VRAM (Void Reducing Asphalt Membrane)

A Proactive Solution to Improving Longitudinal Joint Performance

NEAUPG Annual Meeting
Albany, NY
November 2, 2022

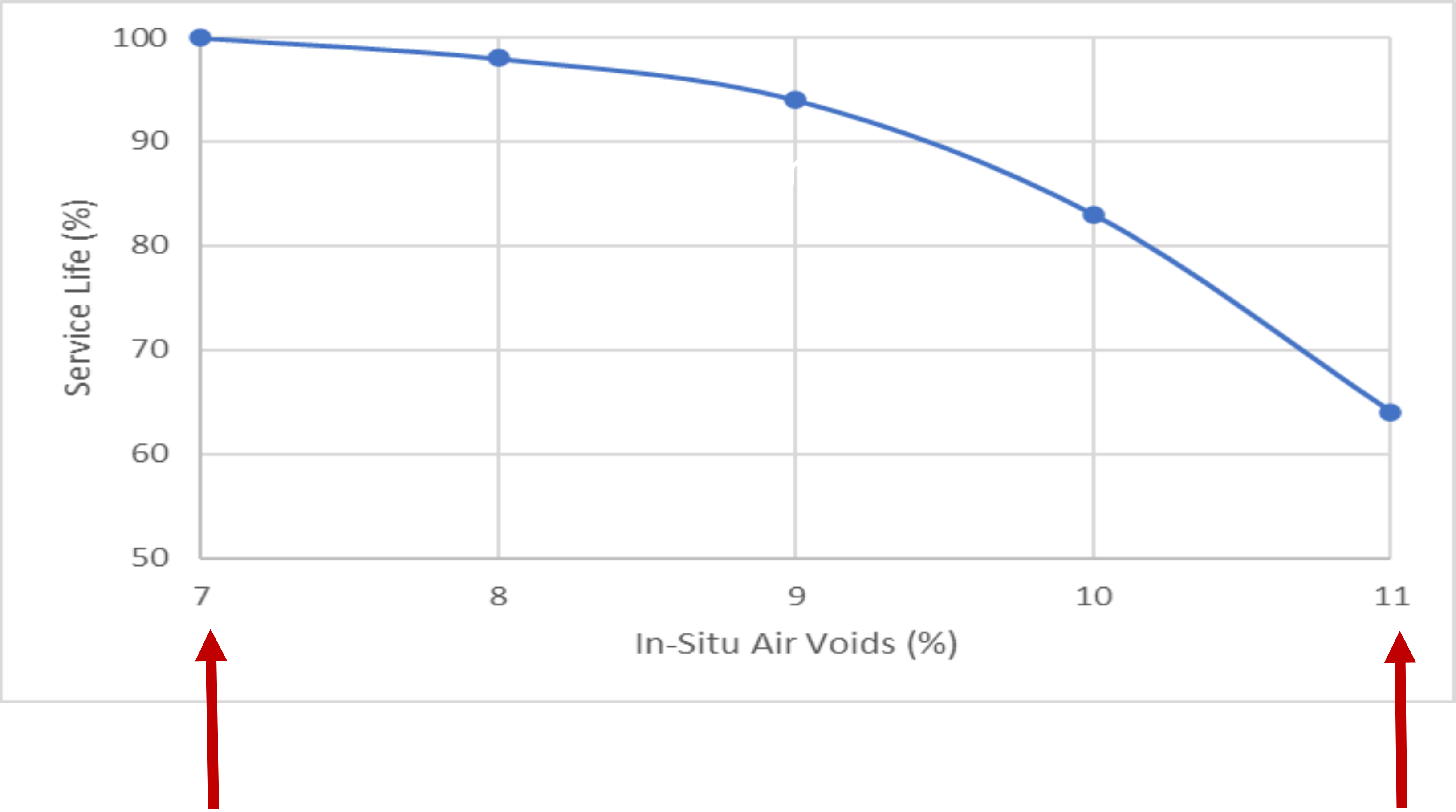
Michael Worden
Associated Asphalt

Agenda

- Washington State DOT Study on Air Voids
- What is VRAM & how does it work?
- VRAM Performance History
  - Illinois DOT – 20 years
  - Northeast – 4 years
- Sustainability & Safety
- Alternative & Suggested Uses
- Summary of Takeaways

Washington State DOT Study

Why do joints fail early?



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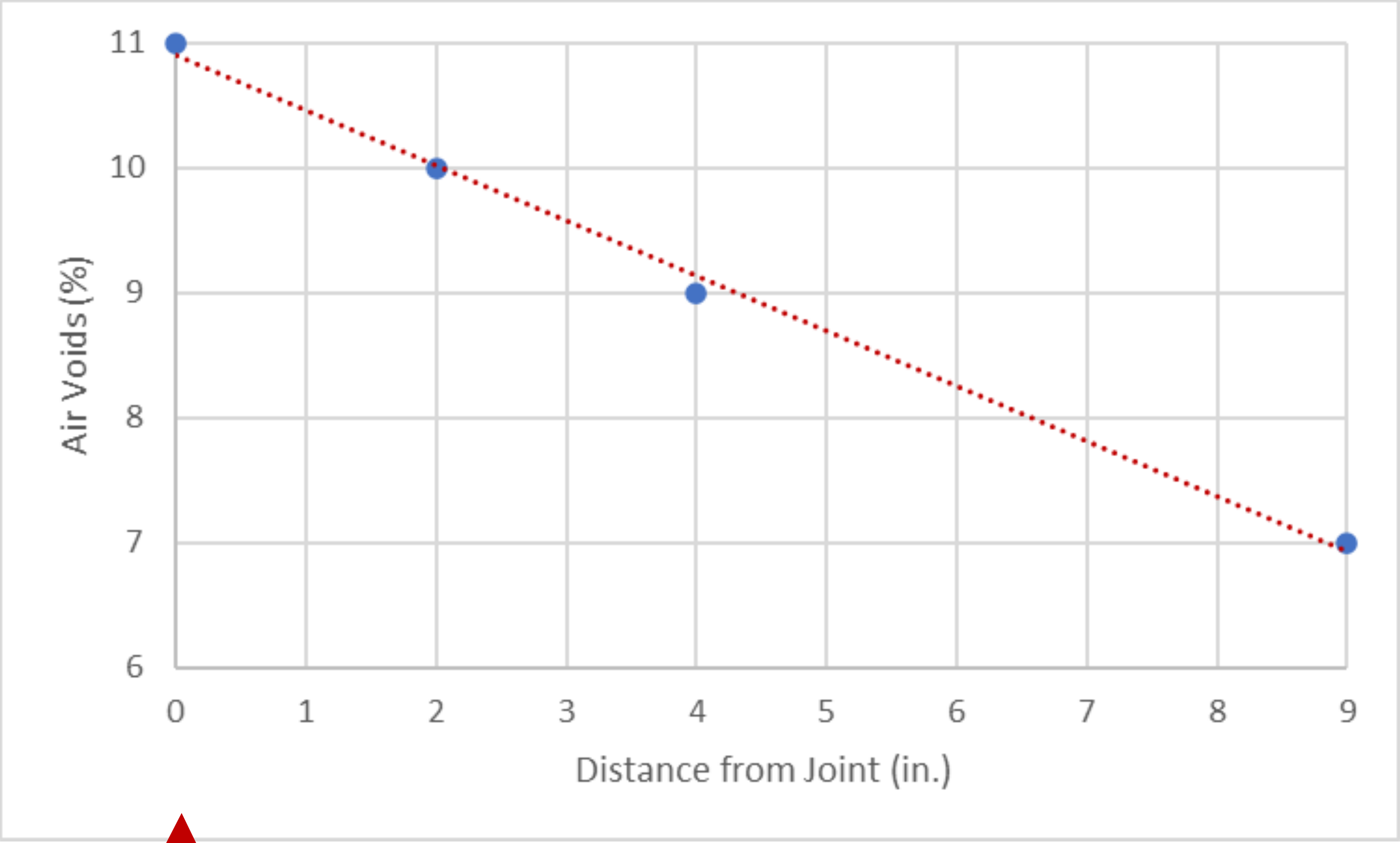
Air Voids from Joint Towards Center of Lane

