



What's New In Asphalt Pavement R&D: Reducing Reflecting Cracking in Concrete - Using a Reflective Crack Relief (Asphalt) Interlayer

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- Background
- Timeline
- Mix Design
- Site Selection
- Construction
- Projects

Background

Interlayer Targeted Reduction in Reflective Cracking



Photo by Purdue University

Timeline

- Early 1990's: Asphalt interlayers were used in France with varying levels of success.
 - Sand Anti Fissure/Fracture (SAF)
- 1998: Technology was introduced into US by Koch Materials Company (very large polymer asphalt supplier in 1990's and early 2000's)
 - High asphalt content (>8.0% AC)
 - #4 (4.75mm mix)
 - Usually placed 1" thick
 - Impermeable
 - Composite pavement design
- 2000: Varying levels of success because climate and materials



Timeline

- 2000-2002: Koch Materials Company began product development of an engineered interlayer
 - Site review to look at location and distress
 - Thickness of overlay based on traffic
 - Performance based spec:
 - 4-point flexural beam fatigue with varying climate requirements – key flexural test to ensure reflective cracking performance. Temperature 10°C, 15°C, 20°C based on climate, 2000 microstrain, 2-3% air voids
 - Hveem stabilometer for rutting (1 test temperature since interlayer is in mid-pavement placement)

Timeline

- 2002-2006: Advance modeling and development continued with research partner
 - Co-research at University of Illinois (Buttler, Dave, Song, Wagner) including NSF GOALI (grant) that included modeling, accelerated loading, testing, etc.
 - GOALI award ID: 0219566 - *Reflective Crack Control Treatment and Design Procedures: A New Integrated Approach*
 - DCT was developed out of this work as a test to measure thinner roadway core properties



UNIVERSITY OF
ILLINOIS
URBANA - CHAMPAIGN

Timeline

- 2023: 25 years after introducing into the US by Koch in 1998
 - Used at some level in about 20 states with varying specs (TX: with overlay test, WI/IA/KS/KY/NJ with fatigue, etc.)
 - 2024: Alberta, Ontario, New Brunswick-Canada & PA Turnpike Commission
 - Adoption slowed down due to lack of understanding, lack of high polymer asphalt, and cost
 - Today, interlayers are still intact while the surface has been replaced
 - Can use other tests (DCT, IDEAL-CT that correlate with flexural beam fatigue) to design
 - Polymer aramid fiber seems to be direct replacement for original high-polymer asphalt design

Data at the End of My Tenure at Koch Materials Company (~2006)

Average **71% Improvement** in Reflection Cracking on Strata (high polymer, performance design) interlayer projects compared to control sections

98% reliable overlay & 100,000+ fatigue cycle interlayer

Data represents 18 projects built with control sections, up to 4 years old.

Mix Design Example



Recommended Performance/BMD Spec

Specification adjusted per location

| Test | Criteria |
|--------------------------------------|-----------|
| Air Voids (Va), % | 0.5-2.0 |
| Voids in the Mineral Aggregate (VMA) | 16.0 min. |

| Sieve | % Passing |
|-----------------------------|-----------|
| 9.5 mm (3/8 inch) | 100 |
| 4.75 mm (No. 4) | 80-100 |
| 2.36 mm (No. 8) | 60-85 |
| 1.18 mm (No. 16) | 40-70 |
| 600 μm (No. 30) | 25-55 |
| 300 μm (No. 50) | 15-35 |
| 150 μm (No. 100) | 8-20 |
| 75 μm (No. 200) | 6-14 |

Recommended Performance/BMD Spec

Specification adjusted per location

| Performance Test | Climate | | |
|---|------------------------------|------------------------------|-----------------------------|
| | Cool (using ~PG 64-34) | Warm (using ~PG 70-28) | Hot (using ~PG 76-22) |
| Crack Resistance. IDEAL-CT, min. CT index | 300 @ 19°C | 300 @ 21°C | 300 @ 25°C |
| Rut Resistance. Hamburg Wheel Tracker (HWT), min. passes | 4,000 @ 40 or 45°C | 4,000 @ 45°C | 4,000 @ 50°C |

All samples to be made near field density of 97.0 of max or $3.0 \pm 0.5\%$ air voids.

Note: 300 CT index at 3% av ~ 750 CT index at 7% AV.

Design Example - Materials

There is no RAP in the interlayer.

