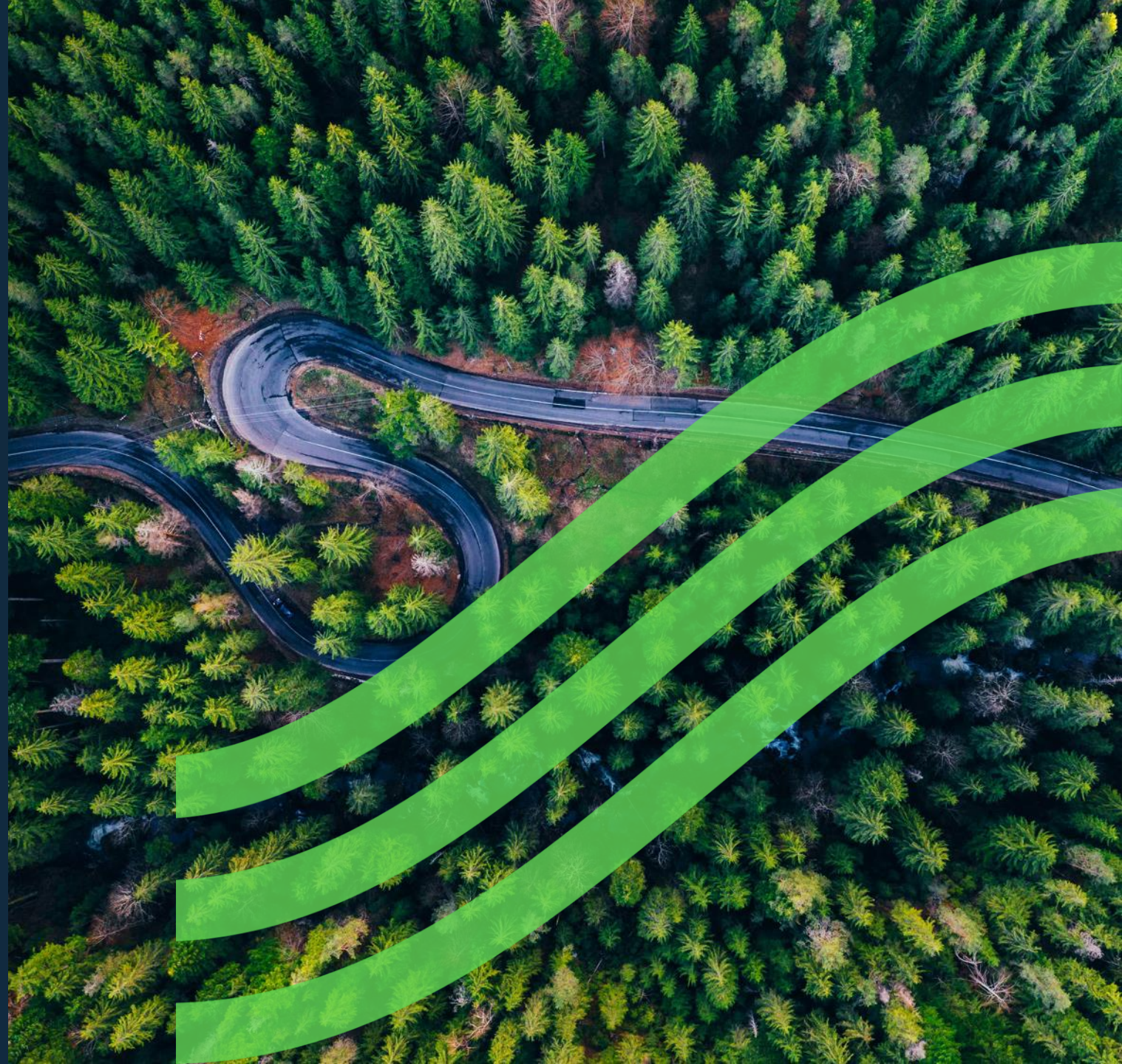
SOLMAX

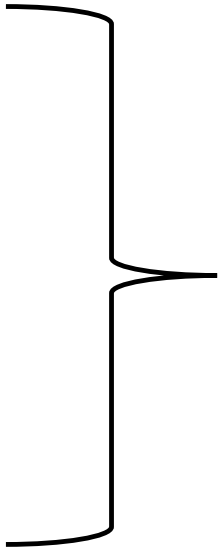
Geosynthetics for Energy Sector Development



Rocio Lopez-Velasco MSc. Eng.
Engineering Business Manager
Louisiana & Texas

Wood
Steel
Cement / Concrete
Soil
Bituminous Materials

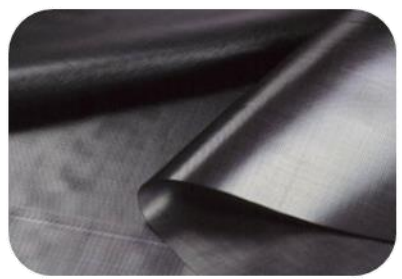
Geosynthetics



Engineering Materials

Geosynthetics = Engineering Material

The term **geosynthetic**s describes a family of synthetic products used in geotechnical applications to stabilize terrain. **Geosynthetics** are typically polymeric products encompassing geotextiles (a.k.a., fabrics), geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites.



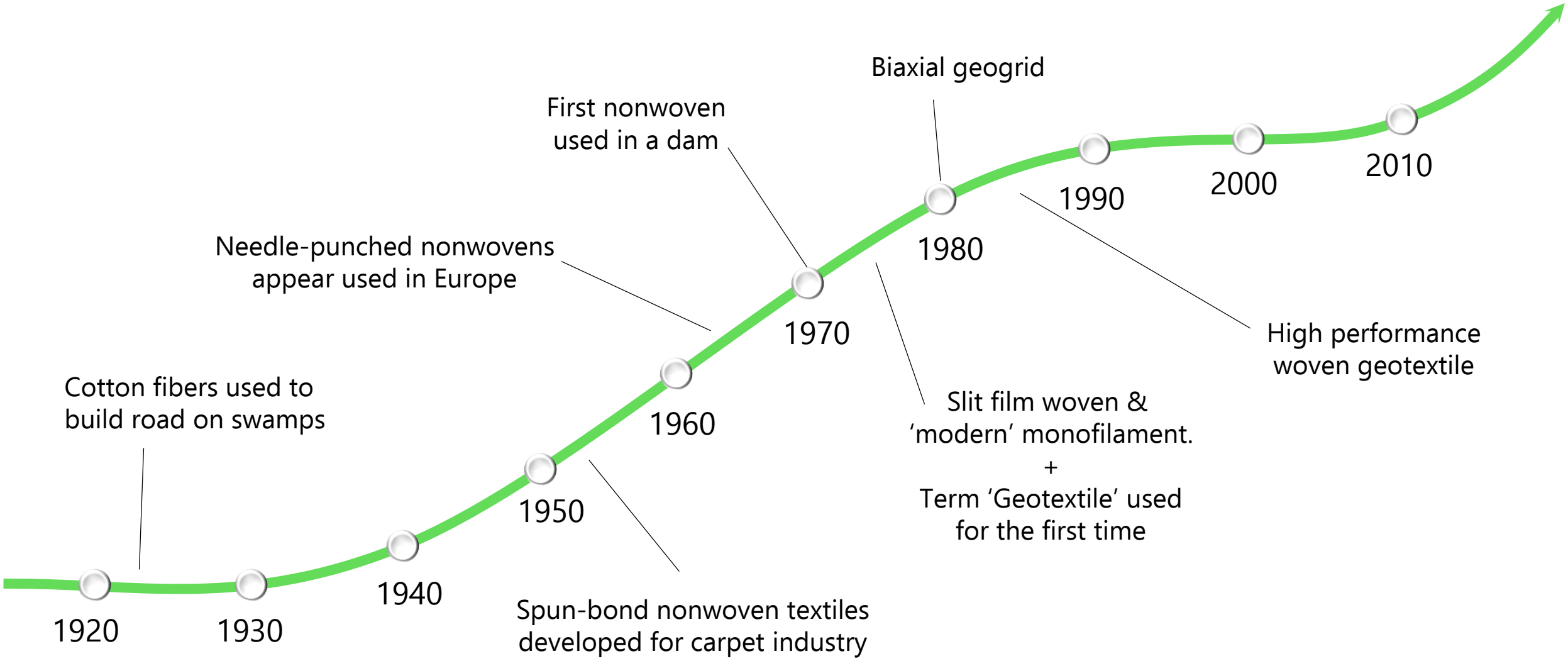
WOVENS

NON-WOVENS

GEOGRIDS


10439
Haslage
Trucking
PUCO
124630-P

Geosynthetics 101



Why use Geosynthetics?

Why use Geosynthetics?

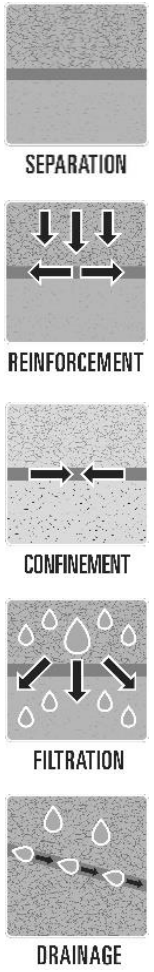
- Faster Construction
- Less Natural Resources
- More Sustainable Solution
- More Resilient Solution
- Less Cost

Functions of Geosynthetics in Roadways

SOLMAX

Geosynthetic Selection in Roadway Applications

- Separation
- Reinforcement
- Confinement
- Filtration
- Drainage



Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

Separation

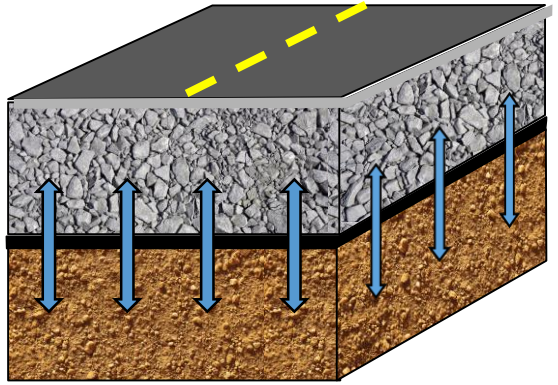
Maintains integrity & function of two dissimilar materials

Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

Separation

Filtration



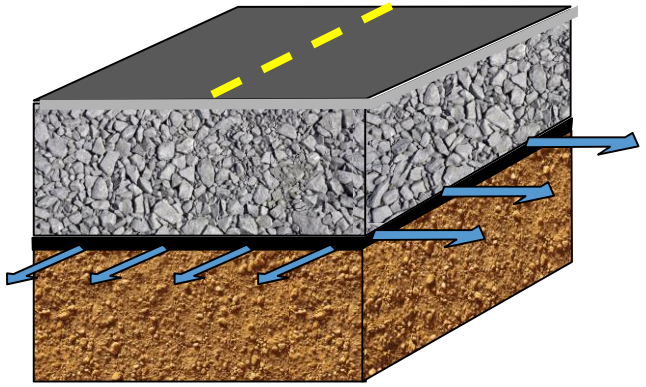
Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