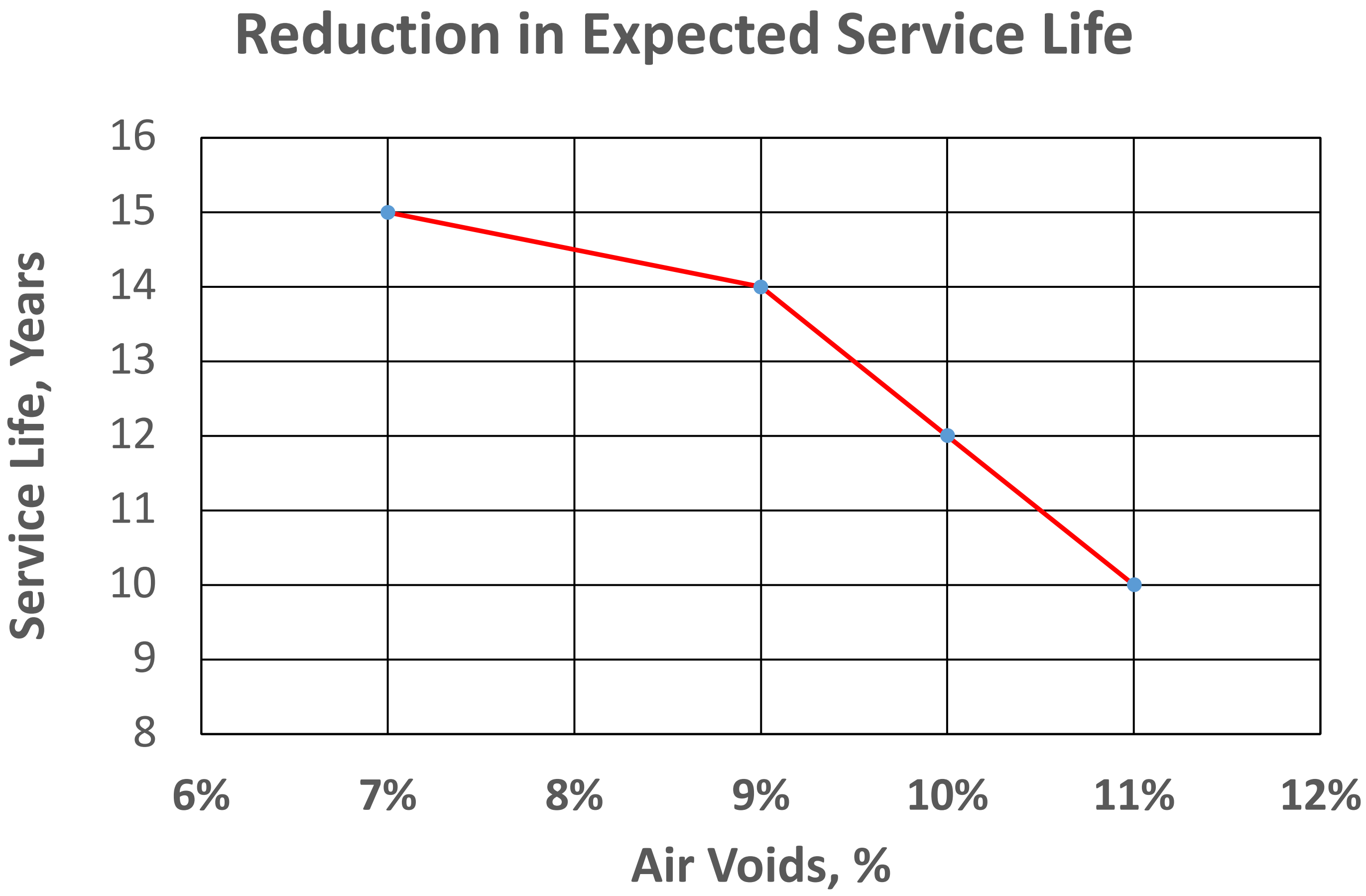


Washington State DOT Study?

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, the joint fails 5 years earlier than the rest of the Pavement.



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

Associated Asphalt

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

Associated Asphalt

Longitudinal Joint Performance 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)

VRAM

- What is VRAM? VRAM is a thick application of hot-applied, polymer-modified asphalt.
    - VRAM is not an emulsion.
    - True Grade 88-28, but with some additional properties added.

- The product is also referenced as:
    - LJS – Longitudinal Joint Sealant
    - VRAM – Void Reducing Asphalt Membrane

- Associated Asphalt’s VRAM/LJS product is J-Band®

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

Special Provision – Rates by mix type and thickness

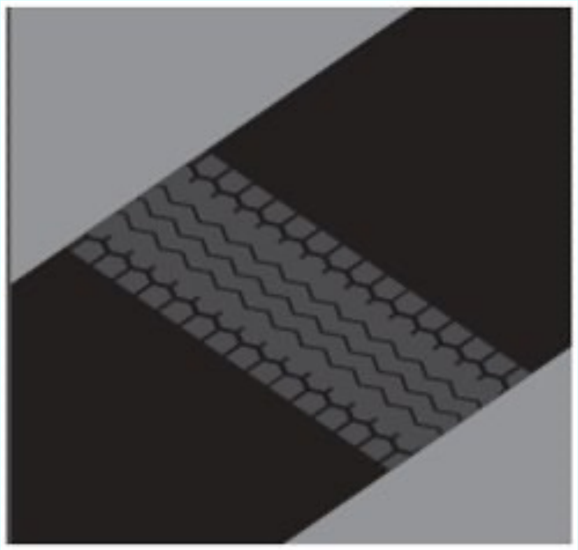
Coarse and fine-graded based on No. 8 sieve*

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		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1 ½	18	1.26
1 ¾	18	1.39
≥ 2	18	1.51

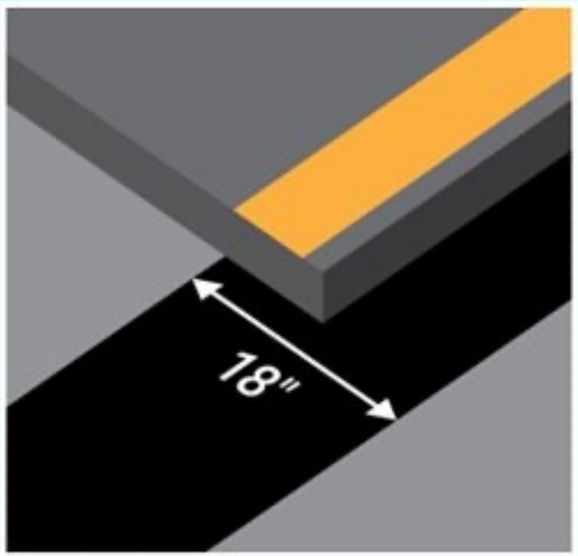
***No. 8 limits – 19-mm, 35% - 12.5-mm, 40% - 9.5-mm, 45%**

How Does VRAM Work

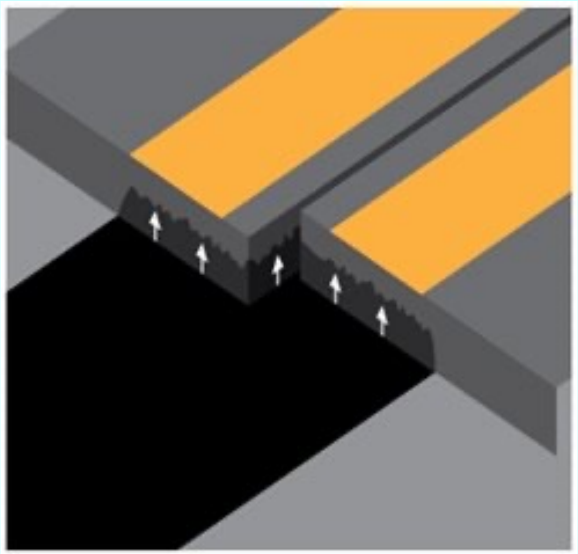
Apply a heavy band of polymer modified binder in the area where the new paving joint will be placed.



