

A stylized illustration of a two-lane asphalt road curving to the right. The road has a yellow curb on the left and a white line on the right. There are two blue directional signs on the right side of the road. The background consists of a dense line of green trees under a white sky.

NCAT Cracking Test Validation

Pennsylvania Asphalt Pavement Association Annual Conference

Randy C. West

NCAT History

*NCAT main office and lab
277 Technology Parkway
Auburn, AL*

- Established in 1986
- A partnership between Auburn University and the National Asphalt Pavement Association Research & Education Foundation
- Best known for the “NCAT Textbook”, the ignition method, the Professor Training Course, the *Asphalt Technology News* newsletter, the NCAT Test Track, and applied research.
- The majority of funding for research comes from state Departments of Transportation.

Training & Education

- Training Courses

- Technician certification courses
- General asphalt technology
- Mix design: Superpave and BMD
- Asphalt Engineers Workshops

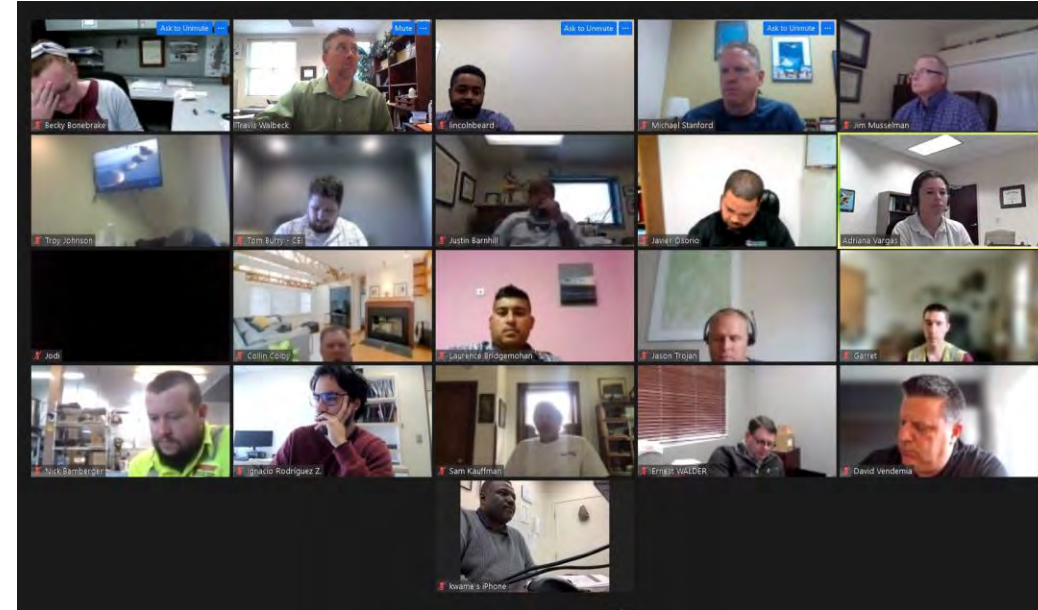
- 7 graduate courses in Pavement Engineering: traditional and on-line
- Professor Training Course

Each year, NCAT typically trains over 1000 industry personnel



Virtual Training Courses

- Asphalt Engineers Workshop
 - North Dakota 2020
 - Colorado 2021
 - North Carolina 2022
- Asphalt Technology Workshop
 - April 2021
 - 29 Attendees
 - 5 Countries
 - 16 States



Professor Training Course

- Began in 1988
- Offered every two years
- Free to US Professors
- Designed to equip professors to offer undergraduate asphalt education
- Attendance
 - 500 – US Professors
 - +80 – Other Attendees
 - 580 – Trained

PROFESSOR TRAINING COURSE

June
2021



For college and university
civil engineering faculty

This training will provide you with clear and up-to-date instructional resources to teach the asphalt portion of an undergraduate civil engineering materials course



Program provides 40 continuing education units and includes five days of intensive lectures, laboratory exercises, and discussions



There is **no fee** for domestic participants, and eligible attendees can receive a **stipend** for housing, food, and transportation

APPLICATION
DEADLINE



For additional information, visit:
ncat.us/education/training
or call: 334.844.6202



facebook.com/NCATAuburn



Airfield Asphalt Certification Program

- Goal: Increase the quality of construction for work performed under the UFGS asphalt airfield specifications.

Airfield Asphalt
QC Manager

Airfield Asphalt
Paving Inspector

Airfield Asphalt
Lab Technician



Airfield Asphalt Certification Program

- Quality Control Manager and Asphalt Laboratory Technician taught by NCAT
- Course scheduled quarterly in Auburn
- Remote hosted courses as needed
 - Hawaii – October 2021
 - California – November 2021
- 67 Technicians Certified to date



<http://airfieldasphaltcert.com/>





TRAINING IN YOUR POCKET

- YouTube based short asphalt videos
- Subscribers – 436
- Current videos – 15
- Views - >5300





Training In Your Pocket

436 subscribers

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Training in Your Pocket

1.2K views • 6 months ago

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Hamburg Wheel Track Test

669 views • 6 months ago

CC



Ideal Cracking Test (ICT)

591 views • 6 months ago

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Asphalt Paver

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Safety & PPE

341 views • 6 months ago

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Volumetric Gmb Gmm Va

324 views • 5 months ago

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Volumetric Terms

275 views • 5 months ago

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PG Binder Grading Explained

241 views • 2 months ago

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Types of Rollers Used for Asphalt Paving

234 views • 1 month ago

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Four Approaches to Balanced Mix Design

217 views • 3 months ago

CC



Airfield Asphalt Certification Program



Publications

Access detailed information about key research projects in our publications and technical reports.

[View details »](#)

Education and Training

We offer a wide range of training opportunities including hands on classes and online continuing education courses.

[View details »](#)

Facilities

Our Test Track and state-of-the-art laboratories make us a world leader in asphalt pavement research.

[View details »](#)

Our Team

Our researchers and staff are instrumental in bringing new concepts and technologies to practice across the country.

[View details »](#)

NCAT's mission is to provide innovative, relevant and implementable research, technology development and education that advances safe, durable and sustainable asphalt pavements.



Fall 2021
Vol. 33, No. 2

Asphalt

Technology News

Features

- Eighth Test Track research cycle
- Friction studies
- BMD implementation
- Cracking group experiment
- Optimizing recycled materials
- AAPT scholarships awarded
- Successful hybrid conference



Contents



3

Message from the Director: Another Perspective



4

Eighth Test Track Cycle Focuses on Innovative Materials



11

Recent Friction Studies at the NCAT Test Track



13

Paths to BMD Implementation



16

Which Cracking Test? NCAT's Test Track Provides Answers.



18

Optimizing Recycled Materials Contents by Using Recycling Agents



21

Graduate Students Awarded AAPT Scholarships



22

NCAT Adapts For Successful Hybrid Conference

Other recent NCAT Research Reports you don't want to miss



NCAT Report 20-06

METHODS FOR ADDRESSING TACK TRACKING

LITERATURE REVIEW

Jim Musselman
Raquel Moraes
Travis Walbeck
Randy C. West

November 2020


277 Technology Parkway ■ Auburn, AL 36830



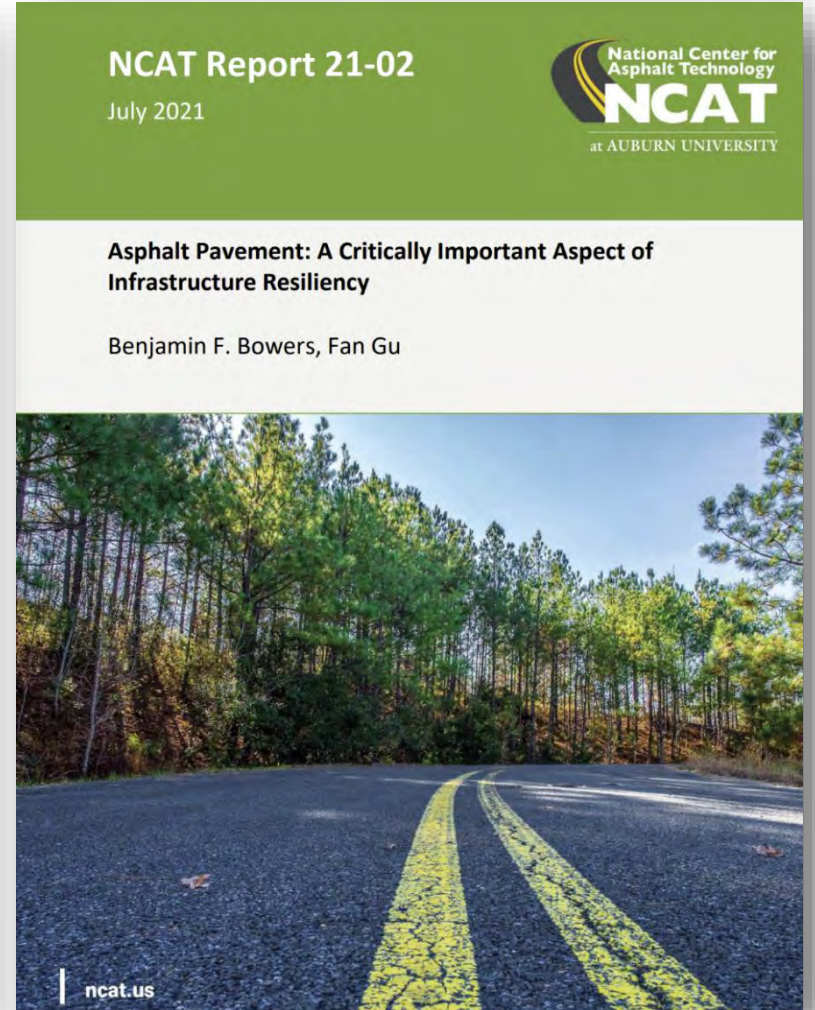
NCAT Report 20-03

BENEFITS OF REHABILITATING CONCRETE PAVEMENTS WITH SLAB FRACTURING AND ASPHALT OVERLAYS

By
Randy West
Fan Gu
Benjamin F. Bowers

May 2020


277 Technology Parkway ■ Auburn, AL 36830



NCAT Report 21-02
July 2021

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Asphalt Pavement: A Critically Important Aspect of Infrastructure Resiliency

Benjamin F. Bowers, Fan Gu

ncat.us

An aerial photograph of a road experiment site. A long, winding road curves through a dense forest. The road is divided into sections, with some sections appearing to be under construction or recently paved. A large white truck is visible on the road. In the foreground, there are several small buildings with green roofs and a pond. The background shows a large, open field with some buildings and a parking lot.

Cracking Group Experiment 2015-2021

Cracking Group Experiment

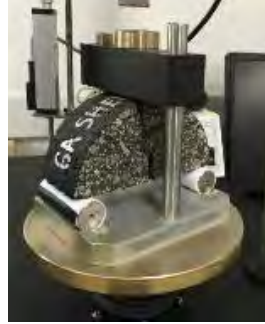
Which Tests Correlate to Field the Best?



