# Geosynthetics Enhance Transportation Projects

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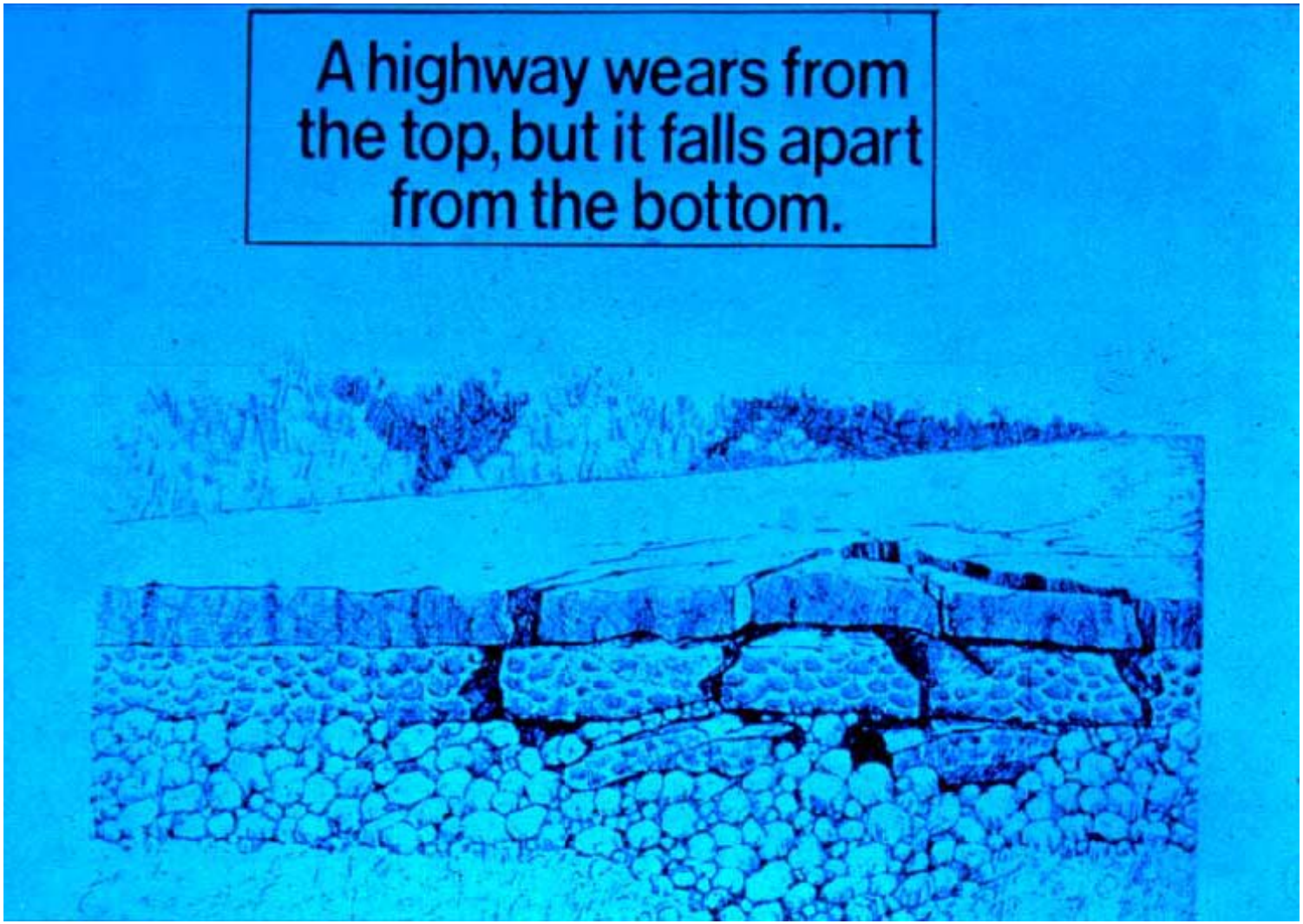
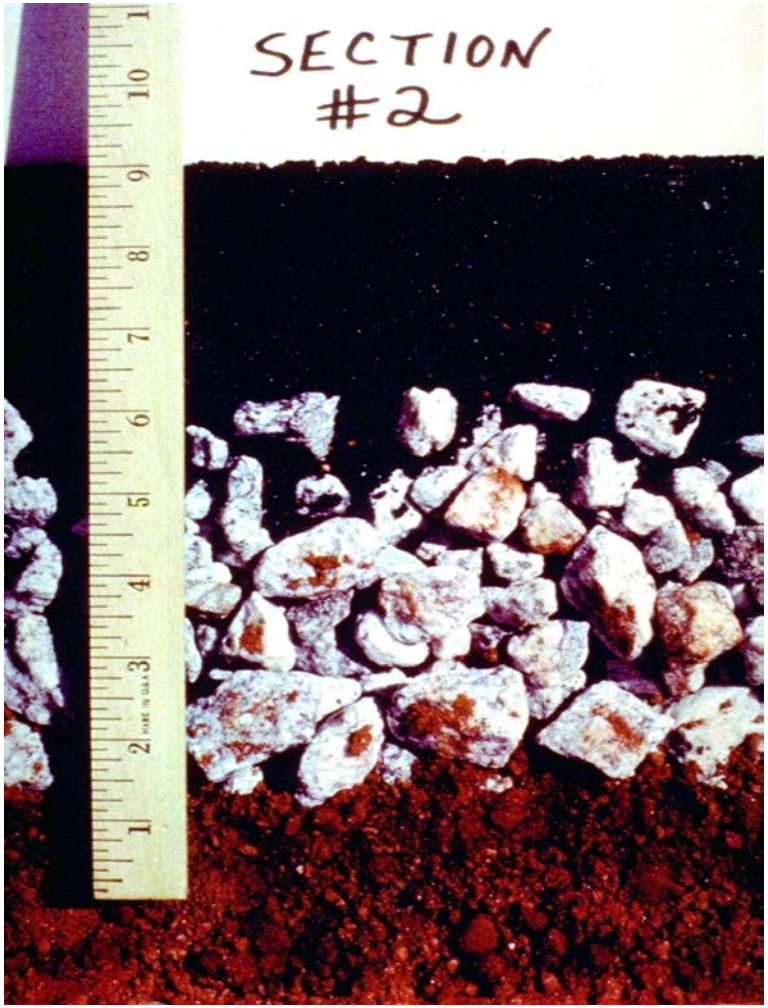
# Workshop Road Map

- How Geosynthetics reduce the cost and extend the life of new pavements and unpaved roads.
- How Geosynthetics are used in pavement maintenance to reduce cost and extend treatment life.
- How Geosynthetics enhance civil structures associated with transportation projects.
- How Geosynthetics provide cost effective erosion control for transportation projects.

# Understanding the Basics

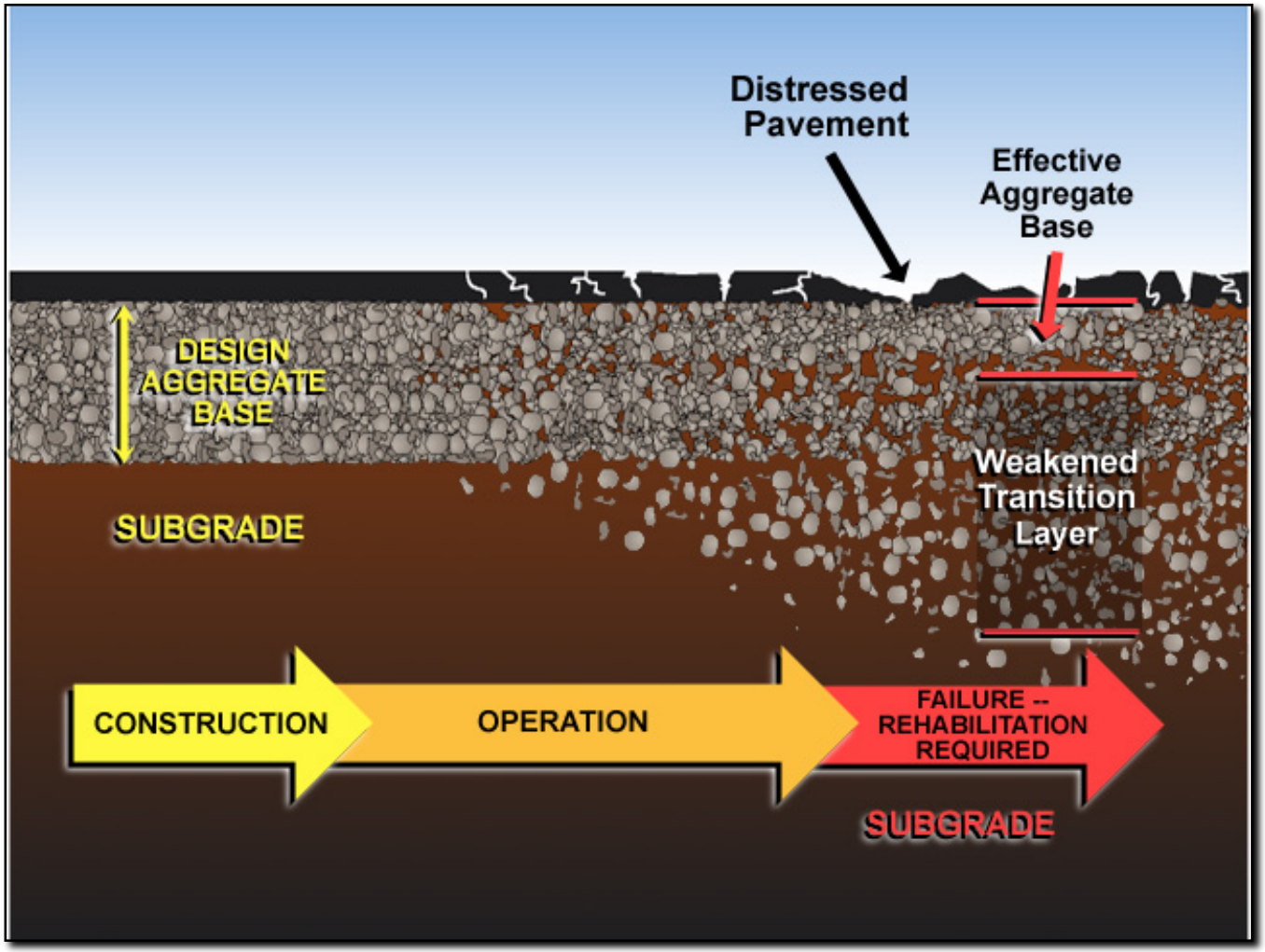





A typical light duty pavement—as built.


After a period in service, the base becomes contaminated. Effective base thickness is now only 2 inches.

# Progressive Loss of Pavement Foundation



Engineering Adage:

“If you combine 10 pounds of stone and 10 pounds of mud, you have 20 pounds of mud”

# The Major Cause of Premature Road Failure

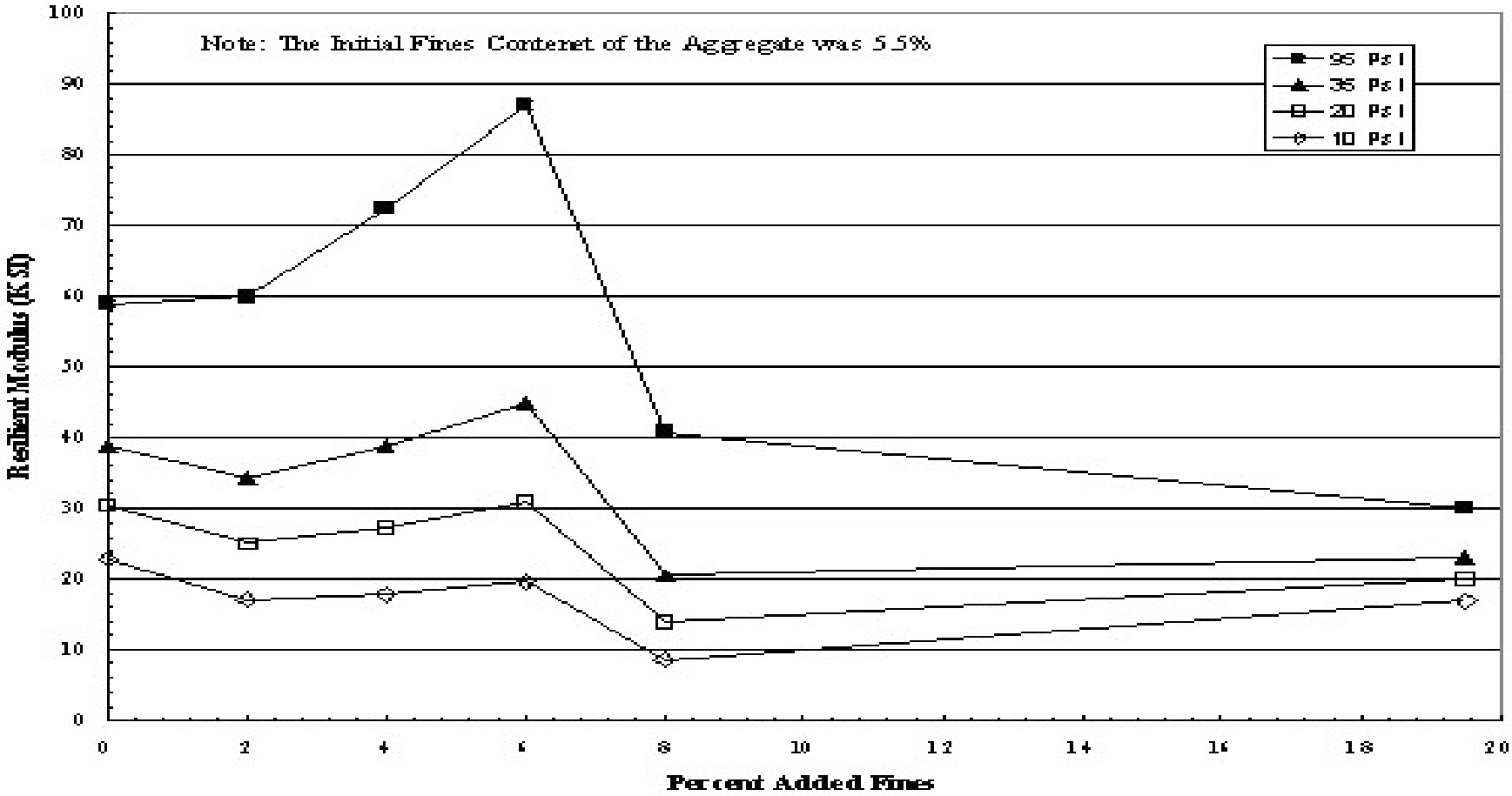
--Loss of road base foundation support is the **number one cause** of premature pavement failure, although other excuses are given.

--Aggregate bases are the **largest** transportation asset for most State and Local DOTs.

--Forensic analyses are never performed on failed roads. Without recognition of the base contamination problem, it will  never get fixed.

# Jorenby & Hicks Research Findings

- Used a 1” minus crushed aggregate with 5.5% initial fines
- Contamination from a CBR 8% soil
- Aggregate structural strength drops 50% with only 13% total fines
- Loss of drainage capacity occurs with only 8% total fines content
- Contaminated road base loss averages >4”


Note: The Initial Fines Conteret of the Aggregate was 5.5%
95 Psi
35 Psi
20 Psi
10 Psi
Resilient Modulus (KSI)
Percent Added Fines
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20

A road that started out with an aggregate base now has just a weak subgrade soil/base stone mixture support.

# Minneapolis Base Contamination

Road failing due to base contamination.

# Where are the Forensics?

DOTs spend millions forensically investigating bridge and wall failures, but never spend a dime investigating the failure of their largest infrastructure asset—**road bases**!

Some DOTs do realize their road foundations are failing so what do they do to address the problem?

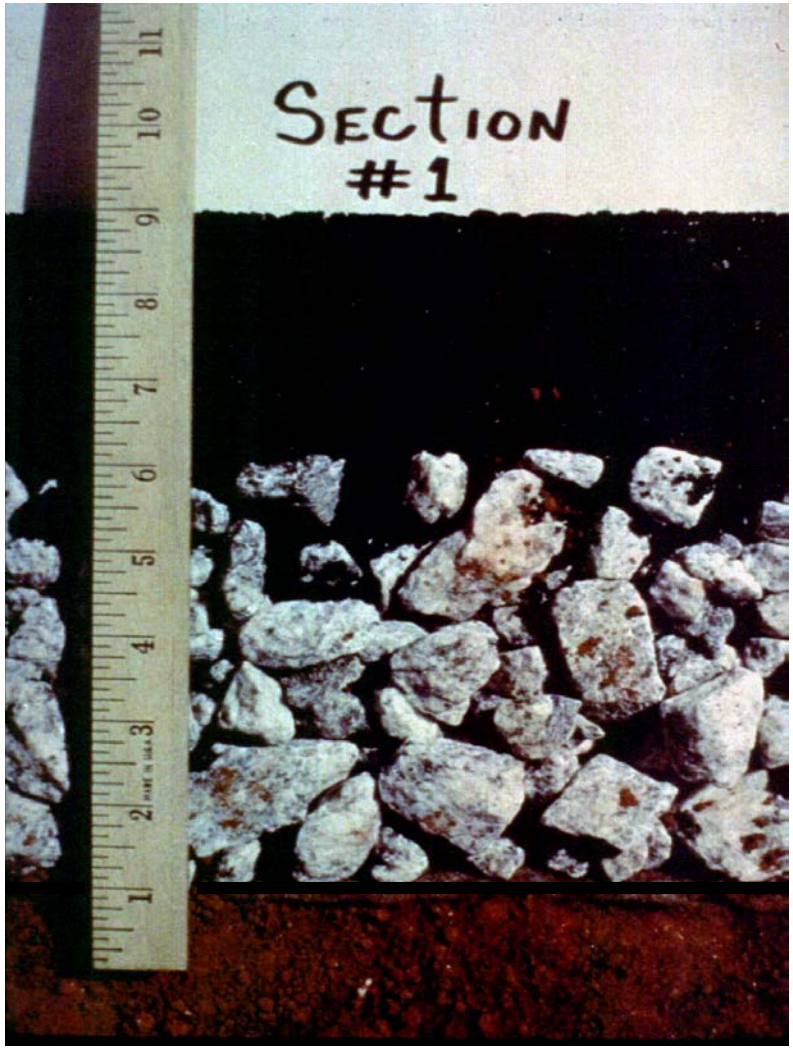
# Traditional Efforts To Minimize Base Contamination By Subgrade Soils

1. Remove all weak subgrade with over excavation, then use a structural fill
2. Eliminate unbound base materials
   a. Asphalt treated base
   b. Cement treated base
3. Use tighter base gradation
4. Use subbase as a separator
5. Subgrade modification
   a. Lime stabilization or lime injection
   b. Cement stabilization

A tight base gradation to minimize subgrade intrusion.

Lime treatment of a weak subgrade soil.

# The Simple, Inexpensive Solution

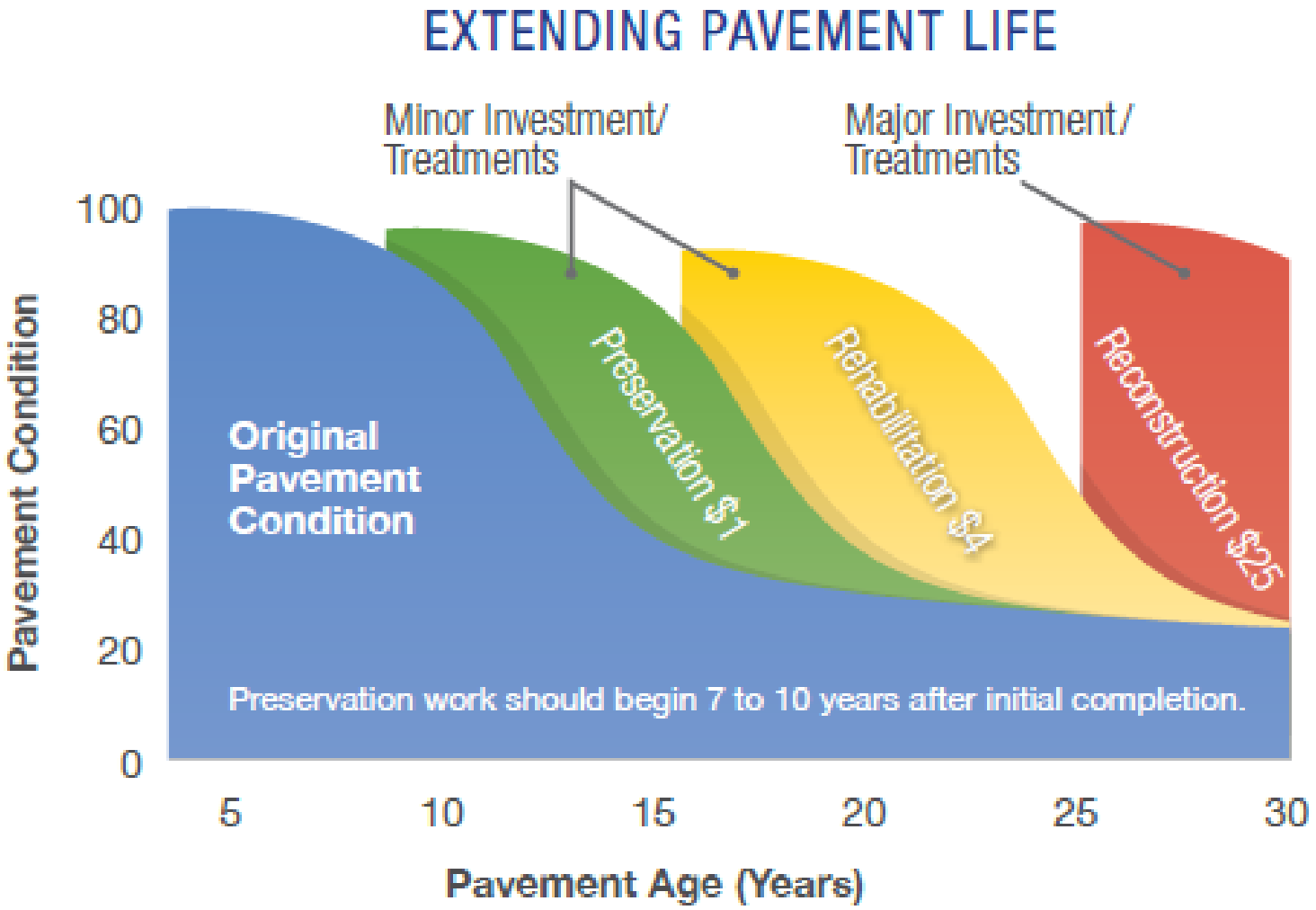



Separation/Stabilization
Geotextile

# Perpetual Aggregate Base (PAB)

The latest Transportation initiative is the use of a Perpetual Aggregate Base (PAB) beneath all new roads. If the aggregate base pavement foundation remains intact indefinitely, future maintenance will only require surficial pavement treatments, such as an overlay, chip seal, or mill and fill. Complete reconstruction should **never** be required. This saves maintenance dollars, and traffic congestion, with its associated accidents and fatalities. Base resources are not wasted.

