

XIII Congreso Mexicano del Asfalto. 20, 21y 22 de agosto de 2025, Cancún, Quintana Roo, México



@AMAACmx

<http://www.amaac.org.mx>



Engineering Challenges and Solutions in High RAP Mixtures: A case-based approach

Phillip B. Blankenship

Blankenship Asphalt Tech and Training, PLLC

XIII Congreso Mexicano del Asfalto. 20, 21y 22 de agosto de 2025, Cancún, Quintana Roo, México

Scope of Work

- Design, construction, and documentation of **two (2) high-RAP** asphalt pavement installations placed by three different contractors in 2020
- Each project had **control sections** of the “normal mix”
- Locations



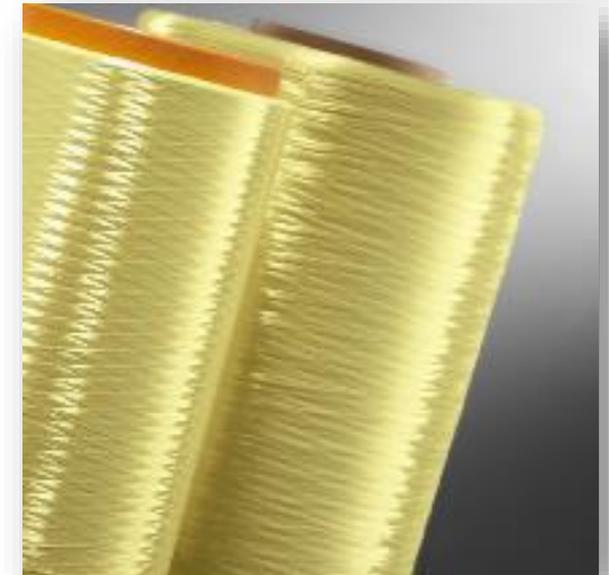
Terms



- High RAP: “Higher than normal” at 35% +
- Aramid fiber
- Fiber dosage:
 - 1x dose = 2.1 oz aramid fiber/mix ton (65.6 g/metric tonne)
 - 2x dose = 4.2 oz aramid fiber/mix ton (131.2 g/metric tonne)

What Is Aramid Fiber?

- Aramid is a high-performance man-made (polymer) fibre suitable for challenging applications:
- Uses:
 - Ballistic Protection
 - Heat & Cut Protection
 - Automotive Industry (Brakes, Tires & Hoses)
 - Ropes & Cables
 - Optical Fibre Cables
 - Conveyor Belts

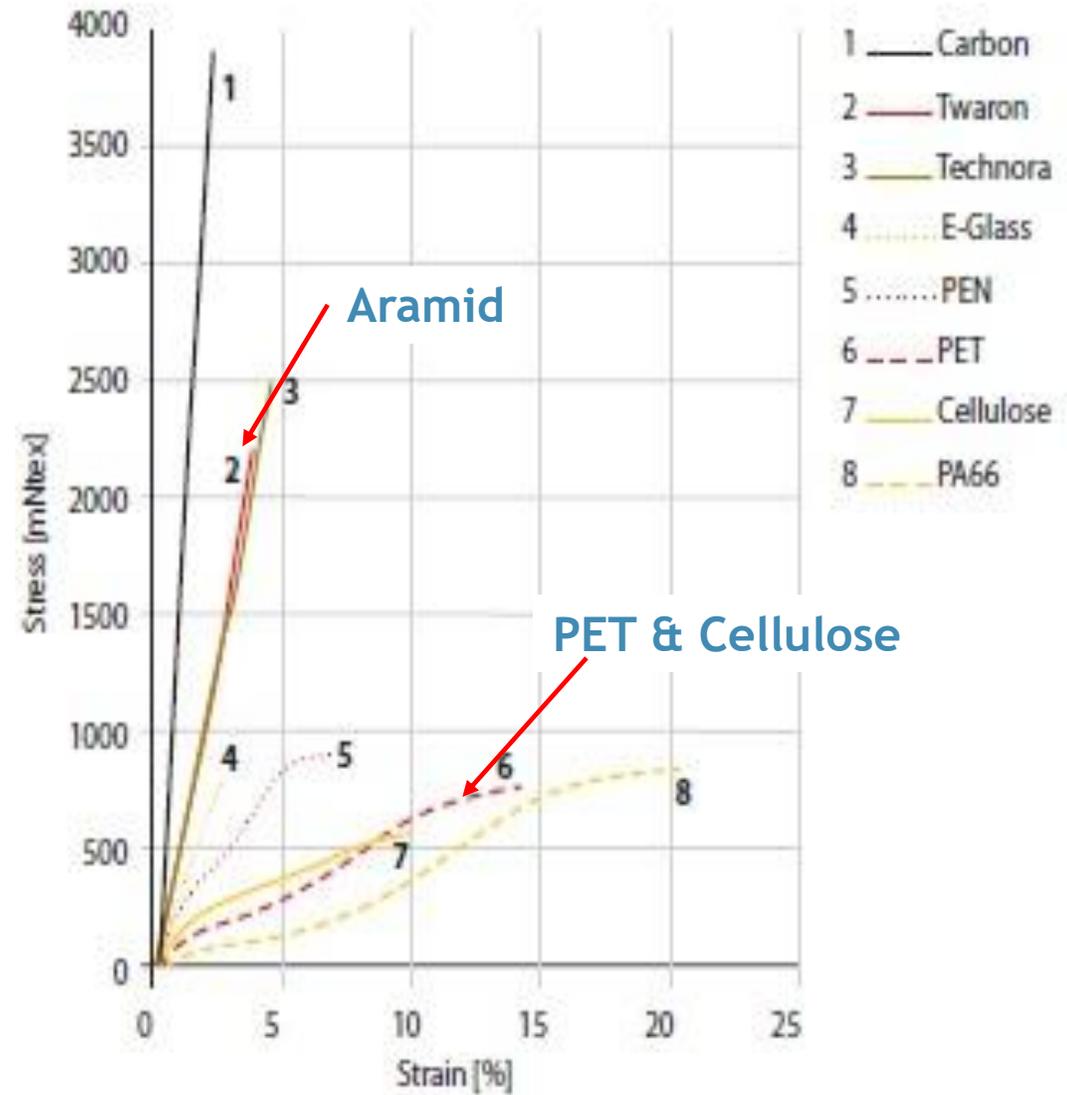


| | | |
|--------------------------|------------------------------|-----------------------------------|
| Density | (g/cm ³) | 1.44-1.45 |
| Tensile strength | (GPa) | 2.4-3.6 |
| Tenacity | (N/tex) | 1.65-2.5 |
| Modulus | (GPa) | 60-120 |
| Elongation at break | (%) | 2.2-4.4 |
| Moisture | (wt%) | 3.2-5 |
| Glass transition | (°C) (°F) | - - |
| Decomposition or Melting | (°C) (°F) (°C) (°F) | 500 932 - - |
| LOI | (%) | 29 ² - 37 ³ |

= 400,000 psi
(5 x steel)

HMA = 400 F

Stress/strain curves High Strength at Low Strain



ASTM Specification D8395



CELEBRATING 125 YEARS

All

Products & Services Get Involved About News

Home / Products & Services / Standards & Publications / Standards Products

Do you already have an ASTM Compass® Subscription? Access your content now.

[Go to ASTM Compass®](#)

Standard Active

Last Updated: May 12, 2023

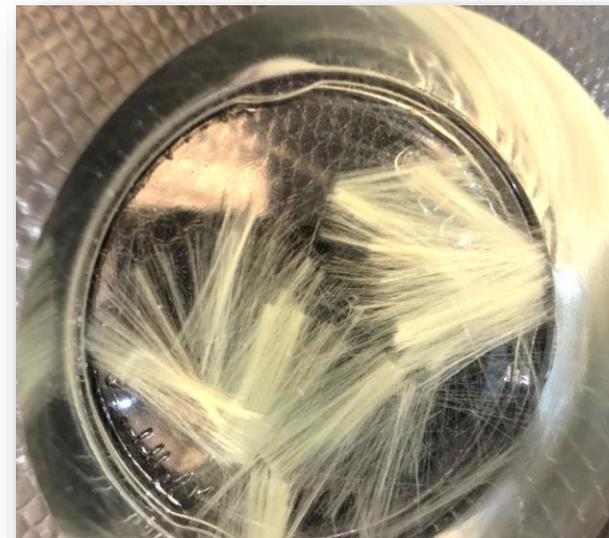
[Track Document](#)

