JBAND
The Bottom-Up Joint Solution

A Proactive Solution to Improving Longitudinal Joint Performance

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Associated Asphalt®

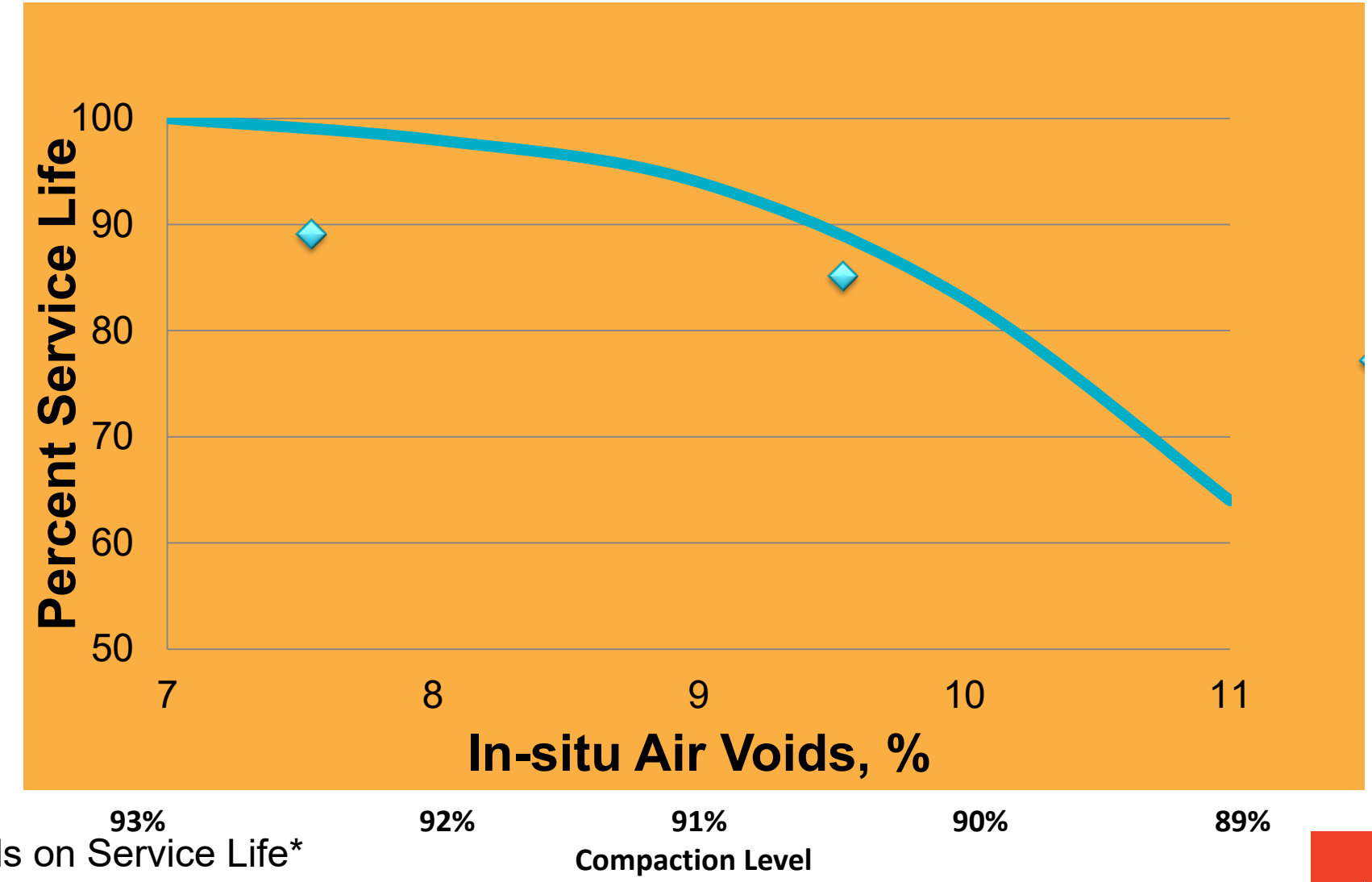
Longitudinal Construction Joints

- Issues
  - Cannot achieve the same density at the joint as in the mat
  - Water and air intrusion accelerates damage
- Longitudinal construction joints
  - Commonly, the first area requiring maintenance on a pavement

Longitudinal Construction Joints

- Methods to improve joint performance
  - Joint density requirements (typically target voids at 4” from joint to within 2% of center mat voids)
  - Echelon paving (eliminate the joint)
  - Notched wedge joint
  - Cut off lower density unconfined edge
  - Mill and inlay
- All the above are “mechanical” solutions

