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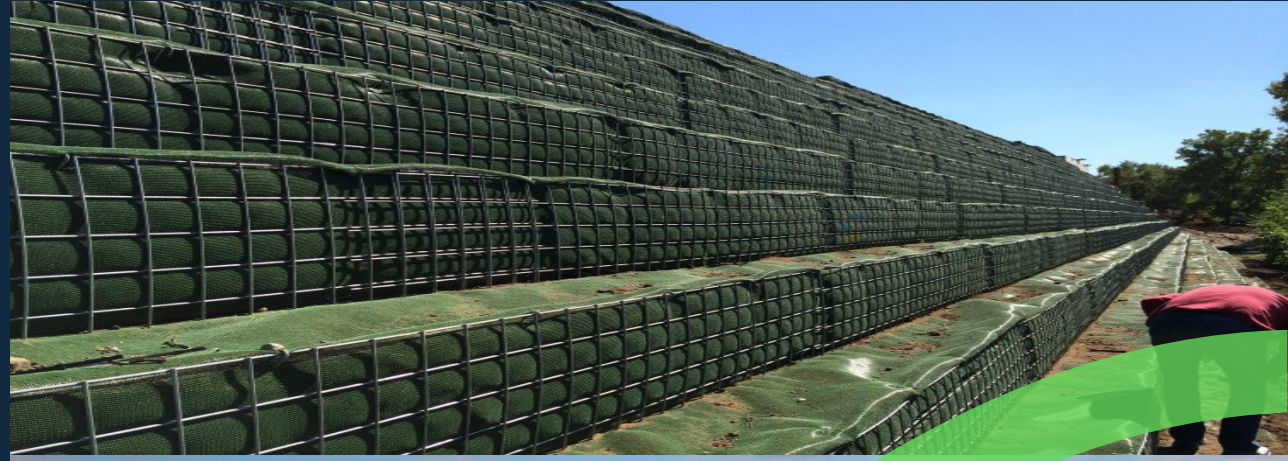
# Michigan CEW 2024 Geosynthetics 101

## Geotextiles for Stabilization, Separation, Drainage and Filtration




7 February 2024
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Engineering Business Manager
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Leaders in their fields

# Who is Solmax?

TENCATE GEOSYNTHETICS

Global leader in geosynthetics for civil infrastructure

Propex® GEOSOLUTIONS

Global leader in geosynthetics for erosion control

SOLMAX

Global leader in geosynthetics for environmental infrastructure

We enable the sustainable construction of environmental & civil infrastructure for tomorrow

# Who is Solmax?

My email…

@solmax.com



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# Engineering Materials



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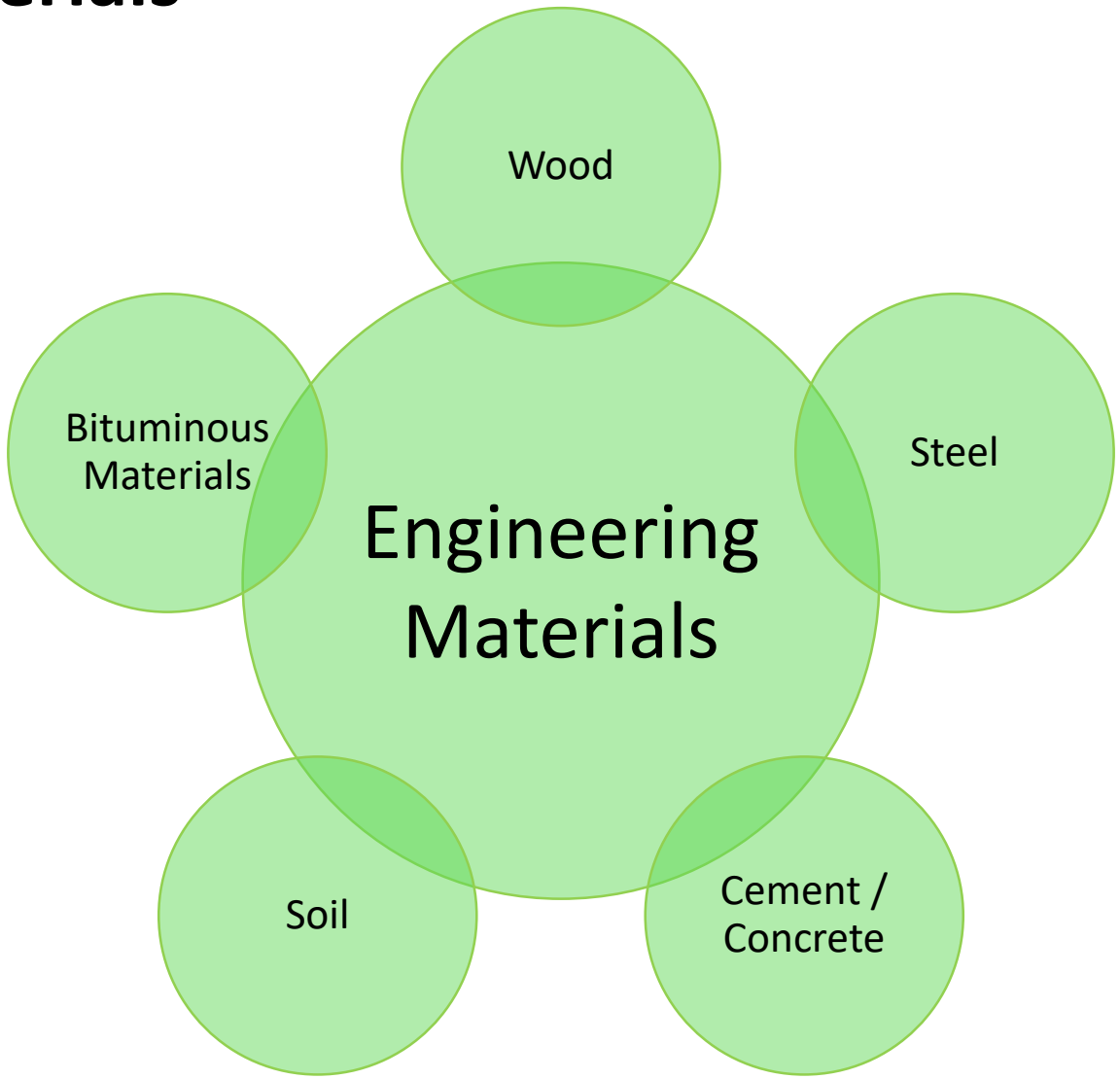
# Engineering Materials



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# Engineering Materials

Geosynthetics



Engineering Materials



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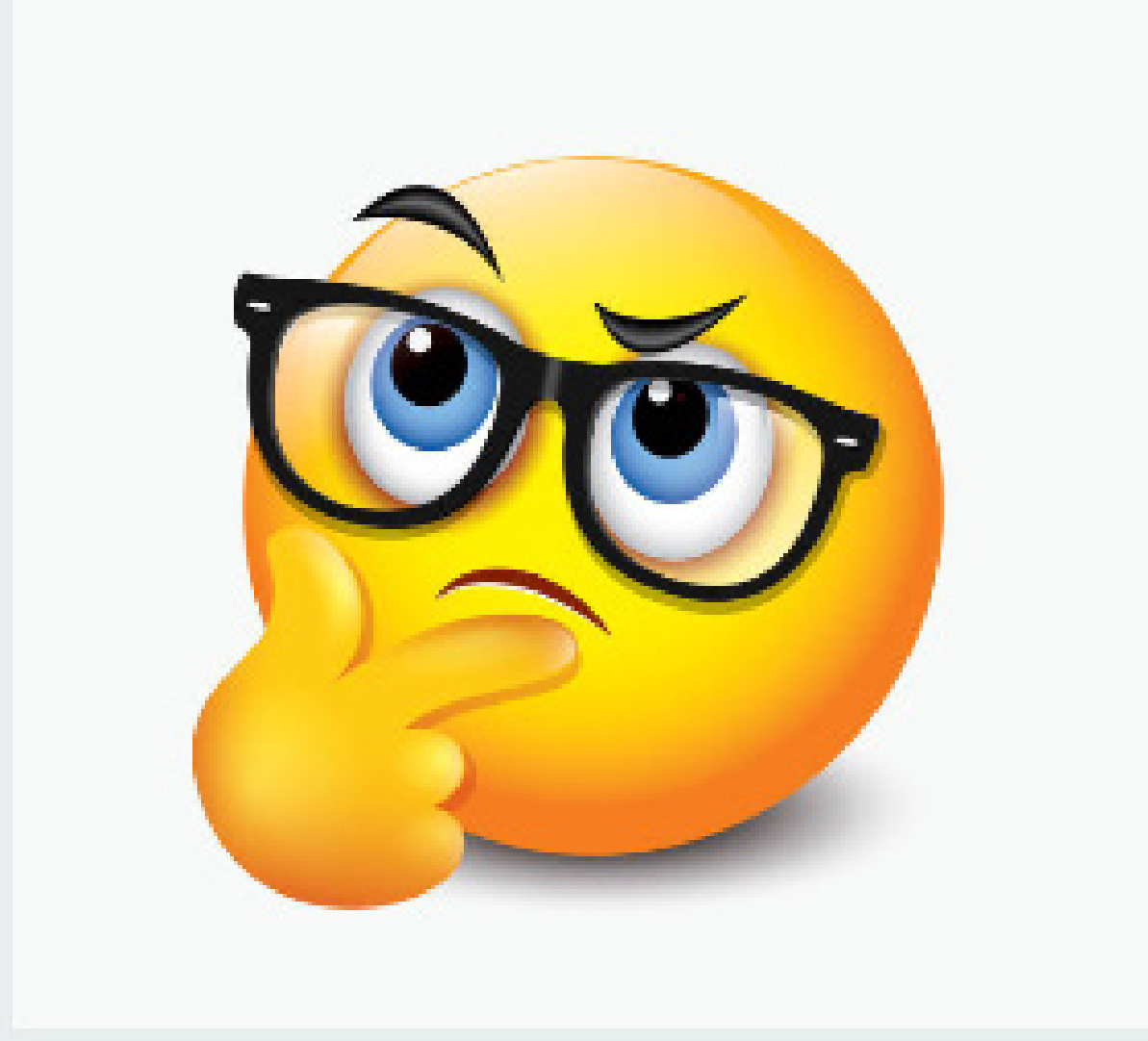
# What are geosynthetics?





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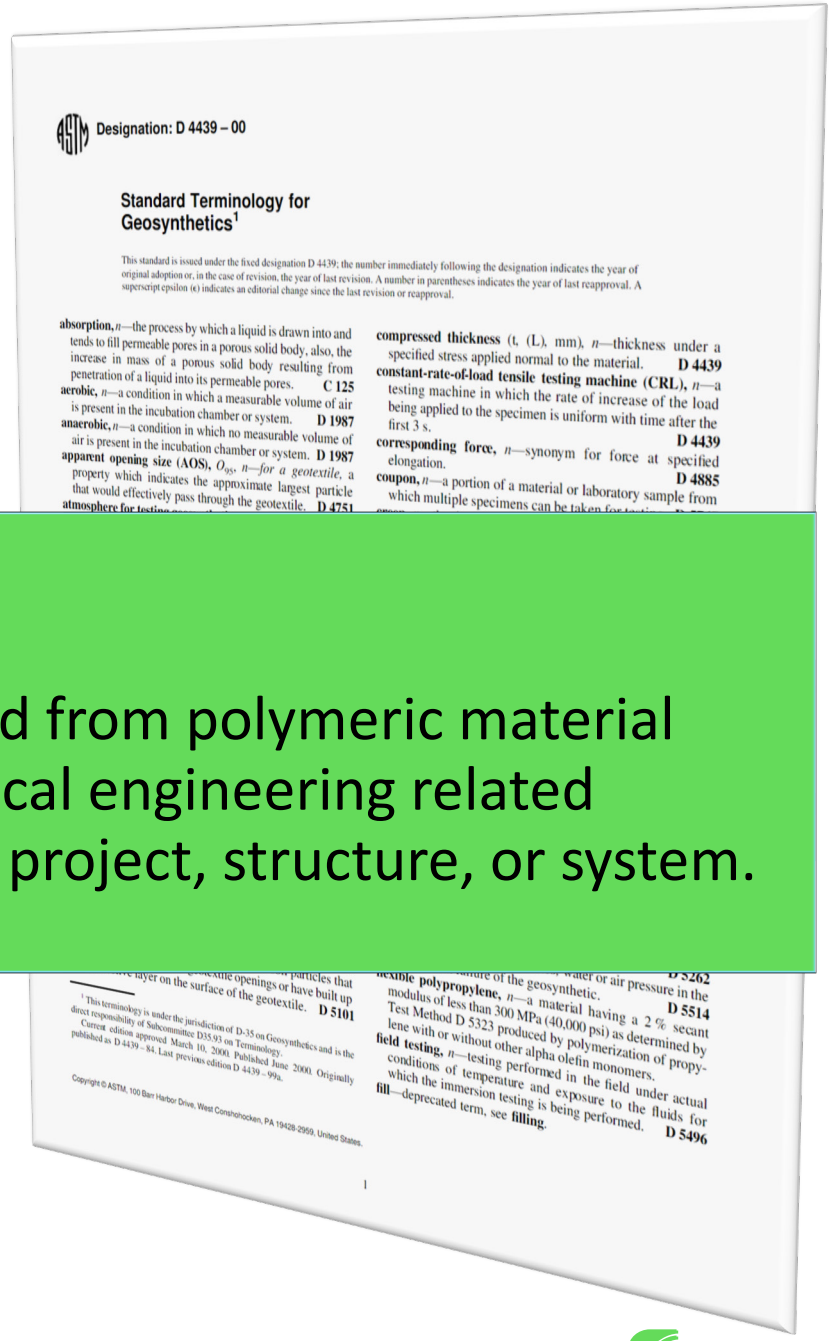
# Geosynthetics 101



Designation: D 4439 – 00

Standard Terminology for Geosynthetics[1]

This standard is issued under the fixed designation D 4439; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

**absorption,** *n*—the process by which a liquid is drawn into and tends to fill permeable pores in a porous solid body, also, the increase in mass of a porous solid body resulting from penetration of a liquid into its permeable pores. **C 125**

**aerobic,** *n*—a condition in which a measurable volume of air is present in the incubation chamber or system. **D 1987**

**anaerobic,** *n*—a condition in which no measurable volume of air is present in the incubation chamber or system. **D 1987**

**apparent opening size (AOS),** $O_{95}$, *n—for a geotextile,* a property which indicates the approximate largest particle that would effectively pass through the geotextile. **D 4751**

**atmosphere for testing**

**compressed thickness** (t, (L), mm), *n*—thickness under a specified stress applied normal to the material. **D 4439**

**constant-rate-of-load tensile testing machine (CRL),** *n*—a testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 s. **D 4439**

**corresponding force,** *n*—synonym for force at specified elongation. **D 4885**

**coupon,** *n*—a portion of a material or laboratory sample from which multiple specimens can be taken for

**flexible polypropylene,** *n*—a material having a 2 % secant modulus of less than 300 MPa (40,000 psi) as determined by Test Method D 5323 produced by polymerization of propylene with or without other alpha olefin monomers. **D 5514**

**field testing,** *n*—testing performed in the field under actual conditions of temperature and exposure to the fluids for which the immersion testing is being performed. **D 5496**

**fill**—deprecated term, see **filling**.

layer on the surface of the geotextile. **D 5101**

[1] This terminology is under the jurisdiction of D-35 on Geosynthetics and is the direct responsibility of Subcommittee D35.93 on Terminology.
Current edition approved March 10, 2000. Published June 2000. Originally published as D 4439 – 84. Last previous edition D 4439 – 99a.



ASTM D4439

Geosynthetic – a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a human-made project, structure, or system.



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The term ***geosynthetics*** 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.

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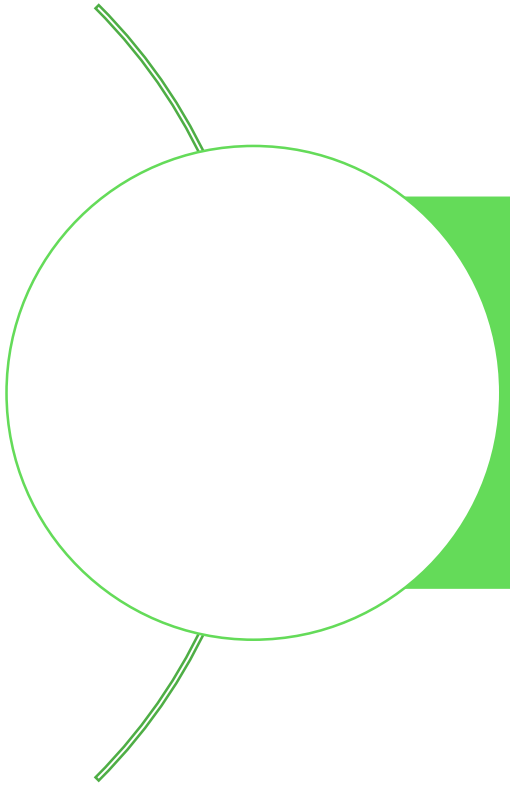
# Geogrids

What is a geogrid?

# Geosynthetics 101



ASTM D4439

***Geogrid*** – a geosynthetic formed by a network of integrally connected elements with apertures greater than ¼ inch (6.35 mm) to allow interlocking with surrounding soil, earth, rock and other surrounding material to act primarily as reinforcement.



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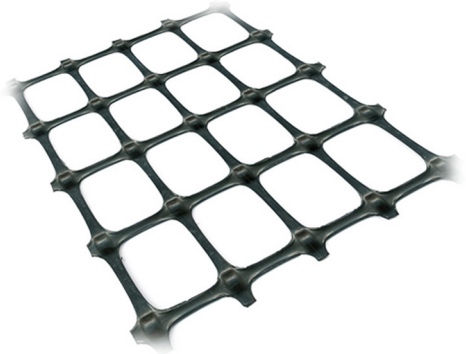
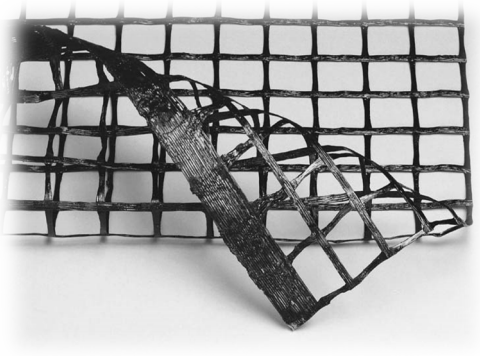
Several different manufacturing processes…

…different plastics.

