Assessing the Impact of J-Band on Pavement Performance

What Was the Need?
Potholes and similar failures in asphalt typically occur at the seams between lanes, where the mixture is known to lose density during compaction because the edges are not confined like they would be with cement concrete forms.

At these edges, asphalt’s higher air void content makes it more susceptible to moisture penetration, freeze-thaw damage, reduced underlying layer strength and failures that lead to potholing and other damage. Typically, asphalt mats in Minnesota have reached an air void value of 7% to 10% or higher at longitudinal joints between lanes. The design and as-built goal is, in many cases, 5%.

To mitigate this potential shortcoming, crews can spray a void-reducing asphalt membrane (VRAM) at the seam location before the asphalt pour. VRAM products—mixes of asphalt binder, polymer and modifiers—hold the new asphalt in place and are believed to migrate upward into the asphalt layer, filling air voids and keeping the asphalt from spreading and losing density.

What Was Our Goal?
The goal of this project was to evaluate the use of J-Band, a VRAM product, to improve the performance of hot-mix asphalt (HMA) longitudinal joints. Researchers conducted laboratory testing to verify the efficacy of J-Band to reduce air void levels and moisture susceptibility, improve pavement durability and extend service life in the field.

What Did We Do?
The research team focused on an asphalt pavement project conducted in 2018 on State Highway 22 in Blue Earth County south of Mankato. One mile of the asphalt pavement included J-Band applied in an 18-inch-wide band at the longitudinal joint followed by a top layer of 1.5 to 2 inches. Another mile of pavement with no VRAM served as a control.

Researchers gathered a sample of the HMA to determine binder and mix gradation, and collected about 40 cores from the two sections, most of them 6-inch diameter samples. The research team conducted laboratory tests, including fluorescence microscopy, on cores for low-temperature bend, bond energy, permeability and other properties.

The research team returned to the paving site in October 2019 to conduct a visual survey for signs of distress and to use ground penetrating radar (GPR) for density examinations of mat locations and joints.

What Did We Learn?
VRAM seems to improve asphalt strength and reduce water incursion, and can be expected to improve asphalt mat performance. Researchers found that J-Band migrates up into the top asphalt layer, improving asphalt macrostructure by filling voids. J-Band was found to reduce 8.5% air voids to 5%. The field survey proved inconclusive due to the relative youth of the new pavement.

Researchers evaluated the use of J-Band in an asphalt pavement on State Highway 22. Tests showed higher bond strength, lower permeability and air void levels, and improved crack resistance. The material offers, at a minimum, a savings of over $900 per two-lane mile per year.
In laboratory testing, VRAM performs better than control sections in terms of bond energy, fracture energy, work of fracture and surface energy. Longitudinal cracking at joints should develop more slowly than in the control due to the high surface and joint bond energies. The high fracture resistance also indicates a likely improvement in cracking resistance at the joints. Reduced air voids and permeability in the tested VRAM samples suggest lower water intrusion and better long-term pavement performance.

Use of VRAM offers incremental annual savings and an increase in extended service life. Purchased in bulk, the material will cost $12,500 per two-lane mile to apply and may yield significant savings in maintenance expenditures compared to non-VRAM sections. Based on its use by Illinois Department of Transportation (DOT) since 2003, researchers determined potential cost savings. Illinois DOT observed lower levels of deterioration in VRAM than in controls experiencing the same loading and weather. If service life improves only one year from the use of VRAM, the Illinois experience suggests a net present value savings of $911 per two-lane mile per year or $4,737 per four-lane mile annually.

**What’s Next?**

Fully quantifying the benefits of VRAM will require further field study. Evaluation of more sections will reduce the impact of construction variability, binder grades, layer thickness and other materials used on results. Logging and tracking maintenance activity like joint sealing, crack sealing and patching at these test sites over the next five to 10 years or more may inform future assessment and evaluation of VRAM performance and value.

Further development of lab methods for testing VRAM products may improve on the difficulty of working with and examining VRAM as it becomes more familiar to engineers. Fluorescence microscopy testing, in particular, requires refinement and may need to be used on thinner sample sections to reduce the impact of fluorescence in aggregates in binder analysis.