ASTM D8395-23 ⓘ

Standard Specification for Aramid Fiber for Asphalt Mixtures

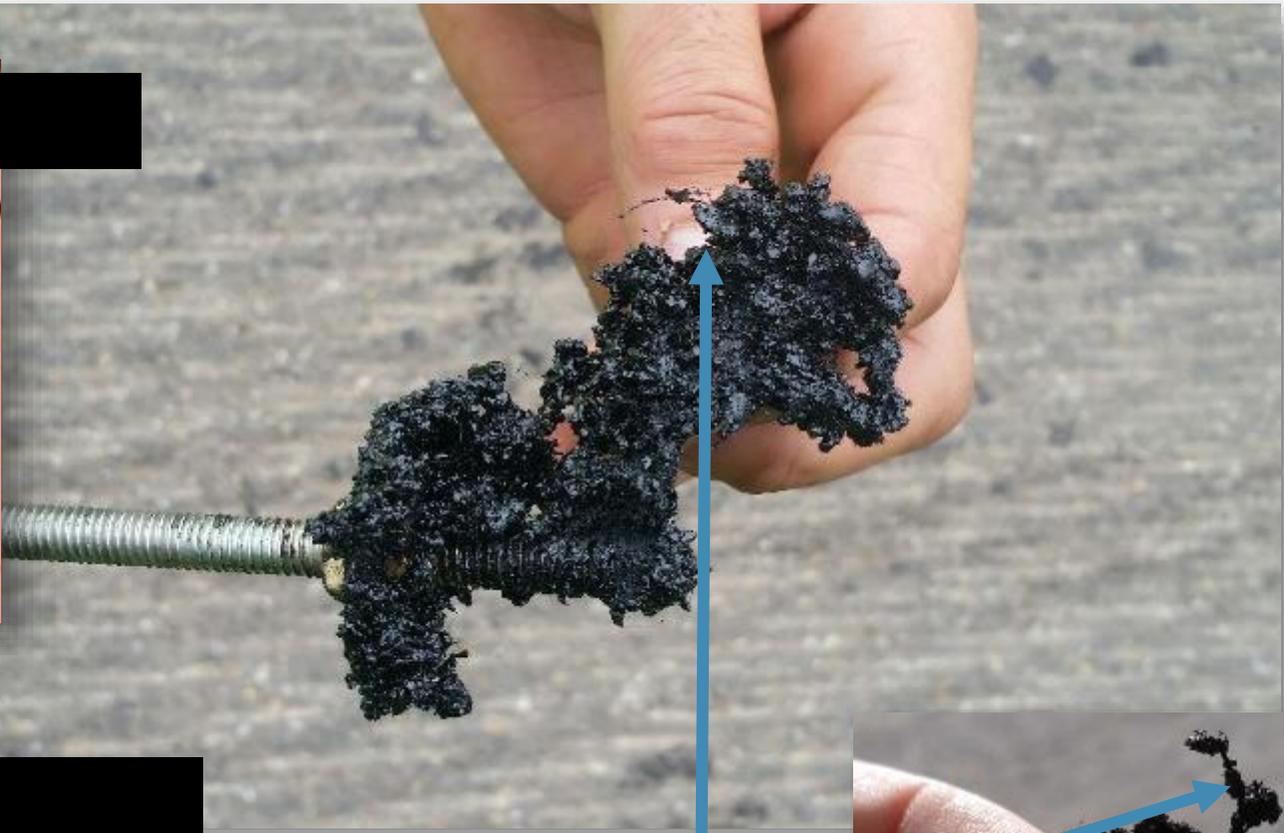
Scope

1.1 This standard specification covers a standardized method whereby an aromatic polyamide fiber can be evaluated prior to modification where the finished product (formulation of aramid fiber plus some form of treatment) is to be used in asphalt mixtures. The aromatic, polyamide fiber (shortened to “aramid” in non-treated form) can be specified by physical and mechanical properties whereby the

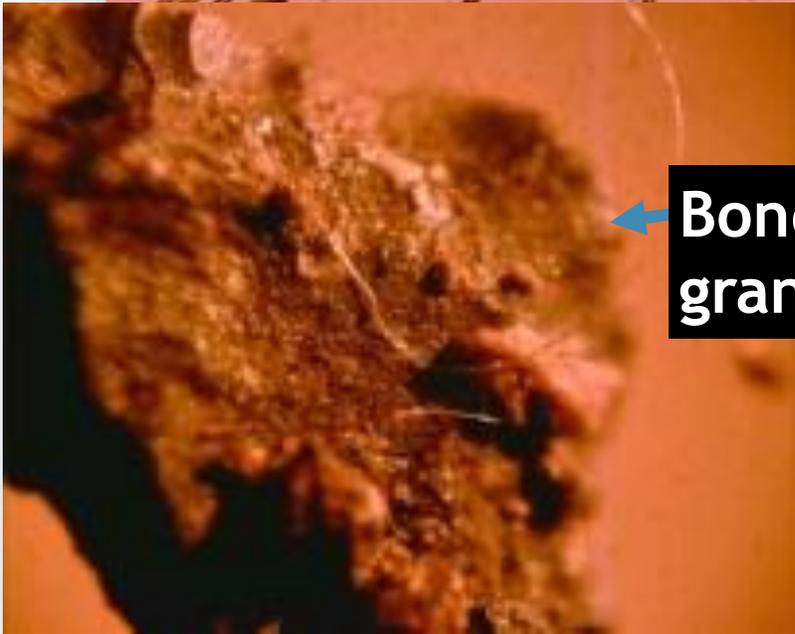




Hair-like
fibrils



“Roots” into



Bonds to
granules



Challenge of Sustainability

2025 ASCE Infrastructure Report Card



2025 REPORT CARD
FOR AMERICA'S INFRASTRUCTURE

[View 2025 Report](#)

[Take Action](#)

[Bridging the Gap Report](#)

[Donate](#)

JOIN
ASCE

[ABOUT](#)

[EXPLORE CATEGORIES](#)

[STATE FACTS](#)

[SOLUTIONS](#)

[INVESTMENT PAYS](#)

[NEWS & INSIGHTS](#)



Roads



Asociación Mexicana
del Asfalto, A.C.

[@AMAACmx](#)

<http://www.amaac.org.mx>



Sustainability

- Push to evaluate sustainable options
- Happening at a time we are trying to fix our mixes
 - USA mixes have been generally low in asphalt binder
 - May need softer grades in some of USA



What Does Success Look Like?

- Easy to construct
- Same or better performance as “low RAP” projects
- Improved Life Cycle Assessment
 - Cradle to Gate- Lower net CO2 (use of RAP)
 - Cradle to Grave: Ideally last longer than low RAP extending construction cycle
- May or may not have a net cost increase



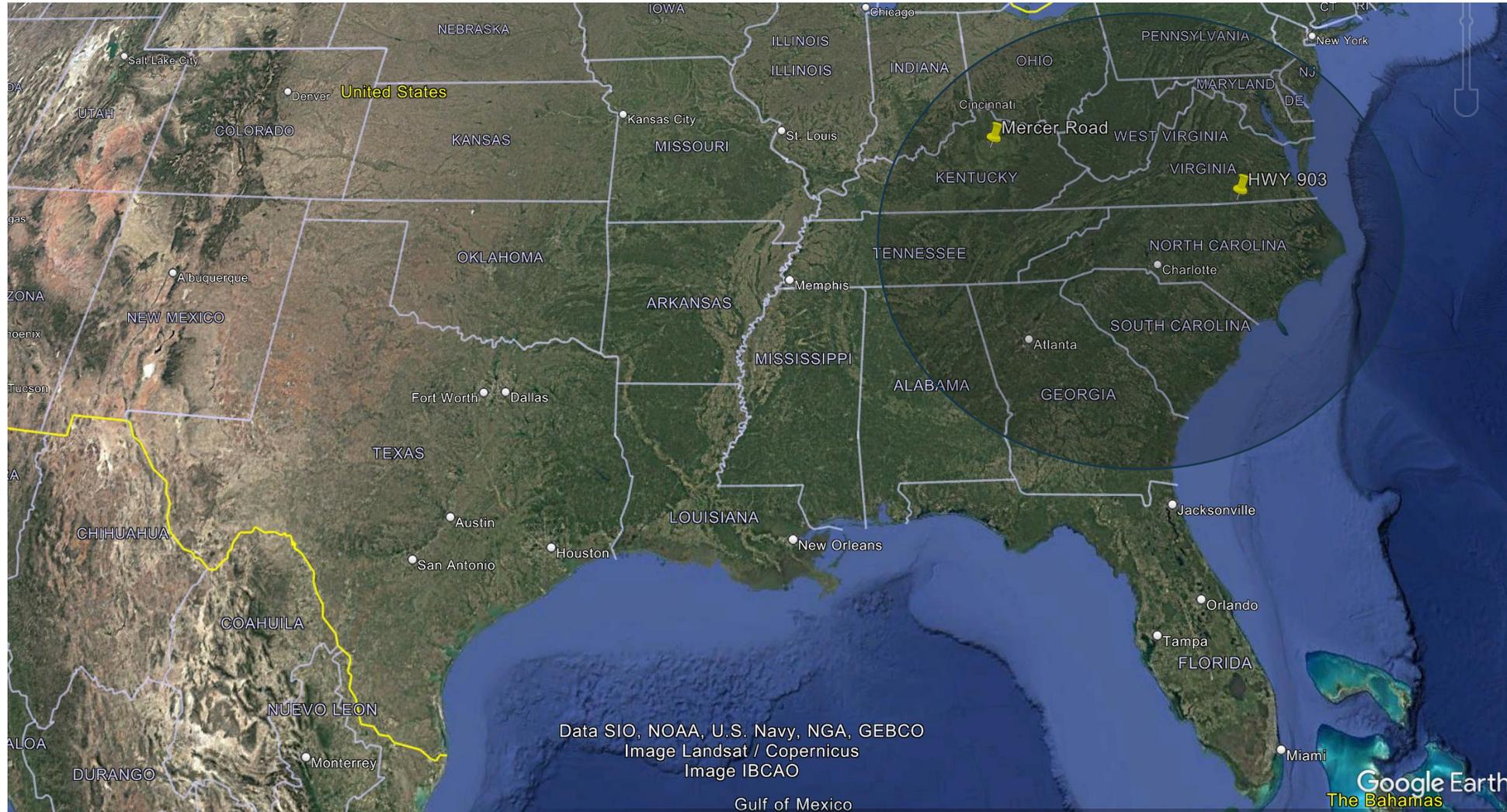
Project Construction and Performance

Why Are These 2020 High RAP Projects “Sustainable”?

