



U.S. Department  
of Transportation

**Federal Highway  
Administration**

# Pavement Preservation – Treatments & Construction

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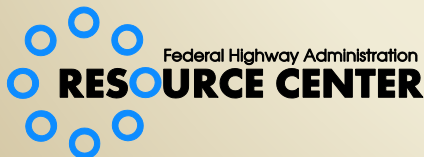
FHWA Resource Center

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US-Territorial Peer Exchange

August 24, 2018

Lakewood, CO



**Pavement & Materials  
Technical Service Team**

# Key Topics of Discussion



## Distress Identification



## Maintenance Applications



## Combined Treatments

# Typical Causes of Distresses in the Surface Layer

- Structural failures
  - Poor design
  - Excess traffic volumes or weights
  - Poor drainage
  - Poor materials
  - Poor construction practices



# Typical Causes of Distresses in the Surface Layer

- Structural failures
  - Aging
  - Surface abrasion
  - Poor materials
  - Inappropriate use of treatments



# Distresses in the Asphalt Surface Layer of a Pavement Structure

Cracking	<ul style="list-style-type: none"><li>• Can occur as a result of traffic loading and thermal stresses</li><li>• Colder climates are more susceptible</li></ul>
Deformation (Rutting, Shoving, etc.)	<ul style="list-style-type: none"><li>• Caused by traffic loading at elevated temperatures</li><li>• Rutting can occur in large areas</li></ul>
Deterioration (Raveling, Stripping, etc.)	<ul style="list-style-type: none"><li>• Caused by a variety of factors such as problems with HMA materials, mix design problems, environmental conditions, and traffic loading</li></ul>
Mat Problems (Segregation, Bleeding, etc.)	<ul style="list-style-type: none"><li>• Associated with mix design or improper construction techniques</li></ul>

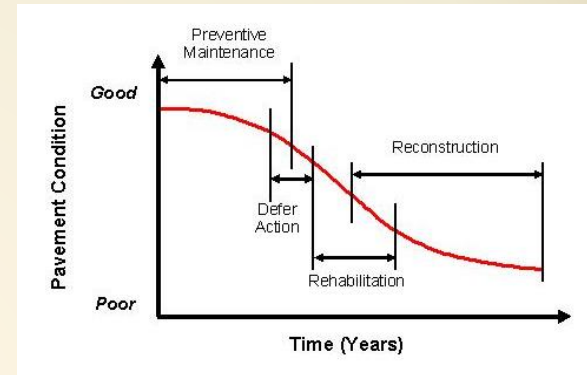
# Typical Treatments

- Treatment of subsurface layers of asphalt
  - Removal and replacement
  - More expensive than treatment distresses
- Correcting problems in surface layers
  - Major rehabilitation or reconstruction
  - Can be preventative
- Timing
  - Early intervention
  - Most economical option



# What Is Pavement Preservation?

- A proactive approach in maintaining roadways
- Addresses pavements whose structural section is still in good condition with significant remaining service life
- By applying a cost-effective treatment at the right time, the pavement surface can be restored almost to its original condition



# Components of Pavement Preservation

- Includes all types of maintenance activities (i.e., routine, reactive, corrective, and preventive)
- Includes minor rehabilitation activities
- Does not include major rehabilitation or reconstruction



# Types of Maintenance Activities

Type	Planned?	Before Deterioration?	Extends Facility Life
Routine	Yes	Not Necessary	Sometimes
Reactive (Demand)	No	No	Probably Not
Corrective	Generally	No	Sometimes
Preventive	Yes	Yes	Yes

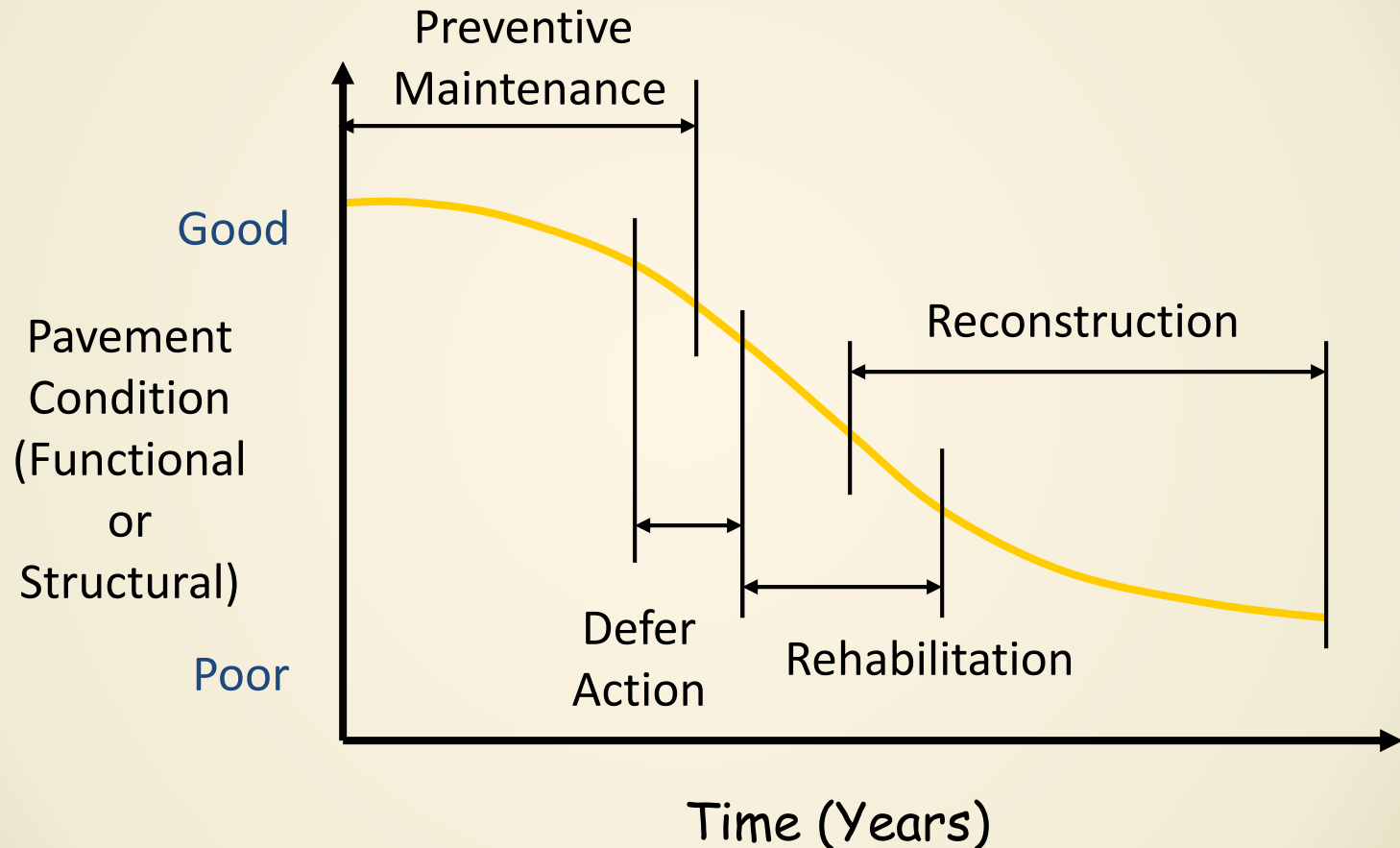
# What Is Preventive Maintenance?