**Geogrid**



Punched and Drawn



Woven

Welded

Knitted



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## Uniaxial Geogrid




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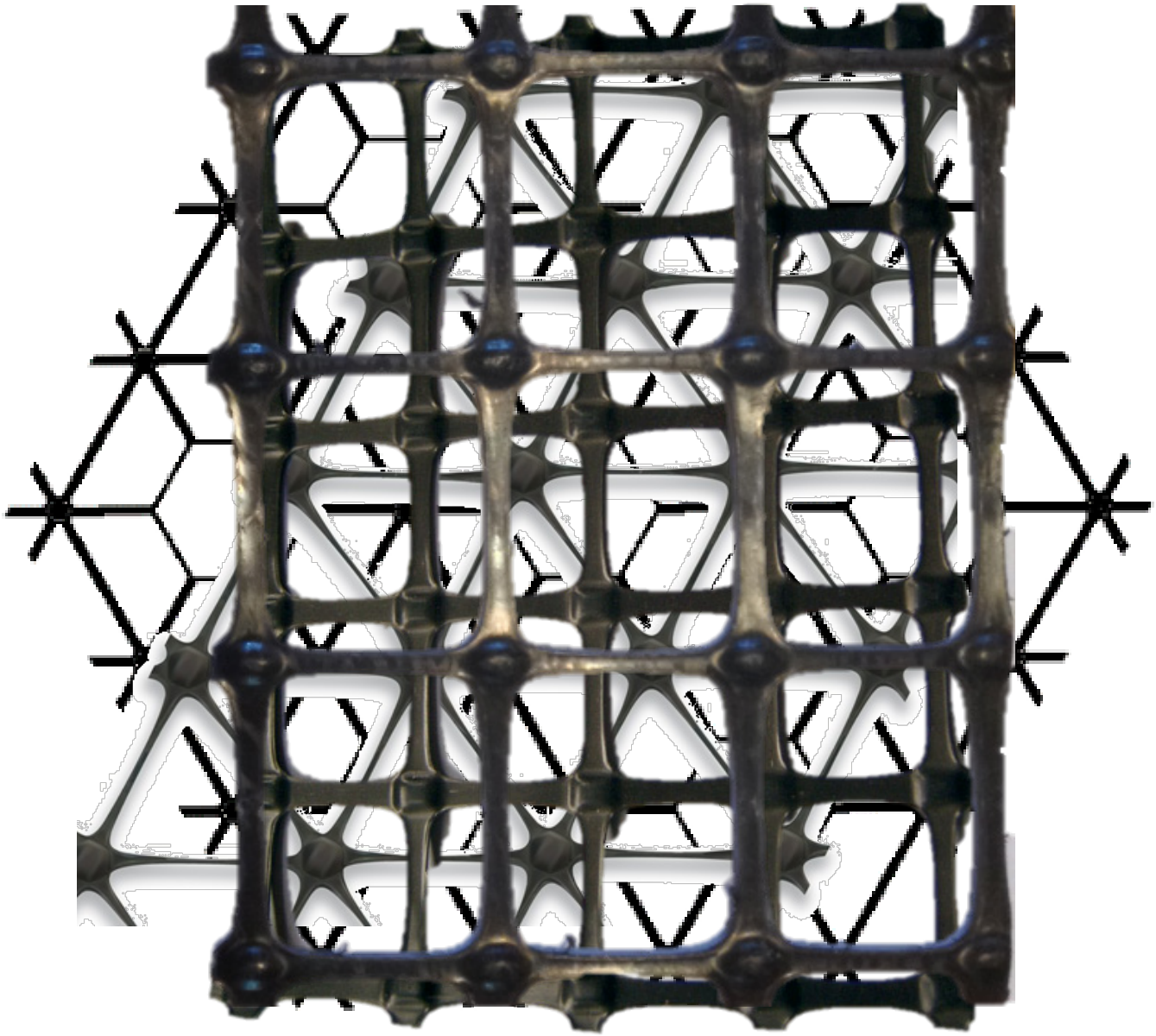
## Multiaxial Geogrid

Different Shapes





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Go from this…




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to this…


OCT 11 2002

Geogrid

# Geosynthetics 101

## Pros

+ High strength to weight ratio
+ High soil interaction
+ Easy to handle, cut and install

## Cons

- No separation / filtration
- Cannot do sewn seams



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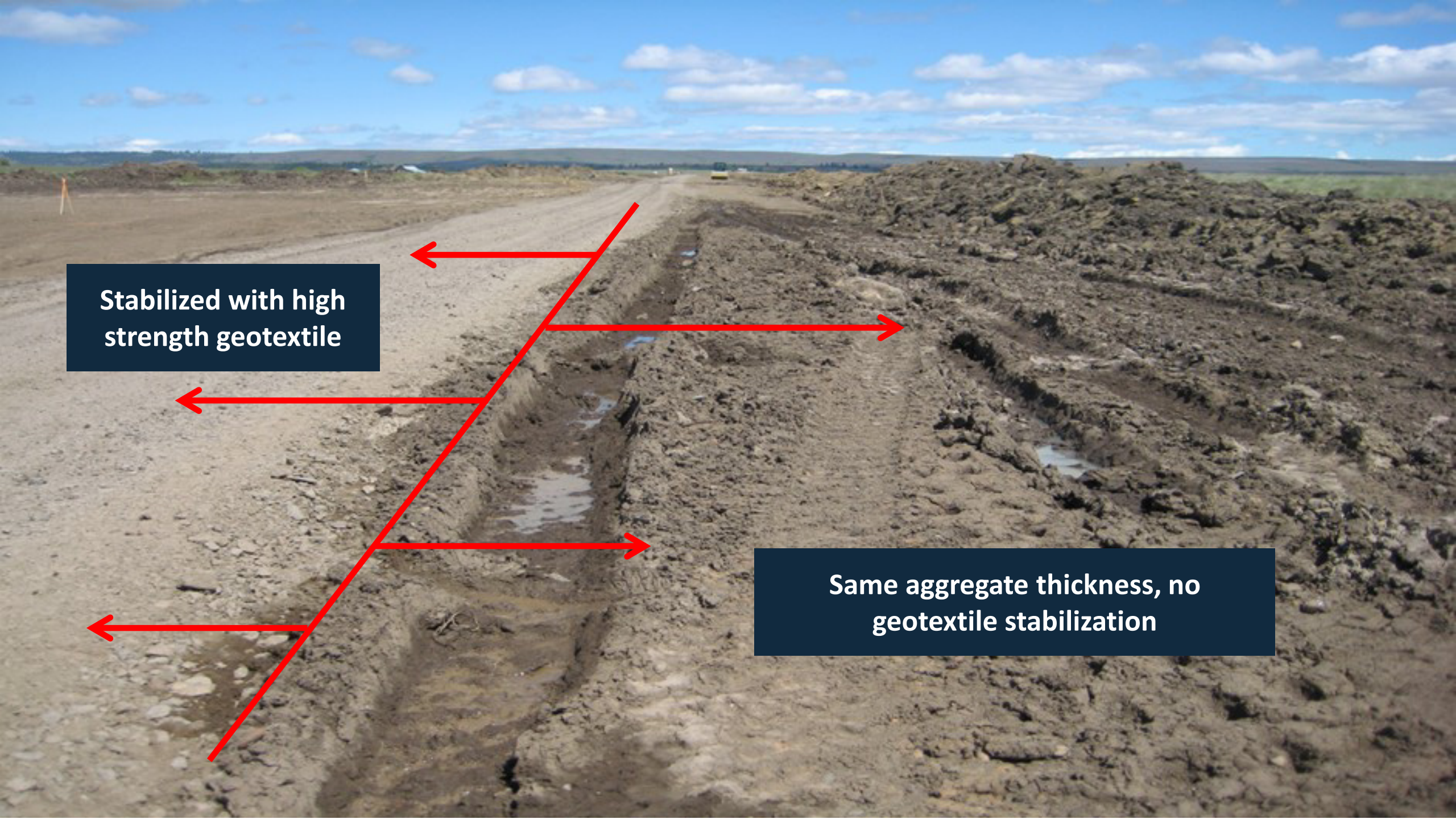
# Geosynthetics 101

ASTM D4439

***Geotextile*** – a permeable geosynthetic comprised solely of textiles.


Stabilized with high strength geotextile
Same aggregate thickness, no geotextile stabilization

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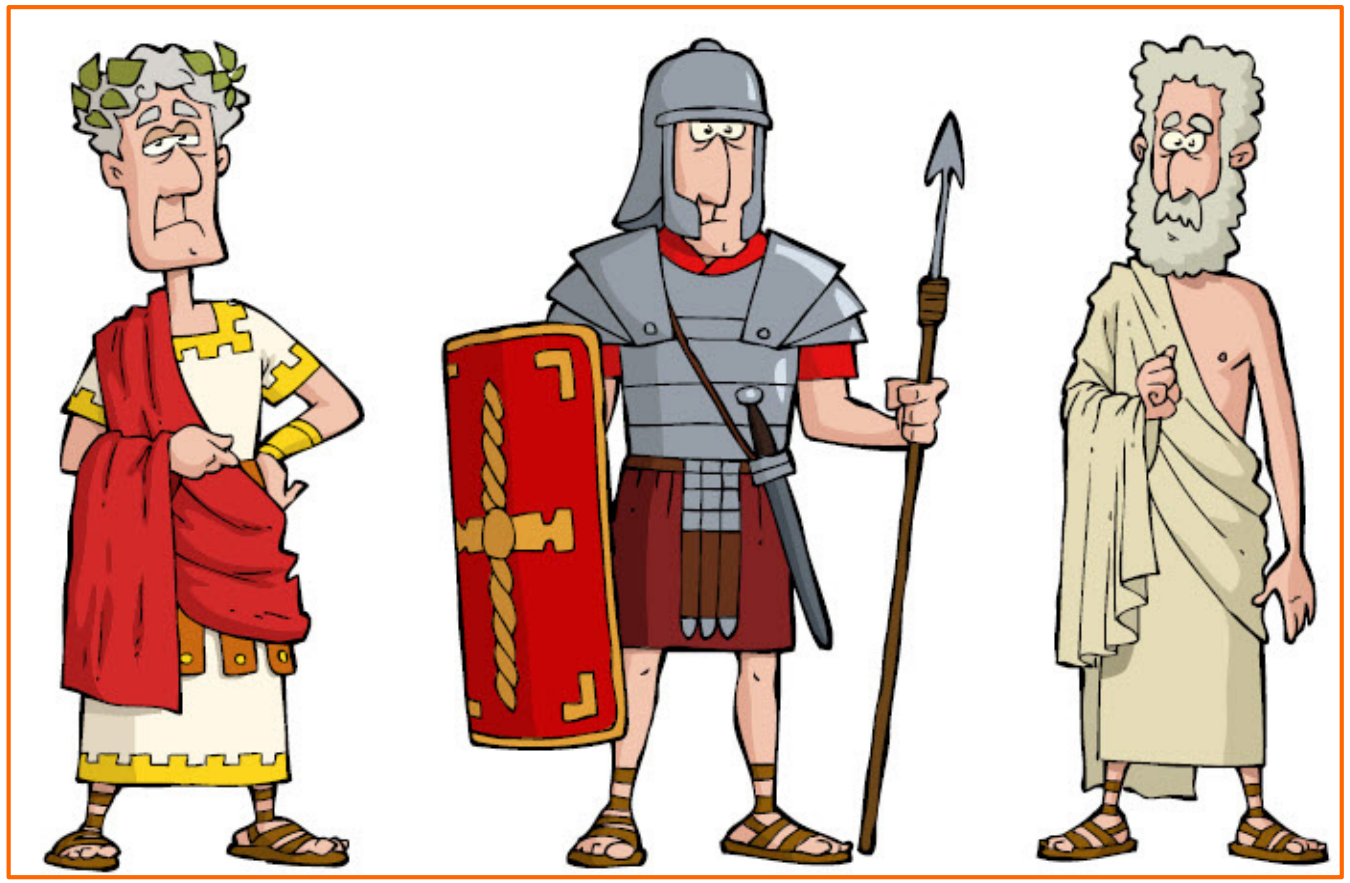

Ancient Roman Engineering
…Corduroy Roads

## Benefits from using geosynthetics

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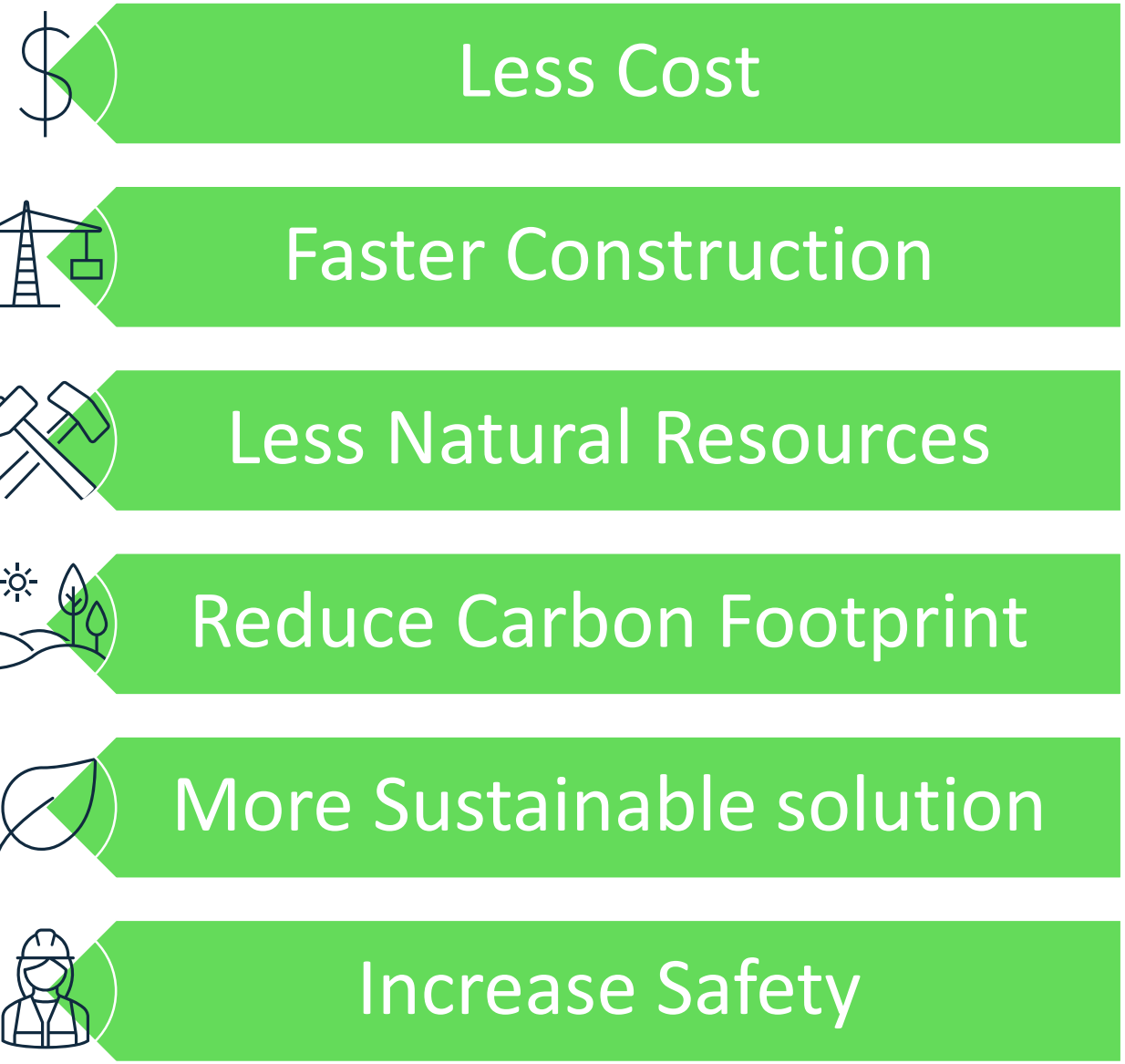




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# Geotextiles

Types of Geotextiles

# Geosynthetics 101

**Nonwoven**

**Woven**



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# Geosynthetics 101

## Nonwoven



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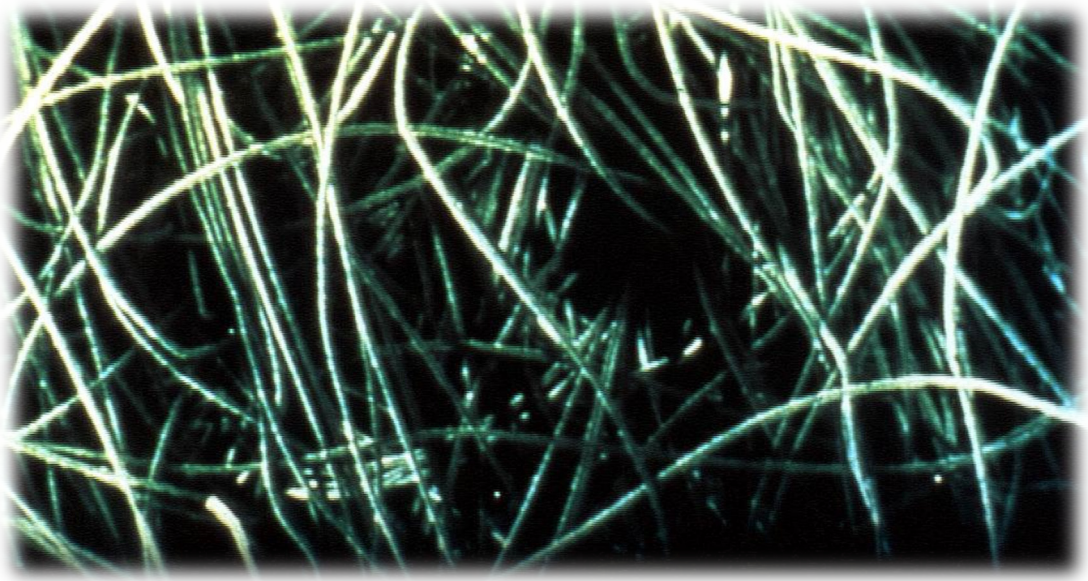
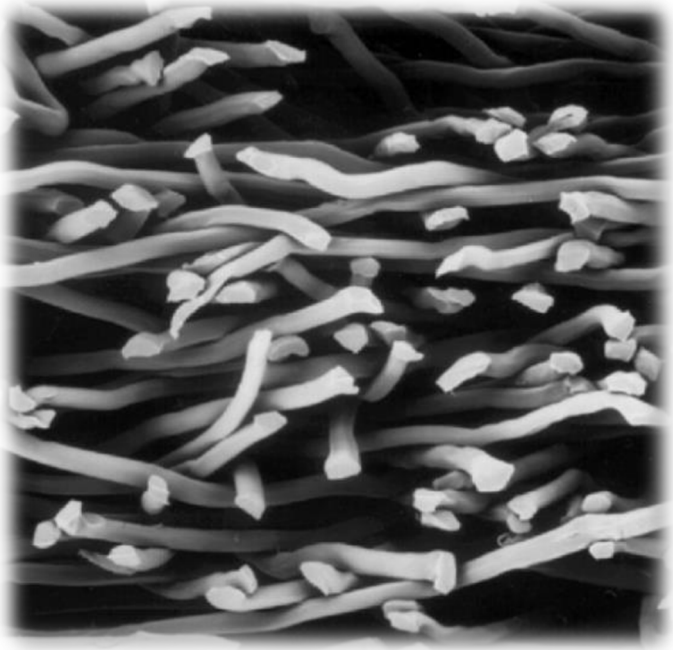
# Geosynthetics 101

## Nonwoven

Yarns or fibers are mechanically or chemically entangled or bonded to produce a textile material.

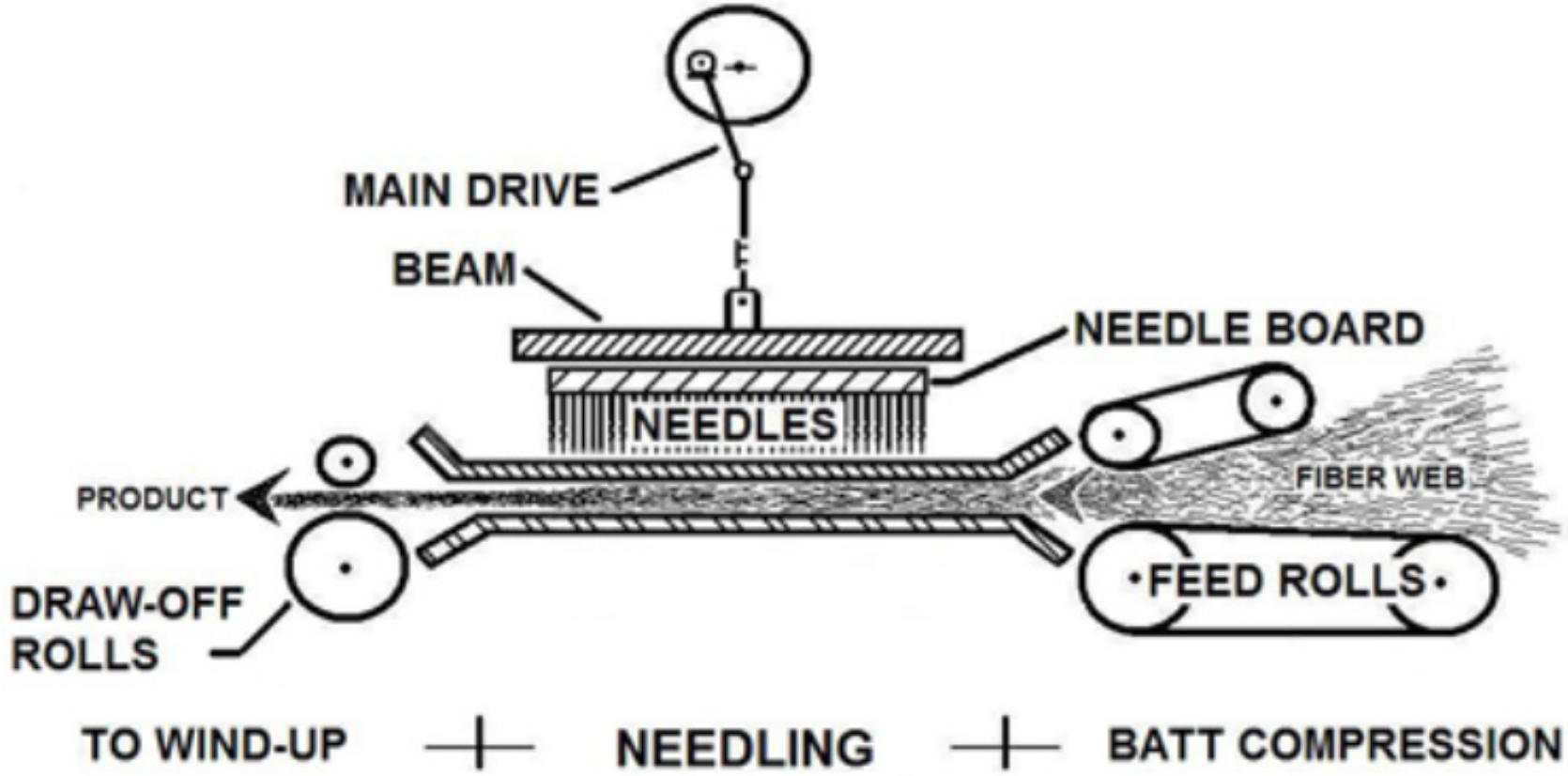
Most are are needle punched (i.e., mechanically entangled).