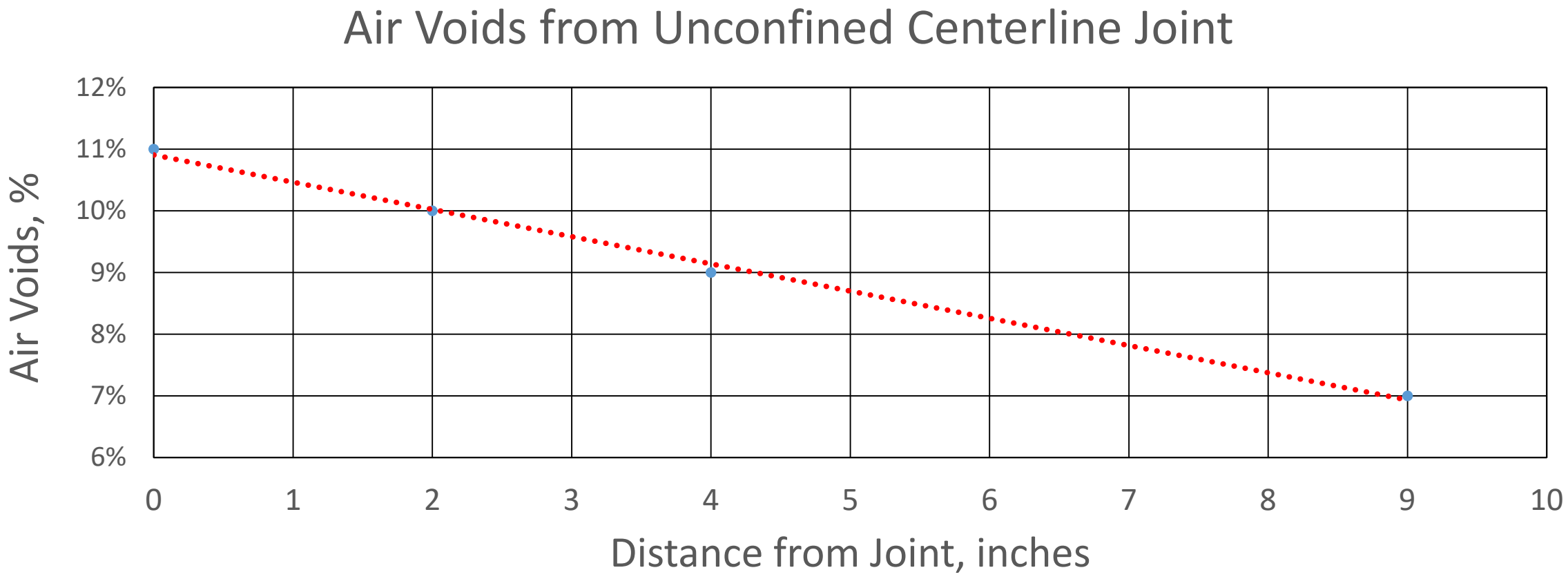
Why do joints fail early?



*Washington State DOT Study

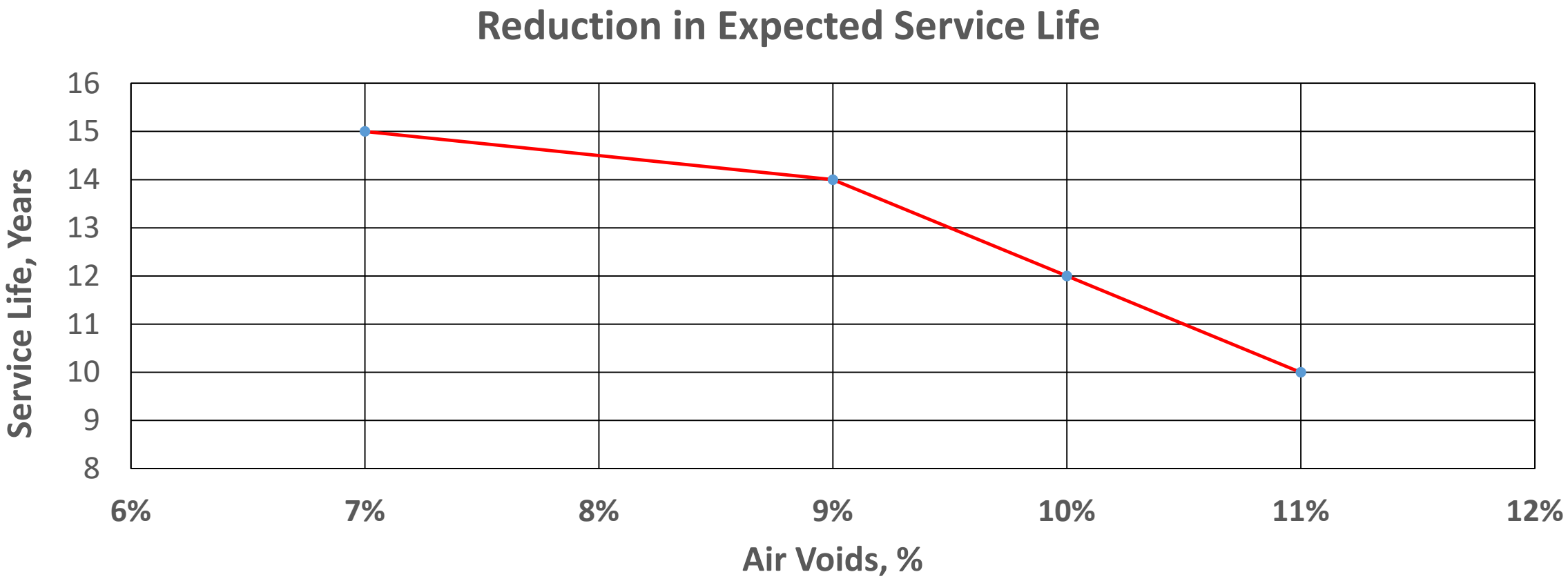
"Effect of In-Place Voids on Service Life*

Air Voids from Joint Towards Center of Lane



Centerline going towards interior of mat ⟶

Effect of Air Voids on Pavement Service Life



If the center of the mat is at 7% voids or less, but the joint is at 11% voids, <u>the joint fails 5 years earlier</u> than the rest of the pavement.

