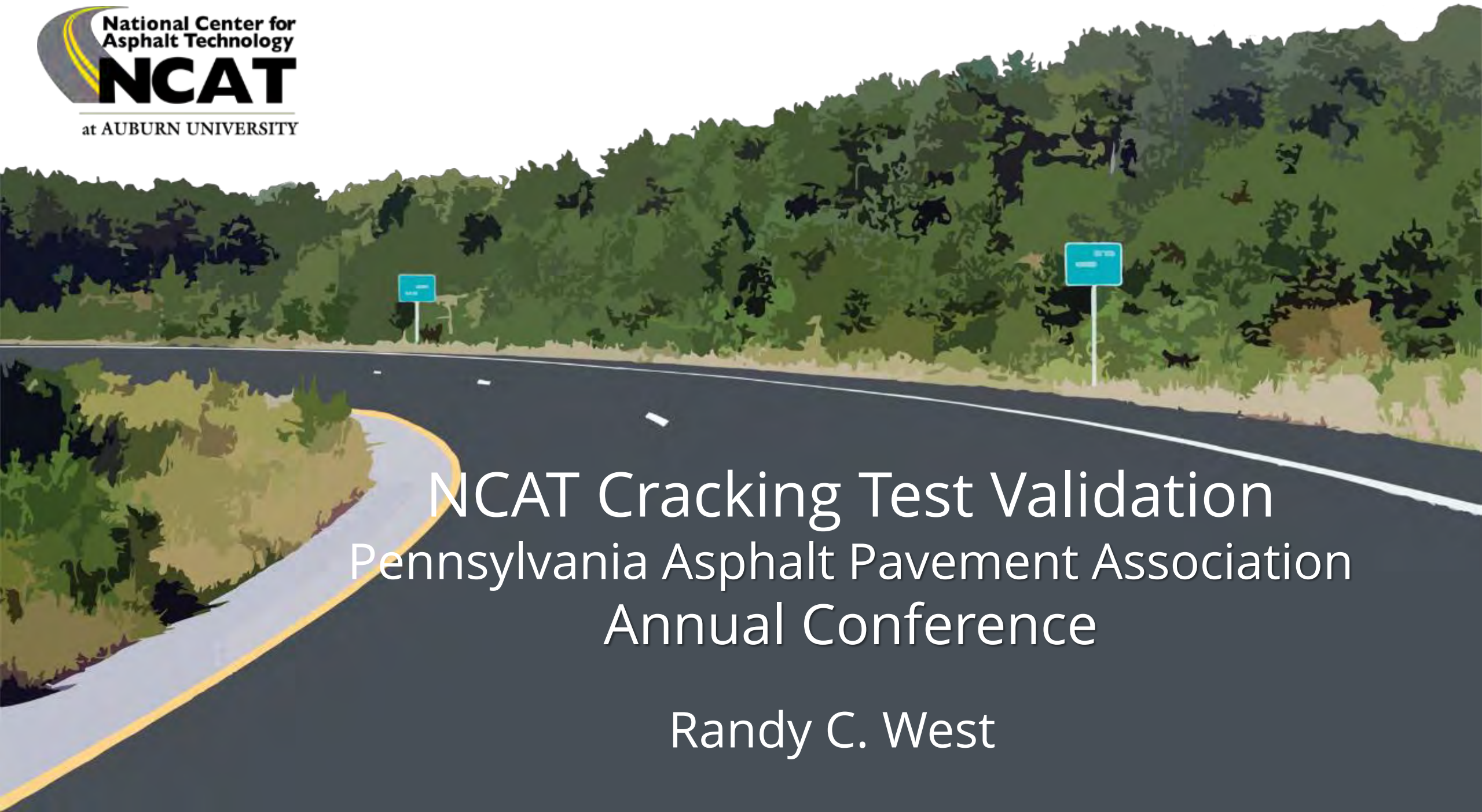
National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY



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

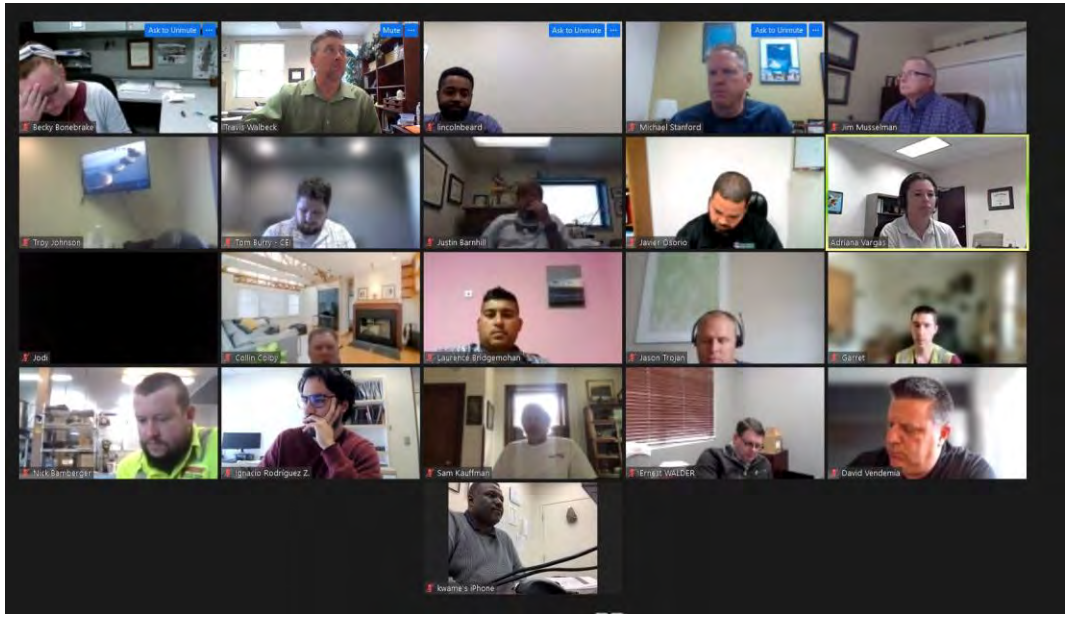
- Training Courses
  - Technician certification courses
  - General asphalt technology
  - Mix design: Superpave and BMD
  - Asphalt Engineers Workshops
- 7 graduate courses in Pavement Engineering: traditional and on-line
- Professor Training Course

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



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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

Airfield Asphalt Certification Program

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

AACP

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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

AACP

http://airfieldasphaltcert.com/

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

TRAINING IN YOUR POCKET

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

SCAN ME

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Training In Your Pocket

436 subscribers

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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

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Types of Rollers Used for Asphalt Paving

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Four Approaches to Balanced Mix Design

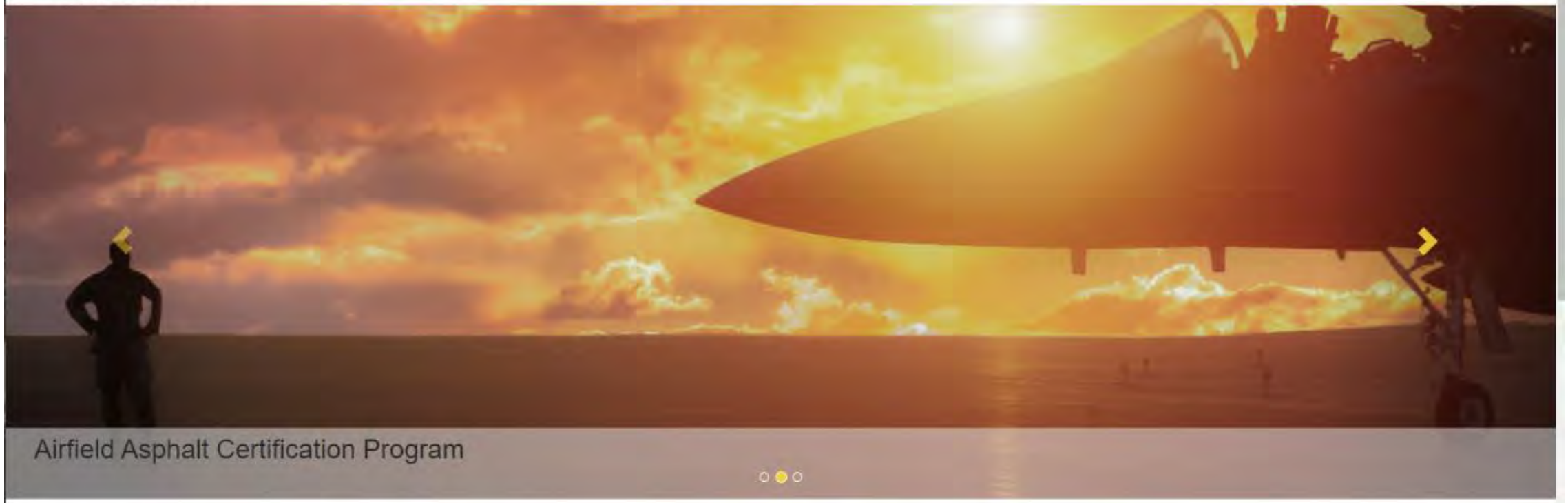
217 views • 3 months ago

CC

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

www.ncat.us

About NCAT | Test Track | Pavement Preservation | Education & Training | Our Research



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

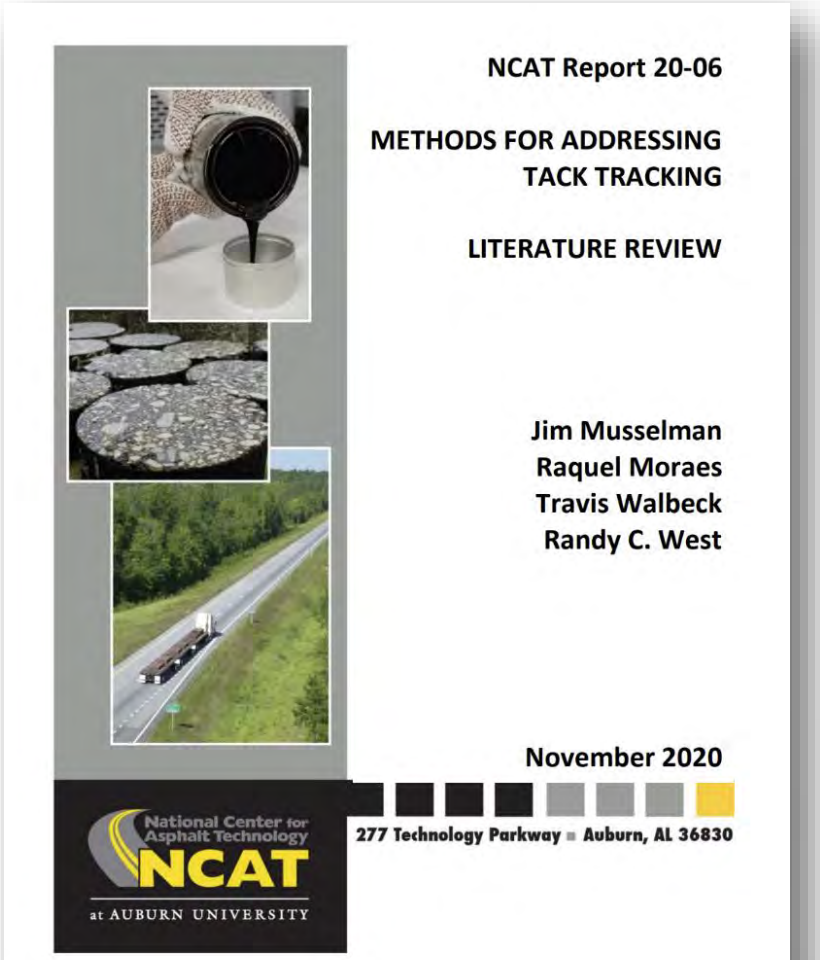
Our researchers and staff are instrumental in bringing new concepts and technologies to practice across the country.