# Geosynthetics 101

## Needle Punching



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Nonwoven Geotextiles

# Geosynthetics 101

## Pros

+ High flow rate
+ Fine filtration
+ High elongation
+ Flexible
+ Can provide cushion/protection

## Cons

- Low strength to weight ratio
- High elongation
- Subject to blinding and clogging



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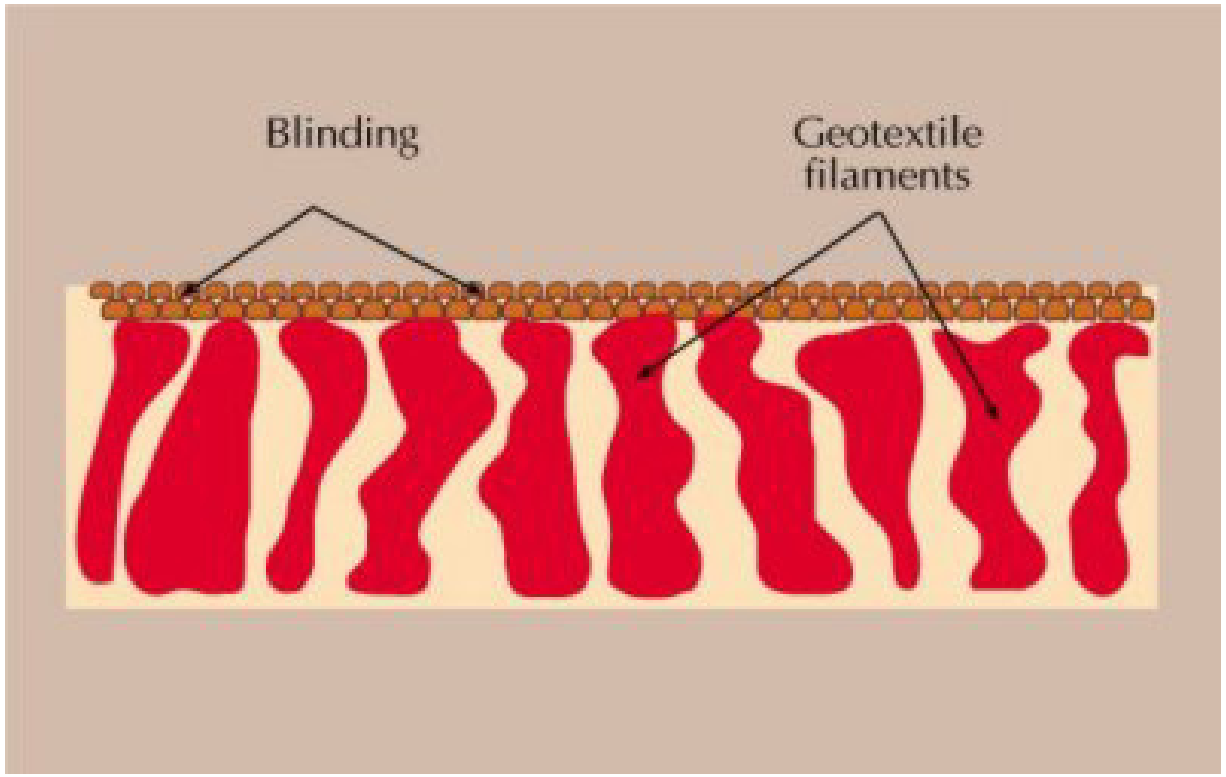
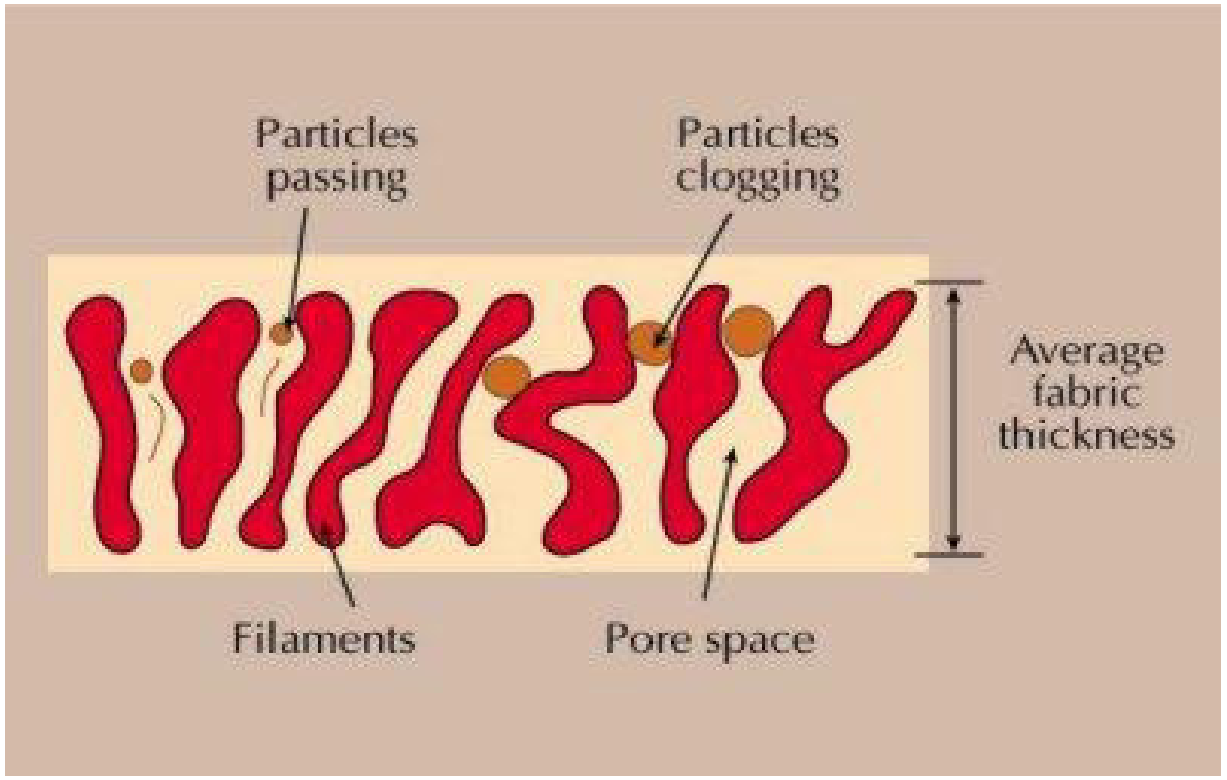
# Geosynthetics 101




Blinding




Clogging



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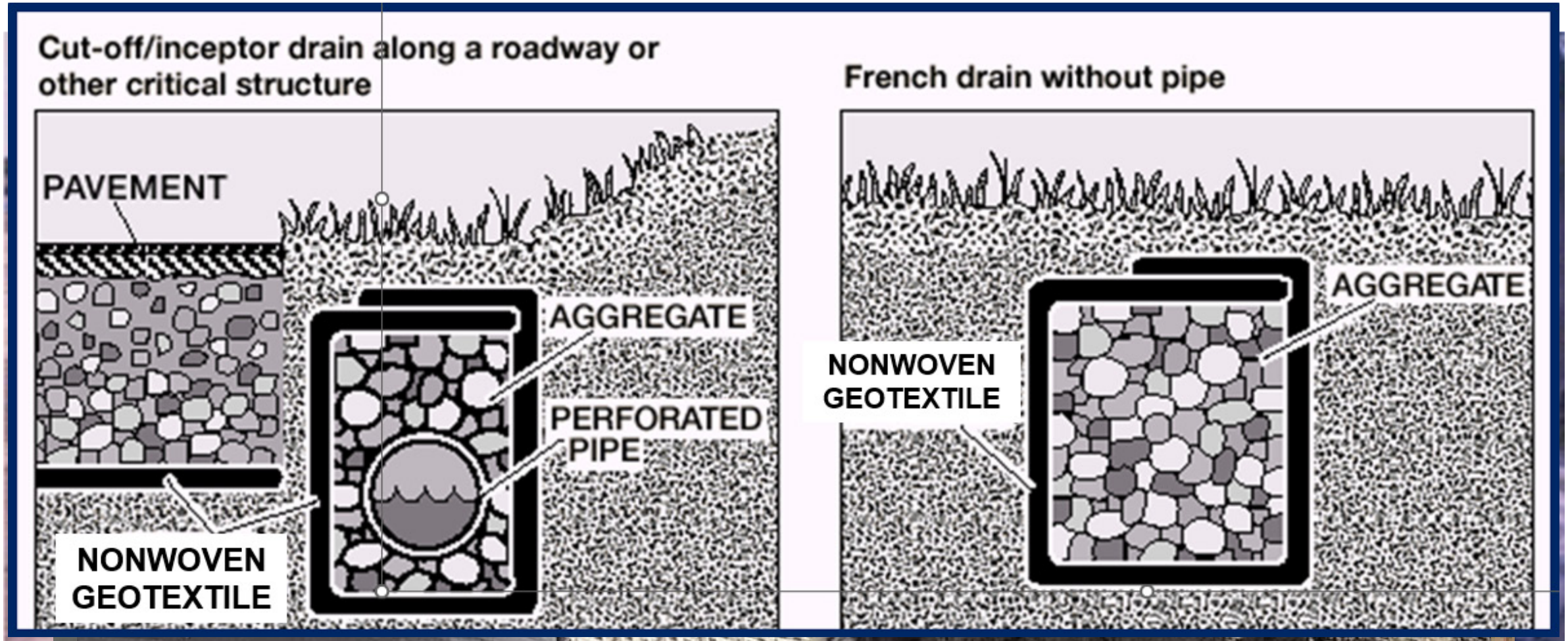
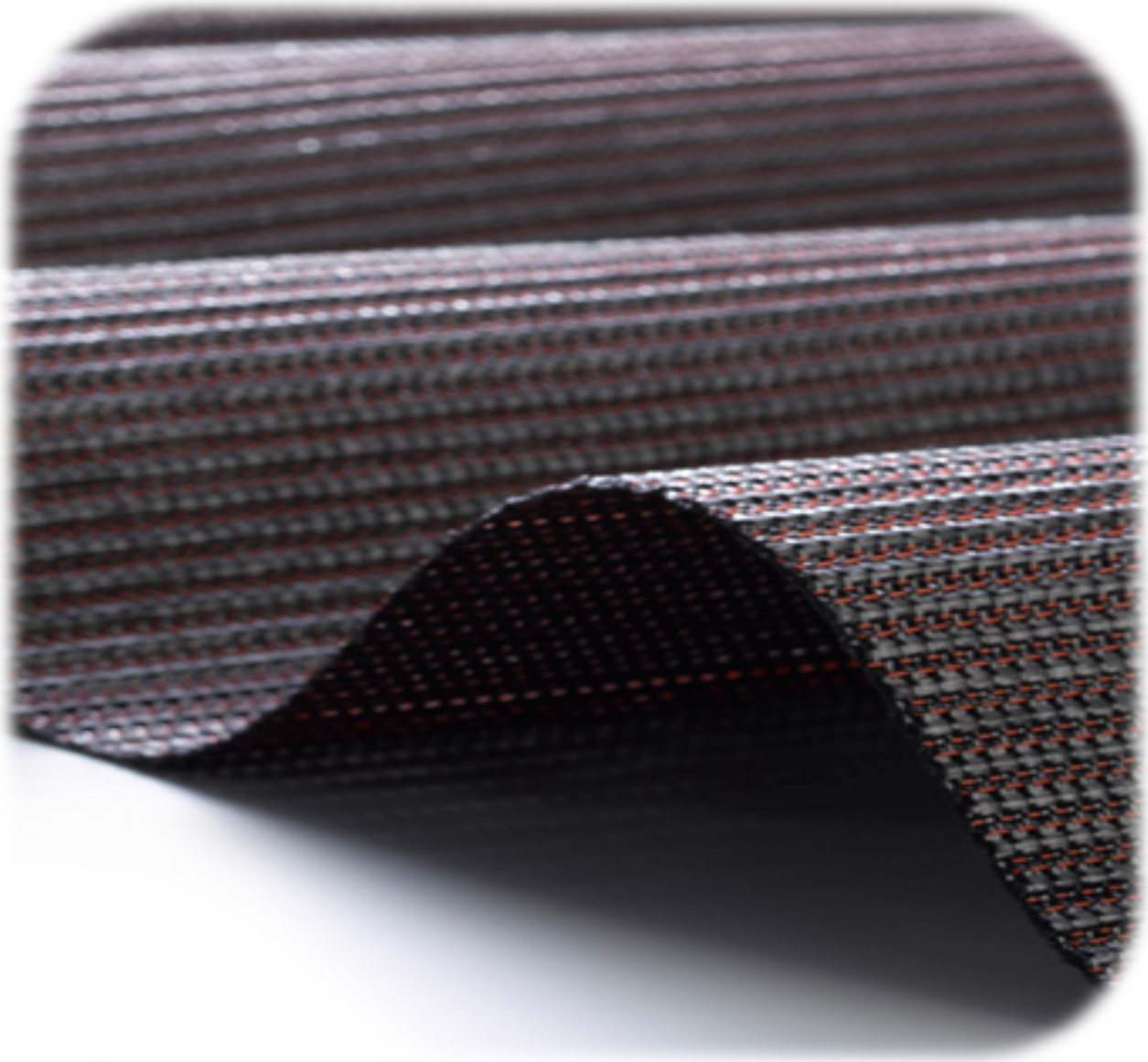

Cut-off/inceptor drain along a roadway or other critical structure
PAVEMENT
AGGREGATE
PERFORATED PIPE
NONWOVEN GEOTEXTILE
French drain without pipe
AGGREGATE
NONWOVEN GEOTEXTILE

Types of Geotextiles

# Geosynthetics 101

## Woven

Yarns are mechanically interlaced to produce a textile material.





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# Geosynthetics 101

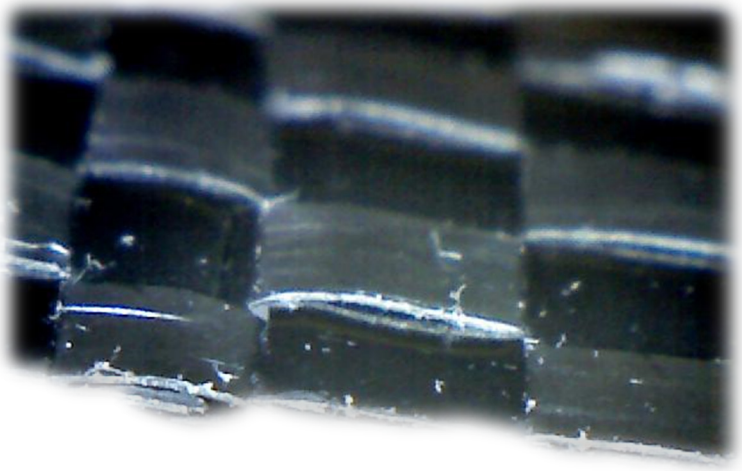
## Woven

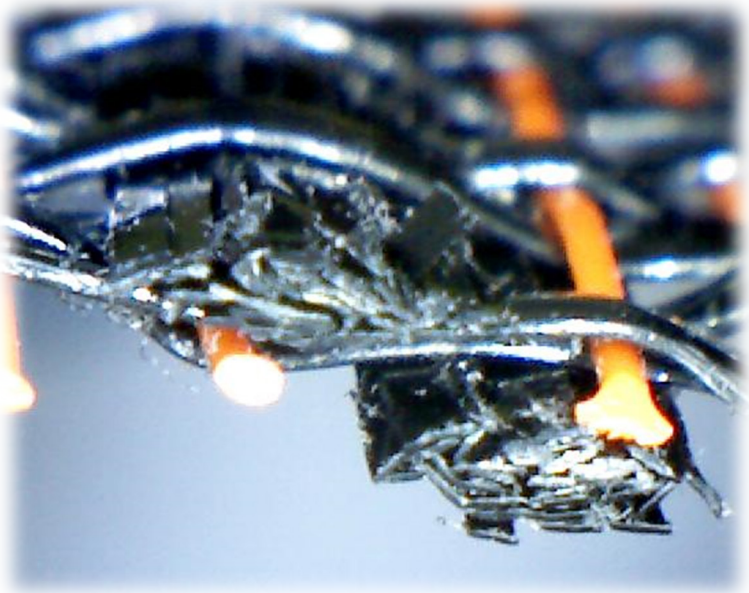
Yarns are mechanically interlaced to produce a textile material.

# Geosynthetics 101

Not all woven geotextiles are the same!

## Woven







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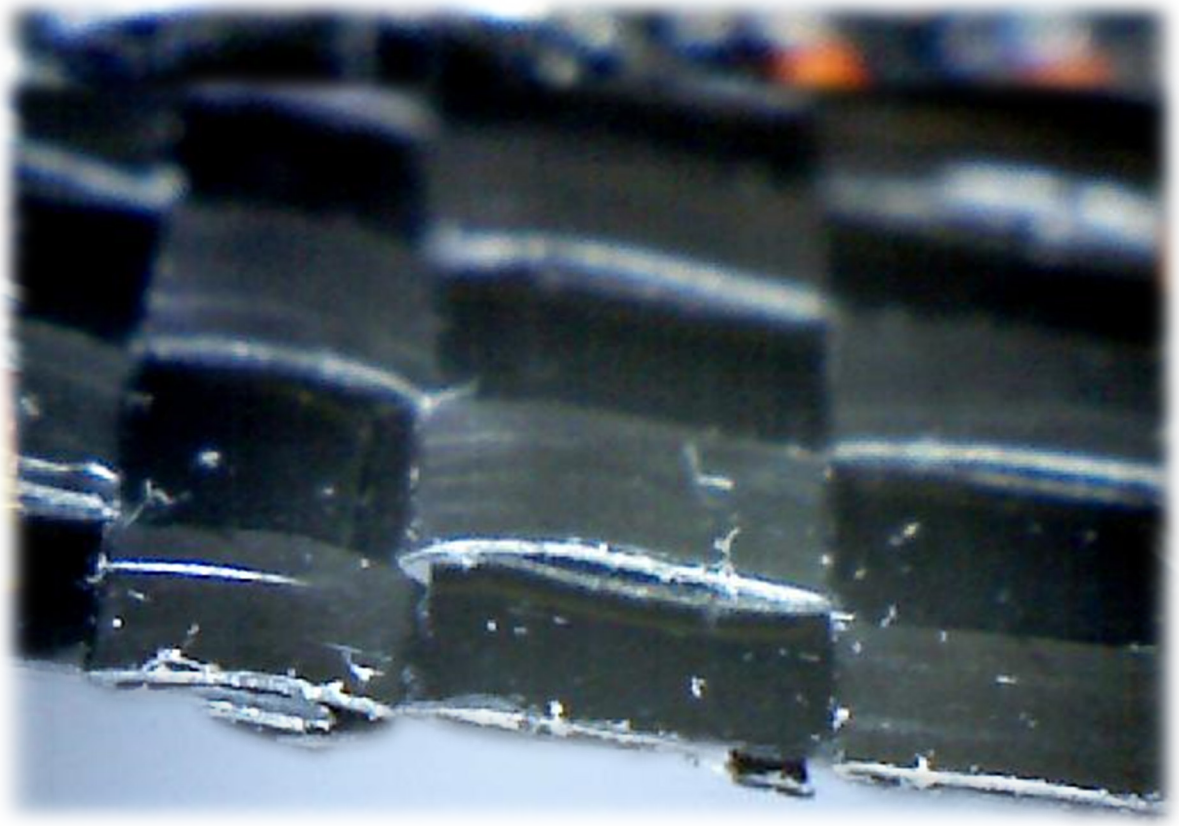
# Geosynthetics 101



## Pros

+ High flow rate (most)
+ Controlled flow rate
+ Controlled filtration
+ Low elongation w/ high tensile strength (i.e., high tensile modulus)
+ Durable (more resistant to installation damage)

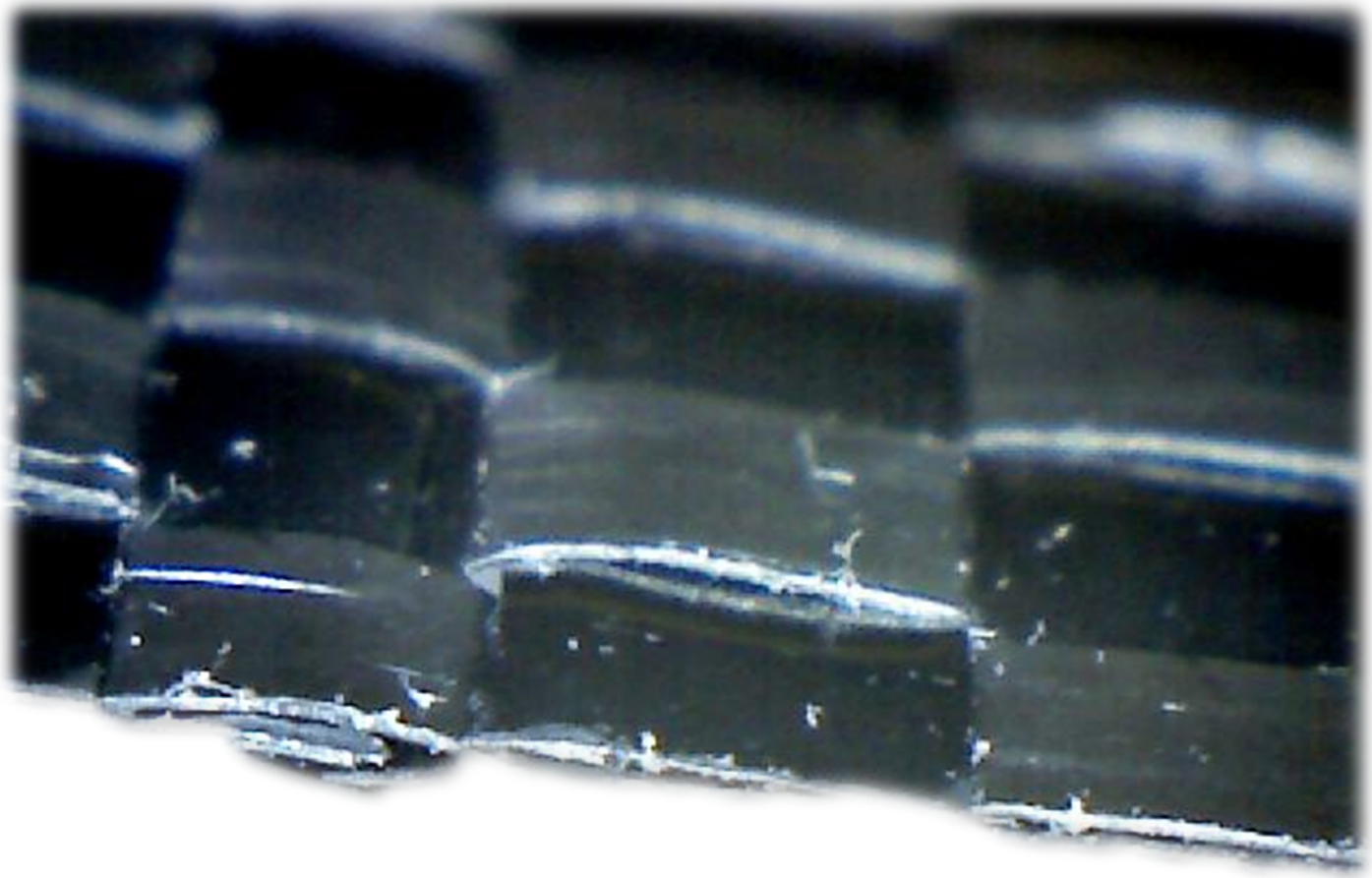
## Cons

- Can posses very poor flow-through & filtration
- Can posses a very low coefficient of friction, i.e., poor interaction with fill material
- Slit Tape / Slit Film Wovens!