- “A **planned** strategy of cost-effective treatments to an existing roadway system its appurtenances that **preserves** the system, **retards** future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the **structural capacity**)” – Source AASHTO Standing Committee on Highways

# Pavement Preservation Guidelines

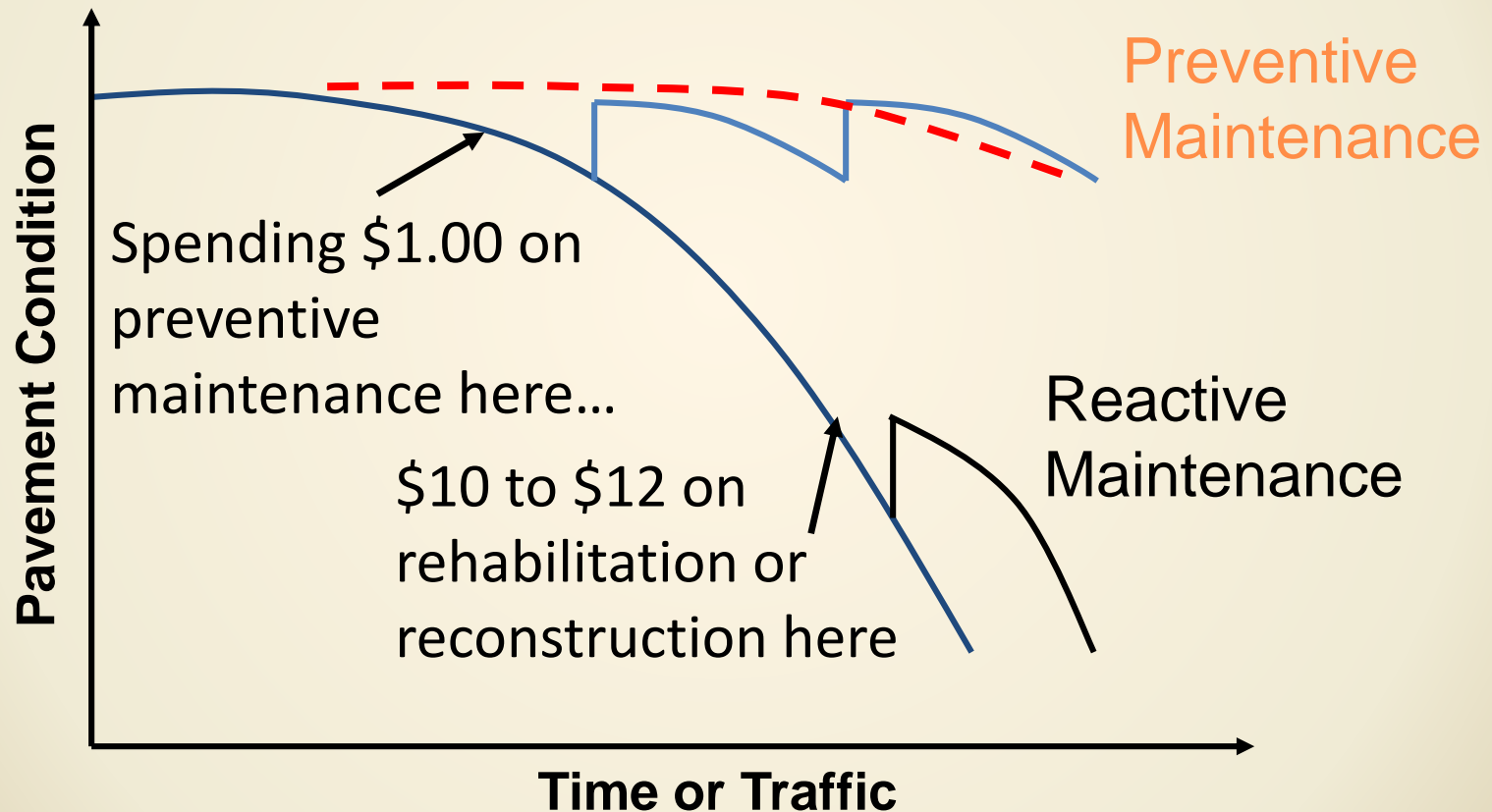
	Type of Activity	Increase Capacity	Increase Strength	Reduce Aging	Restore Serviceability
	New Construction	X	X	X	X
	Reconstruction	X	X	X	X
	Major (Heavy) Rehab.		X	X	X
	Structural Overlay		X	X	X
Pavement Preservation	Minor (Light) Rehabilitation			X	X
	Preventive Maintenance			X	X
	Routine Maintenance				X
	Corrective (Reactive) Maintenance				X
	Catastrophic Maintenance				X

# When Should Preventive Maintenance Be Applied?



# Expected Benefits

## Improved Pavement Performance



# Selection Process

- Three steps
  1. Assess the existing conditions
  2. Determine the feasible treatment options
  3. Select the most cost-effective feasible option







# Condition: Timing Maximizes Effectiveness



↑  
**Too  
Early!**



← **Too  
Late!**

**Right Time!**



# Key Topics of Discussion



Distress Identification



**Maintenance Applications**



Combined Treatments



# Preventive Maintenance Treatments

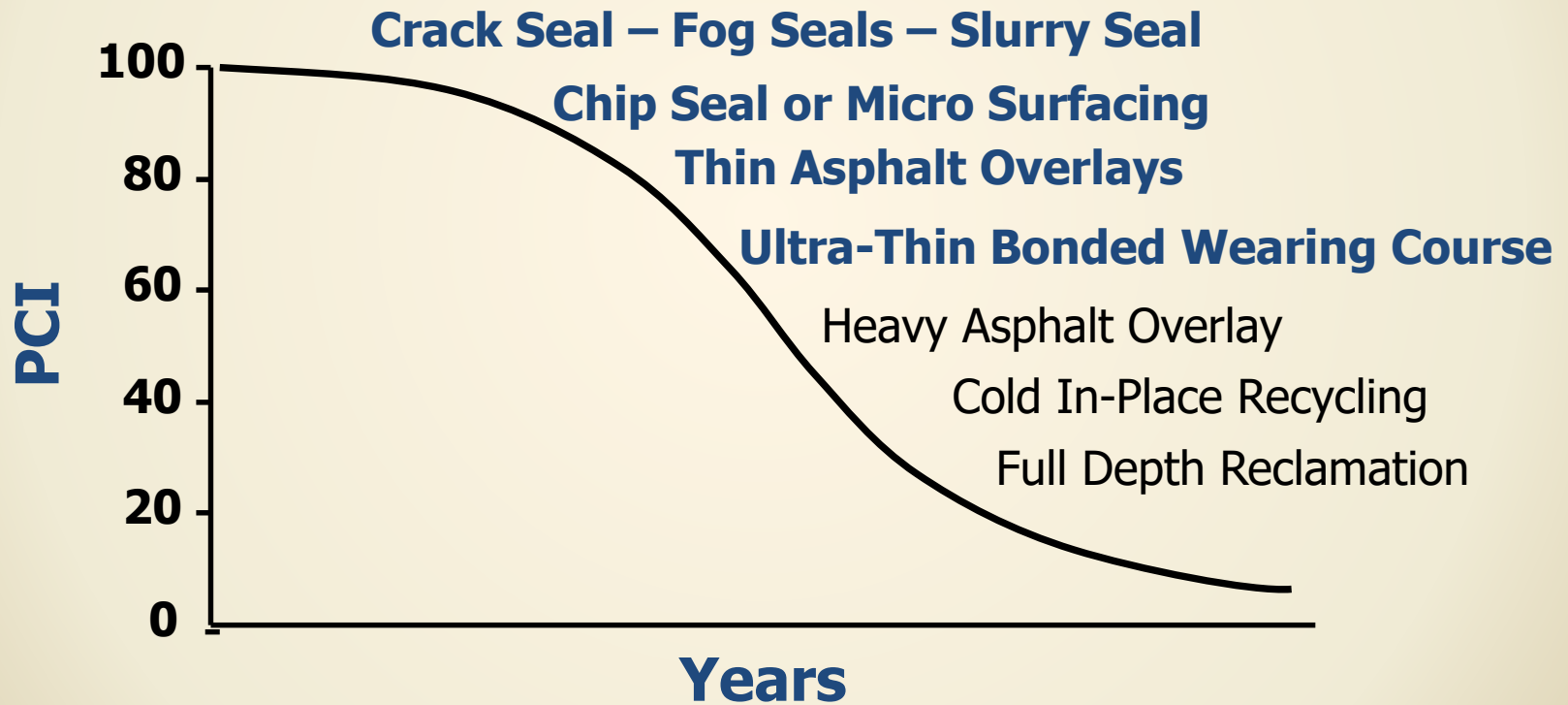
- Crack filling and sealing
- Fog seals
- Slurry seals



