National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

NCAT Test Track Update

Asphalt Pavement Association of Michigan
2022 Annual Paving Conference

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National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

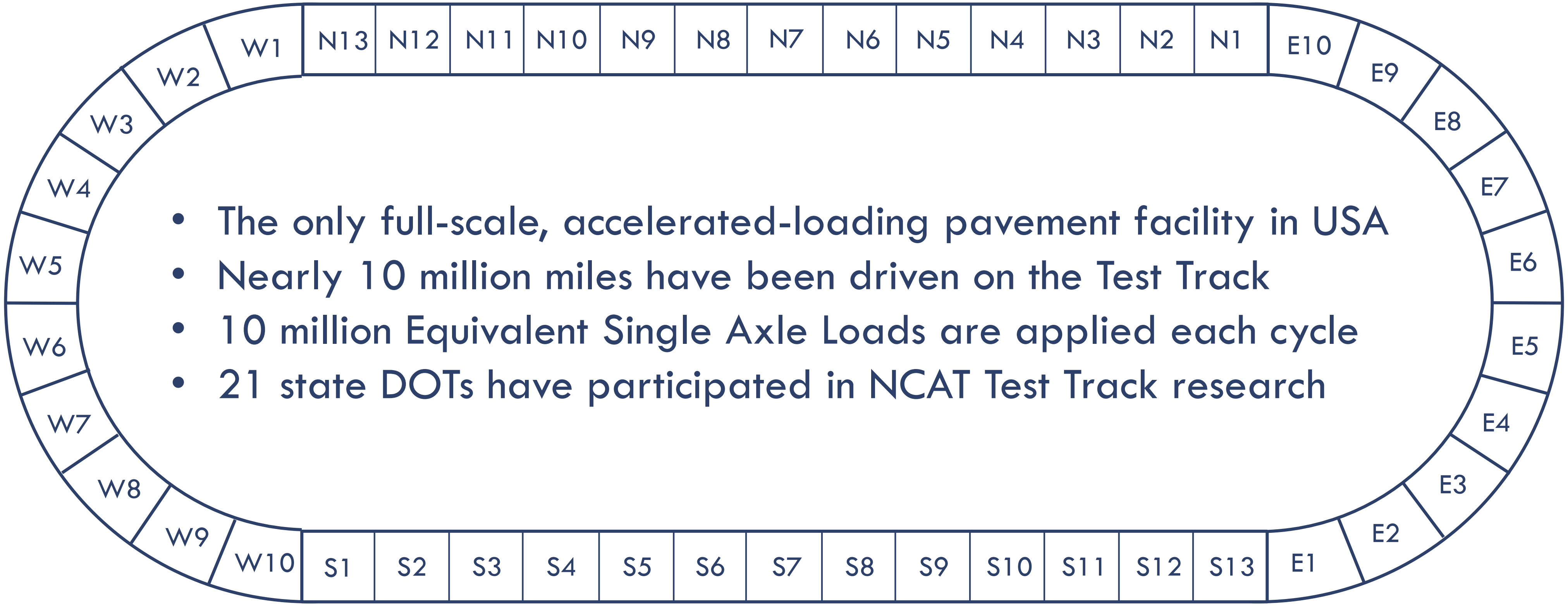
The NCAT Test Track

America's Asphalt Pavement Proving Ground

Turnkey Research

- Test sections are evaluated continuously over 3 year cycles
- 2021 began our 8th cycle
- 46 Test Sections, 200 ft. each
- 5 trucks each pulling 3 heavily loaded trailers make 400 laps/day

NCAT Test Track Facts



- The only full-scale, accelerated-loading pavement facility in USA
- Nearly 10 million miles have been driven on the Test Track
- 10 million Equivalent Single Axle Loads are applied each cycle
- 21 state DOTs have participated in NCAT Test Track research

Types of Test Track Experiments

1. Structural Experiments
   - Full-depth reconstruction of cross-section
   - Instrumented with stress & strain sensors and temperature probes.
   - FWD testing throughout experiment

2. Surface-layer Experiments
   - Only upper layer(s) replaced
   - No instrumentation

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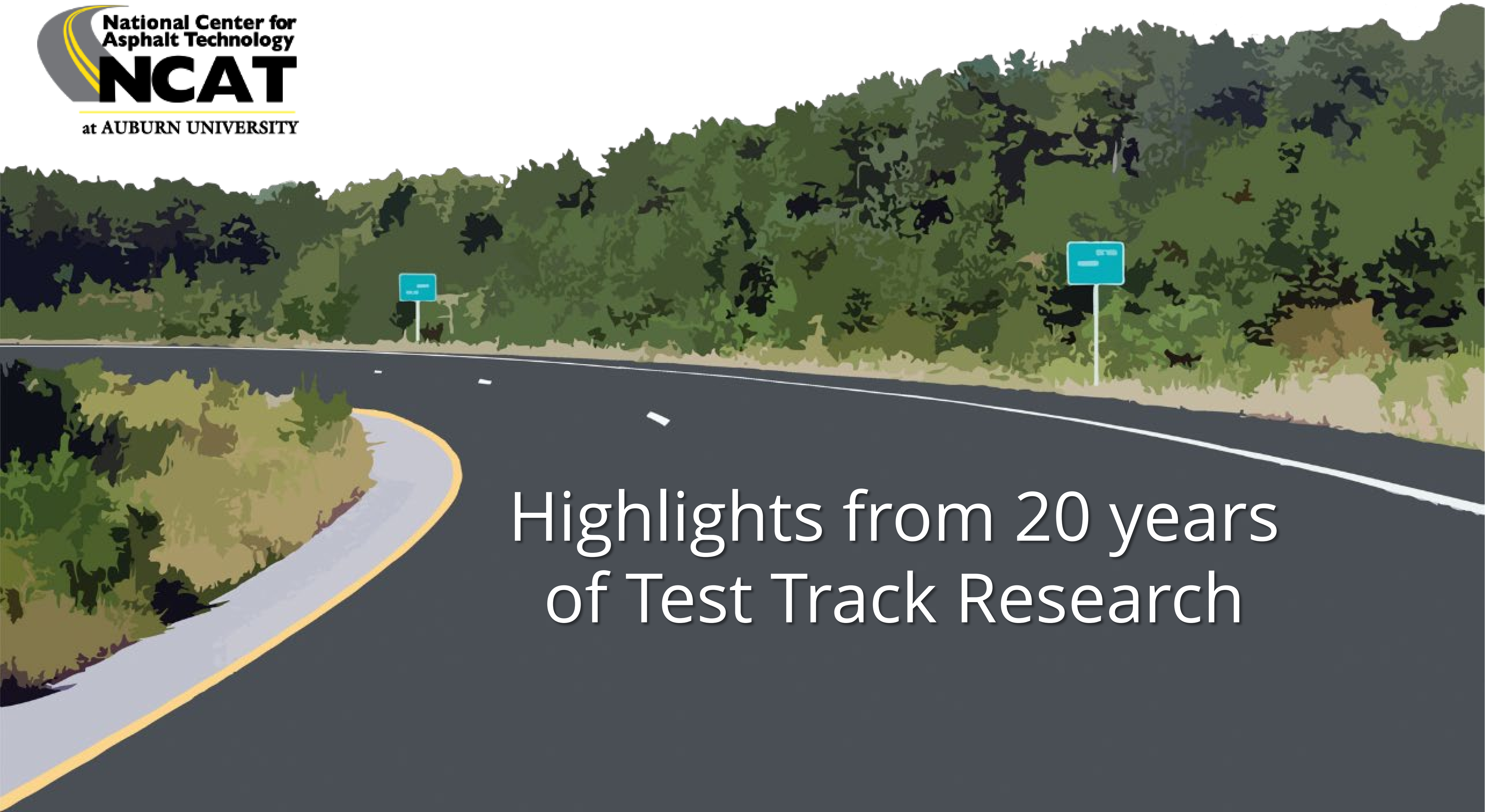
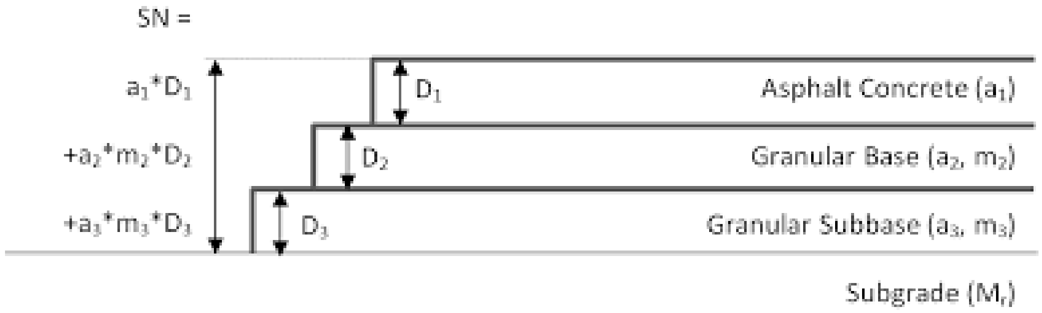
Highlights from 20 years of Test Track Research