# Let us review some of the more predominant types of woven geotextiles used in civil infrastructure applications…

# Geosynthetics 101

Slit Tape, a.k.a., Slit Film





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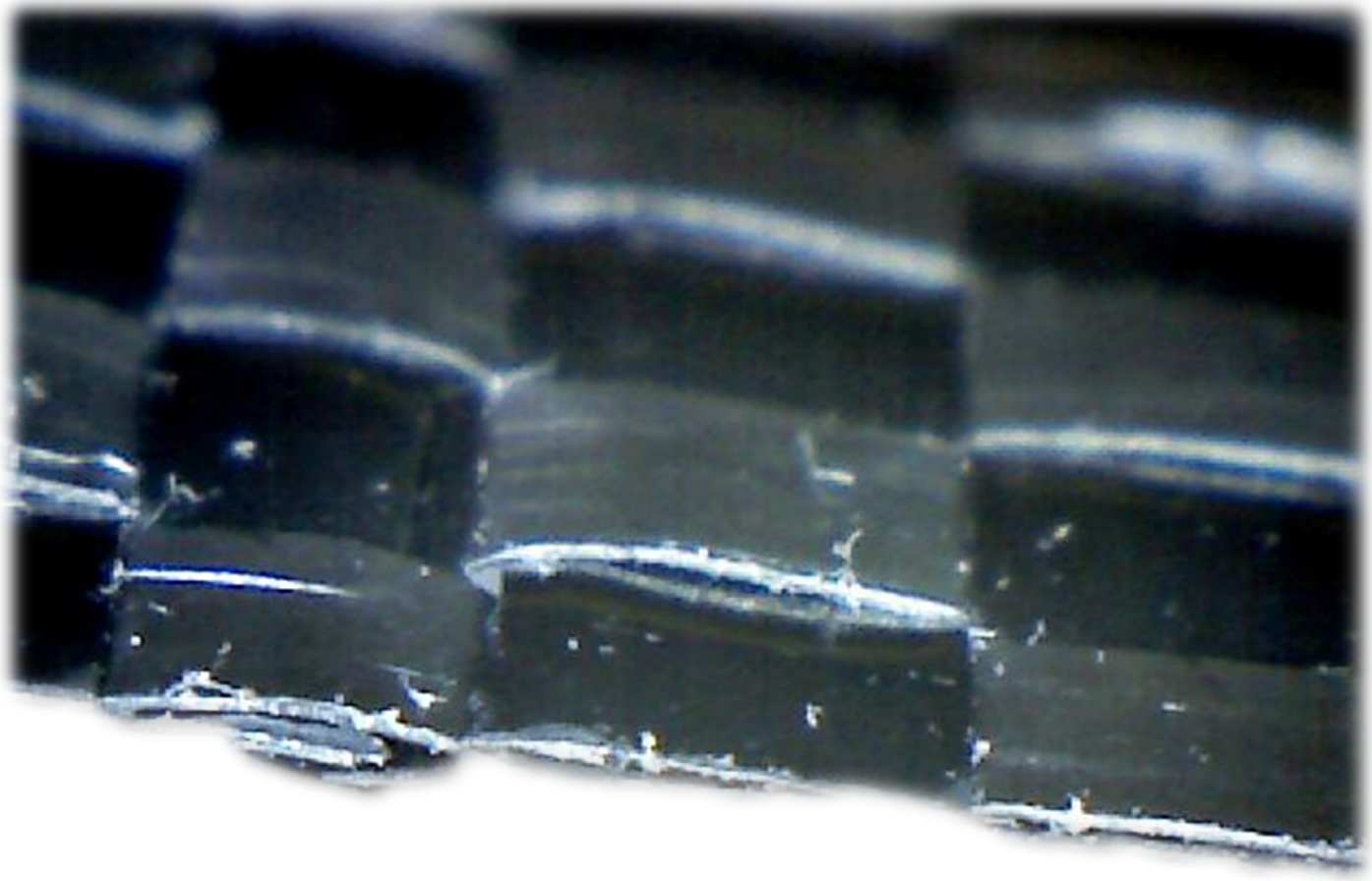
# Geosynthetics 101

**MDOT Section 910**
**Table 910-1**
Woven Geotextile Separator
and
Stabilization Geotextile





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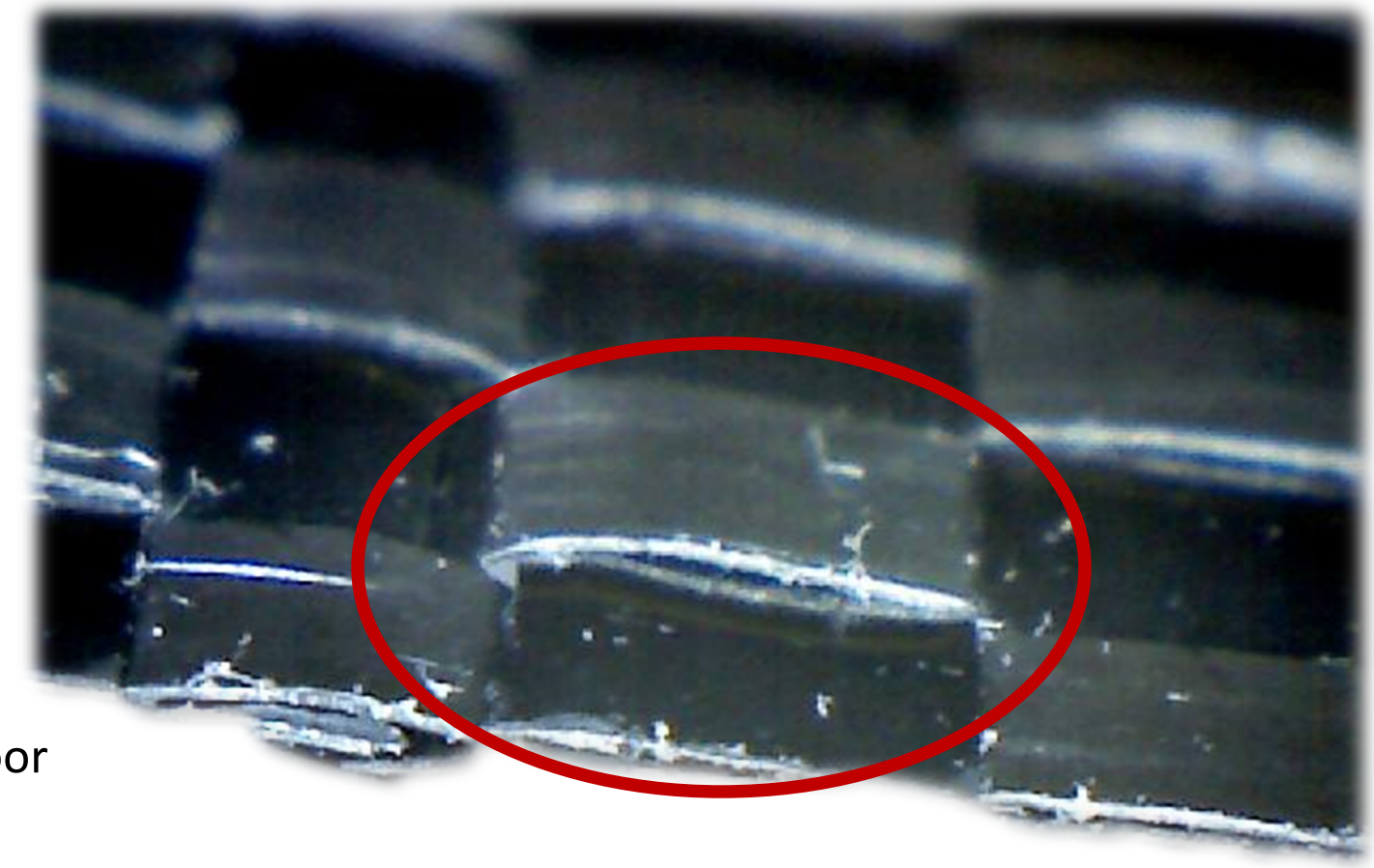
Remember this?

# Slit Tape / Slit Film

# Geosynthetics 101



## Slit Tape/Slit Film Woven Geotextile

- very poor flow-through & filtration
- very low coefficient of friction, i.e., poor interaction with fill material



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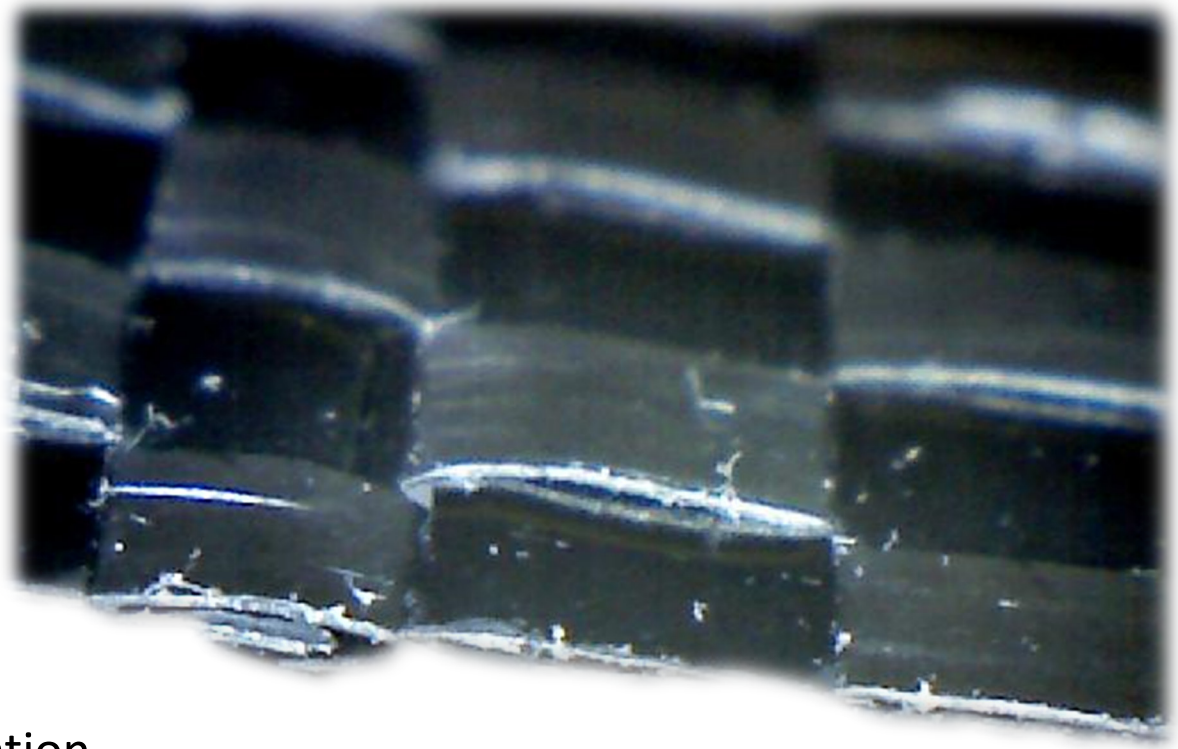
# Geosynthetics 101

## Pros

+ High flow rate (most)
+ Controlled flow rate
+ Controlled filtration
+ Low elongation w/ high tensile strength (i.e., high tensile modulus)
+ Durable (more resistant to installation damage)

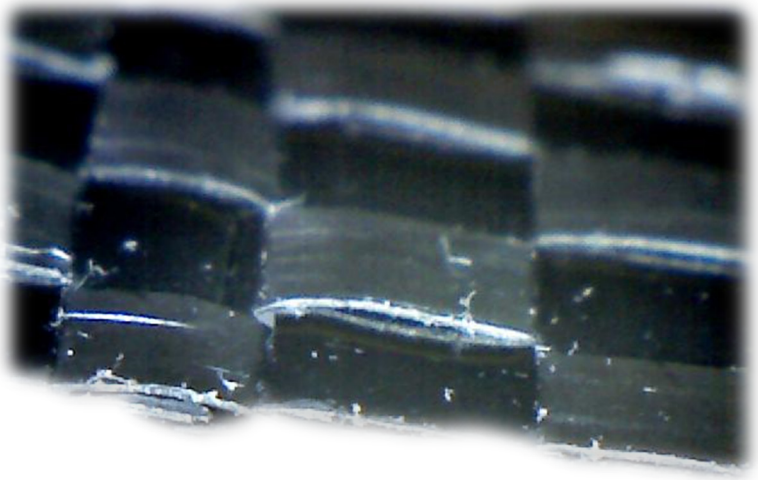


## Cons

- Can posses very poor flow-through & filtration
- Can posses a very low coefficient of friction, i.e., poor interaction with fill material
- ***Slit Tape/Slit Film Wovens!***

## Woven Geotextiles – Slit Tape = SILT FENCE!

# Geosynthetics 101





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# Geosynthetics 101

Slit Tapes are not allowed by:

- AREMA Design Guide
- FHWA
- 20 State DOTs and counting

# Geosynthetics 101

Monofilament Yarns
Filter Fabric



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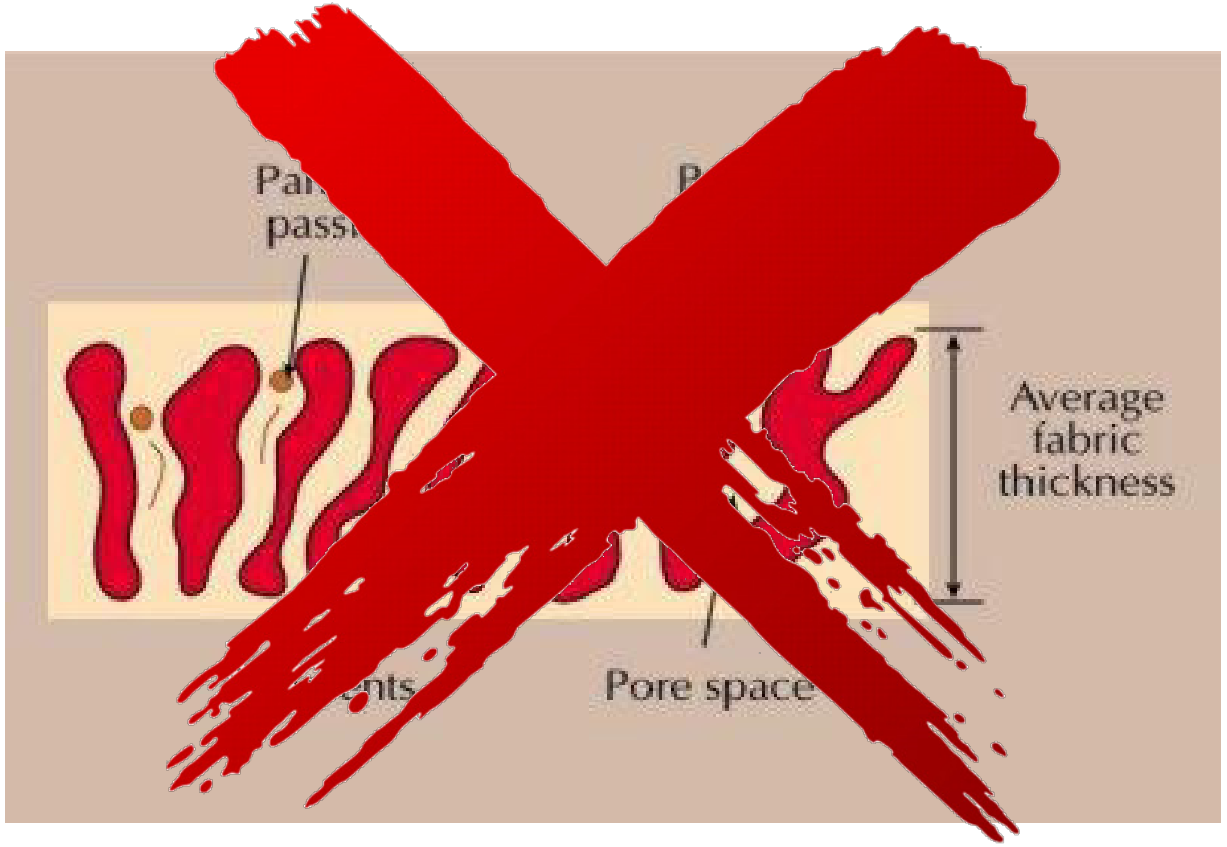
# Geosynthetics 101

Blinding




Clogging



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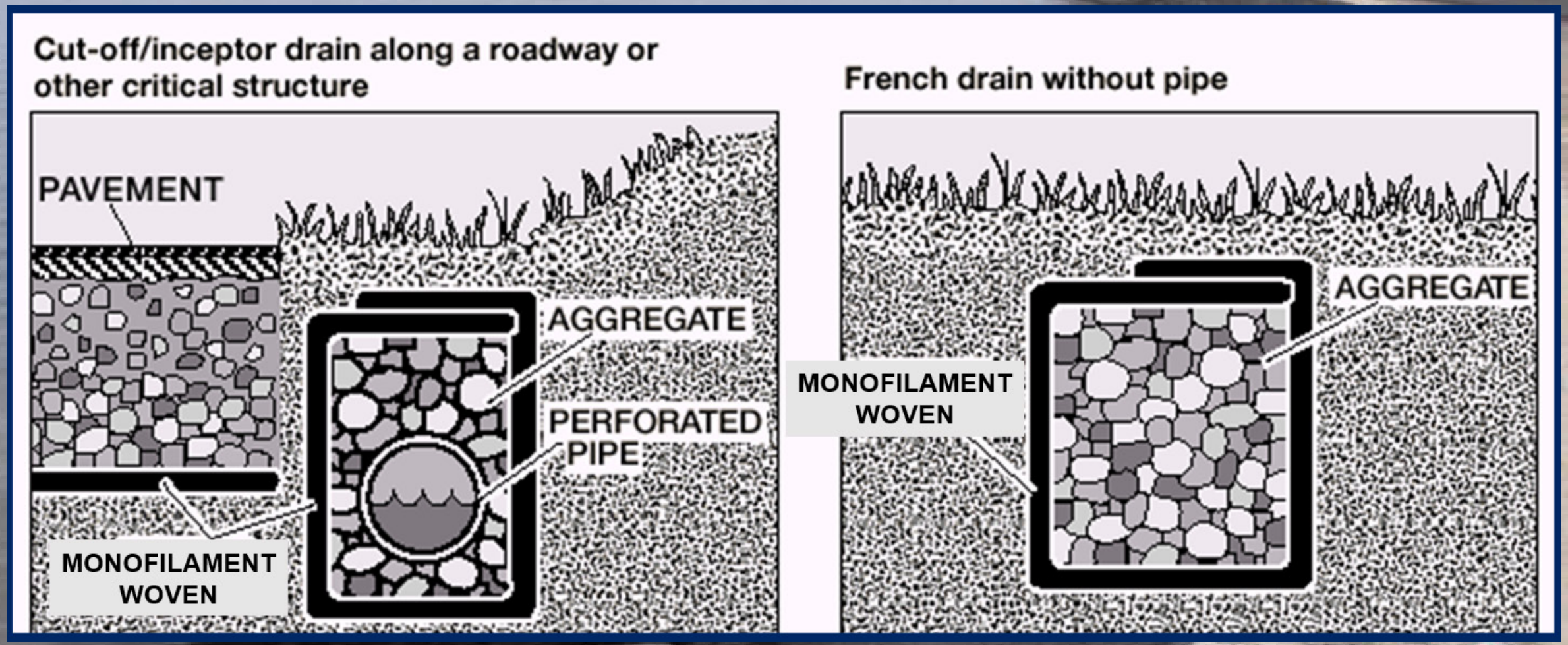

