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CONSORTIUM FOR ASPHALT
PAVEMENT RESEARCH AND IMPLEMENTATION

Material Solutions for Longitudinal Joints

CAPRI Spring Meeting

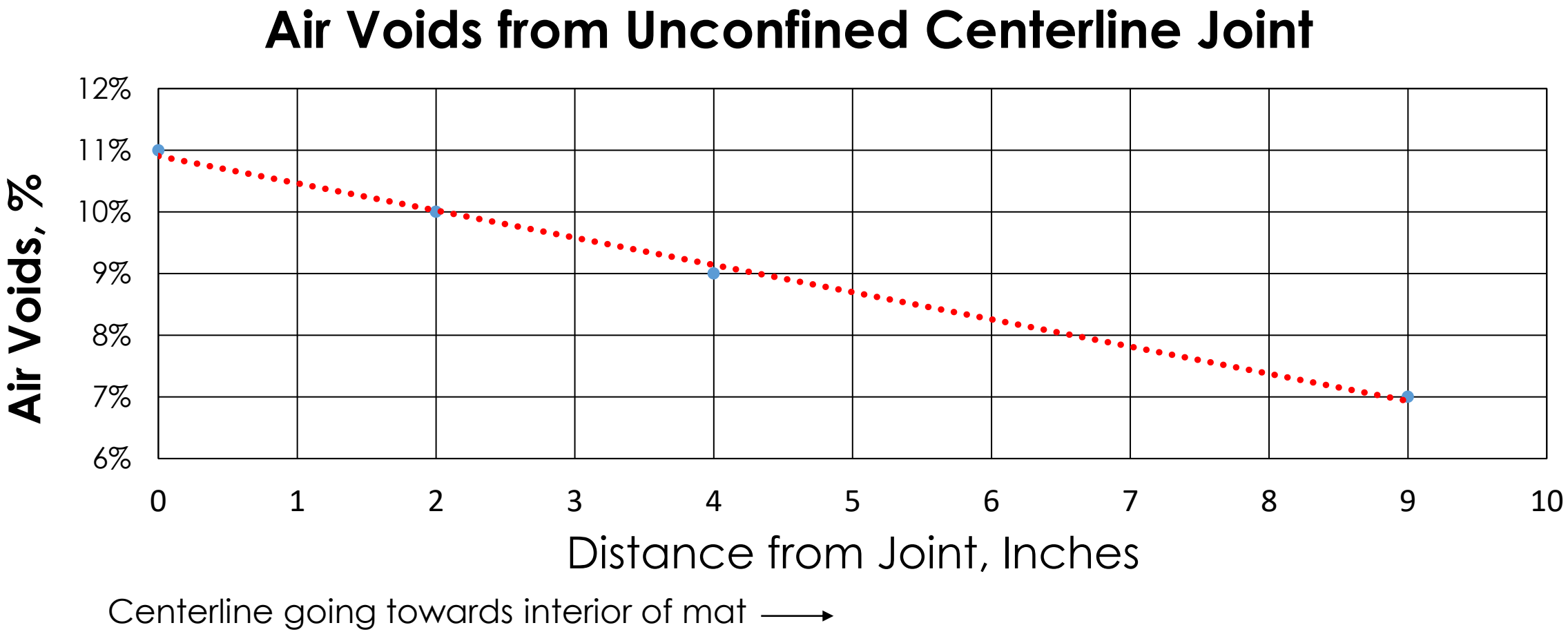
March 8th, 2023

How difficult is it to find pavements like these?

Longitudinal Construction Joints

- Common Issues…
  - Cannot achieve the same density at the joint as in the mat
  - Water and air intrusion accelerates damage
  - One of the first areas requiring maintenance on a pavement

Air Voids from Joint Towards Center of Lane



Centerline going towards interior of mat ⟶

*Graph for demonstration purposes only

Longitudinal Construction Joints - Historical Methods

Mechanical methods to improve joint performance:

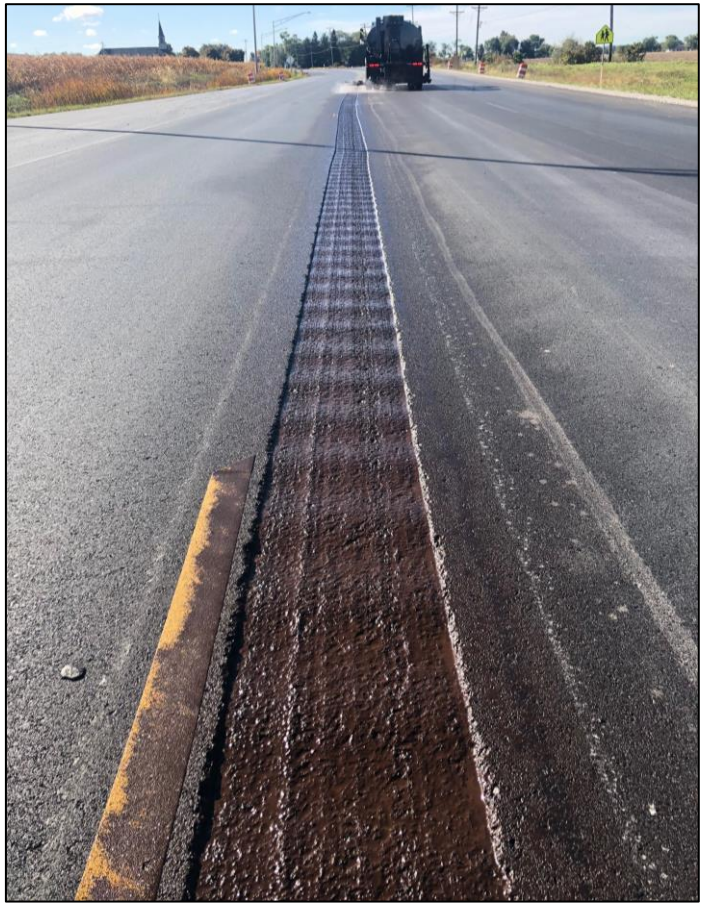
- Joint density requirements (typically target voids at 4" from joint to within 2% of center mat voids)
- Echelon paving (hot joint)
- Notched wedge joint
- Cut off lower density unconfined edge
- Mill and inlay (confined)

Two Material Approaches

"Bottom Up"

Void Reducing Asphalt Membrane (VRAM)

