The World of RAP:

Specifying and Producing Higher RAP Mixes for Lower Life Cycle Cost

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1/22/2025

Content

- Experience with high RAP content mixes
- Additional controls required for producers
- Role of BMD in design and construction.

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Background

- Equal (or improved) life cycle performance
- Consideration of existing pavement structure
- Impact of multigenerational RAP (80s→90s→100s)
- Quantity and quality of effective binder content
- Corrected optimum asphalt content (COAC)
- Recycling agents with long-term benefits.

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NCAT Pavement Test Track

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High RAP Track Experience

- 2000 Almost exclusively hot virgin mixes
- 2003 Some low RAP mix mill/inlays, first WMA
- 2006 First high (45%) RAP mix mill/inlays (perpetual)
- 2009 Full depth high (50%) RAP structural sections
- 2012 Green Group (GG) recycling experiment, PG
- 2015 Cracking Group (CG) performance testing
- 2018 Simple BMD specification for AL counties.

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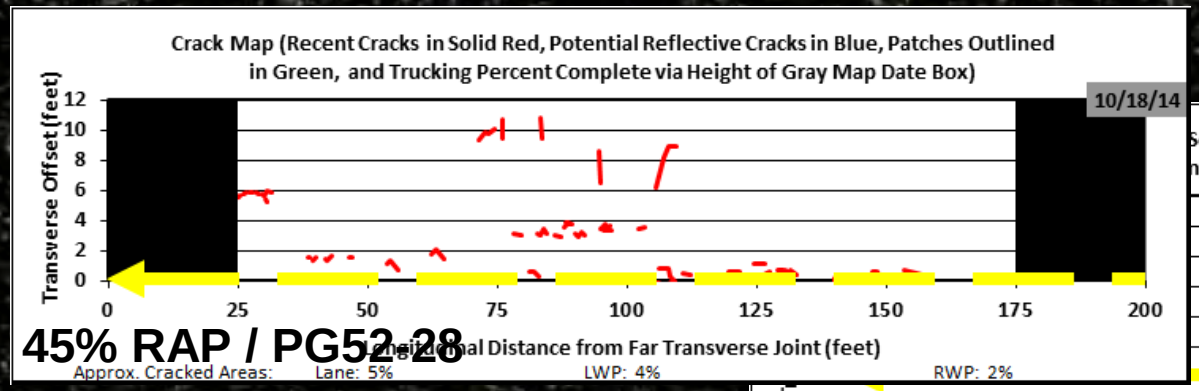
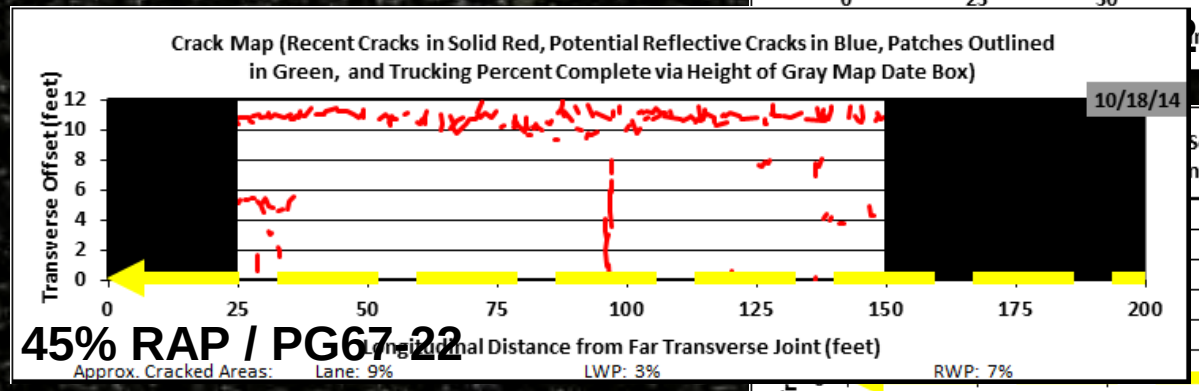
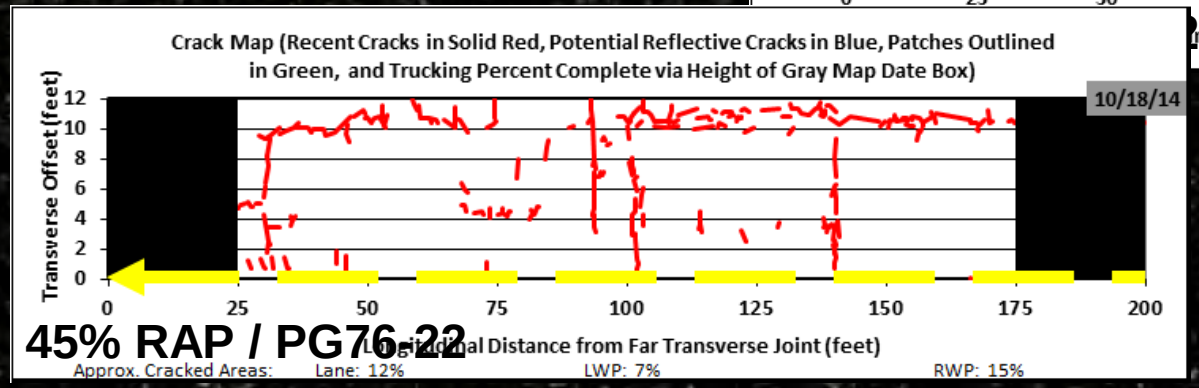
2006 NCAT Pavement Test Track