Separation

Filtration

Drainage



Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

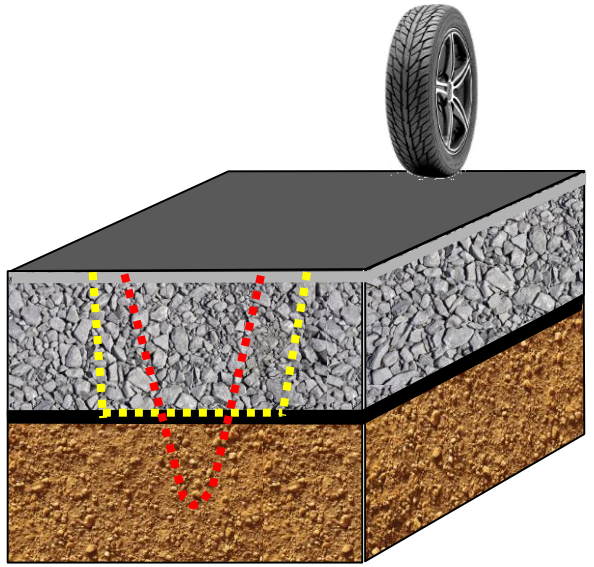
Separation

Filtration

Drainage

Reinforcement

- Bearing Capacity Increase



Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

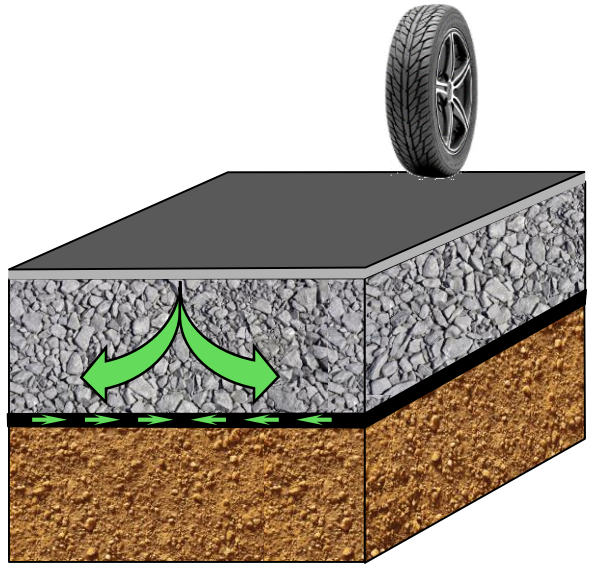
Separation

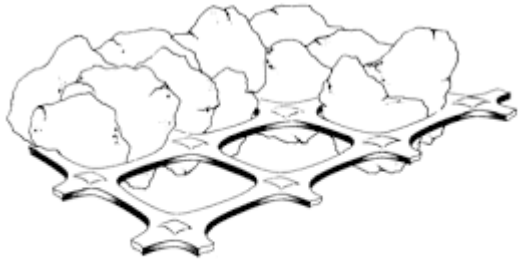
Filtration

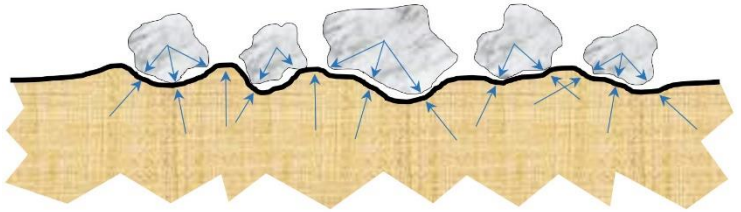
Drainage

Reinforcement

- Bearing Capacity Increase
- Lateral Restraint/Confinement







Definitions: Geosynthetic Functions in Roadway Applications

FHWA-07-092 Geosynthetic Design & Construction Guidelines

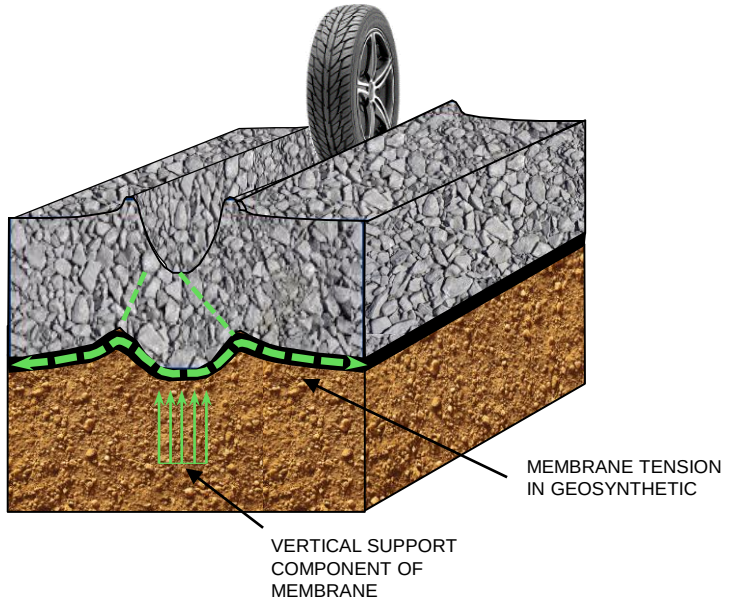
Separation

Filtration

Drainage

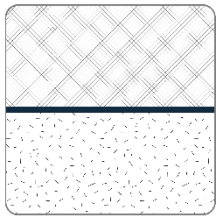
Reinforcement

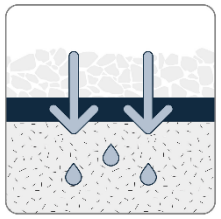
- Bearing Capacity Increase
- Lateral Restraint/Confinement
- Membrane Tension Support

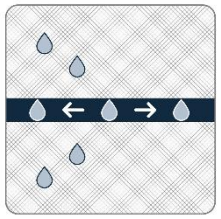


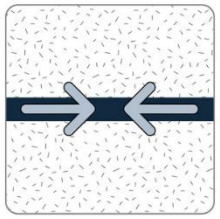
Geosynthetic Functions in Roadways/Stabilization

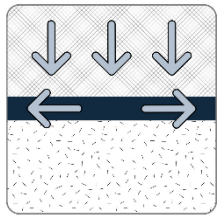
GMA White Paper II – Section 1.4.1


SEPARATION


FILTRATION


DRAINAGE


CONFINEMENT

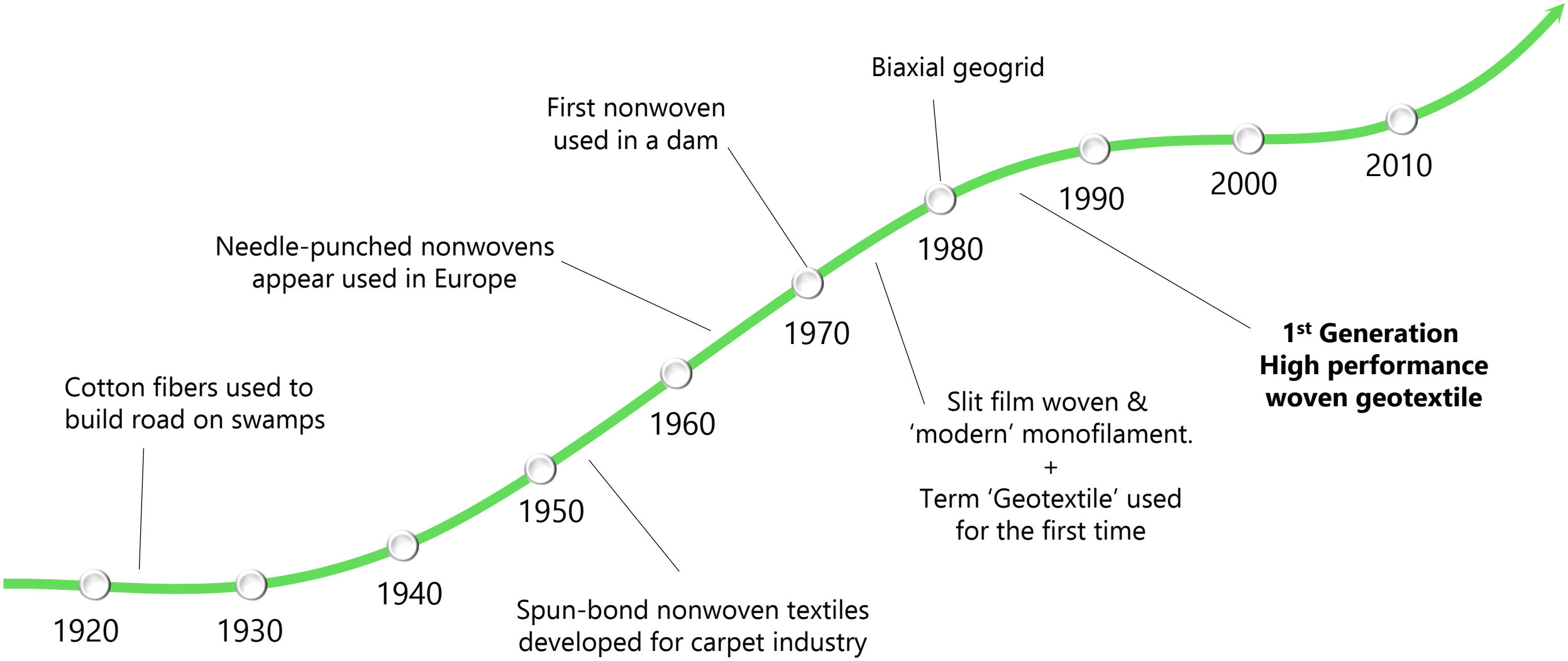

REINFORCEMENT

	SEPARATION	FILTRATION	DRAINAGE	CONFINEMENT	REINFORCEMENT
High Strength Woven Geotextile	✓	✓	✓	✓	✓
Geogrids	✗	✗	✗	✓	✓