# Utah DOT Asset Management




*Once deterioration occurs, taxpayers will shoulder a much higher cost to repair or rebuild pavement and bridges.*

# Separation / Stabilization Geotextile

- Separates dissimilar materials indefinitely
- Confines and restrains aggregate
- Confines subgrade soil
- Maintains vertical loading on subgrade soil
- Allows the use of open, free-draining aggregate for more structural credit

# Aggregate Confinement/Restraint

- The strength of the geosynthetic is not as important as its ability to keep the aggregate from moving laterally due to traffic loading.
- Nonwoven Geotextiles and Geogrids provide interface friction equal to the aggregate while woven geotextiles are more slick and provide only 70% interface efficiency and can induce a slip plane.

# Confines Subgrade Soil—Increases Strength

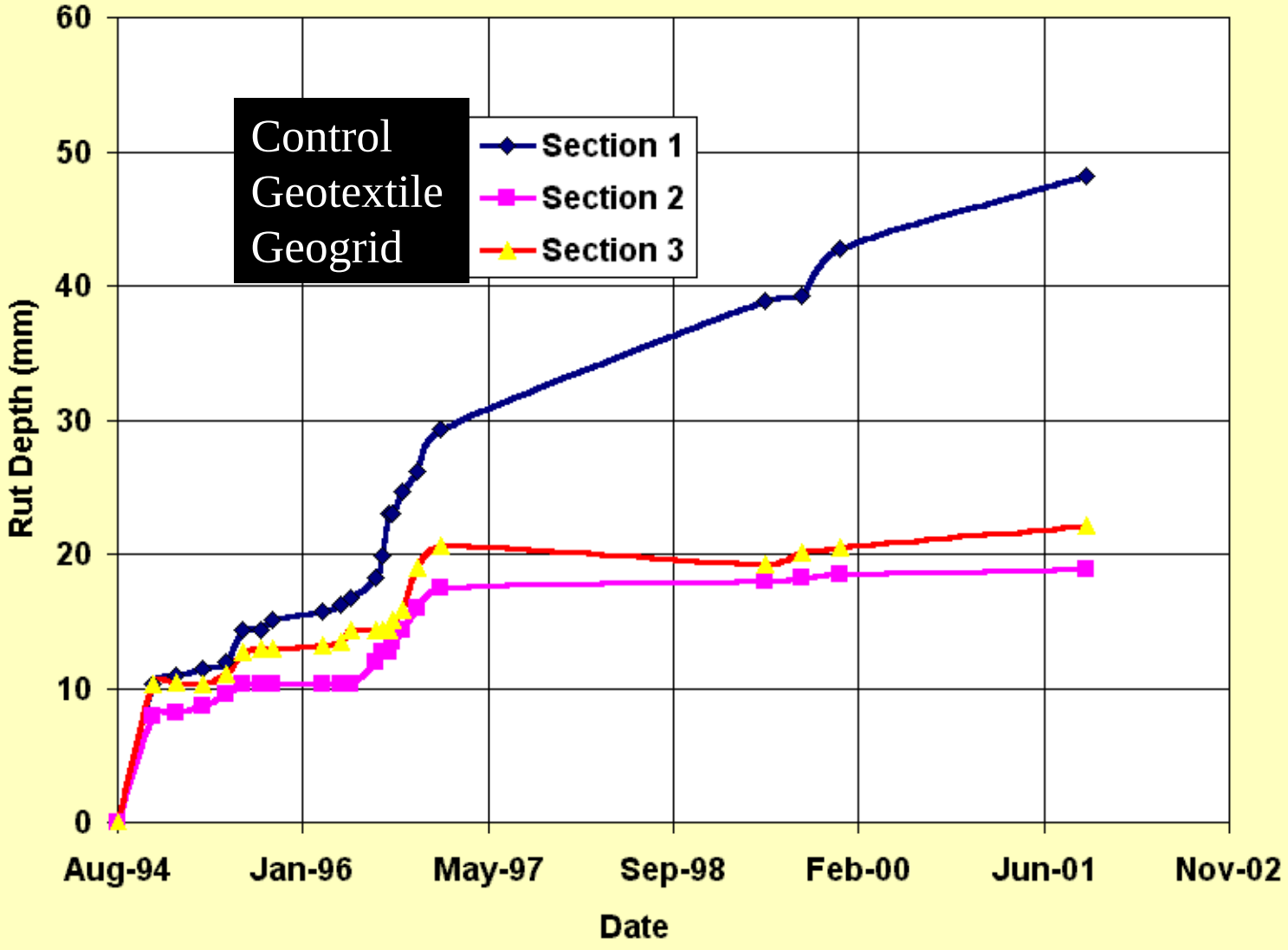
As traffic loading loads the geotextile around the area of the subgrade subject to shear failure, it changes the mode of failure from local shear to general shear. This provides an effective increase in the bearing capacity of the subgrade soil of 80%. It is like going from an unconfined compression test to a confined compression test.

This is how a road structural section may be reduced over a geotextile.

# VA Tech Lab and Field Geosynthetic Testing

Installing the Bedford, VA Road test sections

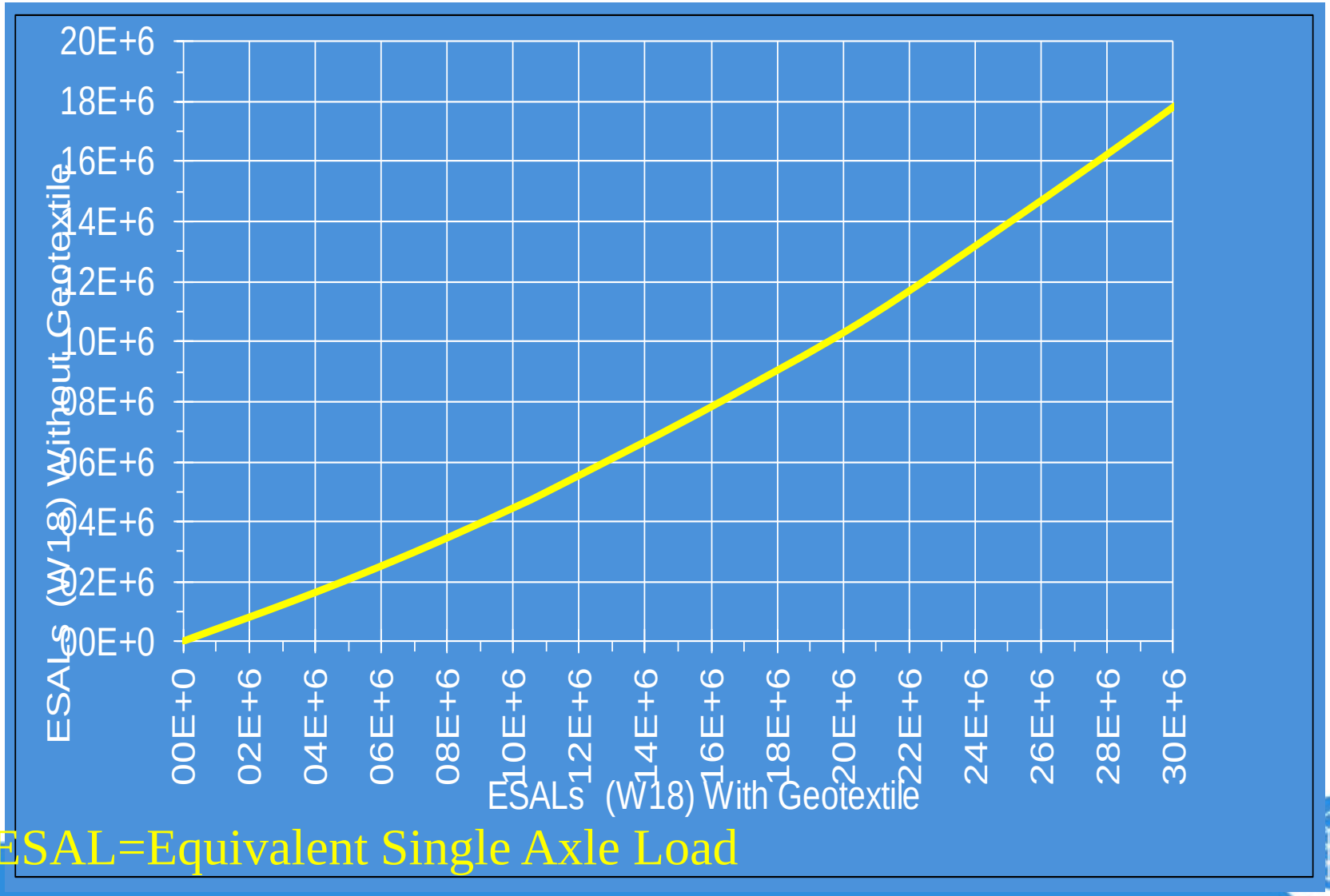
# Bedford Road After Eight Years


Control
Geotextile
Geogrid
Section 1
Section 2
Section 3
Rut Depth (mm)
60
50
40
30
20
10
0
Aug-94
Jan-96
May-97
Sep-98
Feb-00
Jun-01
Nov-02
Date

The geogrid section showed soil contamination coming up through the open grid structure—**no separation**.

The geotextile section showed a clean separation and stone indentations which have not moved since day one.

# Flexible Pavement ESAL Design Curve




ESAL=Equivalent Single Axle Load

# Summary Of Pavement Research

- GEOTEXTILE INCREASED PAVEMENT SERVICE LIFE 2 TO 3 TIMES
- GEOTEXTILE PREVENTS CONTAMINATED TRANSITION LAYER
- GEOTEXTILE IS THE MOST COST EFFECTIVE DESIGN STRATEGY FOR PAVEMENTS

# Geotextile Installation


Back dumping the aggregate.


D37

Compact the aggregate


CATERPILLAR

# Geogrids Do Not Separate

# Not The Right Solution

Oklahoma DOT Case Study—Geotextile and unbound base aggregate versus Lime Stabilization

After 15 years, the geotextile is in excellent shape. Original wrinkles prove there is no global membrane tension. Stone impressions help lock up aggregate.

# OK DOT monitored Pavement performance for 15 Years


FWD Road Evaluation



Pavement Rut Measurement

Results at 5 and 15 years proved that the use of a separation/stabilization geotextile and 6” of base stone has maintained a higher quality road than 24” of lime stabilized subgrade with the same overlying pavement.

The section with the geotextile cost about one fourth of the lime stabilized section and was built in a fraction of the time. Oklahoma DOT now widely uses geotextiles beneath their roads.

Contaminated aggregate base beneath a Portland Cement Concrete. Separation/Stabilization is just as critical here as under asphalt concrete—slab pumping.

When unbound aggregate base is used beneath a pavement, you essentially have an unpaved road beneath the pavement, you just cannot see how well it is functioning.  You can only tell how well it continues to support the pavement by the condition of the pavement.

Let’s look at unpaved roads next.

Case History--Oklahoma unpaved county road.

Back dumping surface aggregate onto the geotextile.

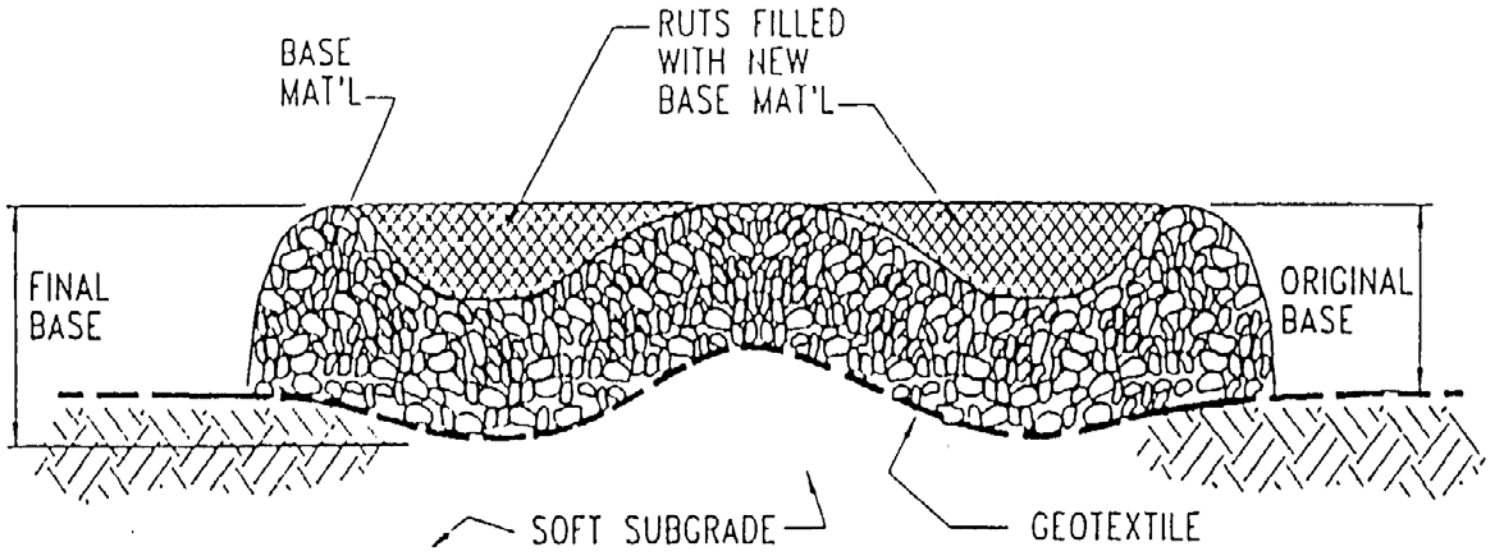
Spreading surface aggregate over a woven geotextile.

Aggregate in place over geotextile and control sections.

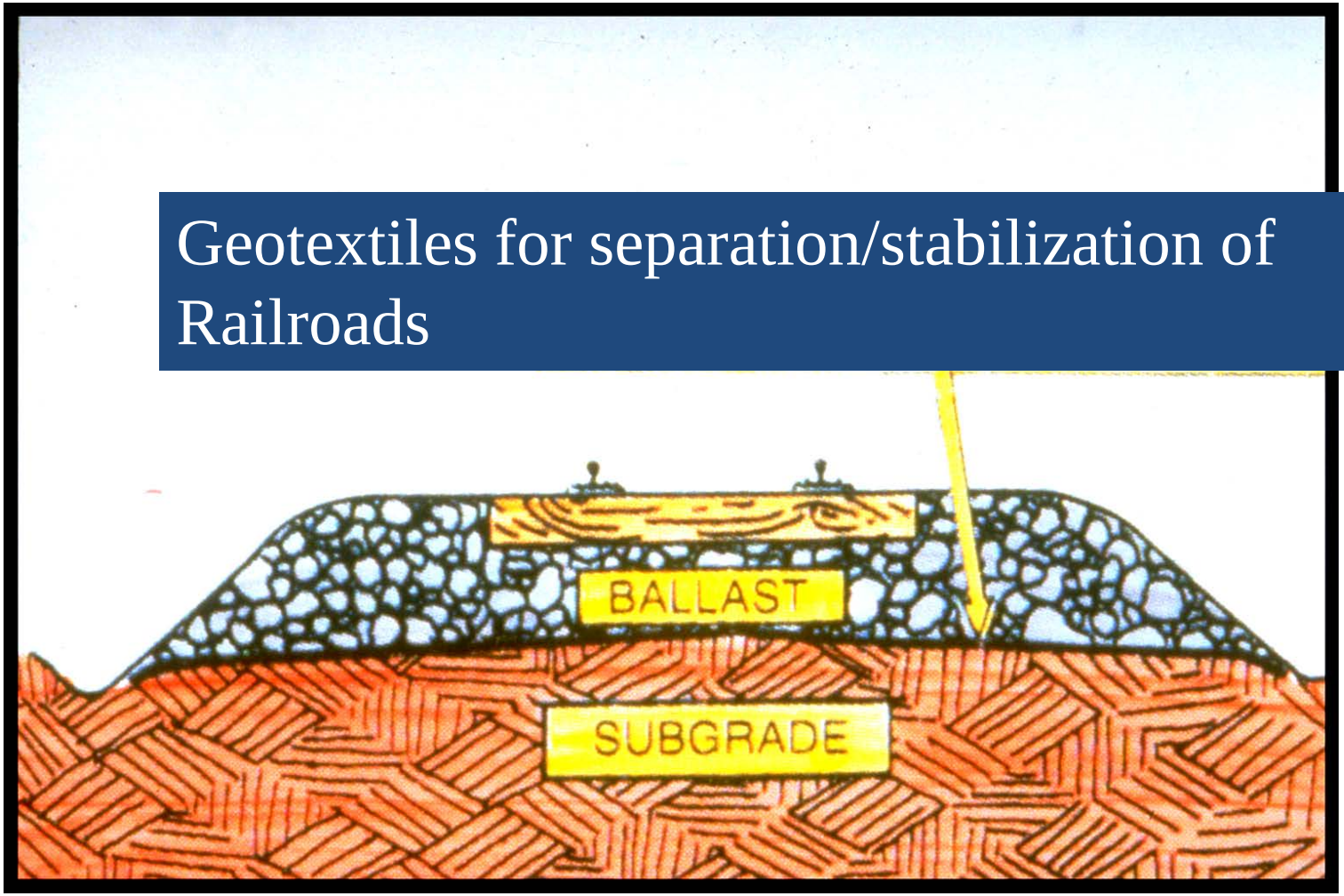
Better performing, geotextile sections were easy to spot—the surface aggregate was still supporting traffic.

Complete aggregate loss in no-geotextile sections.

Fill any ruts with additional aggregate and compact.



# Geotextiles for separation/stabilization of Railroads




Railroad track rehabilitation with geotextiles

Heavy weight nonwoven geotextile stops subgrade fines pumping and ballast contamination

# In Summary, Geotextiles Allow You To:

--Preserves the as-built structural section

*Lowest cost safety factor available*

--Add structural strength to a road section

*Allows the use of less materials to save $*

--Allow use of better structural materials

*Cost effective drainable aggregate*

--Reduce future maintenance costs

*Mandated usage a growing trend*

--Never need full-depth reconstruction again.