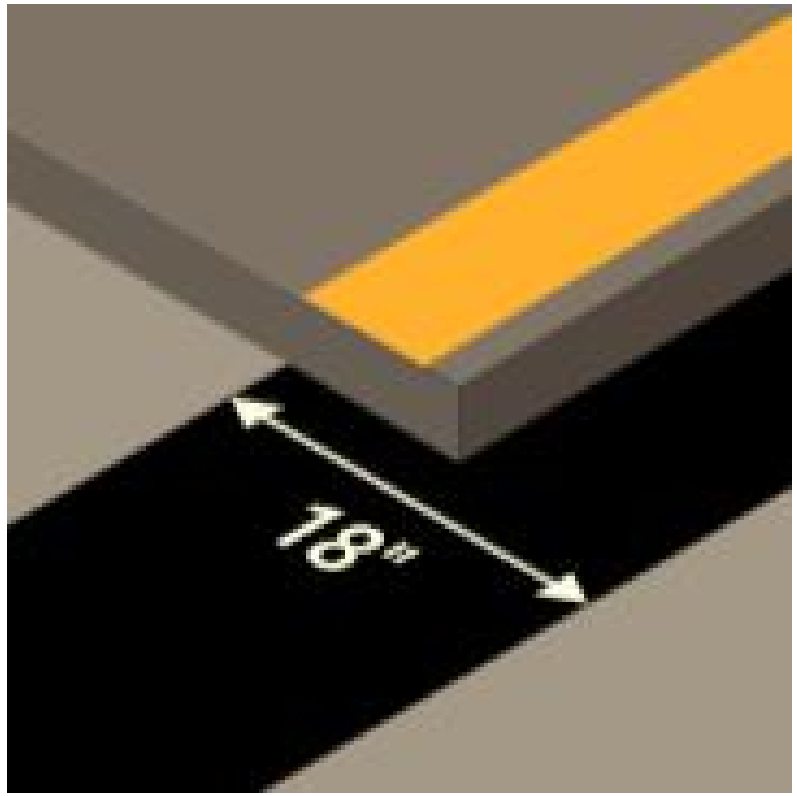
Longitudinal Joint Improvement Plan

- Early 2000 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)

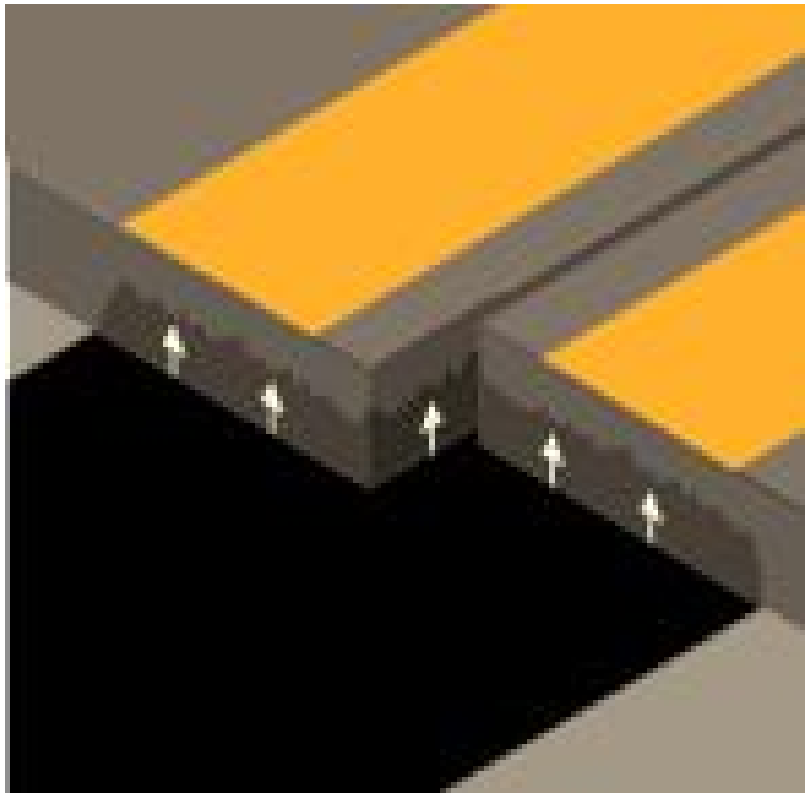
Falling head permeameter

A Materials 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



Polymer modified binder migrates into the HMA at the joint

VRAM Performance History

9 IDOT VRAM 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 US-50 Richton Park
- District 2 IL-26 Cedarville

VRAM Field Performance
IDOT D7 Elwin US-51 after 15 Years

VRAM Joint transition to control

VRAM section

VRAM Field Performance
IDOT D2 Cedarville IL-26 after 14 years

VRAM Test Section

All pictures were taken in 2017

Transition from Control Section to VRAM Section

Control Section

VRAM Field Performance

IDOT D1 IL-50 Richton Park after 14 years

VRAM Test Section

Control Section

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

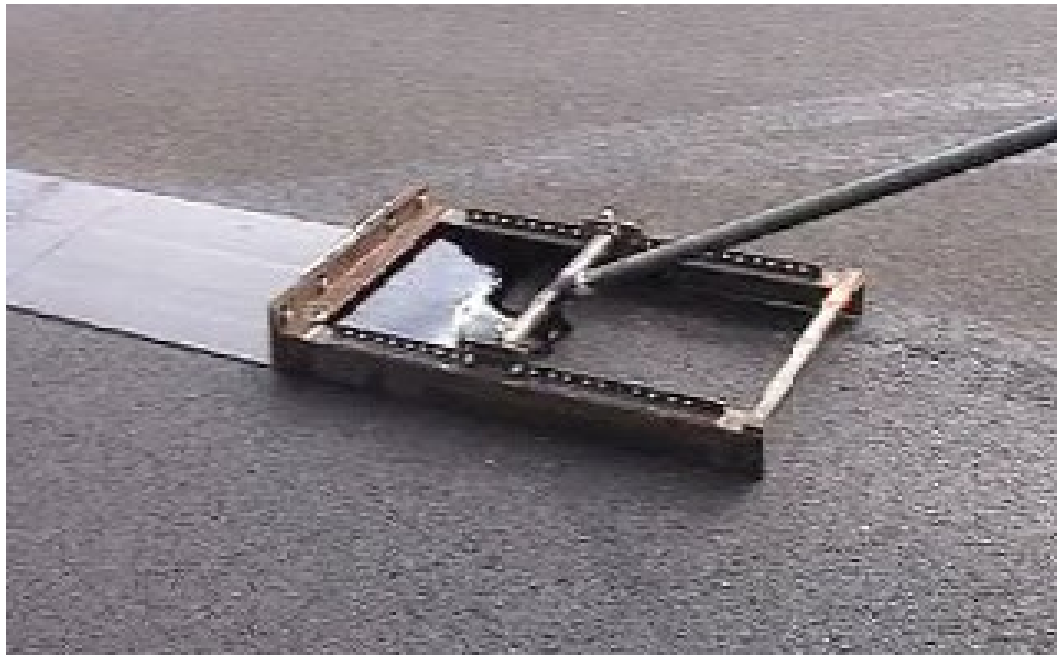
VRAM Material Features

- Migration upward from heat of mix and compaction to reduce permeability at the joint
  - Voids filled to 50% or more of overlay height filled over the width of the application
- Bonds to the underlying pavement and bond at the joint
- Crack resistance at the joint