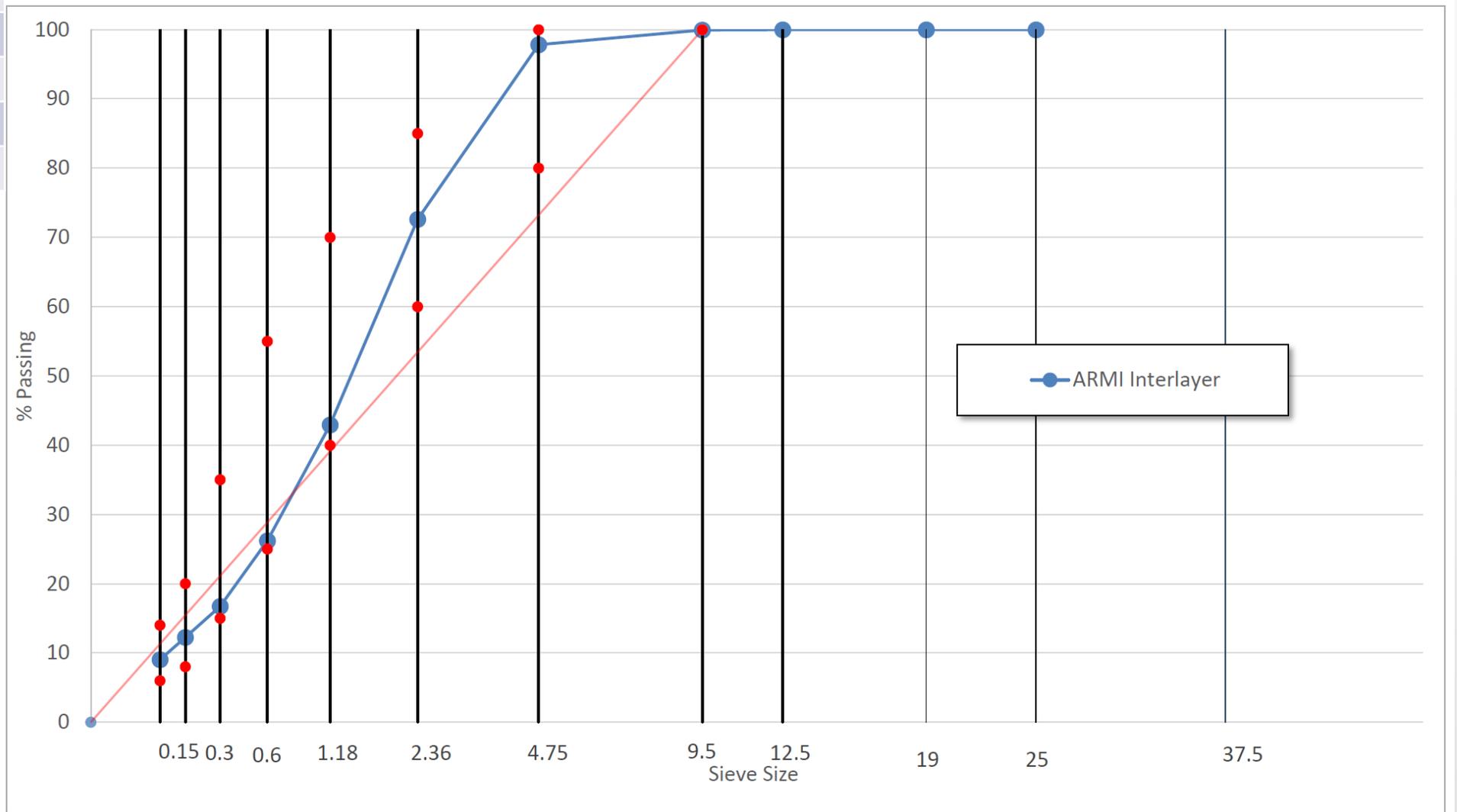
| Performance Grade (PG) | | PG Source | |
|---|----------------------|-----------|--------------|
| Cold region (PG 64-34) | | | |
| | Aggregate Stockpiles | Blend % | Bulk Gravity |
| 1 | Washed Sand | 71% | 2.717 |
| 2 | Sand | 25% | 2.771 |
| 3 | Baghouse | 4% | 2.725 |
| Aramid Polymer Fiber | | | |
| Aramid Fiber (1.5"/38mm) at 4.2 ounces/ton (2x) | | | 1.44 |

Usually a blend of:

- washed manufactured sand
- unwashed sand (screenings), and
- natural sand

| Sieve Size | Combined, % Passing |
|------------|---------------------|
| 9.5 | 100 |
| 4.75 | 98 |
| 2.36 | 73 |
| 1.18 | 43 |
| 0.600 | 26 |
| 0.300 | 17 |
| 0.150 | 12 |
| 0.075 | 9.0 |

Ultra-Fine #4 (4.75 mm) Gradation



Why Use Aramid Fiber in Asphalt Interlayer?