- Yes, we need to use **RAP responsibly** and increase use www.asphaltmagazine.com/fix-your-mix/
- Yes, there is **bio oil (soy bean base)**
- Yes, **aramid fibers** extend service life
- **Performance-based design** for longer life
- **Project goals:**
 - **Virginia DOT** - Evaluate high RAP sections using bio oil and aramid fiber
 - **City of Lexington** - wants a greener, sustainable solution BUT not at a cost of pavement performance



Project location



Project Goals

Highway 903 - VA DOT in Bracey, Virginia

- Design high RAP with Balanced Mix Design (BMD) performance-based testing
- Evaluate high RAP sections using:
 - bio oils
 - aramid fiber



Volumetric Data

All Projects – As Constructed

Mixture Data

| Mix ID | Bracey VA (rural secondary) | Lexington KY (industrial route) |
|-------------------------------------|--------------------------------|------------------------------------|
| RAP, % of mix | 35 | 45 |
| Bio oil, % of binder | 3.4 + WMA | 4.2 |
| Aramid Fiber, oz/mix ton | 2.1 | 4.2 |
| PG | 58-28 | 64-22 |
| AC, % of mix | 6.2 | 5.25 |
| Approx. Binder Replacement from RAP | 1.9 (32%) | 2.5 (48%) |
| G_{mm} | 2.480 | 2.510 |
| G_{mb} @ N_{des} | 2.434 | 2.491 |
| Density @ N_{des} | 98.1 | 99.2 |
| Voids @ N_{des} | 1.9 | 0.8 |
| VMA | 15.0 | 11.3 |
| VFA | 87.3 | ~93 |

Notes:

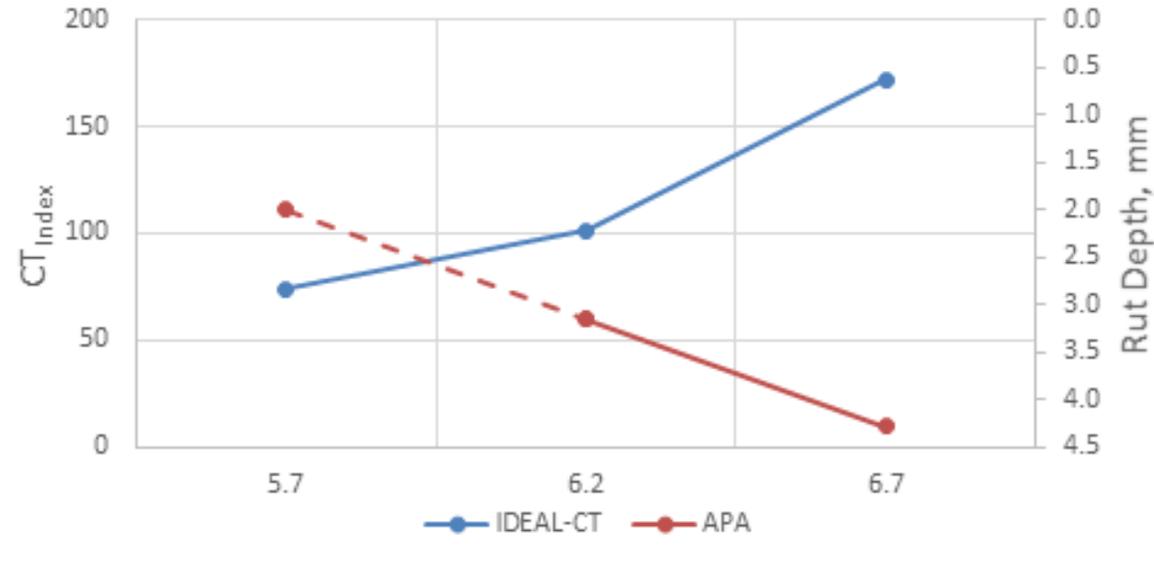
- Performance samples made at 7.0% voids
- Compaction temperature 290°F
 - Focuses on consistent time in oven while reheat compaction temperature may vary 20°F
- Total reheat time from start to finish was around 4 to 5 hours
- Design air voids were allowed a range to meet BMD requirements
- Normal field density were targeted

Highway 903 - Bracey, VA



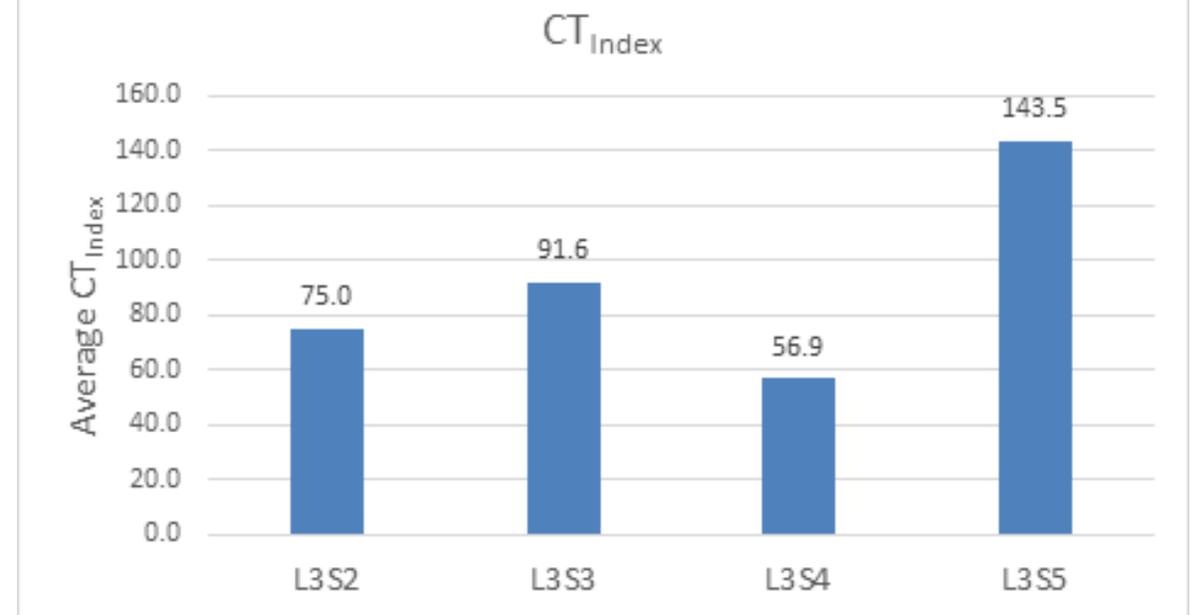
Design

REARM HR Rutting & Cracking Potential vs Total AC Content



As-Produced

Colony Paving Plant Mix Control Samples Average



Highway 903 - Bracey, VA



Data from lab (Re-heated samples)

| Test | Control | 35% RAP |
|---|---------|---------|
| Hamburg Wheel Tracker, passes to 12.5mm | NA | 12,202 |
| IDEAL-CT, 25° C | 91.8 | 117.3 |
| Cantabro, % mass loss | 5.67 | 3.75 |

