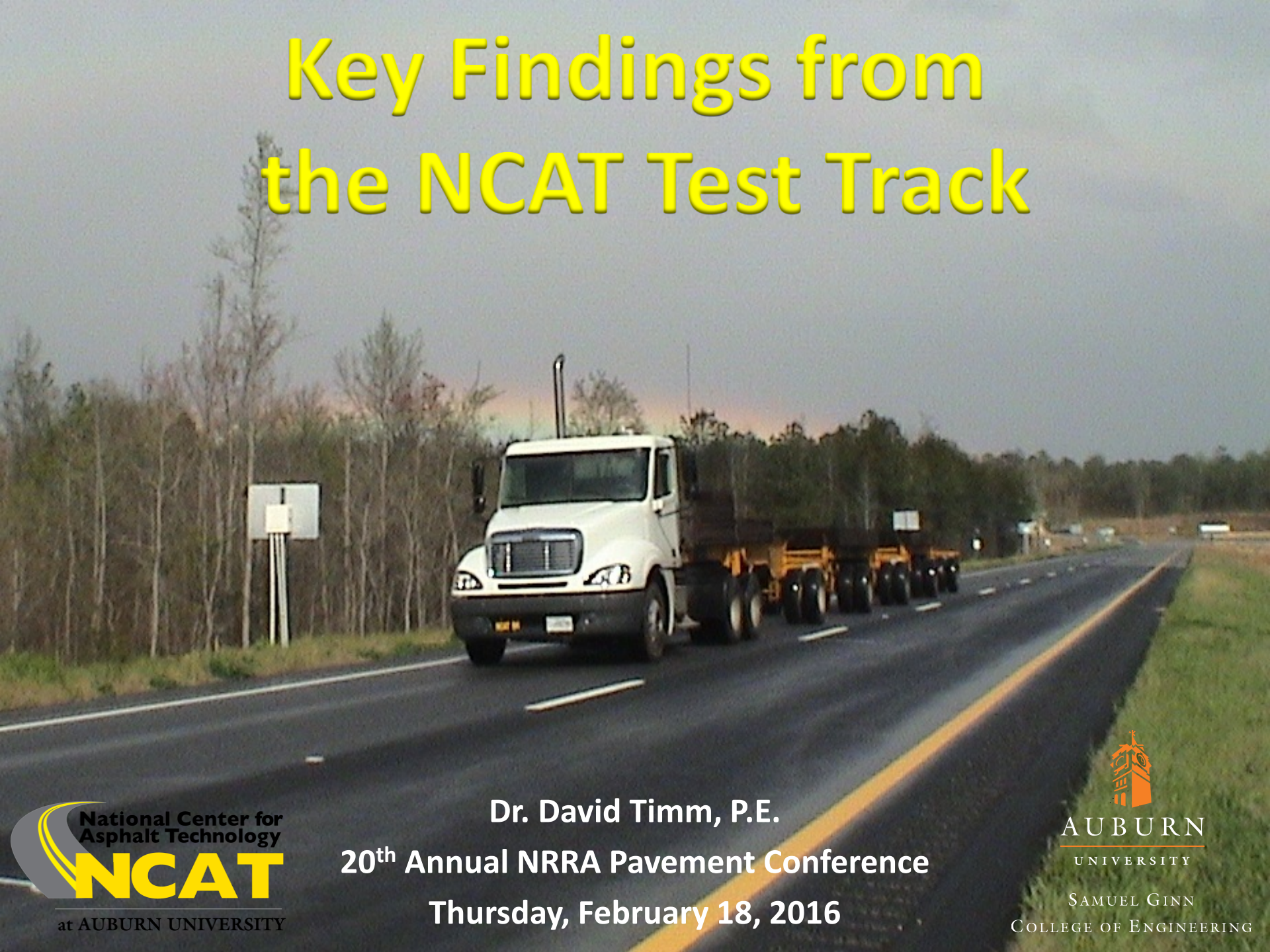
Key Findings from the NCAT Test Track



Dr. David Timm, P.E.

20th Annual NRRA Pavement Conference

Thursday, February 18, 2016

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

AUBURN UNIVERSITY
SAMUEL GINN COLLEGE OF ENGINEERING

Test Track Overview

- Started operations in 2000
- 3-year Research Cycles
- 46 Test Sections, 200 ft. each
  - 26 sections in tangents
  - 20 sections in curves
- Test Sections are sponsored
- Increasing complexity over time

Test Track Timeline

Outline

- General Findings
- Structural Studies
  - Structural Coefficient Recalibration
  - Perpetual Pavements
  - Cold Central Plant Recycling (CCPR)
- 2015 Test Track and MnROAD Partnership

General Findings – Mix Design

- Fine and coarse Superpave mixes perform similarly
- Modified binders cut rutting approximately 50%
- Dense-graded mixes perform as well as SMA for rutting resistance, but SMA is more durable
- Lowering N_{design} is OK

General Findings - Aggregates

- Elimination of the Restricted Zone
- Limit polishing prone aggregates
- Allow gravel in SMA & OGFC
- Allow some F&E for SMA & OGFC

Structural Coefficient Calibration

- Current ALDOT pavement design based on AASHO Road Test

- Structural coefficients (a_i) are key inputs
  - Express relative “strength” of component layers
  - Used to determine required thicknesses of layers

- ALDOT asphalt coefficients were set in 1990
  - No changes since then

AASHO HMA Coefficients

Loop	Layer Coefficient (a_1)	Test Sections	R^2
2	0.83	44	0.80
3	0.44	60	0.83
4	0.44	60	0.90
5	0.47	60	0.92
6	0.33	60	0.81

Figure 92. Automatic batch-type plant used to produce binder course mixture; dryers in tandem.

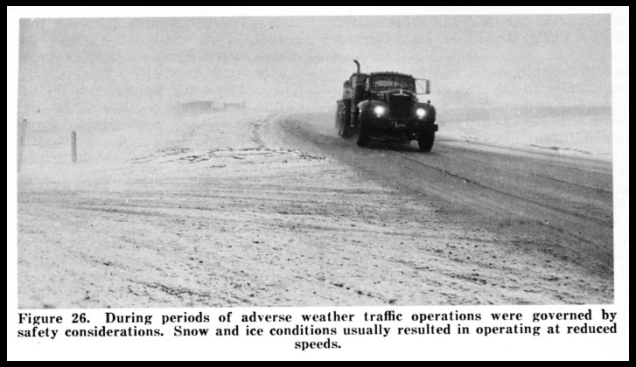


Figure 26. During periods of adverse weather traffic operations were governed by safety considerations. Snow and ice conditions usually resulted in operating at reduced speeds.


Figure 1. Looking east, Loops 5 and 2 in foreground.

N1 – Predicted and Measured Traffic

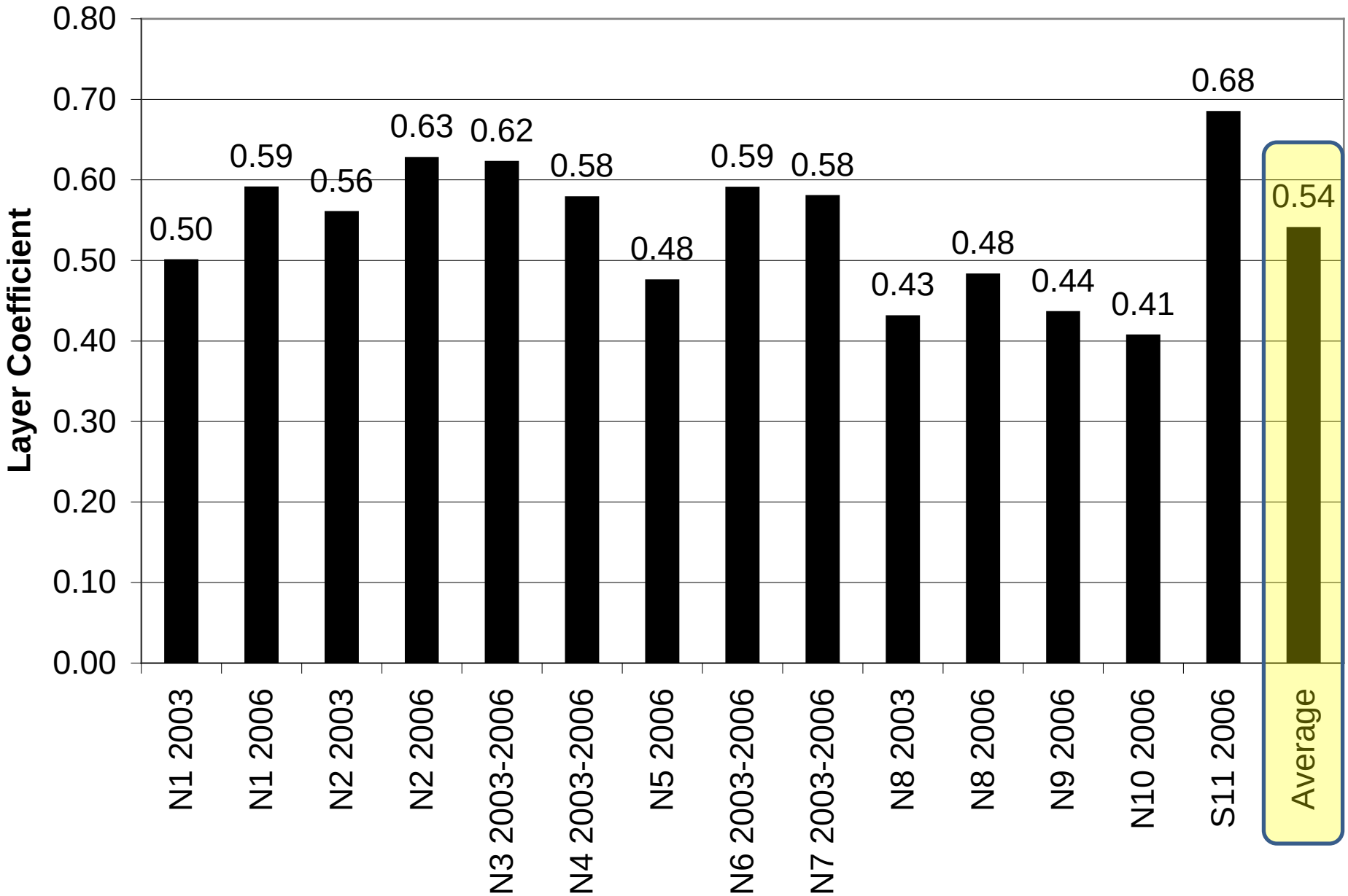
$a_1 = 0.44$ ($R^2 = 0.08$)

Predicted ESALs	Measured ESALs	Difference	% Error
802,367	2,267,922	1,465,555	65%
1,126,574	2,837,091	1,710,517	60%
1,270,712	2,963,064	1,692,352	57%
1,638,661	3,212,141	1,573,480	49%
2,340,290	4,321,771	1,981,481	46%