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



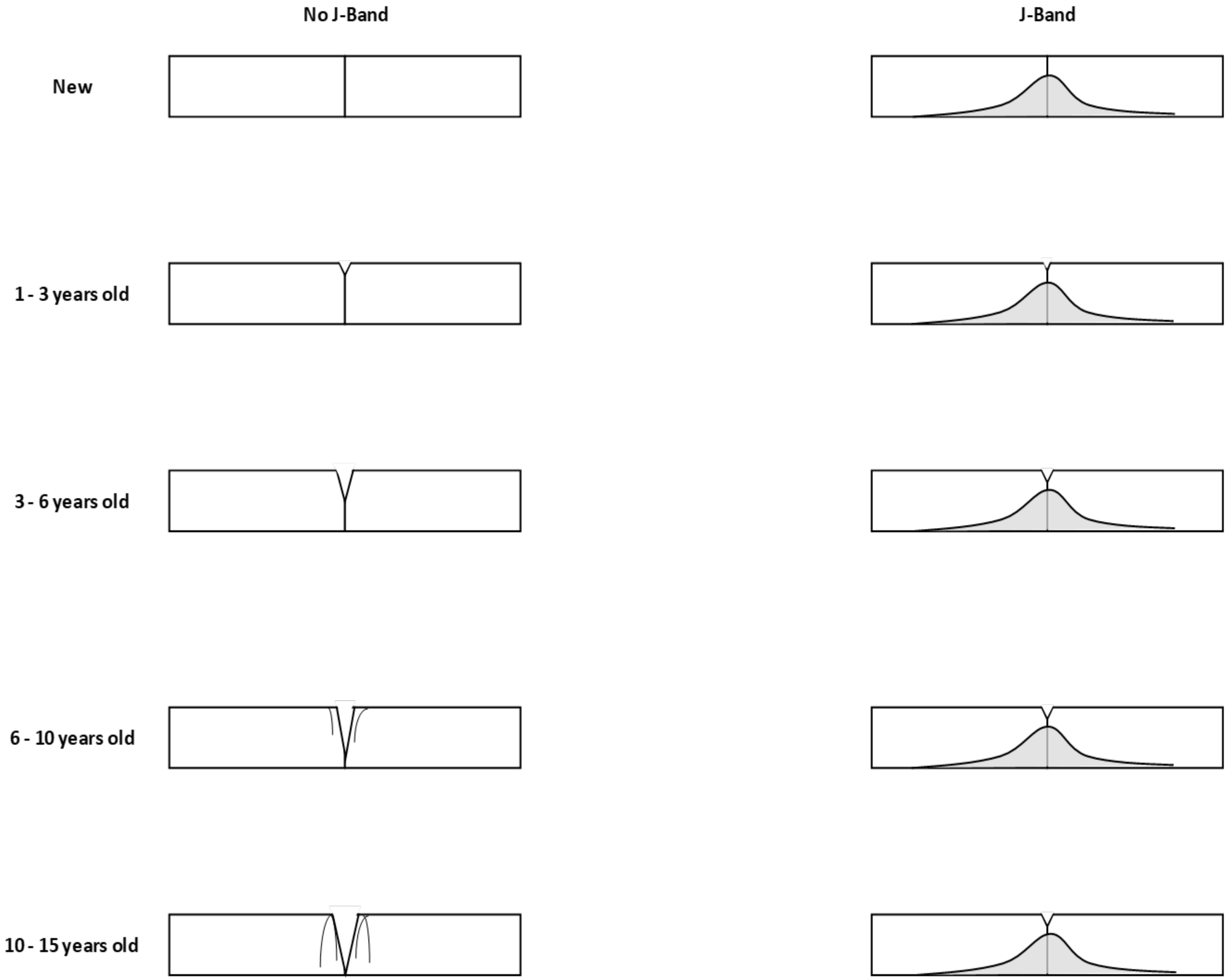
Place the first paving pass over half the width of the band of polymer modified binder



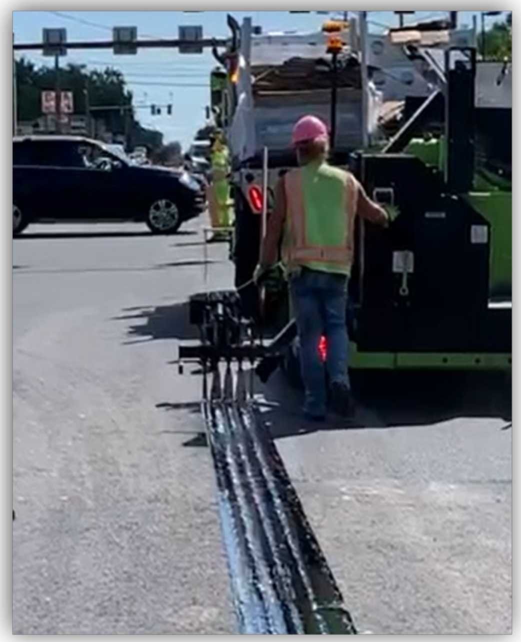
Polymer modified binder migrates into the HMA at the joint

Associated Asphalt

Crack Progression

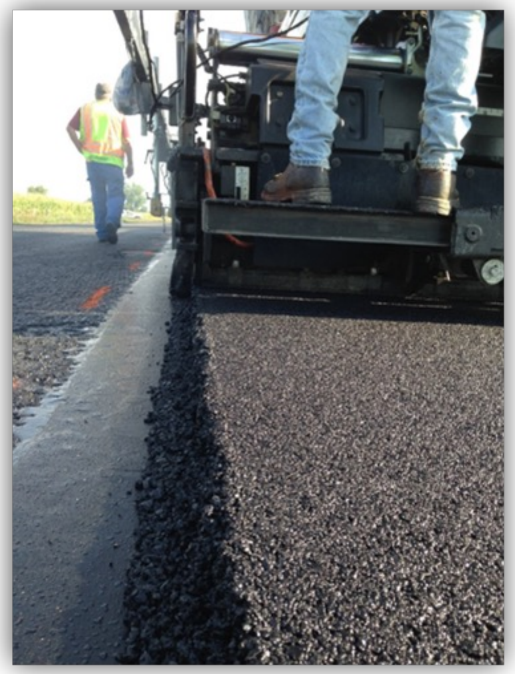


VRAM Application



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.

Where is VRAM applied?

- Joint defined as
  - Within travelled way
- Or between
  - travelled way and auxiliary lane
  - travelled way and paved shoulder
  - auxiliary lane and paved shoulder

VRAM Application Methods

Placed by pressure distributor with mechanical agitation in tank

Manual strike off box fed from melting kettle

Tow behind melter applicator

Effect of VRAM on Voids and Asphalt at Joint

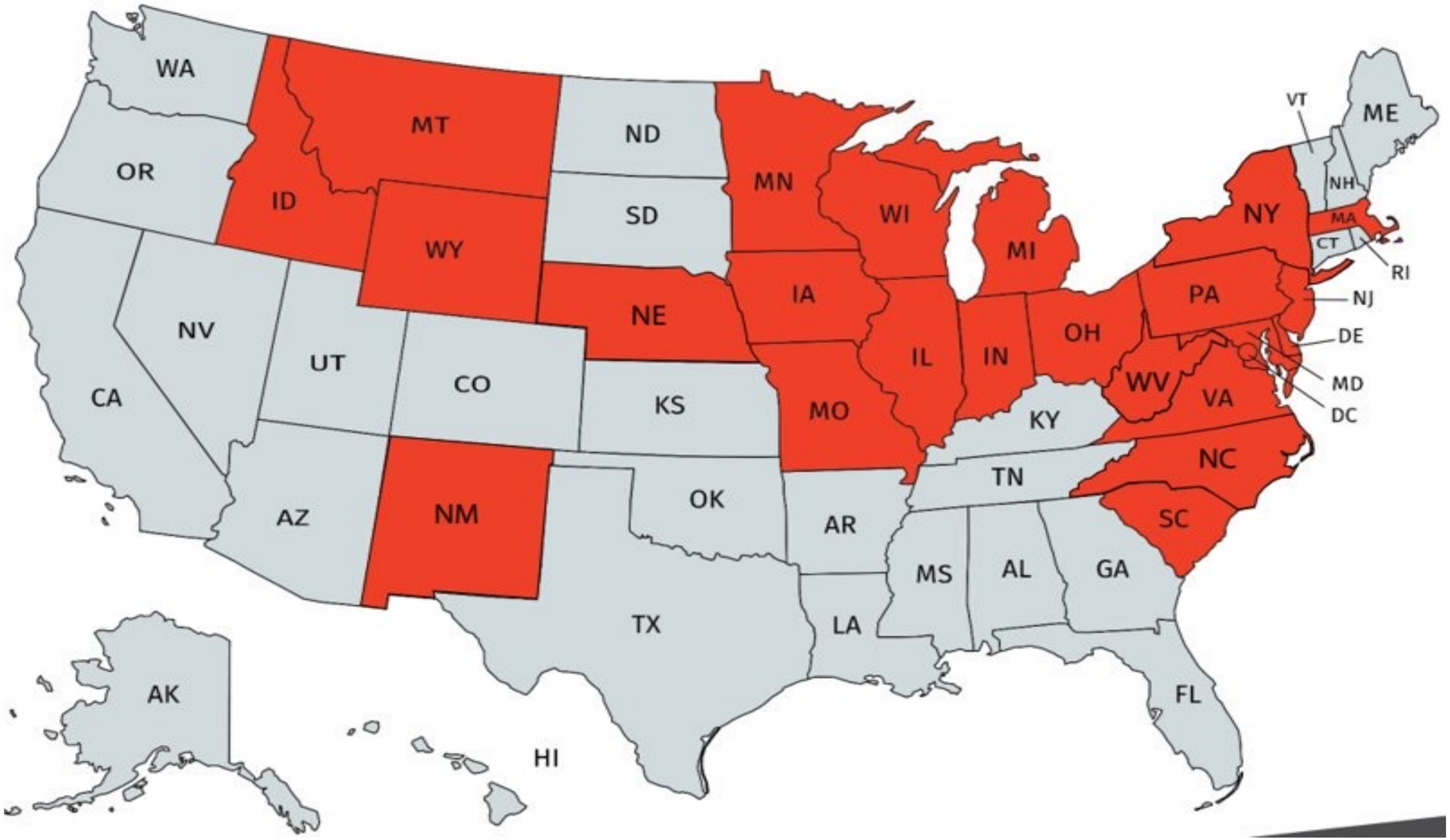
- The VRAM will migrate into the available air voids with heat and compaction
- **Example** HMA @ 6.0% AC, @ 1.5” thick/square yard = 9.9 lb of AC from mix
- VRAM @ 18” with VRAM weight per SY and total asphalt in joint area:

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 smaller and less inter-connected voids than coarse-graded mixes**

Current States with VRAM Experience

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



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 D1 IL-50 Richton Park After 14 Years

VRAM Test Section

Control Section

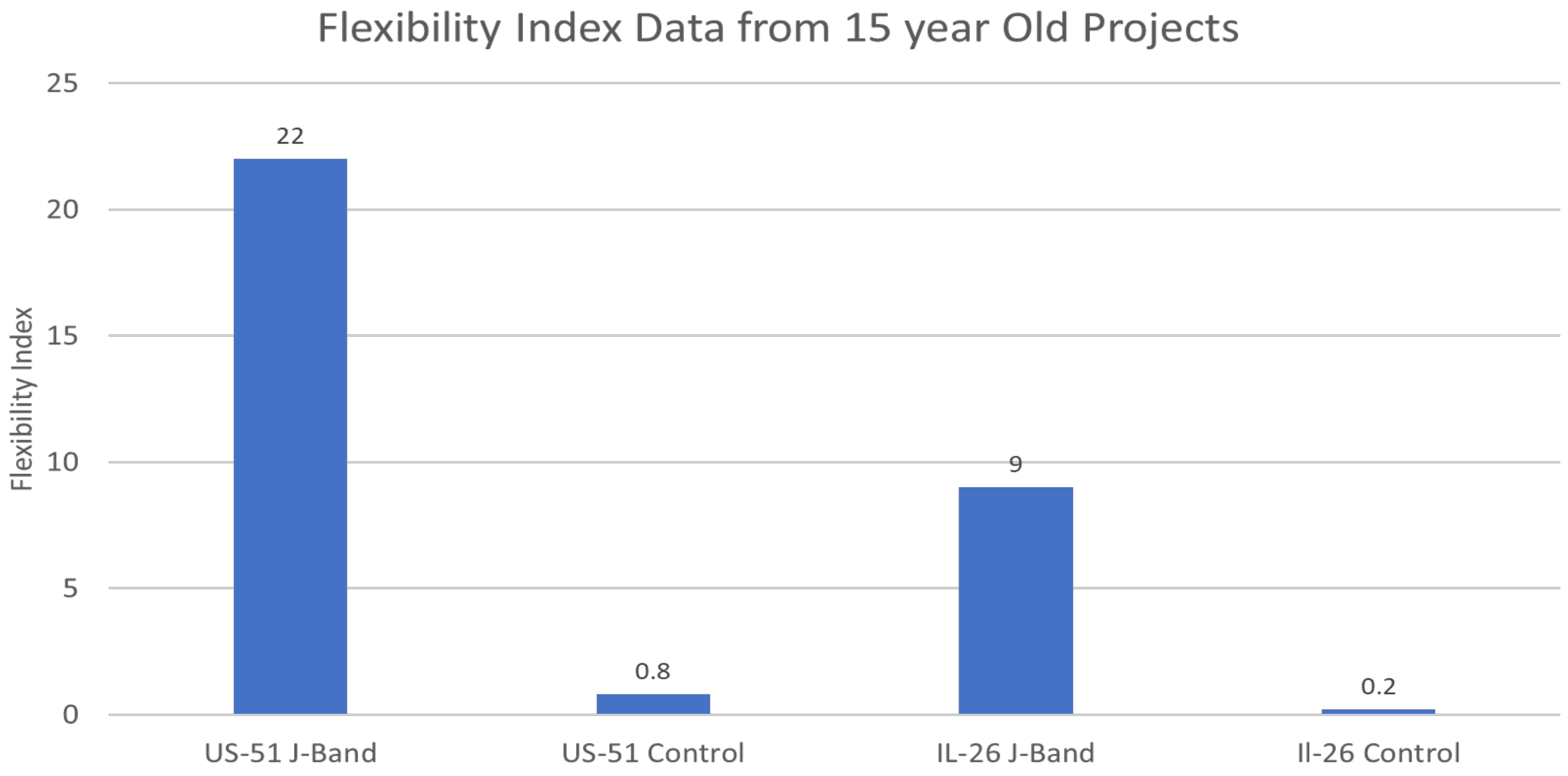
VRAM Field Performance
IDOT D2 Cedarville IL-26 After 14 Years

All pictures were taken in 2017

VRAM Test Section

Transition from Control Section to VRAM Section

Control Section


Flexibility Index Data from 15 year Old Projects
Flexibility Index
25
20
15
10
5
0
22
0.8
9
0.2
US-51 J-Band
US-51 Control
IL-26 J-Band
Il-26 Control

IDOT VRAM / LJS Study Summary

A Materials Approach to Improving Asphalt Pavement Longitudinal Joint Performance

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- Many approaches to improving the performance of asphalt pavement longitudinal joints have been tried by various agencies with mixed or marginal success.
- IDOT looked at a bottom-up material approach to seal the voids in the lower-density longitudinal joint area, with the result being lower permeability and an improvement in predicted laboratory flexibility and field performance.
- The high polymer LJS material has rut resistant and crack resistant binder properties and has been easily imbedded into the construction process of surface courses.
- 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.