*Minimize road downtime and traffic deaths*

# Which Separation/Stabilization Geotextile Should I Use?

Unless you are sinking to your knees, use a **NONWOVEN** because:

--Same aggregate interlock as a geogrid (woven @ 70%)

--3X confined strength increase, 1X woven and grids

--The best filtration/separation

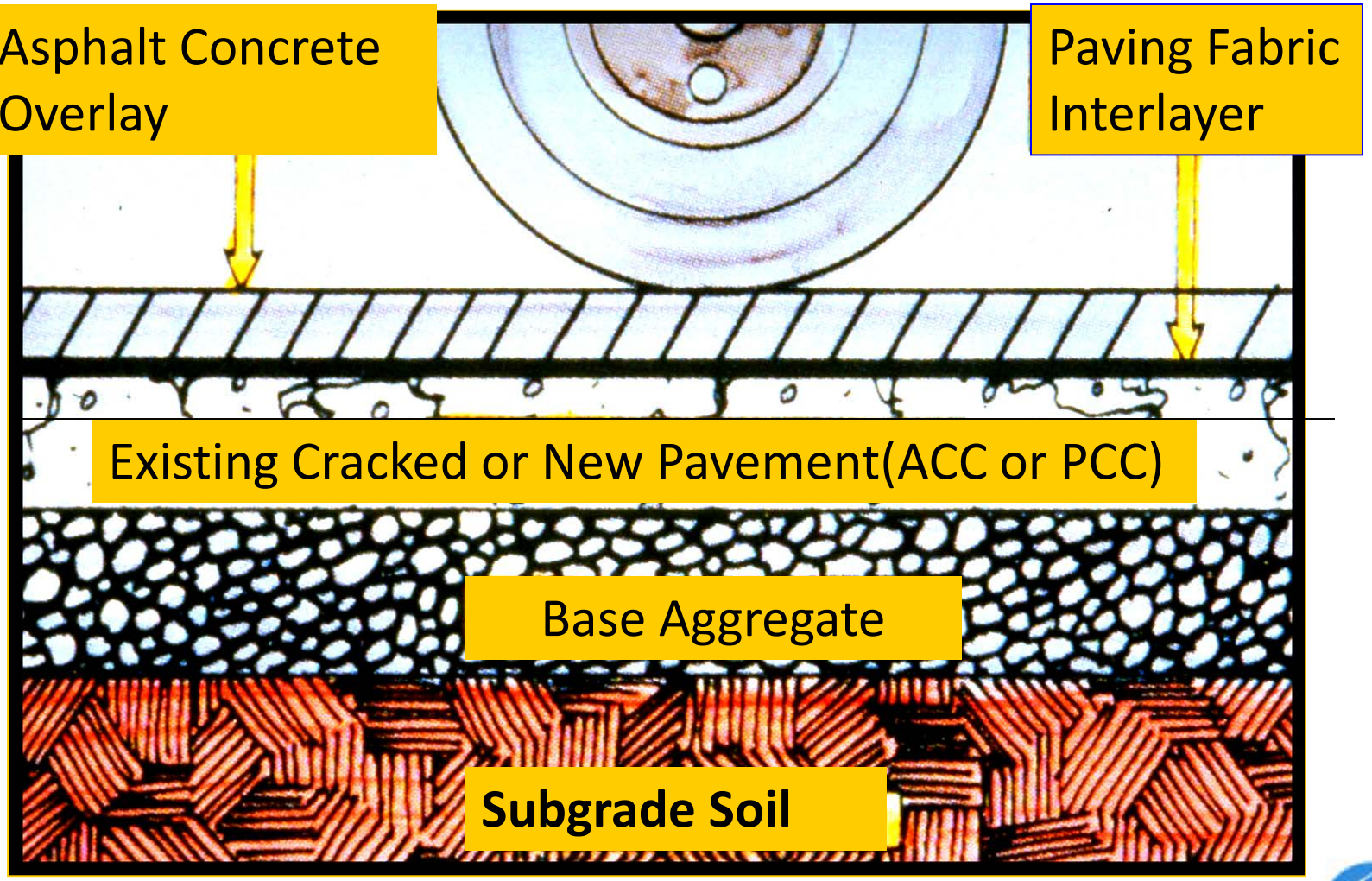
--Highly permeable, no water impedance

--Relieves pore pressure

--More durable, less construction damage

--Wicks water and provides a capillary break

# What is a Geosynthetic Interlayer System?



# Different Types of Geosynthetic Pavement Interlayer Systems

- Paving Fabric, full road width-Petromat
- Paving Mats, full road width
- Self-Adhesive Strip Membrane-Petrotac
- Paving Fabric/Grid Composite

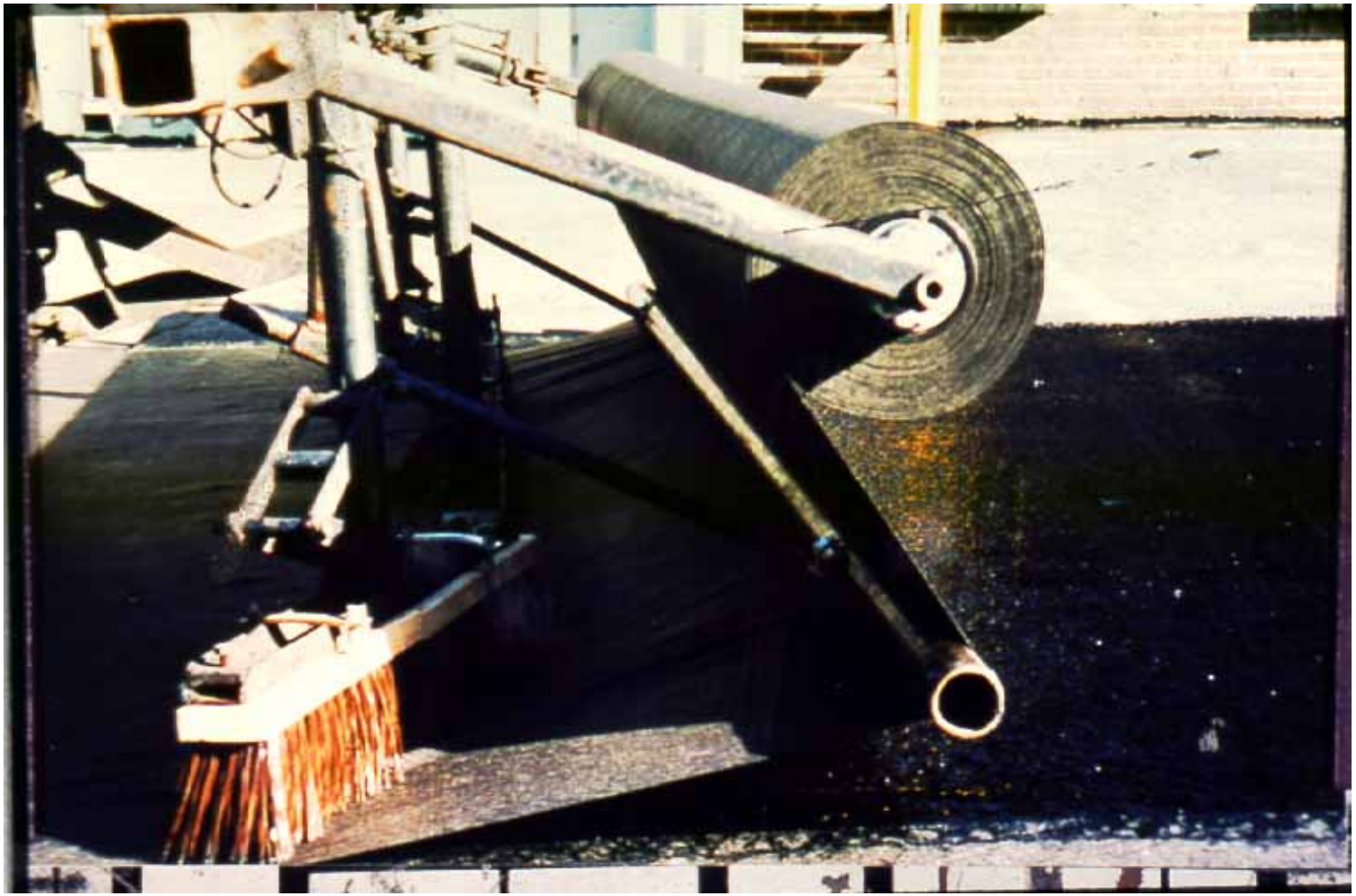
# Paving Fabric Interlayer System Components:

- A nonwoven paving fabric, such as Petromat is about 4.1 ounces per square yard, needle-punched nonwoven, and made of polypropylene and polyester fibers. This fabric becomes field saturated with asphalt cement during installation as shown in the next few slides. The needle-punched nonwoven has the bulk to absorb and hold sufficient asphalt cement. Thin fabrics like spunbonds and wovens cannot hold enough asphalt cement to be an effective moisture barrier.

**First, a uniform asphalt cement tack coat of 0.25 gallon/sq. yd. (0.9 liter/sq. m.) is sprayed onto a clean dry pavement surface**

The paving fabric is laid immediately onto the warm tack coat.

**Petromat** paving fabric being installed very well by Missouri Petroleum



Nonwoven Paving Fabric being “Broomed” into an asphalt cement tack coat

Freshly installed paving fabric system, ready to receive an asphalt concrete overlay.


Then, at least 1.5 inches(38mm) of compacted asphalt concrete is laid over the fabric.  The heat of the overlay reactivates the tack coat moving it upward to saturate the  fabric and to bond to the overlay.

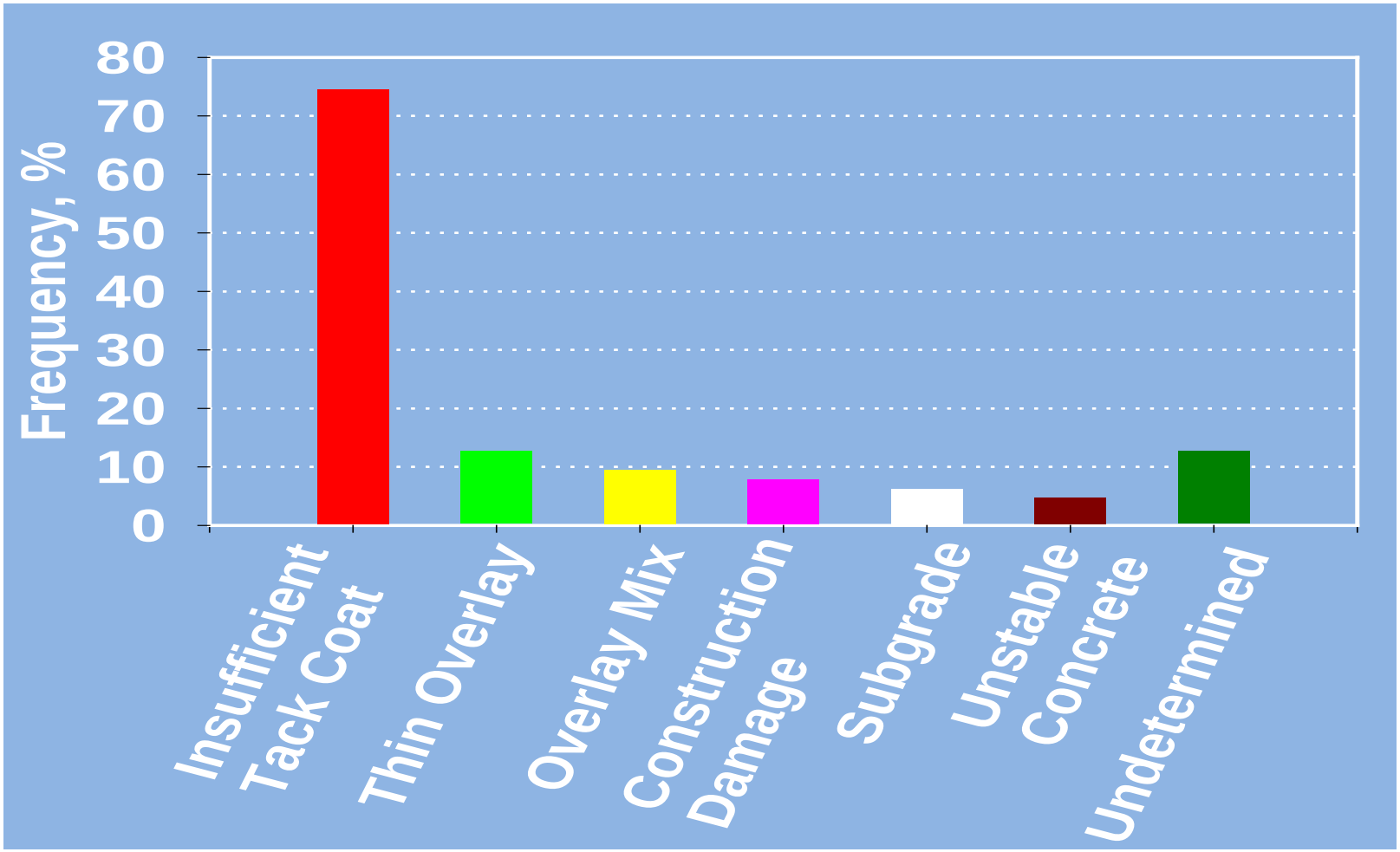
This tack coat will not produce a waterproofing membrane and may result in a failed system due to lack of proper bonding.

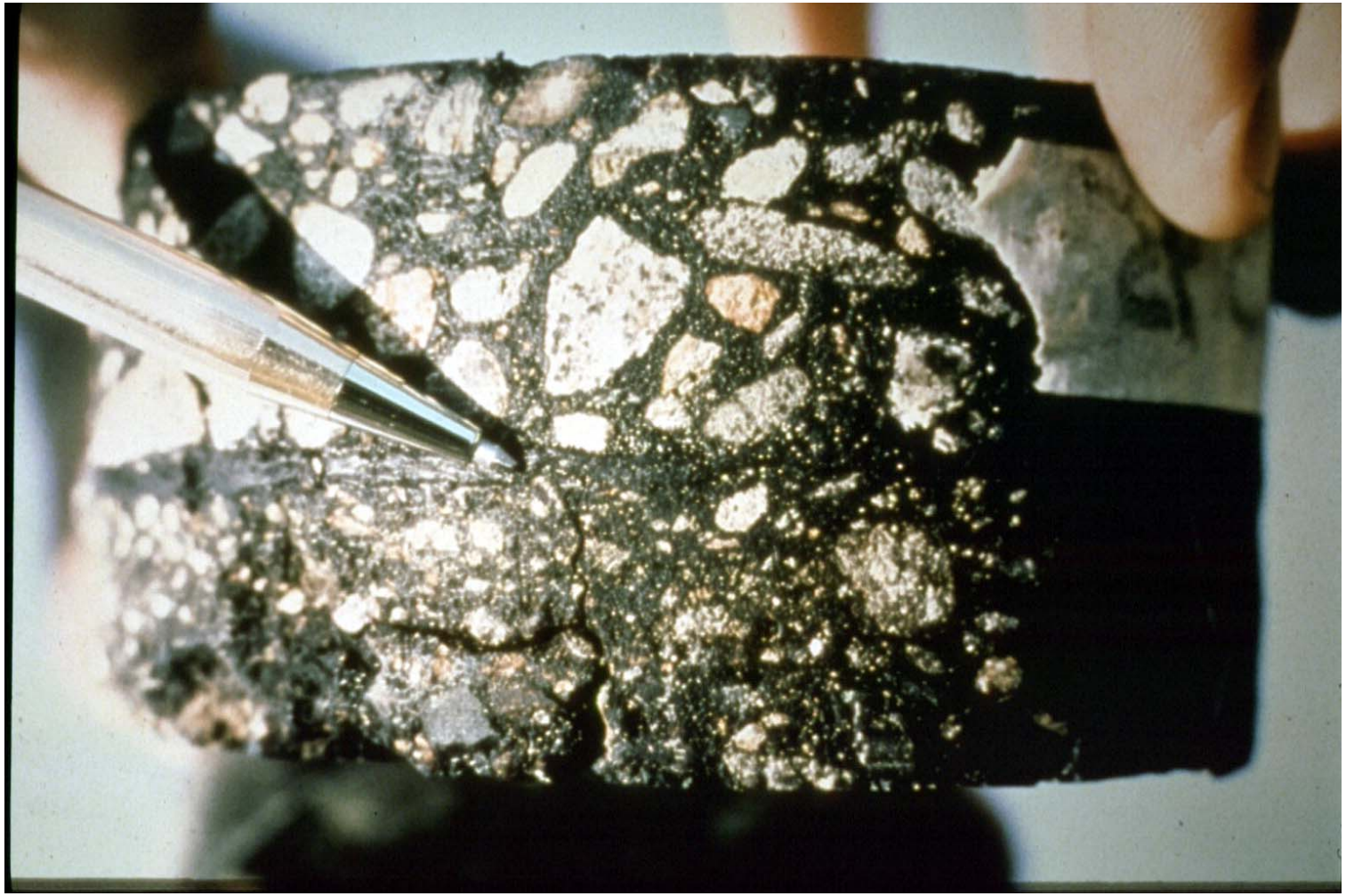
Possibly the correct quantity, but uneven application

If used, emulsions will often run off high points and pond in low areas, resulting in poor, spotty paving fabric saturation.

Residential street, Vancouver, BC
emulsion flowed to the curb

# Leading Causes Of Paving Fabric Complaints





As shown in this pavement core, the result is a well-bonded system with a fairly thick asphalt saturated paving fabric interlayer.

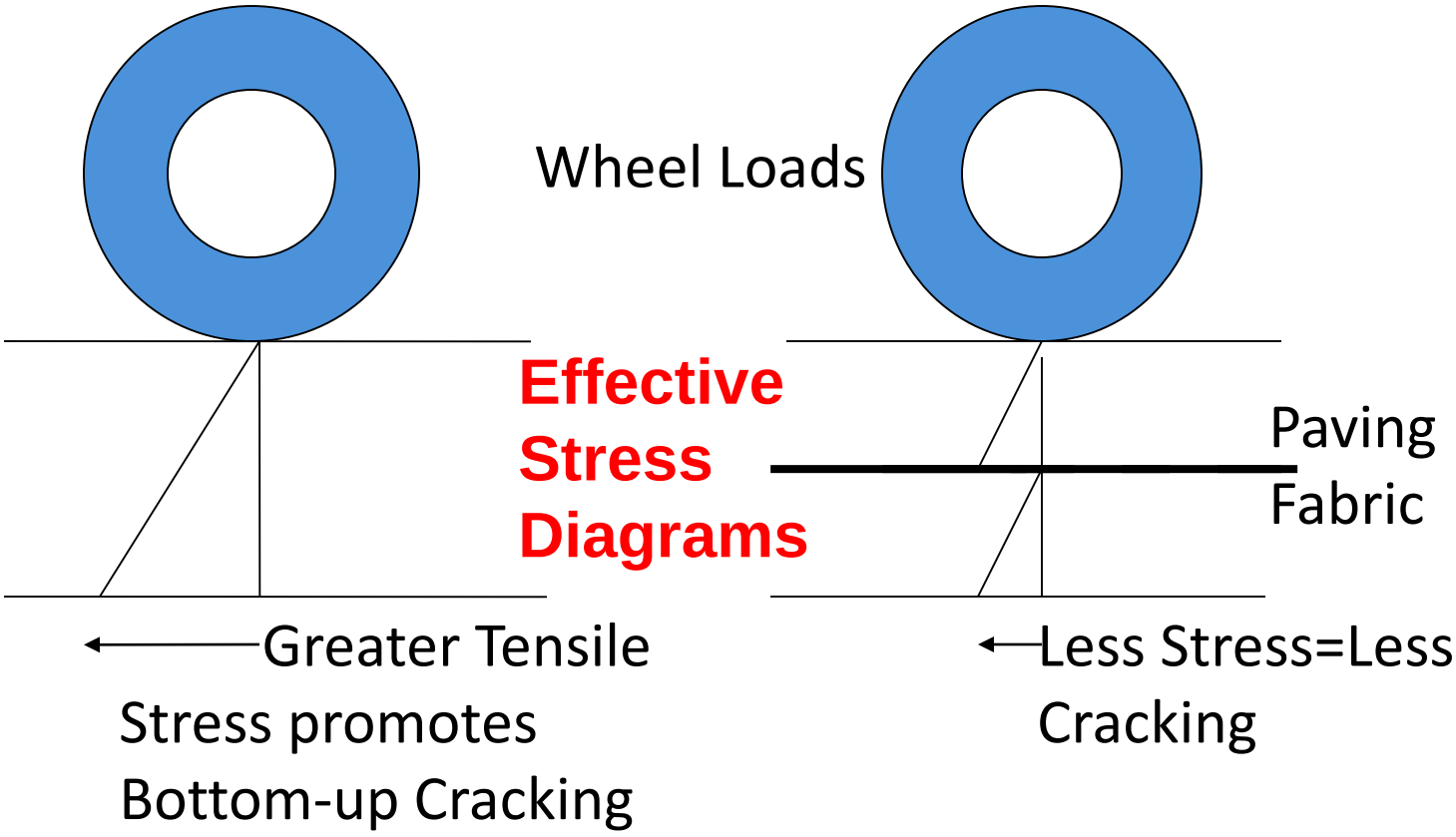
# Paving Fabric Interlayer Functions:

- A stress absorbing interlayer

- A pavement moisture barrier membrane

# Stress Absorption Retards:

- Fatigue cracking due to pavement flexure
- Reflective cracking due to existing stresses in overlaid pavement

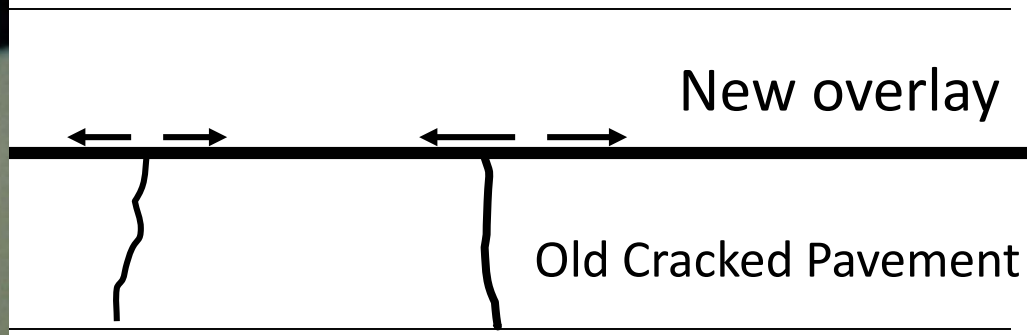



Effective layering, due to the paving fabric interlayer, reduces tensile stress in the base of each layer due to pavement flexure, as shown on the stress diagrams above. This reduces tensile crack development and **increases fatigue life.**

# Tests at Ohio State University

-Pavement with a Paving Fabric Interlayer Resisted Cracking 10 to 20 Times Longer Than Control Section, Without Fabric

The thick, asphalt-saturated fabric interlayer also absorbs and dissipates stresses due to underlying existing cracks to **retard reflective cracking.**




However, excessive joint of crack movement should be stabilized first and/or treated with a heavy duty self adhesive geosynthetic strip membrane interlayer.