1. Non-absorptive to asphalt cement
2. High tensile strength (>2750 MPa)
3. High melting temperature(>425°C)
4. High modulus



ASTM 8395-23 - Standard Specification for Aramid Fiber for Asphalt Mixtures

| Aramid Properties | Measure | Standard |
|-------------------|-------------------|----------------------------|
| Material | Para-Aramid Fiber | Manufacturer Certification |
| Linear Density | >3200 dTex | ASTM D1907 |
| Decomposition | >425 °C | n/a |
| Length | 38mm | n/a |
| Tensile Strength | >2700 MPa | ASTM D2256, D7269 |
| Young's Modulus | >80 GPa | ASTM D2256, D7269 |



Design Example – PA Turnpike 2024

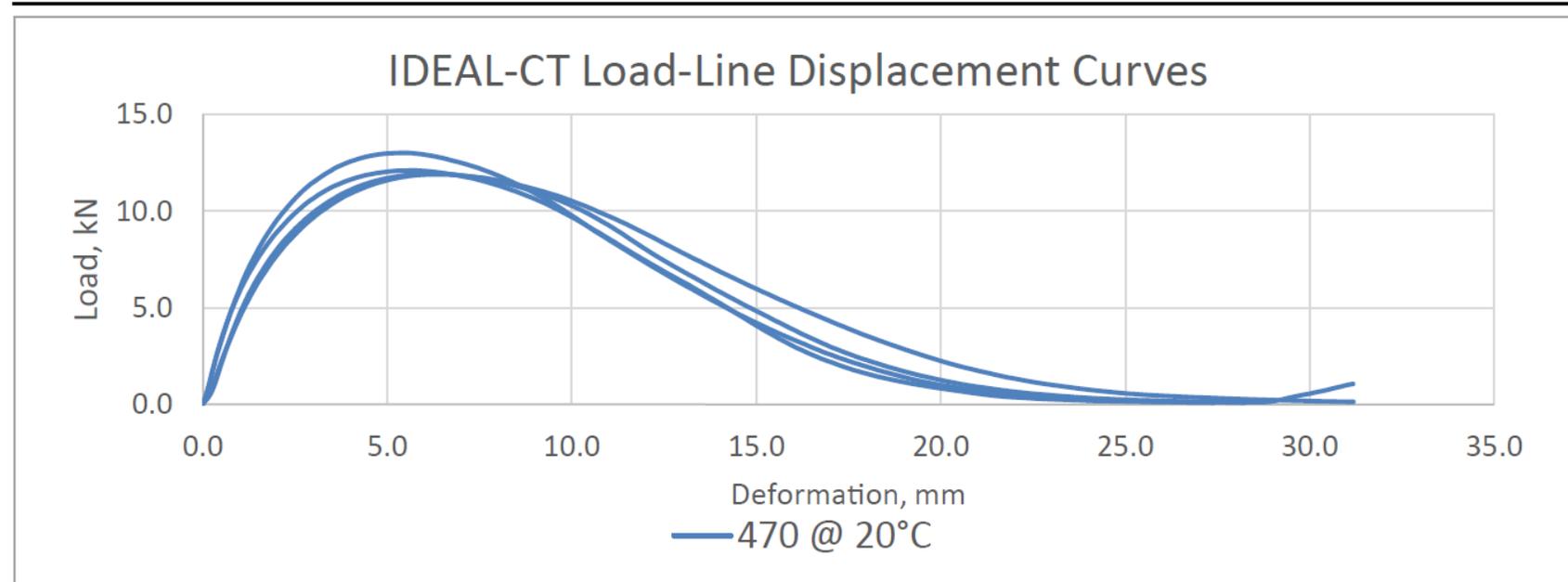
Optimized Volumetrics

| Optimum Design Volumetrics | | | | | | |
|----------------------------|----------|----------|----------|-----------|-----------|---------------|
| Total % AC | G_{mm} | G_{se} | G_{sb} | Gyrations | G_{mb} | Compaction, % |
| 8.50 | 2.421 | 2.815 | 2.731 | 50 | 2.387 | 98.6 |
| Voids, % | VMA, % | VFA, % | P_{ba} | P_{be} | DP or D/A | |
| 1.4 | 18.9 | 92.6 | 1.1 | 7.5 | 1.2 | |

