

# Asphalt Emulsions in Flexible Pavement Preservation: Part 1

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SPTC Workshop Series  
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# Outline

- ▶ Today (April 10, 2024)
  - Pavement preservation
  - Flexible pavement maintenance treatments
  - Asphalt emulsions
  - Asphalt emulsions in maintenance treatments
- ▶ Next week (April 17, 2024)
  - Asphalt emulsion quality control and testing
  - Specification best practices for asphalt emulsion maintenance treatments
  - Inspecting construction of asphalt emulsion treatments

**Lots to cover, let's get started!**

# Pavement preservation

- ▶ Agency
  - Federal Highway Administration (FHWA)
  - Oklahoma DOT (ODOT)
- ▶ Organizations
  - RoadResource.org
  - Transportation Research Board (TRB)
- ▶ Research
  - Strategic Highway Research Program 2 (SHRP 2)
  - University of Arkansas (UofA)



Micro surfacing in Arkansas

No one definition

# Pavement preservation: FHWA

- ▶ Work that is:
  - Planned and performed
  - Improves or sustains the condition of the transportation facility in a state of good repair
- ▶ When
  - Applying a pavement preservation treatment at the right time
- ▶ Where
  - On the right project
- ▶ How
  - With quality materials and construction



# Pavement preservation: ODOT

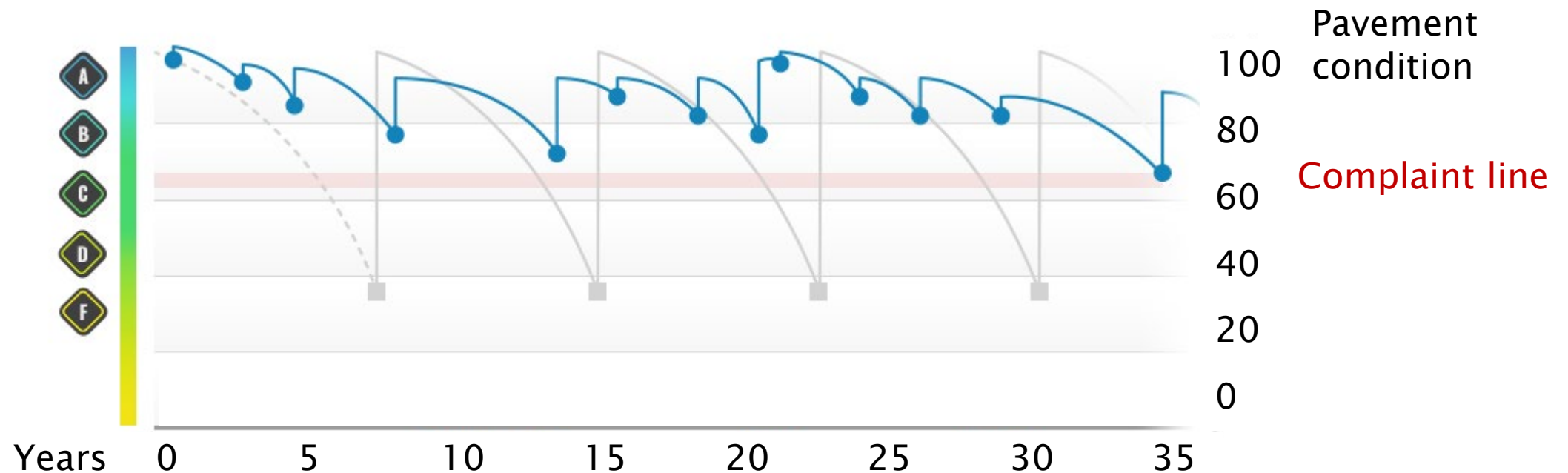
- ▶ From 2022-2031 Transportation Asset Management Plan
- ▶ Definition
  - Preserve/maintain system in state of good repair through risk-based, data-driven decision-making
- ▶ Normalized distress index
  - Preservation occurs in 88-93
- ▶ Treatments
  - Resurface, seal coat, micro surface, ultra thin



**OKLAHOMA**  
Transportation

# Pavement preservation: RoadResource.org

- ▶ Cost-effective, green approach
- ▶ Get most life out of your roads
- ▶ Making taxpayer dollars go further
- ▶ Faster application times



# Pavement preservation: TRB

- ▶ AKT20: Proactive use of cost-effective treatments to extend the life of existing pavements
- ▶ Compare to maintenance (AKT30):
  - Routine and reactive maintenance
  - Including deterioration and subsequent means/methods to treat resulting deficiencies