Northeast Field Observations and Performance

PennDOT Project I-380; November 2019 Field View

No VRAM

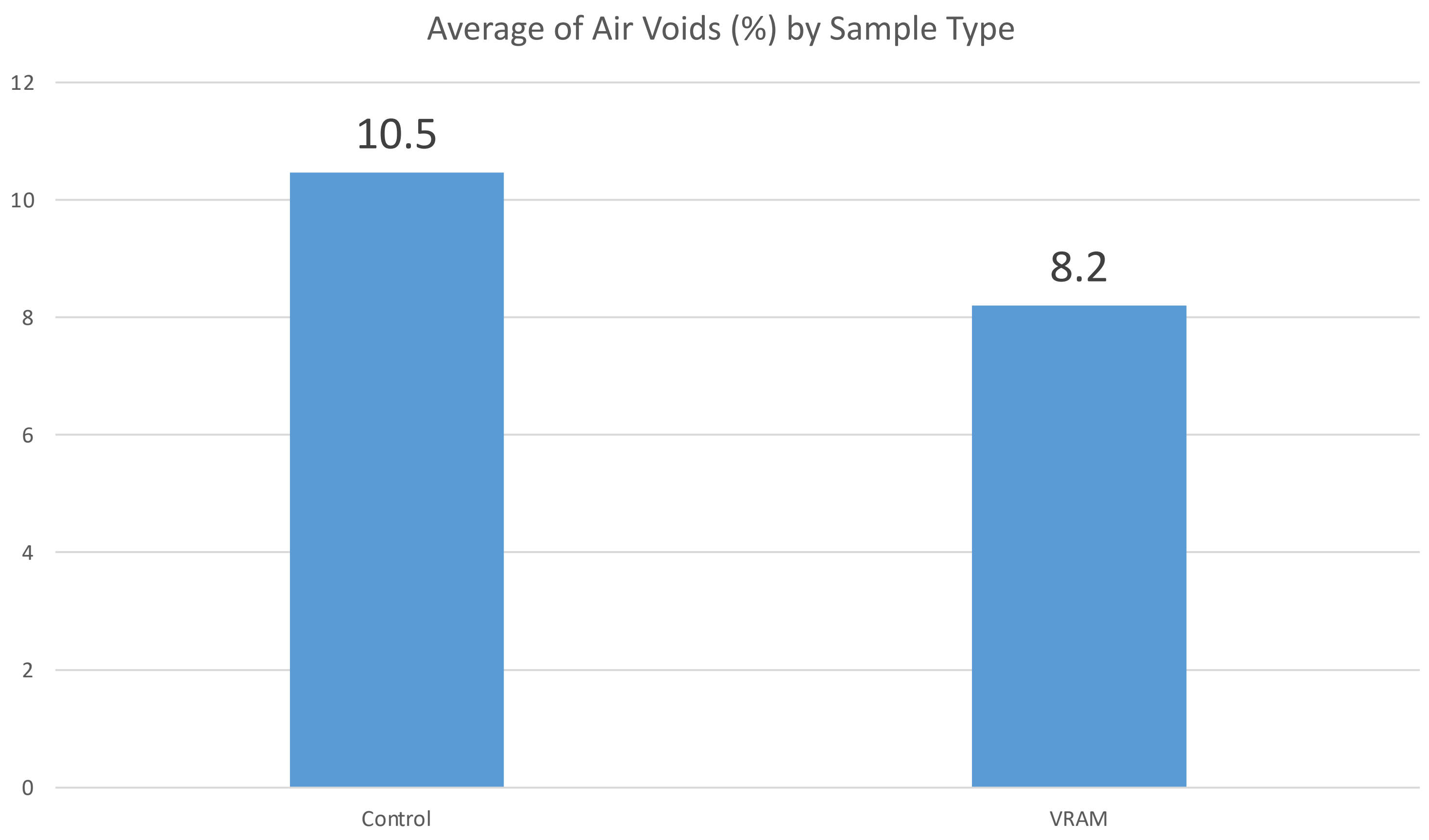
VRAM

PennDOT Project I-380; December 2021 Field View

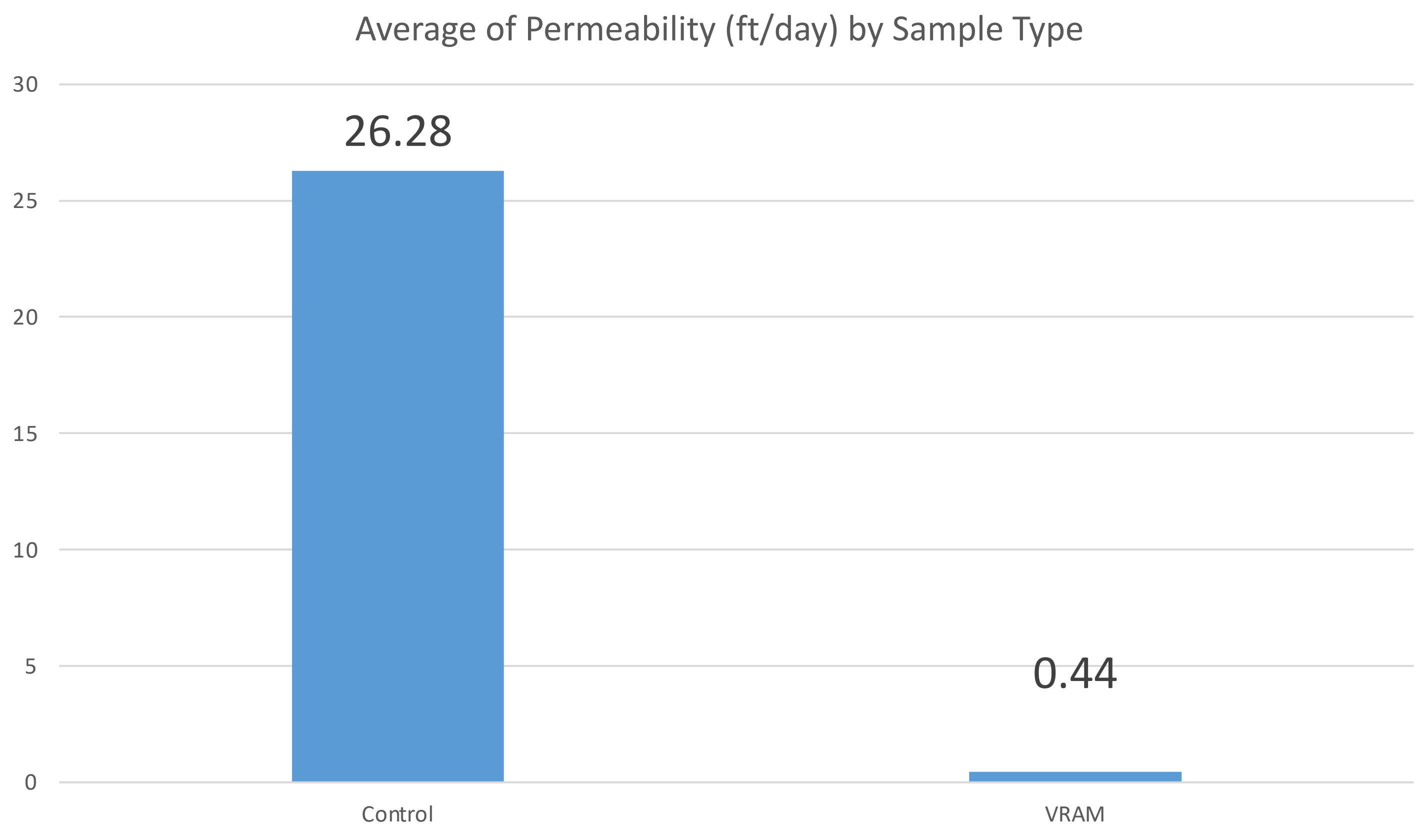
- VRAM joint after 3 Years

- VRAM joint after 3 years

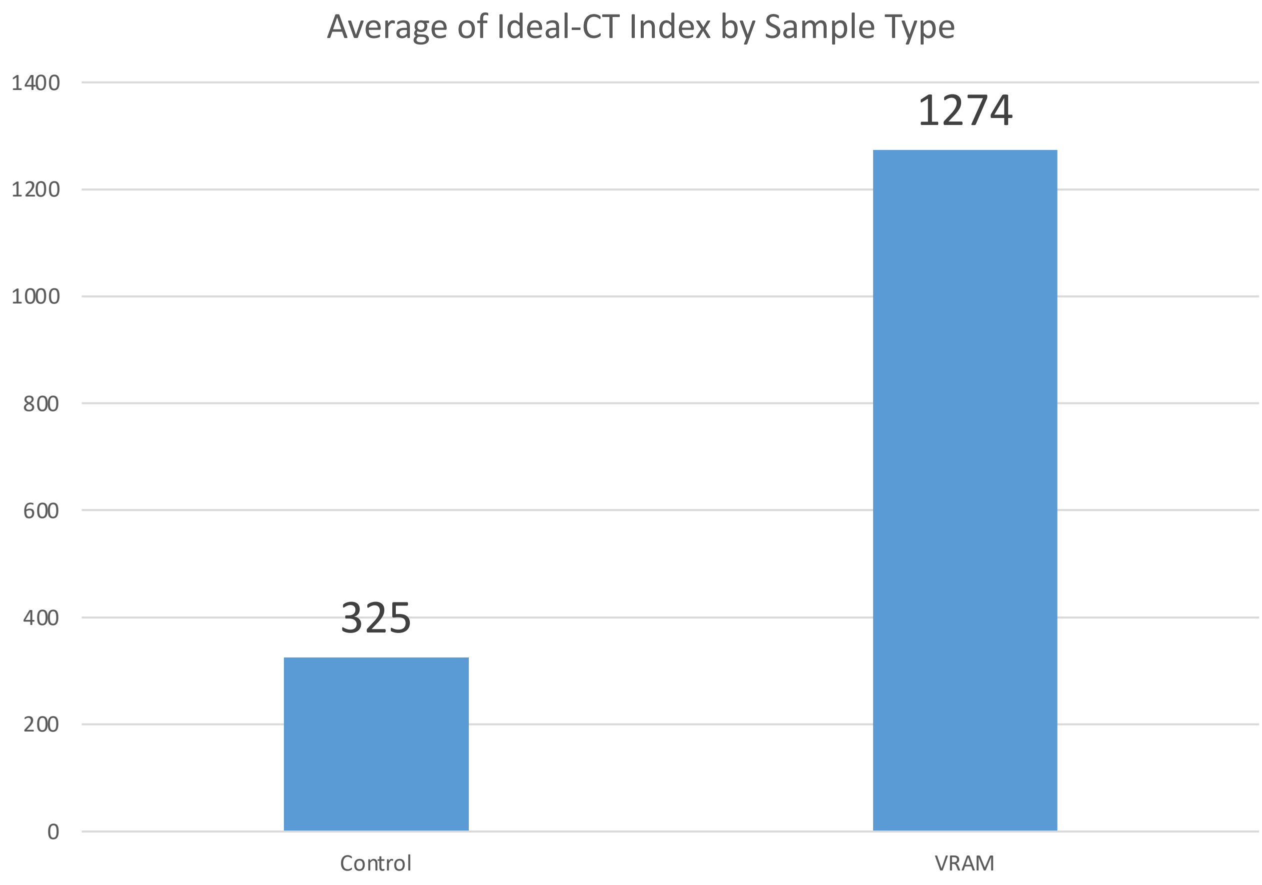
I-380 Test Data from 3-Year Old Cores



I-380 Test Data from 3-Year Old Cores



I-380 Test Data from 3-Year Old Cores



VRAM Development at PennDOT

- 2018 – Initial Demonstration Project
- 2019/2020 – Evaluation Period
- 2020 – Begin letting on a few projects for 2021
- 2021 – 1 Project in each District (Except 2,3 & 10)
  - Working on Standard Special Provision(SSP)
  - Cores for testing from 1st Project
- 2022 – Introduce SSP
  - Work with Districts to get 4-5 in each location
  - Continue exchange of information
  - First draft of CT has been reviewed
  - Draft spec due out by end of 2022

NYSDOT Southern State Parkway Project

Figure 3 – Falling Head Permeability Apparatus (not to scale) Used in Study

The permeability results are shown in Table 2 and Figure 4 below. The average permeability measured in the Control cores was 1,561.2 cm/sec x 10^{-5} (44.3 ft/day). Meanwhile, the average permeability for the VRAM cores was 177.7 cm/sec x 10^{-5} (5.0 ft/day). Overall, the VRAM cores had permeability values almost 9 times lower than the Control cores. Pictures of the Control cores and VRAM cores prior to permeability testing can be found in Appendix A.

