Performance Testing

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NCAT
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Outline

- NCAT current focus areas
- What are Performance Tests?
- Why do we need them?
- When should we use them?
- What tests are being considered?
- What is being done to move toward implementation?

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NCAT's current research focus areas

- Advancements in Pavement Design
- Balanced Mix Design
- Sustainable Pavements
- Pavement Preservation
- Safety and Pavement Friction

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With the current volumetric mix design system…

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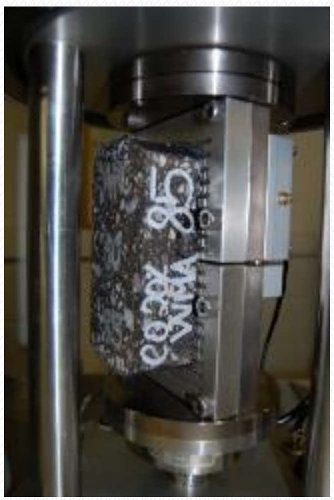
Balanced Mix Design

Cracking Resistance



Rutting Resistance

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What are “Performance Tests"

- Additional tests beyond volumetric properties
- Intended to indicate a mix's resistance to particular distresses (i.e. field performance)
- May or may not yield an engineering property that can be used in pavement design or analysis.

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Performance testing is the art of molding materials we do not wholly understand…

into shapes we cannot precisely analyze,

so as to withstand forces we cannot assess,

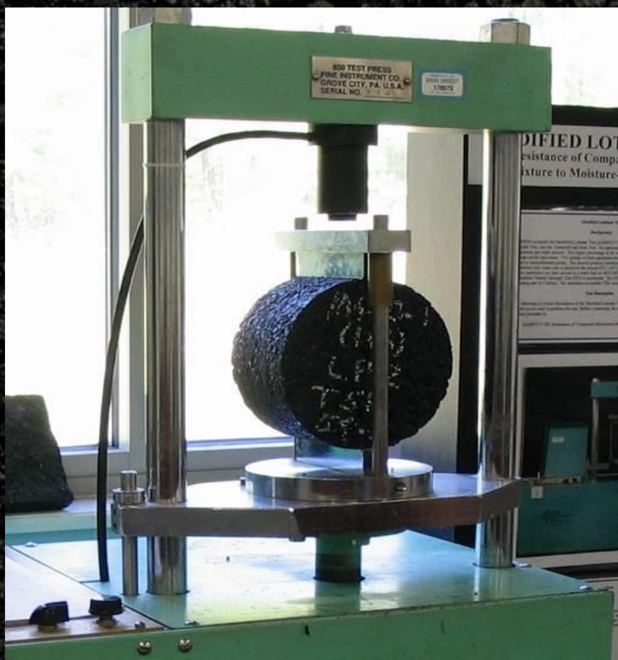
in such a way that the community at large has no reason to suspect our ignorance.

Source unknown

Uses of Performance Tests

- For Research Purposes
  - To evaluate new materials or design strategies
- As part of mix design process (i.e. Balanced Mix Design)
  - To identify mixtures prone to performance problems
  - To gain confidence on Warranty projects
- For Quality Assurance purposes
  - To assess how plant mix could impact performance and use in pay adjustment factors

Moisture Damage Susceptibility Tests



Tensile Strength Ratio
AASHTO T 283

Hamburg Wheel Tracker
AASHTO T 324

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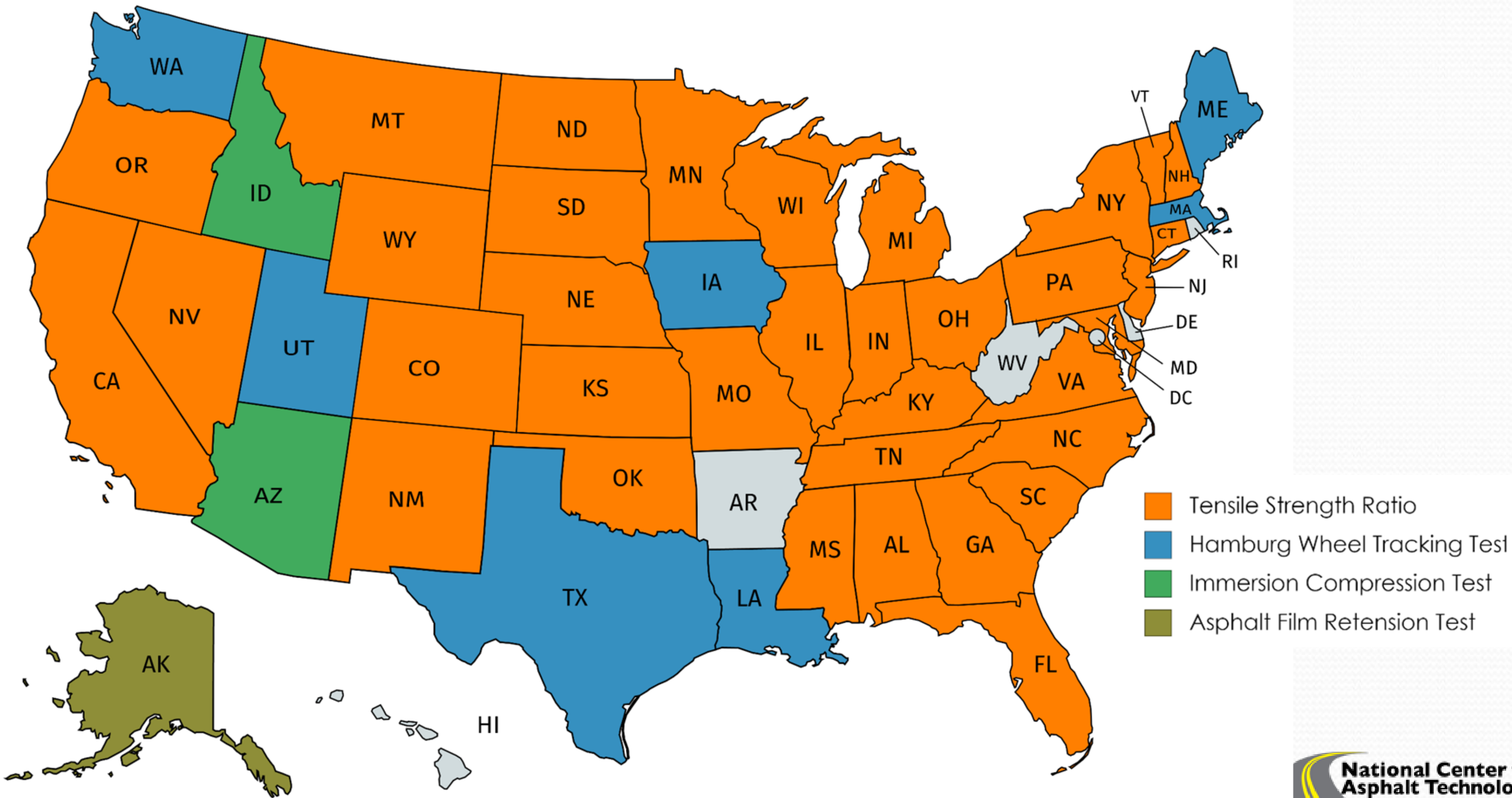
Current Use of Moisture Damage Tests