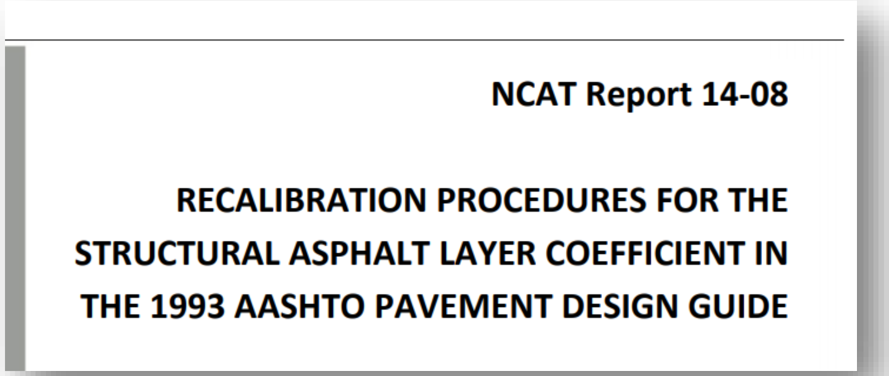
Structural Experiments

Revised Asphalt Layer Coefficient, a_1

- 1993 AASHTO Pavement Design Guide
- a_1 increased from 0.44 to 0.54
- Analysis based on…
  - ✓ Lab Modulus
  - ✓ Field deflections and backcalculation
  - ✓ Field Performance

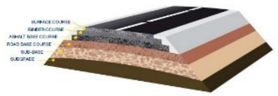


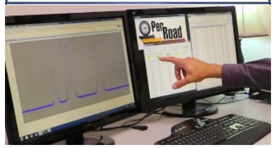
Implemented in Alabama in 2010
Annual Savings between $25 and $50 million


NCAT Report 14-08

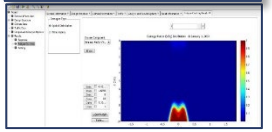
RECALIBRATION PROCEDURES FOR THE STRUCTURAL ASPHALT LAYER COEFFICIENT IN THE 1993 AASHTO PAVEMENT DESIGN GUIDE

Mechanistic-Empirical Design Procedures

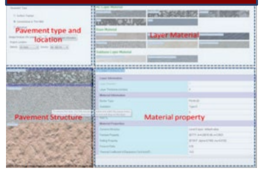




FlexPAVE™



TxME

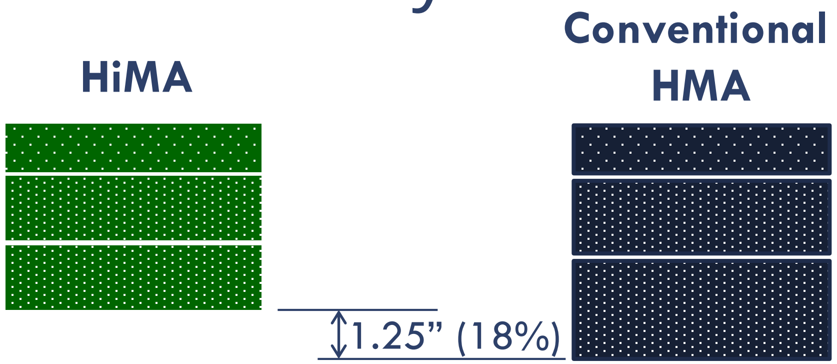


- All of these programs have used NCAT test sections for model calibration.
- MEPDG over-predicted rutting by 50-100% using default national calibration coefficients.
- MEPDG fatigue prediction was poor even after adjusting coefficients.
- Several non-traditional asphalt mixtures and other materials have been validated.

NCAT Test Track

Highly Modified HMA Structural Assessment

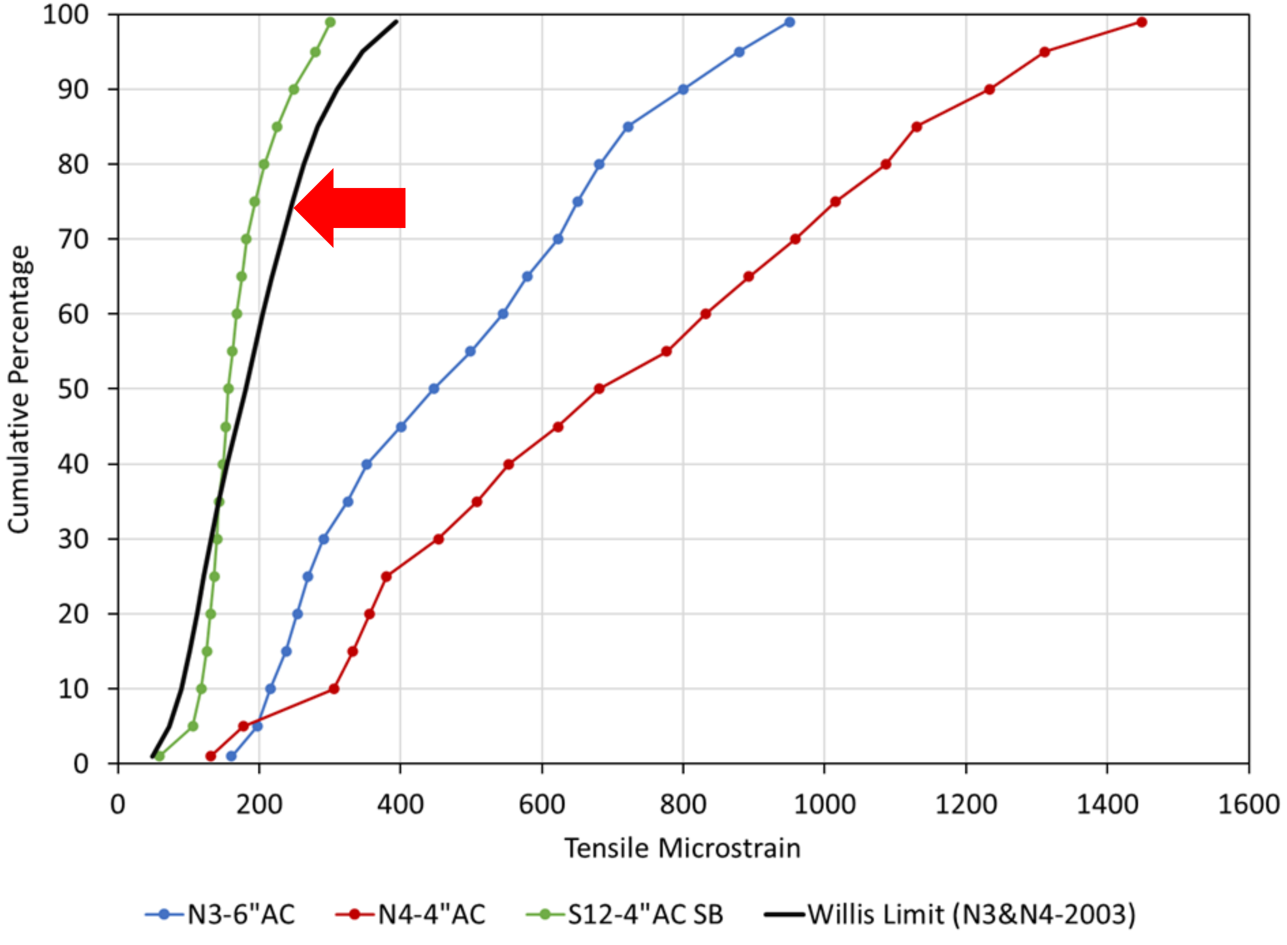
- 5.75 inches vs 7 inches
- Same mix designs in surface, intermediate, and base layers

