National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

The Cracking Group Experiment

Randy West

SEVENTH
RESEARCH CYCLE

NCAT TEST TRACK CONFERENCE

Cracking Group Experiments

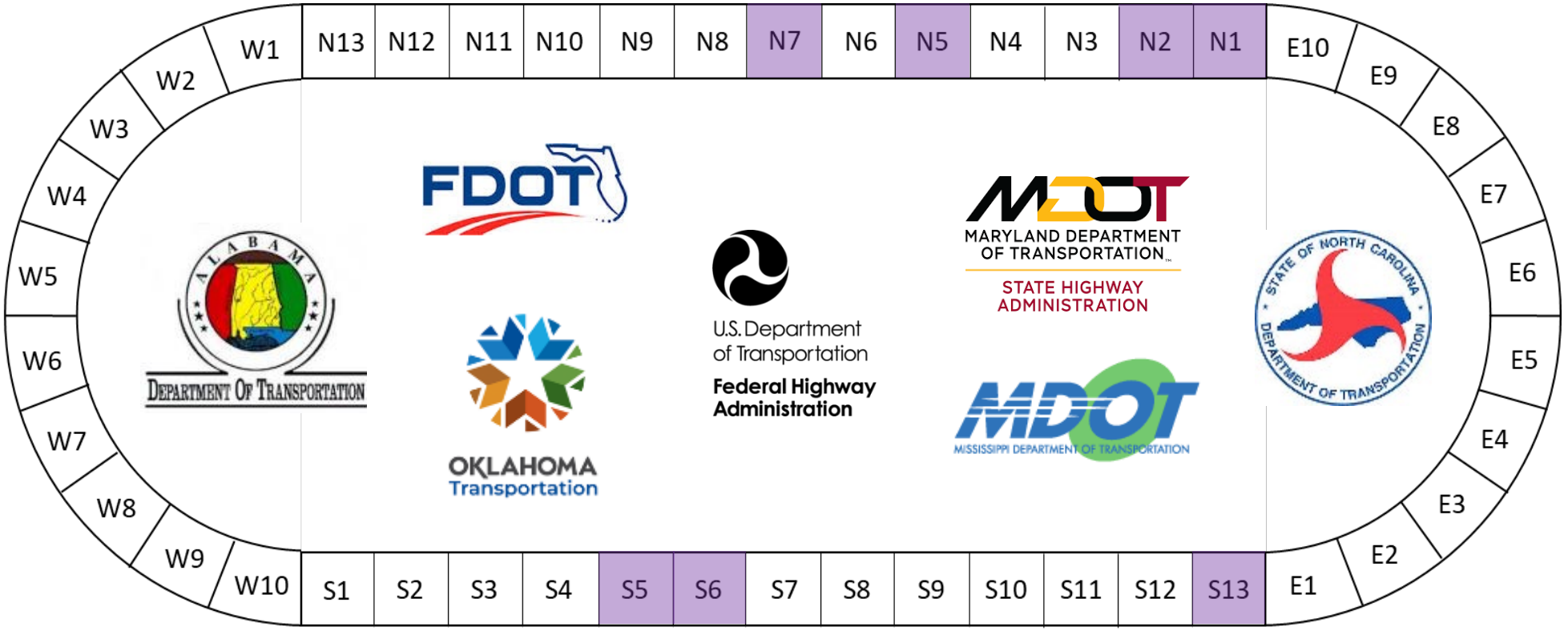
MnROAD

Low-temperature cracking

NCAT Test Track

Top-down cracking

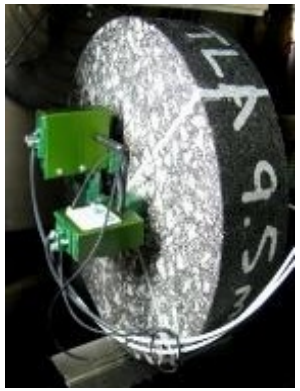
2015-2021 NCAT Cracking Group Experiment Sponsors



Cracking Group Experiment - Objective

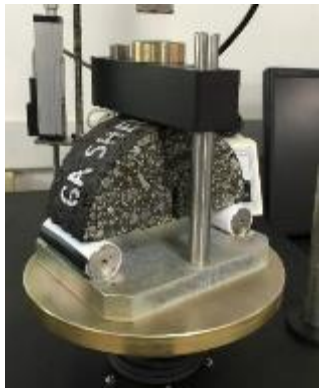
To determine which lab tests provide results that best match field performance.

Selected Top Down Cracking Tests



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

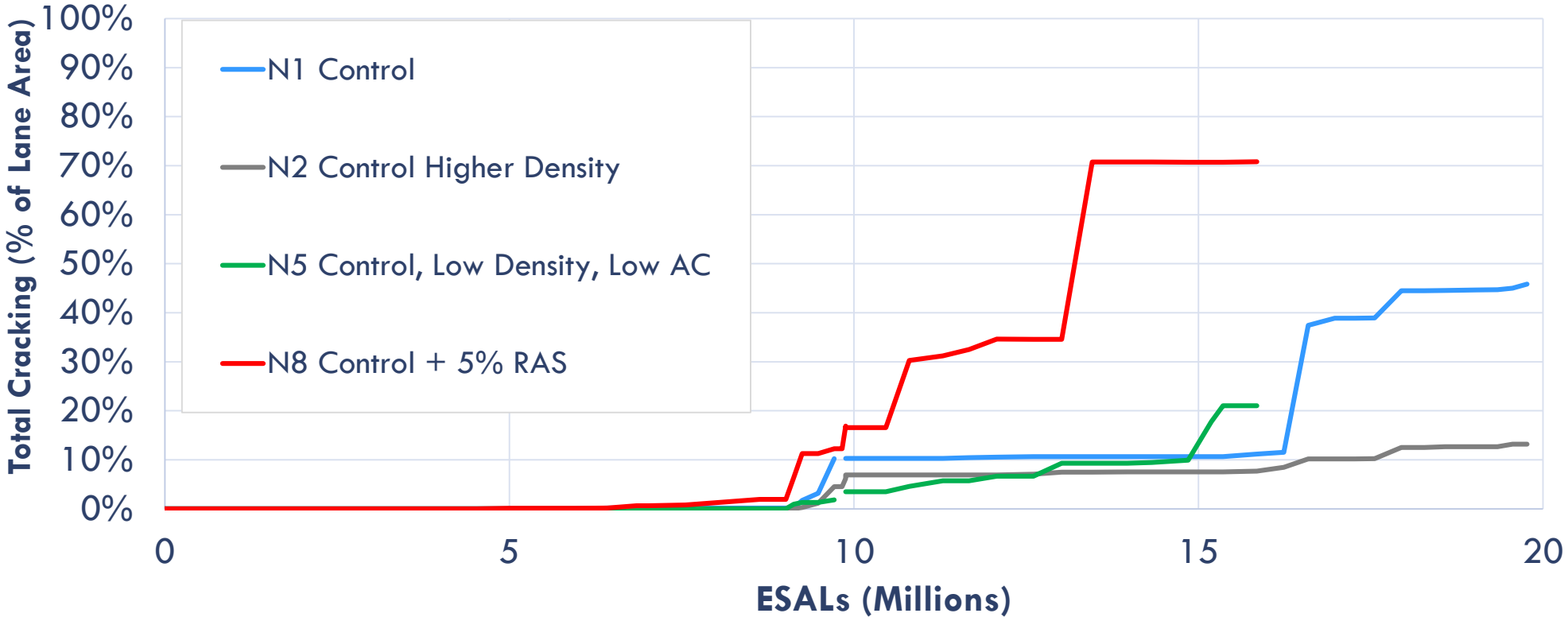
Test Section Layer Thicknesses

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

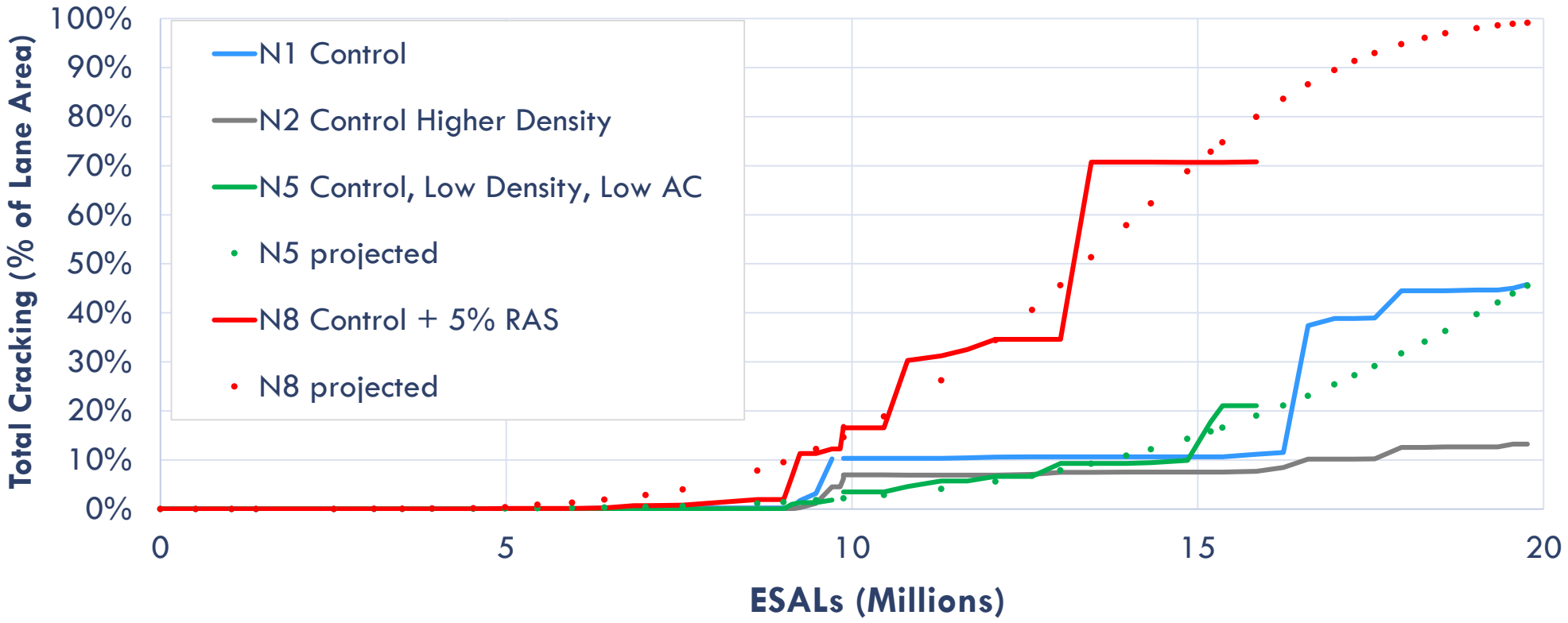
NCAT Cracking Group Experiment – Test Sections

