pyramids have truly stood the test of time.

The Matrix of Pyramids

Bi-o-tech-ni-cal com-pos-ite® \ bī-ō-'tek-ni-kəl käm-'päz-ət \ n (1991) the synergistic, mutually beneficial union of living plant tissue and structurally integrated geosynthetic materials to provide permanently enhanced erosion protection and stability.

Through the years, flexible soft armor techniques have emerged as proven and preferred alternatives to traditional hard erosion control approaches emphasizing expensive and unattractive rock, concrete and structural materials. Yet many designers have been hesitant to employ environmentally superior soft solutions due to concerns regarding their retained strength, durability and performance through *time, the fourth dimension*.

Focused on superior, long-term performance, designers at SI® Geosolutions have created Pyramat® high performance turf reinforcement mat. This patented, *three-dimensional woven geotextile matrix* is composed of UV stabilized polypropylene monofilament yarns woven into a dimensionally stable, uniform configuration of resilient *pyramid-like projections*.

Using a novel and highly sophisticated weaving process all yarns are locked in place to create a unique turf reinforcement mat which exceeds the vegetal reinforcement capabilities of conventional *biotechnical composites* and combines the long-term strength, dimensional stability, durability and functional longevity of a *high performance geotextile*.

The efficient geometry of Pyramat erosion matrix helps stabilize soils and reinforce vegetation. Upward and downward protruding "pyra-cells" capture and contain soil while the multiple layers of gridlike "pyra-ribs" interlock with surrounding soils.

In addition, close inspection of the lofty matrix will reveal "hidden chambers" which literally entomb soils, even under high flow conditions. Pyramat *high performance turf reinforcement mat* (HP-TRM) is the product for demanding erosion control applications – where reinforcement of vegetation is desired to replace hard armor and increase soil stability.

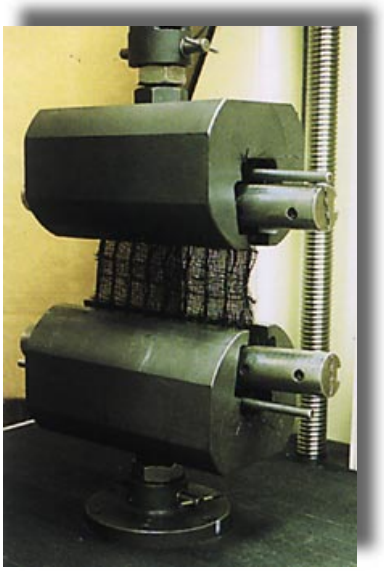
Demonstration of soil containment and interlock by pyramidal cells and ribs.

Pyramid Power

Pyramat® high performance turf reinforcement mat is a precise, highly engineered product possessing the optimal qualities for *geobotanical reinforcement*. Unparalleled strength and dimensional stability in an open, three-dimensional geotextile designed to nurture and reinforce vegetation, makes Pyramat the ultimate "new generation" turf reinforcement mat.

Part of the Landlok® family of erosion control products, Pyramat provides many times the strength of popular Turf Reinforcement Mats (TRMs) currently available. The tensile properties of Pyramat even exceed those of many conventional, two-dimensional geotextiles and geogrids. Moreover, the strength of Pyramat is distributed over three dimensions.

Direct shear and pullout testing has demonstrated that Pyramat's three-dimensional structure has a very high coefficient of friction with soils. A high interface shearing resistance makes Pyramat erosion matrix an ideal material to stabilize coast lines, embankments and landfill caps. Once emerging roots of the developing vegetation reach the zone of reinforcement, the resulting revegetation platform will provide increased slope stability and erosion control on critical sites.