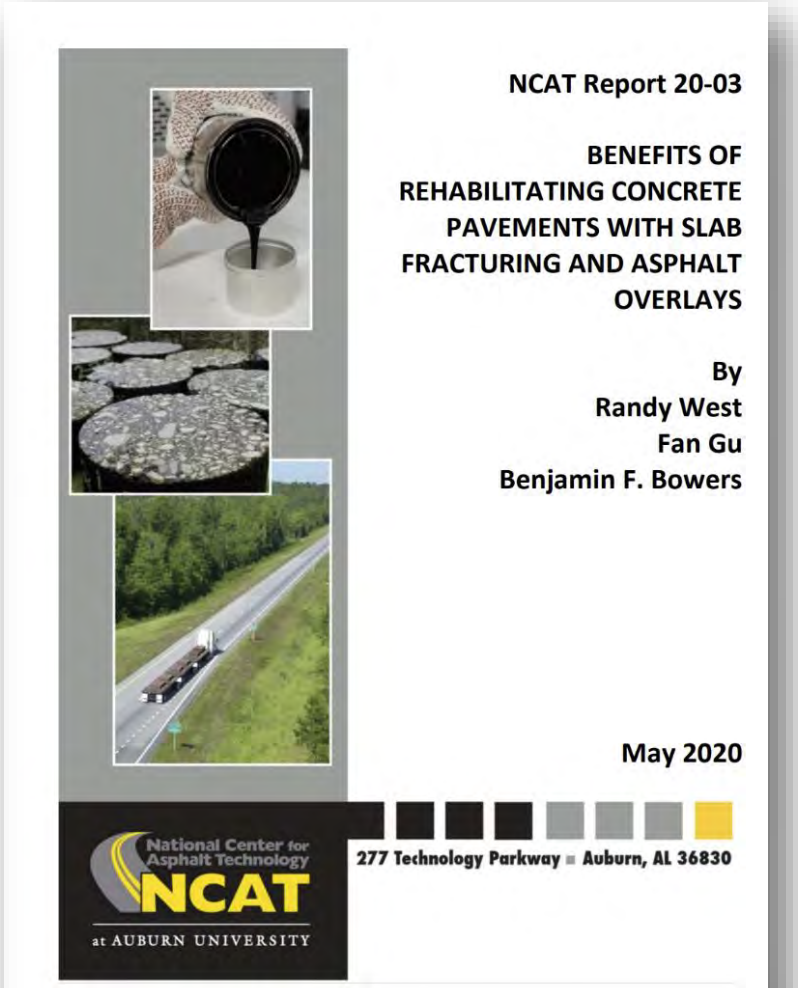
View details »

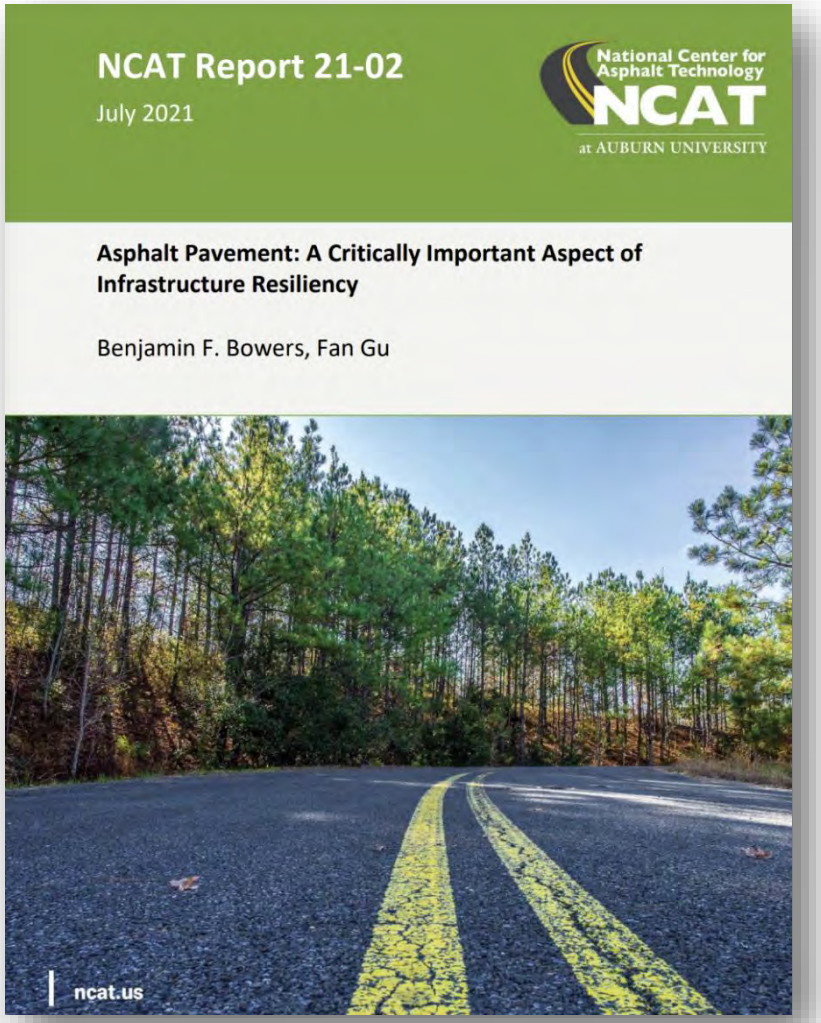
NCAT's mission is to provide innovative, relevant and implementable research, technology development and education that advances safe, durable and sustainable asphalt pavements.

Contents

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







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Cracking Group Experiment 2015-2021

Cracking Group Experiment

Which Tests Correlate to Field the Best?

Energy Ratio

SCB-LA

I-FIT

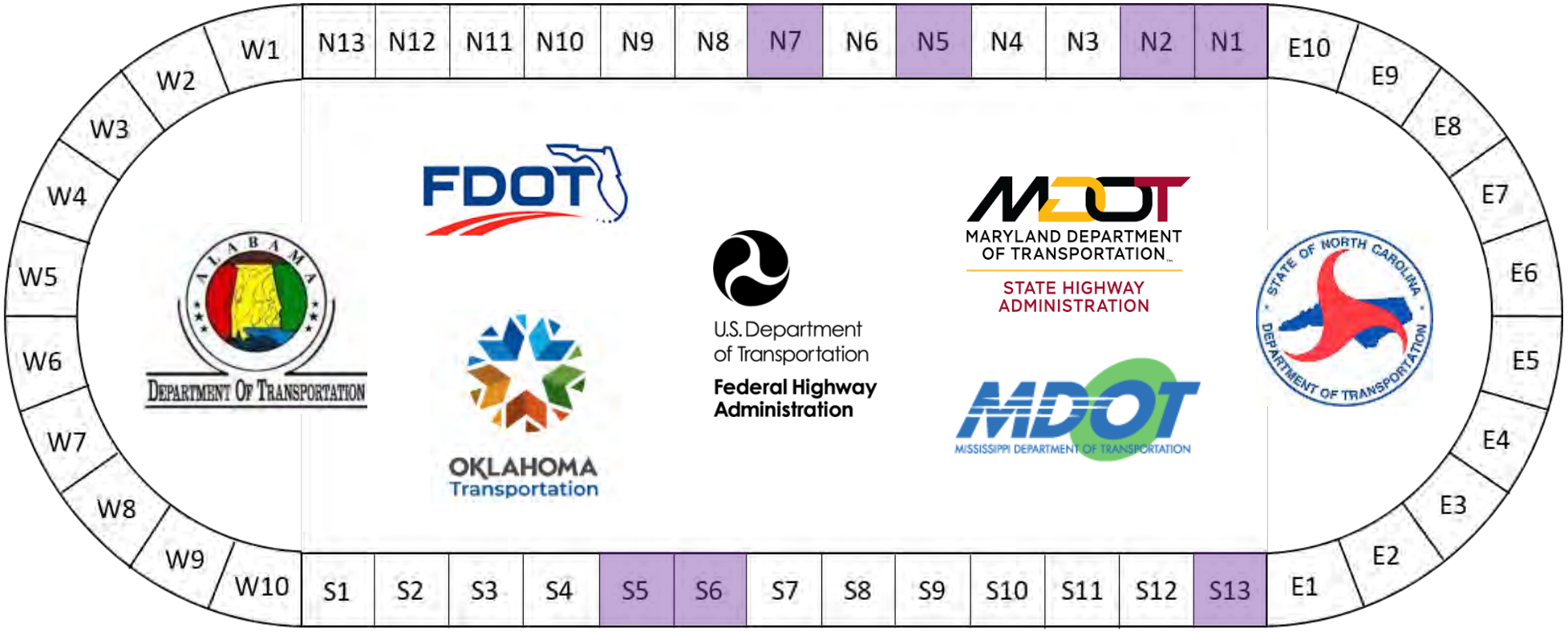
OT-TX

OT-NCAT

IDEAL-CT

AMPT Cyclic Fatigue

2015-2021 NCAT Cracking Group Experiment Sponsors

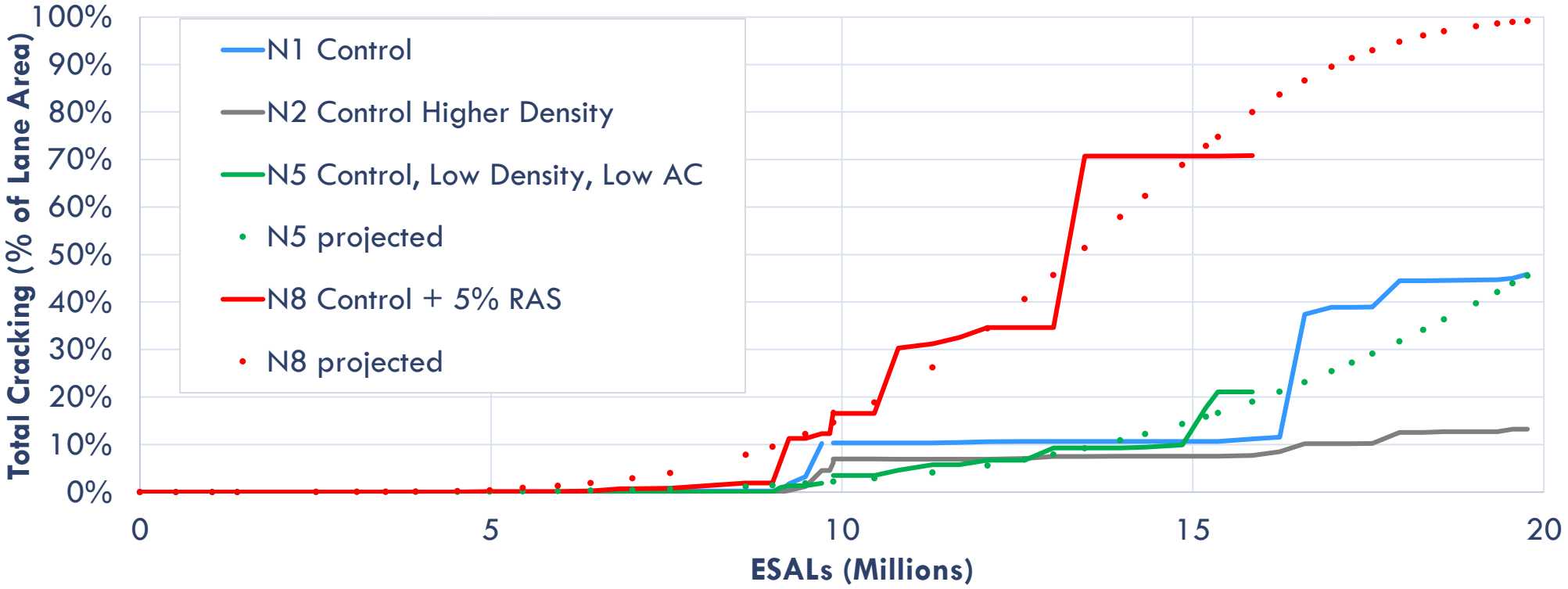


Test Section Layer Thicknesses

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


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

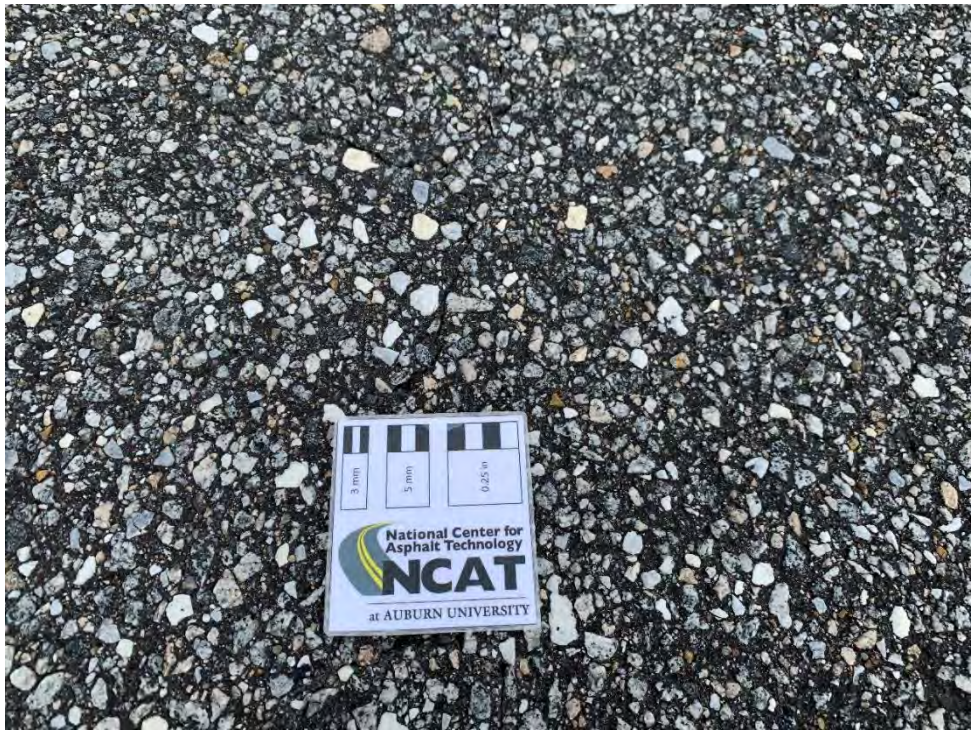
NCAT Cracking Group Experiment - Performance

