

# Asphalt Emulsions in Flexible Pavement Preservation: Part 2

Andrew Braham, Professor  
University of Arkansas – Fayetteville  
SPTC Workshop Series  
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# Outline

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

Let's continue!

# Asphalt emulsion recap

## ▶ Setting speed

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

## ▶ Particle charge

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

## ▶ P → polymer

## Linking to standards

AASHTO M 316: Polymer Modified  
(11 grades)

AASHTO M 208: Cationic  
(12 grades)

AASHTO M 140: Emulsified Asphalt  
(15 grades)

Let's take a look at M 208

# M 208: Cationic asphalt emulsion

Grade	CQS-1h		CQS-1		CMS-2h	
	Min	Max	Min	Max	Min	Max
<i>Tests on emulsified asphalt:</i>						
Viscosity, Saybolt Furol at 25°C (77°F), s <sup>b,c</sup>	20	100	20	100		
<i>Or</i>						
Viscosity, Rotational Paddle at 25°C (77°F), mPa·s <sup>b,c</sup>	40	200	40	200		
Viscosity, Saybolt Furol at 50°C (122°F), s <sup>b,c</sup>					50	450
<i>Or</i>						
Viscosity, Rotational Paddle at 50°C (122°F), mPa·s <sup>b,c</sup>					100	900
Storage stability test, 24 h, % <sup>b,c</sup>						
Particle charge test <sup>b</sup>		Positive		Positive		Positive
Sieve test, % <sup>b,c</sup>		0.10		0.10		0.10
Cement mixing test, %						
Distillation:						
Oil distillation, by volume of emulsified asphalt, %						12
Residue, % <sup>d</sup>	62		62		65	
<i>Tests on residue from distillation:</i>						
Penetration, 25°C (77°F), 100 g, 5 s, 0.1 mm	40	90	90	250	40	90
Ductility, 25°C (77°F), 5 cm/min, cm	40		40		40	
Ash content, %		1		1		1

What is another way to look at this? AASHTO T 59

# T 59: Emulsified asphalt tests: emulsion

## ► Composition

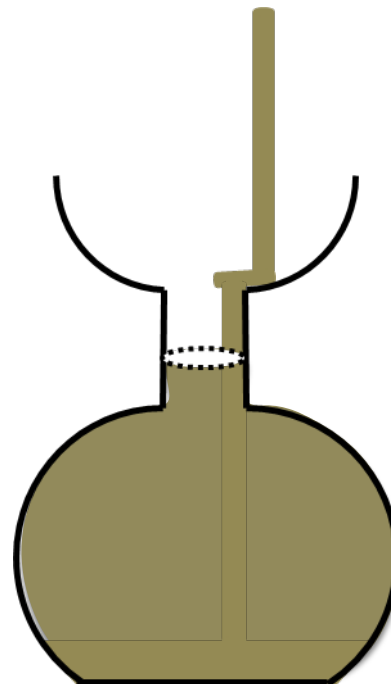
- Water Content
- Residue and Oil Distillate by Distillation
- Residue by Evaporation
- Particle Charge

## ► Consistency

- Viscosity (Saybolt and Paddle)



Distillation ([humboldtmet.com](http://humboldtmet.com))



Saybolt



Paddle  
([cannoninstrument.com](http://cannoninstrument.com))

