

### **NCHRP 10-114**

Developing Performance and Safety Specifications for Rejuvenating Seals

AASHTO TSP•2 - Emulsion Task Force (ETF) Meeting
June 6, 2025

## Objectives

- Characterize rejuvenating seals based on chemistry and rheology,
- Determine how different rejuvenating compounds are penetrating and rejuvenating the underlying pavement,
- Determine how the desired performance for a rejuvenating seal is measured and quantified (laboratory and field),
- Determine the life-extending benefit (LEB) and impact on friction properties
  of a rejuvenating seal (laboratory and field), and
- Guide on selecting a rejuvenating seal's optimum dose and application rate.
- 36 months: 08/04/2022 to 08/04/2025

10-month no-cost extension requested (pending)



## Research Approach



### Phase I

- Task 1. Literature review
- Task 2. Review previous work related to similar preservation treatments and survey
- Task 3. Materials Selection
- Task 4. Interim report

### Phase II

Task 5. Determine the efficacy of rejuvenating additives in rejuvenating seals



- Task 6. Determine the LEB of a rejuvenating seal
- Task 7. Determine the effect of rejuvenating seals on pavement friction, and macro texture and micro texture properties
- Task 8. Guide dosage selection
- Task 9. AASHTO specification
- Task 10. Final deliverables

## Materials Selection

Collect 12 products, including both petroleum- and bio-based rejuvenators.

Product Name	Producer	Description				
BioRestor® BioRestor® Low VOC	BioBased Spray Systems LLC					
BioMAG <sup>TM</sup>	Iowa State University					
Invigorate <sup>TM</sup>		Bio-based				
Delta Mist® RPE-R	Collaborative Aggregates LLC H. G. Meigs, LLC					
RePlay™	BioSpan Technologies					
GSB-88®	Asphalt Systems, Inc.	Hybrid product containing bio- and petroleum-based components				
ARA1 Ti CRF®	Tricor Refining, LLC	Detroloure bood				
Reclamite <sup>®</sup> Replenify <sup>™</sup>	Pavement Technology, Inc. Flint Hills Resources	Petroleum-based				

### NCAT and MnROAD Field Sections

**NCAT Test Track** 



### **MnROAD**



## Phase II Work Plan (5 Tasks)

1 Determine the Efficacy of Rejuvenating Additives in Rejuvenating Seals



- 2 Determine the Life Extending Benefit (LEB) of a Rejuvenating Seal (laboratory and field)
- Determine the Effect of Rejuvenating Seals on Pavement Friction, and Macrotexture and Microtexture Properties
- 4 Guide Dosage Selection

**5** AASHTO Specification

# Task 5. Determine the Efficacy of Rejuvenating Additives in Rejuvenating Seals

- Three approaches
  - Experiment 1. Stand-alone characterization of rejuvenating seals.
  - Experiment 2. Characterization of rejuvenating seals after application on the pavement surface.
  - Experiment 3. Evaluation of the potential interrelationship between pavements' permeability and rejuvenating seals' chemical characteristics.

# **Experiment 1**. Stand-alone Characterization of Rejuvenating Seals: Gas Chromatograph/Mass Spectrometry (GC/MS)

	Characteristic							
Product	Petroleum Asphalt	Triglyceride Fatty Acid	Fatty Acid Ester	Carrier	Surfactant	Glycol Ether	Phthalate	Polymer
Product 1			Χ	Χ				X
Product 2			Χ		X			X
Product 3			Χ	Χ				Χ
Product 4			X					Χ
Product 5, Part A		Χ				Χ		
Product 5, Part B		X		Χ				
Product 6		X						
Product 7		X			Χ			
Product 8, Part A							Χ	Χ
Product 8, Part B	X	X						
Product 9	X							
Product 10	X							
Product 11	X							
Product 12	Χ							



# **Experiment 2.** Characterization of Rejuvenating Seals after Application on Pavement Surface

### **SARA** fractions key findings

- Depending on base binder chemistry, spray-on rejuvenators can perform differently.
- Varying levels of effectiveness observed across different products.
- Some products slowed the increase in asphaltenes → reduction in oxidative aging.
- Other products preserved aromatics and resins → better balance within SARA fractions.
- Certain products accelerated asphaltene formation  $\rightarrow$  potential ineffectiveness.
- Important qualification:
  - Highly polar bio-oil molecules may precipitate with asphaltenes.
  - These molecules may still enhance rheology despite precipitation.