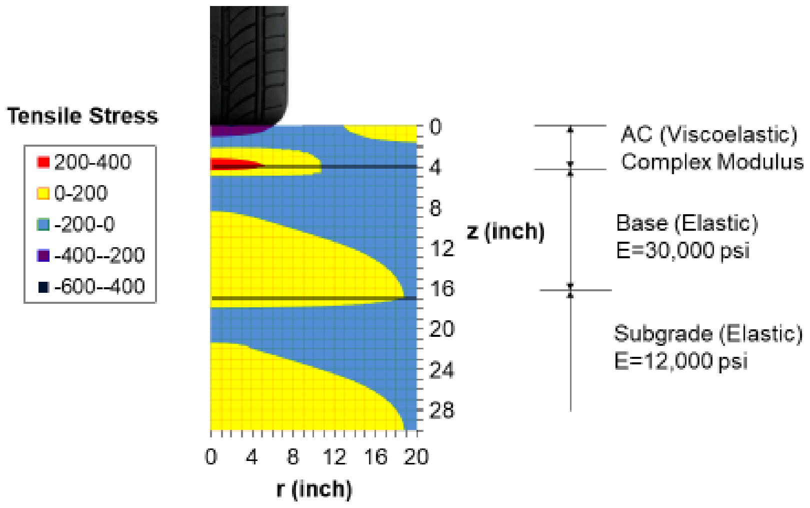


- Control section: 10% of lane area fatigue cracking
- HiMA section: 6% of lane area top-down cracking

Cold Central Plant Recycling

Perpetual Pavement Strain Distributions

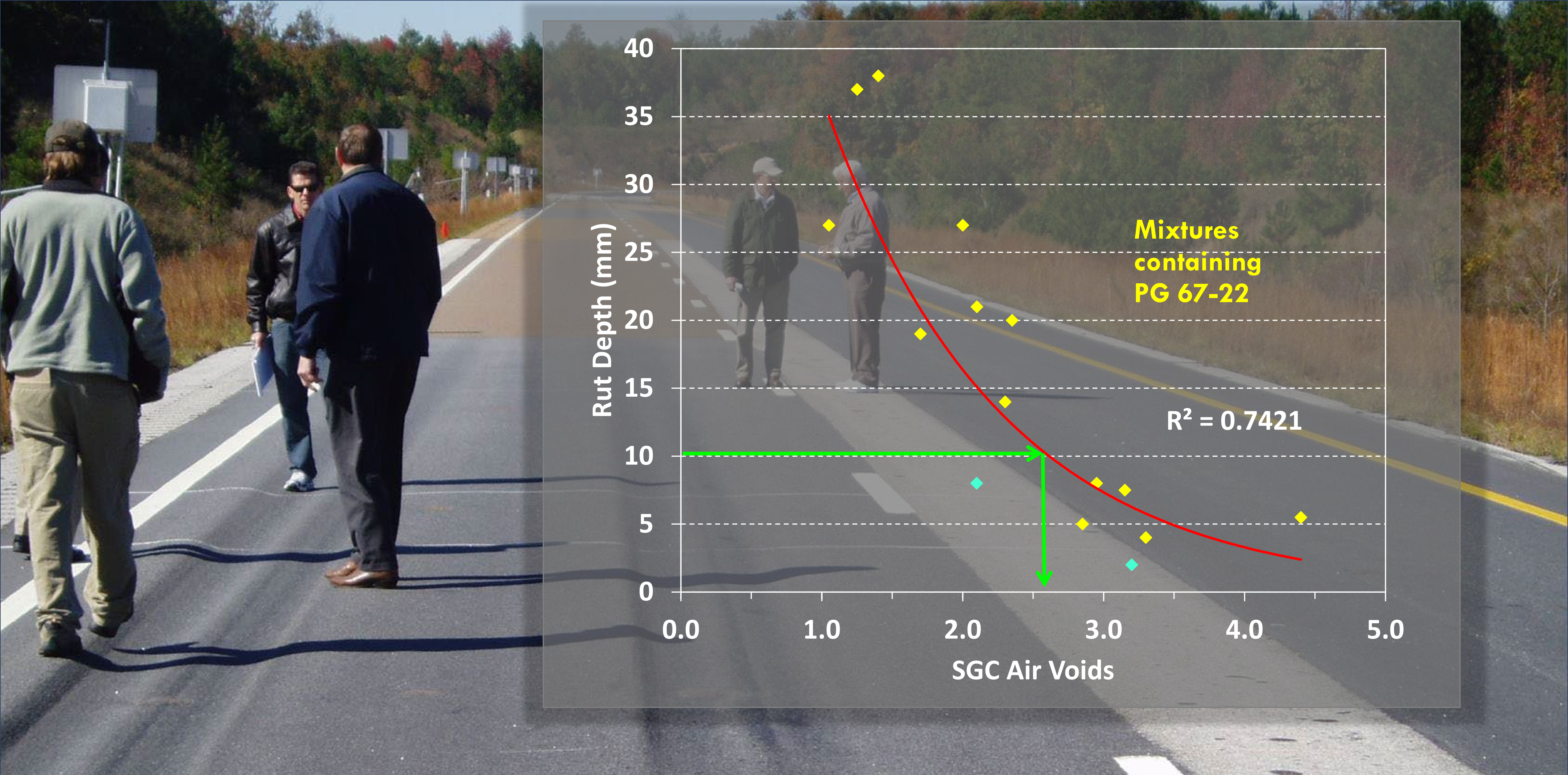




Surface Mix Experiments

Refinements to Mix Design Specifications

- Fine and coarse Superpave mixes perform similarly regardless of aggregate type
- PG 76 vs PG 67 - reduces rutting approximately 50%
- Dense-graded as rut resistant as SMA, but SMA is more durable
- Lowering N_{design} is OK
- 50% RAP mixes perform equal to virgin mixtures in all layers



Indiana Low Air Voids Experiment

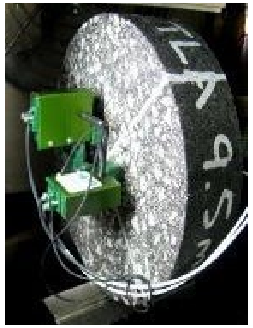
Aggregate Specifications

- Elimination of the Restricted Zone
- Evaluation of marginal aggregate
- Gravel suitability in SMA & OGFC
- Higher F&E content for SMA & OGFC
- Maximum limestone content for friction

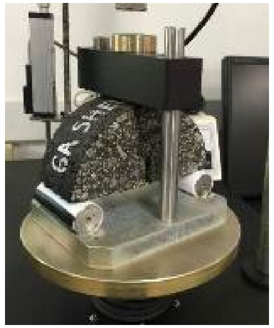
NCAT Test Track

Cracking Group Experiment

Which Tests Correlate to Field the Best?


