

REARM™

Low Cost High Performance
Sustainability

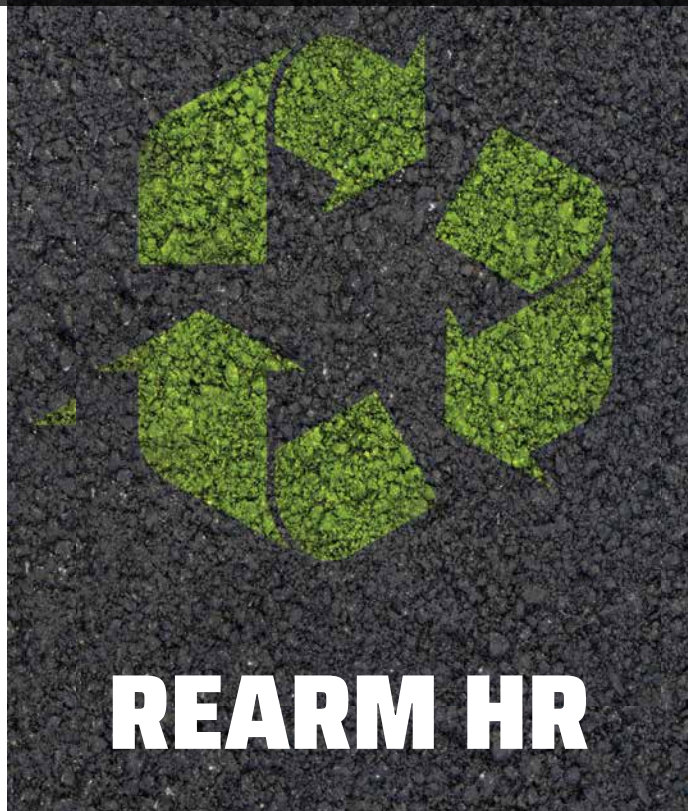


**Combining technologies allows HIGH RAP
asphalt concrete mix designs to achieve new
performance and sustainability levels.**



SURFACE TECH™

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By combining AQU™ Polymer Fiber manufactured by Surface Tech, LLC and TUFFTREK 4007 manufactured by Bakelite Synthetics, HIGH RAP mix designs can provide equal to or enhanced cracking and rutting performance as compared to lower RAP mixes. The key to these performance improvements is relying on the unique strengths of each product.

TUFFTREK 4007, typically 1 to 5% of total binder content, is used to reactivate the aged RAP binder. AQU™ Polymer Fiber is used to reinforce the resulting combined binder with 10 to 20 million individual high strength 38mm aramid fibers depending on dosage. By varying the dosage of each product, 50% RAP usage can be obtained without sacrificing performance of the lower RAP design mix, in fact, improved performance can be achieved if desired.

TAKE CONTROL OF YOUR RAP

- » Reduce the Virgin Binder Used
- » Reduce the Virgin Aggregate Used
- » Reduce Use of Polymer Modified Binders
- » Reduce the Mountains of RAP

- » Lower Cost of Asphalt Pavement
- » More Roads Paved with the Same Budget
- » Lower Valuable Raw Materials Used
- » Sustainability & Lower CO2 Emissions

Plant introduced technologies are a SMART choice for asphalt producers.

TUFFTREK 4007 and AQU™ Polymer Fiber are introduced at the plant during production. This puts the control with the plant and allows for the HIGH RAP mixes to be started and stopped as necessary to accommodate other manufacturing needs. TUFFTREK 4007 is available in totes, tanker or rail cars and is in-line added to the virgin binder during production. AQU™ Polymer Fiber is added to either the RAP Collar of a drum plant or the weigh hopper of a batch plant. Equipment for dosing both materials is available to purchase or rent with the purchase of the REARM HR technology from Surface Tech and or their Distribution Partners.

Let's be SMART about increasing the use of RAP (Recycled Asphalt Pavement) by running the IDEAL CT crack test (ASTM D8225) and the Hamburg Wheel Tracker rut test (AASHTO T324) in the lab and determine the performance of the existing mix design and compare that performance to the HIGH RAP version to ensure the desired in-place performance when making the mix design change. Asphalt pavement performance is a choice, and with the testing procedures and technology available today, we should expect MORE from our asphalt pavement performance even when designing REARM HR mixes.

