JBAND®
The Bottom-Up Joint Solution

Longitudinal Joint Enhancement with Void Reducing Asphalt Membranes

Todd Thomas, P.E. – Asphalt Materials, Inc.

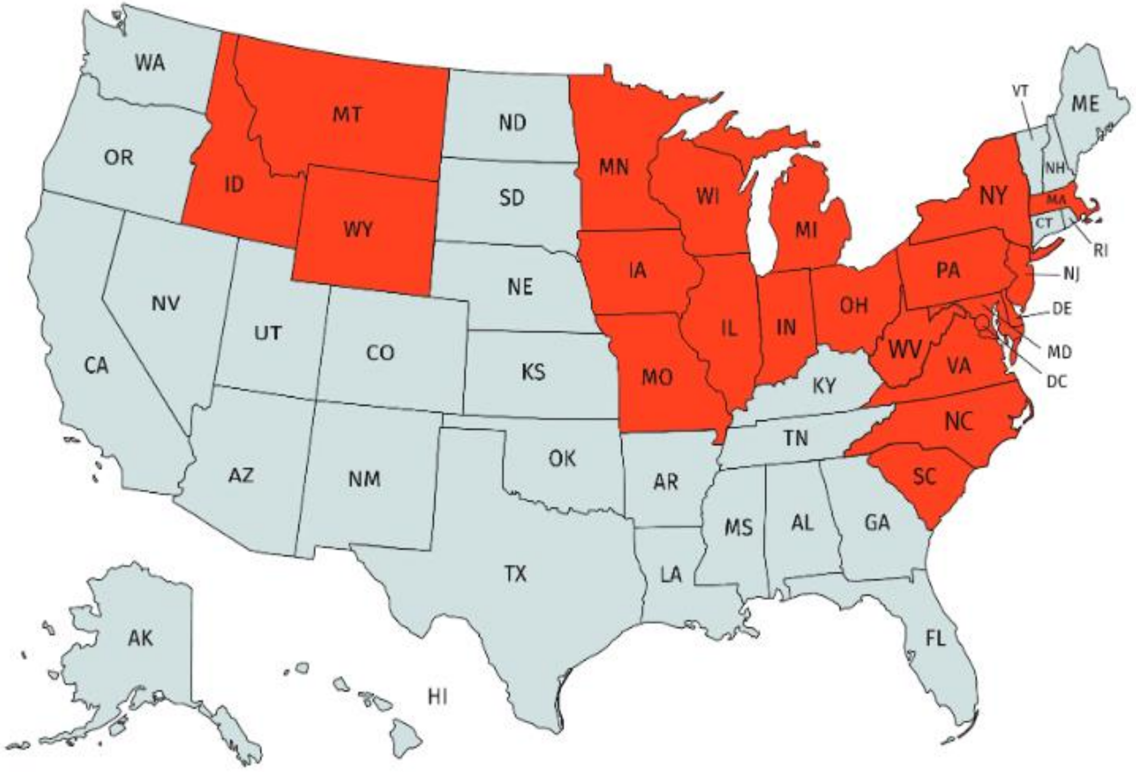
Montana Asphalt Conference
March 23, 2022

Current States* with VRAM Experience

*and District of Columbia

- New Jersey
- Pennsylvania
- Massachusetts
- Maryland
- Virginia
- Delaware
- South Carolina
- District of Columbia
- New York
- North Carolina
- West Virginia

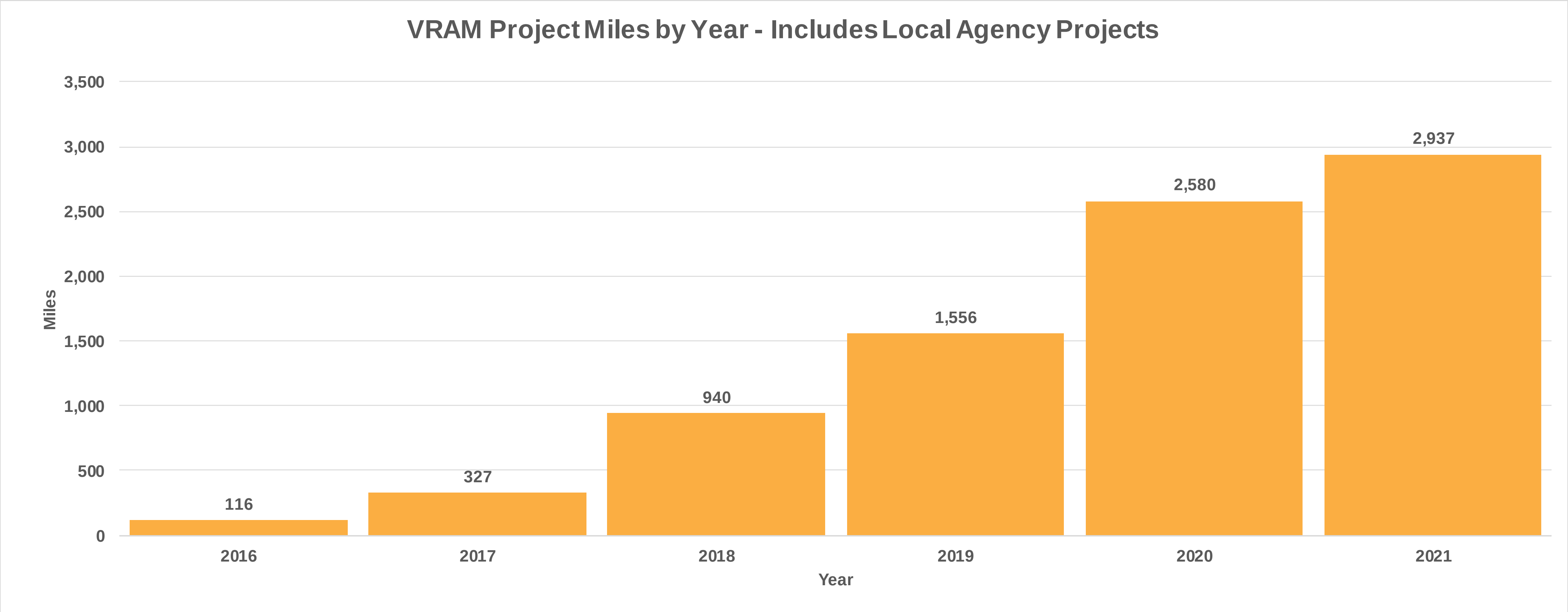
- Illinois
- Indiana
- Ohio
- Iowa
- Michigan
- Missouri
- Wisconsin
- Minnesota
- Wyoming
- Montana
- Idaho