# T 59: Emulsified asphalt tests: emulsion

## ▶ Stability

- Demulsibility
- Cement Mixing
- Sieve Test
- Storage Stability
- Settlement

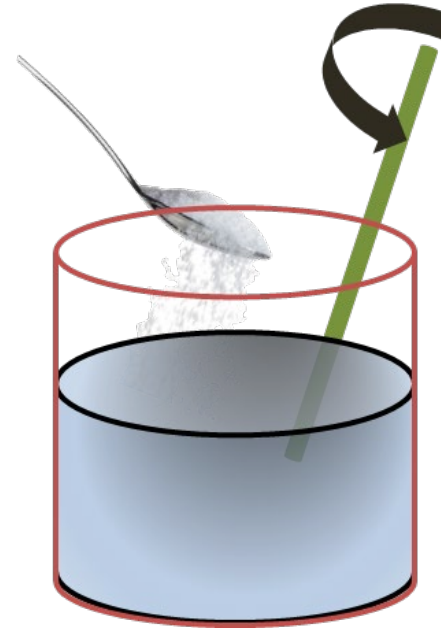
## ▶ Coating tests

- Lab and field

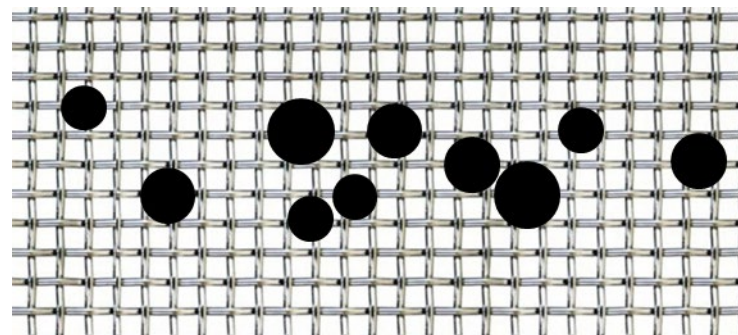
## ▶ Density



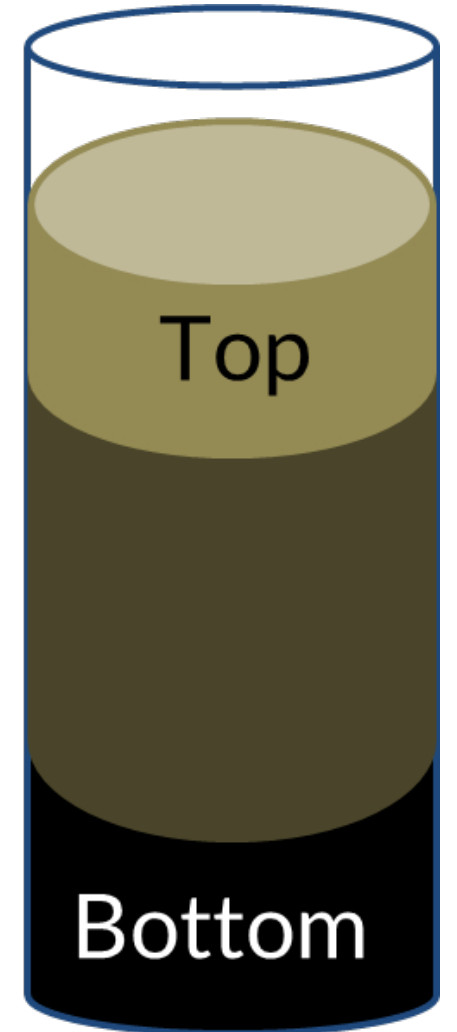
Demulsibility



Cement Mixing



Sieve

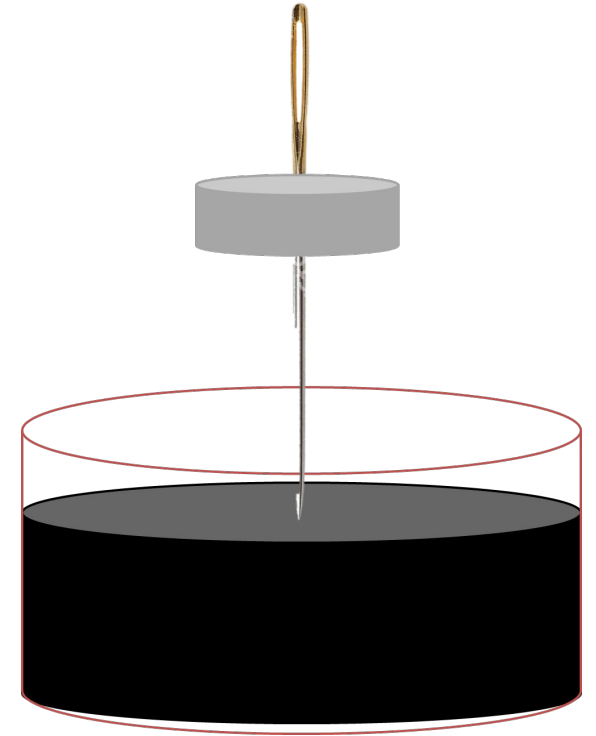


Storage Stability

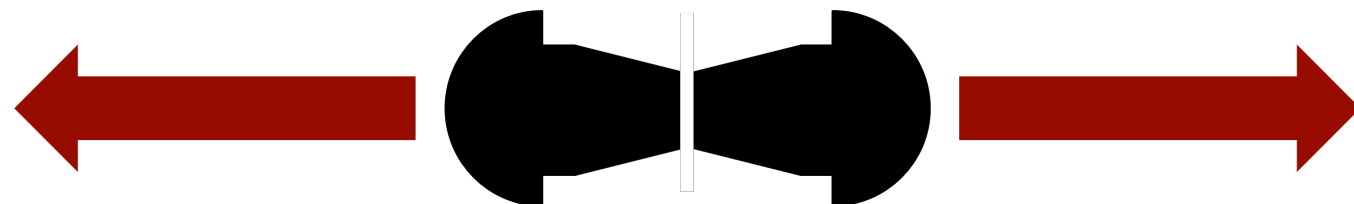
# T 59: Emulsified asphalt tests: residue