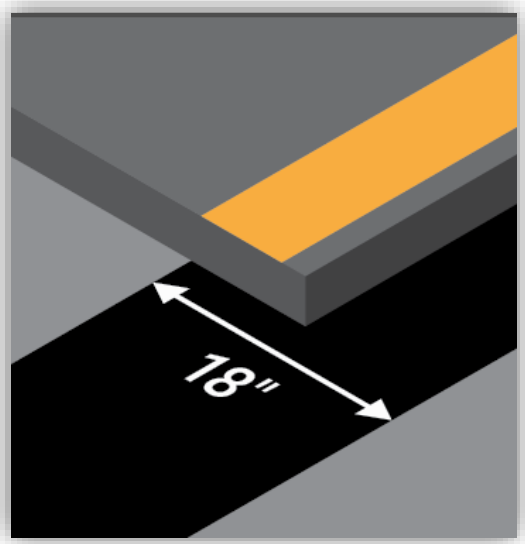
"Top Down"



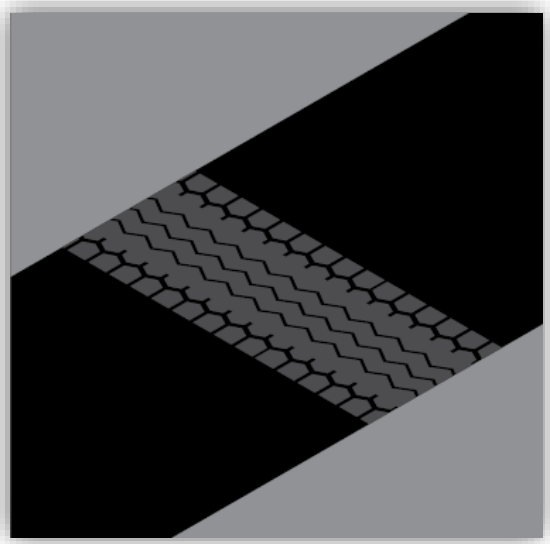
Rapid Penetrating Emulsion (RPE)

Bottom-up Approach to Improve Joint Performance

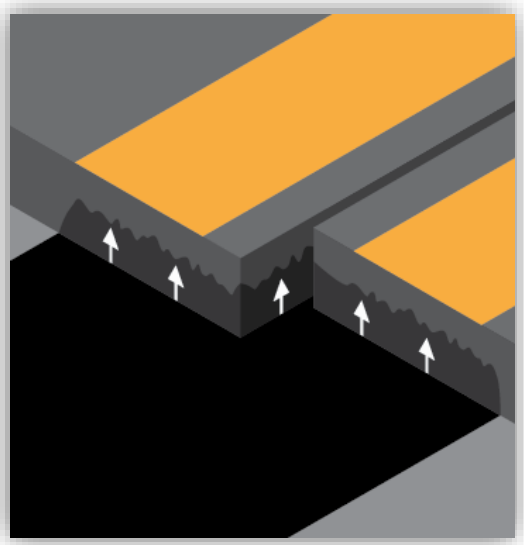
Apply a heavy band of polymer-modified binder in the area where the new paving joint will be placed.



Place the first paving pass over half the width of the band of polymer-modified binder.



Fast acting, the road is ready for construction traffic, keeping the installation process efficient and traffic flowing.



Polymer-modified binder migrates into the HMA at the joint.

Void Reducing Asphalt Membrane (VRAM)

- Thick application of hot-applied, **polymer-modified asphalt** (~ 1 gal/sq yd for 1 ½" overlay)
- Application of an 18" band applied **before** paving in the location of the new longitudinal joint
- **Fills voids** and **reduces water intrusion** at joint from the bottom up
- **Protects** underlying pavement layers
- **Materials** approach to improving joint performance

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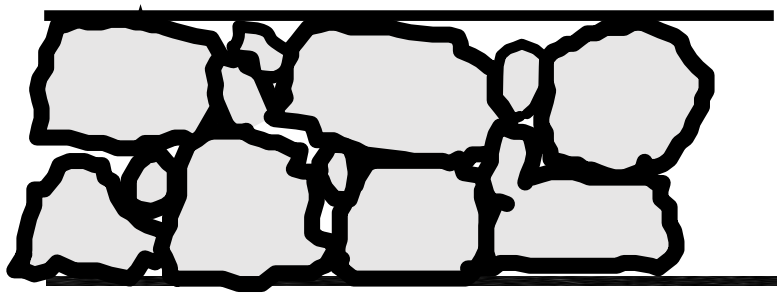
Effect of VRAM on Voids and Asphalt at Joint

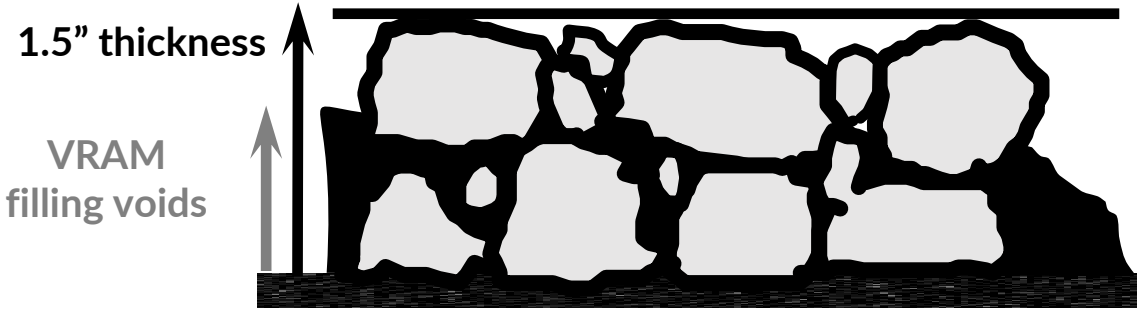
- The VRAM will migrate into the available air voids with heat and compaction
- Example HMA @ 6.0% AC, @ 1.5" thick/square yard = 9.9 lb of AC from mix
- VRAM @ 18" with VRAM weight per SY and total asphalt in joint area:

Mix type	VRAM rate, lb/ft	VRAM, lb/SY	Total asphalt in joint area, %
Coarse-graded	1.47	8.8	11.3
SMA/SP5	1.26	7.6	10.6
Fine-graded	0.95	5.7	9.6