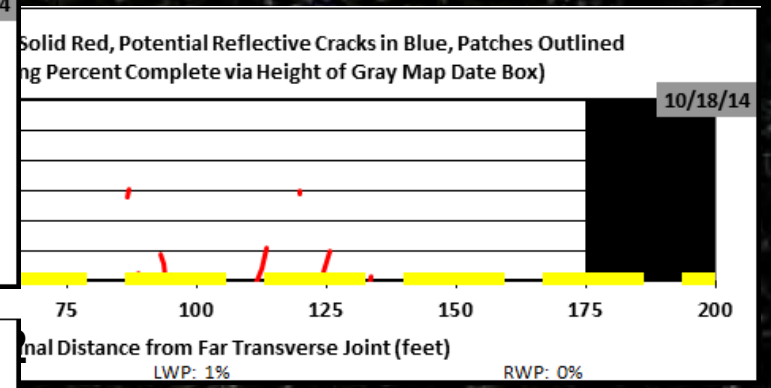
45% RAP / PG52-28

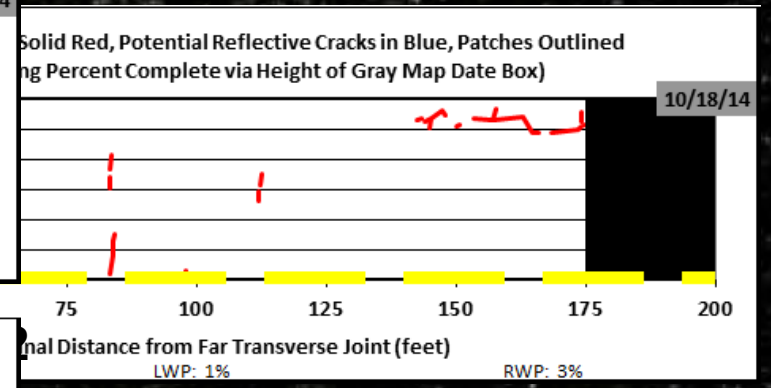


45% RAP / PG67-22



45% RAP / PG76-22





40M ESALs !

