



# Spray Applied Polymer Surface Seals

SEPPP Meeting – May 2008  
Gayle & Helen King



# Study Participants – Acknowledgements

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- FHWA Office of Construction & Pavement Preservation - Sorenson**
  - Foundation for Pavement Preservation (FP2) - Eller**
  -
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# Industry Participants

## Acknowledgements

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### **Tricor Refining**

- Reclamite; ERA-1;  
ERA-25

### **Western Emulsions**

- Pass QB

### **Blacklidge Emulsions**

- LD-7

### **Asphalt Supply**

- GSB-Modified

### **SemMaterials/Koch**

- CSS-1

### **Flint Hills Refining**

- CRS-2Pd

### **Paramount Refining**

- CSS-1
-



# Research Participants

## Acknowledgements

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- **Western Research Institute**
    - Binder extraction/ chemical & rheological tests
  - **North Central Superpave Center**
    - Friction/permeability
  - **Mathy Technology & Engineering**
    - Dynamic shear rheometer – torsion
  - **University of Minnesota**
    - Bending beam rheometry on thin mix
  - **University of Texas at El Paso**
    - Portable Seismic Pavement Analyzer
  - **Akzo Nobel**
    - Emulsion surface tension & particle size tests
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# Fog Seal

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- **AEMA Definition:** a light spray application of dilute asphalt emulsion used primarily to seal an existing asphalt surface to reduce raveling and enrich dry and weathered surfaces
  - **FHWA Definition:** the light application of diluted, slow setting asphalt emulsion without aggregate cover. The purpose of fog seals are to seal the pavement, inhibit raveling, and enrich hardened/oxidized asphalt.
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# Fog Seal

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- ❑ **CALTRANS Maintenance Technical Advisory Guide:** a method of adding asphalt to an existing pavement surface to improve sealing or waterproofing, prevent further stone loss by holding aggregate in place, or simply improve the surface appearance. However, inappropriate use can result in slick pavements and tracking of excess material.
-

CALTRANS MTAG:

## **Rejuvenating Fog Seal**

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- Rejuvenating emulsions contain oils which soften an age-embrittled binder.**
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# An Effective Preservation Program

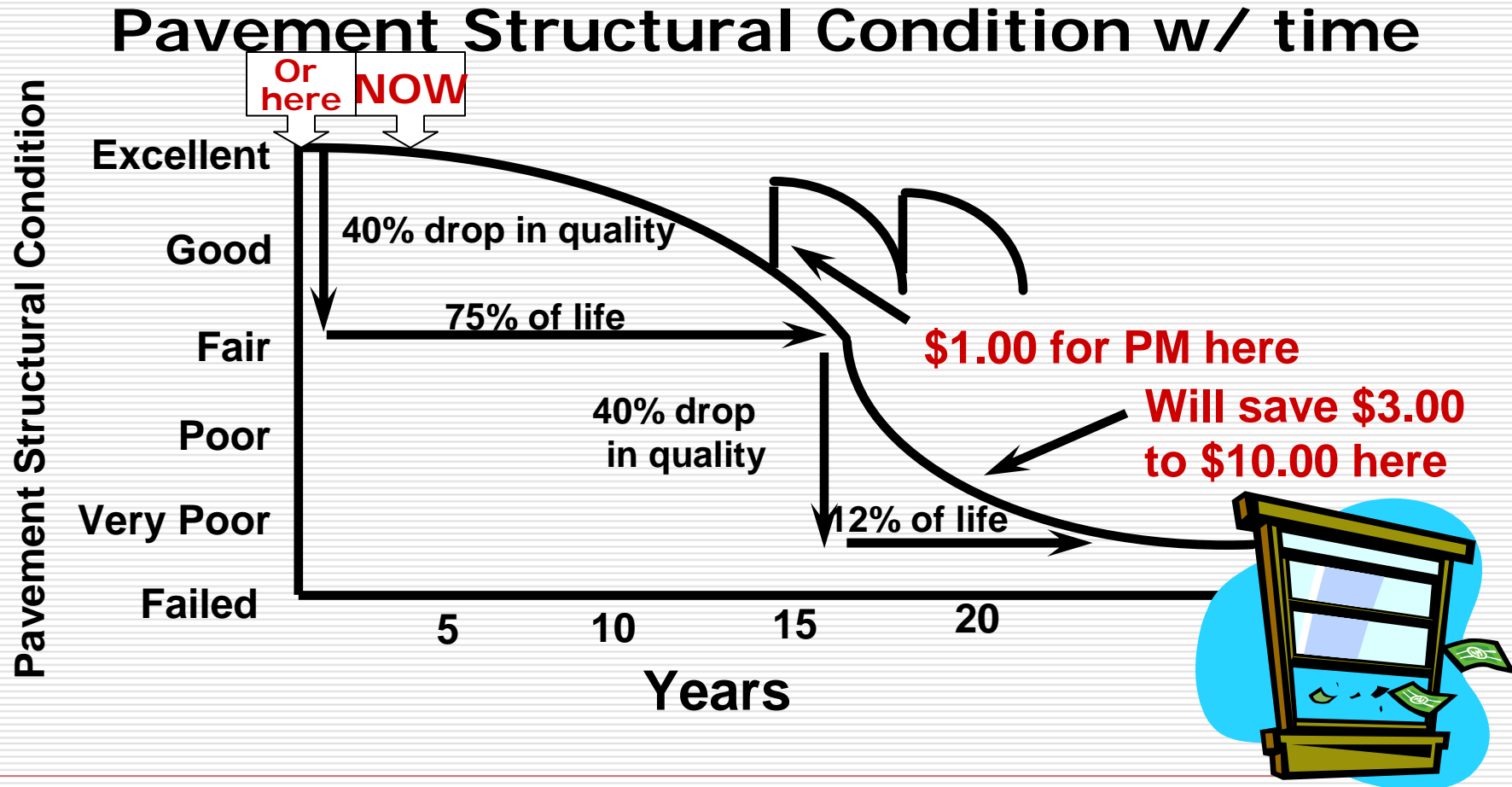
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- Cost effectively extends pavement life**
  - Minimizes extensive rehabilitation & resulting traffic congestion**
  - Improves ride quality & safety**
    - Provides smoother, high friction surfaces**
-





# Pavement Preservation Benefits of Preventive Maintenance





Spray Applied Surface Seal :

# Study Objectives

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- **Evaluate Effectiveness and Safety**
    - Sealers
    - Rejuvenators
  
  - **Optimize Timing Of Applications**
    - *Right Place, Right Time, Right Application*
    - Evaluate lab methods as potential “triggers” for timing strategies
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# Spray Applied Surface Seal :

## The Project

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### □ **Information gathering**

- Government/industry/academia expert task group advisory meetings
- State DOT survey
- Literature search
- Two national workshops

### □ **Field projects & lab testing**

- Apply fog seals on different pavement types
- Monitor performance vs. timing of applications
- Evaluate safety concerns
- Develop performance-related test methods

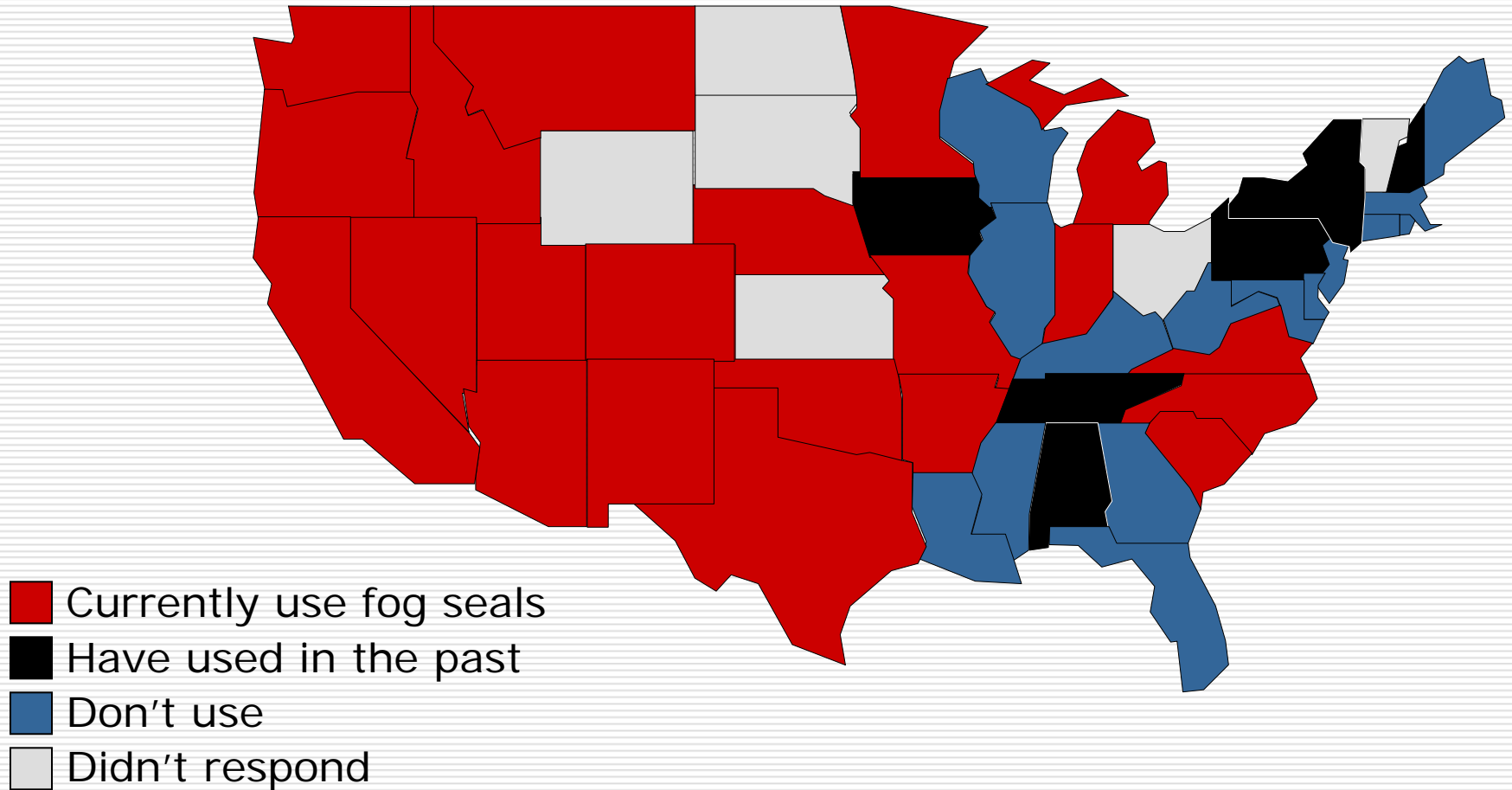
### □ **Technology Transfer – “lessons learned”**

- Workshops, CD, website (hosted by FPP), [www.pavementpreservation.org/fogseals/](http://www.pavementpreservation.org/fogseals/)
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# 1. DOT Survey

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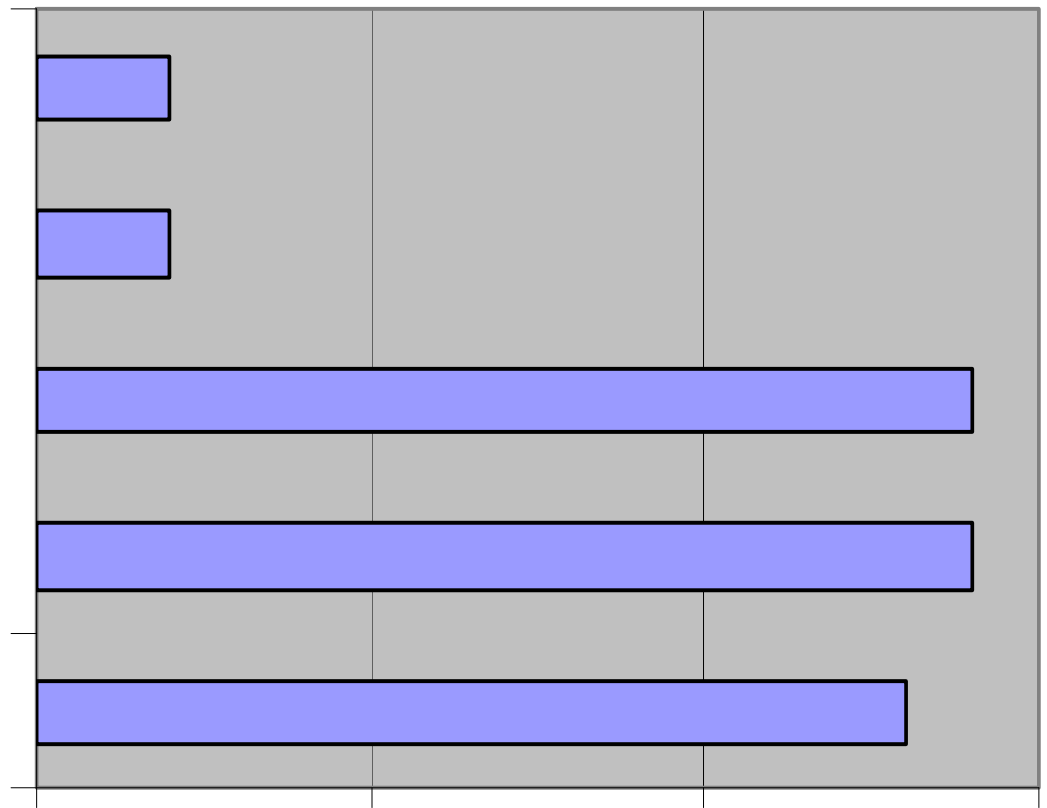




# DOT Survey

## Surface Types That Are Fog Sealed

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# Upper Midwest Experiences

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## **Minnesota**

- Sealing most chip seals and shoulders

## **Nebraska**

- 600 miles planned for '07
- Fog sealing lower volume roadways

## **South Dakota**

- 280 miles: mainly fog seal on new chip seals

## **North Dakota**

- 235 miles of fog seal on new chip seals
- 35 miles of fog seal on new HBP pavements

## **Iowa**

- 222 miles of Interstate shoulder fog sealing



MN - Why Fog Seal A Chip Seal?