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Moisture Damage Susceptibility Testing

AASHTO T 283
Tensile Strength Ratio

- Procedure is well established for mix design approval and verification of plant mix
- 1 week to complete the test
- Precision statistics
  - Single-operator d2s = 0.093
  - Multi-lab d2s = 0.247
- Pass/Fail criteria based on TSR
- Some states also have minimum conditioned tensile strength

AASHTO T 324
Hamburg Wheel Tracking Test

- Specified by a growing number of states and used by numerous researchers
- 1 to 2 days to complete test
- $60,000+ equipment cost
- Precision statistics unknown, suspected to be poor
- Pass/Fail criteria based on Stripping Inflection Point
- Also provides an indication of rutting resistance

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Rutting Tests

E* and Fn
AASHTO TP 79

iRLPD
AASHTO TP 116

APA
AASHTO TP 63

Hamburg
AASHTO T 324

Shear Stiffness
AASHTO T 320

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Rutting Tests

E* and Fn
AASHTO TP 79

iRLPD
AASHTO TP 116

APA
AASHTO TP 63

Hamburg
AASHTO T 324

Shear Stiffness
AASHTO T 320

Traffic, MESALs	Min. Flow No.		APA max. rut depth (mm)[3]	SST Max. Perm. Shear Strain (%)[1]
	HMA[1]	WMA[2]		
<3	NA	NA	NA	NA
3 to <10	53	30	5	3.4
10 to <30	190	105	4	2.1
> 30	740	415	3	0.8

[1]NCHRP Rpt. 673, [2]NCHRP 9-43, [3]OKDOT

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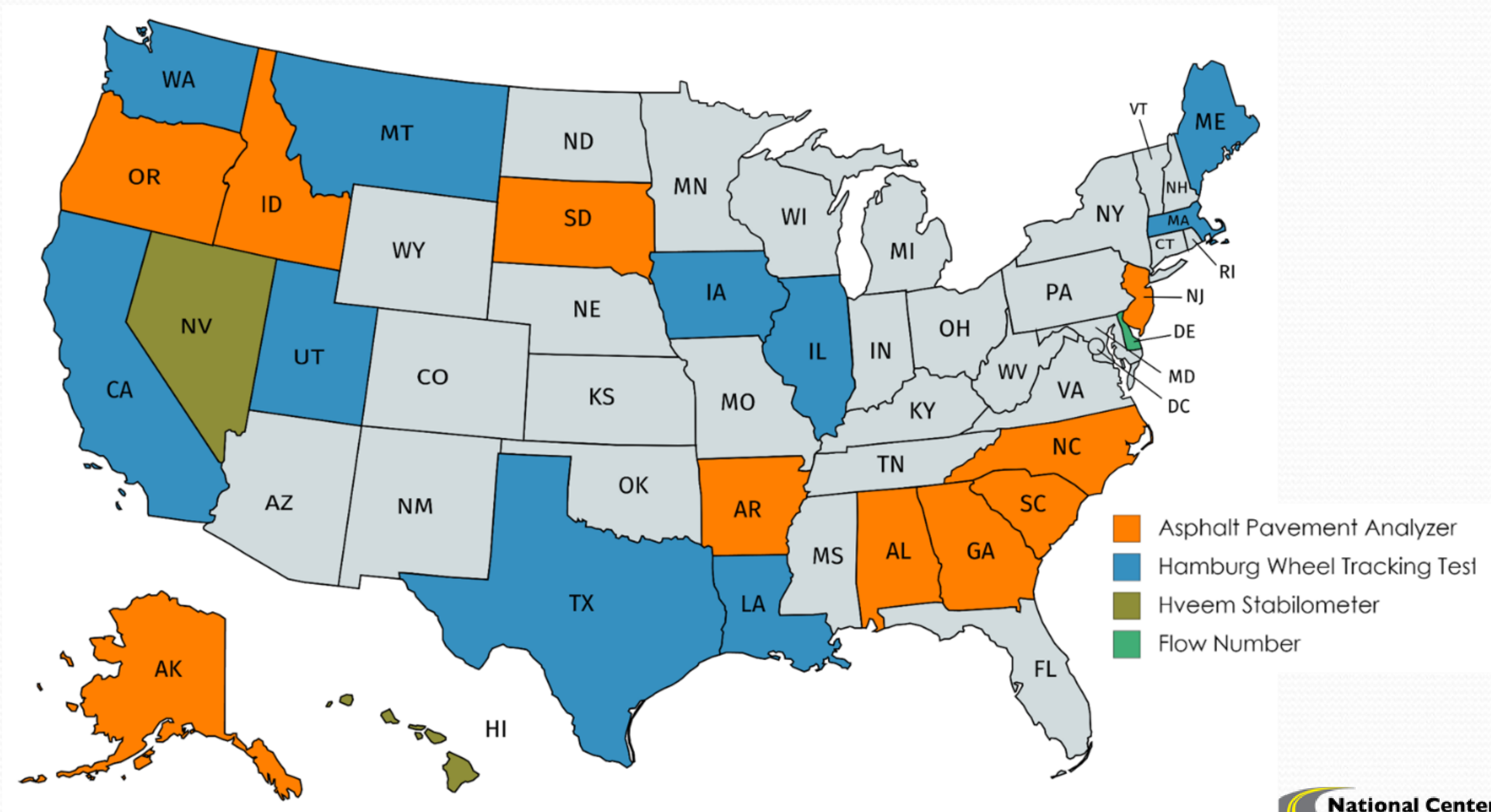
Current Use of Rutting Tests



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Modes of Cracking

Fatigue

Top-Down

Reflection

Thermal

Block

Load Related (Fatigue, Top-Down, Reflection)

Environment Related (Reflection, Thermal, Block)