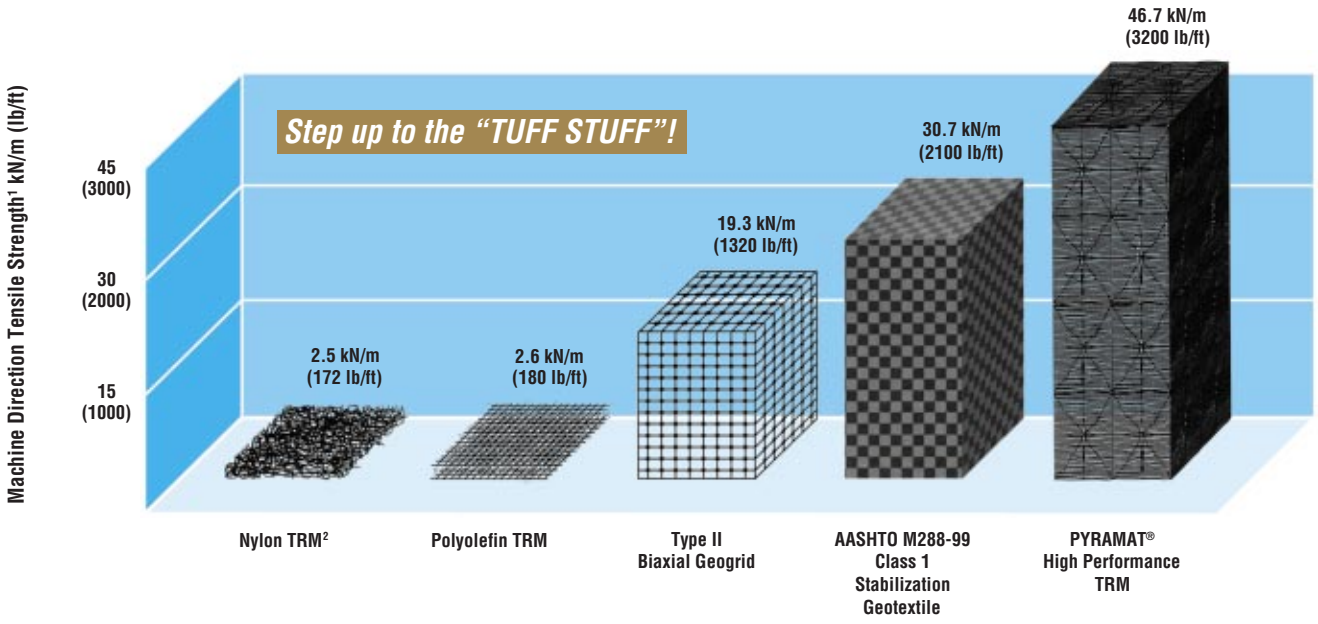


Wide width tensile testing of Pyramat®.

The abrasion resistant, resilient Pyramat structure also provides maximum resistance to construction and maintenance induced stresses. Field surveys have demonstrated that low strength mattings may sustain mechanical damage and rutting from passes of maintenance (mowing), emergency, service and recreational vehicles.

Pyramat provides greater tensile properties than an AASHTO M288-99*, Class 1, Stabilization Geotextile, ensuring protection from both anticipated and unanticipated abuse.

PUBLISHED TENSILE STRENGTHS FOR GEOSYNTHETIC MATERIALS



1 Minimum average roll values; wide width tensile test per ASTM D-4595

2 Manufacturer only publishes typical values

* AASHTO is an acronym for the American Association of State Highway Transportation Officials