Placed <u>under</u> the intended area for an overlay longitudinal construction joint

VRAM Construction Features

- Non-lateral flow at placement
- Minimal time from placement to start of paving
- Fast release to traffic for moving construction zone
- Non-tracking, no pick up from construction operation or traffic



Placed <u>under</u> the intended area for an overlay longitudinal construction joint

VRAM Application

Placed by pressure distributor with mechanical agitation in tank

OR

Manual strike off box fed from melting kettle

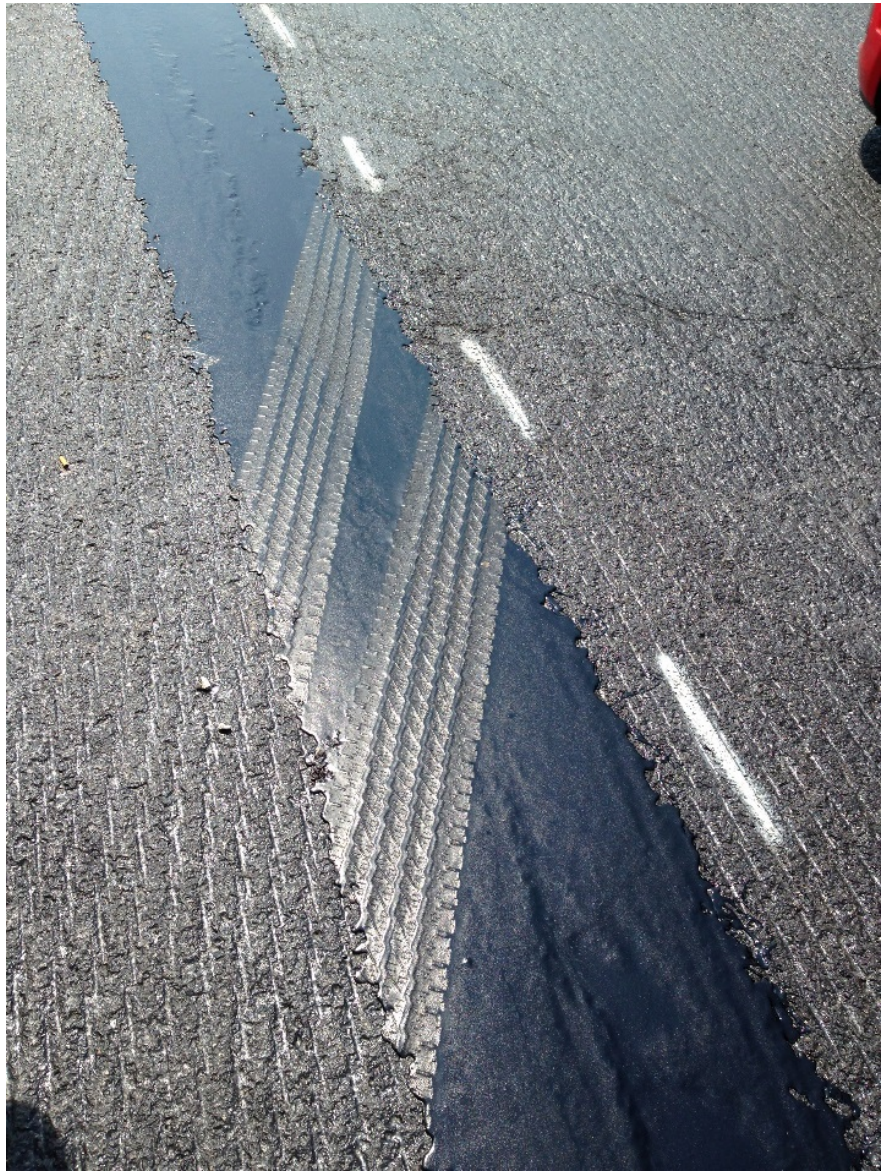
Application of VRAM

- VRAM should be applied between 265F and 320F or as recommended by the supplier.
- Exact placement location of VRAM should be discussed prior to performing on the project.

SR-119 Elkhart Co, IN

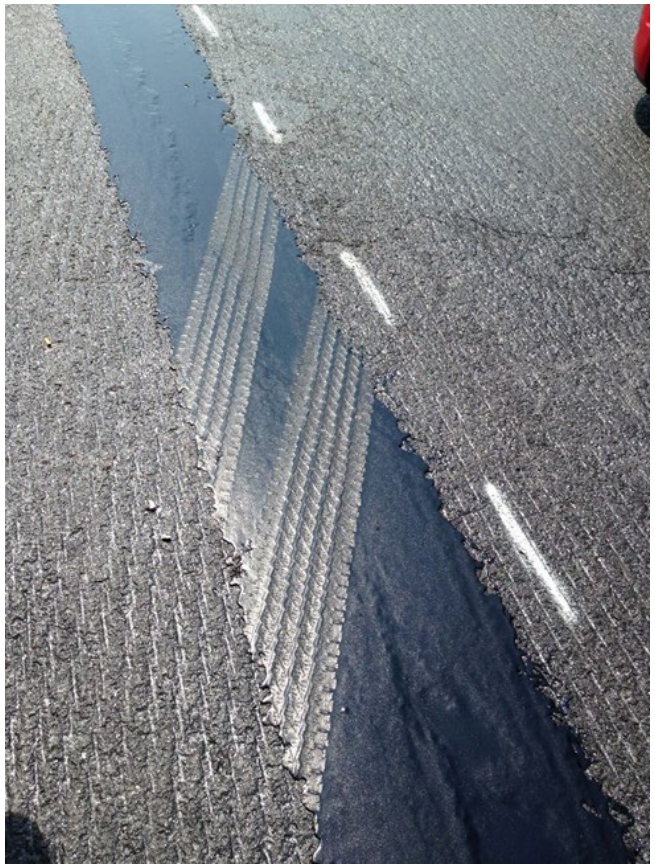
Application of VRAM

- Vehicles may cross over the VRAM once cooled to 130F or less. **Do not permit** vehicles to stop on or drive longitudinally on top of the VRAM.
- A guideline is placed for the applicator to follow.