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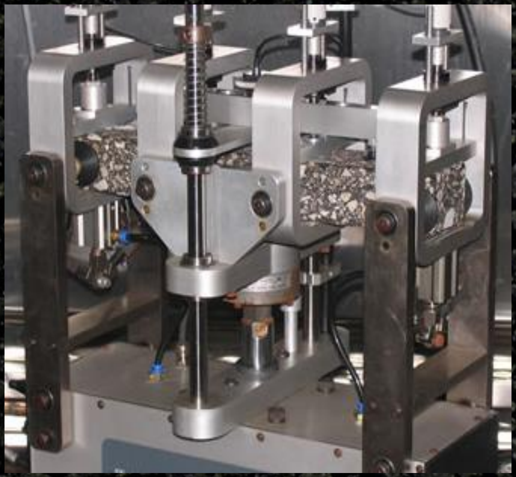
Fatigue Tests (repeated load tests)



Beam Fatigue
AASHTO T 321

Simplified Visco-Elastic Continuum Damage

Texas Overlay Tester
TEX 248-F

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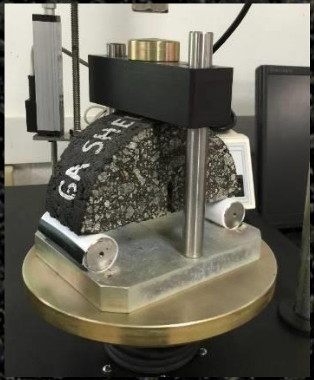
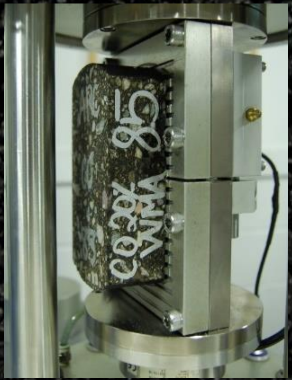
Top-Down Cracking Tests

SCB-LA



SCB-IL

OT-TX



OT-NCAT

Energy Ratio

Nflex Factor or Ideal CT

Cantabro

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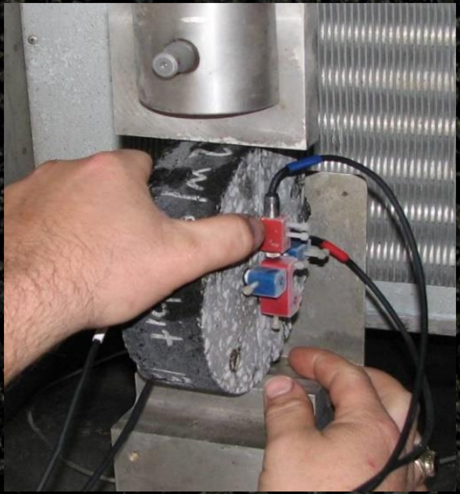
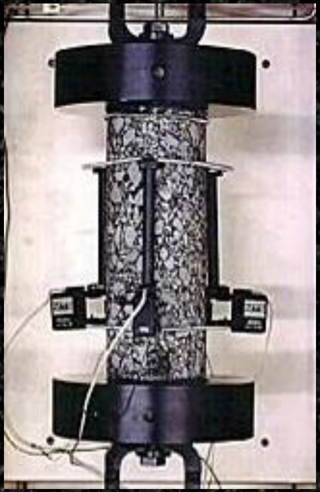
Low Temperature Cracking Tests



IDT Creep Compliance
AASHTO T 322

Semi-Circular Bend

Disk-Shaped Compact Tension



TSRST

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Important Test Aspects

1. Strong relationship to performance
2. Practical: cost, time, complexity
3. Repeatable, reproducible

Validation of Performance Tests

- Researchers typically develop methods independently
- Most tests lack a regional or national validation effort with field pavements
- Most have unknown precision statistics
- Laboratory aging protocols are still being researched

MnROAD + NCAT Partnership

Working together on national need research projects

1. Validating cracking tests for balanced mix design
2. Documenting the life cycle benefits of Pavement Preservation

MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research

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ADEM
Alabama Department of Environmental Management

ALABAMA
Department Of Transportation

COLLABORATIVE
AGGREGATES LLC

CO
CDOT

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

FP2

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

GDOT
Georgia Department of Transportation

Illinois Department
of Transportation

KENTUCKY
TRANSPORTATION
CABINET

SHA
State Highway
Administration
Maryland Department of Transportation

MDOT
Michigan Department of Transportation

MDOT
MISSISSIPPI DEPARTMENT OF TRANSPORTATION

MINNESOTA
DEPARTMENT OF TRANSPORTATION

MoDOT

NEW YORK
STATE OF
OPPORTUNITY.
Department of
Transportation

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

ODOT
Oklahoma Department
of Transportation

SCDOT
South Carolina Department of Transportation

TN
TDOT
Department of
Transportation

VDOT
Virginia Department of Transportation

WISCONSIN
DEPARTMENT OF TRANSPORTATION

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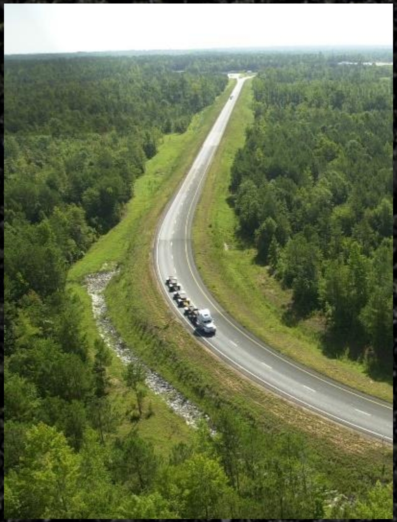
Safer, Smarter, Sustainable Pavements Through Innovative Research