Energy Ratio



SCB-LA



I-FIT



OT-TX



OT-NCAT

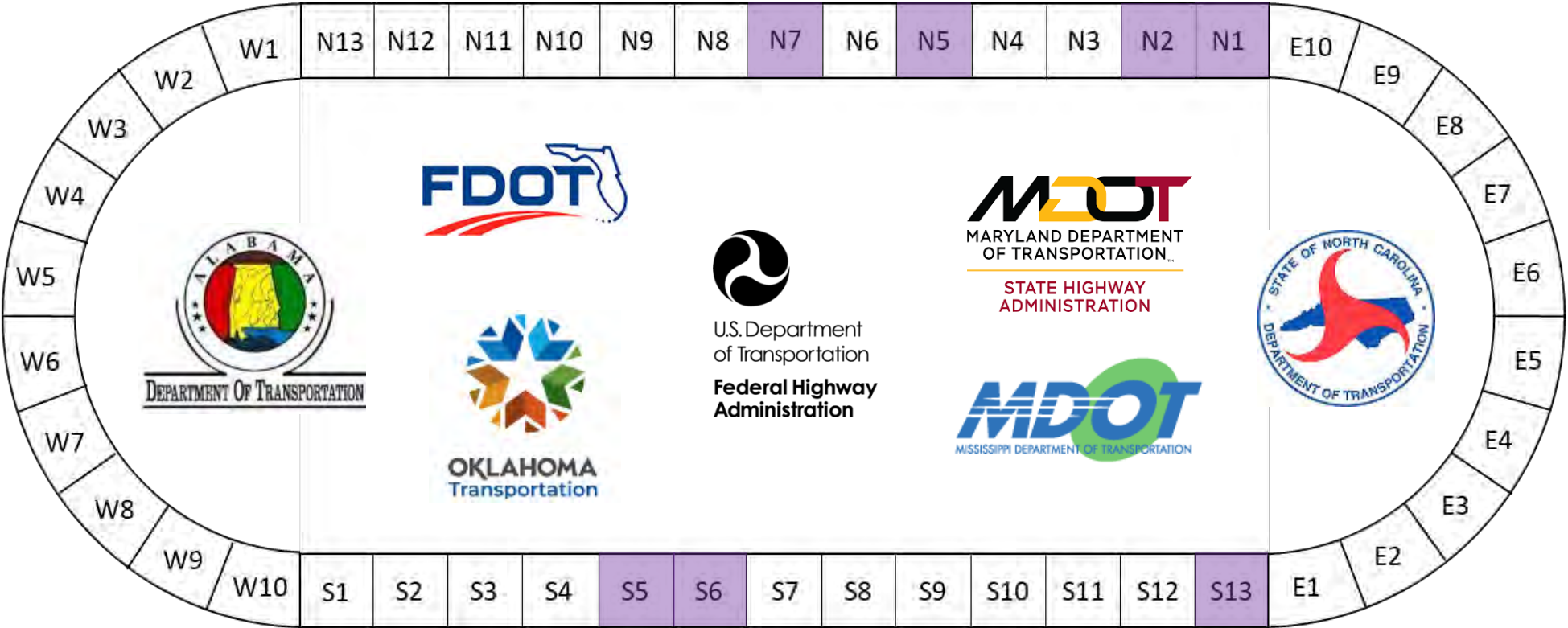


IDEAL-CT



*AMPT
Cyclic Fatigue*

2015-2021 NCAT Cracking Group Experiment Sponsors



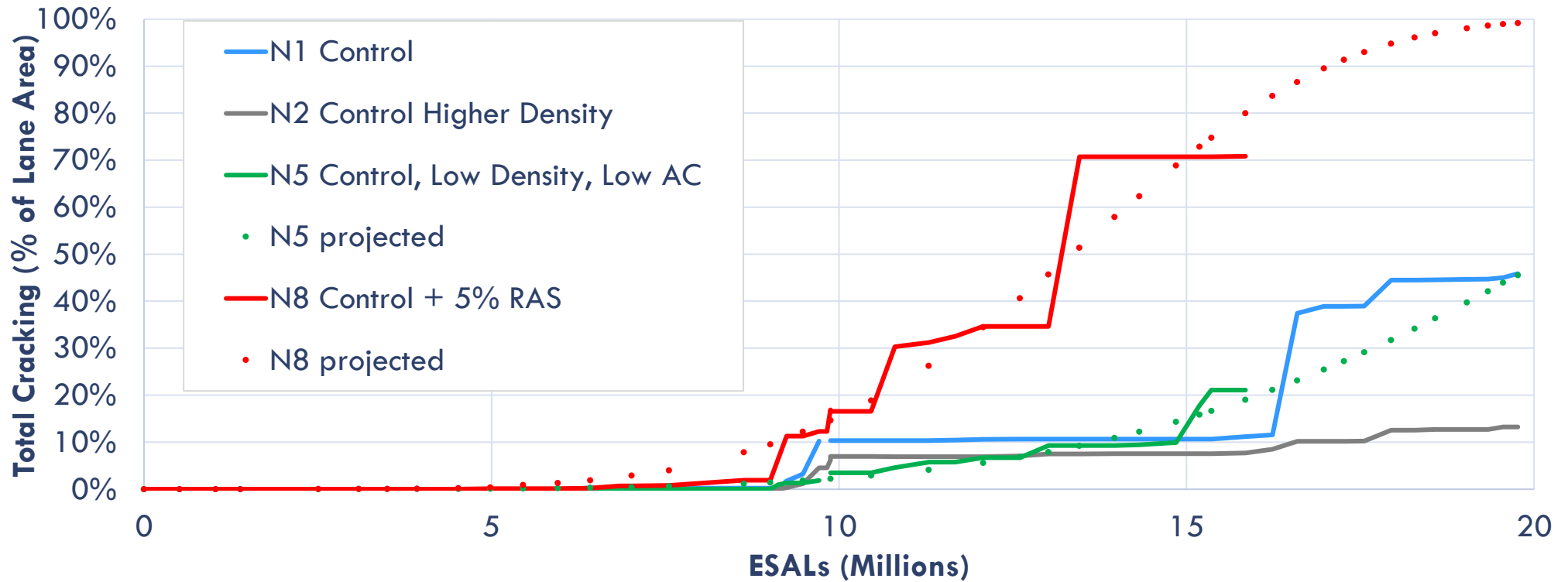
Test Section Layer Thicknesses



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



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

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



N2 (Control, 2.5% Higher Density), Jan. 2021



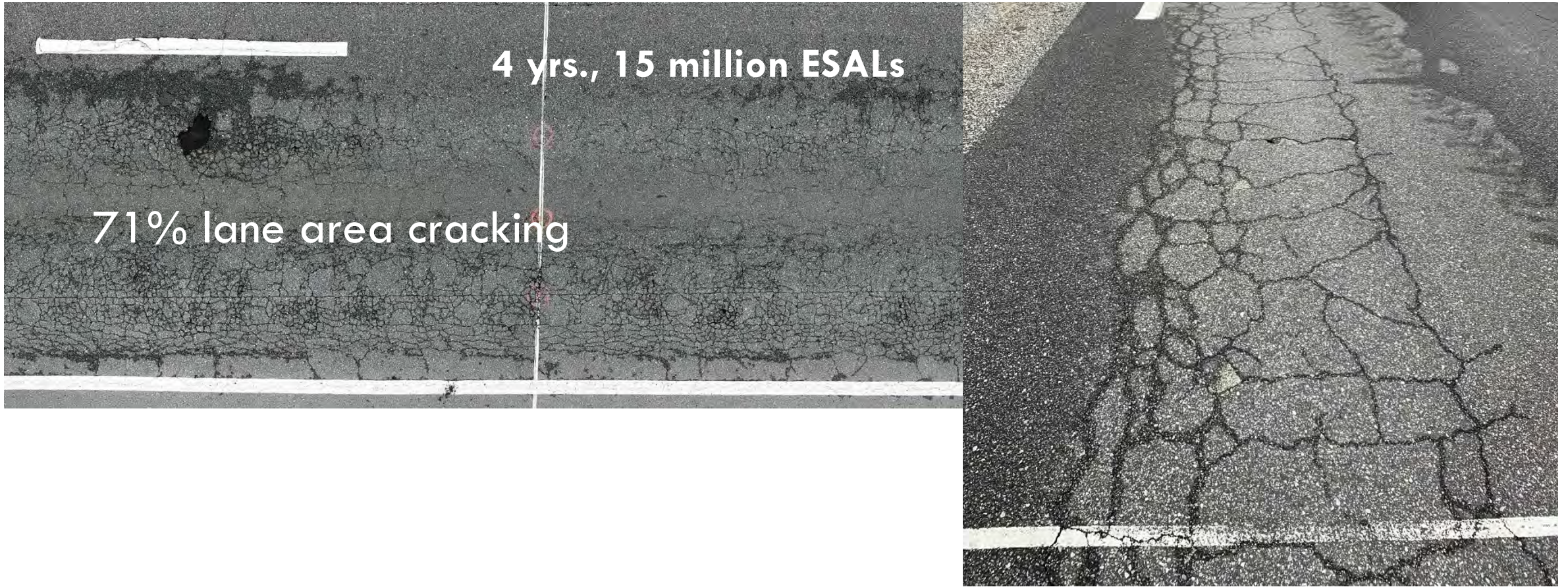
N5 (Control, Low AC, Low Density), Dec. 2019



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



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



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



S6 (Control w/ HiMA binder), Jan. 2021



S13 (Gap-Graded, Asphalt-Rubber), Jan. 2021



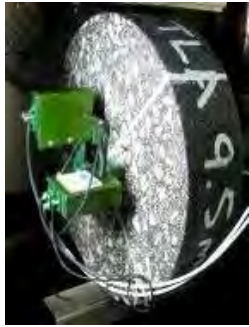
S13 (Gap-Graded, Asphalt-Rubber), Jan. 2021



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.

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*

Tests* were conducted on:

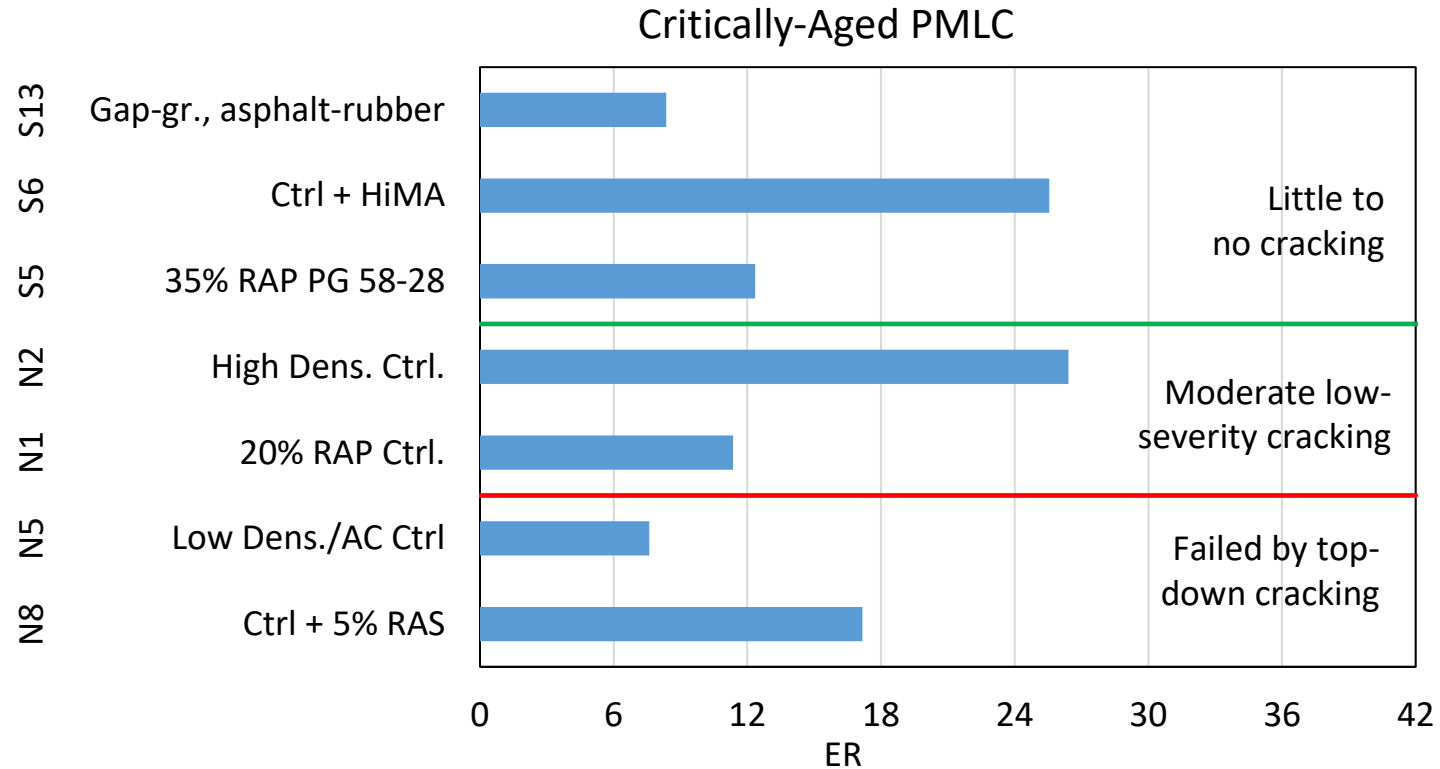
1. lab prepared mix after short-term aging
2. lab prepared mix after short-term and critical aging
3. plant mix samples that were reheated
4. plant mix samples that were reheated and critically aged