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

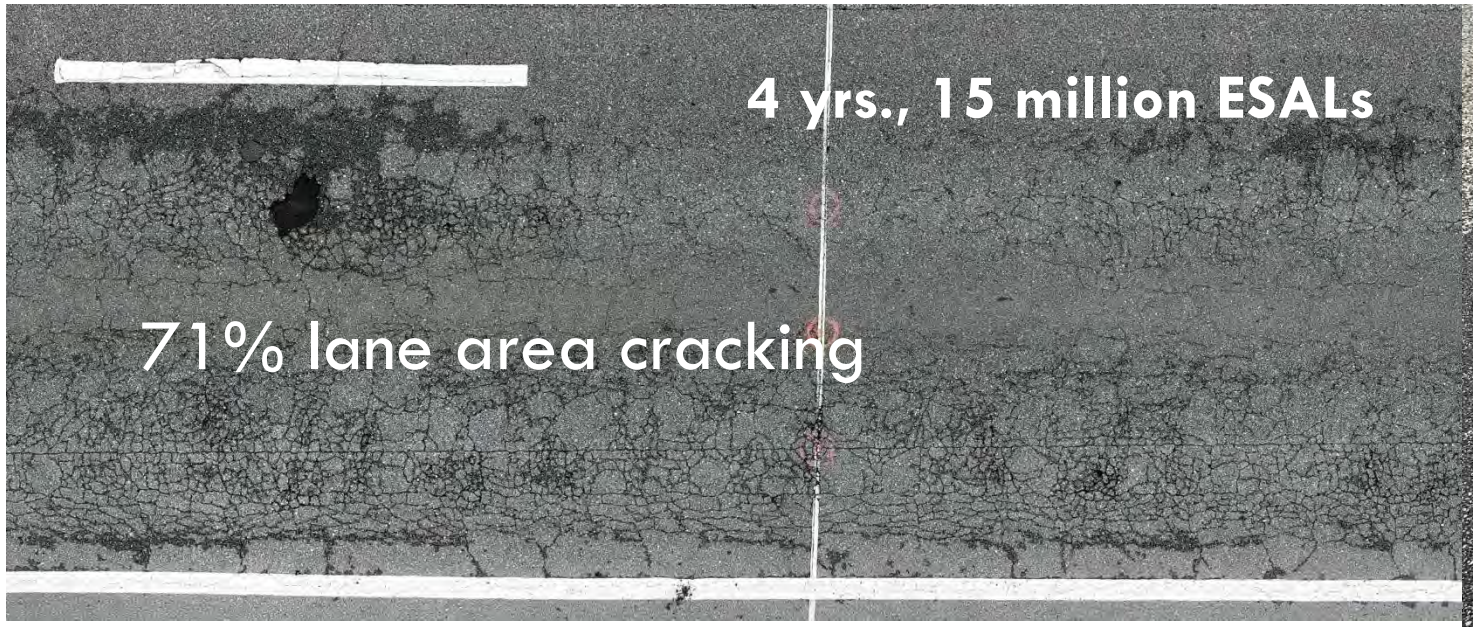


N2 (Control, 2.5% Higher Density), Jan. 2021

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

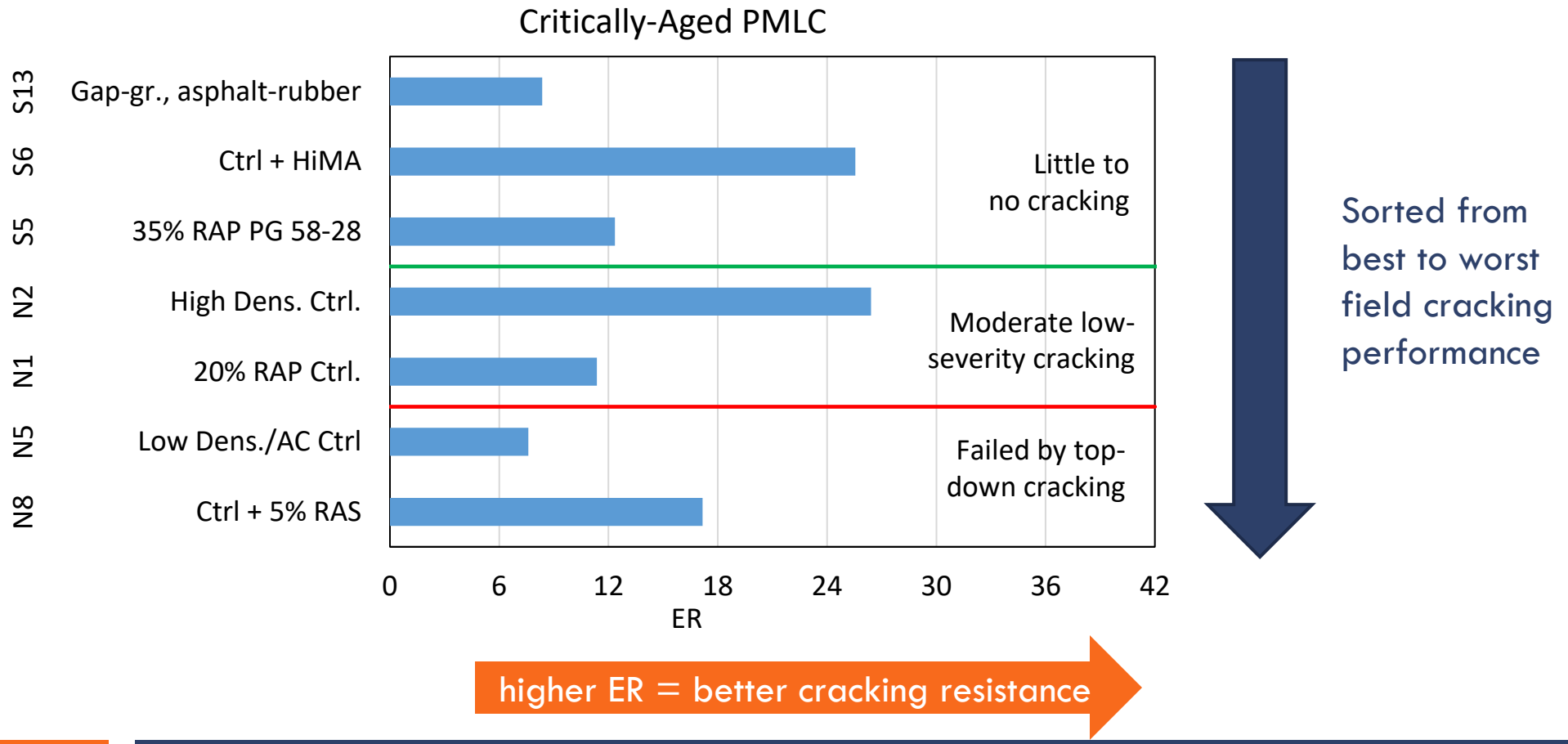
Tests* were conducted on:

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

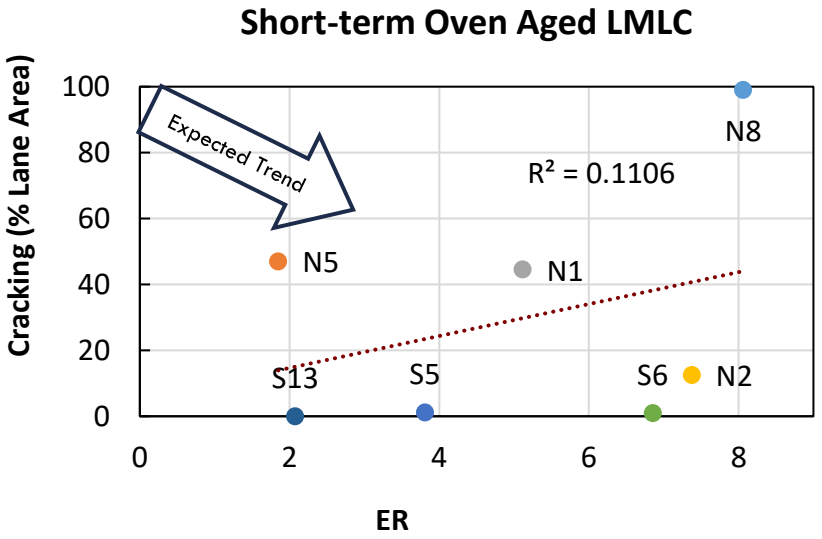
*AMPT Cyclic Fatigue Tests were tested only on plant mix samples