Energy Ratio


SCB-LA


I-FIT


OT-TX


OT-NCAT


IDEAL-CT

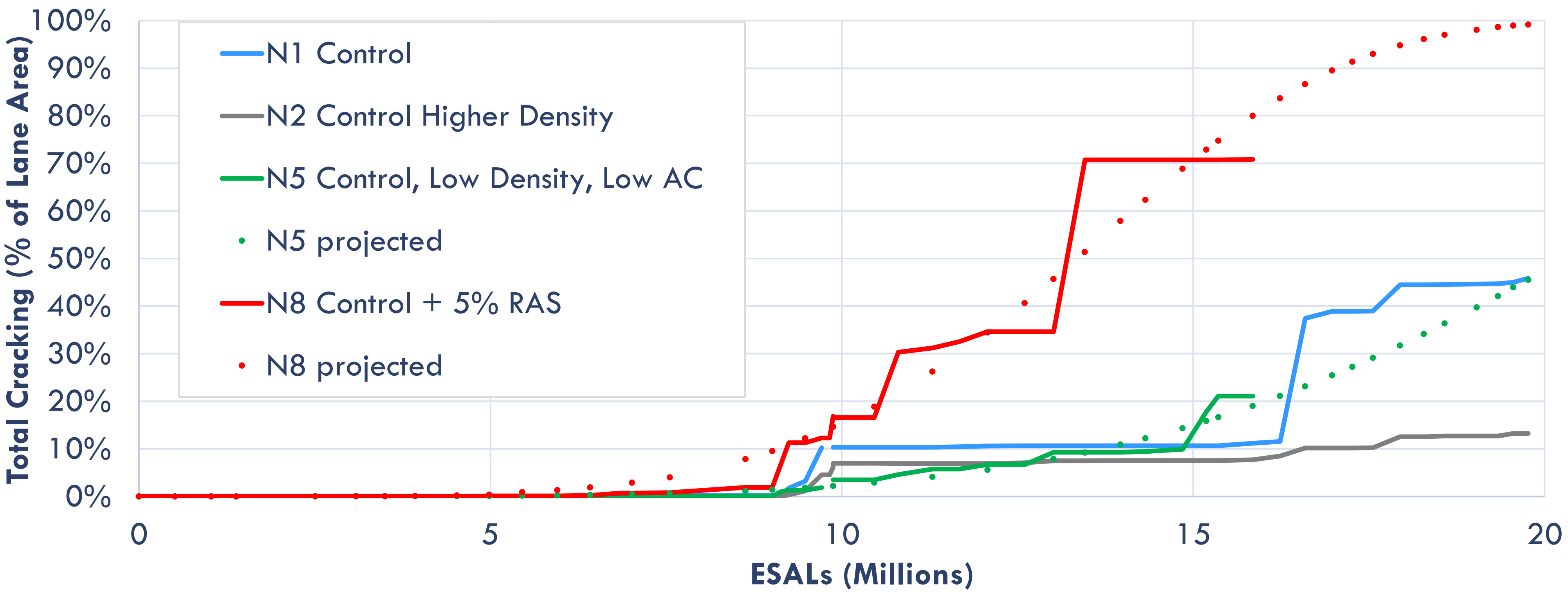

AMPT Cyclic Fatigue

Test Section Layer Thicknesses

Surface Layer	**1.5”**
HiMA mix Intermediate Layer	2.25”
HiMA mix Base Layer	2.25”
Granular base	6”
Stiff track subgrade	infinite

NCAT Cracking Group Experiment – Test Sections

Section	Description	NMAS	As-Const. Density (%G_{mm})	Eff. Binder Content (%)	Recovered Binder Cont. Grade
N1	20% RAP (Control)	9.5 mm	93.6	4.7	88.6 -16.6
N2	Control w/ High Density	9.5 mm	96.1	4.7	89.9 -15.9
N5	Control, Low AC, Low Density	9.5 mm	90.3	4.4	88.0 -18.5
N8	Control, + 5% RAS	9.5 mm	91.5	4.8	107.3 -5.4
S5	35% RAP, PG 64-28	9.5 mm	92.2	5.1	82.8 -23.0
S6	Control w HiMA	9.5 mm	91.8	5.0	101.4 -21.5
S13	Gap-Graded, Asphalt- Rubber Mix	12.5 mm	92.7	6.6	N/A



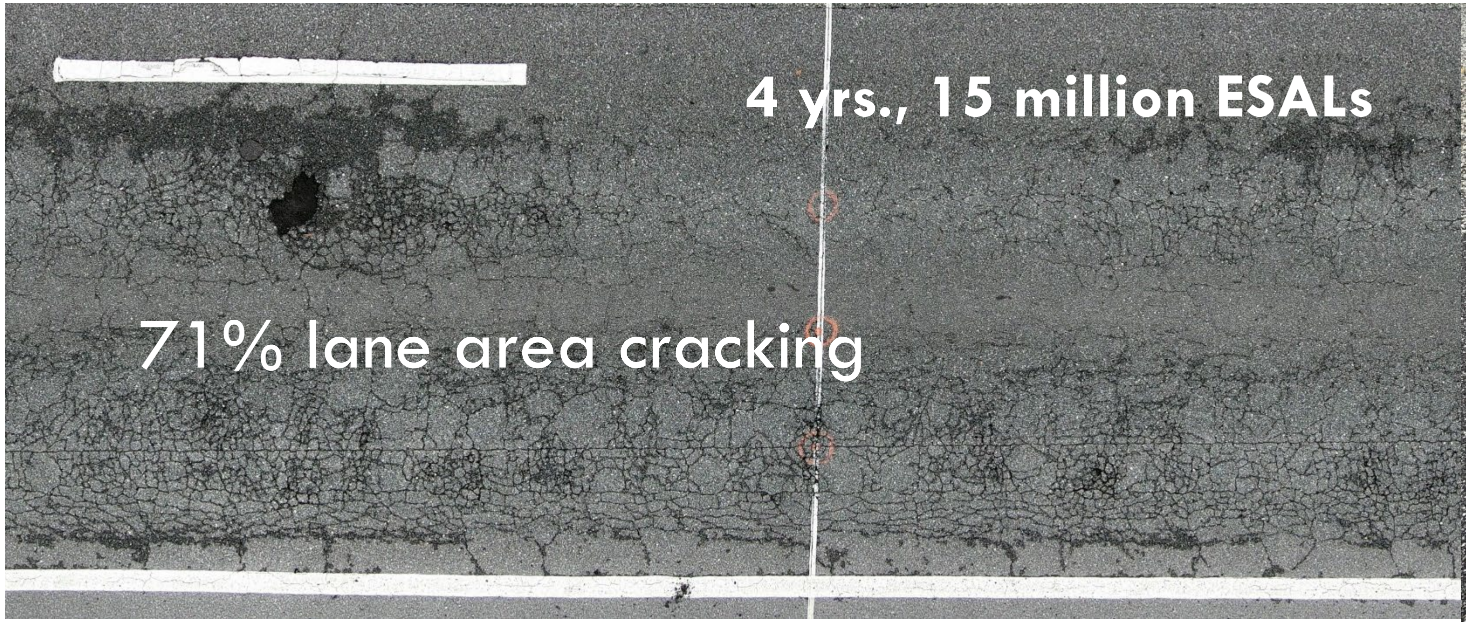
Total Cracking (% of Lane Area)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
N1 Control
N2 Control Higher Density
N5 Control, Low Density, Low AC
N5 projected
N8 Control + 5% RAS
N8 projected
0
5
10
15
20
ESALs (Millions)

NCAT Cracking Group Experiment – Performance

Section	Description	As-Const. Density (%G_{mm})	% Lane Area Cracked	
			Feb. 2020 16 MESALs	Feb. 2021 20 MESALs
N1	20% RAP (Control)	93.6	11.2	44.5
N2	Control w/ High Density	96.1	7.7	12.5
N5	Low AC, Low Density	90.3	21.1 [a]	47.4 [b]
N8	20% RAP 5% RAS	91.5	70.8 [a]	99.3 [b]
S5	35% RAP PG 67-28	92.2	0.2	1.1
S6	Control w HiMA	91.8	0	0.9
S13	Gap-Graded, Asphalt-Rubber Mix	92.7	0	0

[a] Failed due to top down cracking. Removed from experiment in March 2020
[b] Projected from data through 16 MESALs using a sigmoidal function

N8 (Control +5% RAS), Dec. 2019



N5 (Control, Low AC, Low Density), Dec. 2019

N1 Control (20% RAP, PG 67-22), Jan. 2021

S5 (35% RAP w/ PG 64-28), Jan. 2021

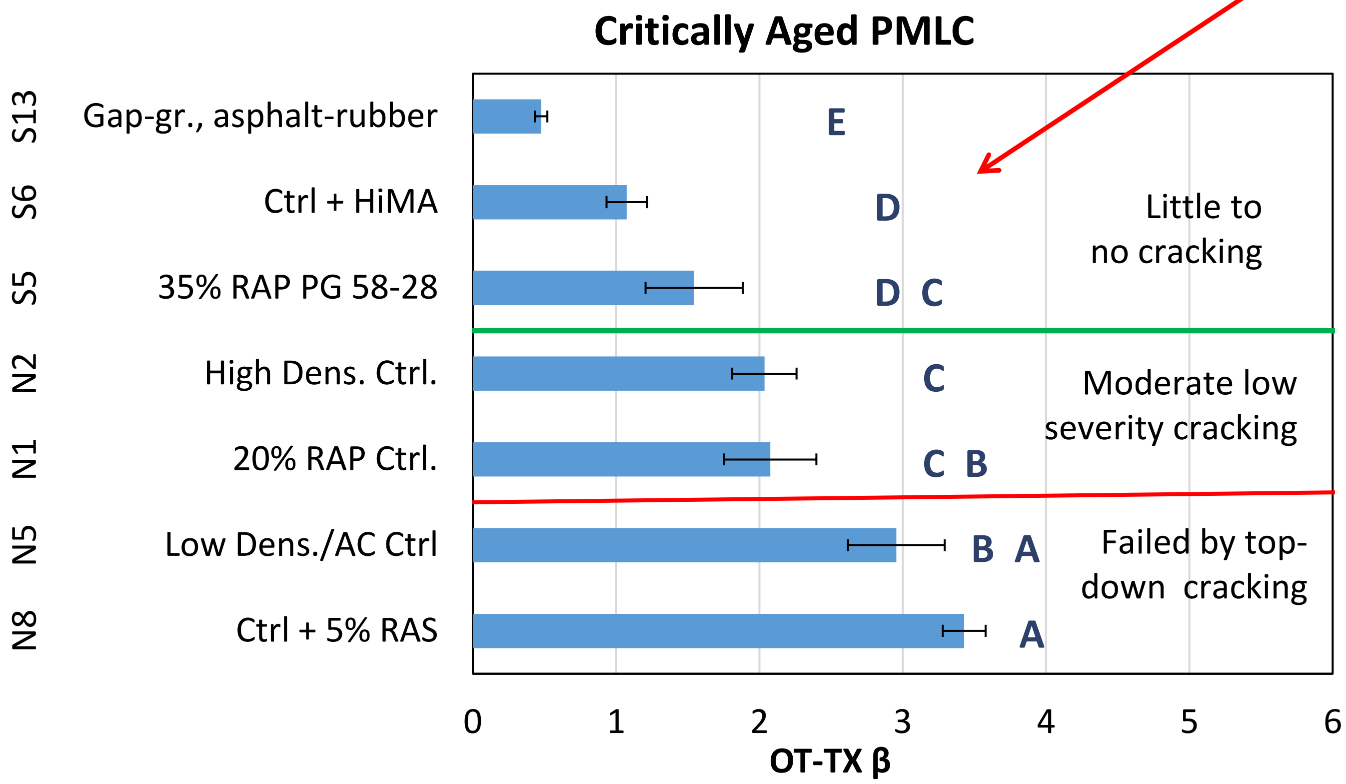
Cracking Group Field Performance Findings