# MNDOT Sealing Shoulders with CRS-2P(d)



# MN shoulders: Shedding Light Rain

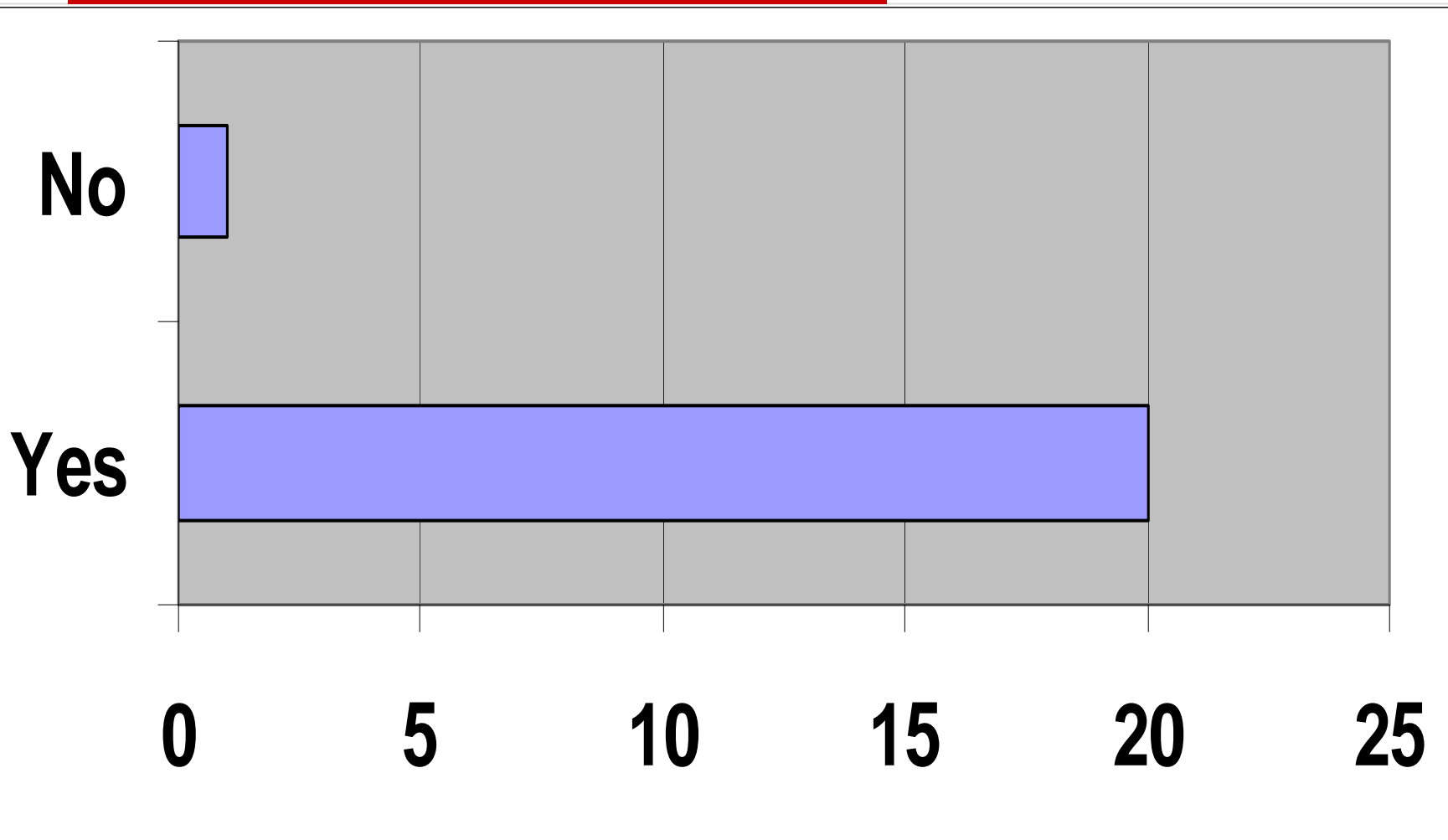




# DOT Survey

## Are Fog Seals Cost Effective?

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# What do we know about Fog Seals?

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- ❑ **Low cost preventive maintenance**
    - 13 cents to \$1.60 per square yard
  - ❑ **Fog seal**
    - Emulsion with a hard residue meant to bind or seal
  - ❑ **Rejuvenating fog seal**
    - Light application of dilute oil or oil/asphalt emulsion
    - Alter rheology of oxidized asphalt near the surface
  - ❑ **Emulsion must infiltrate a dense HMA surface to reduce moisture intrusion or rejuvenate aged asphalt.**
-

# How Do We Do It?

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## □ Spray Applied Emulsified Surface Applications

- Seal & Bind
  - Dense
  - OGFC
  - AC-Rubber
  - Chip Seal
- Restore AC

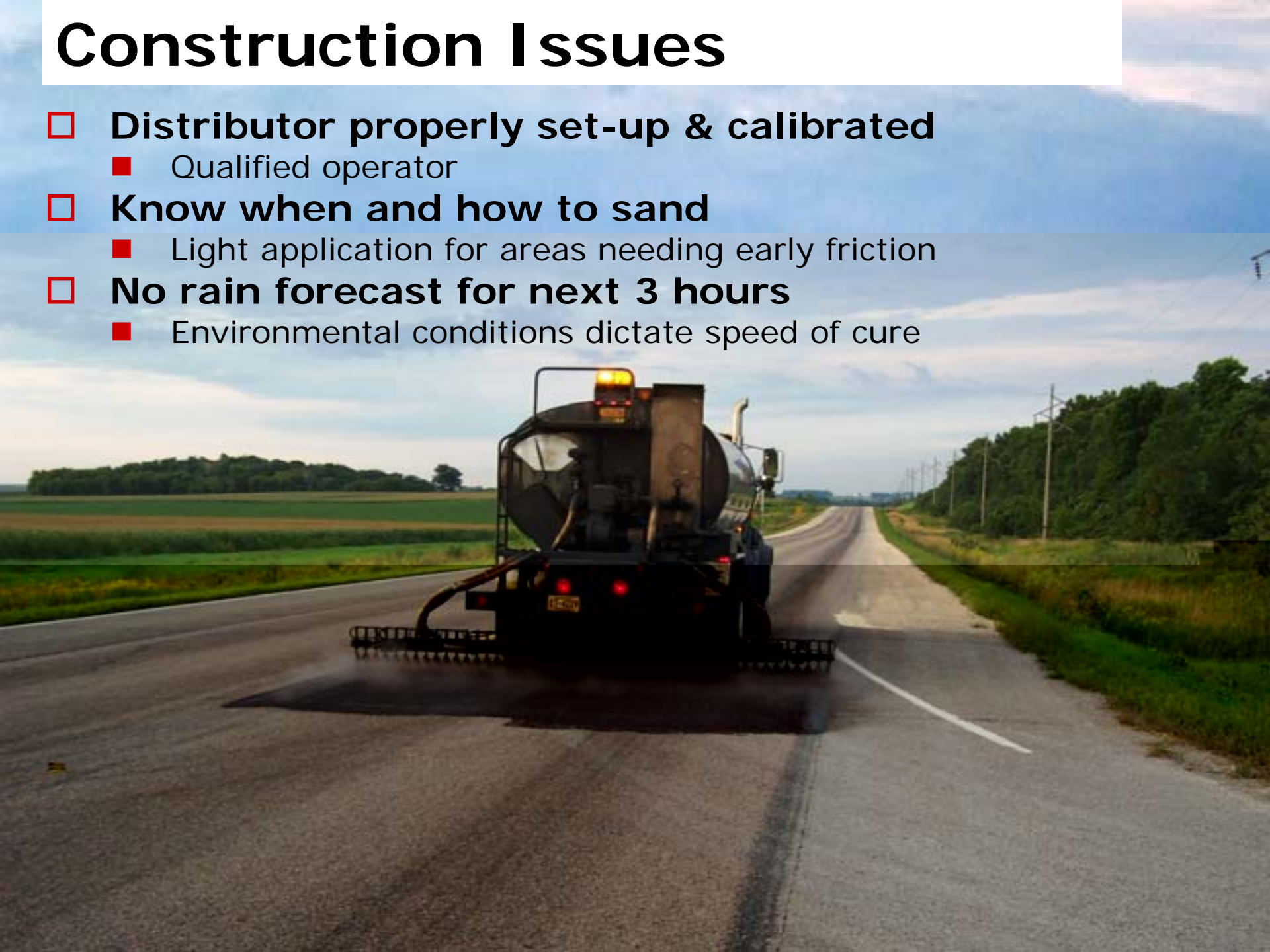
NOT  
Rocket Science!





# Construction Issues

- ❑ **Distributor properly set-up & calibrated**
  - Qualified operator
- ❑ **Know when and how to sand**
  - Light application for areas needing early friction
- ❑ **No rain forecast for next 3 hours**
  - Environmental conditions dictate speed of cure



# How to Apply Seals

## Caltrans MTAG Guidelines

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### Distributor: well calibrated

- Correct nozzles, angle, no clogs
- Spray bar height, pattern, speed
- Correct width; preserve stripping?

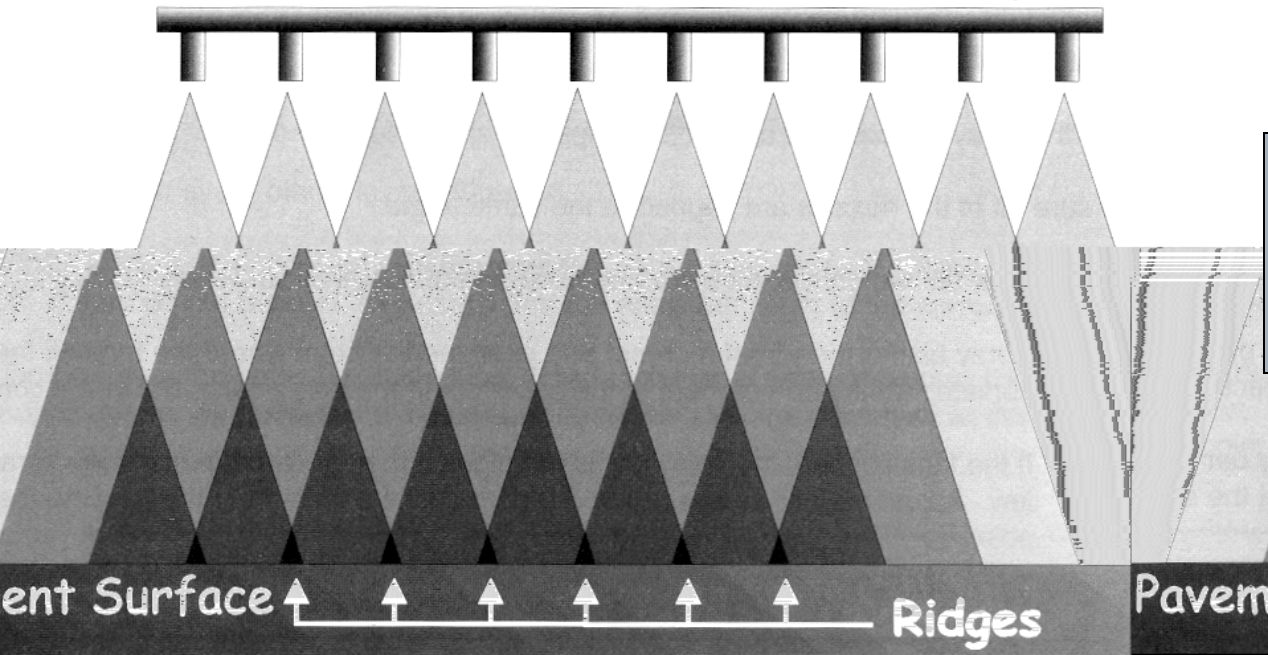
### Application rates: depend on surface & product

- Even, full coverage to protect
  - No excess material to track, cause skid problems
  - Experience, supplier recommendations
  - Test strip recommended
- 