This testing is available through Surface Tech and/or their Distribution Partners in conjunction with Blankenship Asphalt Tech and Training (The BATT LAB).

Superior asphalt performance through SMART innovation

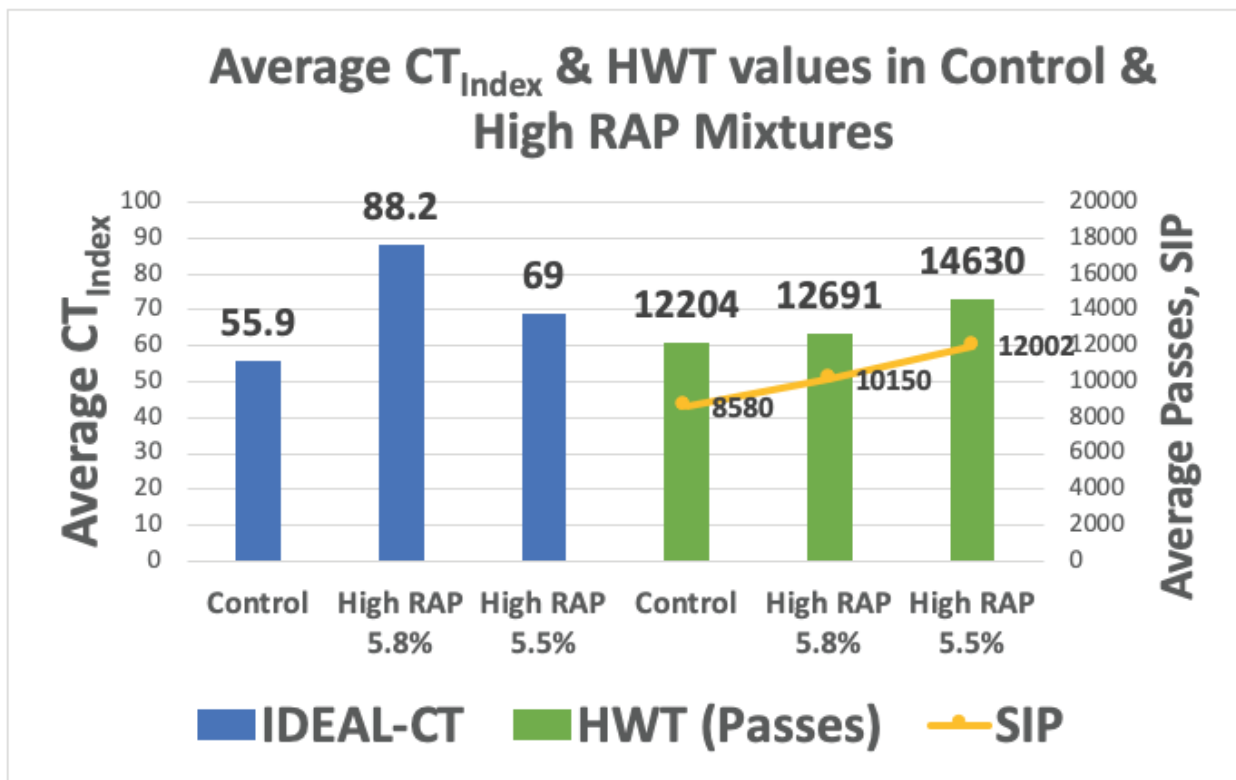


Fig 1 – IDEAL CT and Hamburg Wheel Tracker Data for Control Mix with 5.6% PG 64-22 Virgin Binder and 20% RAP. High Rap Mix with 36% RAP, TUFFTREK 4007 & 38mm AQU Polymer Fiber Testing Performed by Blankenship Asphalt Tech & Training.

AQU™ Polymer Fiber is a true achievement in additive technology to enhance asphalt concrete performance.