*AMPT Cyclic Fatigue Tests were tested only on plant mix samples

Energy Ratio



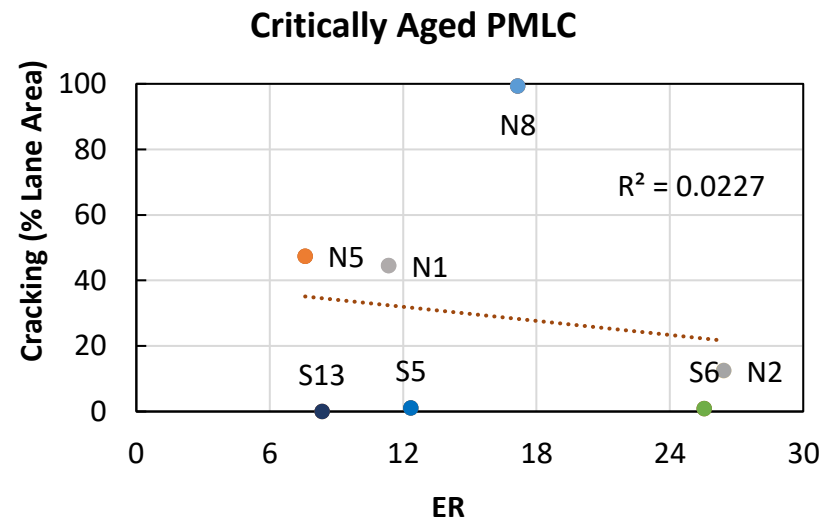
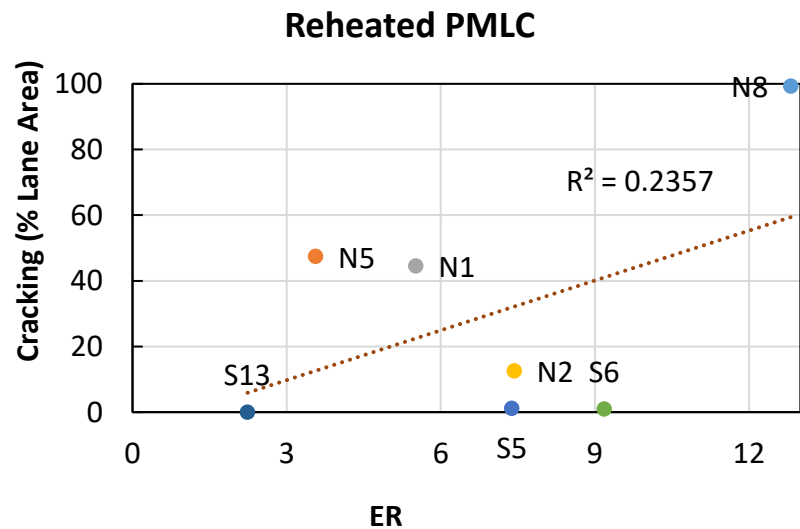
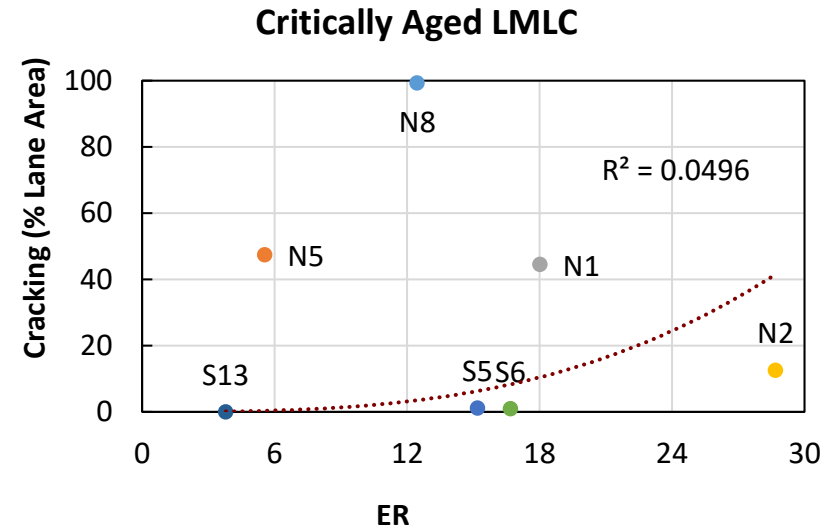
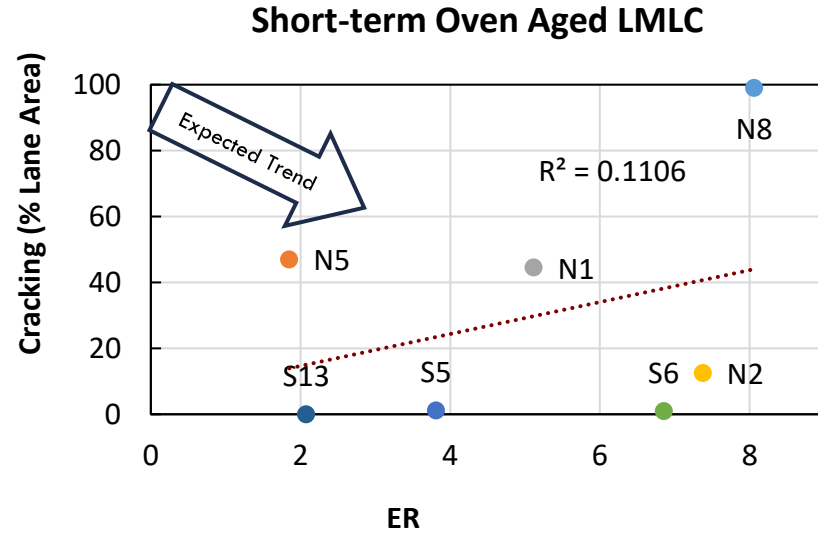
Energy Ratio



higher ER = better cracking resistance

NCAT Test Track

Correlations of Energy Ratio to Cracking on the Test Track



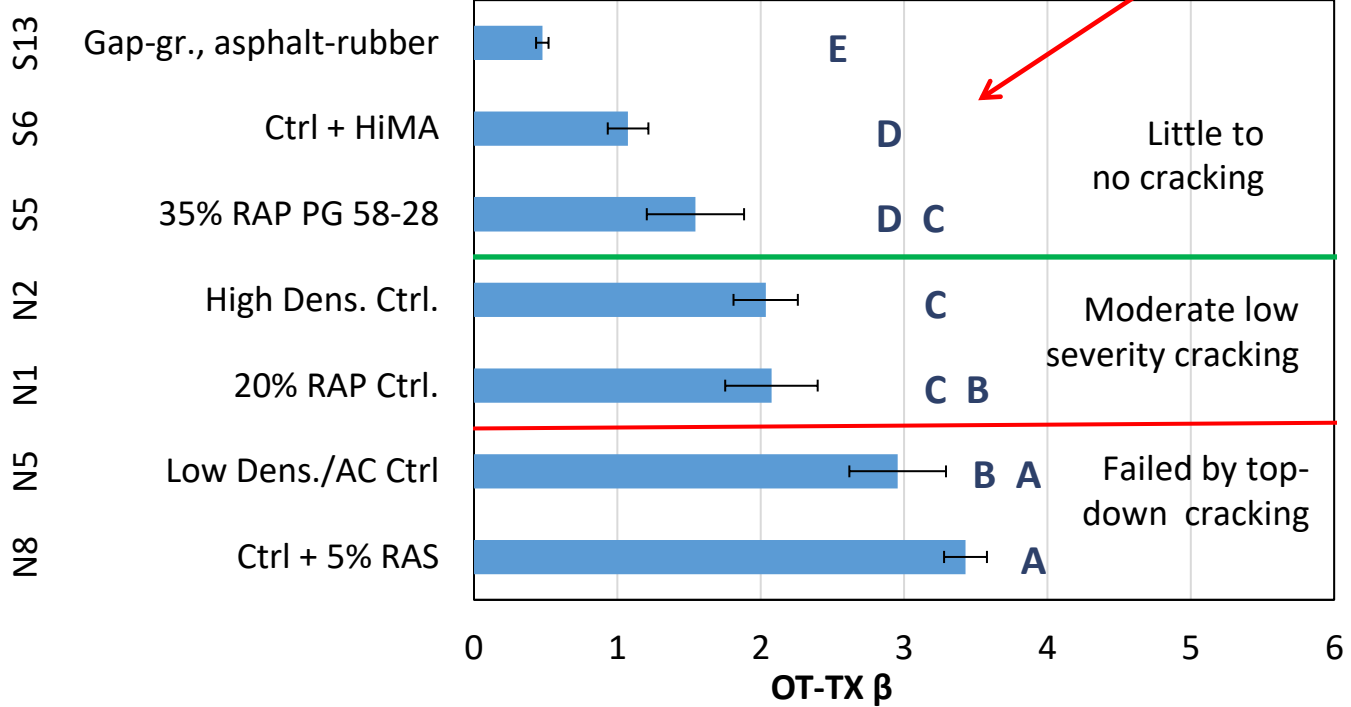
Texas Overlay Test (Tex-248-F)