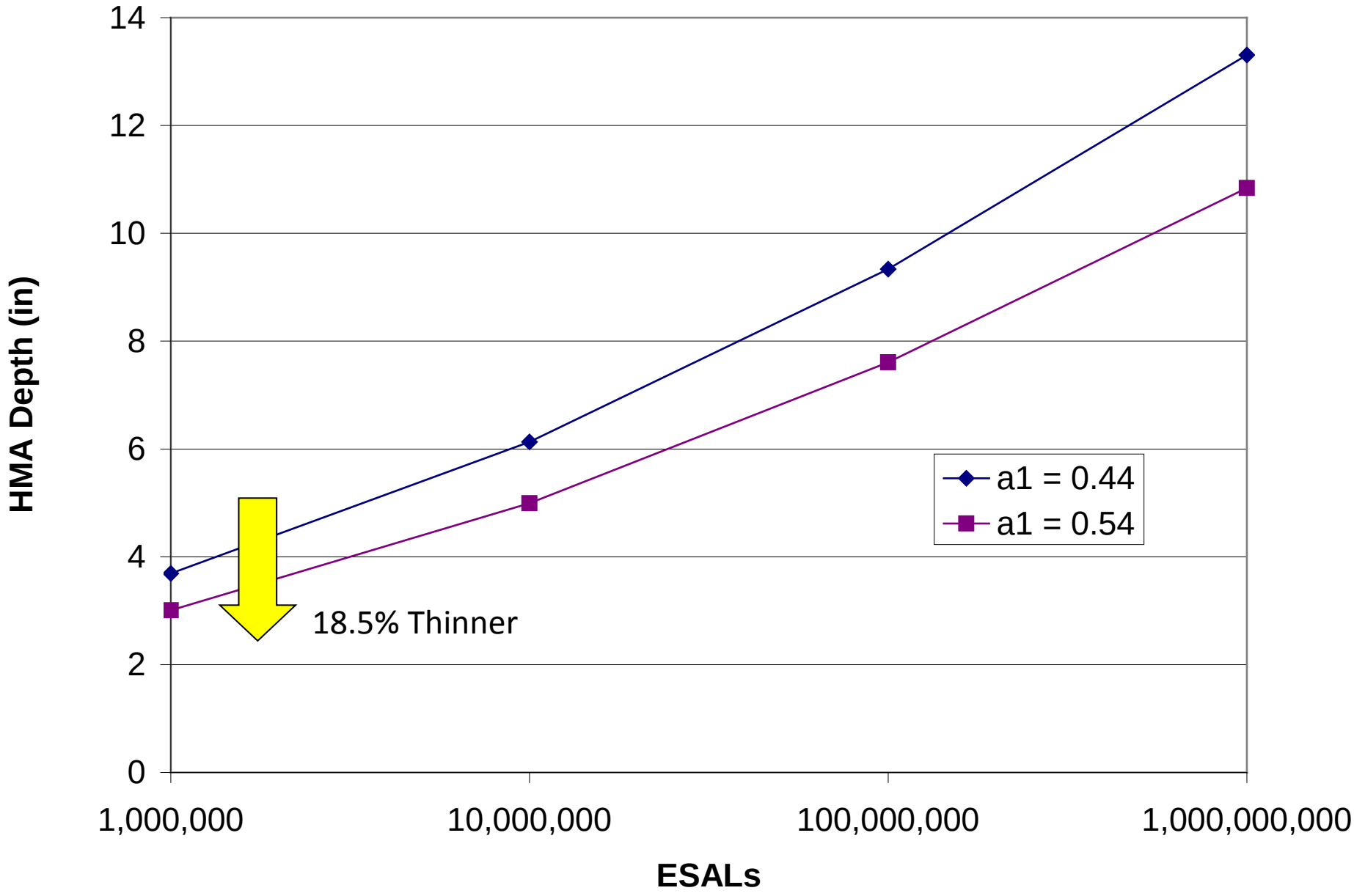
$a_1 = 0.55$ ($R^2 = 0.74$)

Predicted ESALs	Measured ESALs	Difference	% Error
1,314,680	2,224,691	910012	41%
2,007,491	2,806,554	799065	28%
2,332,763	2,939,906	607145	21%
3,203,489	3,207,147	3661	0%
4,996,650	4,353,456	643194	15%

a_1 Summary

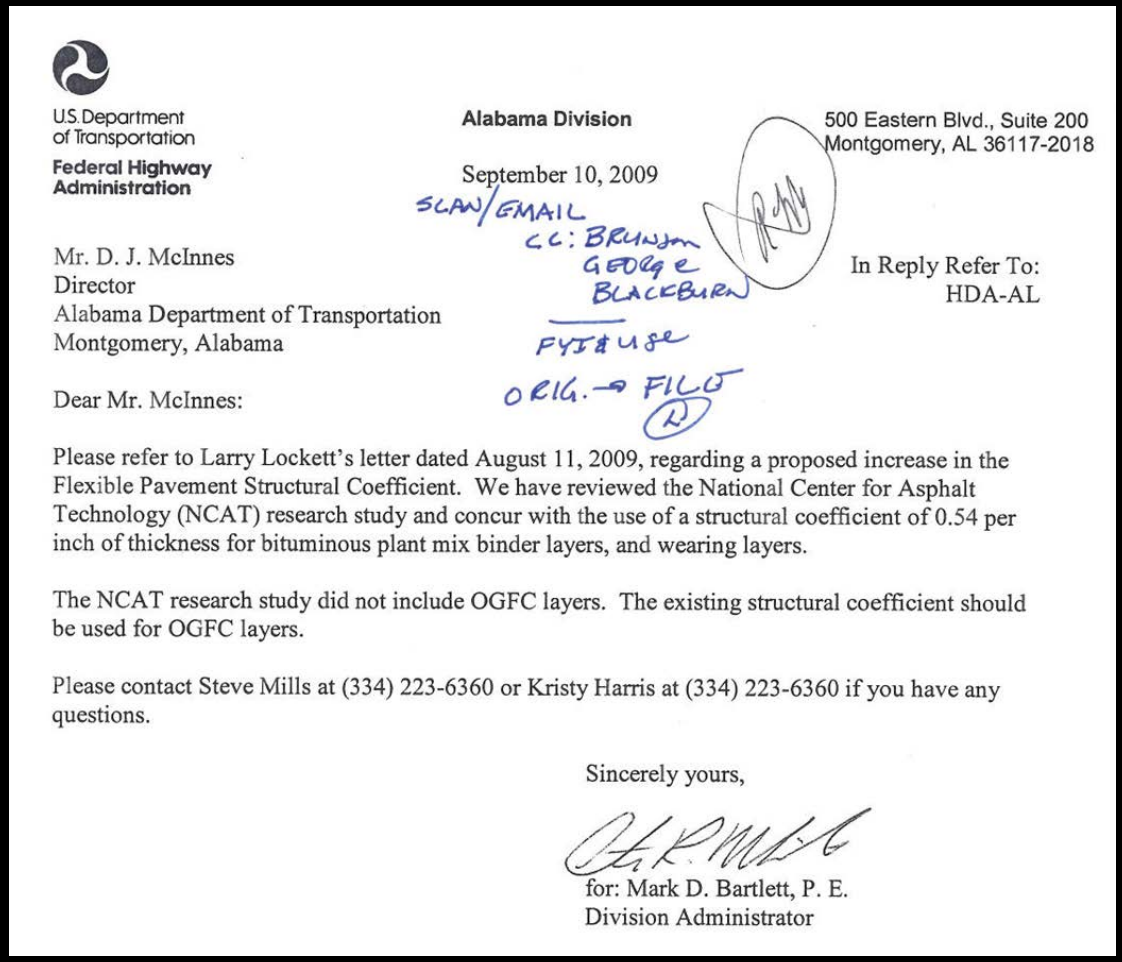

Layer Coefficient
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.50
0.59
0.56
0.63
0.62
0.58
0.48
0.59
0.58
0.43
0.48
0.44
0.41
0.68
0.54
N1 2003
N1 2006
N2 2003
N2 2006
N3 2003-2006
N4 2003-2006
N5 2006
N6 2003-2006
N7 2003-2006
N8 2003
N8 2006
N9 2006
N10 2006
S11 2006
Average

Effect on Pavement Design



Structural Coefficient Implementation

- Not calibrated for thicknesses < 5”
  - ALDOT recommends 5” min thickness



U.S. Department of Transportation
Federal Highway Administration

Alabama Division

500 Eastern Blvd., Suite 200
Montgomery, AL 36117-2018

September 10, 2009

SCAN/EMAIL
cc: BRUNSON
GEORGE
BLACKBURN

FYI & USE

ORIG. → FILE

In Reply Refer To:
HDA-AL

Mr. D. J. McInnes
Director
Alabama Department of Transportation
Montgomery, Alabama

Dear Mr. McInnes:

Please refer to Larry Lockett's letter dated August 11, 2009, regarding a proposed increase in the Flexible Pavement Structural Coefficient. We have reviewed the National Center for Asphalt Technology (NCAT) research study and concur with the use of a structural coefficient of 0.54 per inch of thickness for bituminous plant mix binder layers, and wearing layers.

The NCAT research study did not include OGFC layers. The existing structural coefficient should be used for OGFC layers.

Please contact Steve Mills at (334) 223-6360 or Kristy Harris at (334) 223-6360 if you have any questions.

Sincerely yours,

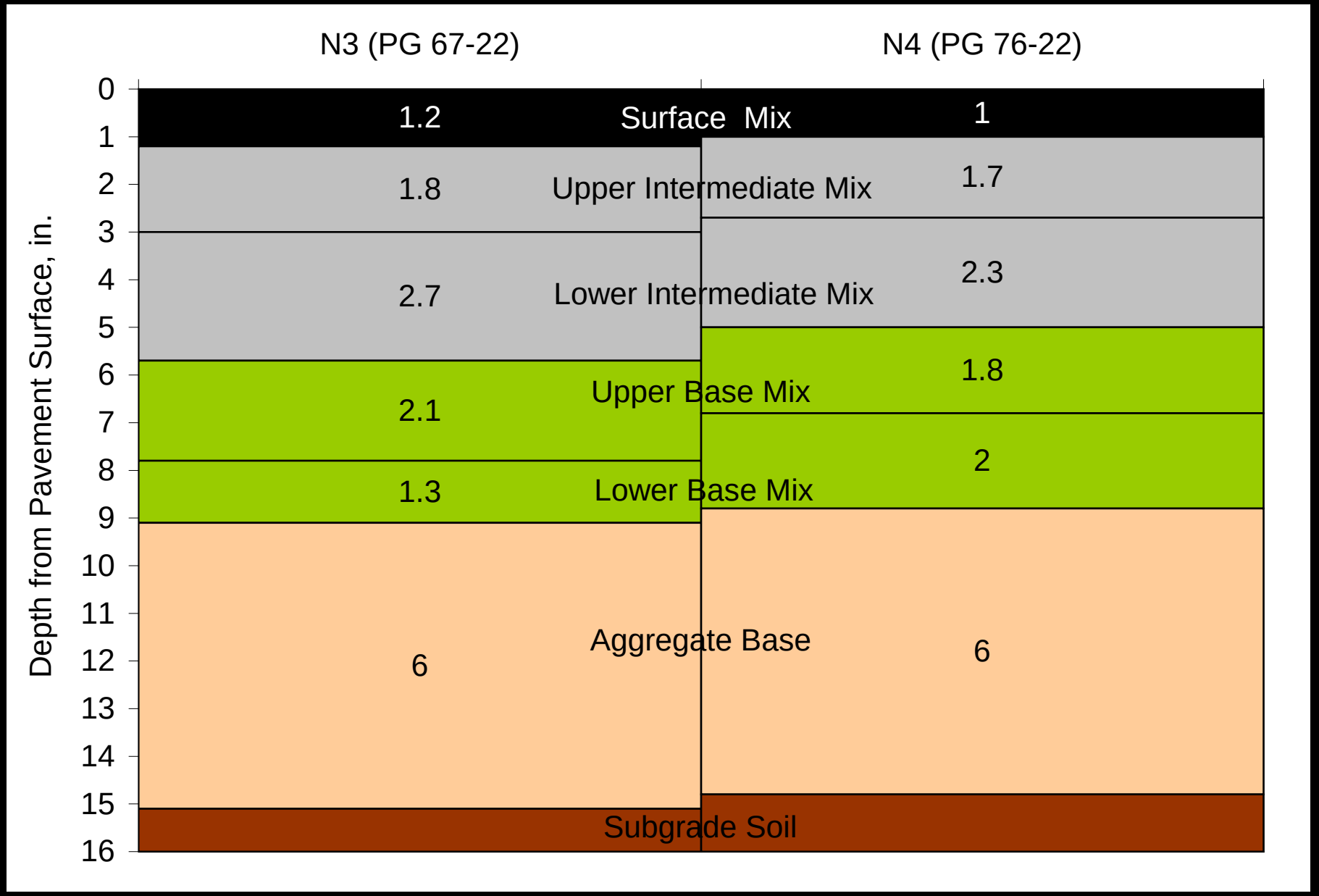
for: Mark D. Bartlett, P. E.
Division Administrator