# **Experiment 2.** Characterization of Rejuvenating Seals after Application on Pavement Surface

### FTIR key findings

- Control binders showed most oxidation (C=O + S=O increase) between 1 and 12 months.
- Petroleum-based products showed stable, gradual oxidation over 24 months.
- Bio-based and hybrid products had more variability.
- Early oxidation data may not fully reflect long-term binder performance; focus on  $\Delta_{@24 \text{ months}}$  for meaningful comparison.

# Task 6. Determine the Life Extending Benefit (LEB) of a Rejuvenating Seal (laboratory and field)

 The methodology developed compares performance over time of <u>treated</u> <u>versus</u> untreated pavements.

LEB: difference in the time required to reach a threshold cracking value for treated and

% Cracking

0.0

2.0

Life-extending benefit

--A-- Good - Untreated

10.0

untreated sections.



- Existing field and laboratory data (AL, MN)
- Rheological properties (stiffness and relaxation)
- Time for rejuvenated sections to return to values similar to untreated
- Binder test results will correlate directly with field performance data

## Task 7. Determine the Effect of Rejuvenating Seals on Pavement Friction, and Macro Texture and Micro Texture Properties

Field and laboratory experiments

Pavement micro texture



Locked Wheel Skid Trailer (LWST)



Dynamic Friction Tester (DFT)

Pavement macro texture





Circular Track Meter (CTM)

Traffic simulation



Three-Wheel Polishing Device (TWPD)

# Task 7. Determine the Effect of Rejuvenating Seals on Pavement Friction, and Macrotexture and Microtexture Properties

### Field Experiment

One bio-based and one petroleum-based treatment was applied in October.
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## Field Experiment

### Bio-based Product 6:

- Immediate friction reduction on the inside wheel path.
- Partial recovery (50%) in 24-96 hours (dependent on application rate).
- Full recovery in 32-35 days (including 18-21 days of truck traffic).
- Outside wheel path: minimal friction loss, rapid recovery (24 h).
- No significant or lasting surface texture changes.

#### Petroleum-based Product 10:

- Immediate friction reduction.
- Full recovery in 8 days (low application rate) and 21 days (high application rate).
- Outside wheel path: smaller friction loss, immediate recovery after sand removal.
- No measurable surface texture changes.

#### Common Observations:

- Sand mitigated application rate effects.
- Consistent behavior across both Sections E7 and E4.

## Task 8. Guide Dosage Selection

- Results of Tasks 1 through 7 will be used to formulate a practical approach for agencies to determine a correct rejuvenating seal dosage.
- The approach will consider:
  - (1) existing pavement surface type and age,
  - (2) climatic conditions,
  - (3) rejuvenating seal type, and
  - (4) minimum allowable post-application friction (traffic level crash risk).

## Task 9. AASHTO Specification

- The Research Team will prepare a two-part AASHTO deliverable.
- Part 1 will focus on the <u>material specifications</u> for petroleum- and bio-based rejuvenating seals.
  - Selection, property characterization, and dosage optimization for pavement sealing applications.

COMPLIANCE

 Part 2 will focus on the best practices for determining the impacts of rejuvenating seals on the <u>performance and surface</u> characteristics (friction and texture) and the life span of underlying asphalt pavements.

### Task 10. Final Deliverables

### A draft final report

 Documenting the results from the project, summarizing findings, drawing conclusions, and presenting the proposed AASHTO Standard Practice to implement performance-based evaluation of rejuvenating seals.

### A virtual workshop and associated materials

Describing the research results and the proposed comprehensive AASHTO
 Standard Practice to be given to the AASHTO Transportation System
 Preservation-Technical Services Program (TSP2) Emulsion Task Force (ETF).