The Performance Pyramid

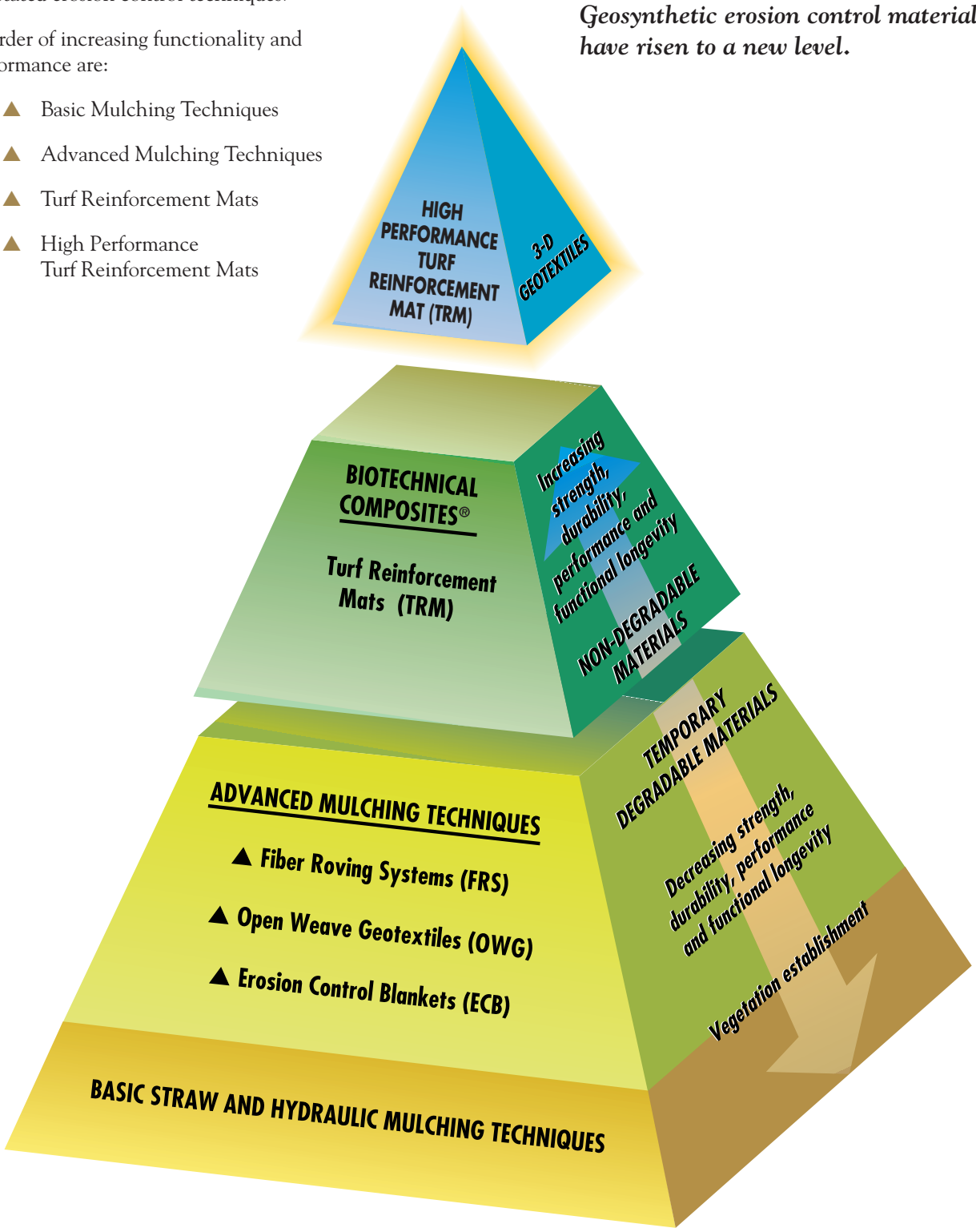
The erosion and sediment control industry has rapidly evolved into a diverse hierarchy of cost-effective methods and techniques. The adjacent *Performance Pyramid* highlights the four primary divisions of vegetated erosion control techniques.

In order of increasing functionality and performance are:

- Basic Mulching Techniques
- Advanced Mulching Techniques
- Turf Reinforcement Mats
- High Performance Turf Reinforcement Mats

Superior tensile properties combined with rugged construction, durability, proven performance and unsurpassed functional longevity clearly separate the high survivability Pyramat® from existing TRMs.

Geosynthetic erosion control materials have risen to a new level.