Perpetual Pavement Research

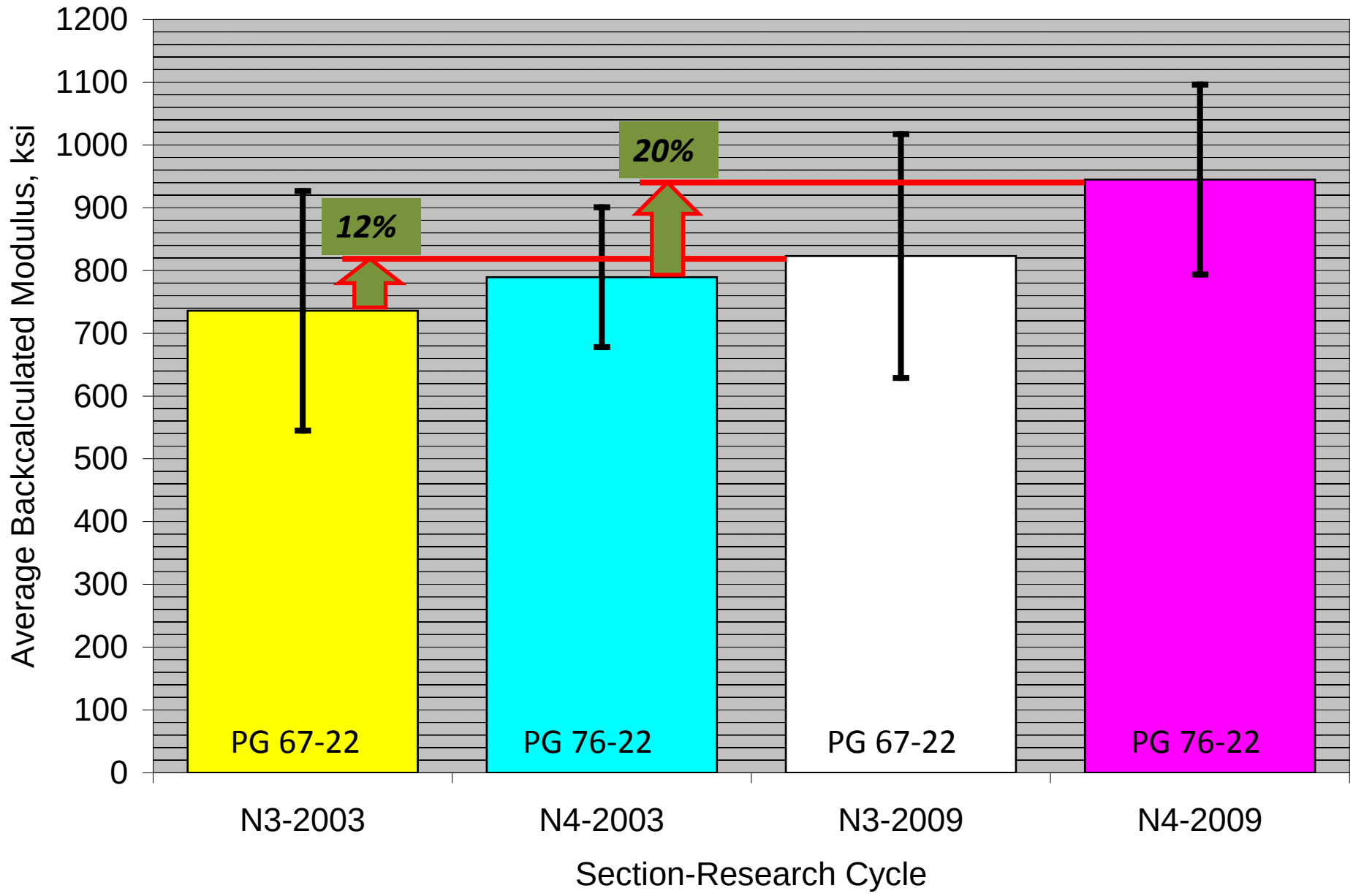
Perpetual Pavements at Test Track

- Sections N3 & N4
  - Built in 2003 as part of structural study
  - Expected to fail after 10 million ESAL
  - Have experienced 30 million ESAL
  - Excellent performance from both
- Sections N8 & N9
  - Built in 2006 as a perpetual experiment
  - 4 inch difference in AC depth with rich bottom
  - Drastic difference in section performance

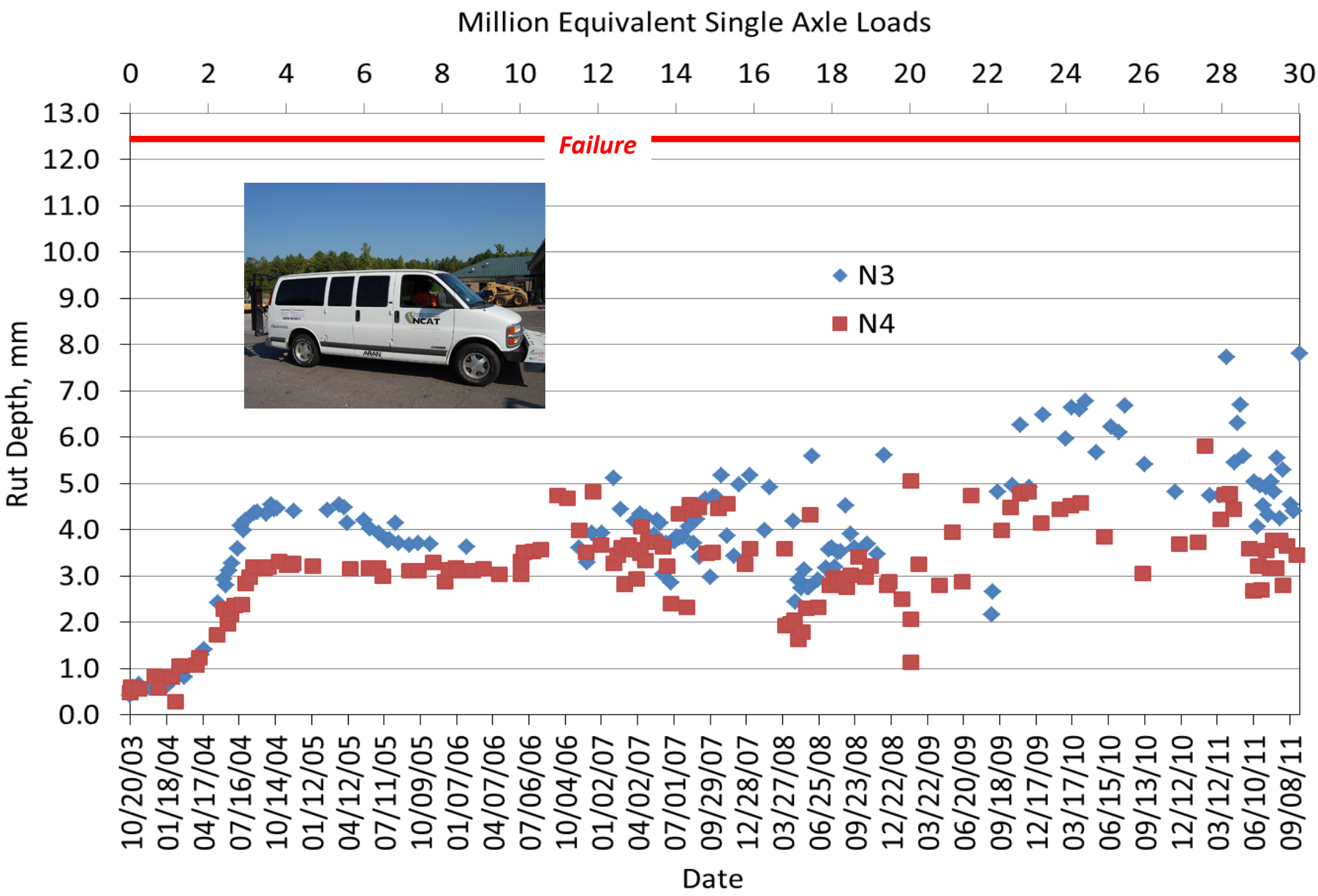
N3 & N4


N3 (PG 67-22)
N4 (PG 76-22)
Depth from Pavement Surface, in.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
1.2
Surface Mix
1
1.8
Upper Intermediate Mix
1.7
2.7
Lower Intermediate Mix
2.3
2.1
Upper Base Mix
1.8
1.3
Lower Base Mix
2
6
Aggregate Base
6
Subgrade Soil