1. Higher in-place density (96.1% vs. 93.6%) reduced cracking by 70%.
2. Lower asphalt content and lower in-place density substantially reduced the life of the surface layer.
3. Using a softer virgin binder with a high RAP mix can provide outstanding mix durability.
4. Using HiMA instead of the PG 67-22 binder in the control mix dramatically improved its cracking resistance (45% lane area cracking vs. 1% after 5.5 years and 20 million ESALs).
5. Gap-Graded, asphalt-rubber mixes (with higher asphalt contents) can provide superior performance for surface layers.

Texas Overlay Test (Tex-248-F)

Results with the same letter are not statistically different

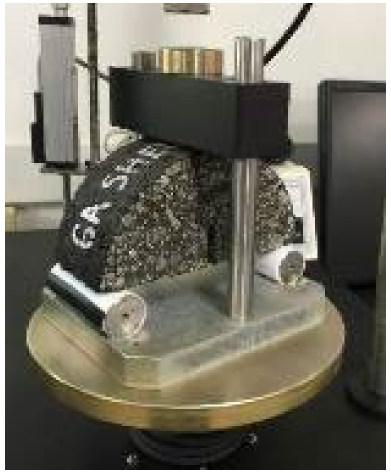
OT-TX



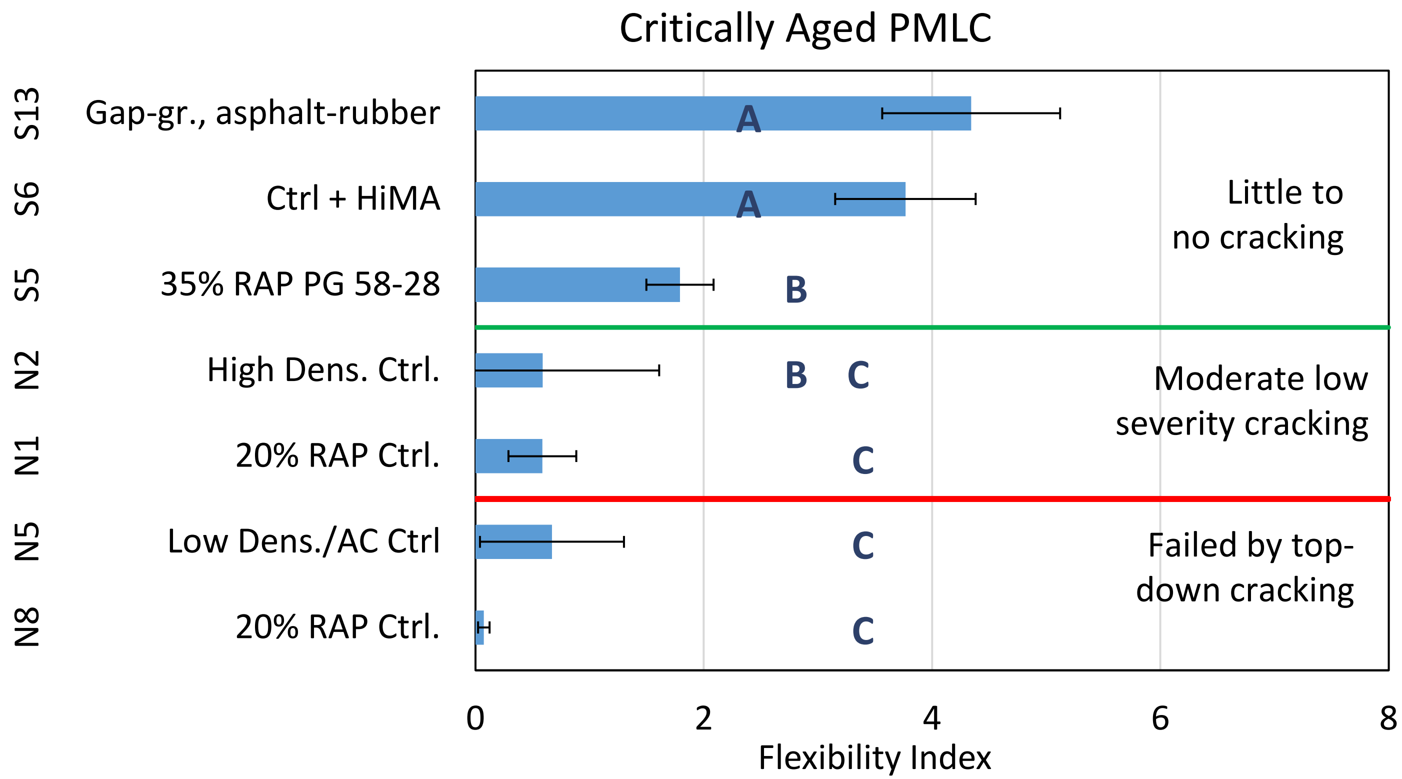
Sorted from best to worst field cracking performance

lower β = better cracking resistance

Illinois Flexibility Index Test (AASHTO TP 124)