Table 2 – Permeability Results of NYSDOT Southern State Parkway J-Band Trial

Sample Type	Core ID	Air Voids (%)	Permeability (cm/s x 10^{-5})		Permeability (ft/d)	
			Ave	Std Dev	Ave	Std Dev
Mainline Core	PC1	4.7	2.2	0.2	0.06	0.01
Conventional Joint	PC2	11.1	1605.4	6.7	45.51	0.19
	PC3	10.3	1979.9	7.3	56.12	0.21
	PC4	7.2	1098.3	180.9	31.13	5.13
VRAM	PVJ1	5.8	23.4	1.2	0.66	0.03
	PVJ2	8.2	124.6	1.3	3.53	0.04
	PVJ3	5.8	7.5	0.5	0.21	0.01
	PVJ4	10.3	555.2	10.7	15.74	0.30

PA Turnpike Data

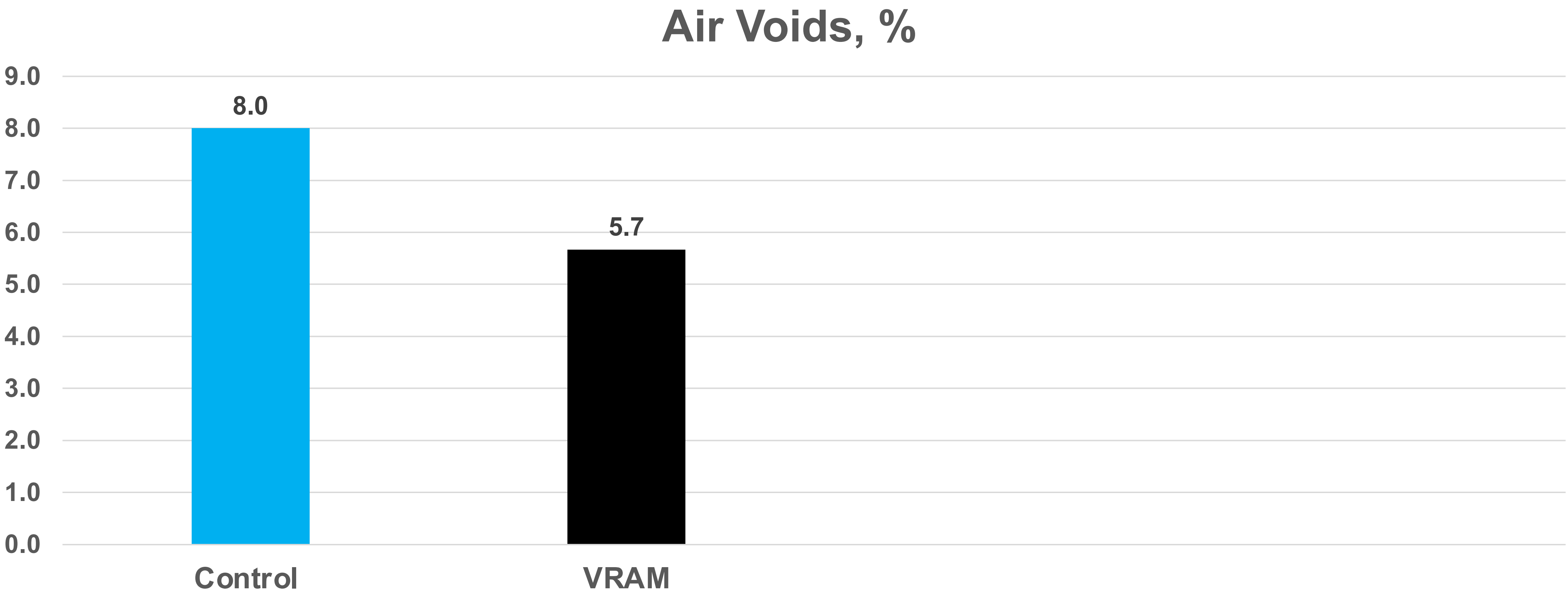
For this study, the IDEAL-CT Index testing was conducted using Rutgers University's InstroTek Smart Jig on a Pine Instruments screw driven compression machine. All test specimens were conditioned at 25ºC overnight in an environmental chamber prior to testing.

The IDEAL-CT Index results for the PATP MP 94 to 99 J-Band Trial are shown in Table 4. The results indicate that the VRAM section cores had a higher average fracture energy (31,880 vs 7559 J/m^2) and resulted in a higher average IDEAL-CT Index (1829.6 vs 824.6). This indicates that the VRAM section cores need more force (or energy) to separate the longitudinal construction joint than the conventional joint construction practices used on the PATP MP 94 to 99. The detailed results from the testing can be found in the Appendix B of the report.

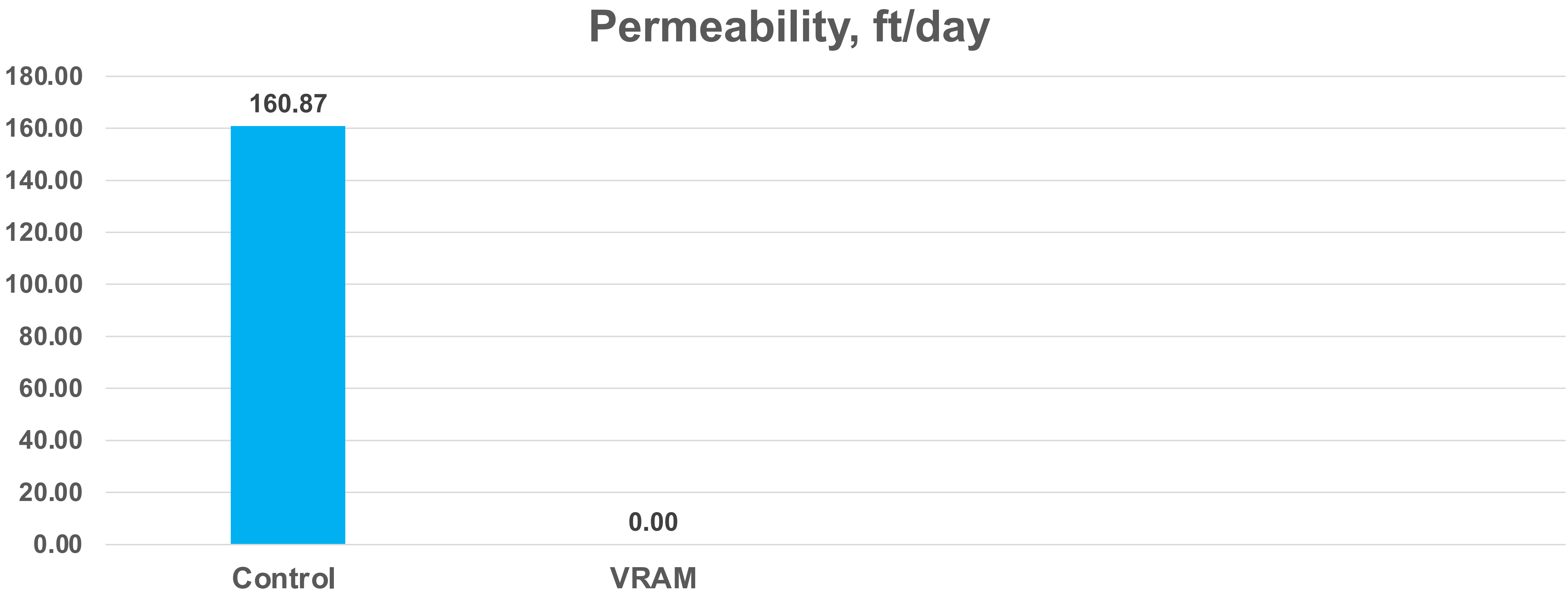
IDEAL-CT Index Results of PATP MP 94 to 99 J-Band Trial