PA Turnpike 2024 - IDEAL-CT

Work Performed at BATT

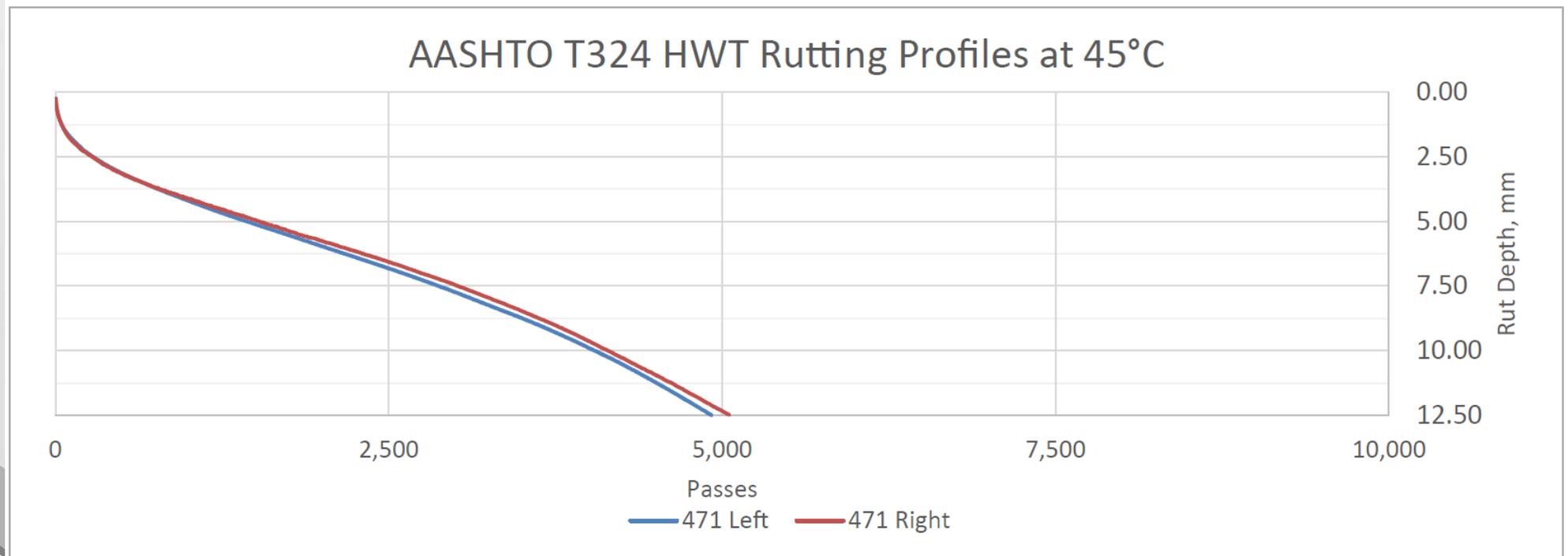
| Mixture | Voids | Disp (mm) | Slope (kN) | Strength (kPa) | Energy (J/m ²) | CT _{Index} | SD | COV |
|-----------------|-------|-----------|------------|----------------|----------------------------|---------------------|-------|------|
| ARMI Interlayer | 3.3% | 10.0 | -1.2 | 891.2 | 16,673 | 927.5 | | |
| | 3.5% | 11.2 | -1.2 | 817.7 | 16,375 | 1,059.5 | | |
| | 3.3% | 10.9 | -1.1 | 829.2 | 16,503 | 1,057.9 | | |
| | 3.5% | 11.8 | -0.9 | 815.0 | 17,885 | 1,517.2 | | |
| | | | | | | | | |
| | 3.4% | 11.0 | -1.1 | 838.3 | 16,859 | 1,140.6 | 258.6 | 22.7 |



PA Turnpike 2024 - Design Example

Work Performed at BATT

| Mixture | Voids | Wheel | Rut Depth (mm) @ Passes | | | | Total Passes | Max Depth | SIP | Creep Slope | Stripping Slope |
|-----------------|-------|-------|-------------------------|-------|-------|--------|--------------|--------------|-------|-------------|-----------------|
| | | | 1,000 | 2,500 | 5,000 | 10,000 | | | | | |
| ARMI Interlayer | 3.4 | Left | 4.21 | 6.82 | n/a | n/a | 4,916 | 12.52 | 3,411 | 1.59E-03 | 2.78E-03 |
| | 3.4 | | | | | | | | | | |
| | 3.6 | Right | 4.12 | 6.58 | 12.35 | n/a | 5,054 | 12.50 | 3376 | 1.49E-03 | 2.79E-03 |
| | 3.5 | | | | | | | | | | |