AQU™ Polymer Fiber extends pavement service life by dramatically improving the dynamic modulus of the asphalt layer and increasing the asphalt's resistance to cracking and rutting (distresses that may cause premature failure). To create AQU™ Polymer Fiber, high-strength man-made "aromatic polyamide" or para-aramid fibers are bundled and prepared with a special H2O binder to create an asphalt concrete additive that is simple to mix with any WMA or HMA in through a drum and or batch asphalt operation. The 3-dimensional reinforcement throughout the asphalt layer increases the asphalt's resistance to cracking, rutting, and fatigue while providing improved ESAL (Equivalent Single Axel Load) capacity.



Para-aramid fiber
(2.1 to 4.2 ounces/ton)



Special H₂O Binder
(0.7 to 1.4 ounces/ton)



AQU™ Polymer Fiber
(2.8 to 5.6 ounces/ton)

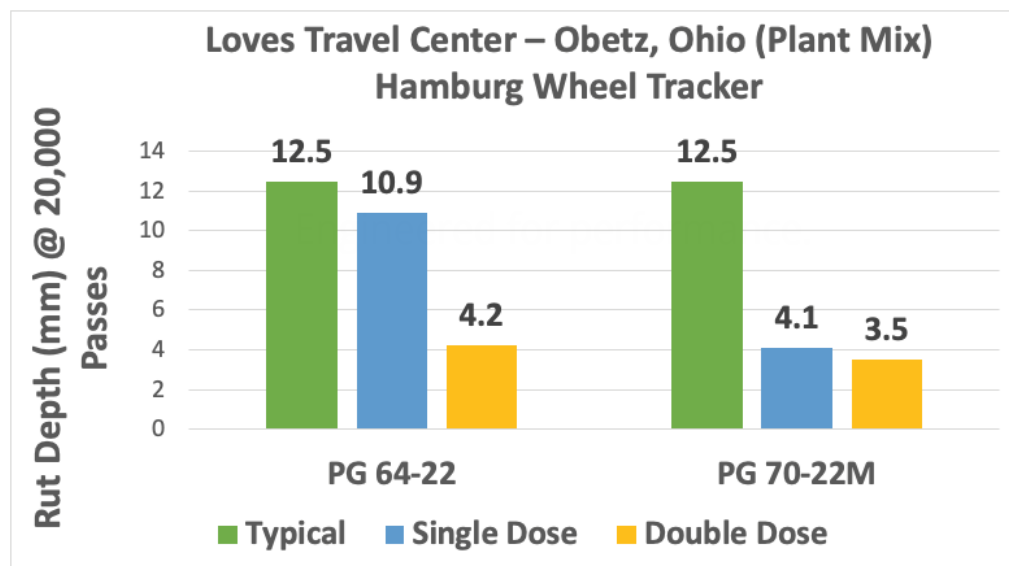
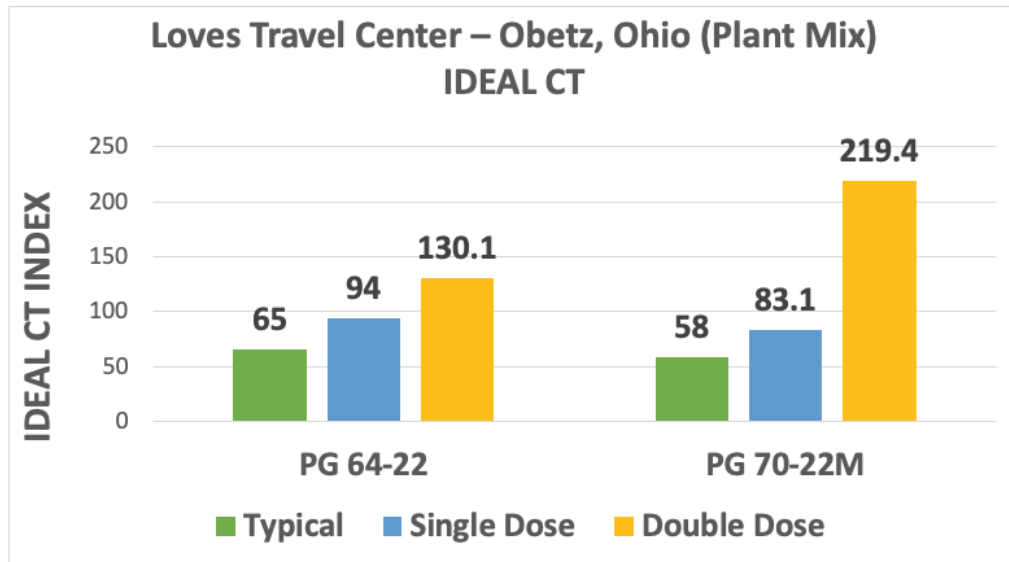
AQU POLYMER FIBER SPECIFICATIONS