Results with the same letter are not statistically different



OT-TX

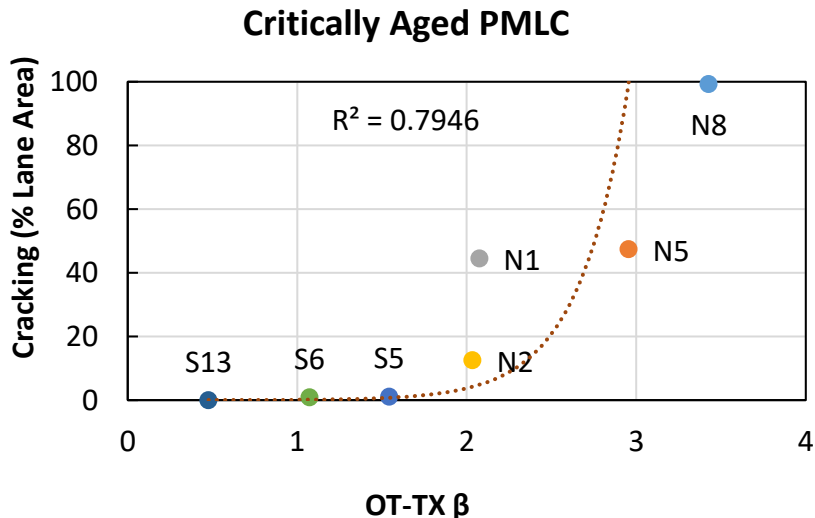
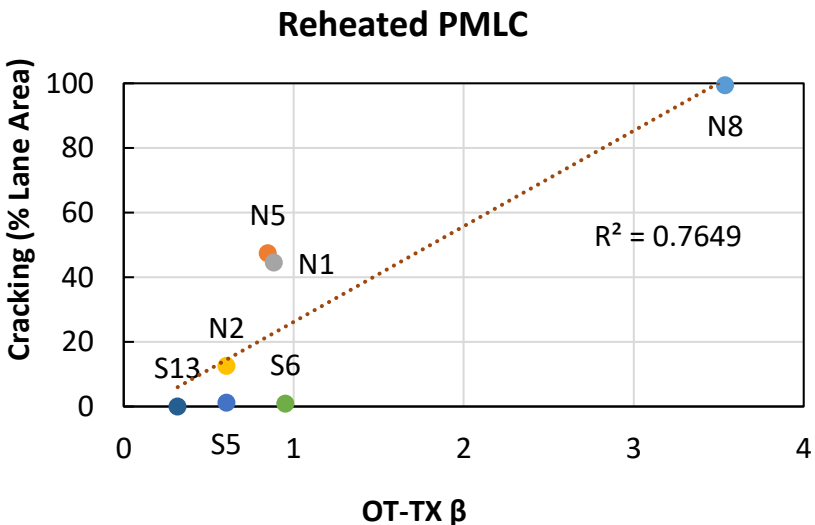
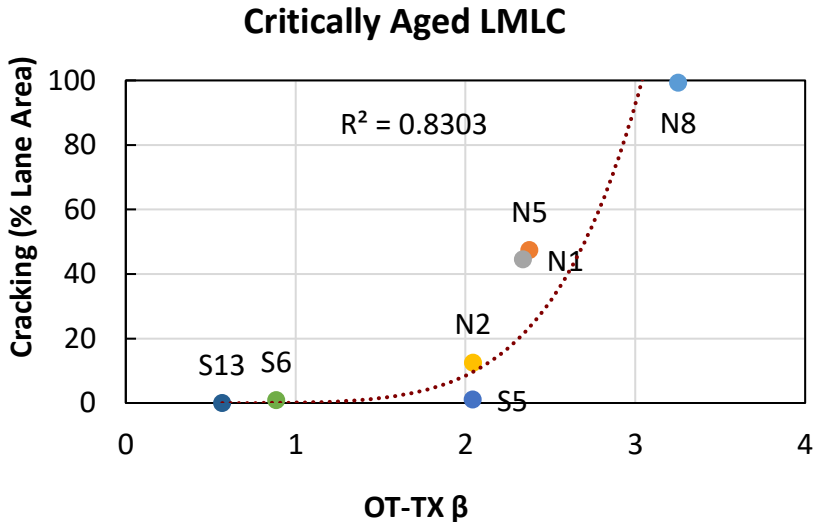
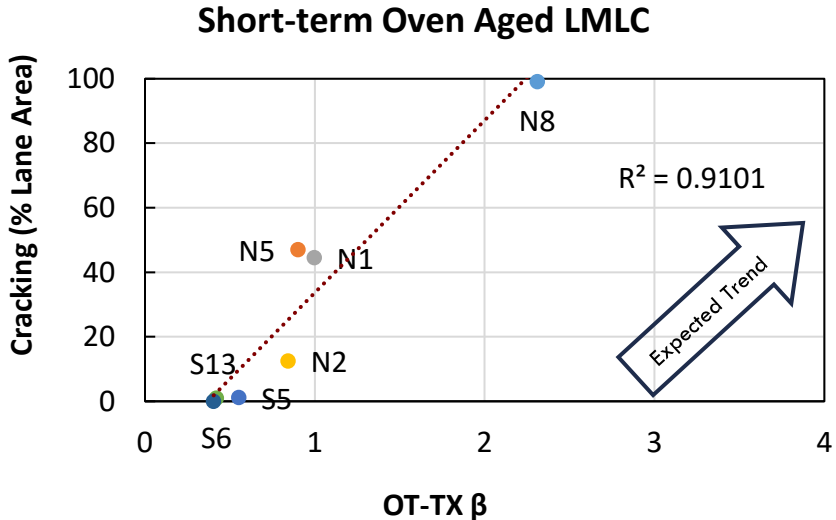
Critically Aged PMLC



Sorted from best to worst field cracking performance

← lower β = better cracking resistance

Correlations of Texas Overlay Test Results to Cracking on the Test Track

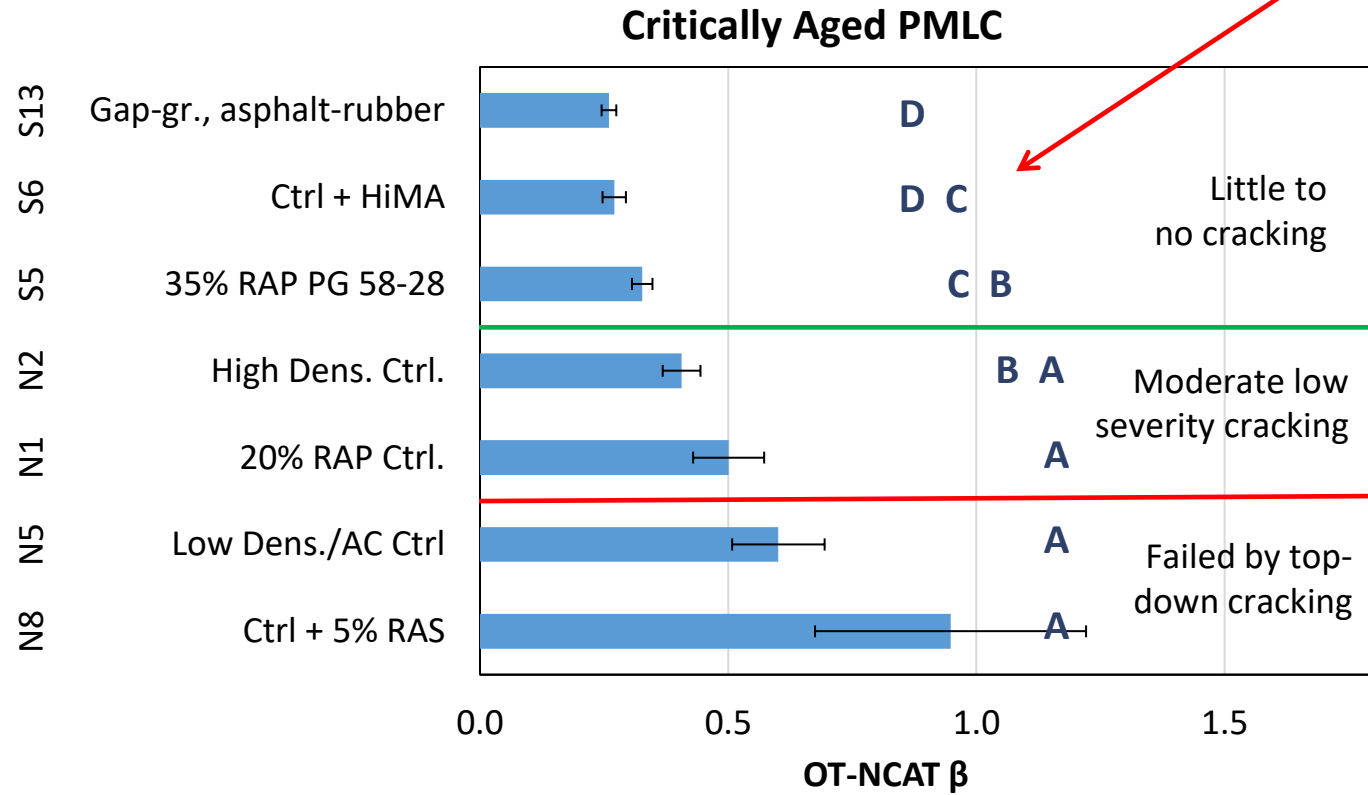


NCAT Overlay Test (Ma, 2014)

Results with the same letter are not statistically different



OT-NCAT

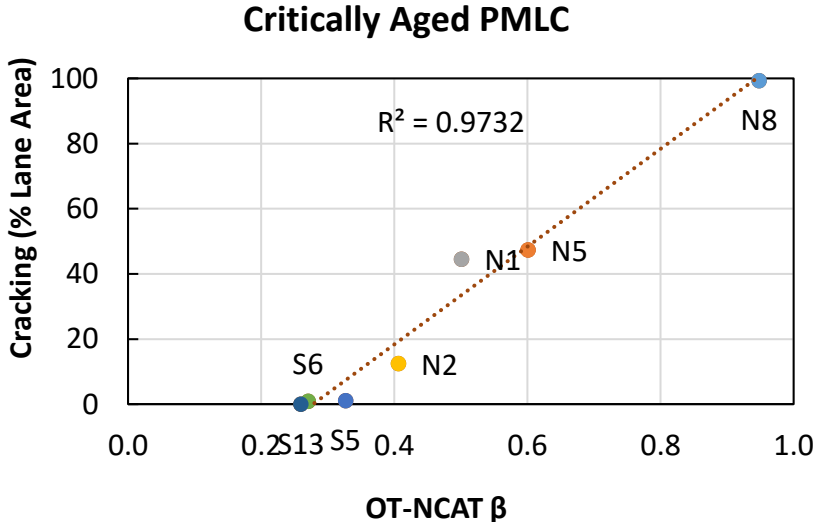
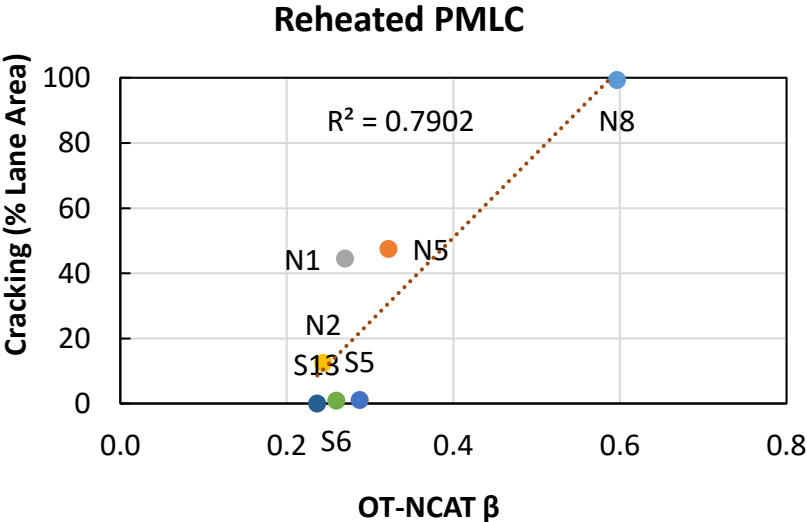
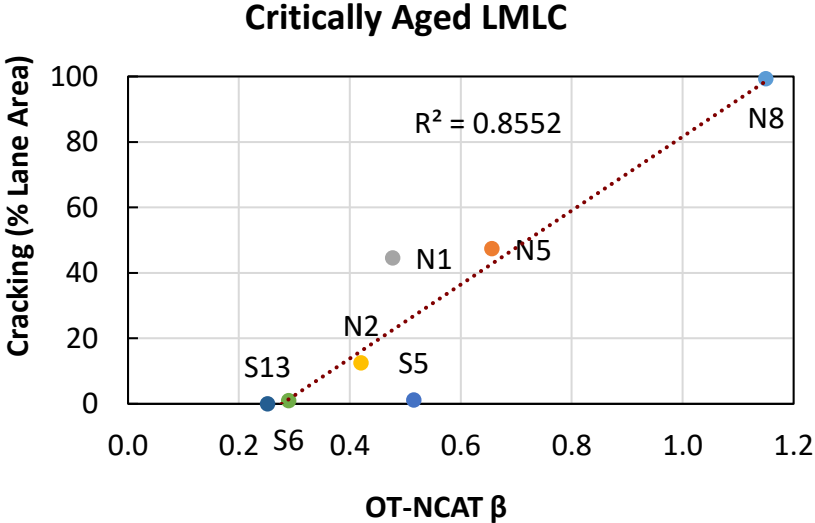
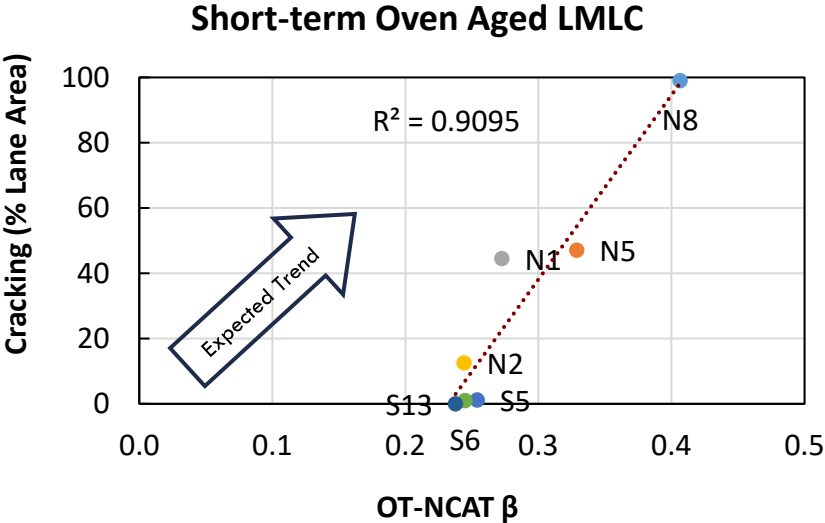