- ▶ Specific Gravity
- ▶ Ash Content
- ▶ Solubility in Trichloroethylene
- ▶ Penetration
- ▶ Ductility
  - Pull to break or limit
- ▶ Float Test

Penetration



Ductility



# Additional tests of note

## ▶ Residue recovery

- T 59, Section A: 500°F (260°C), 15 minutes
- T 59, Section B: 325°F (163°C), 4 hours
- R 78, Procedure A: 77°F (25°C) + 140°F (60°C), 24 + 24 hours
- R 78, Procedure B: 140°F (60°C), 6 hours (thinner than A)
- Track NCHRP 09-63, Asphalt Institute

## ▶ Elastic recovery

- Pull, stretch, cut, recover
- Polymer modified only

## ▶ Softening point



R 78, Procedure A

These are the tests,  
what about quality?

Two perspectives:  
lab and field



# Lab quality: AASHTO R 18

- ▶ Establishing Quality Management System (QMS)
- ▶ Eight management areas
  - Document control
  - Organization
  - Staff (including QMS manager)
  - Technician training and evaluation
  - Internal audits
  - Management reviews
  - Corective action
  - Records retention
- ▶ Nine technical requirements
  - Equipment lists
  - General equipment procedures
  - Individual equipment procedures
  - Equipment intervals
  - Equipment records
  - Sample management
  - Test records/reports
  - Subcontracting
  - Assuring quality of results

What about in the field?

# Field quality: emulsion example

Process Control Test	Test Method	Minimum Frequency
Viscosity	AASHTO T 59 or T 382	Once per 48,000 gal (181,700 L) of asphalt emulsion placed.
Temperature	N/A	Once per delivery tanker.
Particle Charge	AASHTO T 59	Prior to loading emulsion distributor
Demulsibility	AASHTO T 59	Once per 48,000 gal (181,700 L) of asphalt emulsion placed.
Sieve	AASHTO T 59	Once per 48,000 gal (181,700 L) of asphalt emulsion placed.
Storage Stability	AASHTO T 59	Once per 48,000 gal (181,700 L) of asphalt emulsion placed.
Residue**	AASHTO R 78	Once per 48,000 gal (181,700 L) of asphalt emulsion placed.
Application Rate	Computer Printout, Volumetric Measurement, Plate on Roadway	Once at startup each production day, then each 48,000 gal (181,700 L) of asphalt emulsion placed.

Next, pivot to treatments

# Emulsion based maintenance treatments

- ▶ In Braham's mind
  - Maintenance = surface treatments
  - Rehabilitation = structural treatments
- ▶ Maintenance treatments
  - Fog seal (standard and rejuvenating)
  - Chip seal, sand seal, and scrub seal
  - Slurry surfacing (slurry and micro)
  - Ultra thin bonded wearing course
  - Combination treatment



Rejuvenating fog seal (RoadResource.org)

Several AASHTO resources

# AASHTO Resources

Emulsion Treatment	Material Standard	Design Practice Standard	Construction Guide	Quality Guide
Chip seal	AASHTO M 340	AASHTO R 102	NCHRP 14-37	Yes
Micro surfacing	AASHTO M 341	AASHTO R 103	NCHRP 14-37	Yes
Slurry seal	AASHTO M 342	AASHTO R 104	NCHRP 14-44	Yes
Fog seal	AASHTO M 343	AASHTO R 105	NCHRP 14-37	No
Sand seal	AASHTO M 344	AASHTO R 106	NCHRP 14-48	Yes
Scrub seal	AASHTO M 345	AASHTO R 107	NCHRP 14-44	Yes
Ultrathin bonded overlay	AASHTO M 346	AASHTO R 108	NCHRP 14-48	Yes

[Search “Emulsion Task Force”](#)  
[Click specifications – some drafts available](#)

# AASHTO chip seal materials (M 340)

- ▶ Asphalt emulsion
  - M 140, M 208, M 316
- ▶ Aggregate
  - Four gradations (single size, low dust)
  - Fracture, abrasion requirements

Sieve Size (see T 11 or T 27)	Passing, %			
	A	B	C	D <sup>a</sup>
3/4 in.	100	—	—	—
1/2 in.	90–100	100	—	—
3/8 in.	5–30	90–100	100	100
No. 4	0–10	5–30	90–100	0–65
No. 8	—	0–10	5–30	0–15
No. 16	0–2	—	0–10	0–10
No. 30	—	0–2	—	—
No. 50	—	—	0–2	0–6
No. 200	0–1	0–1	0–1	0–3

<sup>a</sup> Limit use to Class I chip seals as defined in Table 2.