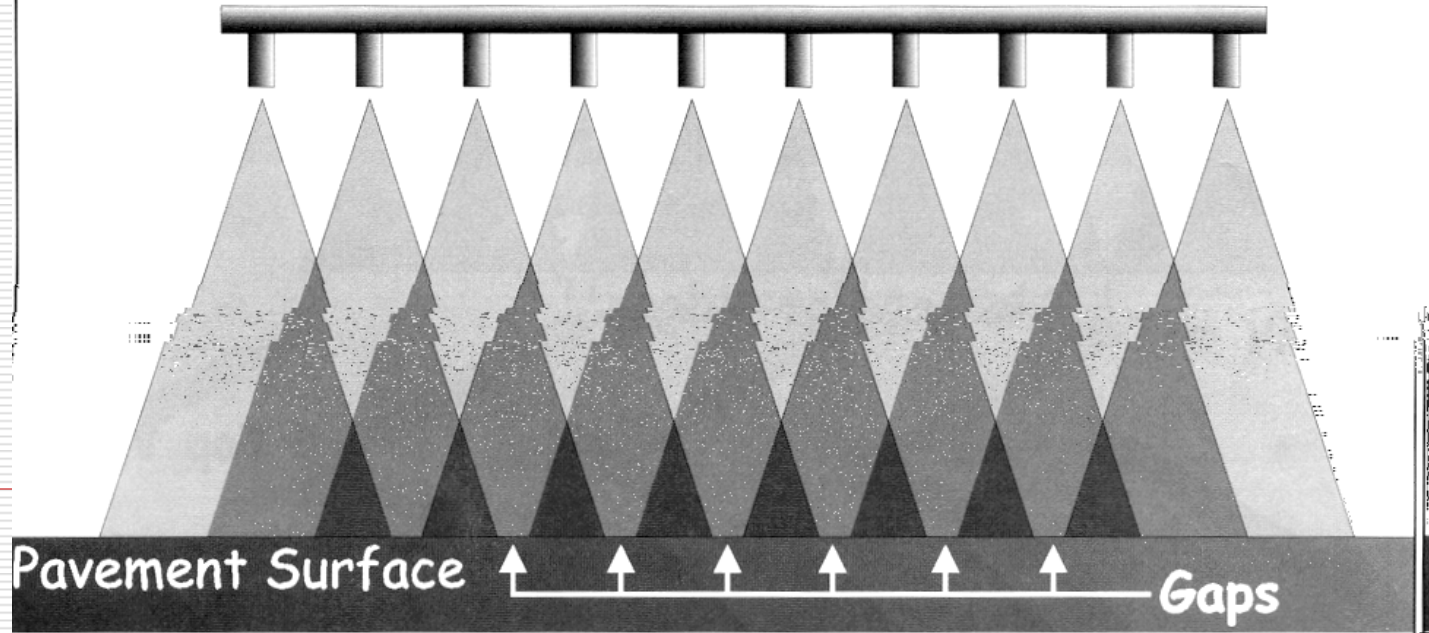
# Spray Bar Too High = Streaking



Tricks of the Trade

**The mystery of the triple overlap!**

# Spray Bar Too Low = Streaking



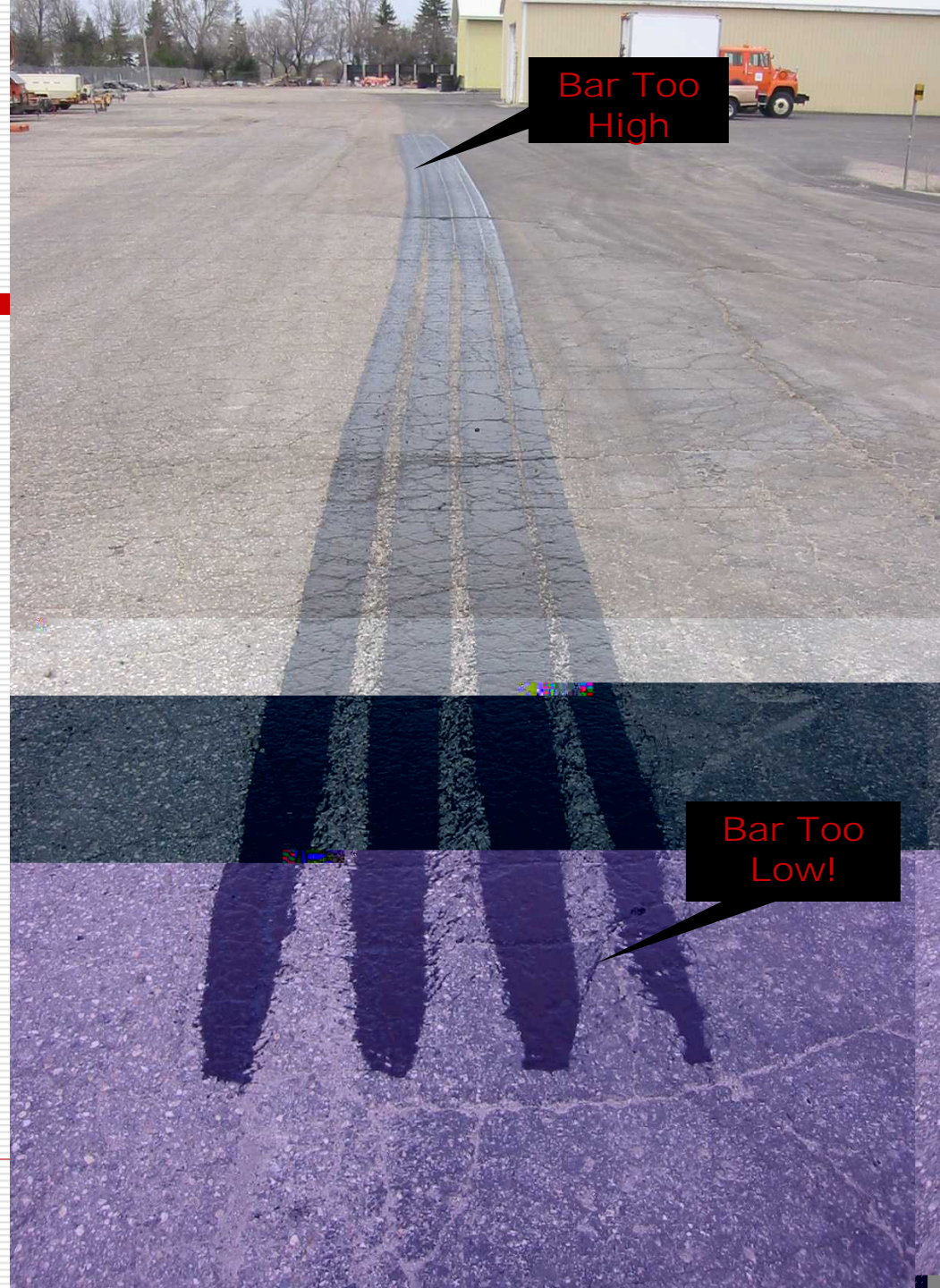
Tricks of the Trade

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# Setting Proper Bar Height

Open Every Third Nozzle  
Set Speed & Bar Pressure  
Gradually Elevate Bar

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# Fog Seal Products

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## **Sealer emulsions**

- SS/CSS; CSS-1hP; Ralumac®
- QS/CQS: LD-7®
- RS/CRS; CRS-2Pd, HFE-100S
- Gilsonite-based: GSB®-Modified



## **Rejuvenator emulsions**

- Oils: ETR-1; ARA-1; Reclamite®
- AC/Oil: Cyclogen®; ERA®



## **Hybrids**

- PMAC/Oil: Pass QB®
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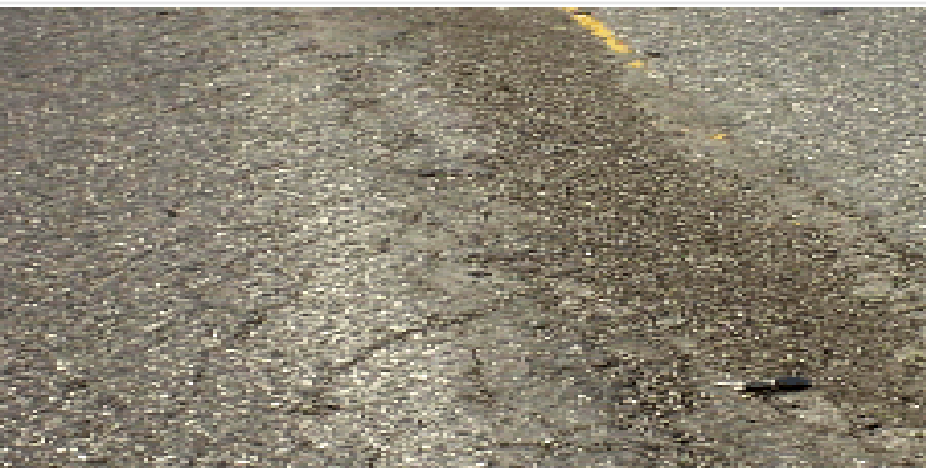
# Test Section Locations

- ❑ **AZ - US 87, Winslow (2001 & 2006)**
  - 3 Surfaces (dense, rubber, chip seal), 18 test sections
- ❑ **CA - 78, Salton Sea (2001)**
  - Asphalt rubber surface, 5 sections
- ❑ **CA - I-5, Marysville (2002)**
  - Dense-graded surface, 6 sections
- ❑ **MI - M-35, Perkins, MI (2002)**
  - Site abandoned – problems with field application rate
- ❑ **MN - 251, Maple Island (2002, 2004, 2006)**
  - Dense-graded surface, 8 sections
- ❑ **MN - County Rte 112, Rochester (2006)**
  - Newly constructed pavement
  - Coarse Superpave surface, 8 sections
  - Sanding study; evaluate early friction
  - New trial with WRI study: Fall '06

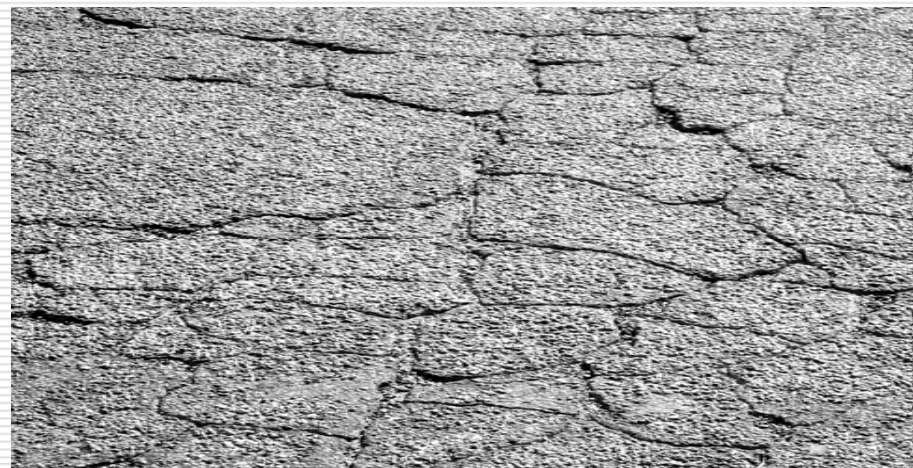
# Why Fog?

## Prevent Damage from Asphalt Aging

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**Raveling**



**Block Cracking**



# Why Fog? Improve Aggregate Retention for Chip Seals

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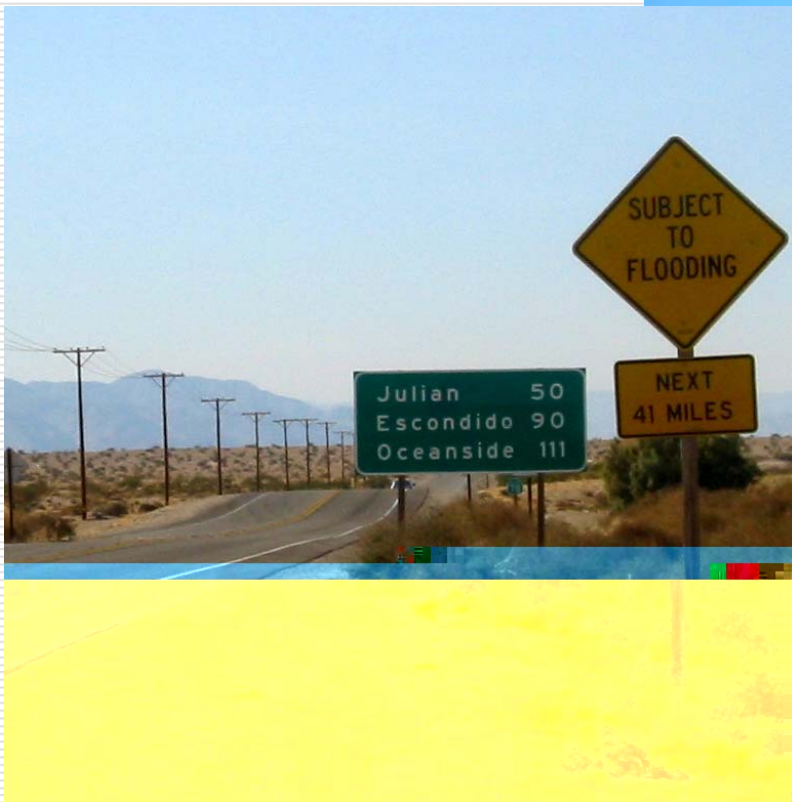
Arizona Highway 87 – four yrs after fogging



# Why Fog?

## CA 78 – Salton Sea

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4-yrs after  
application

# Control – 4 yrs later

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# SS-1h – 4 yrs later

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# CQS-1h – 4 yrs later

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# Pass QB – 4 yrs later

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# Reclamite – 4 yrs later

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City of Cleveland  
Reclamite® Evaluation  
1977/1987

West 110th Street

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Left half  
treated with  
Reclamite®