Next Generation Geosynthetics

SOLMAX

Geosynthetics 101



First Generation

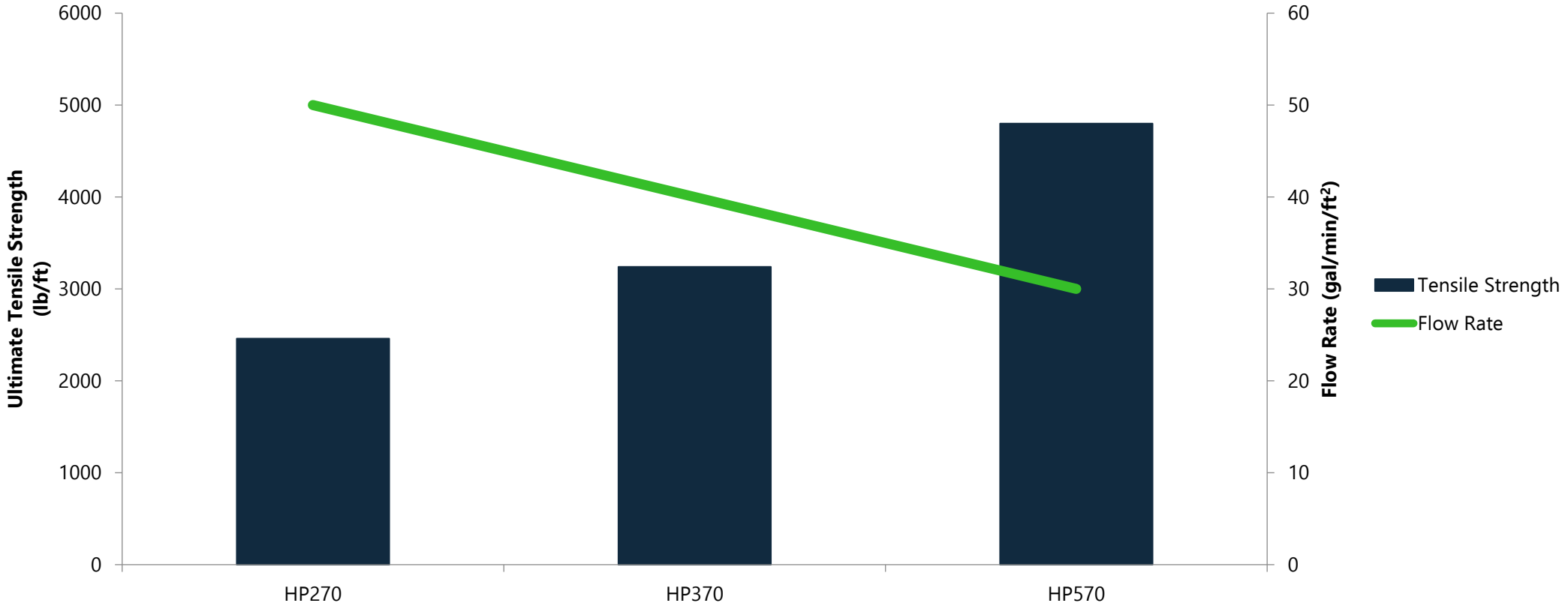
HP-Series

HP Series

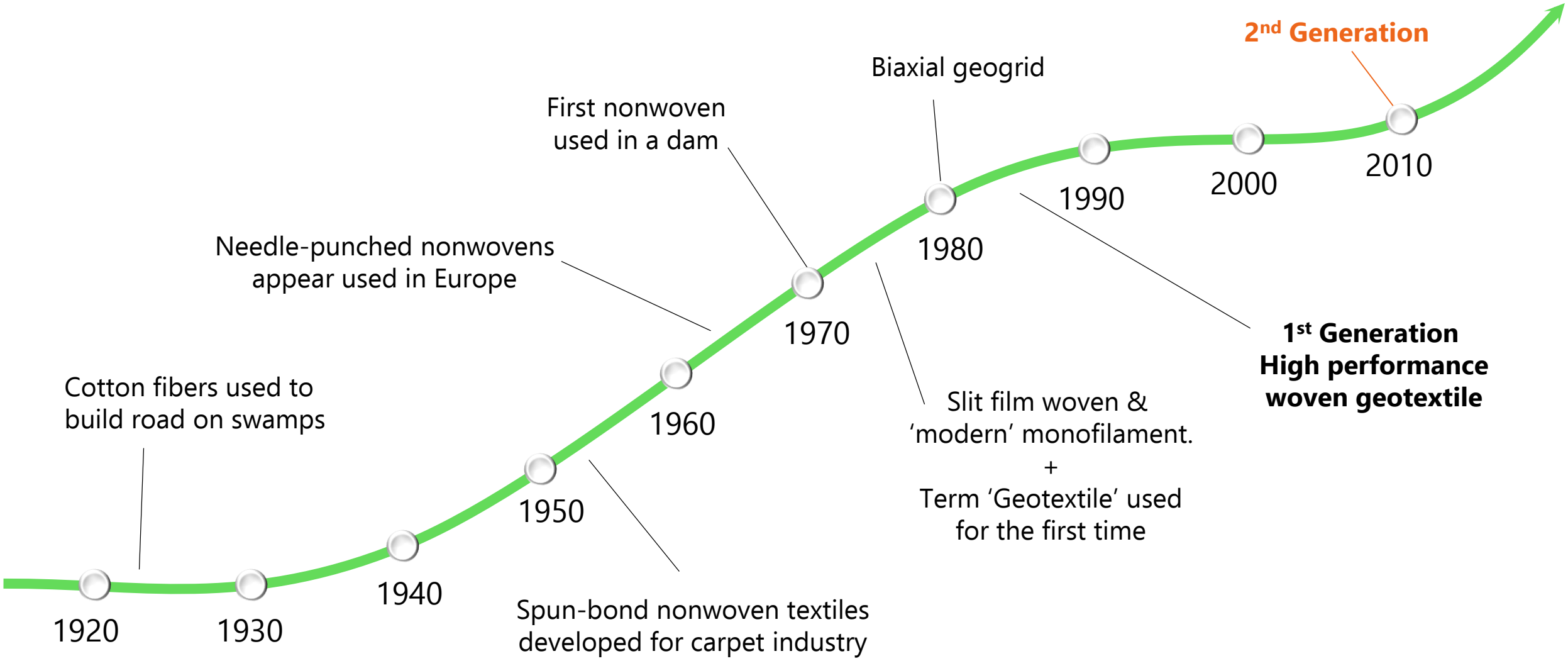
- Multifilament
- Stabilization Fabric
- First Iteration of an all-in-one Geosynthetic

Tensile strengths vs. flow rates

HP-Series



Geosynthetics 101

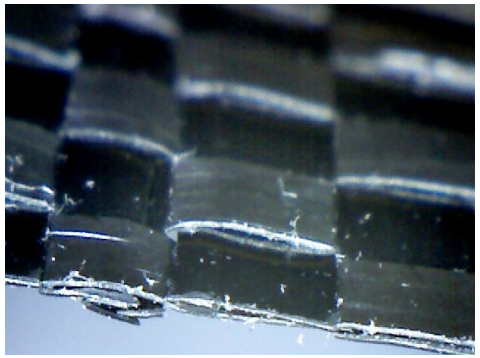



2nd Generation

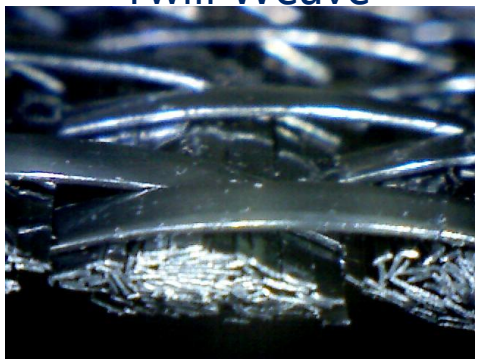
What Differentiates 2nd Generation?

Monofilament
(Basket Weave)

Slit Tape
(Basket Weave)



First
Generation
Twill Weave



Second Generation
Double Layer Weave

Second Generation

RSi-Series

RS*i* Series

- High Flow Rate Stabilization
- Separation, Filtration & Reinforcement
- Confinement by friction

2nd Generation		1st Generation
Double layer weave	**Manufacturing**	Single layer weave
Significantly stronger	**Tensile Strengths**	Industry standards for wovens
70 – 75 gal/min/ft^2	**Flow Rates**	30 – 60 gal/min/ft^2
#40 US Sieve or 425 microns	**Apparent Opening Size**	#30 US Sieve or 600 microns
Minimum of 0.89	**Coefficient of Interaction**	Ranges from 0.80 to 0.85

What happened here?

Mirafi® Roadway Geosynthetics

RS*i* Case Study – Temporary Construction Access

Mirafi® Roadway Geosynthetics

RS*i* Case Study

Chicot Solar Energy Center – Chicot County, AR

Stabilization with RS380i provided 38% cost savings and got crews back to work in stopped conditions

PROBLEM:

Low strength soils causing equipment break downs and stopped construction activities

SOLUTION:

Mirafi® RS380i (70,000 yd2) with 7” of clean stone

BENEFITS:

Cost effective, permanent solution


QCELLS
Engineered in Germany
TRANS
CUBE

Pinnington Solar – Texas

Stabilization with RS380i provided huge cost savings

INITIAL INSTALLATION PHASE

SOLUTION:

Mirafi® RS380i with 6” of aggregate

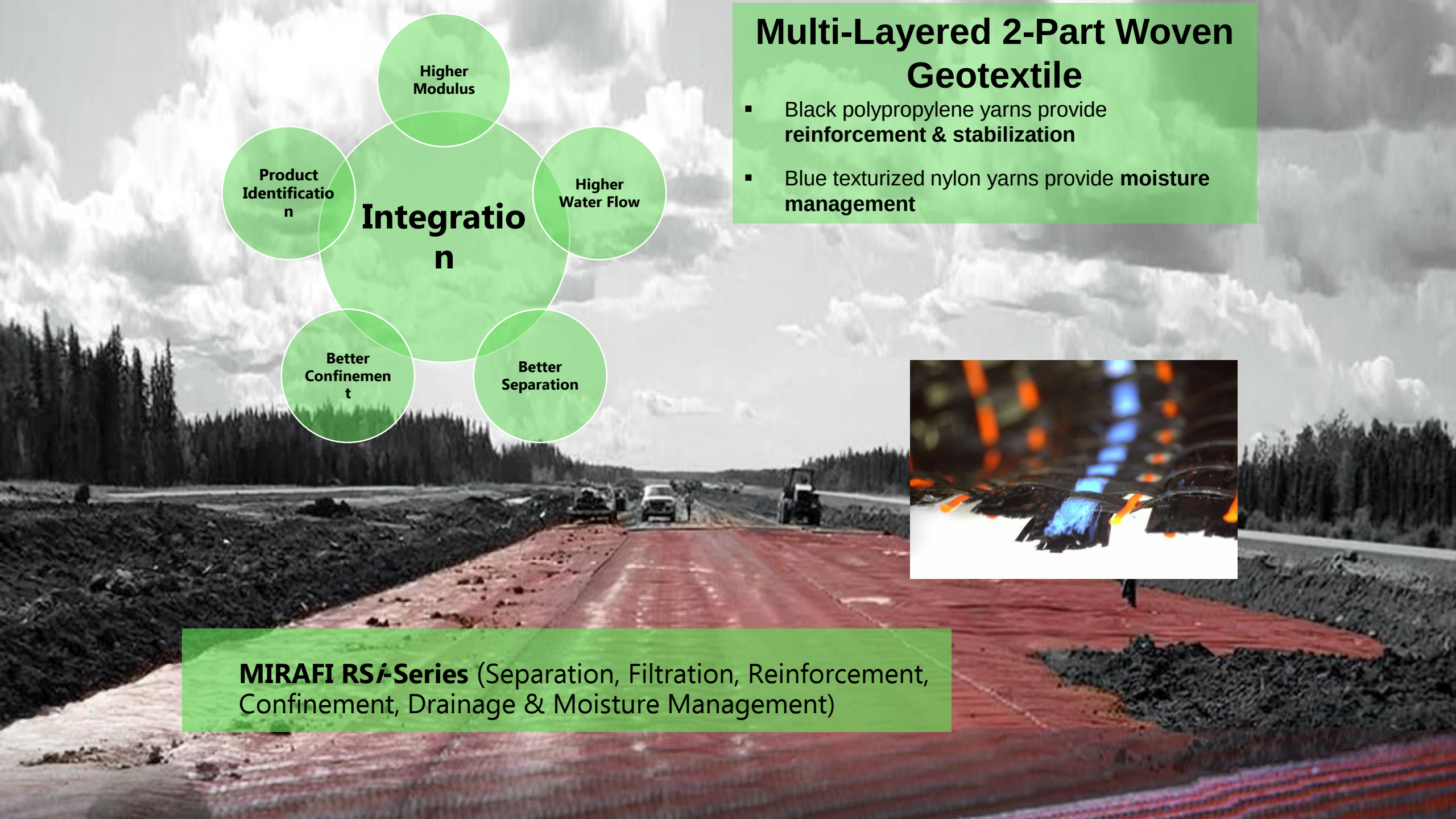
BENEFITS:

Cost effective, permanent solution

Integrated High Engineered Geotextile

Active Moisture Management & Reinforcement

SOLMAX

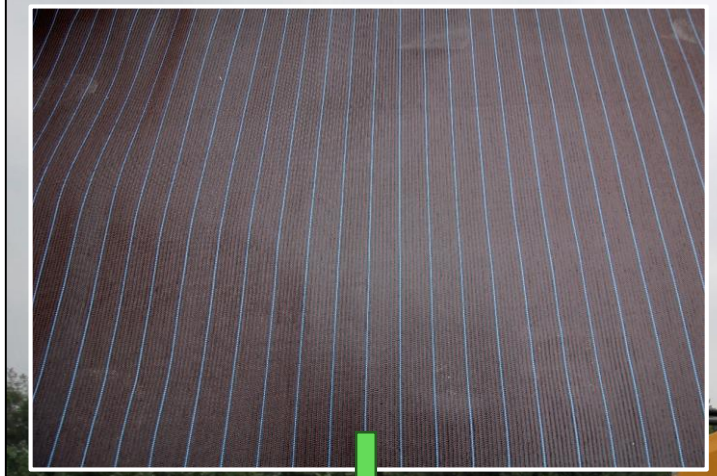


Multi-Layered 2-Part Woven Geotextile

- Black polypropylene yarns provide **reinforcement & stabilization**
- Blue texturized nylon yarns provide **moisture management**