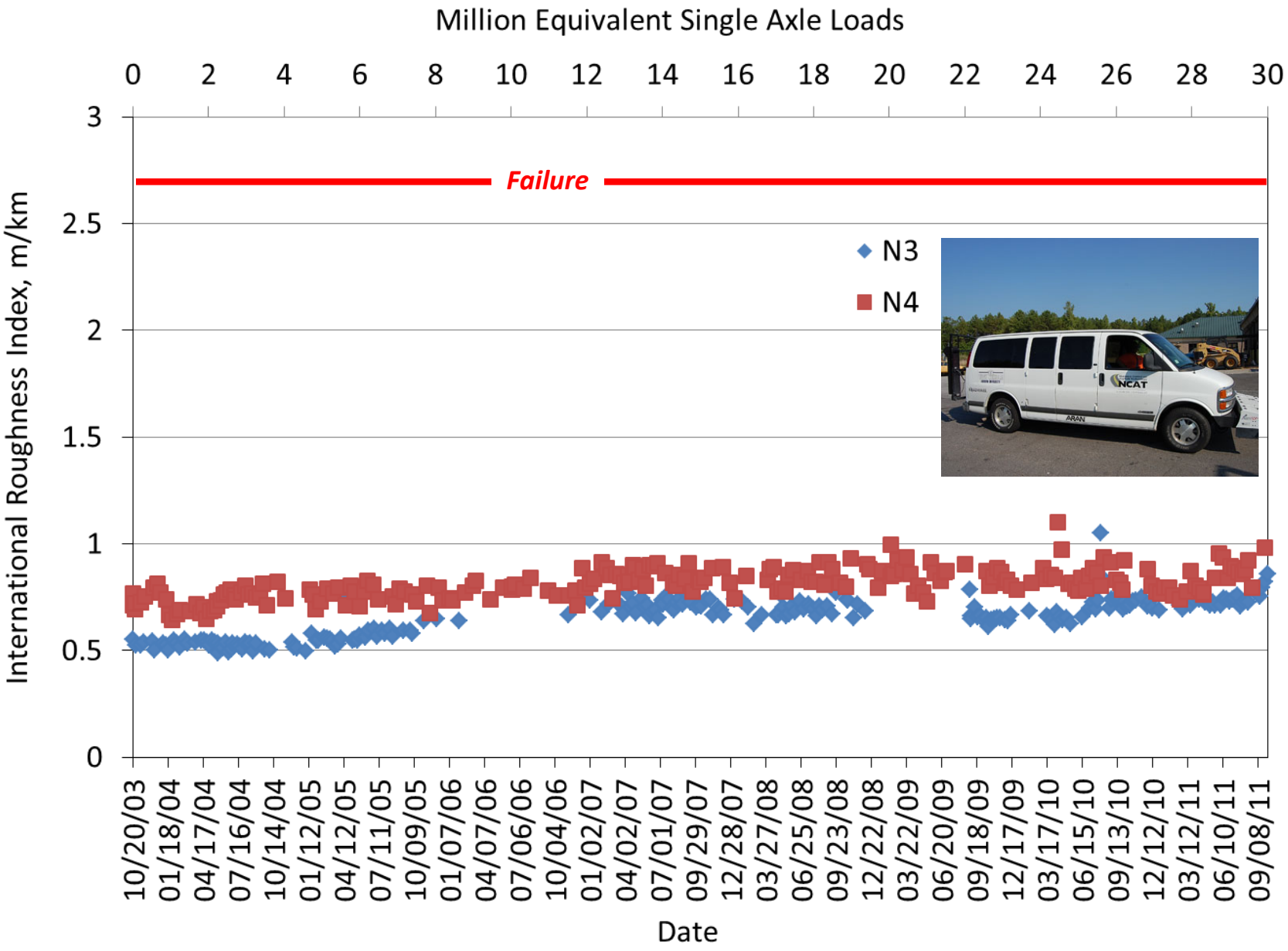
AC Modulus at 68F



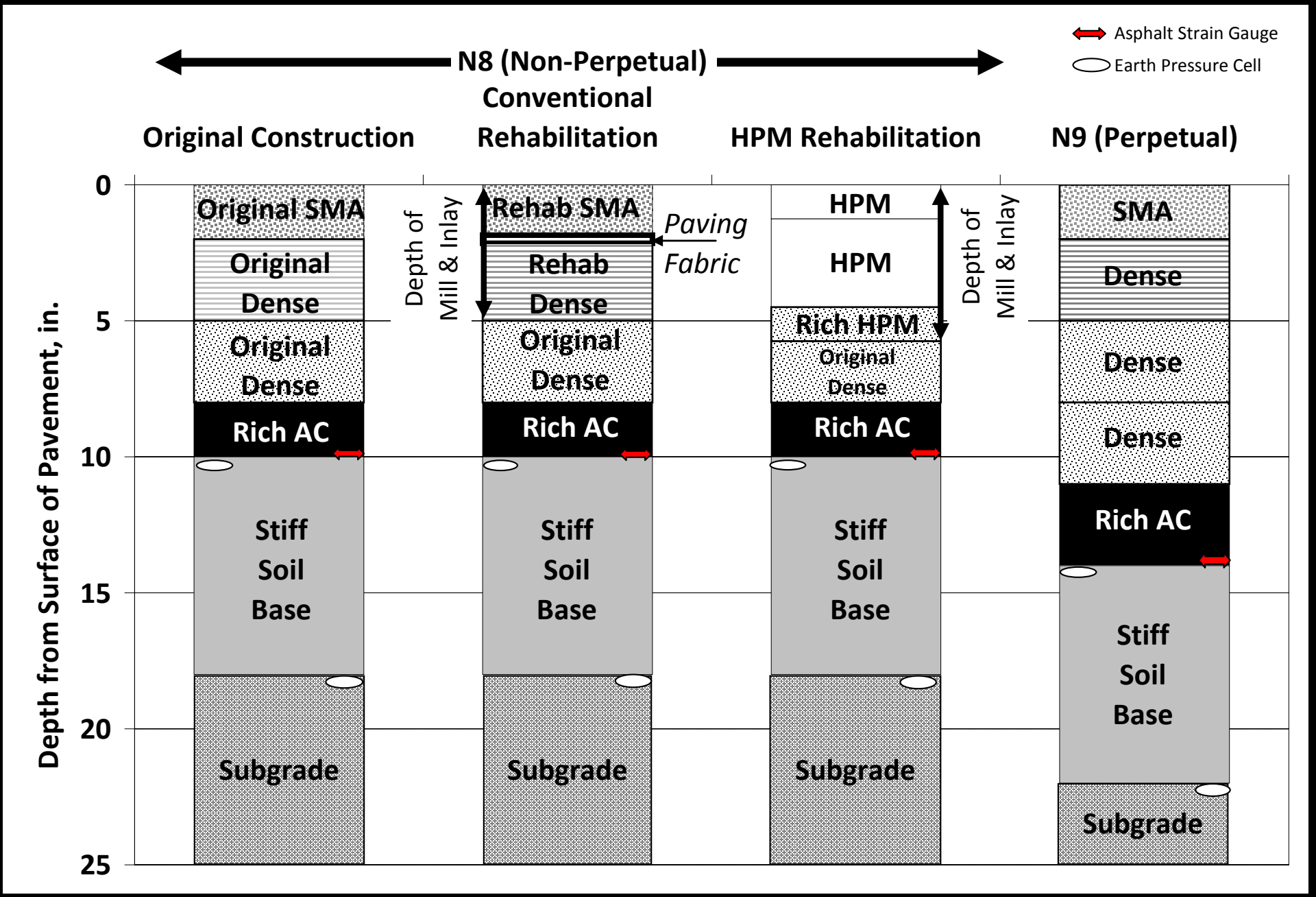
Rutting Performance



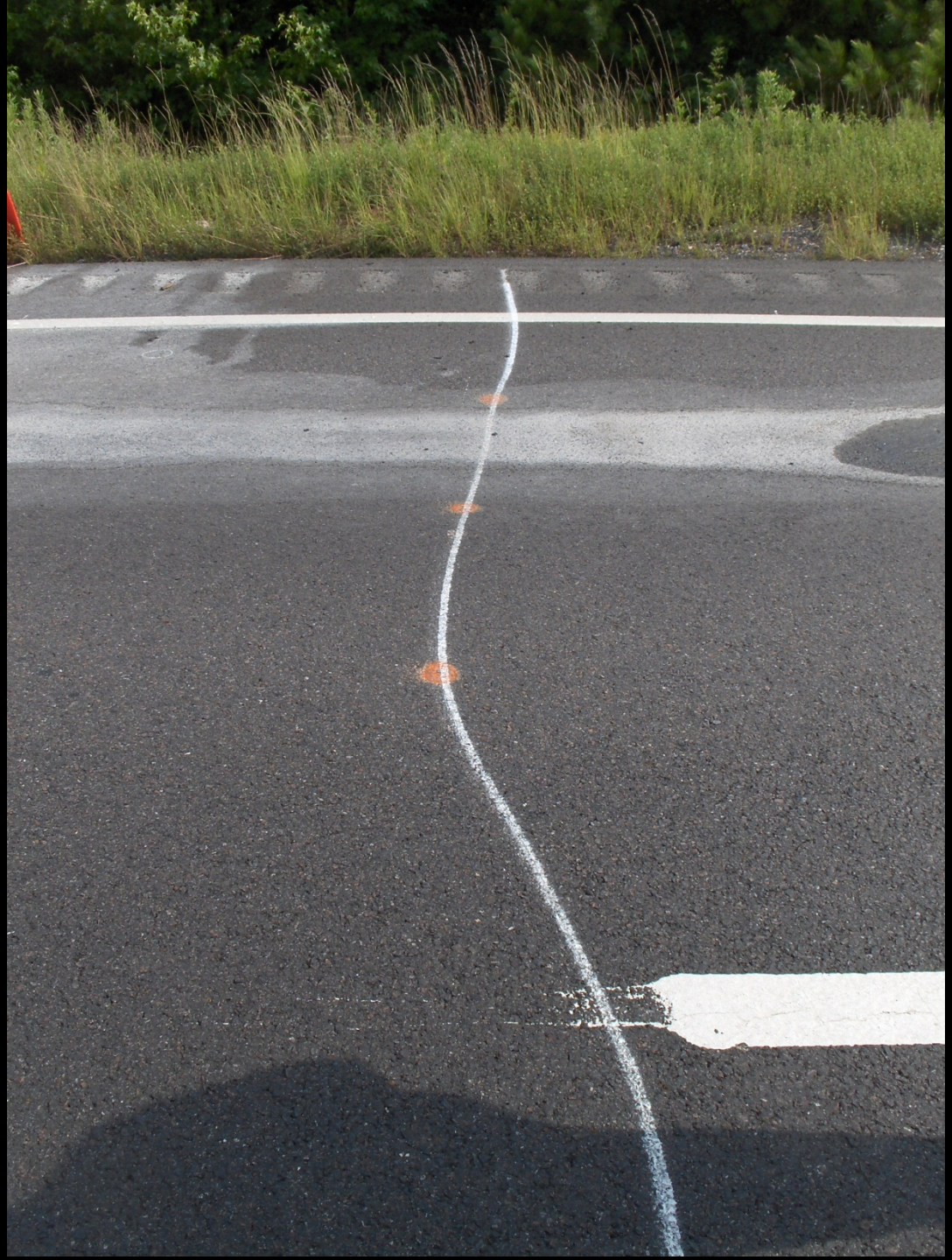
International Roughness Index



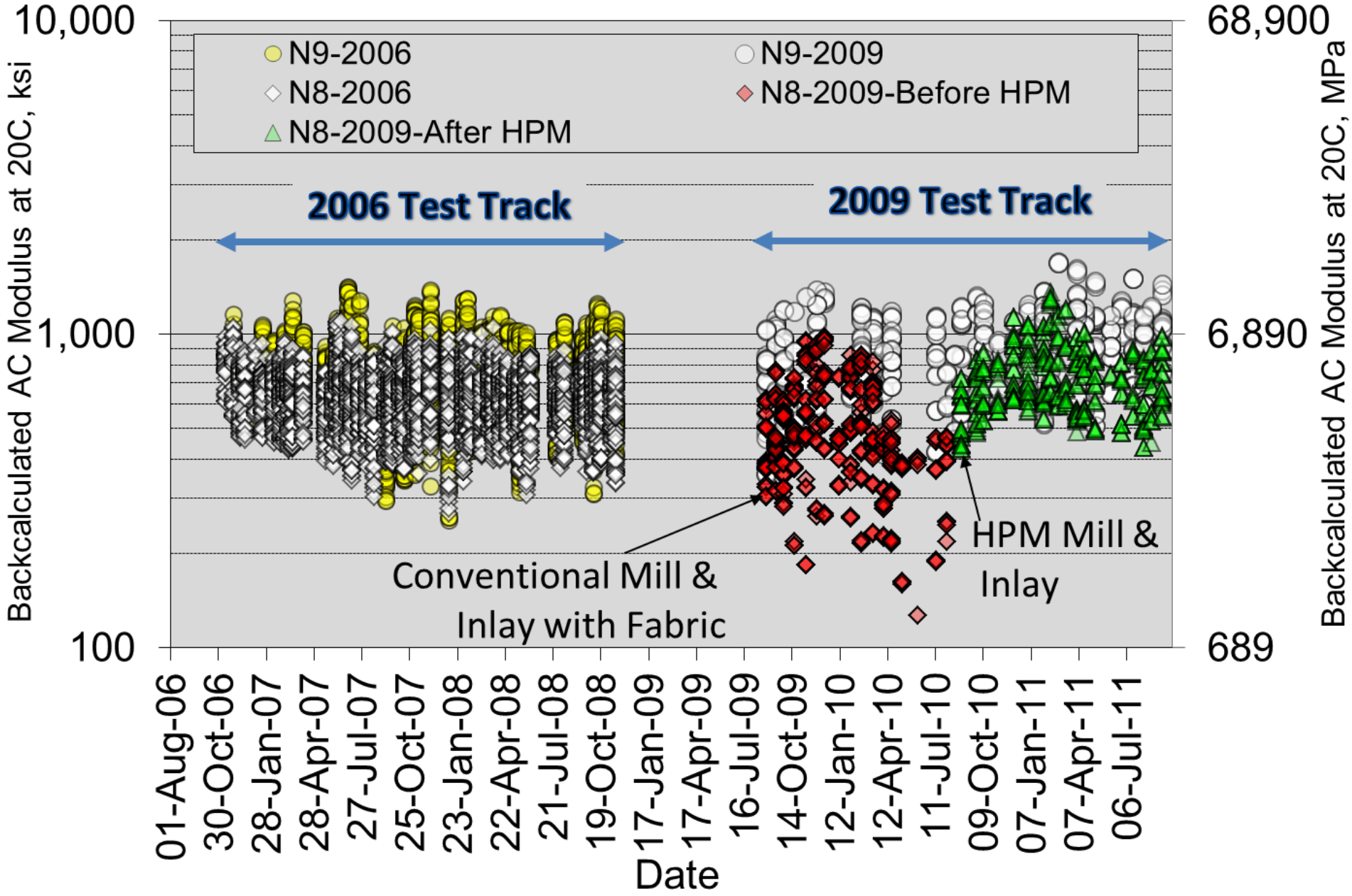
N8 & N9


Asphalt Strain Gauge
Earth Pressure Cell
N8 (Non-Perpetual)
Conventional
Original Construction
Rehabilitation
HPM Rehabilitation
N9 (Perpetual)
Depth from Surface of Pavement, in.
0
5
10
15
20
25
Original SMA
Original Dense
Original Dense
Rich AC
Stiff Soil Base
Subgrade
Depth of Mill & Inlay
Rehab SMA
Paving Fabric
Rehab Dense
Original Dense
Rich AC
Stiff Soil Base
Subgrade
HPM
HPM
Depth of Mill & Inlay
Rich HPM
Original Dense
Rich AC
Stiff Soil Base
Subgrade
SMA
Dense
Dense
Dense
Rich AC
Stiff Soil Base
Subgrade