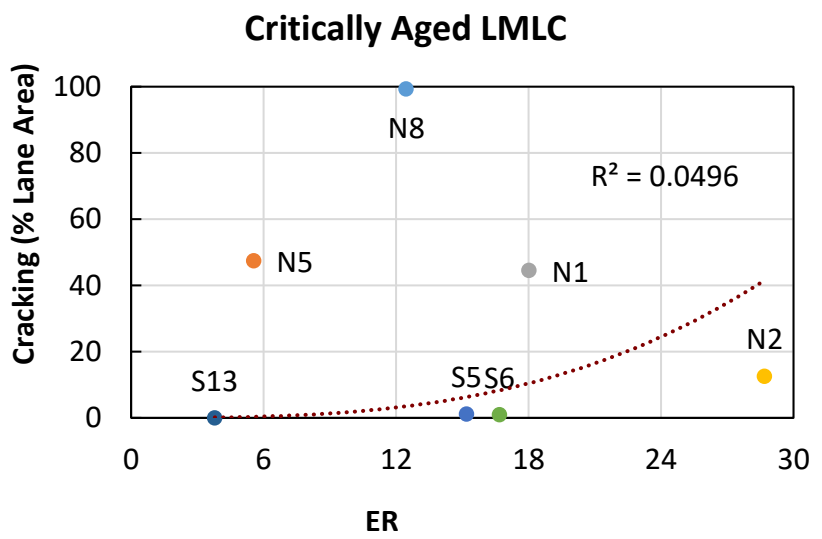
Energy Ratio

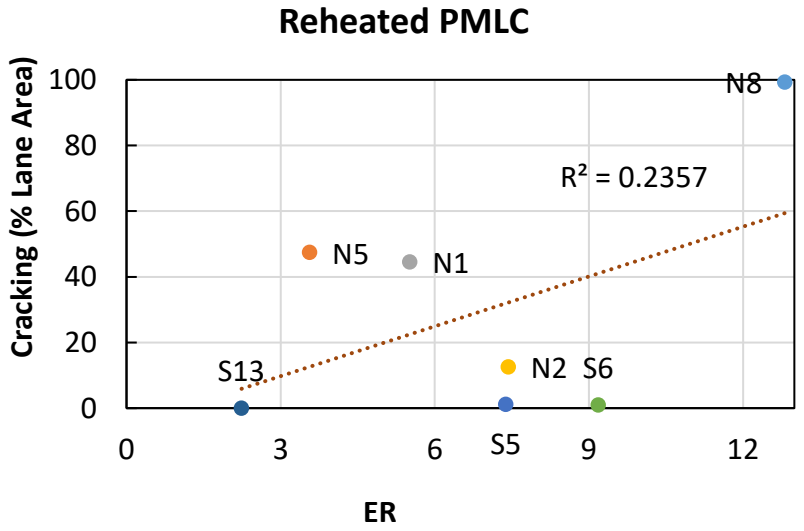
Energy Ratio

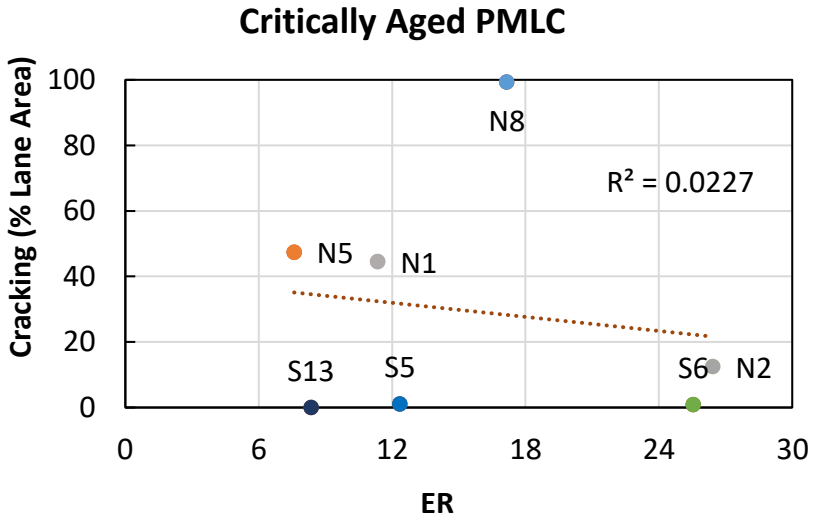


Correlations of Energy Ratio to Cracking on the Test Track





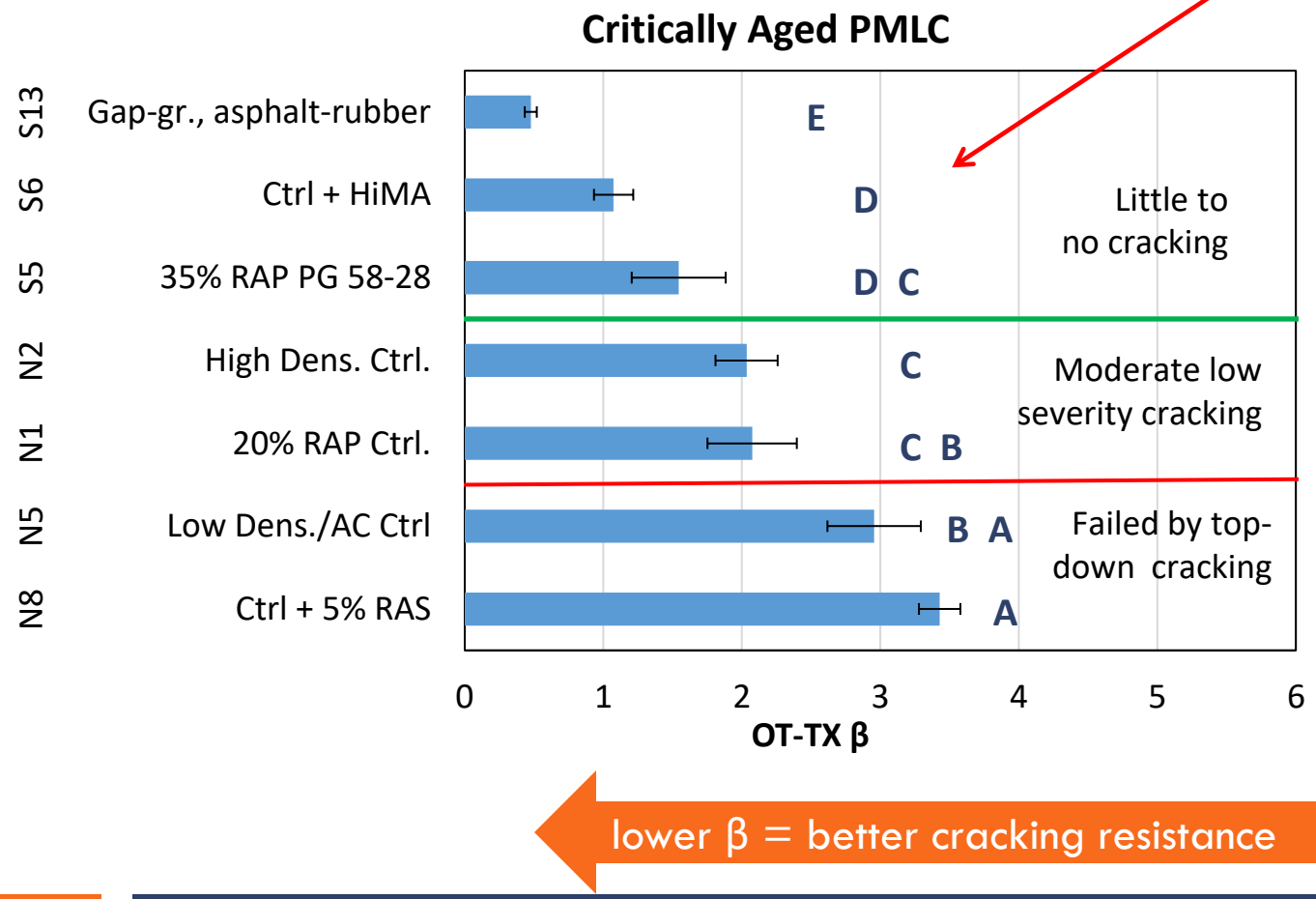




Texas Overlay Test (Tex-248-F)

Results with the same letter are not statistically different

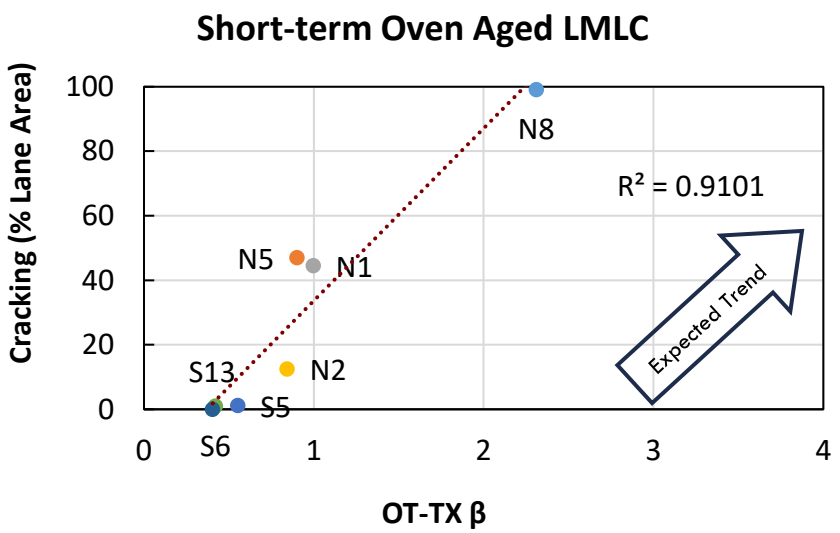
OT-TX

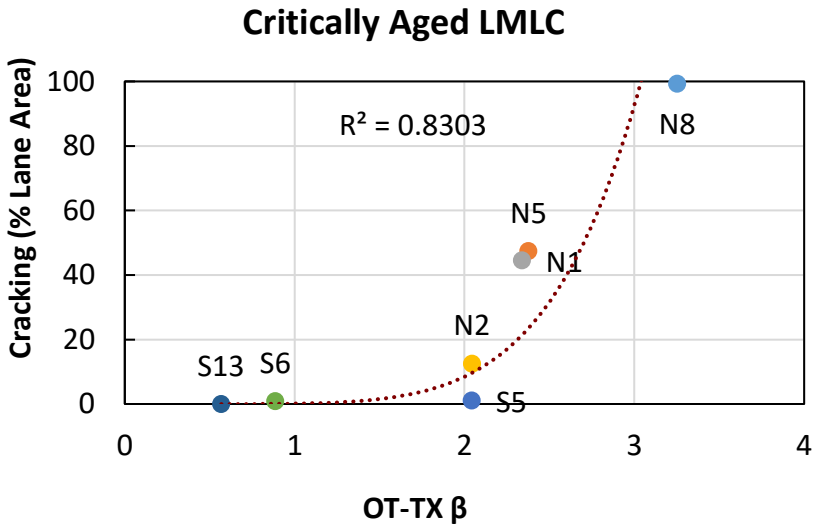


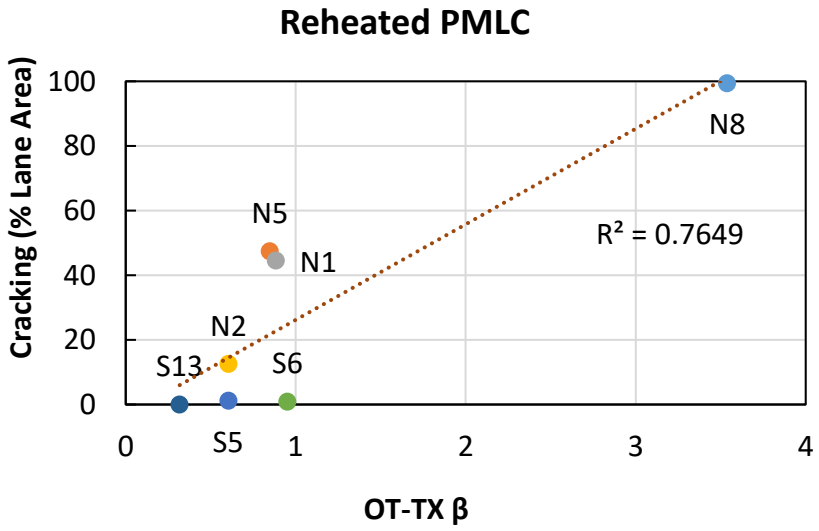
Sorted from best to worst field cracking performance

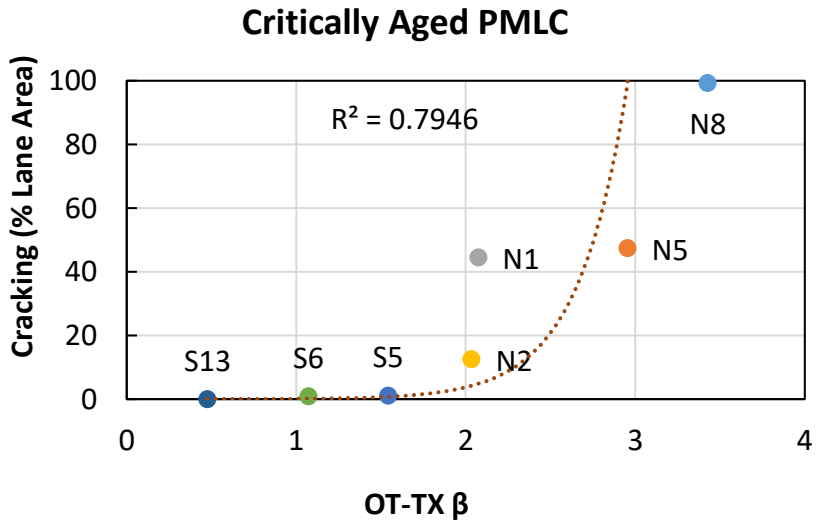
lower β = better cracking resistance

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





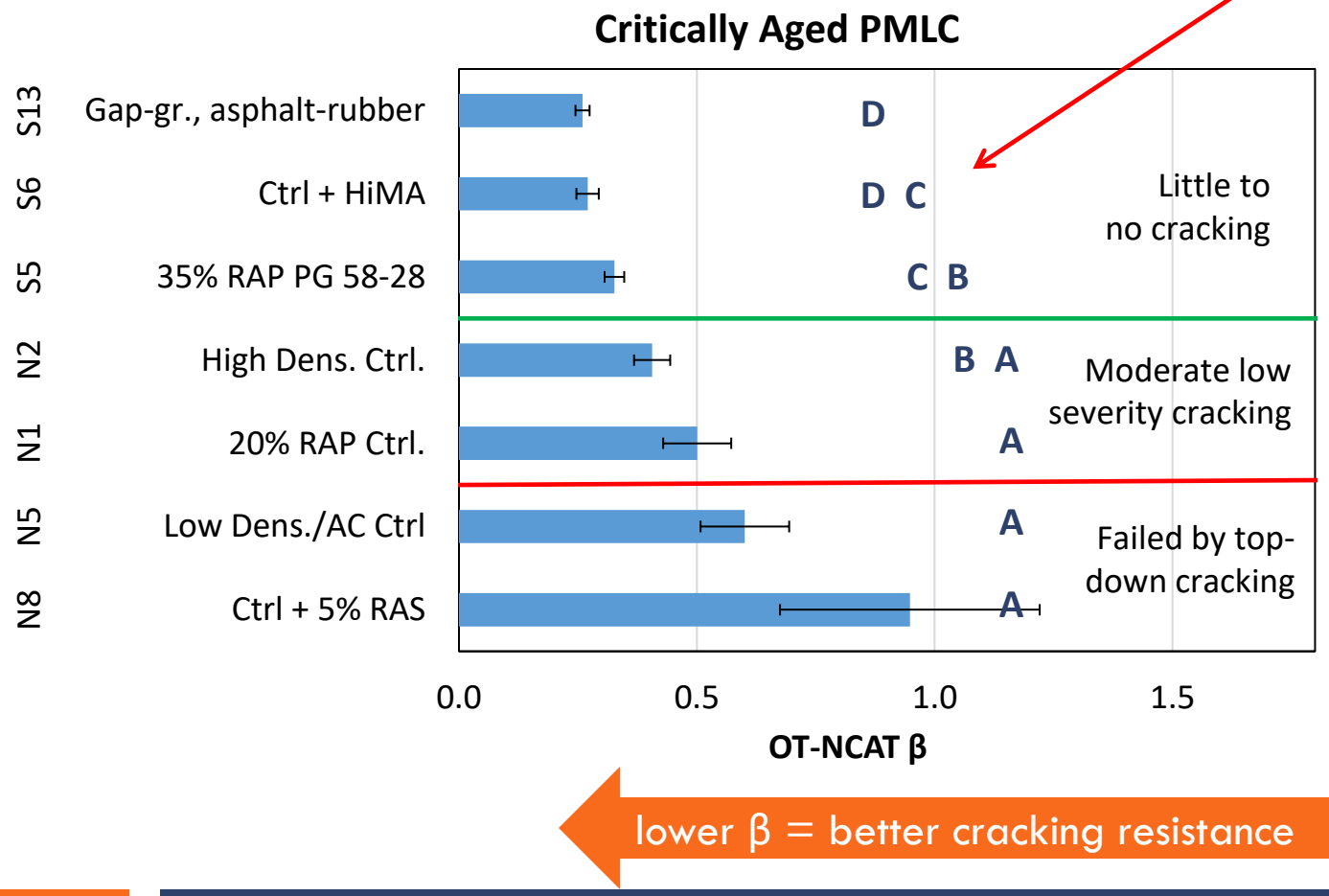




NCAT Overlay Test (Ma, 2014)