Braham and his research team at TRB

# Pavement preservation: SHRP 2

- ▶ Network-level, long-term strategy
- ▶ Enhances pavement performance
- ▶ Uses an integrated cost-effective set of practices to extend pavement life, improve safety, and meet motorist expectations
- ▶ Includes: preventive maintenance, minor rehabilitation, part of routine/corrective maintenance



(azmag.gov)

See “Guidelines for the Preservation of High-Traffic-Volume Roadways” by Peshkin et al., 2011



# Pavement preservation: UofA

Pedro and Andrew at "The Tent"

- ▶ Entire network in PCI A or B condition
  - Very good or good
- ▶ Remaining service life (RSL) = zero
  - Pavement network "static"
  - Does not change



RSL → lane mile years



# What is a pavement's purpose?

1. Safe traveling surface
2. Structural capacity
3. Water drainage
4. Surface friction
5. Smoothness



I-40 in eastern Arkansas

**All five required for proper performance**



# 1. SAFETY

2. Structural capacity

Pavement structure

- 3. Water drainage
- 4. Surface friction
- 5. Smoothness

Pavement surface

If structure is sound – can we just focus on the flexible pavement surface?

# Flexible pavement surface treatments

- ▶ Just liquids (least “intensive”)
  - Fog seal, rejuvenating fog seal, crack seal
- ▶ Liquids + rocks
  - Chip seal, slurry seal, scrub seal, micro surfacing
- ▶ Combination treatment
  - Chip seal/scrub seal plus fog seal
  - Cape seal (chip or scrub + slurry or micro)
- ▶ Asphalt mixture based (most “intensive”)
  - Ultrathin bonded wearing course (UTBWC)
  - Thin lift asphalt mixture



Chip seal asphalt emulsion in Wisconsin

# Surface treatments: liquids

## ▶ Crack seal

- >1/8” in summer, working crack; otherwise crack fill
- Place adhesive material into crack
- Prevents moisture, material infiltration into pavement
- Hot asphalt, polymer/rubber modified, asphalt emulsion
- Additional resources: ISSA Guideline A175 and NCHRP Report 784

## ▶ Fog seal

- Spray diluted asphalt emulsion
- Stops raveling, seals minor cracks, restores oxidized surface
- Can have rejuvenating components



Crack seal in Nebraska



International Slurry  
Surfacing Association:  
[slurry.org](http://slurry.org)

# Surface treatments: liquids + rocks

## ▶ Chip seal

- Asphalt emulsion/hot applied binder with aggregate chips distributed on top
- Provides skid resistance and impermeable layer, stops raveling, seals minor cracks
- ISSA Guideline A175

## ▶ Slurry surfacing (slurry and micro)

- Asphalt emulsion mixed with fine aggregate
- Provides skid resistance, restrict moisture intrusion, stops oxidation and raveling
- ISSA Guidelines A105, A115, A143



Chip seal in Kansas



Micro surfacing in Arkansas

# Surface treatments: combination

- ▶ Surface friction + color/retention:
  - First treatment: chip seal or scrub seal
  - Second treatment: fog seal
  - High surface friction from chip/scrub
  - Black color and aggregate retention from fog
- ▶ Cape seal
  - First treatment: chip seal or scrub seal
  - Second treatment: slurry surfacing
  - Impermeable layer, strong seal from chip/scrub
  - Smoother surface and surface friction from slurry/micro



Chip seal: both lanes, plus fog seal right lane  
(forconstructionpros.com)

**Get the best of both worlds!**

# Surface treatments: asphalt mixture

- ▶ Ultrathin bonded wearing course
  - Polymer modified asphalt emulsion + open graded asphalt mixture, <1” thick
  - Placed using a spray paver
  - Restores surface friction, provides new traveling surface, seals pavement surface
- ▶ Thin lift asphalt mixture
  - Asphalt mixture <1.5” thick (ultrathin <1.0”)
  - Restores surface friction, provides new traveling surface
  - FHWA Tech Brief: FHWA-HIF-19-053



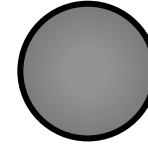
UTBWC in New York

**Lots of talk about asphalt emulsion – what is it?**



# What is an asphalt emulsion?

small particles of asphalt binder (~65%)