City of Cleveland  
- 110<sup>th</sup> Street

**Treated**

**After five years**

**Untreated**





City of Cleveland

West 110th Street

**Treated**

**After ten years  
Untreated**



# Spray Applied Binder Study

## Testing Protocols

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### □ Pavement Field Testing

- Distress evaluation
- Permeability/infiltration testing
- Friction & texture measurement
- Non-destructive testing for assessing when to apply treatments

### □ Laboratory Testing

- Extracted binder chemical/rheological tests
  - Mixture tests on thin specimens (DSR, BBR)
  - Emulsion properties
  - Permeability
-

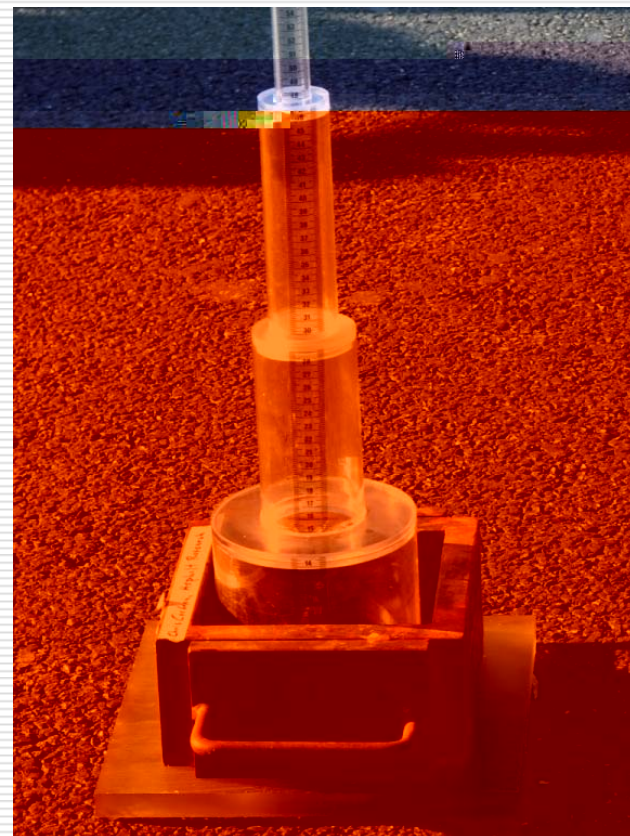


# Fog Seal Pavement Permeability



## ❑ NCAT Device

*Impossible to seal device on  
open-graded surface*



Fog Seal

# Emulsion Infiltration Test

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□ **Ring Test** – *a bit subjective, but useful*

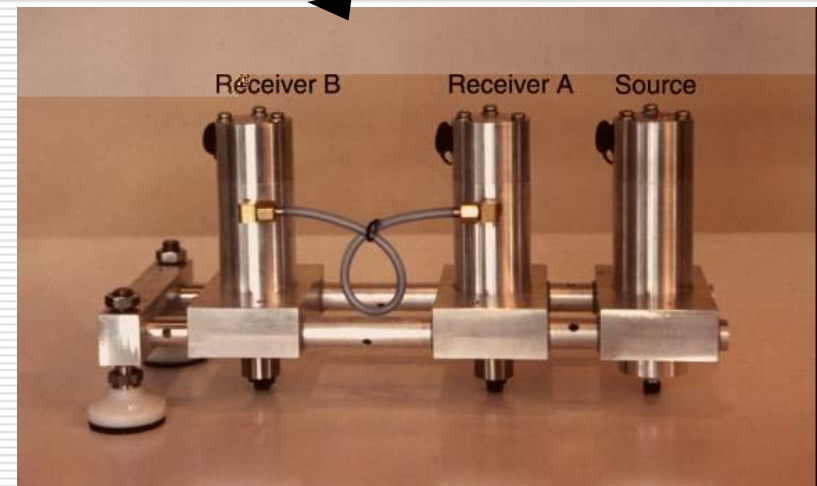


# Fog Seal Surface Modulus

- ❑ Spectral Wave Analysis with Portable Seismic Pavement Analyzer (PSPA)

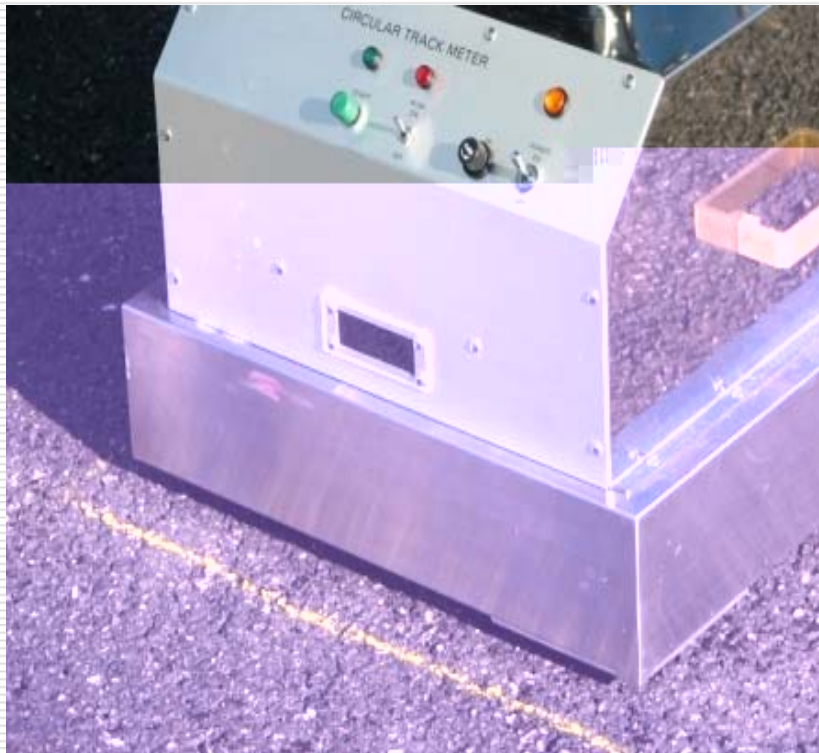
*Results showed instrument not sensitive enough to detect differences in top 0.3" of pavement*

*Testing by UTEP*



# Fog Seal Pavement Friction

## ❑ Circular Texture Meter ASTM E-2157



*Portable, easy-to-use, repeatable*

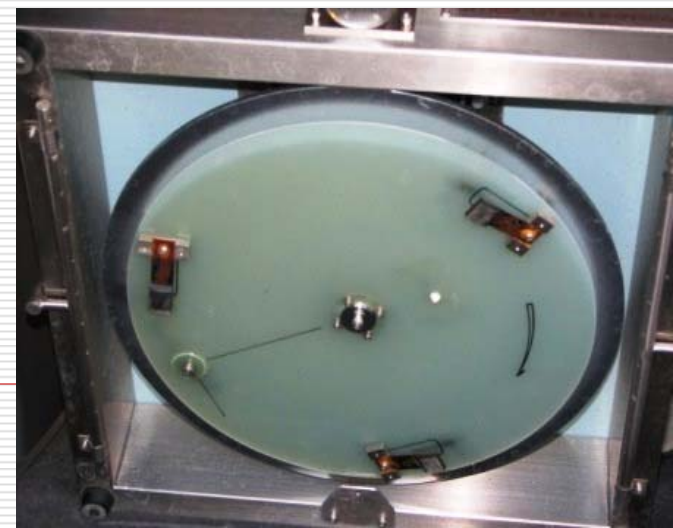
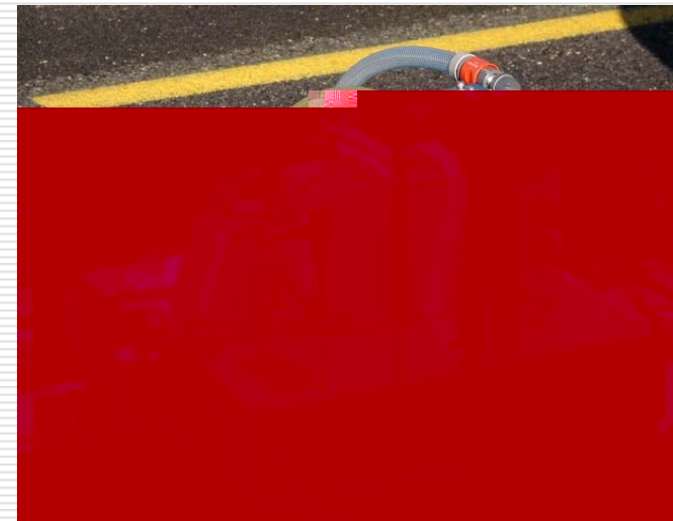
# Fog Seal Friction & Texture Testing

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## Dynamic Friction Test ASTM E-1911

- Calculate IFI
  - Friction & Texture
  - Reasonable correlation with skid trailers
- Good Repeatability
  - 3 replicates OK