# Thermal Cracking in Pavements

*Thermal cracking occurs in the overlay due to the inherent expansion and contraction within the surficial pavement layer. It may or may not be reflective from below.

*A paving fabric interlayer does not stop the thermal movement that causes cracking, but it will waterproof cracks that form.

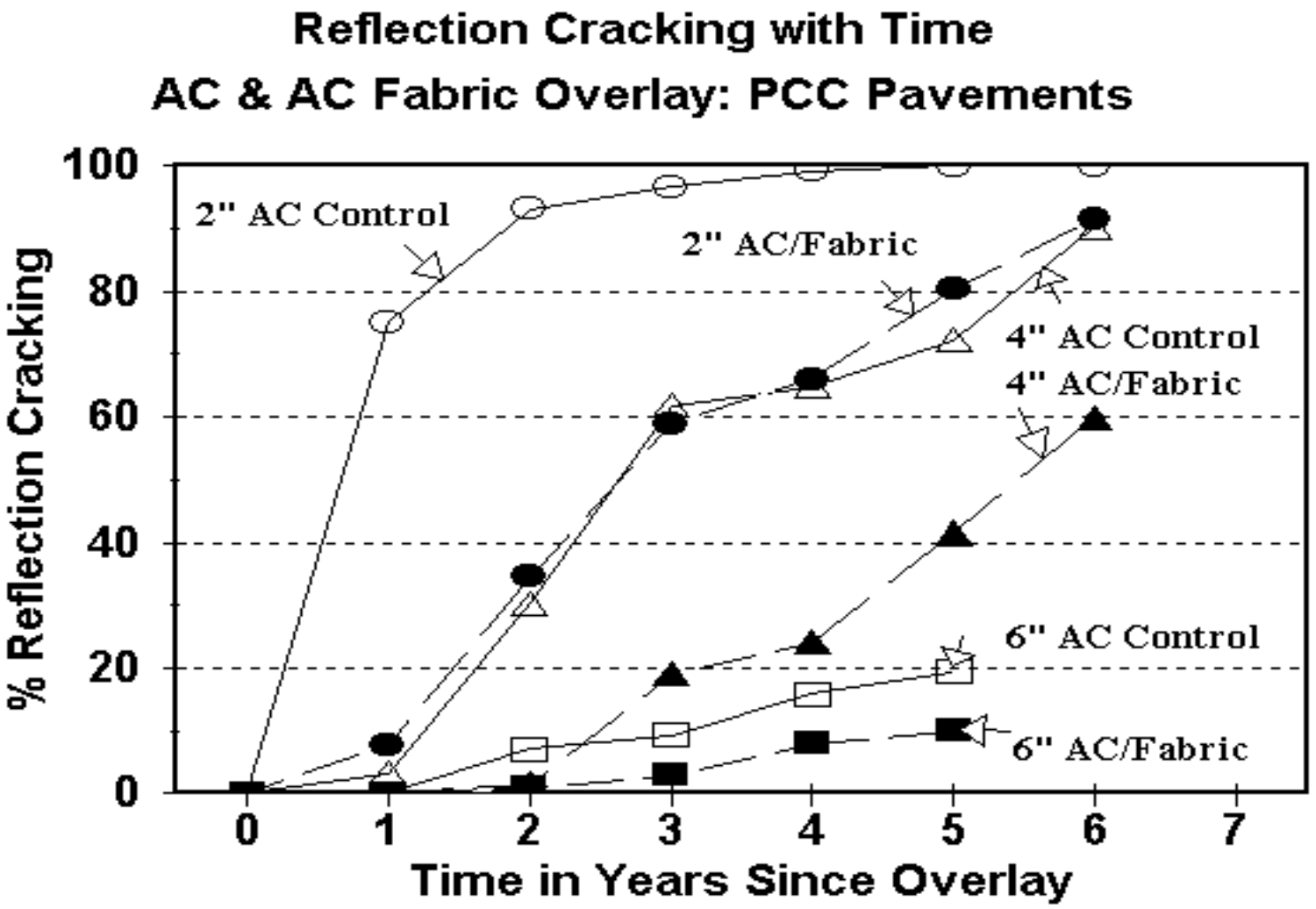
*Also, by limiting free water in the road base, frost heave is minimized. The paving fabric interlayer will also minimize potential reflective cracking from existing thermal cracking.


Intact paving fabric interlayer beneath a thermal crack in North Dakota—still providing the moisture barrier benefits.

# Documented Field Performance

- Maxim Research Summary Review Report
- Propex Tech Notes and Case Histories
- CALTRANS  and Other States' Research
- Greenville County, South Carolina Study
- General Findings—For crack retardation, the inclusion of a Paving Fabric Interlayer:
  - *Provides equivalent performance as an additional 1.2 to 1.5 inch(0.10 foot+) AC overlay thickness*
  - *Or, applied another way, it doubles the life of a typical asphalt concrete overlay*

- Georgia DOT performed a trial to test the effectiveness of Paving Fabric Interlayers over PCC joints, to retard reflective cracking.  The following slides show the results.




Curves overlaid to compare performance. Note doubling of pavement life or, performs like adding a thicker asphalt cement concrete overlay.

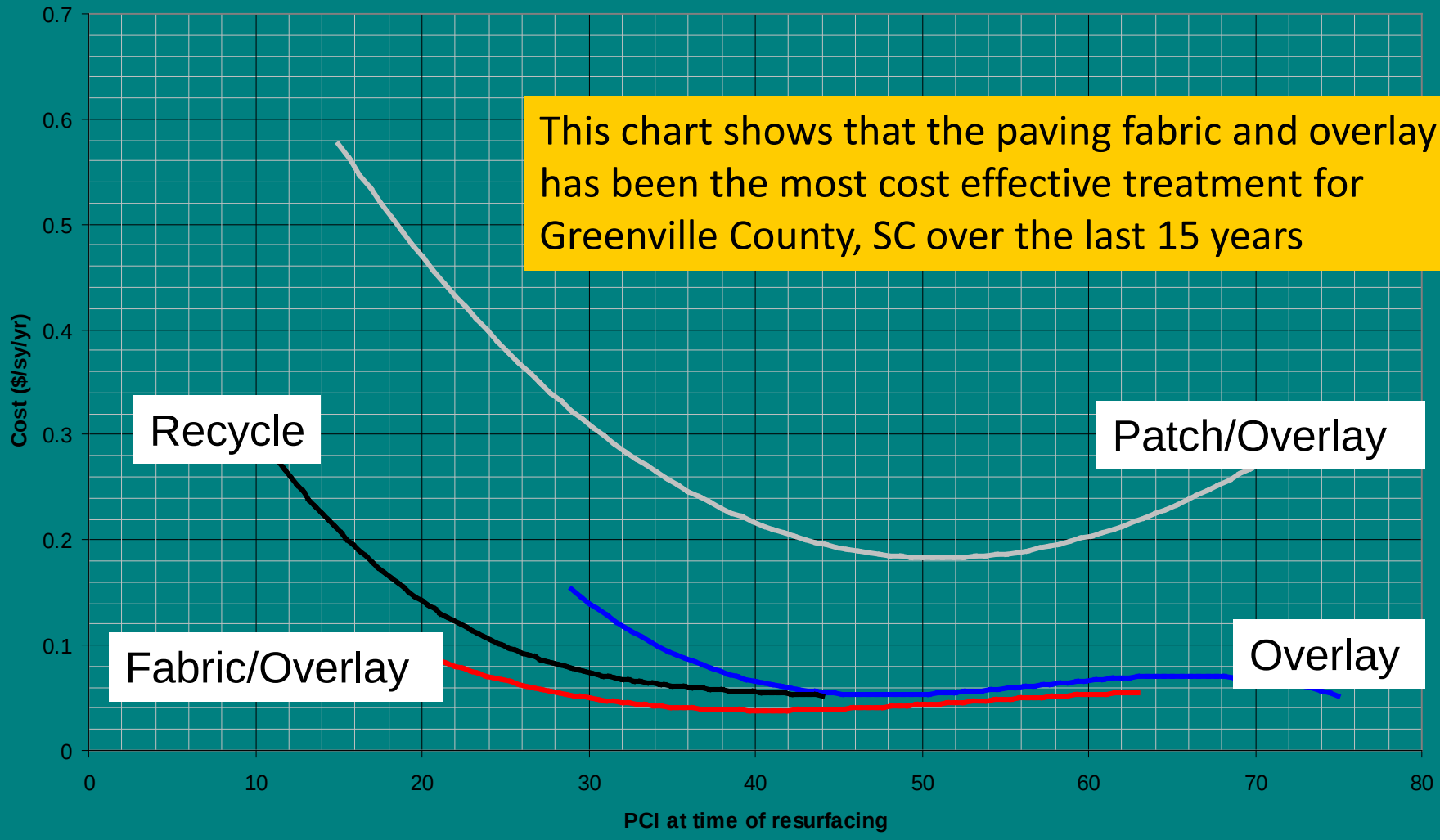
Installed paving fabric interlayers generally cost less than 0.05 ft. of asphalt concrete.

**But,**

fabric interlayers have the equivalent benefit of more than 0.10 ft. of additional asphalt concrete overlay thickness.

**Effective Cost – Zero – A Cost Reduction**

**Resurfacing Cost vs. Pavement Condition**
(Based on Greenville County, SC Study - Phase 1)



# Order of Effectiveness:

--Longitudinal cracks/joints, like lane widening joint

--Fatigue cracking/alligator cracking (tensile fatigue from load flexing)

--Heaving/swelling cracking—frost and expansive clays

--Transverse cracking from underlying joints and cracks

--Thermal cracking

# Step 1-Prepare The Surface

- Pavement surface must be stable
- Crack >3 mm(1/8 inch) must be filled
- Surface must be dry
- Surface must be cleaned of any foreign material before paving fabric placement
- Grade should drain surface water

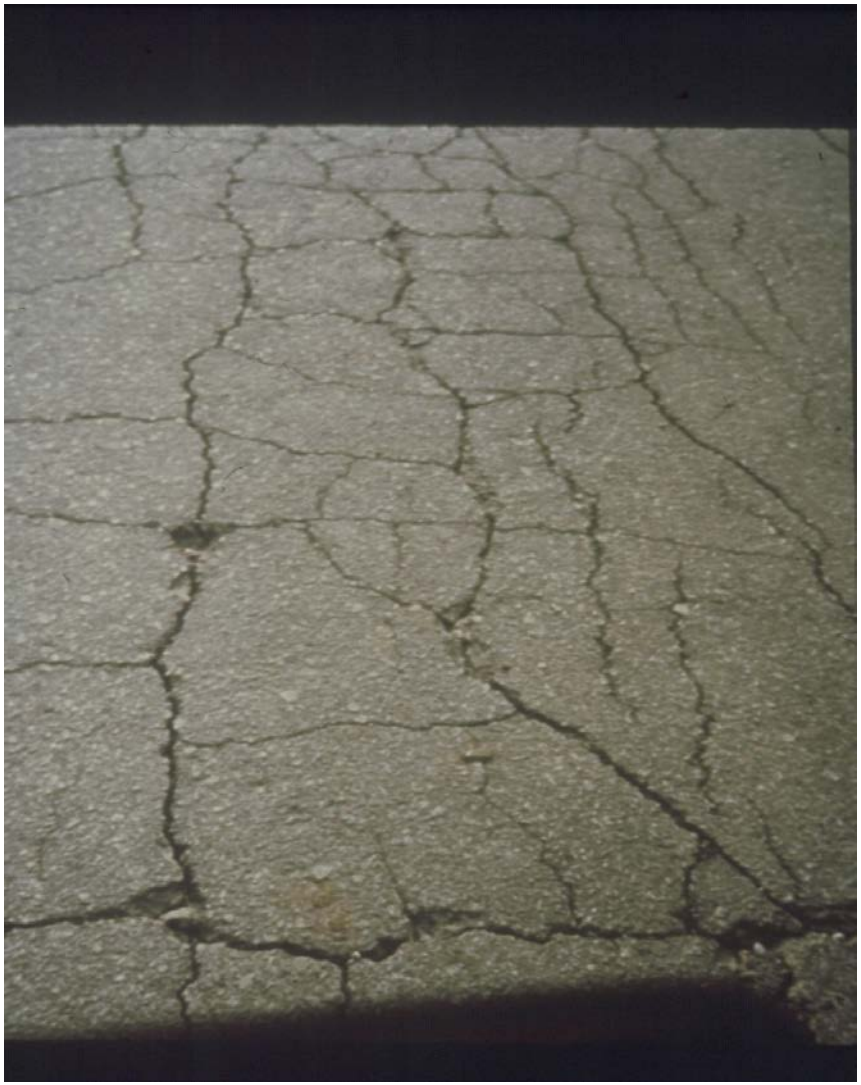
Important Note:  Do not place a moisture barrier directly on a pavement rut or it could hold water.  Establish a drainable surface first by milling or by applying a leveling course.

Paving fabric may be placed over a milled surface.  Here, wedge milling allows 1.5” overlay to be level with the curb.

Unsuitable for Petromat placement.

Unsuitable for Petromat placement.

Borderline—requires a leveling course



Borderline—requires a leveling course

Borderline—requires a leveling course and/or milling

Borderline—requires a leveling course or milling


Typical results of a paving fabric section over fatigue cracking after 5 years.

Paving Fabric Interlayer System As A Pavement Moisture Barrier.

The moisture barrier function is just as important to pavement performance as crack retardation and, both enhancements are additive

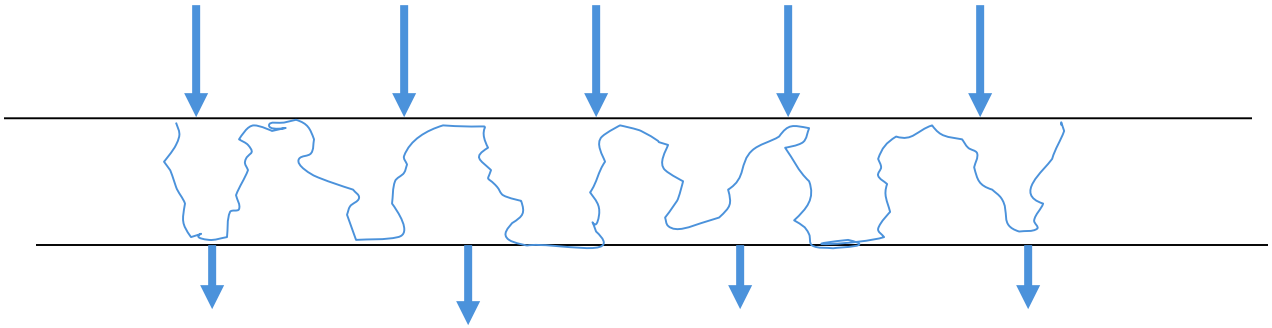
# **WATER** Is The Root Cause Of Most Pavement Deterioration

# How Does Water Get Into Pavement Sections?

- Precipitation Infiltration
  - Through Uncracked Pavement
  - Through Pavement Cracking and Joints
- Ground Water
  - Springs
  - Lateral Seepage
  - Capillary Rise

# The Major Source:

Seepage Through Pavements,
Including New Pavements--



Into Road Base Layers and Subgrade

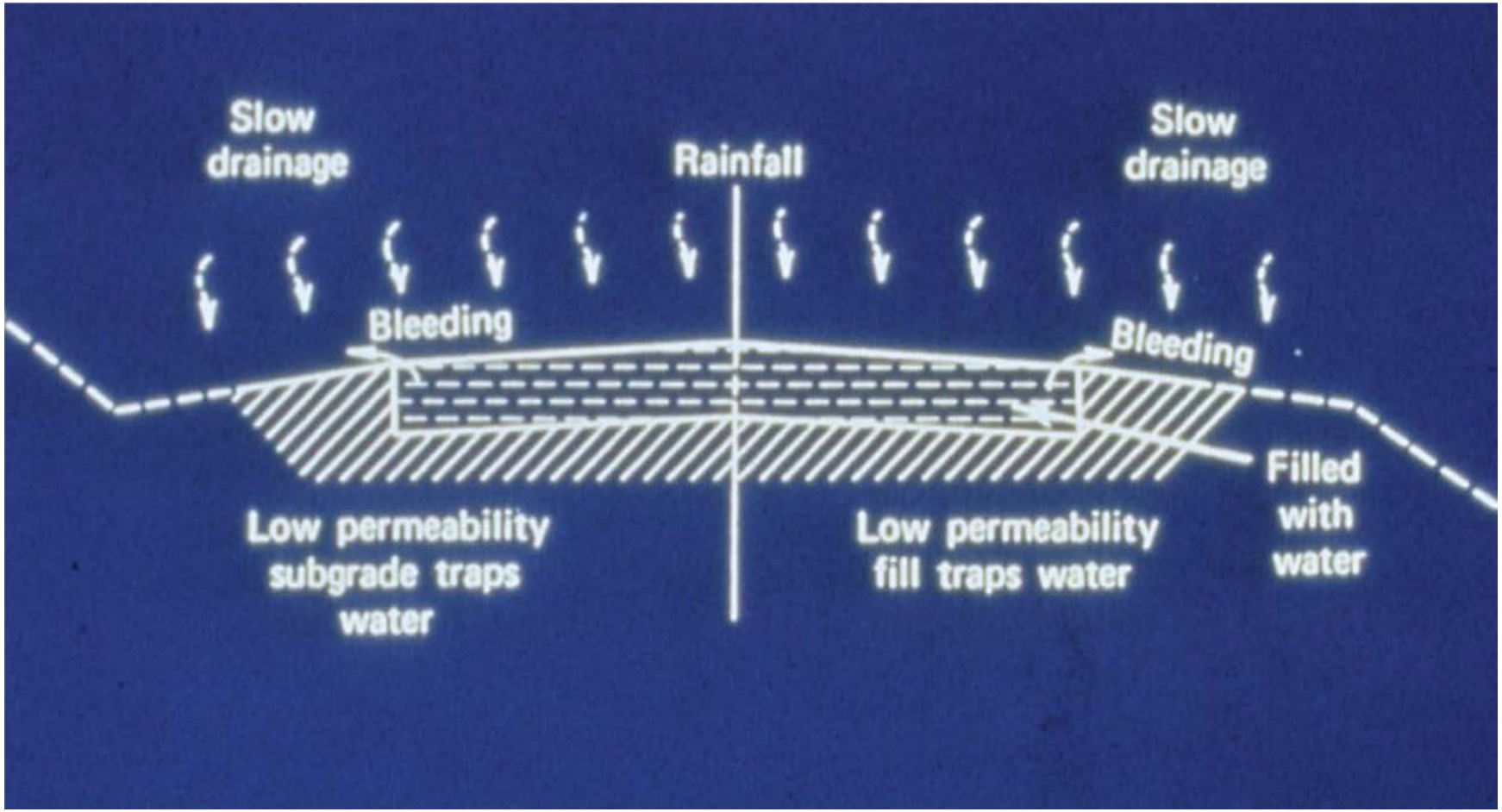
# Precipitation Infiltration Coefficients for Typical, Uncracked Pavements

- PCC-- .50 to .67
- ACC-- .33 to .50
- Precipitation X Coefficients = Infiltration Amount Through Pavements

(Federal Highway Administration Study)

CALTRANS, for example, uses a design infiltration factor of 0.33 for asphalt concrete pavements; meaning approximately one third of the precipitation amount passes through the pavement, to weaken the base and subbase


Then, once cracked, a pavement can infiltrate almost 100% of rainwater (infiltration coefficient near 1.0)




Once water enters a pavement structural section, it often cannot get out because the base materials won't drain or there is no drainage outlet. So, many roads are "bathtubs".