MIRAFI RS*i*-Series (Separation, Filtration, Reinforcement, Confinement, Drainage & Moisture Management)

Blue texturized nylon yarns provide passive moisture management

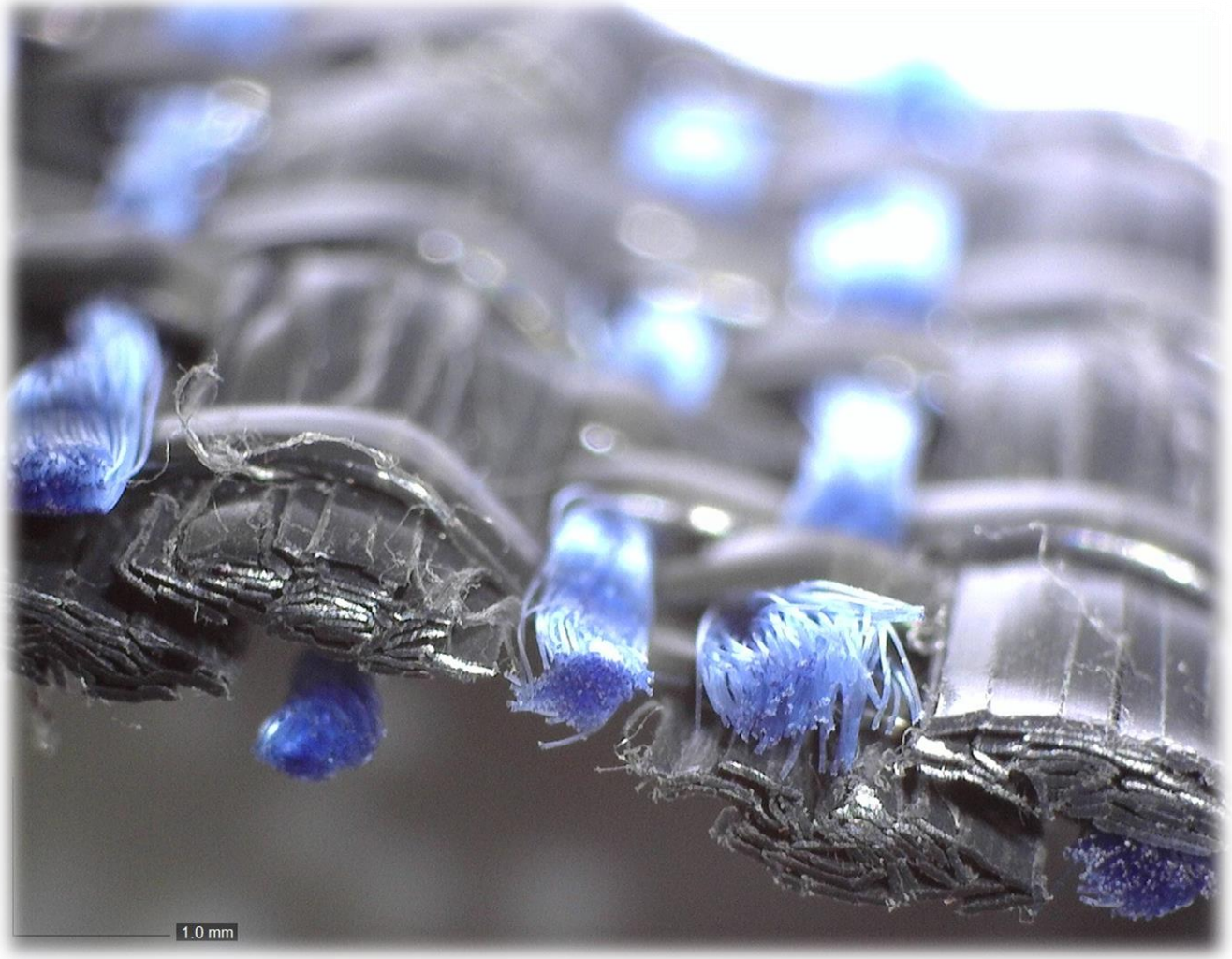


Third Generation – Wicking Geosynthetic

H2Ri-Series

Multi-layered 2-part woven geotextile

- **Black polypropylene** yarns provide reinforcement & stabilization
- Blue nylon yarns provide continuous moisture management
- Separation, filtration, reinforcement, confinement & **enhanced** drainage
- Ideal for expansive soil areas



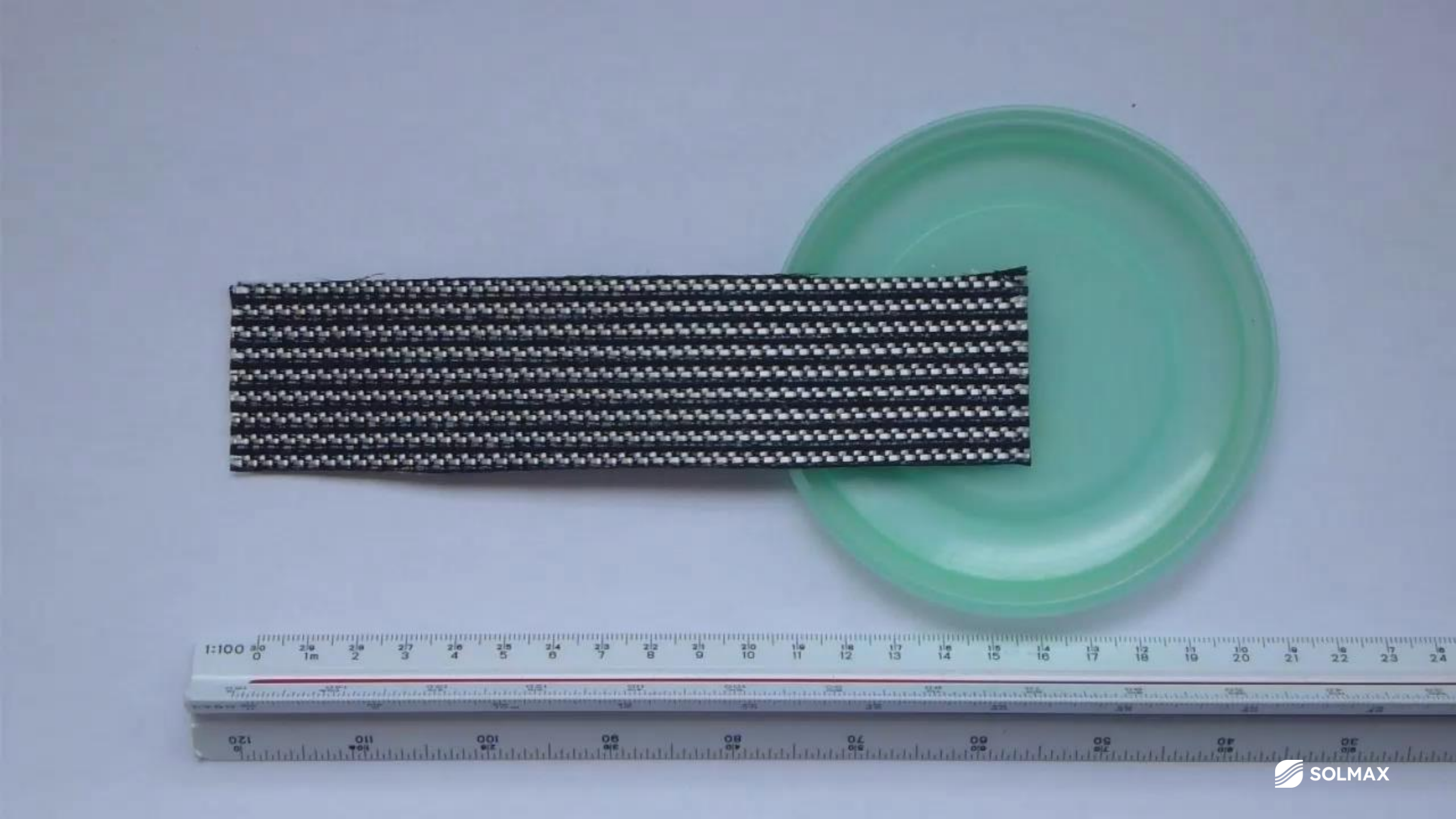
Multi-Layered 2-Part Woven Geotextile

MIRAFI H_2R*i* Series (Separation, Filtration, Reinforcement, Confinement, Drainage & **Enhanced** Moisture Management)

Placement of H_2Ri

Dalton Highway without Mirafi® H₂Ri, June 2013

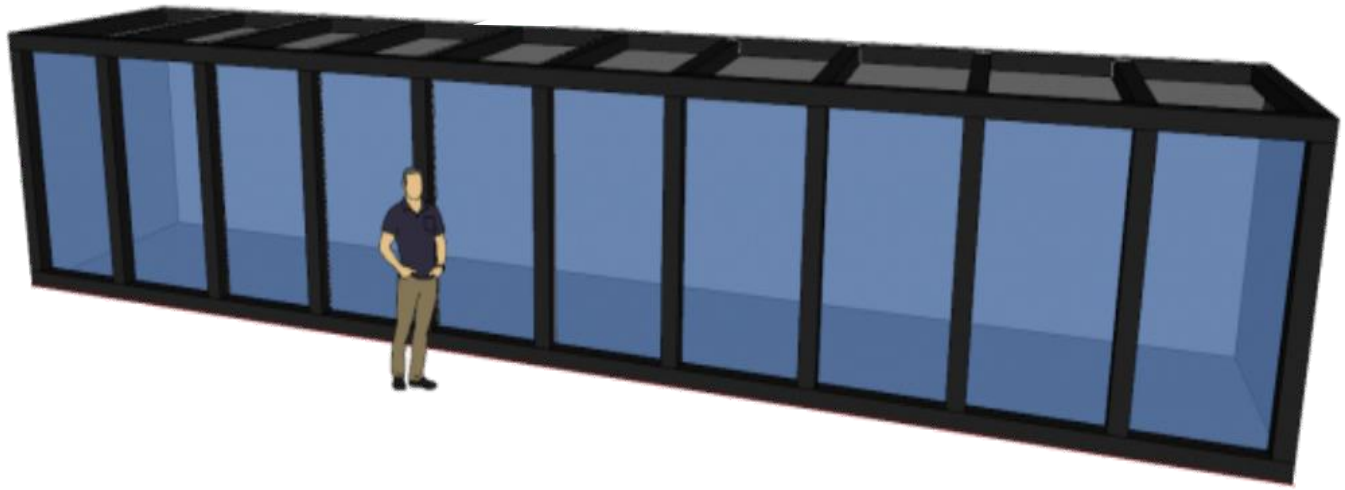
Dalton Highway with Mirafi® H_2R_i June 2013