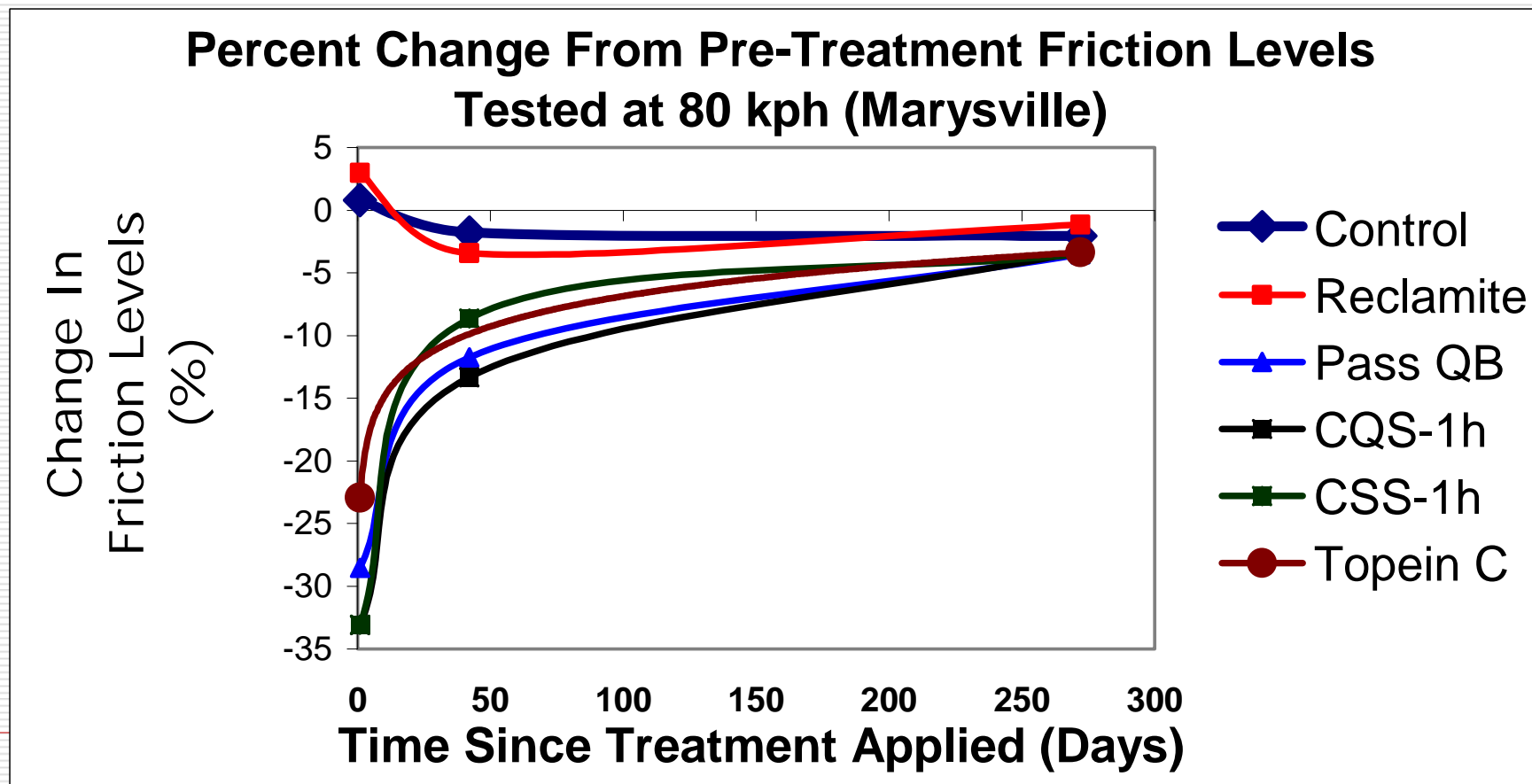


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*Portable, easy-to-use*

# Fog Seal on Dense Surfaces Effect on Skid Resistance

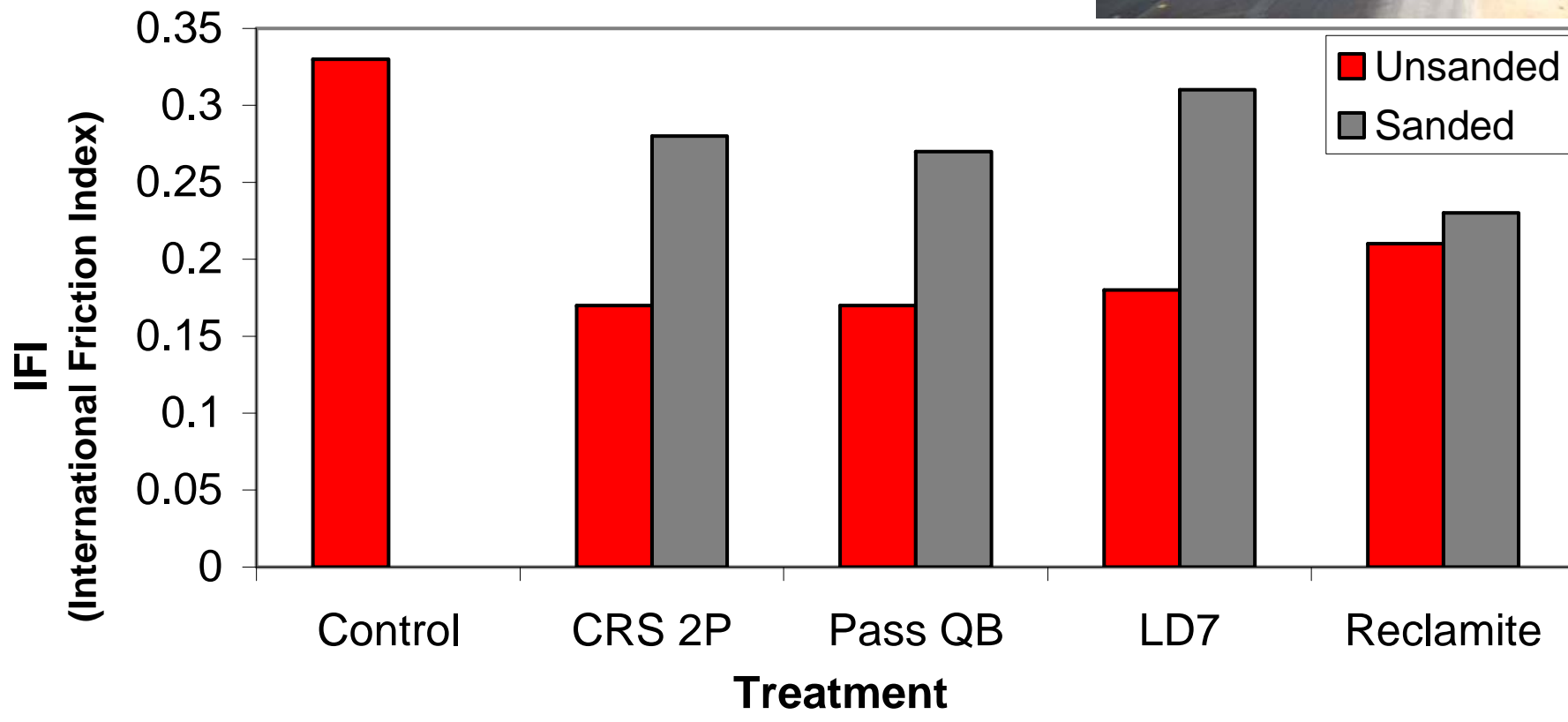
Friction initially reduced, but returns to original level with time



# Friction of Newly Treated MN TR 112 With & Without Sand



*Sanding increases friction*



*From Dynamic Friction Tester/ Circular Texture Meter immediately after application and curing.  
Tested by North Central Superpave Center*



# Fog Seal

## Lab Test Methods

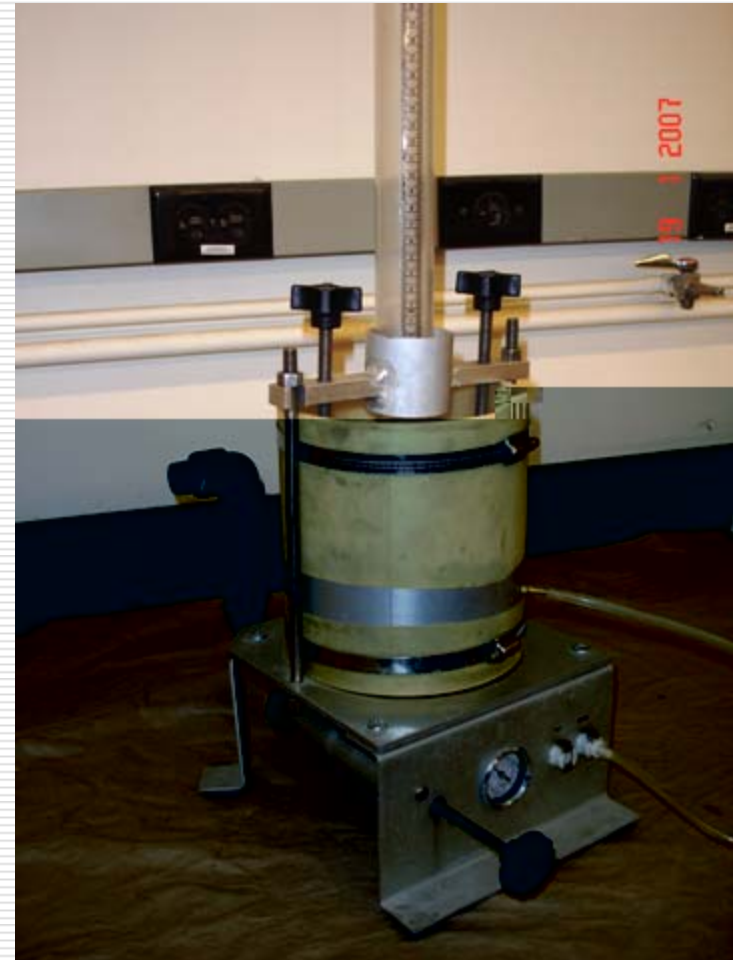
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- ❑ **Lab permeability of pavement cores - NCSC**
  - ❑ **Fog Seal emulsion properties - AKZO**
    - Viscosity, surface tension, particle size
  - ❑ **Extracted binder properties - WRI**
    - DSR
    - Low temperature characterization – BBR, DTT
  - ❑ **Mixture tests on thin surface specimens**
    - DSR torsion - MTE
    - BBR S & m-value - UMinn
  - ❑ **Emulsion residue properties**
-



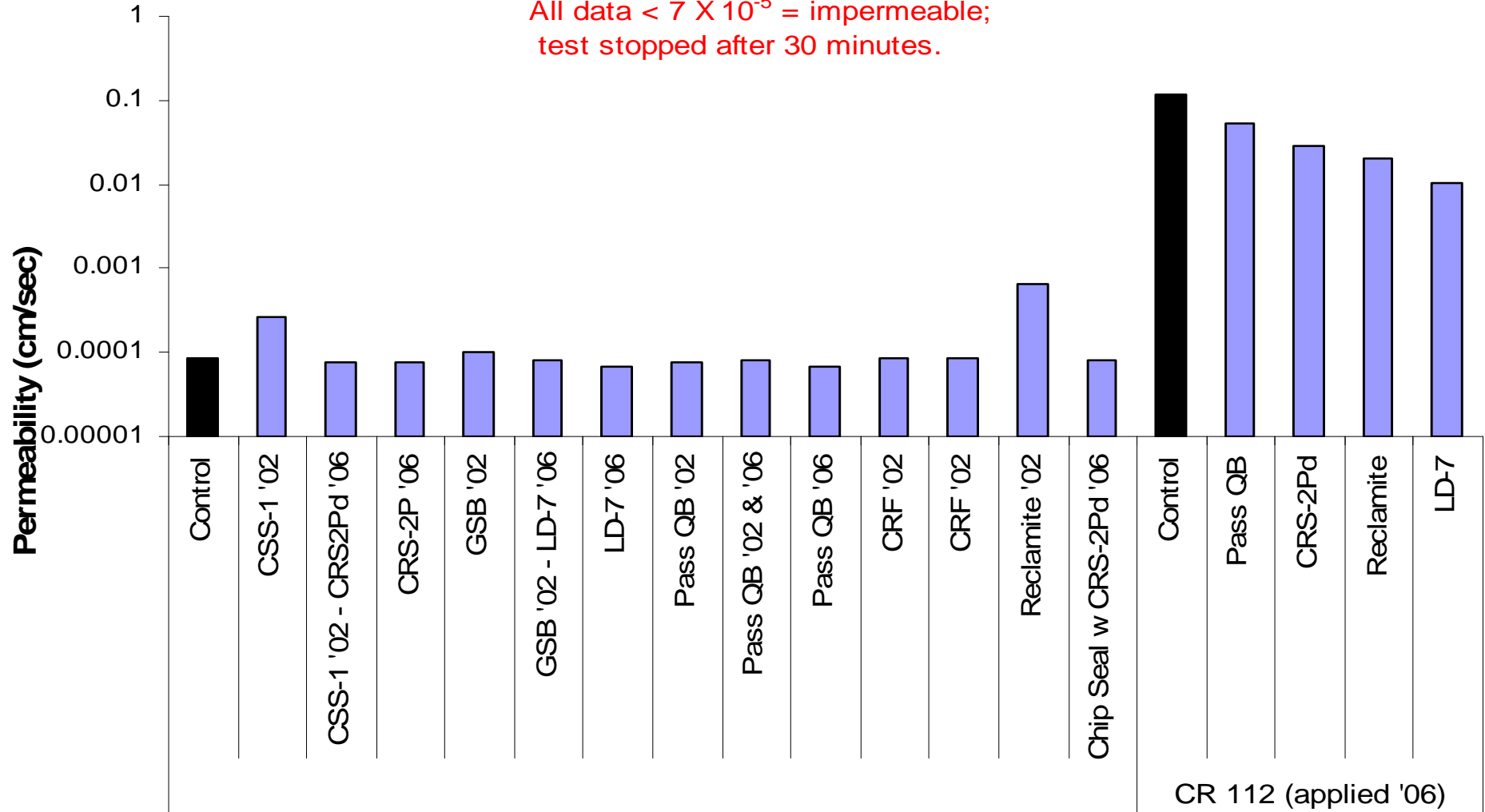
# Fog Seal Lab Permeability

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# Permeabilities – MN 251 & OCR 112

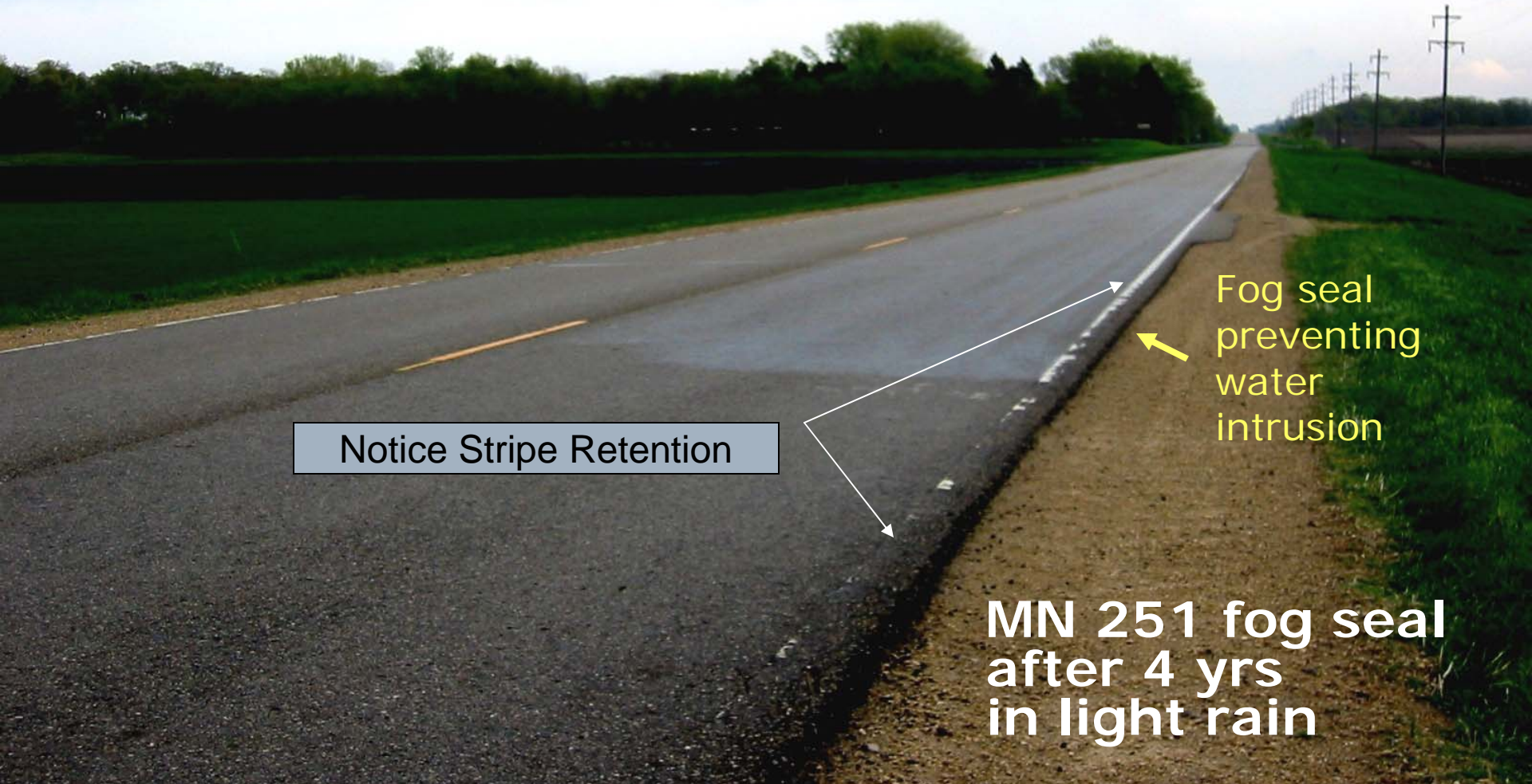
All data <  $7 \times 10^{-5}$  = impermeable;  
test stopped after 30 minutes.