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

Progression of Cracking



Progression of Cracking



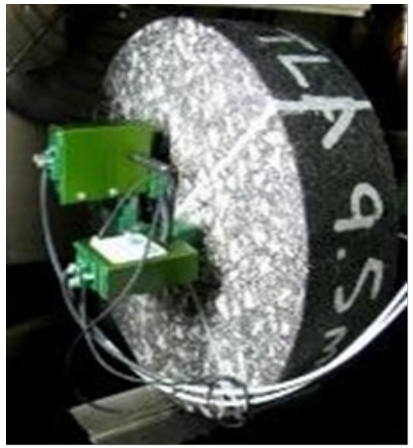
NCAT Cracking Group Experiment - Performance

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 64-28	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

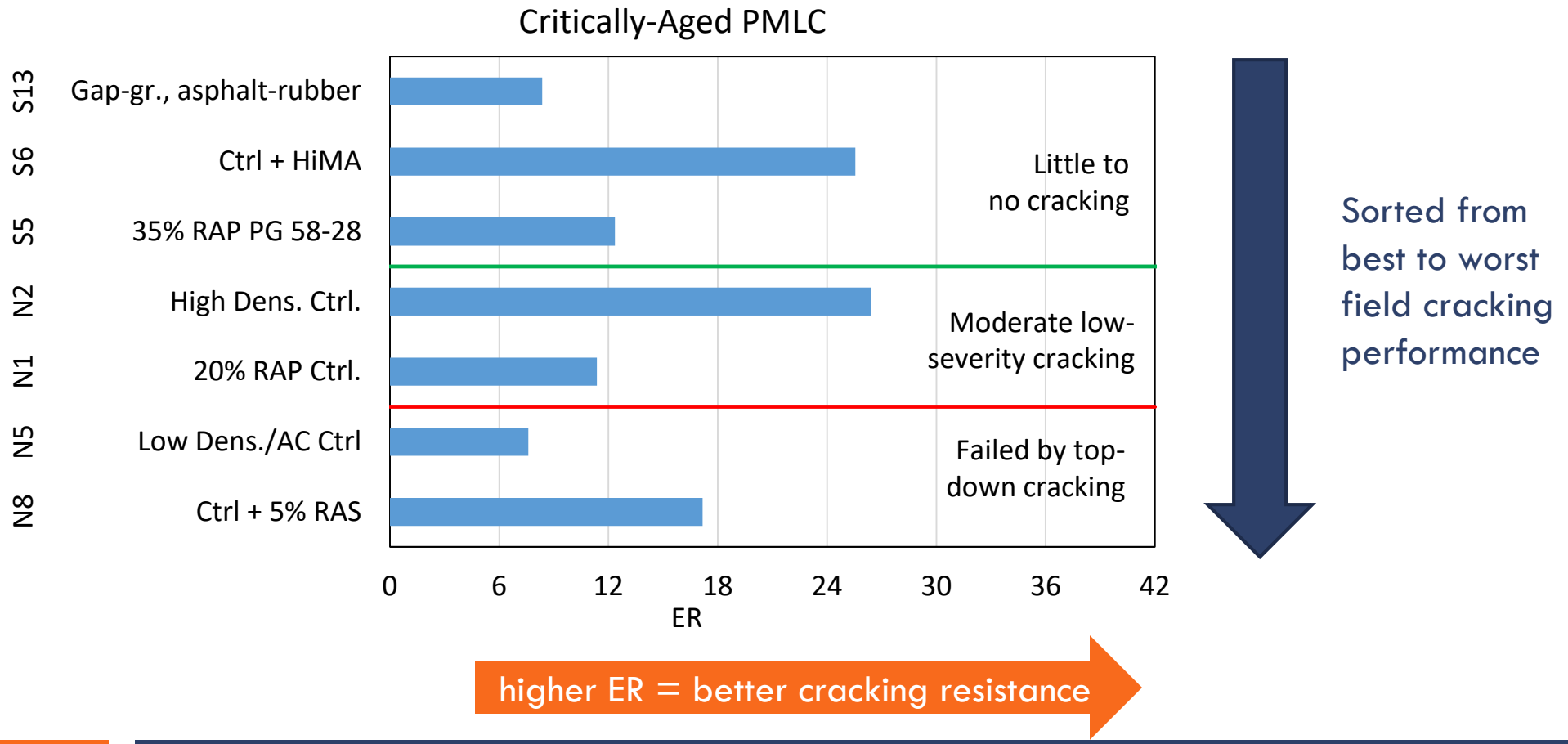
[a] Failed due to top down cracking. Removed from experiment in March 2020