- Finer mixes have less inter-connected voids than coarse-graded mixes



Mix without VRAM

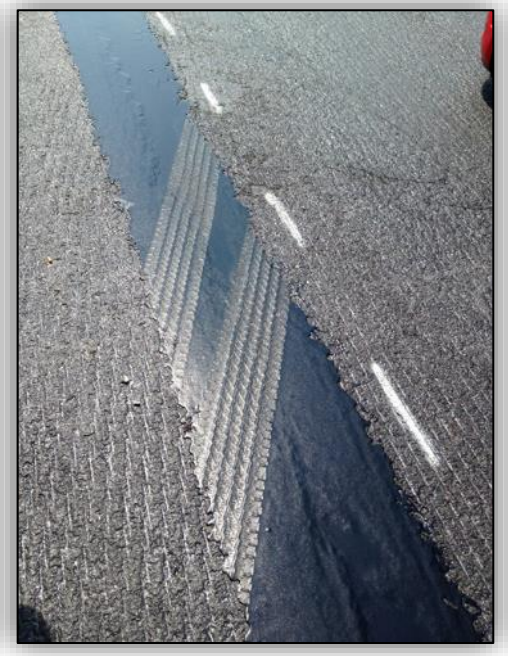


Mix with VRAM

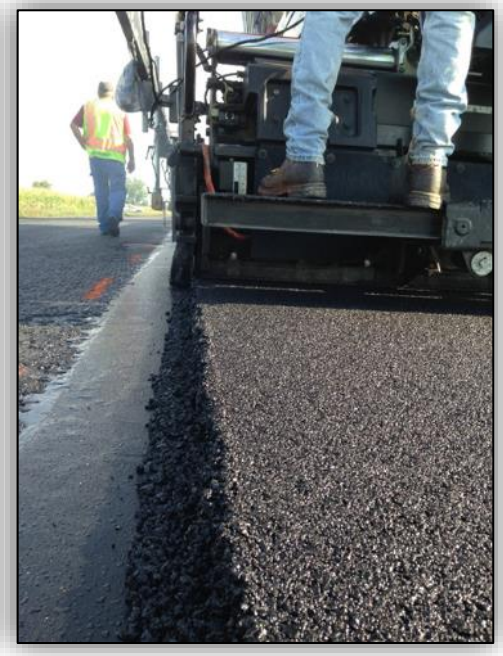
Cross Sectional View at Longitudinal Joint

VRAM Application

18" wide VRAM application or
9" wide mill and fill



Non-tracking < 30 min
Based on cooling time



1st HMA pass
covering half VRAM
width

VRAM Experimental Projects

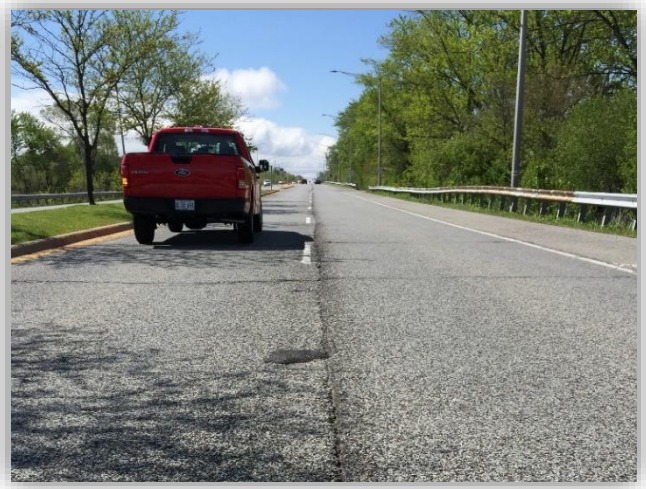
Control

Control

Control

IDOT US-51 VRAM
section 15 yr old

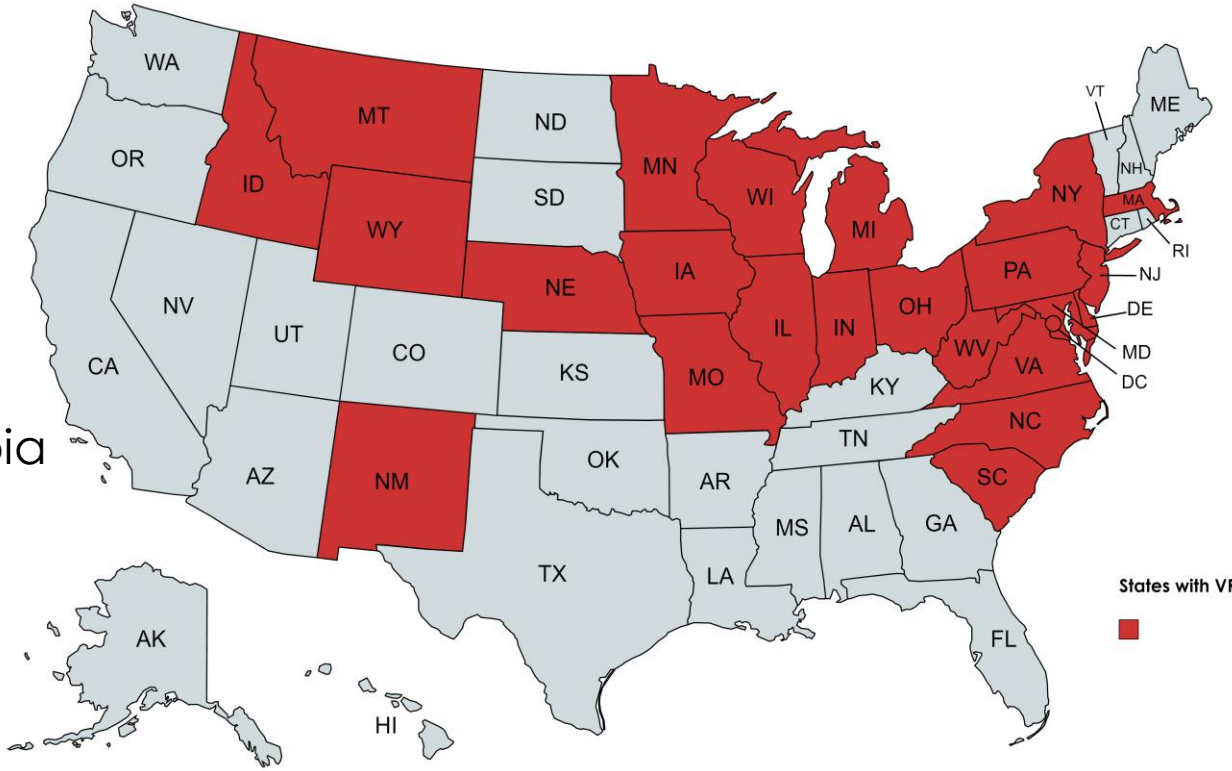
IDOT IL-26 VRAM
section 14 yr old



IDOT IL-50 VRAM
section 14 yr old

Current States* with VRAM Experience

- Illinois
- Indiana
- Ohio
- Iowa
- Michigan
- Missouri
- Wisconsin
- Minnesota
- Wyoming
- Montana
- Idaho
- New Jersey
- Pennsylvania
- Massachusetts
- Maryland
- Virginia
- Delaware
- South Carolina
- District of Columbia
- New York
- North Carolina
- West Virginia
- Nebraska
- New Mexico