1:100
SOLMAX

Wicking Geosynthetic

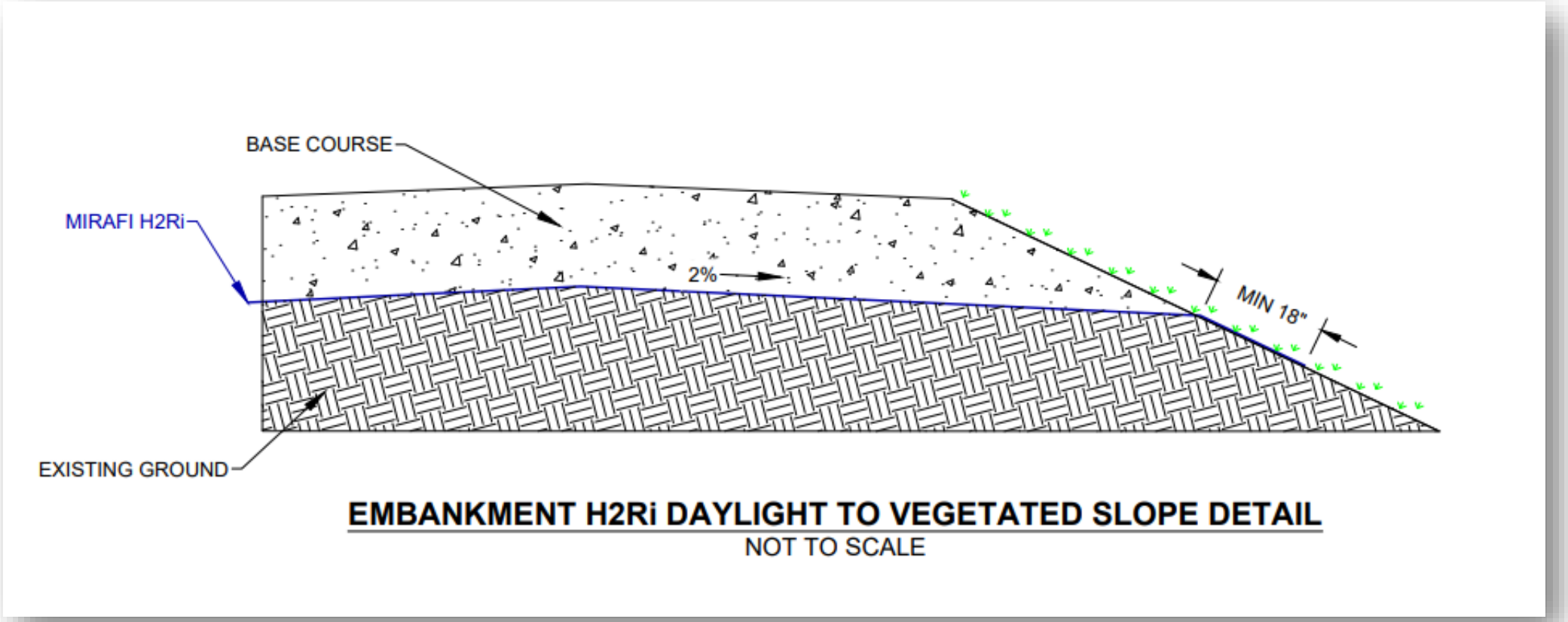
Lets See How It Works

- Up to 1.4 gal/day/lineal foot
- Each roll can remove up to 375 gal/day per exposed edge
- Up to ~15,000 gal/day per mile of roadway



Wicking Geosynthetic

Installation



EMBANKMENT H2Ri DAYLIGHT TO VEGETATED SLOPE DETAIL

NOT TO SCALE

Wicking Geosynthetic

Installation

Drainable edges on both side of the road

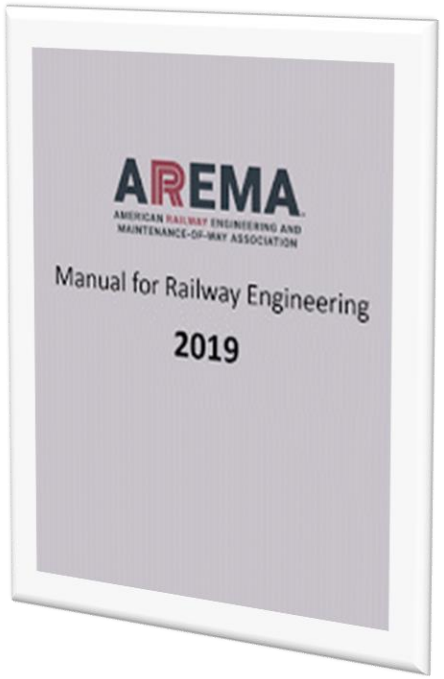
Center panel on top

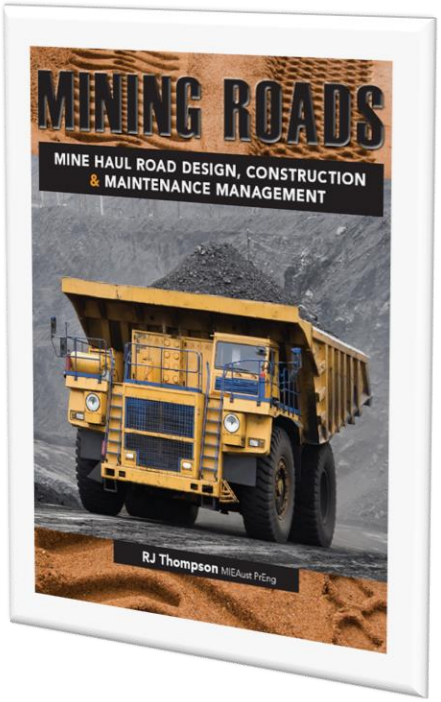
Drainable edge on one side of the road

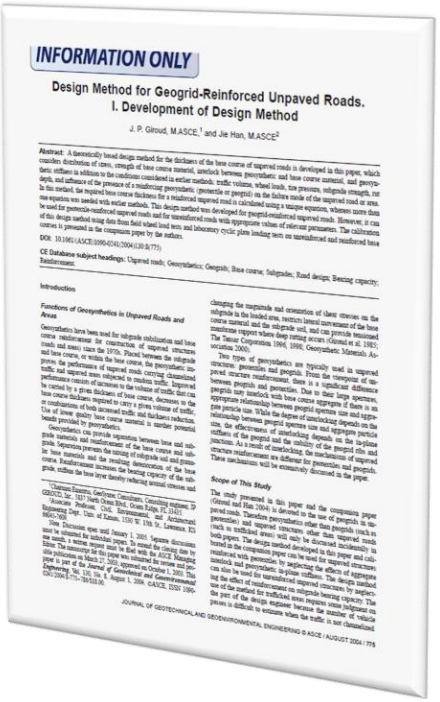
Far side panel on top

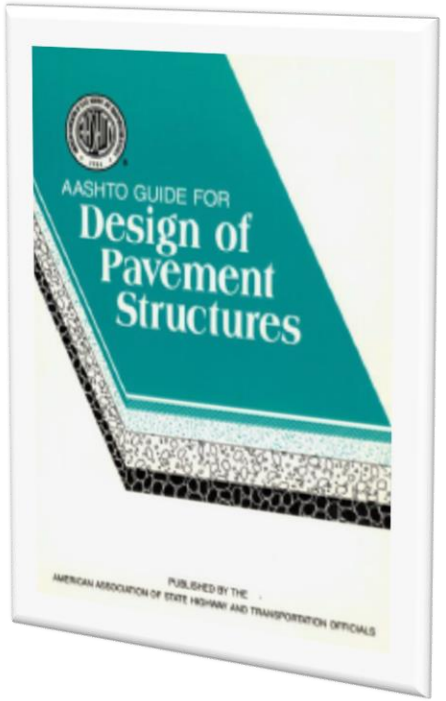
Current Roadway Design Methodologies Using Geosynthetics

Paved Roads, Unpaved Roads, and Rail Ballast Structures









InfraSolve

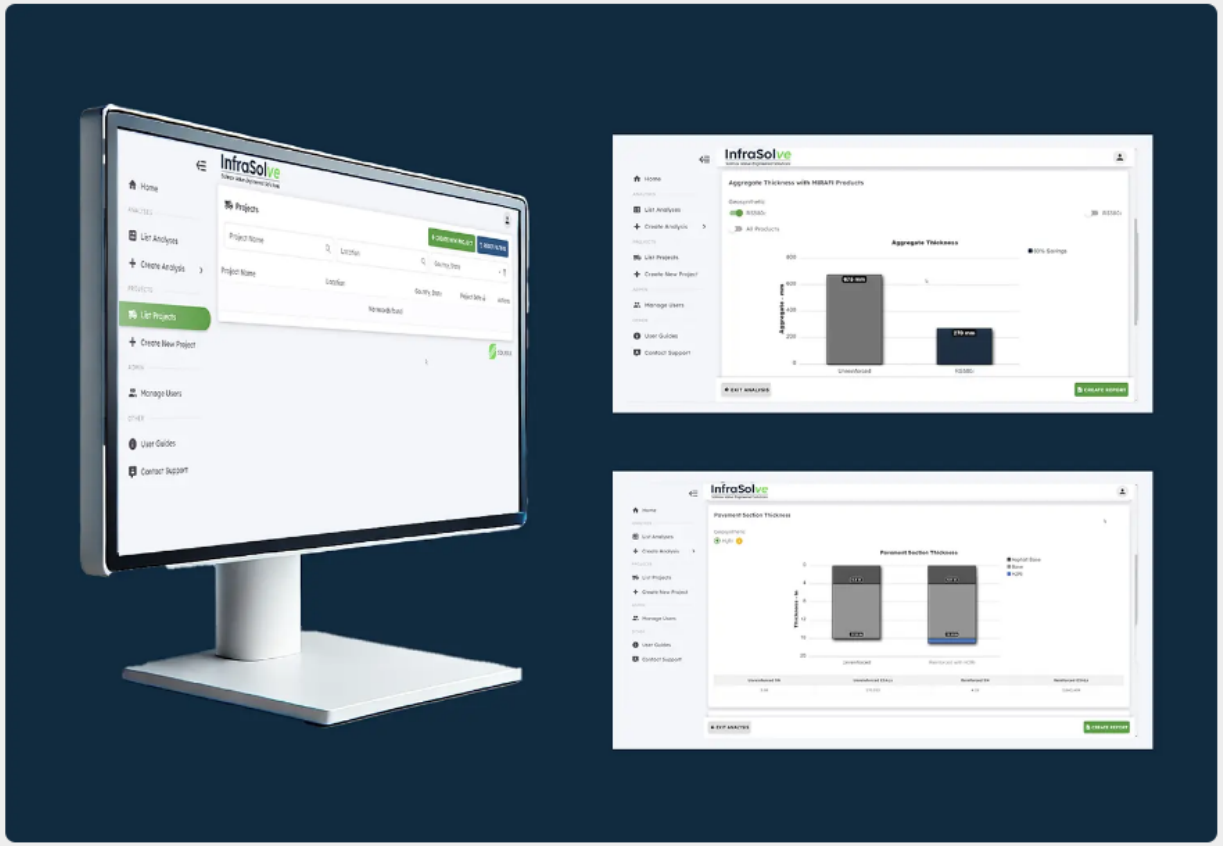
Introducing InfraSolve™, a powerful web-based application developed specifically for engineers in civil, environmental, and geotechnical fields. This comprehensive tool integrates proven design methods with sustainable best practices to design more resilient roadways. InfraSolve offers advanced analysis features for paved and unpaved roadways, utilizing AASHTO Pavement Design or Giroud-Han unpaved design methods.

With a focus on practicality, users can calculate, compare, and assess project costs quickly and efficiently, helping to optimize designs and performance while keeping expenses in check. Plus, there is no need to download or install software to use this program.

Whether you're working on a small-scale parking lot or a complex highway system, InfraSolve enables you to design a cost-effective, geosynthetic solution based on extensive performance research.