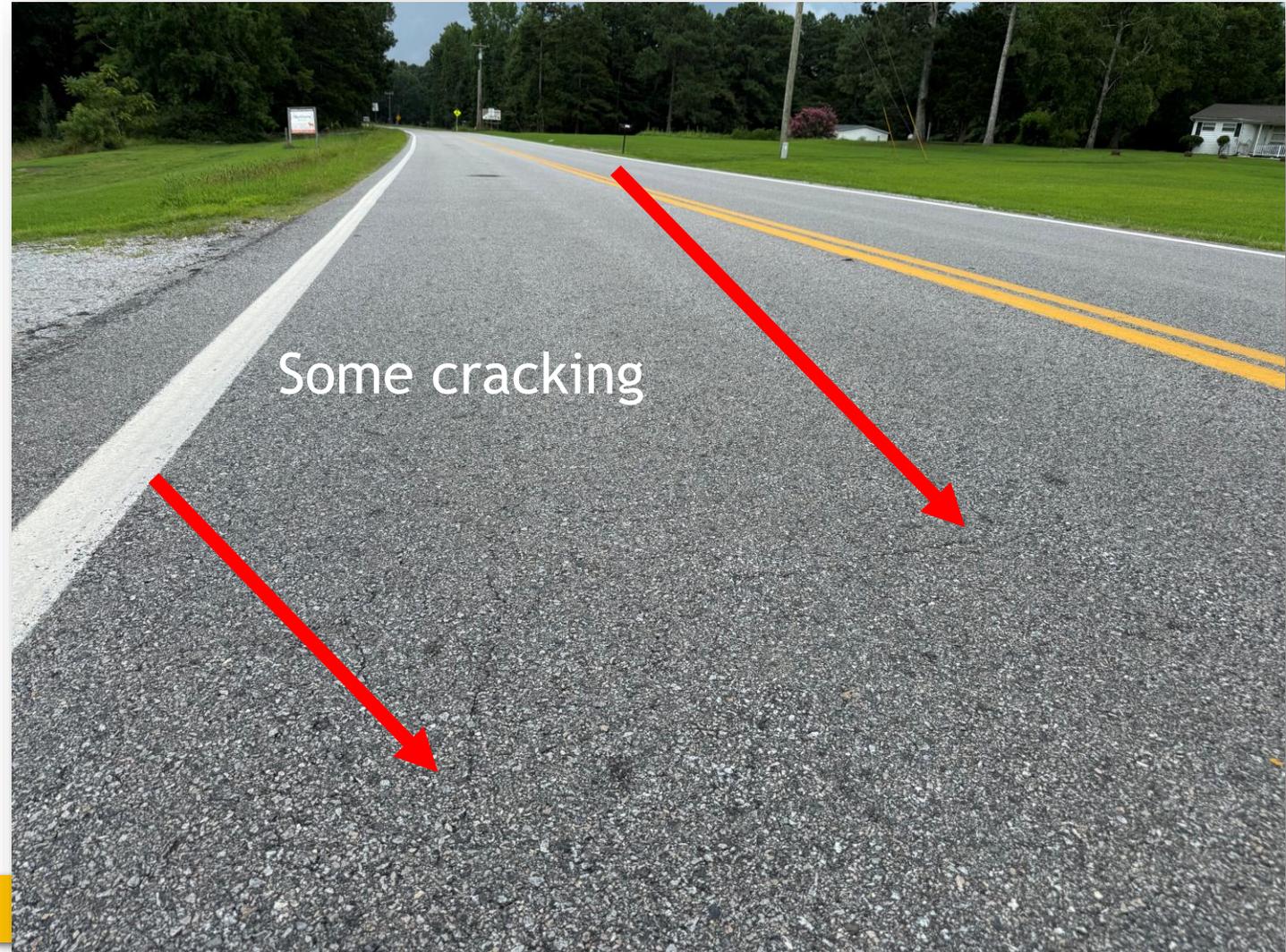
Highway 903 - Bracey, VA with 35% RAP – 2020 Construction



*Used contractor-controlled mix
modification. Combo of bio oil &
aramid fiber*



CONTROL: Highway 903 Bracey, VA with 35% RAP – 2025 (After 5 Years)





PAVEMENT CONDITION - PCI



Zoom to



Bracy Station

Paschall

Lake Gaston

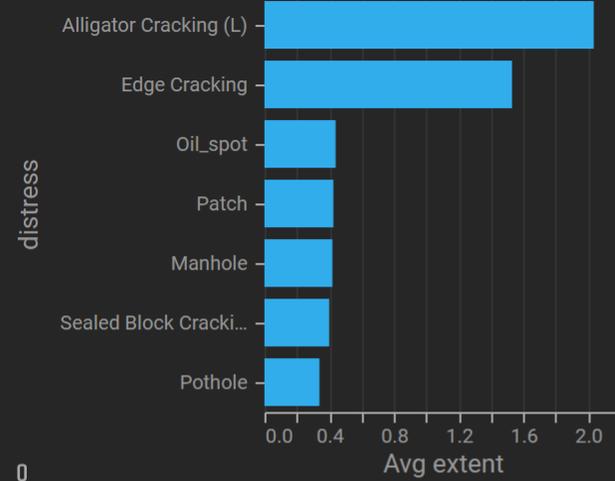
1 km



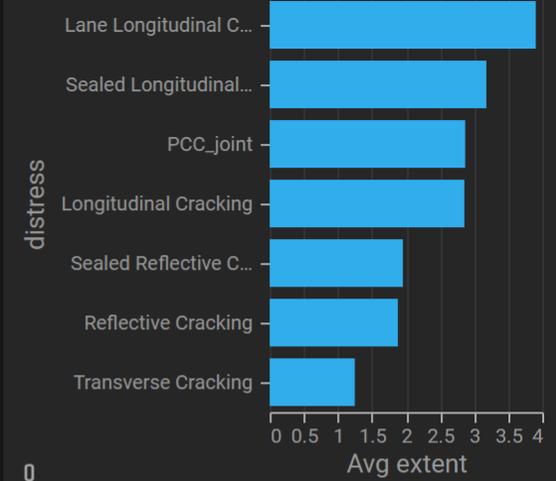
AVG PCI

91

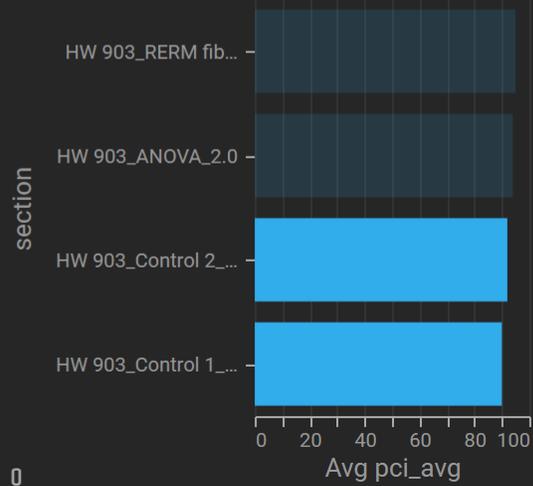
AVG EXTENT BY DISTRESS TYPE - Mete...



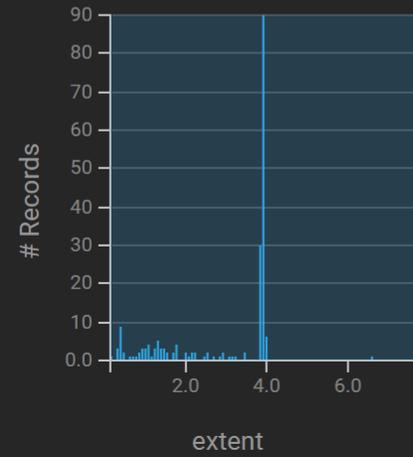
AVG EXTENT BY DISTRESS TYPE - ...



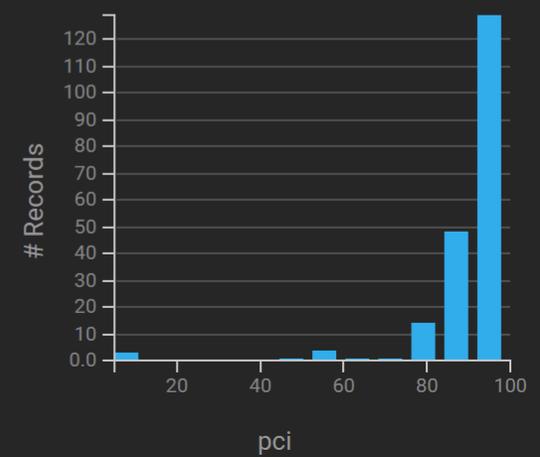
AVG PCI BY SECTION



RECORDS BY EXTENT



RECORDS BY PCI



Asociación Mexicana del Asfalto, A.C.