[b] Projected from data through 16 MESALs using a sigmoidal function

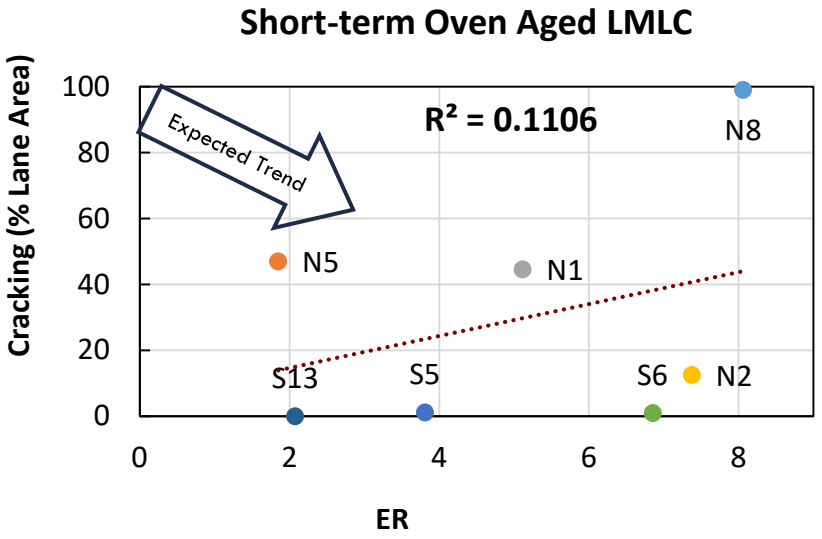
Energy Ratio

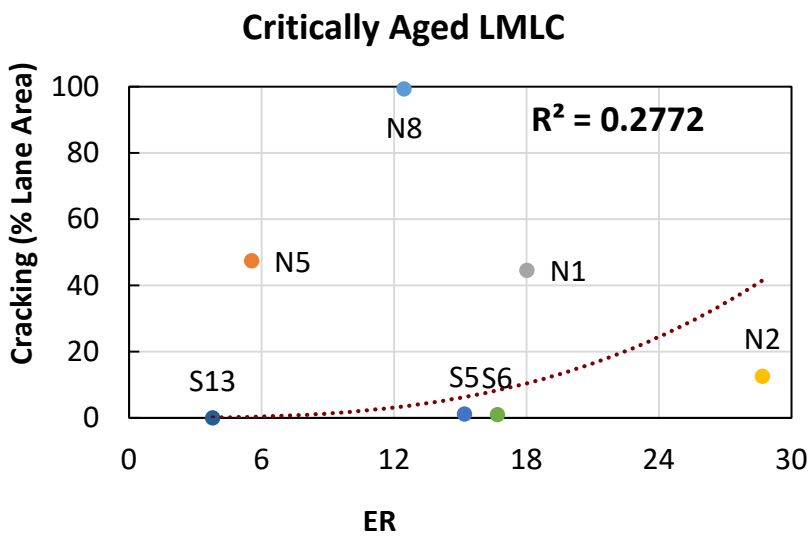


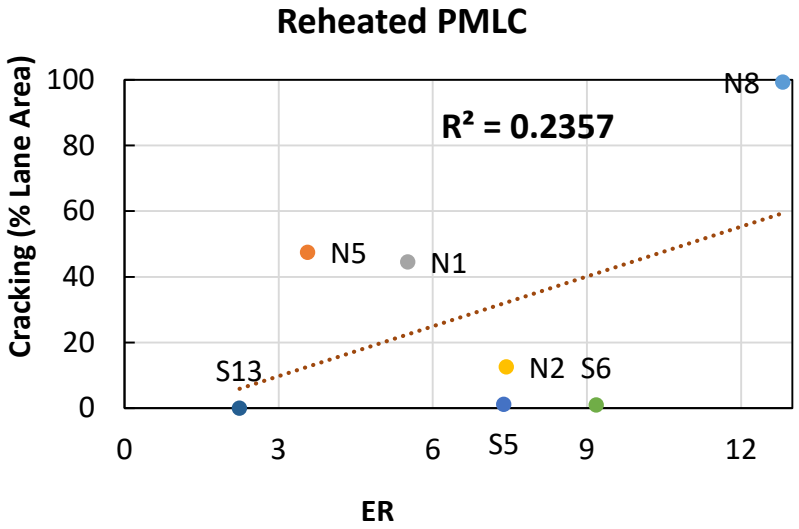
Energy Ratio

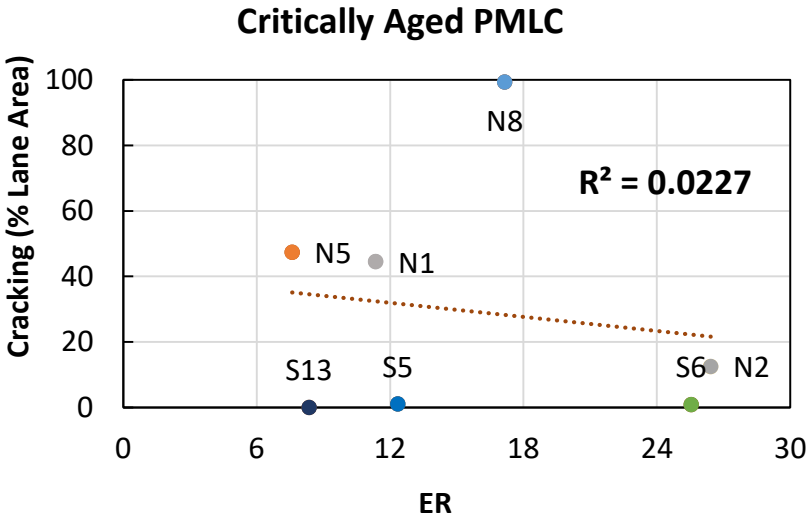


Correlations of Energy Ratio to Cracking on the Test Track





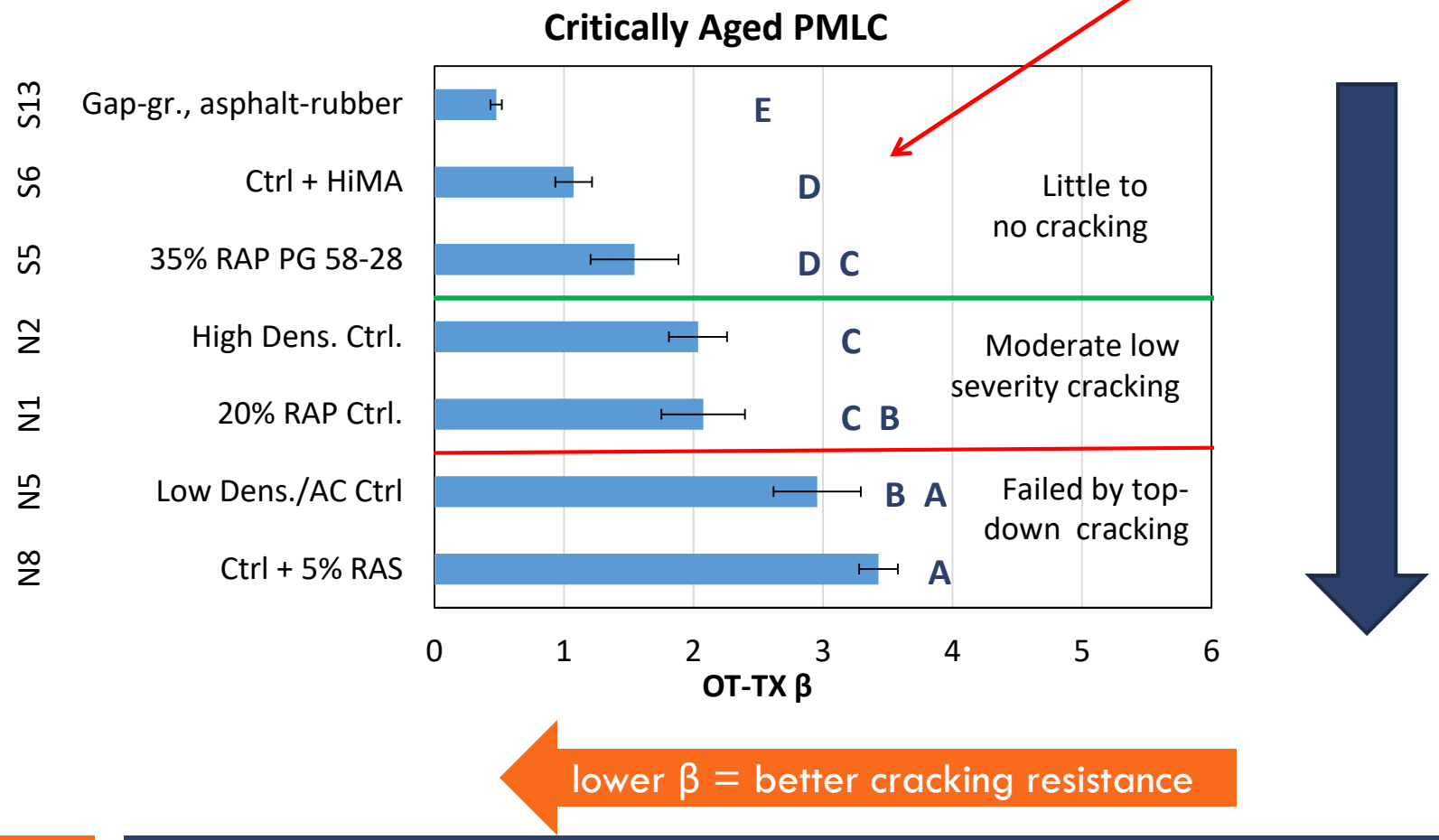




Texas Overlay Test (Tex-248-F)

Results with the same letter are not statistically different

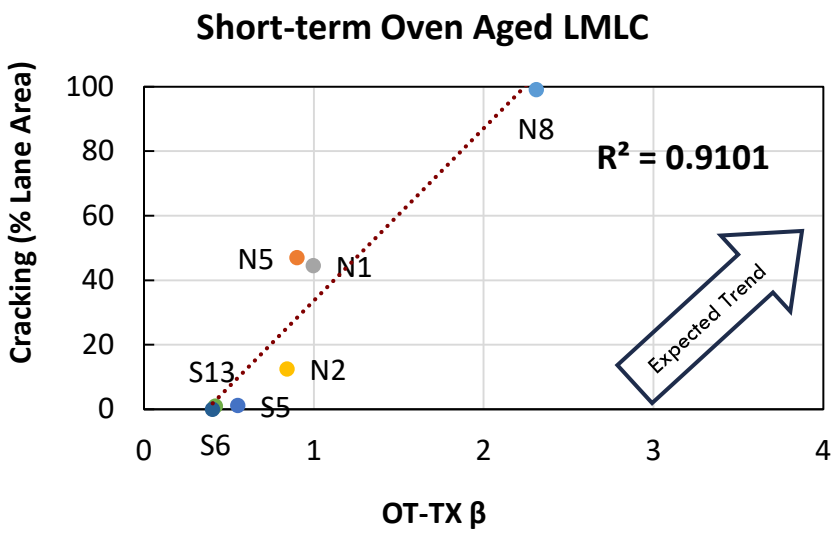
OT-TX

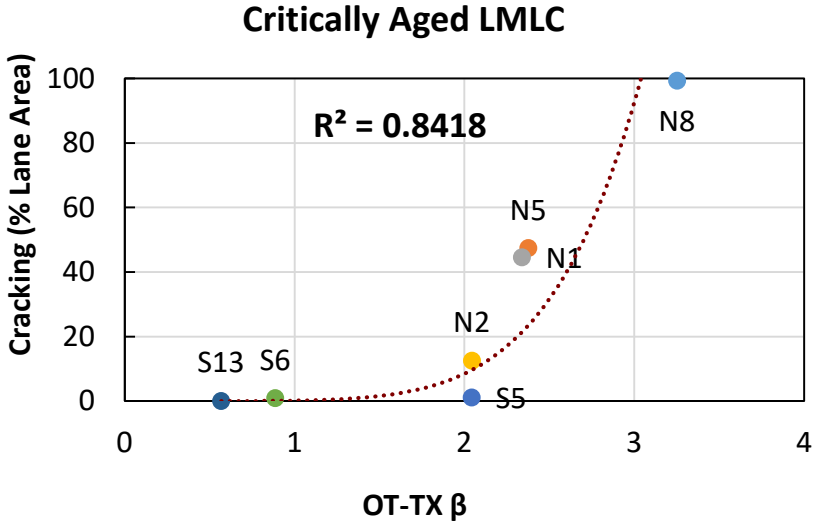


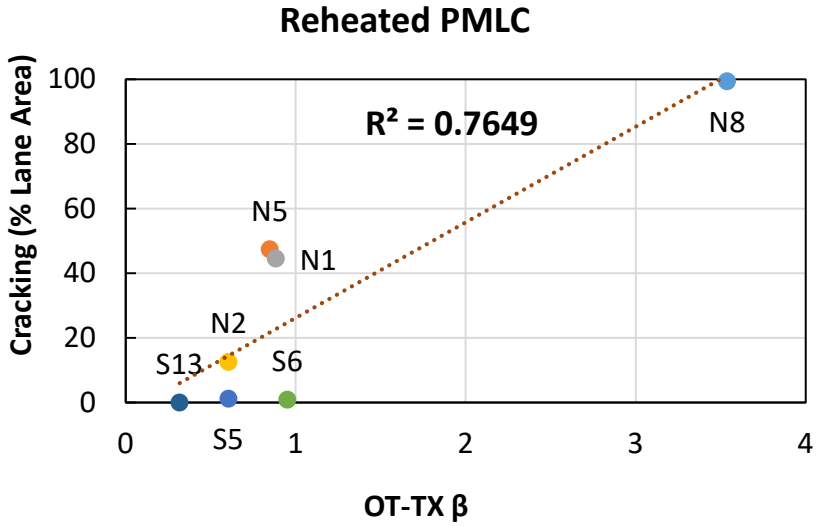
Sorted from best to worst field cracking performance