Click here to create your login

.



InfraSolve Design Software

Paved (AASHTO)

Unpaved

SOLMAX

InfraSolve Design Software – Unpaved Roads

INFORMATION ONLY

Design Method for Geogrid-Reinforced Unpaved Roads. I. Development of Design Method

J. P. Giroud, M.ASCE,[1] and Jie Han, M.ASCE[2]

Abstract: A theoretically based design method for the thickness of the base course of unpaved roads is developed in this paper, which considers distribution of stress, strength of base course material, interlock between geosynthetic and base course material, and geosynthetic stiffness in addition to the conditions considered in earlier methods: traffic volume, wheel loads, tire pressure, subgrade strength, rut depth, and influence of the presence of a reinforcing geosynthetic (geotextile or geogrid) on the failure mode of the unpaved road or area. In this method, the required base course thickness for a reinforced unpaved road is calculated using a unique equation, whereas more than one equation was needed with earlier methods. This design method was developed for geogrid-reinforced unpaved roads. However, it can be used for geotextile-reinforced unpaved roads and for unreinforced roads with appropriate values of relevant parameters. The calibration of this design method using data from field wheel load tests and laboratory cyclic plate loading tests on unreinforced and reinforced base courses is presented in the companion paper by the authors.

DOI: 10.1061/(ASCE)1090-0241(2004)130:8(775)

CE Database subject headings: Unpaved roads; Geosynthetics; Geogrids; Base course; Subgrades; Road design; Bearing capacity; Reinforcement.

Introduction

Functions of Geosynthetics in Unpaved Roads and Areas

Geosynthetics have been used for subgrade stabilization and base course reinforcement for construction of unpaved structures (roads and areas) since the 1970s. Placed between the subgrade and base course, or within the base course, the geosynthetic improves the performance of unpaved roads carrying channelized traffic and unpaved areas subjected to random traffic. Improved performance consists of increases to the volume of traffic that can be carried by a given thickness of base course, decreases to the base course thickness required to carry a given volume of traffic, or combinations of both increased traffic and thickness reduction. Use of lower quality base course material is another potential benefit provided by geosynthetics.

Geosynthetics can provide separation between base and subgrade materials and reinforcement of the base course and subgrade. Separation prevents the mixing of subgrade soil and granular base materials and the resulting deterioration of the base course. Reinforcement increases the bearing capacity of the subgrade, stiffens the base layer thereby reducing normal stresses and changing the magnitude and orientation of shear stresses on the subgrade in the loaded area, restricts lateral movement of the base course material and the subgrade soil, and can provide tensioned membrane support where deep rutting occurs (Giroud et al. 1985; The Tensar Corporation 1996, 1998; Geosynthetic Materials Association 2000).

Two types of geosynthetics are typically used in unpaved structures, geotextiles and geogrids. From the viewpoint of unpaved structure reinforcement, there is a significant difference between geogrids and geotextiles. Due to their large apertures, geogrids may interlock with base course aggregate if there is an appropriate relationship between geogrid aperture size and aggregate particle size. While the degree of interlocking depends on the relationship between geogrid aperture size and aggregate particle size, the effectiveness of interlocking depends on the in-plane stiffness of the geogrid and the stability of the geogrid ribs and junctions. As a result of interlocking, the mechanisms of unpaved structure reinforcement are different for geotextiles and geogrids. These mechanisms will be extensively discussed in the paper.

Scope of This Study

The study presented in this paper and the companion paper (Giroud and Han 2004) is devoted to the use of geogrids in unpaved roads. Therefore geosynthetics other than geogrids (such as geotextiles) and unpaved structures other than unpaved roads (such as trafficked areas) will only be discussed incidentally in both papers. The design method developed in this paper and calibrated in the companion paper can be used for unpaved roads reinforced with geogrids or geocells. The design method can also be used for unreinforced unpaved roads by neglecting the effect of reinforcement on subgrade bearing capacity. The use of the method for trafficked areas requires some refinement on the part of the design engineer because the number of vehicle passes is difficult to estimate when the traffic is not channelized.

[1]Chairman Emeritus, GeoSyntec Consultants, Consulting engineers, 19 GIROUD, Inc., 5817 North Ocean Blvd., Ocean Ridge, FL 33435.
[2]Associate Professor, Univ. of Kansas, 1530 W. 15th St., Lawrence, KS Engineering Dept., Univ. of Kansas, 1530 W. 15th St., Lawrence, KS 66045-7609.

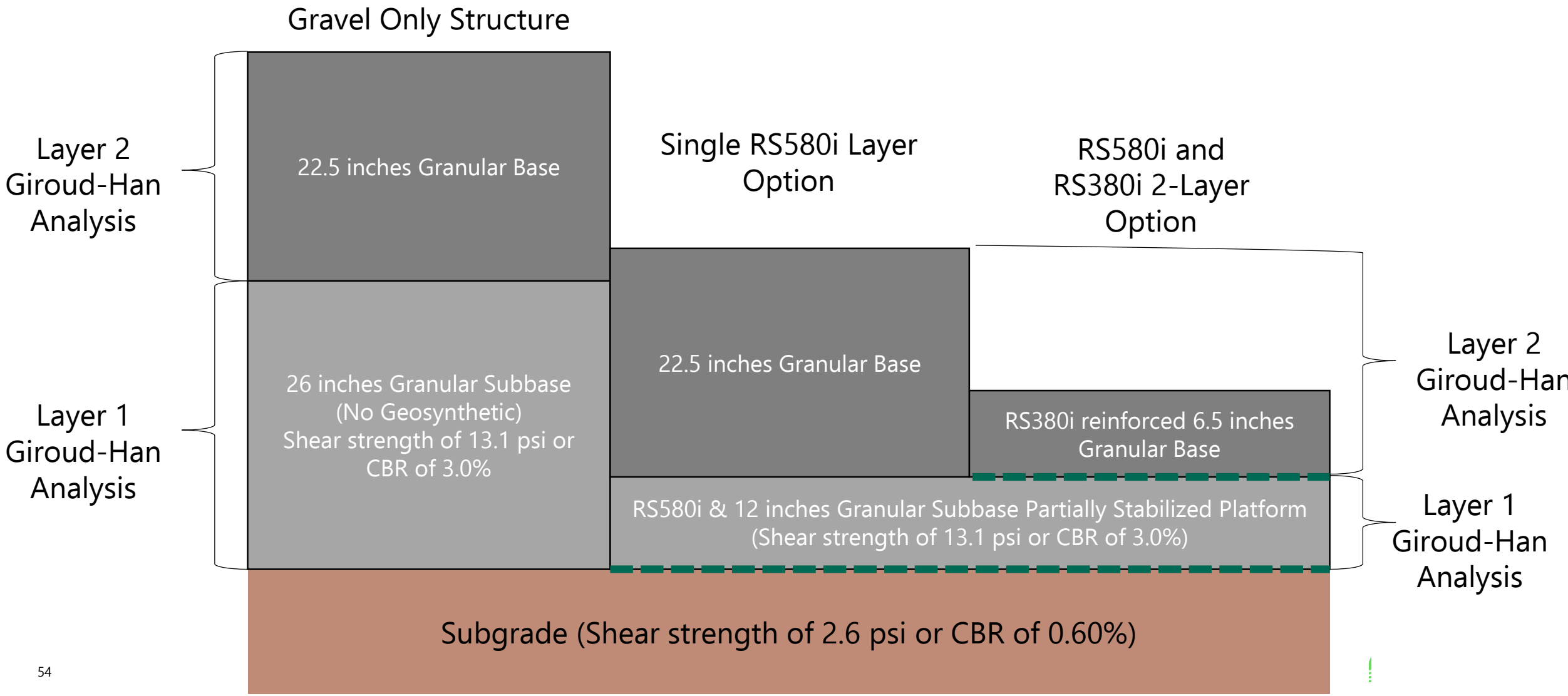
Note. Discussion open until January 1, 2005. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on March 27, 2003; approved on October 1, 2003. This paper is part of the *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 8, August 1, 2004. ©ASCE, ISSN 1090-0241/2004/8-772–786/$18.00.

JOURNAL OF GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING © ASCE / AUGUST 2004 / 775

Giroud-Han Design Method

- Design Method for Geogrid-Reinforced Unpaved Roads
- Modified for geotextiles and geocells
- Industry standard design method
- Suitable for weak subgrade soils:

STABILIZATION DESIGN – SOFT SUBGRADES



STABILIZATION DESIGN – SOFT SUBGRADES

Layer 1 Parameter	Value
Subgrade Shear Strength	2.6 lb/in^2
Axle Load	18,000 lb
Axle Passes	500 to 750
Tire Pressure	110 lb/in^2
Rut Depth	3 inches
CBR of Roadway Aggregate	20
Factor of Safety	1.0

STABILIZATION DESIGN – SOFT SUBGRADES

Layer 1 Parameter	Value
Subgrade Shear Strength	2.6 lb/in^2
Axle Load	18,000 lb
Axle Passes	500 to 750
Tire Pressure	110 lb/in^2
Rut Depth	3 inches
CBR of Roadway Aggregate	20
Factor of Safety	1.0

Determined using observed subgrade conditions or field testing:

Visual	SPT	Shear Strength	CBR
Person standing sinks more than 3 inches	<2	< 1.7 psi	< 0.4%
Person walking sinks 2 to 3 inches	2 – 4	1.7 to 3.5 psi	0.4% to 0.8%
Person walking sinks about 1 inch	4 - 8	3.5 to 7 psi	0.8% to 1.6%

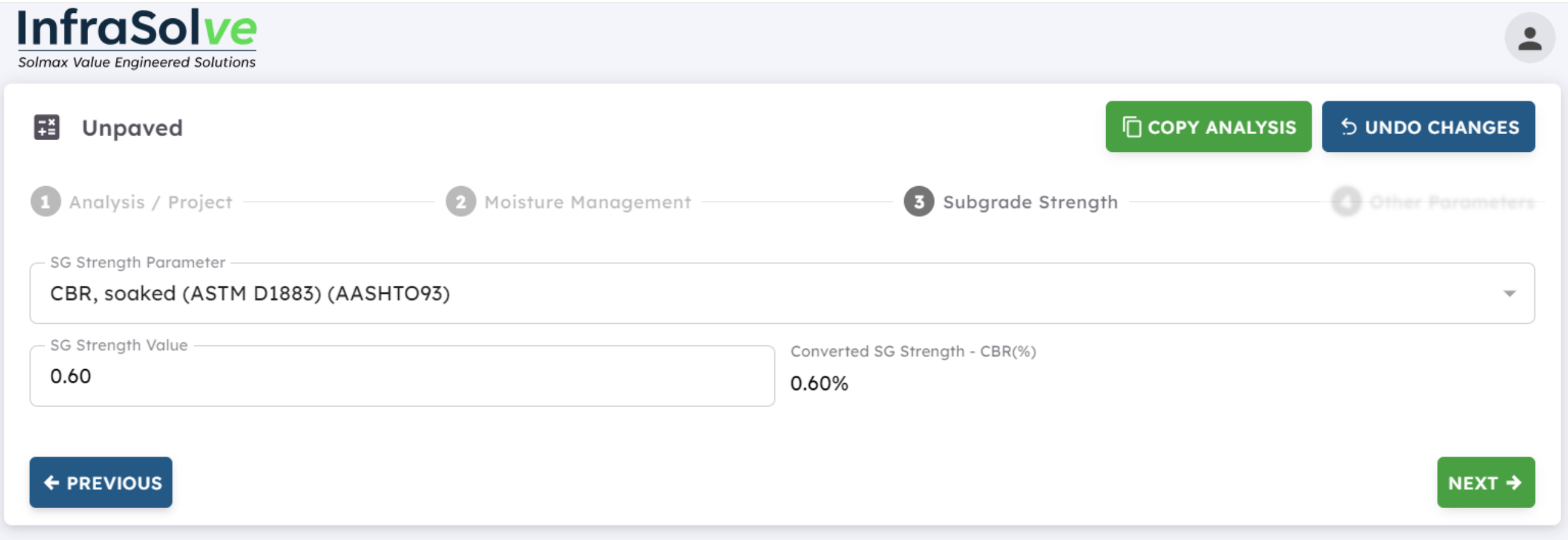
STABILIZATION DESIGN – SOFT SUBGRADES

Layer 1 Parameter	Value
Subgrade Shear Strength	2.6 lb/in^2
Axle Load	18,000 lb
Axle Passes	500 to 750
Tire Pressure	110 lb/in^2
Rut Depth	3 inches
CBR of Roadway Aggregate	20
Factor of Safety	1.0