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Fractionation

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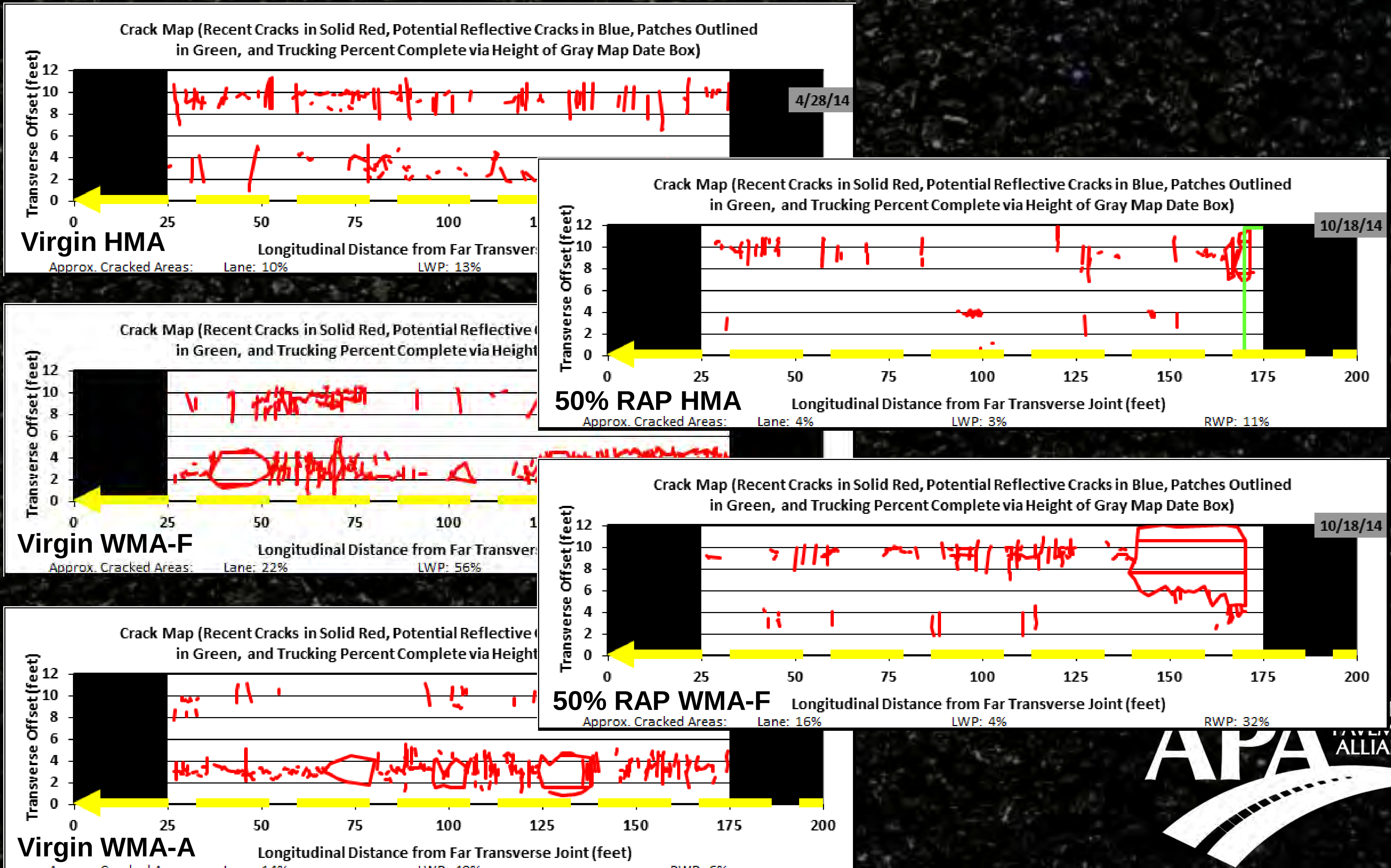
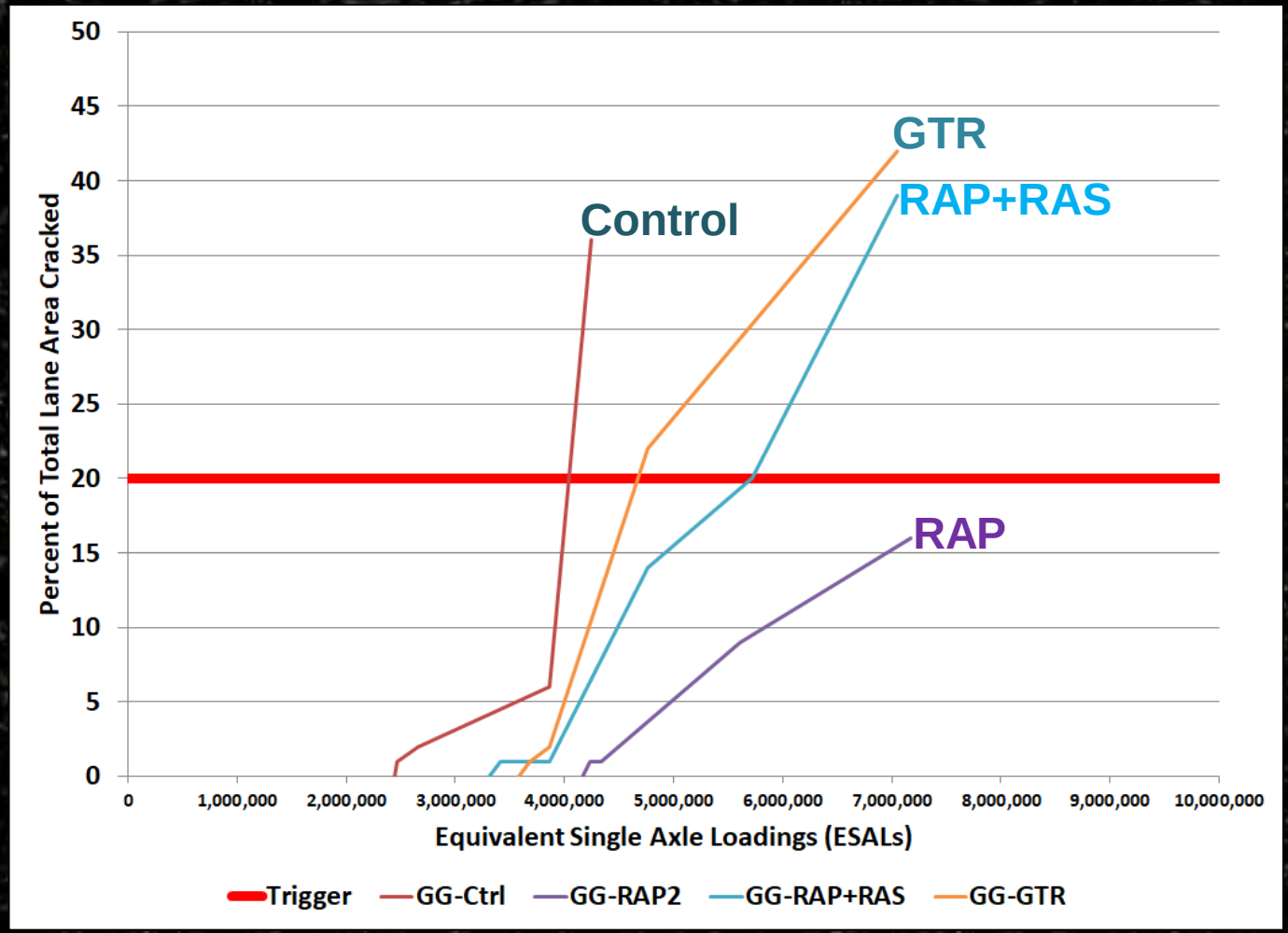
2009 NCAT Pavement Test Track