Sample Type	Core ID	Air Voids (%)	Fracture Energy	IDEAL-CT Index
Control	PC1	6.0	7,197.7	776.7
	PC2	7.1	8,145.1	1128.9
	PC3	6.4	7,333.5	568.1
VRAM	PVJ1	4.6	44,014.7	2524.3
	PVJ2	4.8	34,781.4	1784.9
	PVJ3	5.9	18,696.3	749.1
	PVJ4	5.3	30,030.9	2260.1

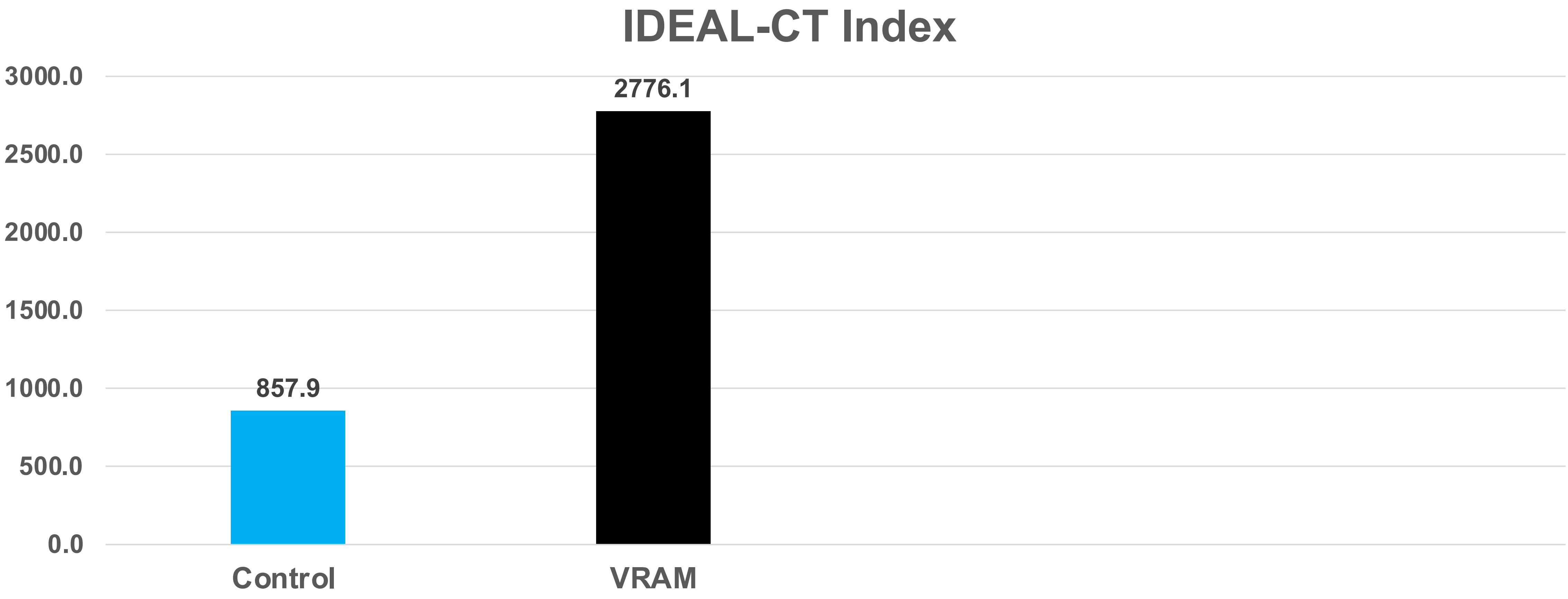
MDTA I-95 – Air Voids



MDTA I-95 – Permeability



MDTA I-95 – IDEAL-CT Index

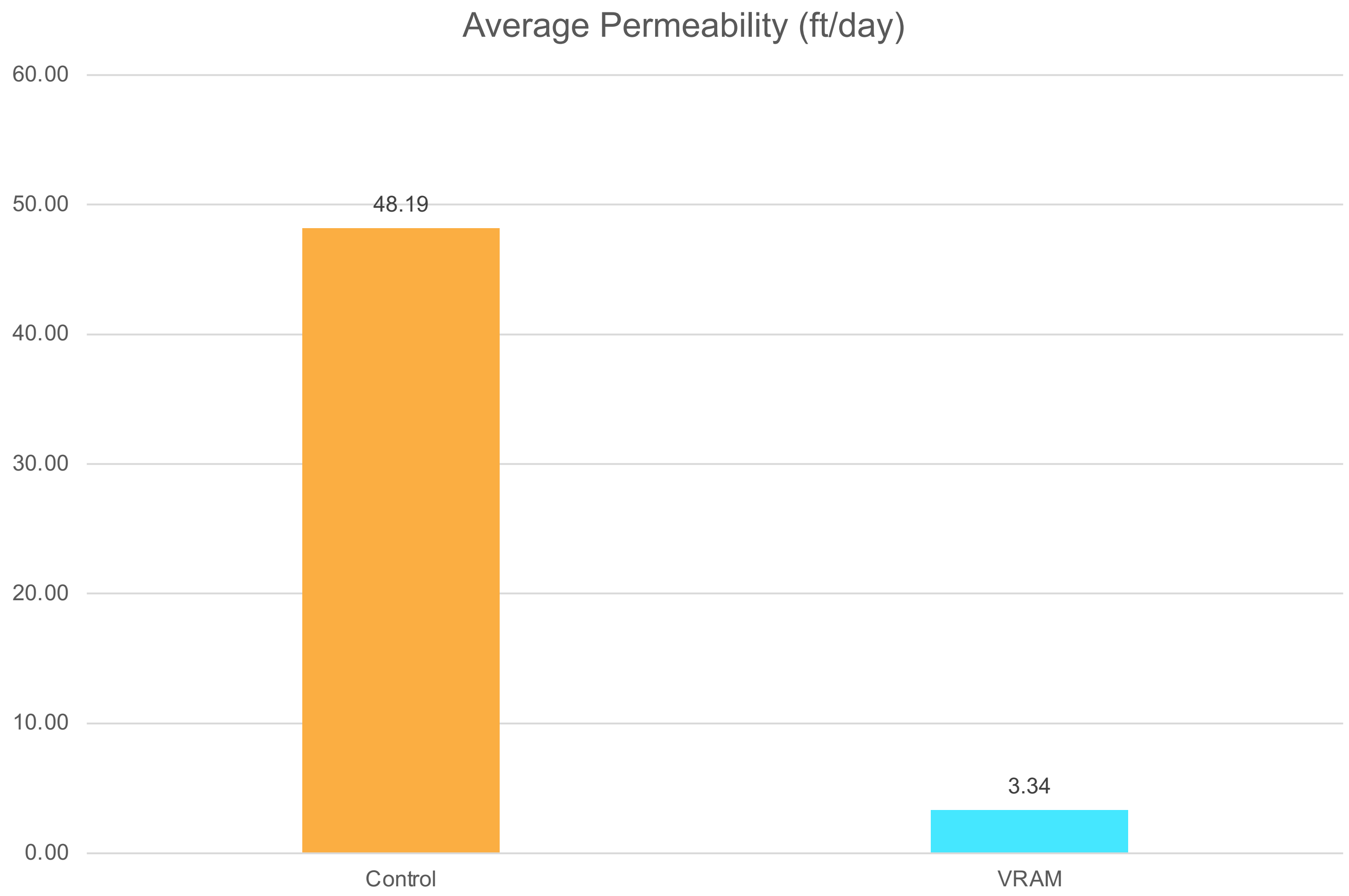


MDTA I-95

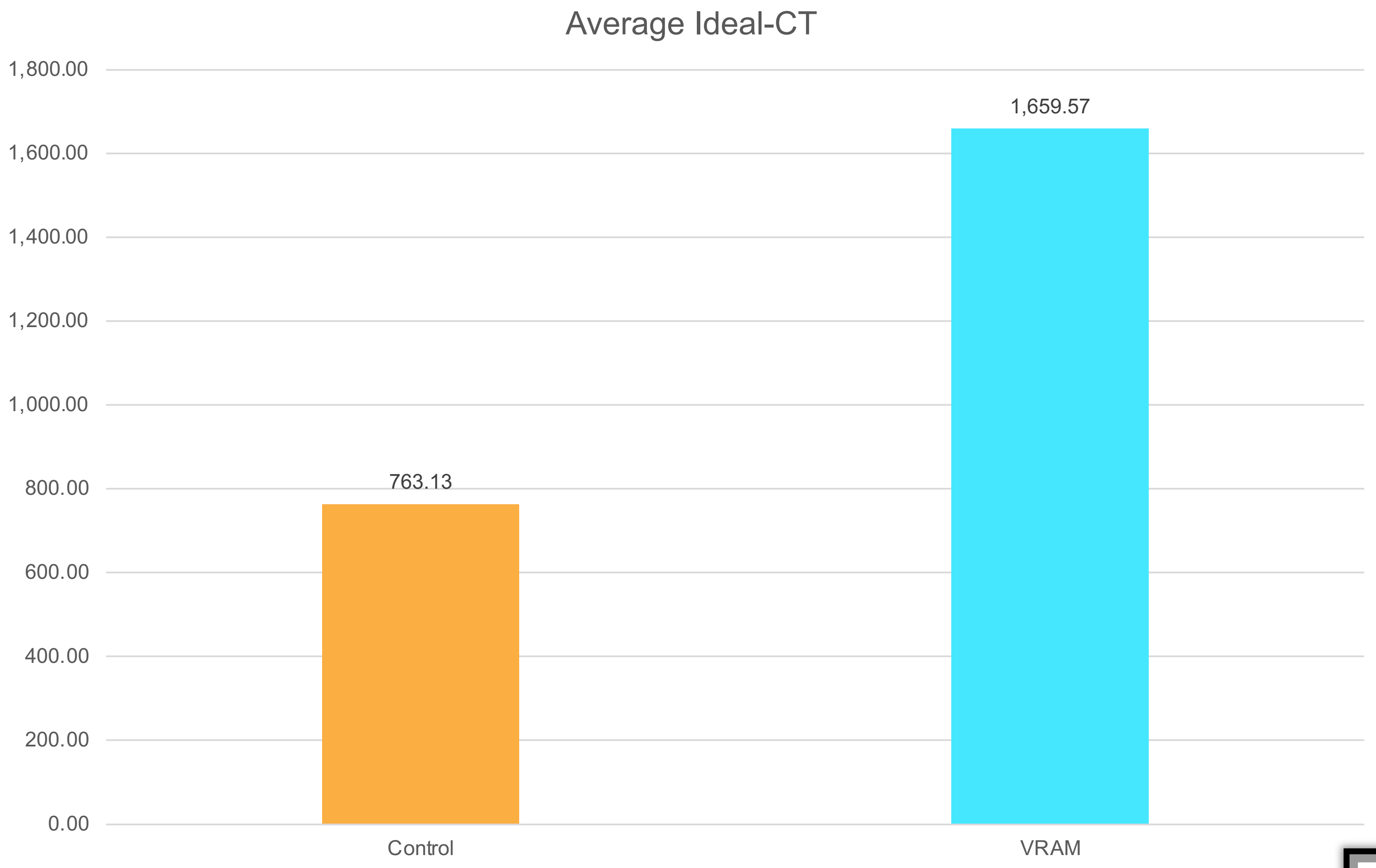
MDTA I-95 Project Test Results:

- Air Voids decreased by **29%**
- Permeability decreased to **0.00**
- IDEAL CT Cracking Index increased by **224%**

Permeability

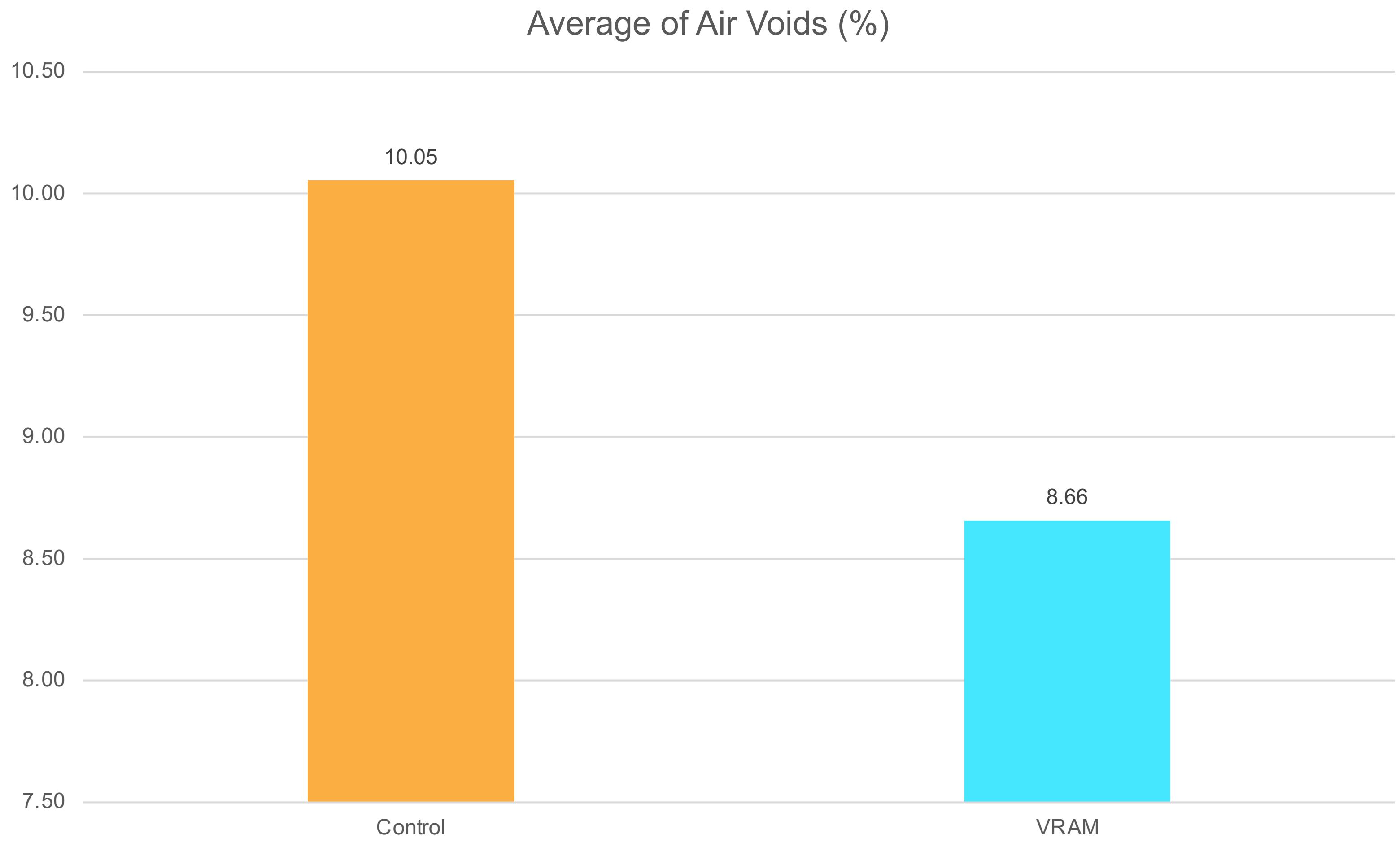


IDEAL-CT



Average Ideal-CT
1,800.00
1,600.00
1,400.00
1,200.00
1,000.00
800.00
600.00
400.00
200.00
0.00
763.13
1,659.57
Control
VRAM

Air Voids Results



What is the Data Showing Us?

- Testing for East Coast project by 3rd Party Lab
  - Constructed Air Voids using AASHTO T166
  - Permeability using (FDOT) test method, FM 5-565
  - Tensile Strength using IDEAL-CT
 - Results:
   - Air Voids average **5**% improvement
   - Permeability on an average, showed improvements of **16X** control joint
   - Tensile Strength/Cracking Resistance increased by **90%-150%**
 - Rutgers University- Thomas Bennert, PH.D.