Not fully stabilized. Goal of analysis is to achieve results that are similar to a weak subgrade (CBR of about 3.0%):

Visual	SPT	Shear Strength	CBR
Loaded dump truck ruts 1 to 3 inches	15 - 30	14 to 28 psi	3.2% to 6.4%

STABILIZATION DESIGN – SOFT SUBGRADES



STABILIZATION DESIGN – SOFT SUBGRADES

InfraSolve
Solmax Value Engineered Solutions

Unpaved

COPY ANALYSIS | UNDO CHANGES

1 Analysis / Project — 2 Moisture Management — 3 Subgrade Strength — 4 Other Parameters

Axle Load - P	18,000 lbs	Axle Passes - N	500
Tire Pressure - p	110 psi	Rut Depth - s	3.00 inches
CBR of Roadway Aggregate	20.0	Factor of Safety - FS	1.00

← PREVIOUS

RESULTS →

STABILIZATION DESIGN – SOFT SUBGRADES

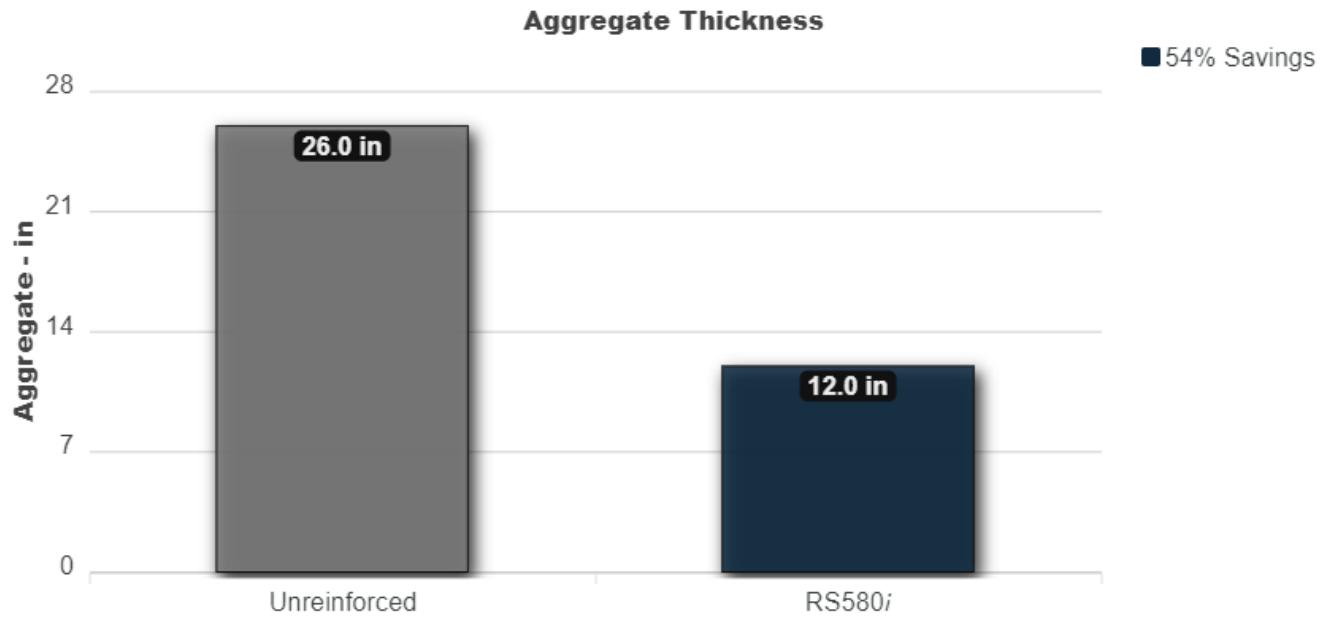
InfraSolve
Solmax Value Engineered Solutions

Aggregate Thickness with MIRAFI Products

Geosynthetic

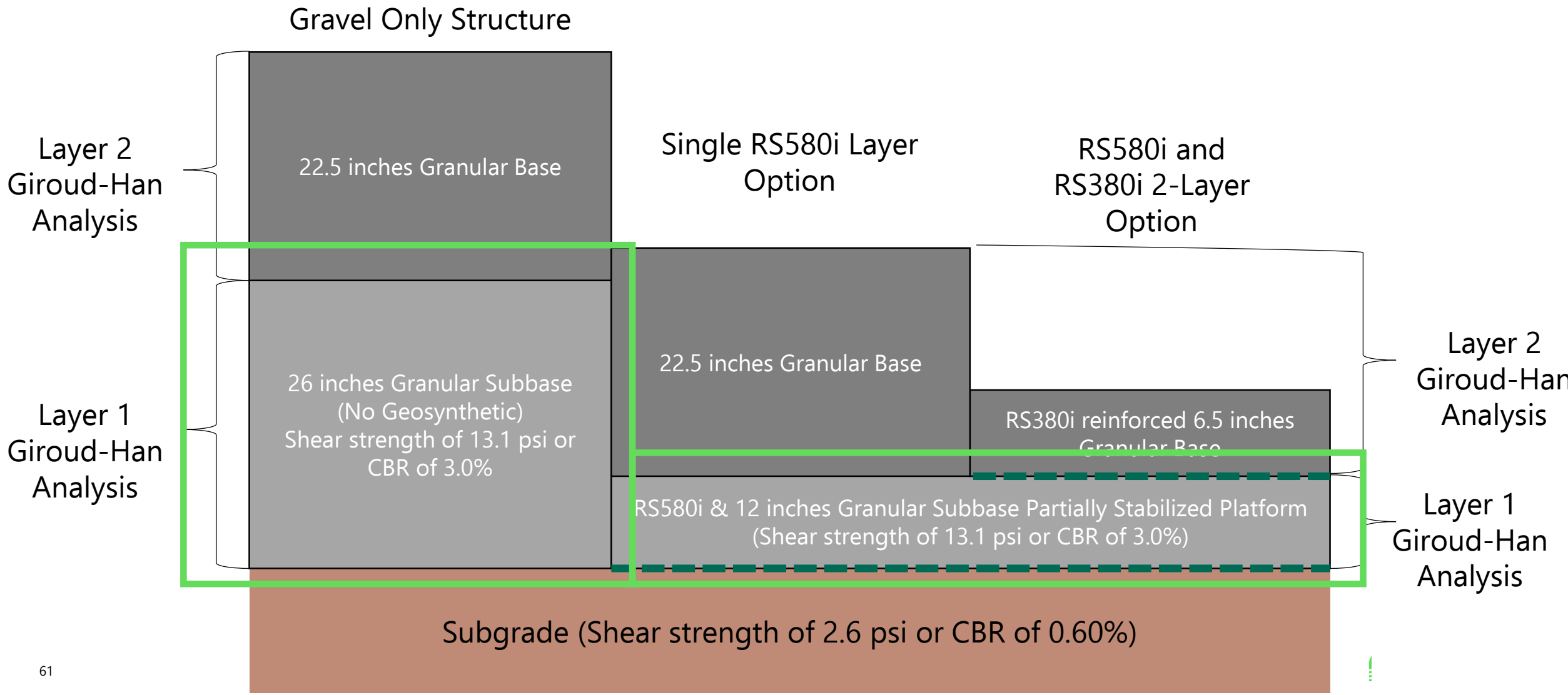
RS580*i*

All Products



Minimum thickness recommendations shown in the graph above.

STABILIZATION DESIGN – SOFT SUBGRADES



STABILIZATION DESIGN – SOFT SUBGRADES

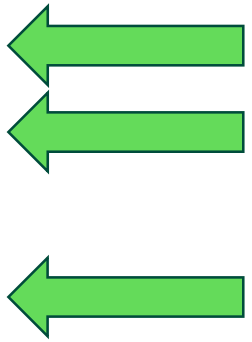
Layer 2 Parameters	Value
Subgrade Strength	3.0%
Axle Load	18,000 lb
Axle Passes	25,000
Tire Pressure	110 lb/in^2
Rut Depth	1.5 inches
CBR of Roadway Aggregate	20
Factor of Safety	1.2

Remember what the results of the analysis of the first layer is simulating:

Visual	SPT	Shear Strength	CBR
Loaded dump truck ruts 1 to 3 inches	15 - 30	14 to 28 psi	3.2% to 6.4%

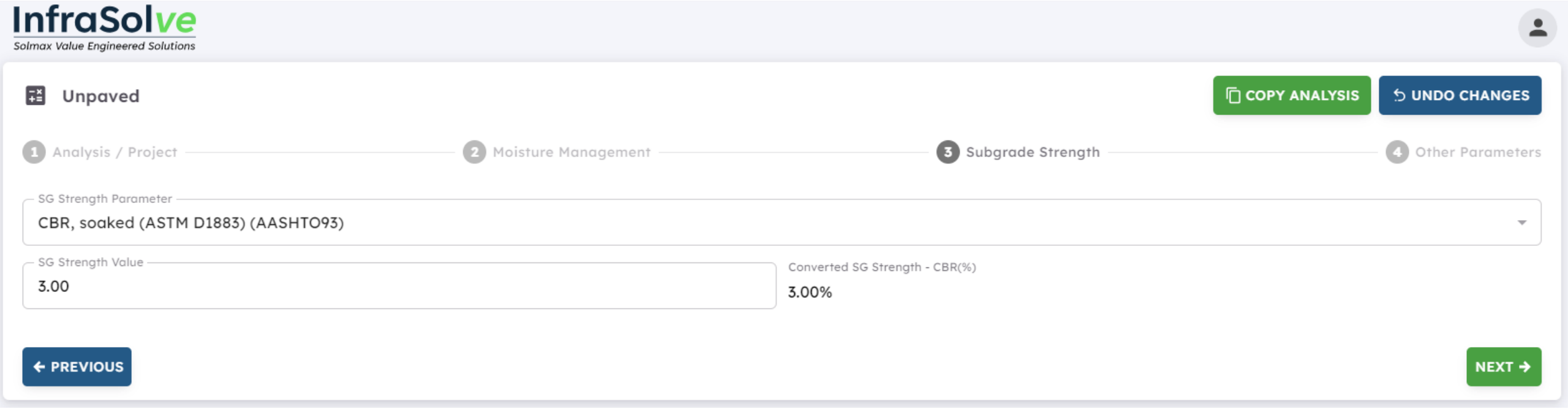
STABILIZATION DESIGN – SOFT SUBGRADES

Layer 2 Parameters	Value
Subgrade Strength	3.0%
Axle Load	18,000 lb
Axle Passes	25,000
Tire Pressure	110 lb/in^2
Rut Depth	1.5 inches
CBR of Roadway Aggregate	20
Factor of Safety	1.2