Since 2002, VRAMs have grown in popularity and are now found on roads in 21 states and the District of Columbia

Growth of VRAMs

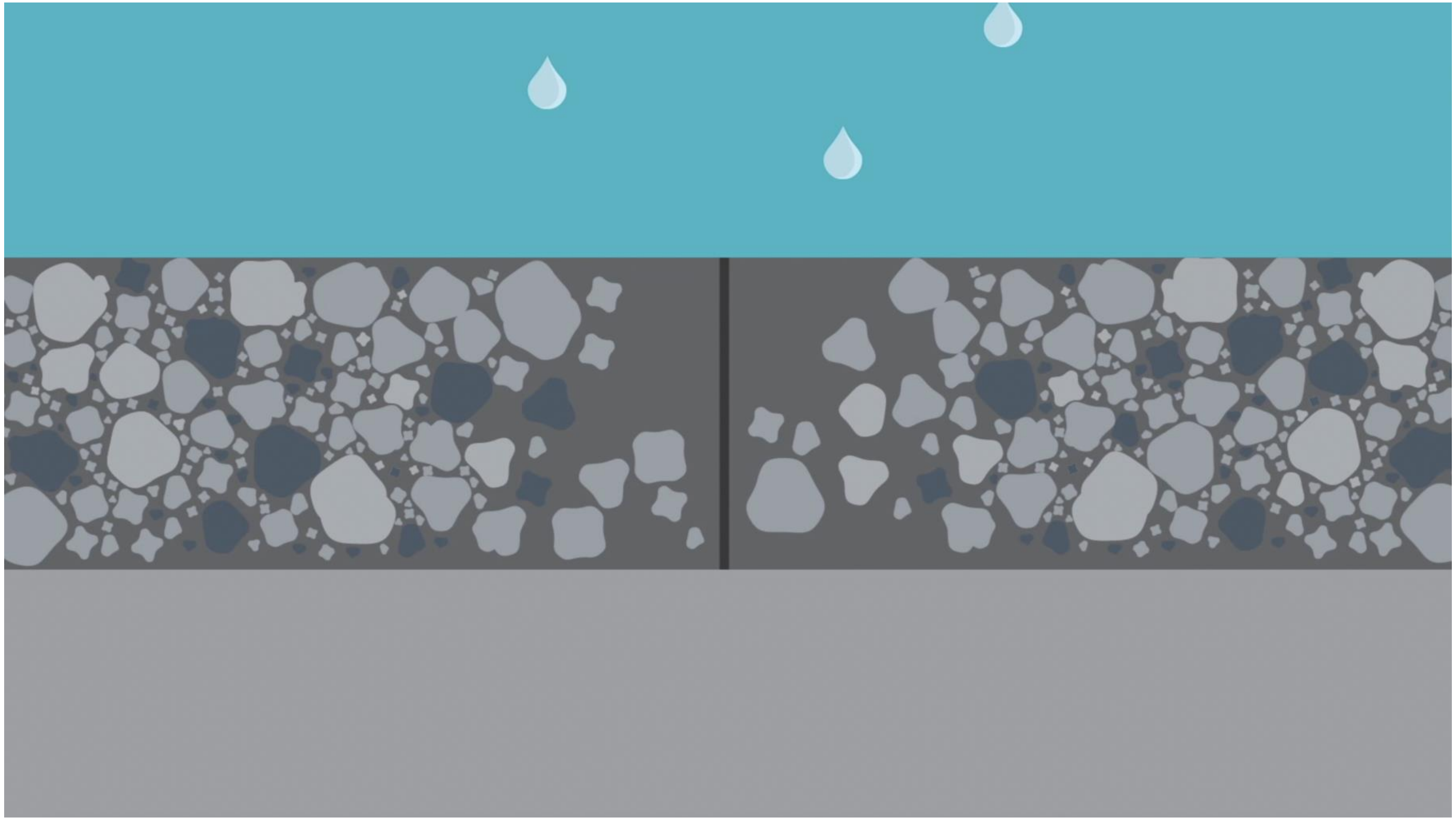
Snapshot taken mid-August 2021



Topics to be Covered

- **Problem**: Longitudinal Joints Failures
- **Solution**: VRAM
  Void Reducing Asphalt Membrane
  - Intro and terminology
  - Concept and Performance History
  - Application
  - Special Provisions
  - Research
  - Life Cycle Cost Analysis (LCCA)
  - Montana Rt. 83 Project
  - Safety & Sustainability

VRAM 'How it Works' Animation



J-Band/Asphalt Materials, Inc. - Bing video

RESOURCE: www.thejointsolution.com

Terminology

VRAM	Void Reducing Asphalt Membrane
LJS	Longitudinal Joint Sealant *(Illinois DOT Terminology)*
J-Band®	Asphalt Materials, Inc. Trade Name

Longitudinal Joint Issues

How difficult is it to find pavements like these?