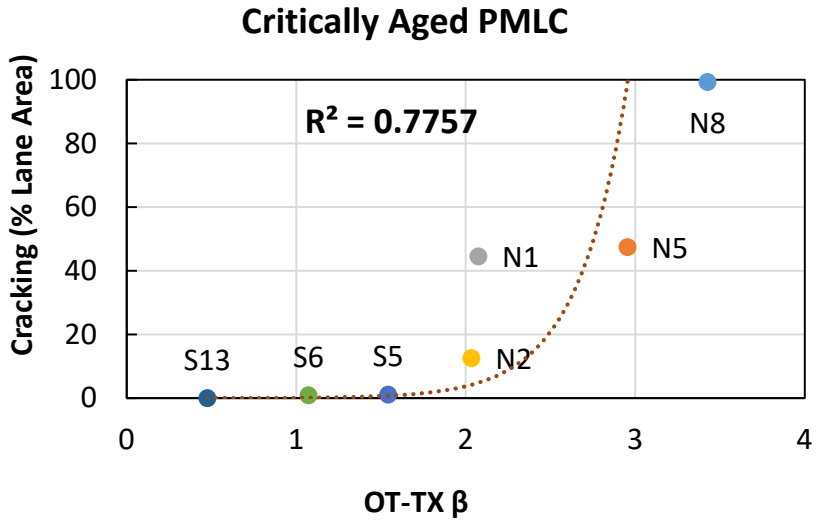
lower β = better cracking resistance

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





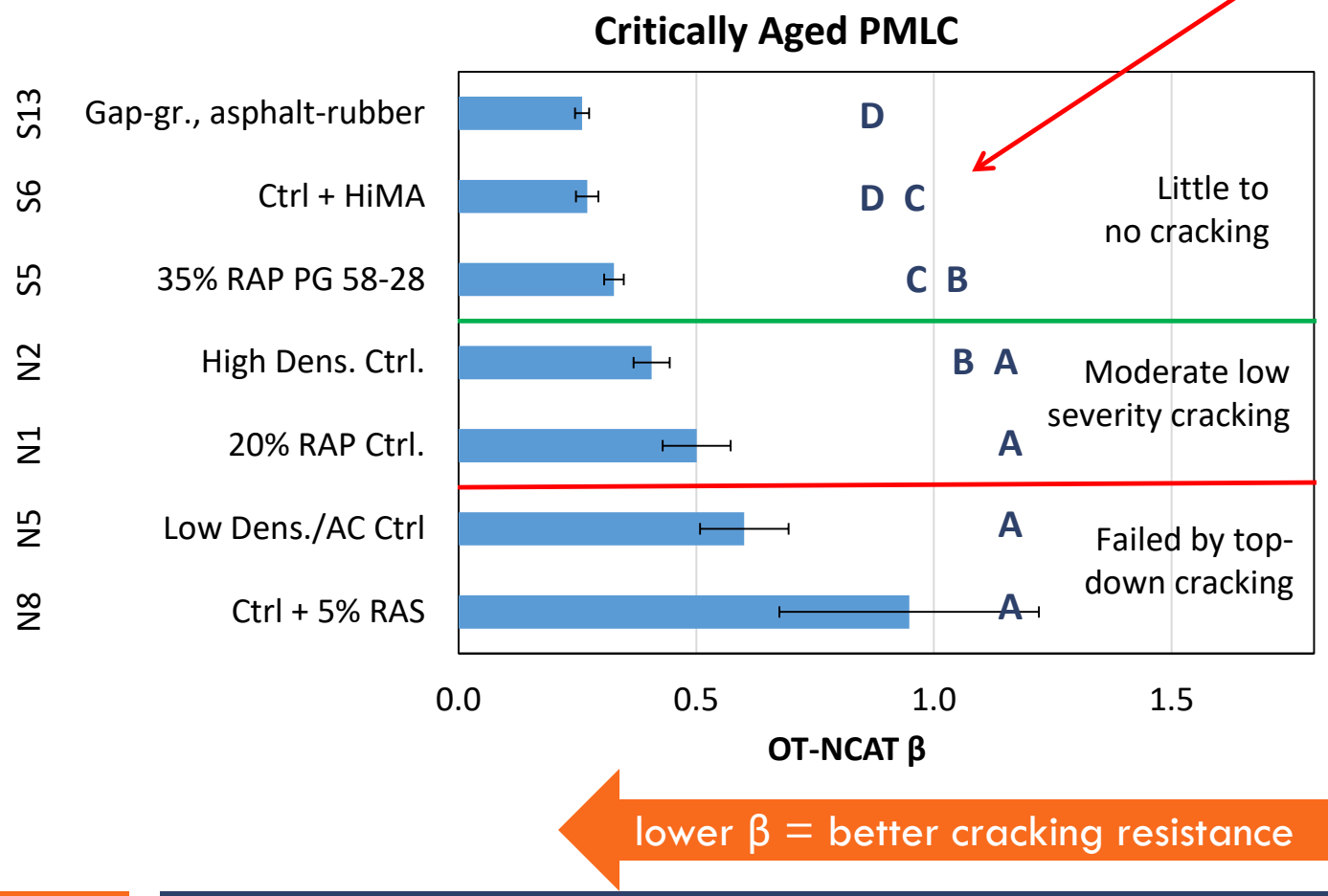




NCAT Overlay Test (Ma, 2014)

Results with the same letter are not statistically different

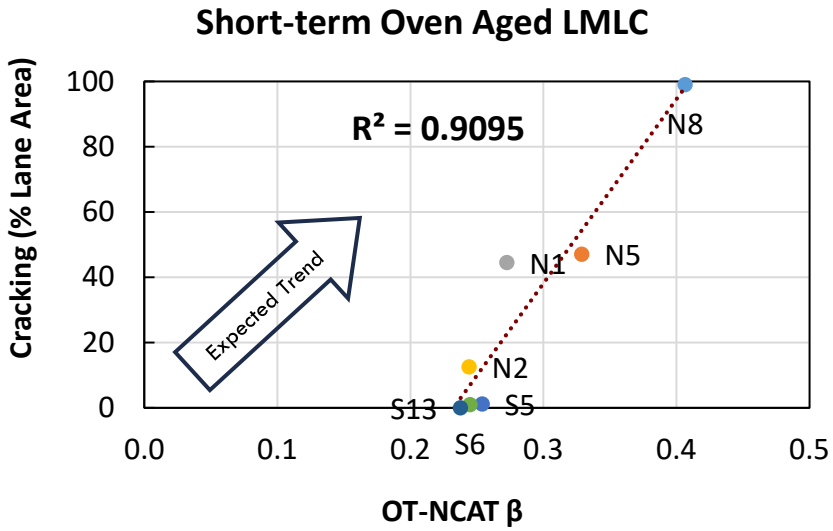
OT-NCAT

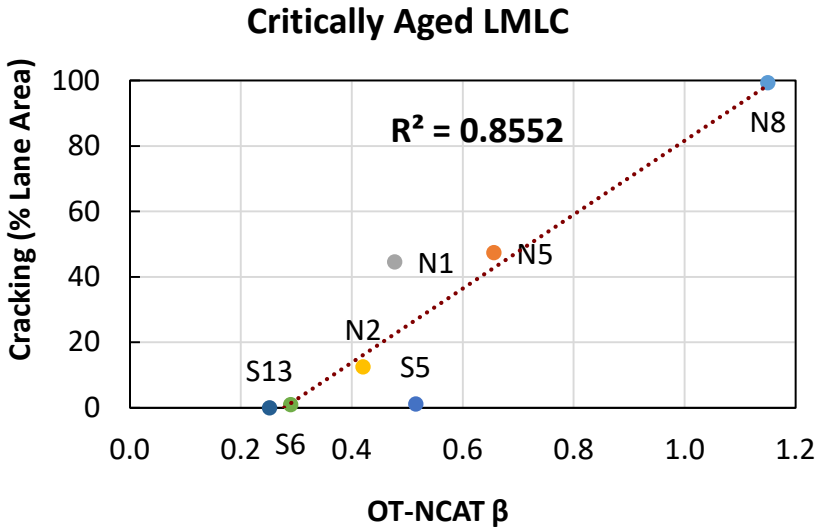


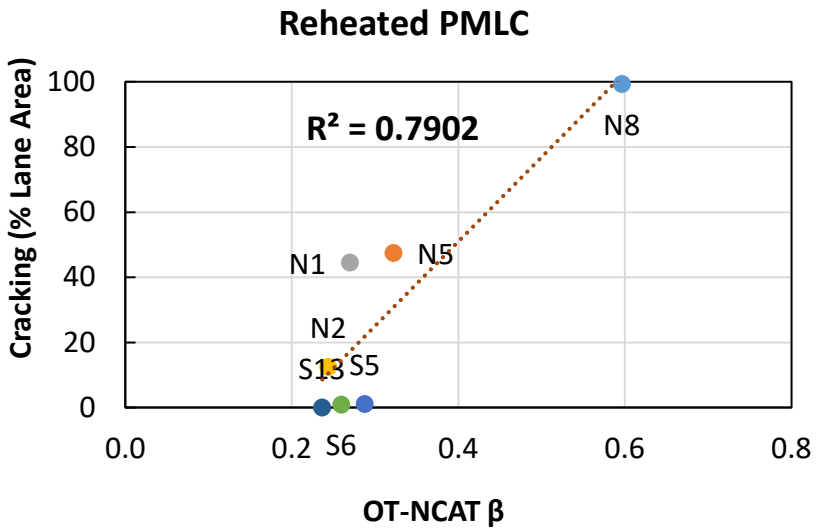
Sorted from best to worst field cracking performance