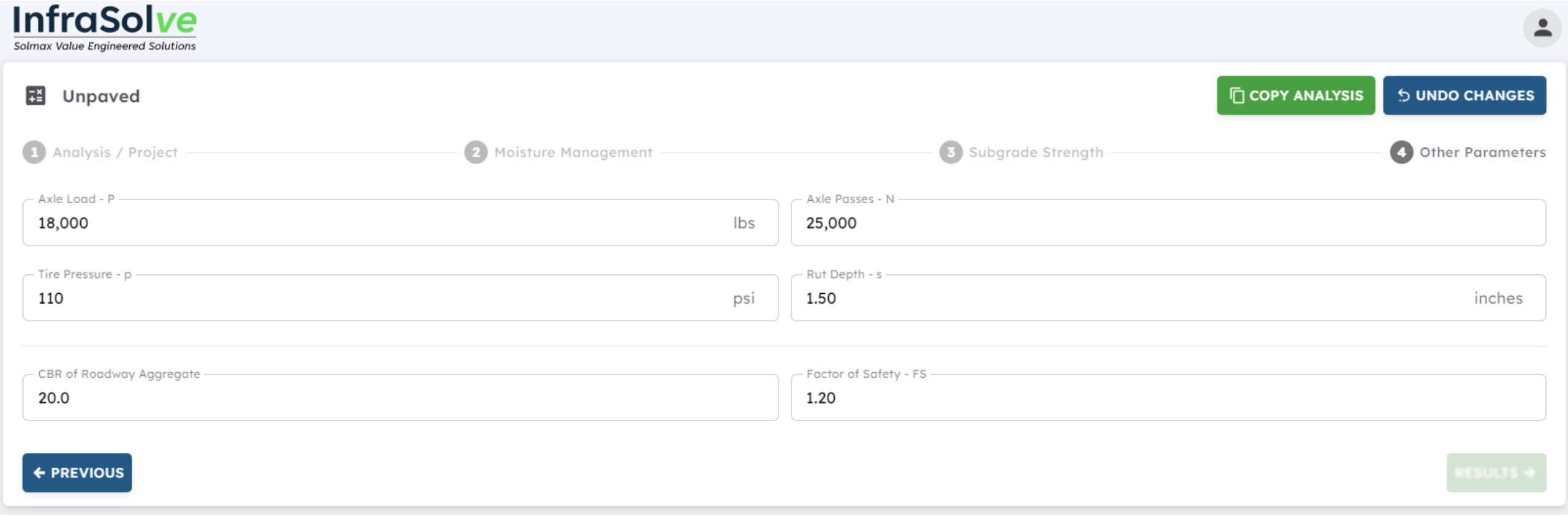


Goal of analysis is to achieve fully stabilized results that are able to support construction activities. Customize for individual project.

STABILIZATION DESIGN – SOFT SUBGRADES



STABILIZATION DESIGN – SOFT SUBGRADES



STABILIZATION DESIGN – SOFT SUBGRADES

InfraSolve
Solmax Value Engineered Solutions

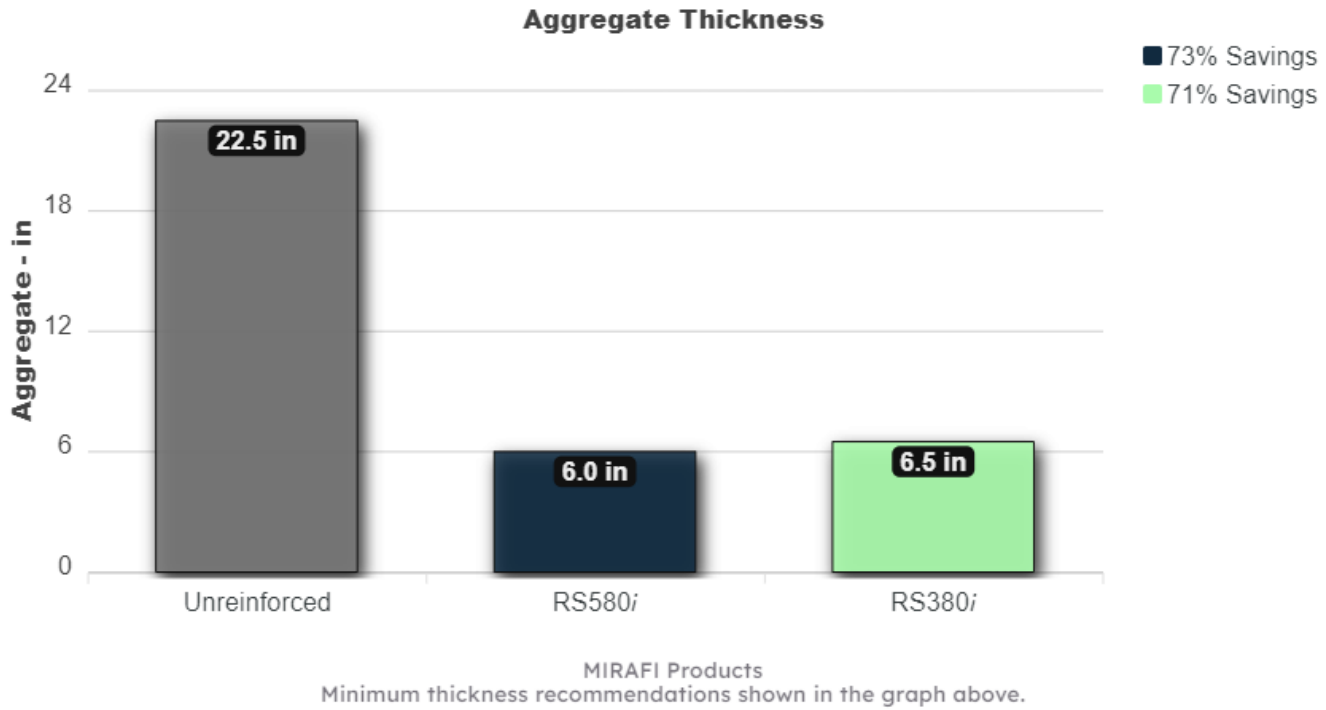
Aggregate Thickness with MIRAFI Products

Geosynthetic

RS580*i*

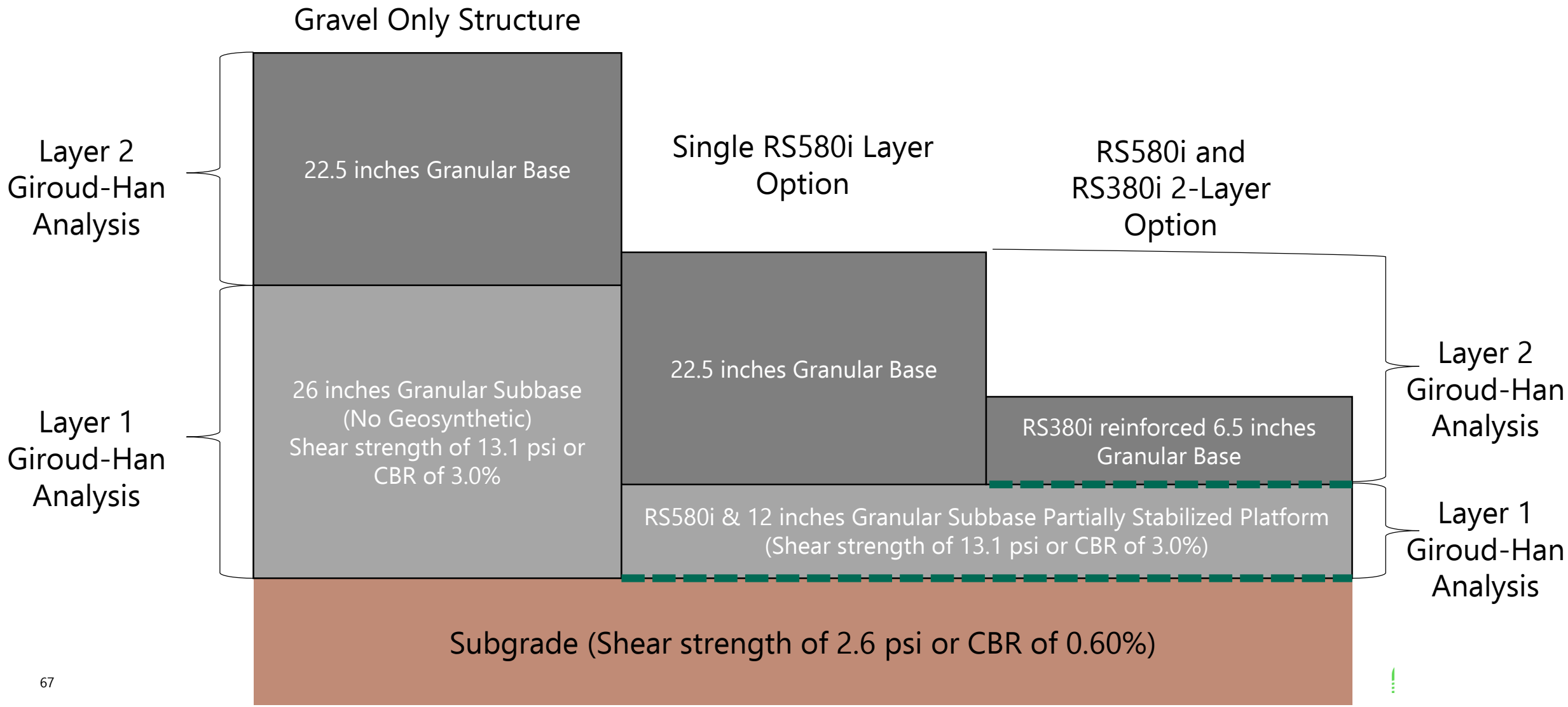
All Products

RS380*i*



MIRAFI Products
Minimum thickness recommendations shown in the graph above.

STABILIZATION DESIGN – SOFT SUBGRADES



Geosynthetics - Savings Beyond Financial Value

- Reduced excavation and disposal of original subgrade soil
- Time and effort to place and compact 3-4 additional lifts of stone
- Reduced construction traffic on the site and surrounding roads
- Less risk of encountering contaminated subgrade soil
- Reduced carbon emissions

Reduced Carbon Footprint

Reduced Cost

Sustainable Manufacturing

Reduced Transportation Traffic & Emissions

Benefits to Using Geosynthetic for Subgrade Stabilization and Reinforcement over Chemical Stabilization

High Strength Woven Geotextiles		Chemical Stabilization
No specialized equipment needed	**Ease of installation**	Specialized equipment and contractor needed.
No curing time – construction can continue immediately after installation.	**Construction time**	Standard cure time is 7 days
Can be installed in all weather conditions, including wind and cold.	**Installation environment**	Cannot be installed in windy conditions due to the caustic nature of the materials. Materials are harmful to inhale and can cause damage to car paint.
Validated through multiple full-scale performance testing with third-party experts	**Performance verification & third-party testing**	No design ESAL or structural number provided by chemical stabilization, which is required for an AASHTO 93 design
Service life of the geosynthetic is longer than the roadway itself. Once installed the geosynthetic will continue to improve performance and will not break down due to freeze/thaw and wet/dry cycles.	**Performance life**	Commonly exhibits poor strength retention when exposed to hydration, providing only a short-term solution.
Allows for the proper drainage of the pavement area to improve overall performance.	**Performance - drainage**	No drainage layer is included, making roadway susceptible to water damage.
If future maintenance is needed, it can occur above the level of the geosynthetic. MIRAFI H2Ri & RSi will continue to improve the roadway's performance after maintenance and rehabilitation.	**Future maintenance**	Full-depth repair is needed when roadways fail and the chemical stabilization process will need to be repeated.

Thank you

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