Rumble Strips / Corrugations

- Being used on an increasing basis for safety
- Placed in the weakest area of the pavement, centerline joint or outside edge of paving creating early failure
- Water settles in rumble strips, even after the rest of the road is dry

Longitudinal Construction Joints

- **Issues**
  - Cannot achieve the same density at the joint as in the mat
  - Water and air intrusion due to permeability accelerates damage

- **Longitudinal construction joints**
  - Commonly, the first area requiring maintenance on a pavement

Longitudinal Construction Joints Traditional Methods

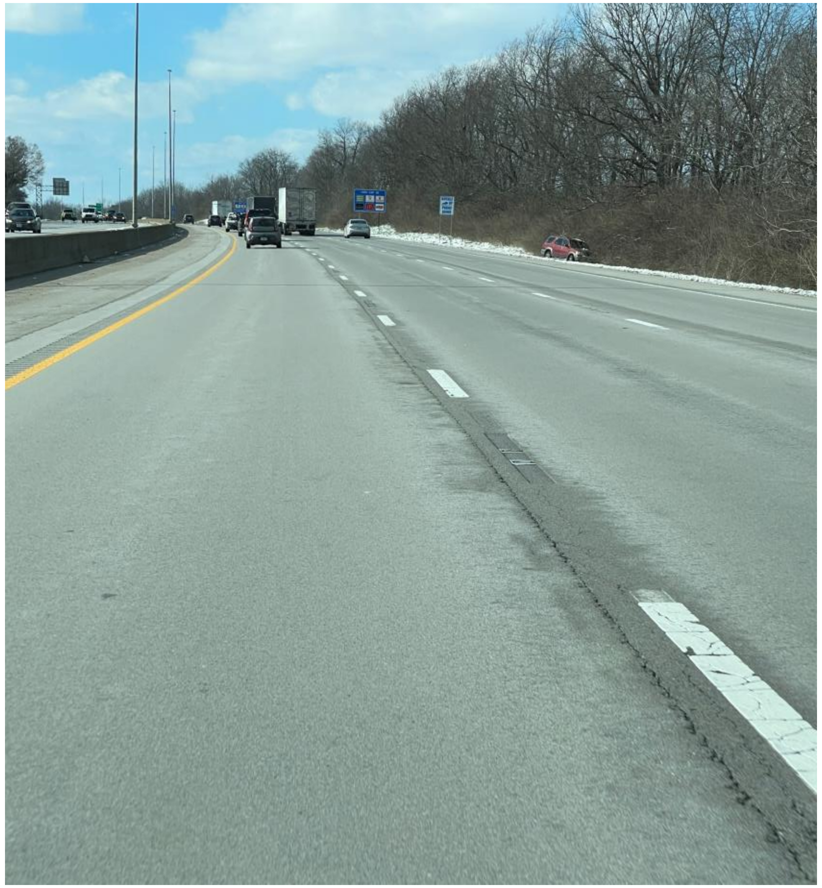
Mechanical methods to improve joint performance

- Joint density requirements (typically target voids at 4" from joint to within 2% of center mat voids)
- Echelon paving (hot joint)
- Joint heater
- Notched wedge joint
- Pave wide and trim back
- Mill and inlay (confined)


A Materials Solution

Longitudinal Joint Improvement Plan

- Early 2000's timeframe
- Illinois DOT recognized need for better joint performance
- Failure mechanism
  - **PERMEABILITY**
- **Concept:** Fill a portion of the voids with an asphalt product from bottom up, a Void Reducing Asphalt Membrane (**VRAM**)



LJS Performance History

- 9 IDOT LJS Experimental Test Sections Placed in 2002 – 2003

- Illinois DOT took cores for testing 3 of these in 2017
  - District 7 US-51 Elwin
  - District 1 IL-50 Richton Park
  - District 2 IL-26 Cedarville

JBAND

LJS 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

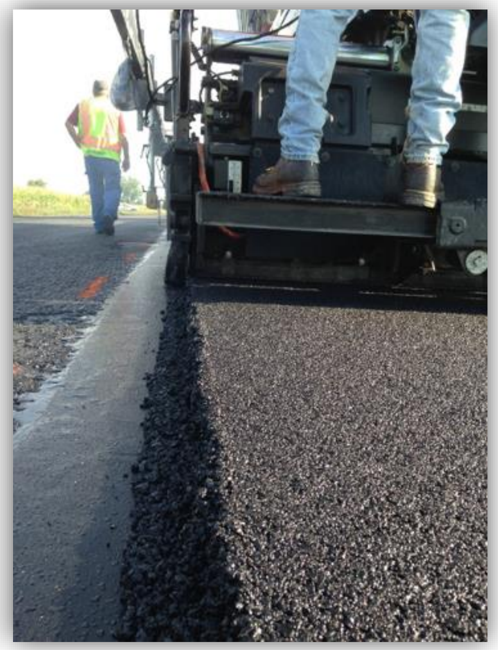
Attributes and Specs

Saves Time

VRAM Application

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

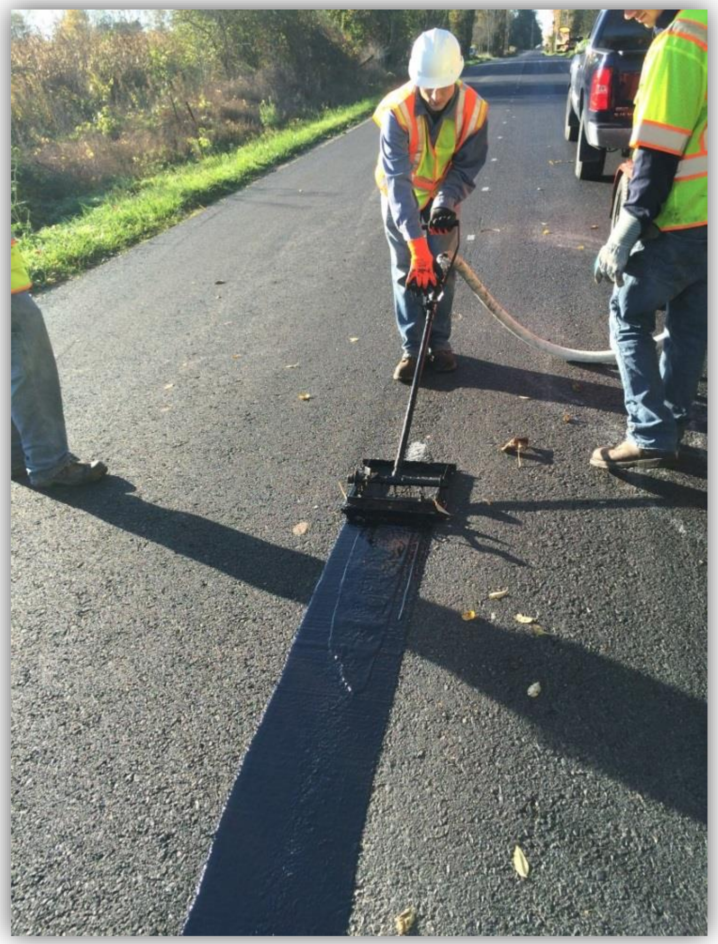
Non-tracking < 30 min
Based on cooling time



1st pass covering
half VRAM width.
Joint density testing
not required within
1 ft from joint.