Several days after a rain this base is still saturated and pumping out trapped water and subgrade fines (note early slab cracking)

# Irrigation Water

-Can Be As Harmful As Natural Precipitation

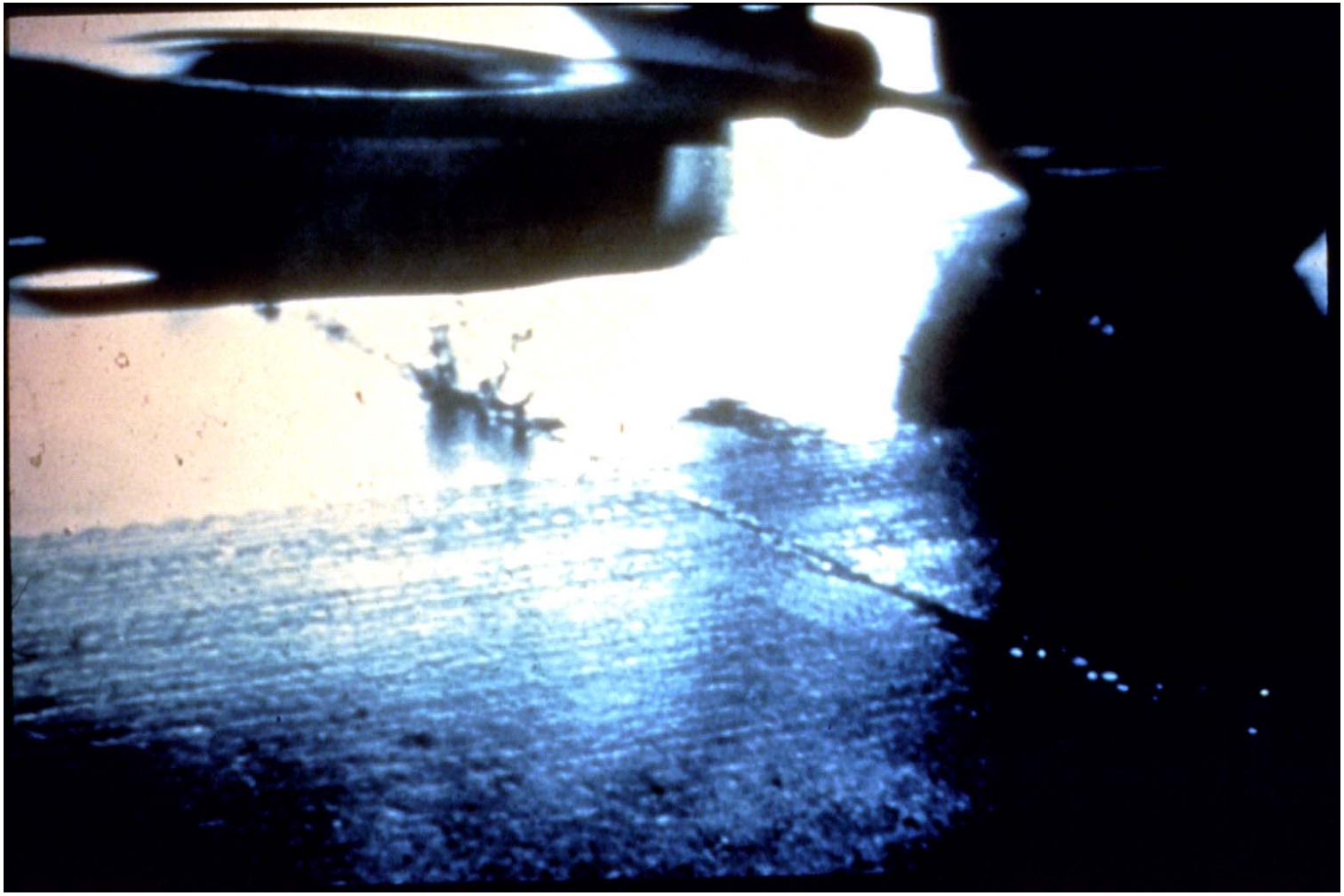
Green islands are generally over watered, on a regular basis.


Maintenance washing water can provide harmful moisture as it infiltrates through the pavement.

# Effects of Water In Pavement Sections

- Softens Subgrade Soil/Promotes Damaging Intermixing with Base Aggregate
- Effects of Free Water—Pumps Out Fines
- Effects of Pore Water Pressure—Loss of Support
- Effects of Freezing-Ice Expansion, Heaves the road and can form ice lenses

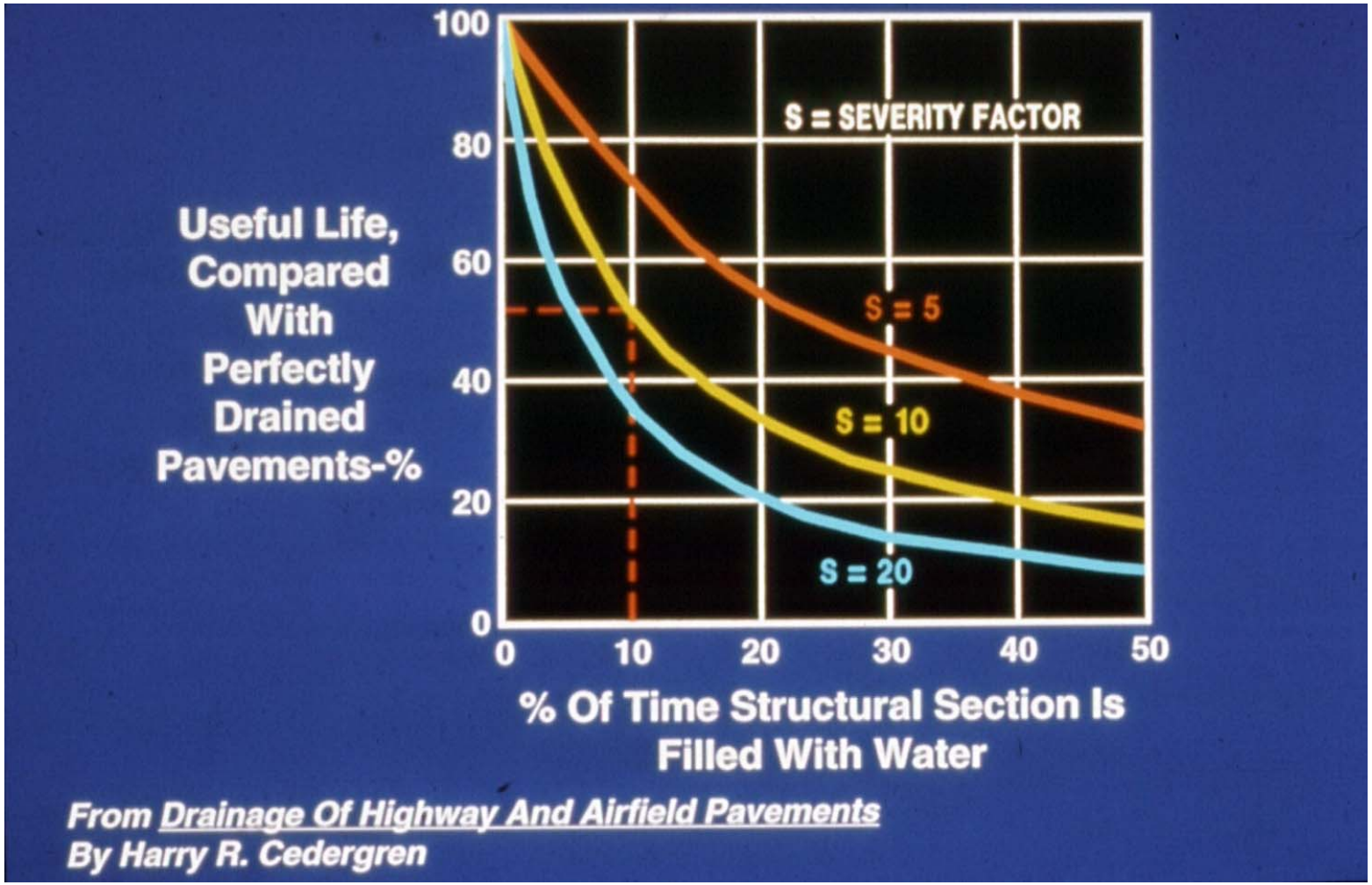
Moisture softens the subgrade soil promoting intermixing with the  base aggregate.  Aggregate with fines contamination loses strength and drain-ability.



Trapped water jets up carrying fines out of the roadbase.


This creates voids resulting in pavement settlement and cracking.

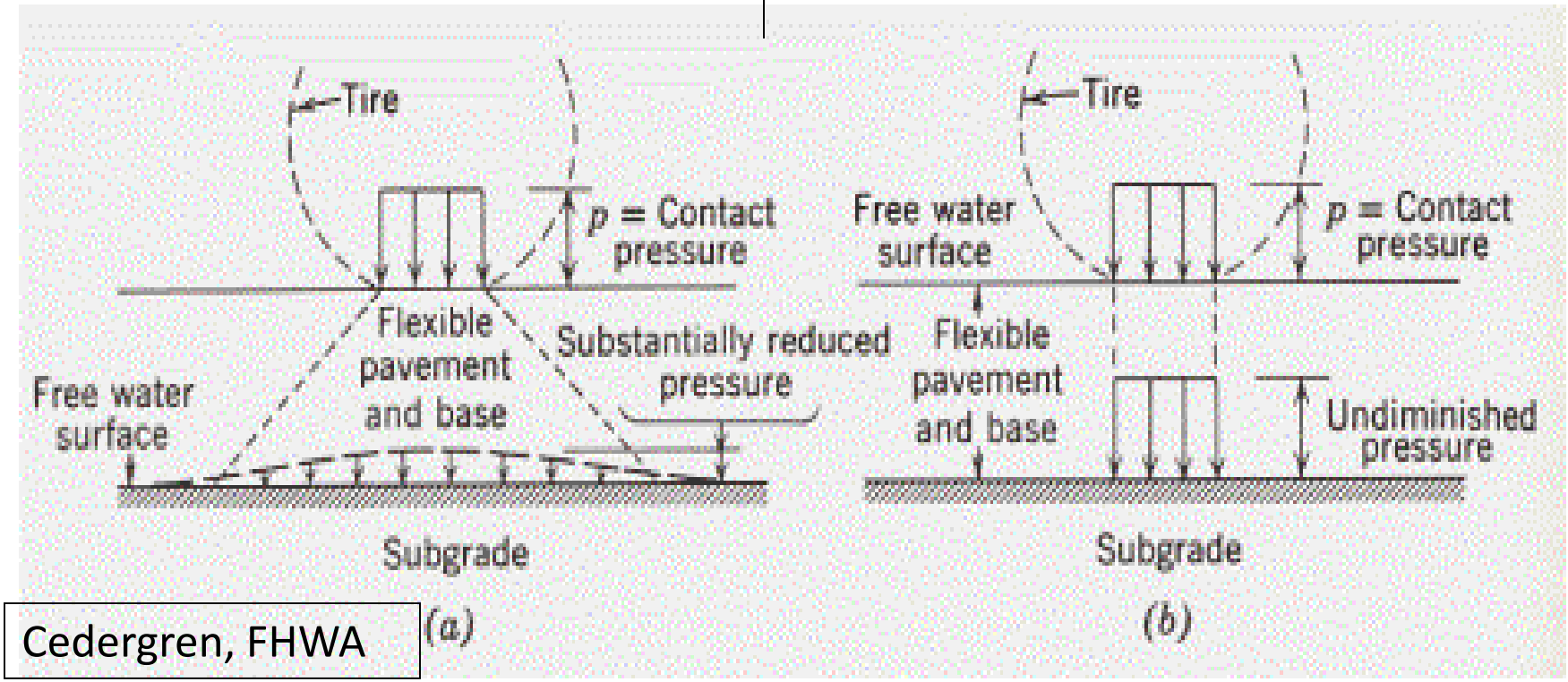
# Cumulative Effect of Water in Roadbase Materials (FHWA)




**For example from the slide above, if the pavement section is saturated 10% of the time, the useful life of the road is reduced by over 50%.**

Drained Base, Proper Load Spreading

Saturated Base, Focused, Pore Pressure Loading




Cedergren, FHWA

Pore pressures in trapped road-base water override the structural bridging of the aggregate base, overloads and damages subgrade. Pore pressure builds immediately under a passing truck.

# “Structural Credit” For Drainage

By AASHTO design, the more often you have water in the pavement section, the weaker the structural layers.  Using AASHTO drainage coefficients, the better the drainage, the higher the strength you may assign to unbound aggregate bases.

# AASHTO Base Drainage Definitions

| **Quality of Drainage** | **Water Removed Within:** |
|---|---|
| Excellent | Two hours |
| Good | One day |
| Fair | One week |
| Poor | One month |
| Very Poor | Will not drain |

# AASHTO Recommended Drainage Coefficients For Flexible Pavements

| Drainage | Lower Rainfall Area | High Rainfall Area |
|---|---|---|
| Excellent | 1.25 | 1.20 |
| Good | 1.08 | 1.00 |
| Fair | 0.90 | 0.80 |
| Poor | 0.70 | 0.60 |
| Very Poor | 0.58 | 0.40 |

Drainage coefficient X Structural coef. = Base Structural Number

- For Example, in a wet climate, if a base thickness of 8” has excellent drainage, or no water is allowed to enter the base, it has an effective strength of 9.6”.  If the 8” base has poor drainage, it only has an effective strength of 4.8”, per AASHTO Design—only 50% of the strength!

# Traditional Attempt to Solve Moisture Problems–

Highway Edge Drains

- For an edge drain system to work, the pavement base layer must have a permeability of at least $10^{-1}$ mm/sec. Otherwise, the water cannot get to the edge drain fast enough to keep the pavement drained.

- Very few existing pavements would qualify and few pavement base gradations in use today would effectively drain.

If the base is tight and holds water, like this typical base aggregate, edge drains will not be an effective solution.

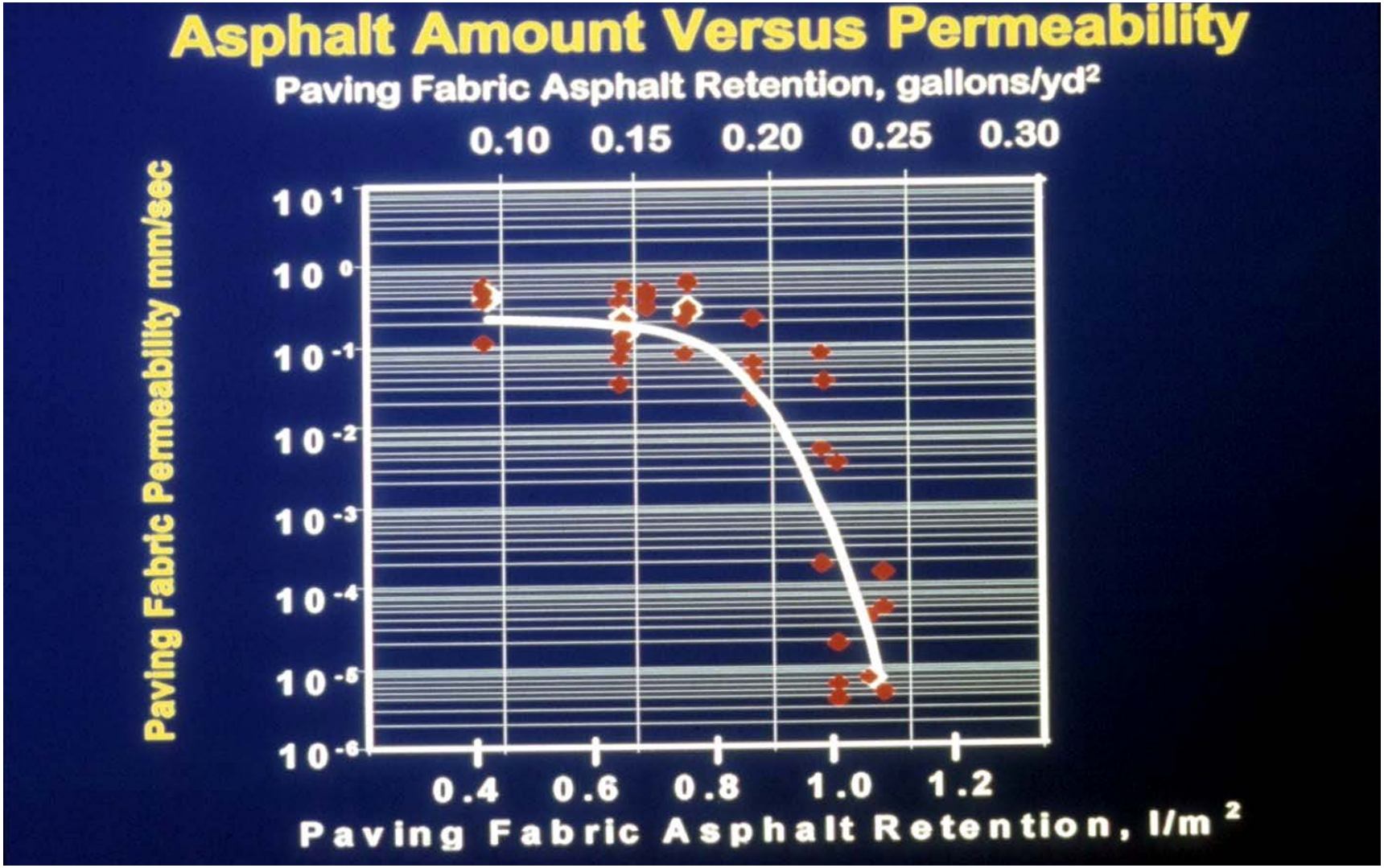
# The Alternative to Pavement Drainage:

Cap the pavement with a moisture barrier, like a paving fabric interlayer.

➔If you don’t let the water in, you won’t have to drain it.(Duh)

# California DOT Permeability Test Results On Pavement Cores Taken After 2 Years Of Service

| Core No. | Core Type | Vacuum Perm. mls/100 sec. |
|---|---|---|
| 4 | Control (No Fabric) | 2.75 |
| 5 | Control (No Fabric) | 8.25 |
| 6 | with Paving Fabric | 0.00 |
| 7 | with Paving Fabric | 0.00 |
| 8 | with Paving Fabric | 0.00 |
| 9 | with Paving Fabric | 0.00 |
| 10 | with Paving Fabric | 0.04 |
| 11 | with Paving Fabric | 0.00 |




Asphalt Tack Amount versus Paving Fabric Permeability From Laboratory Testing—It is Important to have Adequate Tack Coat

# Field Evaluations of the Low Permeability of Paving Fabric Membrane Interlayer Systems

Testing moisture content beneath a pavement using Ground Penetrating Radar (GPR)

# Ground Penetrating Radar Findings:

Significantly more moisture beneath pavements without a paving fabric than beneath pavements that incorporate a paving fabric interlayer system.

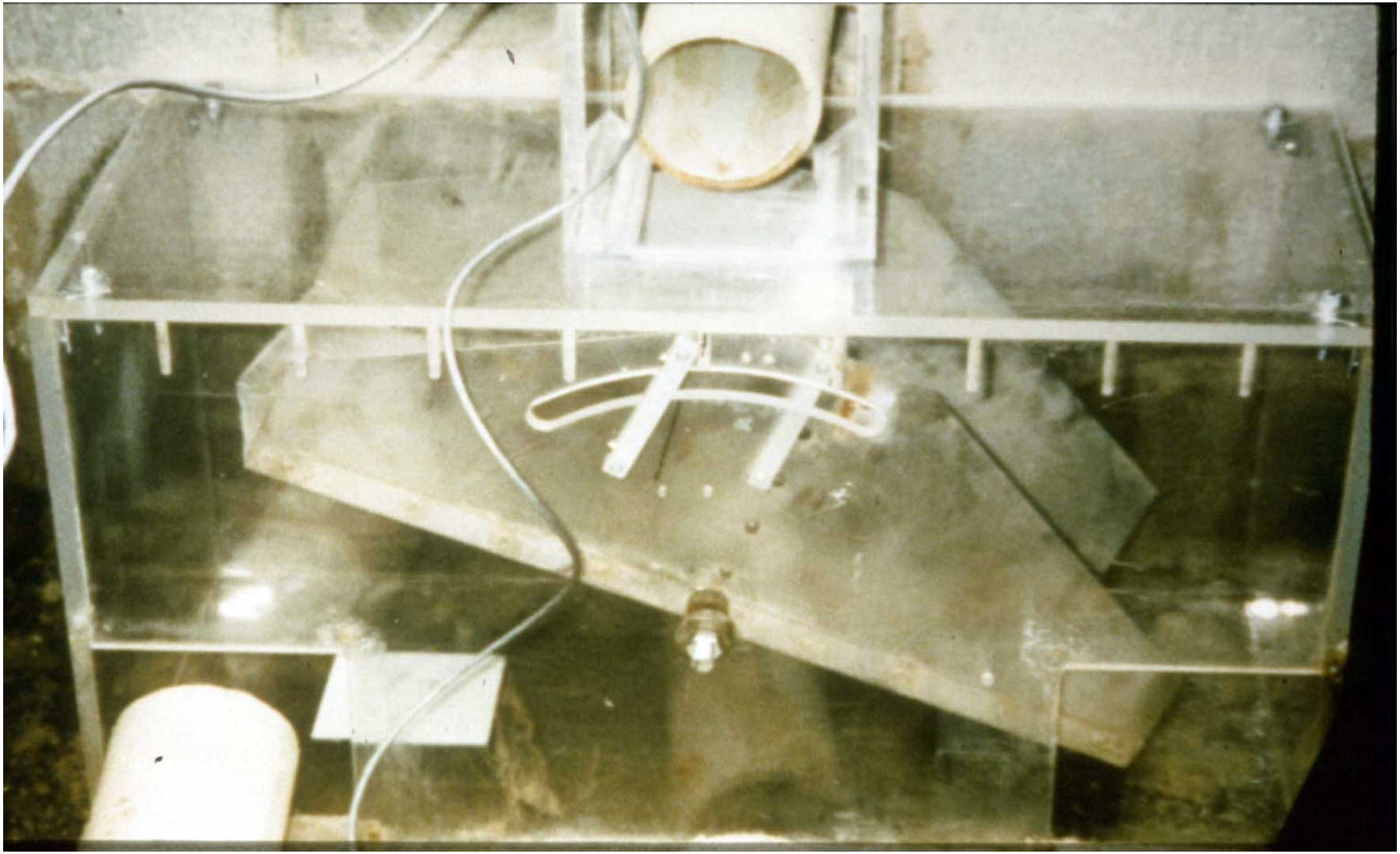
# Oklahoma DOT Large Scale Field Permeability Test

- The state of Oklahoma often uses highway edge drain systems. When they recently tested 5 systems, four were draining over 30% of the rainfall hitting the roads, but one was <1%. They thought the edge drain had clogged, but we thought it was because we had placed a paving fabric on that one road. They agreed to run a test to find out.