Cut-off/inceptor drain along a roadway or other critical structure
PAVEMENT
AGGREGATE
PERFORATED PIPE
MONOFILAMENT WOVEN
French drain without pipe
AGGREGATE
MONOFILAMENT WOVEN

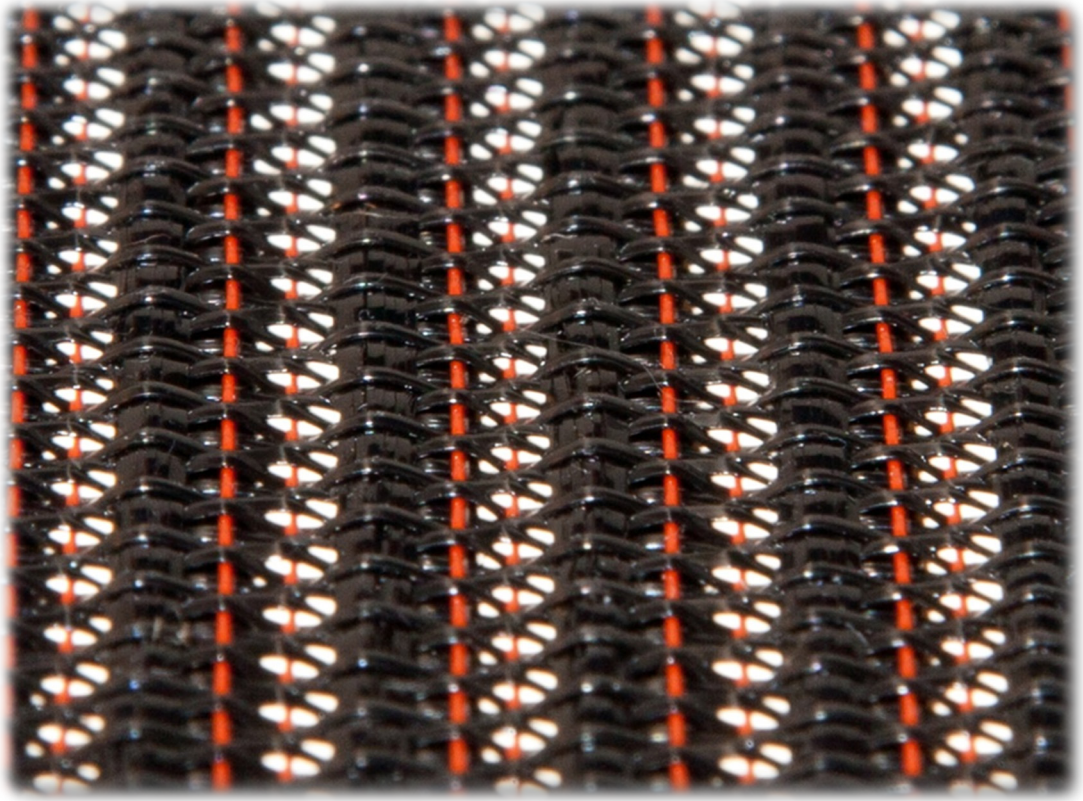
# Geosynthetics 101

## Woven

### High Strength Wovens

Multifilament

- Different yarns and/or yarn combinations
- Different weave patterns
- Different engineering properties and therefore different functional capabilities
- Different/specialized applications

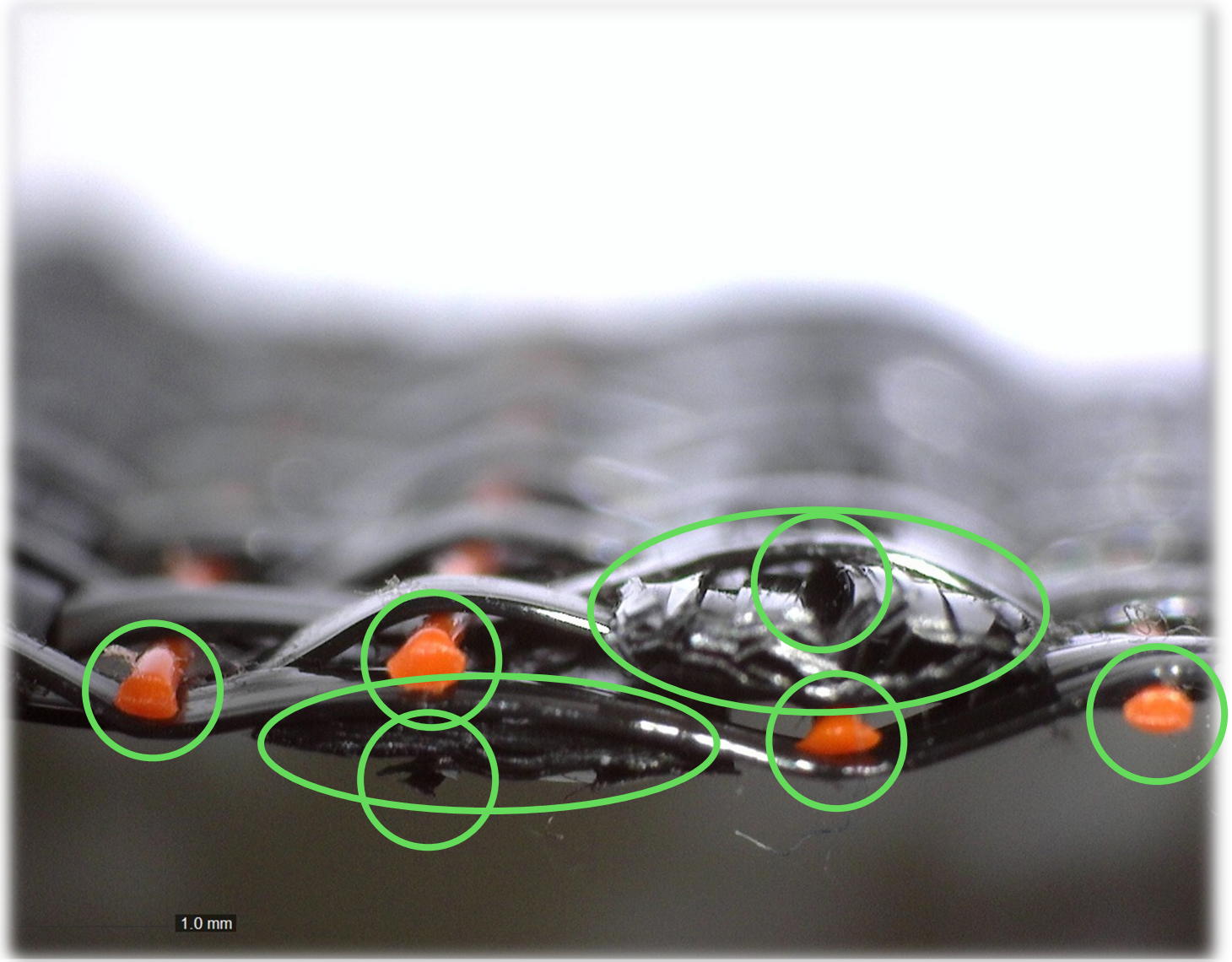


# Woven Geotextile

**Engineered Integrated High Strength Woven Geotextile**

Multifilament Yarns

Patented Double Layer Weave Pattern



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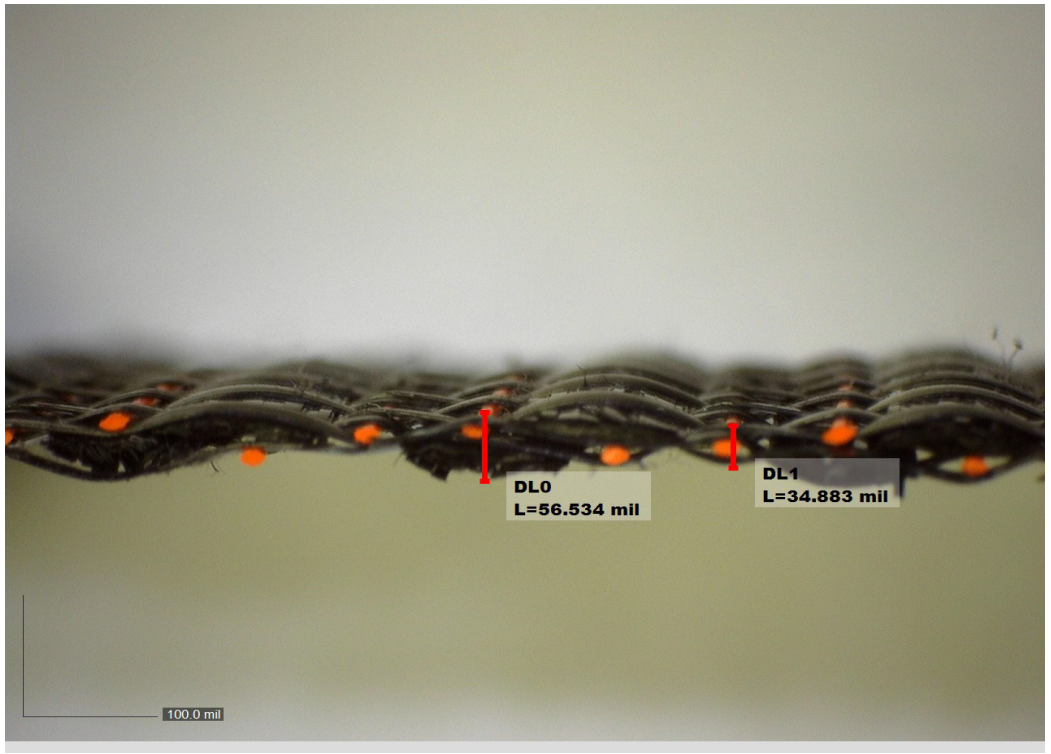
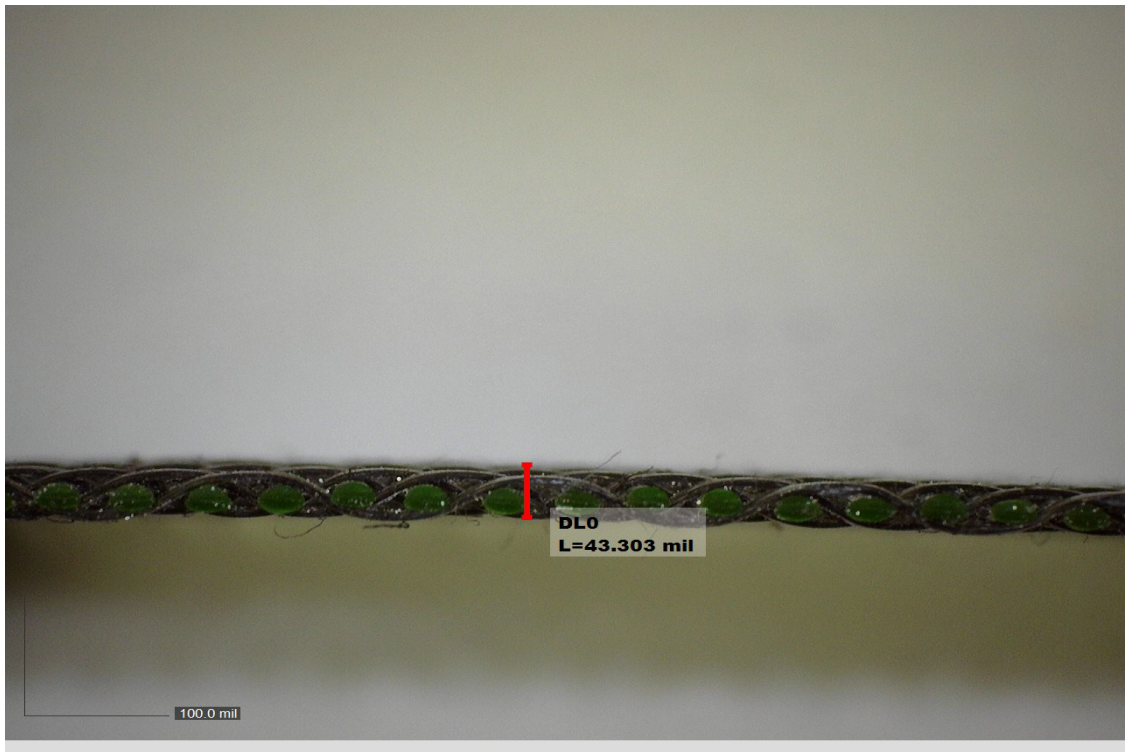
Comparing competitive ‘equivalent’

# Look at the difference in peaks and valleys

## Engineered Integrated High Strength Woven




## ‘Me Too’



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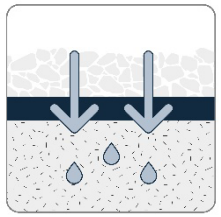
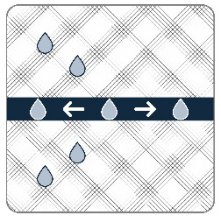
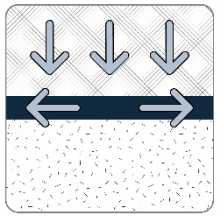
# Geosynthetic Functions in Site Civil Applications

GMA White Paper II – Section 1.4.1 (June 2002)

# Geosynthetic Performance Functions


## SEPARATION

Prevention of subgrade soil intrusion into aggregate base and prevention of aggregate base migrating into the subgrade

## FILTRATION

Restricting the movement of soil particles, while allowing water to move from the filtered soil to the coarser soil adjacent to it

## DRAINAGE

The lateral movement of water within the plane of the geosynthetic

## REINFORCEMENT

The addition of structural or load-carrying capacity to a pavement system by the transfer of load to the geosynthetic material



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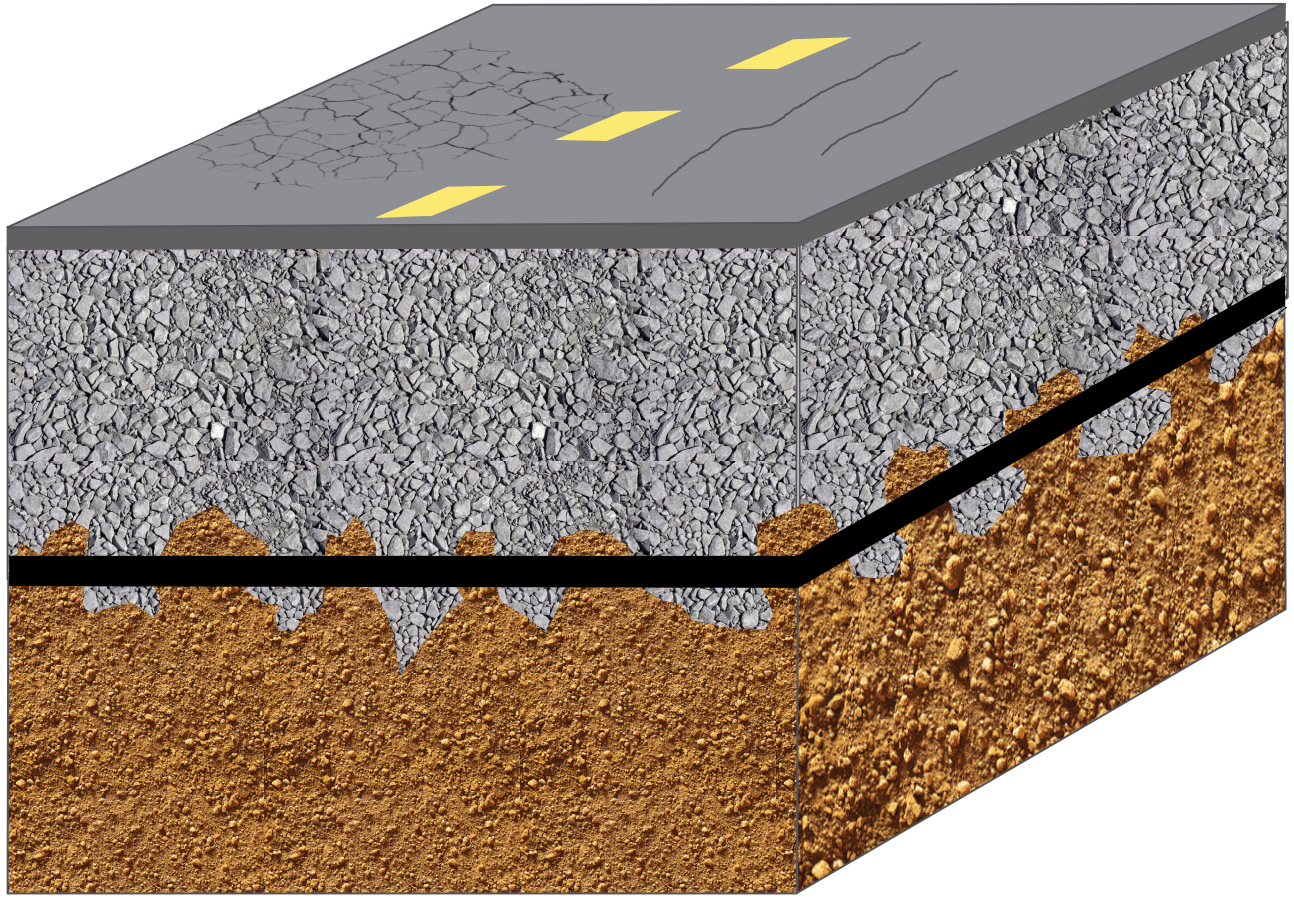
## Key Functions of Geosynthetics - Separation

# Geosynthetics




Maintains integrity & function of
dissimilar materials

*"10 lbs of stone + 20 lbs of mud = 20 lbs of mud"*



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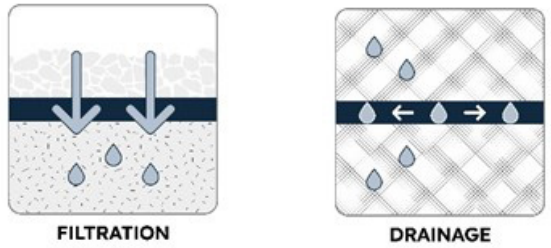
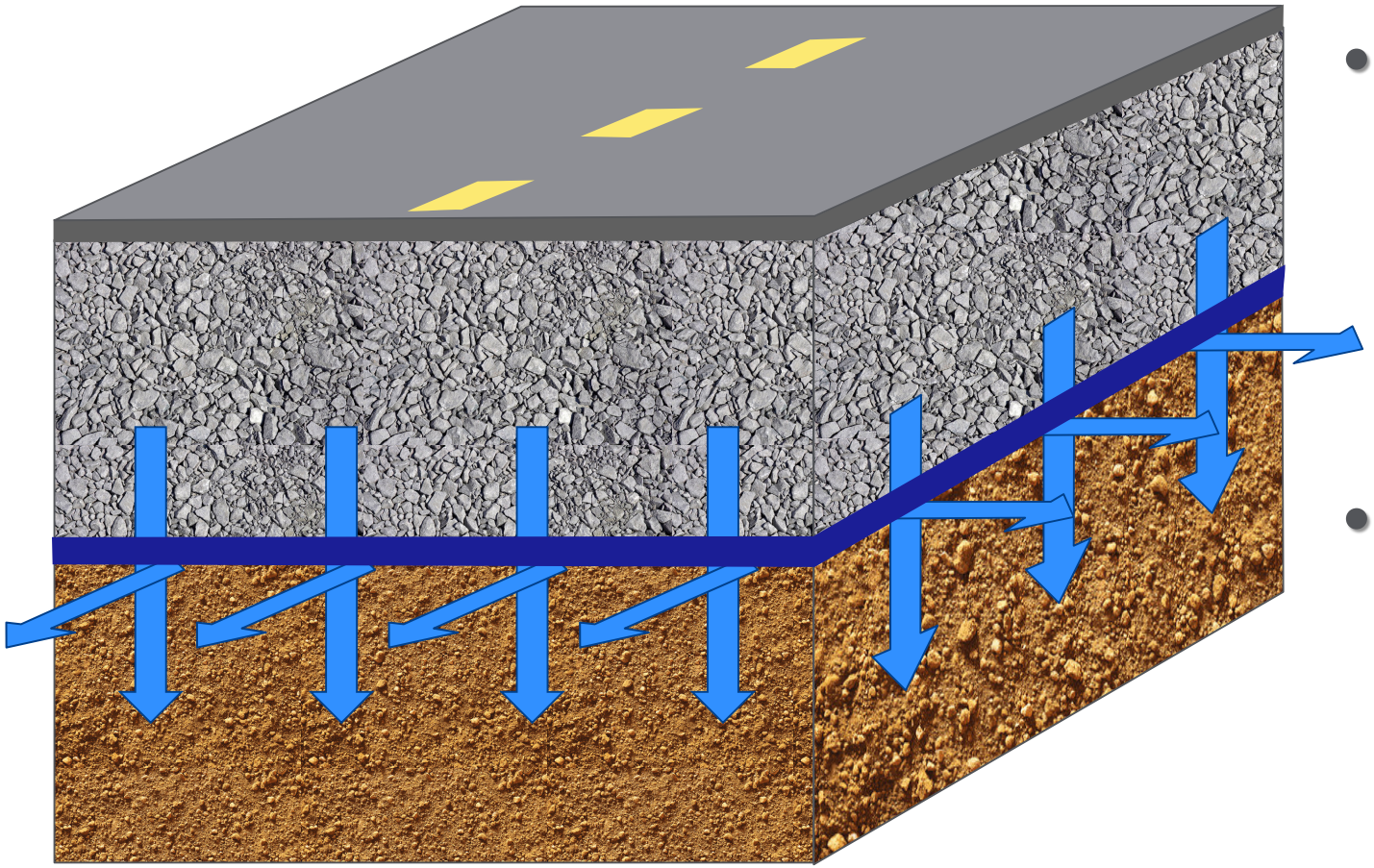
## Key Functions of Geosynthetics – Filtration and Drainage