Lessons Learned

# Why Fog? Repel Water



Notice Stripe Retention

Fog seal preventing water intrusion

MN 251 fog seal after 4 yrs in light rain

# Fog Seal Emulsion Properties

Surface Tension



Particle Size



Disk Centrifuge

Saybolt-Furol Viscosity



*Not enough testing in this study for any conclusions*



# Fog Seal Binder Properties

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## ❑ Binder Extraction

- Toluene/95% Ethanol

## ❑ Binder Rheology

- DSR;  $G^*$ , phase angle, MSCR
- BBR:  $S$ , "m-value", physical hardening

## ❑ Binder Chemistry

- Infrared spectroscopy (IR) - carbonyl
- Nuclear magnetic resonance (NMR) - branching
- Differential scanning calorimetry (DSC) - wax
- Elemental analysis - chemical fingerprint
- HPLC - EH&S issues
- Rostler, Corbett, asphaltenes



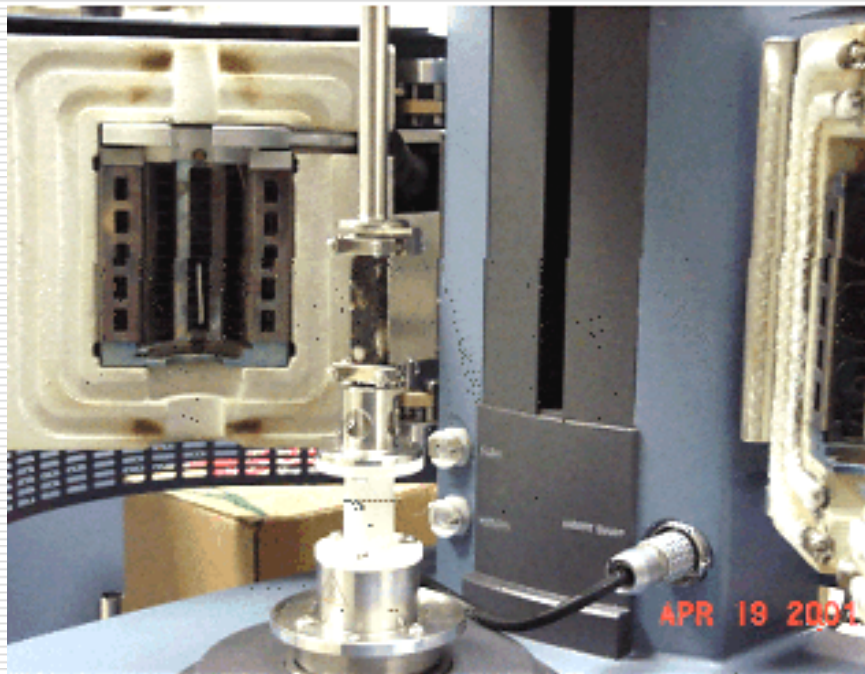
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*Test results: characterizations did not relate much to performance*

# Fog Seal Surface Modulus

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- **Dynamic Creep (DSR Torsion)**
  - (time to 5% strain) - MTE

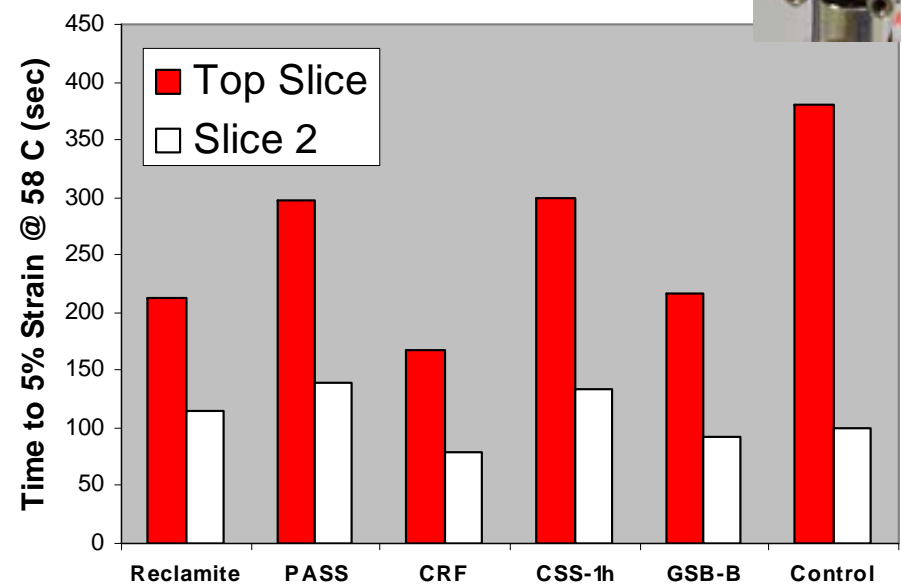
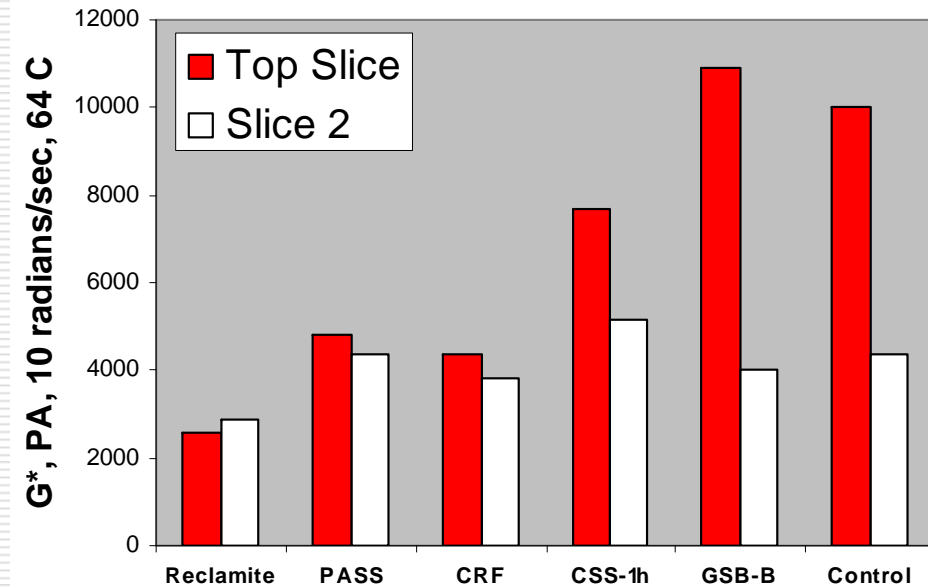


# Rheology Testing of Field Samples



**Rheology of Extracted Cores  
MN 251**

**Rheology of Core Slices  
MN 251**

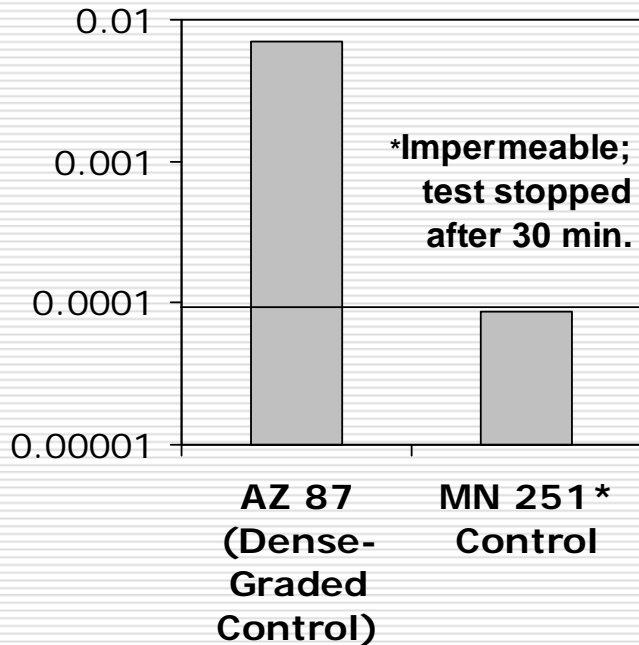


Tested by Western Research Institute  
Dynamic Shear Rheometry on Liquid Samples Extracted from Field Cores (DSR)

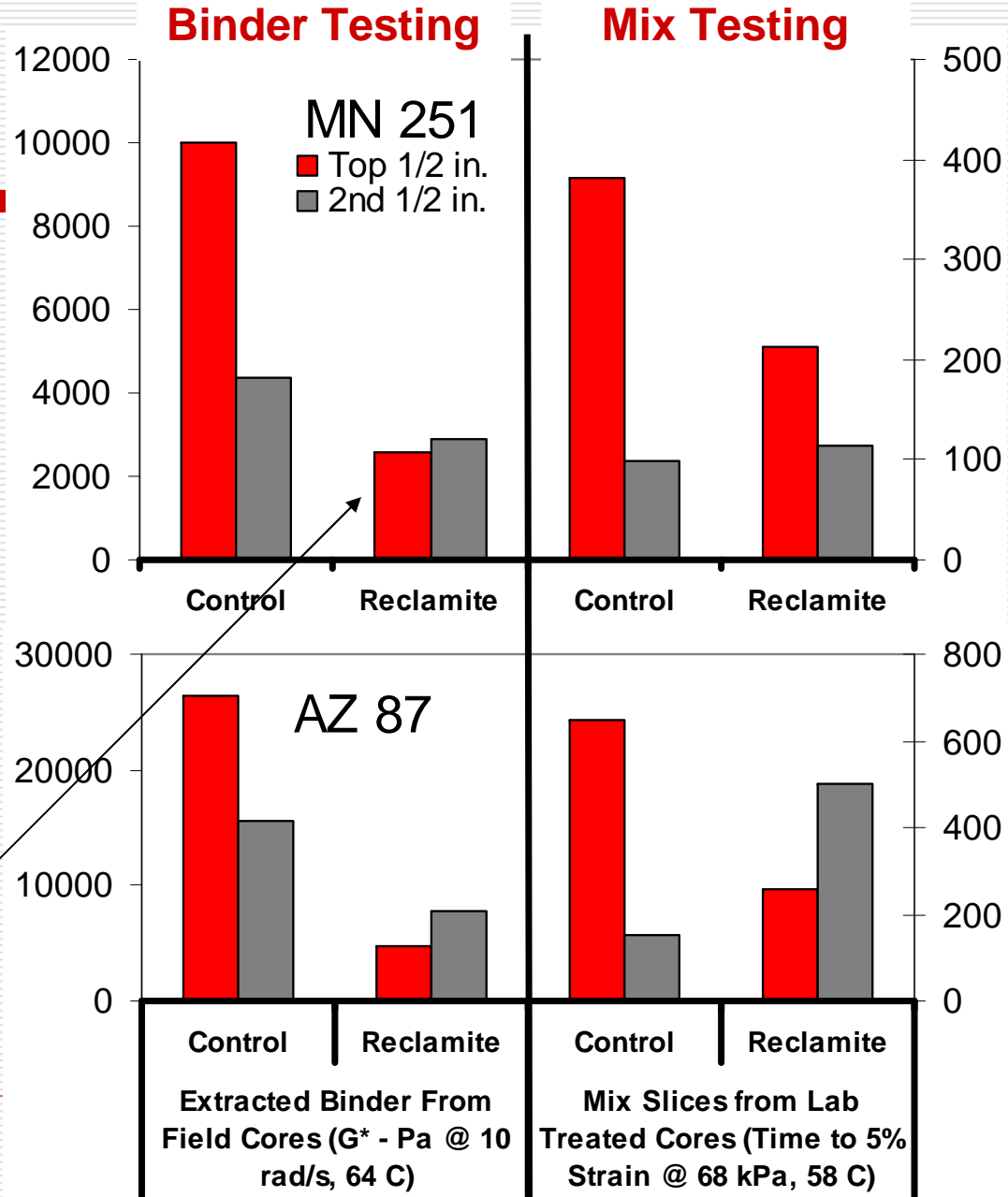
Tested by Mathy Technology & Engineering Services, Inc.  
Dynamic Creep Test on Rectangular Specimens from Field Cores (DSR)

*MN TH 251 Project - Dense-Graded, Impermeable Surface*  
*Tests on binder from extracted cores by WRI, Tests on mix slices from cores by MTE*