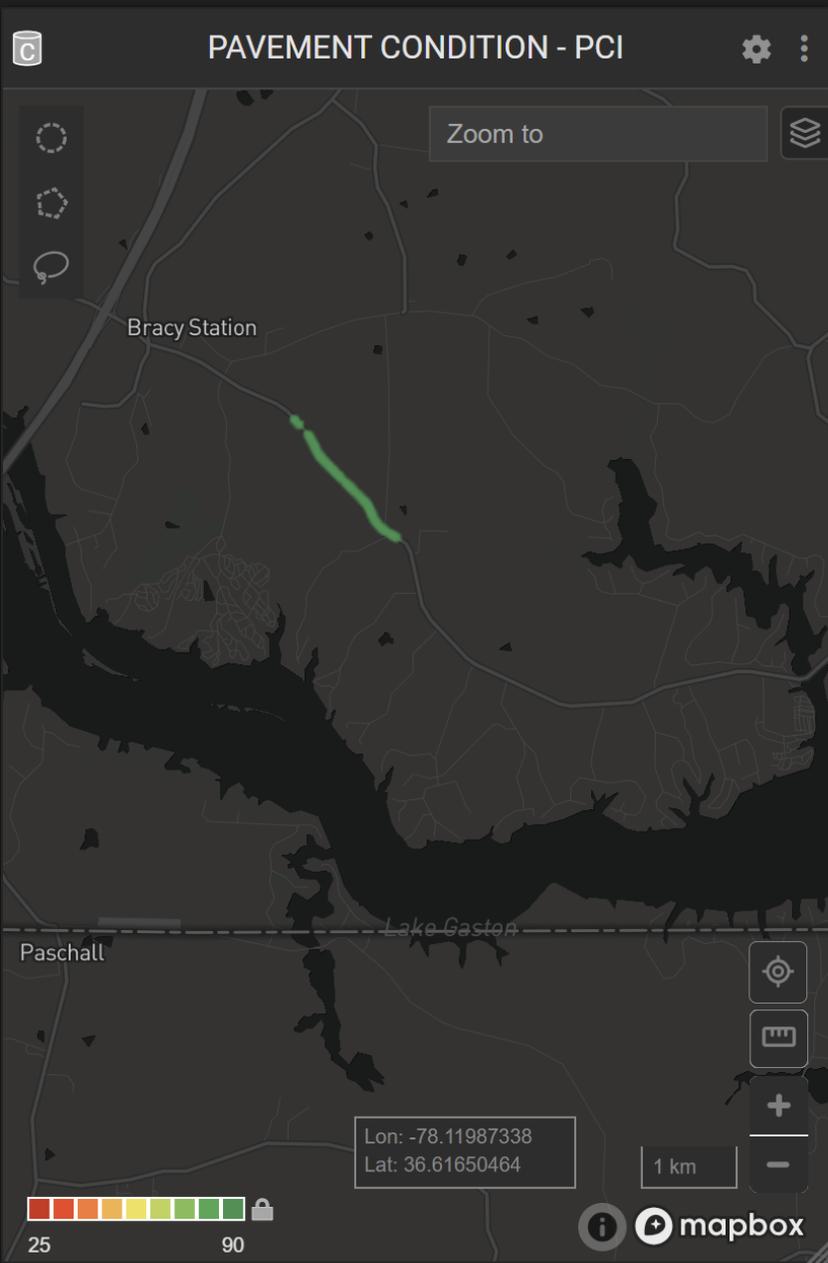
@AMAACmx

<http://www.amaac.org.mx>



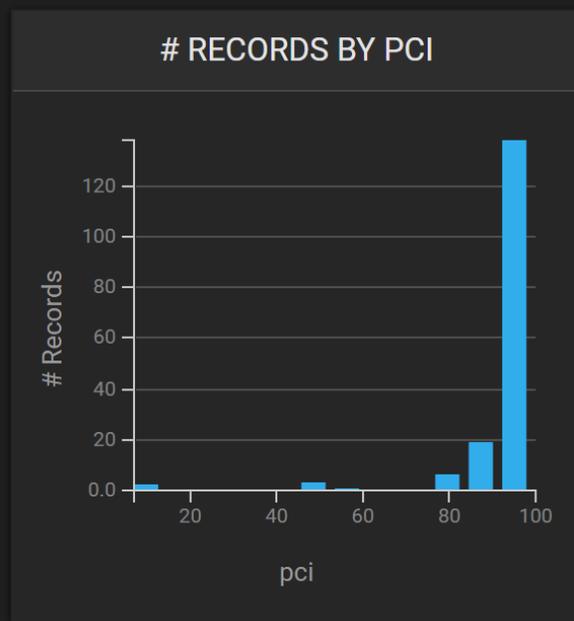
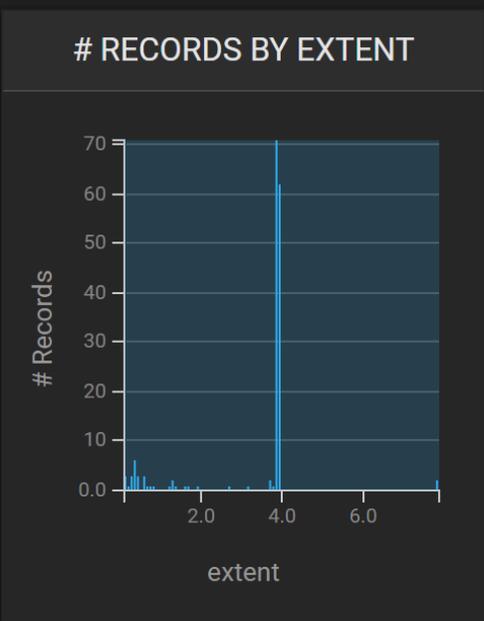
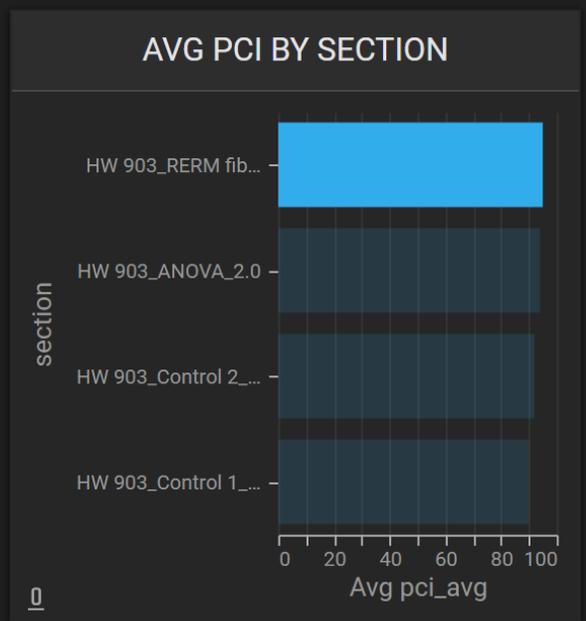
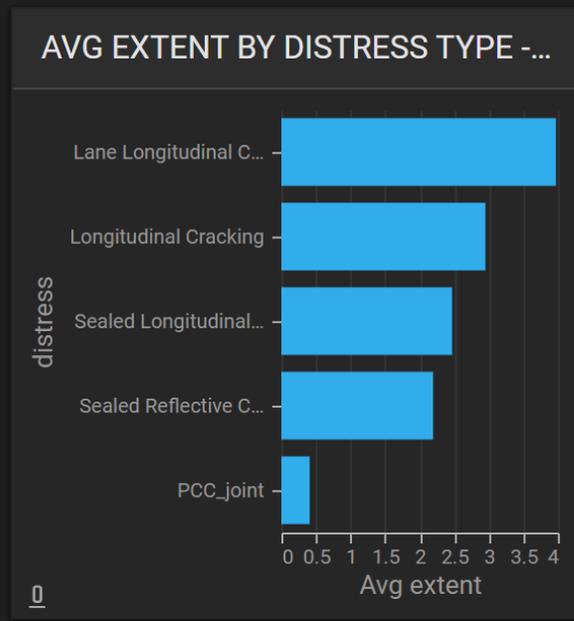
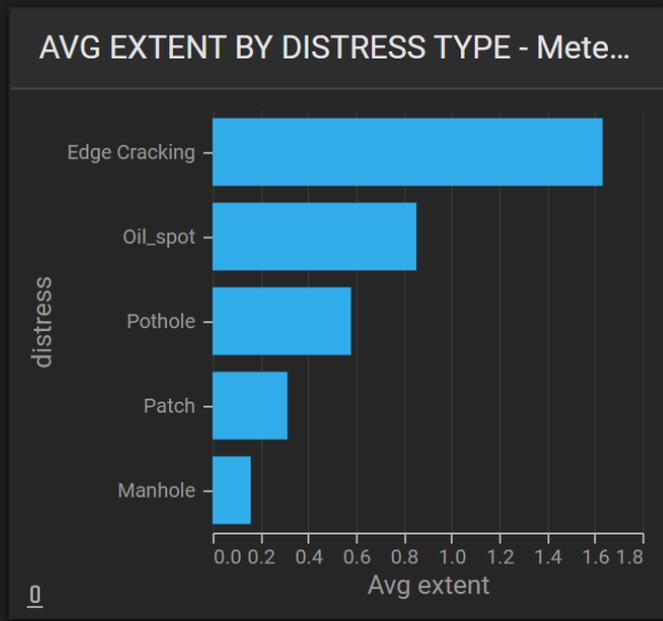
Fiber + Bio Oil: Highway 903 Bracey, VA with 35% RAP – After 5 years