Property	Chip Seal Class <sup>a</sup>		
	I	II	III
Fracture, 1 Face, % min (see T 335)	70	85	95
Fracture, 2 Faces, % min (see T 335)	60	80	90
Los Angeles Abrasion, max % loss (see T 96)	40	35	30
Flakiness Index Value, max % (see FLH T 508)	35	30	25

<sup>a</sup> Class I is less than ≤500 AADT; Class II is 501–5000 AADT; and Class III is greater than 5000 AADT.



# AASHTO chip seal design (R 102)

- ▶ Aggregate – board test for spread rate
- ▶ Asphalt emulsion
  - Embedment rate
  - Traffic
  - Existing surface

$$A = \frac{\left\{ 5.61e \times d \times \left[ 1 - \left( \frac{W}{62.4G} \right) \right] T \right\} + V}{R}$$

where:

$A$  = emulsified asphalt quantity, gal/yd<sup>2</sup>;

5.61 = constant for converting the units to gal/yd<sup>2</sup>

$e$  = percent embedment from Figure 1 expressed as a decimal;

$d$  = average mat depth, 1.33  $Q/W$ ;

$Q$  = quantity of chips from the board test, lb/yd<sup>2</sup>;

$W$  = dry loose unit weight of chips, pcf (see T 19M/T 19, Section 12 on shoveling);

62.4 = unit weight of water, pcf

$G$  = dry bulk specific gravity of chips (see T 84 and T 85);

$T$  = traffic correction factor from Table 1;

$V$  = pavement surface correction factor; and

$R$  = emulsified asphalt residue, expressed as a decimal, e. g., 0.65 = 65 percent

# AASHTO construction guide overview

▶ Seven sections total

1. Description

406.1.

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**DESCRIPTION**

This guide specification is intended to provide information needed for owners or contractors to construct emulsified asphalt chip seals. An emulsified asphalt chip seal is the application of emulsified asphalt, followed immediately by a single layer of aggregate chips to a prepared surface.

2. Referenced documents

3. Terminology

4. Materials



References M 140, M 208, M 316, M 340, R 102

★ 5. Construction

6. Measurement

7. Payment



Unit price or completed chip seal

**Key section is construction**

# AASHTO construction guide: construction

- ▶ Equipment
  - Asphalt distributor, aggregate spreader, pneumatic-tire roller, brooms, trucks
- ▶ Equipment calibration
  - Distributor: nozzle angle, spray bar height, transverse/longitudinal flow rate
  - Spreader: transverse/longitudinal spread rate
- ▶ Preconstruction meeting
- ▶ Road surface preparation
  - Cleaning pavement, protecting accessories, stripe removal
- ▶ Application
  - Weather, test strip, emulsion and aggregate placement, paper joints, rolling, sweeping, traffic control, protecting motor vehicles, fog seal

**Lots of good details**



# AASHTO quality assurance guide

- ▶ Quality Assurance
  - AASHTO R 10: definitions
  - Includes: Quality Control (QC), agency acceptance, Independent Assurance (IA)
- ▶ Quality control
  - Personnel, labs and equipment, activities, contractor's plan, records and documentation, compliance with specifications
- ▶ Agency acceptance
  - Sampling and testing, traffic control, surface preparation, calibration, equipment, application rate, production inspection
- ▶ Independent assurance
  - Unbiased/independent evaluation
  - FHWA-HIF-12-001 (2011)

More good details!