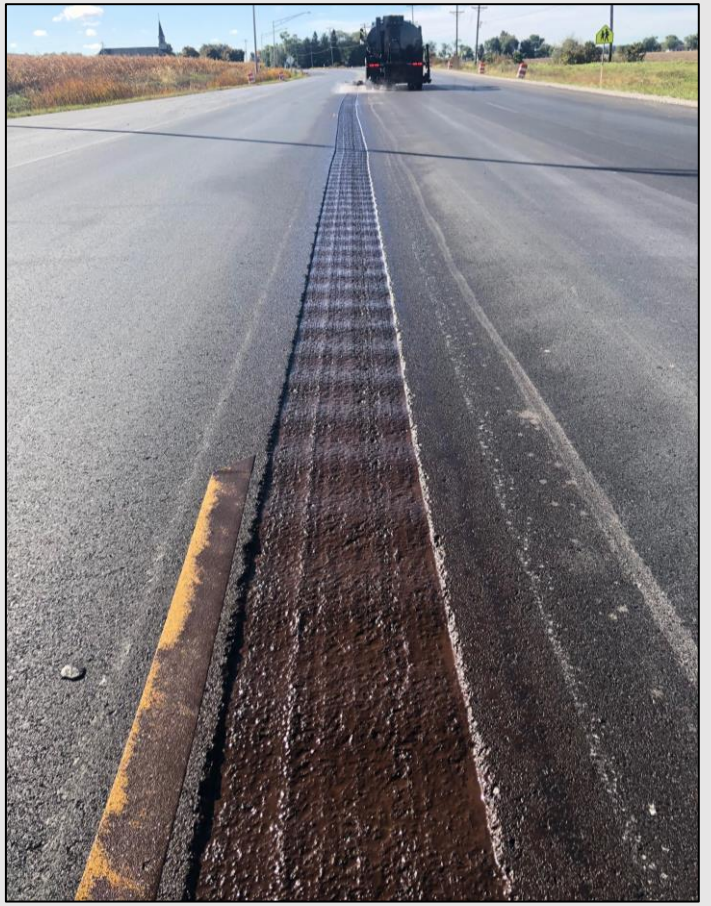
Since 2002, VRAM has grown in popularity and is now found on roads across 23 states and the District of Columbia.

Two Material Approaches

"Bottom Up"

Void Reducing Asphalt Membrane (VRAM)

"Top Down"

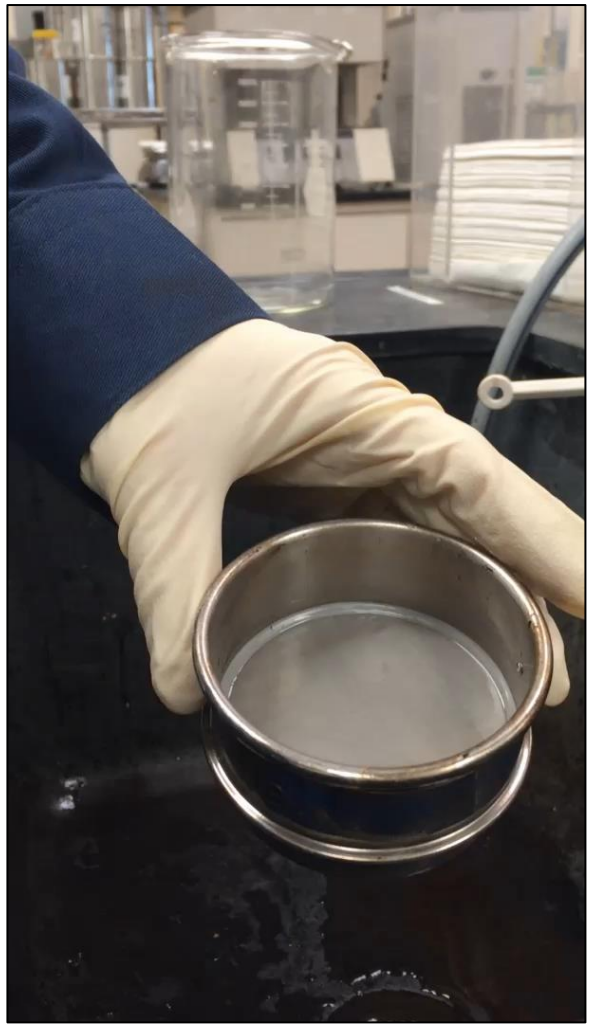


Rapid Penetrating Emulsion (RPE)

What is a Rapid Penetrating Emulsion (RPE)?