Results with the same letter are not statistically different

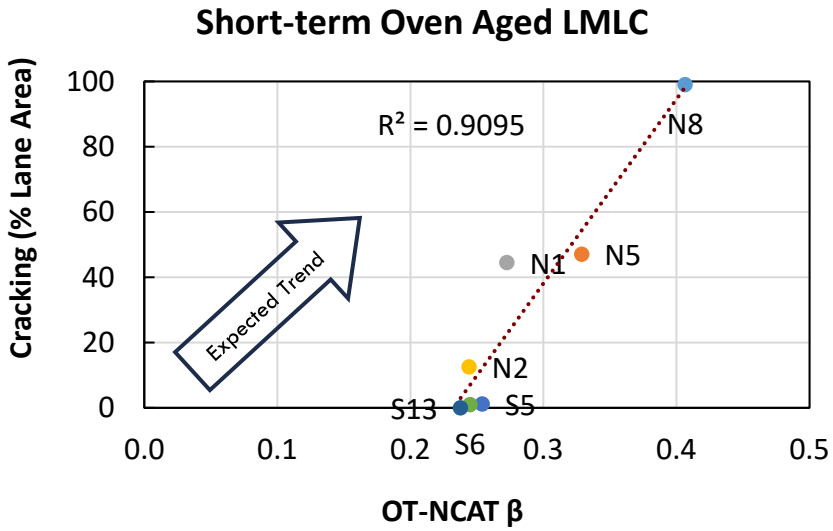
OT-NCAT

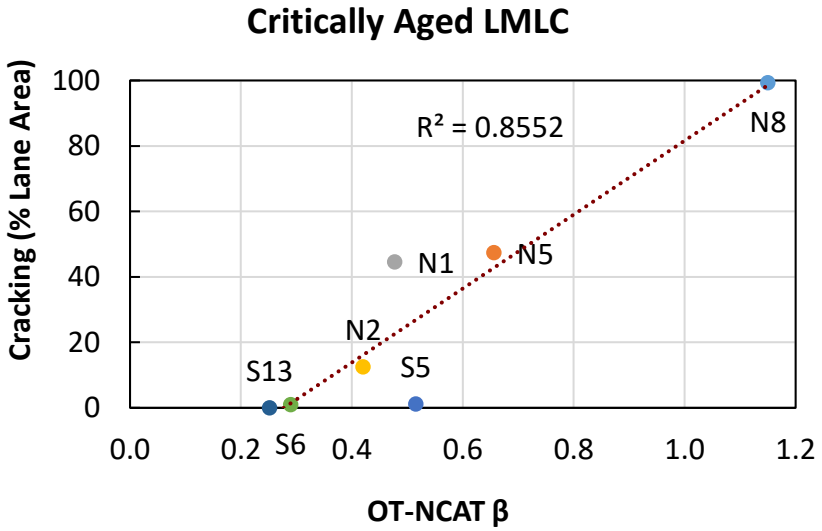


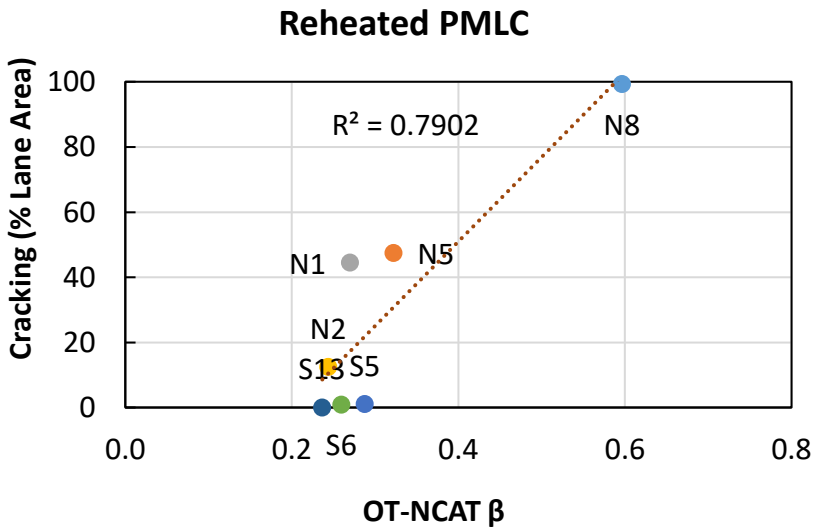
Sorted from best to worst field cracking performance

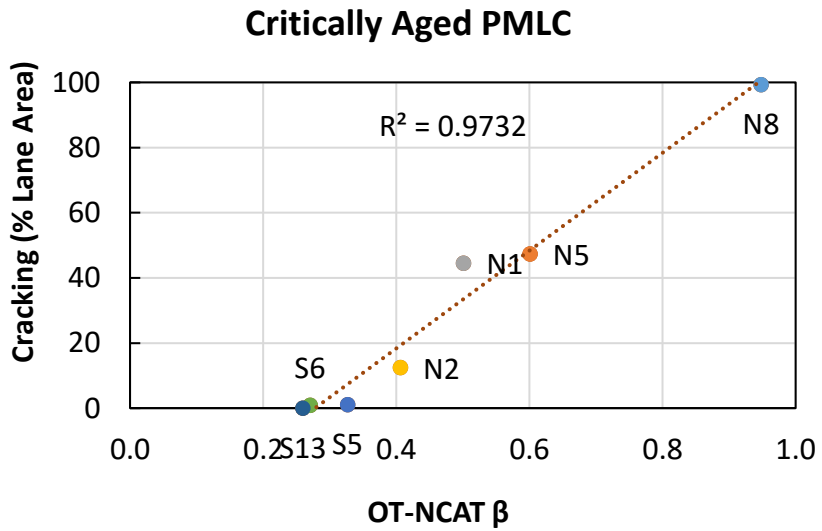
lower β = better cracking resistance

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



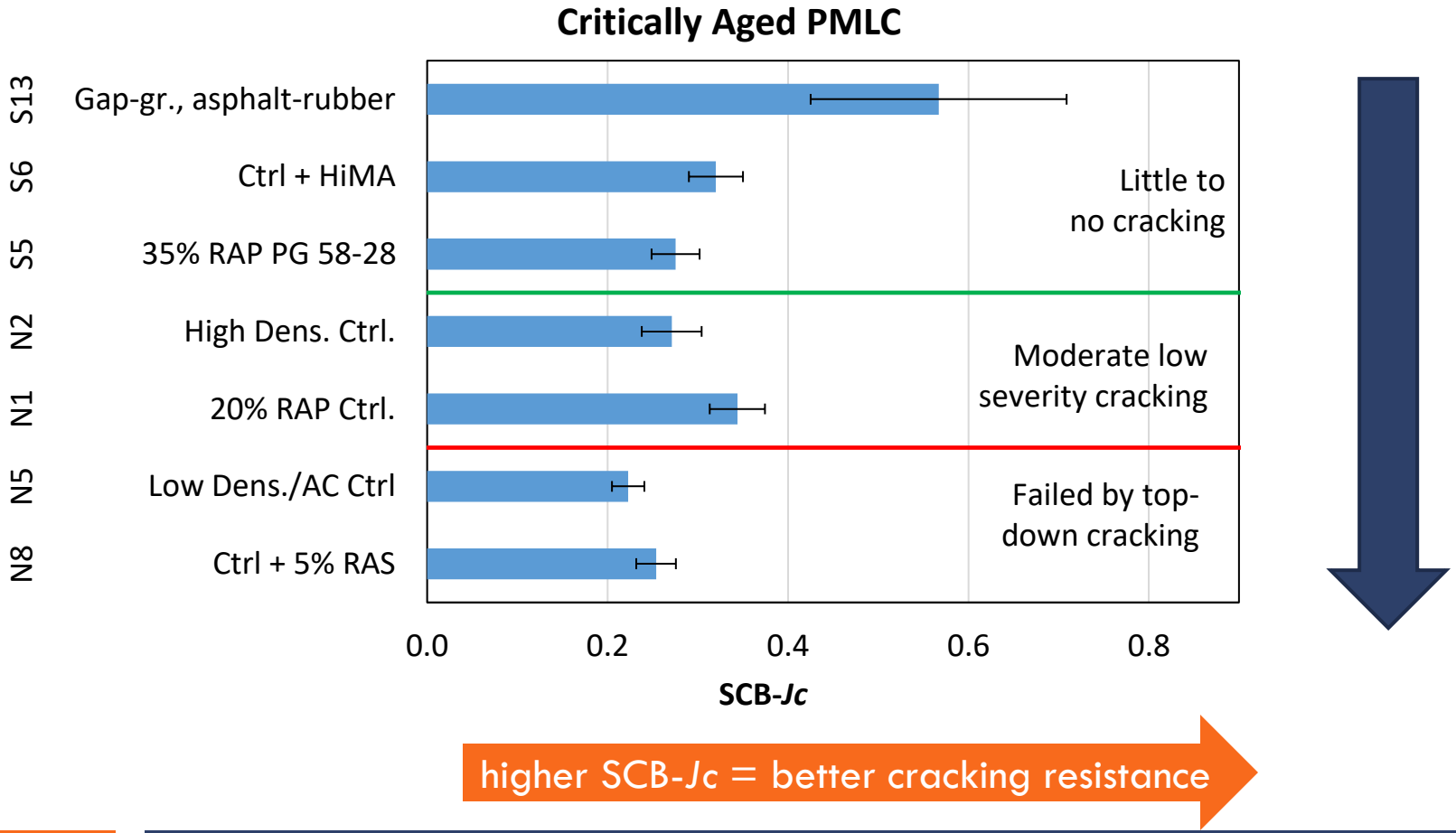






Louisiana SCB Test (ASTM D8044-16)

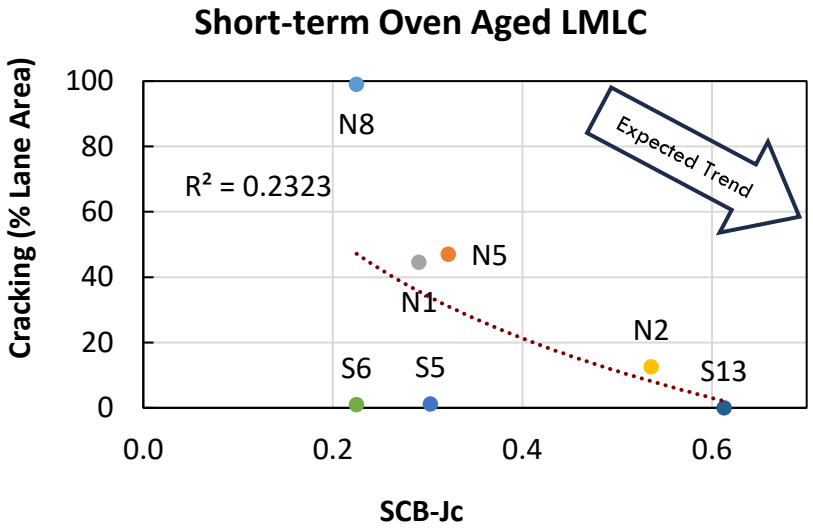
SCB-LA

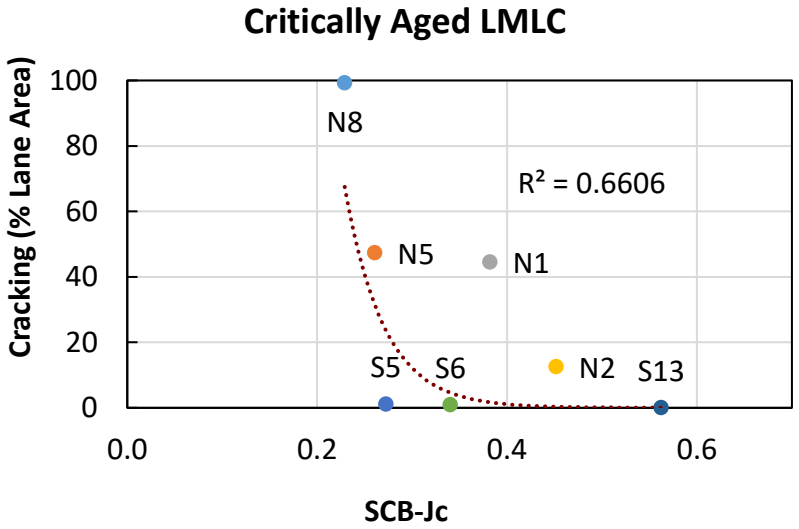


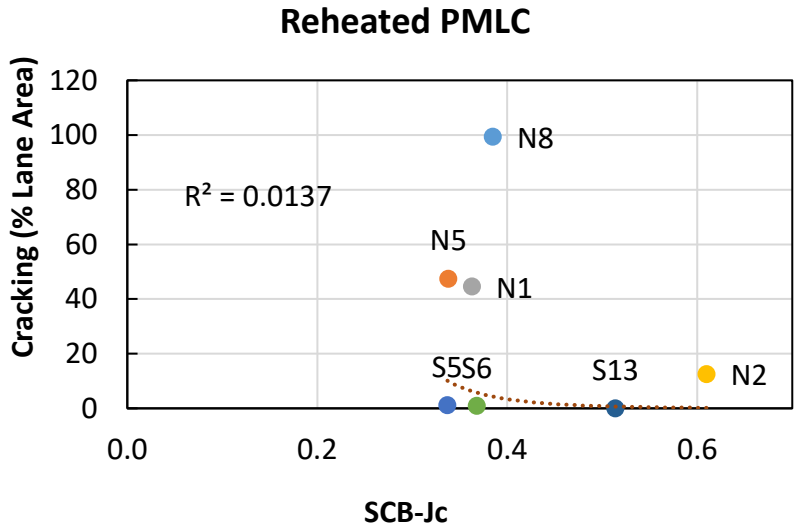
Sorted from best to worst field cracking performance