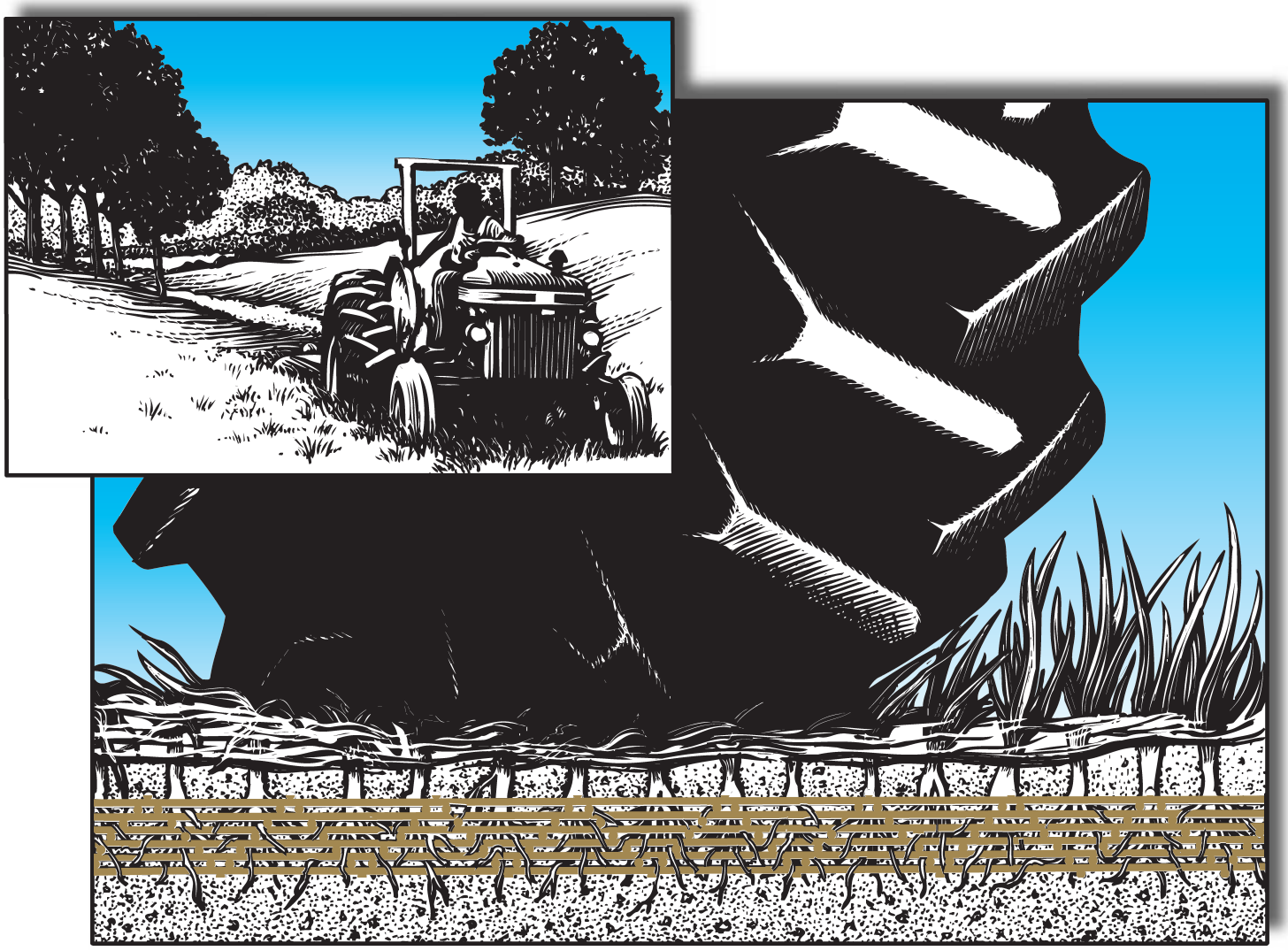
Functional Longevity for the Ages

Reinforcement matrices must provide long-term performance under adverse conditions. In arid to semi-arid regions or sites where establishment of vegetation is slow, inadequately stabilized TRMs may undergo significant UV degradation prior to performing their primary function.

The durable Pyramat® erosion matrix is designed to withstand prolonged exposure in the challenging conditions of demanding jobsites or inhospitable climates. Ultraviolet stabilizers assure functional longevity when vegetative establishment is delayed or the matrix is otherwise exposed to extended periods of sunlight.