Scope of Experiments

NCAT Test Track

- Top-down cracking



MnROAD

- Low-temperature cracking

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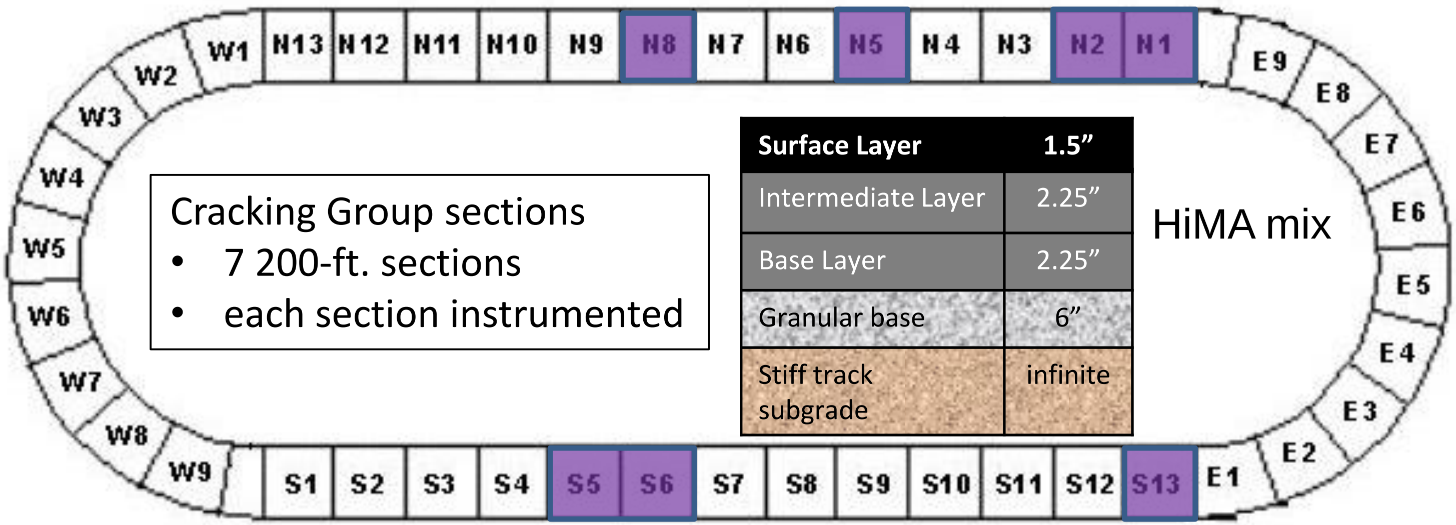
Top-Down Cracking Sections



Cracking Group sections
- 7 200-ft. sections
- each section instrumented

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

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CG Performance to Date
August 7, 2017
8,267,580 ESALs

Section	Description	Rutting (mm)	Δ IRI (in/mi.)	Δ MTD (mm)	Cracking (% of lane)
N1	20% RAP (Control)	3.4	3	0.4	0.2
N2	Control w/ High Density	3.0	7	0.5	0
N5	Low AC, Low Density	1.7	5	0.4	0
N8	20% RAP 5% RAS	2.0	13	0.7	1.9
S5	35% RAP PG 58-28	2.1	1	0.5	0
S6	Control w HiMA	1.4	10	0.6	0
S13	AZ Rubber Mix	3.3	3	0.1	0

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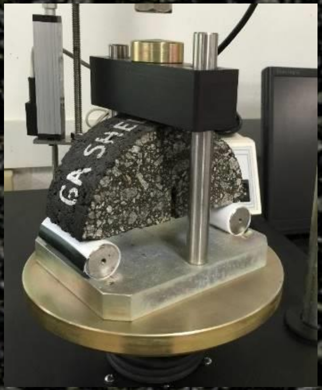
Selected Top-Down (Intermediate Temp. Fracture) Cracking Tests

Added early summer 2017

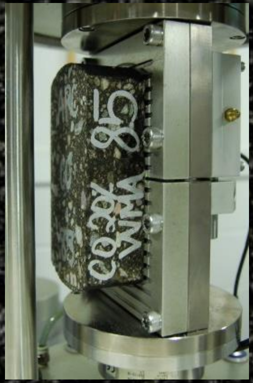
Energy Ratio

SCB-LA



IFIT

OT-TX



OT-NCAT

IDEAL-CT

These tests are being conducted on both lab mix and plant mix samples that are aged and unaged.

Also conducting cyclic fatigue (SVECD) with FlexPave analysis

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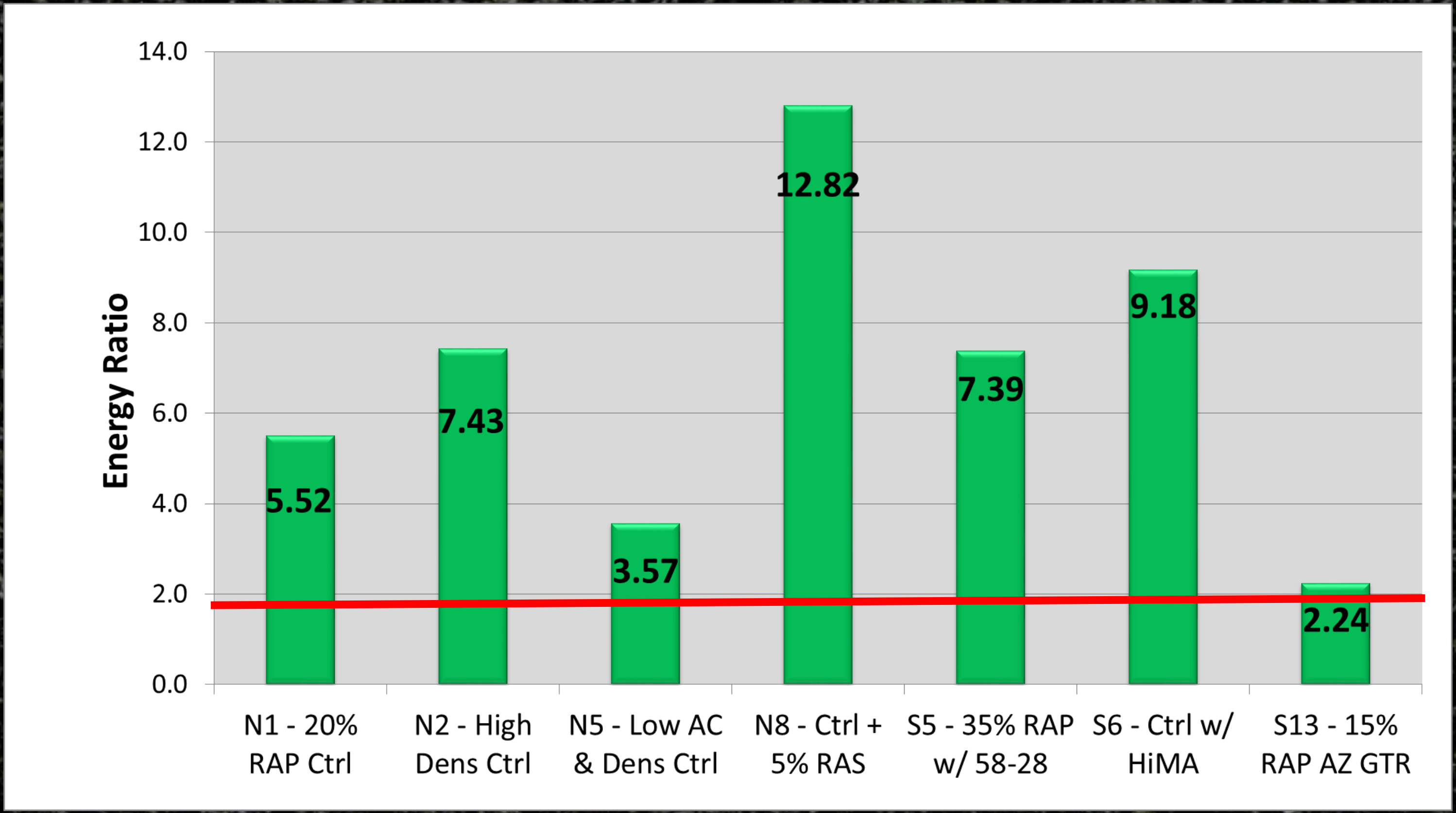
Energy Ratio on Unaged PMLC Specimens