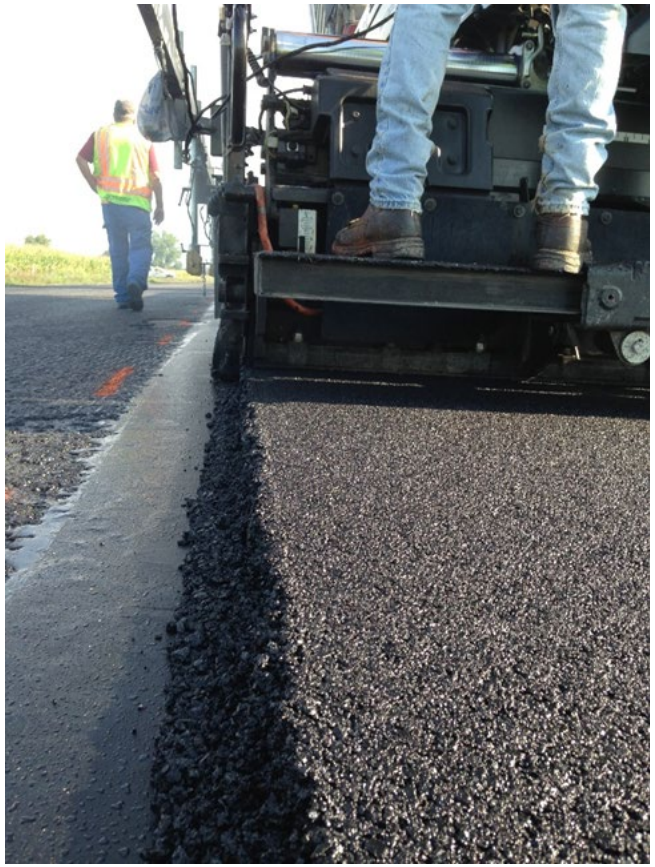


VRAM Application

18” wide VRAM application



Non-tracking < 30 min



1st pass covering half VRAM width

VRAM Special Provision

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.	AASHTO T301
Separation of Polymer, Difference in °C of the softening point (ring and ball)	3 max.	ASTM D7173, AASHTO T53

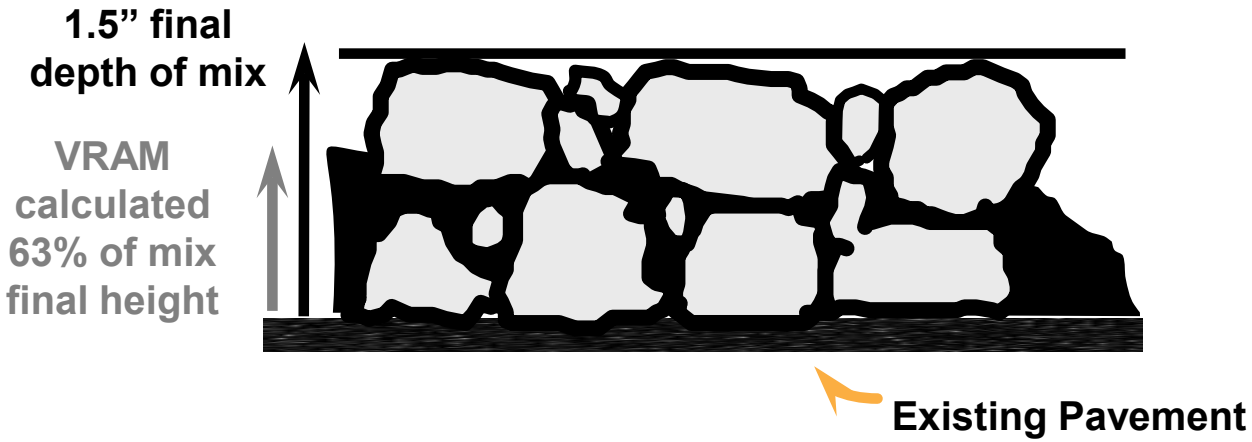
New VRAM Application Rate Table

VRAM Application Table for 18” width			
	Application Rate, lb/ft		
Overlay Thickness, in	Coarse-Graded	Fine-Graded	SMA/SP5
1	1.15	0.80	
1 ¼	1.31	0.88	
1 ½	1.47	0.95	1.26
1 ¾	1.63	0.95	1.38
≥ 2	1.80	0.95	1.51
Tolerance	± 10%	± 10%	± 10%

Effect of VRAM on Voids at Joint

Example

- **HMA @ 5.5% AC, @ 1.5” thick/square yard = 9 lb of AC**
- **VRAM @ 1.47 lb/ft – 18” equates to 8.8 lb AC/square yard**
- **Total AC in HMA + VRAM = 10.3%**
- **For 10-13% air voids @ joint, VRAM would occupy 2/3 of overlay height**



Cross Sectional View at Longitudinal Joint

VRAM Special Provision

VRAM shall be

- … suitable for construction traffic to drive on without pick up or tracking within 30 minutes of placement.
- … be applied not less or greater than 1.5” of the width specified in the plans. The VRAM shall not flow more than 2” from the initial placement width.
- Density testing, one foot on either side of the joint, will be waived.