Pyramat's polypropylene yarns are resistant to biodegradation and unaffected by chemicals normally found in soils. Some polymers, such as moisture absorbing polyamides (nylon), may be subject to temporary and permanent loss of strength from both chemical and hydrolytic attack. Because polyolefins (polypropylene) absorb negligible amounts of water, Pyramat will maintain its tensile properties under saturated conditions with no long-term loss of strength via hydrolysis.

This corrosion resistant matrix will endure as a key component of a shoreline protection system, even in brackish or salt water conditions. Careful polymer selection, high strength, resiliency, abrasion and puncture resistance, and unsurpassed dimensional stability ensure *these pyramids will also stand the test of time*.



Pyramat® high performance TRM provides "rebar for root systems."

Peak Performance

Performance of Pyramat® erosion matrix has been extensively evaluated at two renowned hydraulics testing laboratories in the western United States.

Establishing a flow rate versus time continuum, performance (see graph below) has been quantified using vegetated and non-vegetated mattings versus nonreinforced vegetation and bare soil. These studies identify the design window which provides performance guidelines from time of installation, transitioning to a mature vegetated condition for the long-term design life of the project.

Maximum recommended permissible velocities and shear stresses for Pyramat are presented in the table above. Vegetated, Pyramat will resist flow velocities of up to 7.6 m/sec (25 ft/sec) at shear stresses up to 48.9 kg/m^2 (10 lb/ft^2).

Additionally, the resistance of unvegetated Pyramat to directly applied shear stresses was measured using a specially designed flume. The Pyramat three-dimensional structure resisted the maximum shear developed at full-flume capacity with no deformation whatsoever. Maximum shear stress developed was approximately 39.2 kg/m^2 (8 lb/ft^2) at a velocity of 6.1 m/sec (20 ft/sec).

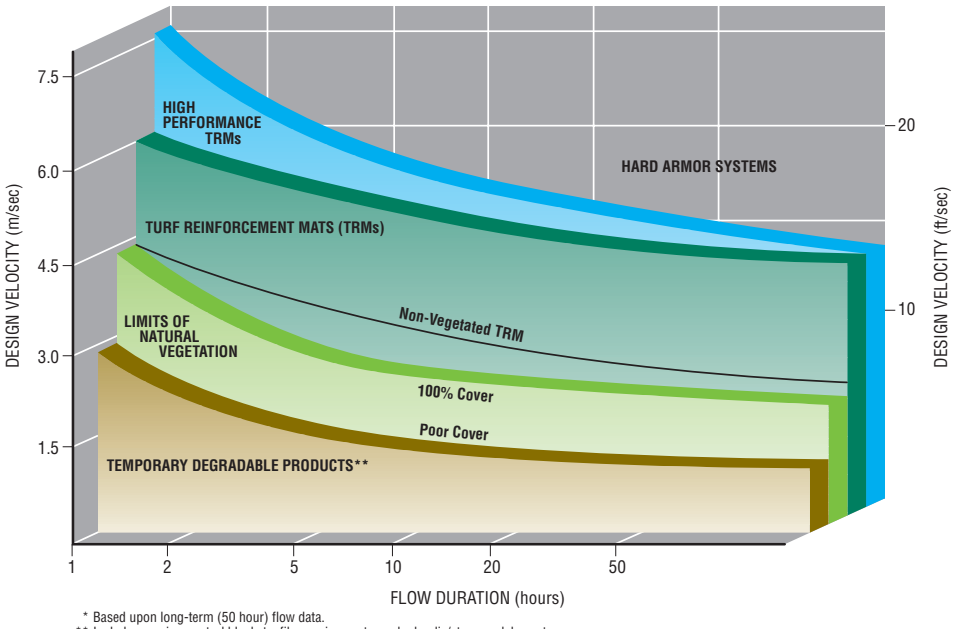
The graph below illustrates the enhanced performance of Pyramat high performance turf reinforcement mat above that of conventional *Biotechnical Composites*® and natural vegetation.