based on field cores aged in service

UF recommended criteria

- ***1.95 for ≥ 1 MESAls per year***

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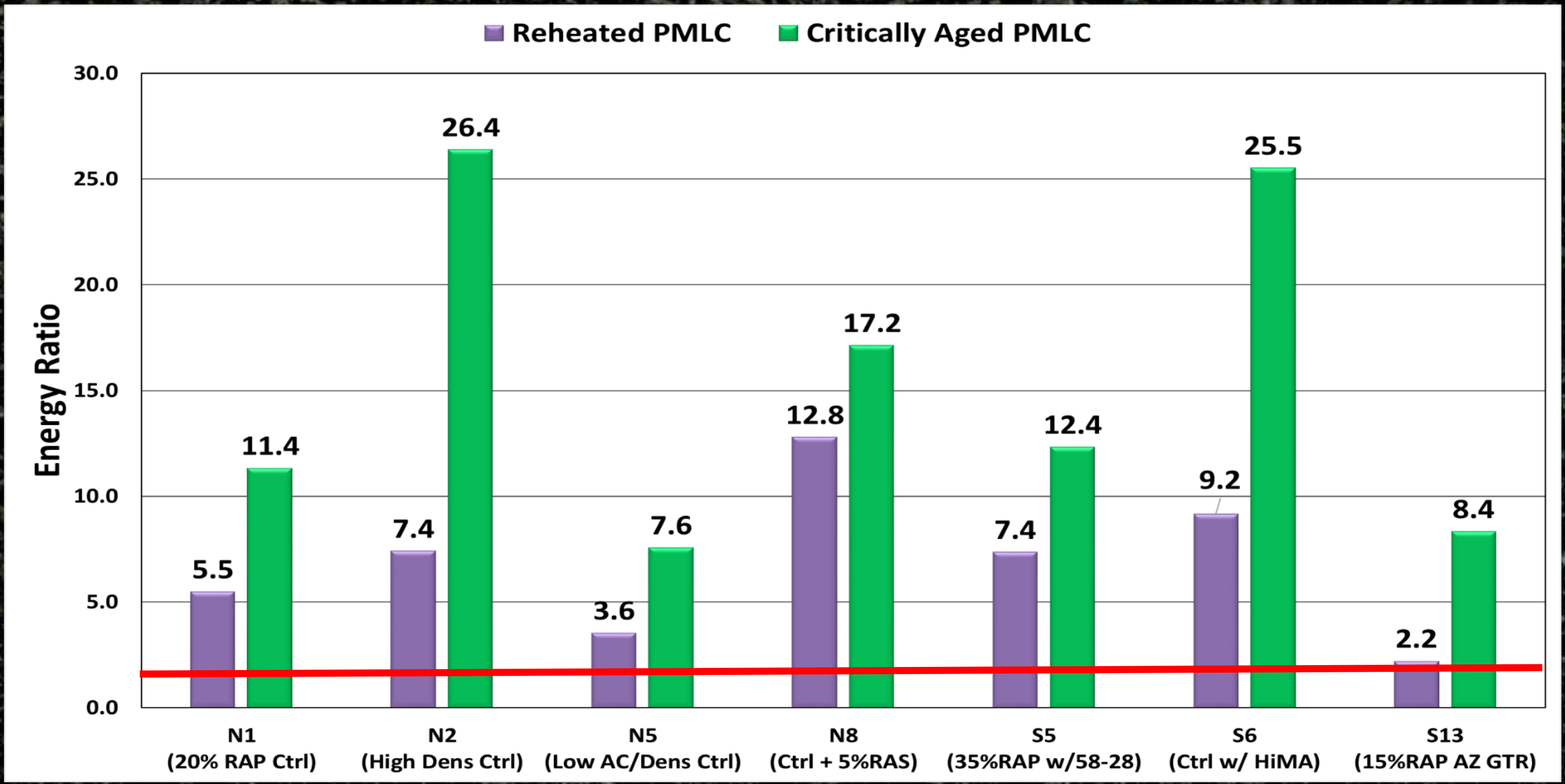
Energy Ratio on PMLC Specimens