- Asphalt emulsion ~30 - 40% AC
- Designed to **penetrate** voids of bituminous pavement
- Reduces air and water intrusion while maintaining pavement texture
- "In" the pavement instead of "on" the pavement
- Quick resistance to water
- Most effective when applied in **first year** of pavement life

Classification Test for RPE



Water on #500 sieve

RPE on #500 sieve

RPE Penetrating Capability

Lab compacted slab

ONE RPE Application vs **ONE** Diluted SS-1H Application

0.15 gal/sy 0.15gal/sy

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RPE Penetrating Capability

Same lab compacted slab as previous slide

FOUR RPE Application vs **TWO** Diluted SS-1H Application

0.60 gal/sy 0.30 gal/sy

Measuring Texture and Permeability

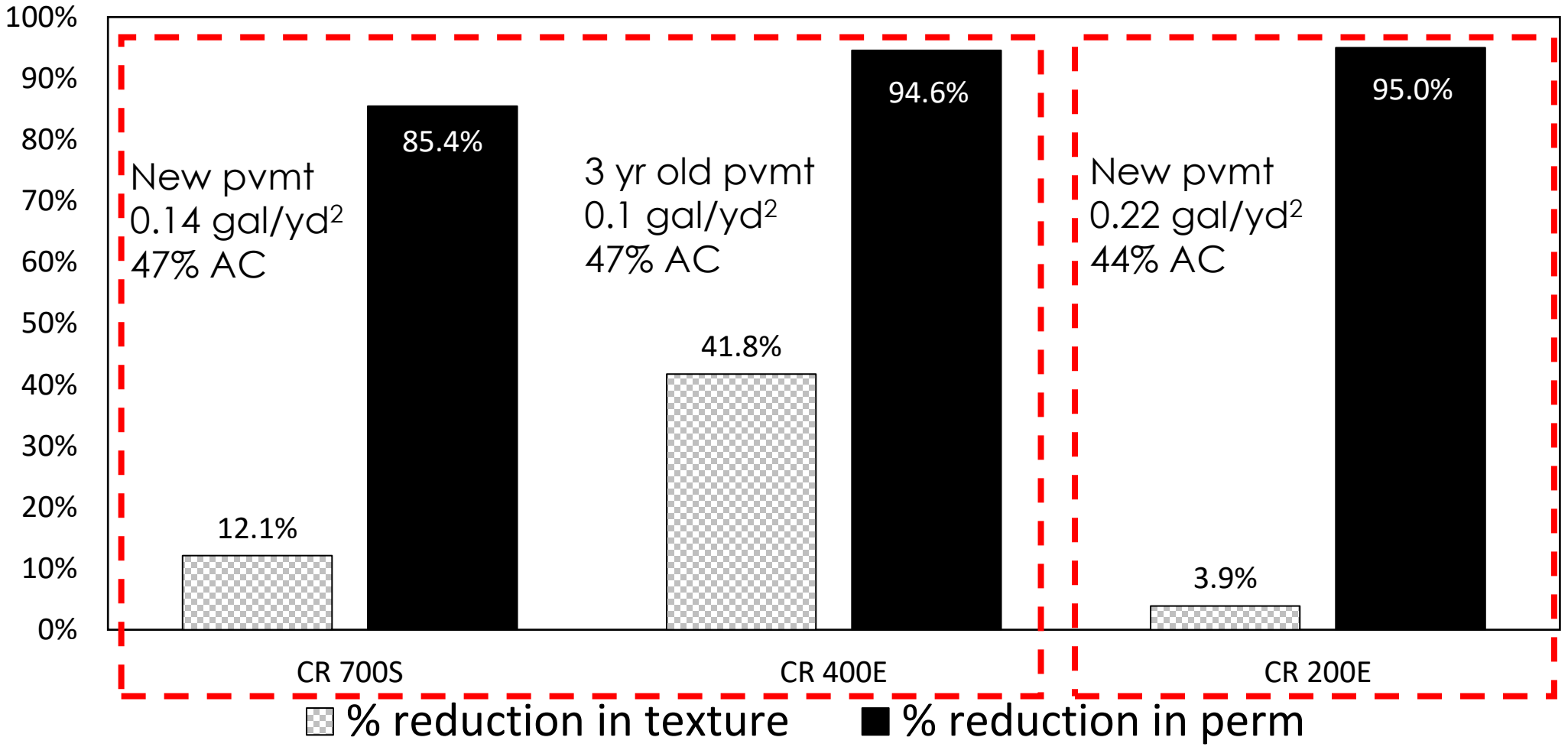
Testing Equipment

Field Permeameter

Circular Track Meter ASTM E-2157

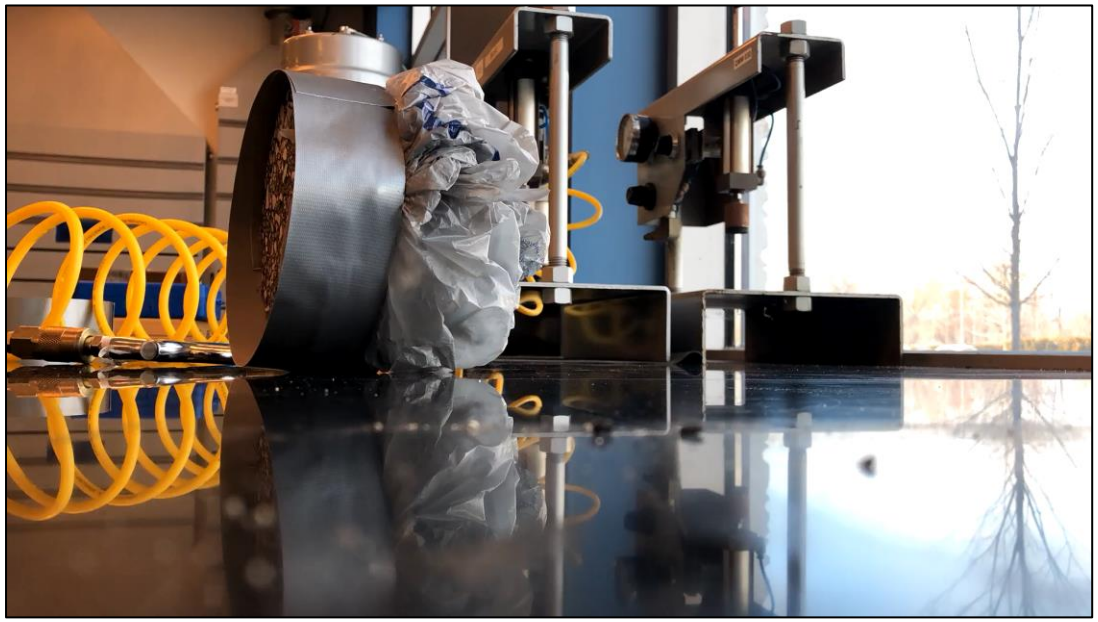
RPE Effect on Permeability and Texture

Hendricks County, IN 2016

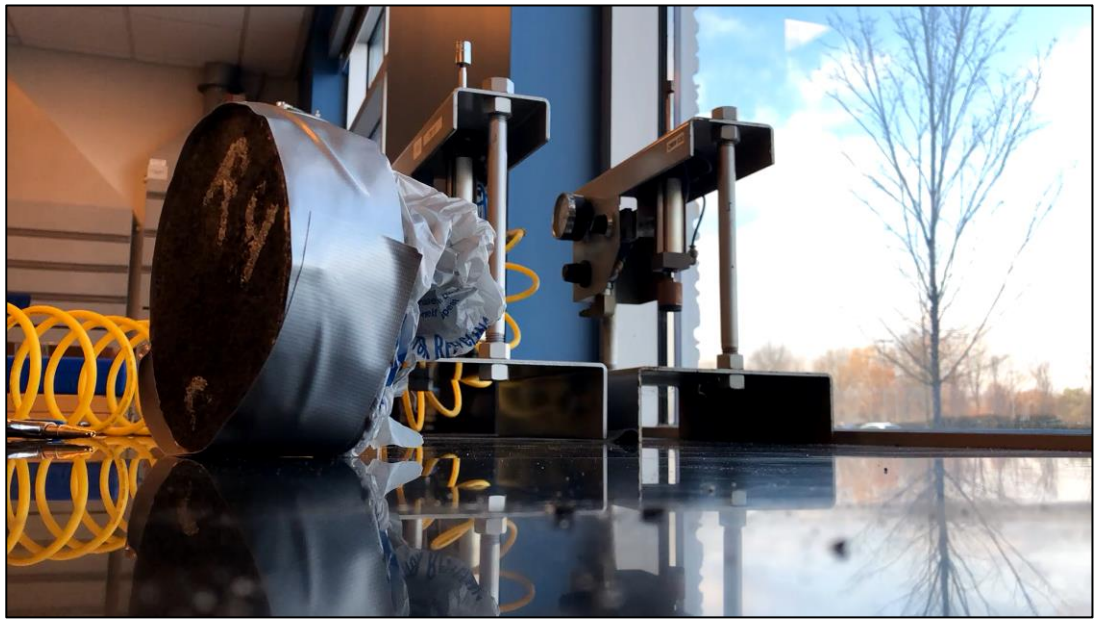


Air Permeability

Hendricks County, IN CR 500E Cores



Untreated 9.5mm 1” Surface



RPE Treated Surface

Where is RPE used?

Project Selection

- New Hot Mix Asphalt Pavement
  - **Centerline Joint**
  - Full Width
- Recycled Pavements
  - Full Width
- Low density areas
  - Spot Repair

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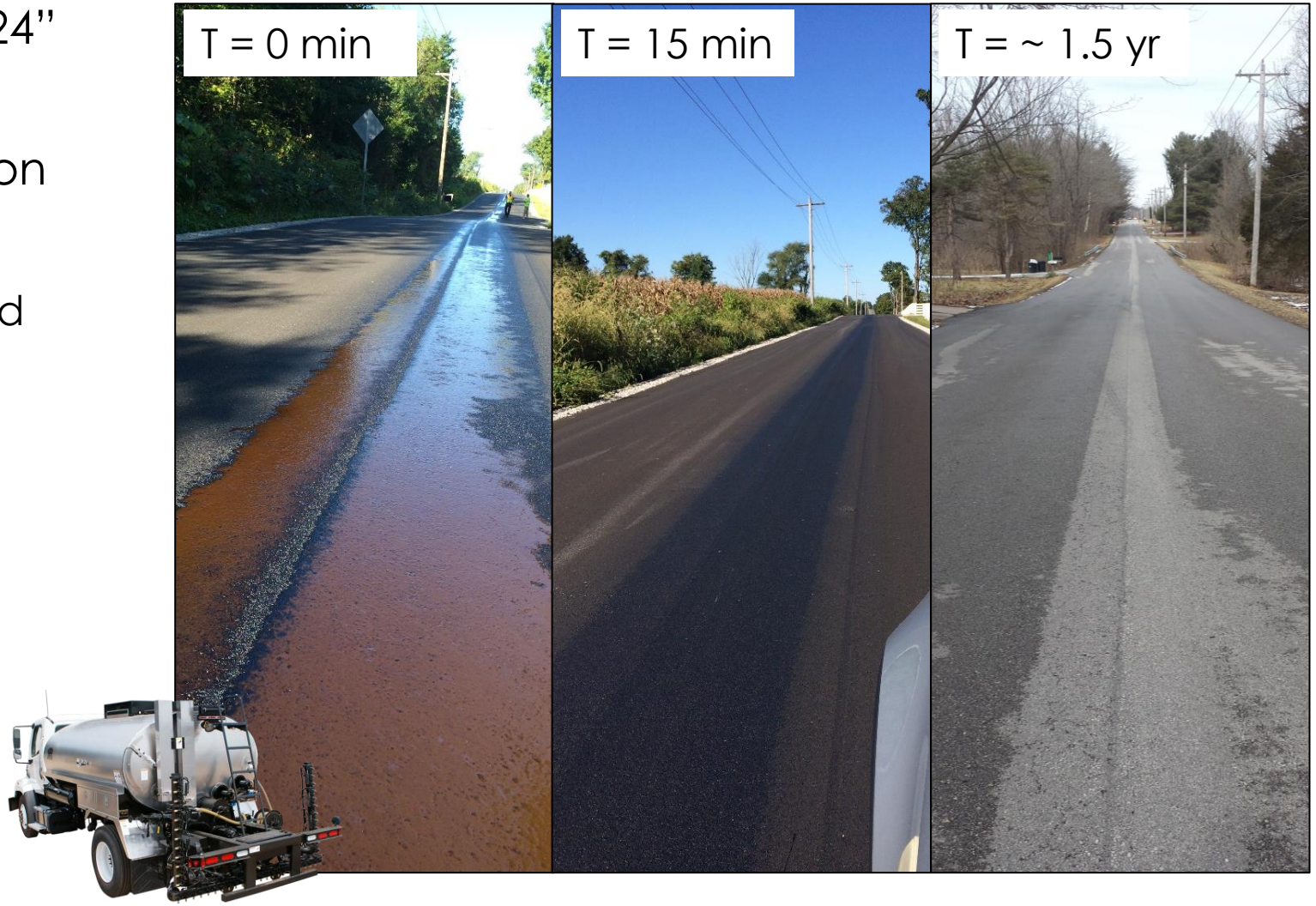
Centerline Joint Application