AVG PCI

95





Project Goals

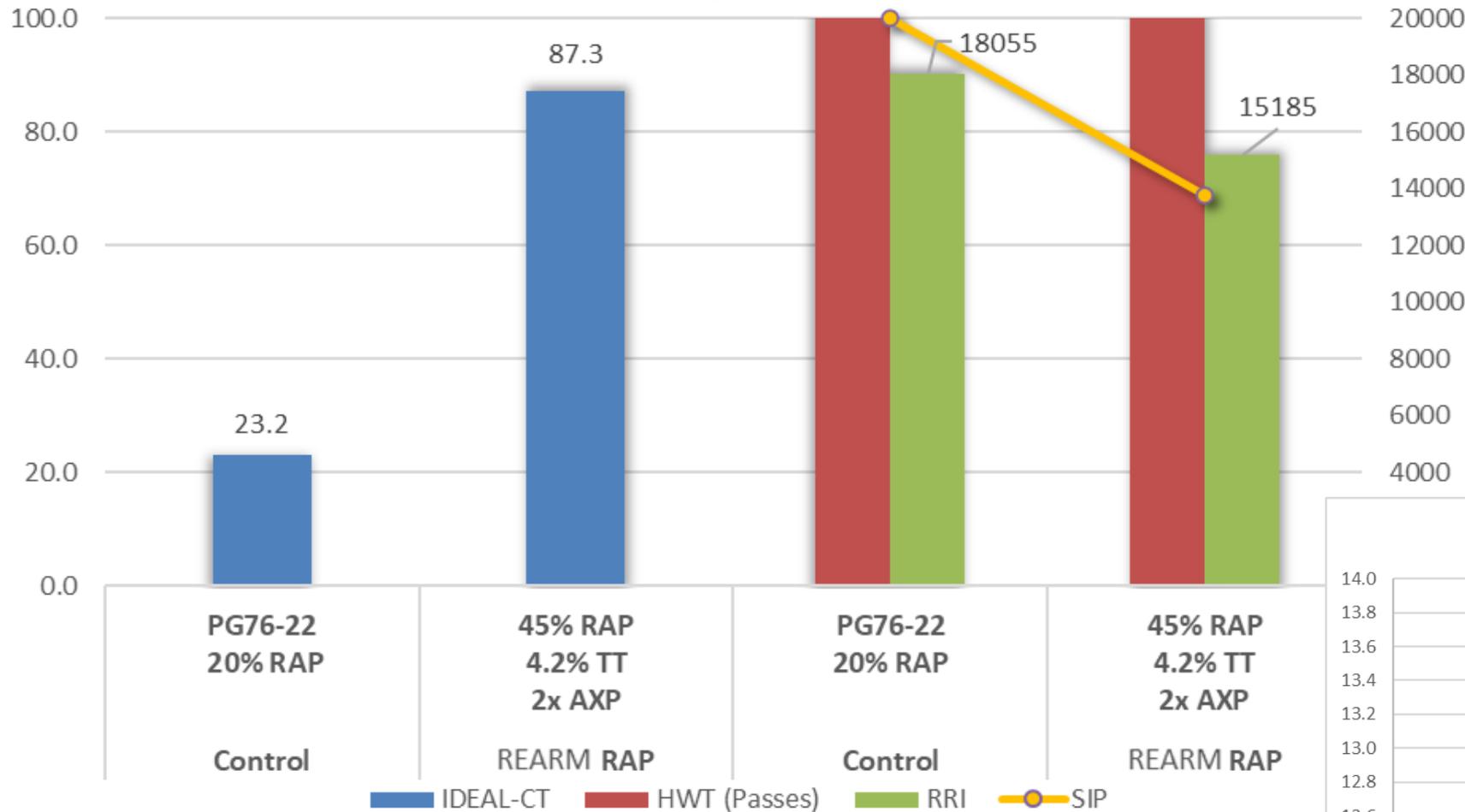
Mercer Road - City of Lexington, Kentucky

- Design high RAP with Balanced Mix Design (BMD) performance-based testing
- Encourage use of high RAP mix with these rules:
 - Do not increase cracking
 - Do not increase rutting
 - Compare to standard (with aramid fiber) and without fiber
 - Monitor and document
 - We are “cautiously optimistic”