# We just scratched the surface

Emulsion Treatment	Material Standard	Design Practice Standard	Construction Guide	Quality Guide
Chip seal	AASHTO M 340	AASHTO R 102	NCHRP 14-37	Yes
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Ultrathin bonded overlay	AASHTO M 346	AASHTO R 108	NCHRP 14-48	Yes

Next up: inspection

# The different lenses of inspection

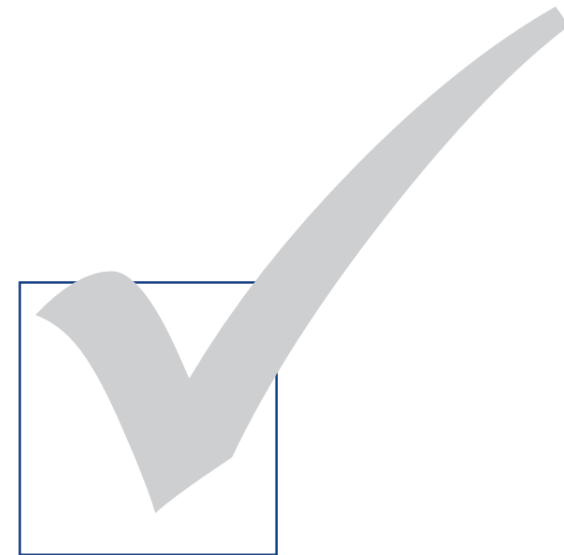
- ▶ Two key resources for flexible pavement preservation
  - FHWA Pavement Preservation Checklist Series
  - ISSA's Design & Inspection Manual
- ▶ FHWA: free of charge
  - Search “2019 Pavement Preservation Checklists”
  - Fog seal, chip seal, scrub seal, slurry seal, micro surfacing, cape seal, UTBWC
- ▶ ISSA: free if you are a member
  - Deep dive into slurry seal and micro surfacing

FHWA: chip seal

# FHWA-HIF-19-029: responsibilities

- ▶ Preliminary
- ▶ Pre-application inspection
- ▶ Project inspection
- ▶ Opening to traffic
- ▶ Cleanup
- ▶ Bonus sections

## 2 Chip Seal



(FHWA)

Breaking each category down

# FHWA-HIF-19-029: preliminary

- ▶ Document review
- ▶ Project review
  - Is the project a good candidate?
- ▶ Materials checks
  - Emulsion-based and asphalt rubber/hot applied
  - Compatibility of binder and aggregate, approved suppliers, proper sampling/testing of properties

## Document Review

- Project specifications
- Traffic control plan
- Construction manual
- Agency requirements
- Manufacturer's instructions
- Safety data sheets
- Applicable Occupational Safety and Health Administration (OSHA) safety requirements
- Certification requirements
- Contractor quality control (QC) plan

(FHWA)

# FHWA-HIF-19-029: pre-application inspection

- ▶ Pavement surface preparation
- ▶ Equipment inspection
  - Distributor, chip spreader, haul trucks, rollers, sweepers
- ▶ Weather
- ▶ Determining application rates
  - Existing surface, traffic level, aggregate
- ▶ Checking application rates
  - Two asphalt, two aggregate methods
- ▶ Traffic control

## Weather Requirements

- ❑ Follow the range of dates established by the agency when chip sealing can be performed.
- ❑ Construct a chip seal only during daylight hours.
- ❑ Air and surface temperatures have been checked at the coolest location on the project.
- ❑ Air and surface temperatures is 50°F and rising unless warranted by agency requirements.
- ❑ Suspend chip sealing if pavement temperatures exceed 140°F unless warranted by agency requirements.
- ❑ Construct chip seal only when chance for precipitation is zero or very low.
- ❑ High winds can create problems with asphalt application. Work should be avoided when wind speeds exceed 20 mph.
- ❑ Air and pavement surface temperatures, humidity and wind will affect how long the asphalt emulsion takes to break.

(FHWA)

# FHWA-HIF-19-029: project inspection

- ▶ Asphalt application
- ▶ Aggregate application
- ▶ Truck operation
- ▶ Rolling
- ▶ Longitudinal joints
  - Method A: exposed strip of asphalt
  - Method B: end nozzle turned 90°
- ▶ Transverse joints
- ▶ Sweeping

## Longitudinal Joints

- ❑ The distributor lines up so that the end nozzle sprays the longitudinal joint.
- ❑ The longitudinal joint should be overlapped 2–4 in. for uniform appearance.
- ❑ The longitudinal joints are never made in the wheel paths.
- ❑ The longitudinal joints are made at the center of the road, center of a lane, or edge of a lane.
- ❑ The longitudinal joints are not left uncovered overnight.