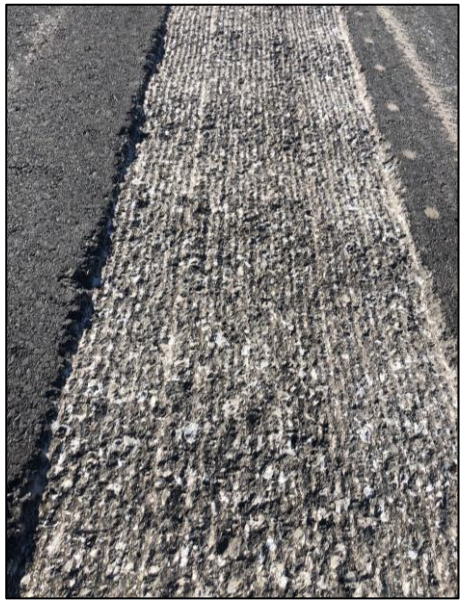
- Spray application by distributor ~24" wide at centerline
- Typical RPE-Centerline application
  - ~0.15 gallons/square yard
  - ~0.11 gallons/square yard – milled corrugations
- Pictures left to right:
  - Time of application
  - 15 minutes after
  - ~1.5 yr review
- Penetrating surface = lasting permeability reduction
- Decrease dry time sustained



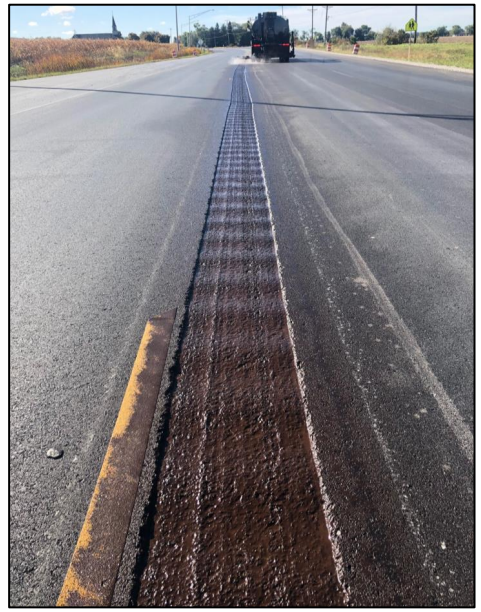
Complimentary Joint Construction and Preservation

- **VRAM**: Protect joint, preserve rumble strips
- **Rumble strips**: reduce traffic fatalities
- **RPE**: Further joint protection and rumble strip preservation without compromising line striping adhesion, penetrates below surface (not worn off)
- **Long-lasting traffic markings**: long-term safety, higher retro reflectivity on darker contrasting RPE-treated surface

VRAM – Beneath The Joint



Rumble Strips



RPE – Over The Joint

Indianapolis Motor Speedway

- Last resurfaced in 2004 using **VRAM** at the joints
- Prior resurfaced every 8 to 9 years
- 2023 – No resurfacings
  - **RPE** used for pavement preservation (2018, 2019 and 2021)

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Questions?

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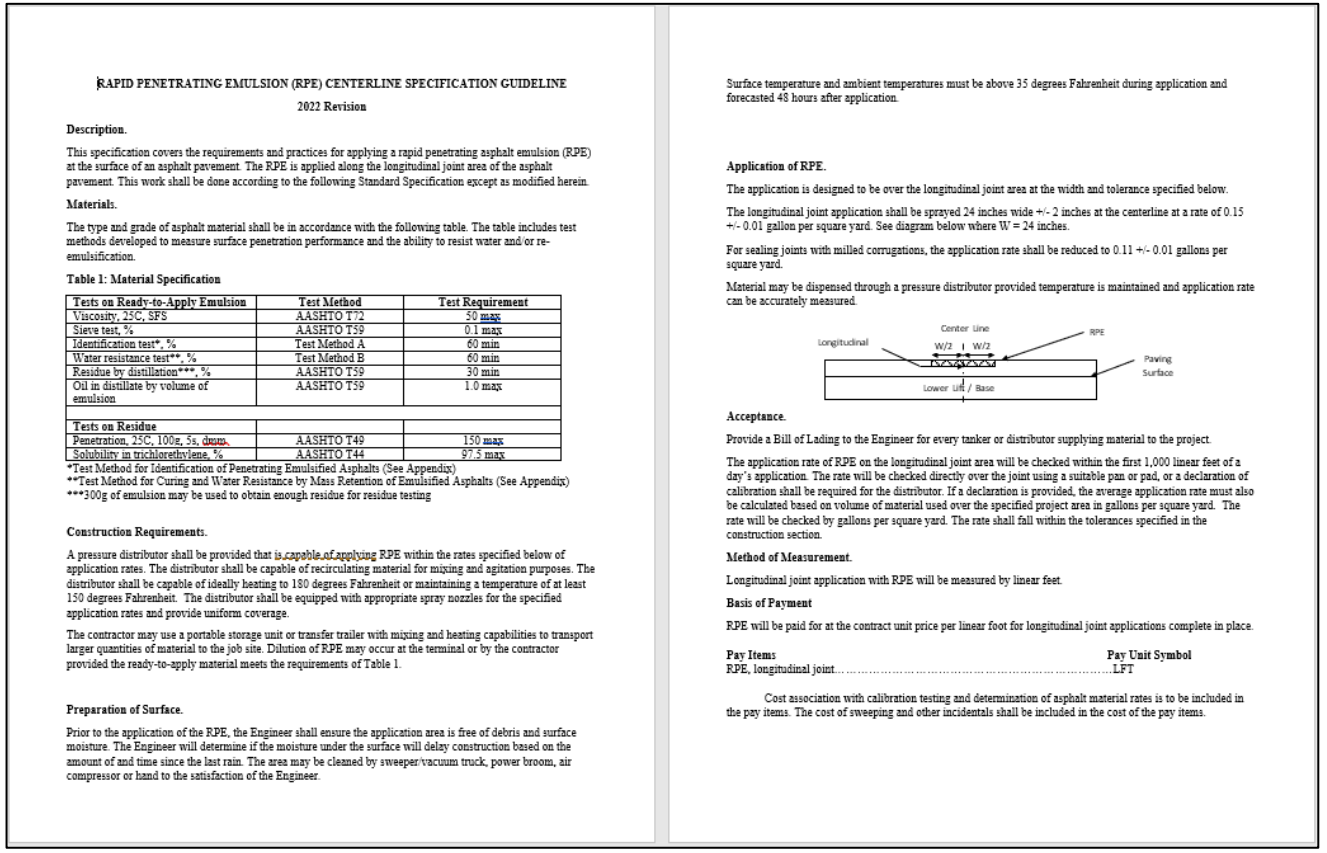
J-Band vs RPE