VRAM Application Methods

Placed by pressure distributor with mechanical agitation in tank

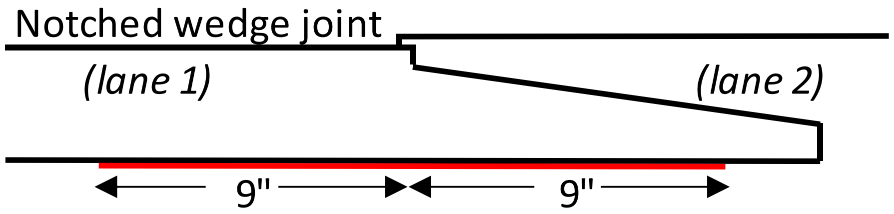


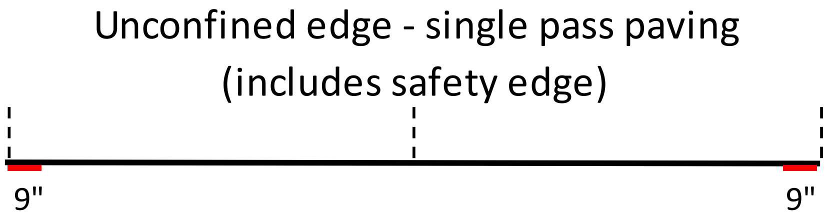
Manual strike off box fed from melting kettle

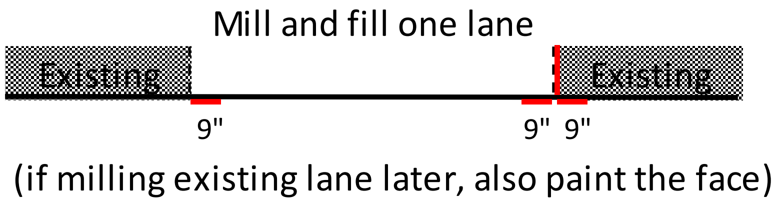
Tow behind melter applicator

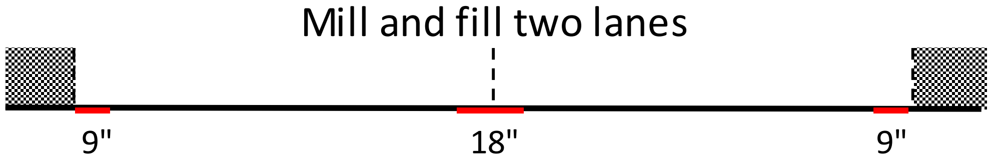
JBAND

VRAM Application Scenarios









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

Special Provision – Material properties

Test	Test Requirement	Test Method
Dynamic shear @ 88°C (unaged), G*/sin δ, kPa	1.00 min.	AASHTO T 315
Creep stiffness @ -18°C (unaged), Stiffness (S), MPa m-value	300 max. 0.300 min.	AASHTO T 313
Ash, %	1.0 – 4.0	AASHTO T 111
Elastic Recovery*, 100 mm elongation, cut immediately, 25°C, %	70 min.	ASTM D6084 Method A
Separation of Polymer, Difference in °C of the softening point (ring and ball)	3 max.	ASTM D7173

Special Provision – Rates by mix type and thickness

Coarse and fine-graded based on No. 8 sieve*

VRAM Application Table		
Coarse-Graded HMA Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1	18	1.15
1 ¼	18	1.31
1 ½	18	1.47
1 ¾	18	1.63
≥ 2	18	1.80
Fine-Graded HMA Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1	18	0.80
1 ¼	18	0.88
≥ 1 ½	18	0.95
SMA Mixtures/SuperPave 5 Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1 ½	18	1.26
1 ¾	18	1.38
≥ 2	18	1.51

*No. 8 limits – 19-mm, 35% - 12.5-mm, 40% - 9.5-mm, 45%

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	9.9	10.8
SMA/SP5	1.26	9.1	10.6
Fine-graded	0.95	5.7	9.6

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

Research and LCCA

Saves Money

DEPARTMENT OF TRANSPORTATION

Use of J-Band to Improve the Performance of the HMA Longitudinal Joint

Status: Complete
Report Date: 12/23/2020

Summary:

The density and air void content of asphalt mixtures affect the durability and performance of asphalt pavements. Pavement longitudinal joints typically have a lower density than the mat because they receive less compaction than the center section of the mat for various reasons. The higher air void percentages

- The use of VRAM reduces permeability and air void content, which reduces the intrusion of water into the pavement, indicating that good long-term pavement performance will be achieved
- Longitudinal cracking at the joints will be delayed relative to the control sections

Final Deliverables:

- Report #2020-33

Related Materials:

Project Personnel:

Principal Investigator: Christopher Williams

Co-Principal Investigator: Joseph Podolsky

Technical Liaison: Eddie Johnson

Project Coordinator: Elizabeth Klemann

JBAND®

VRAM in Minnesota

MN 22, Blue Earth County, MN

177th Street South 5,280 ft., South of Mankato, MN

VRAM Application on Sept 17, 2018

VRAM Section on Nov 5, 2020

VRAM in Minnesota

MN 169, Fairbault County, MN

1 mile North of I-90 to 500 ft South of 140th Street

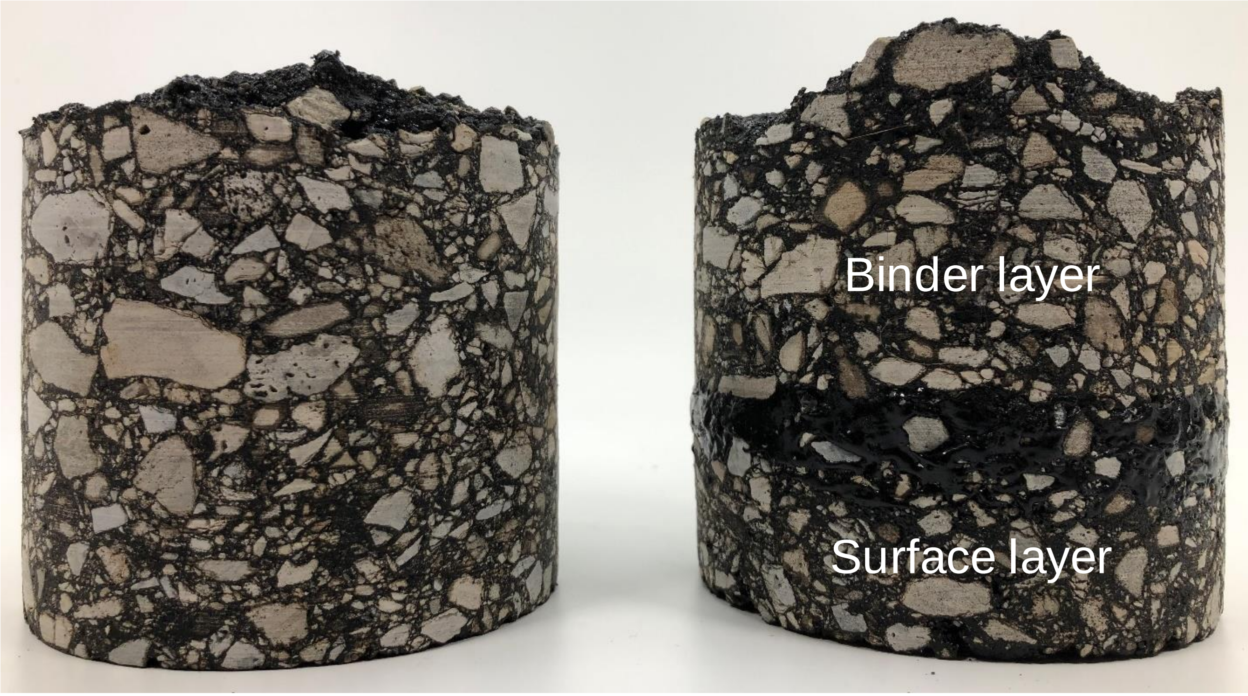
VRAM Application on Oct 2018

VRAM Section Nov 2021

Control Section Nov 2021

IDOT Core Testing 14 Years After Service *(2017)*

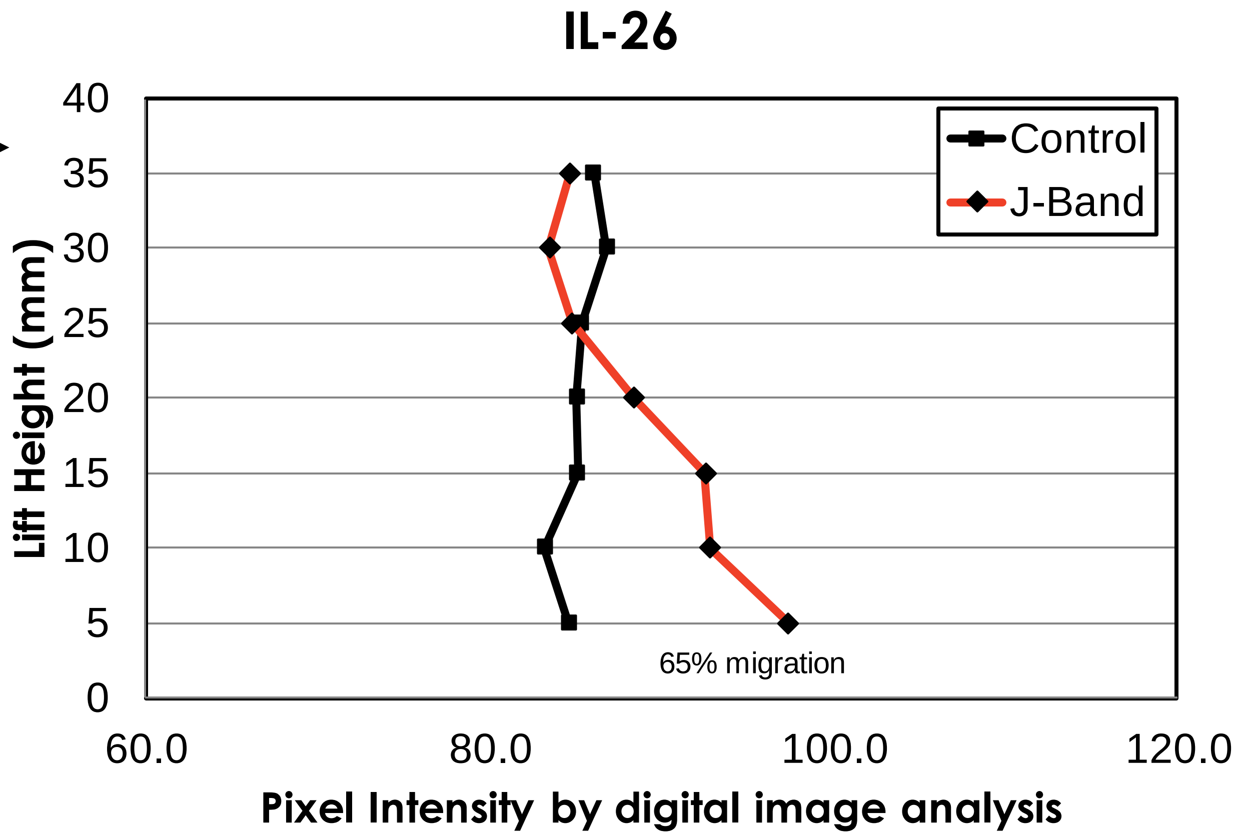
- Asphalt content
- Migration
- Laboratory permeability testing
- I-FIT flexibility index (FI) values



Note: *No LJS on left, with LJS on right.*
Example, not from IDOT research sections.