(FHWA)

# FHWA-HIF-19-029: opening to traffic

- ▶ Control traffic speed with pilot vehicles
- ▶ 25 mph speed limit until swept
- ▶ Reduced speed limit signs when no pilot vehicle
- ▶ Temporary pavement markings after sweeping
- ▶ Remove all construction related signs after opening pavement
- ▶ Traffic can return to asphalt rubber/hot applied once final sweeping complete



# FHWA-HIF-19-029: cleanup

- ▶ Sweep loose aggregate
  - Loose aggregate can't be reused for chip seal
- ▶ Temporary staging areas returned to pre-construction condition
  - For construction equipment and stockpiles



(mntransportationresearch.org)

# FHWA-HIF-19-029: bonus sections

## ▶ Common problems

- Aggregate embedment >80% or <50%
- Excessive asphalt splattering
- Streaking/drill marks in asphalt
- Exposed asphalt after aggregates
- Excessive/uneven aggregate
- Asphalt on top of aggregate
- Dislodged chips
- Asphalt bleeding/flushing

## ▶ Web based training

## ▶ Sources/references

## ▶ Contact information

### **Chips Being Dislodged:**

- Asphalt application rate is too low.
- Aggregate is dirty or dusty.
- Traffic or equipment speeds are too high.
- Emulsion break occurred before the aggregate was placed and rolled. If asphalt rubber or hot applied chip seal, the asphalt had set before the aggregate was placed and rolled.
- Sweeping has been started before the asphalt emulsion has properly set.

(FHWA)

# All the checklists

## 2019 Pavement Preservation Checklists

- [Crack Treatment](#) , FHWA-HIF-19-028
- [Chip Seal](#) , FHWA-HIF-19-029
- [Thin Hot Mix Asphalt Overlay](#), FHWA-HIF-19-030
- [Fog Seal](#) , FHWA-HIF-19-032
- [Micro Surfacing Application](#) , FHWA-HIF-19-031
- [Hot In Place Asphalt Recycling Application](#) , FHWA-HIF-19-034
- [Cold In Place asphalt Recycling Application](#) , FHWA-HIF-19-035
- [Slurry Seal Application](#) , FHWA-HIF-19-036
- [Fabric Interlayer Application](#), FHWA-HIF-19-037
- [Full Depth Reclamation Construction](#), FHWA-HIF-19-038
- [Asphalt Emulsion Based Tack Coat](#) , FHWA-HIF-19-039
- [Scrub Seal](#), FHWA-HIF-19-040
- [HMA Asphalt Patching](#) , FHWA-HIF-19-041
- [High Friction Surface Treatments](#), FHWA-HIF-19-042
- [Cape Seals](#), FHWA-HIF-19-043
- [Ultrathin bonded wearing course](#), FHWA-HIF-19-044
- [Joint and Crack Sealing](#) , FHWA-HIF-19-045
- [Diamond Grinding](#), FHWA-HIF-19-046
- [Dowel Bar Retrofit](#), FHWA-HIF-19-047
- [Partial Depth Repair](#), FHWA-HIF-19-048
- [Full Depth Repair of Portland Cement Concrete Pavements](#), FHWA-HIF-19-049
- [Cross-Stitching for Portland Cement Concrete Pavements](#), FHWA-HIF-19-050
- [Longitudinal Diamond Grooving of Portland Cement Concrete Pavements](#), FHWA-HIF-19-051

<https://www.fhwa.dot.gov/pavement/preservation/ppcl00.cfm>

# Additional resources

- ▶ Arkansas Pavinars (free!)
  - YouTube series: search “Pavinar”
  - Design, rigid pavement, flexible pavement, sustainability, my students, research tips
- ▶ ISSA college classroom modules (free if faculty!)
  - International Slurry Surfacing Association
  - 2-weeks of content, PowerPoints, lecture aids, class project
  - Search “ISSA classroom modules”
- ▶ Asphalt emulsion certificates (\$\$)
  - University of Arkansas: online, on demand
  - Introduction, application, manufacture, quality
  - Search “Arkansas asphalt emulsion”





# Wrap up

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- ▶ Today
  - Asphalt emulsion quality control and testing
  - Specification best practices for asphalt emulsion maintenance treatments
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Scrub seal (RoadResource.org)

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



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ARKANSAS®

**Andrew F. Braham, Ph.D., P.E.**

*Professor*

*Civil Engineering*

4190 Bell Engineering Center  
Fayetteville, AR 72701  
e-mail: [afbraham@uark.edu](mailto:afbraham@uark.edu)

Phone: 479-575-6028  
Fax: 479-575-7168  
[www.andrewbraham.com](http://www.andrewbraham.com)

# Field quality: emulsion example

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