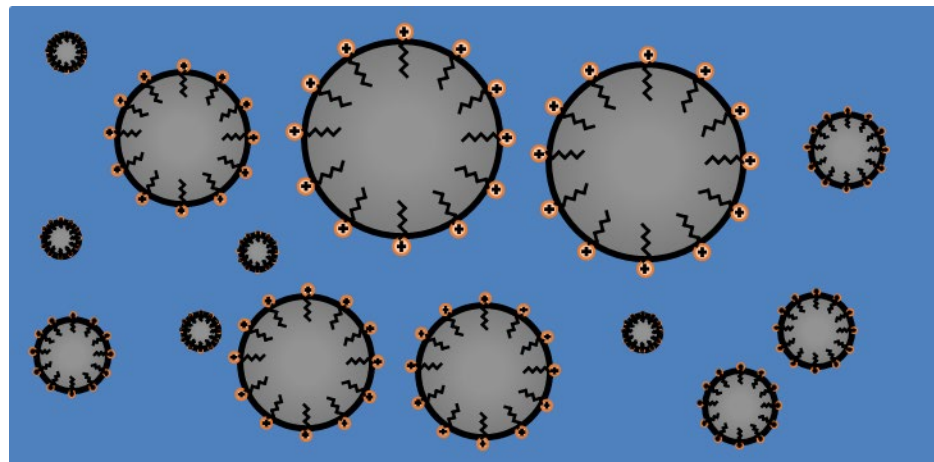


suspended in water (~33%)



asphalt binder can't be dissolved or mixed into the water

asphalt binder is suspended in water with the help of emulsifiers (~0.5-3.0%)



**Goal: low viscosity at ambient temperatures**

# Asphalt emulsion basics

## ▶ Setting speed

- Rapid (R)
- Quick (Q)
- Medium (M)
- Slow (S)

HF: High Float

“-1” → low viscosity      “-2” → high viscosity

## ▶ Particle charge

- Negative (anionic “\_\_\_”)
- Positive (cationic, “C”)
- Neutral (non-ionic)

“h” → hard

“s” → solvent

“P” → polymer

**CRS-1P: cationic, rapid set, low viscosity, polymer modified**

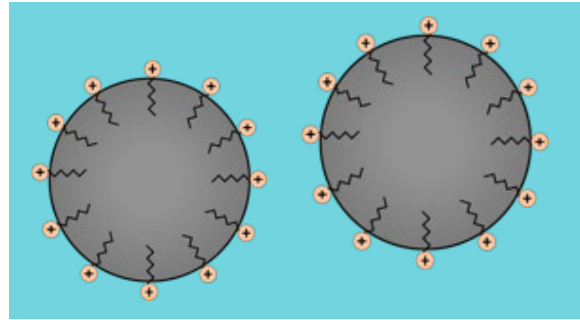
**HFMS-2s: high float, anionic, medium set, high viscosity, solvent**

# Why asphalt emulsions?

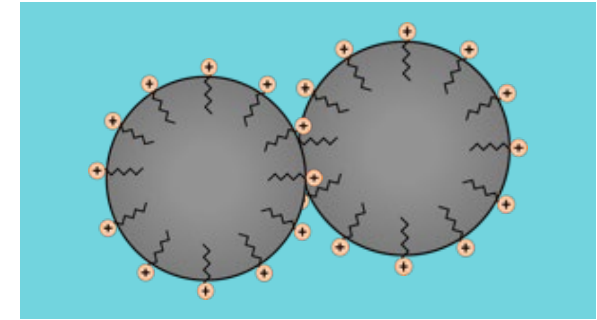
- ▶ Three ways to reduce viscosity of asphalt binder
  - Heat (hot mix, warm mix)
  - Cutback/solvent (i.e. diesel fuel)
  - Asphalt emulsion
- ▶ Emulsions applied at ambient temperatures
  - Reduced emissions
  - Reduce energy consumption
  - Increased safety
  - Less aging of asphalt binder vs. heat

How do they work? Breaking and curing

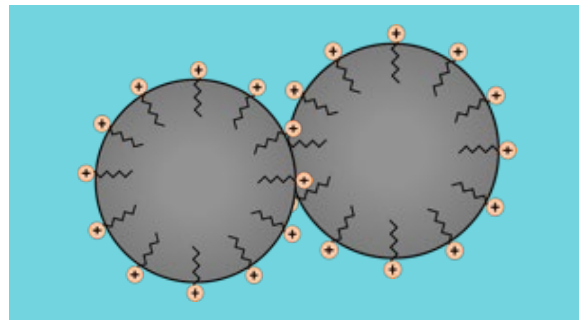
# Breaking: flocculation and coalescence



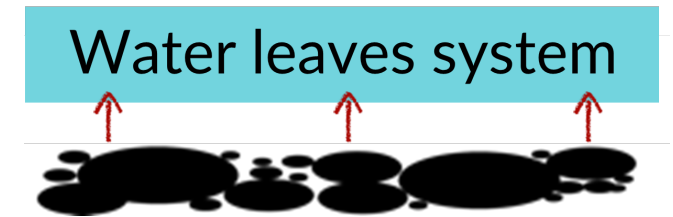
Flocculation



- Stirring
- Diluting
- Adding more emulsifier



Coalescence



- Gravity, freezing
- Water evaporating
- Shearing forces
- Emulsion pH

# Curing: mechanical properties

HIR in Kansas

- ▶ Water is removed from the system
- ▶ Asphalt emulsion reverts to solid
- ▶ Asphalt binder adheres to surface