- Chip seals
- Scrub seals
- Micro surfacing
- Thin overlays

# “The Right Time”

## Preservation and Rehab Strategies - HMA

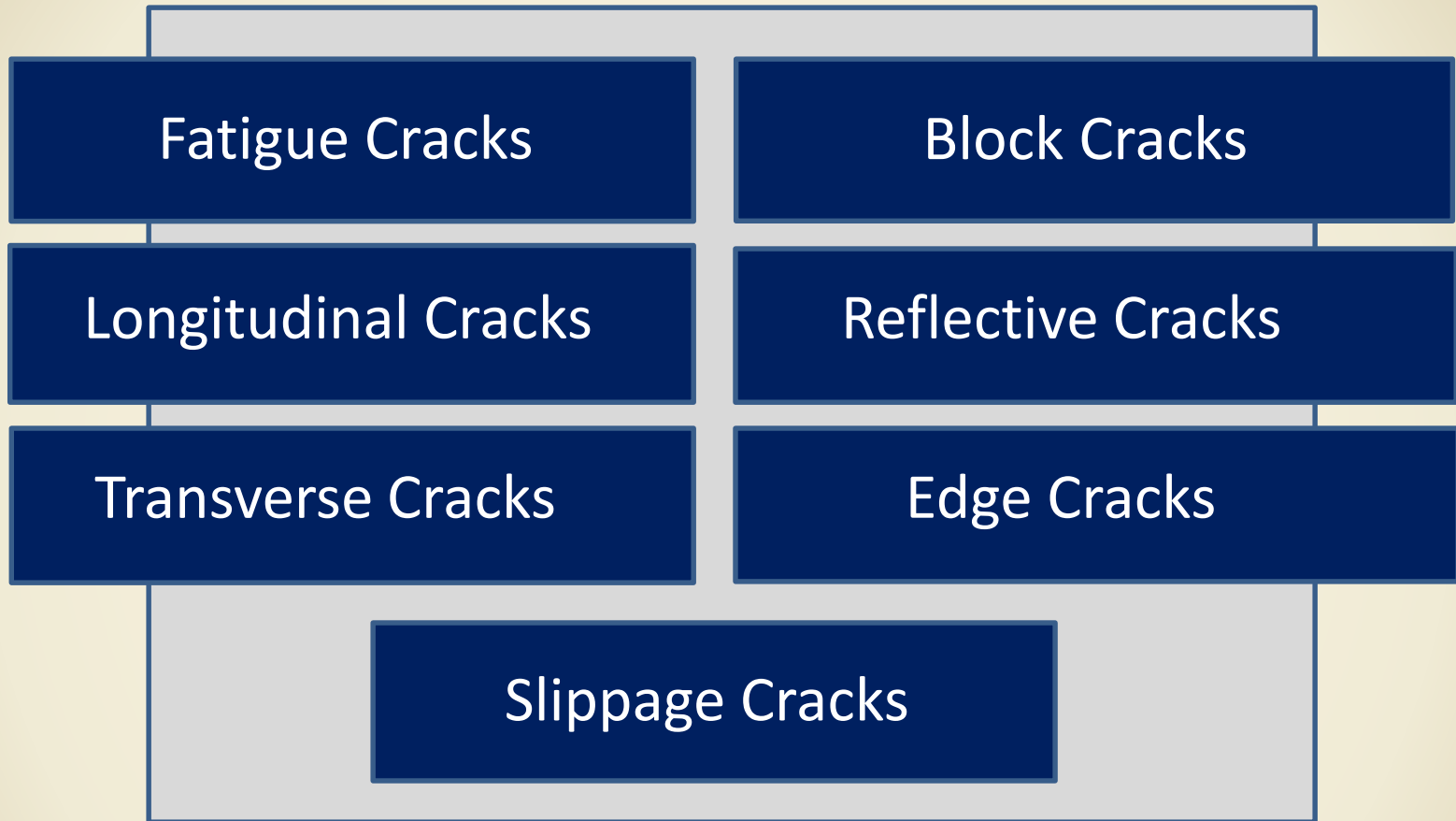


# Crack Filling and Sealing





# Types of Cracks



# What Is Crack Filling and Sealing?

## Description

Placement of material into individual existing cracks

## Purpose

- Reduce water infiltration
- Prevent intrusion of incompressibles
- Provide support to adjacent pavement



# Routing and Sawing

- Cracks need to be cleaned and dried prior to applying the filler or sealant
- When cracked extensively, routing or sawing of cracks may not be appropriate
- Crack cutting allows more filler to be used and provides better control of the crack channel shape
- Crack cutting and routing equipment:
  - ▶ Vertical spindle routers
  - ▶ Rotary impact routers
  - ▶ Random crack saws





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# Combination: Sand Fill with Recessed Finish

## ***Standard Crack Filling Configurations***



**Flush Fill**



**Capped**

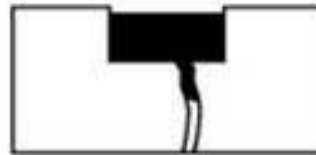


**Simple Overband**

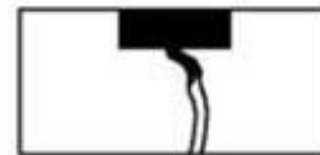
## ***Standard Crack Sealing Configurations***



**Reservoir &  
Overband**



**Reservoir &  
Recessed**



**Reservoir & Flush**



**Reservoir & Flush  
(with backer rod)**



**Shallow Reservoir &  
Overband**

# Crack Filling

- Short-term treatment
- Less crack preparation than sealing
- Placement of materials into nonworking or low movement cracks
- Annual horizontal movement  $< 0.2$  in
- Hot applied rubber or polymer asphalts, or cold applied emulsion-based products
- Treatment life: 2 to 4 years
- Extension of life: 1 to 3 years



# Crack Sealing

- Longer-term treatment than crack filling
- Requires thorough crack preparation
- Requires use of specialized high quality material into or above working cracks
- Annual horizontal movement  $\geq 0.2$  inch
- Rubber-modified asphalt is used for hot applications or silicone based for cold applied
- Treatment life: 3 to 8 years
- Extension of life: 2 to 4 years