IDOT core testing 14 years after service *(2017)*

- **Asphalt content nearly double for VRAM cores**
- **Migration 26 to 66 percent of layer height**
- **Laboratory permeability testing** *(vertical flow)*
  - Top half of all cores had nearly equal lab perm.
  - Bottom half
    - Control: 110 to 372 x 10^{-5} cm/sec
    - VRAM: zero
- **I-FIT flexibility index (FI) values**
  - Controls: 0.2 to 0.8
  - VRAM: 1.9 to 23
  - IDOT long-term aged lab FI ≥ 4.0



Testing VRAM & Control Conditions

- Comparing VRAM to a traditional method
  - Encouragement to have a control section on a VRAM project when first starting out
  - Annual performance review focusing on the joint area

Cores on or near the centerline joint

Good to Know	Must Know
Asphalt Content	Laboratory Permeability Testing (vertical flow)
Migration	Flexibility or Cracking Test

2021 TRB Paper Establishing Agency Value

Written with Illinois DOT – Accepted by Transportation Research Board

A Materials Approach to Improving Asphalt Pavement Longitudinal Joint Performance

Jim Trepanier
Engineer of HMA, Aggregate and Chemical Tests
Illinois Department of Transportation
Springfield, IL 62704
James.Trepanier@Illinois.gov

John Senger
Engineer of Pavement Technology
Illinois Department of Transportation
Springfield, IL 62704
John.Senger@Illinois.gov

Todd Thomas
Technical Specialist
Asphalt Materials, Inc.
Indianapolis, IN 46268
tthomas@asphalt-materials.com

Marvin Exline
Technical Specialist
Asphalt Materials, Inc.
Indianapolis, IN 46268
marvin.exline@asphalt-materials.com

Word Count: 6327 words + 3 tables (250 words per table) = 7077 words

Submitted date July 29, 2020

ABSTRACT

Many states are looking for methods to improve longitudinal joint performance of their asphalt pavements since these joints often fail before the rest of the surface. With their inherently lower density, longitudinal joints fail by cracking, raveling and potholing because of the intrusion of air and water. Due to their longitudinal joint issues, and after trying several less-than-successful traditional solutions, the Illinois Department of Transportation (IDOT) developed a concept to seal the longitudinal joint region, but from the bottom up. Test sections were constructed in 2001 through 2003 to determine how a newly developed material, called longitudinal joint sealant (LJS), would improve joint performance. LJS is a highly-polymer-modified asphalt cement with fillers and is placed at the location of a longitudinal joint prior to paving. As mix is paved over it, the LJS melts and migrates up into voids in the low-density mix, making the mix impermeable to moisture while sealing the longitudinal joint itself. The IDOT test pavements were evaluated after twelve years and found to have longitudinal joints that exhibited significantly better performance than the control joint sections and were in similar or better condition than the rest of the pavement. Laboratory testing of cores showed decreased permeability and increased crack resistance of mix near joints with LJS as compared to similar mix without LJS. The life extension of the joint area is approximately three to five years, and the benefit is calculated to be three to five times the initial cost.

Keywords: Longitudinal joint, longitudinal joint sealant (LJS), void reducing asphalt membrane (VRAM)