I-FIT

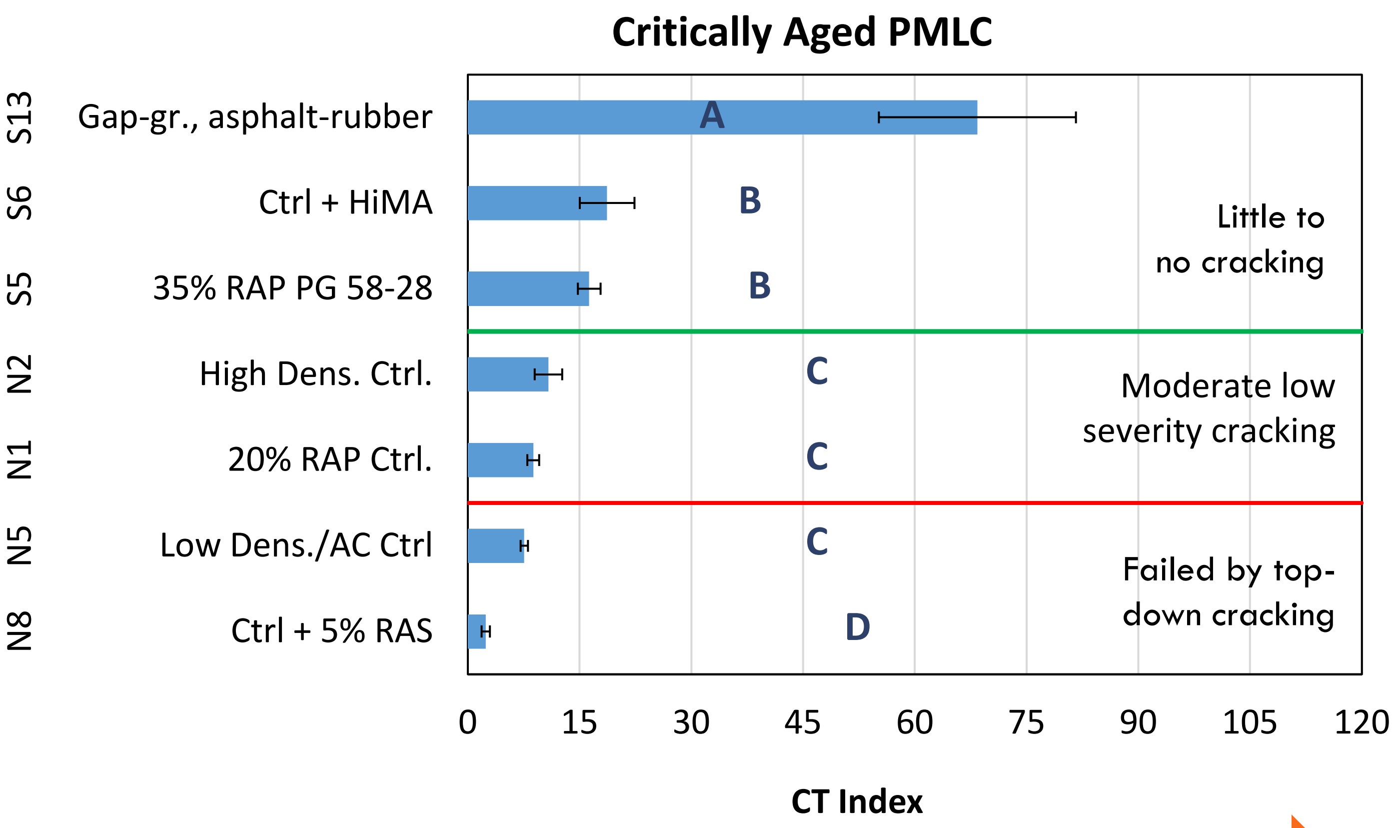


Sorted from best to worst field cracking performance

higher FI = better cracking resistance

IDEAL-CT Test (ASTM D8225-19)

IDEAL-CT



higher CT_{Index} = better cracking resistance

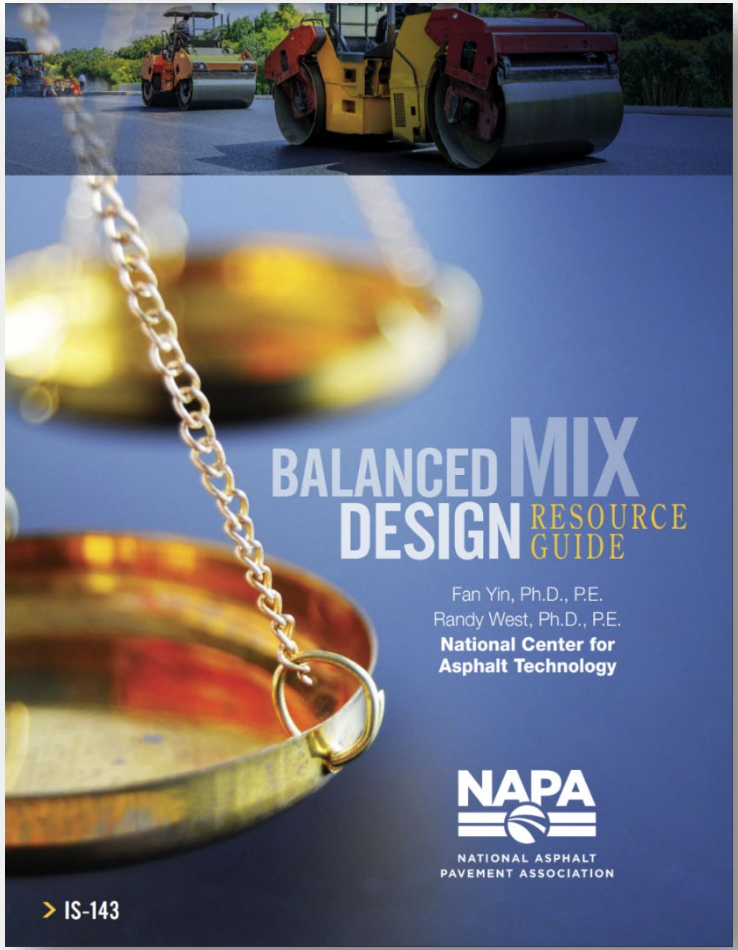
Sorted from best to worst field cracking performance

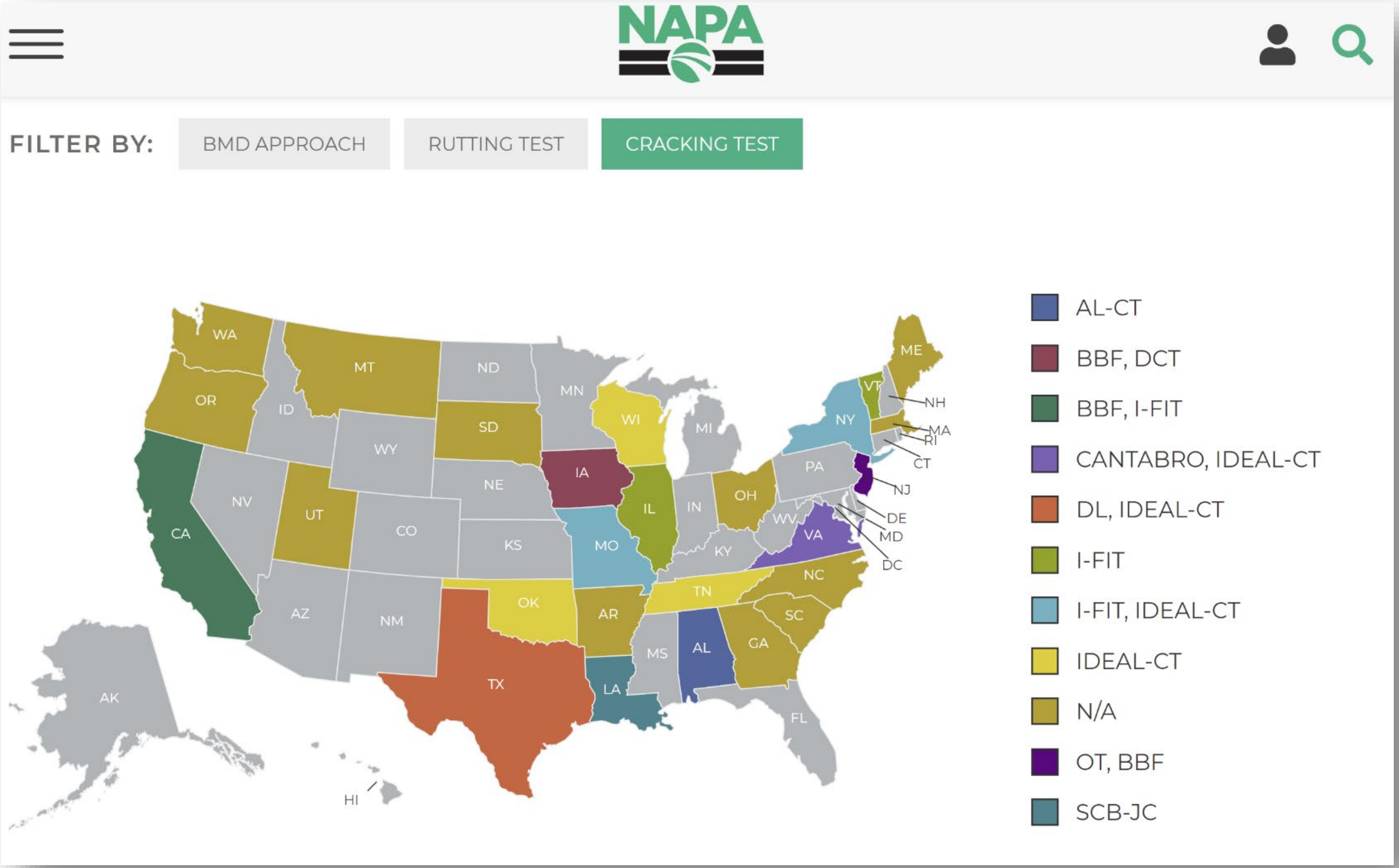
Summary of Correlations

Test and Parameter	Average COV	Games Howell Groups	Range of R^2
Energy Ratio, ER	Not available	Not applicable	0.03 to 0.28
Texas Overlay Test, β	17%	5	0.76 to 0.91
NCAT Overlay Test, β	10%	4	0.79 to 0.97
Louisiana SCB, J_c	20%	Not applicable	0.13 to 0.78
Illinois Flexibility Index Test, *FI*	34%	3	0.76 to 0.89
IDEAL Cracking Test, CT_{Index}	18%	4	0.87 to 0.94
AMPT Cyclic Fatigue, S_{app}	16%	5	0.89 to 0.90