# Crack Filling and Crack Sealing

Material	AASHTO Specifications	Application Type	Approx. Cost \$/lb	Approx. Life (Years)
Asphalt Emulsion	M140, M208	Filling	0.07-0.14	2-4
Asphalt Cements	M20, M226	Filling	0.01-0.07	2-4
Fiber Modified Asphalt	No Specification	Filling	0.16-0.27	6-8
Polymer Modified Emulsion (PME)	M140, M208	Filling (Minor Sealing)	0.36-0.55	3-5
Asphalt Rubber (AR)		Sealing	0.20-0.27	6-8
Specialty AR Low Modulus		Sealing	0.34-0.64	5-9
Silicone		Sealing	2.61-3.07	4-6

# Before and After Deep Patching/Dig Outs/Edge Repair



**1) Before deep patching**  
(identified locations)



**2) After deep patching**



# Surface Preparation

- Before applying any pavement preservation treatment the surface must be:
  - Cleaned with a road sweeper, power broom, or flushed
  - Dry (if flushing is required, it should be completed 24 hours before the application of treatment)



# Fog Seals



# What Is Fog Seal?

## Description:

Light spray application of diluted, slow setting emulsion without aggregate

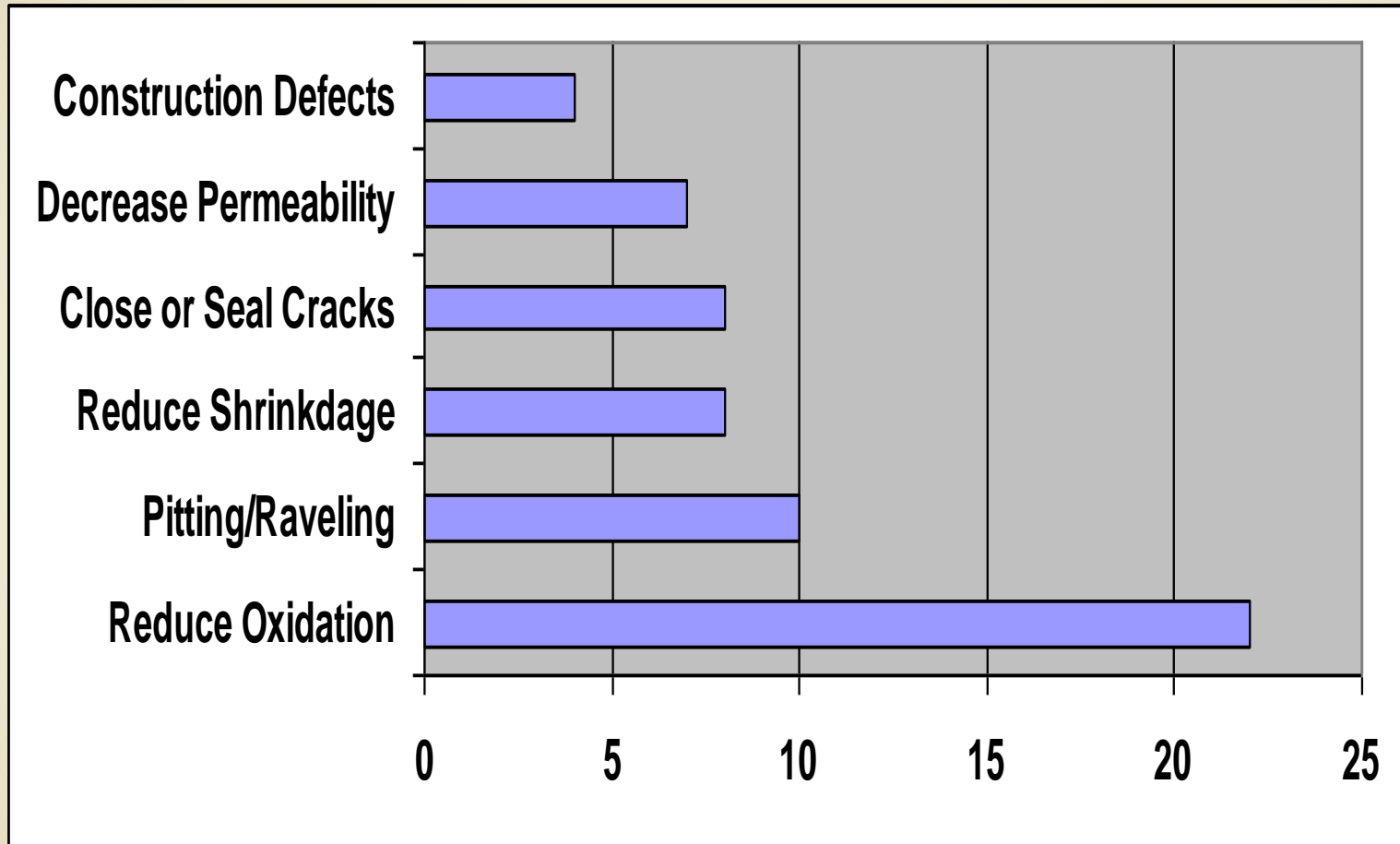


## Purpose:

- Seal existing asphalt surface and small cracks
- Reduce raveling
- Enrich dry and weathered surfaces
- Provide delineation with shoulder