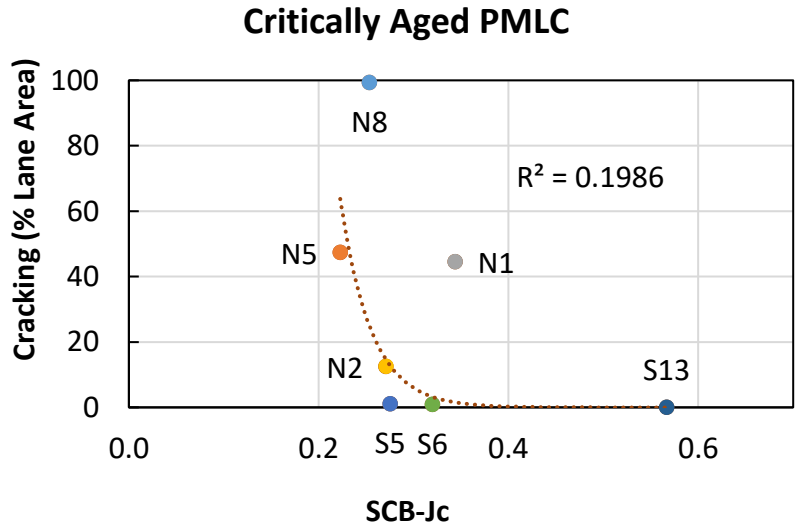
higher SCB-*Jc* = better cracking resistance

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



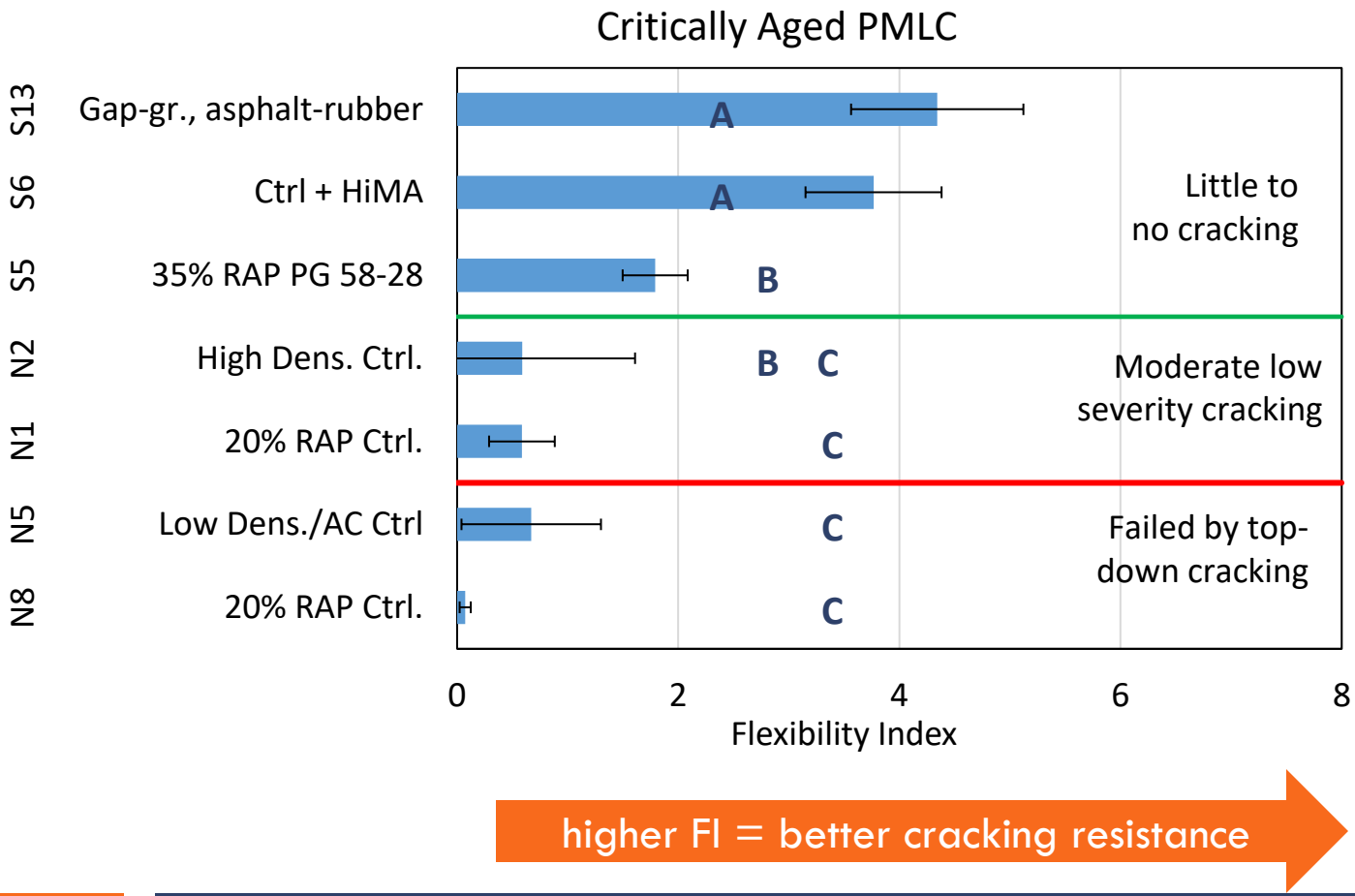






Illinois Flexibility Index Test (AASHTO TP 124)

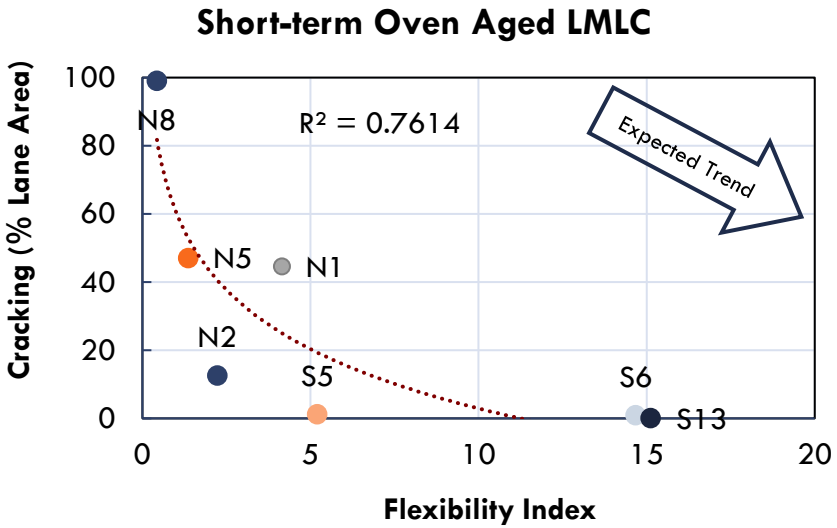
I-FIT

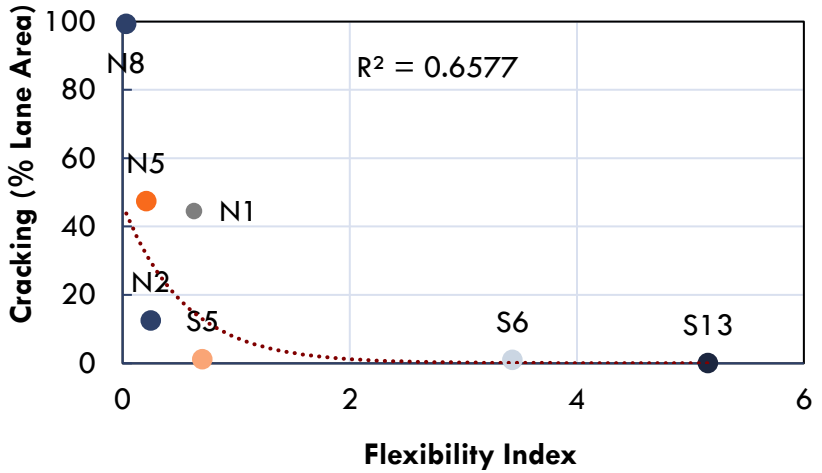


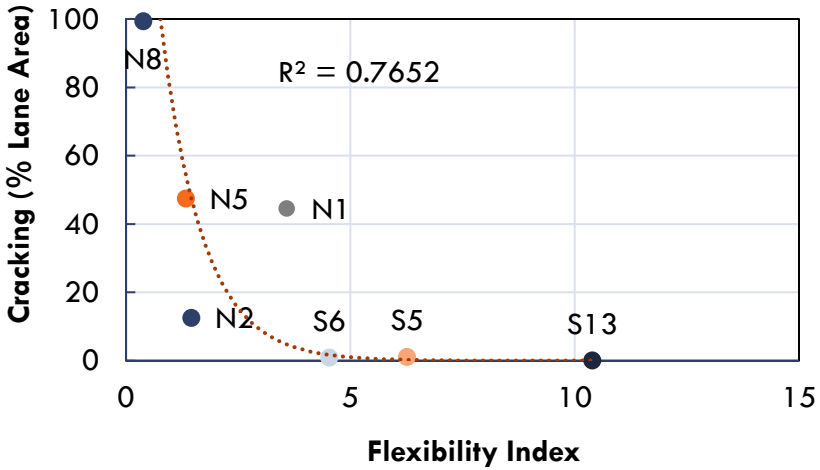
Sorted from best to worst field cracking performance