2012 NCAT Pavement Test Track



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Low Feed Rates

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NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

XBE

Welcome to Hey NAPA

What asphalt pavement questions can I answer for you?

I've been trained on hundreds of NAPA publications and have broad general knowledge of asphalt pavement topics. Ask me anything that you'd like and I'll do my best to provide a concise answer and point you to additional resources.

What does it take to run high RAP mixes?

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HeyNAPA.com

- RAP quality control (source, quality, processing)
- Advanced plant technology (bins, drum, flights, VFD)
- Binder management (softer grade, rejuvenation)
- Mix design (legacy volumetrics → BMD performance)
- Plant production controls (blend w/o degradation)
- Quality assurance protocols (sampling, testing, doc)
- Training and education (plant crew, best practices).

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Specifications

Ensure performance for taxpayers (agencies)

Streamline the testing process (workforce)

Incentivize innovation (contractors).

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Track ThickLay HiMod 2018

- Track base, subgrade
- ≈8” in a single pass
- 25% RAP, HiMA, WMA
- 2½% Va, ½” NMAS mix
- Verified density profile
- ¾“ SMA, ½“ DGA, 4.75
- From 350 to 150 in/mile

ThickLay HiMod in perpetual pavements.

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Utah Implementation

- Port of Entry on I-80 near Bonneville Salt Flats
- 7,900 AADT, 51% trucks, 2½M ESALs/year
- Staker Parson's crew with good SMA experience
- LTPPBind = PG64-28 (98% reliability), extreme heat
- 6" mill/inlay, 330 tons, DGA, 15% RAP, 6% binder
- 50 gyrations, 1% voids, single lift, 1½ hour haul.

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Utah Implementation

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Utah Implementation

- Over 500k tons planned after Bonneville success
- I-215 rebuild originally remove/replace PCC
- Consideration of asphalt on rubblization
- HiMod overlay with 5½“ low (1%) air void mix
- 1½-inch leveling course under 4-inch overlay
- $40 Million Dollar Savings over PCC option!
- Using the savings to extend project 17 miles.

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BMD in Design & Construction

- Legacy volumetrics developed for virgin, neat
- Modern mixes w/ RAP, (high) polymer, additives, etc.
- Confounding effect of true versus assumed Gsb
- Legacy volumetric tools for mix optimization, but…
- Need for spec compliance rapid BMD index testing
- Truck bed to gyratory, ~3½ hours to complete
- Quantity and quality of effective binder content!

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Possible State Specification

- Test strip for plant, critical aging relationship
- Eliminate N_{des} for QC, use "N_{ini}" to flag low air voids
- From truck bed to gyratory with no reheating
- Between ~10 and ~40 gyrations for 7% air voids
- Make test, comparison, dispute pills at same time
- IDEAL-CT/RT for cracking, rutting with startup+ TSR
- Plant proportions in between BMD tests.