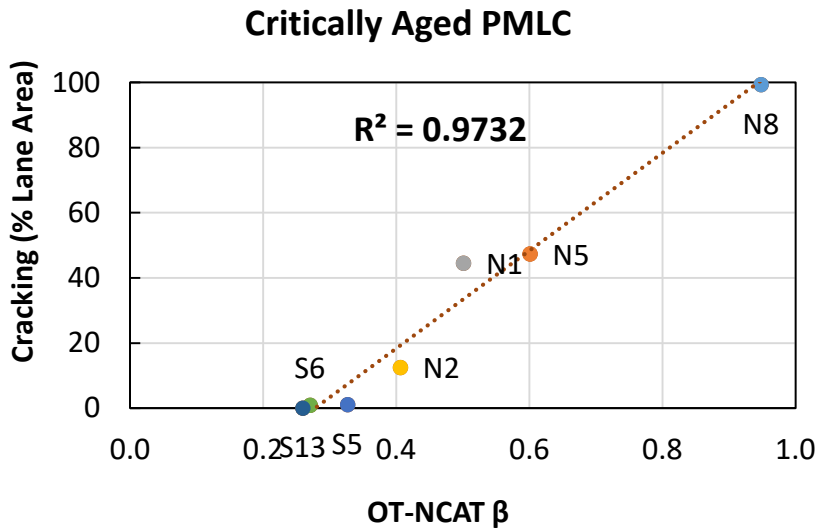
lower β = better cracking resistance

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



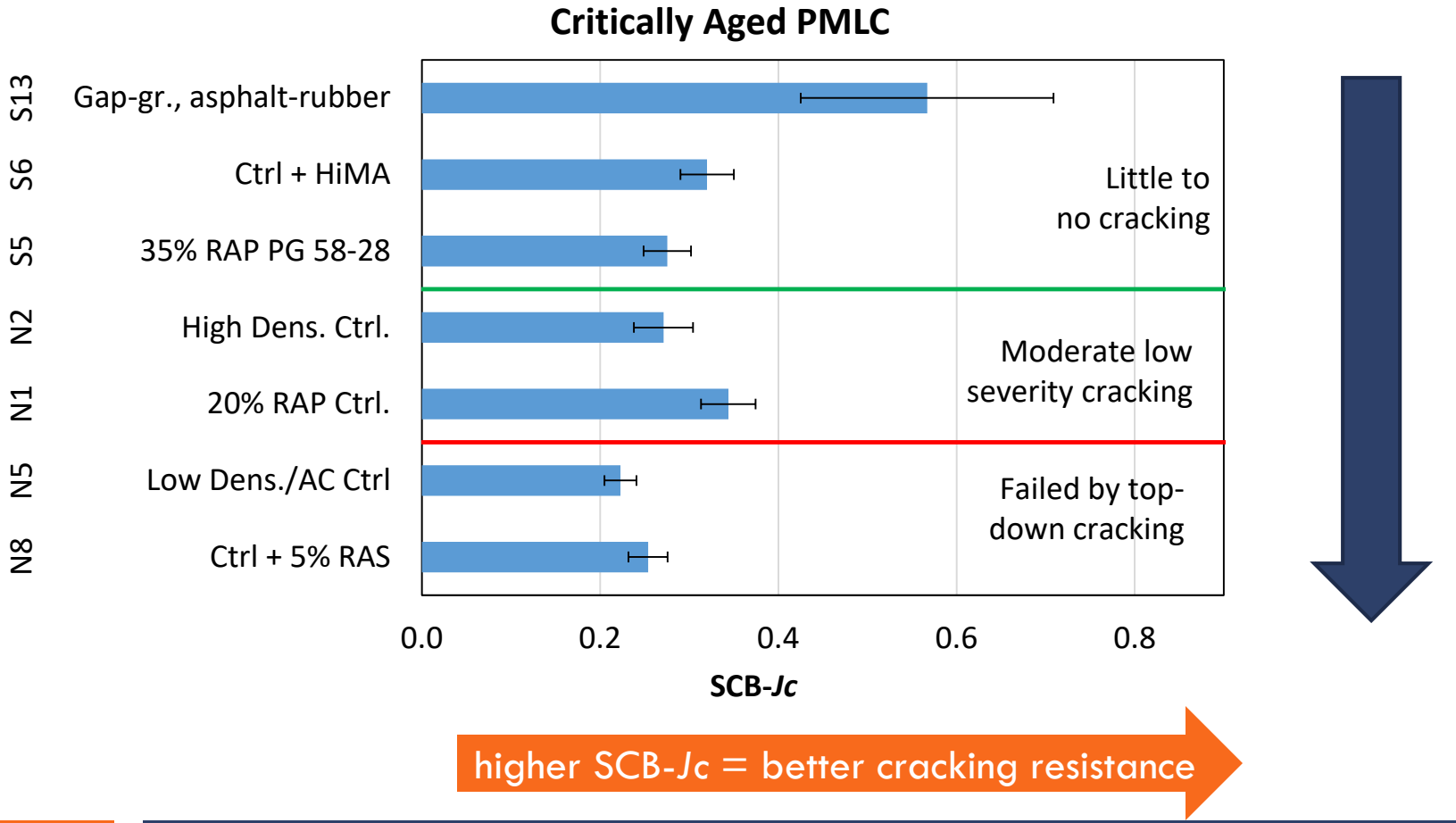




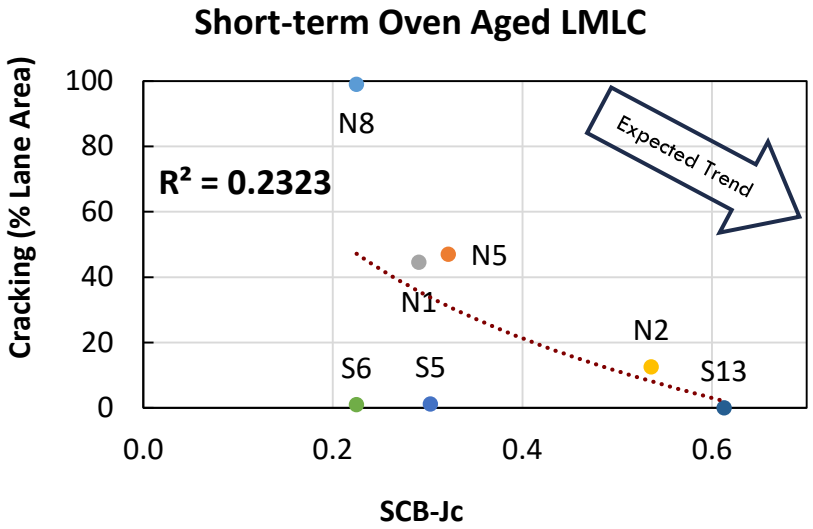


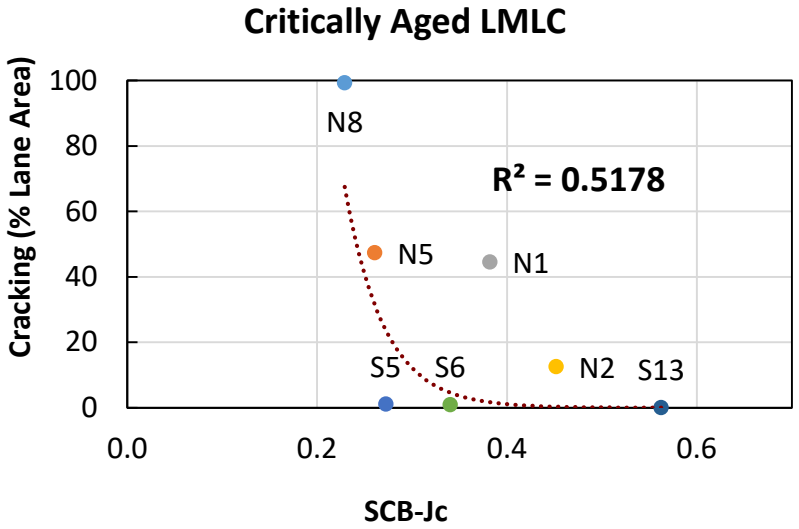
Louisiana SCB Test (ASTM D8044-16)