# Core Slice Binder & Mix Rheology



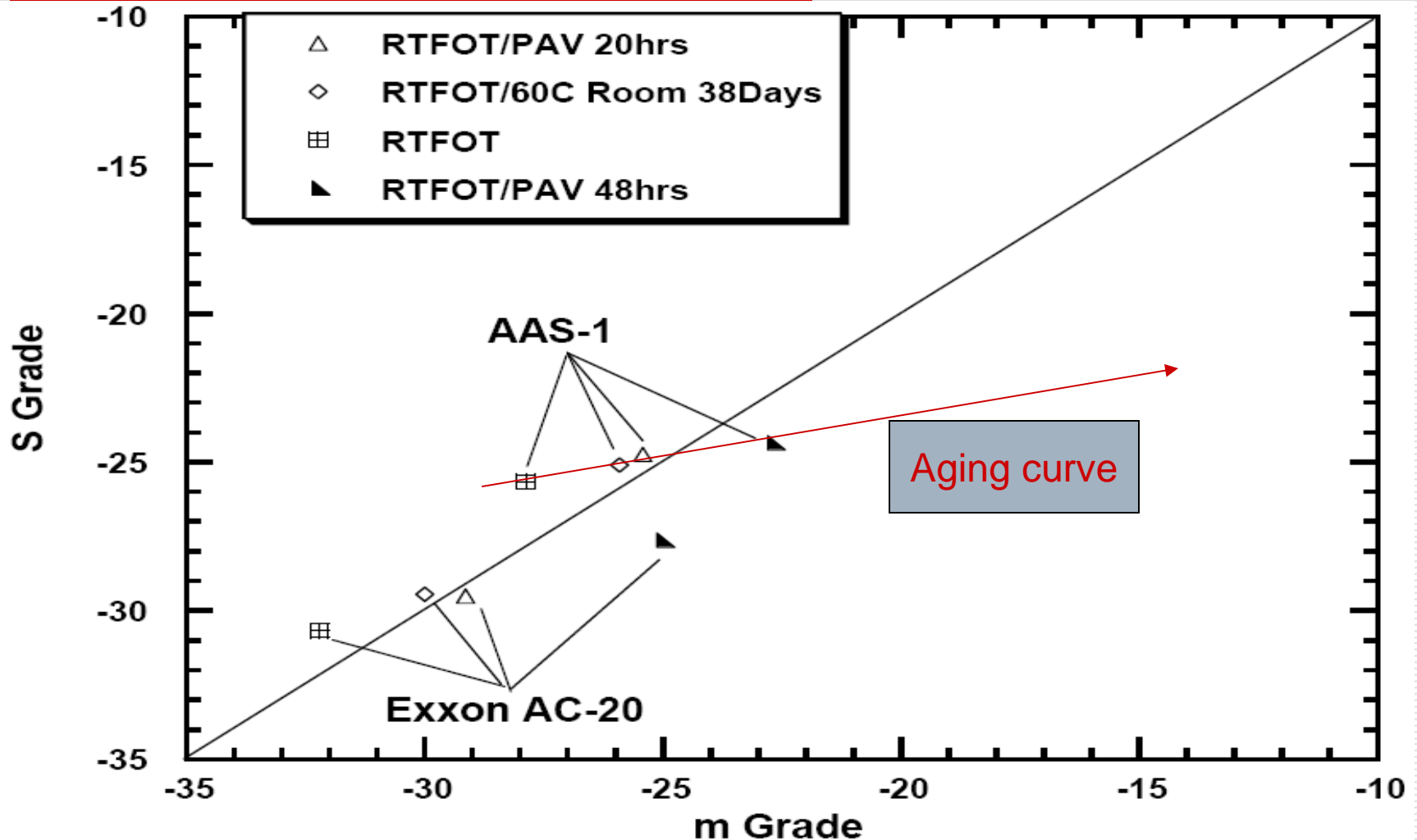
*Impermeable MN 251 shows false softening on extracted test*





# Increasing m-control with aging

for AAS-1 & Exxon AC-20 at Various Aging Times

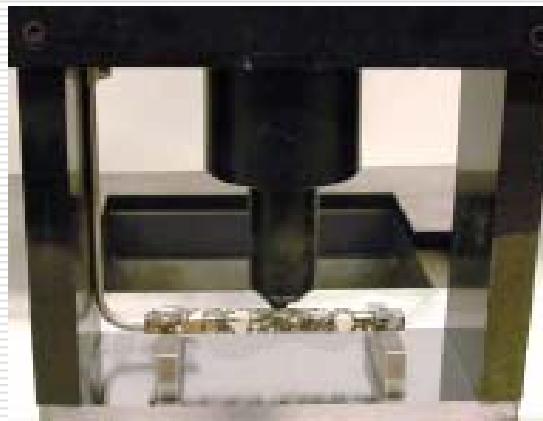


# Fog Seal

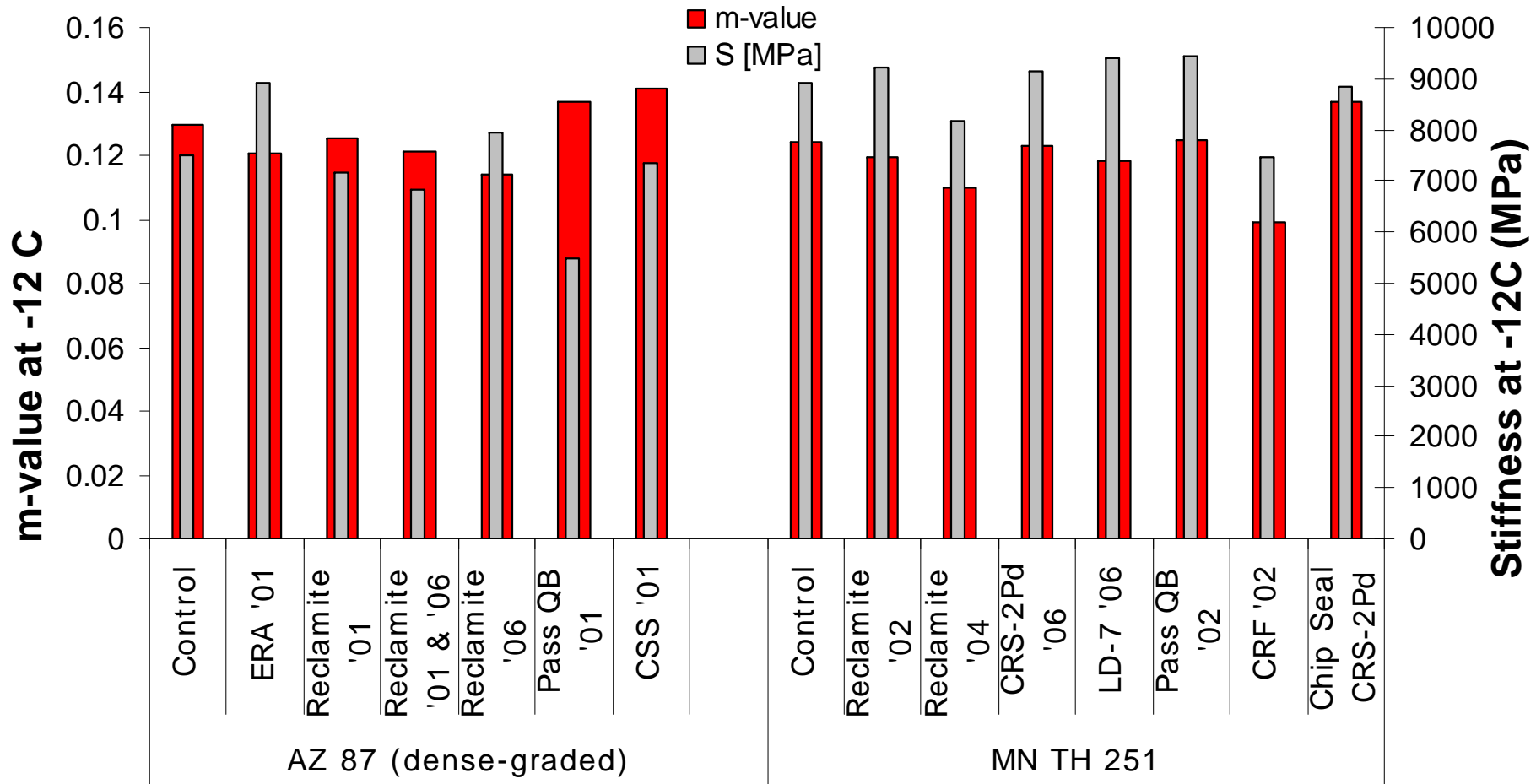
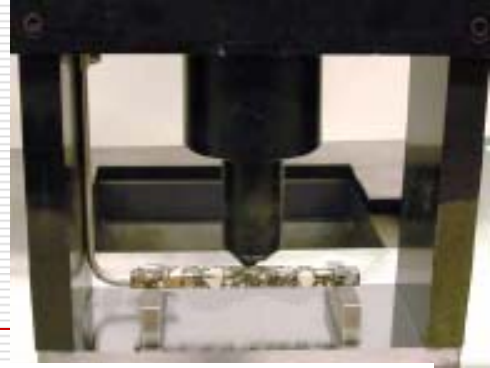
## Low Temperature Mix Stiffness & m-value

### □ Bending Beam Rheometer (BBR)

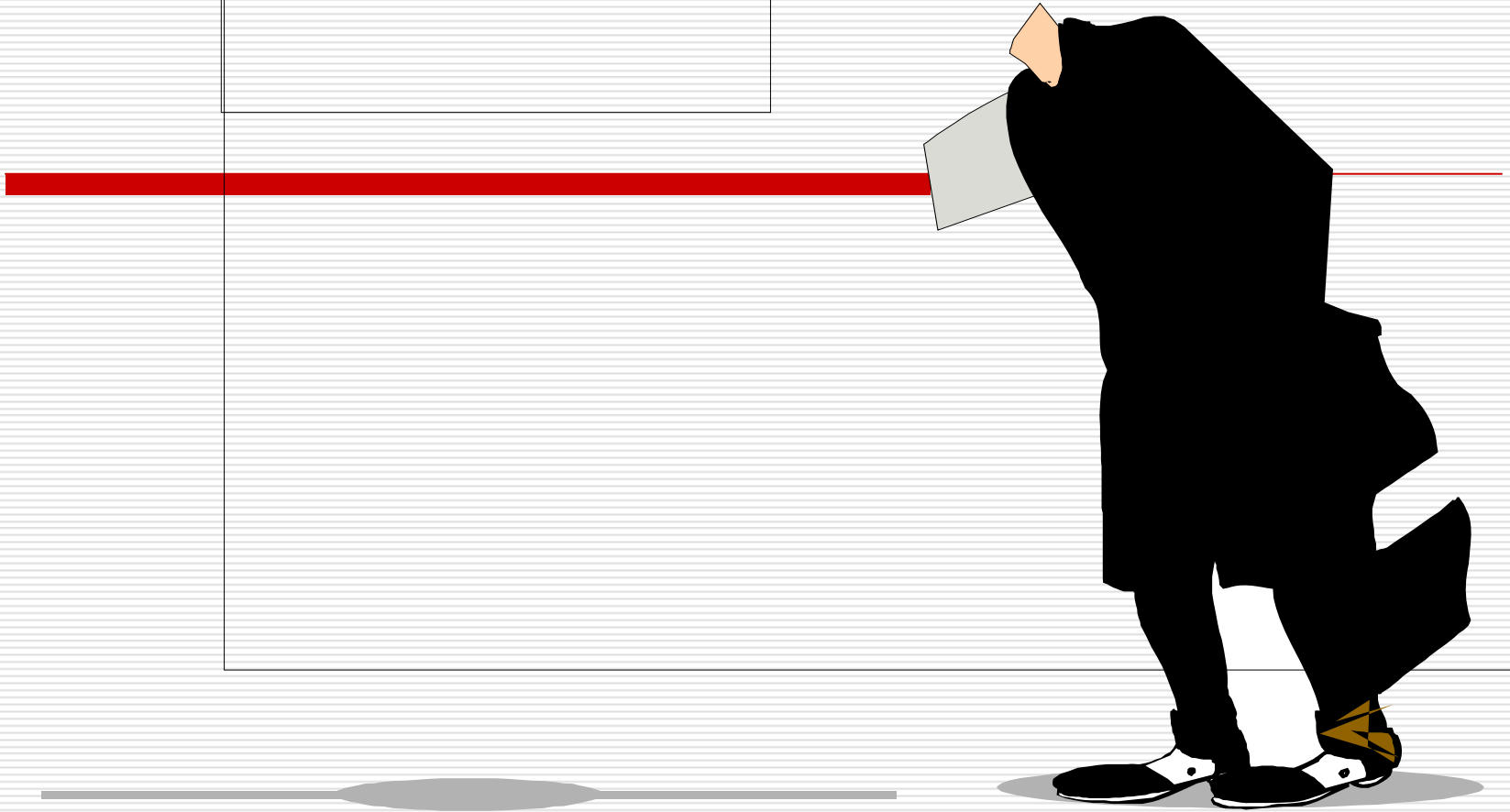
- Standard BBR rectangular beams – 500 g load
  - \$200 tile saw cuts surface mix specimens
- Condition & test in BBR at  $-18$  to  $-6^{\circ}\text{C}$



# Static Bending Test on Rectangular Specimens Cut from Field Cores (BBR)



Static Bending Test on Rectangular Specimens from Field Cores Tested by Bending Beam Rheometer  
 Cores taken in Sept and Oct 2006 - year is date of seal - Samples prepared and tested at UMinn





# Field Observations

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- **Notes & photos of MN, AZ & CA projects taken in 2005 & 2006**
  - Although some 2001 and 2002 seals not clearly visible, effects of treatment were

## Four Year Old Seals

Minnesota



Arizona



California



# Summary Findings

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- **Fog & rejuvenator seals are inexpensive & effective pavement preservation techniques**
  - **Seals are particularly effective over chip seals, OGFC, shoulders**
    - Prevent raveling & broken windshields
    - Reduce surface permeability
    - Prolong service life
  - **Product selection must fit the use**
    - Seal vs Rejuvenate
-