<i>Material Property</i>	<i>Measure</i>
Material	Para-Aramid Fiber (75% by weight)
Treatment	Fugitive Binder (25% by weight)
Length	1.5" (38mm)
Form	Liquid Bound & Cut Fiber Clips
Color	Yellow
Specific Gravity	1.44 g/cm ³
Fiber Tensile Strength	400,000 psi
Fiber Melting Temperature	> 932 ° F

Engineered for performance.

Aramid fibers are used extensively in many industries and applications including ballistic protection, heat & cut protection, automotive, ropes & cables, conveyor belts, etc. However, it takes a special fiber to withstand the extreme production temperatures of asphalt concrete without changes occurring to the reinforcement properties of the fiber. That is why AQU™ Polymer Fiber uses para-aramid fibers exclusively. Para-aramid is a unique man-made, high-strength polymer fiber boasting high tensile strengths over 400,000 psi (5 x steel), a superior stress/strain relationship, and decomposition temperatures of 932oF (well above asphalt mixing temperatures of 350oF). REARM HR utilizes the longest fiber lengths available (1.5") to provide superior long-term reinforcing performance of the binder.

AQU™ Polymer Fiber shows 30% to 50% improvement in cracking and rutting performance per dose used.



APPLICATION BULLETIN



TUFFTREK 4007

Renewable Oil Technology

TUFFTREK 4007 renewable oil technology from Bakelite Synthetics helps restore the viscoelastic properties of aged asphalt binder.

TUFFTREK 4007 benefits include:

- Cost-effective technology
- Improved DCT and IDEAL-CT cracking resistance in lab and field testing
- Allowed increased amounts of RAP and RAS to be used in asphalt pavements
- Restorative improvements to asphalt binder durability characteristics (as measured by ΔT_c and Glover-Rowe)
- Add in-line for ease of incorporation

- Biobased, renewable
- Low viscosity (65 cP at 25°C)
- High flash point (Open Cup 468°F)

TUFFTREK 4007 is easy to handle. It can be blended at the terminal or added at the hot mix plant in-line with the asphalt binder. Product is available throughout North America in totes, tanker truck or rail cars.

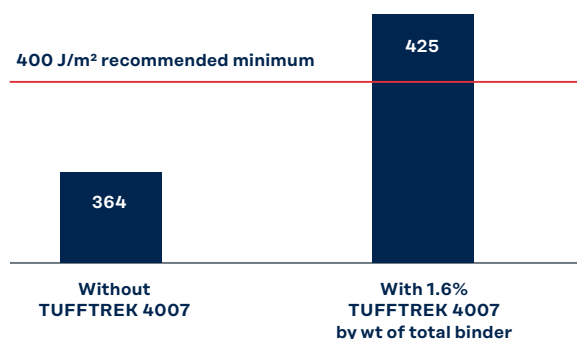
Testing

Test results on a blend of 50% aged asphalt binder and 50% PG 58-28 demonstrate TUFFTREK 4007's softening effectiveness and restorative improvements to binder durability and cracking characteristics, even after 40hrs of PAV aging.