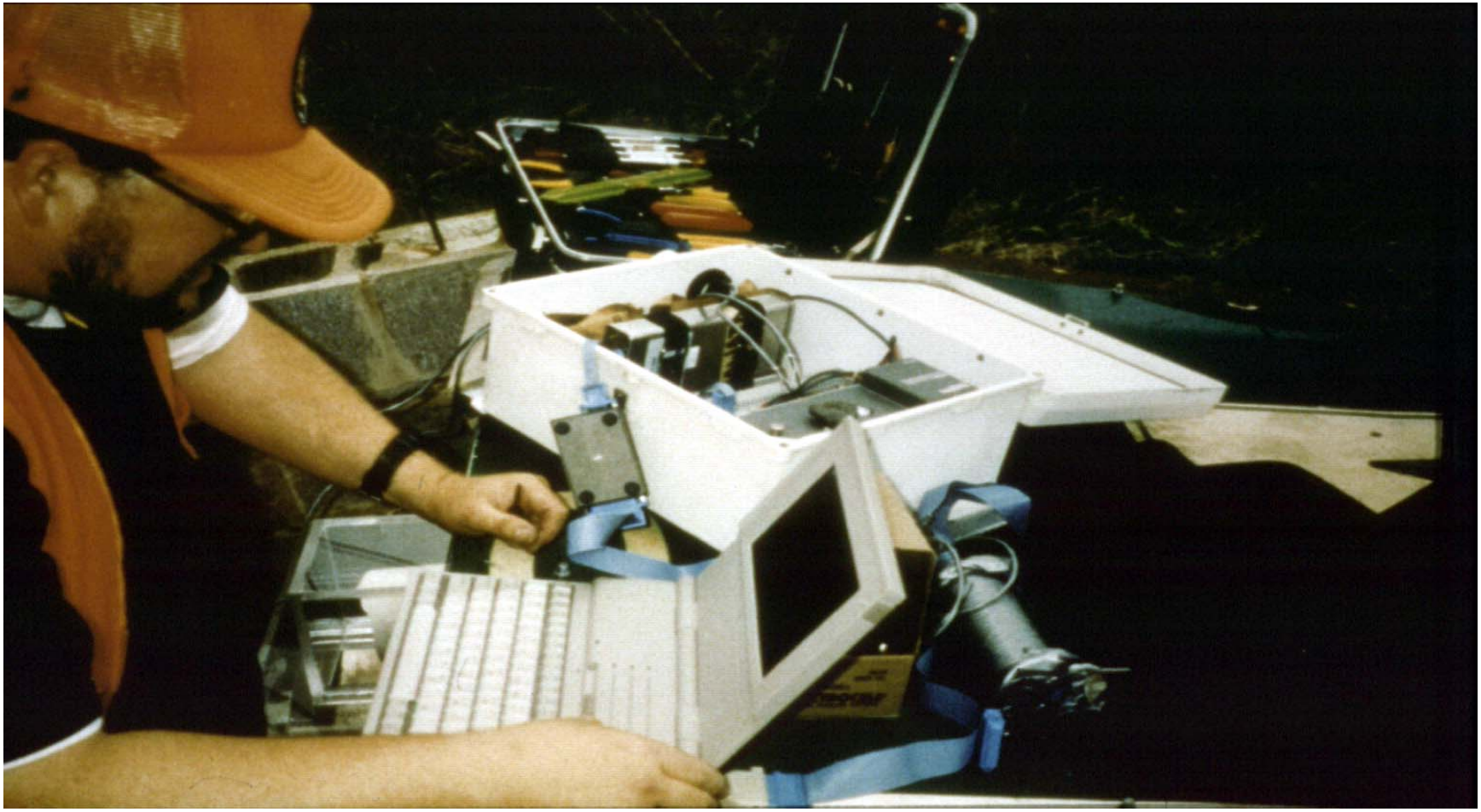
First a hole was drilled through the road so that water could be pumped into the base.

Core showed the asphalt cement tack coat saturated paving fabric interlayer.

A water truck was used to pump water below the pavement into the base aggregate.



A tipping bucket was used to measure the water flowing through the base and out of the edge drain.



The results of the test showed that water ran freely through the base and edge drain, so, it was the paving fabric moisture barrier that was an effective membrane, not allowing water to enter the base stone—not drain clogging as OK DOT had suspected.

When the cost of adding a paving fabric interlayer to an overlay project is compared to the cost of edge drains, the paving fabric is usually a much more cost effective solution.

Again, the interlayer system is simply stopping the water from getting into the aggregate base, so drainage of the infiltrated surface water is unnecessary.

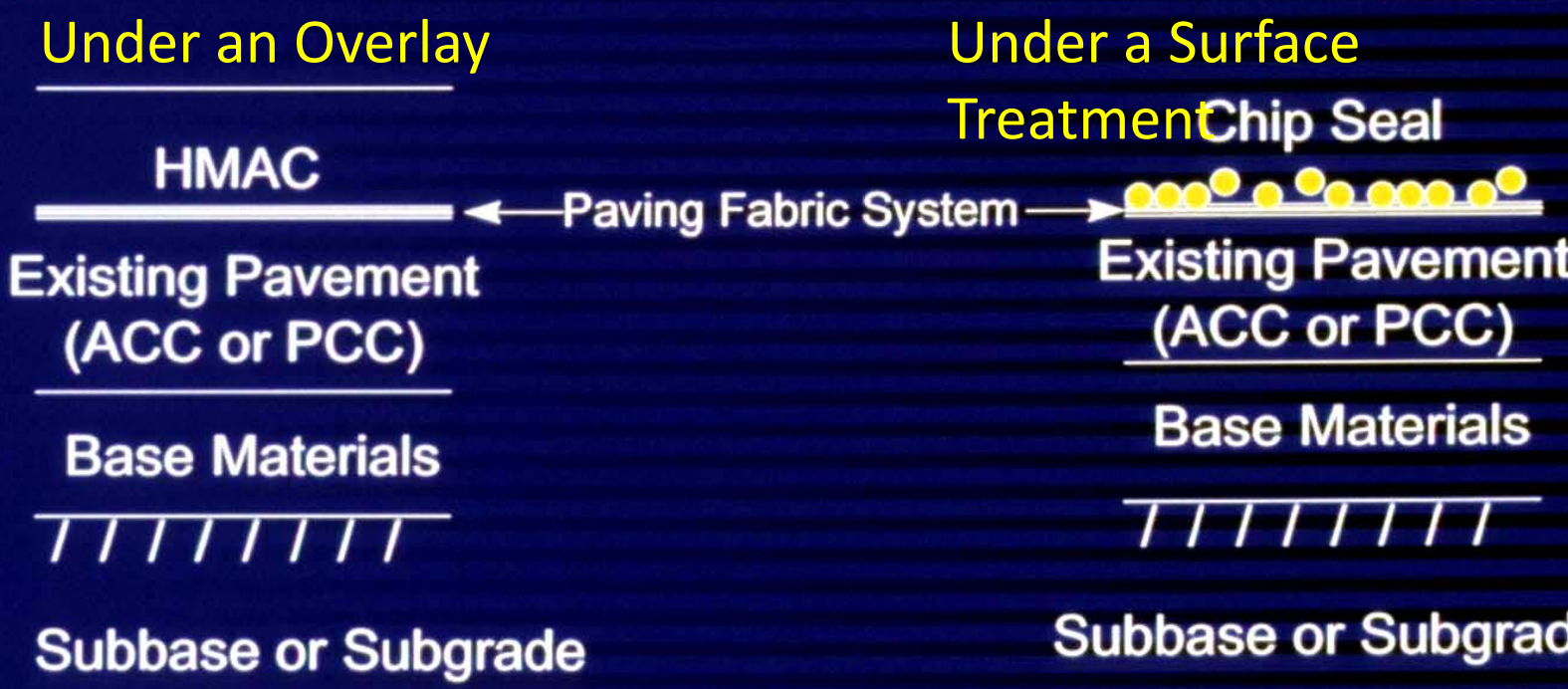
Also, stopping the infiltration is the only viable option when the base stone is a typical dense gradation that does not drain well.

- Another beneficial use of a paving fabric membrane interlayer is to maintain a fairly constant, year around moisture content in expansive clay subgrades, particularly in drier climates, where the expansive soils shrink when dry and then swell dramatically when they get wet.

# Web Available Research Studies on Paving Fabric Performance

- --Reference TRB Online Circular, EC006, found at http://gulliver.trb.org/publications/circulars/ec006.html (Summary of this study is on www.propexglobal.com website under Technical Resources as Tech Note 4)
- -- Nonwoven Paving Fabric Study, found at www.gmanow.com
- --Several other references reside on manufacturer websites

# Paving Fabric System Applications



# When To Use A Paving Fabric:

- Use as a full width application to achieve a pavement moisture barrier.
- Retards reflective and fatigue cracking.
- Paving fabric may be placed onto a milled surface
- May be used below an ACC overlay or below a chip seal surface treatment.
- Effectively used in new ACC pavements to retard the development of the first fatigue cracking and as a moisture barrier.
- Paving fabric is recyclable in pavements

# Paving Fabric Application Beneath a Chip Seal Surface Treatment

- Since there is no heat of an overlay, a different system of rolling the installed paving fabric is used to saturate the paving fabric before the chip seal treatment is installed.
- This is a very effective way of incorporating pavement moisture barrier benefits while greatly extending the life of a chip seal surface treatment.
- See the training module dedicated to this specific paving fabric application

# Why Use Paving Fabrics Beneath Chip Seals

- An economical way to incorporate a paving fabric membrane
- Adds tensile reinforcement to a traditionally unreinforced seal coat
- Makes an excellent seat to hold chip stone and minimize stone loss
- Stabilizes excess crack filling asphalt to keep it off the surface

Since there is no heat from an overlay we must presaturate the fabric by pushing it down into the asphalt tack coat.

Then, place chip seal by traditional methods.

# Chip Seal Over Petromat Installation

Install fabric over tack coat as in any paving fabric installation.


The installed paving fabric is then rolled with a rubber tired roller to push the fabric down into the tack asphalt.


If asphalt bleed through occurs, a light sanding application may be used to break the tackiness, to facilitate the rolling operation.

After rolling, the fabric is saturated with the tack asphalt and looks similar to the original road surface.

Now, a traditional chip seal surface treatment may be placed. If the paving fabric is not quite presaturated completely, the emulsion application may be slightly increased to compensate.

Normal chip sealing operation bring applied over a paving fabric.

Sometimes a double chip application is used with larger stone followed by an application of smaller stone, particularly when a pavement is created through bituminous surface treatment layering.


Typical performance where the same chip seal treatment was applied on both lanes. The lane on the right, with fabric, holds the stone better and covers old, excessive crack filling

Again, using the same original stone application, the foreground, without the paving fabric has lost more stone and the cracking has readily opened back up. Dramatic differences may been seen within just a couple of years.


With fabric
Without

Prudent engineering would say it would be best not to recycle through the paving fabric membrane, since the owner has already paid for this beneficial interlayer.  Therefore, it is preferable to stop the milling at least ½ inch over the paving fabric. However, if necessary, a properly installed paving fabric interlayer may be recycled along with the pavement.

If recycling is necessary, use a rotary milling machine. The targeted depth should be at least ½ inch below the interlayer to make sure the operation is not moving in and out of the interlayer.


The milling will typically result in small pieces of asphalt saturated paving fabric which may be successfully run through a hot recycling operation or may be remixed with a cold mix.

# Paving Mats

These are very thin synthetic interlayers that are installed like a paving fabric, but they do not hold more than about 0.10 gal/sq yd. This low amount of tack cannot be sprayed evenly and without skips, so they are not as effective as moisture barriers. The claim of these mats is that because they are made of mostly brittle fiberglass, they are more easily recycled. Unfortunately they often do not even survive installation.

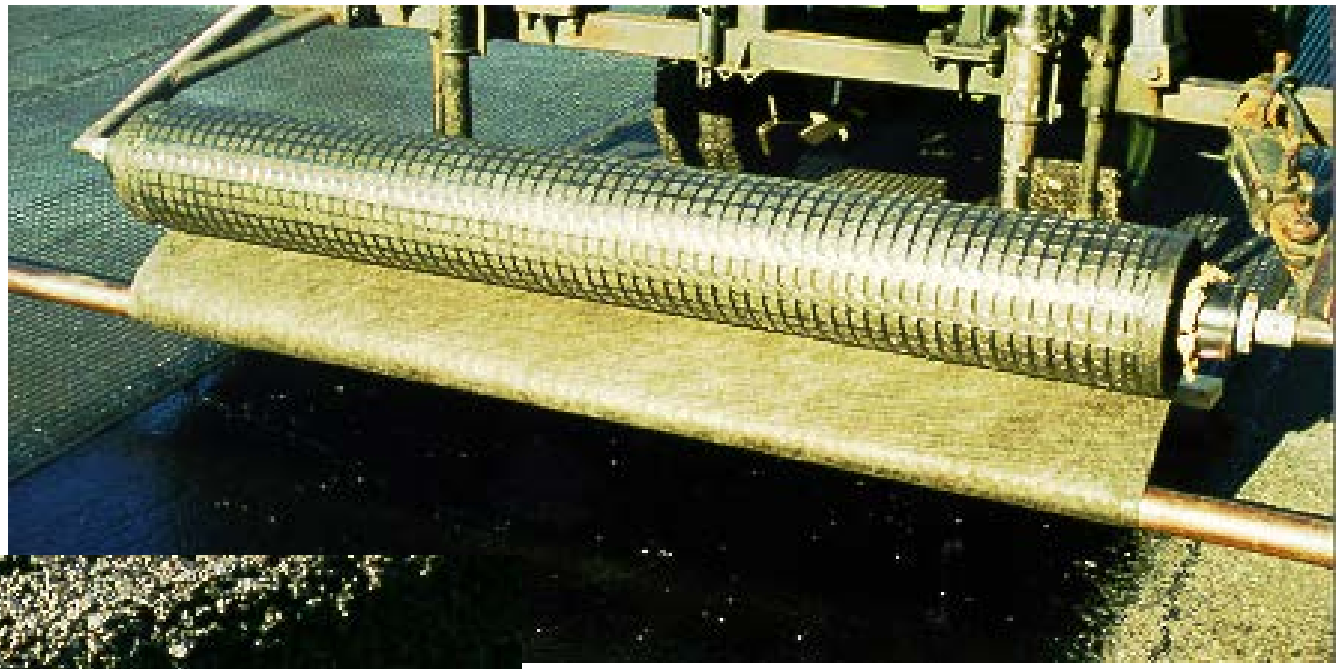
# Fiberglass Paving Mats


Paving mats are mostly fiberglass. A weaker product, but it recycles easily. Wear safety gear.


2 times the cost of the Petromat system—but no better performance

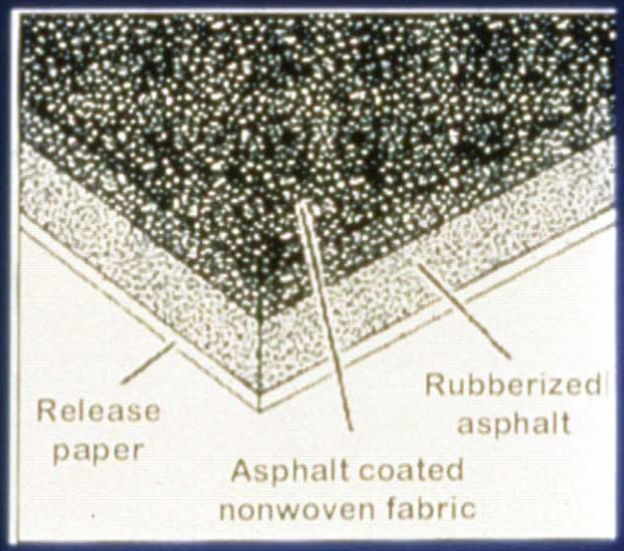
TruPave, GlasPave

# Fiberglass Grids and Grid Composites



# Strip Membrane (peel and stick type)

- A stress-absorbing membrane interlayer




Petrotac

Petrotac comes in boxes. It is best to store the material where it will be dry and at moderate temperatures.

The surface must be clean and completely dry and cracks over 3/8 inch should be filled prior to membrane placement.

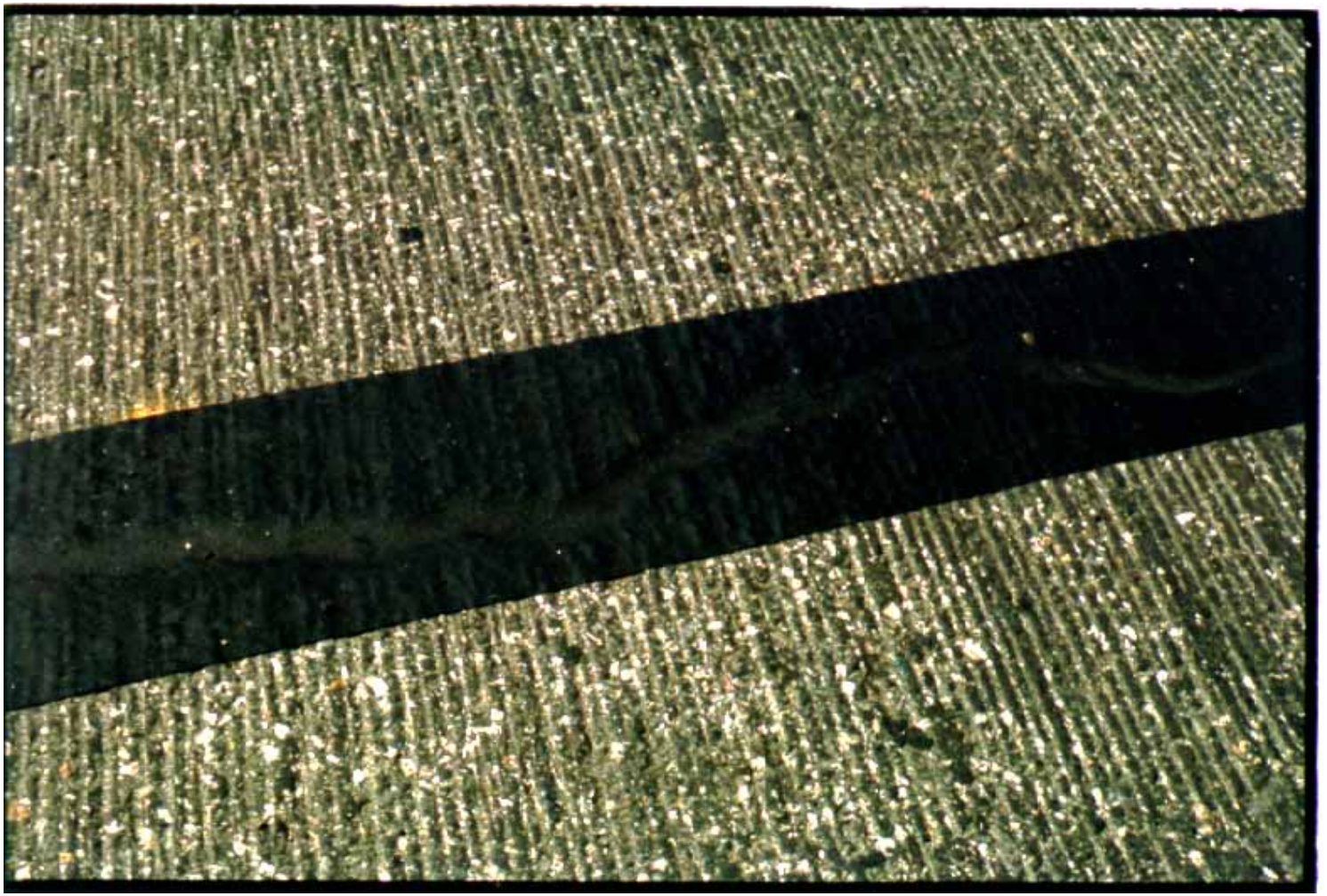
With the pavement dry and greater than 70 degrees F, the Petrotac may be applied directly onto the pavement anomaly, such as over joints, cracks and alligatored areas.