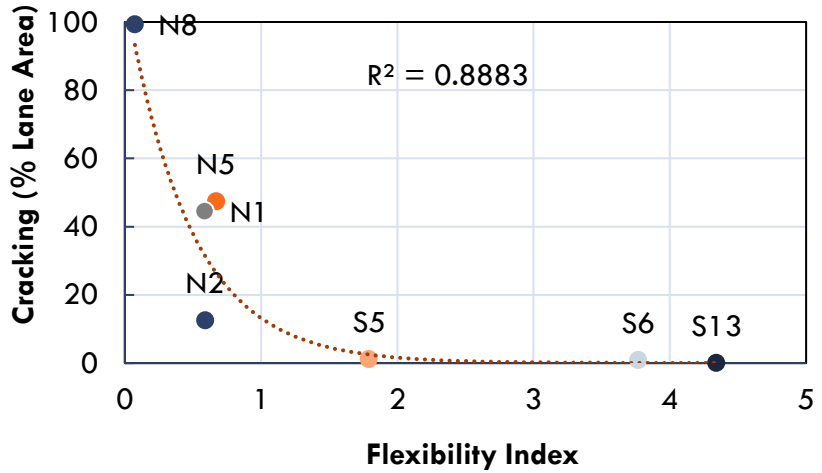
higher FI = better cracking resistance

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



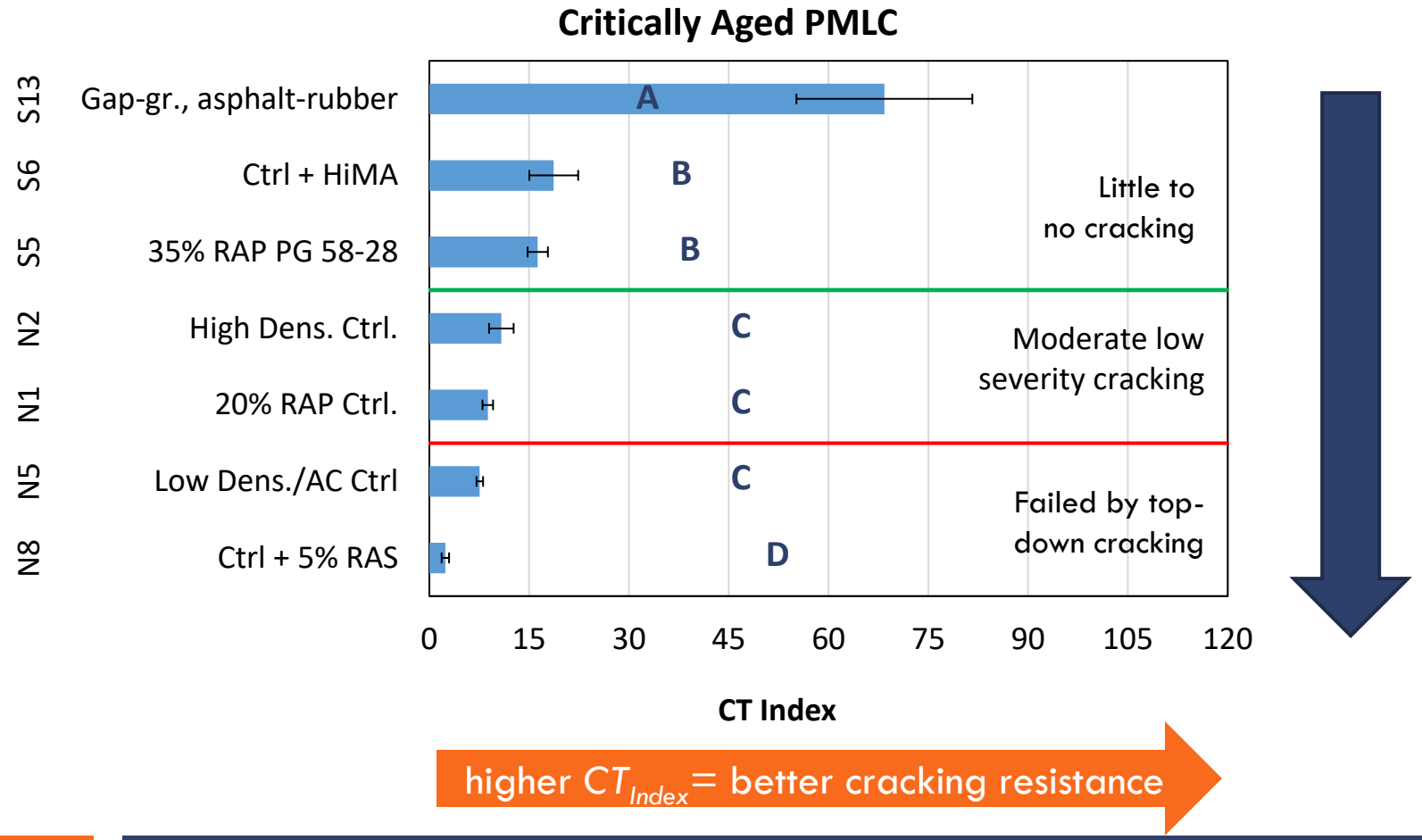






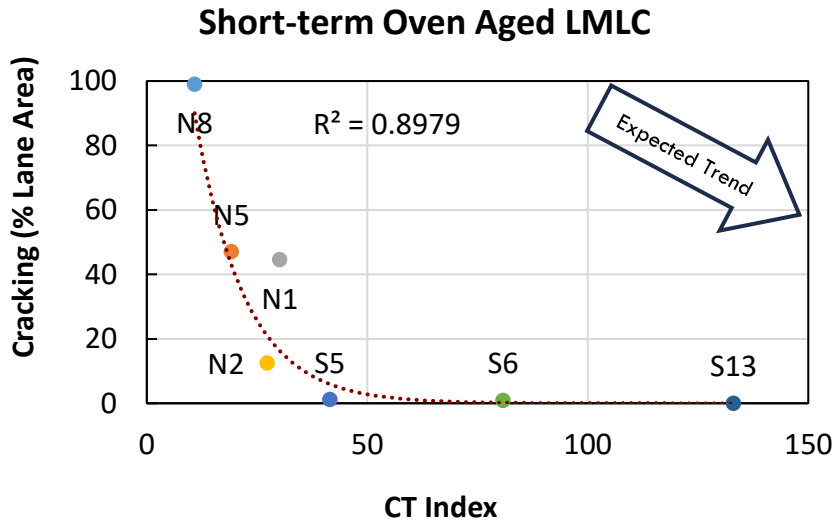
IDEAL-CT Test (ASTM D8225-19)

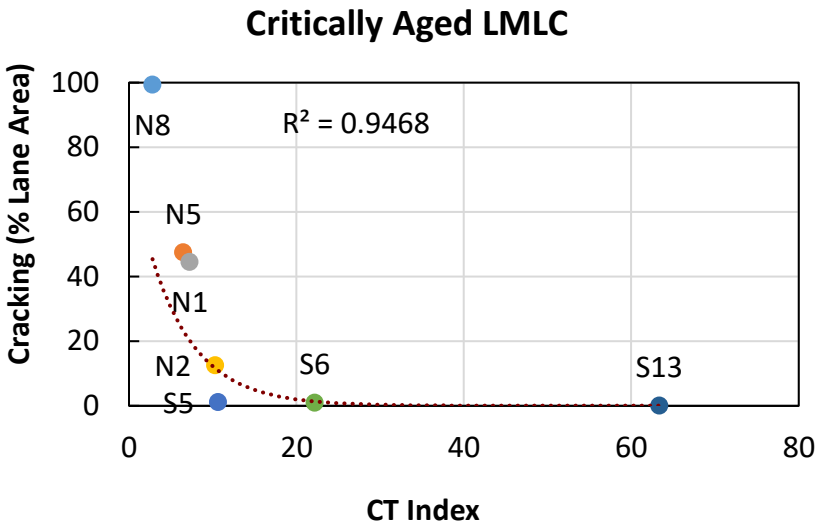
IDEAL-CT

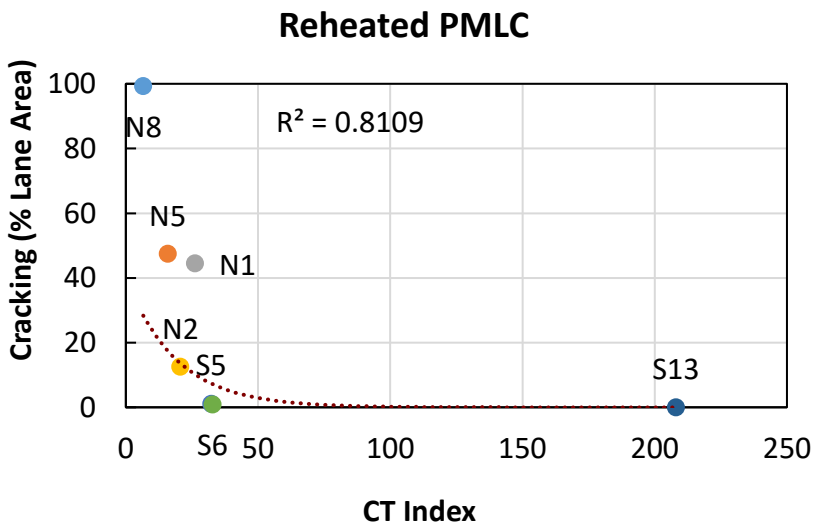


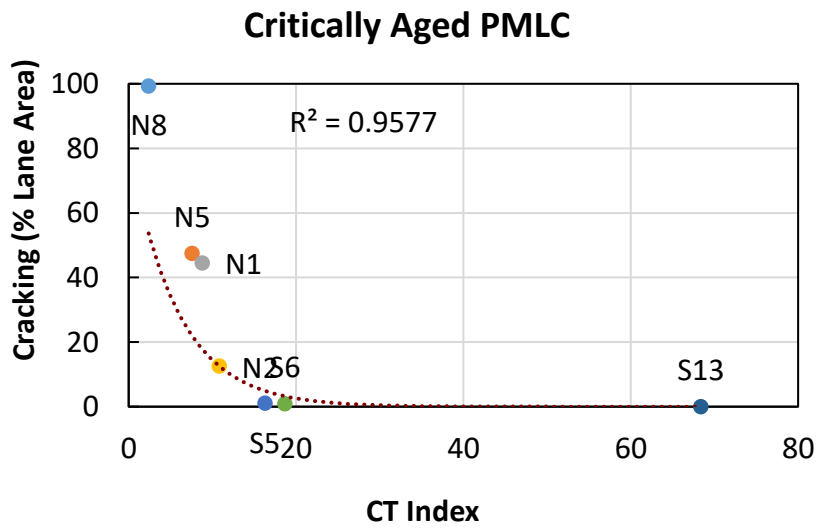
Sorted from best to worst field cracking performance

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



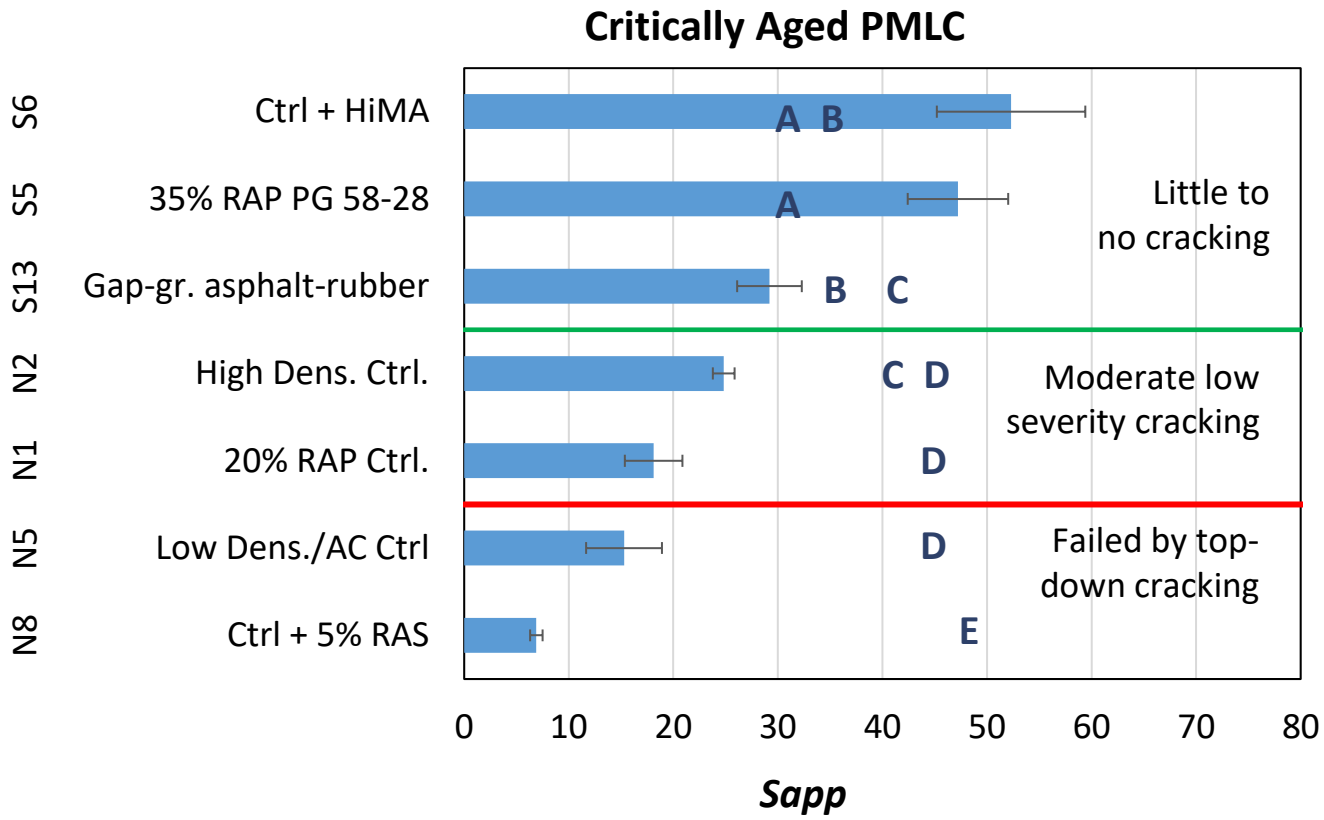






AMPT Cyclic Fatigue Test (AASHTO TP 133-19)