Sorted from best to worst field cracking performance

← lower β = better cracking resistance

NCAT Test Track

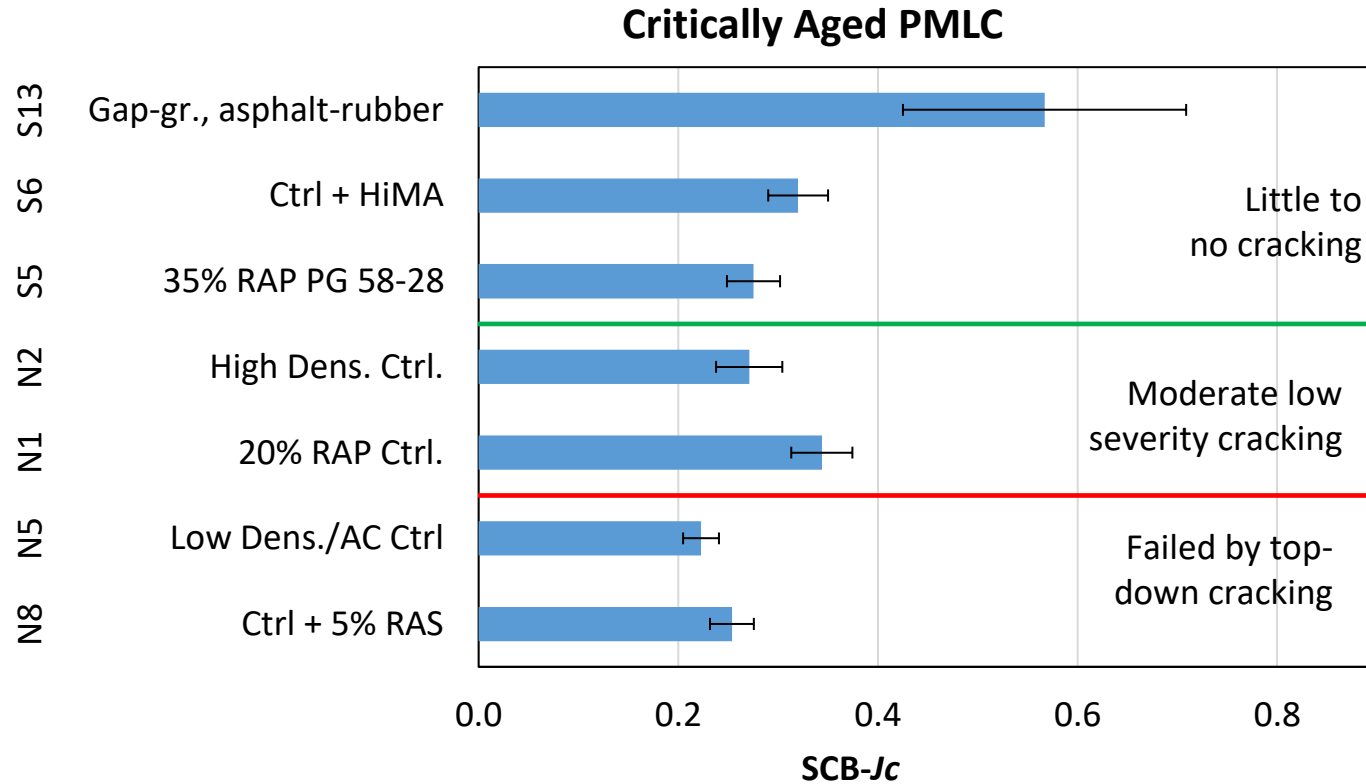
Correlations of NCAT Overlay Test Results to Cracking on the Test Track



Louisiana SCB Test (ASTM D8044-16)



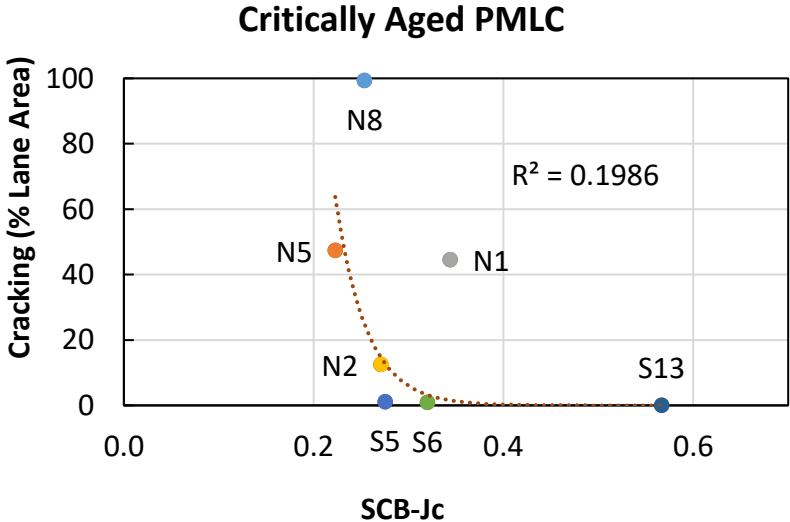
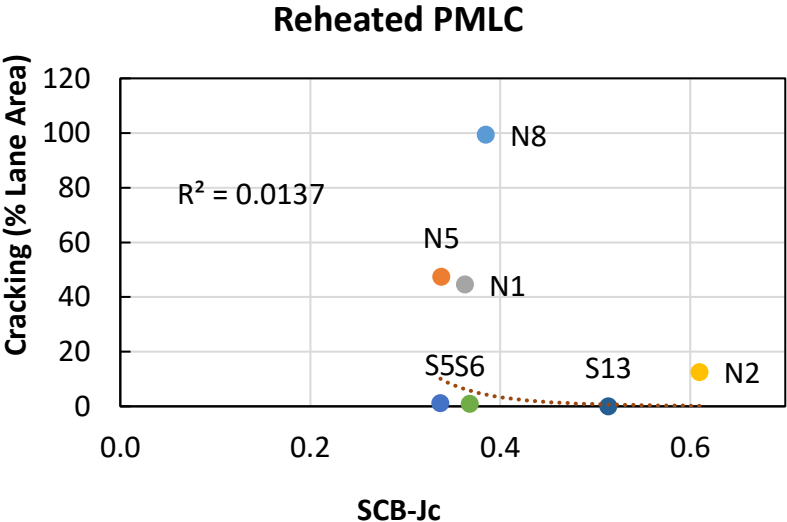
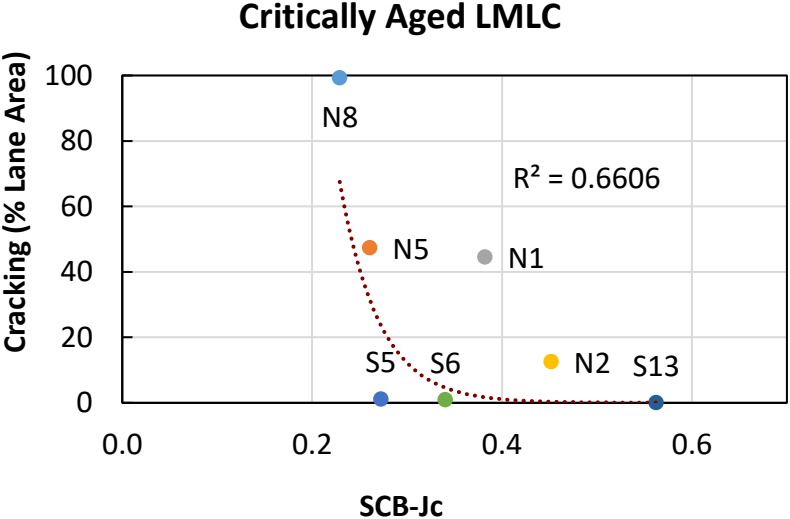
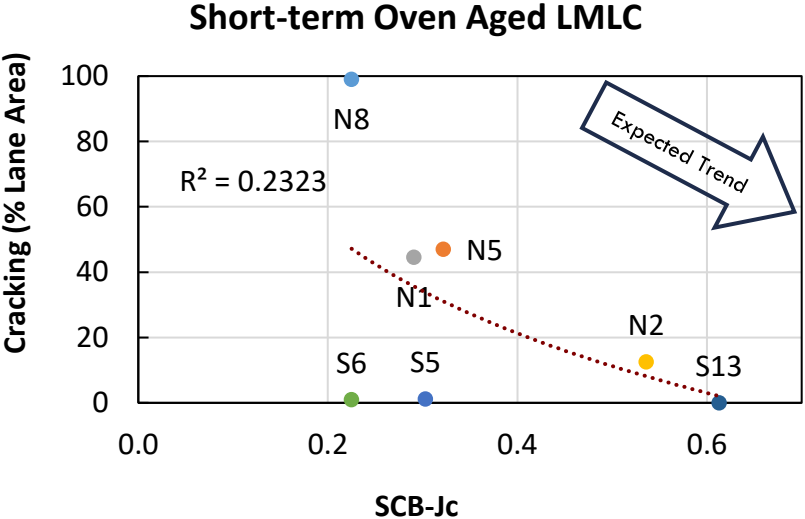
SCB-LA