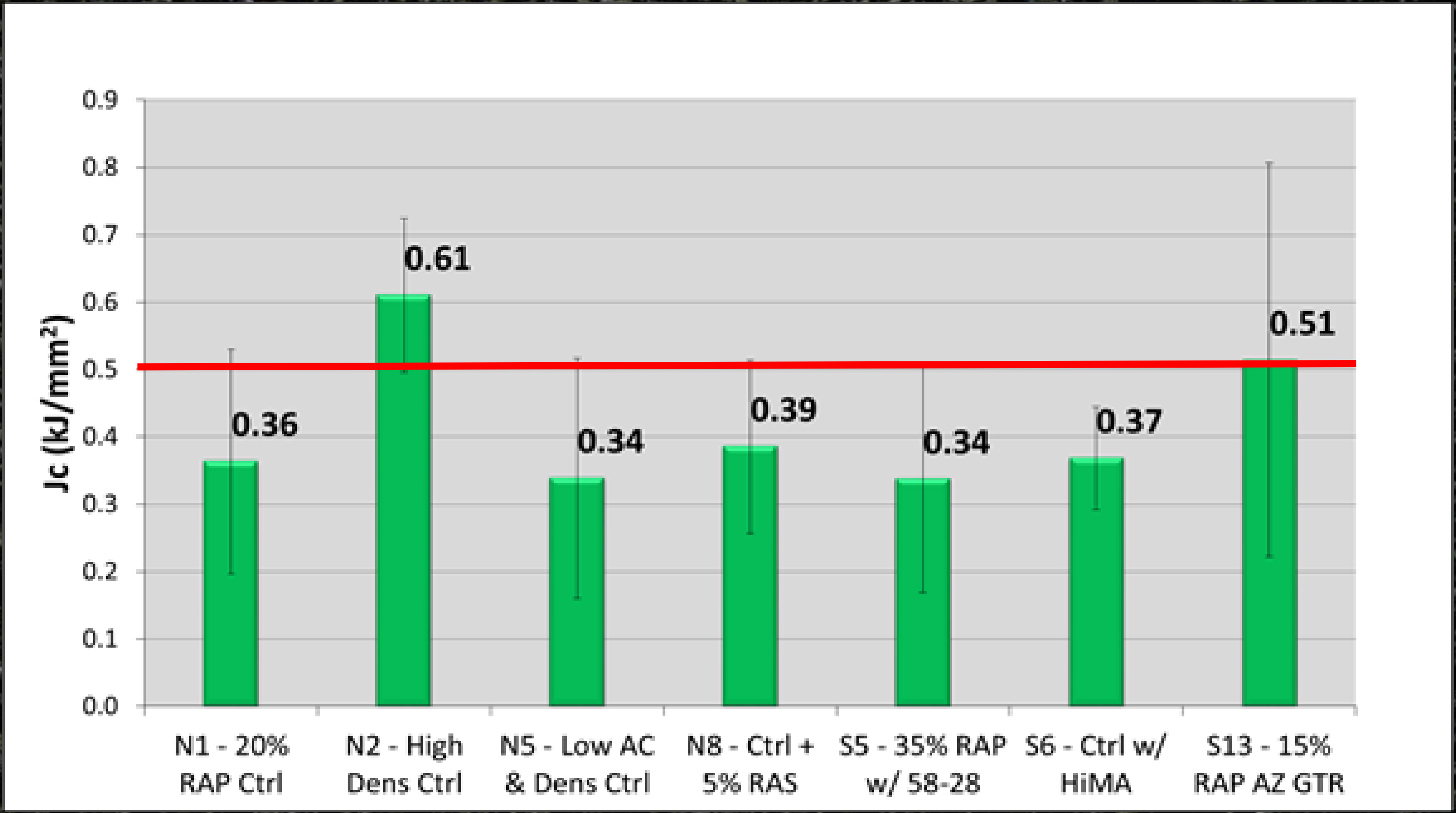


based on field cores aged in service

UF recommended criteria

- *min. 1.95 for ≥ 1 MESALs per year*

SCB on Unaged PMLC Specimens



on LTOA specimens →

LADOTD criteria as of 2016

- ***0.5 kJ/m² for ≤ 3 MESALS for 20 yr. design***
- ***0.6 kJ/m² for ≥ 3 MESALS for 20 yr. design***

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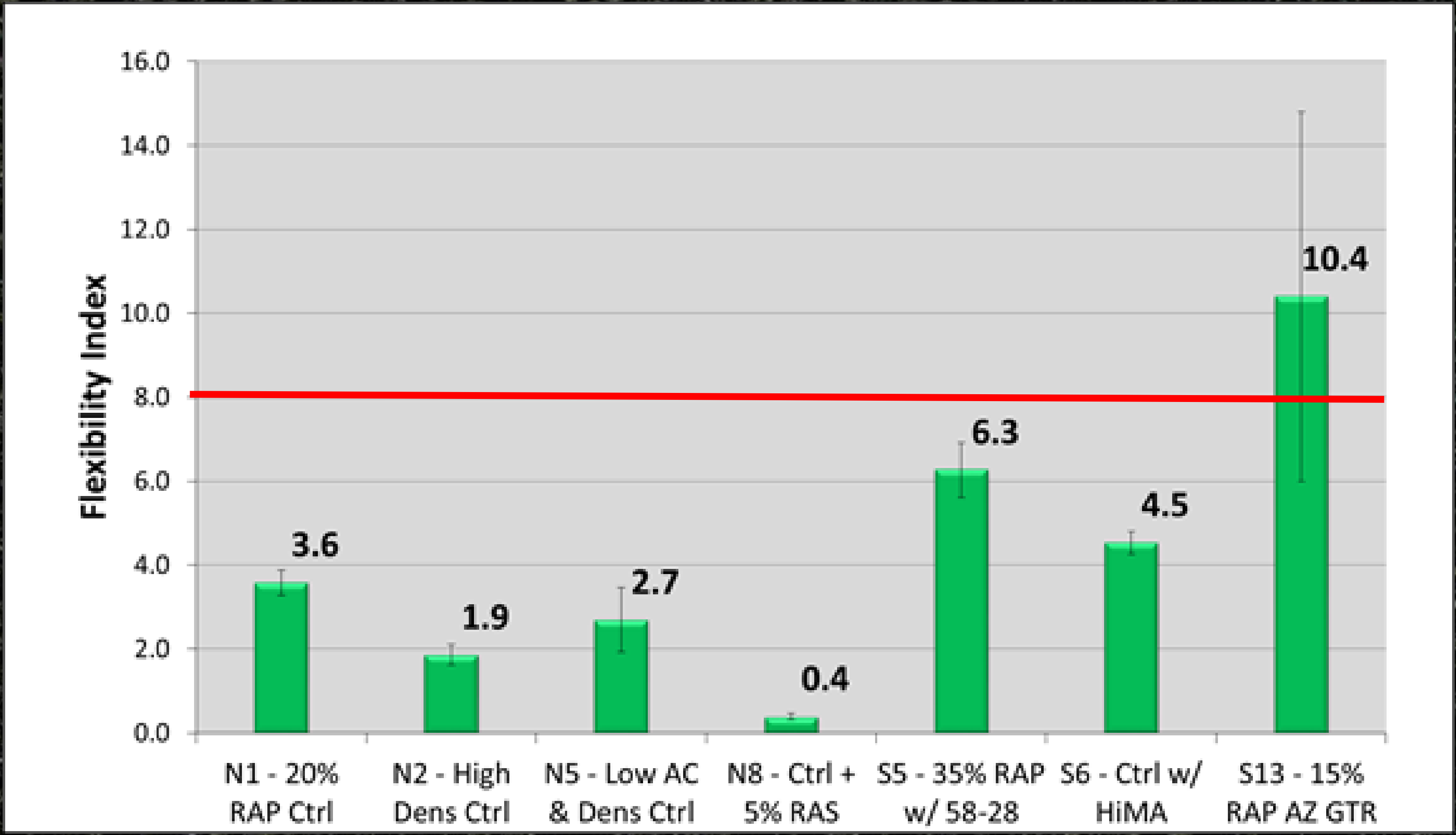
IFIT on Unaged PMLC Specimens