Balanced Mix Design

- Comparison of BMD vs. Superpave
- Preliminary validation of BMD criteria
- Evaluation of innovative additives for improving mix performance and increasing sustainability
- Combining BMD and friction assessment for surface layers





BMD Resources

Scan this code or visit aub.ie/bmd for useful resources related to balanced mix design


Overview of the
NCAT & MnROAD
Additive Group Experiment

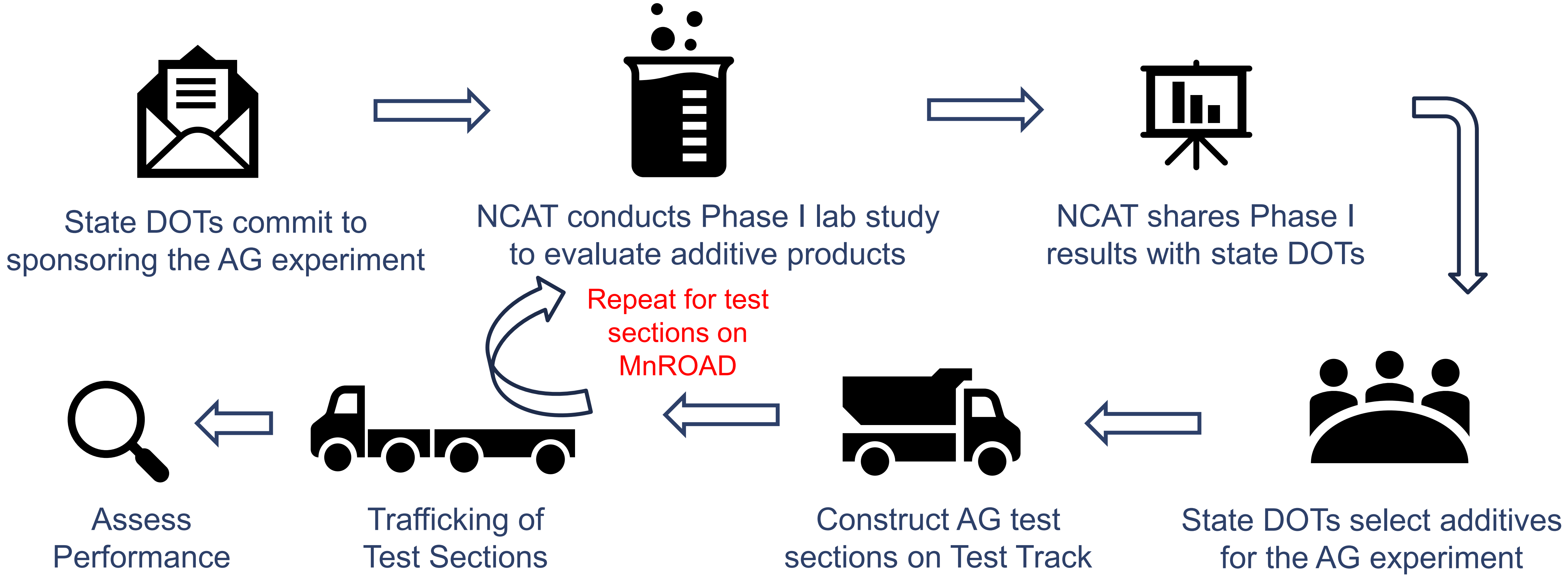
Additive Group Experiment

- A new experiment to comprehensively evaluate sustainable pavement technologies
- Continuation of the partnership between NCAT and MnROAD to address national needs