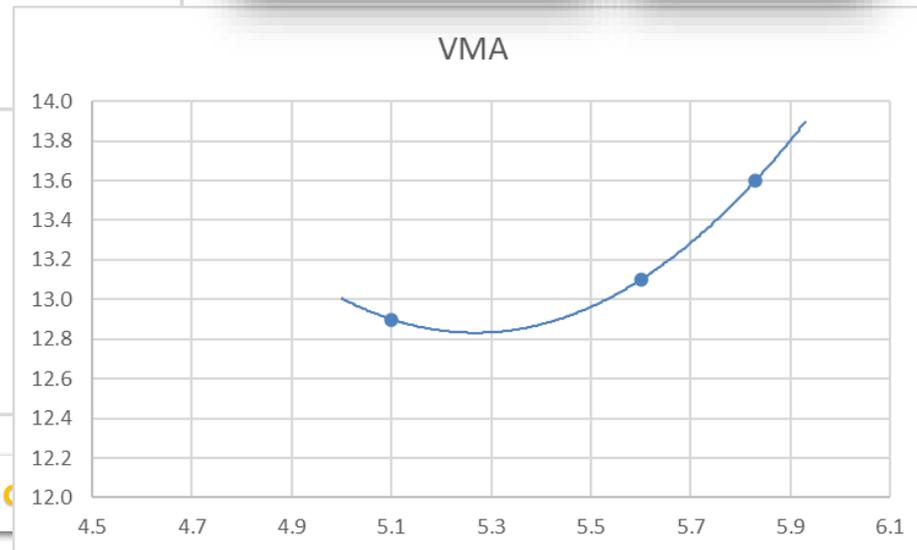


Mercer Road - Lexington, Kentucky

REARM RAP Comparison of IDEAL-CT & HWT Test Results for Mercer

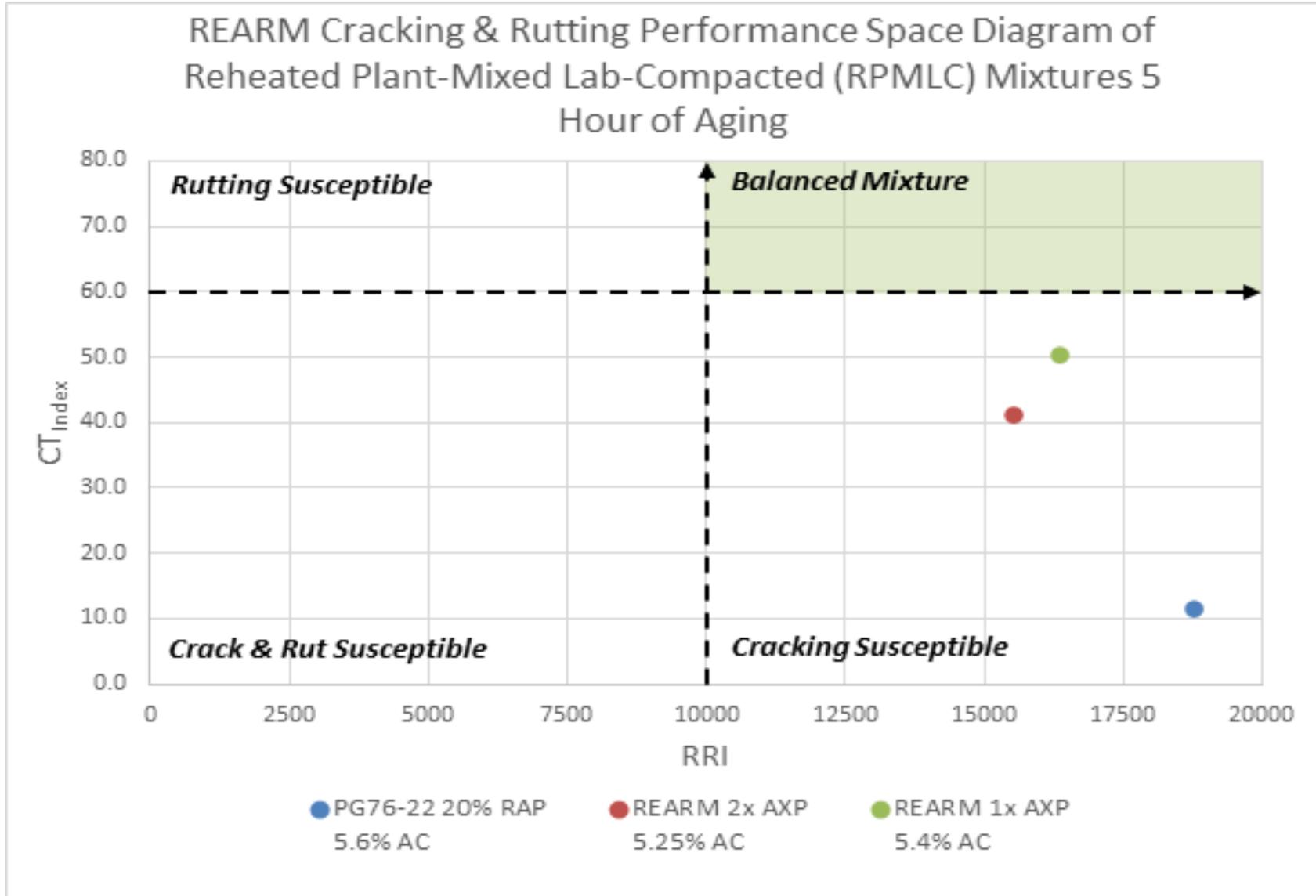


Design data



Mercer Road - Lexington, Kentucky

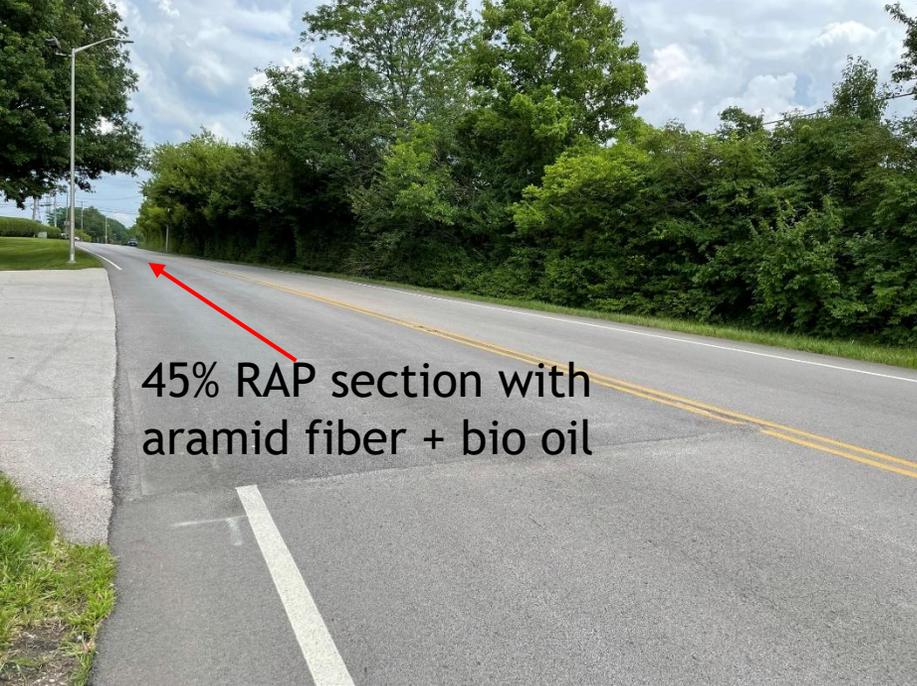
As-Produced



Mercer Road - Lexington Kentucky with 45% RAP – 2020 Construction



Mercer Road - Lexington Kentucky with 45% RAP – 2021 (After 1 Year)



45% RAP section with
aramid fiber + bio oil



45% RAP section
with aramid fiber +



45% RAP section with
aramid fiber + bio oil

Mercer Road - Lexington Kentucky with 45% RAP - 2023 (After 3 Years)



Mercer Road (video) - After 3 Years



45% RAP

Control

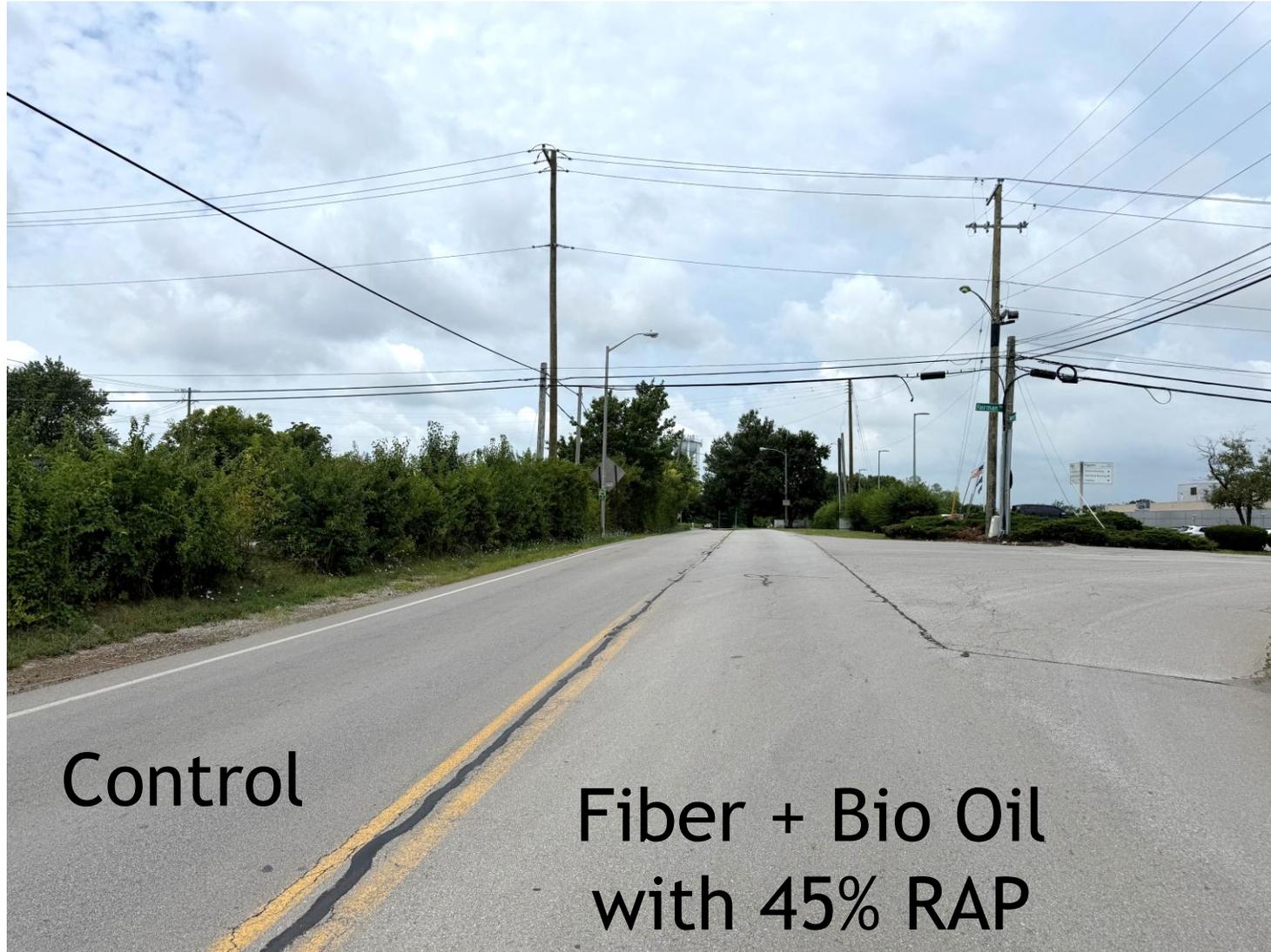


Asociación Mexicana
del Asfalto, A.C.

@AMAACmx



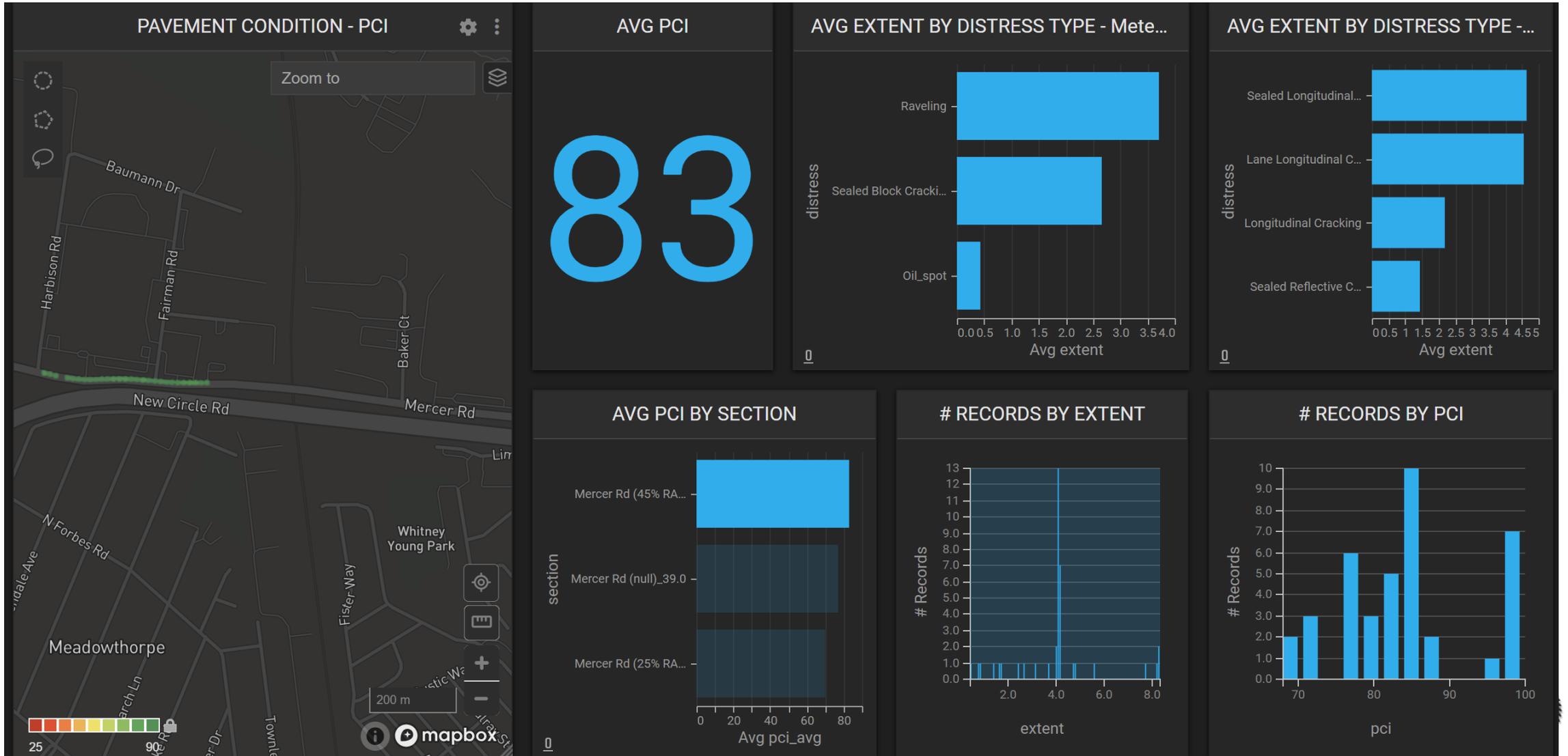
Mercer Road - Lexington Kentucky with 45% RAP -