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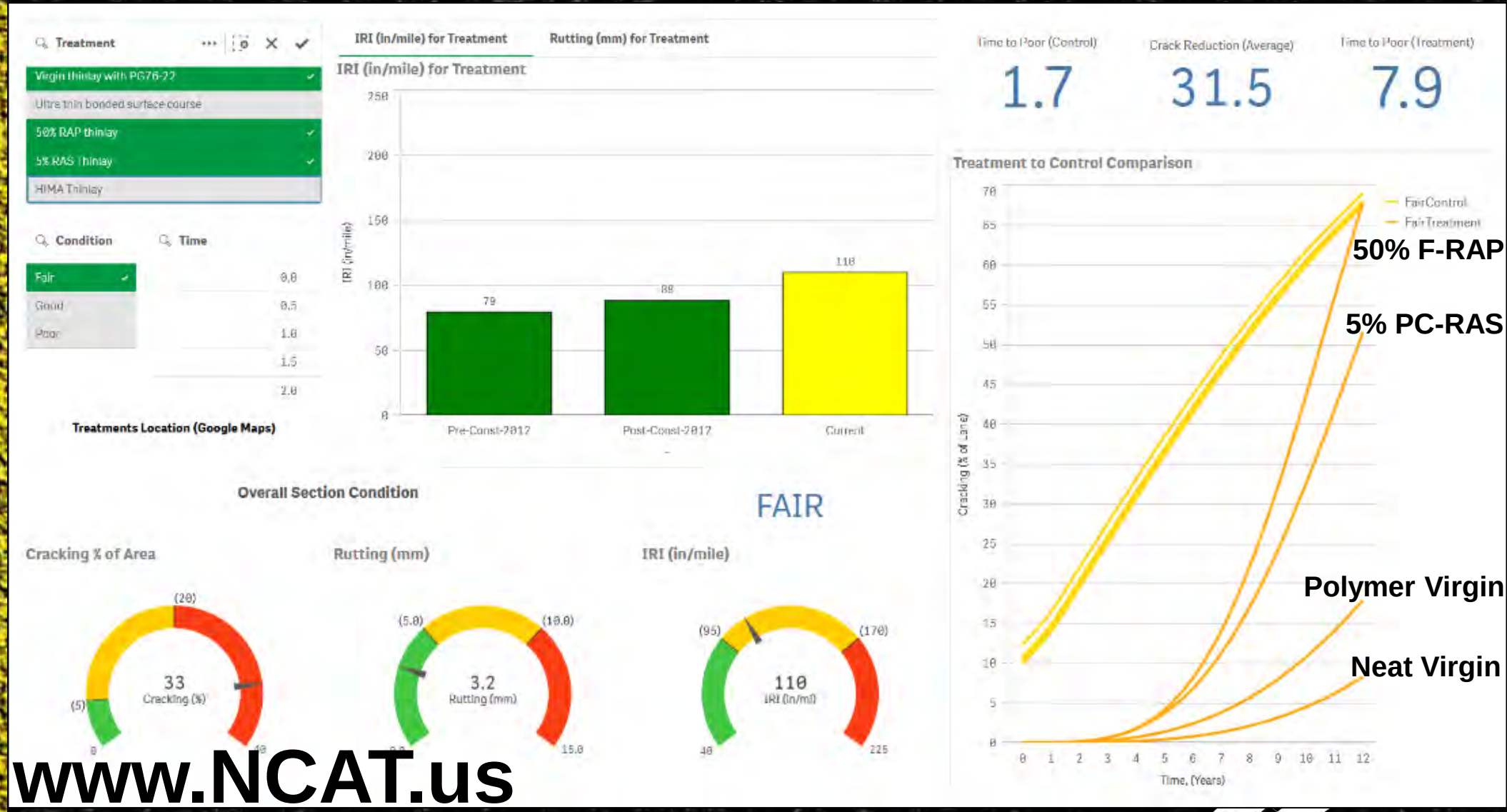
Need for BMD Design & Construction



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Simple BMD for AL Counties

- County request to eliminate RAP to improve mix
- “Simple BMD” suggestion, increase in allowed RAP
- Increase from 20 percent RAP to 35 percent RAP
- BMD criteria from 2015 NCAT Pavement Test Track
- Compliance from plant produced mix (no design)$_{AM/PM}$
- IDEAL-CT ≥ 50, Hot-IDT ≥ 17 psi, air voids ≥ 1 percent
- Reduced cost, improved performance, expansion
- Marshall-like, select RAP, ½-¾ percent ↑AC.

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Takeaways

- Experience with high RAP content mixes - Positive
- Additional controls required for producers - Yes
- Role of BMD in design and construction - BMD_{C-D}

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