A Proactive Solution to Improving Longitudinal Joint Performance

Marvin Exline/Todd Thomas

WV Paving Conference February 28th, 2019
How difficult is it to find pavements like these?
Notice the condition of the rest of the pavement
How much time and cost to patch/repair?
How much danger to do the repair?

Danger from Distracted Drivers
Last Winter in the Midwest

Is this winter going to be any better?
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
  – 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*
Improving Longitudinal Joint Performance

Air Voids from Joint Towards Center of Lane

Air Voids from Unconfined Centerline Joint

Centerline going towards interior of mat
If the center of the mat is at 7% voids or less, but the joint is at 11% voids, the joint fails 5 years earlier 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.
9 IDOT VRAM Experimental Test Sections Placed in 2002 – 2003

Illinois DOT took cores for testing 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

All pictures were taken in 2017

Transition from Control Section to VRAM Section

VRAM Test 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
  o 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 under 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 under 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.
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

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic shear @ 88°C (unaged), $G^*/\sin \delta$, kPa</td>
<td>1.00 min.</td>
<td>AASHTO T 315</td>
</tr>
<tr>
<td>Creep stiffness @ -18°C (unaged), Stiffness (S), MPa m-value</td>
<td>300 max.</td>
<td>AASHTO T 313</td>
</tr>
<tr>
<td></td>
<td>0.300 min.</td>
<td></td>
</tr>
<tr>
<td>Ash, %</td>
<td>1.0 – 4.0</td>
<td>AASHTO T 111</td>
</tr>
<tr>
<td>Elastic Recovery, 100 mm elongation, cut immediately, 25°C, %</td>
<td>70 min.</td>
<td>AASHTO T 301</td>
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<tr>
<td>Separation of Polymer, Difference in °C of the softening point (ring and ball)</td>
<td>3 max.</td>
<td>ASTM D7173, AASHTO T 53</td>
</tr>
</tbody>
</table>
### VRAM Application Table

#### Coarse-Graded HMA Mixtures

<table>
<thead>
<tr>
<th>Overlay Thickness, in</th>
<th>VRAM Width, in.</th>
<th>Application Rate, lb/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>1.15</td>
</tr>
<tr>
<td>1 ¼</td>
<td>18</td>
<td>1.31</td>
</tr>
<tr>
<td>1 ½</td>
<td>18</td>
<td>1.47</td>
</tr>
<tr>
<td>1 ¾</td>
<td>18</td>
<td>1.63</td>
</tr>
<tr>
<td>≥ 2</td>
<td>18</td>
<td>1.80</td>
</tr>
</tbody>
</table>

#### Fine-Graded HMA Mixtures

<table>
<thead>
<tr>
<th>Overlay Thickness, in</th>
<th>VRAM Width, in.</th>
<th>Application Rate, lb/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>0.80</td>
</tr>
<tr>
<td>1 ¼</td>
<td>18</td>
<td>0.88</td>
</tr>
<tr>
<td>≥ 1 ½</td>
<td>18</td>
<td>0.95</td>
</tr>
</tbody>
</table>

#### SMA Mixtures

<table>
<thead>
<tr>
<th>Overlay Thickness, in</th>
<th>VRAM Width, in.</th>
<th>Application Rate, lb/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½</td>
<td>18</td>
<td>1.26</td>
</tr>
<tr>
<td>1 ¾</td>
<td>18</td>
<td>1.39</td>
</tr>
<tr>
<td>≥ 2</td>
<td>18</td>
<td>1.51</td>
</tr>
</tbody>
</table>
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
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
Types of Roads using VRAM

**Interstate:** ODOT I-77

**State:** Indiana SR-26

**County:** Champaign Co, IL Dewey-Fisher Road

**Urban:** Indianapolis DPW 56th St
VRAM Migration in the Field

- The first paving pass has been placed on the left covering half the VRAM
- The mix over the VRAM appears darker
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
Improving Longitudinal Joint Performance

Existing Pavement Not Well Bonded

VRAM will locate the weakest tensile bond. Usually the weakest bond is with the tires of the construction equipment.
VRAM with Live Bottom Trucks

- Live bottom trucks creating HMA windrow
- 1 ½” M,L-4 surface mix
- 1.47 lb/ft VRAM target at 18” width

Iowa DOT Hardin County SR 57
VRAM on Interstate Night Paving

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

- 2” SMA overlay (IL I-80 Henry County)
- 12” width application, 1 lb/ft VRAM
Double VGRAM Application

• Two VGRAM applications (IL 160 Madison Co.)
  – On milled surface, under 4.75mm level, 0.88 lb/ft target
  – On level binder with 1 ½” surface, 1.47 lb/ft VGRAM
• VRAM under notched wedge joint (IL 106 Greene Co.)
• 2 ¼” surface with 1.80 lb/ft VRAM target placed on milled surface
VRAM in New Construction

- Reconstruction and alignment project, InDOT SR 26
- 1 ½” 9.5mm Type 3 HMA over 1.47 lb/ft VRAM
VRAM over Diamond Ground PCC

- PCC with 1 ½” SMA overlay, MoDOT I-170
- 12” VRAM width at 1 lb/ft
VRAM at Outside Edge of Paving

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

SR-119 Elkhart Co, Indiana
VRAM under Rumble Strips

• 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

• VRAM under centerline or edge rumble strips to reduce air/water permeability

• Fog sealed after cuts to further help waterproof from the top
Improving Longitudinal Joint Performance

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)**: $2.00/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
- Provides improved cracking resistance
- 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