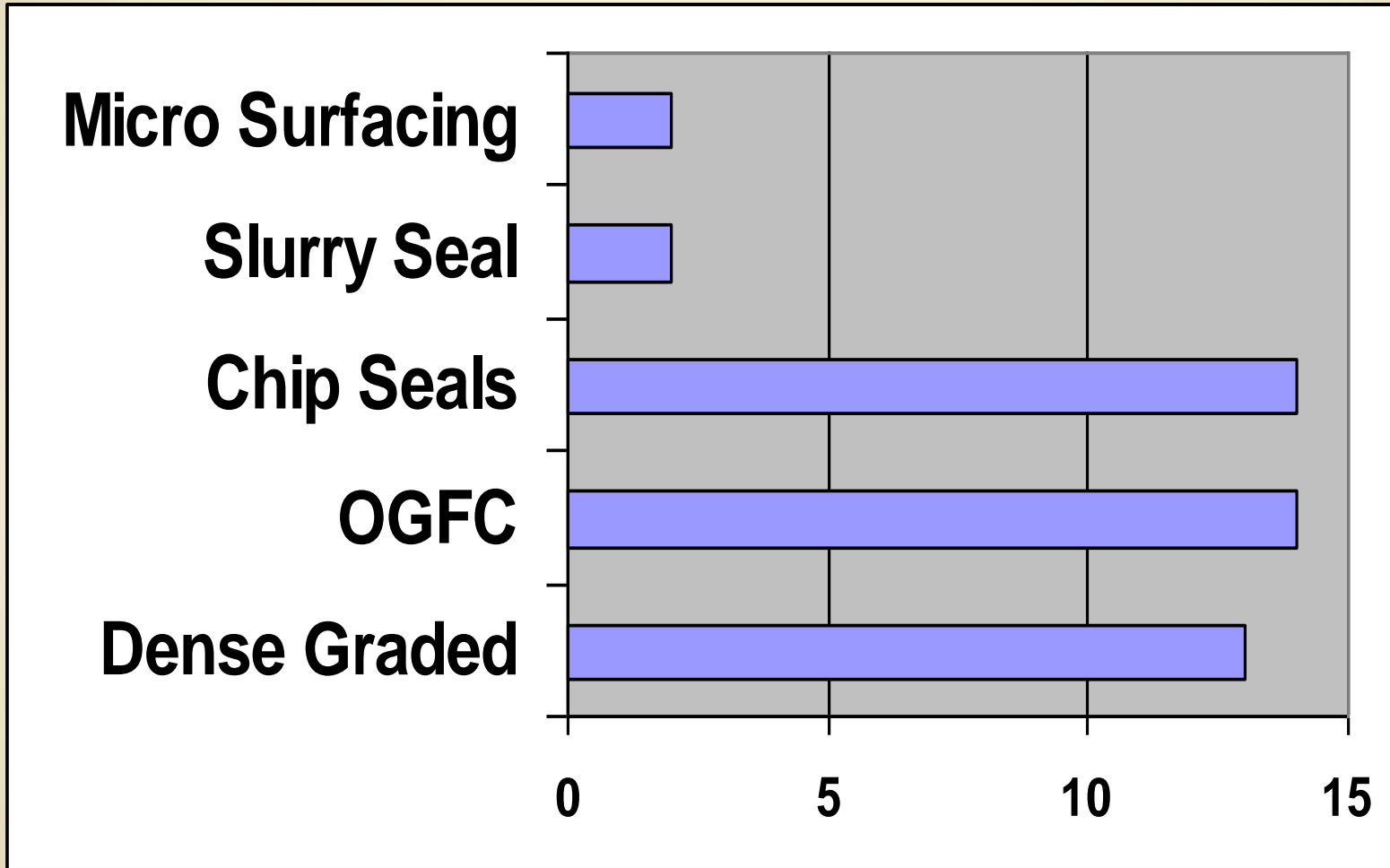


# Fog Seals



Uses of Fog Seals - FHWA Emulsified Sealer/Binder Study

# Fog Seals



Surface Treatments Frequently Fog Sealed to Prolong Pavement Life  
FHWA Emulsified Sealer/Binder Study

# Project Selection

- Visual inspection is the only way to currently quantify the degree of aging pavement
- Different asphalts will age at different rates
- Experience of individuals is key to determining treatment timing
- Fog seals will not correct distresses such as:
  - Cracking
  - Base failure
  - Excessive stone already lost
  - Any other severe pavement structural defects

# Materials

Primarily cationic, with or without rejuvenators, and polymer modifiers, usually diluted



# What Is Rejuvenator?

## Description

Engineered cationic emulsions containing maltenes, saturates (light fractions)

## Purpose

- Soften existing pavement surface
- Enrich weathered pavement





# Application Rate Recommendations

## AEMA Recommendations for Application Rates

% Original Emulsion	Dilution Rate	Tight Surface		Open Surface	
		(l/m <sup>2</sup> )	(gal/yd <sup>2</sup> )	(l/m <sup>2</sup> )	(gal/yd <sup>2</sup> )
50	1:1	0.15-0.5	0.03-0.11	0.4-1.0	0.09-0.22

# Performance: Limitations

- Not useful as seal coats on tight surfaces without the addition of aggregates
- Should not be used on rubberized asphalt concrete (RAC)
- Should not be used on polymer modified mixes unless the pavements are over five years old as these binders age at a slower rate
- Don't apply if temperatures are less than 50°F and pavement temperature less than 15°F

# Slurry Seals





# What Is a Slurry Seal?

## **Description:**

A mixture of asphalt emulsion, graded aggregate, mineral filler, water, and other additives



## **Purpose:**

- Provide a smooth to moderately textured surface
- Seal existing asphalt surface and small cracks
- Reduce raveling
- Enrich dry and weathered surfaces



# Slurry Seal

- Thin surface treatment that is laid in a thickness equal to the largest stone in the grading of its component aggregate
- May include either a conventional or polymer modified emulsion



# Materials

- Designed to be quick curing with and without polymer modification and to produce no dust or loose chip. Mix performance is the product of well-defined aggregate, binder and additives, assuring a mix resistant to raveling.

## Typical Mixing Order:

Aggregate

Mineral Filler

Water

Additive

Emulsion

# Materials

- Thickness is equal to the largest stone in the grading of its component aggregate
- May include either a conventional or polymer modified emulsion

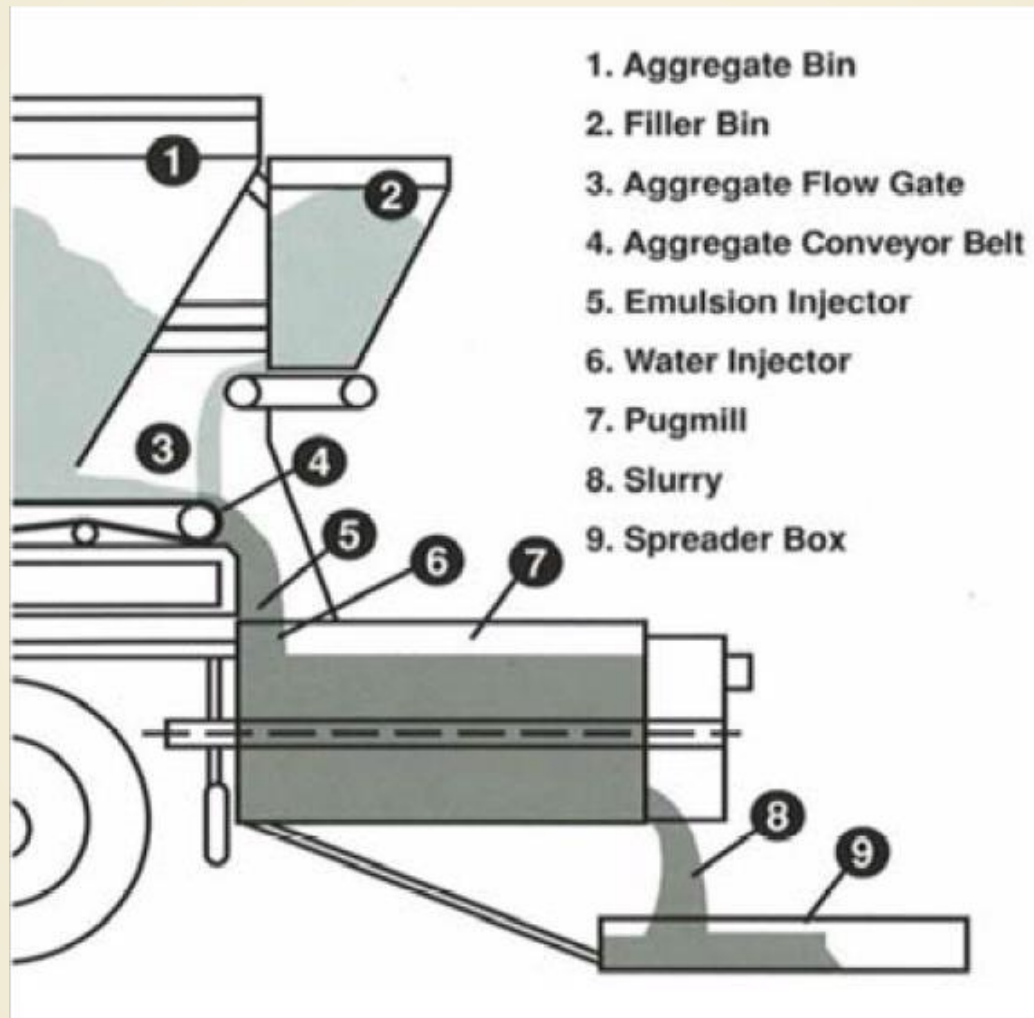
## Slow Setting

- Break mostly by evaporation
- Typically requires several hours to break and cure

## Quick Setting

- Have emulsifiers that react physio-chemically with the aggregate surface
- Maintain a degree of chemical break
- At high temperatures, the emulsions cures very quickly such that the surface treatment can be opened to traffic within about one hour

# Application Equipment Schematic



Equipment can be compact, truck mounted, trailer mounted, or continuous run.