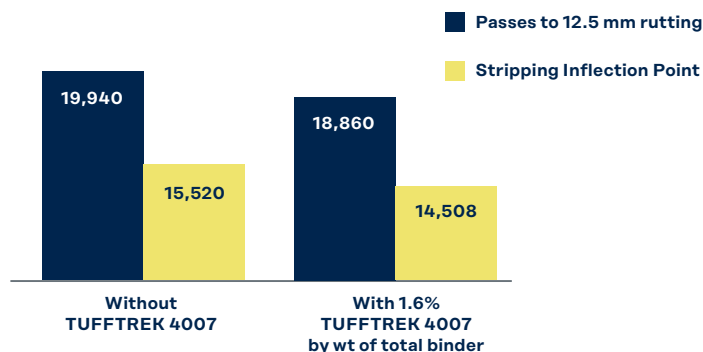
	PG 58-28	50% PG 58-28 50% RAP	50% PG 58-28 50% RAP
% TUFFTREK 4007 Added	0%	0%	2%
High PG	59.9	77.4	62.9
Low PG	-28.7	-23.0	-29.7
40 hr PAV ΔT_c	-1.1	-3.8	-1.4
40 hr PAV Glover-Rowe	56	539	64

Performance tests conducted on a production mix from a Nebraska contractor containing 50% RAP demonstrate TUFFTREK 4007's positive effects on low temperature and intermediate temperature cracking with minimal loss in rutting performance.

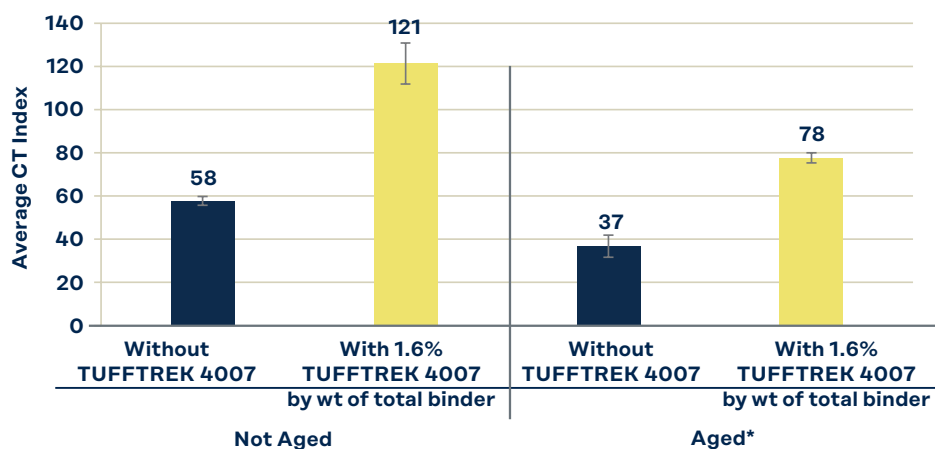
DCT Fracture Energy -18°C



Hamburg Wheel Tracking 45°C



IDEAL-CT (25°C)



*Aged test samples were prepared from field mix reheated in a 135°C oven for 2 hours and then conditioned in a loose mix state for 6 hours.



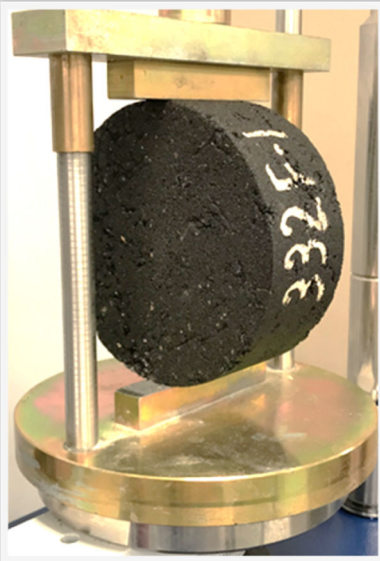
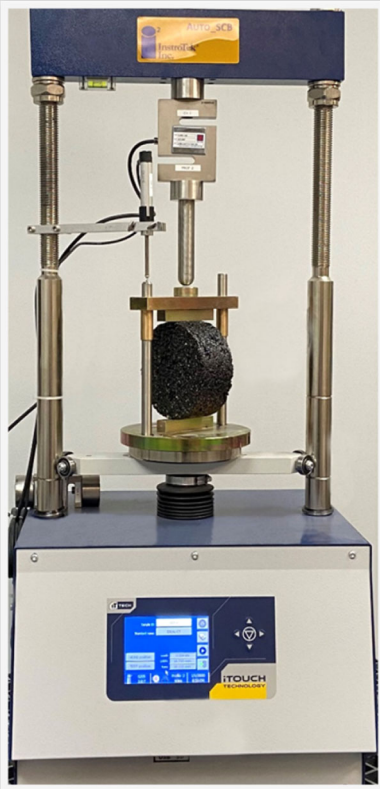
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BAK-200 22/07