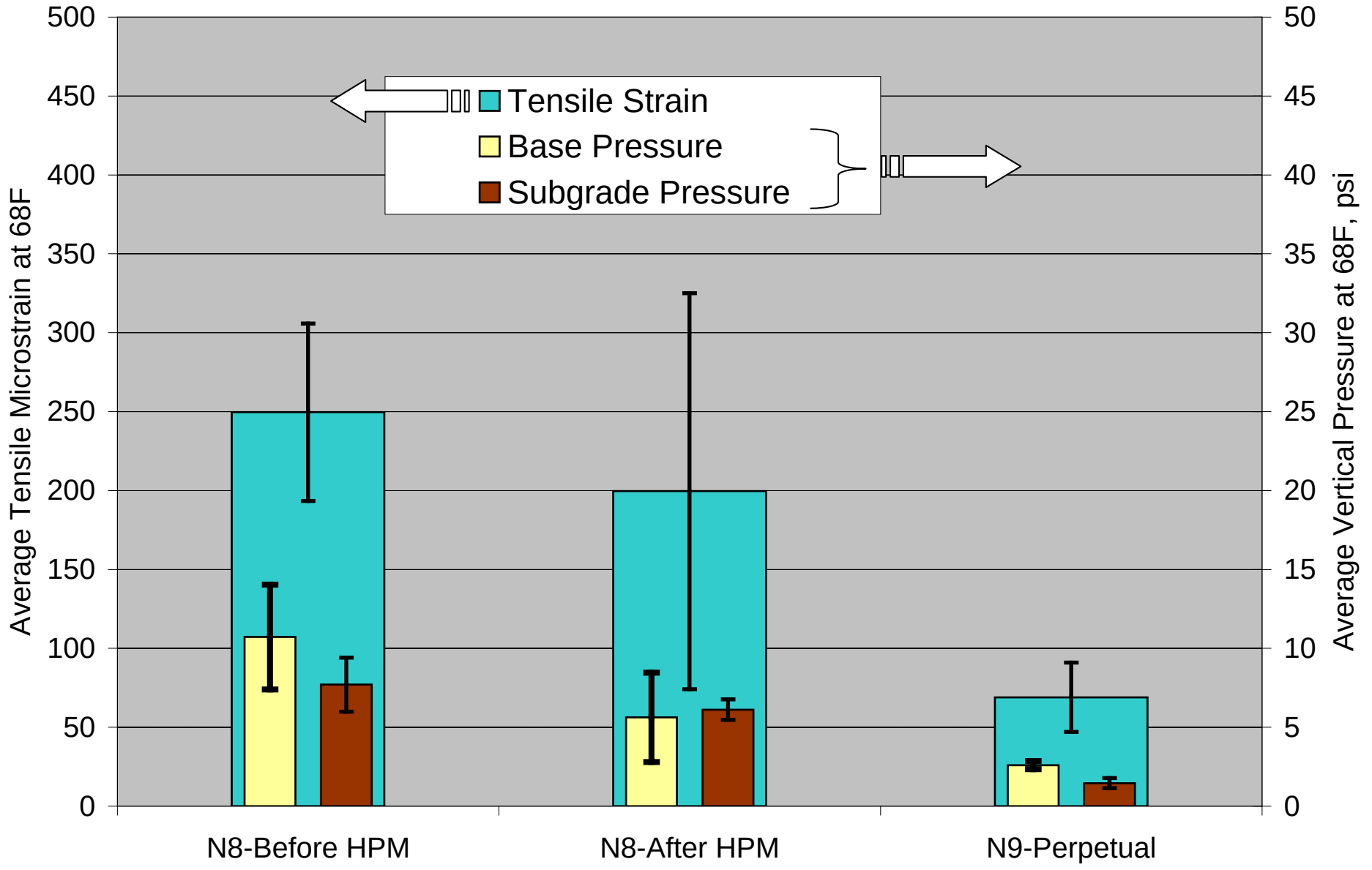

13.5 Million ESALs



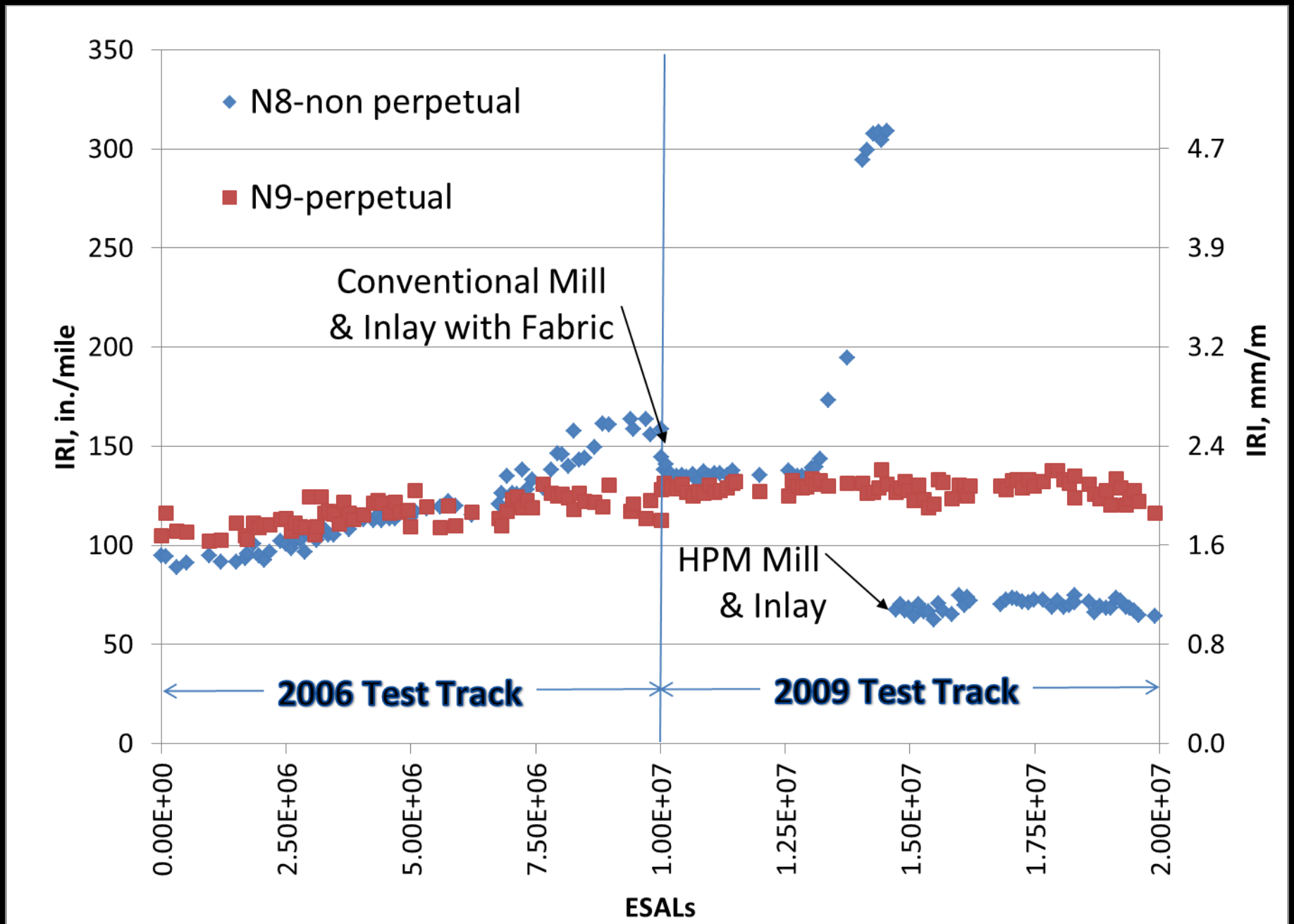
AC Modulus vs Date



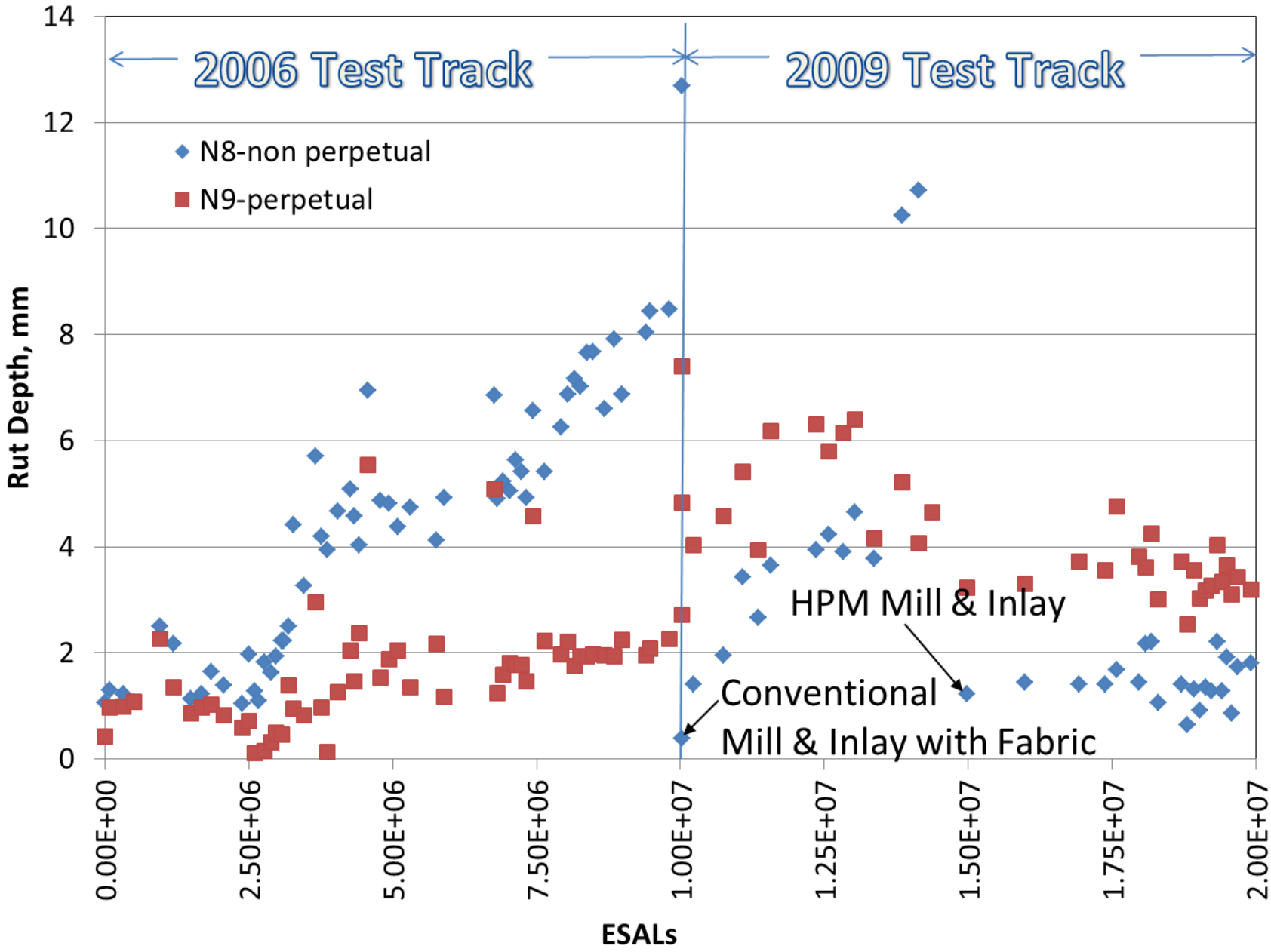
Measured Pavement Response



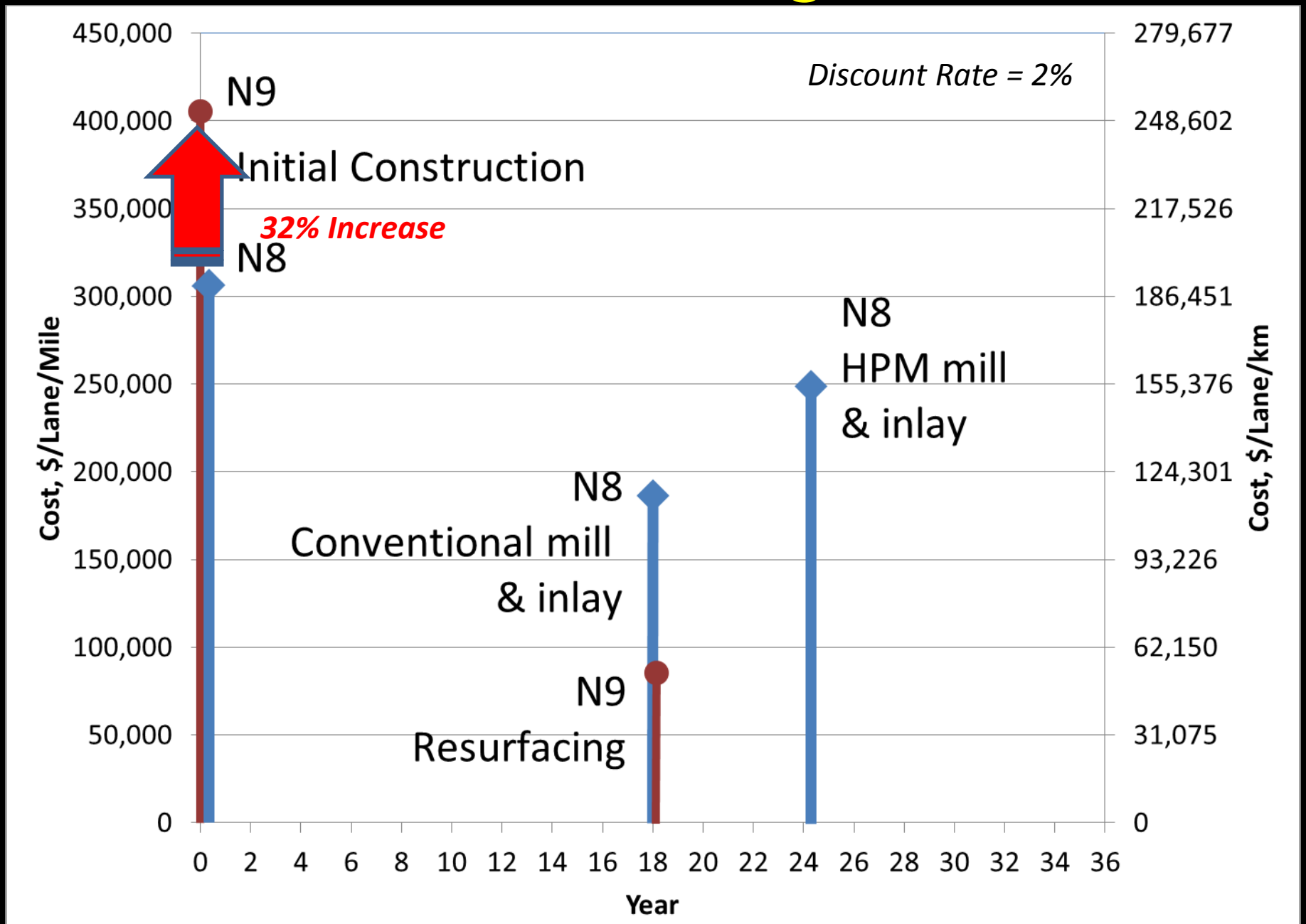
Section Performance - IRI



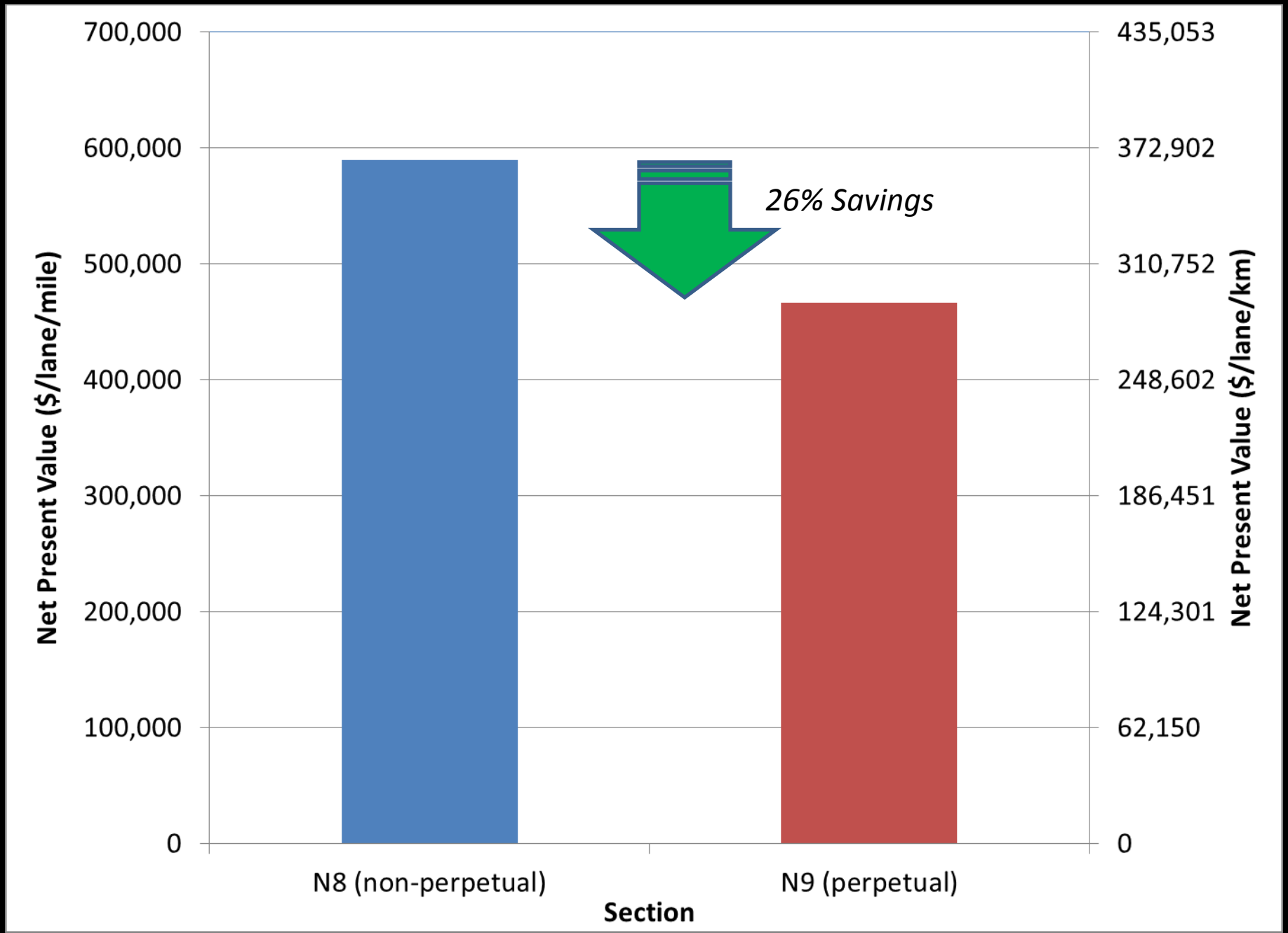