# Chip Seals



# What Are Chip Seals?

## **Description:**

Asphalt (generally emulsified) and then immediately covered with aggregate and rolled (pneumatic-tired rollers)

## **Purpose:**

- Improve surface friction
- Retard reflection cracking on HMA overlays
- Seal existing asphalt surface and small cracks
- Reduce raveling
- Enrich dry and weathered surfaces



# Materials

- Cationic or anionic, rejuvenating, polymer modified, and high float formulations



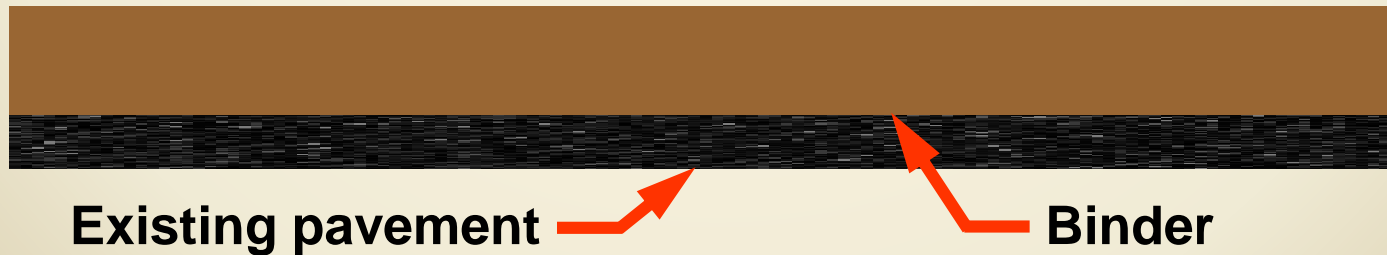
# Good Chip Seal Candidates

- In past: low-volume roads; now: almost any
- Structurally sound
- Cracks < 0.25 inch wide
- No medium- or high-severity alligator cracking
- Few or no potholes
- Rutting < 1 inch
- Relatively smooth surface