Preliminary Flexibility Index criteria = 8

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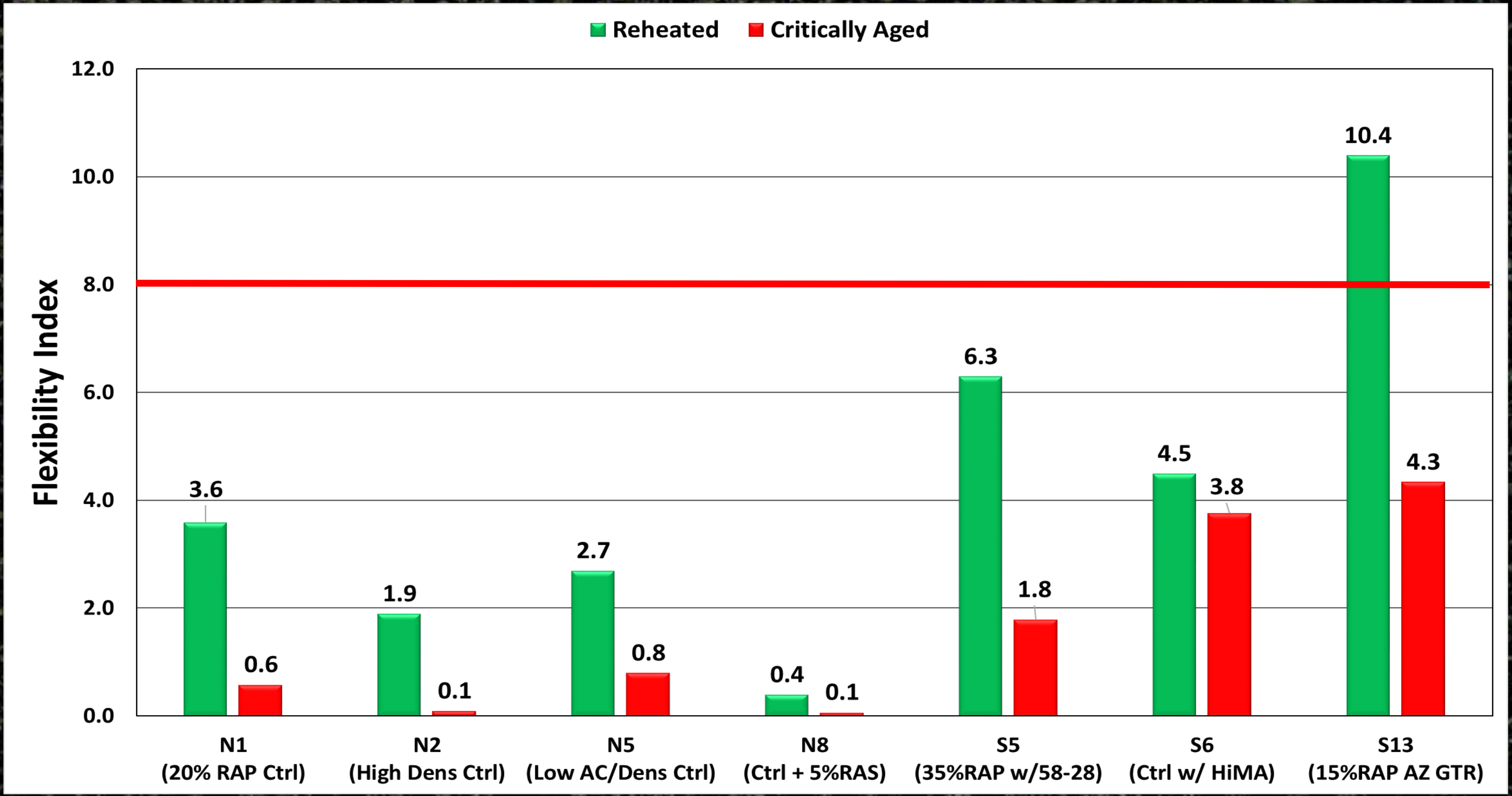
IFIT on PMLC Specimens



Preliminary ILDOT Flexibility Index criteria = 8

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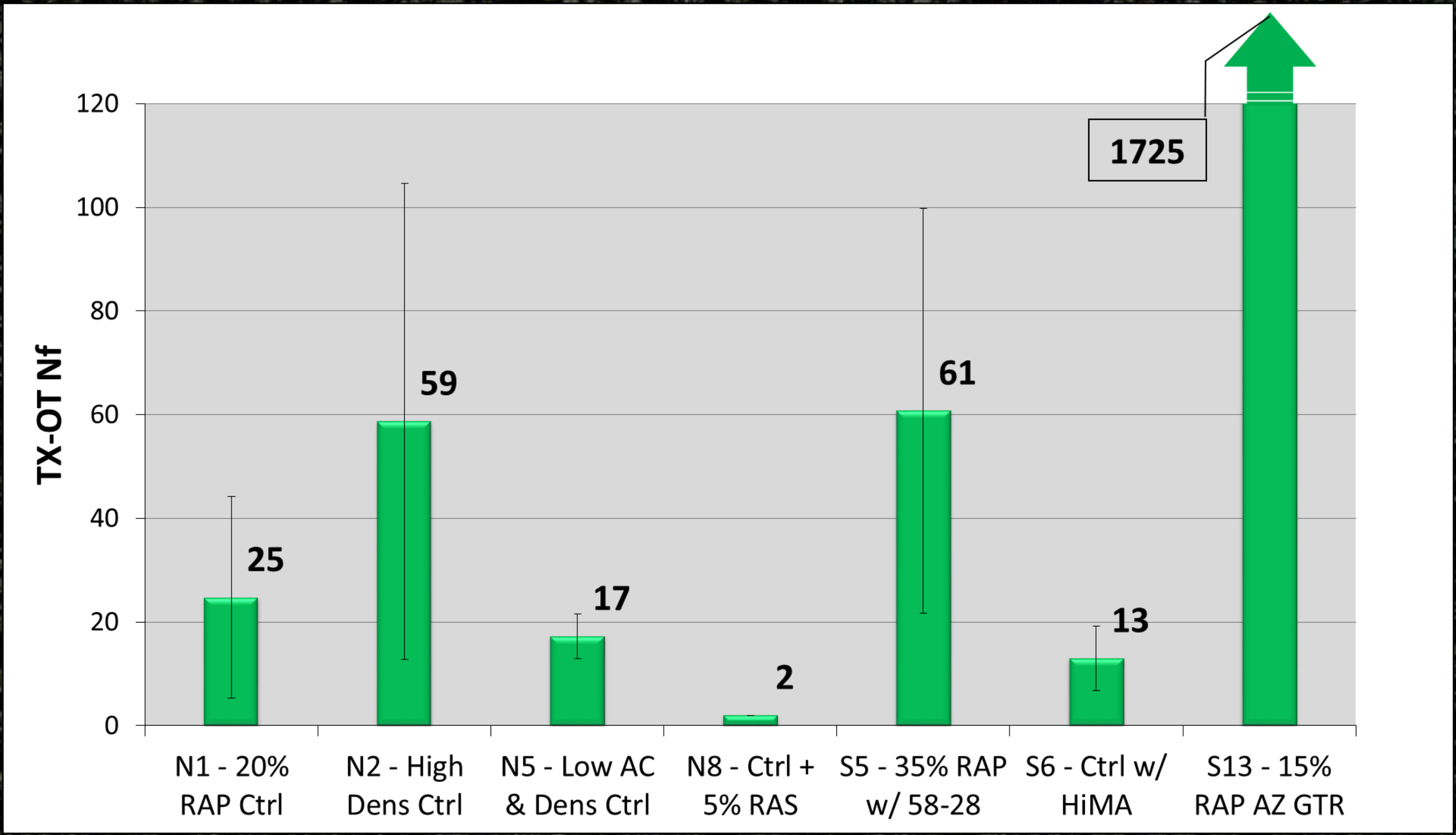
OT on Unaged PMLC Specimens