Field Observations and Performance

Current States with VRAM Experience

- Illinois
- Ohio
- Iowa
- Indiana
- Michigan
- Missouri
- Wyoming
- Minnesota
- Pennsylvania
- Delaware

VRAM Application Temperature Limitations

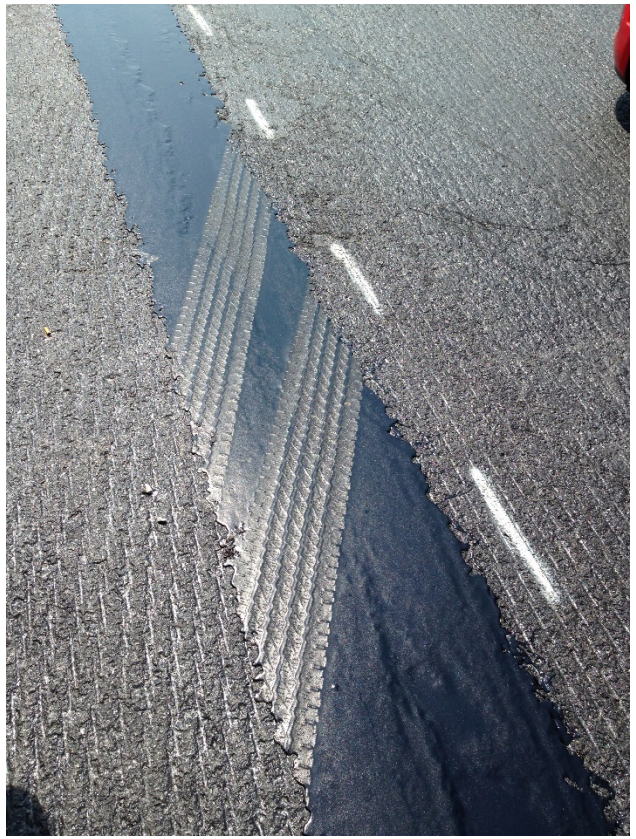
- Paving temperatures and conditions will dictate

November 7th , 2018, Collinsville, Illinois

Milled Surface Preparation for VRAM Application

- Compressed air may be used to remove dust and fine materials from the area where VRAM will be applied.
- Roads posted < 45 miles/hour, should use compressed air to clean the surface where VRAM will be placed.
- Final cleaning within 24 hours of the placement of VRAM

VRAM Over Milled Surface



- Milled surface with 1 ½” 9.5mm surface (IL 1/US 150)
- 18” width application, 1.47 lb/ft VRAM

Mill and Fill VRAM Applications

- When only one-half of the joint is exposed, VRAM is applied at one-half the prescribed width and rate and adjacent to the center of the joint

I-74 west of Crawfordsville, Indiana

Existing Pavement Not Well Bonded

VRAM will locate the <u>weakest tensile bond</u>. Usually the weakest bond is with the tires of the construction equipment.

VRAM on Interstate Night Paving

I-71 Near Strongsville, OH

- Night paving on milled surface
- 1 ½” 9.5mm HMA, 1.47 lb/ft target rate of VRAM at 18” width

VRAM at Outside Edge of Paving

- Historical weak edge of paving
- 2 lane, 22’ wide, milled surface
- VRAM placed 18” on <u>outside edges of paving</u> under two paving lifts
  - 2 ½” 19mm Intermediate mix
  - 1 ½” 9.5mm Surface mix

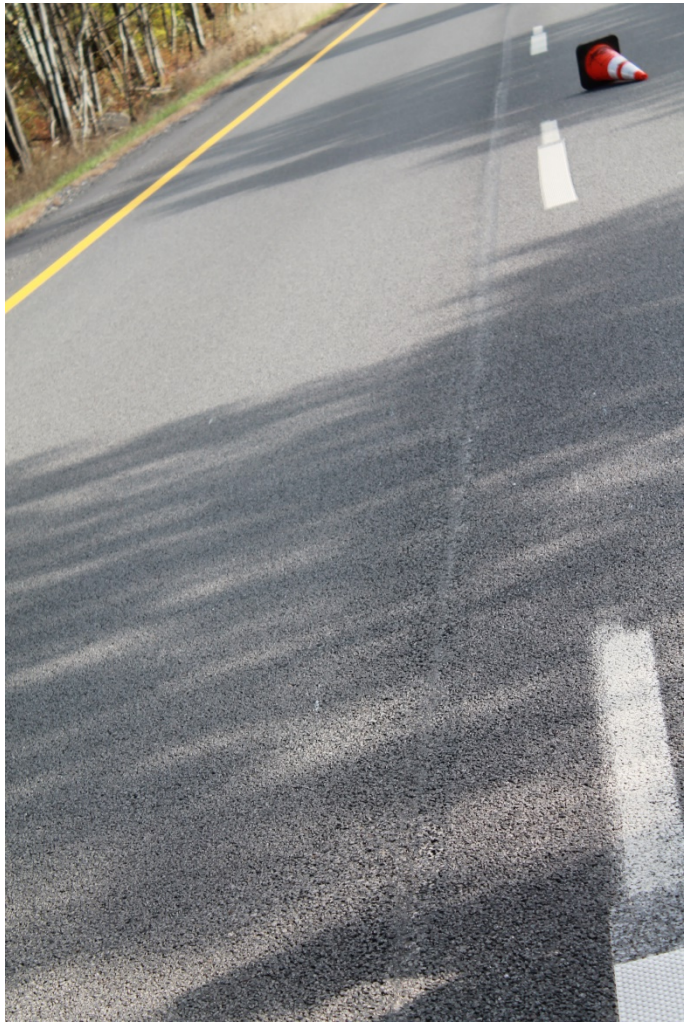
SR-119 Elkhart Co, Indiana

Penn Dot Field Test Site 1

- Paved on October 17, 2018
  - ECMS #87661, SR 81-24M
  - Location: Placed under the Centerline joint for two (2) miles in the I-81 Northbound lanes, between MM 132.0 and 134.0
  - Type of Mix SMA