Advantages

- Significantly **delays cracking**
- **Impermeable** to force lateral drainage
- Generic **performance-based specification**
 - Updating with newer tests (DCT, IDEAL-CT)
- Can be milled but can **leave in place** – “perpetual”
- **Standard** HMA production & construction methods
 - Uses locally available materials
- **Quick construction** time and return to traffic

The text "Site Selection" is written in a white, sans-serif font. It is positioned on the left side of the image, overlaid on a dark, semi-transparent rectangular area that covers the left half of the background. The background image shows a yellow Caterpillar roller on a newly paved road, with another roller visible in the distance under a bright sky.

Site Selection

- RCRI will increase the life of an overlay about 50%+ because of its stress and water isolating attributes
- Place on concrete or asphalt
 - A complimentary overlay with advanced crack resistance works well with interlayer
 - PCC joint load transfer of 70 or better is desired
 - Can be used over crack and seat but will need to level
 - Interlayer will knead into larger cracks or joints
 - Joint seal may bubble through, but does not affect the performance
- Avoid trapping moisture or paving after a rain. The interlayer is impermeable.
 - Leave some asphalt over the concrete or use leveling course



Required Overlay Thickness to Protect Interlayer

| Traffic Level | Thickness (mm) |
|-------------------------|----------------|
| < 3 million ESAL's | 1.5" (40 mm) |
| 3 to 10 million ESAL's | 2.5" (65 mm) |
| 10 to 30 million ESAL's | 3.0" (75 mm) |
| >30 million ESAL's | 3.5" (90 mm) |

A large background image showing a construction site. On the left, a yellow Caterpillar roller is parked on a dark asphalt surface. In the distance, another yellow roller is working on a newly laid asphalt road that stretches into the horizon. The right side of the road is bordered by green grass and a clear blue sky with scattered clouds. A large, stylized graphic element consisting of two parallel lines, one blue and one grey, runs diagonally from the bottom left towards the top right, partially overlapping the road and sky.

Construction



Construction Recommendations

- Use only steel wheel rollers (static mode preferred) for compaction of the interlayer
- Target density of the in-place interlayer is 96.0% of the maximum specific gravity (G_{mm})
 - Do not be afraid to roll
- Final rolled surface should be 1 inch thick
- Release to traffic and any overlay placement:
 - Pave over/open to traffic after it has cooled to less than ~150 °F or local standard
 - Cover within 5 days after placement or sooner
 - Tack before placing the interlayer and on top of interlayer before placing surface.

2019 Example

Taylor County, KY GA
Airport (KAAS)
April 2019

Taylor County, KY GA Airport (KAAS)

April 2019

- Palmer Engineering (Gary Sharpe) was designer; Hayden Materials, contractor
- HMA treatment from 2013 showed signs of early raveling also “microcracking” (right)
- Needed to add structure and not remove surface
- Concern of surface cracking that may reflect
- Treatment:
 - 1” reflective crack relieve interlayer
 - Design performed at BATT. Also provided on-site support.
 - Lack of local high-polymer binder supply. Chose to use aramid polymer fiber to meet design targets.
 - 2” Superpave overlay
- Project awarded ASCE-KY Engineering Excellence Award and is now eligible to compete in the 2021 ACEC National Engineering Excellence Award competition



Existing surface 2019



Drone photo by Palmer Engineering

Taylor County, KY GA Airport (KAAS)

April 2019



*Aramid polymer
fiber reinforcement*



Taylor County, KY GA Airport (KAAS)

April 2019

- Compacts approximately 1/8" per inch
- Extremely flexible but does not shove under load



2024 Projects

Ontario

New Brunswick

PA Turnpike Commission

PA Turnpike Commission, I-76 – 2024

Existing



PA Turnpike Commission, I-76 – 2024 Placement



PA Turnpike Commission, I-76 – 2024 Placement



PA Turnpike Commission, I-76 – 2024 Placement





2025 Project

Lexington, NC

Existing



Existing with Tack



Blythe Plant



BLYTHER

On-Site Spot Check of Fiber Inclusion



Paving and Handwork



Compaction



Overlay Placement 4 Hours Later



Players



WithersRavenel consultants



Tim Hobbs

Lexington, NC Project Wrap Up



2026 Annual Meeting

Hyatt Regency
Boston, MA
March 23-26, 2026



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Q&A

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