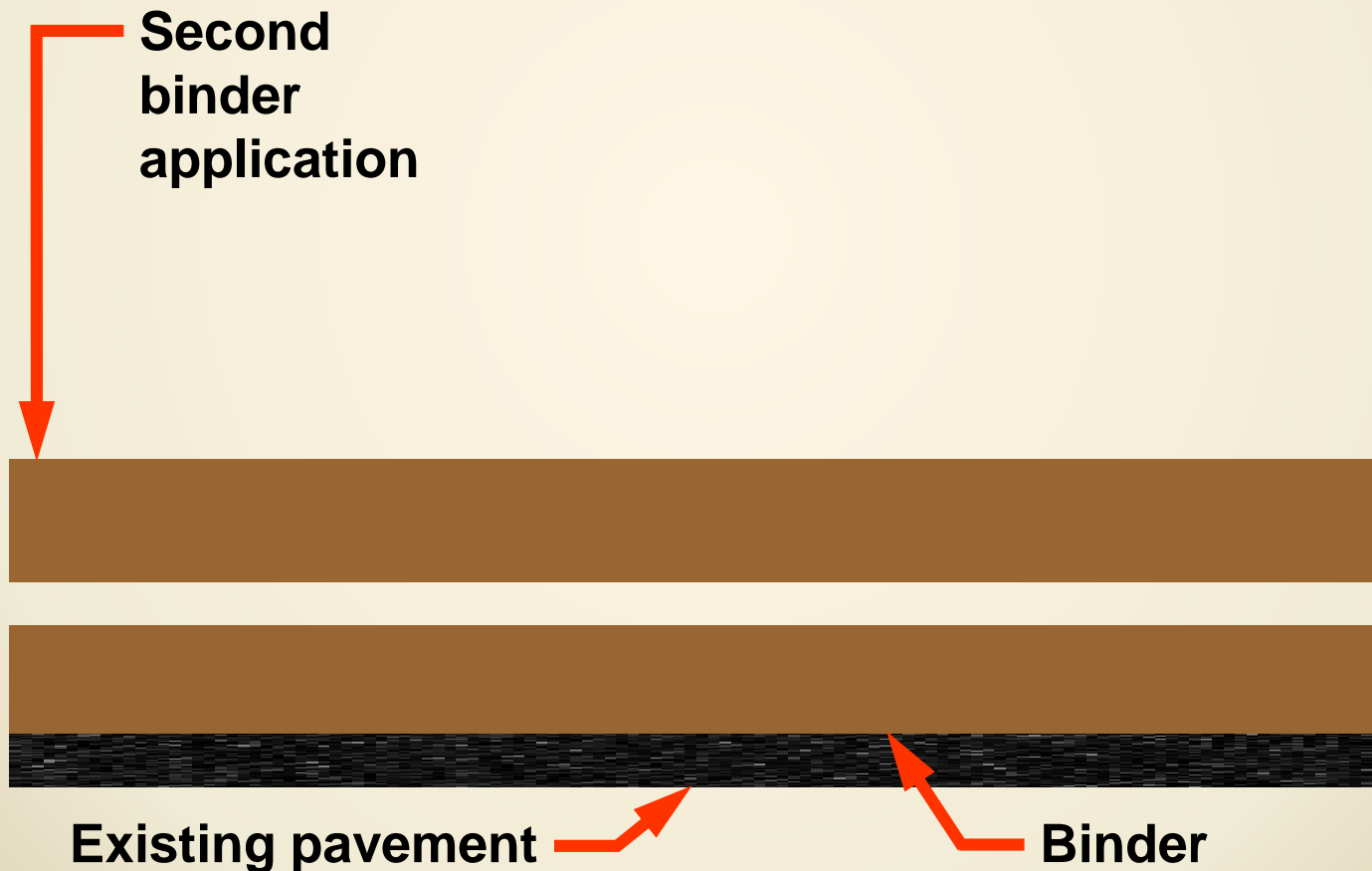
# Chip Seal Variations

## Single Chip Seals



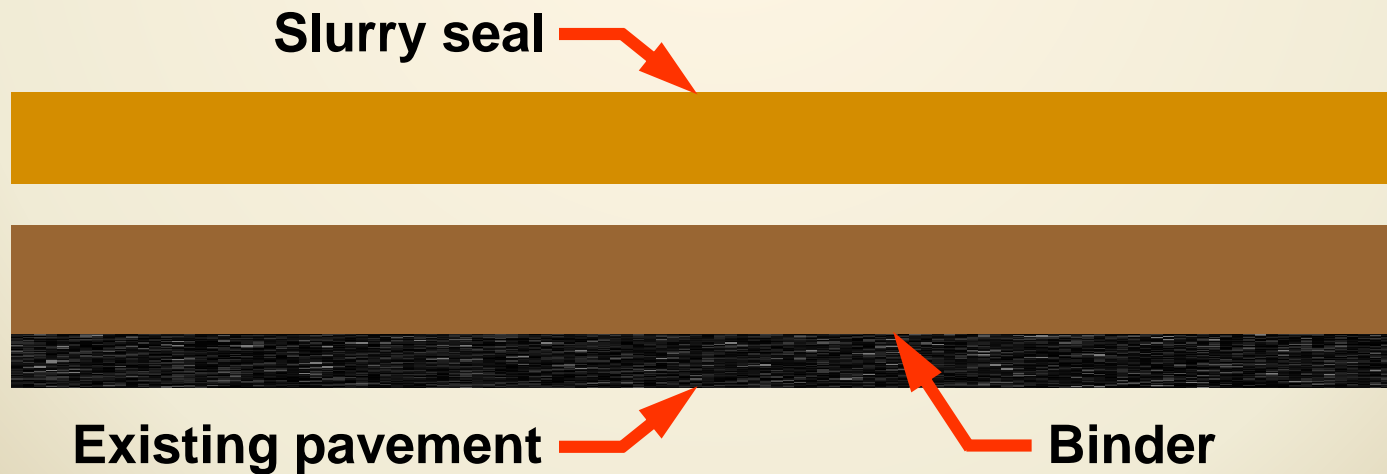
# Chip Seal Variations

## Double Chip Seals



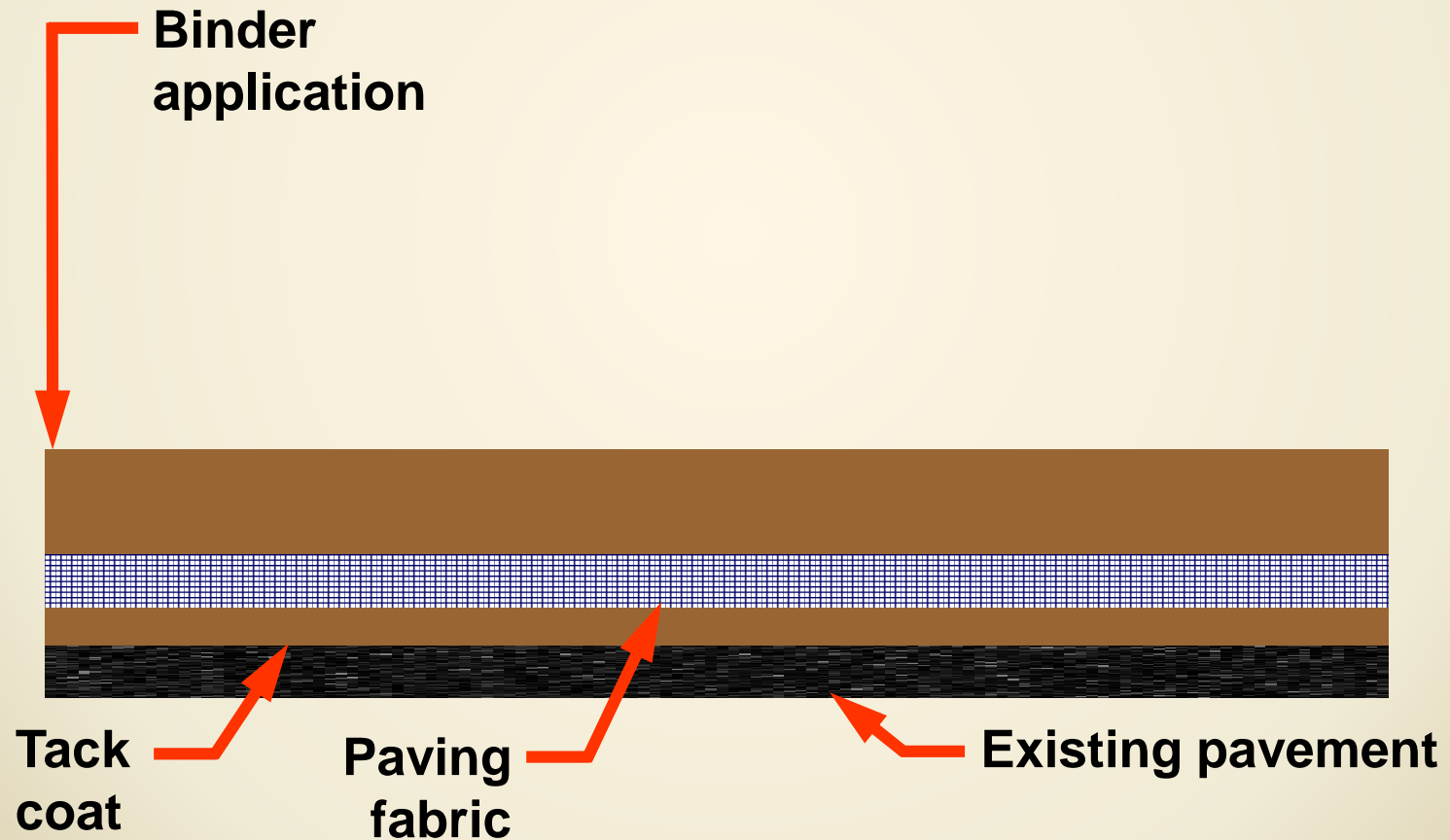
# Chip Seal Variations

## Cape Seals



# Chip Seal Variations

## Fabric and Chip Seals





# Chip Seal with Fog Seal

Before



After



# Stress-Absorbing Membrane (SAM) Seal

- SAM is a single-chip seal in which a modified binder, often asphalt rubber, is applied, followed by a layer of aggregate
  - The aggregate is then rolled into the binder
- Binder application rates are much higher than those used for conventional chip seals

# Stress-Absorbing Membrane Interlayer (SAMI)

- SAMI is a membrane seal that retards the rate of reflection cracking in new overlays
- Consists of an application of modified binder by a layer of aggregate which is spread and rolled
  - An overlay is placed over the membrane
- If necessary, traffic may be allowed on the SAMI before construction of the overlay

# Sand Seal Applications

- Sand seals enrich weathered pavements and fill fine cracks in the pavement surface
- Can provide additional skid resistance to the pavement while also inhibiting raveling
- Consist of a sprayed asphalt emulsion followed by a covering of clean sand or fine aggregate
- Provide thicker coating on the pavement than fog seals, resulting in longer life expectancy



# Binder Type and Suitable Applications

Binder Type	Chip Seal Single Course	Chip Seal Multiple Course	Sand Seal	SAM and SAMI
Asphalt Emulsion	Yes	Yes	Yes	No
Performance Graded Binders PBA	Yes	Yes	Yes	No
Chemically Modified Crumb Rubber Asphalt (CMCRA)	Yes	Yes	Yes	Yes
Rejuvenating Emulsions	Yes	Yes	Yes	No

# Scrub Seals



# What Ares Scrub Seals?

## Description:

An emulsion scrubbed into the existing surface followed by an application of rock



## Purpose:

- Seal oxidized or distressed pavements
- No crack sealing required
- Provide new wearing course



# Materials

Primarily cationic mixing grade, with or without rejuvenators or polymer modifiers, formulated to allow “scrubbing” action without breaking prematurely





# Scrub Seals



# Rolling/Compaction Equipment



Pneumatic Roller



# Vacuum Broom



Minimize fugitive dust

# Scrub Appearance and Benefit - UT





# Micro Surfacing



# What Is Micro Surfacing?

## Description:

A mixture of asphalt emulsion, graded aggregate, mineral filler, water, and other additives



## Purpose:

- Rut-filling
- Reduce raveling
- Provide a smooth to moderately textured surface
- Seal existing asphalt surface and small cracks

# Materials

- Formulation is based on mix design parameters that include resistance to raveling, lateral displacement and resistance to moisture damage. Curing is controlled by chemistry of the emulsion to enable cure at thicknesses of several inches.