# Summary Findings

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## Primary constraint: friction loss

- Construct short test sections**
    - Check equipment
    - Confirm application rate
    - Use DFT/CTM or skid trailer to estimate friction
  - Sanding helps early friction**
  - Traffic control essential**
  - Friction returns over time**
  - If friction is not sufficient for traffic, have a remediation plan**
-

# Summary Findings

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- Equipment calibration essential**
  - Redefine asphalt aging & resulting block cracking as a low temp failure**
  - Specify the ability of the emulsion to penetrate into the pavement**
  - Full reports on project at:  
[www.pavementpreservation.org/fogseals/](http://www.pavementpreservation.org/fogseals/)**
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# Recommendations for Future Study

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## □ **Not in scope of study:**

- Simple, reliable field permeability test
  - Develop relationship between emulsion rheology and infiltration
  - Define procedure for optimal application rates
  - Verify if pay-item test strip improves performance and safety
  - Define sand quality for best friction
  - Performance-related specifications needed
-



# Interactive CD & Website

[www.pavementpreservation.org/fogseals](http://www.pavementpreservation.org/fogseals)

## Spray Applied Polymer Surface Seals

### *Lessons Learned Workbook -*

HOME
INTRO
TEST PLAN
WHERE
WHEN
HOW
PRODUCTS
TESTS & SPECS
CONCLUSIONS
PROJECT LIBRARY
BIBLIOGRAPHY
PHOTO GALLERY

- Introduction to Sealers & Rejuvenators
- Field Project Plan
- Where to Use Sealers & Rejuvenators
- When to Use Sealers & Rejuvenators
- Application
- Products
- Test Methods & Specifications
- General Conclusions & Recommendations
- Project Library
- Bibliography
- Photo Gallery

*Click here for  
a printable &  
downloadable  
report with  
the  
information  
on these  
pages.*

*Provide Early and Sustained Pavement Preservation*

**TSP<sup>2</sup>** Transportation System Preservation Technical Services Program

**AASHTO**  
THE VOICE OF TRANSPORTATION



### Member Home

#### tsp<sup>2</sup> information

- Welcome
- TSP<sup>2</sup> Brochure

#### tsp<sup>2</sup> news

- Yellowstone Greens Up with WMA
- Idaho Board Freezes Future Road Projects
- Summer Gas Tax Holiday Plan Still Alive
- McCain's Gas Tax Holiday Would Devastate Highways
- 12th Maintenance Mgmt. Conference
- TSP Research Roadmap Survey

### In the Spotlight



#### Research Roadmap

#### Research Roadmap Now Available:

The FHWA has partnered with AASHTO and the preservation industry to sponsor a study to determine what the most critical knowledge gaps in pavement

and bridge preservation are and what research is necessary to fill those gaps.

The TSP<sup>2</sup> Research, Development, and Implementation Roadmap is the output of that partnership effort, and is now available for download...[\[more\]](#)



#### Event Calendar

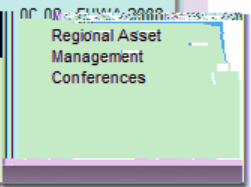
- May-04-08 - AASHTO Spring Meeting
- May-06-08 - Southeast Pavement Preservation Partnership Meeting

- Pavement Preservation EIS
- AASHTO Responds to Transportation Commission Report
- R/P: Bottom-up Bridge Management System
- R/P: Waste Tire Rubber in Roads & Bridges
- Research Roadmap Available
- Quick Network Checkup

### Help Desk Resources



The TSP<sup>2</sup> Help Desk features integrated on-line interactive capabilities in the form of a bulletin board, email, contact forms, and LISTSERVs. To participate, select from the options below.



#### contact info.

- Email the NCPP

# Contents

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- **All reports**
  - User survey
  - Construction
  - Technical
  - Final
  
- **Lessons learned**
  - What & who
  - Where & when
  - How
  - Field & lab test methods
  
- **Downloadable resources**
  - FP<sup>2</sup>/FHWA checklist, Caltrans MTAG
  - Annotated bibliography
  - Products listing
  - PowerPoints
  - Photos & video clips

## Spray Applied Polymer Surface Seals

*Lessons Learned Workbook*



# Lessons Learned - When

## Lessons Learned Workbook

- HOME
- INTRO
- TEST PLAN
- WHERE
- WHEN
- HOW
- PRODUCTS
- TESTS & SPECS
- CONCLUSIONS
- PROJECT LIBRARY
- BIBLIOGRAPHY
- PHOTO GALLERY

### When to Use Sealers & Rejuvenators

One goal of the study is to determine the timing of sealing applications.

#### Lessons Learned:



**MN 251 Showing 4-Yr Old Fogged Section (back) Repelling Moisture during Light Rain Storm While Water is Penetrating into Unfogged Section (foreground)**

The DOT survey showed that many agencies have a scheduled fog seal application program for preventive maintenance that begins between two and ten years after HMA construction. Several agencies also routinely use spray applied seals immediately after chip sealing because the seals keep down dust, blacken the surface, improve visibility, and, most importantly, reduce chip loss, raveling and vehicle damage. Minnesota also reports a greatly reduced incidence of snow plow damage.

Observations of four year old seals in this study showed that most materials exhibited minimal visible color difference between sealed and control sections because most asphalt residue had worn off of the surface aggregate. However, the water, raveling and cracking protection still appeared to be intact. As one example, a project condition survey at the Maple Island site was conducted during a light drizzle. (See photo.) The sealed sections appeared wet, whereas water was quickly soaking into comparable unsealed areas. Although still effective at reducing permeability to moisture, an earlier resealing was probably warranted to prevent excessive hardening between applications.

There is a question if it is better to have a regular application schedule, or to use some critical test parameter to determine when it is time to reseal. Some of the analytical methods discussed later could be used. In particular, the bending beam procedure uses relatively inexpensive saws to cut thin surface specimens and BBR equipment already available in most agency and supplier laboratories. Unfortunately, the BBR method and similar

DOWNLOADABLE DOCUMENTS:  
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Sealer & Rejuvenator Overview

FPP/FHWA Fog Seal Checklist

Rejuvenator Seal Checklist

Caltrans Technical Advisory Guide

Full Project Report

# Lessons Learned - Testing

## Lessons Learned Workbook

- HOME
- INTRO
- TEST PLAN
- WHERE
- WHEN
- HOW
- PRODUCTS
- TESTS & SPECS
- CONCLUSIONS
- PROJECT LIBRARY
- BIBLIOGRAPHY
- PHOTO GALLERY

### Test Methods, Test Results & Specifications

#### Pavement Testing:

- **Surface Texture: Circular Texture Meter (CT Meter) ASTM E-2157**  
The equipment conforms to the Standard Test Method for Measuring Pavement Macrotexture Using the Circular Track Meter. The CTM uses a laser to measure the profile in an 800-mm circumference circle. The mean depth of texture for each 100-mm segment of the arc is computed according to ASTM standard practice. The averages of depths of the two arcs perpendicular to the traveled direction and the two arcs parallel to it are computed.
- **Friction: Dynamic Friction Tester (DFT) ASTM E-1911**  
The equipment conforms to Standard Test Method for Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester. The DFT has three rubber sliders that are spring-mounted on a horizontal rotary disk at a distance of 350mm. The disk is initially suspended above the pavement surface and is driven by a motor until the tangential speed of the sliders is 90 km/h. Water is then applied to the pavement surface by the device, whereupon the motor is disengaged and the disk is lowered to the test surface. The three rubber sliders contact the surface and the friction force is measured by a transducer as the disk spins down. The friction force and the speed during the spin down are saved to a file. This results in a continuous spectrum of dynamic coefficients of friction. The equipment reproduces actual speeds between 0-80 km/hr) and surface bearing loads of vehicles commonly in use.
- **International Friction Index: as calculated from CTM and DFT measurements**
- **Friction: ASTM E-274, Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire**
- **Permeability: NCAT Field Permeameter**
- **Infiltration: Method Of Test For Determining The Quantity Of Asphalt Rejuvenating Agent Required For An Asphaltic Pavement (Ring Test) Caltrans CT 345**
- **Change in Modulus: Spectral Wave Analysis with Portable Seismic**

#### Photo Gallery - Test Methods

#### DOWNLOADABLE DOCUMENTS: (Click to open)

#### Friction/Permeability

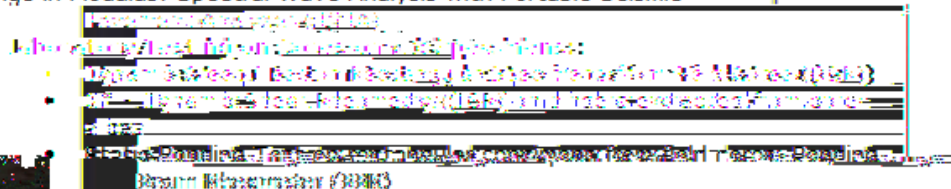
#### Portable Seismic Pavement Analyzer Report

#### Dynamic Creep (DSR) on Cores

#### Static Bending (BBR) on Cores

#### Particle Size & Surface Tension

#### Caltrans Technical Advisory Guide



# Resources

## ANALYSIS OF SEALER - REJUVENATORS AND PAVEMENT FIELD AGING

MICHAEL HARNSBERGER

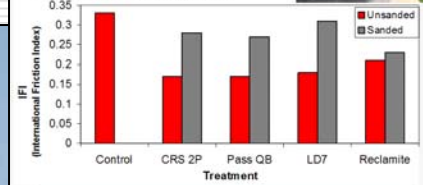
SEALER-REJUVENATOR STUDY  
LESSONS LEARNED WORKSHOP

### Lessons Learned

Friction of Newly Treated MN TR 112 With & Without Sand



Sanding increases friction



From Dynamic Friction Tester by North Carolina

TECHNOLOGIES PRINT CHECKLISTS

### Pavement Preservation Checklist Series

# 4 Fog Seal Application

### FOG SEAL GUIDELINES

### Spray Applied Polymer Surface Seals

Final Report, August 2007

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## Spray Applied Polymer Surface Seals

### Lessons Learned Workbook

- HOME
- INTRO
- TEST PLAN
- WHERE
- WHEN
- HOW
- PRODUCTS
- TESTS & SPECS
- CONCLUSIONS
- PROJECT LIBRARY
- BIBLIOGRAPHY
- PHOTO GALLERY

### Project Library

DOWNLOADABLE & PRINTABLE DOCUMENTS (Click to open)

#### Reports

- [Final Report](#)
- [Appendix 1 - User Survey](#)
- [Appendix 2 - Construction Reports](#)
- [Appendix 3 - Photo Gallery Thumbnails](#)
- [Appendix 4 - Subcontractor Research Reports](#)
- [Rejuvenator Seal Checklist](#)
- [Sealer & Rejuvenator Overview](#)
- [Distributor Truck Review](#)
- [Annotated Bibliography](#)

#### Data Reports

- [WRI \(Western Research Institute\) Chemical Testing and Binder DSR Reports](#)
- [MTE \(Mathy Technology & Engineering Services\) DSR Dynamic Creep Testing Reports](#)
- [UTEP Portable Seismic Pavement Analyzer Report](#)
- [North Central Superpave Center Friction and Permeability Reports](#)
- [UMinn Static Bending - Bending Beam Reports](#)
- [CA Marysville Friction Data](#)

#### Presentations

- [Project Overview PowerPoint - \('Save' to download PowerPoint with notes - 13MB\)](#)
- [Slides & Speaker's notes for Project Overview Powerpoint \(pdf\)](#)
- [2002 Project Update](#)
- [National DOT Survey Results](#)
- [1/2007 Workshop](#)
- [Project Summary 1/2007](#)
- [Caltrans Experience](#)
- **Research Presentations**
  - [Friction/Permeability](#)
  - [Extracted Binder Rheology - Aging](#)
  - [BBR Testing of Mixtures](#)
  - [Emulsions: Surface Tension, Particle Size](#)
- **Supplier Presentations**
  - [Reclamite](#)
  - [LD-7](#)

#### Proposal & Work Plan

- [Project Proposal](#)
- [Detailed Task Listing](#)
- [Work Plan](#)
- Construction Reports**
- [AZ US 87 2001](#)
- [AZ US 87 2006](#)
- [CA Marysville](#)
- [CA SR 78 Salton Sea](#)
- [MI M35 Project](#)
- [MN SR 251 2002](#)
- [MN SR 251 2004](#)
- [MN SR 251 2006](#)
- [MN Olmstead CR112 2006](#)



# Photos – *Downloadable for your use*

## **Lessons Learned Workbook**

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HOME	HOME	HOME
INTRO	INTRO	INTRO
TEST P	WHERE	WHERE
WHE	WHE	WHERE
WHE	HOW	WHEN
HOW	HOW	HOW
PRODU	PRODU	PRODUCTS
TESTS	TESTS	TESTS & SPECS
SPEC	SPEC	
CONCLUS	PROJE	PROJECT LIBRARY
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PHOTO	GALLE	
GALLE		



# Spray Applied Polymer Surface Seal Project

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A photograph of a road surface, likely asphalt, with a yellow line painted across it. There is a visible crack in the asphalt below the yellow line. The background shows a grassy area under a bright sky. The word "Questions?" is overlaid in large, bold, red font in the center of the image.

**Questions?**