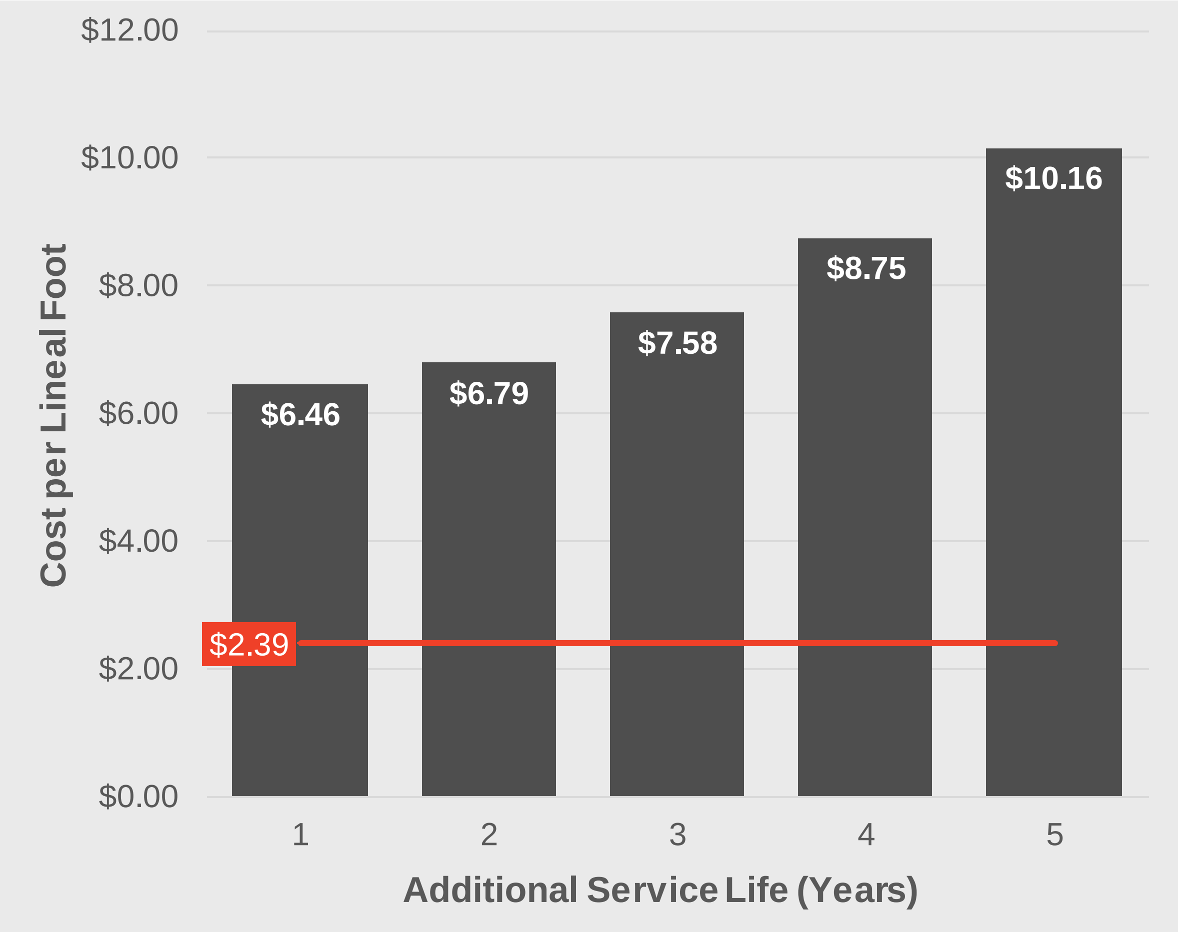
TRB Paper is available upon request

IDOT's ROI:
3-5 times the cost of VRAM

IDOT VRAM Life Cycle Cost Analysis

2-lane roadway
15-year basis

Includes shoulder joint maintenance



IDOT expects VRAM to provide a life extension of 3-5 years

The benefit of this practice is 3-5 times the cost of the material, per IDOT

VRAM vs Echelon Paving

Study completed by STATE Testing for DuPage County, Illinois

Table 1

2016 DuPage North - Gary Avenue					
Mix Type	Vir AC	Section Type	DCT (J/m^2)	I-FIT (FI)	Ave Density
N70E	SBS PG70-28	J-Band	675.5	41.0	98.9[1]
N70E	SBS PG70-28	Echelon	485.5	14.7	94.1
N70E	SBS PG70-28	Joint Heater	418.5	12.3	90.4
1 - Gmm calculated from cores					

Table 2

2016 DuPage South - Hobson Road					
Mix Type	Vir AC	Section Type	DCT (J/m^2)	I-FIT (FI)	Ave Density
N70E	SBS PG70-28	J-Band	395.5	48.5	95.7[1]
N70E	SBS PG70-28	Echelon	418.5	10.7	93.3
N70E	SBS PG70-28	Joint Heater	340.0	11.0	92.8
1 - Gmm calculated from cores					

- Echelon Paving may not always be the best option
- There are construction, safety and traffic concerns that must be considered

J BAND®

Montana Route 83 Project

Saves Money

Montana Route 83, July 2020

- Contractor: LHC
- Applied by Z & Z Asphalt using a Cimline MA4 Distributor and Seneca packaged VRAM
- 75,557-foot project in Missoula County, MT, starting 4 miles north of Condon, MT to 12 miles south of Condon
- With mill and fill, spray application was 9” wide and planned 0.83 lb/ft for the 1.8” surface course.

JBAND®

Montana Route 83

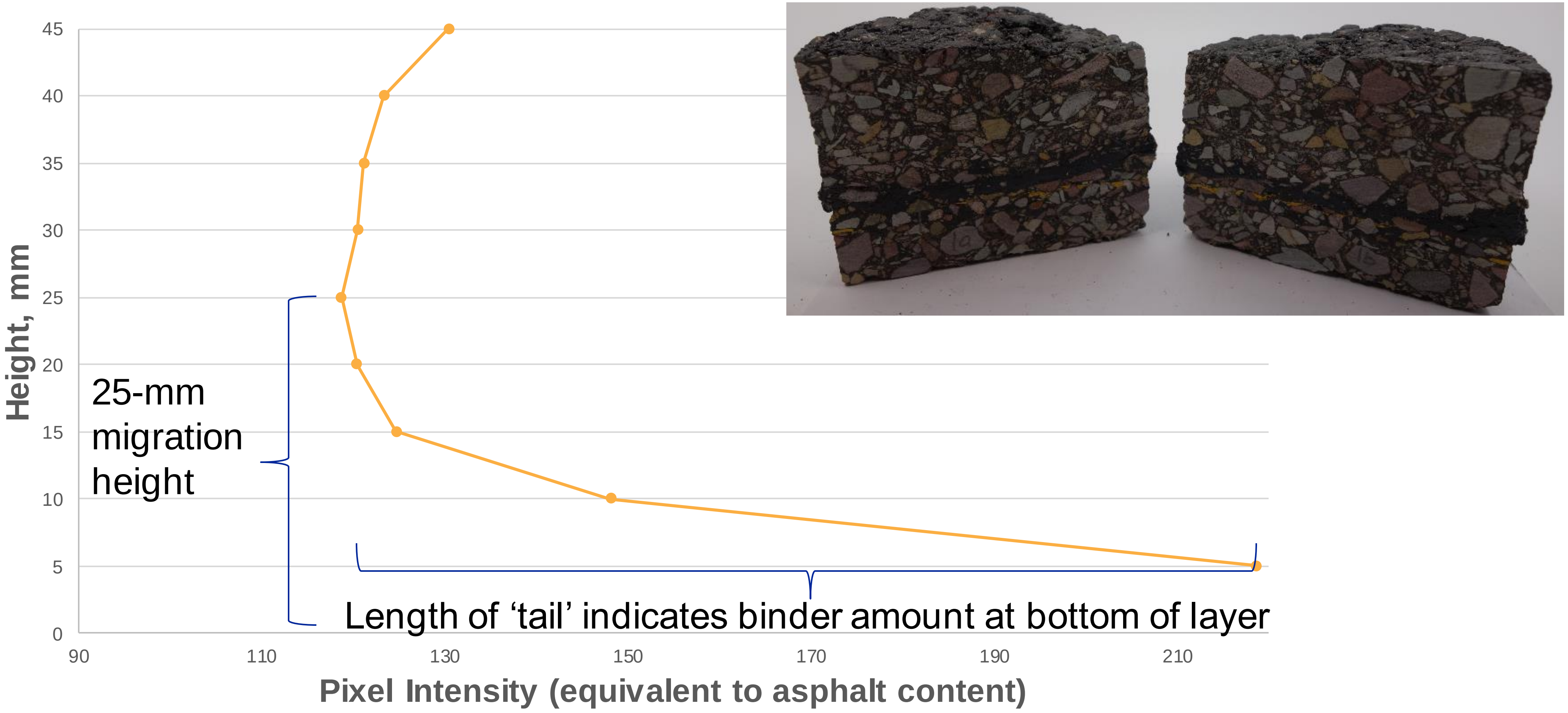
- Contractor: LHC
- One to two days between VRAM application and paving