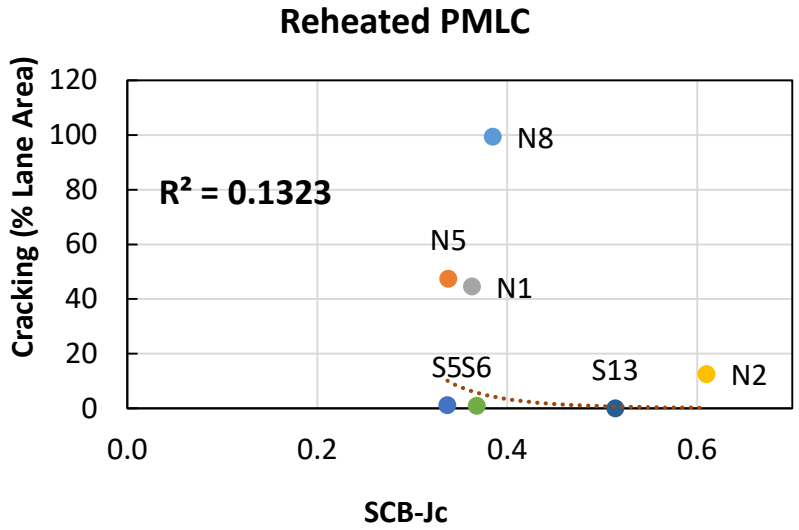
SCB-LA

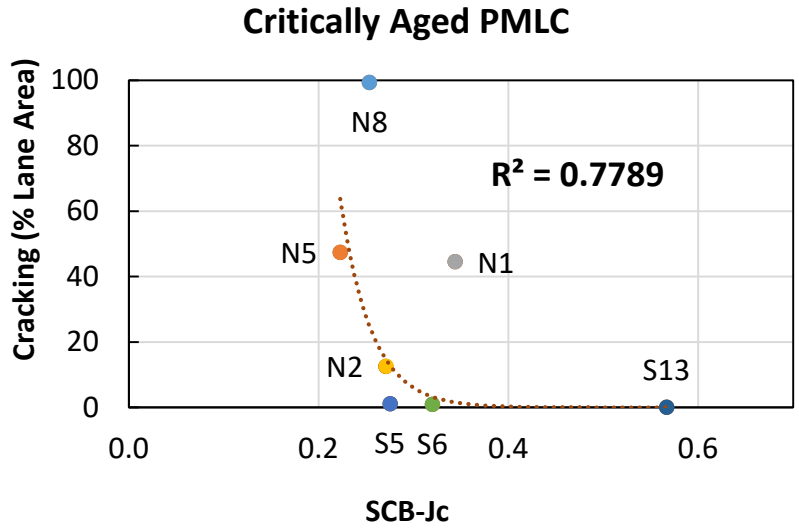


Correlations of Louisiana SCB Test Results to Cracking on the Test Track

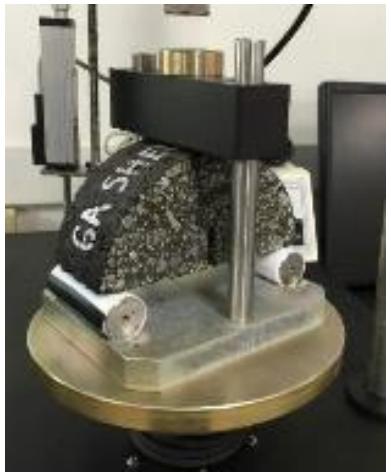




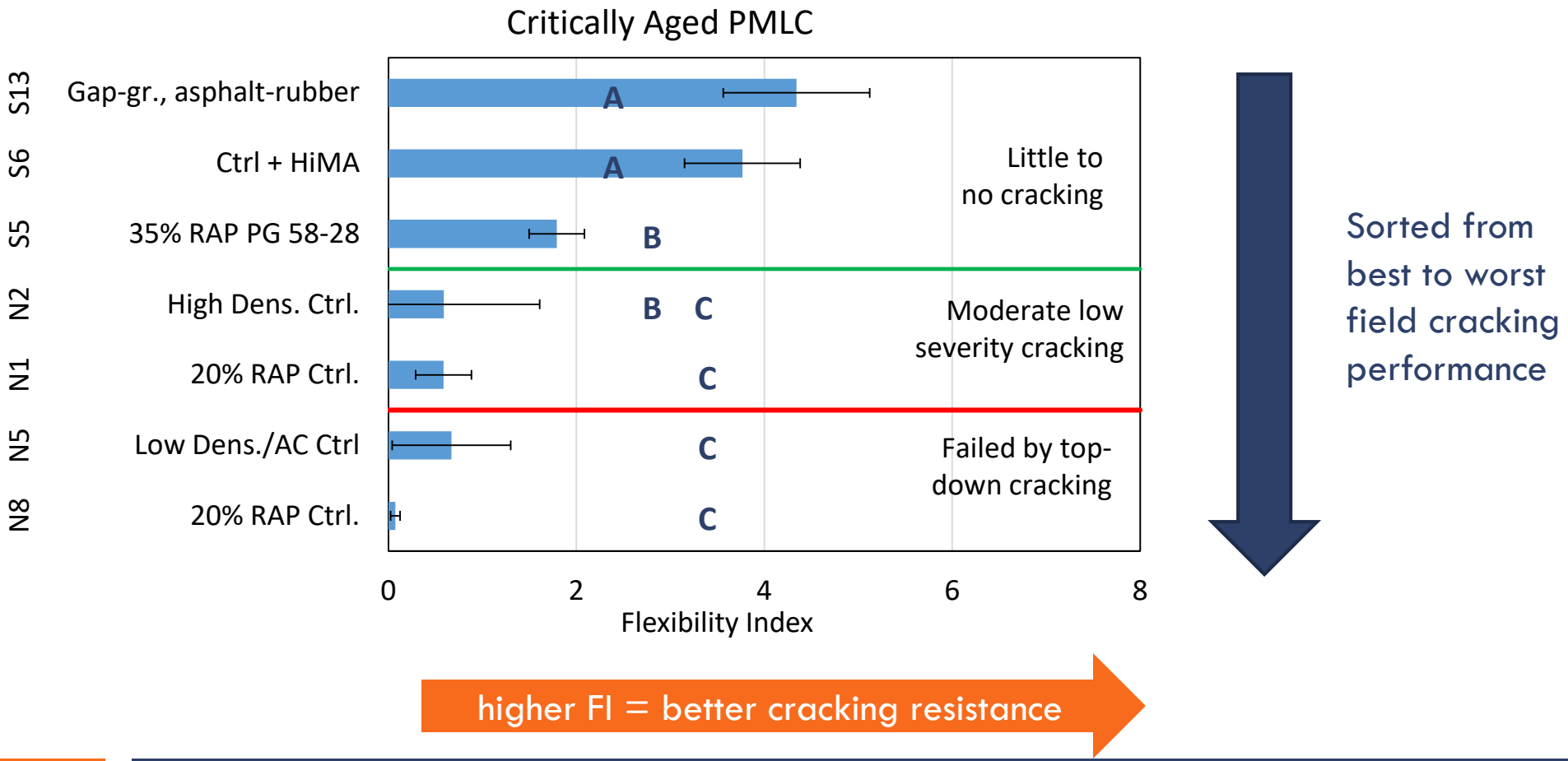




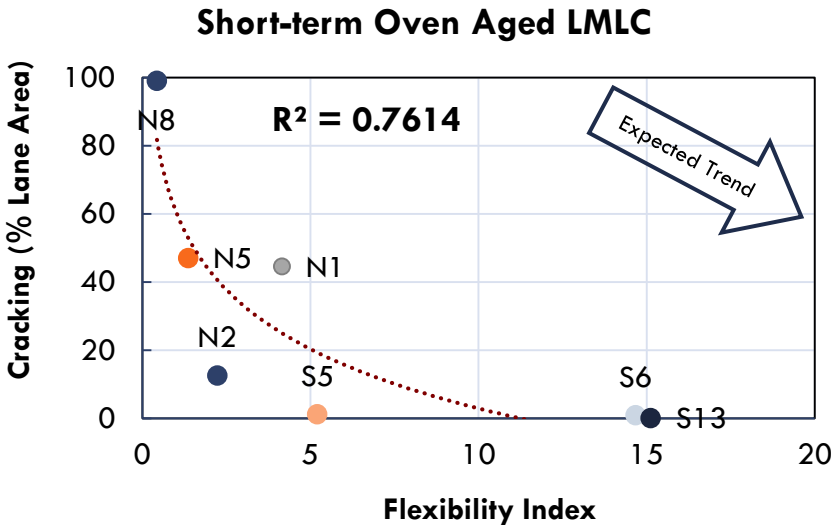
Illinois Flexibility Index Test (AASHTO TP 124)