higher SCB-Jc = better cracking resistance

NCAT Test Track

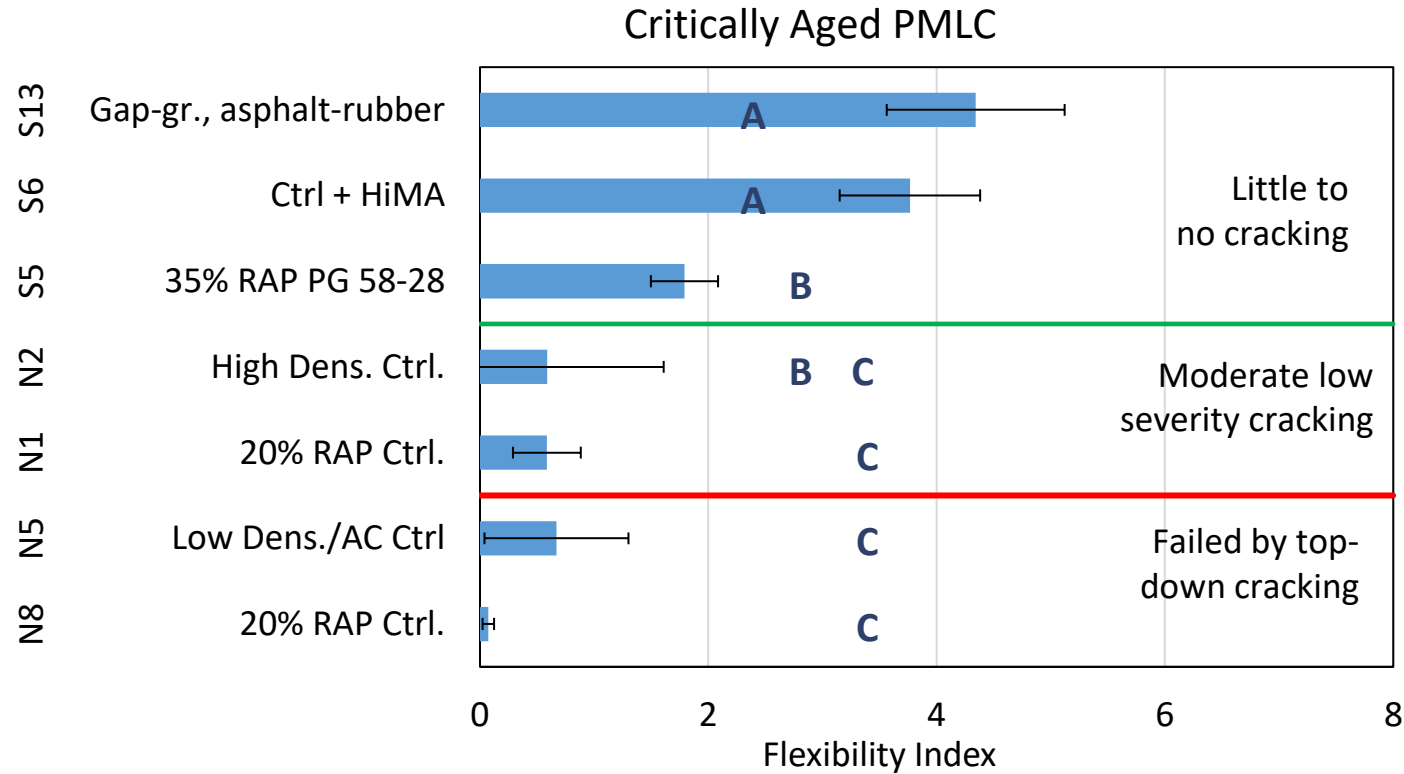
Correlations of Louisiana SCB Test Results to Cracking on the Test Track



Illinois Flexibility Index Test (AASHTO TP 124)



I-FIT

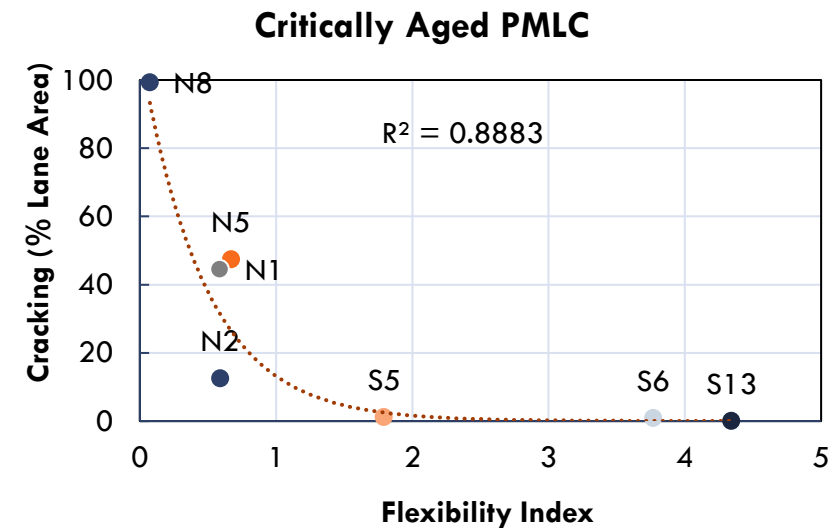
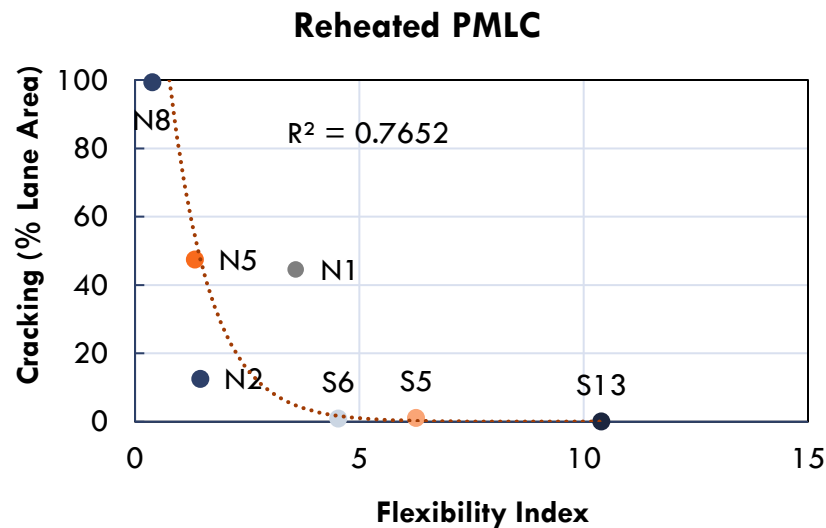
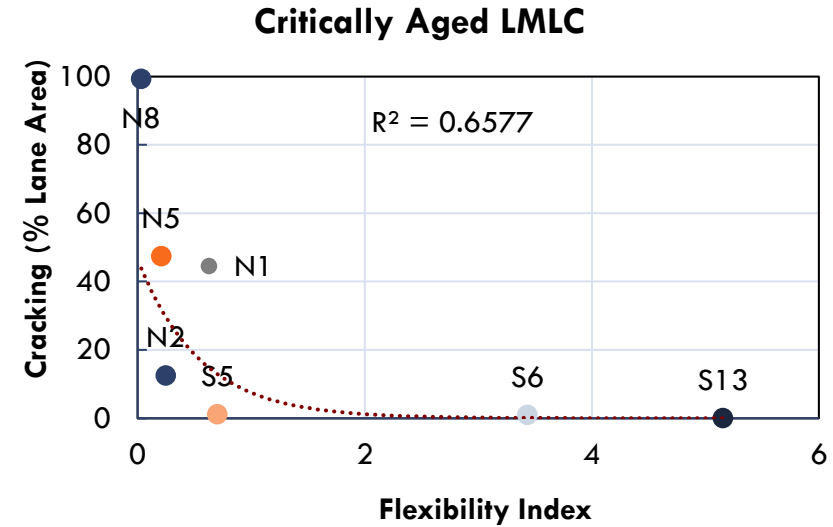
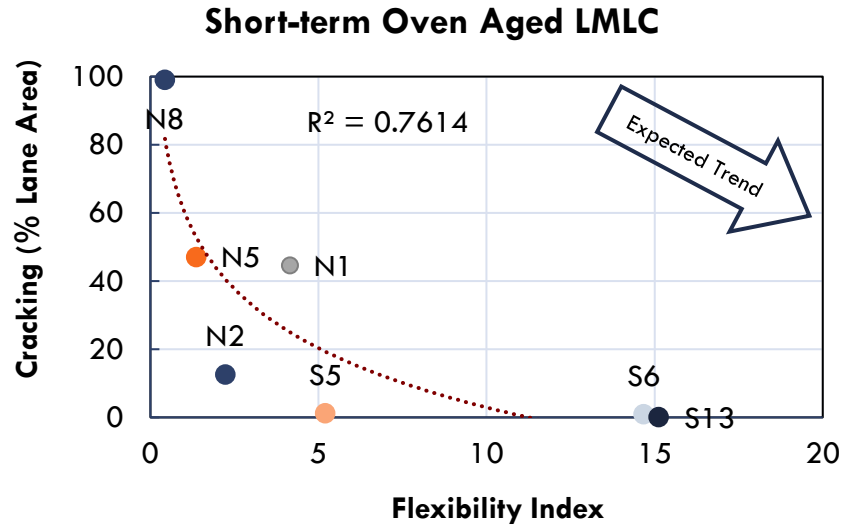


Sorted from best to worst field cracking performance

higher FI = better cracking resistance

NCAT Test Track

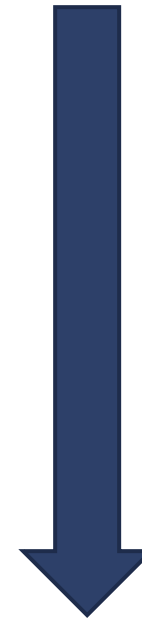
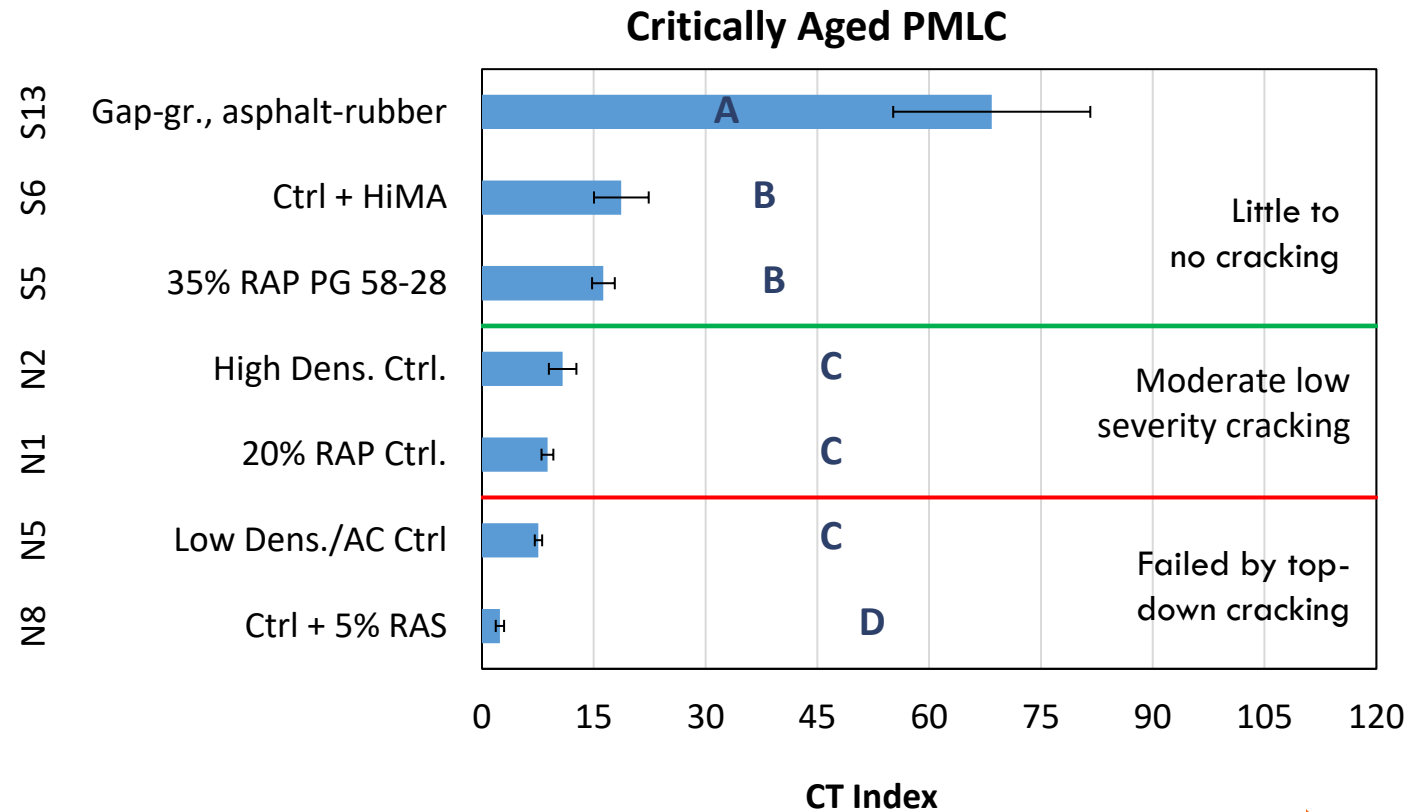
Correlations of I-FIT Results to Cracking on the Test Track