Section Performance - Rutting



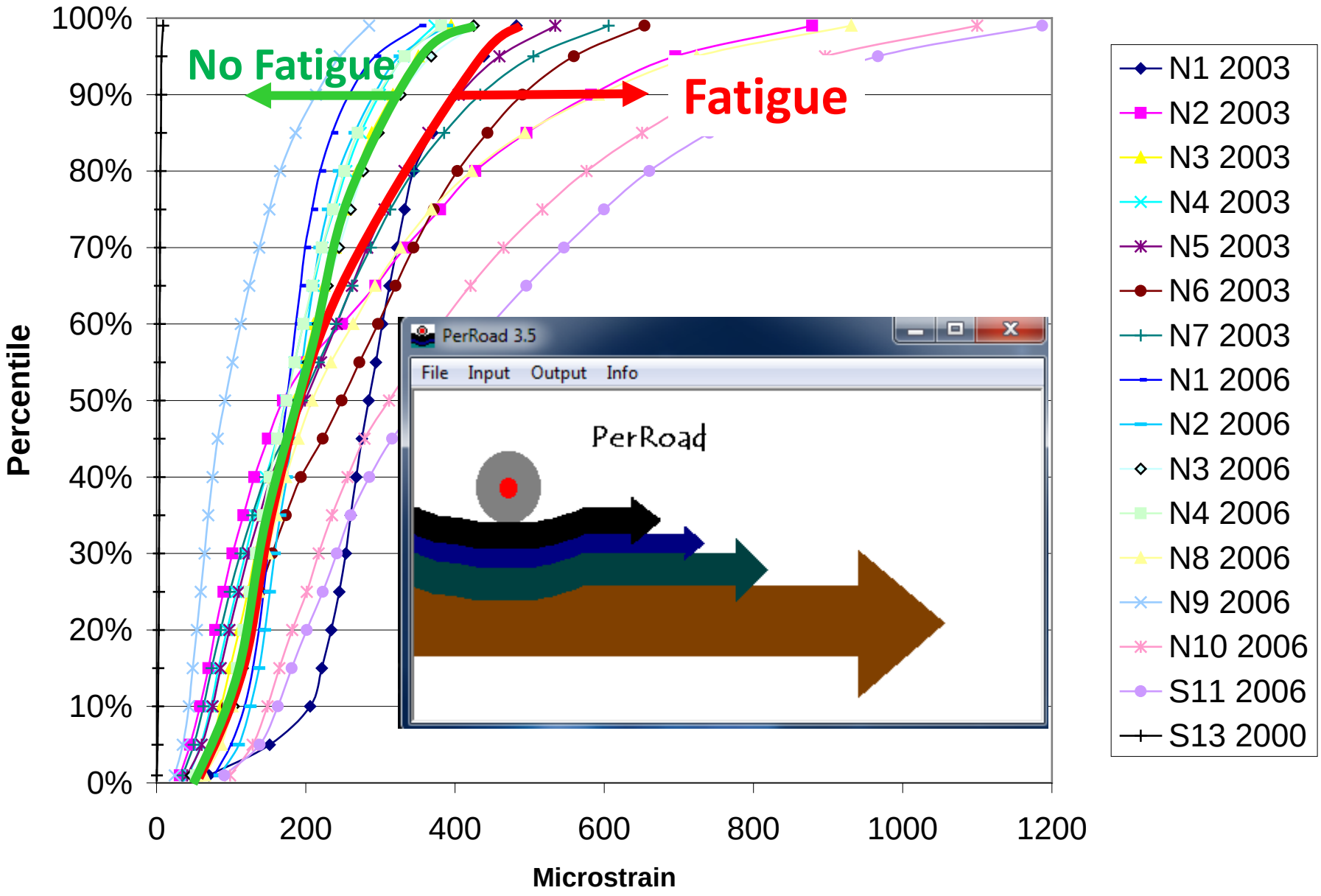
Cash Flow Diagram



Net Present Value



Strain Distributions for Perpetual Design



Cold Central Plant Recycling

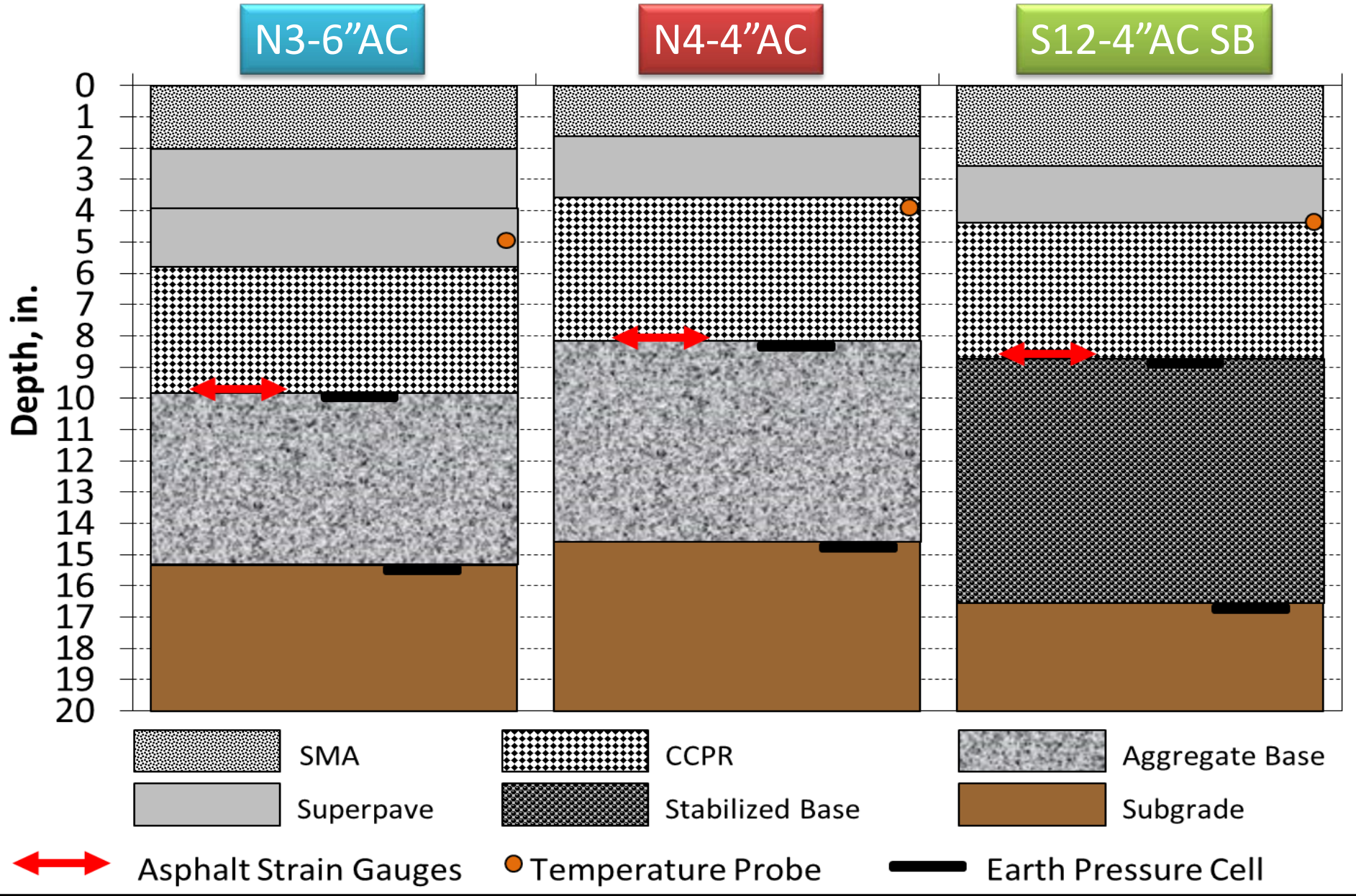
Milling

Fractionation

CCPR Mixing (RAP+binding agents)