PYRAMAT® MAXIMUM PERMISSIBLE DESIGN VALUES

PERFORMANCE	SHORT-TERM (½ hr)	LONG-TERM (50 hrs)
VELOCITY		
Vegetated	7.6 m/sec (25 ft/sec)	4.3 m/sec (14 ft/sec)
Unvegetated	6.1 m/sec (20 ft/sec)	3.0 m/sec (10 ft/sec)
SHEAR STRESS		
Vegetated	48.9 kg/m^2 (10 lb/ft^2)	29.3 kg/m^2 (6 lb/ft^2)
Unvegetated	39.2 kg/m^2 (8 lb/ft^2)	14.7 kg/m^2 (3 lb/ft^2)

High velocity hydraulic flume testing.

LONG-TERM PERFORMANCE GUIDELINES*



* Based upon long-term (50 hour) flow data.
** Includes erosion control blankets, fiber roving systems, hydraulic/straw mulches, etc.

Pyramat® high performance TRM (HP-TRM) takes turf reinforcement to unprecedented levels.

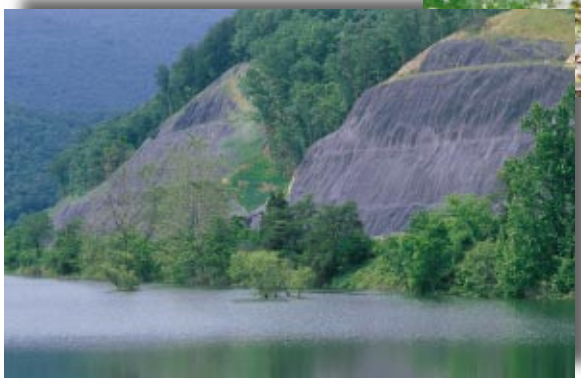
PYRAMAT® Applications

Pyramat® handles a broad range of discriminating biotechnical applications requiring vegetated soil reinforcement and stabilization including:

- Stormwater/Drainage High Flow Channels
- Landfill Caps, Slopes & Diversion Structures
- Dam, Dike & Levee Protection
- Bank & Shoreline Stabilization
- Geosynthetic Reinforced Earth Structures
- Vegetated Geotextile Slope Facings
- Veneer Cover Soil Stabilization
- Inlet/Outlet Protection

Other potential applications include:

- Grassed Access Roads/Temporary Parking Areas
- Pre-grown Reinforced Vegetated Carpets
- Bioengineered "Geologs"
- Sports Turf Protection
- High Friction/High Flow Geotextile Beneath Hard Armor
- Grout-Filled Transitional Matrix for:
  - Low Flow, Pilot or Trickle Channels
  - Outfall Protection
  - Pond & Lagoon Shorelines



Steep slope stabilization.

PYRAMAT® Installation

The rugged Pyramat matrix will also absorb considerable installation stress permitting the use of mechanical equipment. The matrix will perform best when installed beneath the soil surface.

- When used as a vegetative reinforcement matrix, the product should be installed first, seeded, then a ½″ – 1″ veneer of soil placed and compacted into the "pyra-cells."
- Light weight wheeled equipment or vibratory tampers may be carefully utilized to facilitate compaction.
- Refer to the Synthetic Industries Pyramat Installation instructions as a soil-filled matrix.
- For other installation requirements, please contact SI® Geosolutions for prompt recommendations and on-site construction assistance at (423) 899-0444 or toll free in the USA at (800) FIX-SOIL.

Channel protection.

Engineering Specifications

The **HIGH PERFORMANCE TURF REINFORCEMENT MAT** shall be a three-dimensional, lofty, woven polypropylene geotextile specially designed for erosion control applications on steep slopes, water containment structures and vegetated waterways. The matrix shall be composed of polypropylene monofilament yarns woven into a uniform, dimensionally stable configuration of resilient pyramid-like projections. The material shall exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus. The high performance TRM shall conform to the property values listed below under dry or saturated conditions.