IDEAL-CT Test (ASTM D8225-19)



IDEAL-CT

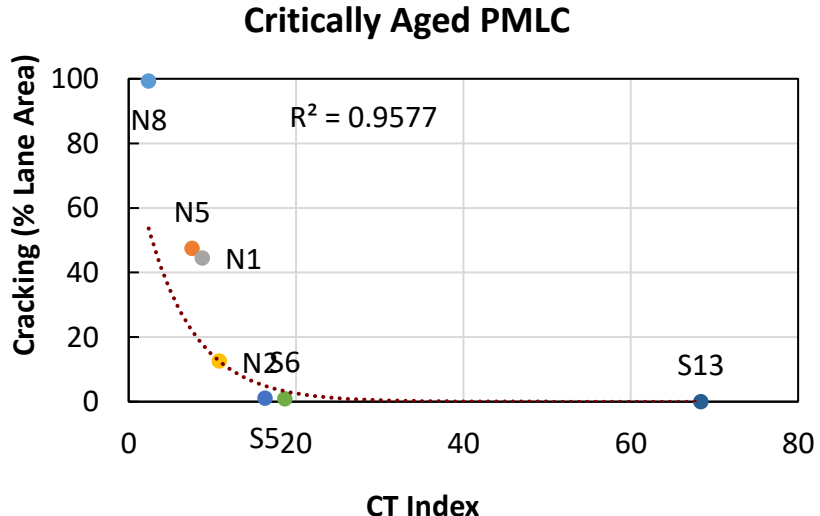
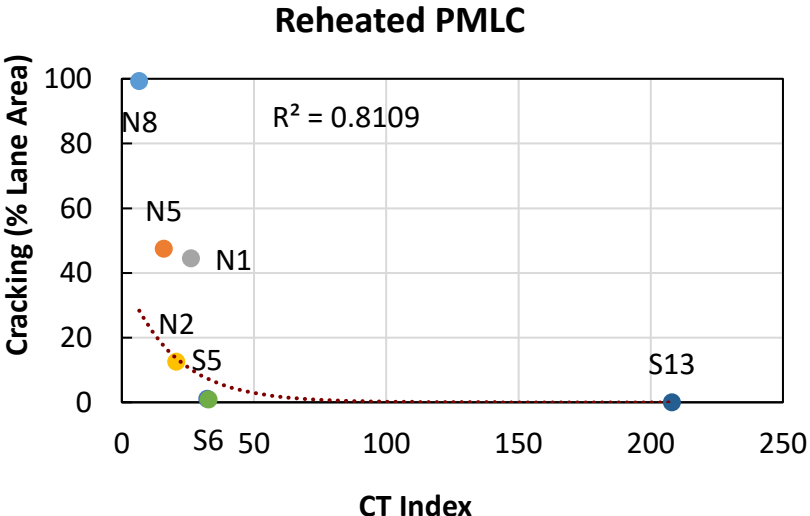
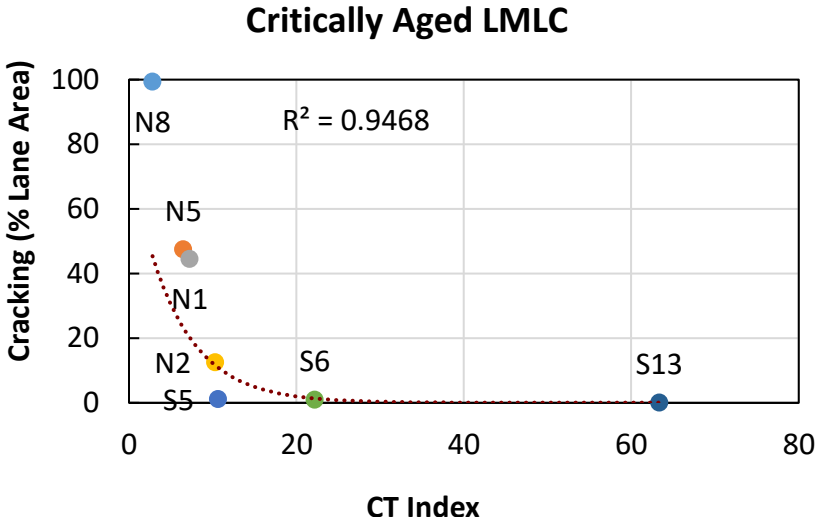
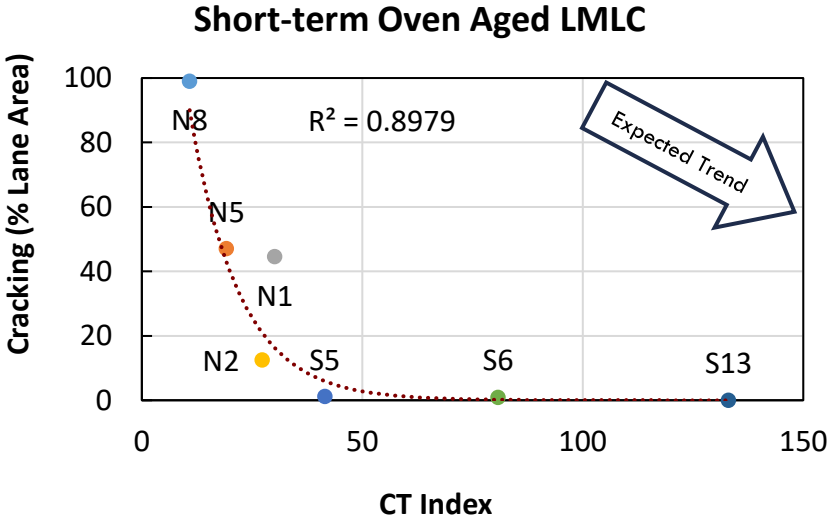


Sorted from best to worst field cracking performance

higher CT_{Index} = better cracking resistance

NCAT Test Track

Correlations of IDEAL-CT Results to Cracking on the Test Track

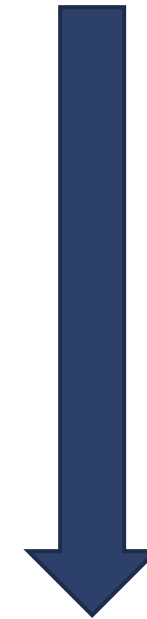
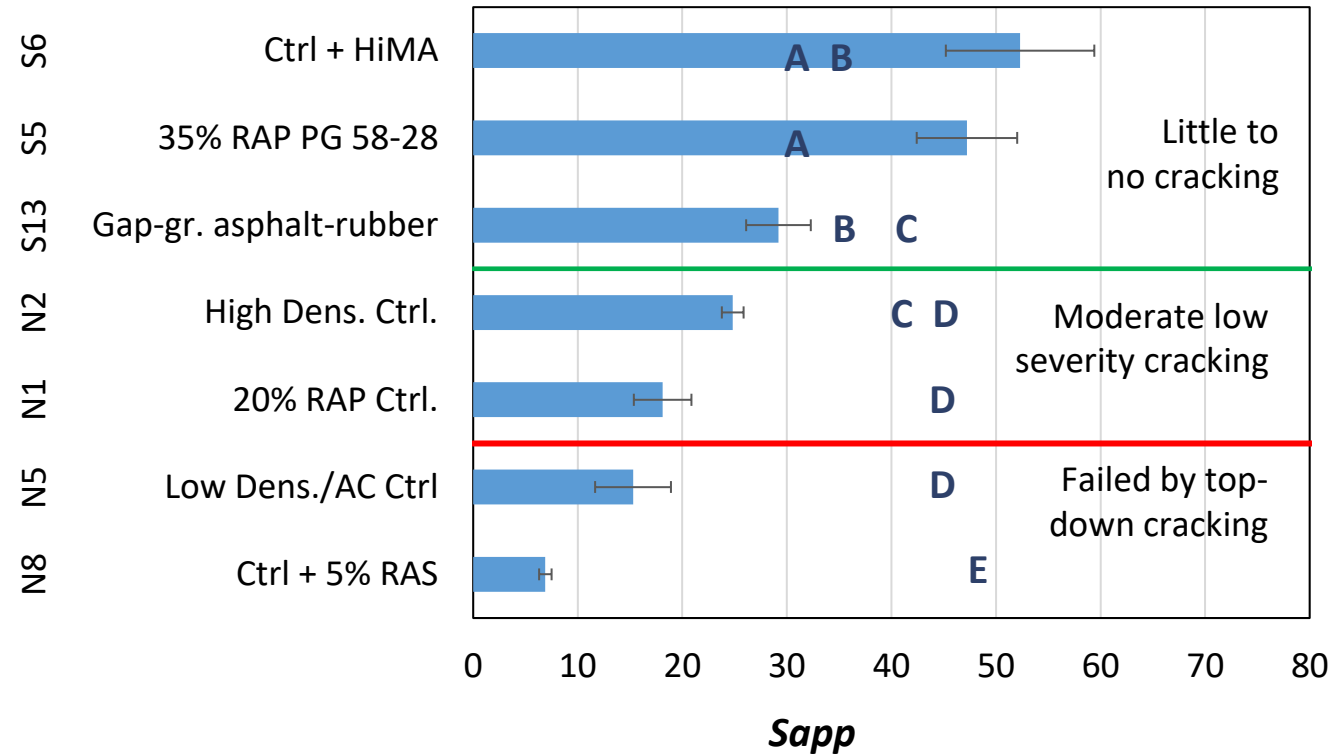


AMPT Cyclic Fatigue Test (AASHTO TP 133-19)