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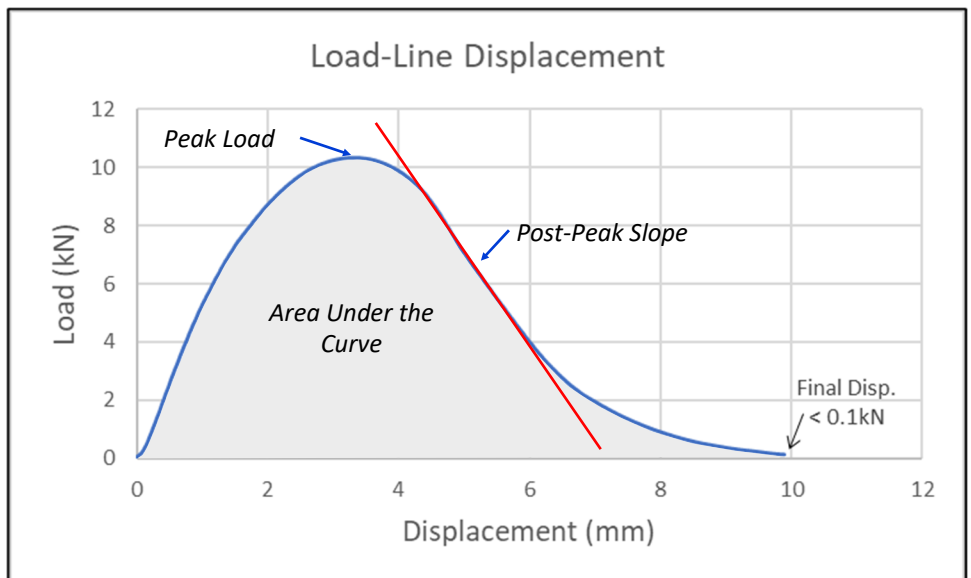


IDEAL-CT test, or *Indirect Tensile Asphalt Cracking Test*, is a performance indicator test measure the crack resistance of the asphalt mixture. Testing is conducted at intermediate temperatures and uses a tensile loading fixture with platens to hold the cylindrical gyratory compacted specimens or field cores. The result of the test produces a CT_{Index} value used to predict performance.

Test Basics

- *Specimen geometry: 150 mm diameter by 62 mm tall specimens*
- *Uses lab or plant prepared HMA. Can be used with field cores.*
- *Samples can be prepared from 2500 g (5.5 lbs) of HMA.*
- *Requires minimum of four (4) samples.*
- *No instrumentation, gluing, cutting or other preparations*
- *Samples are tested between 15-35°C (59-95°F)*
- *Test uses constant loading rate of 50 mm/min (2 in/min)*
- *Test concludes at complete fracture of specimen*
- *Test duration approx. 2-3 mins*

The CT_{Index} value is calculated from the from the “area under the curve” or failure energy, load-line displacement (LLD) and post-peak slope of the tested specimen. Index values are sensitive to *binders, modifiers, and recycle materials*. There is not a definitive range or minimum value associated with the CT_{Index} , but generally higher values indicate better performance to crack resistance.