PennDOT J-Band Project I-81 - November 2019

PennDOT J-Band Project I-81 - November 2019



Picture dated October 2019
J-Band Test Section

PennDOT J-Band Project I-81 - November 2019

Picture dated October 2019
Control Section – no J-Band

PennDOT J-Band Project I-81 - November 2019

Picture dated October 2019
Note open surface texture

PennDOT J-Band Project I-81 - November 2019

Picture dated October 2019

PennDOT J-Band Project I-81 - November 2019

Picture dated October 2019

Penn Dot Field Test Site 2

- Paved October 17, 2018
  - ECMS #111081, SR 380-WD-2
  - Location: Placed under the centerline longitudinal joint for one (1) mile in the northbound lane of I-380, between MM 1.4 and 2.6
  - Type of mix was SMA

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019
Note open surface texture

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019

PennDOT J-Band Project I-380 - November 2019

Picture dated October 2019
Control Section – no J-Band

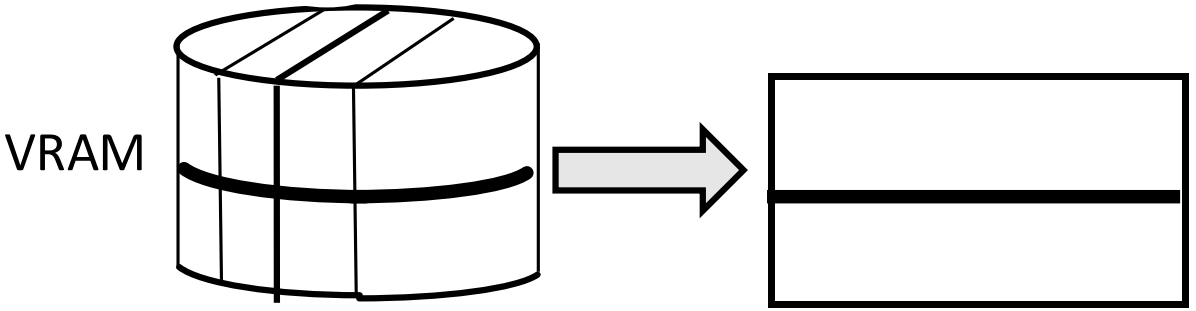
PennDOT J-Band Project I-380 - November 2019

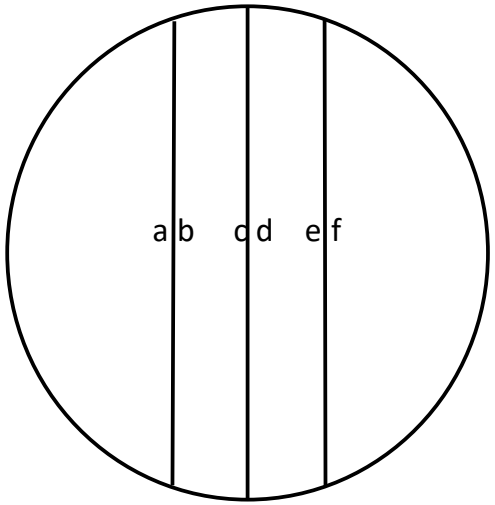
Picture dated October 2019
Control Section – no J-Band

What's Next for Penn Dot?

- Continue to evaluate SR 81 and SR380 projects (18-24 month)
- Penn Dot Work Plan- Research Project #2018-223
  - Marcy Lucas MALUCAS@pa.gov
- First Penn Dot Project bid
  - ECMS #111658 on 12/12/2019, Prime- Plum Contracting, Inc.
- Next on the books;
  - ECMS #93710 SR 924 Gold Star Highway, bids on 1/30/2020
- Testing
  - DIA; Digital Image Analysis.
    - Used to determine the migration height and penetration depth of VRAM

Preparation and naming scheme

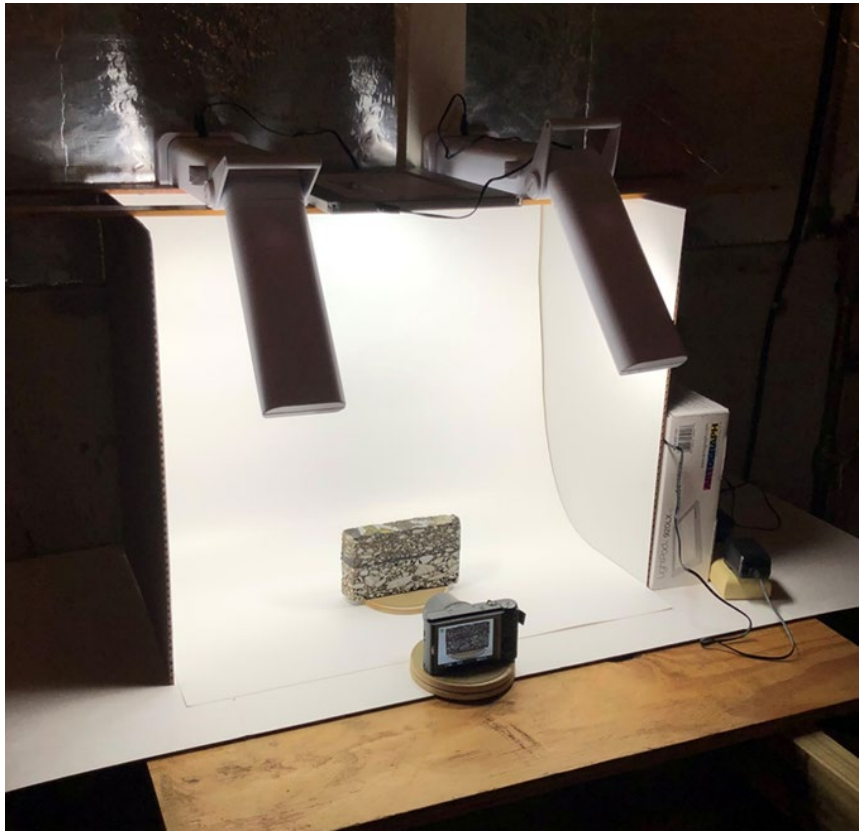




The 6” diameter cores were frozen before saw cutting into one-inch thick slices.