# Geosynthetics



- *Filtration*: Movement of liquid through the geosynthetic (permittivity) while retaining soil on upstream side

- *Drainage*: Movement of liquid within the plane of the geosynthetic (transmissivity)



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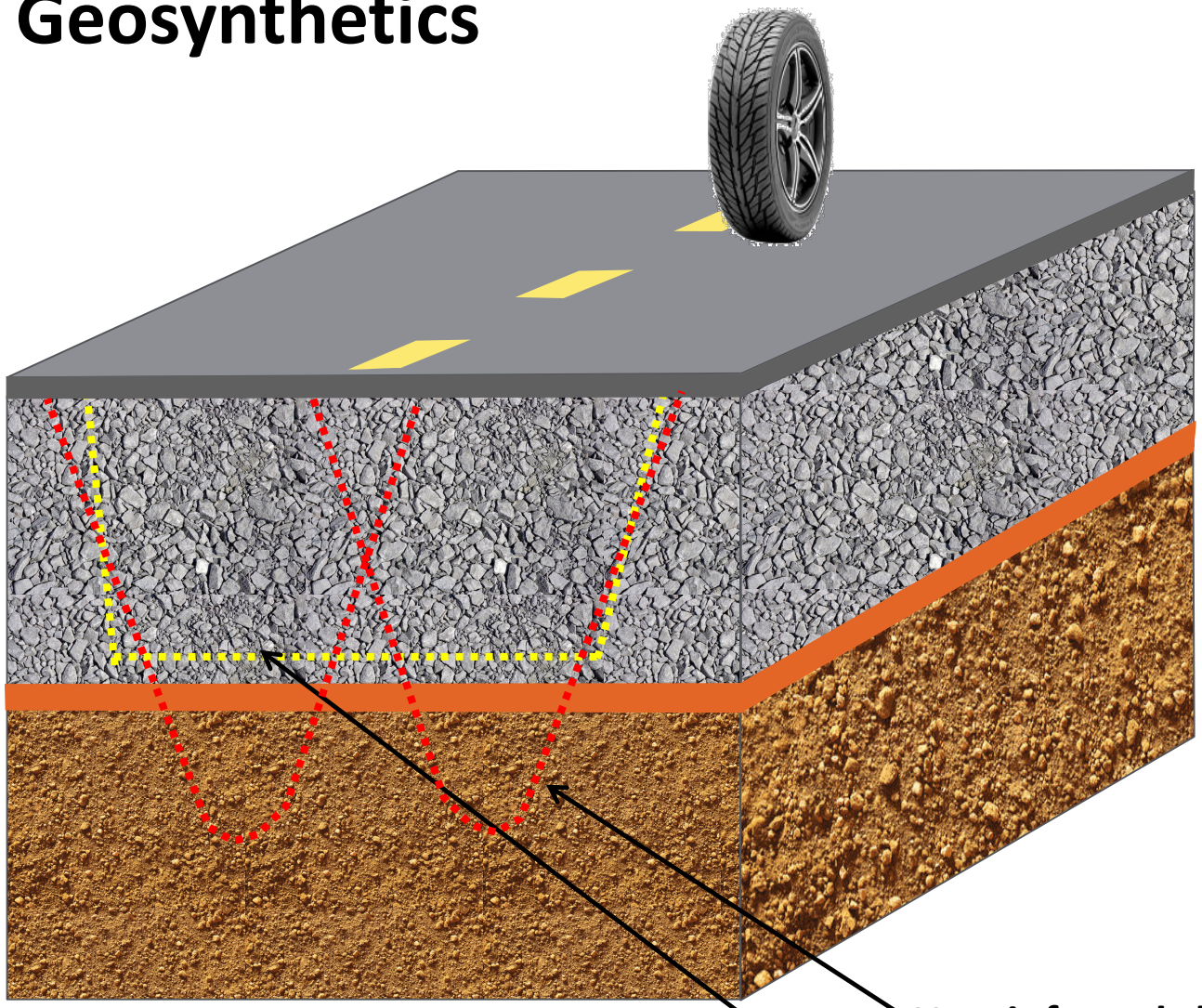
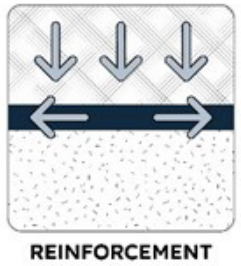
## Key Functions of Geosynthetics – Reinforcement (and Confinement)

# Geosynthetics




- Introduce a tensile element & create composite section
- Improve bearing capacity
- Fine-grained silts & clays



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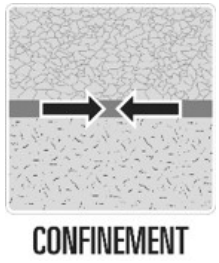
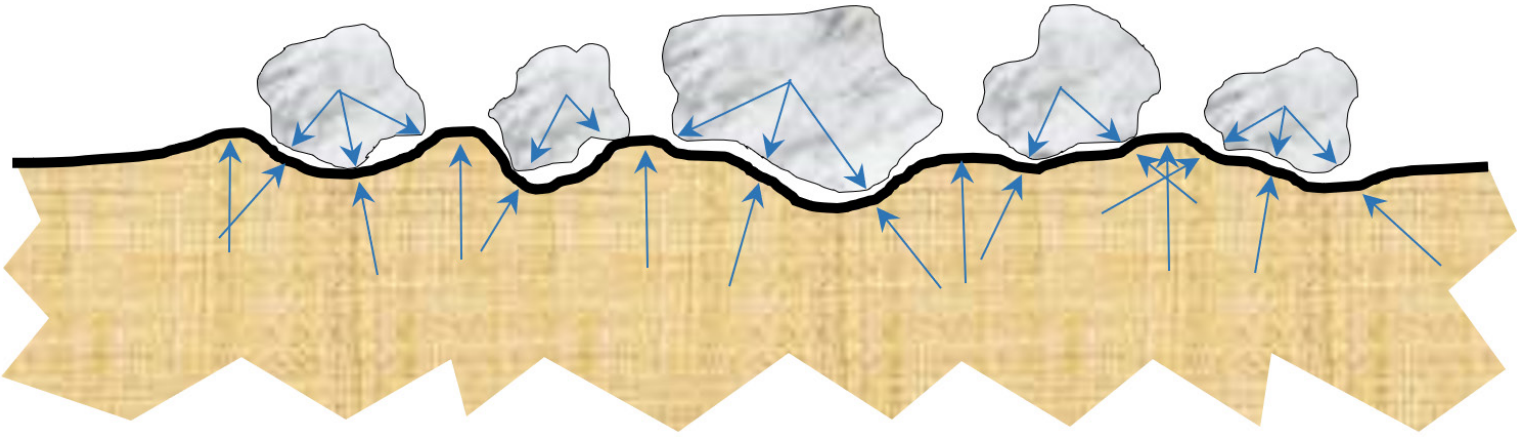
# Geosynthetics




*Geotextile: friction*





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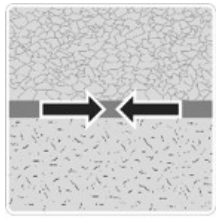
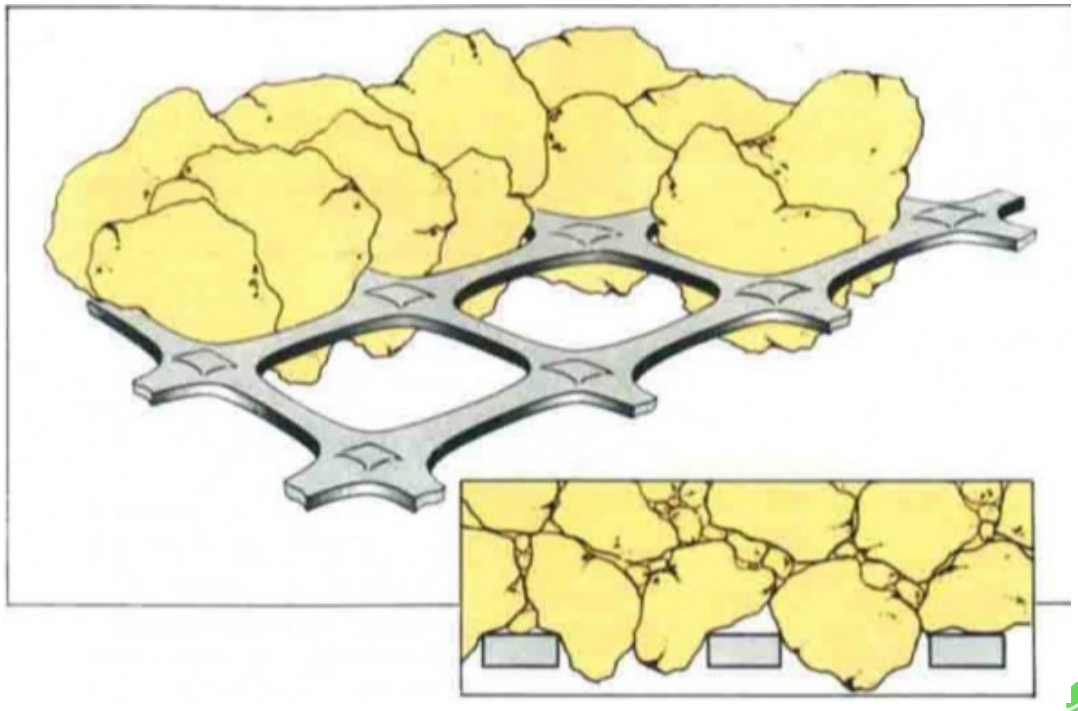
# Geosynthetics




*Geogrid: interlock*





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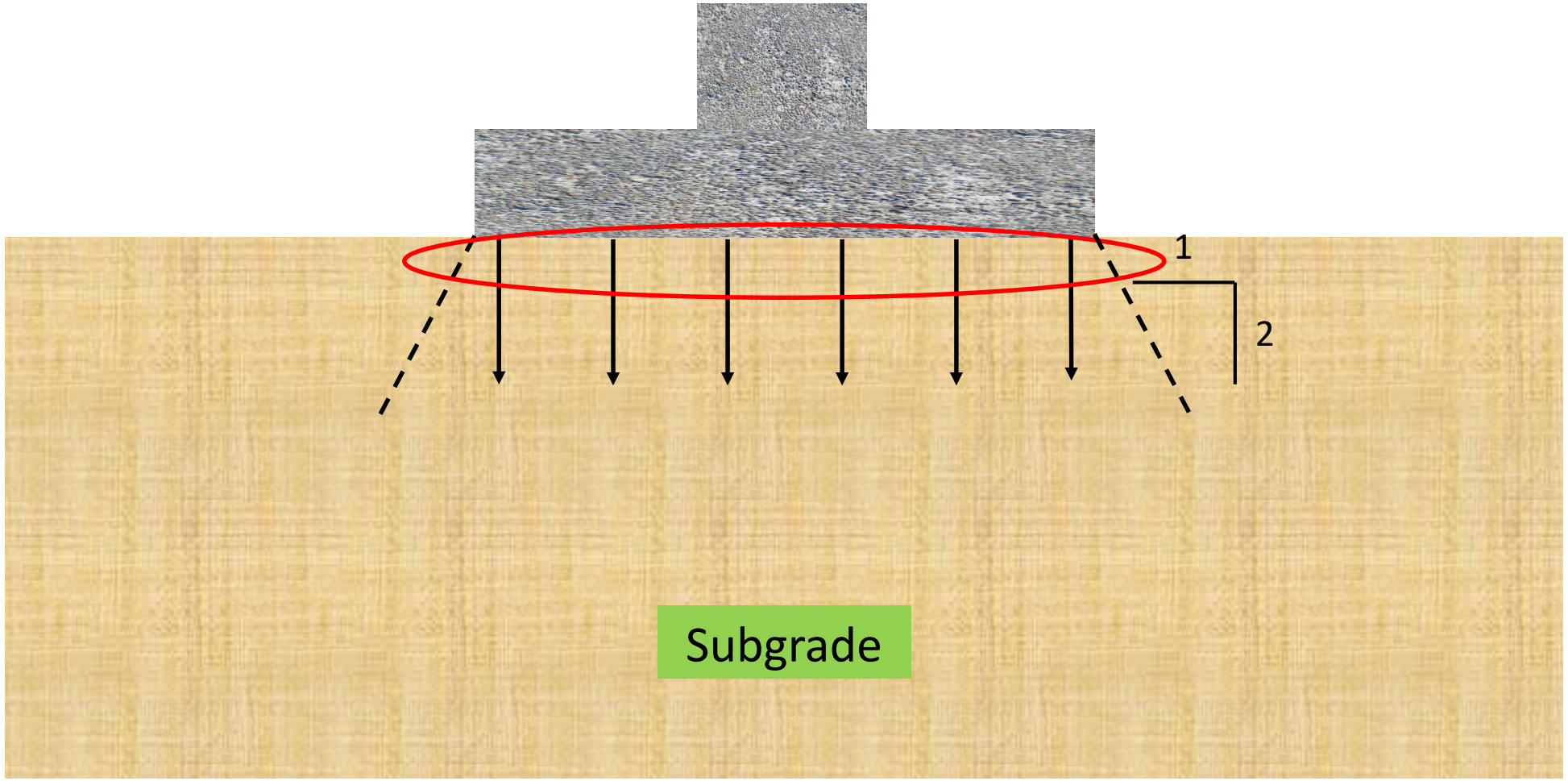
# Engineered Roadway Geosynthetics

It’s all about managing stress…

Unreinforced

# Stress Distribution



# Stress Distribution

Shear failure beneath a structure –
Settlement –



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Shear Failure – Rutting

# Stress Distribution

Shear failure beneath a roadway – Rutting –



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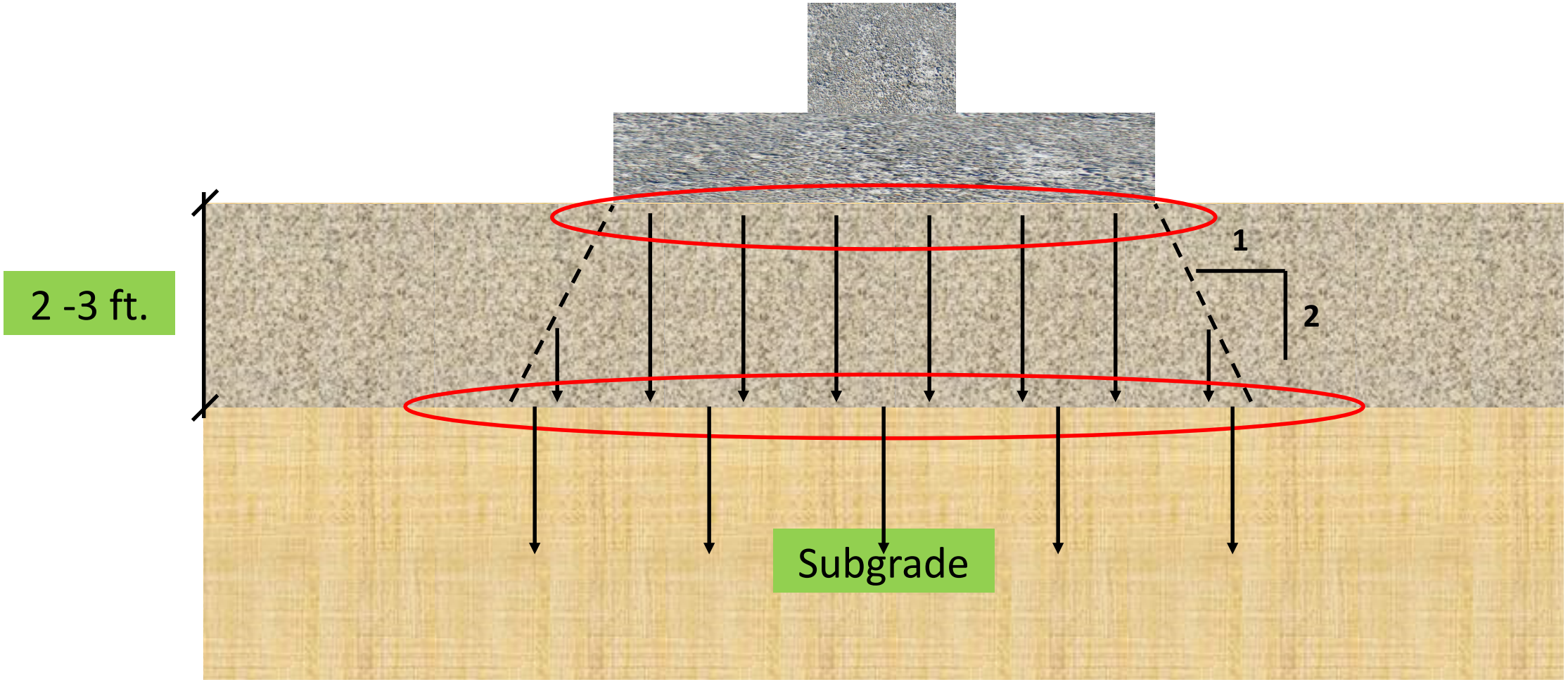
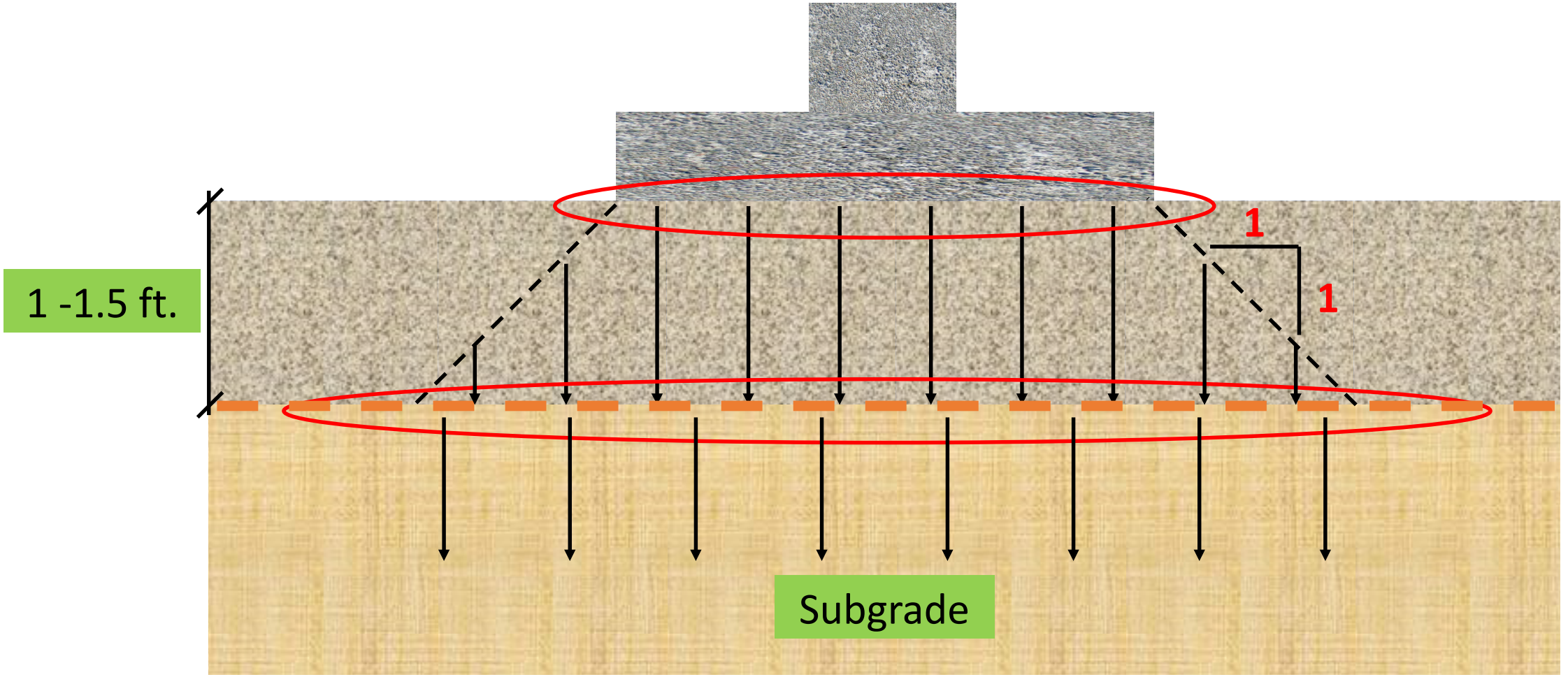
## Unreinforced – Undercut and Replace