## Typical Mixing Order:

Aggregate

Portland Cement

Water

Additive

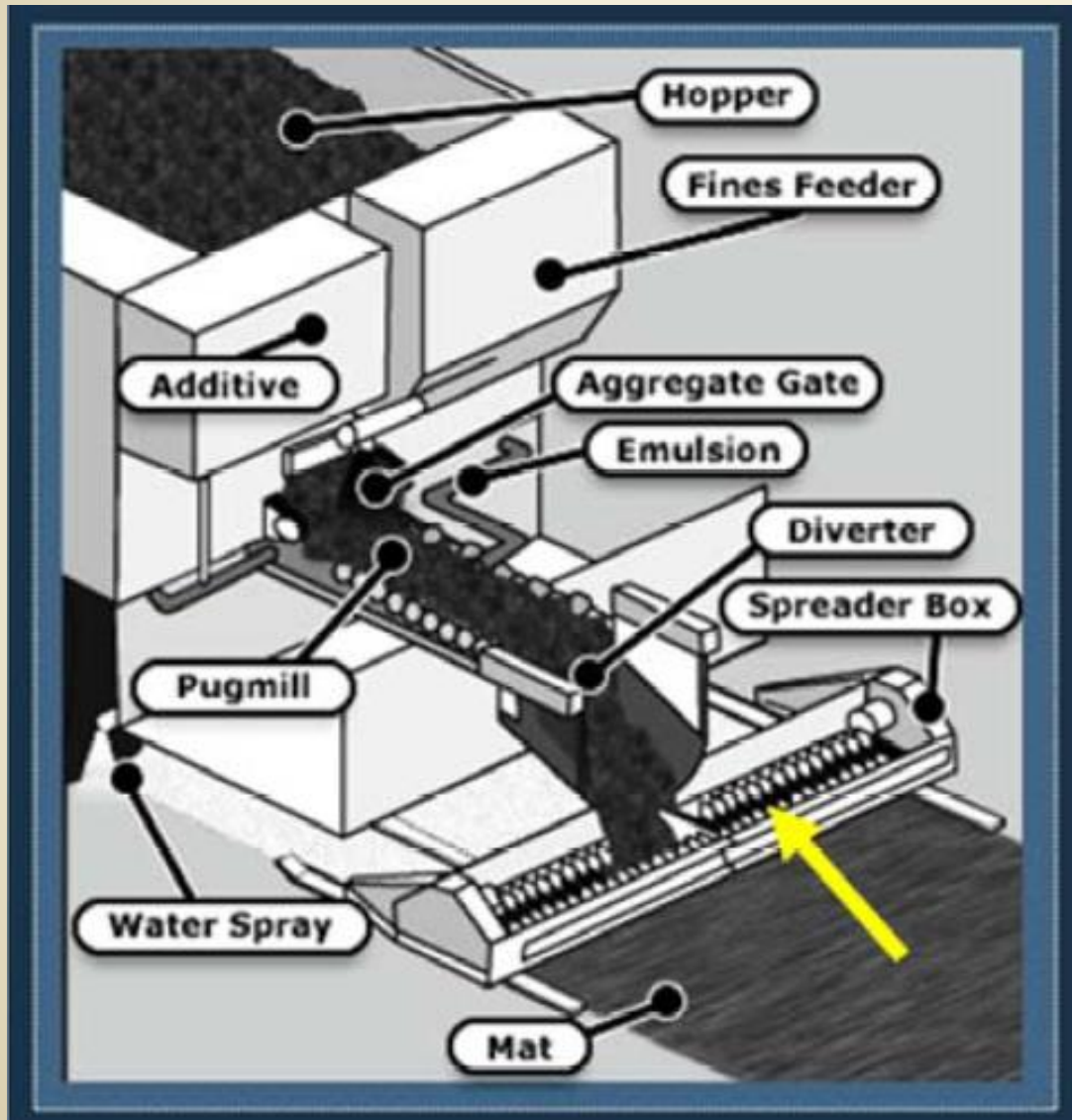
Emulsion

# Materials

- Cationic emulsions are most common
  - CSS-1h, CQS-1h, and QS-1h are all commonly used
- Only quick-set (QS) emulsions are used in micro surfacing
- Emulsion plays a key part in micro surfacing
- Mineral filler is used as a mixing aid allowing the mixing time to be extended and creating a creamy consistency that is easy to spread
- Additives may include: Emulsifier solutions, aluminum sulfate, aluminum chloride, borax, and lime



# Schematic of Application Equipment



To accommodate rapid- setting, controlled cure mixes, the micro machines are equipped with a continuous feed mixing shaft and augered laydown box. This ensures that there are no “dead” spots where mix can break and ball up.

# Micro for Rut-filling



Rut-filling box  
attachment for  
micro machine



# Micro for Rut-filling



# Micro Surfacing Applications

- Thin surfacing
- Can be laid at two to three times the thickness of the largest stone in the grading
- Emulsion in the system is always polymer modified and special additives are used to create a chemical break that is largely independent of weather conditions
- Can typically be opened to traffic within one hour or less of its application under range of conditions



# Thin Asphalt Overlays



# Thin Asphalt Overlays

- Traditional overlay process
- With or without milling
- Thickness between 0.75 inch and 1.50 inch
- Applicable for pavements in good condition
- Three types: Conventional dense-graded, open graded friction course (OGFC), and stone matrix asphalt (SMA)

# Key Topics of Discussion



Distress Identification



Maintenance Applications



**Combined Treatments**

# Cape Seals

- Purpose:
  - Seal and waterproof existing surface, eliminate loose chip by sealing with a slurry or micro surfacing mix.
- Types of emulsions:
  - Chip seal emulsions are anionic or cationic rapid-set with or without rejuvenating agents and/or polymer modifiers
  - Slurry or micro are cationic emulsions and usually have polymer modifiers



# Cape Scrub Seals

- Purpose:
  - Extend pavement life by sealing surface cracks in distressed surface prior to chip and slurry or micro surfacing. Slurry or micro eliminate loose chip and provide a smooth surface.
- Types of emulsion:
  - Cationic rapid setting emulsions, may have rejuvenating and polymer modifiers.

# Ultra-Thin Bonded Wearing Course

- Purpose:
  - An ultra-thin bonded wearing course is an application of asphalt emulsion immediately covered by a thin layer of hotmix. The emulsion is effectively drawn up into the hotmix to form a strong cohesive bond with both the pavement and the existing surface.
- Types of emulsion:
  - Cationic polymer modified formulations.

# PAVEMENT PRESERVATION Checklist Series



1 Crack Seal Application

2 Chip Seal Application

3 Thin Hot-Mix Asphalt Overlay

4 Fog Seal Application

5 Microsurfacing Application

6 Joint Sealing Portland Cement Concrete Pavements

7 Diamond Grinding of Portland Cement Concrete Pavements

8 Dowel-Bar Retrofit for Portland Cement Concrete Pavements



## Home Thin Hot-Mix Asphalt Overlay

1) Thin Hot-Mix Asphalt Overlay Checklist >



### Pavement Preservation Checklist Series

3

## Thin Hot-Mix Asphalt Overlay



1

### Pavement Preservation Checklist Series

## Crack Seal Application



# Six Asphalt Checklists

- To be developed by the National Center for Pavement Preservation
  - Tack Coat
  - Scrub Seal
  - Patching
  - High Friction Surface Treatments
  - Cap Seals
  - Ultrathin Bonded Wearing Course
- In addition to 10 existing checklists





# Free Web-based Training

FHWA/ISSA partnership

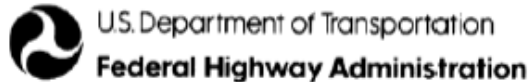
- Flexible surfaced
  - Chip Seal, Micro Surfacing, Slurry Seal Boxes

<https://www.slurry.org/page/indtrainingcourses>

# What questions do you have?



# For more information:



The Office of Technical Services

- *FHWA Resource Center*
- *National Highway Institute*
- *Technology Partnership Programs*

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