When the temperature is cooler, a primer is required.  Primers are listed in the installation manual at propexglobal.com

Interstate highway joints treated with strip membrane

All joints treated on Boeing Field, Seattle, Washington

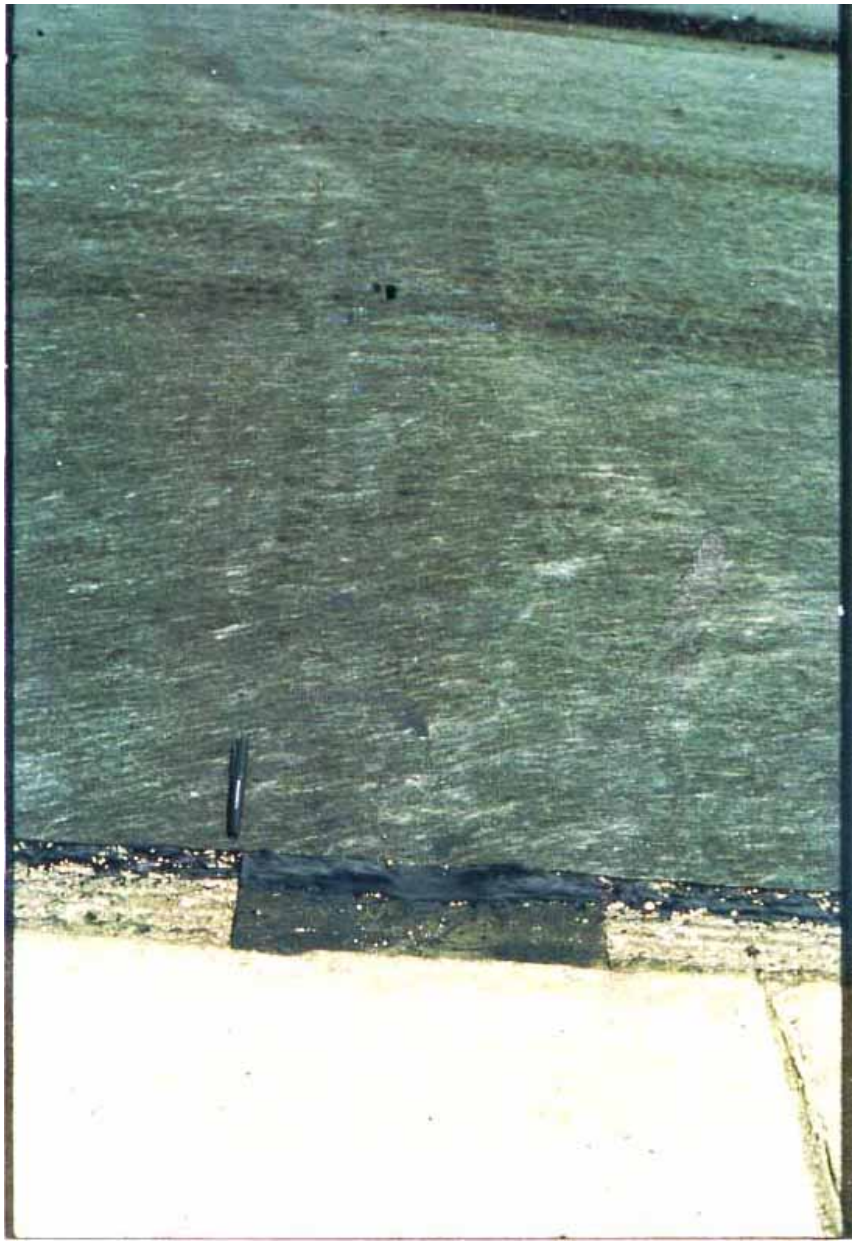
Before overlaying, a normal pre-hot mix tack is applied to the pavement and over the membrane.



Petrotac may be applied to a milled surface, with good rolling for adhesion.


The strip membrane may be used redundantly with a full width paving fabric for extra stress absorption over the crack or joint.

Paving fabric installed over the strip membrane



A common practice for treating a pothole is to properly clean and fill the hole then apply a surface patch of the Petrotac membrane to hold the repair in place to avoid repeated repair.

Large or spalled joints or cracks may be filled, compacted and then covered with an adhesive strip membrane.


36” wide Petrotac being applied over a wide joint that was filled.

When left exposed as a surface “band-aid” the membrane lasts a long time before is finally wears down and holds the pothole or large crack patch material in place.  Sanding will increase skid resistance if that is a concern due to traffic patterns and speeds.

Membrane being applied over a localized fatigue cracked area of a parking lot before placing the overlay.

Strip membrane placement around this utility repair.


Then, the final overlay placement.

Here, the crack treatment is placed by milling down to get the membrane treatment at least 3-4 inches down where it will be more effective.  This way, a thinner overlay, like 1.5 inches over a paving fabric will be a more cost effective solution.

The milled and strip membrane treated cut is filled and now a full width paving fabric and at least 1.5 inches of overlay are placed.  This has proven to be a very effective methodology.

When Petrotac is applied as a bridge deck waterproofing membrane, it is applied full coverage, overlapped like shingles up from the low point to the high point of the bridge deck.

A primer is always used on a bridge deck due to the typical presence of moisture in the deck.

A suggested list of Primers and Mastics and Installation Instructions may be obtained from the manufacturers of these products

This is a good way to guide the application of the Petrotac strip membrane.

A mastic is typically used along any potential areas for water penetration, such as along the wall of the bridge deck.

Recommended Primers and Mastics may be found in the Petrotac installation manual, found at www.propexglobal.com

# Unbonded Concrete Interlayer Geotextile

- Heavyweight nonwoven geotextile, black or new solar reflective white
- Used in new and rehabilitated rigid pavements

- Replaces traditional HMA interlayer

- Provides disbonding beneath the new PCC surface layer to decrease friction between the layers
- Absorbs stresses from crack movement below
- Improves the hydraulics of the pavement structure
- Can improve curing temperatures

- Used over existing PCC, AC, or composite pavements to “float” the new slabs over deteriorated pavement
- Used over cement or lime treated bases, as a separator/interlayer to prevent reflective shrinkage cracking

- **Asphalt Interlayers – HMA**
  - Preferable new, optimum HMA mix
  - Existing asphalt concrete layers in composite pavements often considered an interlayer, but may not be effective
  - Placement over a milled surface--too high friction
- **Geotextile Interlayers; 14-16 oz. Nonwovens**
  - There are two types of concrete interlayer geotextiles, the standard black version and a the innovative new highly reflective white version

# MN, MO, SD, OK, GA, Great Results, Saved $$$


GOMACO

## Cost

- Geotextile:$2.00-$3.00/yd.$^2$ Installed, anywhere
- HMA Interlayer: At least $5/sq.yd. greater cost

## Placement/Installation

- No asphalt on the project
- No need for multiple contractors or large equipment
- Geotextiles can be placed in more diverse weather conditions vs. HMA
- Much faster install rates; less prep, easy install
- Less traffic delay—greener construction—less carbon footprint



## Grade Control

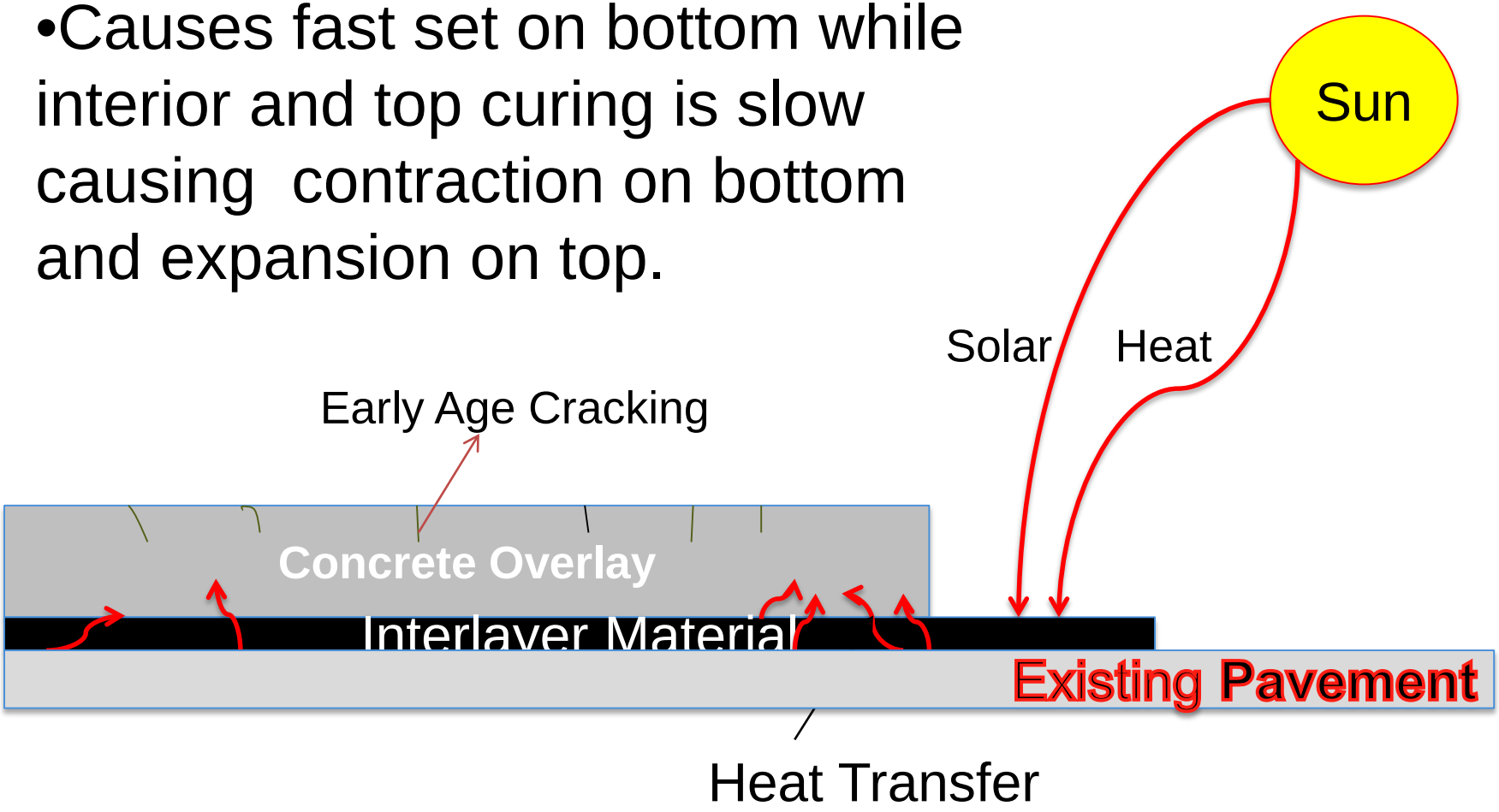
- <1/4” for Geotextile vs. >1-2” for HMA
- Lowers cost of grade adjustments

## Performance

- Geotextile allows true disbonding for lower friction between layers--increases allowable threshold for thermal expansion/contraction
- Stress absorption better than hard contact
- Higher lateral transmissivity to remove water from the pavement structure(U of MN research)
- PCC temperature control (New)

## Increased Heat Transfer

- Causes fast set on bottom while interior and top curing is slow causing contraction on bottom and expansion on top.



# A highly solar reflective geotextile-**Reflectex**

Development and testing involved three key players

- Propex, the manufacturer of the geotextile
- Transtec Group, Austin, TX
  - Dr. Robert Rasmussen (CEO) and Staff– Pioneers of using geotextiles as interlayers in unbonded concrete overlays
- Polymer Additive Development Specialists
  - Achieved optimum solar heat reflectance

## Reflectex Interlayer vs. Black Interlayers

- Reduces solar heat absorption—50+ degrees F demonstrated, does not bake in the heat
- Significantly reduces heat transfer to new concrete
- Can eliminate use of water for wetting interlayer
- Can allow daytime paving versus night
- Increases worker safety, reduces fatigue
- Reduces early age cracking in concrete by 8% to 10%
- Maintains temperature during cold weather paving conditions
- Less friction between existing pavement and concrete overlay (more efficient expansion and contraction)

- Overlap should be at least 6” to 8”
- Spray adhesive 18” swath along edges
- Hilti fasteners spaced  3’ to 6’ dependent on conditions
- Wetting of the fabric only in high wind situations

- Avoid sudden changes in acceleration
- Avoid sharp or sudden turns
- Wrinkles should be cut out and fixed before paving over

- Ensure braking is off and truck is in neutral before dumping
- Allows concrete placement equipment to move truck without damaging geotextile

- Allow room for overlap of geotextile between new pavement and shoulder

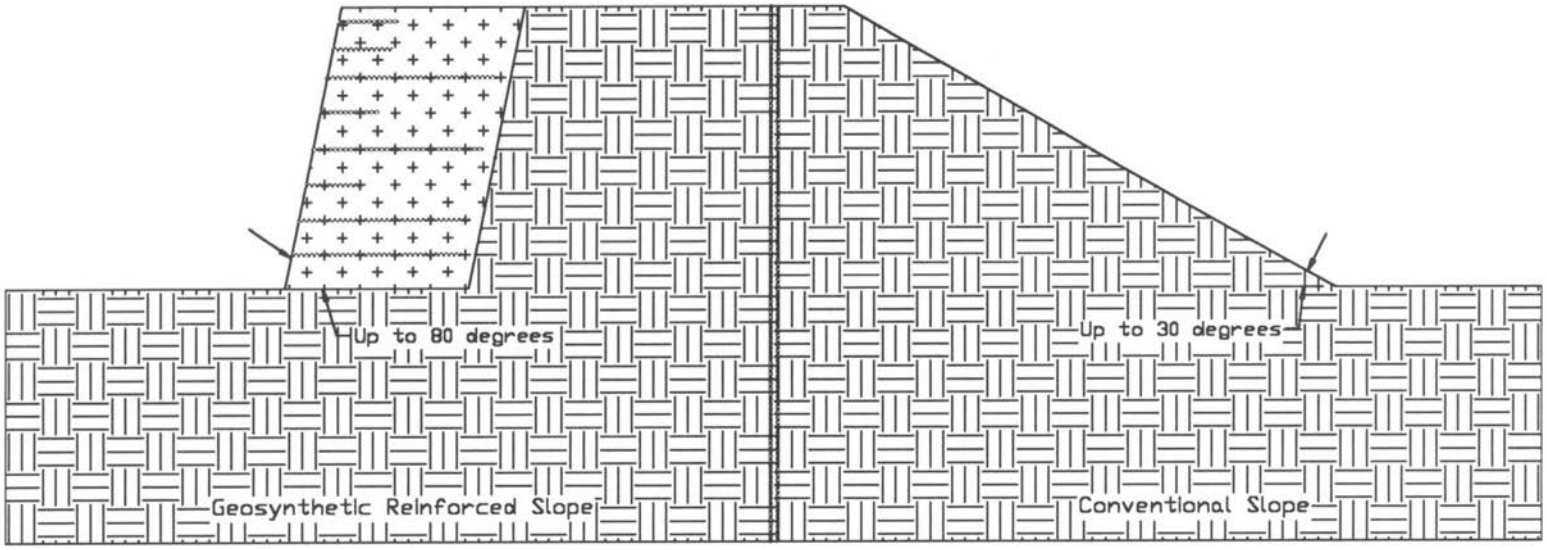
True disbonding is possible with the geotextile interlayer.

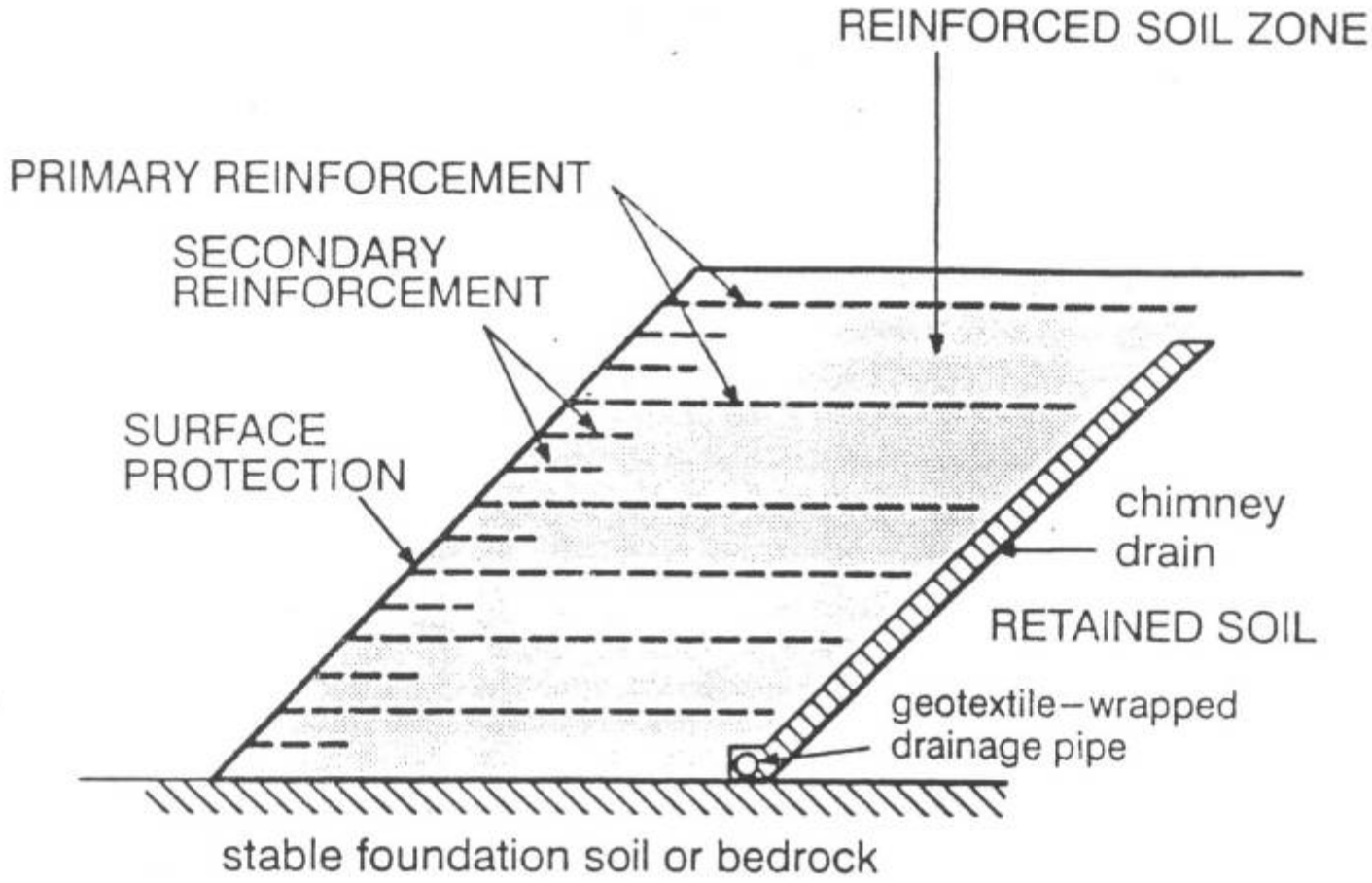
Note how fabric is only slightly penetrated and retains good lateral water flow capability.

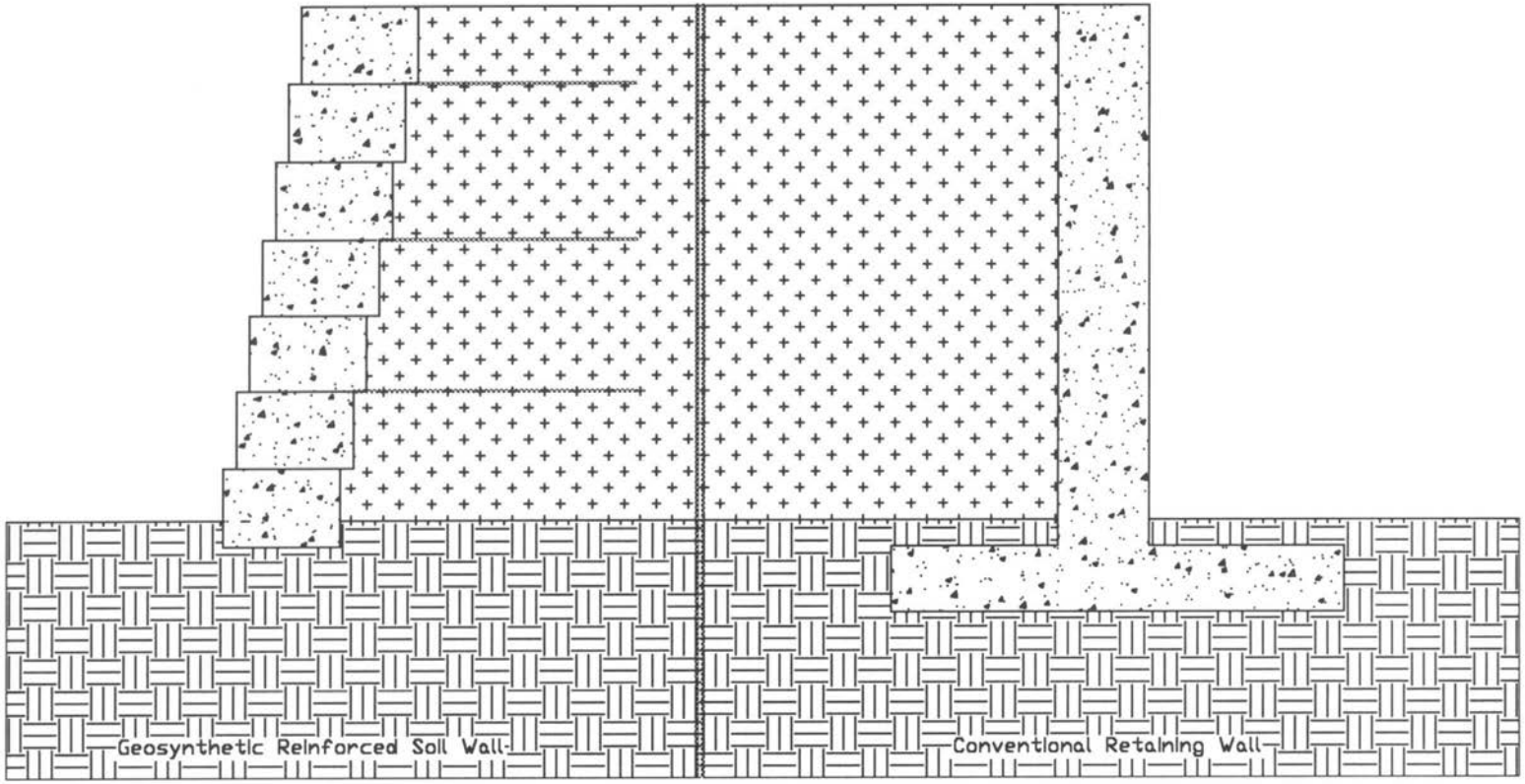
# Rigid Pavement Solutions

*Other PCC problems are shrinkage cracking , thin slab brittleness, and crack widening.*

The geosynthetic solution here is the addition of micro and macro fibers to address the different cracking problems. PCC cost is now more comparable with asphalt concrete so research is being done to push the limits of PCC slabs.