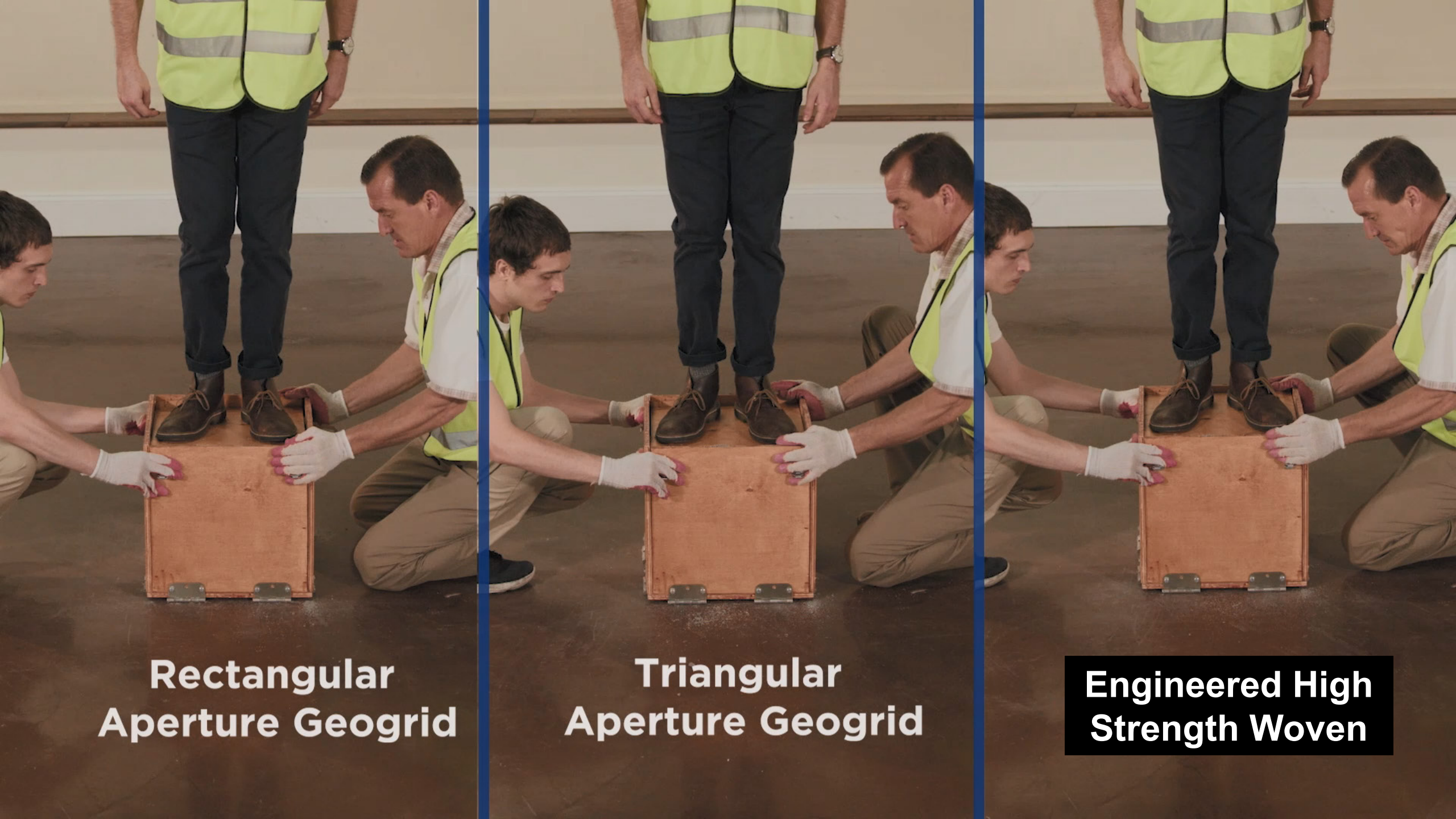
# Stress Distribution



Reinforced – Geosynthetic Reinforced Composite Section

# Stress Distribution




Rectangular
Aperture Geogrid
Triangular
Aperture Geogrid
Engineered High
Strength Woven

Engineered High Strength Woven Geotextile

# Engineered Roadway Geotextiles

What if you don’t have good quality aggregate?



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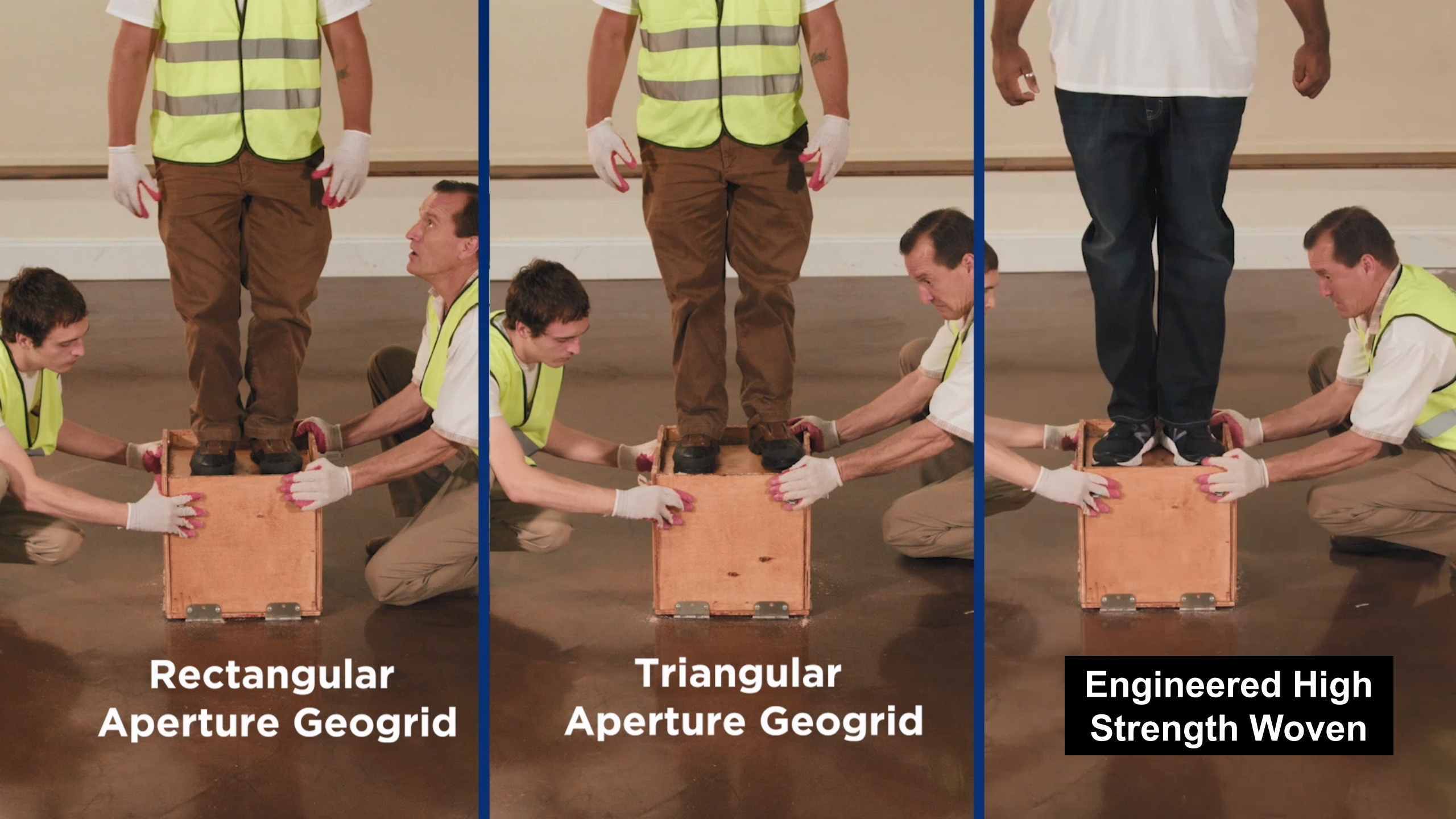
Rectangular
Aperture Geogrid
Triangular
Aperture Geogrid
Engineered High
Strength Woven

Engineered High Strength Woven Geotextile

# Engineered Roadway Geotextiles

What about the size of the stone?



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# Case Study

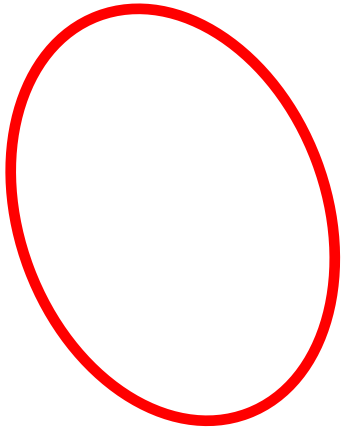
Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH

**Akron Water Reclamation Facility Upgrades Project** – construction of two new treatment facility structures, which included an admin/control room, screen building, load-out building and 4 grit tanks.

Column loads up to 200 kips, wall loads approaching 6 kips per lf.

Site lies in the flood plane of the Cuyahoga River.





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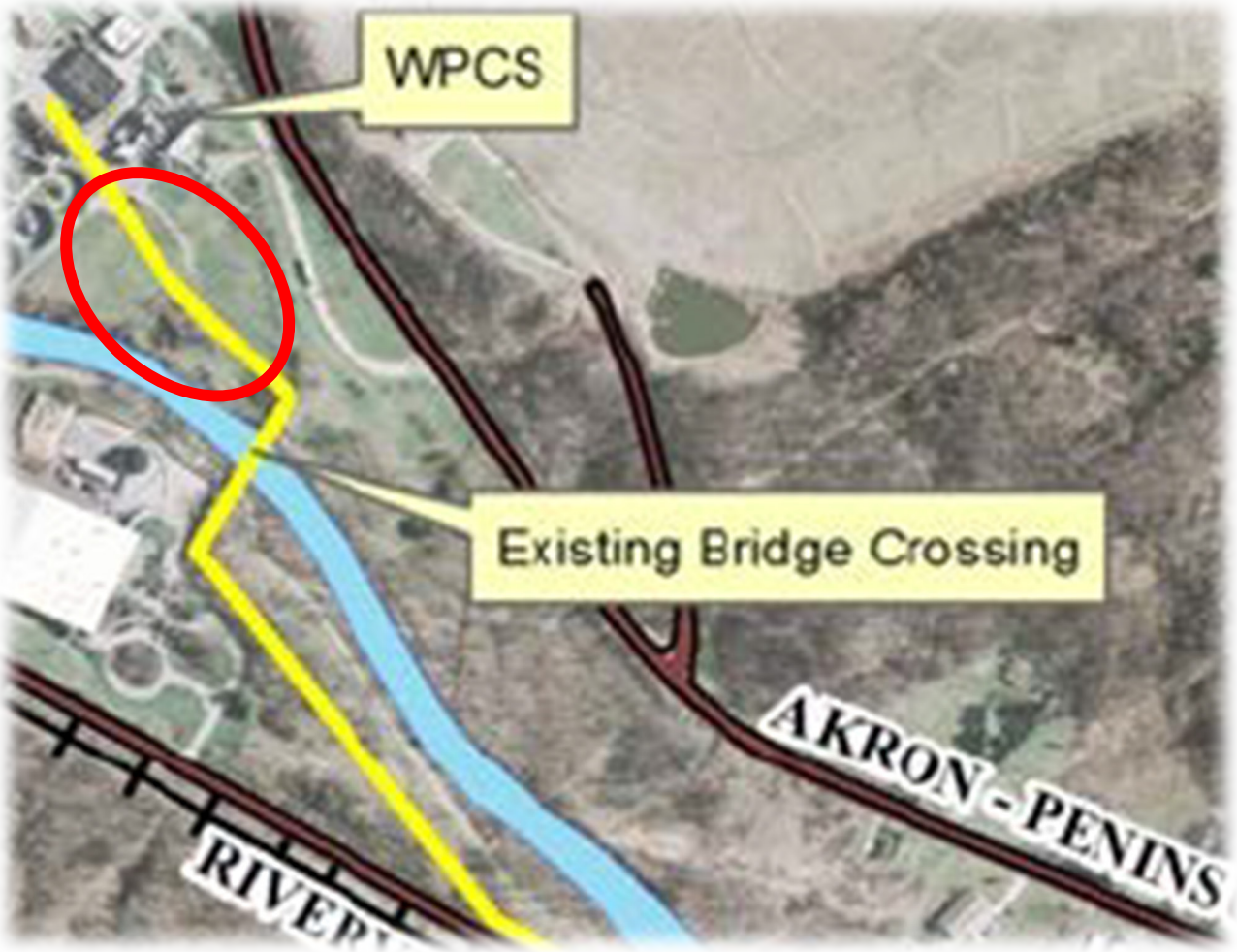
Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH

- Site lies in the floodplain of the Cuyahoga River
- Geotech investigation revealed subgrade consisting of black organic silts and sands, underlain by clean channel sands and gravels.
- Organics extended from 5.5 feet to 38 feet below grade.
- New structures required deep foundation system; auger-cast piles.



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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH



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Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH

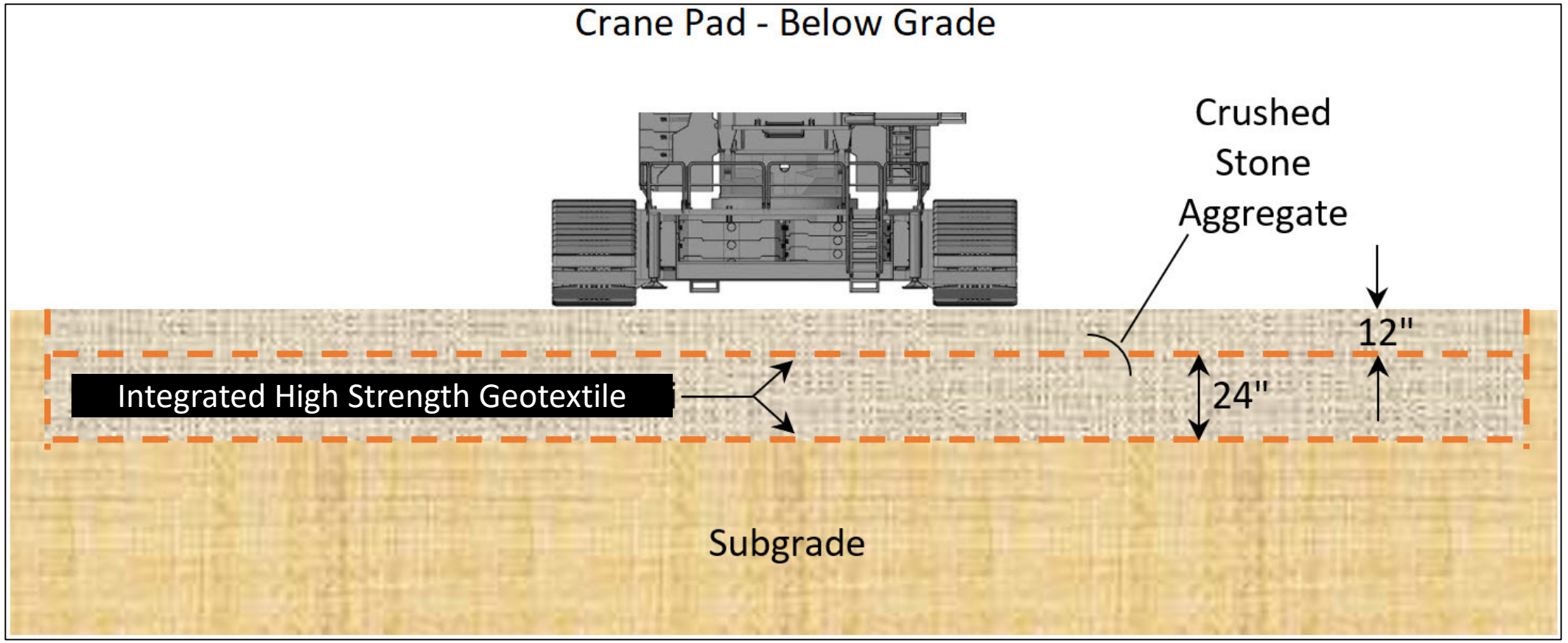
Surficial subgrade soils

In-situ shear strength 245 psf

Correlates to CBR 0.4%

## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH



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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH




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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH




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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH




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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH




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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH



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## Integrated Geosynthetic Reinforced Working Platform Application

# Akron Main Outfall Sewer (MOS) Crane Pad – Akron, OH



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# Integrated High Engineered Geotextile

Active Moisture Management & Reinforcement



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# What exactly is an Active Moisture Management geotextile?

**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




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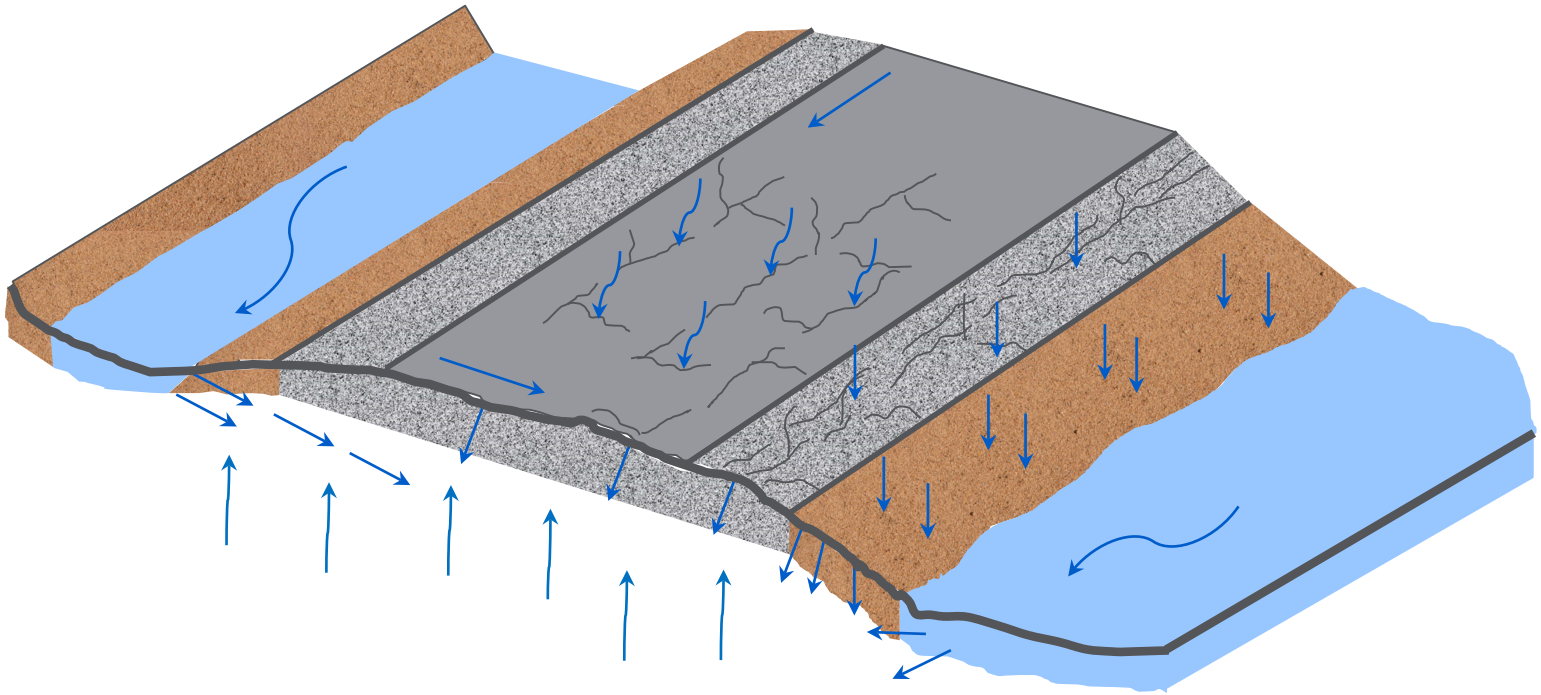
# Sources of water infiltration into a pavement system





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# “Geotechnical Aspects of Pavements” – FHWA NHI-05-037 (2006)