AMPT
Cyclic Fatigue

Critically Aged PMLC

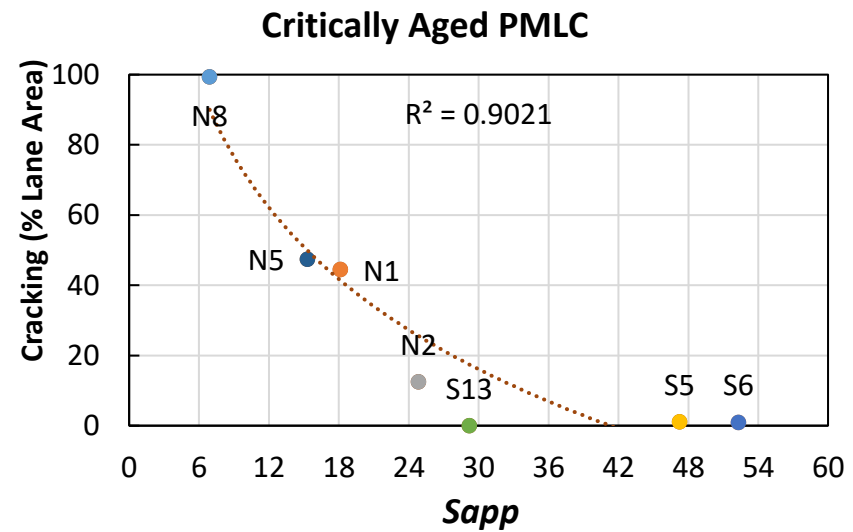
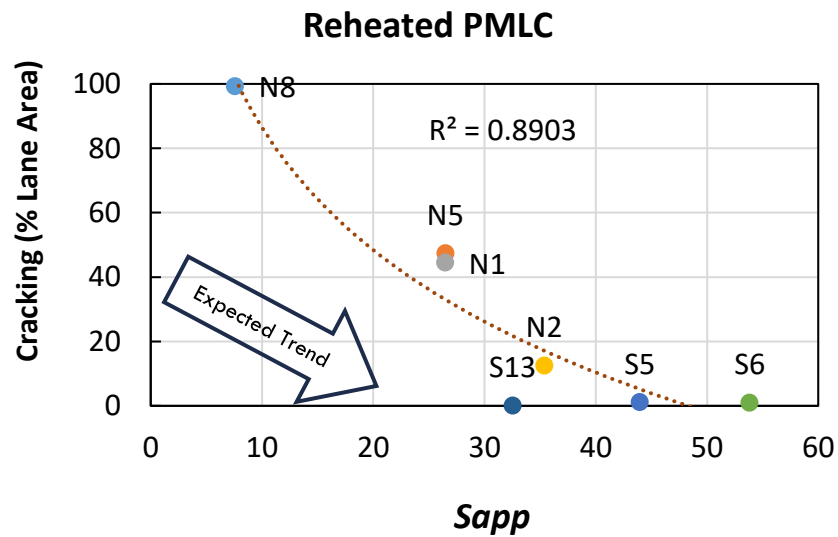


Sorted from
best to worst
field cracking
performance

higher FI = better cracking resistance

NCAT Test Track

Correlations of AMPT Cyclic Fatigue Results to Cracking on the Test Track

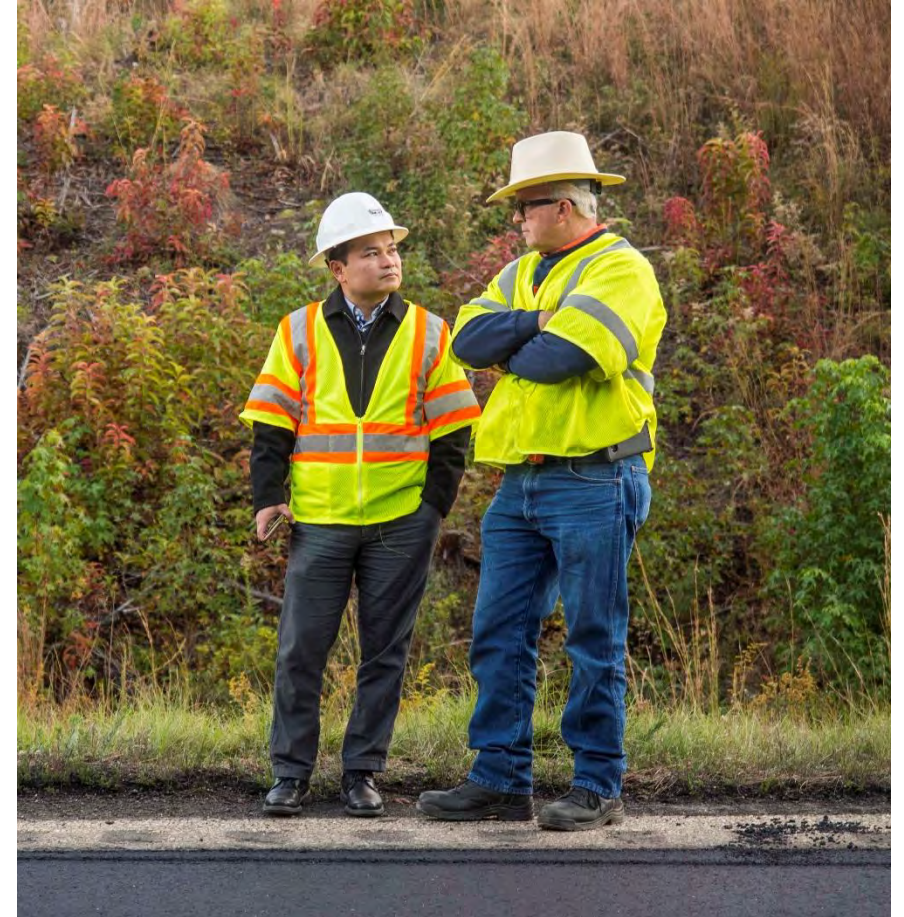


Summary of Correlations

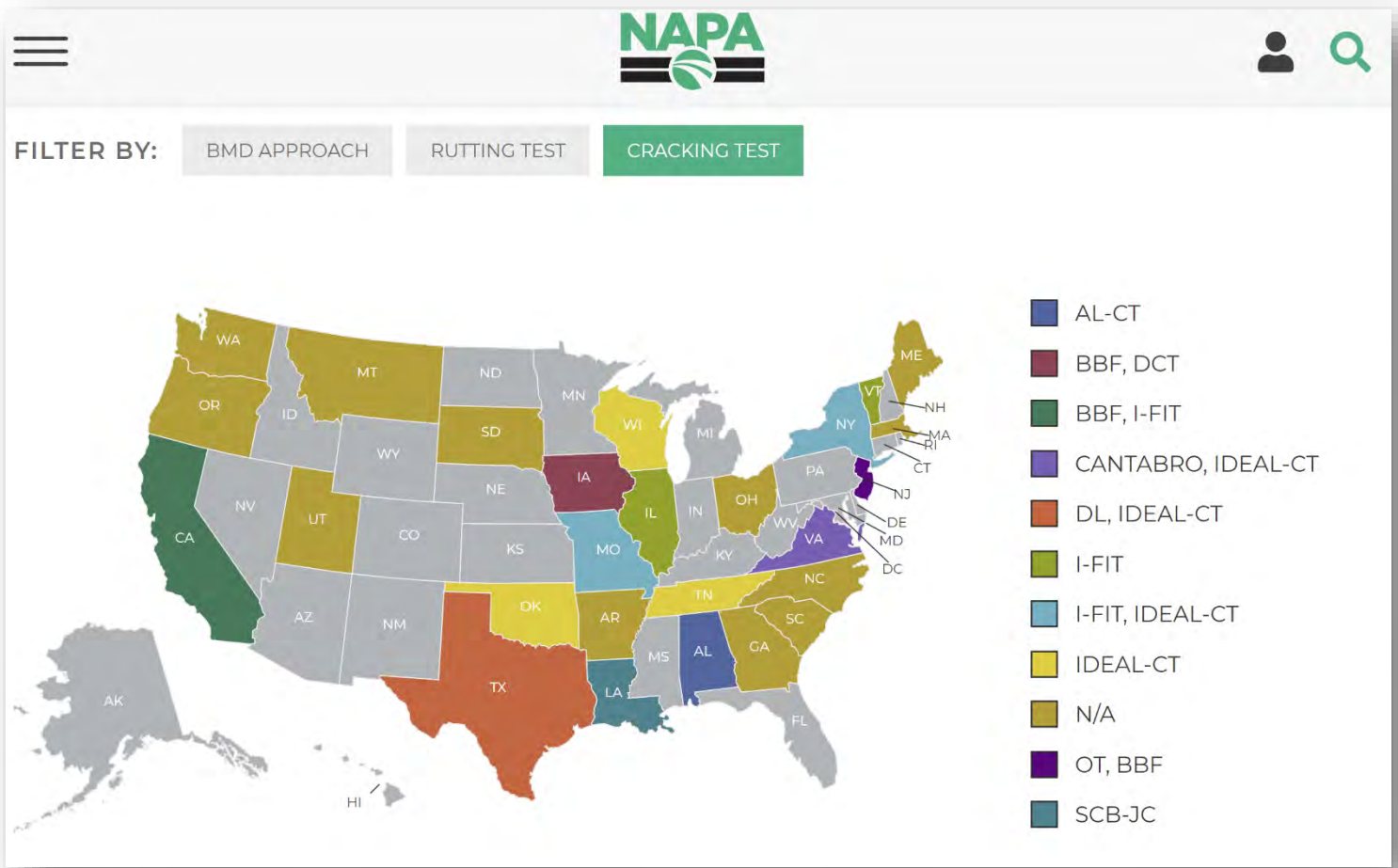
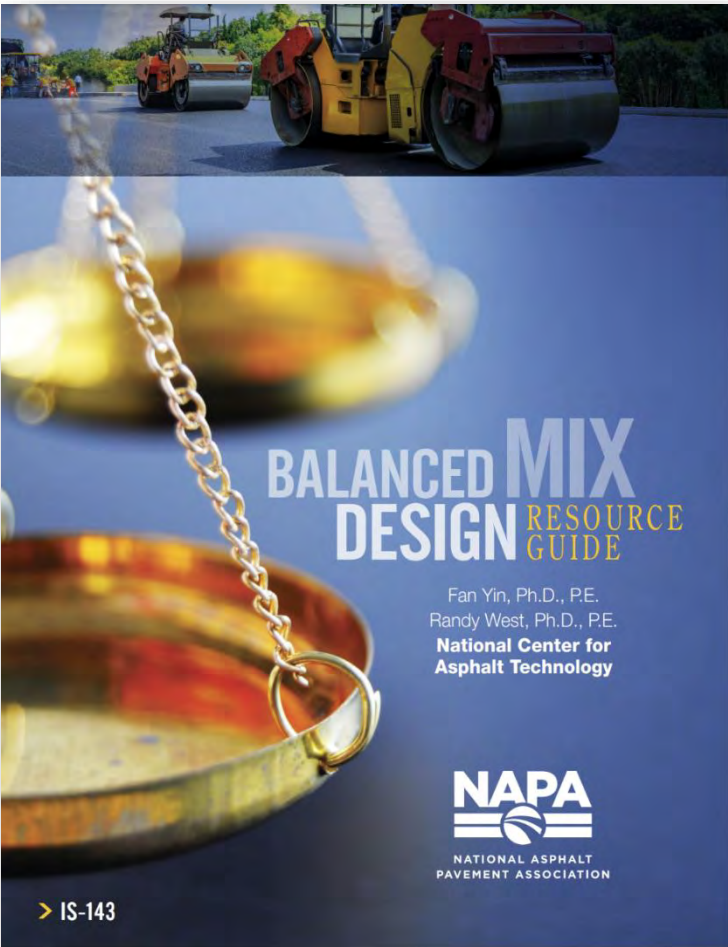
Test and Parameter	Average COV	Games Howell Groups	Range of R ²
Energy Ratio, ER	Not available	Not applicable	0.03 to 0.28
Texas Overlay Test, β	17%	5	0.76 to 0.91
NCAT Overlay Test, β	10%	4	0.79 to 0.97
Louisiana SCB, J_c	20%	Not applicable	0.13 to 0.78
Illinois Flexibility Index Test, FI	34%	3	0.76 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



NCAT Test Track



BMD Resources

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



The Bucket Brigade



Questions and Answers