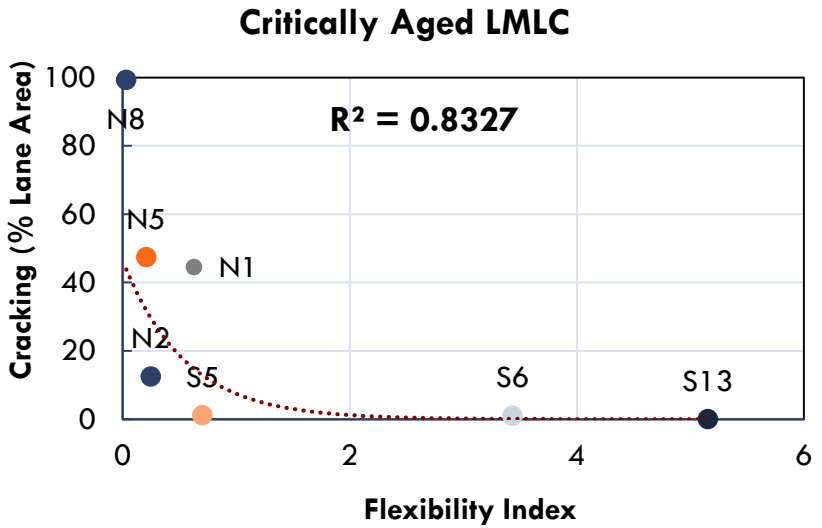


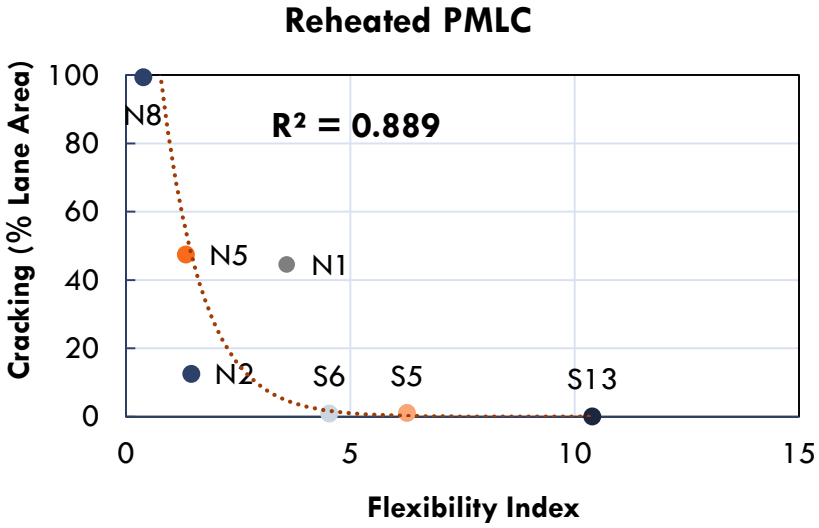
I-FIT

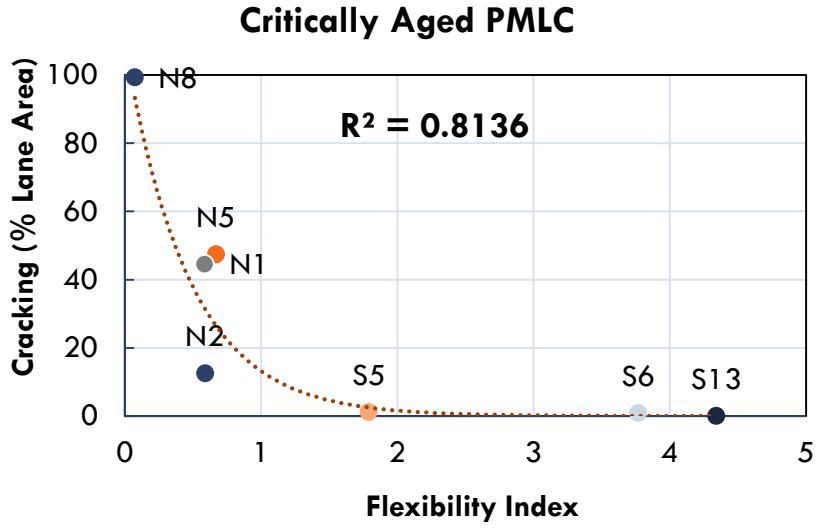


Correlations of I-FIT Results to Cracking on the Test Track



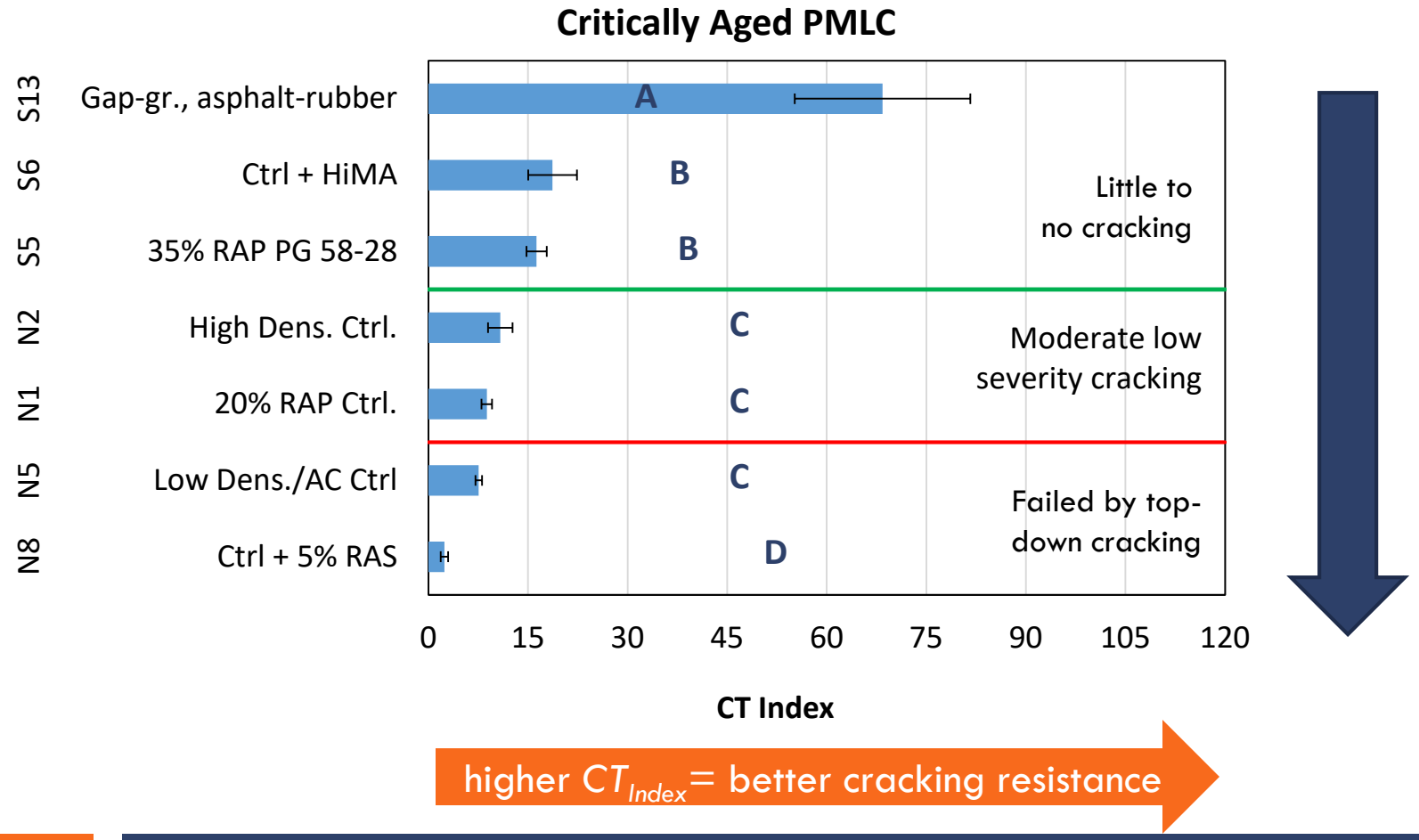






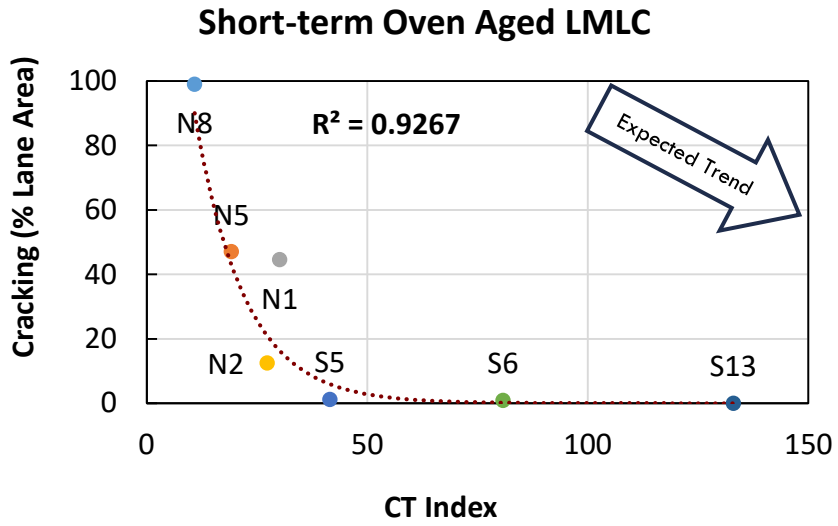
IDEAL-CT Test (ASTM D8225-19)