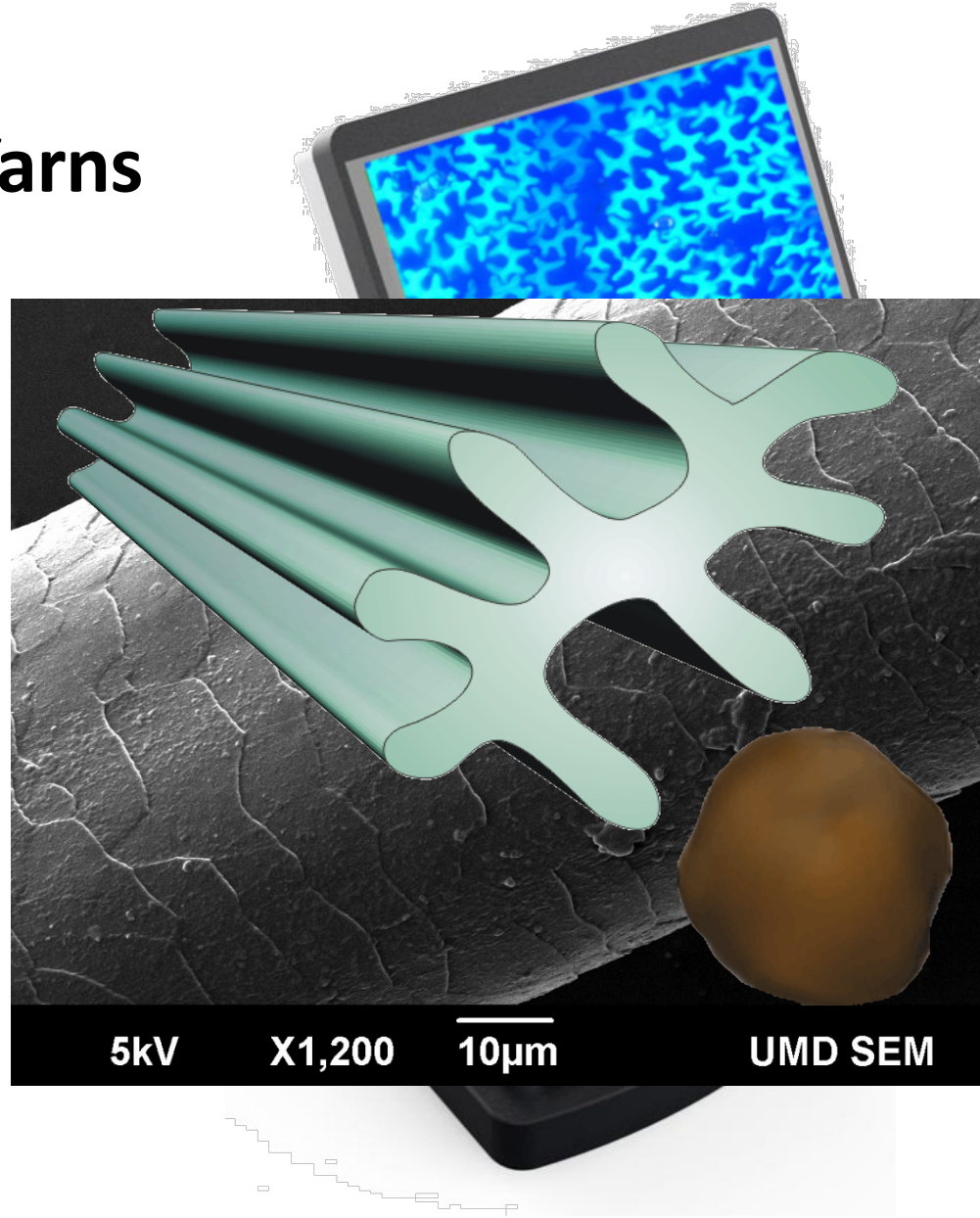
- Chapter 3, Section 3.3.2 Specific Issues

The three main approaches for controlling or reducing moisture problems…

- Prevent moisture from entering the pavement system.
- Use materials and design features that are insensitive to the effects of moisture.
- Quickly remove moisture that enters the pavement system.

# A pathway for moisture – Microchannel Yarns

- Polypropylene reinforcement yarns are **hydrophobic**
- Nylon microchannel yarns are **hygroscopic** & **hydrophilic**
- > half a million microchannel yarns in every 15’ x 300’ roll
- Each microchannel is thinner than a human hair or average silt particle



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# Microchannel Yarns tested with fine-grained soils

Kaolin Clay

Silt



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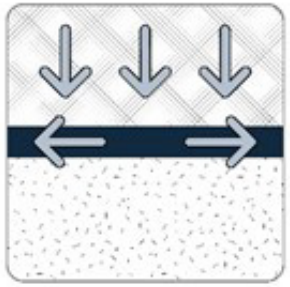
# Reinforcement & Active Moisture Management Geotextile

## Functions of Geosynthetics in Roadways

– Geosynthetic Materials Association (GMA) White Paper II, June 2002



**ENHANCED DRAINAGE**



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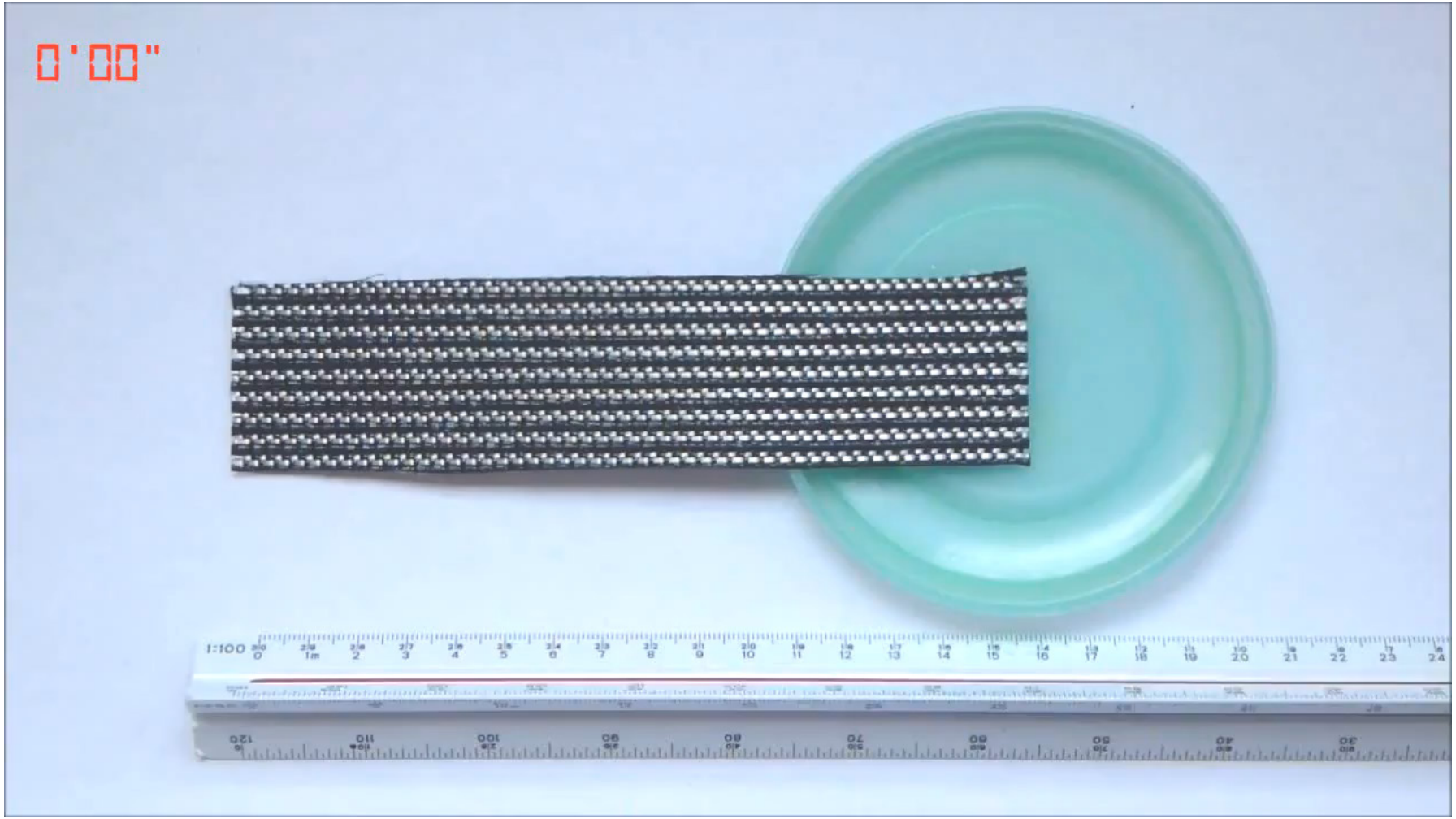
# Let’s see how this works…



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# How much moisture can this move?

- Up to 1.4 gal/day/lf
- Each roll can remove an average 375 gal/day per exposed edge.
- Up to 750 gal/day per 300 lf section of roadway (2 lanes wide w/ 2 rolls)




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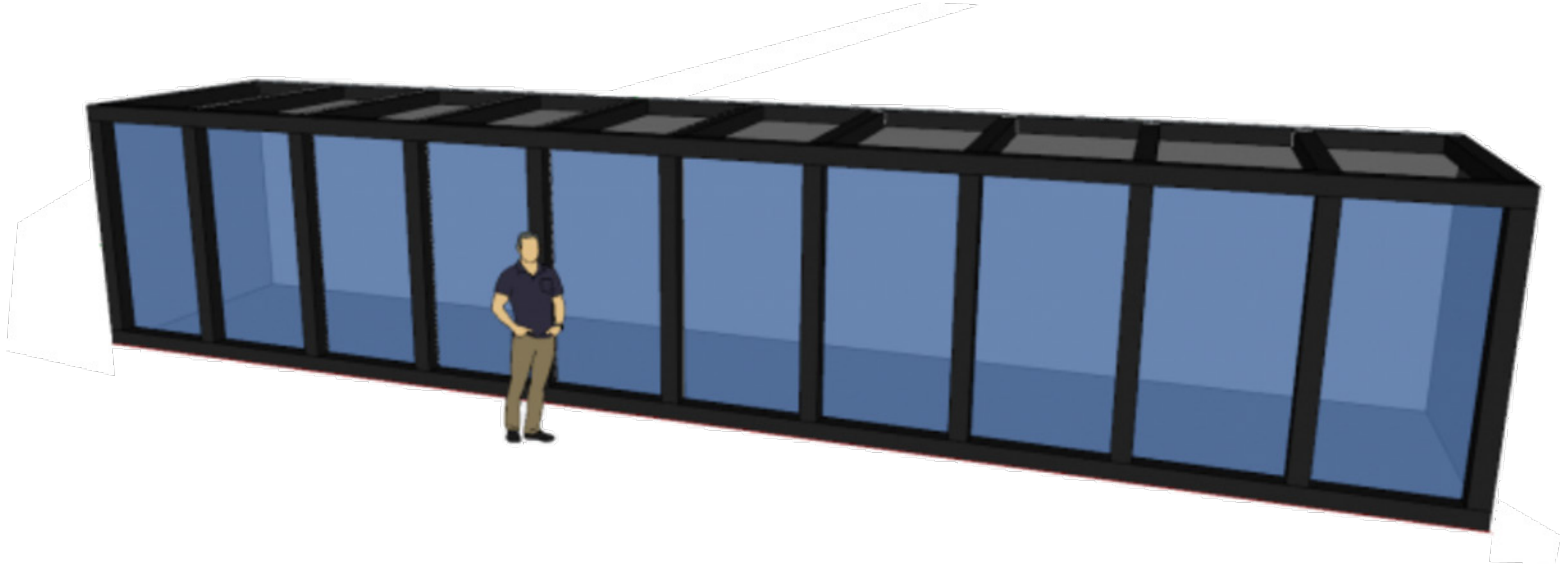
# How much moisture can this move?

For a 2-lane road with 2 rolls of the geotextile discharging to both sides of the road, that’s about 15,000 gallons per day per mile.





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# Placement of the Engineered Geotextile?




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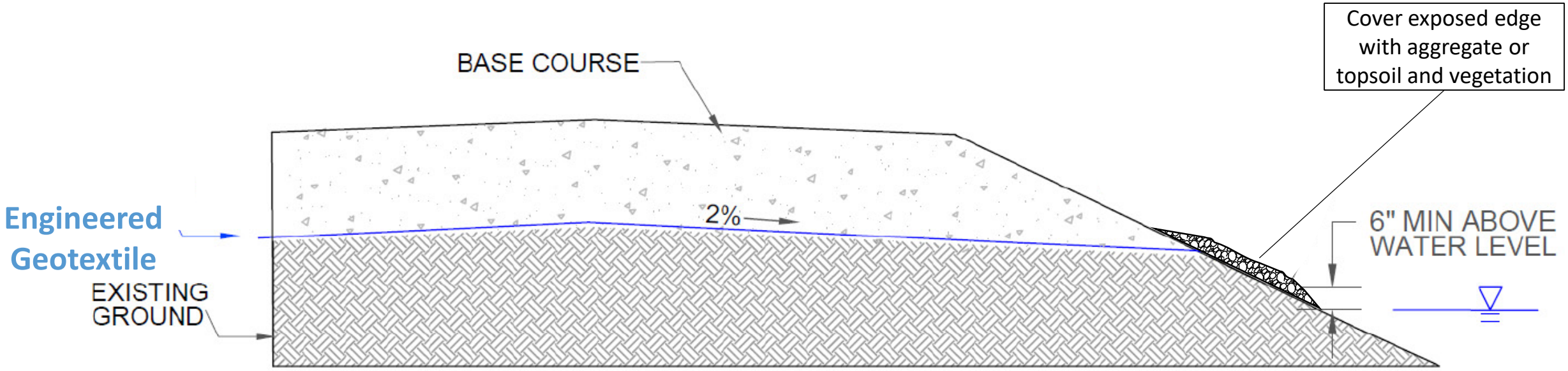
# Termination Details - Ditch



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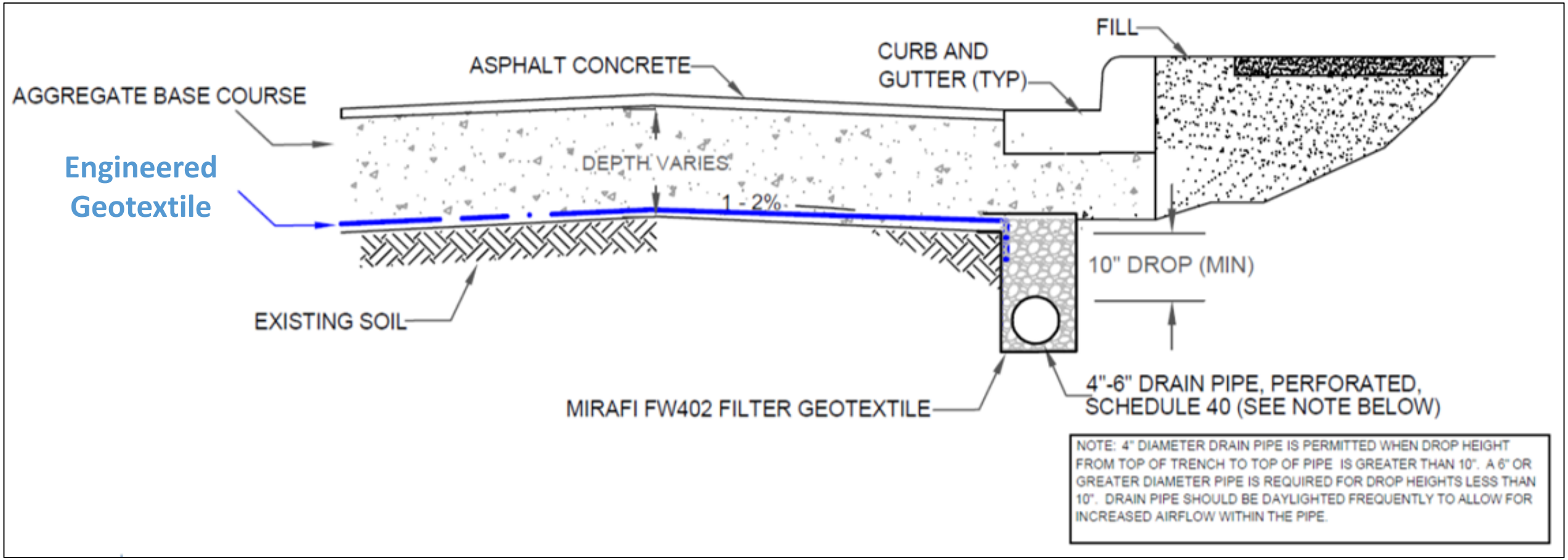
# Termination Details – French Drain



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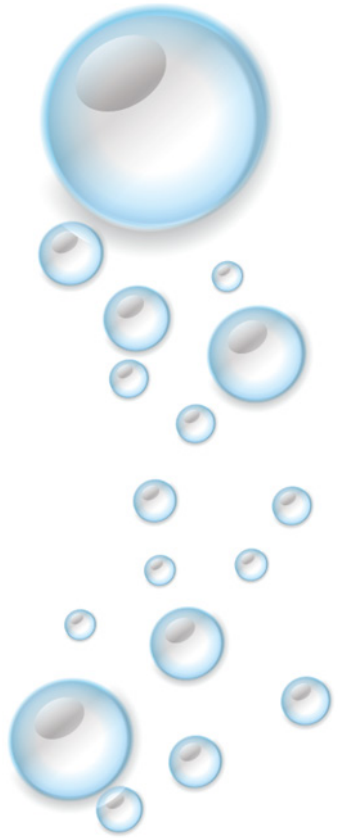
# Situations where you should consider using the Active Moisture Management Geotextile?

- Areas with high water tables
- Excess moisture in base/subbase
- Excess moisture in subgrade
- Expansive soils
- Frost susceptible soils
- ***Anywhere moisture can affect a civil structure***





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# Case Studies

Phase II (2012-2013)

# Dalton Highway MP197-209 Rehabilitation Project

- **Dalton Highway** – originally constructed to support development of the Trans-Alaska Pipeline to service the oil fields on Alaska's North Slope.
- Runs 414 miles from just North of Fairbanks to Prudoe Bay on the shores of the Arctic Ocean.



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Phase II (2012-2013)

# Dalton Highway MP197-209 Rehabilitation Project

## THE PROBLEM

- 27,100 lineal feet of undercut-replace
- Water issues
- Change Order in Phase I: **$278 per linear foot**
- **$140 per lf** for Phase II (Engineers Estimate)

## THE SOLUTION

- **Engineered** Reinforcement & Moisture Management Geotextile

## BENEFITS

- **Reduced** quantities of subgrade excavation and shot-rock fill
- Significantly **reduced** construction schedule
- $48 per lf cost resulted in **$2.5 MM cost savings**
- Provided **more resilient infrastructure**

Dalton MP 197 – 209 Project without **Engineered Geotextile**, May 2012

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Dalton MP 197 – 209 Project with **Engineered Geotextile**, May 2013

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Dalton MP 197 – 209 Project with **Engineered Geotextile**, July 2013

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## Madison AVE SE & Fulton St. Reconstruction (2015)

# CSO 21 & CSO 22 Projects
# Grand Rapids, MI

## THE PROBLEM

- Fluctuating ground water causing water issues with pavement and adjacent buildings.

## THE SOLUTION

- **Engineered** Reinforcement & Moisture Management Geotextile

## BENEFITS

- **Reduced** pavement cross section while maintaining desired structural performance (SN = 4.24)
- Provides continuous active moisture management system beneath pavement section.
- Provides **more resilient infrastructure**

Madison AVE SE & Fulton St. Reconstruction (2015)

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## BENEFITS

- **Reduced** pavement cross section while maintaining desired structural performance (SN = 4.24).
- Provides continuous active moisture management system beneath pavement section.
- Provides **more resilient infrastructure**

LRE Asphalt Parking Lot (2023)

# LRE Engineers & Surveyors Walker, MI

## THE PROBLEM

- Changes in subgrade moisture led to increased settlement, heaving, cracking and deterioration of the asphalt parking lot.

## THE SOLUTION

- **Engineered** Reinforcement & Active Moisture Management Geotextile was used in the reconstructed pavement section.

## BENEFITS

- **Reinforced** aggregate base course of the flexible pavement section to extend service life.
- **Active Moisture Management** technology to continuously remove excess water and minimize impact of moisture on the pavement system.
- Provides **more resilient infrastructure**

LRE

# LRE

## 100th Street SE – Reconstruction (August 2022)

# Kent County Road Commission
# Kent County, MI

## THE PROBLEM

- Excess water in subgrade.
- Perpetual freeze-thaw issues.

## THE SOLUTION

- **Engineered** Reinforcement & Active Moisture Management Geotextile was used in the reconstructed pavement section.

## BENEFITS

- **Reinforced** aggregate base course of the flexible pavement section to extend service life.
- **Active Moisture Management** technology to continuously remove excess water and minimize impact of moisture on the pavement system.
- Provides **more resilient infrastructure**

## 100th Stree

# Kent C

32nd Street – Reconstruction (2023)

# Allegan County Road Commission
# Salem Twp., Allegan Co., MI

## 32nd Street from 146th Ave SW to Ottagan Street

- 4,100 sy pavement section reconstructed with Engineered Active Moisture Management Geotextile in the pavement section.
- Reinforcing the aggregate base while providing continuous active moisture management to remove excess water from the pavement section.

Patented Proprietary Products

# Engineered Roadway Geotextiles

## 23 CFR 635.411(a)-(e)…*"The Proprietary Products Rule"*



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Patented Proprietary Products

# Engineered Roadway Geotextiles

**23 CFR 635.411(a)-(e)**

***Rescinded 28 October 2019***



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# “Nothing changes if nothing changes.”

- Said someone

# Thank you

# Questions?

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spiccoli@solmax.com

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