NCAT Test Track

MnROAD

Overall Additive Group Plan



Phase 1 Additive Technologies

Recycled Tire Rubber

Recycled Plastics

Fibers

Phase 2 Additive Technologies

Recycled Tire Rubber

entech

wet process

Liberty TIRE RECYCLING

dry process

Recycled Plastics

DOW®

wet process

Brand X LDPE rich

dry process

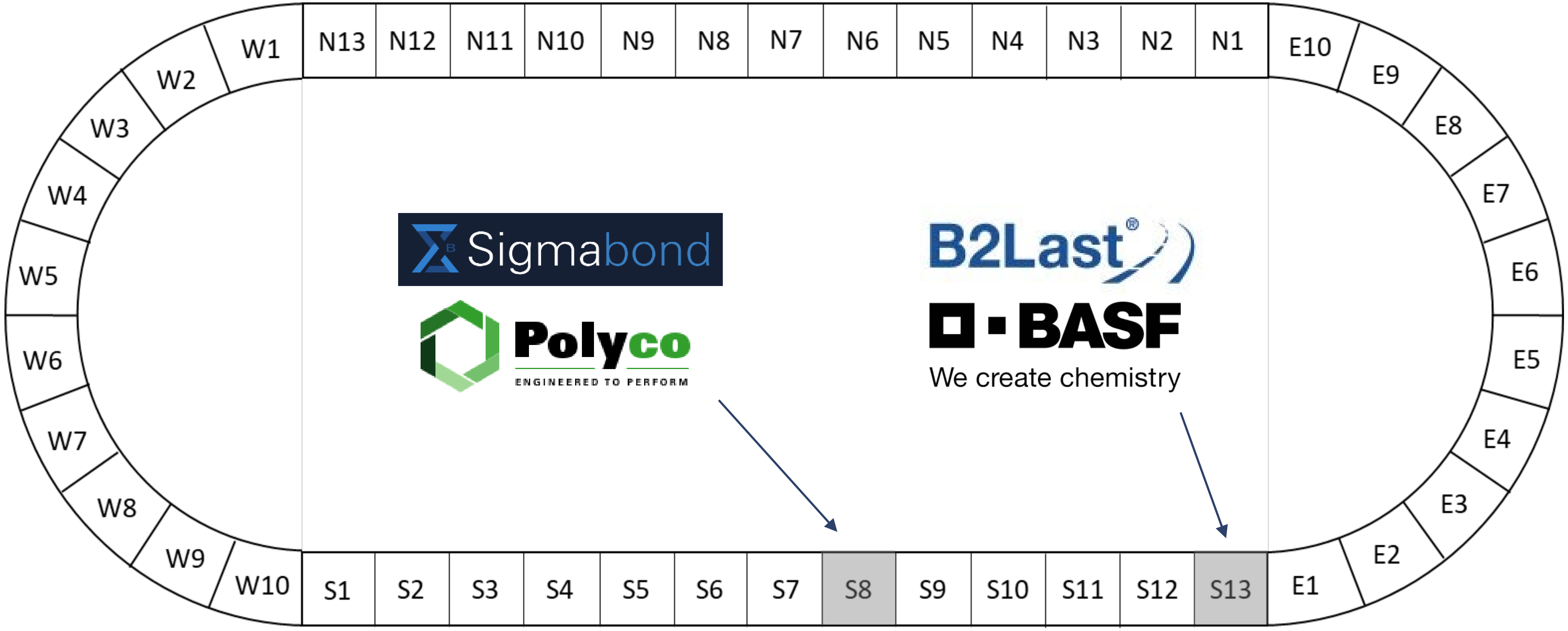
Fibers

SURFACE TECH™

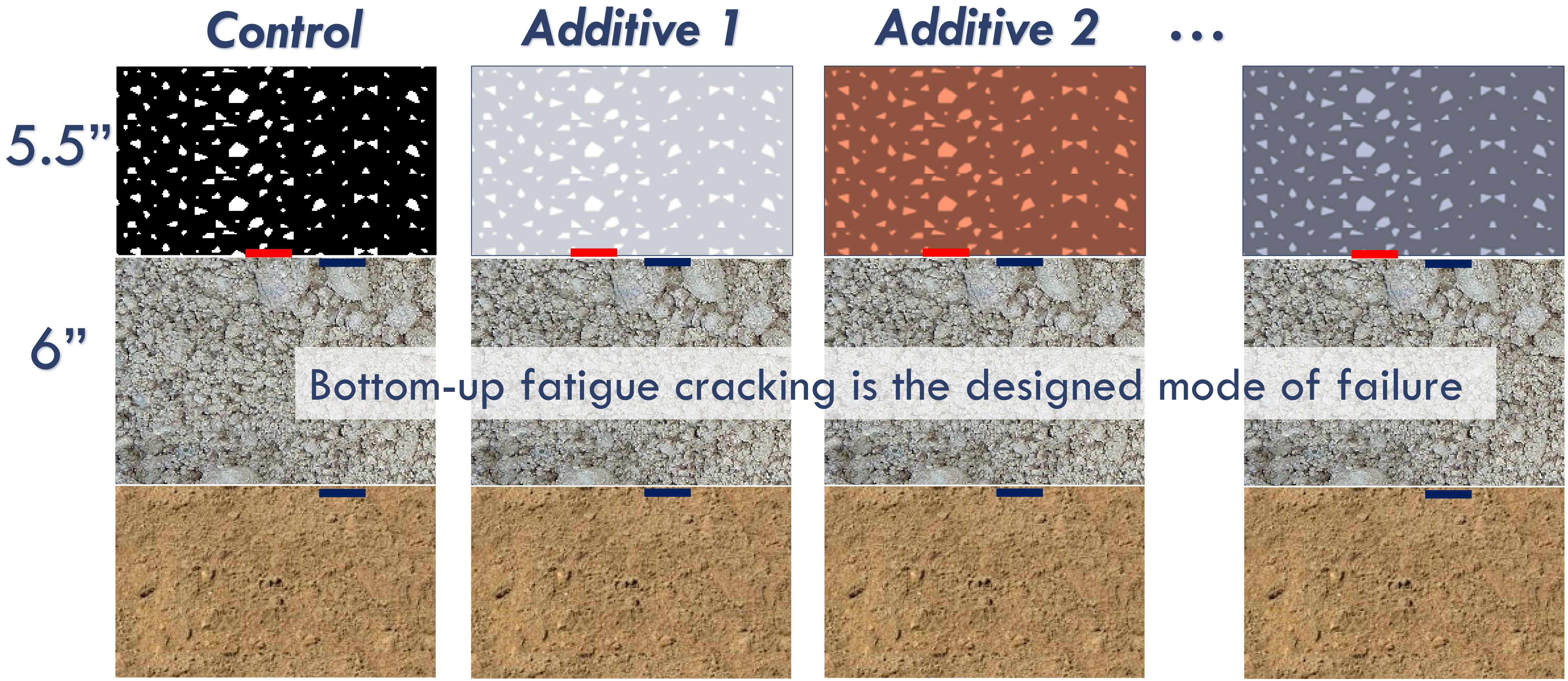
ACE XP POLYMER FIBER

Superior Asphalt Performance

Complementary Sections



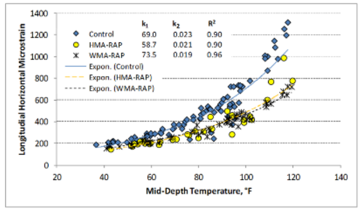
NCAT Additive Group Experiment Design



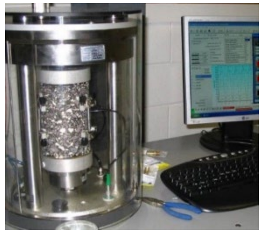
Additive Group Experimental Scope

Performance Data

Structural Response

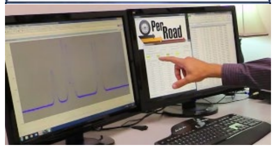


Materials Characterization

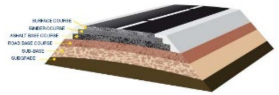


Pavement Design

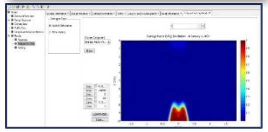
PerRoad



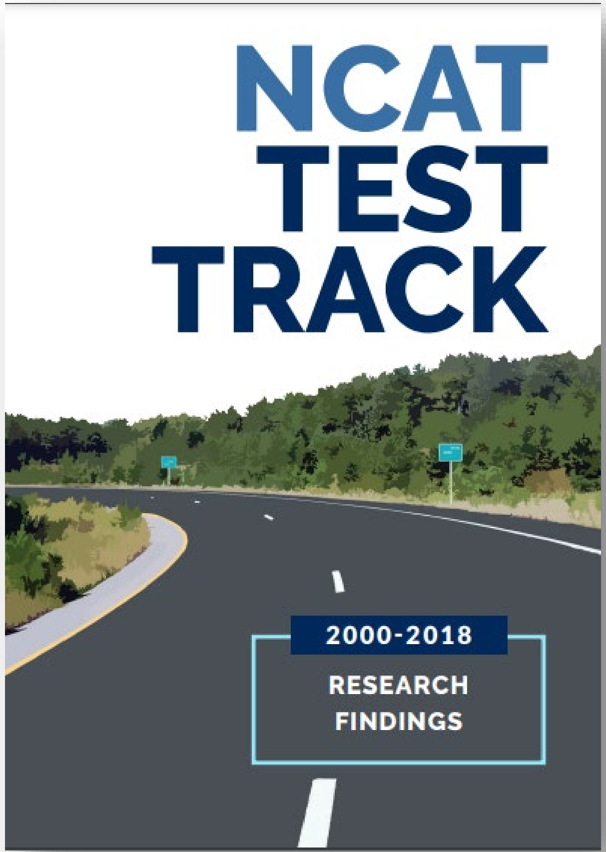
PvD AASHTOWare Pavement ME Design AASHTO



FlexPAVE™



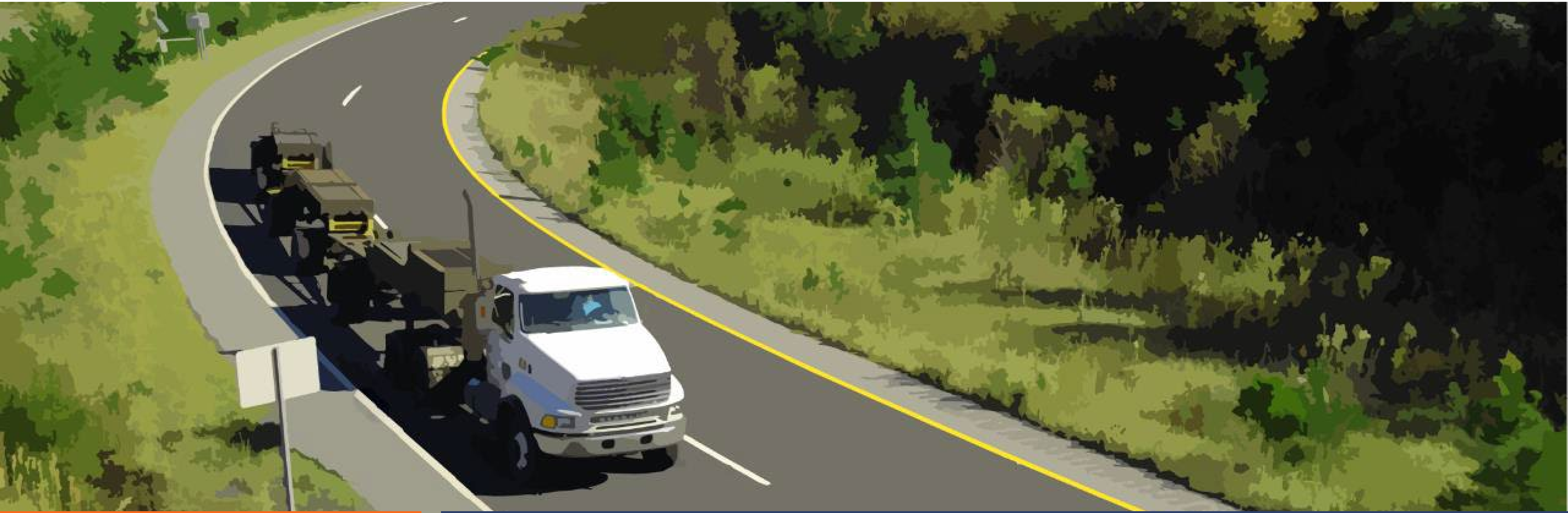
For more information…visit: www.ncat.us



Why is Test Track successful as a research endeavor?

- Results of experiments are evident by the performance of the sections; findings are easy to interpret.
- Highway agencies gain confidence to make changes in their specifications, pavement design methods and construction practices that save money and/or improve performance.
- Sponsors learn from fellow sponsor experiments.
- Industry sponsors use the track to publicly and convincingly demonstrate their technologies to the pavement engineering community.

Questions and Answers



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