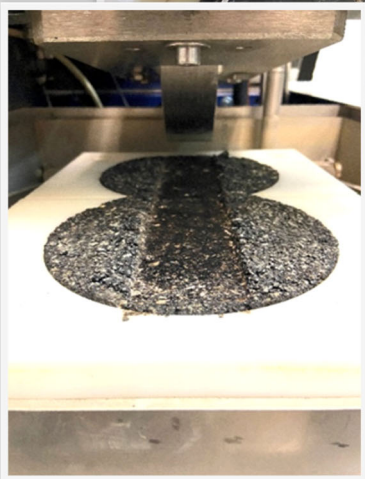
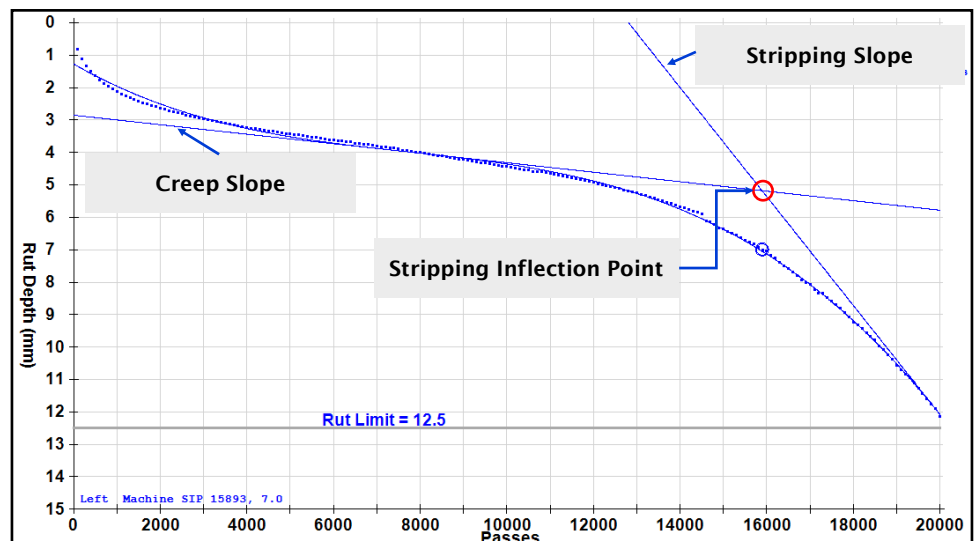


HWT test, or *Hamburg Wheel Tracker test*, is a repeated load test conducted in water at elevated temperatures. The test is designed to indicate a mixture's susceptibility to rutting and moisture-induced damage, otherwise known as stripping.

Test Basics

- Specimen geometry: 150 mm diameter by 62 mm tall
- Uses lab or plant prepared HMA
- Samples can be prepared from 2500 g (5.5 lbs) of HMA
- Requires minimum of four (4) samples. Two (2) samples make one set
- Specimens are cut to smoothly join together in molds
- Samples are typically tested at 50°C (122°F) in water
- 158 lb (72 kg) steel wheel load (203 mm diameter by 47 mm wide)
- Up to 20,000 passes per test, at 52 passes/min
- Typical maximum rut depth of 12.5 mm
- Test duration approx. 7 hours

The test concludes when the sample reaches 20,000 passes or reaches max rut depth of 12.5 mm. Rut depth, passes and stripping inflection point (if present), are outputs from the test. While rut depth and number of passes indicate the mixture's rutting potential, the stripping inflection point provides information on the susceptibility of moisture damage. BATT uses a Rut-Resistance Index (RRI) value to understand the rutting potential of the mixture. The RRI value is an index of rut resistance that combines the number of passes with the rut depth of the sample to provide a single value used to indicate performance.



SURFACE TECH™



Our core is innovation. We search to find ways to make building materials better, stronger, and longer lasting. Extensive research and development, laboratory testing and field trials have proven the Surface Tech advantage.

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Infinite potential. Infinite curiosity. Infinite solutions.... it's what continues to drive us today. From making buildings more fire resistant. To realizing the future of transportation from electric cars to space travel. To improving the productivity of our life-sustaining crops. And ways we haven't even dreamed of quite yet. Together with manufacturers around the world, there's nothing we can't accomplish.

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THE BATT LAB - Blankenship Asphalt Tech and Training, PLLC, offers civil engineering consulting services specializing and laboratory testing in product development, reflective cracking solutions, materials research, materials testing, patenting, pavement evaluation, on-site lab/field support, pavement forensics, and asphalt mix design.

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