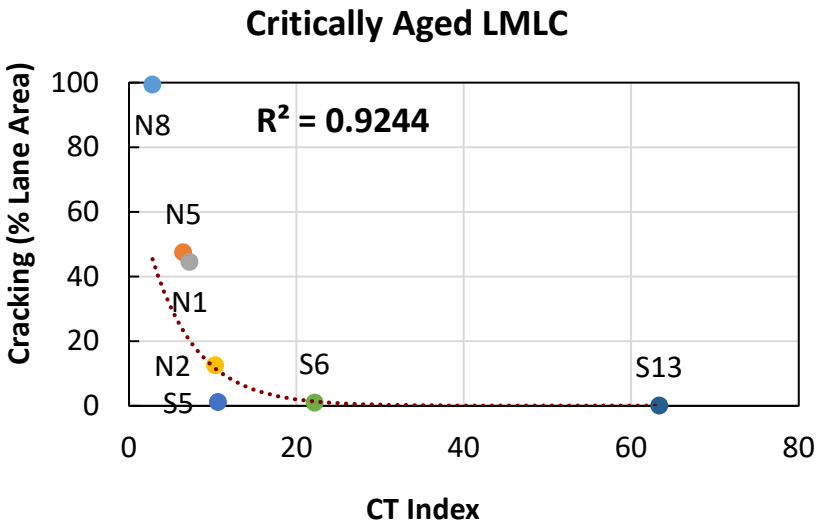
IDEAL-CT

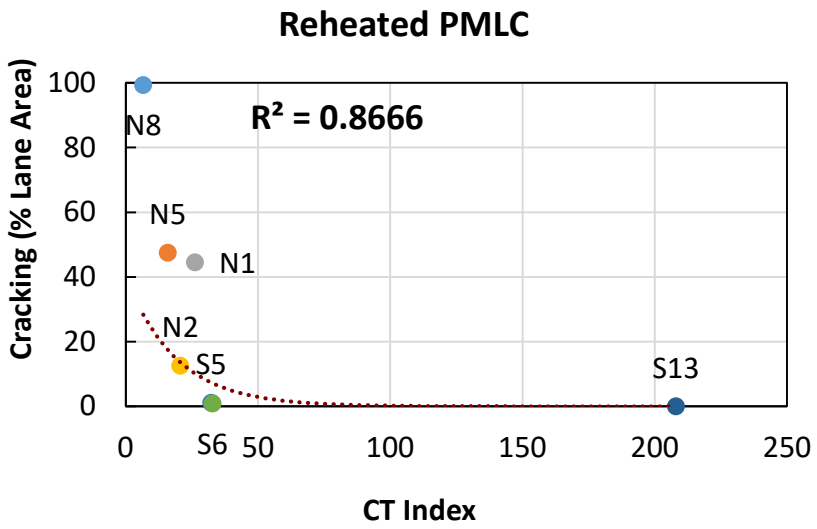


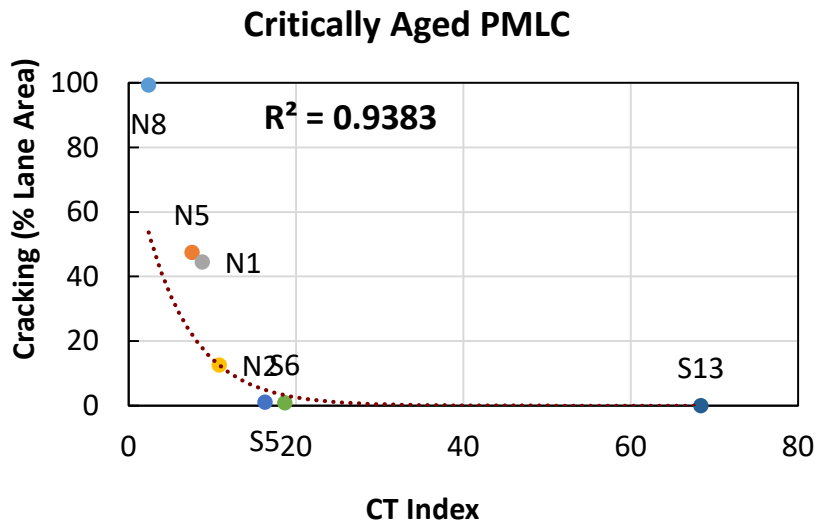
Sorted from best to worst field cracking performance

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



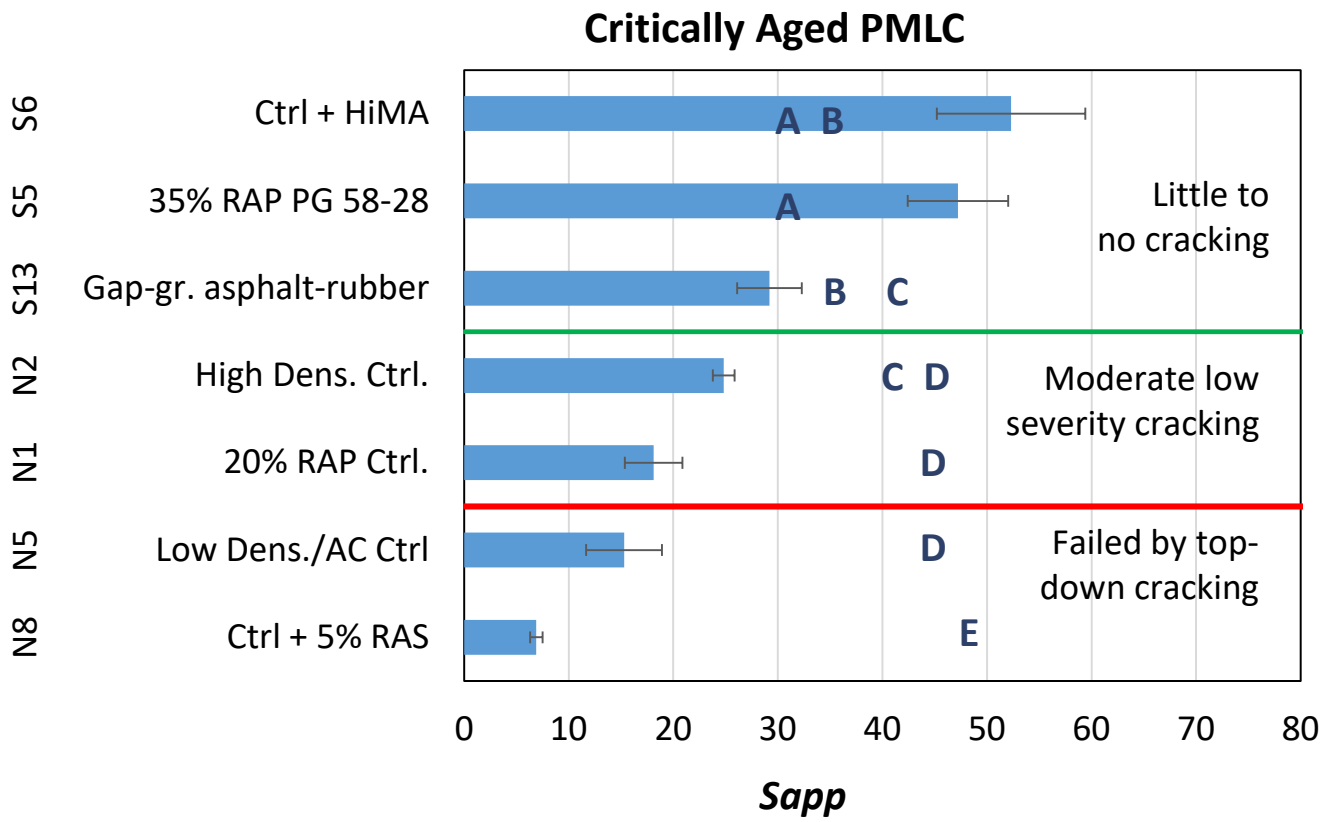






AMPT Cyclic Fatigue Test (AASHTO TP 133-19)

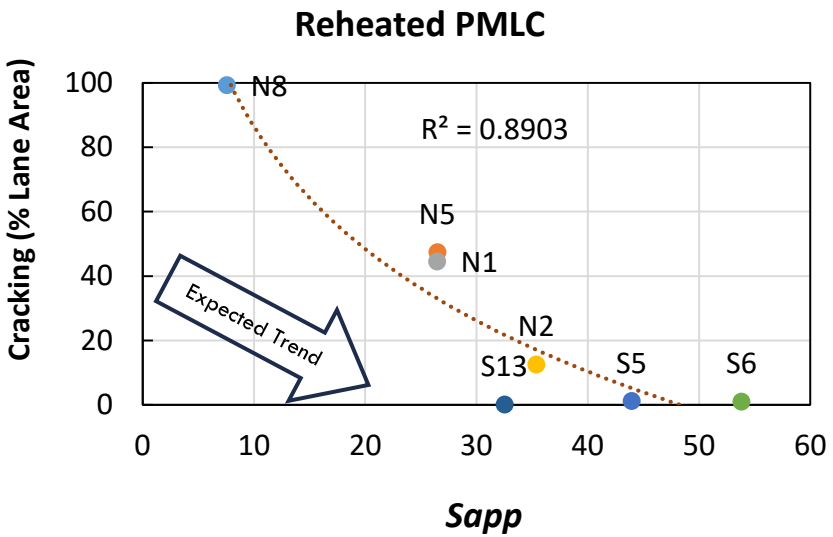
AMPT Cyclic Fatigue

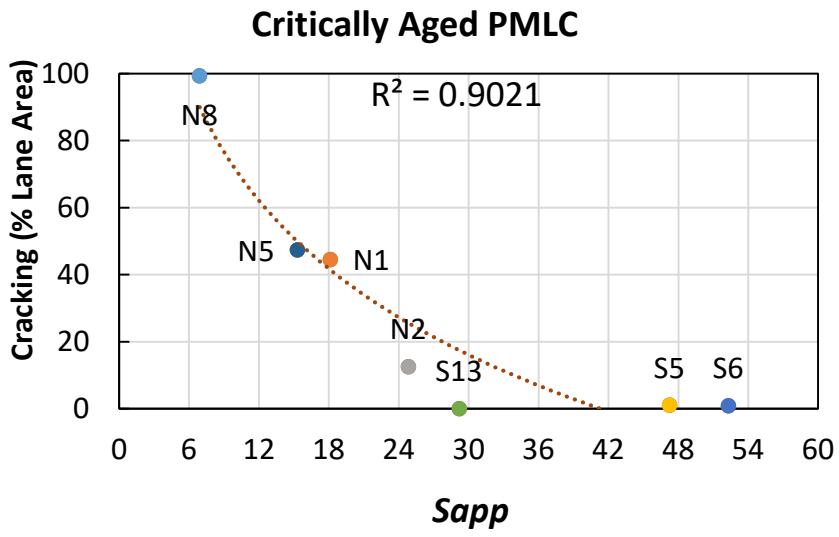


Sorted from best to worst field cracking performance

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	0.02 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

Summary of Test Advantages & Disadvantages

Test & Parameter	Advantages	Disadvantages
Energy Ratio, ER		Poor lab to field correlation, Unable to assess within-lab variability
Texas Overlay Test, β	Good lab to field correlations	Equipment cost; Time to complete a test
NCAT Overlay Test, β	Strong lab to field correlation; Faster & lower COV than TX-OT	Equipment cost; Time to complete a test
Louisiana SCB, J_c		Mixed correlations with field performance; Time to complete a test
Illinois Flexibility Index Test, *FI*	Good lab to field correlations	Effect of specimen air voids is incorrect
IDEAL Cracking Test, CT_{Index}	Very strong to lab to field correlations; Simple; Low cost	Effect of specimen air voids is incorrect
AMPT Cyclic Fatigue, S_{app}	Strong lab to field correlations	Equipment cost; Time to complete a test

Questions and Answers

SEVENTH
RESEARCH CYCLE

NCAT TEST TRACK CONFERENCE