J-Band	RPE
Non-flowing, hot-applied, polymer-modified binder	Low viscosity, neat asphalt binder emulsion (38% AC)
~1 gal/yd2 application	~0.15 gal/yd2 @ 38% AC = 0.06 gal/yd2 res
Applied at interface of new mix to existing surface	Applies to and penetrates pavement surface
Proactive treatment to reduce future costs (part of construction process)	Post construction treatment to extend pavement life by reducing permeability
Bottom half of HMA overlay is impermeable	Reduces permeability but is not impermeable
Fill voids > 50% of overlay height (bottom up)	Penetrates top ¼" of pavement, minimal change in texture
Imparts crack resistance of overlay	Speeds snow/ice removal from darker surface color
Creates a bond to the existing surface with the new overlay	Allows pavement to dry faster after rain event (reduced permeability)
Extends pavement joint life 15+ years	Pavement life extension to be determined
	Topical treatment that may slow aging effect

Specifications – VRAM Example

- Existing
  - INDOT Recurring Special Provision available and in use
  - IL county use for full-width (case-by-case)
  - IL use for remedial work?
- Proposed
  - Specification draft guideline available for review (Full-Width and Longitudinal Application versions)



RAPID PENETRATING EMULSION (RPE) CENTERLINE SPECIFICATION GUIDELINE

2022 Revision

Description.

This specification covers the requirements and practices for applying a rapid penetrating asphalt emulsion (RPE) at the surface of an asphalt pavement. The RPE is applied along the longitudinal joint area of the asphalt pavement. This work shall be done according to the following Standard Specification except as modified herein.

Materials.

The type and grade of asphalt material shall be in accordance with the following table. The table includes test methods developed to measure surface penetration performance and the ability to resist water and/or re-emulsification.

Table 1: Material Specification

Tests on Ready-to-Apply Emulsion	Test Method	Test Requirement
Viscosity, 25C, SFS	AASHTO T72	50 max
Sieve test, %	AASHTO T59	0.1 max
Identification test*, %	Test Method A	60 min
Water resistance test**, %	Test Method B	60 min
Residue by distillation***, %	AASHTO T59	30 min
Oil in distillate by volume of emulsion	AASHTO T59	1.0 max
Tests on Residue		
Penetration, 25C, 100g, 5s, dmm,	AASHTO T49	150 max
Solubility in trichlorethylene, %	AASHTO T44	97.5 max

*Test Method for Identification of Penetrating Emulsified Asphalts (See Appendix)
**Test Method for Curing and Water Resistance by Mass Retention of Emulsified Asphalts (See Appendix)
***300g of emulsion may be used to obtain enough residue for residue testing

Construction Requirements.

A pressure distributor shall be provided that is capable of applying RPE within the rates specified below of application rates. The distributor shall be capable of recirculating material for mixing and agitation purposes. The distributor shall be capable of ideally heating to 180 degrees Fahrenheit or maintaining a temperature of at least 150 degrees Fahrenheit. The distributor shall be equipped with appropriate spray nozzles for the specified application rates and provide uniform coverage.

The contractor may use a portable storage unit or transfer trailer with mixing and heating capabilities to transport larger quantities of material to the job site. Dilution of RPE may occur at the terminal or by the contractor provided the ready-to-apply material meets the requirements of Table 1.

Preparation of Surface.

Prior to the application of the RPE, the Engineer shall ensure the application area is free of debris and surface moisture. The Engineer will determine if the moisture under the surface will delay construction based on the amount of and time since the last rain. The area may be cleaned by sweeper/vacuum truck, power broom, air compressor or hand to the satisfaction of the Engineer.

Surface temperature and ambient temperatures must be above 35 degrees Fahrenheit during application and forecasted 48 hours after application.

Application of RPE.

The application is designed to be over the longitudinal joint area at the width and tolerance specified below.

The longitudinal joint application shall be sprayed 24 inches wide +/- 2 inches at the centerline at a rate of 0.15 +/- 0.01 gallon per square yard. See diagram below where W = 24 inches.

For sealing joints with milled corrugations, the application rate shall be reduced to 0.11 +/- 0.01 gallons per square yard.

Material may be dispensed through a pressure distributor provided temperature is maintained and application rate can be accurately measured.

Acceptance.

Provide a Bill of Lading to the Engineer for every tanker or distributor supplying material to the project.

The application rate of RPE on the longitudinal joint area will be checked within the first 1,000 linear feet of a day's application. The rate will be checked directly over the joint using a suitable pan or pad, or a declaration of calibration shall be required for the distributor. If a declaration is provided, the average application rate must also be calculated based on volume of material used over the specified project area in gallons per square yard. The rate will be checked by gallons per square yard. The rate shall fall within the tolerances specified in the construction section.

Method of Measurement.

Longitudinal joint application with RPE will be measured by linear feet.

Basis of Payment

RPE will be paid for at the contract unit price per linear foot for longitudinal joint applications complete in place.

Pay Items	Pay Unit Symbol
RPE, longitudinal joint	LFT

Cost association with calibration testing and determination of asphalt material rates is to be included in the pay items. The cost of sweeping and other incidentals shall be included in the cost of the pay items.

InDOT Unique Special Provision (RPE)

Contractor applied

- Centerline - 401-R-736 211201
- Additional support

Agency in-house application

Test on Emulsion	*Test Requirement*	*Test Method*
Viscosity, Saybolt Furol at 25C	*50 max*	*AASHTO T 59*
Sieve Test, %	*0.10 max*	*AASHTO T 59*
Oil Distillate by Volume of Emulsified Asphalt, %	*1.0 max*	*AASHTO T 59*
Identification Test, %	*60 min*	*Test Method A*
Water Resistance Test, %	*60 min*	*Test Method B*
Residue by Distillation (Note 1), %	*30 min*	*AASHTO T 59*
Test on Residue	*Test Requirement*	*Test Method*
Penetration (0.1 mm) at 25C, 100g, 5s	*150 max*	*AASHTO T 49*
Ash Content, %	*1.0 max*	*AASHTO T 111*
Note 1: The minimum sample size shall be 300g		