- *The decrease in air voids, decrease in permeability and increase in tensile strength/IDEAL-CT Index of the longitudinal joint would suggest that the initial performance of the "Various Projects" VRAM longitudinal joint section is much greater than the conventional longitudinal joint section (Control).*

Sustainability

There has been movement towards developing a framework for a **LEED-type system** for infrastructure. Greenroads and ENVISION were mentioned as ones to watch.

Sustainability and Safety

	J-Band VRAM	Joint Adhesive	IR Heater	PWTB
Avg per year GHG (kg CO2e)	48.5	50.6	52.8	358.6
Air quality (lb VOC/CO/Nox/PM2.5)	0.2	2.1	1.8	10.9
Injuries per million miles	4	58	64	75
Fatalities per million miles	0.1	1.9	2.1	2.5

Alternative and Suggested Uses

- Unconfined outside edge
- Bridge waterproof system
- Suggested under rumble strips

Takeaways

- 20 years of proven results with VRAM(J-Band®)
- 9" + 9" = 18" (The area that needs addressed)
- Crack Resistance Improved
- Permeability Reduced
- The Bottom-Up Solution
- Promotes Sustainability and Improves Safety
- Adds 3-5 years of service life (pays for itself)
- **ROI:** https://thejointsolution.com/calculator/

Questions?

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