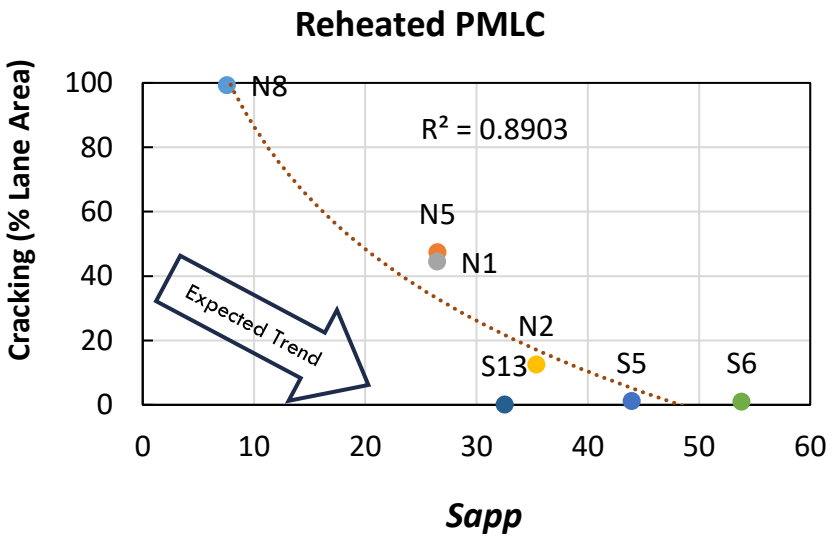
AMPT Cyclic Fatigue

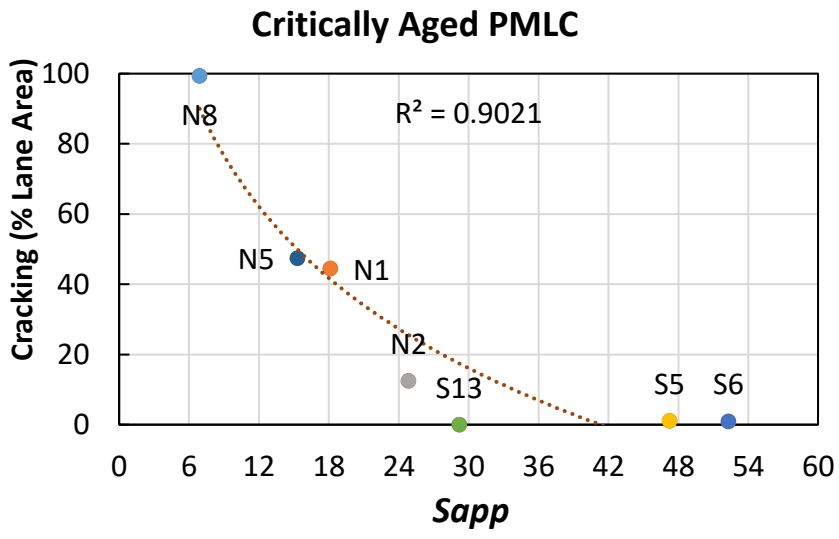


Sorted from best to worst field cracking performance

higher FI = better cracking resistance

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



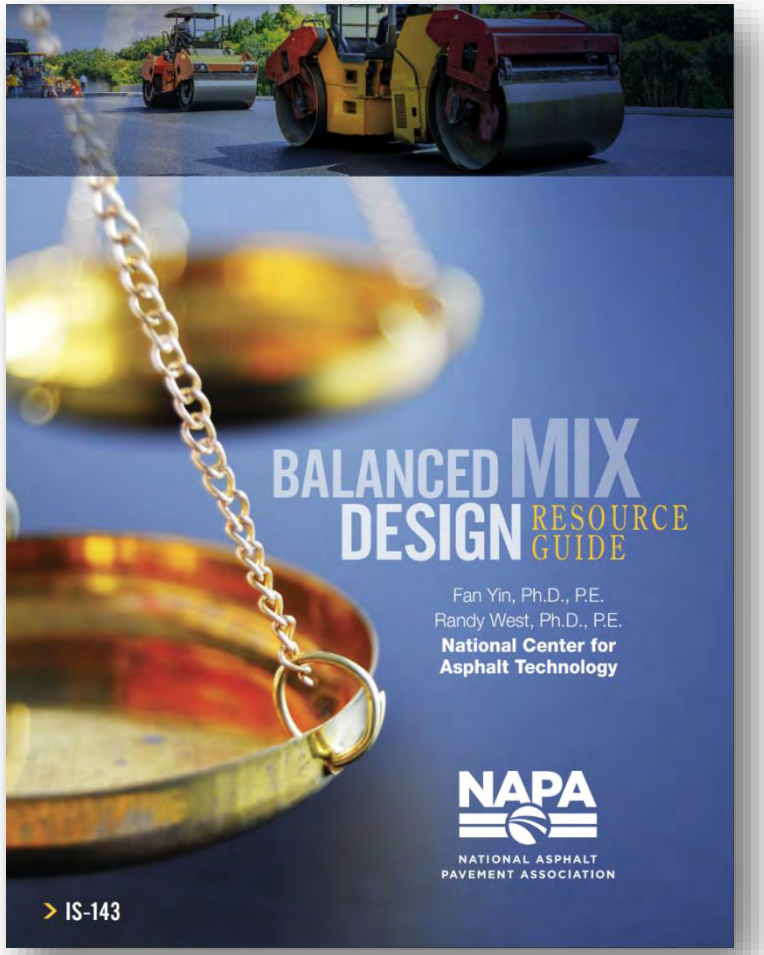


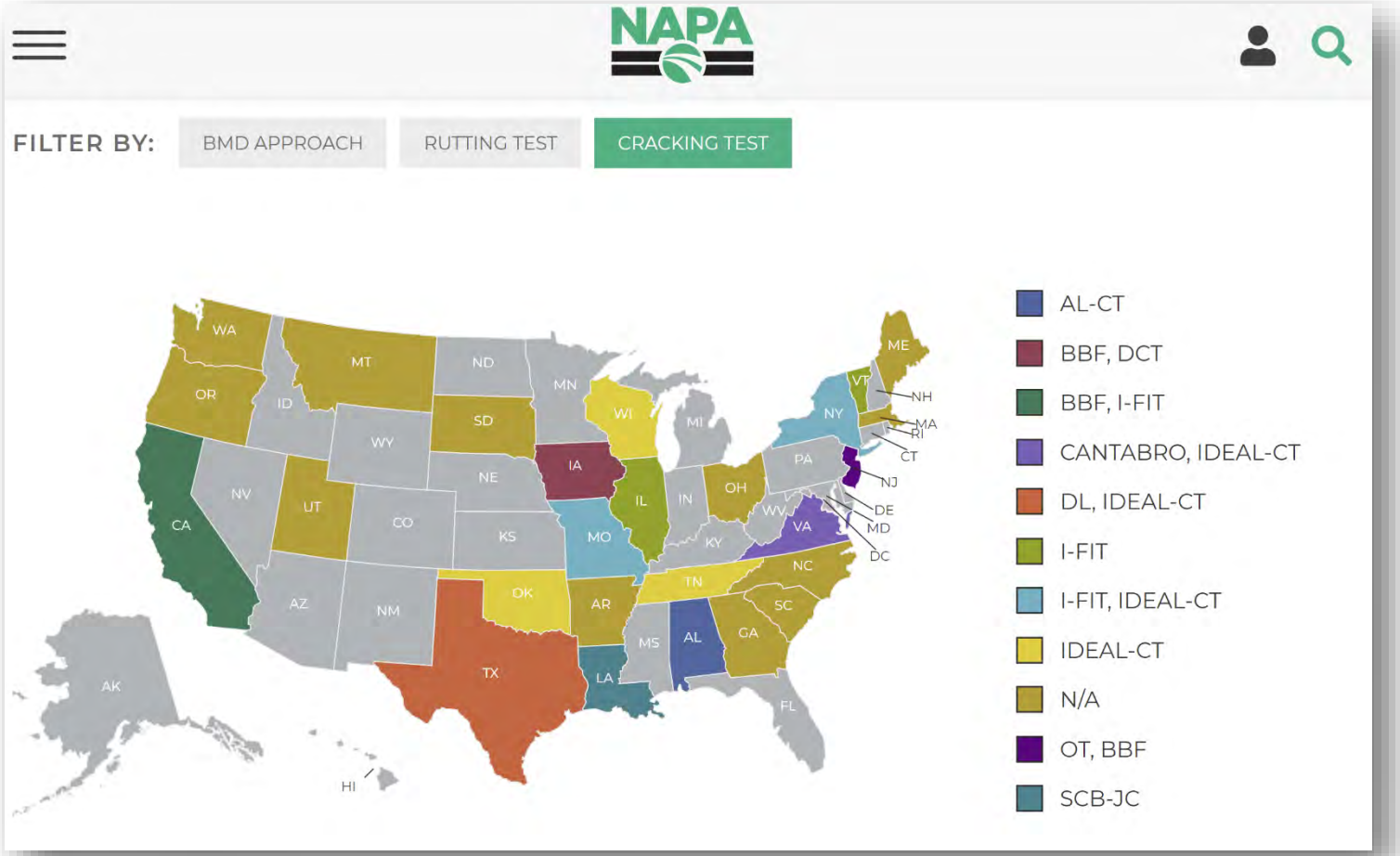
Summary of Correlations

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



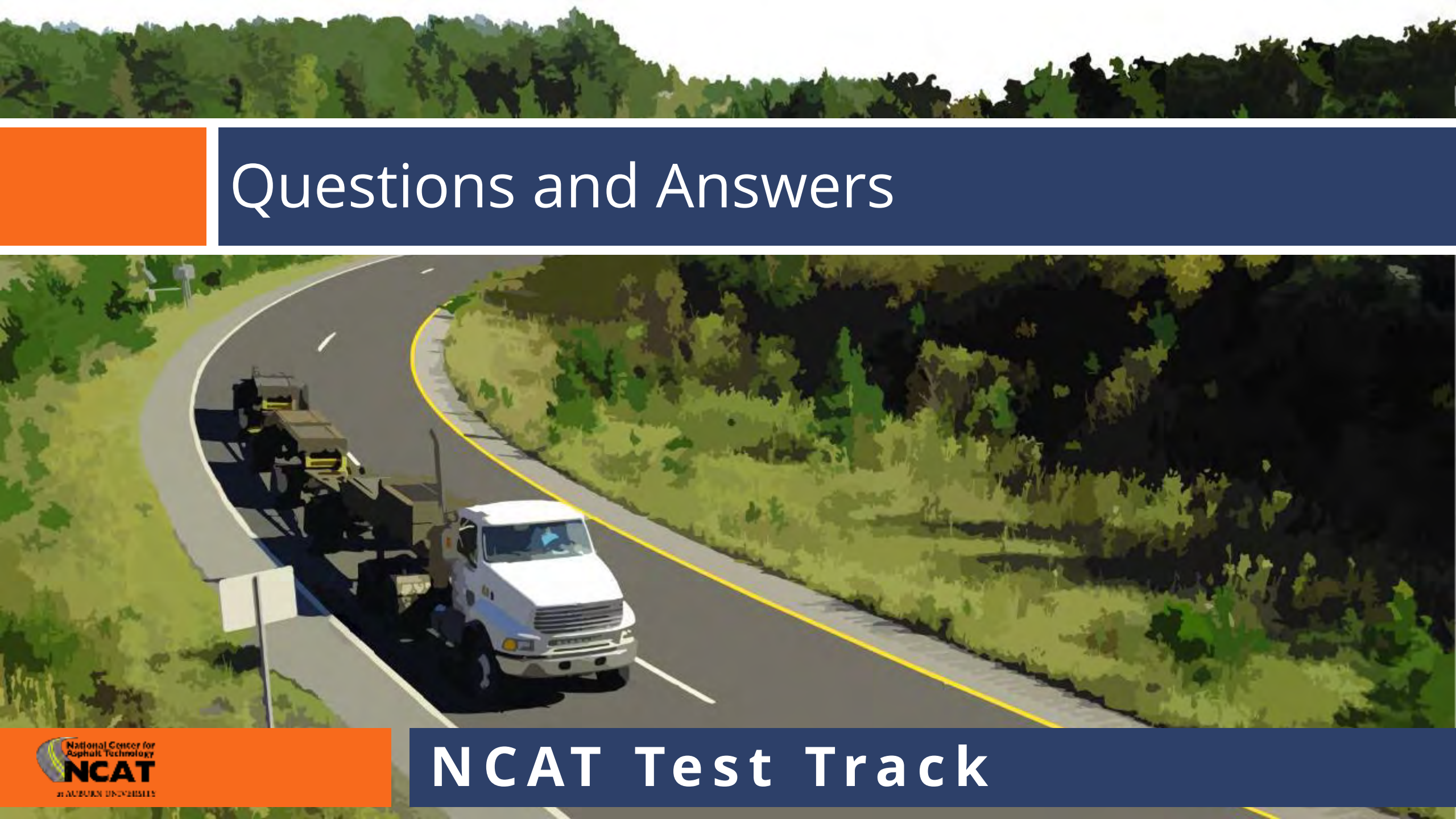


BMD Resources

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

The Bucket Brigade

Questions and Answers



National Center for Asphalt Technology
NCAT
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NCAT Test Track