Mix



Spray



Spraying a double chip seal in New York

# Asphalt emulsions additives

- ▶ Wetting agents
  - Help surface coating
- ▶ Anti-strips
  - Helps asphalt emulsion residue stick to surface
- ▶ Evaporation control agents
  - Determines water evaporation rate
- ▶ Stabilizers
  - Helps keep asphalt emulsion suspended
- ▶ Performance modifiers
  - Polymer, latex → improves cohesion, reduces cracking

# Asphalt emulsions in treatments

- ▶ AASHTO R 5
- ▶ 13 treatments defined
- ▶ Four types (reactivity)
  - Slow, medium, rapid, quick
- ▶ Three classes (charge)
  - Cationic, anionic, high float
- ▶ Two grades (viscosity)
  - High and low
- ▶ Three stiffness (penetration)
  - Hard, soft, standard



Scrub seal in Arkansas  
(photo by D. Gardner)

Based on FHWA-IF-00-027 (2000)

# Slow set emulsions in treatments

	SS-1	SS-1h	CSS-1	CSS-1h
Dense graded	X	X	X	X
Slurry seal	X	X	X	X
Scrub seal			X	X
Fog seal	X	X	X	X
Prime coat	X	X	X	X
Tack coat	X	X	X	X
Crack filler	X	X	X	X



# Medium set emulsions in treatments

	MS-1	HFMS-1	MS-2	HMS-2	HFMS-2s	CMS-2
Dense graded					X	
Sand seal	X	X				
Slurry seal					X	
Fog seal	X	X	X	X	X	X
Prime coat			X	X		
Tack coat	X	X				
Crack filler					X	

# Rapid set emulsions in treatments

	RS-1	RS-2	HFRS-2	CRS-1	CRS-2
Dense graded					
Chip seal	X	X	X	X	X
Sand seal	X	X	X	X	X
Slurry seal					
Sandwich seal		X	X		X
Scrub seal					
Fog seal		X	X		X
Prime coat					
Tack coat	X	X		X	X
Crack filler					

# Quick set emulsions in treatments

	CQS-1	CQS-1h
Slurry seal		X
Tack coat	X	X

# Polymer modified emulsions in treatments

	CRS and CHFRS (2hP, 2P, 2sP)	CQS-1hP, CQS-1P	CRS-1P, SS-1hP, CSS-1hP
Chip seal	X		
Micro surfacing		X	
Sandwich seal	X		
Tack coat			X

# For preservation: in general



Rapid Set



Medium Set  
Slow Set

# Wrap up

## ▶ Today

- Pavement preservation
- Flexible pavement maintenance treatments
- Asphalt emulsions
- Asphalt emulsions in maintenance treatments

## ▶ Next week (April 17, 2024)

- Asphalt emulsion quality control and testing
- Specification best practices for asphalt emulsion maintenance treatments
- Inspecting construction of asphalt emulsion treatments



Slurry seal in New York

Questions? Thank you! [afbraham@uark.edu](mailto:afbraham@uark.edu)



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# Slow set emulsions in treatments

	SS-1	SS-1h	CSS-1	CSS-1h
Dense graded	X	X	X	X
Slurry seal	X	X	X	X
Scrub seal			X	X
Fog seal	X	X	X	X
Prime coat	X	X	X	X
Tack coat	X	X	X	X
Crack filler	X	X	X	X



# Medium set emulsions in treatments

	MS-1	HFMS-1	MS-2	HMS-2	HFMS-2s	CMS-2
Dense graded					X	
Sand seal	X	X				
Slurry seal					X	
Fog seal	X	X	X	X	X	X
Prime coat			X	X		
Tack coat	X	X				
Crack filler					X	

# Rapid set emulsions in treatments

	RS-1	RS-2	HFRS-2	CRS-1	CRS-2
Dense graded					
Chip seal	X	X	X	X	X
Sand seal	X	X	X	X	X
Slurry seal					
Sandwich seal		X	X		X
Scrub seal					
Fog seal		X	X		X
Prime coat					
Tack coat	X	X		X	X
Crack filler					

# Quick set emulsions in treatments

	CQS-1	CQS-1h
Slurry seal		X
Tack coat	X	X

# Polymer modified emulsions in treatments

	CRS and CHFRS (2hP, 2P, 2sP)	CQS-1hP, CQS-1P	CRS-1P, SS-1hP, CSS-1hP
Chip seal	X		
Micro surfacing		X	
Sandwich seal	X		
Tack coat			X