Migration by digital image analysis (DIA) for Rt. 83

- Procedure developed by Illinois DOT
- Contrast of the aggregate v. asphalt in 5-mm increments
- High resolution digital camera
- Software available free on internet
- Actual migration affected by VRAM amount, %voids, void size and connectivity, substrate texture, mix temperature, compaction

Migration DIA for MT Rt. 83

Average of 6 faces



Safety & Sustainability

VRAM As Applied To Safety

Dangers of Distracted Drivers

- A VRAM can extend the life of the construction joint
- Avoids lane closures for maintenance and repair
- Improves public safety and worker safety

VRAM Under Rumble Strips

VRAM Section Nov 2021

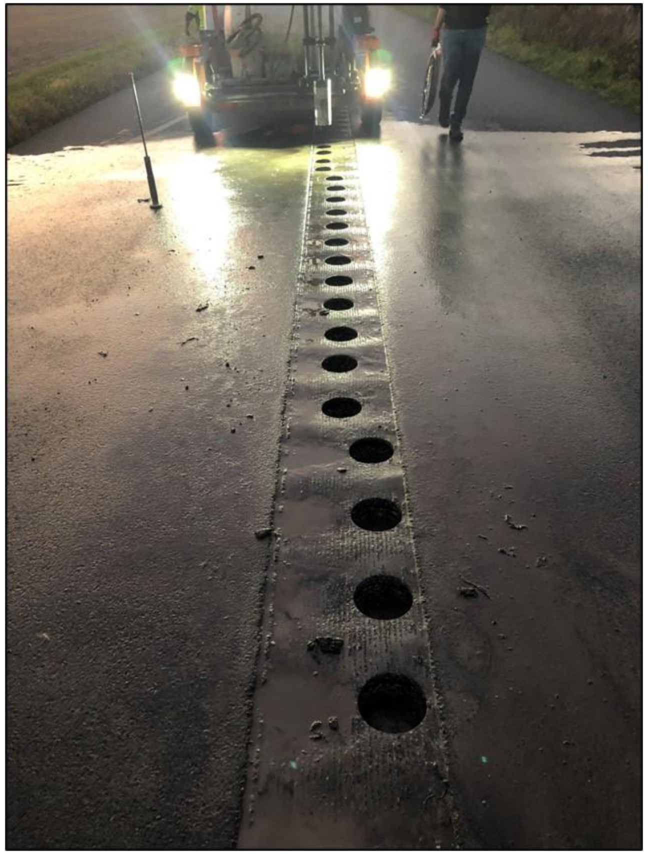
Control Section Nov 2021

- Rumble strips/corrugations
  - Used on an increasing basis for safety
  - Placed in the weakest area of the pavement, centerline joint or outside edge of paving creating early failure
- VRAM under centerline or edge rumble strips to reduce air/water permeability
- Sealed after milled in to reduce water penetration

JBAND

VRAM Under Rumble Strips (RS)

Research by Asphalt Materials, Inc. / Heritage Research Group



	Control	VRAM	Control / RS	VRAM / RS
Avg air voids, %	5.3	3.0	9.2	5.9
Avg k, ft/day	0.03	0.00	4.92	0.01

Extensive lab performance testing underway on cores – built 2021

JBAND®

Sustainability

- AMI partnered with ClimeCo to study sustainability of J-Band
- ClimeCo is a sustainability, climate change, and environmental commodities firm
- AMI wanted to build on J-Band pavement life-extension to understand its sustainability benefits

Sustainability

Greenhouse Gas

	GHG Emissions (kgCO2e)			
	JBand	Joint Adhesive	IR Heater	PWTB
Manufacture	458.6	35.6	-	3,042.4
Transport	136.3	160.0	-	58.1
Application	2.7	119.5	400.0	1,834.1
Maintenance trips	274.7	444.2	444.2	444.2
Total over lifetime	**872.3**	**759.3**	**844.2**	**5,378.8**
Averaged per year emissions	**48.5**	**50.6**	**52.8**	**358.6**

*Greenhouse Gas Emissions, in kilograms of CO2 equivalents, broken down by segments of the construction process. This is for a 1-mile project distance, 50 miles away from manufacturing site**

**Distance only applies to J-Band and Joint Adhesive. Distance between the home base and project site for IR heater and PWTB is assumed to be 30 miles.*

Sustainability

Air Quality

	Lb Pollutant (VOC/CO/NOx/PM2.5)			
	JBand	Joint Adhesive	IR Heater	PWTB
Manufacture	0.00072	0.00004	-	12.60
Transport	1.8	3.7	-	1.6
Application	0.061	1.5	1.5	122.7
Maintenance trips	1.8	26.7	26.7	26.7
Total over lifetime	**3.7**	**31.8**	**28.2**	**163.6**
Averaged per year emissions	**0.2**	**2.1**	**1.8**	**10.9**

*Pounds of pollutants emitted during all phases (manufacture through maintenance) for a 1-mile project distance, 50 miles away from manufacturing site**

**Distance only applies to J-Band and Joint Adhesive. Distance between the home base and project site for IR heater and PWTB is assumed to be 30 miles.*

Sustainability

Safety

	Injuries per million miles				Fatalities per million miles			
	JBand	Joint Adhesive	IR Heater	PWTB	JBand	Joint Adhesive	IR Heater	PWTB
Application	21	32	189	284	0.7	1.1	6.3	9.5
Maintenance Trips	44	837	837	837	1.5	28.0	28.0	28.0
Total over lifetime	**65**	**868**	**1026**	**1120**	**2.2**	**29.1**	**34.4**	**37.5**
Average per year	**4**	**58**	**64**	**75**	**0.1**	**1.9**	**2.1**	**2.5**

Number of worker safety incidents. Safety metrics have been normalized to one million miles for ease of comprehension.

VRAM Summary

- **Material solution** to improve performance at the joints
- Proven technology – multiple projects have been in place for **over 15 years**
- Reduces **permeability** and the need for joint maintenance
- Helps to improve **safety & sustainability** on the roads
- Life Cycle Cost Analysis can prove **savings**

Questions About VRAM?

Todd Thomas

Asphalt Materials, Inc.

973-610-2260

tthomas@asphalt-materials.com

For more information go to
https://www.thejointsolution.com