Up to 80 degrees
Up to 30 degrees
Geosynthetic Reinforced Slope
Conventional Slope


REINFORCED SOIL ZONE
PRIMARY REINFORCEMENT
SECONDARY REINFORCEMENT
SURFACE PROTECTION
chimney drain
RETAINED SOIL
geotextile–wrapped drainage pipe
stable foundation soil or bedrock

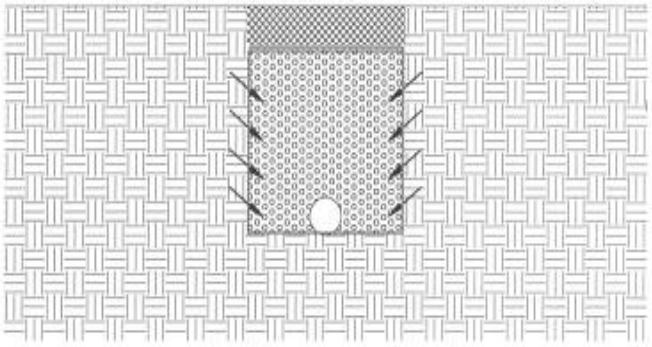

Geosynthetic Reinforced Soil Wall
Conventional Retaining Wall

More recent walls commonly use masonry block units.

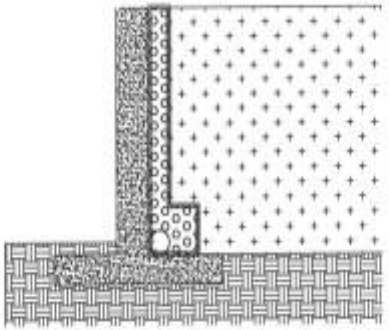
MSE walls have geosynthetic reinforcement layers.

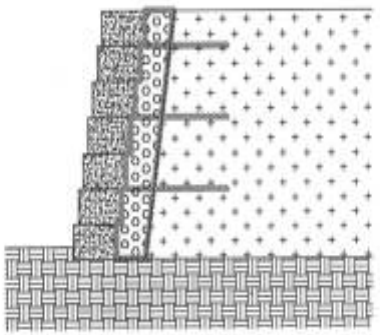
Backfill placed over reinforcement layer.

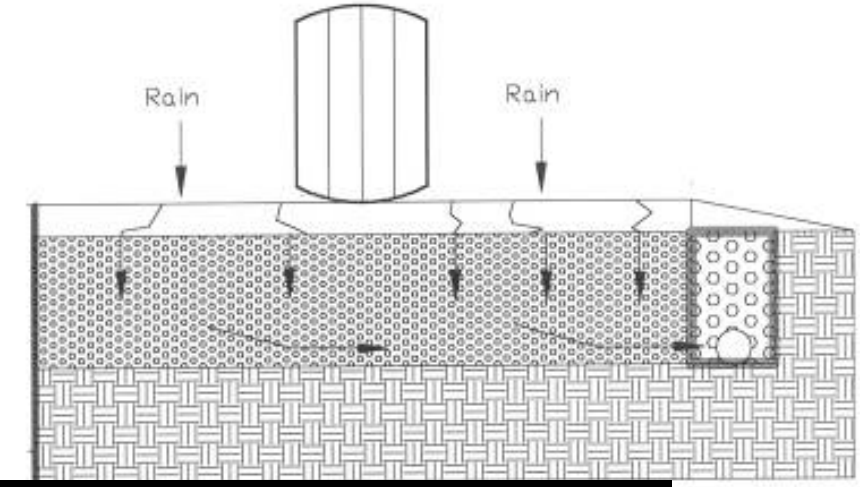
One of numerous, attractive block facing options.



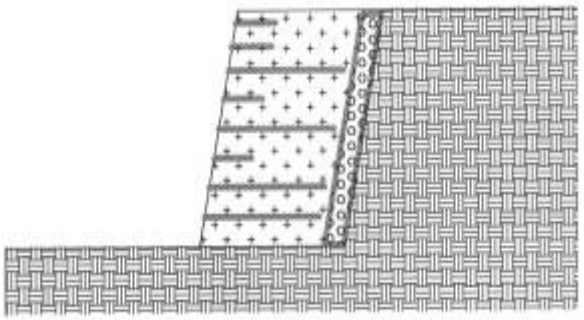
Subgrade Dewatering








Road Base Drainage



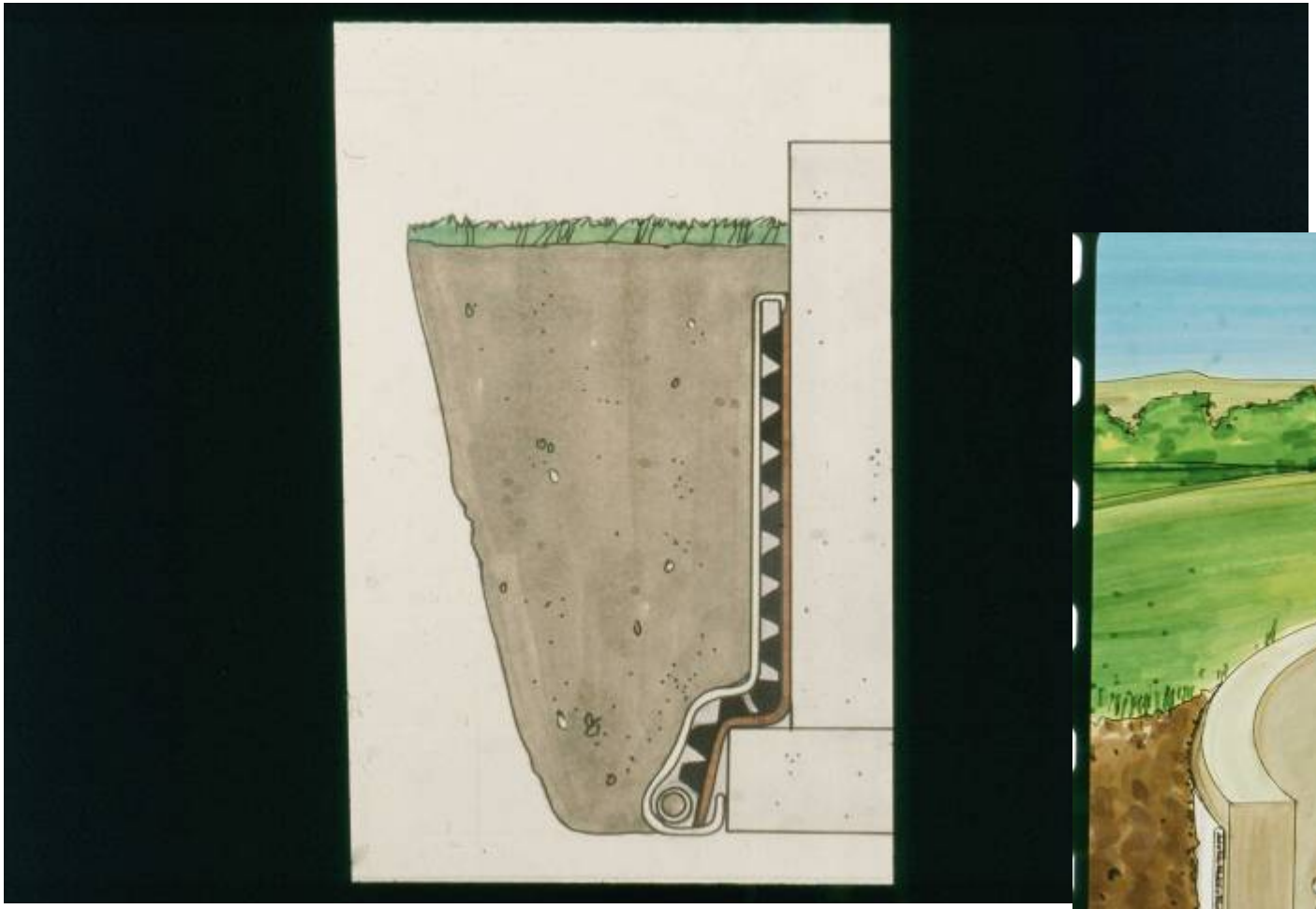
Structure Drainage

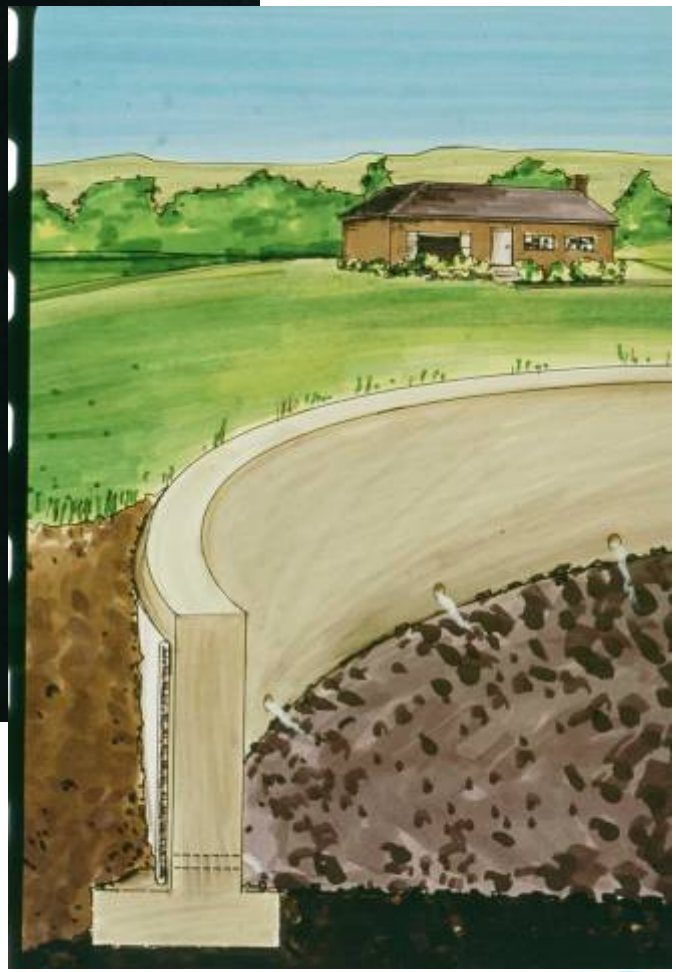
Trench is excavated

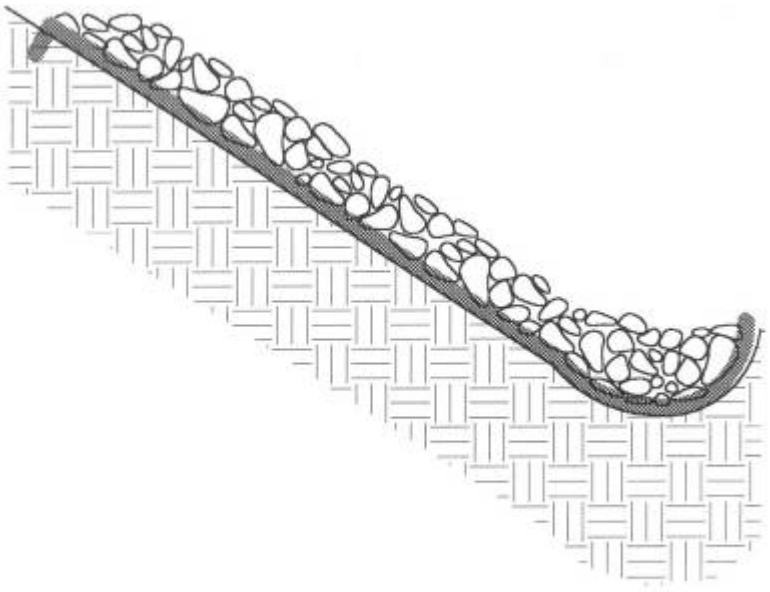
Geotextile filter installed

Placement of coarse aggregate and pipe

Completion of drain by wrapping the geotextile. Then backfill to grade

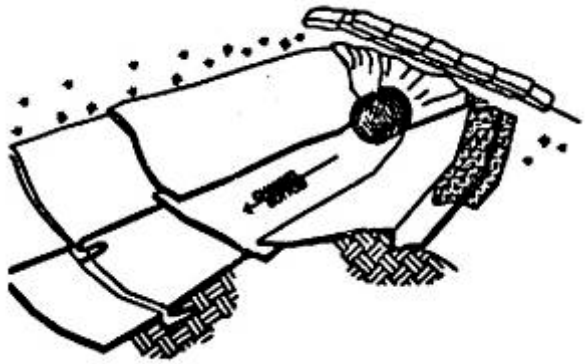




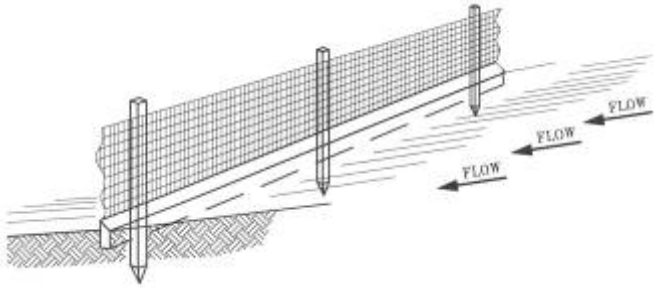


ARMOURED SLOPE

Hard Armor Systems

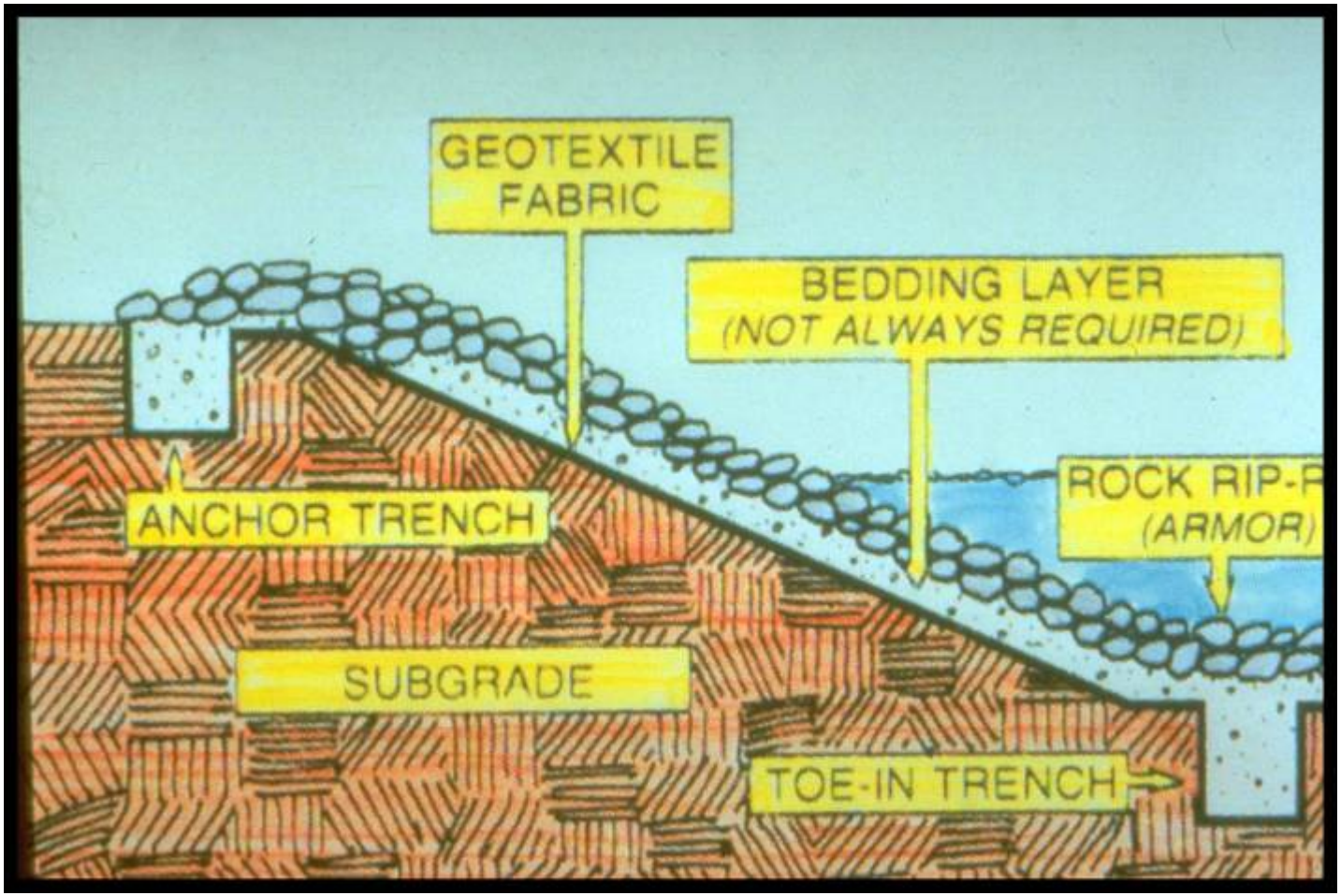


Rolled Erosion Control Products, RECPs



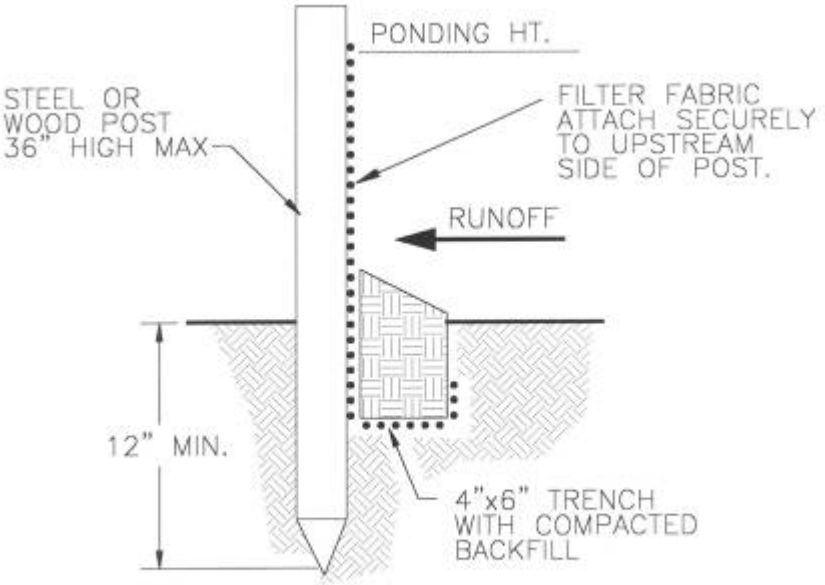

Silt Fence

An Undermined Hard Armor System




Riprap over a geotextile construction

Turf Reinforcement Mats


SILT FENCE DETAIL

Turbidity Curtain

## Specification Criteria:

- Construction Survivability
- In-Service Performance

FHWA FP-03

(www.wfl.fha.dot.gov/design/specs/fp03)

or

AASHTO M288

# Obstacles To Geosynthetics Adoption

--Much of the research is dated—fully vetted and then expected to be adopted
--Not enough curriculum on geosynthetics in Universities
--Transportation agencies do a poor job of maintaining records of successful trials and reporting on results
--Engineering is a profession that resists change
--Transportation Engineers are the most conservative, and have little time for exploration of better solutions
--No reward for innovation and cost saving
--Falsely perceived risk—**there is no down side to separation/stabilization geotextiles**
--Contractor push back—they would rather sell and waste more traditional materials—over and over again!

# Geosynthetic Solutions Conclusion

--Geosynthetics are the most cost effective tools for implementation in pavements
--Geosynthetics replace expensive and diminishing natural resources
--Geosynthetics are the most “Green” and “Sustainable” construction materials
--The is no down-side risk for most applications
--All the pieces are in place for adoption, like AASHTO M 288 guideline specifications
--Transportation budgets can no longer ignore the cost savings—up front and life cycle savings
--Perpetual pavements and sustainability must maintain a lasting foundation—future safety improvements
--Geosynthetics are very versatile and solve a large variety of transportation problems

Propex GEOSOLUTIONS

# Questions!?