		MINIMUM AVERAGE ROLL VALUES (MARV)	
PROPERTY	**TEST METHOD**	**ENGLISH**	**METRIC**
MECHANICAL			
Tensile Strength[2]	ASTM D-4595	3,200 X 2,200 lb/ft	46.7 X 32.1 kN/m
	ASTM D-5035	3,100 X 2,000 lb/ft	45.2 X 29.2 kN/m
Tensile Elongation[2]	ASTM D-4595	80% (max)	80% (max)
	ASTM D-5035	55% (max)	55% (max)
ENDURANCE			
UV Resistance @ 1000 hours	ASTM D-4355	80%	80%
PHYSICAL			
Thickness	ASTM D-1777	0.5 in	12.7 mm
Resiliency[3]	ASTM D-1777	80%	80%
Mass Per Unit Area	ASTM D-5621	14 oz/yd^2	475 g/m^2
Ground Cover Factor[4]	Light Projection Analysis	75%	75%
PERFORMANCE	**MAXIMUM PERMISSIBLE VALUES**		
Velocity	Short-Term (½ hr)		Long-Term (50 hrs)	
Vegetated	25 ft/sec	7.6 m/sec	14 ft/sec	4.3 m/sec
Unvegetated	20 ft/sec	6.1 m/sec	10 ft/sec	3.0 m/sec
Shear Stress				
Vegetated	10 lb/ft^2	48.9 kg/m^2	6 lb/ft^2	29.3 kg/m^2
Unvegetated	8 lb/ft^2	39.2 kg/m^2	3 lb/ft^2	14.7 kg/m^2

NOTES:

1 *All published values are Minimum Average Roll Values (MARV) unless otherwise indicated, yielding a 95% confidence level. Additional property values available upon request.*

2 *Values for both machine and cross machine directions under dry or saturated conditions.*

3 *Resiliency defined as percent of original thickness retained after 3 cycles of a 100 psi load (690 kPa) for 60 seconds without load… thickness measured 30 minutes after load removed in accordance with ASTM D-1777.*

4 *Ground Cover Factor represents "% shade" from Lumite® Light Projection Test.*

5 *Values obtained at an independent hydraulics testing laboratory.*

STANDARD ROLL SIZE INFORMATION

2.59 m x 27.4 m = 71 m^2

8.5 ft x 90 ft = 765 ft^2 = 85 yd^2

EC-DESIGN® 2000

EC-DESIGN® 2000, SI's newest erosion control computer software, lets users select the most appropriate erosion control product for a variety of channel and slope applications. The calculations follow state-of-the-practice U.S. Federal Highway Administration (FHWA) and Department of Agriculture (USDA) procedures, including maximum velocity and shear stress analyses, integration of compound channels, soil loss estimations and pull-down window screens. Once the most appropriate product is selected, the results, specifications and CAD drawings are printed or can be saved electronically.

EC-DESIGN 2000 offers these important features:

- Channel lining design
- Slope protection design analysis
- Maximum permissible velocity and shear stress approaches
- Integration of compound flexible channel lining systems
- Interactive cost analysis for channels and slopes

Specify the best with total confidence.

SMART SOLUTIONS®

Analyzing and solving civil and environmental problems is our focus. We want to work with you on your next project.

FOR ADDITIONAL INFORMATION, PLEASE CALL:

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Membership Affiliations Include:

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International geotextile society

Construction and Civil Engineering Solutions

- GEOTEX® woven and nonwoven geotextiles
- GEOTEX® structural soil reinforcement geotextiles and geotextile tubes
- PAVE-DRY® asphalt overlay fabrics
- LANDLOK® turf reinforcement mats, erosion control blankets and fiber roving systems
- LANDLOK® natural erosion control blankets
- PYRAMAT® high performance turf reinforcement mat
- GEOFIBERS® 3-dimensional soil reinforcement fibers
- FIBERMESH® synthetic fibers for concrete reinforcement
- NOVOCON® steel fibers for concrete reinforcement

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