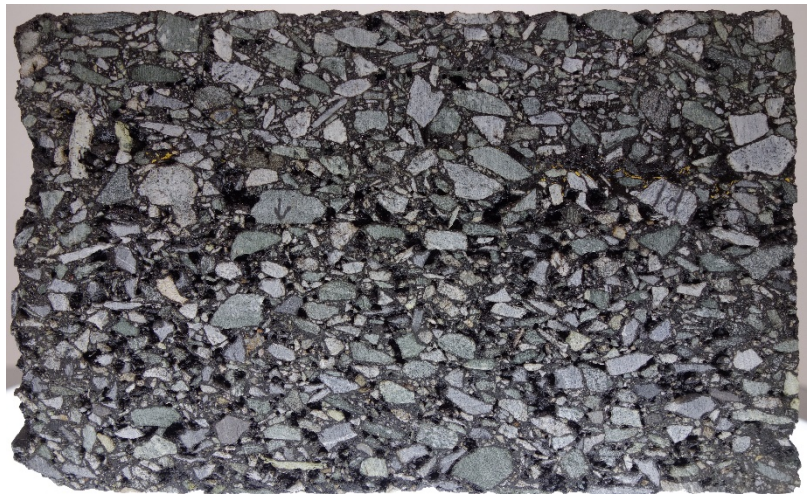
Each core had three cuts to make two slices and rounded ends. Six faces were measured on each core.
Example on naming:
Core 1: 1a, 1b, 1c, 1d, 1e, 1f
Core 4 had only one cut with a and b sides

Migration by digital image analysis (DIA)

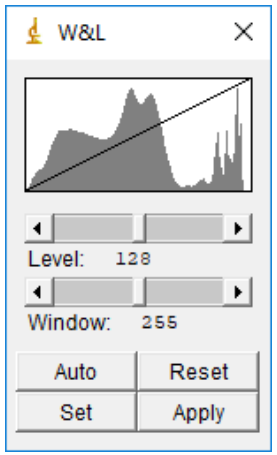


- Used a 20 MP camera and ImageJ software to determine the grey-level of each core slice in 5-mm increments from the bottom to the top of the core
- Relies on the contrast of the aggregate v. asphalt
- DIA migration and penetration affected by voids (shadows), crushed aggregate, segregation, larger aggregates, core height, measurement area, etc.
  - Note – more voids at centerline
- Actual migration and penetration affected by VRAM amount, voids and void size and connectivity, substrate texture, mix temperature, compaction
- Developed by Brian Hill of IDOT

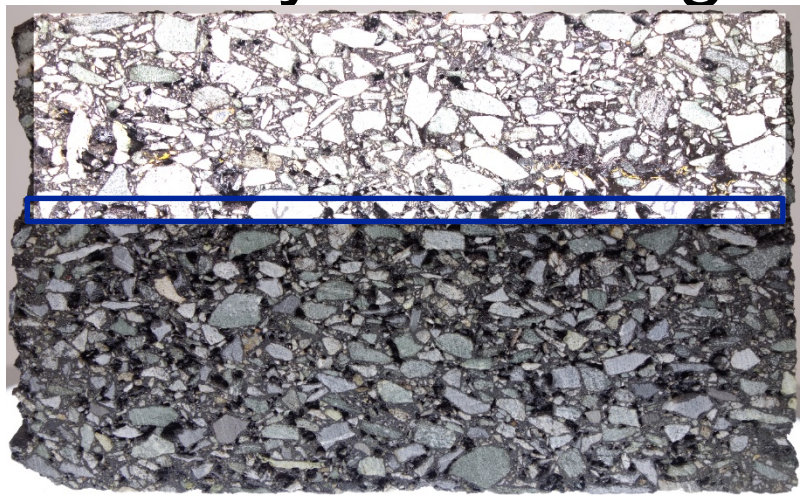
1. Image from high-resolution camera



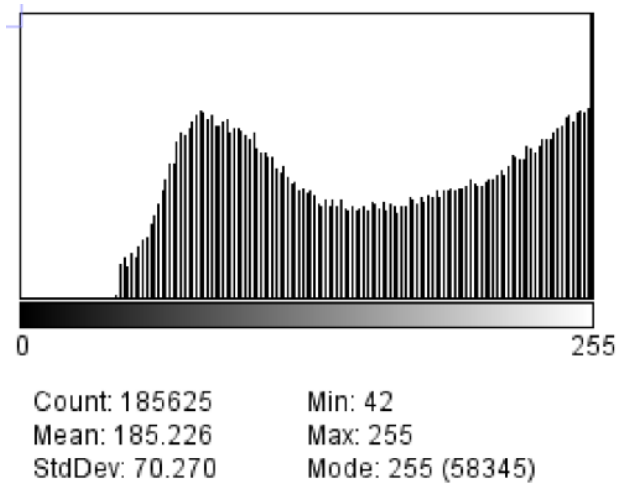
2. Window and level mode to transform image (layer where VRAM is) to a grayscale image (L=40, W=100)



3. Grayscale image



4. Histogram to obtain data on 5-mm tall rectangle in grayscale image to obtain Count, Mean, and Mode – data entered in Excel sheet to calculate pixel intensity per 5-mm rectangle. Repeat after moving rectangle up.



VRAM as applied to Safety

Dangers of Distracted Drivers

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

Cost Comparison*

- Inlay: $8.00/linear ft
  - Includes: traffic control, mobilization, milling, priming, paving, pavement marking
- Microsurfacing: $4.81/linear ft
  - Includes: crack seal, traffic control, pavement marking/removal
- Route and Seal: $2.00/linear ft
  - Includes: prime, crack seal, traffic control
- VRAM (material including placement): $2.50/linear ft

*Illinois DOT HMA Update, 57th Annual Bituminous Conference

VRAM Summary

- Application rate based on volumetrics (tailored to specific mix types)
- Provides a material solution to reducing air voids at the longitudinal joint thereby reducing air and water permeability
- Multiple field projects in place for 15+ years demonstrate improved long term joint performance
- May remove the need for echelon paving
- Reduces need for joint maintenance and increases the life of the pavement
- Increasing joint life reduces need for maintenance, improving safety for construction workers and motoring public


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