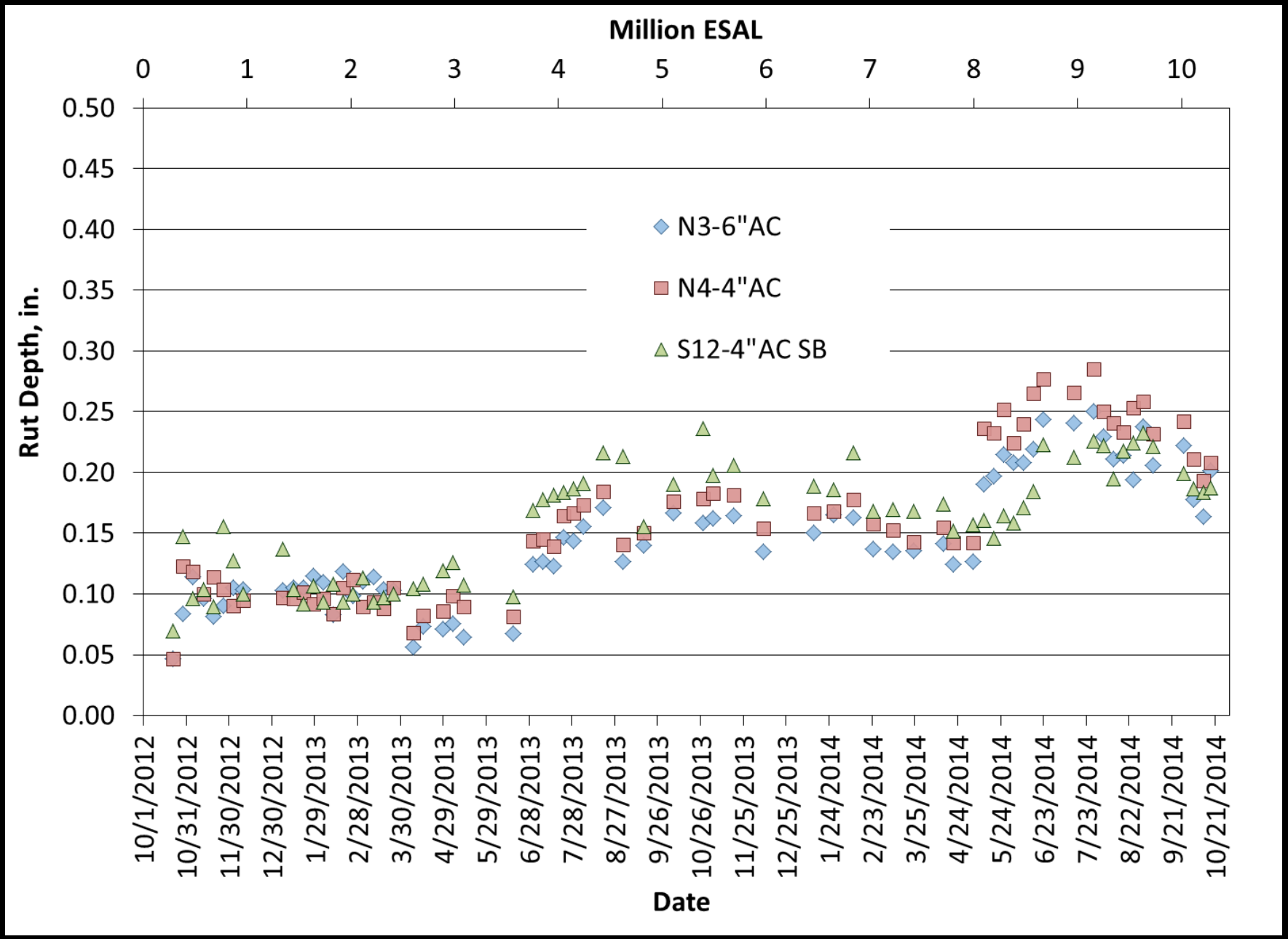
Conventional Paving

Test Sections

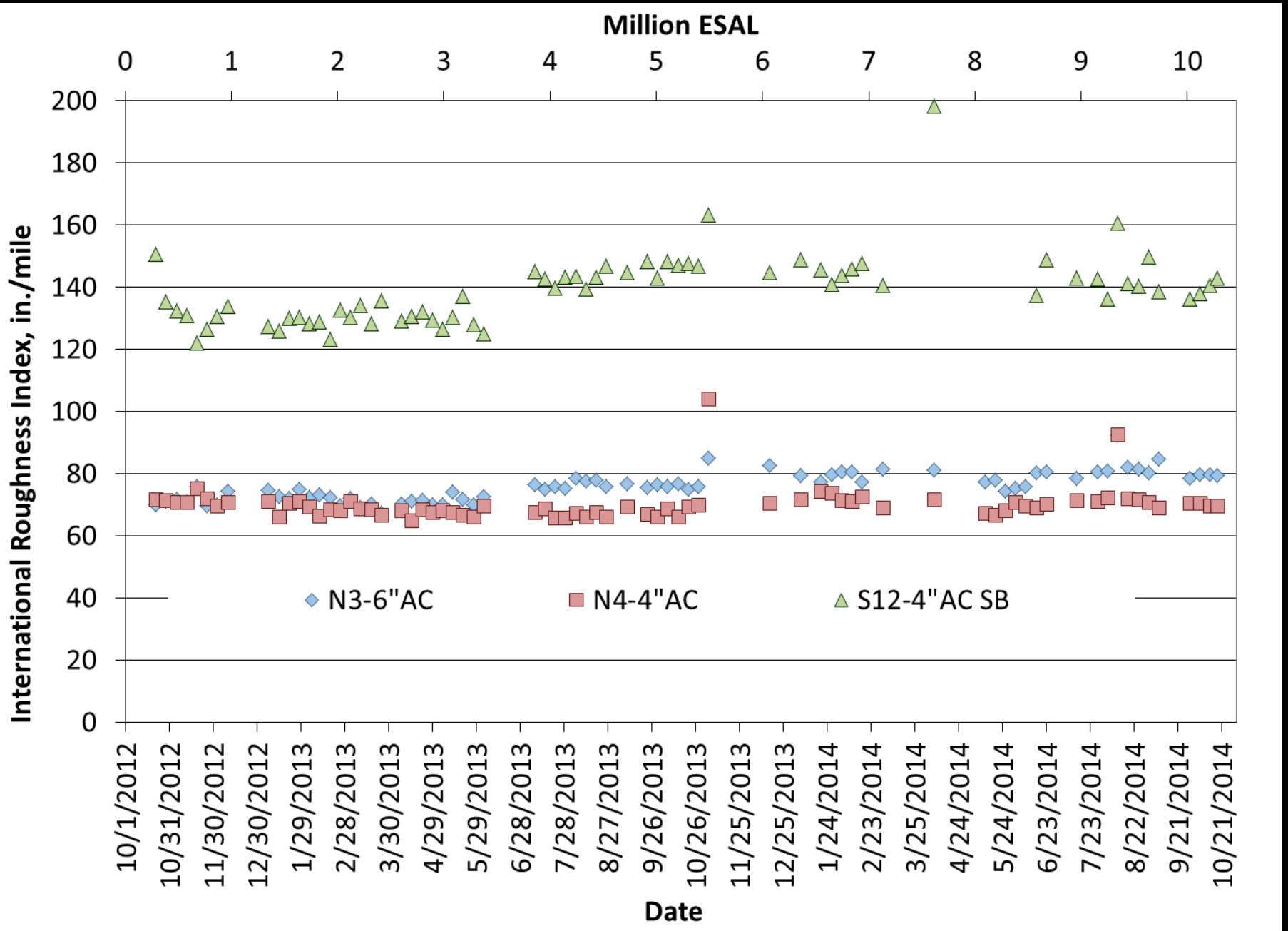


Cracking Performance

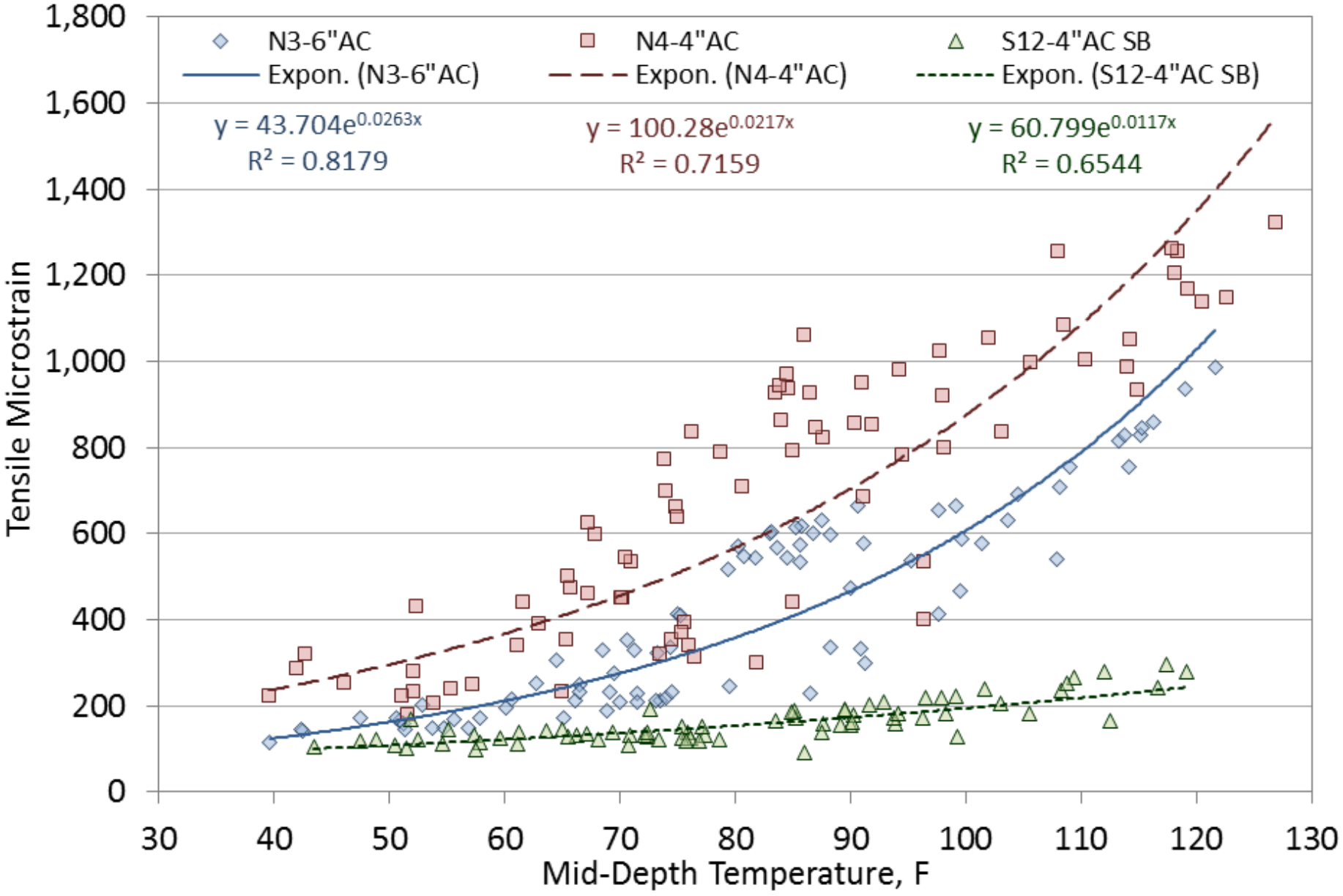
Rutting Performance



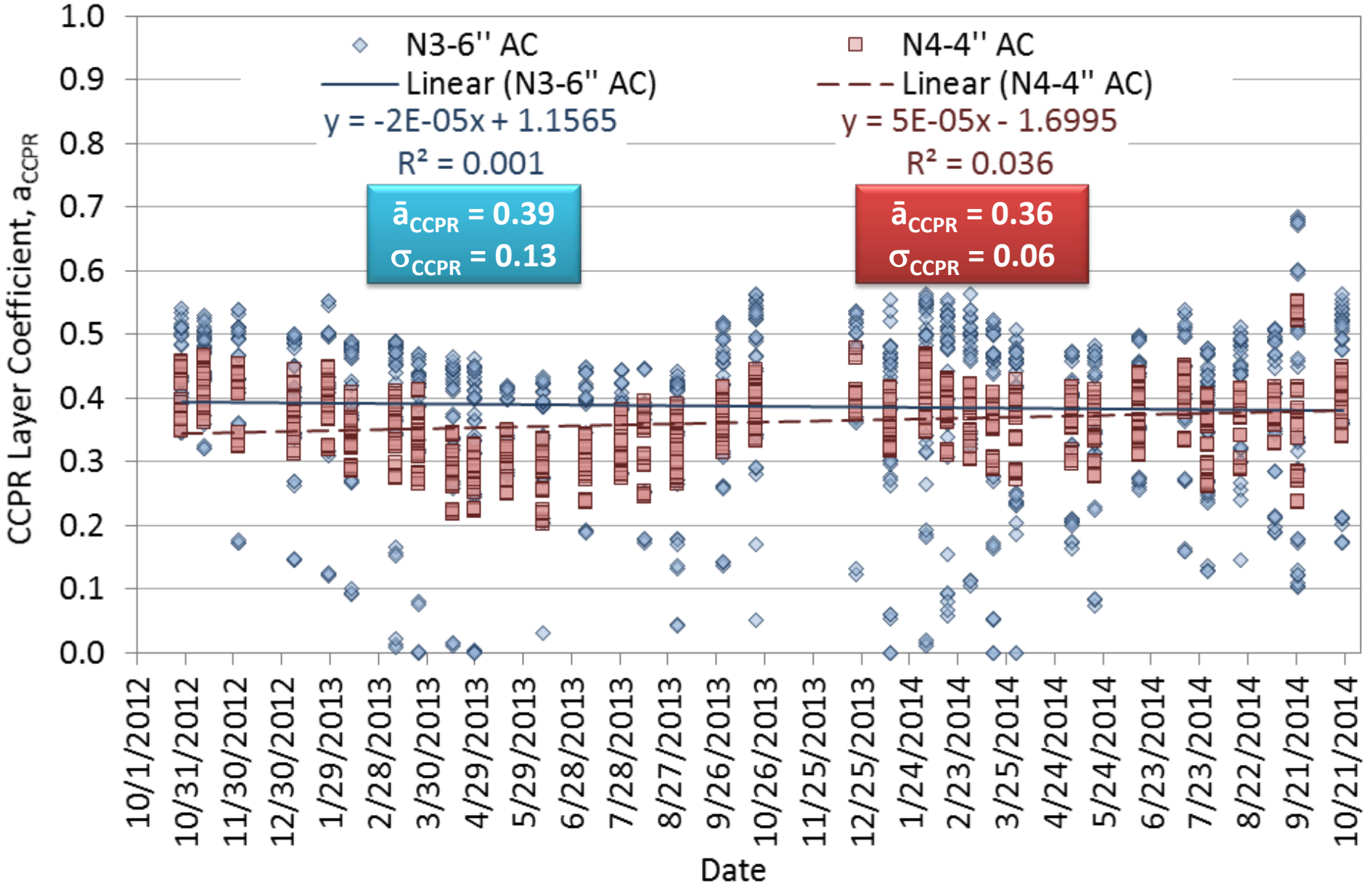
Ride Quality



Tensile Strain vs Temperature