NJDOT criteria as of 2007

- ***150 for PG 64-22 surface mixes***
- ***175 for PG 76-22 surface mixes***

TXDOT criteria

- ***not clear, changing***
- ***300 for some mixes***

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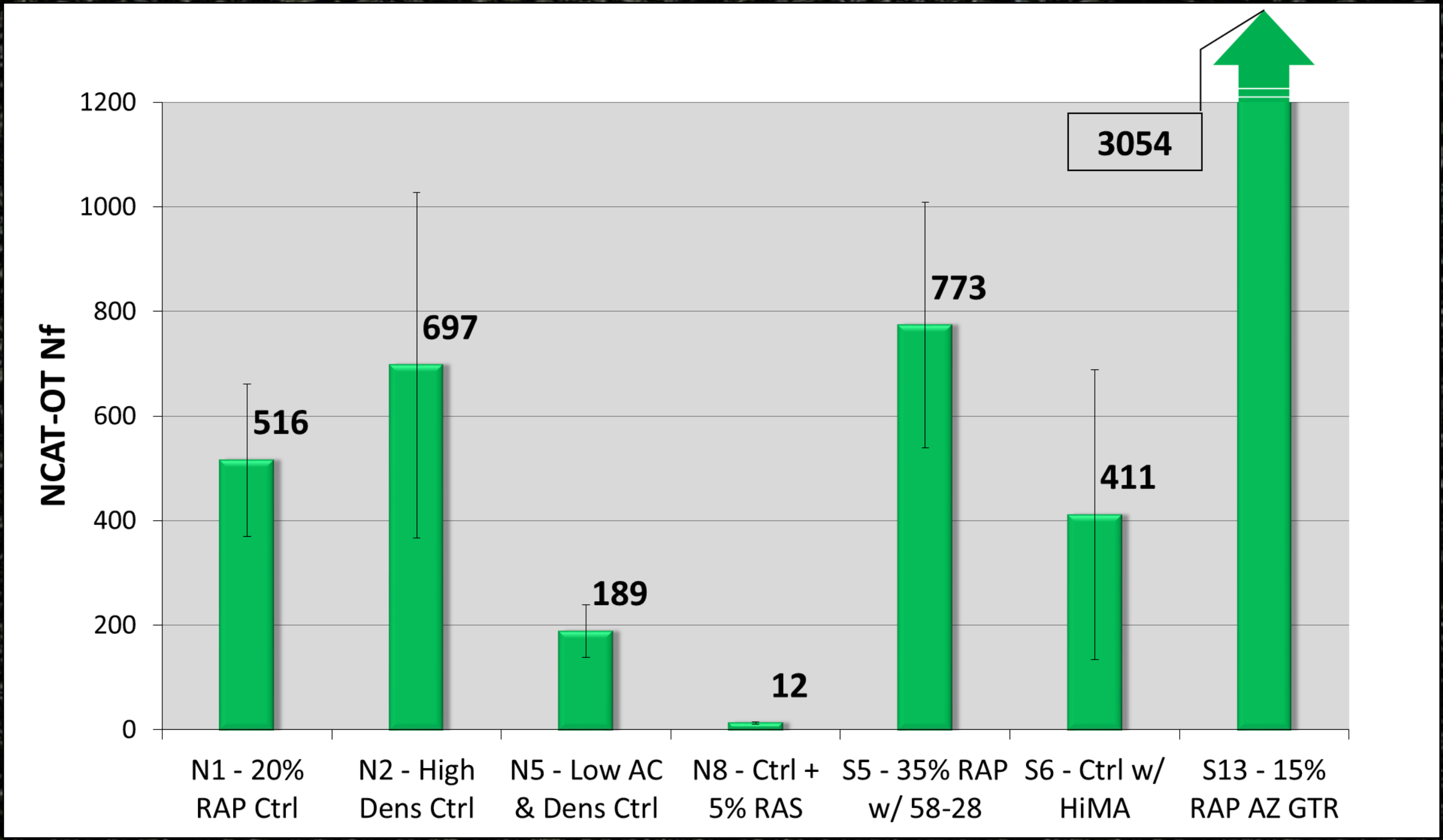
OT-NCAT Mod. on Unaged PMLC Specimens



similar ranking at Texas OT

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Status of Lab Work

Test	Lab Mixed Lab Compacted		Plant Mixed Lab Compacted	
	4 hrs. at Comp. Temp.	8 hrs. at 135°C	Reheated	8 hrs. at 135°C
Energy Ratio	X		X	X
IFIT			X	X
SCB-Jc			X	
OT	X		X	
OT-NCAT	X		X	
Ideal CT				

8 hrs at 135°C = "critically aged" which corresponds to 70,000 CDD

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Performance Tests

- Research is ongoing
  - selection of best test(s)
  - mix aging protocol
  - criteria
  - precision statistics
- Numerous Agencies and Contractors are testing the waters to understand how BMD will change mix designs

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Free to AAPT members

AAPT
Association of Asphalt Paving Technologists

$75/part for non-members

2017 Webinar Series

Balanced Mix Design (BMD) for Asphalt Mixtures

Nov. 2, 9, and 16 (Three Consecutive Thursdays) at 12 PM EST

Part 1: Nov. 2

Background on the need for BMD, different approaches, and path to implementation

Dr. Shane Buchanan
Oldcastle Materials

Part 2: Nov. 9

Developing a BMD framework, current gaps and research needs, how to get started on BMD now

Dr. Randy West
NCAT

Part 3: Nov. 16

A case study of BMD implementation in Louisiana, Lessons learned

Dr. Louay Mohammad, LTRC
Dr. Sam Cooper III, LADOTD
Dr. Jay Winford, Prairie Contractors

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