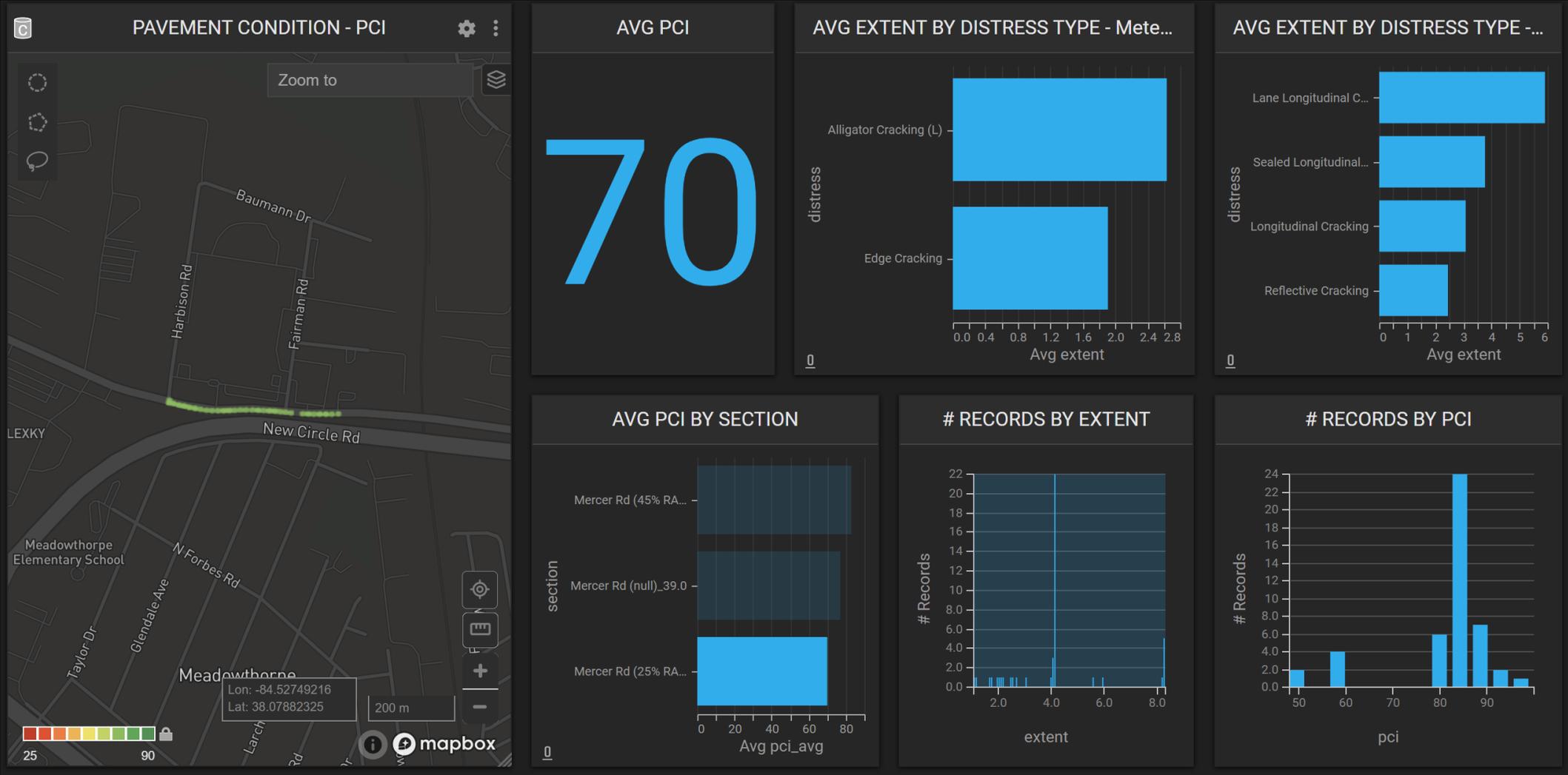
Control

Fiber + Bio Oil
with 45% RAP

Mercer Road - Lexington Kentucky with 45% RAP – 2023 (High RAP After 5 Years)



Mercer Road - Lexington Kentucky with 45% RAP – 2023 (Control After 5 Years)



LESSONS LEARNED

1. Bio oil seems to cause more release of RAP asphalt
 - Initially designed KY projects with 80% useful RAP binder. Had to lower %AC because of too much AC (visual and verified with volumetrics/HWT)
2. When RAP is primary component, time is needed before testing and placement
 - 45% RAP mix needed about 1+ hour to turn from gray to black
 - Additional silo time maybe needed if haul time is short
 - If QC samples are taken immediately, the plant may add too much asphalt or dust to close voids when all is needed is time for binder to release

LESSONS LEARNED

3. When using high RAP mixtures, plants and practices are different
 - These were not the average contractors just trying to make RAP work. These were top contractors who paid close attention to RAP construction practices.
 - When using >50% RAP, a pre-heater may be required
 - Double screening decks are useful to separate fine and course RAP
 - Designs should be done with same provisions as with other aggregates
 - For better control and design, do not just scoop out the RAP as a whole. Separate into 2-3 sizes. All binder is tied up in the fines.
 - Recommendation: Increase virgin aggregate temp 1°F for each %RAP

SUMMARY



Two (2) high RAP, sustainable projects placed in KY and VA using bio oil and aramid fiber

- Design
 - Designs were performed with **basic volumetrics and adjusted with balance mix design** (performance tests). Air voids were allowed to range to meet performance needs.
 - When **RAP is the major component**, adjustments in the design and construction processes



SUMMARY



- Production
 - Hot mix asphalt plants need to plan for high RAP
 - Consider using 2 bins to not run out of RAP (fire hazard)
 - Increased moisture means longer drying time (slower plant)
 - Test samples must be conditioned 2 hours to allow RAP to release and asphalt to absorb
- RAP best practices
 - Sort RAP in more than one size pile. Also consider high and low friction aggregates
 - Keep RAP dry and drained. Cover if possible and store on well-drained area
 - Monitor RAP daily as you would any aggregate (moisture, %AC, and gradation)



SUMMARY



- Performance
 - High-RAP mixtures per design and construction data on Hamburg Wheel Tracker (HWT), Asphalt Pavement Analyzer (APA) and IDEAL-CT **should perform as good if not better in rutting and cracking** as compared to the standard treatment (control).
 - Site visits to projects found **no distresses in first year but normal distresses in year 5**
 - Highway 901 (VA) - **nearly perfect** (best design)
 - Mercer Road (KY) - **some distresses** but expected (drier mix)
- Long-term
 - **Projects will continue to be monitored**

Acknowledgments



Fiber Supplier: Surface Tech (aramid fiber – ACE XP)

Contractors: ATS, Hall Construction, and Colony Paving-



¡ muchas gracias!

Ponente: *Phillip Blankenship, PE, MSCE*

Contacto: Blankenship Asphalt Tech and Training

Phil@BlankenshipAsphaltTech.com

www.BlankenshipAsphaltTech.com

www.linkedin.com/company/batt-lab/

www.x.com/BATT_Lab