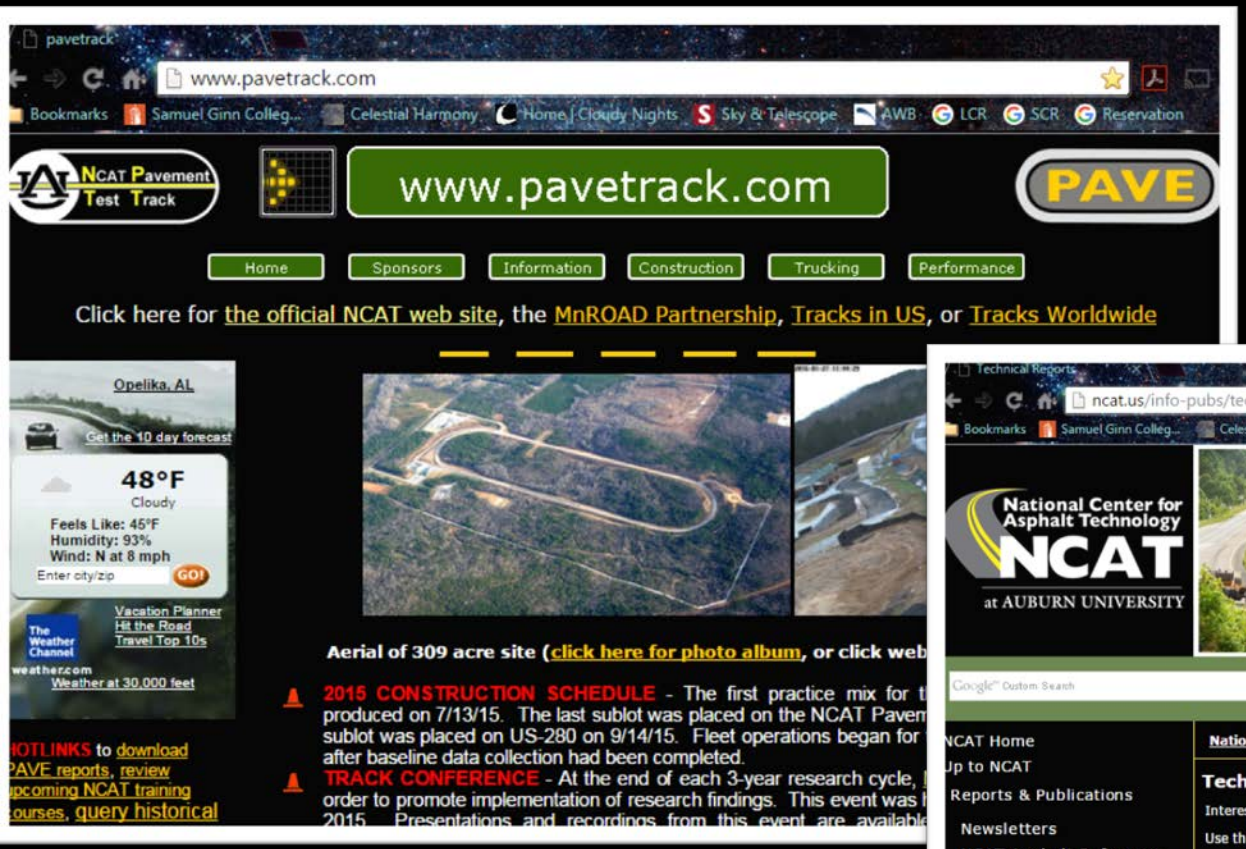
Results - a_{CCPR}

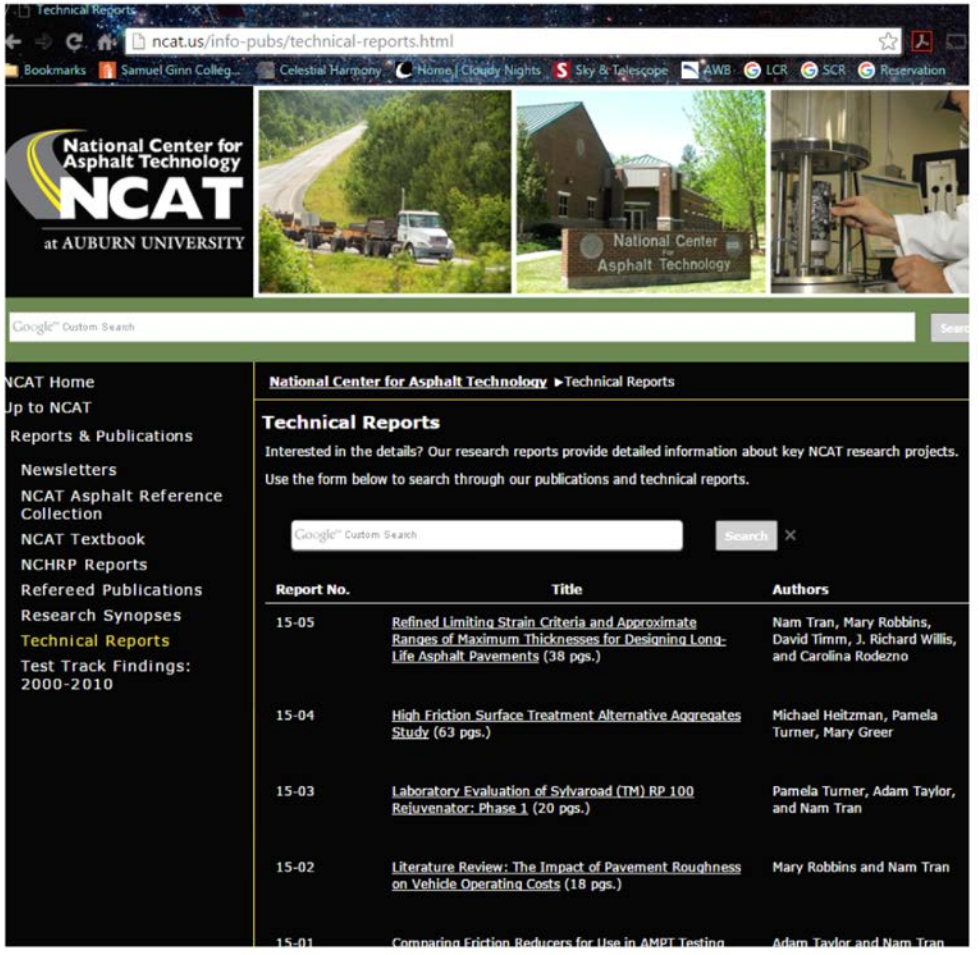


2015 Test Track – Major Research Areas

- Pavement Preservation
- Cracking Experiment
- Partnership with MnROAD

For more information on the NCAT Test Track…





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